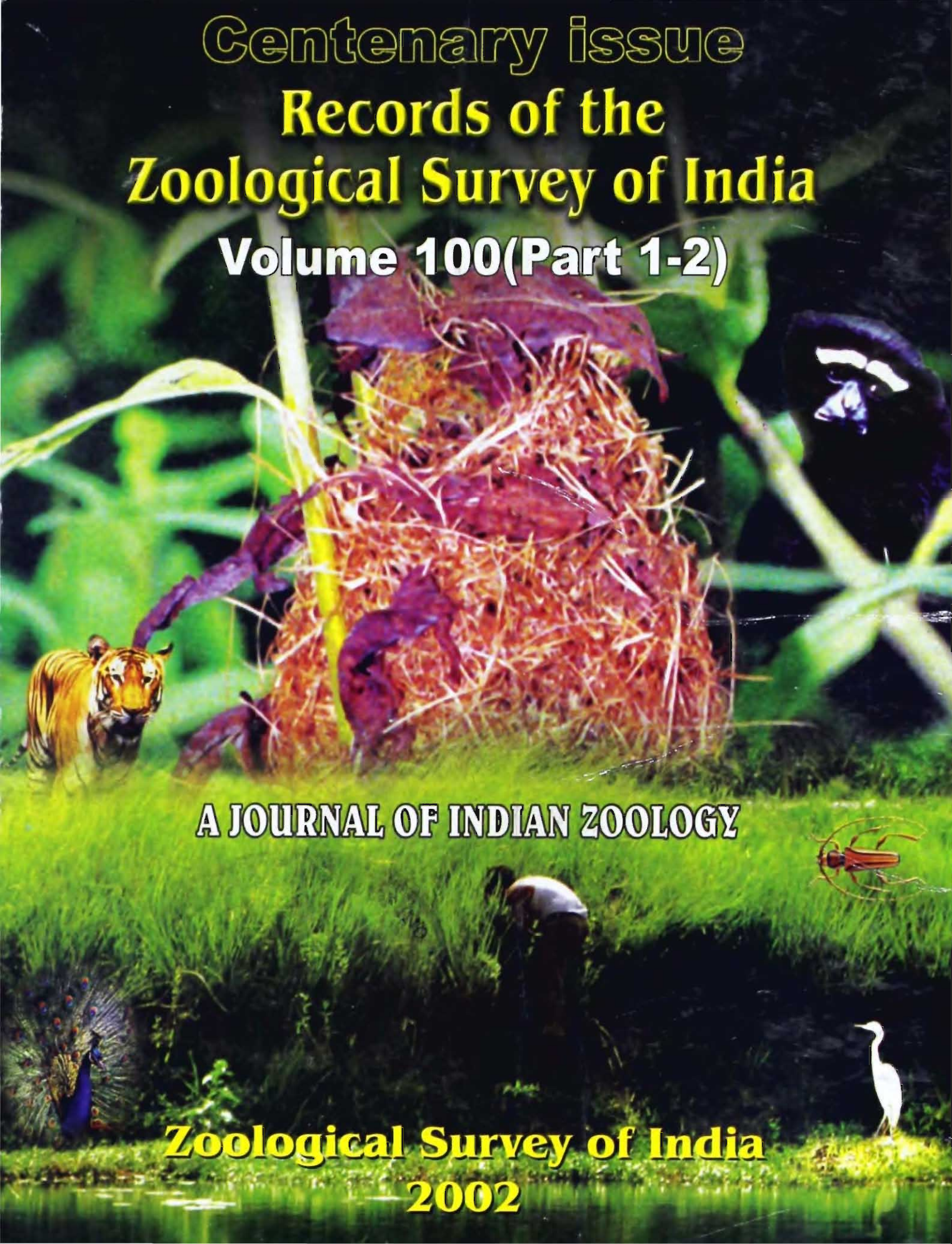


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DR. J. R. B. ALFRED

Director

Zoological Survey of India

RECORDS OF THE ZOOLOGICAL SURVEY OF INDIA

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INCIDENT OF INFANT FALLING IN HOOLOCK GIBBON

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INTRODUCTION

The Hoolock Gibbon, *Hylobates hoolock*, is the only living Ape found in India. The studies on their ecology and behaviour in the wild have been carried out by Alfred and Sati, 1985; 1990 a, b, 1991, 1994; in press; and Sati and Alfred, in press. The incident of infant falling (during locomotion) was noticed only once during the 5 years of field study by the authors. Carpenter (1940) and Chivers (1974) have also reported incidents of infant falling on few occasions in the Lar Gibbon and Siamang respectively. The incident of infant falling and the related behavioural aspects in the Hoolock Gibbon have been discussed here.

OBSERVATIONS

On 20th February 1985 while collecting data every minute on the minute on the ecology and behaviour of the Hoolock Gibbon, using focal animal sampling method (Altmann, 1974), on one of the three study groups, in West Garo Hills, Meghalaya, the incident of infant falling was recorded. Since awakening (04 30 hrs) till 09 45 hrs activities like foraging, feeding, locomotion, social behaviour, territorial call etc. observed in the group were normal as usual. All members of the group after finishing their feeding bout of about 35 minutes (on *Ficus*), jumped over to the adjacent three one after another except the infant (about one and a half years of age). As usual, the group members took a short break and gradually involved in social activities like, grooming and social play. The adult female (mother) was self grooming and though seemed as not interested in her surrounding was seen keeping a continuous watch on the infant that was left behind and once in a way made deep-throated calls directed towards the infant. At 09 50 hrs the infant climbed up to the branch from where the other members jumped over to the next tree. It sat, watched the other group members and apparently judged the distance of the over hanging branches between the two adjacent trees. The infant realized that the distance between the trees was beyond its reach and made low-pitched vocalizations (cuon – cuon...) probably conveying its inability to cross over an asking for help. Till 10 44 hrs the infant was behaving stereotypically *i.e.*, moving up and down on the tree, making a low-pitched cry, watching group members, partial feeding etc., and other behaviour of attracting attention from the group members, specially the mother.

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At 10 45 hrs, when the infant realized that no help was forth coming, it went up to the tip of the branch from where the members crossed and jumped to catch hold of the branch of the adjacent tree (where the other group members were present). Unfortunately it did not succeed. The distance between the two branches of the adjacent trees was almost 20-25 feet. The infant fell and was coming crashing to the ground, which was nearly 100-120 feet below.

As the infant was about to crash to the ground among the dense cane thickets, the mother in a flash of a second reached the place where the infant was falling and placing her right hand below the infant caught hold of the infant, and bringing it towards her ventrum, in the same momentum reached the tree from where the infant fell. The juvenile and adult male of the group jumped back to the tree. The juvenile joined the female, while the male was seen sitting separately, and keeping a continuous watch towards the other group members to possibly inform about the danger in the form of deep-throated growls.

The mother sat on the top branches of the tree and examined the body of the infant thoroughly. During this process the infant was quiet and was breast-fed by the female. The juvenile then came and consoled the infant, by grooming, playing and possibly consoling. At 10 55 hrs, about ten minutes later, the male too joined the group and consoled the infant for 2-3 minutes in the same fashion as the other members did. In fact the consolation was so human that they placed their hand over the shoulder of the infant and possibly telling the little fellow that this is part of life and that he has to learn to survive in such a jungle. Till 11 05 hrs all the group members were with the infant, but at 11 06 hrs all group members again crossed over to the adjacent trees, leaving the infant behind. When the infant found himself alone again, it started behaving stereotypically, as it did before falling. The infant once again made several attempts to cross over but did not want to take any risk. Ultimately at 11 25 hrs (18 minutes later) the watching female probably realizing that the infant was unable to jump over, she jumped back to the tree where the infant was, took the infant up her ventrum and crossed over to the next tree.

ANALYSIS AND REMARKS

In this communication an attempt has been made to analyze the co-ordination and co-operation among the group members as part of the social behaviour in gibbons. This was the first ever incidence of infant falling, observed in the hoolock gibbon during a five year study period on these animals. The co-ordination between the group members, and the manner in which the infant was rescued with in no time, was remarkable. All the group members showed their concern and consoled the infant one by one by grooming, playing etc.

As the gibbons are highly arboreal, and the young ones are also given training to adapt according to the environment and the conditions of the habitat in which they have to live supports the observations

on the Lar Gibbon and Siamang (Carpenter 1940 and Chivers 1974). In this case also the group members might have left behind the infant intentionally to encourage the infant to attempt another jump, to follow them, and to learn the process to jumping, brachiating and leaping.

Repeating the same behaviour again by the group members, seems to be a learning process for the infant. When the infant was unable to cross over the second time it was helped once again by its mother, which not only showed the motherly instinct but also the fact that the infant was still too young to understand distances and hence the concept of jumping from one tree to other.

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NOTES ON GENUS *PARADOHRNIA* SHIRAKI (INSECTA : DERMAPTERA) WITH THE DESCRIPTION OF A NEW SPECIES FROM MYANMAR

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INTRODUCTION

The genus *Paradohrnia* was erected by Shiraki (1928) for the reception of *P. ornatocapitata* from Taiwan (Kerenko). Subsequently Srivastava (1979) described two species, namely *Paradohrnia punctata* and *Paradohrnia longiforceps* from India, Arunachal Pradesh.

It can be easily separated from *Eudohrnia* Burr in having the basal antennal segment cylindrical, not carinate laterally and from *Pterygida* Verhoeff in having metallic sheen on the body and elytra strongly punctate. In general external appearance the members of the genus resemble species of *Eudohrnia*, even sharing behavioural pattern like found under foliage diurnally.

Steinmann (1989) has synonymised this genus under *Pterygida*, which is resurrected in the light of above remarks.

Following is the check-list of species included on the basis of studies conducted by the author.

Paradohrnia ornatocapitata Shiraki, 1928

Paradohrnia punctata Srivastava, 1979

(= *Pterygida harpya* Steinmann, 1989)-**secondary junior synonym**

(= *Eudohrnia subspiniformes* Kapoor & Malla, 1980) – **Syn. nov.**

Paradohrnia uniformes Brindle, 1975 – **comb. nov.**

(= *Paradohrnia longiforceps* Srivastava, 1979)

Paradohrnia mundagodae Kapoor, Bharadwaj & Banerjee, 1972 - **Comb. nov.**

In addition, a new species from Myanmar is described which is close to other known species in external appearance but differ by the shape of forceps, in males, having a lamellate serrated crest near base.

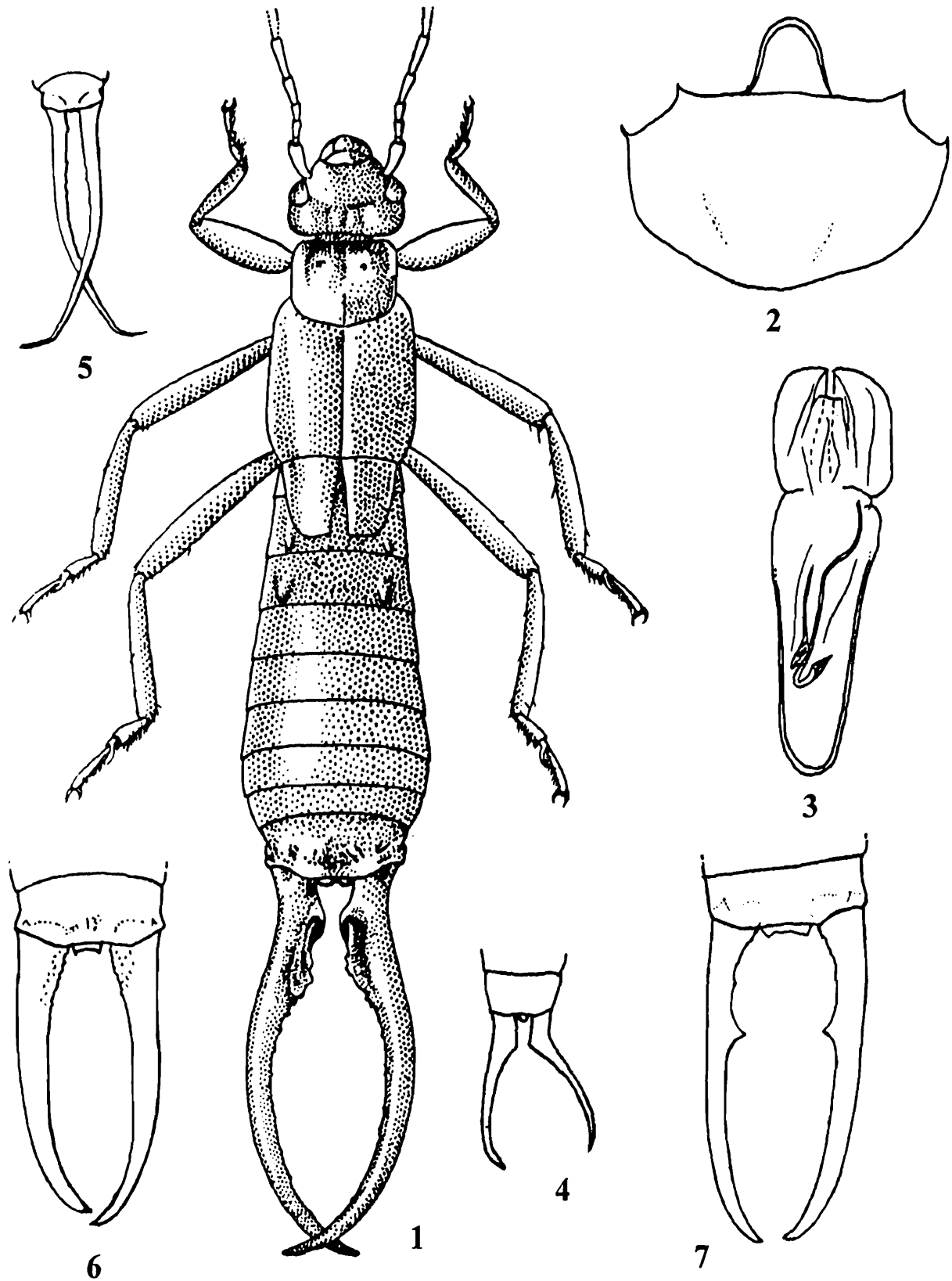
EUDOHRNIINAE***Paradohrnia* Shiraki**

Paradohrnia Shiraki, 1928, *Insecta matsum.*, **3**(1) : 21 (Type species : *Paradohrnia ornatocapitata* Shiraki, 1928); Townes, 1945, *Ann. ent. Soc. Am.*, **38** : 353; Brindle, 1969, *Entomologist's mon. Mag.*, **104** : 320; Sakai, 1973, *Dermapterorum Cat. Prael*, **7** : 98; Sakai, 1982, *Bull. Daito Bunka Univ.*, **20** : 51; Sakai, 1995, *Dermapterorum Cat.*, **27** : 6330 (as synonym of *Pterygida* Verhoeff, 1902); Srivastava, 1976, *Rec. zool. Surv. India, Occ. pap.*, **2** : 65; Srivastava, 1979, *Ceylon J. Sci. (Bio. Sci.)*, **13** (1 & 2) : 23; Steinmann, 1989, *World Catalogue of Dermaptera* : 777 – Proposed as Syn. nov. of *Pterygida* Verhoeff, 1902); Steinmann, 1993, *Das Tierreich*, **108** : 391 (treated as synonym of *Pterygida* Verhoeff, 1902).

Body generally stout; dark coloured often with a faint metallic sheen or hue; antennae with basal segment stout, cylindrical, shorter than the distance between antennal bases, 3rd and 4th subequal but latter stouter, 5th onwards gradually increasing in length; legs long, slender, apical part of tibia and whole of tarsi on underside covered with thick hairs, hind tarsi with 1st segment shorter than 3rd, 2nd enlarged; abdomen cylindrical, usually punctate above; forceps, in males, long, cylindrical, internally serrated.

Key to species (based on males only)

- 1(2). Forceps with a vertical, lamellate crest near base close to internal margin with its inner margin serrated *P. lamellata* sp.n.
- 2(1). Forceps without vertical crest near base
- 3(4). Forceps dilated internally in basal 1/3, afterwards branches cylindrical and incurved *P. ornatocapitata* Shiraki
- 4(3). Forceps not dilated at base, branches long, cylindrical
- 5(6). Pygidium short, bilobed posteriorly; forceps only slightly shorter than body, slender, tip strongly hooked, internal margin with distinct and sharp tubercles *P. uniformes* (Brindle)
- 6(5). Pygidium transverse; forceps distinctly shorter than the body, stout, tip gently hooked, internally armed
- 7(8). Pygidium with hind margin concave, postero-lateral angles with minute points; forceps long, gently incurved, internal margin in basal half faintly serrated and with several minute teeth *P. punctata* Srivastava
- 8(7). Pygidium with hind margin bisinuate, postero-lateral angles with minute point and in middle also; forceps long, gently incurved, armed with a sharp tooth in middle, otherwise unarmed *P. mundagodae* Kapoor, Bharadwaj & Banerjee



Figs.1-7. *Paradohrnia lamellata* sp.n., Holotype Male, 1. Dorsal view, 2. Penultimate sternite, 3. Genitalia; *Paradohrnia ornatocapitata* Shiraki, Male, 4. Ultimate tergite and forceps; *Paradohrnia uniformes* (Brindle), Male, 5. Ultimate tergite and forceps; *Paradohrnia punctata* Srivastava, Male Holotype, 6. Ultimate tergite and forceps; *Paradohrnia mundagoda* (Kapoor, Bhardwaj and Banerjee), Holotype Male, 7. Ultimate tergite and forceps. (Fig. 5. after Srivastava (1979) from the Holotype Male of *Paradohrnia longiforceps* Srivastava).

Paradohrnia lamellata sp.n.

Male : General colour brownish black, knee joints darker. Build stout.

Head longer than broad, smooth, frons and occiput convex, hind margin faintly emarginate in middle, sutures distinct. Antennae multi-segmented (on the right 6 basal and left only basal segment remaining), basal segment, long, cylindrical, expanded apically, shorter than the distance between antennal bases; 2nd short, about as long as broad; 3rd long, slender; 4th almost equal to preceding, but stout; 5th longer than 4th, slender, gently expanded apically; 6th slightly longer than 5th. Eyes small, about half as long as post-ocular area. Pronotum slightly longer than broad, anterior and lateral margin straight, hind margin and postero-lateral angle rounded, median suture complete and distinct, prozona convex smooth, metazona depressed, shallowly punctate. Elytra and wing well developed, punctate, punctures coalescing, on wings slightly shallower. Legs long, slender, hind tarsi with first segment compressed, almost equal to third; 2nd heart shaped, claw without an arolium, clad with golden, short hairs on underside. Abdomen long, gradually enlarging posteriorly, tergites convex, punctate, punctures slightly distantly placed, lateral folds on 3rd tergite weakly and on 4th strongly developed. Penultimate sternite transverse, obscurely punctate, hind margin rounded. Ultimate tergite transverse, narrowed posteriorly, strongly sloping backwards, hind margin trisinate, laterally oblique, above bases of forceps with tumid elevation, depressed in between, postero-lateral angles with an oblique rugose ridge, disc with stripes of shallow punctures and smooth area alternating. Pygidium short, hind margin in middle sinuate. Forceps long, cylindrical at base subcontiguous, afterward elongately incurved, apices hooked, pointed, internal margin near base with a vertical lamellate crest, afterwards margin serrated or with small pegs. Genitalia as seen in fig. 3.

Female : Unknown.

Measurements : (in mm)

	Holotype
	Male
Length of body	18.2
Length of forceps	9.5

Material examined : Myanmar : Long yang, Myitkyina, Holotype Male (genitalia mounted between two coverslips and attached to the pin of the specimen), 17.ix.1930 (*Fo Yone* coll.), ex FRI, Dehra Dun coll.; deposited in the Zoological Survey of India, Calcutta.

Remarks : This species externally resembles *Eudohrnia metallica* (Dohrn) but differs in having the basal antennal segment cylindrical (not bicarinate).

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NOTES ON GENUS *EXYPNUS* BURR (INSECTA : DERMAPTERA : CHELISOCHIDAE) WITH THE DESCRIPTION OF A NEW SPECIES FROM INDIA

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INTRODUCTION

At present only three species, viz. *E. pulchripennis* (Bormans, 1883); *E. koorgensis* (Hebard, 1923) and *E. chinensis* Steinmann, 1974 are known. A new species *E. nathani* is described from India. All the species are distributed in the Oriental Region except *E. pulchripennis*, which occurs in New Guinea also. But in the absence of a precise locality record from the area through literature, it needs verification.

This genus comes close to members of *Adiathetus* Burr, in general build and other morphological details but differs in having the hind femora grooved in apical 1/3 only.

Genus *Exypnus* Burr

Exypnus Burr, 1907. *Trans. ent. Soc. Lond.*, **1907** : 128 (Type species : *Chelisochoes pulchripennis* Bormans, 1883); Burr, 1910. *Fauna British India, Dermaptera* : 132; Burr, 1911. *Genera Insect.*, **122** : 63; Townes, 1945. *Ann. ent. Soc. Am.*, **38** : 348; Kapoor, 1967. *Agra Univ. J. Res. (Sci.)*, **16**(1) : 23; Popham and Brindle, 1968. *Entomologist*, **101** : 133; Sakai, 1971. *Dermapterorum Cat. Prael*, **6** : 31; Sakai, 1982. *Bull. Daito Bunka Univ.*, **20** : 43; Steinmann, 1975. *Acta zool. hung.*, **21** : 214; Steinmann, 1983. *Annls. hist.-nat. Mus. natn. hung.*, **75** : 141; Steinmann, 1987. *Annls. hist.-nat. Mus. natn. hung.*, **79** : 116; Steinmann, 1993. *Das Tierreich*, **108** : 63; Steinmann, 1989. *World Catalogue, Dermaptera* : 619.

Antennae 15-segments or more (generally a few apical ones broken off). Eyes shorter than the post-ocular area. Elytra and wings, both smooth, glabrous and former without any costal carina. Legs long, slender; hind femora furrowed in apical 1/3; tarsi (when viewed from above) compressed, long and slender, 1st segment 5 times longer than broad, slightly longer than 3rd segment. Pygidium in both sexes distinct.

Type species : *Chelisochoes pulchripennis* Bormans, 1883.

Distribution : Oriental Region.

- 1(2). Pronotum and elytra densely punctate; male pygidium broader than long (figs. 1-4)
 *E. chinensis* Steinmann
- 2(1). Pronotum and elytra smooth (not punctulated); pygidium short, globular or about as long as broad
- 3(6). Male forceps at base with a bifid tooth; genitalia with parameres long, narrow, in middle external margin obtusely projecting
- 4(5). Pronotum with lateral margin straight, gently widened posteriorly, hind margin briefly rounded (figs. 5-8) *E. pulchripennis* (Bormans)
- 5(4). Pronotum with lateral margin convex and hind margin well rounded (figs. 9-11)
 *E. koorgensis* Hebard
- 6(3). Male forceps at base with a serrated flang; genitalia with paramere straight, in most part parallel sided, at apex narrowed (figs. 12-16) *E. nathani* sp.n.

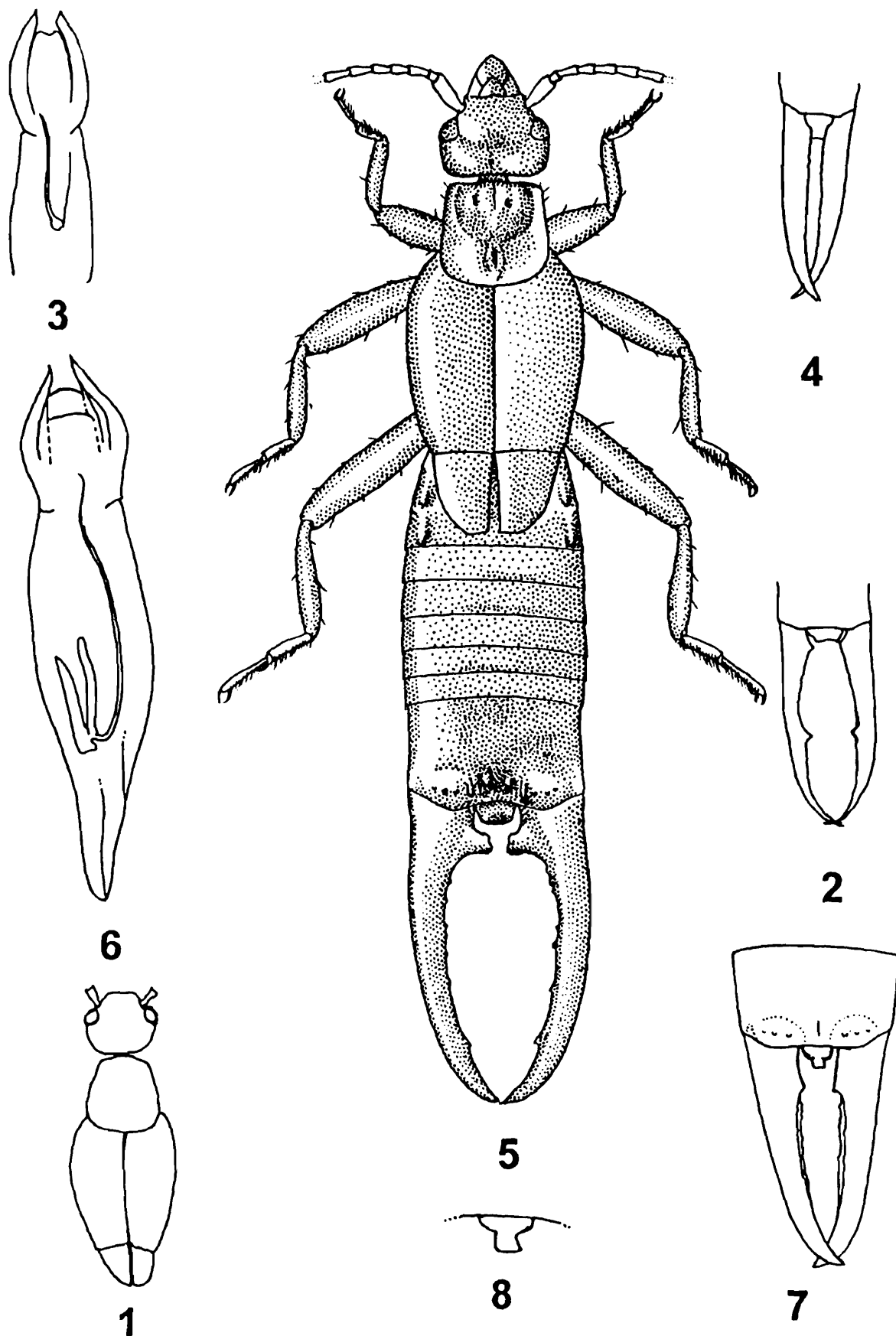
***Exypnus chinensis* Steinmann**

(Figs. 1-4)

Exypnus chinensis Steinmann, 1974. *Folia ent. hung.*, **27** : 195, fig. 21-24 (Holotype Male, Paratypes 5 Male, 7 Females; China : Fukien, Kuatun, 2300 m – Zoölogisches Forschungsinstitut und Museum, Bonn; Paratypes 3 Males & 3 Female in Hungarian Natural History Museum, Budapest); Steinmann, 1983. *Reichenbachia*, **21**(7) : 51, fig. 11; Steinmann, 1983. *Annls. hist.-nat. Mus. natn. hung.*, **75** : 141; Steinmann, 1989. *World Catalogue, Dermaptera* : 62; Steinmann, 1993. *Das Tierreich*, **108** : 64; Sakai, 1982. *Bull. Daito Bunka Univ.*, **20** : 43; Sakai, 1987. *Dermapterorum. Cat.*, **19** : 1240 (coloured photographs of Holotype Male and a female).

Male : Build stout. General colour black; pronotum lighter on sides; wings with a broad yellow stripe along the internal margin; legs blackish brown.

Head about as long as broad, frons convex, sutures distinct, hind margin faintly emarginate in middle. Eyes shorter than post-ocular area. Antennae 17-segmented; 1st segment stout, twice longer than broad, shorter than the distance between antennal bases; 2nd short; 3rd long and slender; 4th slightly shorter than preceding. Pronotum densely punctulate, about as long as broad, gently widened posteriorly, sides straight, hind margin rounded. Elytra and wings well developed former densely punctulate. Legs typical of the genus. Abdomen long, narrowed at base, tergites convex. Ultimate tergite transverse, tumid above bases of forceps. Forceps stout, remote at base, tapering apically, straight, incurved gently in apical 1/3, internal margin with a minute tooth near base, another stronger one at middle. Pygidium transverse, faintly emarginate in middle posteriorly. Genitalia with parameres narrow, tip acute.



Figs. 1-8 : *Exypnus chinensis* Steinmann, Male, 1. Anterior portion of body, 2. Ultimate tergite and forceps; 3. Genitalia; Female, 4. Ultimate tergite and forceps; *Exypnus pulchripennis* (Bormans); Male, 5. Dorsal view, 6. Genitalia; Female, 7. Ultimate tergite and forceps, 8. Pygidium, enlarged.

(Figs. 1-4 after Steinmann, 1974)

Female : Agrees with male in most characters except that ultimate tergite narrowed posteriorly; forceps simple, straight, inner margin with minute teeth and pygidium slightly longer than broad, narrowed posteriorly.

Measurements: (in mm) :

	Male	Female
Length of body	16.5-17.2	15.7-17.1
Length of forceps	6.8-7.1	5.1-5.4

Distribution : China (Fukien, Kuatun, 2300 m).

Remarks : This species can be easily separated from other species of the genus by general body colouration; densely punctate elytra and transverse pygidium.

Specimens for this species were not available for study. The above description is partly after Steinmann (1974) and based upon coloured photographs by Sakai (1987).

Exypnus pulchripennis (Bormans)

(Figs.5-8)

Chelisoches pulchripennis Borman, 1883. *Annls. Soc. ent. Belg.*, **27** : 78, fig. 15 (Male in dorsal view), 15a (Female Ultimate tergite and forceps) (2 Males, Nos. 9314, 9318 and 1 Female, No. 9313; Indes Orientalis, Coll. Brünner – in Genova Mus.); Bormans, 1894. *Annali Mus. civ. Stor. nat. Giacomo Doria*, (2) **14** : 392; Bormans & Krauss, 1900. *Das Tierreich*, **11** : 84; Burr, 1900. *Annls. Soc. ent. Belg.*, **44** : 96; Burr, 1902. *Termeszter Fuz.*, **25** : 484; Kirby, 1904, *Syn.Cat. Orth.*: 33.

Chelisochella pulchripennis; Verhoeff, *Zool. Anz.*, **25**(665) : 196.

Exypnus pulchripennis; Burr, 1907. *Trans. ent. Soc. Lond.*, **1907** : 128; Burr, 1910. *Fauna British India, Dermaptera* : 133, figs. 84, 84a (Burma); Burr, 1911. *Genera Insect*, **122** : 63, pl. 5, figs. 17, 17a-b; Burr, 1912. *Annln naturt. Hofmus Wien*, **26** : 92; Burr, 1917. *Ann. Soc. Ent. Fr.*, **86** : 59; Borelli, 1926, *Treubia*, **8** : 267; Brindle, 1966, *Ark. Zool.*, **18**(18) : 443 (Male; Sumatra); Popham & Brindle, 1968. *Entomologist*, **101** : 133; Vanschuytbroeck, 1969. *Bull. Inst. r. Sci. nat. Belg.*, **45**(41) : 22 (6 exs; Burma), Sakai, 1971, *Dermapterorum Cat. Prael.*, **6** : 36; Sakai, 1987, *Dermapterorum Cat.*, **19** : 1093 & 1146 (showing photographs, figs of Male, Female & other body parts; specimen labelled as 'Holotype Male BMNH' is not correct); Steinmann, 1974. *Folia ent hung.*, **32** : 163 (Sumatra & Burma); Steinmann, 1983. *Annls.hist.-nat. Mus. natn. hung.*, **75** : 141; Steinmann, 1989, *World Catalogue, Dermaptera* : 620; Steinmann, 1993. *Das Tierreich*, **108** : 65; Srivastava, 1976, *Rec. zool. Surv. India, Occ. pap.*, **2** : 48.

Build stout. General colour brownish black, shining, smooth. A few antennal segments in middle brownish white; hind femora light brown and tarsi light blackish brown; forceps light blackish brown.

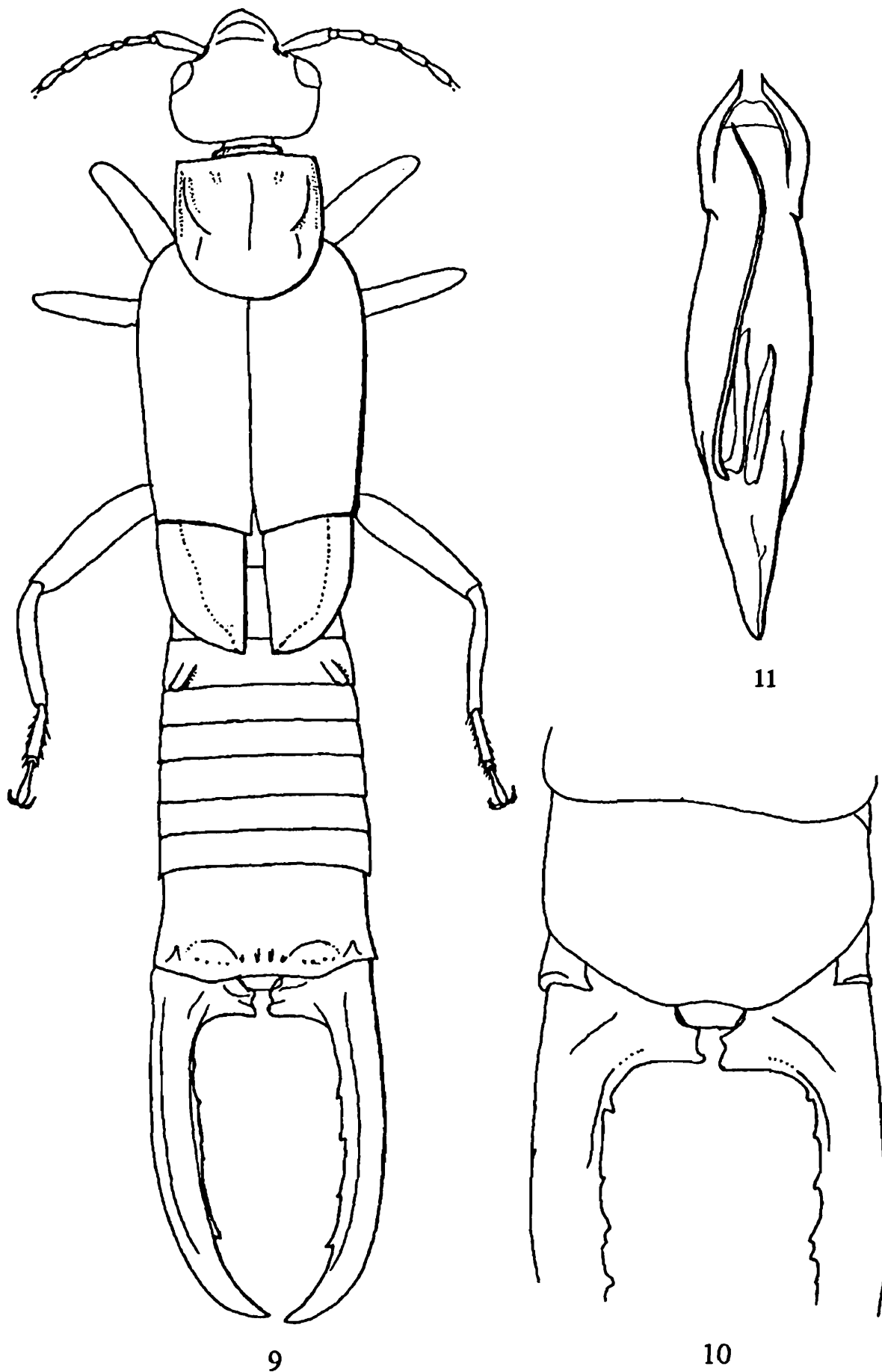
Head about as long as broad, frons and occiput raised, in place of sutures a linear depression visible, hind margin emarginate in middle. Eyes shorter than post-ocular area in length. Antennae 16-segmented; 1st stout, slightly shorter than the distance between antennal bases, narrowed at base; 2nd short, about as long as broad; 3rd long, slender, slightly longer than 4th and 5th which are stouter, gently expanded apically; remaining gradually thinning and increasing in length apically. Pronotum slightly longer than broad, smooth, gently widened posteriorly with margin rounded, prozona raised and metazona less so, median sulcus distinct in anterior half. Elytra and wings well developed, smooth, former with humeral angles prominent but without any carina, latter with inner tip yellowish. Legs long, slender, tibiae in apical third furrowed.

Prosternum with anterior margin convex and hind margin straight. Mesosternum with hind margin straight. Metasternum large, transverse, lobed between hind coxae with its hind margin emarginate. Abdomen parallel sided, weakly convex, punctate above and below, lateral tubercles on 3rd and 4th tergites distinct. Penultimate sternite narrowed posteriorly with hind margin in middle obtuse but with slight emargination in centre. Ultimate tergite transverse, gently expanded posteriorly, almost smooth (impunctate), posteriorly in middle depressed with two pairs of large compressed tubercles and several smaller ones on the low tubercles above the bases of forceps. Pygidium small, rounded, hind margin thickened and raised above. Forceps (in f. *macrolabia*), long, cylindrical attenuate, gradually curving from base to apex, inner margin near base with a depressed tooth, faintly bifid apically, afterwards provided with several small teeth ventrally of which largest one a little before apex, (in f. *cyclolabia*) branches remote at base, stout shorter, depressed, gently curved in apical third, with apices hooked; internally a little before middle armed with a sharp pointed teeth and provided with another smaller tooth dorsally, inner margin a little before apex sharp & toothed, otherwise smooth. Genitalia as seen in fig. 6.

Female : Agrees with males in most characters except that head in the specimens before me is dark brownish; ultimate tergite in middle posteriorly as well on the elevations above the roots of forceps with very small tubercles; penultimate sternite broadly rounded posteriorly. Pygidium at base broad, convex and subvertical, afterwards horizontal, narrowed with sides straight or diverging, hind margin subtruncate and forceps simple and straight, inner ventral margin sharp for a short distance from base, then provided a tooth followed by smaller ones up to a little before apex, above also margin with one or two teeth.

Measurements : (in mm) :

	Male	Female
Length of body	11.6-15.2	11.4-13.4
Length of forceps	4.2-6.5	4.4-4.8



Figs. 9-11: *Exypnus koorgensis* Hebrd, Holotype Male, 9. Dorsal view, 10. Penultimate sternite and basal portion of forceps, ventral view; 11. Genitalia.

Material examined : Birmanie, Carin Cheba, 900-1100 m, 2Males, 2Females, V.xii.88, 500-1000 m, 1Female, ...xii.87; Carin, Asciuii Cheba, 1200-1300 m, ...1 Male, 1.88, all *L. Fea* Coll.; det. by Bormans "*Chel. pulchripennis*" Borm. and by P. Vanschuytbroeck as *Exypnus pulchripennis* (Institut royal des sciences naturelles Belgique, Bruxelles).

Distribution: Myanmar, Vietnam, Sumatra and Borneo.

Record from New Guinea should be treated with reserve since no precise locality record through literature is available.

Exypnus koorgensis Hebard

(Figs. 9-11)

Exypnus koorgensis Hebard, 1923. *Mem. Dept. Agric. ent. Ser.*, **7** : 218, pl. 20, figs.14-15 (Holotype Male (macrolabic), Paratype Male (brachylabic); India : Coorg, Sidapur, 3000 ft. – deposited with Philadelphia Academy of Sciences, U.S.A.); Borelli, 1932, *Bull. Raffles Mus.*, **7** : 89 (Malaya, Parek); Sakai, 1971. *Dermapterorum Cat. Parel*, **6** : 37; Sakai, 1987. *Dermapterorum Cat.*, **19** : 1147; Srivastava, 1976, *Rec. zool. Surv. India, Occ. pap.*, **2** : 48; Steinmann, 1983. *Annl. hist.-nat. Mus. natn. hung.*, **75** : 141; Steinmann, 1987. *Annl. hist.- nat. Mus. natn. hung.*, **79** : 116; Steinmann, 1989. *World Catalogue, Dermaptera* : 620; Steinmann, 1993. *Das Tierreich*, **108** : 66.

General colour shining blackish brown, forceps somewhat reddish brown, wings yellowish brown in internal half only.

Head about as long as broad, frons weakly convex and occiput decidedly raised or tumid, sutures distinct, hind margin faintly emarginate in middle. Eyes much shorter than post-ocular area. Antennae 18-segmented, 1st equal to 2nd, 3rd and 4th together; 2nd short; 3rd long and slender; 4th slightly shorter than preceding and sub-clavate, only slightly longer than 2nd; remaining gradually increasing in length distally. Pronotum slightly longer than broad, anterior margin convex, laterally straight and depressed, hind angles and margin well rounded, prozona raised and metazona depressed, median sulcus well marked in anterior half only with a faint depression present on either side of it, close to anterior margin. Elytra glabrous, smooth, humeral angle weak, meeting along the median axis, hind margin obliquely concave. Wings well developed. Legs typical of the genus; hind tarsi with 1st segment slightly longer than third; 2nd segment produced below the third but in less than half of its length; tarsi flattened (grooved) above in apical one third only, undersurface strongly pubescent and with thick setae; claw without an arolium. Abdomen moderately convex, parallel sided, punctate, lateral fold on 3rd weakly and on 4th strongly developed. Penultimate sternite with hind margin narrowly rounded with slight emargination in middle. Ultimate tergite transverse, sides straight but postero-lateral angles slightly projecting, weakly tumid above the roots of forceps and depressed in middle with pair of compressed tubercles and several tubercles above tumid elevations

as well, hind margin feebly trisinate, laterally oblique. Forceps (in forma macrolabia) at base internally with a bifid, depressed tooth, afterwards branches slender, somewhat depressed, tapering apically and regularly curved, apices pointed and gently hooked, internal margin below with a few sharp, posteriorly directed teeth; (in f. cyclolabia) forceps a little shorter in length, internally armed with a sharp posteriorly directed triangular tooth followed by another smaller one. Pygidium small, vertical, convex above. Genitalia as seen in fig. 11.

Material examined : India, Coorg, Sidapaur, 3000 ft, 19.vi.1917 (T.R.N. coll.), Holotype Male, (H. 773) Philadelphia Academy of Sciences.

Measurements: (In mm) :

	Holotype Male (macrolabic)	Paratype Male (cyclolabic)
Length of body	13.5	12.0
Length forceps	4.5	2.9

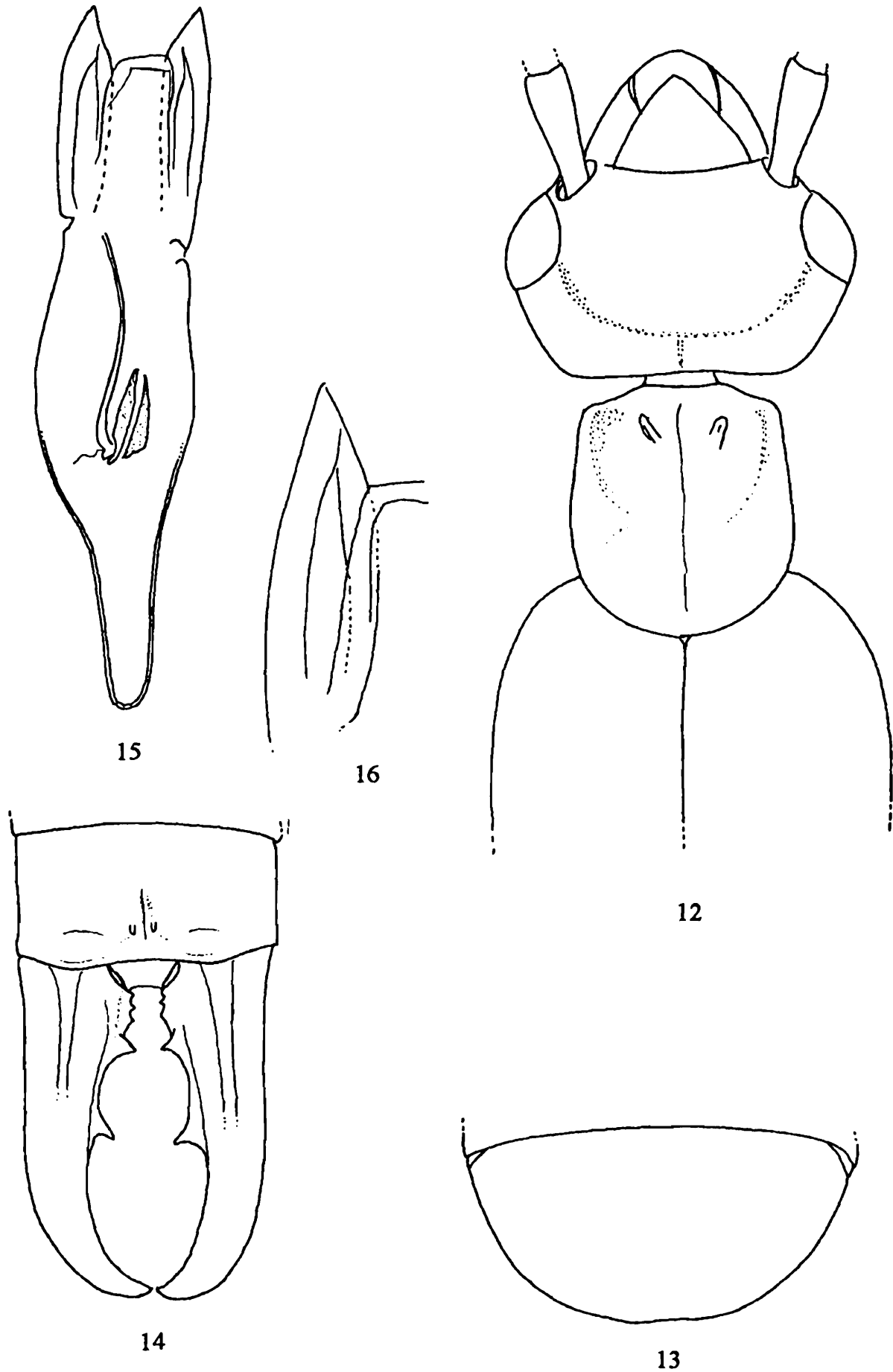
Distribution : India and Sumatra.

Exypnus nathani sp.n.

(Figs. 12-16)

Holotype : Male : Build stout, glabrous. General colour brownish black; pronotum in middle yellowish brown, blackish laterally; elytra and wings yellowish brown laterally darker; abdominal tergites up to 5th black on sides.

Head about as long as broad, smooth, frons and occiput raised, sutures marked by a distinct depression, hind margin faintly emarginate in middle. Antennae with basal segments of the right side present, stout, narrowed basally, shorter than the distance between antennal bases. Eyes prominent about as long as the post-ocular area. Pronotum slightly longer than broad, impunctate, gently widened posteriorly, hind angles and margin broadly rounded, median sulcus distinct, prozona weakly raised and differentiated from weakly depressed metazona. Elytra and wings well developed, smooth, former with humeral angles distinct, hind margin concave. Legs typical of the genus, hind femora with a faint groove in a little less than apical half, hind tarsi with 1st segment equal to 3rd, clad on underside with thick pubescence. Abdomen elongated, enlarged in middle, tergites weakly depressed, micro-reticulated, lateral folds on 3rd faintly and on 4th strongly marked. Penultimate sternite transverse, punctate, hind margin broadly rounded. Ultimate tergite transverse, weakly depressed, impunctate in middle, laterally with broad stripe of obscure punctation, gently sloping backwards, depressed in middle posteriorly with a pair of small compressed tubercles in middle, above the bases of forceps with weak elevations, hind margin faintly tri-sinuate, laterally oblique.



Figs. 12-16 : *Exypnus nathani* sp.n., Holotype Male, 12. Anterior portion of body, 13. Penultimate sternite, 14. Ultimate tergite and forceps, 15. Genitalia, 16. Left paramere – enlarged.

Pygidium vertical, trapezoidal, narrowed posteriorly with hind margin faintly concave, postero-lateral angles with a minute point. Forceps stout, depressed, almost straight, gently arcuate in a little less than apical half, at base separated by the pygidium, with a serrated area terminating in to a large tooth, followed by another slightly larger, triangular tooth at a little beyond middle. Genitalia with parameres lanceolate, parallel sided in most part, gradually narrowing from apical $\frac{1}{4}$ to pointed tip; virga fine, tubular.

Female : Unknown.

Measurements : (in mm) :

	Holotype
	Male
Length of body	8.8
Length of forceps	2.35

Material examined : India : Karnataka, Coimbatore, 1400 ft., Holotype Male (genitalia mounted between two coverslips; and attached to the pin of the specimen), 9.xi.1961 (*P. S. Nathan* coll.); deposited in the Zoological Survey of India, Calcutta.

Remarks : This species comes close to *E. koorgensis* Hebard, but differs by the internal armature of Male forceps and parameres is being almost straight, narrowed at apex.

ACKNOWLEDGEMENTS

I am thankful to Dr. J.R.B. Alfred, Director, Zoological Survey of India, Calcutta, for necessary facilities and to Dr. G. Demoulin, Institut royal des Sciences naturelle de Belgique, Bruxelles for placing at my disposal specimens listed under *Exypnus pulchripennis* (Bormans).

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TAXONOMIC STUDIES ON *CALLITULA* SPINOLA WITH THE DESCRIPTION OF FOUR NEW SPECIES FROM INDIAN SUBCONTINENT (HYMENOPTERA : CHALCIDOIDEA : PTEROMALIDAE)

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INTRODUCTION

Callitula Spinola belonging to the subfamily Pteromalinae of Pteromalidae is distributed in all parts of the world. According to Boucek (1988) the members of the genus are parasites of small Diptera especially Agromyzidae and they prefer the host's larvae that burrow in grass stems or other plant parts. Though widely distributed, the genus is little known from the tropics (about 5 species described). From the Indian subcontinent the genus is so far represented by one species viz. *C. rugosa* (Waterston) from India and Sri Lanka. Four new species of *Callitula* are described in this paper based upon the collections from Kerala, India. A key to separate the species of *Callitula* from the Indian subcontinent is also provided.

Type specimens of the species are deposited in Zoological Survey of India, Western Ghats Field Research Station, Calicut, India.

The morphological terminology used in this paper generally follows that of Boucek (1988). The following abbreviations are used in the text : Fl-F5–funicular segments 1 to 5; MV–marginal vein; OOL–ocellocular distance; PMV–postmarginal vein; POL–postocellar distance; SMV–submarginal vein; STV–stigmatal vein; T1–T3–gastral tergites 1 to 3; BMNH–British Museum (Natural History), London, U. K.

Genus *Callitula* Spinola

1811. 151. *Callitula* Spinola. Type species *Callitula bicolor* Spinola by monotypy.

1833. 371, 464. *Micromelus* Walker. Type species *Micromelus rufomaculatus* Walker by designation of Westwood, 1840.

1856. 145. *Baeotomus* Forster. Unnecessary replacement name for *Micromelus*, supposedly preoccupied.

The other synonyms are *Pterosemoidea* Girault, 1913, *Apteroosemoidea* Girault 1913, *Eurydinotella* Girault, 1913, *Pseudosphegigasterus* Girault, 1913, *Eurydinotelleus* Girault, 1913 and *Polycystomyia* Dodd in Girault, 1915 (syn. by Boucek, 1988; 439).

Key to the species of Callitula from the Indian subcontinent

1. Anterior margin of clypeus roundly produced (Figs. 7, 10) 2
Anterior margin of clypeus slightly or moderately emarginate 3
2. Gaster (Fig. 5) distinctly longer than mesosoma, not collapsing, in dorsal view length 2.7x width; forewing (Fig. 8) with basal cell open below, speculum broad; antenna (Fig. 6) with pedicel shorter than F1; pronotal collar not margined anteriorly, only little raised in the middle; POL sub equal to OOL; gaster with metallic blue reflection on T1 dorsally. *C. keralensis* sp. nov.
Gaster (Fig. 13) as long as mesosoma, sunken dorsally, in dorsal view length 1.8x width; forewing (Fig. 12) with basal cell closed below, speculum narrow; pedicel (Fig. 11) little longer than F1; pronotal collar distinctly margined at least medially; POL 1.6x OOL; gaster without metallic blue reflection dorsally on T1. *C. anguloclypea* sp. nov.
3. Body (Fig. 1) robust, length 3.7 mm; gaster (Fig. 4) 1.1x as long as head plus mesosoma and length 3.1x width in dorsal view; antenna (Fig. 2) with scape not exceeding level of vertex *C. robusta* sp. nov.
Body not robust, smaller species; gaster shorter than head plus mesosoma combined; scape exceeding level of vertex 4
4. Gaster with T2 large (Fig. 16) occupying 0.2x total length; head and mesosoma dark metallic blue; legs with coxae brown *C. rugosa* (Waterston)
Gaster with T2 not as above (Fig. 18); head and mesosoma black; legs including coxae testaceous *C. travancorensis* sp. nov.

1. *Callitula robusta* sp. nov.

(Figs. 1–4)

Female : Length 3.7 mm. Head and mesosoma bright metallic bluish green with golden reflection; gaster metallic blue, almost black dorsally; antennae with scape and pedicel testaceous, remainder dark brown; coxae concolrous with mesosoma, remainder of legs testaceous with tips of tarsi brown; tegulae testaceous; wings hyaline; veins pale brown.

Head : (Fig. 1) raised reticulate, finely reticulate on genae. In dorsal view head 1.4x as wide as mesosoma and width 2.2x length; POL : OOL = 8 : 9; temple length half of eye length; anterior margin of clypeus weakly emarginate; malar space length half of eye height. Antennae (Fig. 2) inserted above middle of face; scape length 0.8x eye height, reaching just level of vertex, pedicel plus flagellum little shorter than head width; pedicel shorter than F1; funicular segments slightly widening towards tip; clava as long as two preceeding segments combined.

Mesosoma : (Fig. 1) length 1.6x width; pronotal collar anteriorly ridged in the middle, moderately reticulate with smooth strip posteriorly. Mesoscutum width 2x length, reticulate punctate. Scutellum as long as wide, similarly sculptured as on mesoscutum. Propodeum (Fig. 4) width 2x median length, median area moderately reticulate, raised in the median line; posterior margin of nucha deeply emarginate; spiracles elongate ovate, close to metanotum. Forewing (Fig. 3) length 2.5 width; marginal fringe small; pubescence less dense, basal vein setate; speculum open below. Relative lengths; SMV 39, MV 22.5, PMV 15, STV 9.

Gaster : (Fig. 1, 4) elongate, lanceolate, length 1.1x head plus mesosoma combined; in dorsal view length 3.1x width.

Holotype : Female : INDIA : Kerala, Parambikulam wild life sanctuary, Anappady, 6.v.1989, Coll. P. M. Sureshan.

Remarks : In having an elongate gaster and larger body size this species resembles *C. elongata* (Thomson) but differs from it in having antennal scape shorter than eye, not reaching well above level of vertex, F1 distinctly longer than pedicel; anterior margin of clypeus weakly emarginate and gaster 3.1x as long as wide (in *elongata* scape longer than eye, reaching well above level of vertex; F1 shorter than pedicel; anterior margin of clypeus deeply emarginate, appearing bidentate and gaster only 2.3–2.4x as long as wide).

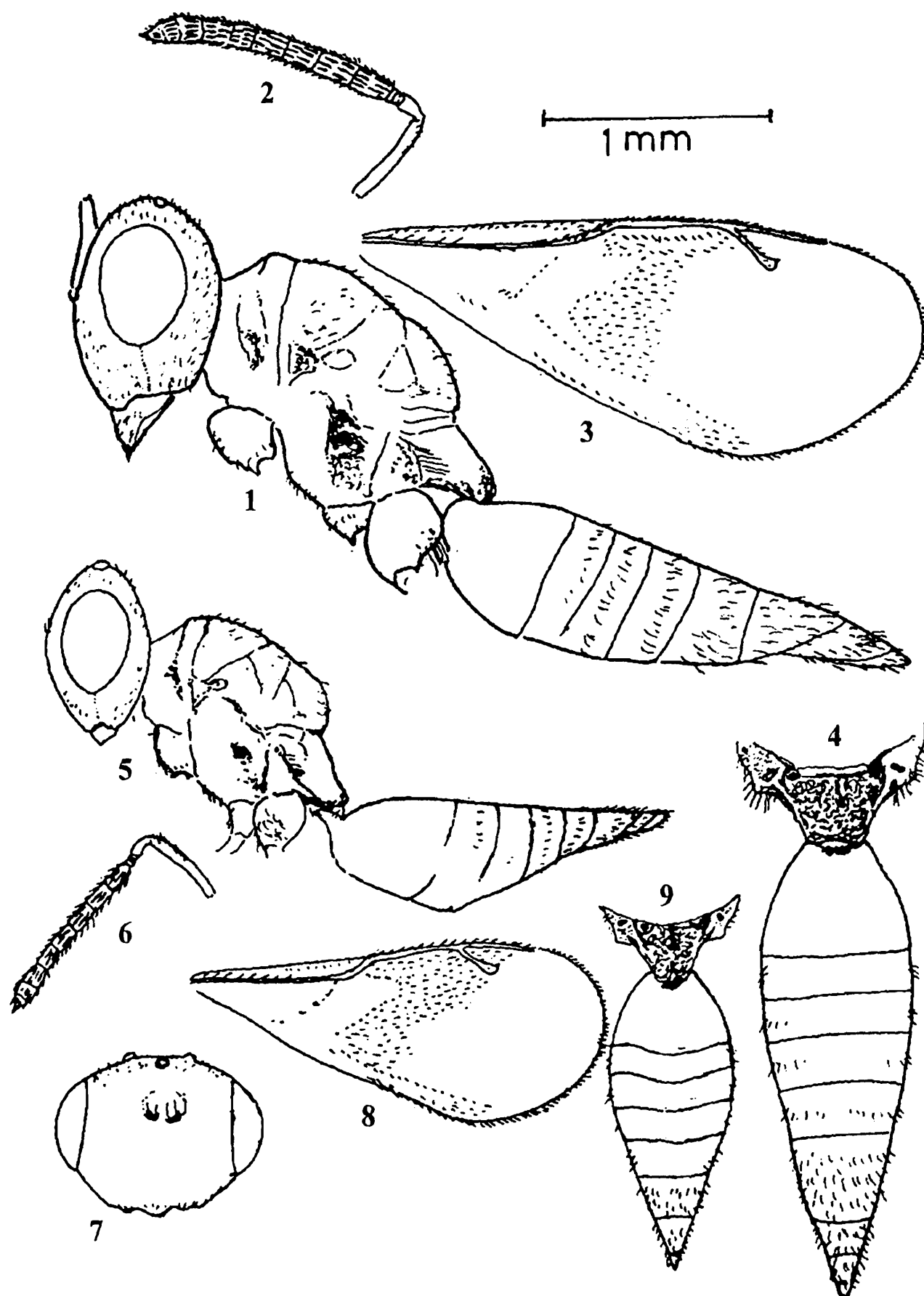
2. *Callitula keralensis* sp. nov.

(Figs. 5–9)

Female : Length 1.7–2.7 mm. (Holotype 2.7 mm). Head and mesosoma dark metallic blue; gaster almost black with metallic blue reflection on T1 dorsally and on other tergites dorso-laterally; antennae brown except scape and pedicel testaceous; fore and hind coxae concolorous with mesosoma; mid coxae and remainder of legs testaceous; tegulae testaceous; wings hyaline; veins brown.

Head : (Figs. 5, 7) 1.14x as wide as mesosoma, moderately reticulate. In dorsal view head width 2x length and in front view width 1.3x height; POL : OOL = 6.5 : 6; temple length 0.34x eye length; malar space length half of eye height; eyes separated by 1.4x their height; lower margin of clypeus slightly convex and roundly produced. Antennae (Fig. 6) inserted slightly above middle of face; scape length 0.9x eye height, exceeding level of vertex; pedicel plus flagellum length 1.12x head width; pedicel shorter than F1 (3.5 : 4.5); clava little longer than two preceeding segments combined, terminal stylus sharp.

Mesosoma : (Fig. 5) length 1.7x width; pronotal collar not margined but little raised in the middle. Mesoscutum width 2x length, coarsely reticulate. Scutellum almost as wide as long, little longer than mesoscutum, sculptured as on middle lobe of mesoscutum. Propodeum (Fig. 9) shorter than scutellum, width 2.3x median length, median area moderately reticulate; plicae reaching up to middle; spiracles



Figs. 1-9. : 1-4. *Callitula robusta* sp. nov. Female : 1, body in profile; 2, antenna; 3, forewing; 4, propodeum and gaster in dorsal view. 5-9. *Callitula keralensis* sp. nov. Female : 5, body in profile; 6, antenna; 7, head in front view; 8, forewing; 9, propodeum and gaster in dorsal view.

long, oval. Forewing (Fig. 8) length 2.3x width; basal part bare; basal hairline indicated, costal cell with an incomplete row of hairs; stigma slightly capitate. Relative lengths : SMV 31, MV 16, PMV 11.5, STV 6.5.

Gaster : (Figs. 5, 9) distinctly longer than mesosoma, not collapsing; petiole finely reticulate; gaster length 2.7x width in dorsal view and 2.5x hind tibia; hind margin of T1–T3 slightly produced.

Holotype : Female : INDIA : Kerala, Malappuram district, Vaniyampuzha, 30.iv.1993, Coll. P. M. Sureshan.

Paratypes : 1 Female, Kerala, Kannur district, Tellicherry, 4.xi.1995; 1 Female, Palghat district, Silent valley, 10.xii.1987; 1 Female, Kasaragod district, Manjeswaram, 27.ii.1988; 1 Female, wayanad district, Vattappoyil, 2.iii.1994; 1 Female, Ernakulam, 9.ii.1989; 1 Female, Trichur district, Pecchi, 6.ii.1989; 2 Female, Malappuram district, Calicut University campus, 20.iv.1988, 7.ix.1988, Coll. P. M. Sureshan.

Remarks : This species resembles *C. nigricoxa* Kamijo in the nature of clypeus, antennae and forewing venation but differs in having a long gaster (length 2.7x width) distinctly longer than mesosoma, forewing with basal cell bare, pronotal collar not margined anteriorly and POL only very little longer than OOL (in *nigricoxa* gaster short, length 1.63x width, slightly shorter than mesosoma, basal cell of forewing closed below, pronotal collar distinctly margined and POL 1.5x OOL).

3. *Callitula anguloclypea* sp. nov.

(Figs. 10–13)

Female : Length 1.2–1.7 mm. (Holotype 1.6mm). Head and mesosoma black; gaster brown with an yellowish spot at base dorsally; scape, pedicel and anelli testaceous, remainder of antenna brown; legs including coxae testaceous except fore coxae basally and tips of tarsi brown; tegulae pale brown; wings hyaline; veins pale brown.

Head : (Fig. 10) 1.3x as wide as mesosoma, uniformly engraved reticulate, finely on lower face and vertex; vertex curving over strongly to occiput. In dorsal view head width 2x length and in front view width 1.3x height; POL 1.6x OOL; temple almost half of eye length; clypeus finely radiately striated, smooth in the centre; anterior margin roundly produced; eyes separated by 1.4x their height; malar space length about half of eye height. Antennae (Fig. 11) inserted almost in the middle of face, scape as long as eye, reaching very little above level of vertex; pedicel plus flagellum length almost equal to head width; pedicel twice as long as wide, third anellus slightly wider; F1 little shorter than pedicel; F2 little longer than F1; clava as long as two preceeding segments combined; terminal stylus distinct, sensillae in one row on each segment.

Mesosoma : Length 1.6x width with scattered long white hairs; pronotal collar distinctly margined at least medially with a broad smooth strip in posterior half. Mesoscutum width 2.3x length, coarsely

reticulate. Scutellum as long as mesoscutum, little wider than long. Propodeum (Fig. 13) width 1.8x median length, strongly produced posteriorly, median area coarsely reticulate; plicae weakly indicated up to middle; nucha occupying one third length of propodeum; spiracles close to hind margin of metanotum, separated by less than their diameter. Forewing (Fig. 12) length 2.4x width, marginal fringe long; basal vein setate; basal cell closed below; costal cell with a single incomplete row of hairs. Relative lengths : SMV 19, MV 12, PMV 9.5, STV 4.5.

Gaster : (Fig. 13) as long as mesosoma, acuminate, sunken dorsally; petiole finely reticulate; T1 occupying one third length of gaster, hind margin curved medially.

Male : Length 1.3mm. Resembles female but differs in having antennae with third anellus elongate, equal to first and second combined, flagellum with long hairs and gaster shorter than mesosoma, compressed and broadly ovate towards the tip.

Holotype : Female : INDIA : Kerala, Parambikulam wild life sanctuary, Orukomban, 3.xi.1995, Coll. P. M. Sureshan.

Paratypes : 1 Female, 1 Male, Kerala, Trichur district, Vazhani, 7.iii.1988; 1 Female, Kerala, Kannur district, Aralam farm, 25.ii.1988; 3 Female, Kerala, Peechi, 5.ii.1989; 2 Female, Kerala, Malampuzha, 16.i.1986; 2 Female, Kerala, Malappuram district, Chungathara, 24.iv.1989; 1 Female, Kerala, Kovalam, 24.ii.1989. Coll. P. M. Sureshan.

Remarks : *C. anguloclypea* closely resembles *C. nigricoxa* Kamijo in general morphology, but differs in having antenna with F1 little shorter than pedicel, clava as long as two preceeding segments combined, forewing with PMV not much shorter than MV; gaster as long as mesosoma and all coxae testaceous (in *nigricoxa* F1 as long as or slightly longer than pedicel, clava little longer than two preceeding segments combined; PMV much shorter than MV; gaster slightly shorter than mesosoma and all coxae blackish).

4. *Callitula travancorensis* sp. nov.

(Figs. 18–20)

Female : Length 1.1–1.4mm. (Holotype 1.4mm). Head and mesosoma black; gaster mostly yellowish brown, dark brown towards the tip dorsally and dorsolaterally; antennae dark brown except scape and pedicel testaceous. Legs reddish brown except tips of tarsi darker; tegulae pale brown; wings hyaline; veins pale brown.

Head : (Fig. 20) 1.3x as broad as mesosoma, engraved reticulate with broad meshes on upper face and vertex. In dorsal view head width 1.9x length and in front view width 1.3x height; POL 1.7x OOL; temple length 0.4x eye length; anterior margin of clypeus weakly emarginate; malar space length 0.8x eye height; eyes separated by 1.8x their height. Antennae (Fig. 20) inserted a little above middle of face; scape length 1.2x eye height, reaching above level of vertex; pedicel plus flagellum little longer

than head width (22.5 : 21); pedicel slightly longer than F1; clava as long as two preceeding segments combined; terminal stylus short.

Mesosoma : (Fig. 20) length 1.5x width. Pronotum finely reticulate, anterior margin of collar finely but sharply carinate. Mesoscutum width 2.2x length. Scutellum little wider than long, coarsely reticulate. Propodeum (Fig. 18) with median area coarsely reticulate; plicae less sharp, reaching upto base of nucha; spiracles round, separated by more than their diameter from metanotum. Forewing (Fig. 19) length 2.5x width; basal cell closed below, more hairy towards the distal end; speculum very narrow, almost closed below; costal cell with a single row of hairs. Relative lengths : SMV 18, MV 12, PMV 8, STV 5.

Gaster : (Figs. 18, 20) short, ovate, non collapsing, length 0.72x head plus mesosoma combined and 1.5x width in dorsal view; petiole wider than long, shiny, T1 reaching more than one third length (10.5 : 24).

Holotype : Female : INDIA : Kerala, Ernakulam, 9.ii.1989, Coll. P. M. Sureshan.

Paratypes : 5 Female, Kerala, Palghat district, Agali, 12.xii.1987; 1 Female, Trichur district, Peechi, 5.ii.1989; 2 Female, Shertallai, 14.iv.1988, 27.ii.1989; 1 Female, Quilon district, Chavara, 22.ii.1989; 1 Female, Trivandrum district, Kattakada, 24.ii.1989, Coll. P. M. Sureshan.

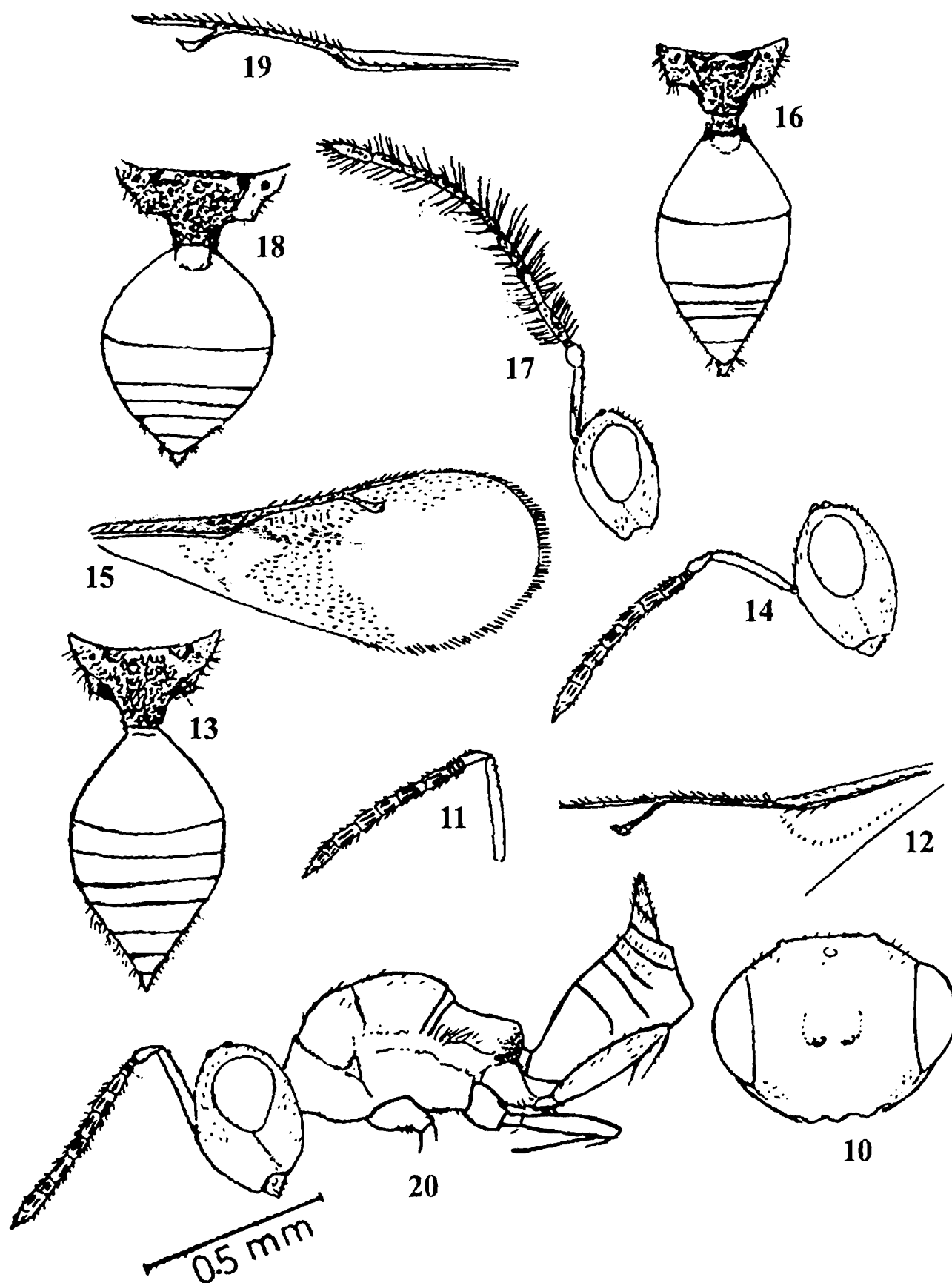
Remarks : This species can be distinguished from other species in having antenna with terminal stylus less distinct; forewing with basal cell hairy towards the distal end, speculum very narrow, almost closed below, smaller body size and colour black. In the nature of forewing venation, narrow basal cell and general morphology it resembles *C. nigricoxa* Kamijo but differs in the nature of clypeus, antenna, gaster and colour of coxae.

5. *Callitula rugosa* (Waterston)

(Figs. 14–17)

Trigonogastra rugosa Waterston, 1915. *Bull. ent. Res.* V. 326–328. M, F. Sri Lanka (BMNH) (examined).

Waterston (1915) described the species based on male holotype and also provided description of female. I have examined the male holotype in BMNH (Type No. BM 5–867) in a very poor condition with only one antenna, gaster, part of one wing and parts of legs. The description of male holotype by Waterston tallies with the type material, but in the description and figures of female the antennal formula is shown as 11263 which is quite unusual for the females of *Callitula* genus which has 11353 in all other known species. It is possible that Waterston (1915) might have misidentified the female. I got males and females of *C. rugosa* in my collection and a redescription of the species is provided here based on my collection.



Figs. 10–20. : 10–13. *Callitula anguloclypea* sp. nov. Female : 10, head in front view; 11, antenna; 12, forewing venation; 13, propodeum and gaster in dorsal view. 14–17. *Callitula rugosa* (Waterston) Female : 14, head and antenna in profile; 15, forewing; 16, propodeum and gaster in dorsal view; 17, male head and antenna in profile. 18–20. *Callitula travancorensis* sp. nov. Female : 18, propodeum and gaster in dorsal view; 19, forewing venation; 20, body in profile.

Female : Length 1.5–1.8mm. Head and mesosoma dark metallic blue, almost black; gaster brownish black; scape yellowish brown, remainder of antenna brown; coxae brown; hind coxae darker, remainder of legs testaceous; tegulae pale yellow; wings hyaline, veins pale yellow.

Head : (Fig. 14) 1.3x as broad as mesosoma, moderately reticulate. In dorsal view head width 1.8x length and in front view width 1.3x height; temple length 0.53x eye length; POL 1.5x OOL; anterior margin of clypeus slightly emarginate. Antennae with scape reaching above level of vertex, length 1.2x eye height; pedicel plus flagellum length 1.2x head with; F1 little shorter than pedicel; clava little longer than two preceding segments combined.

Mesosoma : 1.6x as long as broad. pronotal collar sharply margined, almost smooth. Mesoscutum width 2.3x length, coarsely reticulate. Scutellum medially longer than mesoscutum. Propodeum (Fig. 16) as long as scutellum, median area strongly sculptured; plicae indicated posteriorly, becoming weaker medially; spiracles small, round, separated by their diameter from hind margin of metanotum. Forewing (Fig. 15) length 2.5x width; basal vein hairy; basal cell closed below with few scattered hairs; speculum open below; MV 2x STV; PMV little shorter than MV; underside of forewing with a row of 8 long hairs below MV.

Gaster : (Fig. 16) petiole finely reticulate with sharp lateral ridges; gaster 0.8x as long as head plus mesosoma combined and 1.9x as long as broad; T2 large, little longer than half length of T1 dorsally.

Male : Length 1.1mm. Closely resembles female but differs in the nature of antenna and gaster; toruli situated higher on face with 2 short anelli and long funicular segments; gaster short, shiny blackish brown with a pale brown spot dorsally, reaching up to middle.

Remarks : *C. rugosa* (Waterston) closely resembles *C. yasudai* Kamijo but differs from it in having propodeum as long as scutellum; gastral petiole reaching apices of hind coxae; forewing with MV longer than PMV; propodeum with spiracles separated from hind margin of metanotum by their diameter and gaster 1.9x as long as broad. (in *yasudai* propodeum distinctly shorter than scutellum, petiole not reaching apices of hind coxae; MV about as long as PMV; spiracles separated by less than their diameter from metanotum and gaster 1.5–1.6x as long as broad).

Material examined : Holotype : Male : CEYLON : Paradeniya, Coll. Rutherford (BMNH); 7 female, 1 male, INDIA : Kerala, Malappuram district, Chungathara, 24.iv.1989; 2 Female, Kerala, Calicut University campus, 10.iv.1989; 2 Female, Kerala, Payyannur, 26.ii.1988; 4 female, Kerala, Kayamkulam, 21.ii.1989; 1 Male, Kerala, Chavara, 22.ii.1989; Coll. P. M. Sureshan; 1 Male, Kerala, Trivandrum, 24.ii.1989; 1 male, Calicut University campus, 2.iv.1985, Coll. T. C. Narendran & party.

Host : Bean fly *Agromyza phaseoli* Coq. (Waterston, 1915).

SUMMARY

Four new species of *Callitula* Spinola viz. *C. robusta*, *C. keralensis*, *C. anguloclypea* and *C. travancorensis* are described from India. *C. rugosa* (Waterston) is redescribed based on the study of male holotype and other Indian specimens. A key to separate the species of *Callitula* from the Indian subcontinent is provided.

ACKNOWLEDGEMENTS

I am grateful to the Director, Zoological Survey of India, Kolkata and the Officer-in-charge, Zoological Survey of India, Western Ghat Field Research station, Calicut for providing facilities and encouragement. I am also thankful to Miss. Suzanne Lewis and Dr. John. S. Noyes, BMNH, London for arranging the loan of specimens and Dr. T. C. Narendran, Professor, University of Calicut, Kerala for valuable suggestions and encouragement.

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OCCURRENCE OF *CRAMBIONELLA ANNANDALEI* RAO, A SCYPHOZOAN JELLYFISH (RHIZOSTOMAE : CATOSTYLIDAE) FROM DIGHA COAST, MIDNAPORE, WEST BENGAL

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INTRODUCTION

During the course of investigation on jellyfishes at the coast of West Bengal, the authors noticed a numbers of *Crambionella annandalei* Rao., the scyphozoan jellyfishes belonging to the family : Catostylidae, caught in drag net, operated by local fishermen at Digha coast, Midnapore, West Bengal.

Scyphomedusae from Bay of Bengal is known from the works of Rao (1931). Haldar and Chowdhury (1995) reported a number of medusa from Hughly-Matla estuary, West Bengal, but in their accounts, there is no record of this species from this area and hence this is the first record of *Crambionella annandalei* Rao from coast of West Bengal.

A brief description of this species is given below.

MATERIALAND METHOD

The specimens were collected by drag net during fishing and after collection, the specimens are preserved in 5% formalin solution.

SYSTEMATIC ACCOUNT

Phylum CNIDARIA
Class SCYPHOZOA
Order RHIZOSTOMEAE
Family CATOSTYLIDAE

***Crambionella annandalei* Rao**

1930. ? *Crambionella stuhlmanni* Menon., *Bull. Govt. Mus. Madras* (N.S.). III. p.18, pl. iii, figs. 14a, c, e.

Materials examined : 5 exs., Digha Hospital Ghat., coll. J. Sarkar and S. Talukdar., Regd. No. 2197 dt. 26.ix.96.

* Zoological Survey of India, M-Block, New Alipore, Kolkata

Diagnosis : Bell dome-shaped, margin more or less incurved, exumbrellar surface finely granulated, minute short furrows and ridges arranged radially, velar lappets 14 in each octant, mouth-arm well developed with stout long terminal club. Base of mouth arm cylindrical, middle part with trifoliate wing. Terminal club about half of entire mouth-arm and devoid of whip-like filament.

Colour : Light brown when freshly caught but centre of the bell lighter than margin.

Measurements (in mm) :

Specimens	Diameter of bell	Total length of mouth-arm	Length of terminal club
1	141.4	25	13
2	172.8	37	20
3	204.2	39	22
4	251.4	50	26
5	267.1	55	28

Distribution : India : Coast of Puri, Visakhapatnam, Madras and Andaman & Nicobar Islands. Occurrence of *C. annandalei* at Digha coast indicates the northern range of extension of the species. Elsewhere : Burma.

DISCUSSION

The description of the species is based on the specimen collected in September, 1996. After that in September, 1998 and in October, 1999 the authors again noticed the same species in large number from Digha coast and Shankarpur coast near Digha. From this observation it is said that this species is the permanent visitor of this estuarine areas.

ACKNOWLEDGEMENTS

The authors wish to express their deep felt gratitude to Dr. J. R. B. Alfred, Director, Zoological Survey of India, Kolkata, and Dr. T. K. Chatterjee, Officer-in-charge, MARC, ZSI, Digha for providing facilities.

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PLATE I



Fig. I. *Crambionella annandalei* Rao.

FOUR NEW INDIAN GALL MIDGES OF *ANARETELLA* ENDERLEIN [DIPTERA : CECIDOMYIIDAE : LESTREMIINAE]

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INTRODUCTION

The genus *Anaretella* Enderlein was established in 1911 with its type species *Lestremia defecta* Winnertz by original description, subsequently *Naptunimyia* Felt [1912] and *Plocimas* Enderlein [1936] were merged with *Anaretella*. Grover [1964] *Lestremia orientalis* [based on males] from Allahabad, but while revising the Indian Lestremiinae she transferred the species of the genus *Anaretella* recording the genus for the first time from India.

The genus *Anaretella* is recognized by the following combination of characters : Male antenna with 2 + 14 segments, female with 2 + 9; each flagellar segment with two well developed whorls of long bristles medially and a pair of digitate sensoria distally on basal 5 to 7 segments, last antennal segments of female entire, not constricted near tip. Wing with vein Cu1 hardly extending back beyond the bend of Cu2; branches of median fork evenly divergent; male styles without terminal teeth; roots of gonocoxites directed anteriorly; tegmen broad.

While studying the gall midges from Maharashtra we encountered four new species of *Anaretella* which are described here. All the types are retained for the time being in first author's collection at Science College, Nanded [Maharashtra].

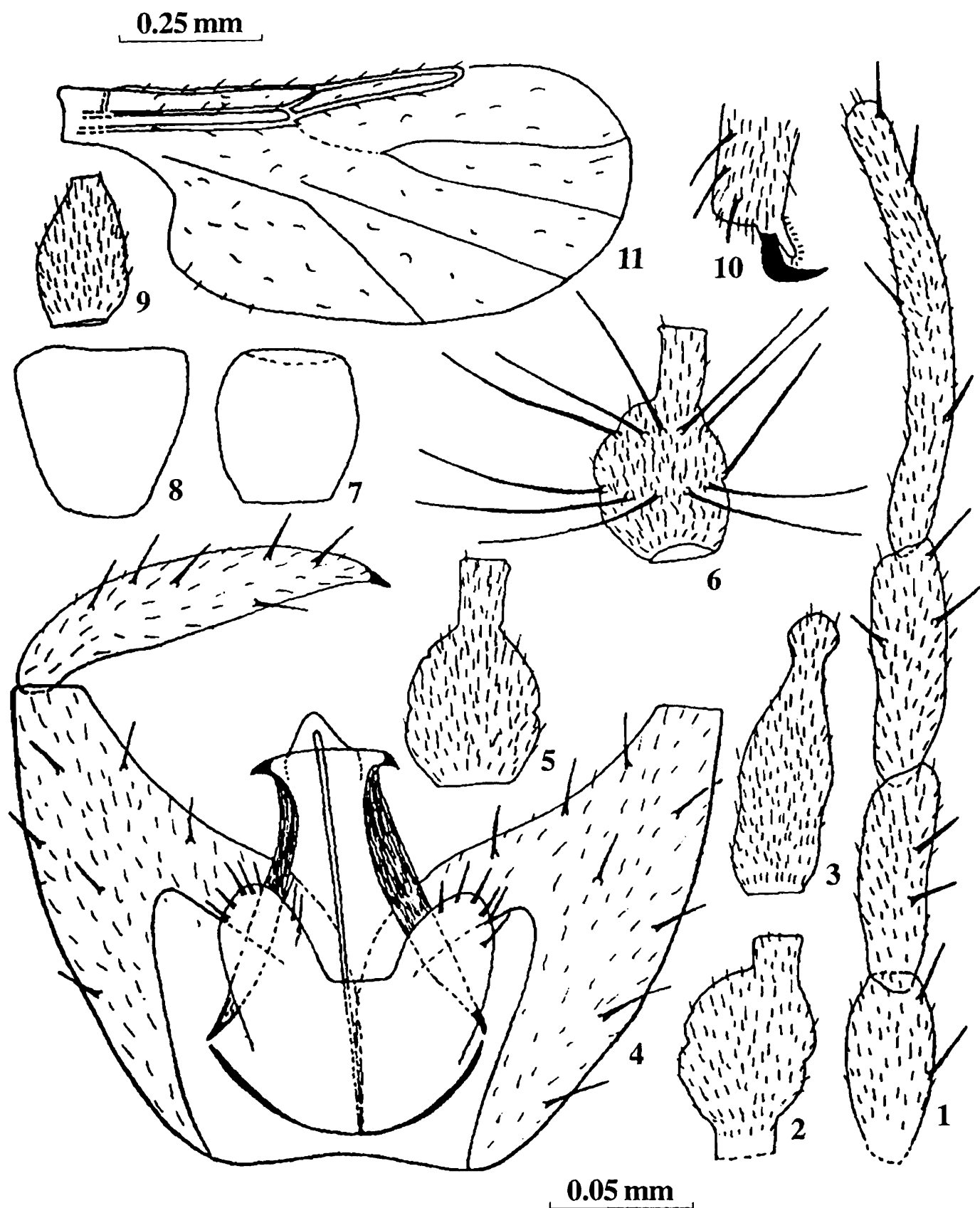
1. *Anaretella spinosa* sp. nov.

(Figs. 1–11)

Male : Body 1.00mm long. Ocelli two. Trophi normal. Palpus quadriarticulate, densely hairy; first segment oval, short, 2.16x its maximum thickness [13 : 6]; second segment subcylindrical, longer and thinner than first, 3.20x its maximum thickness [16 : 5]; third segment subcylindrical, as long as second and 3.20x its maximum thickness; fourth palpal segment longest of all and 10.6x its maximum thickness [32 : 3]. Antenna : shorter than body, with 2 + 14 segments, segments cylindrical with

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Figs. 1-11. *Anaretella spinosa* : 1. Palpus; 2. Third antennal segment; 3. Terminal antennal segment; 4. Genitalia; 5. Fourth antennal segment; 6. Fifth antennal segment; 7. Pedicel; 8. Scape; 9. Penultimate antennal segment; 10. Claw; 11. Wing.

short apical stems, enlargements with whorls of long setae and short digital sensorial processes medially; scape [13 : 13] cup shaped; pedicel [10 : 11] subglobose; Third segment [15], not confluent with and as long as fourth, with a short basal prolongation, enlargement [11 : 9] 0.74 the length of the segment and 1.22x its maximum thickness, apical stem [3 : 4] 0.27 the length of the segment; fourth segment [15] with enlargement [10 : 9] 0.57 the length of the segment and 1.66x its maximum thickness, apical stem [5 : 3] 0.33 the length of the segment; fifth segment [16] longer than fourth; penultimate segment [10 : 6] shortest of all, without stem, 1.66x its maximum thickness, terminal segment [20 : 6] longest of all, 3.33x its maximum thickness, stem in the form of a round nipple like prolongation. Wing : [36 : 15] roughly rectangular, 2.40x as long broad, vein Rs distinct at an oblique angle, vein R5 short, wing margin interrupted at the union of R5 with costa at three-fourth of wing, vein M1+2 present, fork of M1+2 longer than its stem, later obsolete, vein M3+4 complete, vein Cu simple. Legs : long, densely hairy, metatarsus [80], nearly as long as the following segments combined together [81], claw simple on all legs, evenly curved, empodium 0.60 the length of the claw [3 : 5]. Genitalia : dark brown, sparsely setose; basal clasp segment without lobe, root directed upwards, 2x its maximum thickness [40 : 20]; terminal clasp segment tapering towards the tip, ending in a tooth, 0.67 the length of the basal clasp segment and 5x its maximum thickness [30 : 6]; dorsal plate [12 : 23] bilobed, deeply lobed, lobes oval and covered with stiff bristles; subdorsal plate [31 : 10], flask shaped, enlarged submedially, with a pair of spines apically and submedially, emarginate laterally, tip truncated, longer than dorsal plate; tegmen [34], shorter than basal clasp segment, genital rod elongated, longer than subdorsal plate and nearly as long as tegmen, 33x as long as thick [33 : 1], tip rounded.

Female : Unknown.

Material examined : *Holotype* : Male dissected and mounted on slide labeled, “at light, MSEB Office, Bhokar, Dist. Nanded, Maharashtra, T. H. Shaikh coll., dated 13.v.1994”

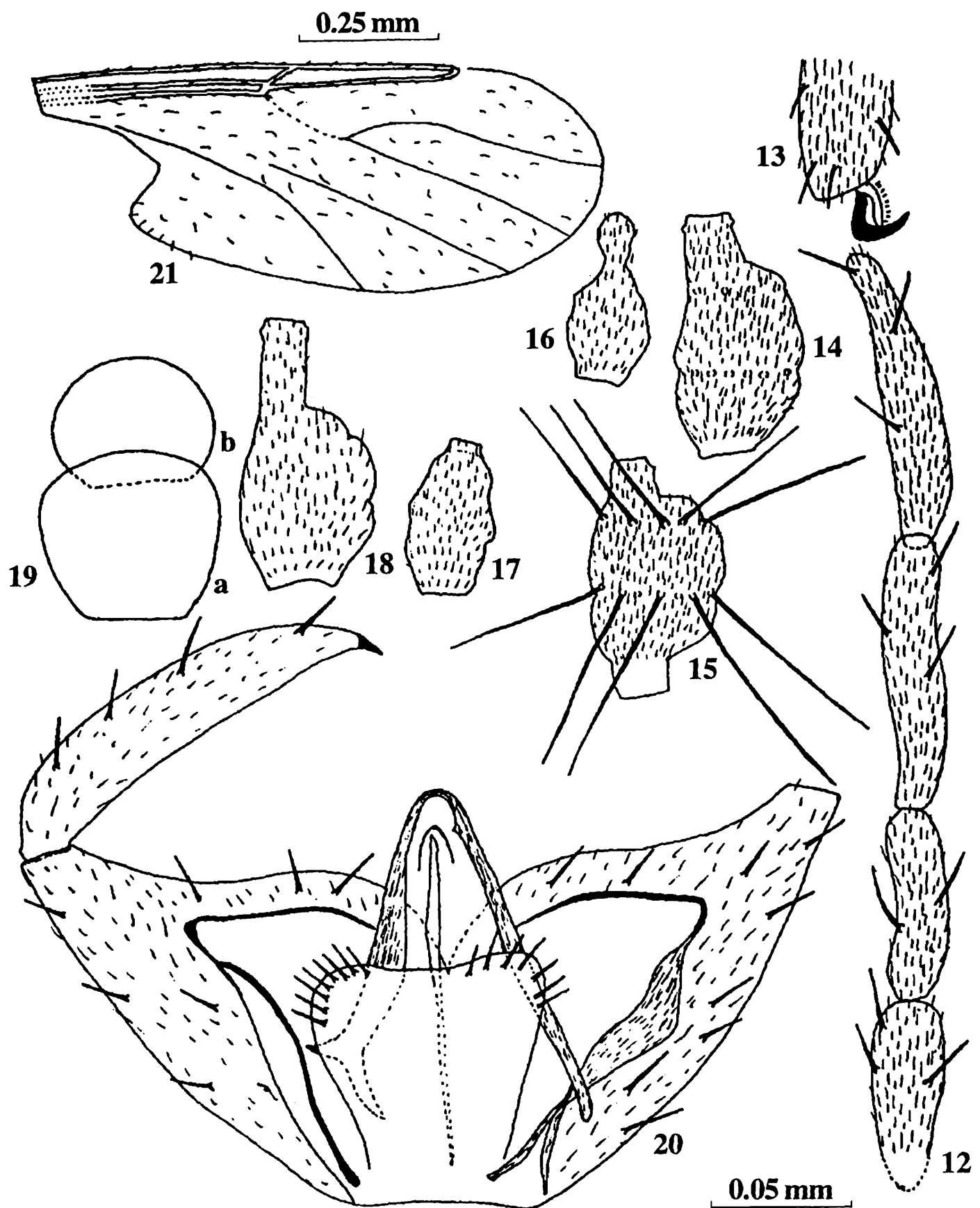
Paratype : Three males dissected and mounted on slides labeled as in *Holotype*.

Etymology : The specific epithet refers to spines present on subdorsal plate.

2. *Anaretella deepica* sp. nov.

(Figs. 12–21)

Male : Body 1.15mm long. Ocelli two. Trophi normal. Palpus quadriarticulate, long densely setose; first segment subcylindrical, 2.60x its maximum thickness [13 : 6]; second segment cylindrical, slightly longer and thinner than first, 3.50x its maximum thickness [14 : 4]; third segment cylindrical, longer than second and 5.00x its maximum thickness [20 : 4]; fourth palpal segment longest of all, cylindrical, 5.50x its maximum thickness [22 : 4]. Antenna : shorter than body, with 2+14 segments, segments cylindrical with short apical stems, enlargements with two whorls of long setae and short digital sensorial processes medially; scape [12 : 13] cup shaped, wider than long; pedicel [9 : 11],



Figs. 12-21. *Anaretella deepica* : 12. Palpus; 13. Claw; 14. Fourth antennal segment; 15. Third antennal segment; 16. Terminal antennal segment; 17. Penultimate antennal segment; 18. Fifth antennal segment; 19a. Scape; 19b. Pedicel; 20. Genitalia; 21. Wing.

subglobose, shorter than scape; third segment [17] not confluent but as long as fourth, with short basal prolongation [2 : 5], enlargement [12 : 9] 0.79 the length of the segment and 1.33x its maximum thickness, stem [3 : 4] 0.18 the length of the segment and thicker than long; fourth segment [17] with enlargement [13 : 9] 0.76 the length of the segment and 1.33x its maximum thickness, stem [4 : 4] 0.23 the length of the segment and as long as thick; fifth segment [19] slightly longer than fourth, penultimate segment [11 : 6] enlargement 0.90 the length of the segment and 1.66x its maximum thickness, stem [1 : 2] very short; terminal segment [12] with enlargement [9 : 6] 1.5x its maximum thickness, stem [3 : 3] ending into a nipple like prolongation. Wing : [35 : 14], hyaline, roughly rectangular, 2.50x as long as broad; vein R1 meeting costa before middle of the wing, vein Rs distinct, vein R5 unites with costa at three-fourth of the wing, fork of vein M1+2 longer than stem, the latter obsolete, vein M3+4 complete, vein Cu simple. Legs : long, densely hairy, metatarsus [60], longest of all, shorter than the following segments combined together [66]; Claw simple, evenly curved, empodium 0.66 the length of the claw [3 : 5]. Genitalia : dark brown, sparsely setose, basal clasp segment [44 : 22], without lobe, broad medially, length 2x its maximum thickness, roots directed outwards; terminal clasp segment [35 : 7], tapering towards tip, ending in a tooth, 0.75 the length of the basal clasp segment and 5x its maximum thickness; dorsal plate [17 : 20] broader than long, very shallowly incised, lobes small, rounded outwardly, covered with stiff bristles; subdorsal plate [32 : 6], broad basally, narrowed apically, emerginate laterally, with a pair of spine submedially, longer than dorsal plate, tip rounded; tegmen with genital rod, later narrow and pointed basally, 26x its maximum thickness [26 : 1], shorter than tegmen, tegmen shorter than subdorsal plate.

Female : Unknown.

Material examined : *Holotype* : Male dissected and mounted on slide, labelled, “at light, MSEB Office, Bhokar, Dist. Nanded, Maharashtra, T. H. Shaikh coll. dated 22.v.1993”

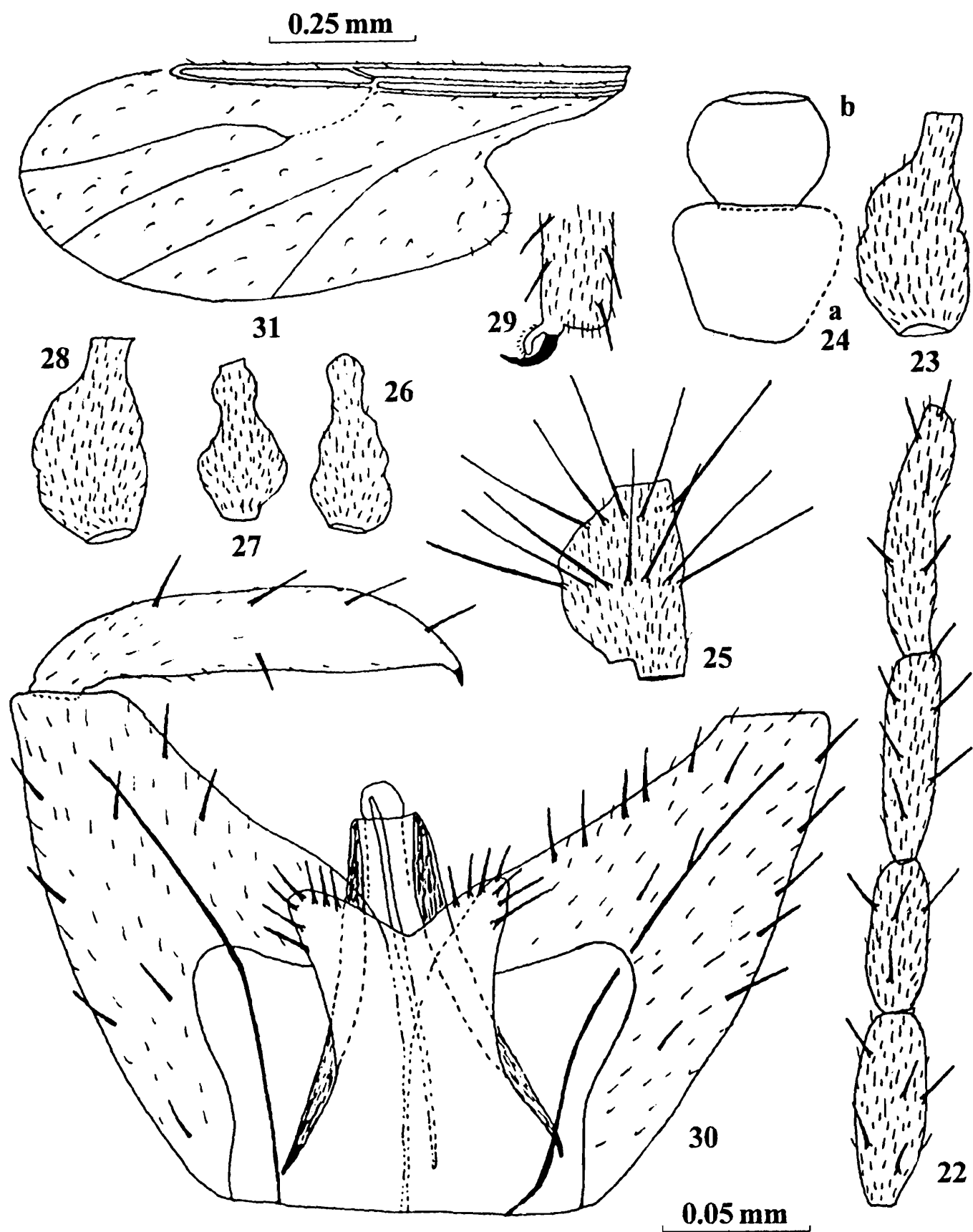
Paratype : Three males dissected and mounted on slides, labelled as in *Holotype*.

Etymology : Species name associated with the Sanskrit word for “Deep” means light.

3. *Anaretella indica* sp. nov.

(Figs. 22–31)

Male : Body 1.05mm long. Ocelli two. Trophi normal. Palpus : quadriarticulate, long, densely hairy; first segment subcylindrical, 2.50x its maximum thickness [15 : 6]; second segment subcylindrical, shorter and thinner than first, 2.40x its maximum thickness [12 : 5]; third segment cylindrical, longer than second, 4.00x its maximum thickness [16 : 4]; fourth segment [20 : 4], cylindrical, longest of all, 5x its maximum thickness. Antenna : shorter than body, with 2+14 segments, segments cylindrical, with short apical stems, enlargements with two whorls of long setae and small digital sensorial processes medially; scape [11 : 14], cup shaped; pedicel [11 : 14], subglobose; third segment [15] not confluent; but as long as fourth, with short basal prolongation [2 : 4], enlargement



Figs. 22-31. *Anaretella indica* : 22. Palpus; 23. fifth antennal segment; 24a. scape; 24b. pedicel; 25. third antennal segment; 26. terminal antennal segment; 27. penultimate antennal segment; 28. fourth antennal segment; 29. claw; 30. genitalia; 31. wing.

[11 : 9] 0.73 the length of the segment and 1.2x its maximum thickness, stem [2 : 4] 0.13 the length of the segment and twice thicker than long; fourth segment [15], with enlargement [11 : 8] 0.73 the length of the segment and 1.37x its maximum thickness, stem [4 : 3] 0.27 the length of the segment and 1.33x its maximum thickness; fifth segment [17], slightly longer than fourth; penultimate segment [11], shorter than fifth, enlargement [8 : 6] 0.72 the length of the segment and 1.33x its maximum thickness; terminal segment [15], longer than penultimate, enlargement [11 : 6] 0.73 the length of the segment and 1.83x its maximum thickness, apical stem [4 : 2] 0.27 the length of the segment and twice as long as thick. Wing : [33 : 13], nearly rectangular, covered with microtrichae, 2.30x as long as broad, vein Rs distinct, vein R5 short, wing margin interrupted at its union of R5 with costa at three-fourth of the wing, vein M1+2 short, fork of M1+2 longer than its stem, vein M3+4 complete, vein Cu simple. Legs : long, densely hairy, metatarsus [90], shorter than the following segments combined together [96]; claw simple, evenly curved, empodium 0.60 the length of the claw [3 : 5]. Genitalia : dark brown, sparsely setose; basal clasp segment [40 : 20], without lobe, broad basally, narrow apically, 2x its maximum thickness, roots directed upwards; terminal clasp segment [30 : 6], 0.75 the length of the basal clasp segment and 5x its maximum thickness, tapering towards tip, ending into tooth; dorsal plate [20 : 22], little wider than long, bilobed, deeply incised, lobes triangular; subdorsal plate [30 : 6], longer than dorsal, broad basally, tip truncated, sclerotised laterally, 5x its maximum thickness; tegmen with genital rod, setose, tegmen rounded apically and slightly longer than genital rod, genital rod [32 : 1], 32x its maximum thickness.

Female : Unknown.

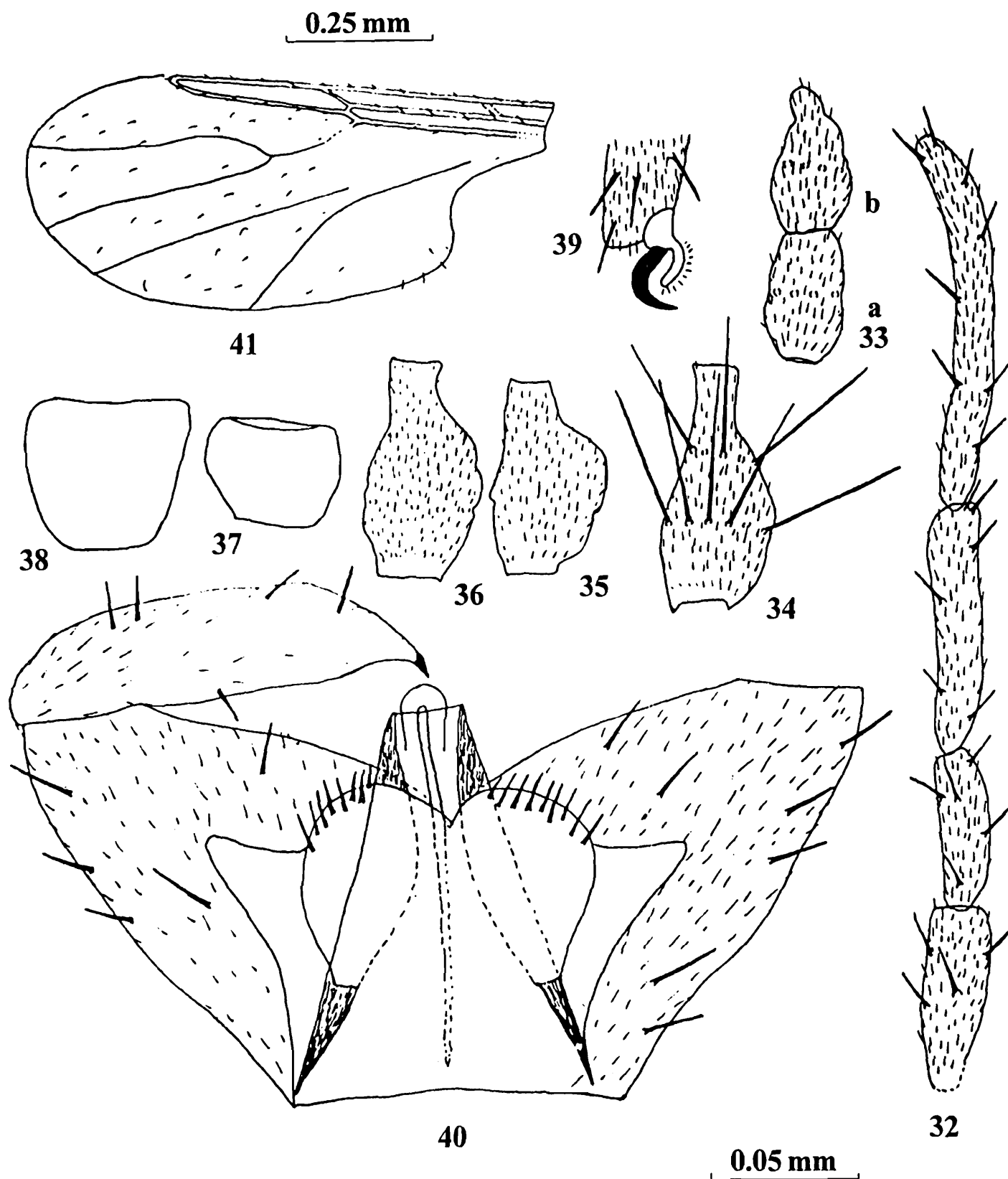
Material examined : *Holotype* : Male dissected and mounted on slide, labelled, "at light, MSEB Office, Bhokar, Dist. Nanded, Maharashtra, T. H. Shaikh coll., dated 22.v.1993"

Paratype : Two males dissected and mounted on slides, labelled as in *Holotype*.

4. *Anaretella bhokarensis* sp. nov.

(Figs. 32–41)

Male : Body 1.00mm long. Ocelli two. Trophi normal. Palpus : quadriarticulate, long, densely hairy; first segment subcylindrical, 3.00x its maximum thickness [15: 5]; second segment subcylindrical, shorter and thinner than first, 3.00x its maximum thickness [12 : 4]; third segment subcylindrical, longer than second, 5.25x its maximum thickness [12 : 4]; fourth palpal segment [30 : 3], longest of all, cylindrical, 10x its maximum thickness. Antenna : shorter than body, with 2+14 segments, segments cylindrical, with short stems, enlargement with two whorls of long setae, and short digital sensorial processes medially; scape [12 : 14], cup shaped, wider than long; pedicel [9 : 11], subglobose; third segment [16], with a short basal prolongation [1 : 4], enlargement [11 : 4], 0.68 the length of the segment and 1.22x its maximum thickness, stem [4 : 4], 0.36 the length of the enlargement and as long as thick; fourth segment [18], not confluent but little longer than third, enlargement



Figs. 32-41. *Anaretella bhokarensis* : 32. Palpus; 33a. penultimate antennal segment; 33b. terminal antennal segment; 34. fifth antennal segment; 35. third antennal segment; 36. fourth antennal segment; 37. scape; 38. pedicel; 39. claw; 40. genitalia; 41. wing.

[13 : 9] 0.72 the length of the segment and 1.44x its maximum thickness, stem [5 : 3] 0.38 the length of the enlargement and 1.66x its maximum thickness; fifth segment [19], slightly longer than fourth; penultimate segment [9 : 7], without apical stem, 1.50x its maximum thickness; terminal segment [12], with enlargement [10 : 6] 1.66x its maximum thickness, stem [2] in the form of small nipple like prolongation. Wing : [43 : 17], rectangular, hyaline, 2.52x as long as broad, vein Rs distinct, wing margin interrupting at union of R5 with costa at three-fourth of the wing, vein M1 + 2 longer than its stem, vein M3 + 4 complete, vein Cu simple. Legs : long, densely hairy, metatarsus [90], shorter than the following segments combined together [98]; claw simple, stout, empodium 0.60 the length of the claw [3 : 5]. Genitalia : dark brown, sparsely setose, basal clasp segment [40 : 23], without lobe, 1.73x its maximum thickness, roots directed outwards; terminal clasp segment [32 : 8], broad, narrow apically, 0.75 the length of the segment, 4x its maximum thickness, ending into a tooth; dorsal plate [20 : 25], bilobed, shallowly incised, lobes rounded apically, broader than long, setose apically; subdorsal plate [33 : 9], broad basally, truncated apically, emarginate apically, 3.9x its maximum thickness basally, tegmen with genital rod, tegmen slightly longer than subdorsal plate, genital rod [30 : 1], as long as subdorsal plate and 30x its maximum length.

Female : Unknown.

Material examined : *Holotype* : Male dissected and mounted on slide, labelled, "at light MSEB Office, Bhokar Dist. Nanded, Maharashtra T. H. Shaikh coll., dated 19.v.1993"

Paratype : Two males dissected and mounted on slides, labelled as in *Holotype*.

All the Types are retained in collection at Science College, Nanded for the time being.

Key to the Indian species of Anaretella Enderlin

1. Antenna with 2 + 13 segments 2
 Antenna with 2 + 14 segments 3
2. Fourth palpal segment 7x as long as thick; dorsal plate narrowly incised, lobes bluntly pointed outwardly *orientalis* ♂ [Grover]
3. Subdorsal plate with spines 4
 Subdorsal plate without spines 5
4. Subdorsal plate with a pair of spine apically and submedially, flask shaped tip, truncated; dorsal plate deeply incised, lobes oval; fourth palpal segment 10.6x as long as thick
 *spinosa* ♂ sp. nov.
 Subdorsal plate with a pair of spine submedially only, broad basally, narrow apically, tip rounded; dorsal plate, shallowly incised, lobes rounded outwardly; fourth palpal segment 5.50x as long as thick *deepica* ♂ sp. nov.

5. Lobes of dorsal plate bluntly triangular; fourth palpal segment 5.00x as long as thick
 *indica* ♂ sp. nov.
- Lobes of dorsal plate broadly rounded apically; fourth palpal segment 10x as long as thick
 *bhokarensis* ♂ sp. nov.

SUMMARY

Four new gall midges viz., *spinosa*, *deepica*, *indica* and *bhokarensis* of genus *Anaretalla* Enderlin, collected from Bhokar Dist. Nanded, Maharashtra, have been described and illustrated. A key to the Indian species is also provided.

ACKNOWLEDGEMENTS

We are thankful to the Principal, Science College, Nanded for providing necessary facilities. One of us (RMS) is grateful to the Director, Zoological Survey of India (Kolkata) and Officer-in-charge Z. S. I., Pune for permitting him to study the collection.

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**GYRODACTYLUS PRESIDENCYUS SP. NOV. (TREMATODA :
MONOGENEA) FROM A FRESH WATER TELEOST, *CHANNA
PUNCTATUS* (BLOCH) IN WEST BENGAL, INDIA**

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INTRODUCTION

Members of the Genus *Gyrodactylus* include viviparous Monogenean ectoparasites characterised by relatively small size, two anterior cephalic lobes, a haptor, a pair of anchors with eight pairs of marginal hooks and a pair of intestinal caeca ending blindly. They occur on the gills of fresh water and marine fishes. Later, Mizelle and Kritsky (1967) found the species from the skin of the fishes and even on the skin of the frogs (Mizelle *et al.*, 1969).

Different species of *Gyrodactylus* are very narrowly specific as judged by their occurrence in host fishes. Specificity develops over a period of long term mutual adaptation between parasite and host (Bychowsky, 1957). Viviparous Gyrodactylids give birth to individuals containing well developed embryos, have high reproductive rates and these promote effective transmission under crowded conditions. Invasion is caused by adult parasites which transfer directly between adjacent hosts and its intensity increases rapidly and thus kills host directly (Lester and Adams, 1974).

Gusseu (1978) opined that Indian Monogeneans are found on single species of host (monohostal). But instances exist when the species of worms occur in more than one host species. Bychowsky (1957) is of the opinion that if this occurs, then the host species belongs to the same genera. Yin and Sproston (1948) disregarded the total consideration and arranged five previously well known species into sub specific ranks on the basis of direction of anchor roots, *viz.*, anterior (*G. elegans* gr.), inward (*G. medius* gr.) and outward (*G. rarus* gr.) and one more subspecies to *G. elegans* from Gold fish in China. Tripathi (1957), following Sproston (1946) further compounded the confusion describing several well known species to sub specific ranks. He described *G. elegans indicus* for the first time from India but the description of this new sub species was most inadequate. Later Venkatanarsaiah (1979) described *G. hyderabadensis* from *Channa* sp. and another species *G. eutheraponsis* was described by Venkatanarsaiah and Kulkarni (1980) from a marine perciform

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fish *Eutherapons therops*. Rukmini and Madhavi (1989) described *G. recurvensis* from two larvivorous fishes *Aplocheilichthys panchax* and *A. blochi*. Three new species of *Gyrodactylus* viz. *G. raipurensis*, *G. gussevi* and *G. mizellei* were also reported by Dubey, Gupta and Agarwal (1990) from *C. punctatus* and *C. gachua*, *Heteropneustes fossilis* and *Mystus vittatus* respectively. Another new species *G. neonephrotus malmbergi* described from *Heteropneustes fossilis* by Singh and Agrawal (1994).

A new species of *Gyrodactylus* viz. *G. presidencyus* has been proposed and described in this present communication for the first time from West Bengal, India. The type slides will be deposited in the National Collection of the Zoological Survey of India, Kolkata.

Key Words : *Gyrodactylus presidencyus* sp. nov.; Monogenea; Trematoda; Teleost; *Channa punctatus*.

MATERIAL AND METHODS

The common snake-headed fish *Channa punctatus* (Bloch) were collected from a pond of South Bengal (Port Canning, South 24 Parganas, West Bengal) and were brought alive to the laboratory. They were kept in the aquarium with aerated water. Meanwhile, some fishes were observed to be a little discoloured and also found to move listlessly. They were taken out of the water and observed under binocular microscope. The Gyrodactylids were teased out from the surface of the infected regions of the fishes and were fixed directly in AFA for 3–5 minutes in the watchglass. They were stained with semichons' Carnine. Some photomicrographs were taken by Zeiss Axiolab Microscope using MC-80 camera. Measurements were taken with the help of an ocular micrometer.

RESULTS

Gyrodactylus presidencyus sp. nov. (TEXT FIGURE 1a–c; PLATE I, Figs. 1 & 2).

(All measurements in microns, range in parentheses; N = 20)

Description : Body elongated, dorsoventrally flattened; body measures 410.5 (324–630) in length and width at the pharyngeal level, 94.5 (90–108), at middle region, 98 (90–108) and at the posterior end, 79 (54–90). Anterior part of the body bilobed, provided with a pair of antero-lateral papillae and head organs in either lobe. Globular vesicle present in the head organs, each terminates in an extrusible anterior spine. Pharynx oval, 33 (31.5–43) long, 37 (34–45) wide. It consists of two lobes. The anterior prepharynx 17 (11–22) long, 26 (25–27) wide, while the posterior pharynx proper 13.5 (11–16) long, 36 (31.5–40.5) wide. Haptor slightly demarcated from the body, sub circular, 68.5 (58.5–94.5) long, 66.5 (54–90) wide with fringed margin, each projection accommodating a hooklet

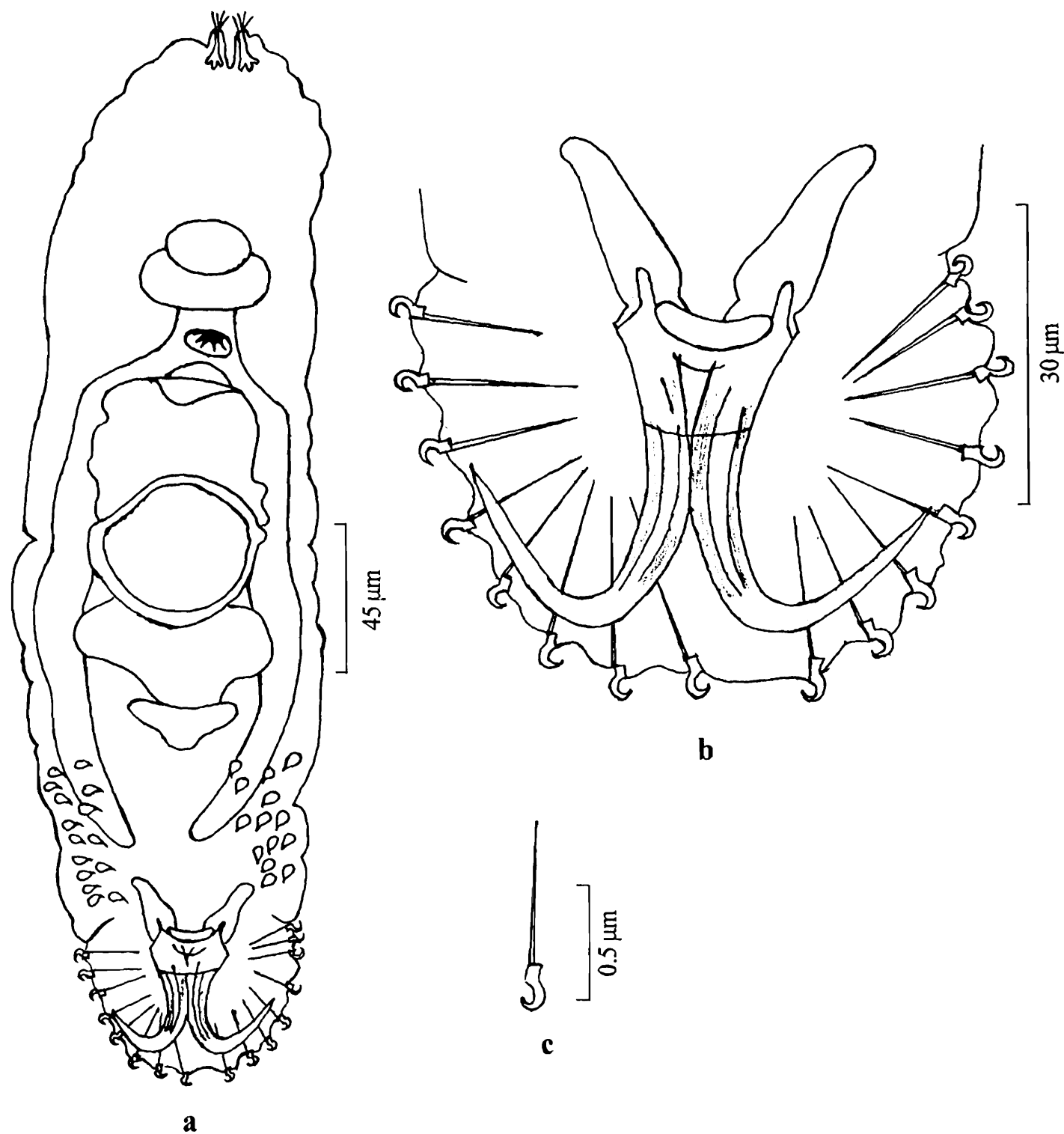


Fig. 1. (a) *Gyrodactylus presidencyus* sp. nov.; (b) Enlarged view of the haptor; (c) Single marginal hooklet.

proper. Anchor moderately stout and comprises three main parts, viz. root, shaft and point. Superficial anchor roots long, diverging; anchor points recurved; deep groove present in the anchor; anchor sharply pointed and curved. Anchor length 62 (58.5–63); length of the main part (shaft length) 59.5 (56–61), superficial root 21 (22–22.5) long, base 9.5 (9–11) wide, point 21 (18–24). Deep bar (dorsal bar) slightly curved, situated above the ventral bar and well secured in between the anchor knobs, measuring 21 (20–22.5) long and invariably 6.75 wide. Superficial bar (ventral bar) is larger than the dorsal bar, it comprises three parts, a median portion, a posterior membranous process and has antero-lateral processes at the extremities. The bar measures : total length 24 (22.5–25), distance between two processes of ventral bar 14.5 (13.5–16), total width 19 (18–20), length of processes 2.5 (2–3), median width 5 (4.5–6) and length of bar membrane 8 (7–9). Marginal hooks composed of a sickle proper, sickle membrane, a long handle, without sickle filament loop. Handle attached at the proximal part of the sickle. Articulating portion of handle slender, straight attached at the outer most portion of the sickle, while the other end is slightly swollen for providing site for the attachment of muscles. Detailed measurements are as follows; total length 24 (22.5–27), sickle length 5 (4.5–6) and length of handle 15 (17–18). Ovary triangular, pretesticular, 38 (36–45) long, 30.5 (27–36) wide. Uterus enclosing a fully developed embryo with its anchors observed in few flukes. Testis post ovarian, elongated and measures 16.5 (16–18) long, 22 (20–22.5) wide. Anteriorly it gives rise to a vas deferens runs forward and finally joins at the base of cirrus pouch. The spherical cirrus situated below the pharynx 16.5 (16–18) long and 14 (13.5–16) wide.

Type Host : *Channa punctatus* (Bloch)

Site of Infection : Skin, Gills [specially on the surface towards caudal peduncle, bases of the fin rays (dorsal, caudal, anal), in gills and in branchiostegal area.]

Type Locality : Port Canning; South 24-Parganas, West Bengal, India.

Prevalence : 60% (9 out of 15 host specimen examined).

DISCUSSION

Gussev (1978) held that the peculiarities of chitinoid armament of attachment disk, viz. number, shape, dimension and functioning of anchors, connecting bars and hooks are of great significance in species and generic diagnosis. Malmberg (1970) had earlier suggested that dimensions and shape of hooks represent the most constant characteristics of species of gyrodactylids of all the armament features. Anchors and connecting bars thus become very important in the species demarcation in gyrodactylids.

Concise keys and supplementary diagnostic features for most species of Gyrodactylids from Eurasia and North America are available from the works of Gussev (1985) and Beverly-Burton (1984).

Gyrodactylus anguillae has been found to parasitise on eels, *Anguilla rostrata* and *A. anguilla* (Malmberg, 1970) and is considered as euryhaline species. Both *Gyrodactylus salmonis* and *G. colemanensis* are common parasites of salmonid fishes in North America (Cone *et al.*, 1983). Another species, *Gyrodactylus crysoleucas* parasitises golden shiner (*Notemigonus crysoleucas*) and causes significant disease in bait fishes in the southern United States (Lewis and Lewis, 1970). *Gyrodactylus ictaluri* has been described from channel catfishes (*Ictalurus punctatus*) of south eastern United States (Hoffman, 1979) and *G. katharineri* parasitises *Cyprinus carpio* throughout Eurasia and caused disease problems in carp ponds. *Gyrodactylus turnbulli*, a common parasite has been reported from imported Guppies (*Poecilia reticulata*) of Singapore to England (Harris, 1986). A comparison of diagnostic specific characters of the above parasites with the present described one shows not only differences of measurements but also differences in habitat and host preferences.

Gyrodactylids from Indian water bodies shows inadequate reports (see Dubey *et al.*, 1990 and Singh and Agrawal, 1994). A comparative account of the measurements of different parts of the nine described species of *Gyrodactylus* from India, including the present one has been presented in the Table I.

If we consider the chitinoid armament (hard parts) as the key feature of the species demarcation, then the newly described one shows its close proximity with *G. recurvensis*. Because the anchor measurements (i.e. length, superficial root, point) has close resemblance but the main part (shaft) differs. Again measurements of marginal hook shows similarity but differs highly in deep bar and superficial bar. Although these two species show similarities, close observation reveals *G. recurvensis* is smaller in dimension in all aspects of 'hard parts' with the newly described one. If we consider the other measurements like body length, width, pharynx, haptor etc., there is marked difference between the two species. Actually, *G. recurvensis* is almost half or less in length than the presently described species.

Another species *G. mizellei* shows close resemblance with the presently described one in anchor, superficial bar and marginal hook measurements. But the deep bar differs greatly. 'Hard parts' of *G. mizellei* are larger in dimension when all the measurements are compared. Comparison shows *G. mizellei* is almost three times larger in length than the presently described species.

The hooklet length and shaft (handle) shows resemblance with *G. eutheraponsis*, but the other parts differs significantly. Even *G. eutheraponsis* can be well demarked in the species level as it described from a completely different habitat (its host *E. therops* is a marine fish).

As regard to the anchor measurements of *G. hyderabadensis* with the described one, the main part, base and point shows resemblance, but the measurement of marginal hook is quite different and even the other measurements viz. the length of the body, width, pharynx show variations.

Table I. Comparative account of measurements of the different parts of Indian species of *Gyrodactylus*.
(All measurements in microns and range in parentheses)

	<i>G. neonephrotus malmbergi</i>	<i>G. raipurensis</i>	<i>G. gussevi</i>	<i>G. mizellei</i>	<i>G. recurvensis</i>	<i>G. eutheraponis</i>	<i>G. hyderabadensis</i>	<i>G. elegans indicus</i>	<i>G. presidencyus n. sp.</i>
Host Species	<i>Heteropneustes fossilis</i>	<i>Channa gachua</i> & <i>C. punctatus</i>	<i>Heteropneustes fossilis</i>	<i>Mystus vittatus</i>	<i>Aplocheilichthys panchax</i> & <i>A. blochi</i>	<i>Eutherapon therops</i>	<i>Channa sp.</i>	<i>Labeo rohita</i> , <i>Cirrhinus mrigala</i> , & <i>C. reba</i>	<i>Channa punctatus</i>
Described by	Singh, H. S. & Agrawal, S. (1994)	Dubey, A., Gupta, A. K. & Agarwal, S. M. (1990)			Rukmini, C. & Madhavi, R. (1989)	Venkatanarsaiah, J. & Kulkarni, T. (1980)	Venkatanarsaiah, J. (1979)	Tripathi, Y. R. (1957)	Present Authors
Body Length	(938–1105)	468 (350–670)	370 (275–474)	1208 (950–1400)	(260–330)	(230–350)	(180–380)	(237–380)	410.5 (324–630)
Width									
Pharyngeal level		103 (60–138)	78 (50–100)	111 (100–150)					94.5 (90–108)
Middle region	(96.4–109)	133 (100–180)	102 (75–138)	195 (170–200)	(70–76)	(70–94)	(40–98)	(45–83)	98 (90–108)
Posterior end		117 (55–190)	81 (45–100)	193 (170–250)					79 (54–90)
Pharynx									
Length	(37–39)	49 (38–68)	40 (33–50)	94 (70–112)			(19–27)		33 (31.5–43)
Width	(34–39)	47 (35–68)	45 (38–50)	104 (85–120)	(17–19)	(20–30) Anterior (30–40) Posterior	(15–20) Anterior (20–30) Posterior	(19–22)	37 (34–45)
Haptor									
Length	(275–279)	64 (40–93)	76 (50–100)	125 (120–130)	(50–55)	(50–60)	(42–72)		68.5 (58.5–94.5)
Width	(302–305)	70 (45–112)	75 (50–100)	143 (110–175)	(50–56)	(50–80)	(42–64)		66.5 (54–90)
Anchor									
Length	(161–164)	36 (29–41)	42 (40–43)	74 (73–75)	(59–61)	(40–50)		(55–60)	62 (58.5–63)
Main Part (Shaft)	(164–165)	38 (28–40)	32 (28–33)		(32–40)		(48–61)		59.5 (56–61)
Superficial root		15 (13–20)	14 (13–15)	27 (23–30)	(21–24)				21 (20–22.5)
Base	(8–9)	10 (8–11)	10	16 (15–17)		(8–10)	(7–9)		9.5 (9–11)
Point	(52–53)	14 (12–17)	19 (18–20)	37 (35–40)	(21–25)	(20–30)	(18–21)		21 (18–24)

Table I. (Contd.).

	<i>G. neonephrotus malmbergi</i>	<i>G. raipurensis</i>	<i>G. gussevi</i>	<i>G. mizellei</i>	<i>G. recurvensis</i>	<i>G. eutheraponsis</i>	<i>G. hyderabadensis</i>	<i>G. elegans indicus</i>	<i>G. presidencius n. sp.</i>
Host Species	<i>Heteropneustes fossilis</i>	<i>Channa gachua</i> & <i>C. punctatus</i>	<i>Heteropneustes fossilis</i>	<i>Mystus vittatus</i>	<i>Aplocheilichthys panchax</i> & <i>A. blochi</i>	<i>Eutherapon therops</i>	<i>Channa sp.</i>	<i>Labeo rohita</i> , <i>Cirrhinus mrigala</i> , & <i>C. reba</i>	<i>Channa punctatus</i>
Described by	Singh, H. S. & Agrawal, S. (1994)	Dubey, A., Gupta, A. K. & Agarwal, S. M. (1990)			Rukmini, C. & Madhavi, R. (1989)	Venkatanarsaiah, J. & Kulkarni, T. (1980)	Venkatanarsaiah, J. (1979)	Tripathi, Y. R. (1957)	Present Authors
Deep bar (Dorsal bar) Length Width	(21–24) (1–3)	16 (13–20) 4 (3–6)	8 (8–10)	12.5 (12–13)	(13–19) (8–9.6)	(16–20) (1–2)	(10–20) 1		21 (20–22.5) 6.75
Superficial bar (Ventral bar) Length Width	(20–22)	34 (30–43) 18 (12–25)	14 (13–15) 12 (10–13)	26 (24–28) 19 (15–22)	(13–16) (3–3.2)	(20–21) (5–6)	(18–26) (3–6)	19	24 (22.5–25) 19 (18–20)
Marginal hook Hook length Hooklet length Shank (Handle) Lamella (Filament)	(37–39) (9–11) (28–29) (13–14)	16 (14–18) 6 (5–8) 10 (8–13) 10 (8–10)	20 (18–23) 5	5 (4–5) 24 (22–25) 15 (13–16)	(21–25) (6–8) (13–21) (3–4)	(5–6) (20–22) (7–8)	(6–8) (13–20) 11	(22–30)	24 (22.5–27) 5 (4.5–6) 15 (17–18) —
Ovary Length Width	(71–72) (52–53)	29 (22.5–40) 26 (17.5–43)	28 (25–33) 23 (15–33)		(20–24) (36–38)	(20–24) (30–40)	27 12		38 (36–45) 30.5 (27–36)
Testis Length Width	(49–51) (22–25)	47 (38–55) 33 (25–45)	33 (28–38) 18			(30–40) (40–50)	27 13		16.5 (16–18) 22 (20–22.5)
Cirrus Length Width		16 (13–28) 16 (13–23)	12.5 12.5	15		(20–21)	8		16.5 (16–18) 14 (13.5–16)

Blank spaces indicate non availability of the data.

However, if body length, width etc. are considered, *G. raipurensis* shows close resemblance with the newly described one. Moreover, the measurements of key specific characters such as the haptor armaments, the deep bar, superficial bar, marginal hooks etc. are quite distinct in the present species in comparison to the others.

Comparison between the measurement of different body parts of *G. gussevi* and *G. elegans indicus* with our described one shows vast differences. Both these two species are smaller in size than the newly described one.

The newly described species when compared with *G. neonephrotus malmbergi* shows a marked difference in 'hardparts'. All parts are larger in dimension. Even, Singh and Agrawal (1994) draw and described this species by mentioning 14 hooklets in the haptor (!) which is a typical generic character in Dactylogyrids (Cone, 1995). Considering its viviparous nature its position in the Gyrodactylidae family might be right but the generic characters require attention to compare with other described ones.

Considering the comparison of measurements in 'hard parts' and other morphological criteria (there are two unique characters, a deep groove runs along the length in the main part of anchors and marginal hooks without sickle filament loop or lamella.) between the described species of *Gyrodactylus* and the present one, a new name *Gyrodactylus presidencyus* sp. nov. has been proposed for the present parasite infecting *Channa punctatus* from West Bengal, India. The species has been coined after the name of the historic Presidency College, Kolkata where the work has been carried out.

SUMMARY

A new species of Monogenean trematode under the genus *Gyrodactylus* from the teleostean host *Channa punctatus* (Bloch) is described and illustrated. The other known species from India along with the present one has been critically reviewed and compared in a comparative chart. The new species has been described for the first time from West Bengal, India.

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PLATE I

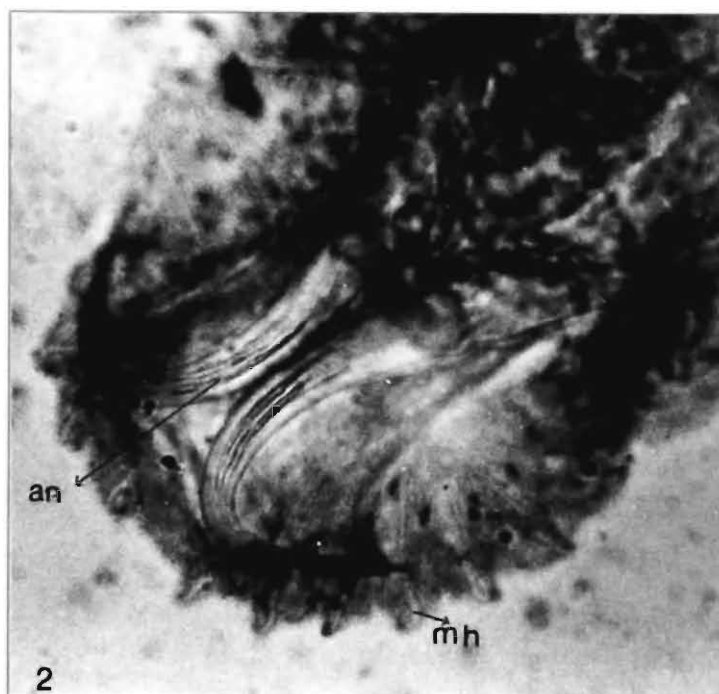


Fig. 1. *Gyrodactylus presidencyus* sp. nov. (x 490).

Fig. 2. Enlarged view (x 1430) of the haptor of *G. presidencyus*
(an: Anchor; mh: Marginal Hooklet).

A CHECK LIST OF GERROMORPHA (HEMIPTERA) FROM INDIA

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INTRODUCTION

The Infraorder Gerromorpha comprises of semi-aquatic bugs characterised by long conspicuous antennae, longer than head and inserted in front of eyes. They are distributed in all kinds of climatic zones, except the coldest and driest parts. This infraorder contains 8 families namely, Gerridae, Veliidae, Hydrometridae, Mesoveliidae, Hebridae, Macroveliidae, Paraphrynoveliidae and Hermatobatidae (Andersen, 1982a).

Knowledge of Indian semi-aquatic Hemiptera is limited to the taxonomic preliminaries, recording species from different parts of the country. (Distant, 1903a; 1910 a&b; Annandale, 1919; Bergroth, 1915a; Paiva, 1919a & b; Dover, 1928; Hafiz & Mathai, 1938; Hafiz & Riberio, 1939; Hafiz & Pradhan, 1947; Pradhan, 1950a, b & 1975; Gupta, 1981; Selvanayagam, 1981; Roy et al. 1988; Ghosh et al. 1989; Polhemus & Starmuhlner, 1990; Bal & Basu, 1994 & 1997; Chen & Zettel, 1999). The revisionary work of Andersen (1975, 1980, 1990 & 1993); Den Boer (1969); Hungerford & Matsuda (1958a & b, 1960, 1962b & 1965); Herring (1961); Polhemus & Andersen (1984); Andersen & Foster (1992); Andersen & Chen (1993); Chen & Nieser (1993a & b); Polhemus & Karunaratne (1993); Polhemus (1994); Polhemus & Polhemus (1994 & 1995a) on a few genera of Gerridae; Lundblad (1936) on the genera *Rhagovelia* Mayr and *Tetraripis* Lundblad; Andersen (1981b, 1983 & 1989); Polhemus (1990) on Veliidae; Andersen & Polhemus (1980) on Mesoveliidae; Hungerford & Evans (1934) and Polhemus & Polhemus (1995b) on Hydrometridae; Andersen (1981a) and Zettel (1998) on Hebridae of the world are also important to understand the present status of Indian Gerromorpha. Consolidation of the information throwing more light on the occurrence and the present status of semi aquatic Hemiptera of India has been attempted by Thirumalai, (1986; 1989; 1992, 1994a & b; 1996; 1999a,b, & c; 2000 and press); Thirumalai & Dam, (1996); Thirumalai & Krishnan, (2000); Thirumalai & Radhakrishnan, (1999); Thirumalai & Sharma (Press); Thirumalai & Venkatraman (press); Zettel & Thirumalai (2001).

Notwithstanding 43 genera and 123 species of semi-aquatic Hemiptera known from India under 5 families (Thirumalai, 1999,a) no comprehensive checklist is available on the fauna of the country. Hence, a checklist is furnished to offer a basic knowledge on the Indian fauna belonging to the Infraorder Gerromorpha. Out of the 8 recognised families, three families viz., Hermatobatidae,

Macroveliidae, Paraphrynoveliidae are not represented in India. As per the present study, a total of species (in genera) 76(25) of Gerridae, 15 (4) of Hebridae, 3(1) of Hydrometridae, 3(1) of Mesoveliidae and 31 species (13) of Veliidae is so far known to occur from India, which represents 128 species or 8.7% of the world fauna of Gerromorpha. For each species, citation of the original description, the Indian synonymy, and other important studies necessary to understand the status of taxon and its distribution in India are given.

HIGHER CLASSIFICATION OF GERROMORPHA

Order HEMIPTERA

Suborder HETEROPTERA

INFRAORDER

GERROMORPHA Popov, 1971

(AFTER, ANDERSEN, 1982a)

* NOT REPRESENTED IN INDIA

Superfamily	Mesovelioidea Douglas & Scott, 1867
Family	Mesoveliidae Douglas & Scott, 1867
Subfamily	Mesoveliinae* Poisson, 1959
Subfamily	Mesoveliinae Douglas & Scott, 1867
Superfamily	Hebroidea Amyot & Serville, 1843
Family	Hebridae Amyot & Serville, 1843
Subfamily	Hebrinae Amyot & Serville, 1843
Subfamily	Hyrantinae Andersen, 1981
Superfamily	Hydrometroidea Billberg, 1820
Family	Paraphrynoveliidae* Andersen, 1978
Family	Macroveliidae* Mckinstry, 1942
Family	Hydrometridae Billberg, 1820
Subfamily	Heterocleptinae* Villiers, 1948
Subfamily	Limnobatodinae* Esaki, 1927
Subfamily	Hydrometrinae Esaki, 1927
Superfamily	Gerroidea Reuter, 1910
Family	Hermatobatidae* Coutiere & Martin, 1901
Family	Veliidae Amyot&Serville, 1843

Subfamily	Ocelloveliinae* Drake & Chapman, 1963
Division	Microveliiformes Andersen, 1982
Subfamily	Microveliinae China & Usinger, 1949
Tribe	Hebroveliini* Lundblad, 1939
Tribe	Velohebrini* Stys, 1976
Tribe	Microveliini Stys, 1976
Subfamily	Haloveliinae Esaki, 1930
Division	Veliiformes Andersen, 1982a
Subfamily	Rhagoveliinae China & Usinger, 1949
Subfamily	Perittopinae China & Usinger, 1949
Subfamily	Veliinae China & Usinger, 1949
Family	Gerridae Leach, 1815
Subfamily	Rhagadotarsinae Lundblad, 1934
Subfamily	Trepobatinae Matsuda, 1960
Tribe	Metrobatini* Polhemus&Polhemus, 1993
Tribe	Naboandelini Polhemus&Polhemus, 1993
Tribe	Stenobatini* Polhemus&Polhemus, 1993
Tribe	Trepobatini Polhemus&Polhemus, 1993
Subfamily	Charmatometrinae* Matsuda, 1960
Division	Gerriformes Andersen, 1982a
Subfamily	Gerrinae Bianchi, 1896
Tribe	Gerrini Andersen, 1975
Tribe	Tachygerrini* Andersen, 1975
Subfamily	Eotrechinae Matsuda, 1960
Division	Halobatiformes Andersen, 1982a
Subfamily	Cylindrostethinae Matsuda, 1960
Subfamily	Ptilomerinae Bianchi, 1896
Subfamily	Halobatinae Bianchi, 1896
Tribe	Halobatini Matsuda, 1960
Tribe	Metrocorini Matsuda, 1960

SYNOPTIC LIST OF GERROMORPHA FROM INDIA

Family GERRIDAE

Subfamily CYLINDROSTETHINAE

Genus *Cylindrostethus* Mayr, 18651. *Cylindrostethus productus* (Spinola, 1840)1840. *Gerris productus* Spinola, Essai Sur less insectes hemipteres rhynchotes on heteropteres, 64.1903a. *Cylindrostethus productus* (Spinola) : Distant, *Fauna British India*, **2** : 184.1994. *Cylindrostethus productus* (Spinola) : Polhemus, *Bishop Mus. Occ. Pap.*, **38** : 10.1910a. *Janias elegantulus* Distant, *Ann. Mag. nat. Hist.*, **5**(8) : 145.*Distribution* : (1) Karnataka; (2) Kerala; (3) Madhya Pradesh; (4) Maharashtra; (5) Orissa; (6) Punjab; (7) Tamilnadu; (8) Uttar pradesh; (9) West Bengal.2. *Cylindrostethus scrutator* (Kirkaldy, 1899)1899. *Gerris scrutator* Kirkaldy, *Rev. Ent.*, **18** : 90.1903a. *Cylindrostethus scrutator* (Kirkaldy) : Distant, *Fauna British India*, **2** : 184.1994. *Cylindrostethus scrutator* (Kirkaldy) : Polhemus, *Bishop Mus. Occ. Pap.*, **38** : 12.*Distribution* : (1) Assam ?

Subfamily EOTRECHINAE

Genus *Amemboa* Esasi, 1925Subgenus *Amemboa* Esaki, 19253. *Amemboa (Amemboa) dentata* Polhemus & Andersen, 19841984. *Amemboa (Amemboa) dentata* Polhemus & Andersen, *Steenstrupia*, **10**(3) : 92.*Distribution* : (1) Uttar Pradesh.4. *Amemboa (Amemboa) kumari* (Distant, 1910)1910a. *Onychotrechus kumari* Distant, *Ann. Mag. nat. Hist.*, **5**(8) : 145.1928. *Onychotrechus kumari* Distant) : Esaki, *Ann. Mag. nat. Hist.*, **2**(10) : 509.1984. *Amemboa (Amemboa) kumari* (Distant) : Polhemus & Andersen, *Steenstrupia*, **10**(3) : 85.1950b. *Amemboa pervati* Pradhan, *Rec. Indian Mus.*, **48**(3&4) : 12.*Distribution* : (1) Karnataka; (2) Kerala; (3) Orissa; (4) Tamilnadu.

Subgenus *Amemboides* Polhemus & Andersen, 19845. *Amemboa* (*Amemboides*) *perlata* Polhemus & Andersen, 19841984. *Amemboa* (*Amemboides*) *perlata* Polhemus & Andersen, *Steenstrupia*, **10**(3) : 100.*Distribution* : (1) Karnataka.Genus *Chimarrhometra* Bianchi, 18966. *Chimarrhometra orientalis* (Distant, 1879)1879. *Halobates* (?) *orientalis* Distant, *Trans. R. ent. Soc. Lond.*, **1879** : 1261896. *Chimarrhometra orientalis* (Distant) : Bianchi, *Ann. Mus. zool. St. Petersbourg*, **1** : 17.1982b. *Chimarrhometra orientalis* (Distant) : Andersen, *Steenstrupia*, **9**(1) : 23.1908a. *Rheumatotrechus himalayanus* Kirkaldy, *Can. Ent.*, **40** : 452.1910a. *Gerris monticola* Distant, *Ann. Mag. nat. Hist.*, **5**(8) : 141.*Distribution* : (1) Arunachal Pradesh; (2) Assam; (3) Himachal Pradesh; (4) Jammu & Kashmir; (5) Meghalaya; (6) Uttar Pradesh; (7) West Bengal.Genus *Eotrechus* Kirkaldy, 19027. *Eotrechus brevipes* Andersen, 19821982b. *Eotrechus brevipes* Andersen, *Steenstrupia*, **9**(1) : 19.*Distribution* : (1) Arunachal Pradesh; (2) Sikkim; (3) West Bengal.8. *Eotrechus kalidasa* Kirkaldy, 19021902. *Eotrechus kalidasa* Kirkaldy, *Entomologist*, **35** : 137.*Distribution* : (1) Meghalaya.9. *Eotrechus longipes* Andersen, 19821982b. *Eotrechus longipes* Andersen, *Steenstrupia*, **9**(1) : 11.*Distribution* : (1) Arunachal Pradesh; (2) Uttar Pradesh; (3) West Bengal.10. *Eotrechus terrestris* Andersen, 19821982b. *Eotrechus terrestris* Andersen, *Steenstrupia*, **9**(1) : 15.*Distribution* : (1) Sikkim; (2) West Bengal.Genus *Onychotrechus* Kirkaldy, 190311. *Onychotrechus major* Andersen, 19801980. *Onychotrechus major* Andersen, *Steenstrupia*, **6**(10) : 133.*Distribution* : (1) Kerala; (2) Maharashtra.

12. *Onychotrechus rhexenor* Kirkaldy, 1903

1903. *Onychotrechus rhexenor* Kirkaldy, *Entomologist*, **36** : 44.

1980. *Onychotrechus rhexenor* Kirkaldy : Andersen, *Steenstrupia*, **6**(10) : 128.

Distribution : (1) Karnataka; (2) Kerala; (3) Maharashtra; (4) Rajasthan; (5) Tamilnadu.

13. *Onychotrechus robustus* Andersen, 1980

1980. *Onychotrechus robustus* Andersen, *Steenstrupia*, **6**(10) : 140.

Distribution : (1) Himachal Pradesh; (2) Uttar Pradesh.

14. *Onychotrechus rupestris* Andersen, 1980

1980. *Onychotrechus rupestris* Andersen, *Steenstrupia*, **6**(10) : 132.

Distribution : (1) Karnataka.

15. *Oncychotrechus spinifer* Andersen, 1980

1980. *Oncychotrechus spinifer* Andersen, *Steenstrupia*, **6**(10) : 138.

Distribution : (1) Karnataka; (2) Kerala; (3) Maharashtra.

Genus *Tarsotrechus* Andersen, 198016. *Tarsotrechus polhemi* Andersen, 1980

1980. *Tarsotrechus polhemi* Andersen, *Steenstrupia*, **6**(10) : 143

Distribution : (1) Karnataka; (2) Kerala.

Subfamily GERRINAE

Genus *Aquarius* Schellenberg, 180017. *Aquarius adelaidis* (Dohrn, 1860)

1860. *Aquarius adelaidis* Dohrn, *Stettin. ent. Ztg.*, **21** : 408.

1990. *Aquarius adelaidis* (Dohrn) : Andersen, *Steenstrupia*, **16**(4) : 61.

1896. *Gerris spinolae* Leth. & Ser., *Cat. gen. Hemiptera*, **3** : 63.

1903a. *Gerris spinolae* (Leth. & Ser.) : Distant, *Fauna British India*, **2** : 180.

Distribution : (1) Andhra Pradesh; (2) Bihar; (3) Karnataka; (4) Kerala; (5) Maharashtra; (6) Orissa; (7) Rajasthan; (8) Tamilnadu; (9) Uttar Pradesh; (10) West Bengal.

18. *Aquarius paludum* (Fabricius, 1794)

1794. *Gerris paludum* Fabricius, *Ent. Syst.*, **4** : 188.

1990. *Aquarius paludum* (Fabricius) : Andersen, *Steenstrupia*, **16**(4) : 58.

Distribution : (1) Meghalaya.

Genus *Gerris* Fabricius, 1794

Subgenus *Gerris* Fabricius, 1794

19. *Gerris (Gerris) nepalensis* Distant, 1910

1910a. *Gerris nepalensis* Distant, *Ann. Mag. nat. Hist.*, **5**(8) : 142.

1993. *Gerris (Gerris) nepalensis* Distant : Andersen, *Ent. Scand.*, **24**(2) : 157.

Distribution : (1) Arunachal Pradesh; (2) Jammu & Kashmir; (3) Sikkim; (4) Uttar Pradesh.

20. *Gerris (Gerris) sahlbergi* Distant, 1879

1879. *Gerris (Limnotrechus) sahlbergi* Distant, *Trans. R. ent. Soc. Lond.*, **1879** : 125.

1903a. *Gerris sahlbergi* Distant, *Fauna British India*, **2** : 179.

1993. *Gerris (Gerris) sahlbergi* Distant : Andersen & Chen, *Ent. Scand.*, **24**(2) : 158.

Distribution : (1) Jammu & Kashmir; (2) Uttar Pradesh.

21. *Gerris (Gerris) thoracicus* Schummel, 1832

1832. *VGerris thoracicus* Schummel, *ersuch einer Genauer Beschreibung der in Schlesien Arten der Familie der Ruderwazen Ploteres Latr.*, 46

1993. *Gerris (Gerris) thoracicus* Schummel : Andersen & Chen, *Ent. Scand.*, **24**(2) : 156.

Distribution : (1) Jammu & Kashmir.

Subgenus *Macrogerris* Andersen, 1993

22. *Gerris (Macrogerris) gracilicornis* (Horvath, 1879)

1879. *Limnotrechus gracilicornis* Horvath, *Termesztetrajzi Fuzeten*, **III** : CIX.

1975. *Gerris (Gerriselloides) gracilicornis* (Horvath) : Andersen, *Ent. Scand. Suppl.*, **7** : 22.

1993. *Gerris (Macrogerris) gracilicornis* (Horvath) : Andersen, *Can. J. Zool.*, **71**(12) : 2482.

1903. *Gerris selma* Kirkaldy, *Entomologist*, **36** : 181.

1910a. *Gerris lepcha* Distant, *Ann. Mag. nat. Hist.*, **5**(8) : 140.

Distribution : (1) Arunachal Pradesh; (2) Assam; (3) Sikkim; (4) Uttar Pradesh; (5) West Bengal.

Genus *Neogerris* Matsumura, 1913

23. *Neogerris parvula* (Stal, 1859)

1859. *Gerris parvula* Stal, *Zoology*, **4** : 265.

1934. *Limnogonus parvulus* (Stal) : Lundblad, *Arch. Hydrobiol. Suppl.*, **12** : 384.

1959. *L. (Limnogonellus) parvulus* (Stal) : Hungerford & Matsuda, *J. Kans. Ent. Soc.*, **32**(1) : 41.

1961. *L. (Neogerris). parvulus* (Stal) : Hungerford & Matsuda, *Insecta matsum.*, **24** : 114.

1975. *Neogerris parvula* (Stal) : Andersen, *Ent. Scand. Suppl.*, **7** : 86.

1899. *Gerris tristan* Kirkaldy, *Revue. Ent.*, **18** : 88.

Distribution : (1) Arunachal Pradesh; (2) Assam; (3) Kerala; (4) Orissa; (5) Pondicherry; (6) Tamilnadu; (7) Uttar Pradesh; (8) West Bengal.

Genus *Limnogonus* Stal, 1868

Subgenus *Limnogonus* Stal, 1868

24. *Limnogonus (Limnogonus) fossarum fossarum* (Fabricius, 1775)

1775. *Cimex fossarum* Fabricius, *Syst. Ent.*, 727.

1794. *Gerris fossarum* Fabricius, *Ent. Syst. emen. aucta*, **IV** : 188.

1868. *Limnogonus fossarum* Stal, *K. Svenska Vetensk. Akad.*, **7** : 133.

1959. *L. (Limnogonus) fossarum* (Fab.,) : Hungerford & Matsuda, *J. Kans. Ent. Soc.*, **32**(1) : 40.

1975. *L. (L.) fossarum* (Fab.,) : Andersen, *Ent. Scand. Suppl.*, **7** : 30.

Distribution : (1) Andaman & Nicobar Islands; (2) Andhra Pradesh; (3) Arunachal Pradesh; (4) Assam; (5) Bihar; (6) Delhi; (7) Goa; (8) Harayana; (9) Himachal Pradesh; (10) Jammu & Kashmir; (11) Karnataka; (12) Kerala; (13) Madhya Pradesh; (14) Maharashtra; (15) Orissa; (16) Pondicherry; (17) Rajasthan; (18) Tamilnadu; (19) West Bengal.

25. *Limnogonus (Limnogonus) hungerfordi* Andersen 1975

1975. *Limnogonus (Limnogonus) hungerfordi* Andersen, *Ent. Scand. Suppl.*, **7** : 46.

Distribution : (1) Andaman & Nicobar Islands.

26. *Limnogonus (Limnogonus) nitidus* (Mayr, 1865)

1865. *Hydrometra nitida* Mayr, *Verh. zool. -bot. Ges. Wien*, **15** : 443.

1903a. *Gerris nitida* (Mayr) : Distant, *Fauna British India*, **2** : 178.

1908b. *Limnogonus. nitidus* (Mayr,) : Kirkaldy, *Wissenschaftl. Ergebn. der Schwed. Zool. Exped. nach dem Kilimandjaro*, **12** : 21.

1960. *L. (Limnogonus) nitidus* (Mayr) : Matsuda, *Kans. Univ. Sci. Bull.*, **41** : 198.

1975. *L. (Limnogonus) nitidus* (Mayr) : Andersen, *Ent. Scand. Suppl.*, **7** : 62.

Distribution : (1) Andaman & Nicobar Islands; (2) Arunachal Pradesh; (3) Assam; (4) Bihar; (5) Delhi; (6) Karnataka; (7) Kerala; (8) Orissa; (9) Rajasthan; (10) Tamilnadu; (11) Tripura; (12) Uttar Pradesh; (13) West Bengal.

Subgenus *Limnogonoides* Poisson, 196527. *Limnogonus (Limnogonoides) pectoralis* (Mayr, 1865)

1865. *Hydrometra pectoralis* Mayr, *Verh. zool. bot. Ges. Wien*, **15** : 443.
 1903a. *Gerris pectoralis* (Mayr) : Distant, *Fauna British India*, **2** : 181
 1975. *Limnogonus (Limnogonoides) pectoralis* (Mayr) : Andersen, *Ent. Scand. Suppl.*, **7** : 69.

Distribution : (1) Karnataka.

Genus *Limnometra* Mayr, 186528. *Limnometra anadyomene* (Kirkaldy, 1901)

- 1901a. *Gerris anadyomene* Kirkaldy, *Entomologist*, **34** : 117.
 1915b. *Tenagogonus anadyomene* (Kirkaldy) : Bergroth, *Zool. Meded. Leiden*, **1**(2) : 122.
 1934. *Limnometra anadyomene* (Kirkaldy) : Lundblad, *Arch. Hydrobiol. Suppl.*, **12** : 371.
 1960. *Tenagogonus (Limnometra) anadyomene* (Kirkaldy) : Matsuda, *Kans. Univ. Sci. Bull.*, **41** : 206.
 1995a. *Limnometra anadyomene* (Kirkaldy) : Andersen, *Steenstrupia*, **21** : 117.
 1986. *Tenagogonus (Limnometra) longispinulus* Thirumalai, *Rec. zool. Surv. India*, **84**(1-4) : 11.

Distribution : (1) Karnataka; (2) Kerala; (3) Tamilnadu.

29. *Limnometra fluviorum* (Fabricius, 1798)

1798. *Cimex fluviorum* Fabricius, *Ent. Syst. Suppl.*, 543.
 1903a. *Gerris fluviorum* (Fab.) : Distant, *Fauna British India*, **2** : 177
 1934. *Limnometra fluviorum* (Fab.) : Lundblad, *Arch. Hydrobiol. Suppl.*, **12** : 371.
 1960. *Tenagogonus Limnometra fluviorum* (Fab.) : Matsuda, *Kans. Univ. Sci. Bull.*, **41** : 206.
 1995a. *Limnometra fluviorum* (Fab.) : Andersen, *Steenstrupia*, **21** : 118.
 1903a. *Gerris armata* Spinola : Distant, *Fauna British India*, **2** : 180.

Distribution : (1) Karnataka; (2) Kerala; (3) Maharashtra; (4) Pondicherry; (5) Tamilnadu; (6) West Bengal.

30. *Limnometra minuta* Mayr, 1865

1865. *Limnometra minuta* Mayr, *Verh. zool.-bot. Wien*, **15** : 444.
 1903a. *Gerris minuta* (Mayr) : Distant, *Fauna British India*, **2** : 181.
 1934. *Limnometra minuta* Mayr : Lundblad, *Arch. Hydrobiol. Suppl.*, **12** : 371.
 1958b. *Limnometra minuta* Mayr : Hungerford & Matsuda, *Kans. Univ. Sci. Bull.*, **39**(9) : 397.

1960. *Tenagogonus (Limnometra) minuta* (Mayr) : Matsuda, *Kans. Univ. Sci. Bull.*, **41** : 206.

1995a. *Limnometra minuta* Mayr : Andersen, *Steenstrupia*, **21** : 118.

Distribution : (1) Andaman & Nicobar Islands.

Genus *Tenagogonus* Stal, 1854

31. *Tenagogonus ceylonensis* Hungerford & Matsuda, 1962

1962a. *Tenagogonus ceylonensis* Hungerford & Matsuda, *Bull. Brooklyn ent. Soc.*, **57** : 141.

Distribution : (1) Karnataka.

32. *Tenagogonus nicobarensis* Andersen, 1964

1964. *Tenagogonus nicobarensis* Andersen, *Ent. Meddr*, **32** : 322.

Distribution : (1) Andaman & Nicobar Islands.

Subfamily HALOBATINAE

Genus *Asclepios* Distant, 1915

33. *Asclepios annandalei* Distant, 1915

1915. *Asclepios annandalei* Distant, *Ann. Mag. nat. Hist.*, **15**(8) : 504.

Distribution : (1) Tamilnadu; (2) West Bengal.

Genus *Halobates* White, 1883

34. *Halobates elephanta* Andersen & Foster, 1992

1992. *Halobates elephanta* Andersen & Foster, *J. Nat. Hist.*, **26** : 537.

Distribution : (1) Andaman Sea; (2) Maharashtra.

35. *Halobates flaviventris* Eschscholtz, 1822

1822. *Halobates flaviventris* Eschscholtz, *Entomographien.*, **1** : 109.

Distribution : (1) Pamban Pass, Tamilnadu.

36. *Halobates formidabilis* (Distant ,1910)

1910a. *Eurates formidabilis* Distant, *Ann. Mag. nat. Hist.*, **5**(8) : 146.

1929. *Halobates formidabilis* (Distant) : Esaki, *Ann. Mag. nat. Hist.*, **4**(10) : 417.

1910b. *Fabatus servus* Distant, *Fauna British India*, **5** : 155.

1992. *Halobates galatea* Herring, 1961: Andersen & Foster, *J. nat. Hist.*, **26** : 542. (Female allotype).

Distribution : (1) Andaman & Nicobar Islands (Andaman Sea); (2) Andhra Pradesh (Bay of Bengal); (3) Maharashtra (Arabian Sea); (4) Orissa (Bay of Bengal).

37. *Halobates galatea* Herring, 1961

1961. *Halobates galatea* Herring, *Pacif. Insects*, **3**(2-3) : 294.

Distribution : (1) Arabian Sea; (2) Goa (Arabian Sea); (3) Maharashtra (Arabian Sea).

38. *Halobates germanus* White, 1883

1883. *Halobates germanus* White, *Voy. Challenger Rept. Zool.*, **7**(19) : 50.

Distribution : (1) Andaman Sea; (2) Arabian Sea; (3) Bay of Bengal.

39. *Halobates hayanus* White, 1883

1883. *Halobates hayanus* White, *Voy. Challenger Rept. Zool.*, **7**(19) : 52.

Distribution : (1) Andaman Sea; (2) Andaman & Nicobar Islands.

40. *Halobates micans* Eschscholtz, 1822

1822. *Halobates micans* Eschscholtz, *Entomographien.*, **1** : 107.

Distribution : (1) Andaman Sea; (2) Indian Ocean.

41. *Halobates proavus* White, 1883

1883. *Halobates proavus* White, *Voy. Challenger Rept. Zool.*, **7**(19) : 54.

Distribution : (1) Andaman Sea.

42. *Halobates trynae* Herring, 1964

1964. *Halobates trynae* Herring, *Proc. ent. Soc. Wash.*, **66** : 85.

Distribution : (1) Andaman & Nicobar Islands; (2) Bay of Bengal.

Genus *Metrocoris* Mayr, 1865

43. *Metrocoris anderseni* Chen & Nieser, 1993

- 1993a. *Metrocoris anderseni* Chen & Nieser, *Steenstrupia*, **19**(1) : 23.

Distribution : (1) Uttar Pradesh.

44. *Metrocoris communis* (Distant, 1910)

- 1910a. *Euodus communis* Distant, *Ann. Mag. nat. Hist.*, **5**(8) : 151.

1929. *Metrocoris communis* (Distant) : Esaki, *Ann. Mag. nat. Hist. Soc.*, **4**(10) : 419.

1965. *Metrocoris communis* (Distant) : Den Boer, *Zool. Verh. Leiden.*, **74** : 13.

1993b. *Metrocoris communis* (Distant) : Chen & Nieser, *Steenstrupia*, **19**(2) : 49.

Distribution : (1) Karnataka; (2) Maharashtra; (3) Tamilnadu; (4) Uttar Pradesh.

45. *Metrocoris communoides* Chen & Nieser, 1993

1993b. *Metrocoris communoides* Chen & Nieser, *Steenstrupia*, **19**(2) : 51.

Distribution : (1) Tamilnadu.

46. *Metrocoris compar* (White, 1883)

1883. *Halobatodes compar* White, *Voy. Challenger Rept. Zool.*, **7**(19) : 68.

1893. *Metrocoris compar* (White) : Dahl, *Ergebn. Plankt. Exp.*, **2** : 8.

1993b. *Metrocoris compar* (White) : Chen & Nieser, *Steenstrupia*, **19**(2) : 65.

Distribution : (1) Arunachal Pradesh; (2) Himachal Pradesh; (3) Sikkim; (4) Uttar Pradesh; (5) West Bengal.

47. *Metrocoris dembickyi* Chen & Zettel, 1999

1999. *Metrocoris dembickyi* Chen & Zettel, *Ann. Naturhist. Mus. Wien*, **101B** : 27

Distribution : (1) Kerala.

48. *Metrocoris falcatus* Chen & Nieser, 1993

1993a. *Metrocoris falcatus* Chen & Nieser, *Steenstrupia*, **19**(1) : 25.

Distribution : (1) Uttar Pradesh.

49. *Metrocoris femoratus* (Paiva, 1919)

1919b. *Metrocoropis femorata* Paiva, *Rec. Indian Mus.*, **16**(3) : 365.

1926. *Metrocoris femoratus* (Paiva) : Esaki, *Annl. naturh. Mus. Hung.*, **23** : 130

1965. *Metrocoris femoratus* (Paiva) : Den Boer, *Zool. Verh. Leiden*, **74** : 16.

Distribution : (1) Assam.

50. *Metrocoris indicus* Chen & Nieser, 1993

1993b. *Metrocoris indicus* Chen & Nieser, *Steenstrupia*, **19**(2) : 48.

1903a. *Metrocoris stali* (Dohrn) : Distant, *Fauna British India*, **2** : 190.

1965. *Metrocoris stali* (Dohrn) : Den Boer, *Zool. Verh. Leiden*, **74** : 8.

1994a. *Metrocoris stali* (Dohrn) : Thirumalai, *Rec. zool. Surv. India, Misc. Occ. Pap.* **165** : 37.

Distribution : (1) Karnataka; (2) Kerala; (3) Maharashtra; (4) Tamilnadu.

Note : Specimens from Southern India Earlier identified as *Metrocoris stali* (Dohrn, 1860) refer to *M. indicus*.

51. *Metrocoris malabaricus* Thirumalai, 1986

1986. *Metrocoris malabaricus* Thirumalai, *Rec. zool. Surv. India*, **84**(1-4) : 22.

Distribution : (1) Karnataka; (2) Kerala.

52. *Metroconis nepalensis* Distant, 1910

1910a. *Metroconis nepalensis* Distant, *Ann. Mag. nat. Hist.*, **5**(8) : 148.

1993b. *Metroconis nepalensis* Distant : Chen & Nieser, *Steenstrupia*, **19**(2) : 66.

Distribution : (1) Arunachal Pradesh; (2) Uttar Pradesh.

53. *Metrocoris tenuicornis* Esaki, 1926

1926. *Metrocoris tenuicornis* Esaki *Annl. naturh. Mus. Hung.*, **23** : 125

1993b. *Metrocoris tenuicornis* Esaki : Chen & Nieser, *Steenstrupia*, **19**(2) : 70.

Distribution : (1) Arunachal Pradesh; (2) Assam; (3) Uttar Pradesh.

54. *Metrocoris variegans* Thirumalai, 1986

1986. *Metrocoris variegans* Thirumalai, *Rec. zool. Surv. India*, **84**(1-4) : 25.

Distribution : (1) Karnataka; (2) Kerala.

55. *Metrocoris velamentus* Chen & Nieser, 1993

1993b. *Metrocoris velamentus* Chen & Nieser, *Steenstrupia*, **19**(2) : 61.

Distribution : (1) Kerala; (2) Tamilnadu.

Genus *Ventidius* Distant, 1910

Subgenus *Ventidius* Distant, 1910

56. *Ventidius (Ventidius) aquarius* Distant, 1910

1910a. *Ventidius aquarius* Distant, *Ann. Mag. nat. Hist.*, **5**(8) : 150.

1960. *Ventidius (Ventidius) aquarius* Distant : Hungerford & Matsuda, *Kans. Univ. Sci. Bull.*, **40**(7) : 324.

Distribution : (1) Karnataka; (2) Kerala; (3) Tamilnadu.

57. *Ventidius (Ventidius) modulatus* Lundblad, 1934

1934. *Ventidius modulatus* Lundblad, *Arch. Hydrobiol. Suppl.*, **12** : 399.

1960. *Ventidius (Ventidius) modulatus* Lundblad : Hungerford & Matsuda, *Kans. Univ. Sci. Bull.*, **40**(7) : 329

Distribution : (1) Arunachal Pradesh.

58. *Ventidius (Ventidius) sushmae* Gupta, 19811981. *Ventidius (Ventidius) sushmae* Gupta, *Orient. Insects*, **15**(1) : 97.*Distribution* : (1) West Bengal.Subgenus *Ventidioides* Hungerford & Matsuda, 196059. *Ventidius (Ventidioides) kuiterti* Hungerford & Matsuda, 19601960. *Ventidius (Ventidioides) kuiterti* Hungerford & Matsuda, *Kans. Univ. Sci. Bull.*, **40**(7) : 333.*Distribution* : (1) Arunachal Pradesh.

Subfamily PTILOMERINAE

Genus *Heterobates* Bianchi, 189660. *Heterobates bilobates* (Esaki, 1927)1927. *Teratobates bilobates* Esaki, *Eos.*, **3** : 261.1958e. *Heterobates bilobates* (Esaki) : Hungerford & Matsuda, *Ent. News*, **69**(8) : 200.*Distribution* : (1) Uttar Pradesh.61. *Heterobates rihandi* (Pradhan, 1950)1950a. *Teratobates rihandi* Pradhan, *Rec. Indian Mus.*, **48** : 103.*Distribution* : (1) Arunachal Pradesh; (2) Uttar Pradesh.Genus *Pleciobates* Esaki, 193062. *Pleciobatus indicus* Thirumalai, 19861986. *Pleciobatus indicus* Thirumalai, *Rec. zool. Surv. India*, **84**(1-4) : 16.*Distribution* : (1) Kerala.63. **Pleciobatus nostras* Thirumalai, 19861986. *Pleciobatus nostras* Thirumalai, *Rec. zool. Surv. India*, **84**(1-4) : 19.*Distribution* : (1) Karnataka; (2) Kerala.

Note : *Nostras* is the correct name, as the name is available according to the ICZN code; *Nostrus* is a printing mistake (Polhemus Personel Communication).

64. **Pleciobatus tuberculatus* Esaki, 19301930. *Pleciobatus tuberculatus* Esaki, *J. fed. Malay St. Mus.*, **16** : 14.*Distribution* : (1) Karnataka; (2) Tamilnadu.

Genus *Ptilomera* Amyot & Serville, 1843Subgenus *Proptilomera* Hungerford & Matsuda, 195865. *Ptilomera (Proptilomera) himalayensis* Hungerford & Matsuda, 1958

1958a. *Ptilomera (Proptilomera) himalayensis* Hungerford & Matsuda, *Bull. Brooklyn ent. Soc.*, **53**(5) : 120.

1975. *P. (P). himalayensis* Hungerford & Matsuda : Pradhan, *ZSI News Letter*, **1**(4) : 57.

Distribution : (1) Arunachal Pradesh; (2) Sikkim; (3) Uttar Pradesh; (4) West Bengal.

Subgenus *Ptilomera* Amyot & Serville, 184366. *Ptilomera (Ptilomera) agroides* Schmidt, 1926

1926. *Ptilomera agroides* Schmidt, *Ent. Mitt.*, **15**(1) : 63.

1960. *Ptilomera (Ptilomera) agroides* Schmidt : Matsuda, *Kans. Univ. Sci. Bull.*, **41**(2) : 269.

1986. *Ptilomera (Ptilomera) agroides* Schmidt : Thirumalai, *Rec. zool. Surv. India*, **84**(1-4) : 15.

1903a. *Ptilomera laticaudata* (Hardwicke) : Distant, *Fauna British India*, **2** : 185 (Fig. 133).

1926. *Ptilomera lachne* Schmidt, *Ent. Mitt.*, **15**(1) : 64.

Distribution : (1) Karnataka; (2) Kerala; (3) Maharashtra; (4) Tamilnadu.

67. *Ptilomera (Ptilomera) assamensis* Hungerford & Matsuda, 1965

1965. *Ptilomera (Ptilomera) assamensis* Hungerford & Matsuda, *Kans. Univ. Sci. Bull.*, **45**(5) : 421.

Distribution : (1) Arunachal Pradesh; (2) Assam.

68. *Ptilomera (Ptilomera) laticaudata* (Hardwicke, 1823)

1823. *Gerris laticaudata* Hardwicke, *Trans. Linn. Soc. London*, **14** : 134.

1843. *Ptilomera laticaudata* (Hardwicke) : Amyot & Serville, *Histoire naturelle des insectes Hemipteres*, 414.

1903a. *Ptilomera laticaudata* (Hardwicke) : Distant, *Fauna British India*, **2** : 185. (Fig. 133 is *P. agroides*)

1960. *Ptilomera (Ptilomera) laticaudata* (Hardwicke) : Matsuda, *Kans. Univ. Sci. Bull.*, **41**(2) : 269.

1965. *P. (Ptilomera) laticaudata* (Hardwicke) : Hungerford & Matsuda, *Kans. Univ. Sci. Bull.*, **45**(5) : 415.

Distribution : (1) Arunachal Pradesh; (2) Himachal Pradesh; (3) Meghalaya; (4) Orissa; (5) Sikkim; (6) West Bengal.

69. *Ptilomera (Ptilomera) tigrina* Uhler, 1860

1860. *Ptilomera tigrina* Uhler, *Proc. Acad. nat. Sci. Philadelphia*, **12** : 230.

1965. *Ptilomera (Ptilomera) tigrina* Uhler : Hungerford & Matsuda, *Kans. Univ. Sci. Bull.*, **45**(5) : 462.

1926. *Ptilomera harpyia* Schmidt, *Ent. Mitt.*, **15**(1) : 65.

Distribution : (1) Andaman & Nicobar Islands.

Genus *Rheumatogonus* Kirkaldy, 190970. *Rheumatogonus burmanus* (Distant, 1910)

1910a. *Jucundus burmanus* Distant, *Ann. Mag. nat. Hist.*, **5**(8) : 143.

1960. *Rheumatogonus burmanus* (Distant) : Matsuda, *Kans. Univ. Sci. Bull.*, **41**(2) : 283.

Distribution : (1) Arunachal Pradesh.

71. *Rheumatogonus custodiendus* (Distant, 1910)

1910a. **Jucundus costodiendus* Distant, *Ann. Mag. nat. Hist.*, **5**(8) : 143.

*Dissolved from synonymy with *R. custodiendus* Zettel & Thirumalai (Press)

Distribution : (1) Karnataka; (2) Kerala.

Subfamily RHAGADOTARSINAE

Genus *Rhagadotarsus* Breddin, 1905Subgenus *Rhagadotarsus* Breddin, 190572. *Rhagadotarsus (Rhagadotarsus) kraepelini* Breddin, 1905

1905. *Rhagadotarsus kraepelini* Breddin, *Mitt. Naturhist. Mus. Hamb.*, **22** : 137.

1960. *R. (Rhagadotarsus) kraepelini* Breddin : Matsuda, *Kans. Univ. Sci. Bull.*, **41**(2) : 322.

1993. *R. (Rhagadotarsus) kraepelini* Breddin : Polhemus & Karunaratne, *Bull. Raffles Mus. (Zoology)*, **41**(1) : 100.

1910a. *Nacebus dux* Distant, *Ann. Mag. nat. Hist.*, **5**(8) : 152.

Distribution : (1) Andhra Pradesh; (2) Arunachal Pradesh; (3) Karnataka; (4) Kerala; (5) Pondicherry; (6) Tamilnadu; (7) West Bengal.

Subfamily TREPOBATINAE

Genus *Calyptobates* Polhemus & Polhemus, 1994

73. *Calyptobates andaman* Polhemus & Polhemus, 1994

1994. *Calyptobates andaman* Polhemus & Polhemus, *Ent. Scand.*, **25**(3) : 338.

Distribution : (1) Andaman & Nicobar Islands.

Genus *Cryptobates* Esaki, 1929

74. *Cryptobatus raja* (Distant, 1910)

1910a. *Gerris raja* Distant, *Ann. Mag. nat. Hist.*, **5**(8) : 142.

1929. *Cryptobatus raja* (Distant) : Esaki, *Ann. Mag. nat. Hist.*, **4**(10) : 412.

1995a. *Cryptobatus raja* (Distant) : Polhemus & Polhemus, *Ent. Scand.*, **26**(1) : 104.

Distribution : (1) Kerala.

Genus *Gnomobates* Polhemus & Polhemus, 1995a.

75. *Gnomobates kuiterti* (Hungerford & Matsuda, 1958)

1958c. *Cryptobates kuiterti* Hungerford & Matsuda, *J. Kans. Ent. Soc.*, **31**(4) : 246.

1995a. *Gnomobates kuiterti* (Hungerford & Matsuda) : Polhemus & Polhemus, *Ent. Scand.*, **26**(1) : 108.

Distribution : (1) Karnataka.

Genus *Naboandelus* Distant, 1910

76. *Naboandelus signatus* Distant, 1910

1910a. *Naboandelus signatus* Distant, *Ann. Mag. nat. Hist.*, **5**(8) : 151.

In press. *Naboandelus signatus* Distant : Thirumalai & Venkatraman, *Rec. zool. Surv. India*.

Distribution : (1) Karnataka; (2) Pondicherry; (3) Tamilnadu; (4) Uttar Pradesh; (5) West Bengal.

Family VELIIDAE

Subfamily HALOVELIINAE

Genus *Halovelis* Bergroth, 1893

1. *Halovelis* sp* Andersen & Foster, 1992.

Distribution : (1) Goa.

*Remarked as new to Science but not yet described.

Genus *Strongylovelia* Easki, 1924

2. *Strongylovelia* sp.

Distribution : (1) Karnataka (fresh water species); (2) Tamilnadu.

3. *Strongylovelia* sp. * Polhemus & Starmuhlner, 1990

Distribution : (1) Andaman & Nicobar Islands (marine species).

*Remarked as new to Science but not yet described.

Genus *Xenobates* Easki, 1924

4. *Xenobates* sp*. Andersen & Foster, 1992.

Distribution : (1) Tamilnadu.

*Not yet described but remarked as new to Science.

Subfamily MICROVELIINAE

Genus *Aquulavelia* Thirumalai, 1999

5. *Aquulavelia occulta* Thirumalai, 1999

1999b. *Aquulavelia occulta* Thirumalai, *Rec. zool. Surv. India*, **97**(3) : 206.

Distribution : (1) Arunachal Pradesh.

6. *Aquulavelia* sp*

Distribution : (1) Madhya Pradesh.

*Polhemus Personal Communication.

Genus *Baptisa* Distant, 1903a

7. *Baptisa angulata* Andersen, 1989

1989. *Baptisa angulata* Andersen, *Ent. Scand.*, **19** : 373.

Distribution : (1) Karnataka.

Genus *Microvelia* Westwood, 1834

Subgenus *Microvelia* Westwood, 1834

8. *Microvelia (Microvelia) annandalei* Distant, 1909

1909. *Microvelia annandalei* Distant, *Ann. Mag. nat. Hist.*, **3**(8) : 501.

1989. *Microvelia annandalei* Distant : Thirumalai, *Misc. Occ. Pap. Rec. zool. Surv. India*, **118** : 52.

Distribution : (1) Tamilnadu; (2) West Bengal.

9. *Microvelia (Microvelia) atromaculata* Paiva, 1919

1919b. *Microvelia atromaculata* Paiva, *Rec. Indian. Mus.*, **16**(3) : 362.

Distribution : (1) Meghalaya.

10. *Microvelia (Microvelia) diluta* Distant, 1909

1909. *Microvelia diluta* Distant, *Ann. Mag. nat. Hist.*, **3**(8) : 500.

1995b. *Microvelia (Microvelia) diluta* Distant : Andersen, *Cat. Het. Palaearctic Region*, **1** : 87.

1989. *Microvelia diluta* Distant : Thirumalai, *Rec. zool. Surv. India, Misc. Occ. Pap.* **118** : 52.

Distribution : (1) Bihar; (2) Delhi; (3) Maharashtra; (4) Meghalaya; (5) Orissa; (6) Tamilnadu; (7) Tripura; (8) West Bengal.

11. *Microvelia (Microvelia) douglasi* Scott, 1874

1874. *Microvelia douglasi* Scott, *Ann. Mag. nat. Hist.*, **14** : 448.

1995b. *Microvelia (Microvelia) douglasi* Distant : Andersen, *Cat. Het. Palaearctic Region*, **1** : 87.

1994a. *Microvelia douglasi* Scott : Thirumalai, *Rec. zool. Surv. India, Misc. Occ. Pap.* **165** : 40.

1903a. *Microvelia repentiana* Distant, *Fauna British India*, **3** : 174.

1909. *M. kumaonensis* Distant, *Ann. Mag. nat. Hist.*, **3**(8) : 500.

Distribution : (1) Andaman & Nicobar Islands; (2) Arunachal Pradesh; (3) Kerala; (4) Karnataka; (5) Maharashtra; (6) Orissa; (7) Tamilnadu; (8) Uttar Pradesh; (9) West Bengal.

12. *Microvelia (Microvelia) javadiensis* Thirumalai, 1989

1989. *Microvelia (Microvelia) javadiensis* Thirumalai, *Misc. Occ. Pap. Rec. zool. Surv. India*, **118** : 53.

Distribution : (1) Tamilnadu.

13. *Microvelia (Microvelia) lineatipes* Paiva, 1919

1919b. *Microvelia lineatipes* Paiva, *Rec. Indian. Mus.*, **16**(3) : 362.

Distribution : (1) Meghalaya.

14. *Microvelia (Microvelia) santala* Hafiz & Ribeiro, 1939

1939. *Microvelia santala* Hafiz & Ribeiro, *Rec. Indian Mus.*, **41**(4) : 424.

Distribution : (1) Bihar; (2) Tamilnadu.

Genus *Neoalardus* Distant, 1912

15. *Neoalardus typicus* (Distant, 1903)

1903b. *Alardus typicus* Distant, *Fascicula Malayenses, Zool.*, **2** : 219.

1912. *Neoalardus typicus* (Distant) : Distant, *Ann. Mag. nat. Hist.*, **9**(8) : 471.

Distribution : (1) Andaman & Nicobar Islands.

Genus *Pseudovelgia* Hoberlandt, 1950

Subgenus *Pseudovelgia* Hoberlandt, 1950

16. *Pseudovelgia (Pseudovelgia) sexualis* (Paiva, 1917)

1917. *Micronecta (Kirkaldya) sexualis* Paiva, *Mem. Asiatic Soc. Bengal*, **6** : 77.

1983. *Pseudovelgia (Pseudovelgia) sexualis* (Paiva) : Andersen, *Ent. Scand.*, **14** : 256.

Distribution : (1) Assam; (2) Karnataka.

Subfamily PERITTOPINAE

Genus *Perittopus* Fieber, 1861

17. *Perittopus campbelli* Lundblad, 1934

1934. *Perittopus campbelli* Lundblad, *Arch. Hydrobiol. Suppl.*, **4** : 304.

Distribution : (1) Tamilnadu.

18. *Perittopus horvathi* Lundblad, 1934

1934. *Perittopus horvathi* Lundblad, *Arch. Hydrobiol. Suppl.*, **4** : 306.

1989. *Perittopus horvathi* Lundblad : Thirumalai, *Rec. zool. Surv. India, Misc. Occ. Pap.* **118** : 49.

Distribution : (1) Tamilnadu.

19. *Perittopus maculatus* Paiva, 1919

1919b. *Perittopus maculatus* Paiva, *Rec. Indian Mus.*, **16** : 364.

Distribution : (1) Meghalaya; (2) Mizoram.

Subfamily RHAGOVELIINAE

Genus *Rhagovelgia* Mayr, 1865

Subgenus *Neorhagovelgia* Matsuda, 1956

20. *Rhagovelgia (Neorhagovelgia) andaman* Polhemus, 1990

1990. *Rhagovelgia andaman* Polhemus, *Raffl. Bull. Zool.*, **38**(1) : 67.

Distribution : (1) Andaman & Nicobar Islands.

21. *Rhagovelia* (*Neorhagovelia*) *nilgiriensis* Thirumalai, 19941994b. *Rhagovelia* (*Neorhagovelia*) *nilgiriensis* Thirumalai, *Rec. zool. Surv. India*, **94**(2-4) : 390.*Distribution* : (1) Tamilnadu.22. *Rhagovelia* (*Neorhagovelia*) *sumatrensis* Lundblad, 19361934. *Rhagovelia femorata* var. *sumatrensis* Lundblad, *Arch Hydrobiol. Suppl.*, **4** : 287.1936. *Rhagovelia sumatrensis* Lundblad, *Ark. Zool.*, **28**(21) : 19.*Distribution* : (1) Andaman & Nicobar Islands; (2) Sikkim.23. *Rhagovelia* (*Neorhagovelia*) sp.*Distribution* : (1) Arunachal Pradesh.24. *Rhagovelia* (*Neorhagovelia*) sp.*Distribution* : (1) Karnataka.Subgenus *Rhagovelia* Mayr, 186525. *Rhagovelia* (*Rhagovelia*) *ceylanica* Lundblad, 19361936. *Rhagovelia ceylanica* Lundblad, *Ark. Zool.*, **28**(21) : 32.1910b. *Rhagovelia nigricans* (Burmeister) : Distant, *Fauna British India*, **5** : 132.1989. *R. (Rhagovelia) ceylanica* Lundblad : Thirumalai, *Rec. zool. Surv. India, Misc. Occ. Pap.* **118** : 51.1994b. *R. (Rhagovelia) ceylanica* Lundblad : Thirumalai, *Rec. zool. Surv. India*, **94**(2-4) : 386.*Distribution* : (1) Assam; (2) Bihar; (3) Himachal Pradesh; (4) Kerala; (5) Maharashtra; (6) Meghalaya; (7) Orissa; (8) Punjab; (9) Tamilnadu; (10) Uttar Pradesh.**Note** : The report on *Rhagovelia* (*R. nigricans*) (Burmister) from India refers to *R. (R.) ceylanica*.26. *Rhagovelia* (*Rhagovelia*) *tibialis* Lundblad, 19361936. *Rhagovelia tibialis* Lundblad, *Ark. Zool.*, **28**(21) : 31.1994b. *R. (Rhagovelia) tibialis* Lundblad : Thirumalai, *Rec. zool. Surv. India*, **94**(2-4) : 382.*Distribution* : (1) Karnataka; (2) Kerala; (3) Tamilnadu.Genus *Tetraripis* Lundblad, 193627. *Tetraripis asymmetricus* Polhemus & Karunaratne, 19791979. *Tetraripis asymmetricus* Polhemus & Karunaratne, *Bull. Fish. Res. Stn., Sri Lanka*, **29** : 99.1996. *Tetraripis asymmetricus* Polhemus & Karunaratne : Thirumalai & Dam, *Hexapoda*, **8**(2) : 67.*Distribution* : (1) Karnataka; (2) Tamilnadu.

Subfamily VELIINAE

Genus *Angilovelina* Andersen, 198128. *Angilovelina y-alba* (Paiva, 1918)1918. *Velia y-alba* Paiva, *Rec. Indian Mus.*, **14** : 20.1981b. *Angilovelina y-alba* (Paiva) : Andersen, *Ent. Scand.*, **12** : 341.*Distribution* : (1) Assam.Genus *Velia* Latreille, 1804Subgenus *Plesiovelia* Tamanini, 195529. *Velia (Plesiovelia) affinis affinis* Kolenati, 18571857. *Velia. currens* var. *affinis* Kolenati, (original not seen) : as quoted in Andersen, 1995b. *Cat. Heteroptera Palaearctic region*, **1** : 93.1981b. *Velia (Plesiovelia) affinis* Kolenati : Andersen, *Ent. Scand.*, **12** : 352.*Distribution* : (1) Punjab.30. *Velia (Plesiovelia) affinis marussi* Tamanini, 19571957. *Velia affinis marussi* Tamanini, *Atti Mus. civ. Stor. nat. Trieste*, **21** : 32.1995b. *Velia affinis marussi* Tamanini : Andersen, *Cat. Heteroptera Palaearctic region*, **1** : 94.*Distribution* : (1) Jammu & Kashmir.Subgenus *Haldwania* Tamanini, 195531. *Velia (Haldwania)* sp. Andersen, 1981*Distribution* : (1) Sikkim.

Family HEBRIDAE

Subfamily HEBRINAE

Genus *Hebrus* Curtis, 1833Subgenus *Hebrus* Curtis, 18331. *Hebrus (Hebrus) bengalensis* Distant, 19091909. *Hebrus bengalensis* Distant, *Ann. Mag. nat. Hist.*, **3(8)** : 497.*Distribution* : (1) West Bengal.

2. *Hebrus (Hebrus) bombayensis* Paiva, 1919

1919a. *Hebrus bombayensis* Paiva, *Rec. Indian Mus.*, **16**(1) : 152.

Distribution : (1) Maharashtra.

Genus *Neotimasius* Andersen, 1981

3. *Neotimasius orientalis* Andersen, 1981

1981a. *Neotimasius orientalis* Andersen, *Syst. Entomol.*, **6** : 405.

Distribution : (1) Karnataka; (2) Tamilnadu.

Genus *Timasius* Distat, 1909

4. *Timasius championi* Andersen, 1981

1981a. *Timasius championi* Andersen, *Syst. Entomol.*, **6** : 402.

Distribution : (1) Uttar Pradesh.

5. *Timasius falcifer* Andersen, 1981

1981a. *Timasius falcifer* Andersen, *Syst. Entomol.*, **6** : 400.

Distribution : (1) Uttar Pradesh.

6. *Timasius himalayensis* Andersen, 1981

1981a. *Timasius himalayensis* Andersen, *Syst. Entomol.*, **6** : 403.

Distribution : (1) Uttar Pradesh.

7. *Timasius major* Andersen, 1981

1981a. *Timasius major* Andersen, *Syst. Entomol.*, **6** : 397.

Distribution : (1) Punjab; (2) Uttar Pradesh.

8. *Timasius minor* Andersen, 1981

1981a. *Timasius minor* Andersen, *Syst. Entomol.*, **6** : 394.

Distribution : (1) Uttar Pradesh.

9. *Timasius rupestris* Andersen, 1981

1981a. *Timasius rupestris* Andersen, *Syst. Entomol.*, **6** : 400.

Distribution : (1) Uttar Pradesh; (2) Himachal Pradesh.

10. *Timasius spinifer* Andersen, 1981

1981a. *Timasius spinifer* Andersen, *Syst. Entomol.*, **6** : 400.

Distribution : (1) Tamilnadu.

11. *Timasius splendens* Distant, 19091909. *Timasius splendens* Distant, *Ann. Mag. nat. Hist.*, **3**(9) : 499.1981a. *Timasius splendens* Distant : Andersen, *Syst. Entomol.*, **6** : 392.*Distribution* : (1) Karnataka; (2) Tamilnadu.12. *Timasius ventralis* Andersen, 19811981a. *Timasius ventralis* Andersen, *Syst. Entomol.*, **6** : 399.*Distribution* : (1) Uttar Pradesh.

Subfamily HYRCANINAE

Genus *Hyrcanus* Distant, 191013. *Hyrcanus capitatus* Distant, 19101910b. *Hyrcanus capitatus* Distant, *Fauna British India*, **5** : 134.1981a. *Hyrcanus capitatus* Distant : Andersen, *Syst. Entomol.*, **6** : 408.*Distribution* : (1) Himachal Pradesh; (2) Meghalaya; (3) Punjab; (4) Sikkim; (5) Uttar Pradesh.14. *Hyrcanus dispar* Andersen, 19811981a. *Hyrcanus dispar* Andersen, *Syst. Entomol.*, **6** : 409.*Distribution* : (1) Uttar Pradesh.15. *Hyrcanus reichli* Zettel, 19981998. *Hyrcanus reichli* Zettel, *Stapfia*, **55** : 597.*Distribution* : (1) Kerala.

Family MESOVELIIDAE

Subfamily MESOVELIINAE

Genus *Mesovelia* Mulsant & Rey, 18521. *Mesovelia horvathi* Lundblad, 19341934. *Mesovelia horvathi* Lundblad, *Arch. Hydrobiol. Suppl.*, **12** : 190.1994a. *Mesovelia horvathi* Lundblad : Thirumalai, *Rec. zool. Surv. India, Misc. Occ. Pap.* **165** : 26.*Distribution* : (1) Tamilnadu.2. *Mesovelia indica* Horvath, 19151915. *Mesovelia indica* Horvath, *Annl. naturh. Mus. Hung.*, **13** : 553.*Distribution* : (1) Tamilnadu.

3. *Mesovelis vittigera* Horvath 1895

1895. *Mesovelis vittigera* Horvath *Revue. ent.*, **14** : 160.

1994a. *Mesovelis vittigera* Horvath : Thirumalai, *Rec. zool. Surv. India, Misc. Occ. Pap.* **165** : 28.

1903a. *Mesovelis mulsanti* White : Distant, *Fauna British India*, **2** : 169.

1901b. *Mesovelis orientalis* Kirkaldy, *Annali Mus. civ. Stor. Nat. Giacomo Doria*, **20** : 808.

Distribution : (1) Andaman & Nicobar Islands; (2) Arunachal Pradesh; (3) Bihar; (4) Karnataka; (5) Kerala; (6) Maharashtra; (7) Orissa; (8) Pondicherry; (9) Tamilnadu; (10) Uttar Pradesh; (11) West Bengal.

Family HYDROMETRIDAE

Subfamily HYDROMETRINAE

Genus *Hydrometra* Latreille, 1796

1*. *Hydrometra bifurcata* ? Hungerford and Evans, 1934

1934. *Hydrometra bifurcata* Hungerford and Evans, *Ann. Mag. nat. Hist.*, **28** : 43.

Distribution : (1) Tamilnadu.

***Note** : This identification is based on a single female specimen collected from Nilgiris by the author. Dr J. T. Polhemus comments that this species is probably either *Hydrometra seychellensis* Polhemus & Polhemus or *H. kahallensis* Gunawardane & Karunaratne or new to science.

2. *Hydrometra butleri* Hungerford and Evans, 1934

1934. *Hydrometra butleri* Hungerford and Evans, *Ann. Mag. nat. Hist.*, **28** : 71.

1994a. *Hydrometra butleri* Hungerford and Evans : Thirumalai, *Rec. zool. Surv. India, Misc. Occ. Pap.* **165** : 29.

Distribution : (1) Karnataka; (2) Kerala; (3) Orissa; (4) Tamilnadu.

3. *Hydrometra greeni* Kirkaldy, 1898.

1898. *Hydrometra greeni* Kirkaldy, *Entomologist*, **31** : 2.

1994a. *Hydrometra greeni* Kirkaldy : Thirumalai, *Rec. zool. Surv. India, Misc. Occ. Pap.* **165** : 29.

1995b. *Hydrometra greeni* Kirkaldy : Polhemus & Polhemus, *Bishop. Mus. Occ. Pap.*, **43** : 22.

1903a. *Hydrometra vittata* (Stal) : Distant, *Fauna British India*, **2** : 170.

Distribution : (1) Andaman & Nicobar Islands; (2) Arunachal Pradesh; (3) Assam; (4) Bihar; (5) Gujarat; (6) Karnataka; (7) Kerala; (8) Maharashtra; (9) Orissa; (10) Pondicherry; (11) Rajasthan; (12) Tamilnadu; (13) Uttar Pradesh; (14) West Bengal.

In addition, the following species of *Halobates* are known from the Indian territorial waters viz., *H. galatea* from Arabian Sea; *H. germanus* from Arabian Sea and Bay of Bengal and *H. micanus* from Indian Ocean.

CONCLUSION

Out of the 32 political divisions recognised in the Indian Union, 5 families (Hebridae, Hydrometridae, Gerridae, Mesoveliidae and Veliidae) occur in Karnataka, Kerala, Maharashtra, Tamilnadu, Uttar Pradesh and West Bengal; 4 families (Hydrometridae, Gerridae, Mesoveliidae and Veliidae) in Andaman & Nicobar Islands, Arunachal Pradesh, Bihar and Orissa; 3 families in Assam (Hydrometridae, Gerridae and Veliidae), Himachal Pradesh, Meghalaya, Punjab, Sikkim (Hebridae, Gerridae and Veliidae) and Pondicherry (Hydrometridae, Gerridae and Mesoveliidae); 2 families in Delhi, Goa, Jammu & Kashmir, Madhya Pradesh, Tripura (Gerridae and Veliidae) and Rajasthan (Hydrometridae and Gerridae); and 1 family in Andhra Pradesh, Haryana (Gerridae), Gujarat (Hydrometridae) and Mizoram (Veliidae). There is no authentic record of Gerromorpha from the remaining 6 political divisions. The distribution of Gerromorpha species so far known from India is presented in the Table 1. Out of 128 species so far recorded, the highest number of species namely, 42, accommodated in 25 genera occur in Tamilnadu followed by Karnataka which harbours 39 species under 25 genera. Further, it is interesting to note that more than 50% of Gerromorpha are found in the states where Western Ghats run through. This is perhaps due to the complex assemblage of ecosystems that harbour diverse faunal constituents (Thirumalai & Krishnan, 2000).

As checklists of provincial areas are of immense value in diversity studies (Daniels, 1997), the present study provides the baseline data to the functional aspects of fresh water communities. Because of their poor dispersal capability, these bugs serve as zoogeographical indicators (Hungerford & Matsuda, 1958d). Figure 1 indicates the necessity for exploration. Needless to say, that the hard-core taxonomy forms a base line work for a meaningful approach to issues concerning biodiversity (Ananthakrishnan, 1999).

ADDENDUM

Since the completion of manuscript, following additions have been made:

Family GERRIDAE

Subfamily PTILOMERINAE

Genus *Stridulobates* Zettel & Thirumalai, 2001

Stridulobates anderseni Zettel & Thirumalai, 2001

Distribution : (1) Karnataka; (2) Kerala.

***Stridulobates nostras* (Thirumalai, 1986)**

Distribution : (1) Karnataka; (2) Kerala.

Hitherto known as *Rheumatogonus custodiendus* (Distant, 1910) from Southern India are to be known as *Jucundus custodiendus* Distant, 1910 (Zettel & Thirumalai, in Press).

CHANDIGARH

1. *Neogerris parvula* (Stal, 1859)
2. *Limnogonus (Limnogonus) fossarum fossarum* (Fabricius, 1775)
3. *Limnogonus (Limnogonus) nitidus* (Mayr, 1865)
4. *Metrocoris communis* (Distant, 1910)
5. *Microvelia (Microvelia) douglasi* Scott, 1874
6. *Mesovelia vittigera* Horvath 1895

HIMACHAL PRADESH

1. *Neogerris parvula* (Stal, 1859)
2. *Limnogonus (Limnogonus) nitidus* (Mayr, 1865)
3. *Heterobates rihandi* (Pradhan, 1950)
4. *Metrocoris communis* (Distant, 1910)
5. *Ptilomera (Proptilomera) himalayensis* Hungerford & Matsuda, 1958
6. *Microvelia (Microvelia) douglasi* Scott, 1874
7. *Mesovelia vittigera* Horvath 1895
8. *Hydrometra butleri* Hungerford and Evans, 1934
9. *Hydrometra greeni* Kirkaldy, 1898

PUNJAB

1. *Amemboa (Amemboa) sp.*
2. *Aquarius adalaidis* (Dohrn, 1860)
3. *Neogerris parvula* (Stal, 1859)
4. *Limnogonus (Limnogonus) fossarum fossarum* (Fabricius, 1775)
5. *Microvelia (Microvelia) diluta* Distant, 1909
6. *Metrocoris communis* (Distant, 1910)
7. *Microvelia (Microvelia) douglasi* Scott, 1874
8. *Mesovelia vittigera* Horvath 1895
9. *Hydrometra greeni* Kirkaldy, 1898.

RAJASTHAN

1. *Amemboa (Amemboa) sp.*
2. *Mesovelia vittigera* Horvath 1895

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TABLE : 1. DISTRIBUTION OF GERROMORPHA IN INDIAN STATES

S.NO	NAME OF THE SPECIES	AN	AP	AR	AS	BI	DE	GO	GU	HA	HP	JK	KA	KE	MP	MR	MG	MI	OR	PO	PU	RA	SI	TN	TR	UP	WB
1	Amemboa (Amemboa) dentata																									P	
2	Amemboa (Amemboa) kumari												P	P					P					P			
3	Amemboa (Amemboides) perlata												P														
4	Angilovelvia Yalba				P																						
5	Aquarius adelaidis		P			P							P	P		P			P			P		P		P	P
6	Aquarius paludum paludum																P										
7	Aquulavelia occulta			P																							
8	Aquulavelia sp.														P												
9	Asclepios annandalei																							P			P
10	Baptista angulata												P														
11	Calyptobates andaman	P																									
12	Chimarrhometra orientalis			P	P						P	P					P									P	P
13	Cryptobates raja													P													
14	Cylindrostethus productus												P	P	P	P			P		P			P		P	P
15	Cylindrostethus scrutator				P																						
16	Eotrechus brevipes			P																				P			P
17	Eotrechus kalidasa																P										
18	Eotrechus longipes			P																						P	P
19	Eotrechus terrestris																						P				P
20	Gerris (Gerris) nepalensis			P								P											P			P	
21	Gerris (Gerris) sahlbergi											P														P	
22	Gerris (Gerris) thoracicus											P															
23	Gerris (Macrogerris) gracilicornis			P	P																		P			P	P
24	Gnomobates kuiterti												P														
25	Halobates elephanta	P														P											
26	Halobates flaviventris																							P			

TABLE : 1. Cont'd.

S.NO	NAME OF THE SPECIES	AN	AP	AR	AS	BI	DE	GO	GU	HA	HP	JK	KA	KE	MP	MR	MG	MI	OR	PO	PU	RA	SI	TN	TR	UP	WB
27	Halobates formidabilis	P	P													P			P								
28	Halobates galatea							P								P											
29	Halobates germanus	P																									
30	Halobates hayanus	P																									
31	Halobates micanus	P																									
32	Halobates proavus	P																									
33	Halobates trynae	P																									
34	Halovelia sp							P																			
35	Hebrus bengalensis																										P
36	Hebrus bombayensis															P											
37	Heterobates bilobates																									P	
38	Heterobates rihandi			P																						P	
39	Hydrometra bifurcata ?																							P			
40	Hydrometra butleri												P	P					P					P			
41	Hydrometra greeni	P		P	P	P			P				P	P		P			P	P		P		P		P	P
42	Hyrcaus capitatus										P						P				P		P			P	
43	Hyrcaus dispar																									P	
44	Hyrcaus reichli													P													
45	Limnogonus (Limnogonus) fossarum fossarum	P	P	P	P	P	P	P		P	P	P	P	P	P	P			P	P		P		P			P
46	Limnogonus (Limnogonus) hungerfordi	P																									
47	Limnogonus (Limnogonus) nitidius	P		P	P	P	P						P	P					P			P		P	P	P	P
48	Limnogonus (Limnogonus) pectoralis												P														
49	Limnometra anadyomene												P	P										P			
50	Limnometra fluviorum												P	P		P				P				P			P
51	Limnometra minuta	P																									
52	Mesovelia horvathi																							P			

TABLE : 1. Cont'd.

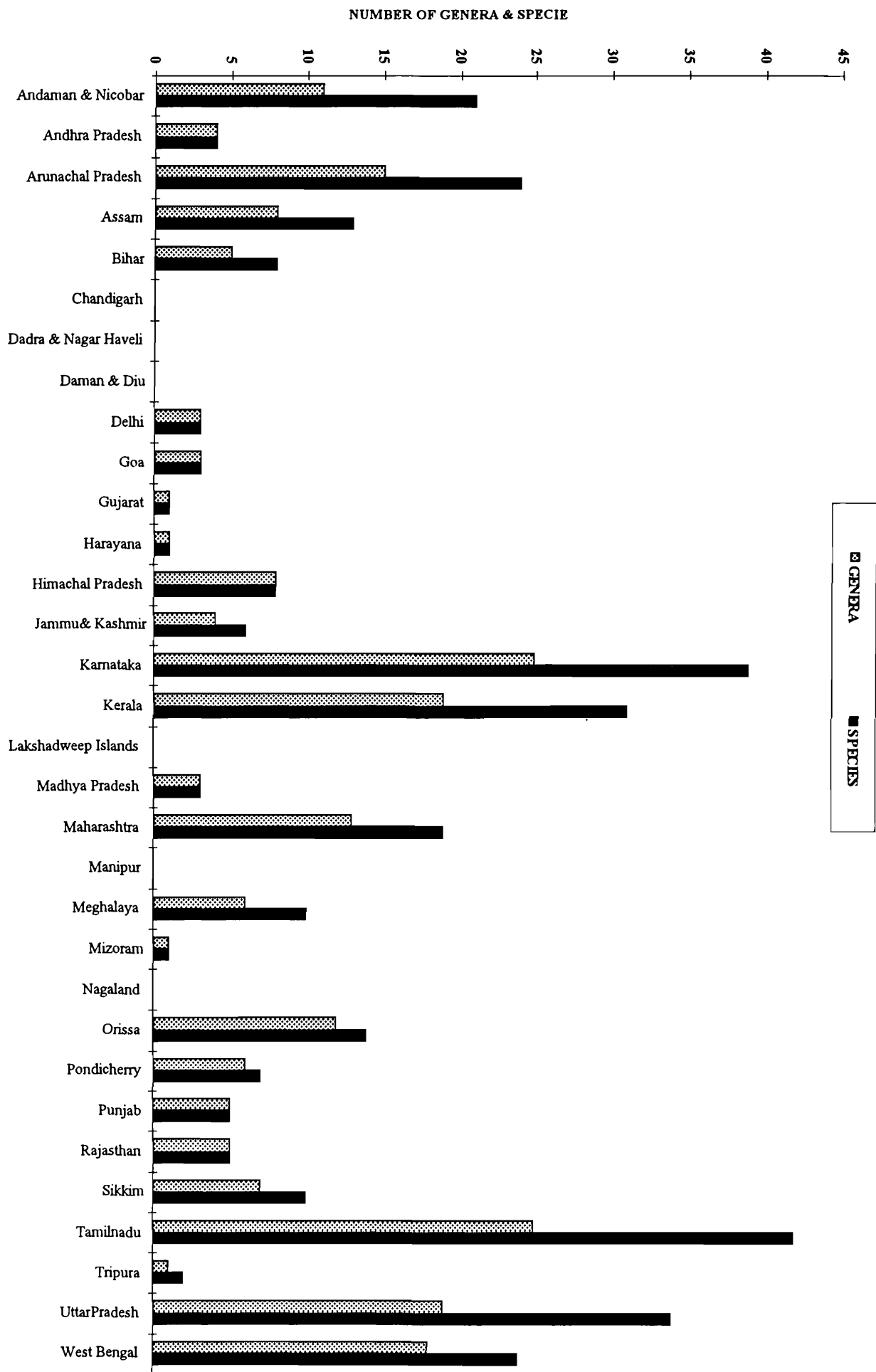
S.NO	NAME OF THE SPECIES	AN	AP	AR	AS	BI	DE	GO	GU	HA	HP	JK	KA	KE	MP	MR	MG	MI	OR	PO	PU	RA	SI	TN	TR	UP	WB
53	Mesovelvia indica																						P				
54	Mesovelvia vittigera	P		P		P							P	P		P			P	P				P		P	P
55	Metrocoris anderseni																									P	
56	Metrocoris communis												P			P								P		P	
57	Metrocoris communoides																							P			
58	Metrocoris compar			P							P												P			P	P
59	Metrocoris demvickyi													P													
60	Metrocoris falcatus																									P	
61	Metrocoris femoratus				P																						
62	Metrocoris indicus												P	P		P								P			
63	Metrocoris malabaricus												P	P													
64	Metrocoris nepalensis			P																						P	
65	Metrocoris tenuicornis			P	P																					P	
66	Metrocoris variegans												P	P													
67	Metrocoris vamentus													P										P			
68	Microvelia (Microvelia) annandalei																							P			P
69	Microvelia (Microvelia) diluta					P	P									P	P		P					P	P		P
70	Microvelia (Microvelia) douglasi	P		P									P	P		P			P					P		P	P
71	Microvelia (Microvelia) javadiensis																							P			
72	Microvelia (Microvelia) santala					P																		P			
73	Microvelia atromaculata																P										
74	Microvelia lineatipes																P										
75	Nabondelus signatus												P							P				P		P	P
76	Neolardus typicus	P																									
77	Neogerris parvula			P	P								P	P					P	P				P		- P	P
78	Neotimasius orientalis												P											P			

TABLE : 1. *Cont'd.*

S.NO	NAME OF THE SPECIES	AN	AP	AR	AS	BI	DE	GO	GU	HA	HP	JK	KA	KE	MP	MR	MG	MI	CR	PO	PU	RA	SI	TN	TR	UP	WB
105	Rheumatogonus custodiendus												P	P													
106	Strongylovelia sp (marine)	P																									
107	Strongylovelia sp (freshwater)												P											P			
108	Tarsotrechus polhemi												P	P													
109	Tenagogonus ceylonensis												P														
110	Tenagogonus nicobarensis	P																									
111	Tetraripis asymmetricus												P											P			
112	Timasius championi																									P	
113	Timasius falcifer																									P	
114	Timasius himalayensis																									P	
115	Timasius major																				P					P	
116	Timasius minor																									P	
117	Timasius rupestris										P															P	
118	Timasius spinifer																							P			
119	Timasius splendens												P											P			
120	Timasius ventralis																									P	
121	Velia (Haldwani) sp																						P				
122	Velia (Plesiovelia) affinis affinis																				P						
123	Velia (Plesiovelia) affinis marussi											P															
124	Ventidius (Ventidiodes) kuiterti			P																							
125	Ventidius (Ventidius) aquarius												P	P										P			
126	Ventidius (Ventidius) sushmae																										P
127	Ventidius modulatus			P																							
128	Xenobates sp																							P			

AN-Andaman & Nicobar Islands; AP-Andhra Pradesh; AR-Arunachal Pradesh; AS-Assam; BI-Bihar; DE-Delhi; GO-Goa; GU-Gujarat; HA-Haryana; HP-Himachal Pradesh; JK-Jammu & Kashmir; KA-Karnataka; KE-Kerala; MP-Madhya Pradesh; MR-Maharashtra; MG-Meghalaya; MI-Manipur; OR-Orissa; PO-Pondicherry; PU-Punjab; RA-Rajasthan; SI-Sikkim; TN-Tamilnadu; TR-Tripura; UP-Uttar Pradesh; WB-West Bengal.

Fig. 1. Statewise Distribution of Genera & Species of Gerromorpha in India.



RESUSCITATION OF *TRICHORYPHA* SCHÖTT, 1893 (COLLEMBOLA : ENTOMOBRYIDAE)

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INTRODUCTION

The genus *Trichorypha* is long known to be a synonym of *Paronella* Schött, 1893. It was established by Schött (1893) with the type-species *Trichorypha atrofasciata* simultaneously with two other genera, viz. , *Paronella* and *Campylothorax* from Cameroons, Africa. He understood the striking difference in the mucronal structure of *Paronella* and *Trichorypha* and thus established the genus.

Schäffer (1898) considered *Trichorypha* as identical with *Paronella*. Schött (1901), however, opined that a precise investigation is needed to confirm Schaffer's contention. In the same publication, he further mentioned that *T. atrofasciata* possessed 8+8 ocelli and not 6+6, as noted by him earlier (Schött, 1893) [vide, foot-note, p. 322].

Schött (1903, 1927), however, synonymised *Trichorypha* with *Paronella* and thus treated the species *atrofasciata* under *Paronella*. Denis (1933), Womersley (1934) and Salmon (1964, 1965) accepted this synonymisation of *Trichorypha* with *Paronella* and they placed *atrofasciata* under the genus *Paronella*.

Schött's (1903) justifications as to the synonymisation of *Trichorypha* with *Paronella* are not sound. It is now evident from this study that Schött was not aware of many outstanding characters possessed by *Paronella fusca* (type species of *Paronella* Schött, 1893) which are altogether absent in *Trichorypha* (Mitra, 1992). *Trichorypha* Schött, as the present study on the basis of syntypes of *Trichorypha atrofasciata* reveals, is a good genus in the possession of many characteristics which do not agree in any way either with *Paronella* or *Dicranocentruga*. A few of such characters are as follows : (i) large paronelline body facies with antennae longer than body; (ii) extra ocular structure absent; (iii) absence of distinct spines on manubrium and dentes being armed with single row of dental spines transiting distally into stiff setae; (iv) number and nature of macrochaetae anteriorly on the anterior face of ventral tube and (v) structure of ungues and mucrones.

Trichorypha is a valid genus and it is to be resuscitated owing to the nature of scalesclothing body, absence of flexed obliquely truncated macrochaetae (achaetoid body), absence of extra ocular structure in addition to the other characters, mentioned above. A redefinition of the genus is given below.

Genus *Trichorypha* Schött, 1893 (Status Nov.)

Trichorypha Schött, 1893, *Bih. Svenska. Ak.*, **19**(2) : 1-28; 1903, *Redögorelse för Allmänna Laroverken I Linköping. Eksö och Vadstena*, Underläsaret 1900-1903 : III-XVI.

Trichorhypha Handschin (*lapsus* for *Trichorypha*), 1925, *Treubia*, **6** : 225-270.

Tricorypha Salmon, 1964, *Bull. Roy. Soc.*, *N. Z.* (7)**2** : 145-644; Salmon, 1965, *Bull. Roy. Soc.*, *N. Z.*, (7) **3** : 645-651 (*lapsus* for *Trichorypha*).

Material : 3 slide-preparations (Nos. 1239-1241) of Schött from the Swedish Museum Natural History, Stockholm, Sweden (Syntypes).

Redefinition : Large species with paronelline body facies cf. the species of *Callyntrura*; antennae longer than body; frontal spines absent; ocelli 8 + 8, arranged in two longitudinal parallel rows; extra ocular structure absent; thorax normal, not humped; unguis and unguiculi long, slender; unguis with paired inner teeth, small, unpaired distal teeth moderately developed, external basolateral teeth small; unguiculi sub lanceolate; tenent hair slender, clavate; ventral tube well developed with 4 distinct macrochaetae anteriorly on its anterior face; manubrium subequal to dentes; mucro short, broad, almost triangular in outline and with four teeth; manubrium without spines, dentes with an inner row of spines transiting distally into stiff setae; dental scale appendage absent; body clothed with hyaline typical scales with round apices; flexed obliquely truncated macrochaetae absent.

Type-species : *Trichorypha atrofasciata* Schött, 1893, by monotypy.

DESCRIPTION OF THE TYPE-SPECIES

Trichorypha atrofasciata Schött, 1893

1893. *Trichorypha atrofasciata* Schött, *Bih. Tillk. Svenska. Vet. Akad. Handl.* **19**(2) : 1-28.

1903. *Paronella atrofasciata* Schött, *Redögorelse för Allmänna Laroverken I Linköping. Eksö och Vadstena*. Underläsaret 1902-1903, pp. III-XVI; 1927, *Medd. Linköping högre allm. laroverks Redögörelse*, pp. 1-39; Denis, 1933, *Boll. Lab. Zool. Portici.* **27** : 222-322; Womersley, 1934a, *Ann. Sth. Afr. Mus.*, (3), **30** : 441-475; Salmon, 1964, *Bull. Roy. Soc.* *N. Z.* (7)**2** : 145-644.

Material : Slide No. 1239, labelled as "*Paronella atrofasciata* H. S. Kamerun, furcula" Slide No. 1240, labelled as "*Paronella atrofasciata* Schött, Kamerun, Ommatidia" Slide No. 1241, labelled as "*Paronella atrofasciata* Kamerun, Tibiotarsus" from the Swedish Museum (Natural History), Stockholm, Sweden (All syntypes).

Colouration : Ground colour yellowish, blue-black patches present laterally on Ths. II, III, Abds. I, II; Abd. IV anteriorly with certain longitudinal strands of same pigment uniting posteriorly with a blue-black patch on each side of the segment; postocular region with a blue-black patch on either side; antennae and legs lightly pigmented.

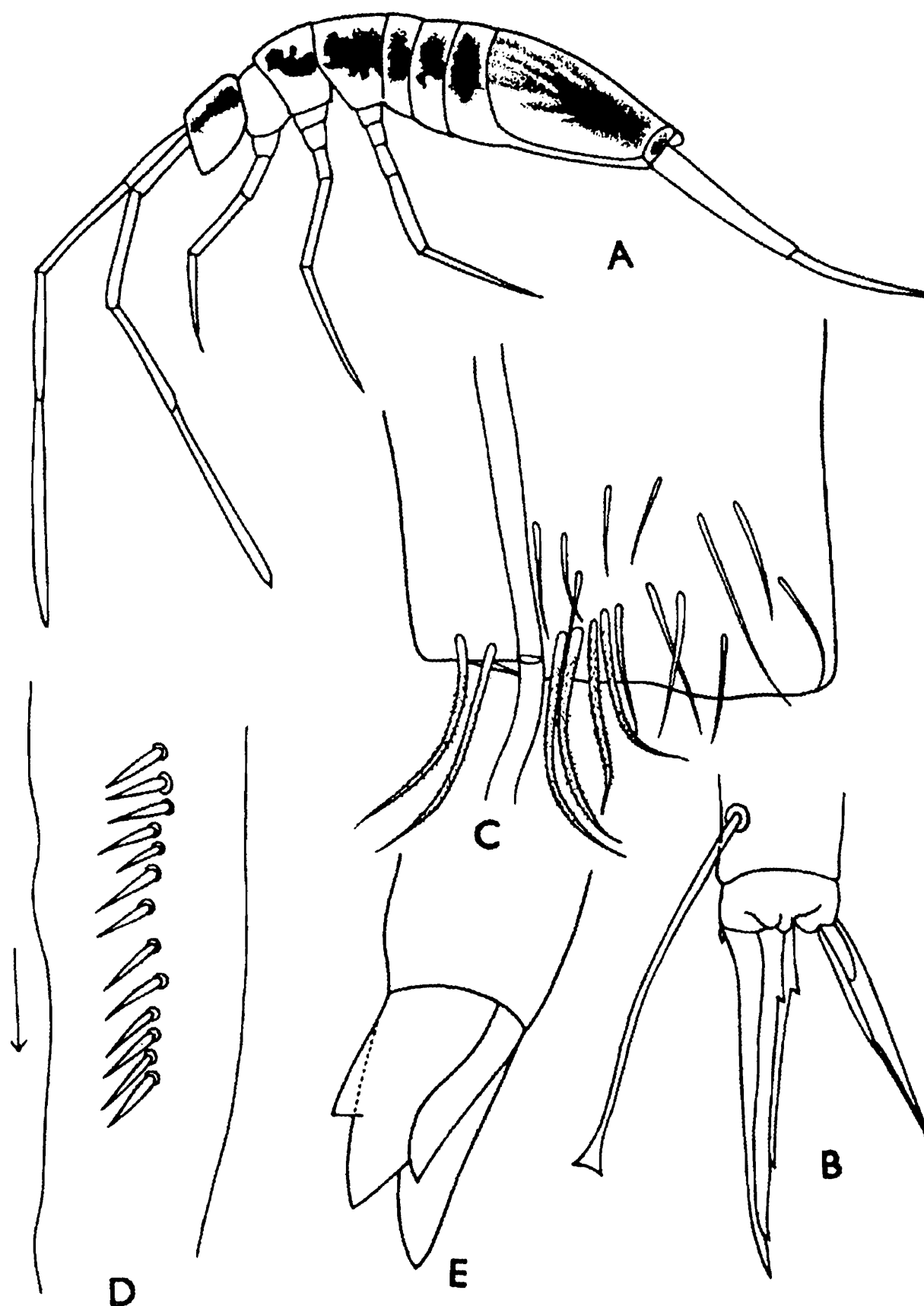


Fig. 1. Structural details of *Trichorypha atrofasciata* Schött. (A) profile; (B) footcomplex of leg III; (C) chaetotaxy of the anterior face of ventral tube; (D) a portion of dentes showing arrangement and nature of spines; (E) mucrone (All from syntypes examined).

Clothing : Body clothed with larger rounded, elongate or oval hyaline scales; setae of any kind absent on Th. III and Abd. I; Th. II, Abds. II, III, IV with some localised, short setae (presence of these can be determined from the sockets only) [Text Fig. 2].

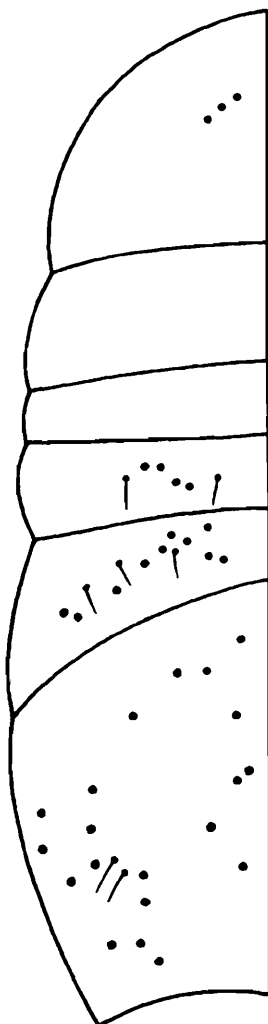


Fig. 2. Chaetotaxy of Ths. II, III and Abds. I-IV of *Trichorypha*.

Head : More or less pear-shaped in outline dorsally; 8 + 8 ocelli in 2 dark ocellar patches, each group of ocelli arranged in two longitudinal parallel rows, ocelli G and H reduced; extra ocular structure absent; frontal spines absent; antennal segments not complete in the material examined.

Thorax : Prothorax reduced, mesothorax little less than half of the metathorax; legs similar, tibiotarsi not segmented; unguis slender, elongate, inner paired basal teeth and 2 distal unpaired teeth small, moderately developed, external basolateral teeth reduced; unguiculi sublanceolate, inner truncate-angle little pronounced; tenent hair long, slender, clavate (Fig. 1, B); trochanteral organ not seen.

Abdomen : Abds. I and II sub-equal in length, Abd. III little longer than abds. I and II; Abd. IV more than four times the length of Abd. III; ventral tube well developed, anterior face of ventral tube anteriorly with 4 conspicuous, ciliated macrochaetae, rest of the anterior and posterior faces with long, slender, apparently smooth setae (Fig. 1, C); manubrium sub-equal to dentes, without

spines; dentes with an inner row of spines, spines transit distally (Fig. 1, D); mucro short, broad, rectangular in outline, with 4 teeth; dental scale appendage absent.

Length (excluding appendages) : 3 mm.

Type specimens : Schött (1893) did not select any type of *Trichorypha atrofasciata*. Examination of 3 slides at disposal, as mentioned in material, indicates that all such material came from the type-locality. It is not known from the literature that Schött ever examined any other freshly collected material other than the specimens on which he (Schött, 1893) based the description of the species. However, the name *Paronella atrofasciata* is inscribed on each of the 3 slides examined and this appears to be a subsequent amendment of the name-labels on the slides. The investigator takes here an opportunity to designate the Slide No. 1239, on which the furcula is mounted, as the lectotype of the species.

Type-locality : Bonge, Cameroons ("Kamerun" of Schött, 1893), Africa.

Comparisons : The genus is known by its type-species only.

Interrelationships : *Trichorypha* though occurs in Africa, it shows little resemblance to the other African genera viz. *Paronella*, *Dicranocentruga* and *Campylothorax* in the absence of E. O. S. It resembles apparently to *Dicranocentroides* in a few characters like the absence of extra ocular structure and frontal spines and in the presence of relatively broad mucrones. However, the dentition of mucrones in the two genera is altogether different. Further, *Trichorypha* differs from *Dicranocentroides* in the possession of a clothing of typical scales and in achaetotic body. *Trichorypha* is distinct from *Bromacanthus*, *Lepidonella* and *Microparonella* in its mucronal structure and in the nature of arrangement of ocelli. Furthermore, the body facies and chaetotaxy of ventral tube in *Trichorypha* make it distinct from those related genera.

SUMMARY

Trichorypha Schött (1893) is not a synonym of *Paronella* Schött (1893). Examination of the syntypes of *Trichorypha atrofasciata* (type species) proves that *Trichorypha* is a valid genus and differs from *Paronella* in its paronelline bodyfacies, absence of manubrial spines and in the nature of a dental spines transiting distally into stiff setae, absence of extra ocular structure and other important morphological features radically different from *Paronella*. *Trichorypha*, therefore, is resuscitated in this investigation as a valid genus.

ACKNOWLEDGEMENTS

The author is grateful to the authorities of the Swedish Museum (Natural History), Stockholm, Sweden for providing an opportunity to study the type-specimens dealt with in this investigation. Thanks are also due to Dr J R B Alfred, Director and Dr G K Srivastava, Addl. Director, Zoological Survey of India, Calcutta for helping in various ways.

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STATUS OF *DICRANOCENTRUGA* WRAY, 1953 WITH THE DESCRIPTION OF A NEW SPECIES (COLLEMBOLA : ENTOMOBRYIDAE)

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INTRODUCTION

The genus *Paronella* Schött, 1893 was a long heterogenous one with species belonging to widely different genera.

While fixing the concept of *Paronella*, Mitra (1992) observed that the species now known under *Paronella* from the Ethiopian and Neotropical Regions are widely different from *Paronella fusca* Schött, 1893 (type species of *Paronella*) and proposed for their inclusion under *Dicranocentruga* Wray, 1953, a genus very insufficiently described from Puerto Rico.

Subsequently, the author had an opportunity to examine a series of collections of the species from Puerto Rico through the courtesy of Dr. Mari Mutt and it is noted that the species possesses the vestigial G and H ocelli and extra ocular structure as in other *Paronella*—like species of these regions. Thus *Dicranocentruga** is a valid genus and the name should be used for accommodating the *Paronella*—like species of the Ethiopian and Neotropical Regions.

The genus *Dicranocentruga* includes most of the species described under *Paronella* from the Ethiopian and Neotropical Regions. Though close to the genus *Paronella*, it is distinct from the latter in the following important characters : (i) general body facies and relatively smaller size, (ii) nature of unguis which is distinctly different from *Paronella* and is uniform in the species, under the genus, (iii) nature of tenent hair which is always clavate in all the known species under the genus, (iv) absence of manubrial spines and dentes being armed with single inner row of spines, often transiting distally, outer row of spines not well developed, (v) nature of mucrones, (vi) in the nature of extra ocular structure and (vii) in the number of macrochaetae anteriorly on the anterior face of ventral tube (4 + 4 vs. 7 + 7 in *Paronella*) [Mitra , 1992].

Denis (1933) though indicated that *Paronella fusca* as a form with larger body facies, with both manubrial and dental spines and possessing tenent hair which is not dilated apically, he did not separate out the group of species lacking such characters. Further, cephalic chaetotaxy of the two genera differs significantly from each other, at least in the orientation of dorsal setae (specially in the orientation of D₁ + D₁ and D₂ + D₂) [Mitra, 1993].

*Mitra (1972) proposed *Metaparonella* to accommodate the *Paronella*—like species from Ethiopian and Neotropical Regions (unpublished, hence, a cheironym).

Dicranocentruga is distinct from *Campylothorax* in all fundamental morphological characters although both of them possess extra ocular structure. In structural details, extra ocular structures of these two genera are different. The genus is distinct from *Microparonella* Carpenter (1916) in its relatively large size, presence of extra ocular structure and nature of unguis and its teeth. Moreover, the nature of scales clothing body, number of ocelli and structure of mucronis in the two genera are also different. It is distinct from *Bromacanthus* and *Lepidonella* in many striking characters like the structure of unguis and unguiculi, presence of extra ocular structure, arrangement of ocelli (in two longitudinal parallel rows vs. circular arrangement in *Bromacanthus* and *Lepidonella*). Moreover, the chaetotaxy of head in the species of *Dicranocentruga* is also distinct from those of *Bromacanthus* and *Lepidonella* (Mitra, 1993).

***Dicranocentruga* Wray, 1953**

Dicranocentruga Wray, 1953. *Jour. Agric. Univ. Puerto Rico*, 37(2) : 140-150.

Material : *Paronella nigromaculata* Schött : 19 original slide-preparations of Schött (Nos. 1255, 1257 to 1274); 30 exs. (syntypes) in 5 vials; *Paronella nigromaculata* det. Wahlgren : c. 115 exs. in spirit in single vial; *Paronella penicillata* Schött : 6 syntypes mounted on 6 slides (Nos. 1276 to 1281). All from the Swedish Museum Natural History, Stockholm, Sweden.

Paronella hirtipes Handschin : 3 syntypes mounted on 3 slides from the Natural History Museum, Basel, Switzerland.

Dicranocentruga jataca Wray : Several topotypes on slides and in alcohol received from Dr. Mari Mutt, Puerto Rico.

Redefinition : Body facies not fusiform like *Paronella fusca*, antennae of variable lengths, normally shorter than half the length of body; apex of Ant. IV with indistinct sense-knob and smooth setae; prelabral setae 4, ciliated, labral setae 5, 5, 4, smooth; ocelli 8 + 8, G and H vestigial, appear nonfunctional; extra ocular structure, 2–3 lobed, outer lobe not drawn into a slender process; unguis with paired inner basal teeth enlarged, distal inner unpaired tooth always present and conspicuous; external basolateral teeth well developed; unguiculi mostly lanceolate, nondentate, in some species fore unguiculi sometime sublanceolate; tenent hair well developed, clavate; tibiotarsal spines absent; ventral tube well developed, anterior face anteriorly with 4 + 4 ciliated macrochaetae; manubrium without spines, dentes with only one inner row of simple, sometime serrated or ciliated spines (in *D. penicillata* n. comb.), which usually transit into stiff setae distally, outer margin with delicate or strong spiny setae but not distinct spines; mucro usually elongate and narrow with 4 teeth, sometimes short and broad, apical tooth rounded or pointed.

Type-species : *Dicranocentruga jataca* Wray, 1953.

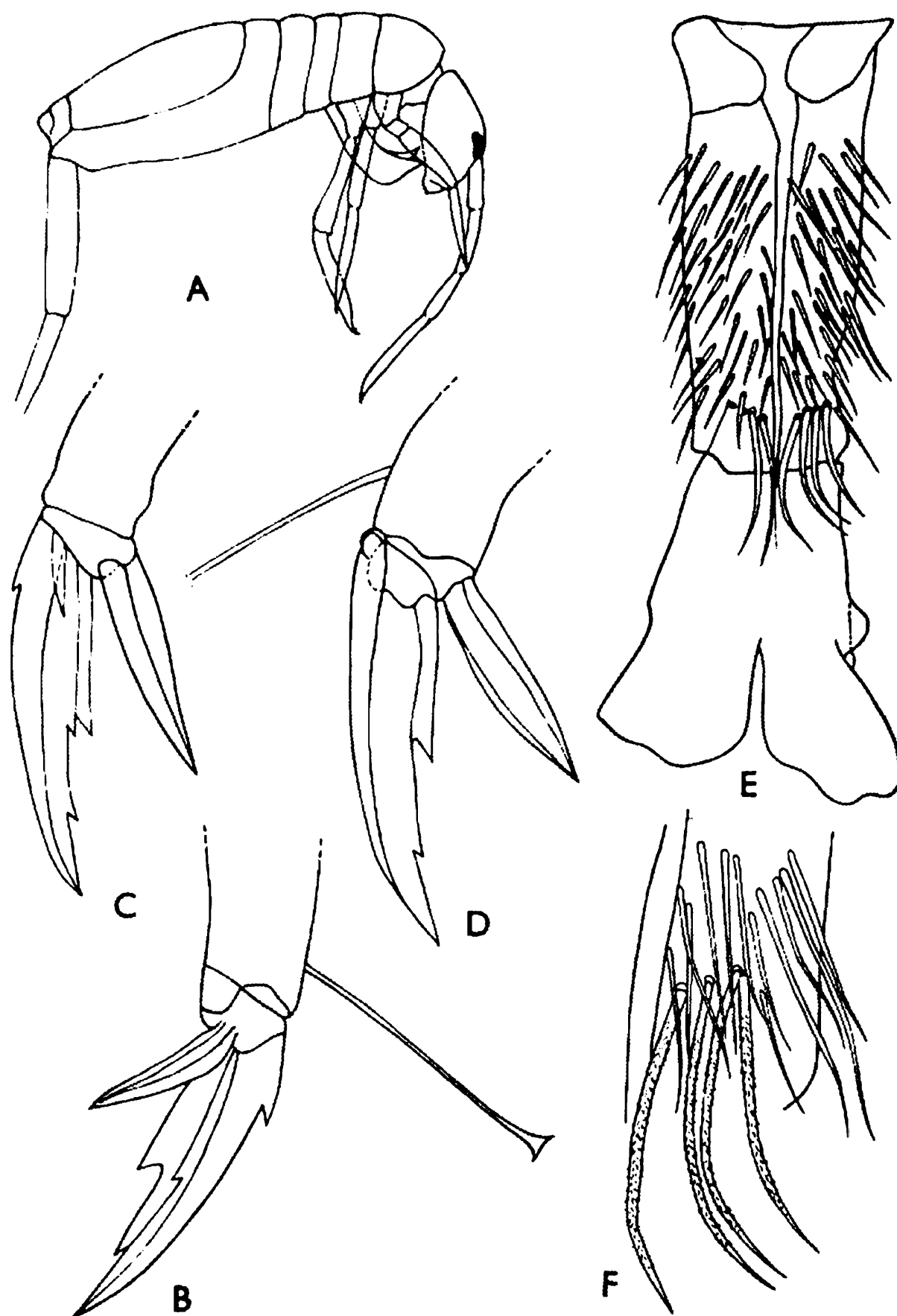


Fig. 1. *Dicranocentruga wahlgreni*, n. sp. : (A) profile; (B) footcomplex of leg I; (C) footcomplex of leg II; (D) footcomplex of leg III; (E) ventral tube (anterior face); (F) chaetotaxy of anterior face of ventral tube.

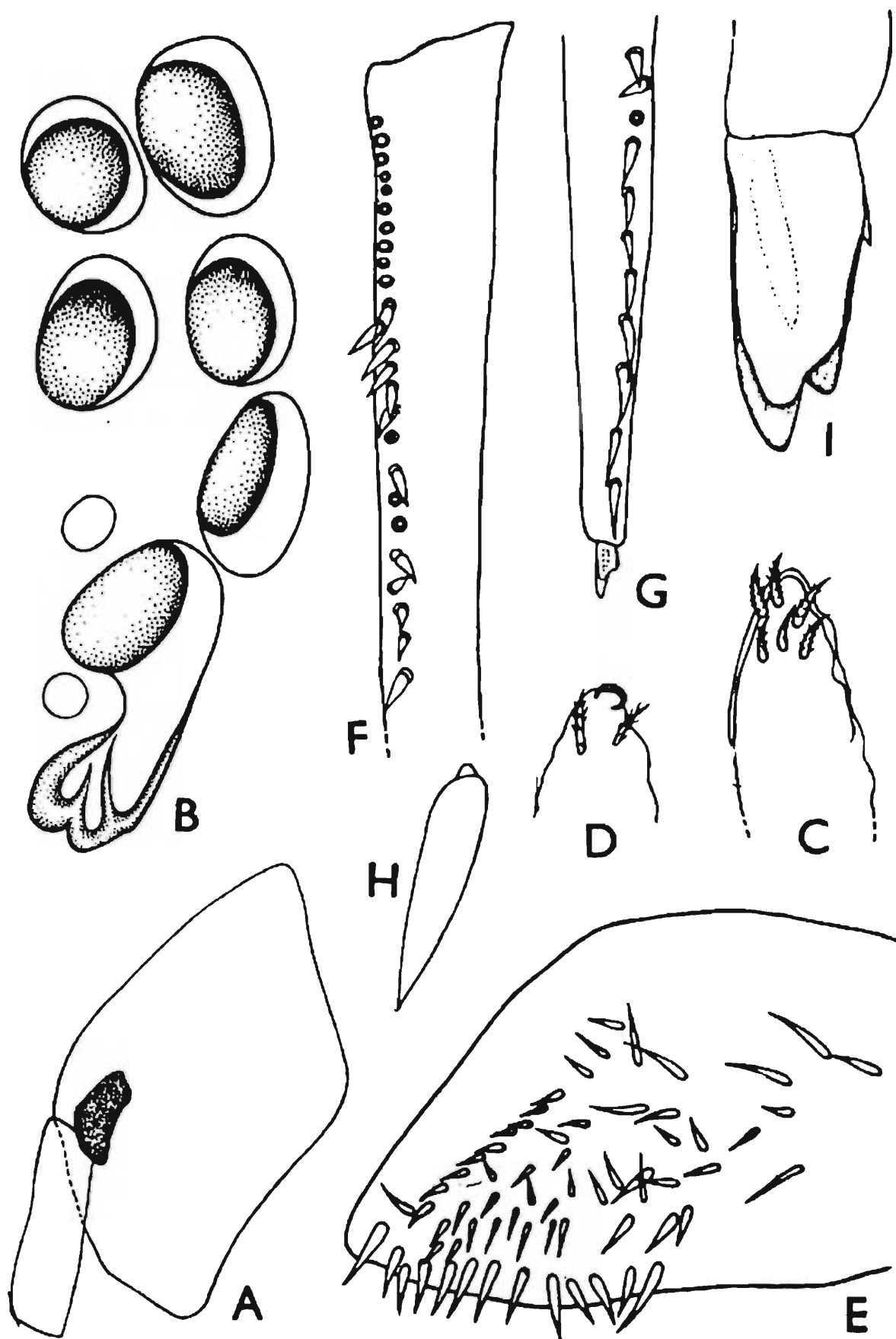


Fig. 2. *Dicranocentruga wahlgreni*, n. sp. : (A) head with pigmented ocellar field; (B) arrangement of ocelli with eos; (C, D) apices of Ant. IV; (E) trochanteral organ; (F, G) nature and arrangement of dental spines; (H) a dental spine (magnified); (I) mucrone.

***Dicranocentruga wahlgreni*, new species**

Material examined : 115 exs. In a single vial from the Swedish Museum Natural History, Stockholm, Sweden, labelled as “*Paronella nigromaculata* Schött, meru, 3, 500 m.,? raguskogen/1, 1906; Colleg. Y. Sjöstedt, Determ. E. Wahlgren”

Colouration : Ground colour uniformly white to pale yellow without any darker pigmented patches on body and appendages; only pigmented regions in the entire body, two ocellar fields, one on each side of head capsule (Text fig. 1, A, 2, A; PL. 1, B).

Clothing : Clothed with scales, scales typical of the tribe Paronellini, being larger, rounded or oval in outline (Text fig. 3); stiff, dark, setae extremely sparse and localised on Th. II, Abds. III, IV (Text fig. 5, B); appendages clothed with slender setae and scales; antennae devoid of smooth erect setae found in other genera; apical sense-knob of Ant. IV not conspicuous, apical smooth erect setae apparently absent.

Head : Pear-shaped dorsally, with two dark ocellar fields, one on each side, each containing 8 ocelli arranged in two longitudinal parallel rows, ocelli G and H reduced (Text fig. 2, B); extra ocular structure short stalked, with 3 conspicuous lobes (Text figs. 2, B; 4, B, C; PL 2); inner two lobes closely apposed with each other; antennae sub-equal to half the length of body; relative length index of Ants. I : II : III : IV = 8 : 11 : 9.5 : 13.5; Ant. IV apparently appears annulated owing to the presence of whorls of setae, sense-knob at its apex inconspicuous (Text figs. 2, C, D); head diagonal/Ant. I = 20/9; prelabral setae, 4, ciliated labral setae, 5, 5, 4, smooth; anterior margin of labrum anteriorly with 2 tubercles; chaetotaxy as in Text fig. 5, A.

Thorax : Relative length index of Ths. II : III = 11 : 7; legs all similar; fore unguiculi smaller than those on mid and hind legs, unguiculi lanceolate, nondentate; ungues with large paired inner teeth located at about half of its length followed by a single unpaired tooth, external basolateral teeth well developed; tenent hair long, clavate (Text figs. 1, B, C, D); trochanteral organ with c. 66 slender spines arranged in a quadrangle (Text fig. 2, E).

Abdomen : Relative length index of Abds. I : II : III : IV : V : VI = 4 : 5 : 5.5 : 27 : 3.5 : 2; ventral tube well developed with 2 protrusible vesicles everted (Text fig. 1, E); anterior face of ventral tube anteriorly with 4 + 4 macrochaetae, rest of the anterior and posterior faces clothed with microchaetae (Text fig. 1, F); rami of retinaculum each with 4 teeth, corpus with a median seta; manubrium and dentes sub-equal in length; dentes with a single inner row of spines which transit distally into stiff, ciliated setae and an outer row of stiff, ciliated setae (Text figs. 2, F, G, H; PL 3, C, D); mucrones with 4 teeth, apical tooth larger than anteapical tooth, V_1 and inner lateral teeth well developed (Text fig. 2, I).

Length (excluding appendages) : 3 mm.

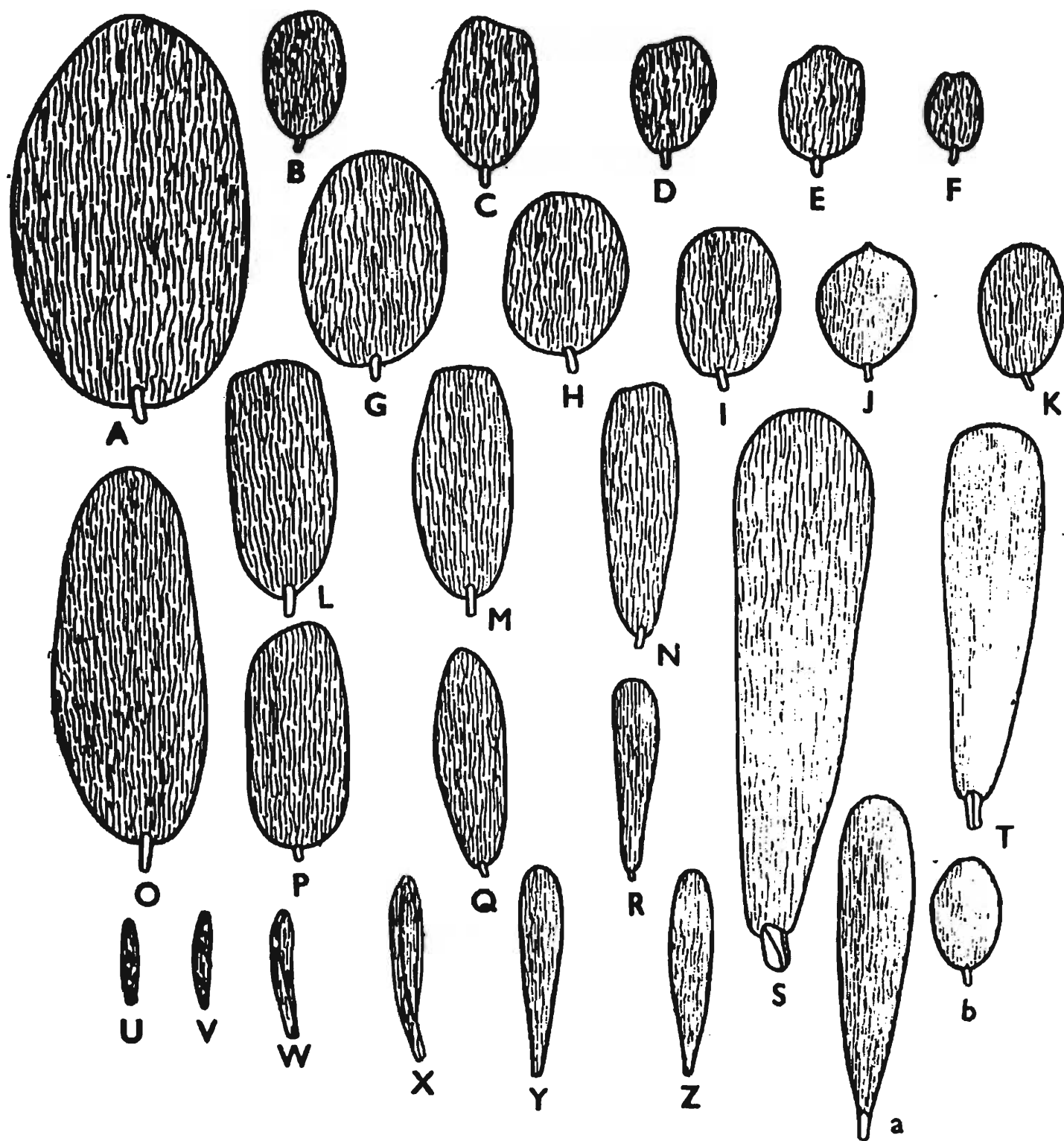


Fig. 3. Typical scales of *Paronella* and *Dicranocentruga*. (A-Q) from body; (R-Z) from dentes; a, b, from dorsal region of manubrium.

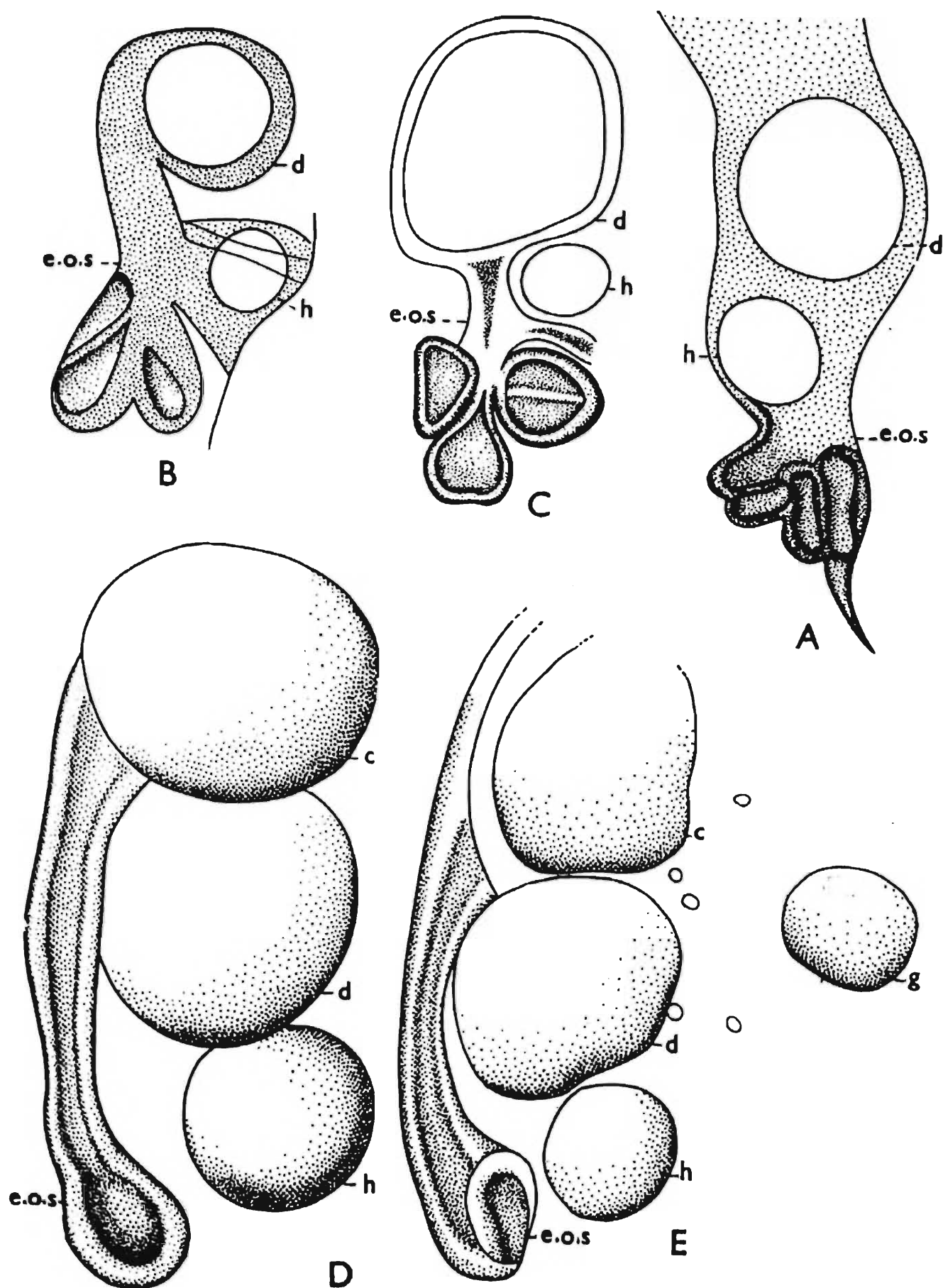


Fig. 4. Extra ocular structures (eos). : (A) *Paronella* Schott; (B, C) *Dicranocentruga*; (D, E) *Campylothorax*.

Type-specimens : Holotype mounted on a slide, 111 paratypes preserved in spirit in a single vial; deposited in the Swedish Museum Natural History, Stockholm, Sweden; single paratype in ZSI, Kolkata.

Type-locality : Meru, Africa (3, 500 m.).

Comparisons : The investigator had an opportunity to examine a vial containing c. 115 examples from the Swedish Museum Natural History, Stockholm, Sweden, which was determined by Wahlgren (1908) as *Paronella nigromaculata* Schött along with a series of syntypes of *Paronella nigromaculata* Schött. A critical examination of those specimens morphologically as well as chaetotaxically reveals that the specimens identified by Schött and Wahlgren involves at least 3 species. The specimens from Meru determined by Wahlgren (1908) as *Paronella nigromaculata* is a new species distinctly differing from *Paronella nigromaculata* species-complex of Schött. Thus the distinctly larger size of *Dicranocentruga wahlgreni* (3 mm. vs. 1.5–2 mm.), its totally nonpigmented body and appendages along with the chaetotaxy of head and body ($D_3 + D_3$ and PO_1 always absent in *M. nigromaculata* species-complex of Schött vs. always present in the new species). Moreover, the extra ocular structure in the 2 species is entirely different (in *M. wahlgreni*, the structure is always short-stalked and trilobed vs. long-stalked and bilobed in *M. nigromaculata* species-complex). The species is named in honour of Dr. W. Wahlgren who had the first opportunity to describe it.

Interrelationships : The genus *Dicranocentruga* includes most of the species described under *Paronella* from Africa, South America and adjoining regions. Although it has closest affinity with the genus *Paronella* in the presence of extra ocular structure, it is distinct from the latter in many important characters like—(i) the general body facies and relatively smaller size of the species, (ii) nature of unguis and tenent hair, (iii) absence of manubrial spines and dentes being armed with one inner row of well developed, transiting spines and (iv) nature of mucrones. Moreover, *Dicranocentruga* is distinct from *Paronella* in the nature of extra ocular structure, in the number of macrochaetae anteriorly on the anterior face of ventral tube (4 + 4 vs. 7 + 7) and in the presence of ciliated prelabral setae. Earlier workers (at least Denis, 1933) although noted some of the differences existing between *Paronella fusca* and others, he, however, did not attempt to segregate these heterogeneous species-groups under *Paronella*. The present study demonstrates pointedly the striking differences that exist between the species of the genus *Dicranocentruga* and *Paronella fusca*. Again in the cephalic chaetotaxy, as mentioned earlier, the two genera differ from each other (at least in the orientation of dorsal setae), *Dicranocentruga* is distinct from *Microparonella* in having relatively larger body-size, in the presence of extra ocular structure and in the nature of unguis and ungual teeth. Moreover, the nature of scales, number of ocelli and structure of mucrones are also distinct from *Microparonella*. The new genus is distinct from *Bromacanthus* Schött (1925) and *Lepidonella* Yosii (1960) in many fundamental characters like the structure of foot complex,

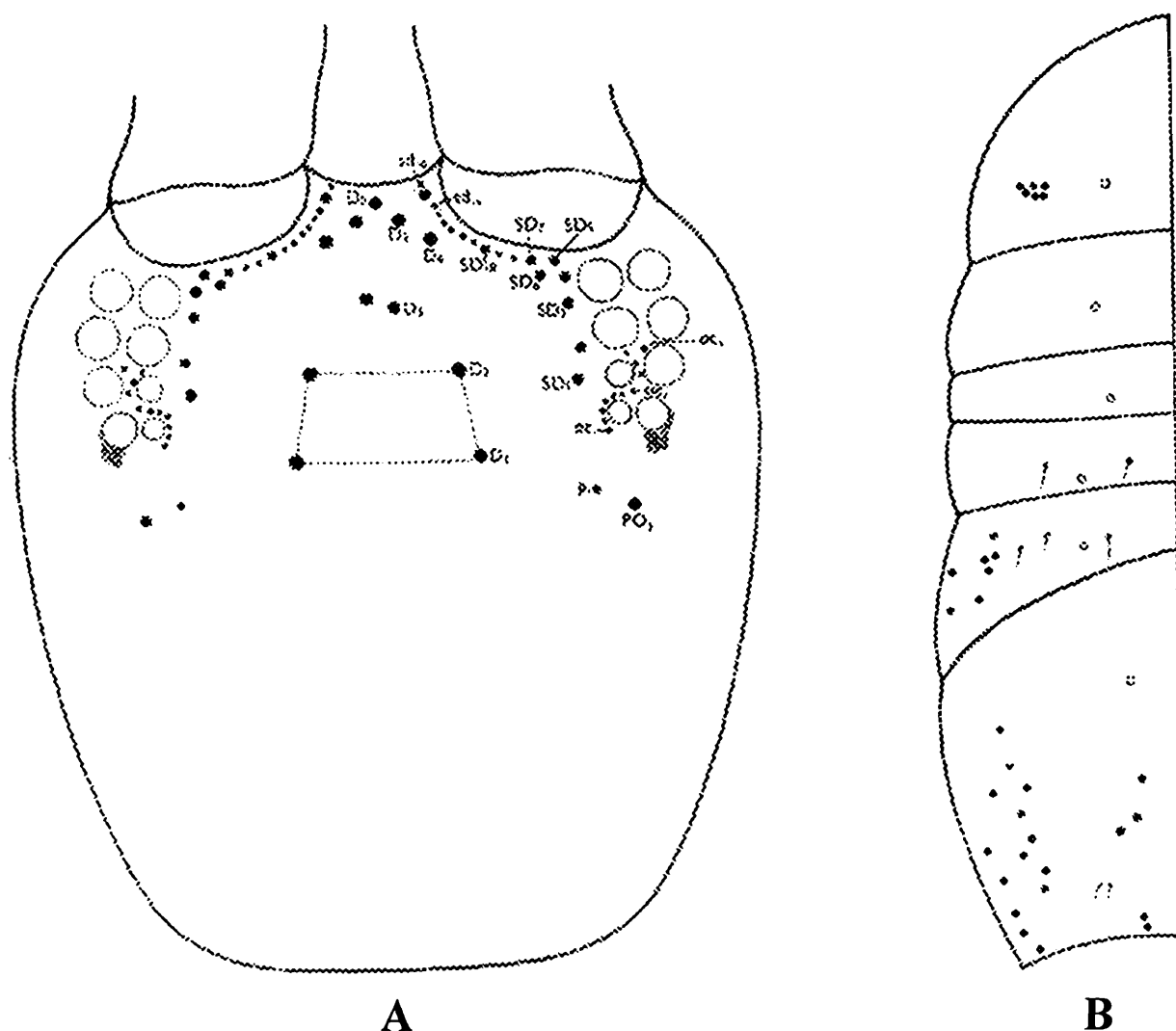


Fig. 5. (A) chaetotaxy of head; (B) chaetotaxy of tergites.

presence of extra ocular structure, arrangement of ocelli (in two longitudinal parallel rows vs. circular arrangement in *Bromacanthus* and *Lepidonella*). Cephalic chaetotaxy in *Dicranocentruga* is also distinct from the two above-mentioned genera.

Distribution : The species belonging to the genus *Dicranocentruga* have been recorded from different parts of Africa, Madagascar and South America. They are widely distributed and are endemic to the Ethiopian and Neotropical Regions.

Species and sub-species included under *Dicranocentruga* Wray, 1953

Borner (1903), Denis (1925, 1933), Marlier (1945) and Delamare Deboutteville (1947, 1950a, b, 1952) described a number of species from the Ethiopian and Neotropical Regions under *Paronella* which agree in all details with the diagnosis of *Dicranocentruga* given in this study. *Aphysa eburnea*, described by Delamare Deboutteville (1951b) from Ivory Coast, has two rows of distinct dental spines and differs from other related species of in the possession of two ventral teeth of mucrones (1 in other species) and longer antennae. Placement of this species in the genus *Aphysa*

Handschin, which does not possess dental spines and has large, complex mucrones, does not appear satisfactory.

- D. nigromaculata* (Schött) 1903, new combination
- D. hirtipes* (Handschin) 1924, new combination
- D. innominata* (Denis) 1933, new combination.
- D. penicillata* (Schött) 1927, new combination
- D. fuelleborni* (Börner) 1903, new combination
- D. beguei* (Delamare Deboutteville) 1950, new combination
- D. carpenteri* (Denis) 1925, new combination
- D. ghesourieri* (Marlier) 1945, new combination
- D. grassei* (Delamare Deboutteville) 1950, new combination
- D. lamottei* (Delamare Deboutteville) 1950, new combination
- D. montana* (Delamare Deboutteville) 1950, new combination
- D. nigromaculata pallida* (Delamare Deboutteville) 1951, new combination
- D. penicillata obscura* (Delamare Deboutteville) 1950, new combination
- D. penicillata pallida* (Delamare Deboutteville) 1952, new combination
- D. villiersi* (Delamare Deboutteville) 1947, new combination
- D. villiersi anomala* (Delamare Deboutteville) 1951, new combination
- D. villiersi pallida* (Delamare Deboutteville) 1950, new combination
- D. aburnea* (Delamare Deboutteville) 1951, new combination.

SUMMARY

In this study, the status of *Paronella* -like species from the Ethiopian and Neotropical Regions has been fixed on the basis of examination of type-specimens and other representative material. The *Dicranocentruga* Wray, 1953 is a valid genus and its concept is precised on the basis of the material from Puerto Rico from where it was described. The eighteen species so far known under *Paronella* from these regions, as this study reveals, belong to *Dicranocentruga* and they, therefore, form new combinations.

ACKNOWLEDGEMENTS

The author is grateful to the authorities of the Swedish Natural History Museum, Stockholm and Natural History Museum, Basel, Switzerland for providing me an opportunity to study the type-specimens and other representative collections of the species, dealt with in this investigation.

To Dr. Mari Mutt of Puerto Rico, I am specially grateful for sending me the material of the species, described by Wray, 1953, without which this work could not have been accomplished.

To Dr. J. R. B. Alfred, Director and Dr. G. K. Srivastava, Additional Director, I accord my sincere thanks for numerous courtesies.

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PLATE I

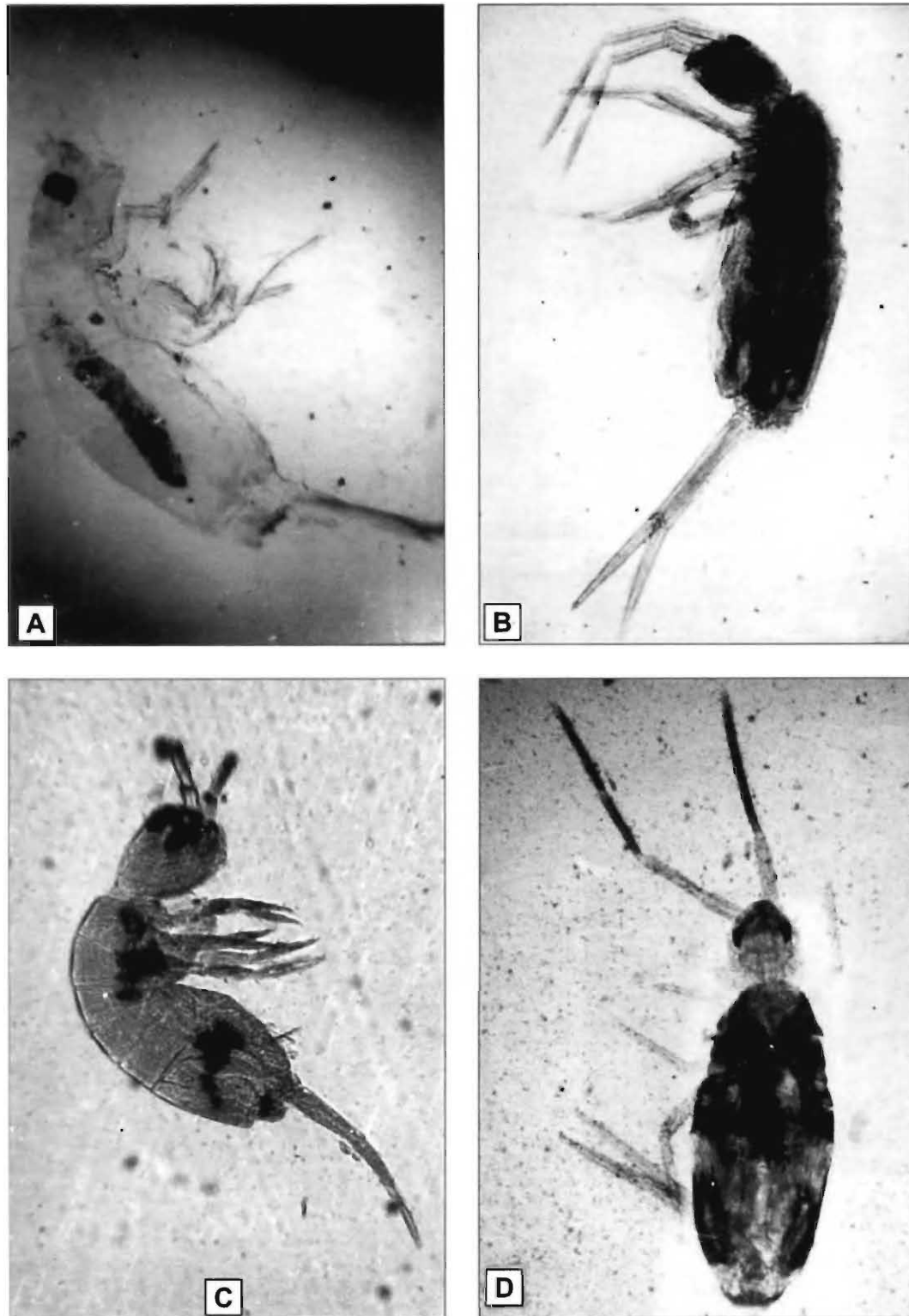


Fig. 1. (A) *Dicranocentruga hirtipes* (Handschin), new combination (Lectotype, Natural History Museum, Basel, Switzerland); (B) *Dicranocentruga wahlgreni*, n. sp. (paratype); (C) *Dicranocentruga penicillata* (Schott), new combination (Syntype, Slide No. 1277); (D) *Dicranocentruga nigromaculata* (Schott), new combination [Syntype (species-a)], new combination. (All from the Swedish Museum Natural History, Stockholm, Sweden).

PLATE II

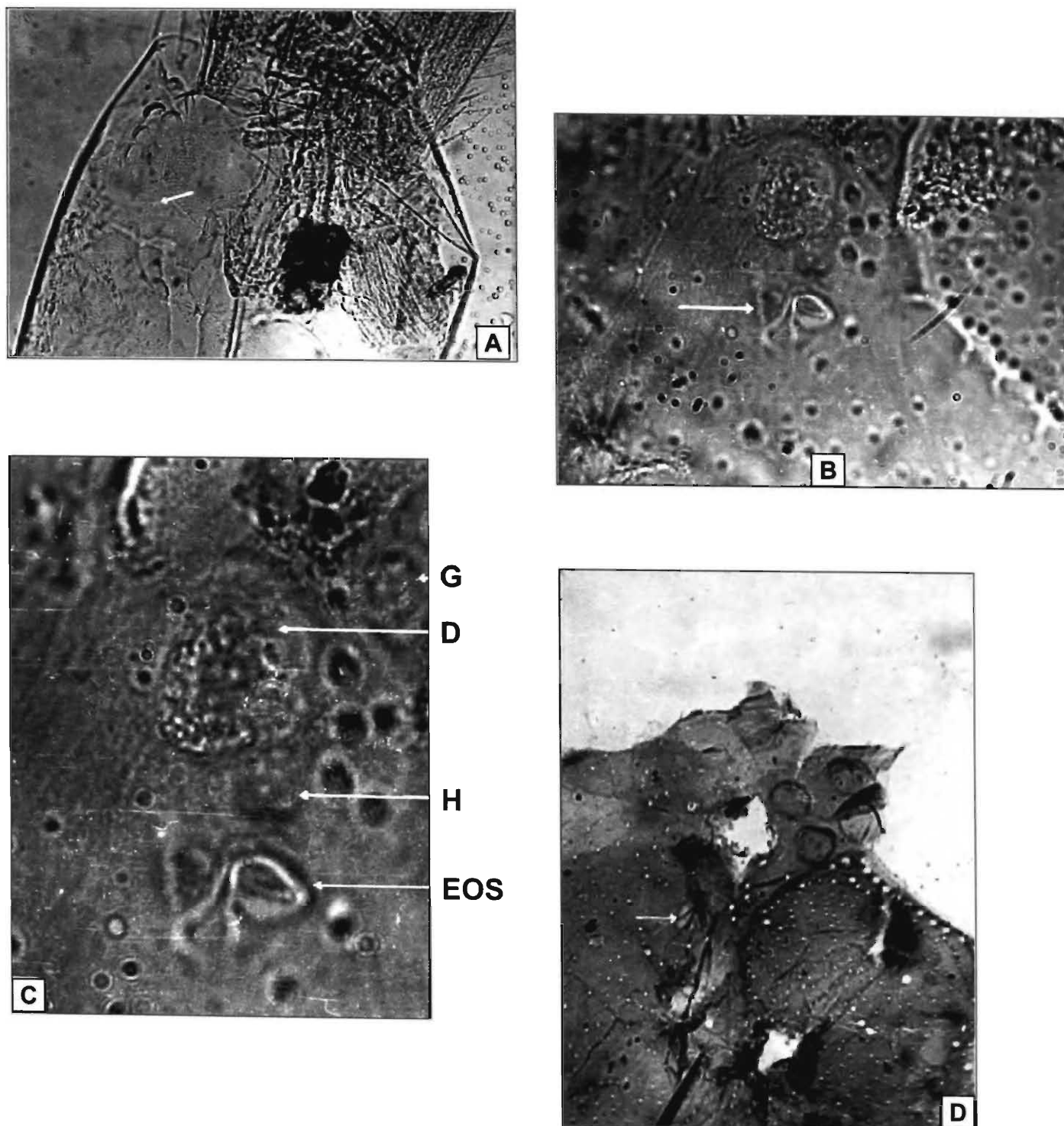


Fig. 2. Extra ocular structures (eos) in relation to ocelli : *Dicranocentruga wahlgreni*, n. sp. (A) eos in relation to ocelli position of eos in relation to ocelli; (B) same, in relation to ocelli D, G and H (viewed ventrally); (C) same, in greater magnification : (D) same in *D. nigromaculata* (Schott) (stained in aqueous nigrocin, viewed laterally).

PLATE III

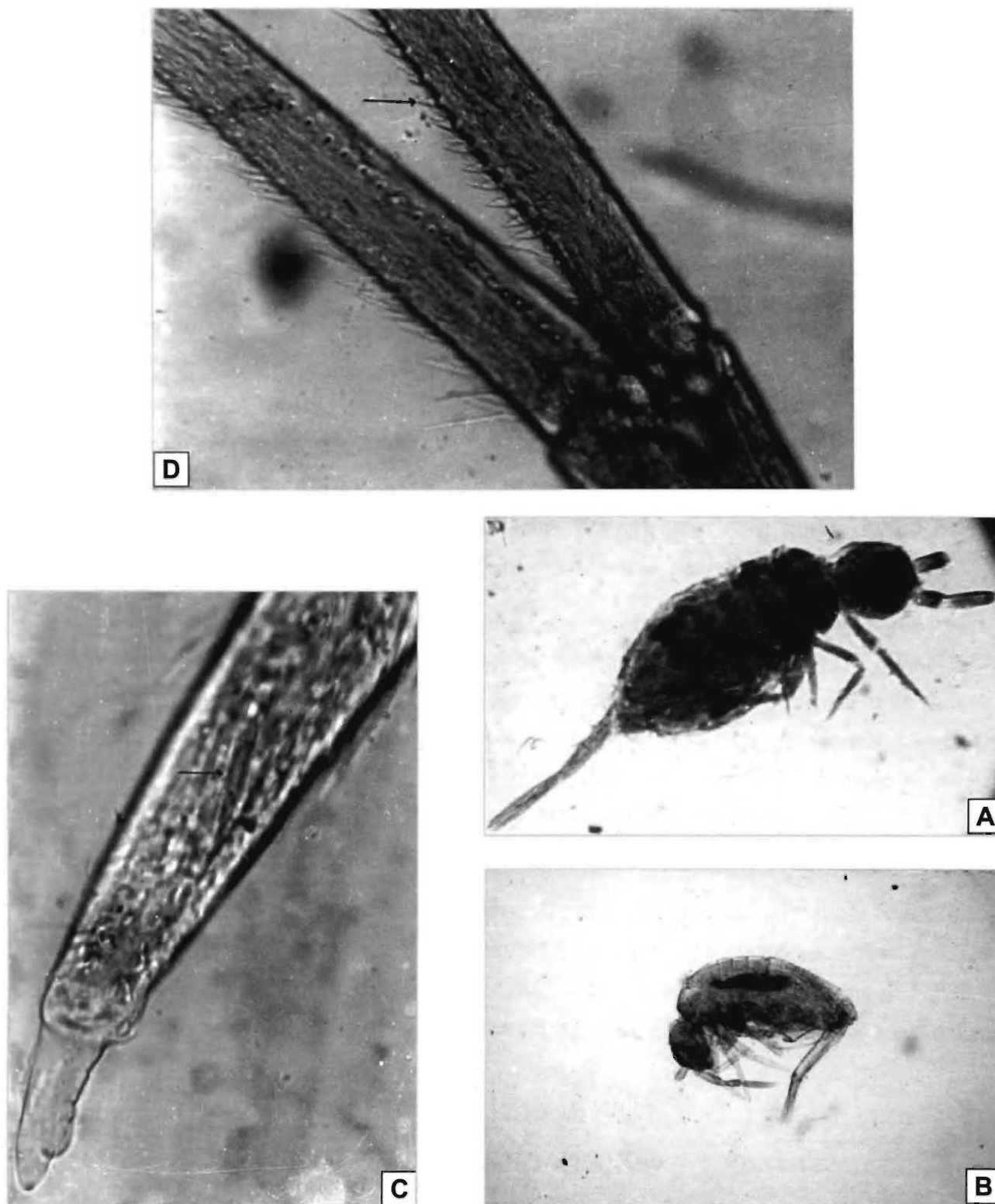


Fig. 3. (A) *Dicranocentruga penicillata*, new combination (Syntype, slide no. 1277); (B) *Dicranocentruga nigromaculata* (Schott), new combination (Syntype, Species-b); (C) *Dicranocentruga wahlgreni*, n. sp.: C, distal portion of Dentes with mucro (note, transitional dental spines); (D) distal portion of manubrium with proximal portion of dentes showing absence of manubrial spines and single row of dental spines. (All specimens from the Swedish Museum Natural History, Stockholm, Sweden).

BLOW FLIES (DIPTERA : CALLIPHORIDAE) OF WEST BENGAL, INDIA WITH A NOTE ON THEIR BIODIVERSITY

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INTRODUCTION

The blow flies are of medical, veterinary, sanitary, forensic and agricultural importance and are distributed in all zoogeographical regions. They have a great potential role in transmitting various types of viruses, bacteria, fungi, protozoans, helminthes which cause summer diarrhea, bacillary and amoebic dysentery, poliomyelitis, cholera, plague and tuberculosis (Greenberg, 1971). They are regarded as the greatest hygienic important flies as because they are attracted and breed in different kinds of dead bodies, garbages, excreta of different animals and thus make public hazards by transmitting various pathogens mechanically from putrefaction materials to human food.

Most of the larvae of this flies are omnivorous, carnivorous or parasitic and cause myiasis in different parts of man and animals (James, 1947; Dasgupta, 1962; Zumpt, 1965). Some larvae are useful in detecting the approximate time of death of a person in murder case and thus help in forensic science (Smith, 1986). Few larvae are parasitic or predator on earthworms, snails, locusts, toads and frogs (Draber-Mónko, 1981). A very few sterile larvae have been used in surgery for treating tubercular abscesses and complex fractures (Busvine, 1980). A few larvae are also causative agents for the loss of dried fish industry and various kinds of meat products (Esser, 1991).

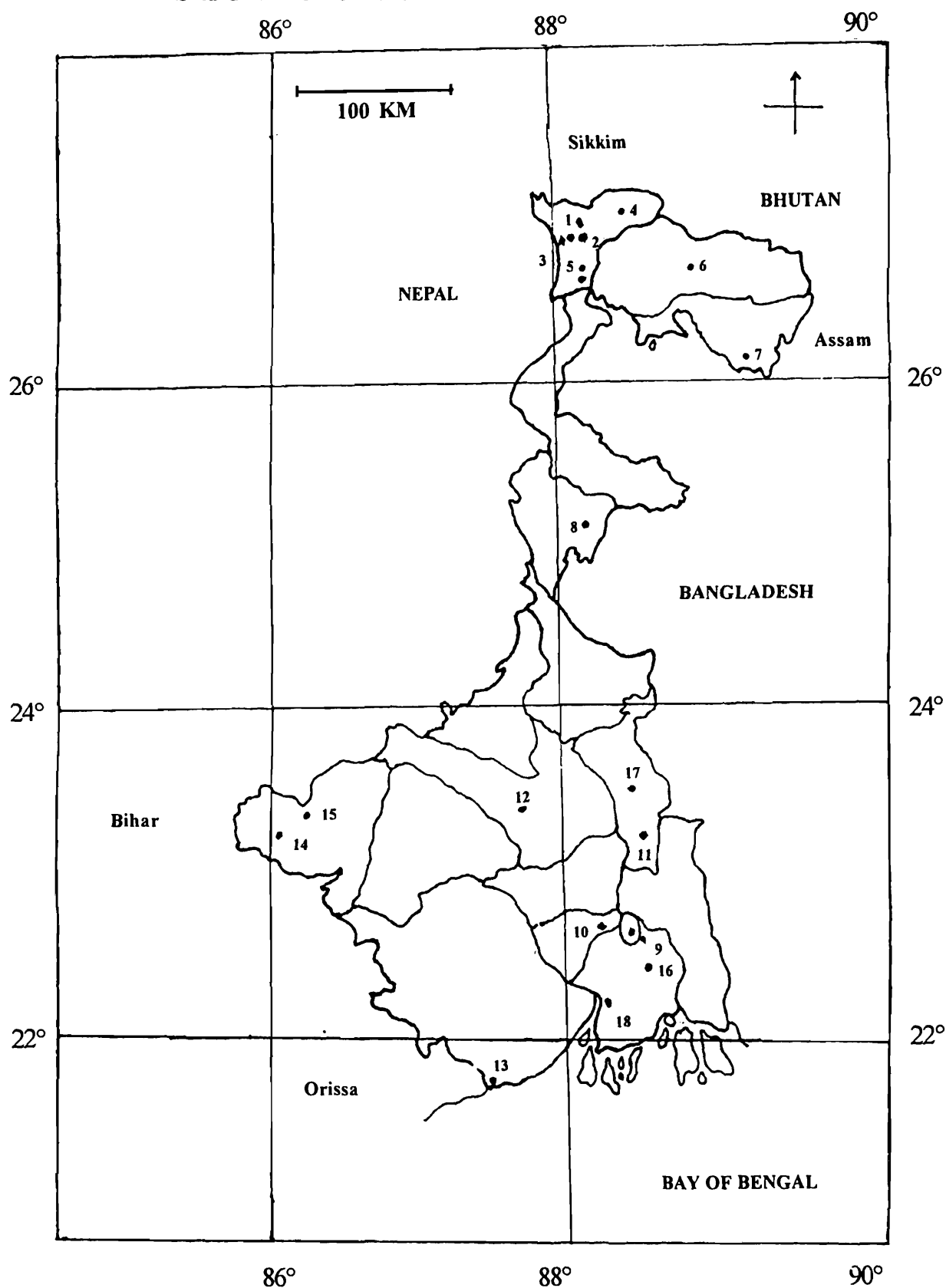
Very little work has been done on this group from India particularly from West Bengal in comparison to other parts of the world. Senior-White *et al.* (1940) reported few species from this area. Datta (1991a, b; Datta *et al.*, 1997) recorded few species from West Bengal. Nandi (1994, 1997) studied this flies from Kolkata and Darjeeling and added few species to the fauna of West Bengal.

MATERIAL AND METHOD

The author collected most of the flies with the help of butterfly net from different parts of West Bengal in different seasons (Vide Map). They were mainly collected from dead bodies and excreta of different animals, fish market, meat shop, garbages, decaying materials, bushes and flowering

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MAP OF WEST BENGAL SHOWING COLLECTION SPOTS



1. Darjeeling Padmaja Naidu Himalayan Zoological Park, 2. Kurseong, 3. Senchal Lake, 4. Kalimpong, 5. Siliguri, 6. Rajabhatkhawa, 7. Coochbehar, 8. Malda, 9. Kolkata, 10. Shibpur Botanical Garden, 11. Ranaghat Hijuli Forest, 12. Burdwan, 13. Digha, 14. Bundwan, 15. Purulia, 16. Budge Budge, 17. Krishnagar, 18. Diamond Harbour.

plants. Genitalia characters were taken as the main criteria for identification of the species besides chaetotaxy and the classification followed here is after Schumann (1986) and Rognes (1991). A total of 41 species under 17 genera are included.

SYSTEMATIC ACCOUNT

Subfamily AMENIINAE

Tribe Catapicephalini

1. *Catapicephala pattoni* Senior-White, Aubertin and Smart

This is generally a forest species and can be collected from decaying leaves and bushes. It is distributed in West Bengal (Kalighat, Ranaghat Hijuli Forest) and Uttar Pradesh.

Tribe Ameniini

2. *Silbomyia asiatica* Crosskey

This is generally a forest species. Crosskey (1965) first reported it from Mungpoo, Darjeeling. No biological data was mentioned and it is distributed in Darjeeling only.

Subfamily CALLIPHORINAE

Tribe Calliphorini

3. *Aldrichina grahami* (Aldrich)

This is generally a mountainous species. Adults are oviparous, saprophagous and are attracted to carrion and animal dung. They are associated with man and carry various types of viruses. The larvae are scavengers, breed in faecal matters, carrion and other decaying garbages and the species can be reared on raw meat in the laboratory. It is distributed in West Bengal (Darjeeling); Bhutan; California; China; East Siberia; Hawaiian Islands; Hong Kong; Japan; Korea; Mexico; North and West America; Pakistan; Russia and Taiwan.

4. *Calliphora* (*s. str.*) *pattoni* Aubertin

Adults are larviparous and can be collected from bushes and flowering plants. It is distributed in West Bengal (Darjeeling, Kalighat, Kurseong, Lebong, Rajabhatkhawa, Senchal Lake area), Meghalaya, Sikkim; China; Myanmar; Nepal; Taiwan and Thailand.

5. *Calliphora* (*s. str.*) *vicina* Robineau-Desvoidy

Adults are oviparous and are attracted to garbages, decaying fruits, carrion, human faeces and different kinds of dead bodies including human corpse. They are associated with man and carry

various types of bacteria, viruses, protozoans and helminthes causing intestinal disorders to human beings. The larvae can be reared on raw meat in the laboratory. They cause intestinal and urinary myiasis and are also involved in forensic science. It is distributed in West Bengal (Alipurduar, Birpara, Darjeeling, Kalimpong, Kurseong, Rajabhatkhawa), Himachal Pradesh, Sikkim, Uttar Pradesh; Australia; Canary Islands; China; Hainan Islands; Hawaiian Islands; Japan; Mauritius; Mongolia; Nepal; New Zealand; Pakistan; Russia; Saudi Arabia; South Africa and USA.

6. *Calliphora (s. str.) vomitoria* (Linnaeus)

Adults are oviparous and are attracted to garbages, carrion and excreta of different animals. This species is associated with various types of viruses, bacteria and protozoans. The larvae are scavengers, found in corpse, privies and garbages and breed in dead animals, human faeces and other animal dung. They act as secondary myiasis producer and are also involved in forensic science. It is distributed in West Bengal (Darjeeling, Senchal Lake area, Sukna), Himachal Pradesh, Meghalaya, Sikkim; Afghanistan; Australia; Bhutan; Canary Islands; China; Europe; Hainan Islands; Hawaiian Islands; Hong Kong; Japan; Korea; Manchuria; Mongolia; Morocco; Nepal; New Zealand; North America; Philippines; Russia; Sweeden; Taiwan and Thailand.

Subfamily BENGALIINAE

Tribe **Bengaliini**

7. *Bengalia labiata* Robineau-Desvoidy

This is generally a forest species and can be collected from bushes and decaying leaves near termite mound. Adults are aggressive predators and feed on ant pupae. It is distributed in West Bengal (Ranaghat Hijuli Forest), Sikkim; Bangladesh; Indonesia; Malaysia; Sumatra and Thailand.

8. *Bengalia surcoufi* Senior-White

This is a forest species and can be collected from decaying leaves and bushes near termite mound. It is distributed in West Bengal (Mungpoo, Nagrakata, Senchal Lake area, Sukna Forest), Assam, Karnataka, Kerala, Meghalaya, Pondichery, Sikkim, Tamil Nadu, Uttar Pradesh and Nepal.

9. *Bengalia torosa* (Wiedemann)

Adults are oviparous, forest species and can be collected from decaying leaves near termite mound. It is parasitic on ant pupae and was recorded to rear it from soil. It is distributed in West Bengal (Alipurduar, Buxa, Jainti, Kalchini, Rajabhatkhawa, Ranaghat), Karnataka, Kerala, Pondichery, Sikkim, Tamil Nadu, Uttar Pradesh; Australia; Bangladesh; Indonesia; Japan; Laos; Malaysia; Nepal; Pakistan; Philippines; South China; Sri Lanka; Taiwan and Thailand.

Subfamily LUCILIINAE

Tribe Luciliini

10. *Hemipyrellia ligurriens* (Wiedemann)

Adults are oviparous, mostly found in fish market and can be collected from garbages and carcasses. The larvae are scavengers or parasitic on other animals and breed in dung, carcasses, human faeces and other decomposed organic matters. It is distributed in West Bengal (Bijanbari, Burdwan, Buxa, Budge Budge, Kalimpong, Kalyani, Kolkata, Madarihat, Ranaghat, Shibpur, Siliguri, Sukna Forest), Bihar, Sikkim, Tamil Nadu; Australia; Amboina; Bangladesh; Bhutan; China; Indonesia; Japan; Korea; Malaysia; Micronesia; New Britain; New Guinea; Nepal; New Ireland; New Zealand; Pakistan; Philippines; Samoa; Sri Lanka; Taiwan and Thailand.

11. *Hemipyrellia pulchra* (Wiedemann)

Adults are oviparous and are attracted to dead animals, garbages and sometimes to flowering plants and fruits. The larvae develop in human faeces, decaying carcasses and garbages. It is distributed in West Bengal (Jaigoan), Bihar, Orissa, Pondichery, Punjab, Tamil Nadu, Uttar Pradesh; Indonesia; Malaysia; Nepal and Thailand.

12. *Lucilia ampullacea* Villeneuve

Adults are scavengers and are attracted to garbages and excreta of different animals. The larvae feed on dead animals, animal excreta and can be reared in the laboratory from fish, horseflesh and excreta of different animals. It is distributed in West Bengal (Darjeeling, Siliguri, Sukna Forest), Kerala; Algeria; Australia; Austria; China; Europe; Japan and Korea.

13. *Lucilia bazini* Séguy

Adults are attracted to carrion and can be collected from dead bodies of different animals. The larvae can not be reared from decomposed animals but it was reported to be parasitic on insects and other vertebrates. It is distributed in West Bengal (Shibpur Botanical Garden); China; East Siberia; Korea; Japan; Malaysia; Russia and Taiwan.

14. *Lucilia cuprina* (Wiedemann)

Adults are oviparous and are attracted to different kinds of dead bodies, garbages and animal dung. They are potential vector of enteric pathogens and are associated with various types of bacteria, protozoans and helminthes. The larvae are scavengers, feed on animal matters producing myiasis in man and other animals and can be reared from fish in the laboratory. It is distributed in West Bengal (Alipurduar, Jaigoan, Kalyani, Rajabhatkhawa, Ranaghat, Sealdah) and almost

cosmopolitan distribution in India; Afghanistan; Australia; Myanmar; Chagos Islands; China; Cuba; Egypt; Europe; Hawaiian Islands; Indonesia; Japan; Kenya; Korea; Kiribati; North and South America; Pakistan; Saudi Arabia; Seychelles; Singapore; South Pacific; Sumatra; Taiwan and Uganda.

15. *Lucilia illustris* (Meigen)

Adults are oviparous and found in animal carcasses and garbages. The larvae are mostly scavengers and frequently occur in garbages, sometimes may be parasitic on some moths. They are associated with few viruses and cause severe form of myiasis in human beings, and wound, ulcer and subdermal myiasis in other vertebrates also. It is distributed in West Bengal (Darjeeling, Jalpaiguri, Kolkata, Senchal Lake area, Siliguri), Sikkim; Australia; Bhutan; Europe; Japan; Korea; Manchuria; Myanmar; North America and Siberia.

16. *Lucilia papuensis* Macquart

Adults are oviparous and generally found in forests. They are mostly gathered on earthworms and other vertebrate's dead bodies. But James (1971) recorded it from marsupial skull and human excrement. Nothing is known regarding its larval development. It is distributed in West Bengal (Ranaghat), Arunachal Pradesh, Kashmir, Kerala; Amboina; Australia; Bangladesh; Bhutan; Celebes; China; Indonesia; Japan; Korea; Malaysia; Nepal; Papua New Guinea; Philippines; Taiwan and Thailand.

17. *Lucilia porphyria* (Walker)

Adults are oviparous, saprophagous, attracted to decaying matters and dead bodies of different animals and frequently found in human dwellings. They are associated with various types of protozoans. The larvae are scavengers producing myiasis in different parts of vertebrate animals, feed on decaying matters and breed in carcasses of birds and other animals. It is distributed in West Bengal (Burdwan, Coochbehar, Rajabhatkhawa, Ranaghat, Shibpur Botanical Garden), Arunachal Pradesh, Assam, Himachal Pradesh, Kashmir, Sikkim; Australia; Bhutan; Borneo; China; Korea; Indonesia; Japan; Malaysia; Nepal; New Britain; Papua New Guinea; Philippines; Sri Lanka; Taiwan and Thailand.

18. *Lucilia sericata* (Meigen)

Adults are oviparous, scavengers and typically a domestic species. They can be collected from decaying matters, carrion, open wounds, faeces, fruits and foods in the market. They are associated with various types of viruses, bacteria, protozoans and helminthes. The larvae are serious pests of sheep in Australia and can be reared on fish in the laboratory. It has also forensic importance. The larvae cause myiasis in different parts of animals and the sterile larvae have been used earlier in

surgery (Pont, 1980). It is distributed in West Bengal (Kalimpong, Malda, Siliguri, Sukna, Takvar); Australia; Easter Island; Europe; Hawaiian Islands; Marshall Islands; Pakistan; Sri Lanka; Volcano Islands; Wake Islands and almost cosmopolitan in distribution.

Subfamily CHRYSOMYINAE

Tribe Chrysomyini

19. *Chrysomya bezziana* Villeneuve

Adults are found in bushes and leaves. The larvae never breed in carrion or decomposed matters but produce myiasis in man and domestic animals. It is distributed in West Bengal (Budge Budge, Burdwan, Kolkata, Shibpur Botanical Garden), Arunachal Pradesh; Africa; Bismark Archipelago; Indonesia; Malaysia; Philippines and Sri Lanka.

20. *Chrysomya megacephala* (Fabricius)

Adults are oviparous, saprophagous and are attracted to dead fishes, human excreta, carcasses and sweets. They are associated with various types of viruses, bacteria, protozoans and helminthes. The larvae are scavengers and feed on decaying matters. They produce myiasis in different parts of man and domestic animals and can be reared on dead animals in the laboratory. They are serious pest of fish products. It is distributed in West Bengal (Alipurduar, Bijanbari, Diamond Harbour, Digha, Jaigoan, Jayanti, Kalyani, Kolkata, Kurseong, Malda, Ranaghat, Rajabhatkhawa, Panitanki, Shibpur Botanical Garden, Siliguri, Singla Bazar, Sukna Forest, Sikkim, Tamil Nadu; Bhutan and almost cosmopolitan in distribution.

21. *Chrysomya pinguis* (Walker)

Adults are forest species and rarely enter houses in search of foods. The larvae breed in carcasses of birds and other animals including garbages. It is distributed in West Bengal (Darjeeling), Assam, Arunachal Pradesh, Himachal Pradesh, Meghalaya, Tamil Nadu; Bangladesh; China; Hainan Islands; Indonesia; Japan; Korea; Malaysia; Nepal; Philippines; Sri Lanka; Thailand and Taiwan.

22. *Chrysomya rufifacies* (Macquart)

Adults are viviparous, saprophagous and are attracted to garbages, dead bodies of different animals and excreta of man. They are associated with various types of bacteria, protozoans and helminthes. The larvae are primarily scavengers but may be predator on other dipteran larvae also. They can be reared on meat in the laboratory. The larvae produce secondary myiasis in different animals. It is distributed in West Bengal (Alipurduar, Bijanbari, Jaigoan, Kalyani, Kurseong, Madarihat, Rajabhatkhawa, Ranaghat, Panitanki, Sealdah, Shibpur, Singla Bazar, Siliguri), Nicobar Islands, Sikkim; Bangladesh and almost cosmopolitan in distribution.

Subfamily MELANOMYINAE

23. *Melinda bengalensis* Nandi

Adults are attracted to flowering plants and can be collected from flowers and bushes. It is distributed in West Bengal (Shibpur Botanical Garden).

24. *Melinda scutellata* (Senior-White)

Adults are oviparous, generally attracted to flowering plants and can be collected from flowers and bushes. It is distributed in West Bengal (Birpara, Mungpoo), Sikkim, Meghalaya; Malaysia; Myanmar and Nepal.

Subfamily POLLENIINAE

Tribe Polleniini

25. *Onesia (Melindopsis) khasiensis* (Senior-White)

Adults are oviparous and can be collected from flowering plants. It is distributed in West Bengal (Darjeeling, Lebong), Assam, Meghalaya, Sikkim; Bangladesh and Malaysia.

26. *Dexopollenia testacea* (Townsend)

Adults are oviparous and can be collected from bushes and flowering plants. A few larvae are parasitic on Lepidoptera. It is distributed in West Bengal (Bijanbari, Darjeeling, Jaigoan, Sukna Forest), Assam and Nepal.

27. *Polleniopsis pilosa* Townsend

Adults are oviparous and can be collected from bushes, decaying leaves and flowering plants. It is distributed in West Bengal (Darjeeling, Kalimpong, Sukna Forest), Assam, Bihar and Meghalaya.

Subfamily RHINIINAE

Tribe Rhiniini

28. *Stomorphina discolor* (Fabricius)

Adults are found in forest and can be collected from flowering plants. The larvae seem to be predacious, attack other larvae and feed on them and the larvae breed in termite nests. It is distributed in West Bengal (Darjeeling, Sukna Forest), Arunachal Pradesh, Assam, Sikkim; Australia; Bangladesh; Borneo; China; Fiji; Hawaiian Islands; Indonesia; Irian Jaya; Malaysia; Nepal; New Caledonia; Pakistan; Papua New Guinea; Philippines; Sri Lanka; Taiwan and Thailand.

29. *Stomorphina procula* (Walker)

Adults are collected from bushes and flowering plants. It is distributed in West Bengal (Darjeeling), Assam, Tamil Nadu; Africa; Borneo; China; Malaysia; Myanmar; Philippines and Queensland.

30. *Idiella euidielloides* (Senior-White)

Adults are forest species and can be collected from bushes and flowering plants. It is distributed in West Bengal (Darjeeling), Assam, Meghalaya, Orissa, Kerala, Sikkim; Irian Jaya; Malaysia; Philippines; Sri Lanka; Taiwan and Thailand.

31. *Idiella mandarina* (Wiedemann)

Adults are forest species and can be collected from flowering plants and bushes. Some larvae are sanguivorous. It is distributed in West Bengal (Darjeeling), Assam, Bihar, Gujarat, Haryana, Kerala, Madhya Pradesh, Maharashtra, Orissa, Uttar Pradesh; Bangladesh; China; Indonesia; Key Islands; Malaysia; Myanmar; Sri Lanka; Taiwan and Thailand.

32. *Idiella tripartita* (Bigot)

Adults are collected from flowering plants and bushes. It is parasitic on vertebrates and blood sucker of pig and sometimes also attack white mouse and pupa of ant. It is distributed in West Bengal (Darjeeling), Sikkim; China; Nepal and Philippines.

33. *Rhinia apicalis* (Wiedemann)

Adults are collected from flowering plants. It is distributed in West Bengal (Darjeeling), Gujarat, Maharashtra, Meghalaya, Nicobar Islands; Australia; Canary Islands; Fiji; Hawaiian Islands; Irian Jaya; Philippines and Solomon Islands.

34. *Rhinia mallochi* (Senior-White, Aubertin and Smart)

Adults are collected from bushes and flowering plants. It is distributed in West Bengal (Budge Budge, Kalimpong, Kolkata, Krishnagar, Purulia, Sukna Forest) and Sikkim.

35. *Metallea setosa* (Townsend)

Adults are collected from flowering plants and bushes. It is distributed in West Bengal (Kurseong, Siliguri); China; Malaysia; Myanmar; Nepal; Singapore; Taiwan and Tibet.

36. *Isomyia ditissima* (Walker)

Adults are collected from flowering plants and bushes. It is distributed in West Bengal (Darjeeling); Indonesia; Myanmar; New Guinea; Philippines and Thailand.

37. *Isomyia flavicornis* (Bigot)

Adults can be collected from flowering plants. It is distributed in West Bengal (Darjeeling, Kolkata), Assam, Bihar, Maharashtra, Meghalaya; Bangladesh; Borneo; Malaysia; Irian Jaya; Nepal and Sri Lanka.

38. *Isomyia malayensis* (Townsend)

Adults can be collected from flowering plants and bushes. It is distributed in West Bengal (Darjeeling, Lebong, Sukna Forest), Sikkim; Malaysia and Singapore.

39. *Isomyia nebulosa* (Townsend)

Adults can be collected from flowering plants. It is distributed in West Bengal (Darjeeling), Assam; Laos and Myanmar.

40. *Isomyia phryxea* (Séguy)

Nothing is known regarding its bionomics and the specimen was not available for study. It is distributed in West Bengal (Kurseong).

41. *Isomyia viridana* (Townsend)

This species can be collected from flowering plants. It is distributed in West Bengal (Kolkata) and Assam.

NOTE ON BIODIVERSITY

The genus *Aldrichina* is totally mountaneous species and has less speciation. The adults are oviparous, saprophagous and the larvae have diversified habitats living on excreta and dead bodies of different animals. They carry the germs of various diseases and take part in major role in public health.

The species of the genera *Calliphora*, *Chrysomya*, *Lucilia* and *Hemipyrellia* have diversified habitats and mostly are synanthropic, few are forest habitants and are generally attracted to garbages, dead bodies of different vertebrate animals and the larvae are found therein. They carry the various types of viruses, bacteria, protozoans and helminthes and have public interest in transmission of enteric diseases. They have also medical, hygienic and forensic importances and most of them are oviparous and few are larviparous. The larvae mostly develop in meat and fish and many of them produce myiasis in man and wild or domestic animals. These genera have wide diversification in speciation.

Species of the genera *Bengalia*, *Catapicephala* and *Silbomyia* are mostly forest species and found in decaying leaves and bushes. Species of *Bengalia* are found in termite mound and are

aggressive predators feeding on pupae and hover the adult termites. Sometimes they snatched the prey from the ant (Pont, 1980). *Bengalia* has rich in speciation in comparison to *Catapicephala* and *Silbomyia*.

Species of the genera *Onesia*, *Metallea*, *Idiella*, *Rhinia*, *Isomyia* and *Stomorphina* are forest species and are attracted to flowers rather than dead bodies of different animals. Kurahashi and Tumrasvin (1992) reported their association with Hymenoptera, Isoptera and Orthoptera. Their most important role is in pollination. One species of *Rhinia* has been reared from nest of sand-wasp. Larvae of *Stomorphina* breed in termite nest and are predaceous or predator on eggs capsule of locust. A few larvae of *Idiella* are sanguinivorous and are mostly found in decaying garbages and meat. *Idiella* and *Isomyia* have more diversity in speciation in comparison to *Rhinia* and *Metallea*. Few larvae of *Onesia* are parasitic or predator on earthworms and snails. *Onesia* and *Metallea* have less speciation.

Species of the genera *Pollenia* and *Melinda* are attracted to flowering plants besides decaying leaves and bushes. Their larvae are found in garbages and decaying meat. The larvae of the former genus are parasitic on Lepidoptera but the later genus are on land snails. *Melinda* has less speciation than *Pollenia*. They are important in pollination.

Species of the genus *Polleniopsis* is attracted to flowering plants and help in pollination. Nothing is known regarding their larvae. The adults are viviparous and the genus has less speciation.

West Bengal is very much rich in faunal diversification due to its variety of biogeographic features and ecological diversity and it is expected that more known and unknown species will be available in near future if thorough faunistic survey is done from different parts of this state of India. The study of this group and their biological diversity will not only help the taxonomists but will be helpful for the medical and veterinary practitioners and forensic entomologists.

SUMMARY

This paper deals with the systematic position of 41 species of calliphorid flies, most of them collected from different parts of West Bengal in different seasons. Biological diversity and distributional records of the species from West Bengal as well as from rest of the world are included. A note on biodiversity of the species under each genera are also incorporated.

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**STRUCTURE OF MID-DORSAL GUARD HAIRS OF HUNTING
LEOPARD, *ACINONYX JUBATUS VENATICUS* (GRIFFITH)
AND LESSER PANDA, *AILURUS FULGENS* F. CUVIER
(MAMMALIA : CARNIVORA)**

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INTRODUCTION

Knowledge about the structure of dorsal guard hairs has not only become the most significant in the study of mammalian taxonomy and food habit but in the mammal survey, forensic science and control of illegal trade also (Brunner and Coman 1974, Koppiker and Sabnis 1976, 1977, Teerink 1991, Chakraborty *et al.*, 1996, 1999). Hair structure of quite a number of mammalian species of India as well as abroad have been worked out (Hausman 1920, Brunner and Coman 1974, Moore *et al.*, 1974, Koppiker and Sabnis 1976, 1977, Keller 1981, Debrot *et al.*, 1982, Teerink 1991, Wallis 1993, Venkatraman *et al.*, 1994, De and Chakraborty 1995, Chakraborty *et al.*, 1996, 1999, De *et al.*, 1998). However, no information is available as regard the structure of dorsal guard hairs of two threatened species of carnivora, *viz.*, Hunting Leopard, *Acinonyx jubatus* (Schreber) [Carnivora : Felidae] and Lesser Panda, *Ailurus fulgens* F. Cuvier (Carnivora : Ursidae). Hunting Leopard was last recorded in India in 1952 and considered as extinct in the country (Ghosh 1994), while Lesser Panda, within Indian limit, is found in Darjeeling (West Bengal), Sikkim and Arunachal Pradesh and considered as endangered (Chakraborty 1994). Both the species are included in the Schedule I of the Indian Wildlife (protection) Act, 1972. In India *A. fulgens* is represented by the nominate subspecies, while *A. jubatus* was represented by the subspecies *venaticus* (Griffith). In the present paper an attempt has been made to reveal the structure of dorsal guard hairs of the above mentioned species.

MATERIAL AND METHODS

Five tufts of guard hairs were collected from the mid-dorsal region of four dry preserved specimens of each species present in the National Zoological Collection of the Zoological Survey of India, Kolkata. Samples were processed for study according to the method of Chakraborty *et al.*, (1996). Surface structure, medullary configuration and cross sectional details of dorsal guard hairs were studied microscopically followed after Brunner and Coman (1974), Teerink (1991) and Chakraborty *et al.*, (1996).

Nomenclature of colour is followed after Ridgway (1891) and structural nomenclature of cuticular as well as medullary configuration is followed after Brunner and Coman (1974) and Moore *et al.*, (1974). Classification was followed after Wozencroft (1993).

OBSERVATIONS

1. *Ailurus fulgens* F. Cuvier

A. Physical Characters :

Colour : Basal – Cinnamon or Fawn

Distal – Brunt Umber

Profile : Straight, Shielded, Spatulate

Length (mm) : 47–56 (50.4 ± 3.07)

Diameter (μ) : Basal : 50–60 (54.5 ± 1.29)

Subshield : 70–80 (76.3 ± 3.358)

Shield : 110–130 (116.4 ± 2.449).

B. Surface structure (Plate I, Fig. 1)

Scale count (per mm of hair length) : 498–535 (522 ± 5.23)

Scale type : Petaloid

Scale pattern : Diamond Petal

Scale margin : Smooth

Scale margin distance : Distant

Side to side scale length (SS) : $3.1-4.4\mu$ (4 ± 0.23)

Proximo-distal scale length (PD) : $10-14.4\mu$ (13.12 ± 0.36).

C. Medulla (Plate I, Fig. 2)

Medullary configuration : Unbroken cellular

Medullary index : 0.61–0.649 (0.63 ± 0.011).

D. Cross section : Circular (Plate I, Fig. 3).

2. *Acinonyx jubatus* (Schreber)

A. Physical characters :

Colour : Basal – Usually Buff

Middle – Tawny

Tip – Brown

Remark : Shades are greatly varied, sometimes whole hair is light Brown or dark Tawny or sometimes more darker.

Length (mm) : 37–47 (43.7 ± 2.07)

Profile : Very thin, straight, rod like

Diameter (μ) : 50–65 (56 ± 3.56).

B. Surface structure (Plate II, Fig. 1)

Scale count : 435–538 (489 ± 6.38)

Scale type : Imbricate, Crenate

Scale pattern : Irregular wave

Scale margin : Irregularly Rippled

Scale margin distance : Intermediate

Side to side scale length (SS) : $7.5-21.87\mu$ (14.81 ± 4.31)

Proximo-distal scale length (PD) : $3.12-9.39\mu$ (5.25 ± 2.24).

C. Medulla (Plate II, Fig. 2)

Medullary configuration : Simple unbroken amorphous

Medullary index : 0.62–0.66 (0.638 ± 0.014).

D. Cross section : Almost circular (Plate II, Fig. 3)

Remark : Cuticular scales are very much irregular in shape and size.

DISCUSSION

Structure of dorsal guard hairs of all the five species of large cats of Indian territory belonging to the genus *Panthera* Oken have been studied (Chakraborty *et al.* 1996). On comparison with the species of the genus *Panthera*, it has been found that scale count in *A. jubatus* is much higher (489 ± 6.38) than that of all the five species of the genus *Panthera*, where highest is 300 in *P. tigris*. Moreover, 'SS' (14.81 ± 4.31) and 'PD' (5.25 ± 2.24) in *A. jubatus* are on average, much lower than those in the species of the genus *Panthera*, where 'SS' and 'PD' are lowest in *P. tigris* being (18 ± 6) and (7 ± 2) respectively. When compared with the hair structure of the 11 species of Indian lesser cats (Chakraborty *et al.* 1999), it has been found that hair structure of *A. jubatus* has no single characteristic by which it may be separated from all of them. However, from the combination of characters like scale count, scale structure, scale margin, scale type, medullary configuration, *A. jubatus* can be distinguished from all the species of lesser cats occurring in India.

Genus *Ailurus* is monotypic and its family placement is much controversial. It has been included under Ailuridae (Pocock 1939), Procyonidae (Ellerman and Morrison Scott 1951), Ailuropodidae (Honacki *et al.*, 1982) and Ursidae (Wozencroft 1993). On the basis of biochemical and molecular evidence, *Ailurus* was considered as intermediate between procyonids and Ursids (O'Brien *et al.* 1985, Tagle *et al.* 1986, Wayne *et al.* 1989). Todd and Pressman (1968), Zhang and Shi (1991) regarded it as closer to procyonids, while reverse opinion was held by Goldman *et al.* (1989).

Hausman (1920) observed 'Diamond Petal' scale pattern and 'Smooth' scale margin in *Ursus americanus* like *A. fulgens*, but in *Ursus arctos* scale pattern is 'Irregular wave' with 'Crenate' scale

margin. Moore *et al.* (1974) studied the hair structure of two species of Ursids viz., *Ursus americanus cinnamomum*, *Ursus arctos imperator* and two species of Procyonids viz., *Procyon lotor hirtus* and *Bassariscus astutus crizonensis*. On comparison of the findings of present study it has been found that *Ailurus* differs from all the four species in having the maximum diameter of hair as low as 60 μ against 153 μ , 148 μ , 154 μ and 83 μ in *U. americanus cinnamomum*, *U. arctos imperator*, *P. lotor hirtus* and *B. astutus crizonensis* respectively. Further, it has been found that medullary configuration is similar being 'Unbroken cellular' in both species of *Ursus*, *A. fulgens* and *B. astutus crizonensis*, but in *P. lotor hirtus* it is different being 'Unbroken vacuolated'

Thus, so far the hair structure is considered, genus *Ailurus* is distinct from all the studied species of Ursids and Procyonids in respect of diameter, while its medullary configuration is similar to both the Ursid species and one Procyonid species. As such, consideration of *Ailurus* as intermediate between Ursids and Procyonids (O'Brien *et al.* 1985, Tagle *et al.* 1986, Wayne *et al.* 1989), appears to be more justified.

SUMMARY

Mid-dorsal guard hairs of Hunting Leopard, *Acinonyx jubatus* (Schreber) and Lesser Panda, *Ailurus fulgens* F. Cuvier have been studied. *Acinonyx jubatus* may be distinguished from other species of large cats of the genus *Panthera* Oken by higher scale count, lower 'SS' and 'PD' *Ailurus fulgens* is distinguished from all the studied species of Ursidae and Procyonidae by higher diameter of the hair. Further, as regard hair structure it is intermediate between Ursids and Procyonids.

ACKNOWLEDGEMENTS

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PLATE I

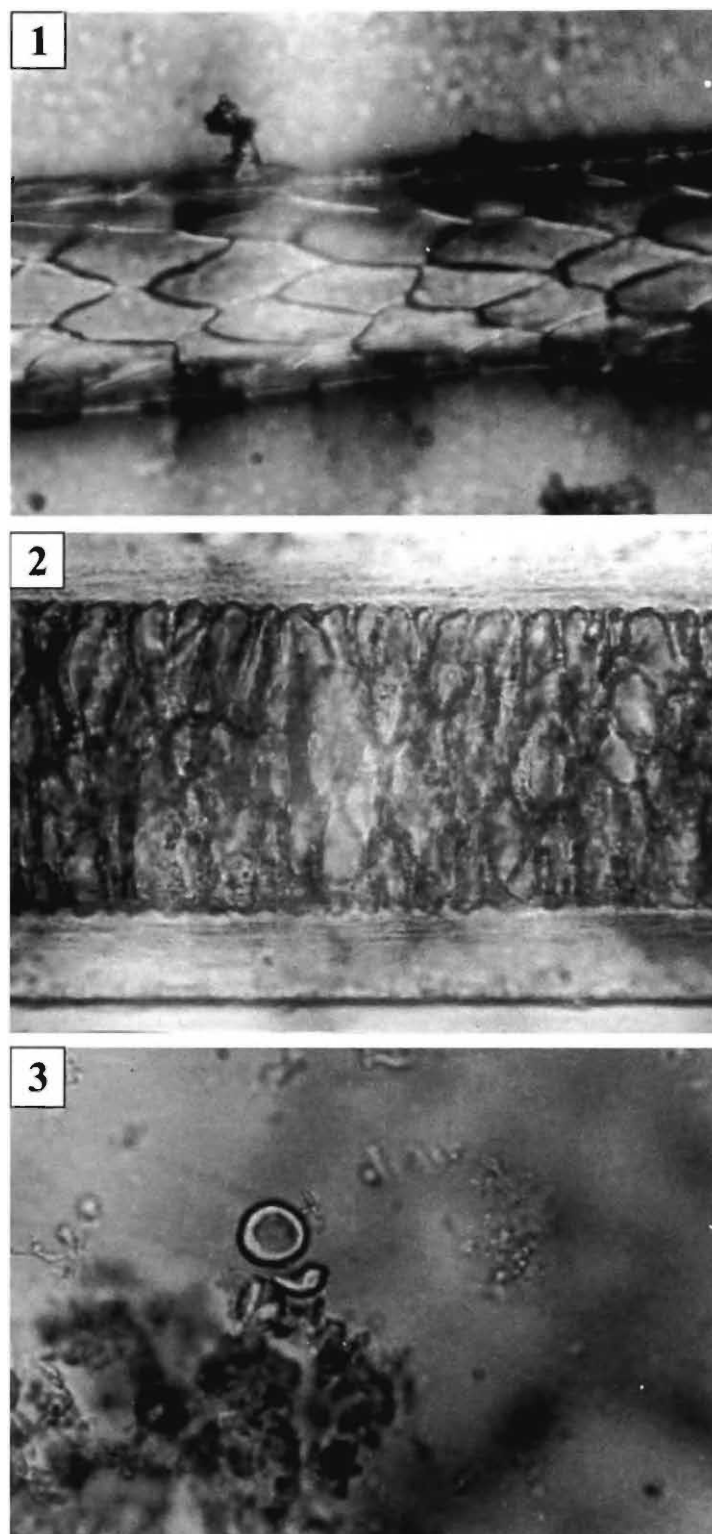


Plate I. Cuticular seale, medulla and Cross-sectional structure of mid-dorsal guard hairs of *Ailurus fulgens*.

Fig. 1. Cuticle of *A. fulgens* : 40X

Fig. 2. Medulla of *A. fulgens* : 40X

Fig. 3. Cross-section of *A. fulgens* : 40X.

PLATE II

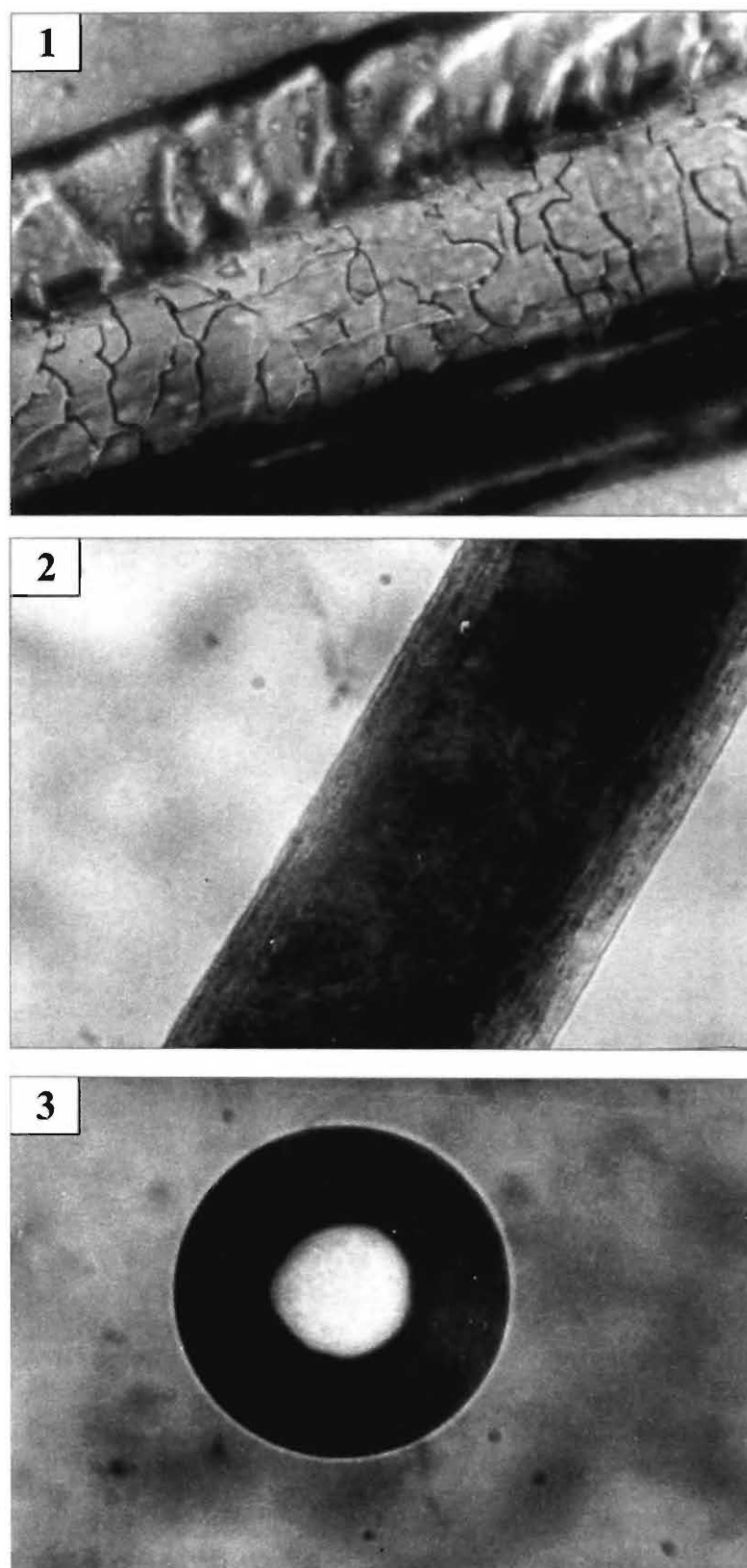


Plate II. Cuticular seale, medulla and Cross-sectional structure of mid-dorsal guard hairs of *Acinonyx jubatus*.

Fig. 1. Cuticle of *A. jubatus* : 40X

Fig. 2. Medulla of *A. jubatus* : 40X

Fig. 3. Cross-section of *A. jubatus* : 40X.

A NEW SYNBRANCHID FISH, *MONOPTERUS DIGRESSUS* FROM KERALA, PENINSULAR INDIA

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INTRODUCTION

Rosen & Greenwood (1976) in their revisionary work on phylogeny and systematics of synbranchiform fishes treated all synbranchid eels under the single family Synbranchidae. They recognized two subfamilies : the Macrotrematinae containing the monotypic genus *Macrotrema* and the *Synbranchinae* with three genera : *Ophisternon*, *Synbranchus* and *Monopterus*.

Of the four genera, the Old world genus *Monopterus* comprises of altogether eight species (Bailey & Gans, 1998). Excluding *Monopterus boueti* (Pellegrin) from Africa and *Monopterus desilvai* Bailey and Carl Gans from Sri Lanka, the species reported from India include *Monopterus albus* (Zuiew), *Monopterus eapeni* Talwar, *Monopterus cuchia* (Hamilton), *Monopterus fossorius* (Nair), *Monopterus indicus* (Silas and Dawson) and *Monopterus roseni* Bailey and Carl Gans. Of these, the three from Kerala, viz., *M. eapeni*, *M. roseni* (both from Kottayam Dist.), *M. fossorius* (from Thuvananthapuram Dist.) and the one from Mahabaleswar, Maharashtra, viz., *M. indicus* are endemic to Peninsular India. *M. eapeni* and *M. roseni* are blind cavernicoles living in subterranean waters. A new species, and the third cavernicole of the genus, is described here as *Monopterus digressus* from Calicut Dist., Kerala, Peninsular India. The new species is the fourth species known from Kerala, the fifth from Peninsular India and the seventh from India. The type specimens are deposited in the faunal collections of the Western Ghats Field Research Station, Zoological Survey of India, Calicut.

Monopterus digressus sp. nov.

(Figs. 1–9)

Material examined : *Holotype* : ZSI-WGFRS, 10684, 218 mm in total length (TL), collected from a homestead well at Kuthiravattom, a suburban locality of Calicut, Kerala, India; Alt. 40 m; Date. 12.x.1998; Coll. Salim.

Paratype : 7 specimens, 150–242 mm TL; Collection data same as of holotype.

Diagnosis : A small, blind species of *Monopterus*. Body slim, naked, subcylindrically elongate and cord-like. Head slightly to moderately conspicuous, with muscular occiput. Upper jaw with jowl-like lip, slightly overhanging the lower jaw. Gill aperture ventral, wide, subtriangular or lunate without lateral folds. Branchiostegal membrane internally fused with isthmus, its skin ventrally drawn into shallow longitudinal folds. Paired suprapharyngeal pouches present. Lateralis system distinct with prominent cephalic pores. Trunk and tail nearly identical in shape (depth and width) except at the tail extremity. Tail extremity compressed and tapering with rudimentary dorsal and anal fin folds (dermal ridges) confluent at the caudal tip. Branchiostegal rays 6. Vertebrae : Precaudal 86-88, caudal 80-82, total 166-170.

Description : Body : (Figs. 1 & 7) : Slim, naked, subcylindrically elongate and cord or thread-like. Dorsal and ventral profiles, excluding head and tail extremity, nearly parallel. Snout to vent (SV) length 62.7% of TL. Tail long, nearly identical in shape to that of trunk except at posterior extremity, about 37.3% of TL, 59.6% of SV length. Tail extremity well compressed and tapering with rudimentary dorsal and anal fin folds (dermal ridges) confluent at the caudal tip. Body depth (maximum) about 1.8%, at vent 1.75% of TL, 40.4% of head length (HL).

Head : (Figs. 2, 3, 4, 8 & 9) : Small, slightly to moderately conspicuous, with gently arched muscular occiput. HL 4.5% of TL, 7.2% of SV length, its depth 52.4% its own length. Eyes absent. Jaws slightly unequal in forward extension, anteriorly truncated or squarely rounded; upper jaw surrounded with a jowl-like tissue (lip) slightly overhanging the lower jaw. Gape length 31.7% of HL. Teeth on palate, and laterally on jaws uniserial, but anteriorly in two, sometimes three, rows. Anterior nostrils small, at the tip of snout; posterior nostrils large, subrectangular. Distance from snout tip to posterior nostril 0.8% of TL, 18.1% of HL. Cephalic lateralis system distinct with a number of pores (figs. 2, 3 & 4) : dorsally a pair of internasal pores between anterior and posterior nares, a median coronal pore just behind the level of posterior nares and a pair of post nasal pores; ventrally 3 pairs of mandibular pores; a fourth pair, one each, behind the gape angles and a fifth pair, one each on either side, in the mid-lateral position. Files of minute sensory papillae also present, becoming indistinct in mucous coating after the preservation of specimen.

Branchial region : (Figs. 4, 6 & 9) : The gill aperture ventral, wide, subtriangular or lunate, its width 22.4% of HL, 64% of head width, internally divided into a pair of pore-like lateral apertures by a midventral fusion between branchiostegal membrane and isthmus; skin of branchiostegal membrane ventrally drawn into shallow longitudinal folds, skin folds not extending laterally to angles of gill aperture. Buccopharyngeal cavity ventrally opening to each of the paired branchial chambers through 4 gill slits. The first and the anterior-most one, the hyo-branchial slit (between hyoid and first branchial arches), the largest, followed by the fourth slit (between fourth and fifth arches). The second and third branchial slits (between one and two, and two and three branchial arches respectively) are comparatively smaller. The third and fourth arches lie closely without a slit in

between. Gills are greatly reduced, with only thin flanges of tissues on branchial arches one to three, each one with a single afferent-efferent vessel. The vessel on the fourth arch is thick and continuous, merging dorsomedially with its counterpart to form an unpaired dorsal aorta. A pair of accessory suprapharyngeal pouches, each one on either side of head, present; pouches posteriorly extending to slightly beyond neck-line, above angles of gill aperture, anteriorly opening to pharynx by a pair of apertures at the roof of pharynx, opposite to the hyo-branchial slits on the floor of pharynx.

Body devoid of scales (naked). Lateral line extending from head to caudal end, becoming indistinct in the mucous coating after preservation of the specimen. Branchiostegal rays 6. Vertebrae : precaudal 86-88, caudal 80-82, total 166-170.

Colouration : Body colour in life blood-red, caudal extremity transparent, making visible the vertebral column and blood vessels; in alcohol, tawny white or pale flesh in colour.

Morphometric data : Given in thousandths of total length (TL) in Table I; certain morphometric ratios (in percentages) are also presented in Table II.

Etymology : The specific epithet *digressus* is derived from Latin 'digressus', meaning deviation, a reference to this species being different from other closely resembling species of *Monopterus*.

Relationship : *M. digressus* closely resembles *M. eapeni* and *M. roseni*, but differs from both by its characteristic body shape, differences in vertebral count, presence of suprapharyngeal respiratory pouches, prominent cephalic lateralis system etc. The body of *M. digressus* is cord-like (uniformly subcylindrical and elongate), rather than whip-like as in *M. eapeni* or *M. roseni*. The count of vertebrae from 3 dissected specimens (TLs : 208 mm., 196 mm., and 180 mm.) of *M. digressus* showed a range of 86-88 precaudal and 80-82 caudal, total 166-170 in contrast to 135 precaudal and 24 caudal, total 159 in *M. eapeni* (Eapen, 1963, Talwar and Jingran, 1991), and 76 precaudal and 71 caudal, total 147 in *M. roseni* (Bailey and Gans, 1998). Accessory suprapharyngeal respiratory pouches are distinctly present in *M. digressus*, whereas they are presumed to be absent in *M. eapeni* and *M. roseni* (Talwar and Jingran, 1991; Bailey and Gans, 1998). The lateralis system of the new species is seen with more number of pores on head compared to a lesser number of pores in *M. eapeni* or *M. roseni*. *M. digressus* is further distinguishable from *M. eapeni* by its vestigial dorsal and anal fin folds (ridges) restricted to caudal extremity (vs. dorsal fin fold commencing from opposite to vent and anal fin fold far posterior to vent in *M. eapeni*), and from *M. roseni* by its slightly overhanging upper jaw (vs. both jaws equal in forward extension in *M. roseni*).

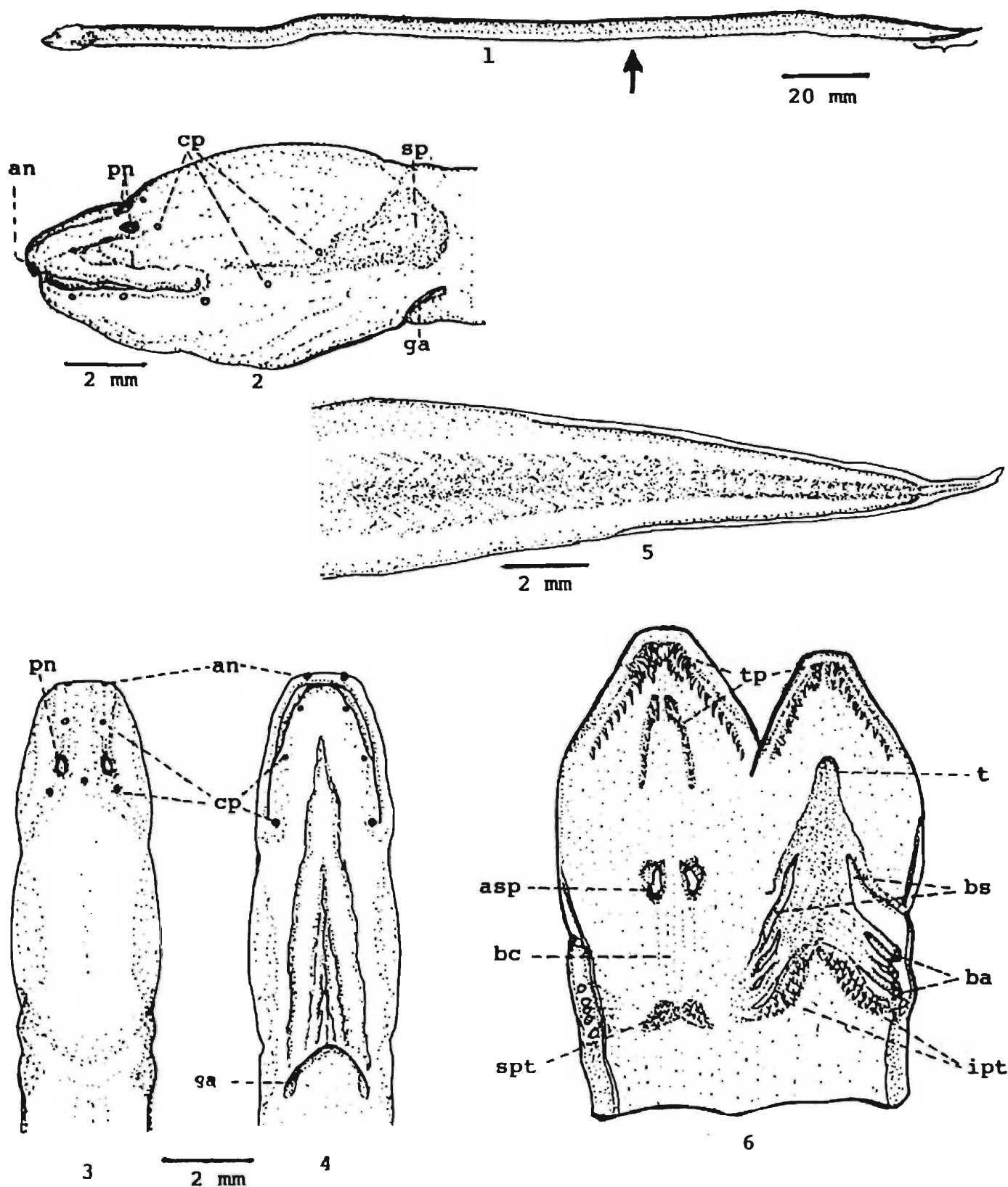
M. digressus can be easily separated from the large and robust bodied species such as *M. albus*, *M. cuchia*, *M. fossorius*, *M. indicus* etc. by its smaller size, slim body, absence of eyes and the ratio of precaudal to caudal lengths, besides differences in vertebral count.

Table I. Morphometric data of *Monopterus digressus* sp. nov. (the holotype and 7 paratypes) and the holotype of *Monopterus roseni* (Bailey and Gans, 1998).

(Measurements in mm and thousandths of total lengths)					
	<i>M. digressus</i>				<i>M. roseni</i>
	<i>Holotype</i>	<i>Paratypes</i>			<i>Holotype</i>
		Range	Mean	s.d	
Total length (TL)—in mm	218	150–242			176
: thousandths of TL					
Snout tip to vent	626	624–629	626.6	1.6	619
Tail length	373	371–376	373.1	1.5	381
Snout tip to occiput	042	041–045	042.5	1.1	048
Snout tip to gill aperture at midline	040.2	039–040.4	039.9	0.4	041
Head length (snout tip to angle of gill aperture)	045.4	044–046	045.1	0.6	048
Snout tip to post naris	008.4	008–009	008.1	0.3	011
Gape length (snout tip to angle of gape)	014.6	014–015	014.4	0.5	020
Width of gill aperture	010.2	009–011	10.0	0.5	011
Distance between anterior nares	004	—004	004.0	—	005
Distance between posterior nares	004.5	004–005	004.9	0.3	006
Head depth	025.0	021–025	022.9	1.4	024
Head width	018.0	014–018	016.0	1.3	018
Body depth (maximum)	018.4	017–019	018.0	0.3	019
Body depth (at vent)	017.4	017–018	017.5	0.3	016
Body width (maximum)	017.0	013–017	015.0	1.4	016
Body width (at vent)	016.0	012–016	014.5	1.3	013

Abbreviations used in the figures :

an—anterior nare; *asp*—aperture of suprapharyngeal pouch; *ba*—cut ends of branchial arches; *bc*—buccopharyngeal cavity; *bs*—branchial slit (opening to branchial chamber); *cp*—cephalic pores; *ga*—gill aperture; *ipt*—infrapharyngeal teeth; *pn*—posterior nare; *sp*—suprapharyngeal pouch (externally visible through head integument); *spt*—suprapharyngeal teeth; *t*—tongue; *tp*—tooth patch.



Figs. 1-6. *Monopterus digressus* sp. nov. : 1. Holotype, 218 mm long. The position of vent is indicated by the arrow. 2. Head : Lateral view; 3. Head : Dorsal view; 4. Head : Ventral view; 5. Tail extremity (the bracketed portion of fig. 1 enlarged); 6. Head region dissected open to show the roof and floor of the buccopharyngeal cavity.

Table II. Morphometric ratios (in percentages) of *Monopterus digressus* sp. nov. (the holotype and 7 paratypes) and the holotype of *Monopterus roseni* (Bailey and Gans, 1998).

	<i>M. digressus</i>				<i>M. roseni</i>
	<i>Holotype</i>	<i>Paratypes</i>			<i>Holotype</i>
		Range	Mean	s.d	
Caudal length/snout to vent length	59.67	59.02–60.32	59.59	0.39	61.47
Head length/snout to vent length	7.25	7.11–7.27	7.22	0.05	7.8
Body depth (max.)/head length	40.6	39.63–42.33	40.35	0.91	40.0
Body depth at vent/head length	39.1	37.66–40.21	38.68	0.78	32.94
Head depth/head length	54.94	39.3–59.94	52.43	12.0	50.59
Gape length/head length	31.31	31.31–32.18	31.72	0.3	41.18
Width of gill aperture/head length	22.42	20.88–22.89	22.39	0.8	22.35
Width of gill aperture/head width	56.35	56.35–70.65	64.0	4.91	61.29

REMARKS

Based on the presence or absence of paired suprapharyngeal pouches and scales on body (mostly in the caudal part), Talwar and Jingran (1991) recognized two subgenera : *Amphipnous* Muller with species having these dual characters (*M. cuchia*, *M. fossorius* and *M. indicus*) and *Monopterus* Lacepede comprising of species devoid of these characters (*M. albus*, *M. eapeni* and *M. roseni*).

But, according to Rosen and Greenwood (1976), the development of suprapharyngeal pouches is a derived shared character (synapomorphy) found in the species of *cuchia*, *indicus* and *fossorius*. Considering more synapomorphies of head anatomy, especially of branchial arch elements, branchial vascular system etc., they have indicated in their proposed phylogenies that the species of *Monopterus* form a monophyletic group and that the African species *M. boueti* having neither suprapharyngeal pouch nor body scales, is more closely related to *M. fossorius*, *M. cuchia* and *M. indicus* than to *M. albus* and *M. eapeni*. Bailey and Gans (1998) regard *Amphipnous* a group name of convenience rather than a subgenus.

M. digressus is having paired suprapharyngeal pouches for aerial respiration, but is devoid of scales on body. This combination of characters is, therefore, not in conformity with the grouping of species of *Monopterus* as proposed by Talwar and Jingran (1991). Nelson (1994) mentioned that most of the synbranchid species are, probably, capable of aerial breathing. Therefore, till its relationship to other species, especially to the closely resembling ones, of the genus *Monopterus* is further revealed, the new species is, presently, not placed under any subgenus or subgroup of *Monopterus*.

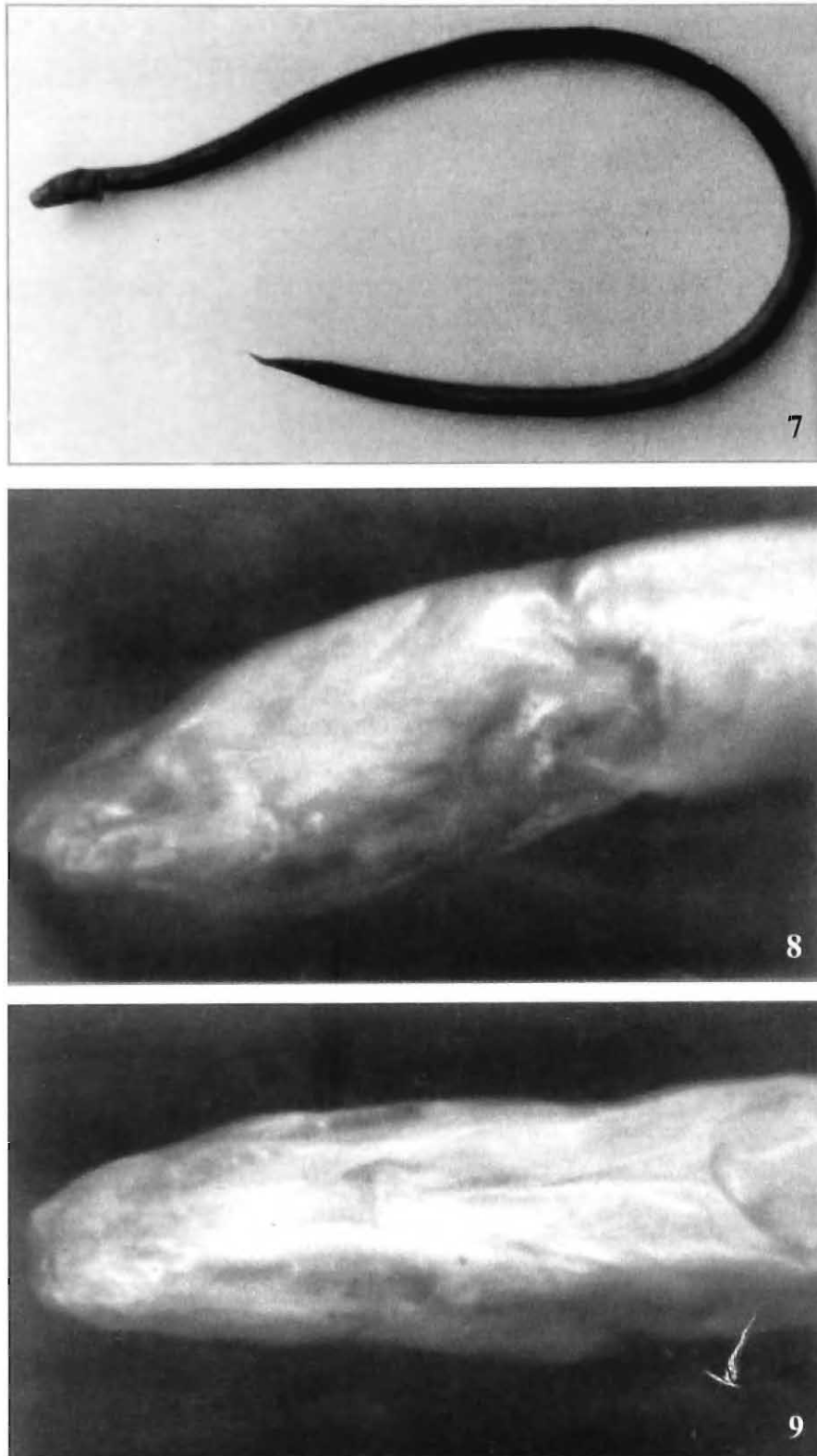
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PLATE I



Figs. 7-9. *Monopterus digressus* sp. nov. : 7. Paratype, size (max) : 242 mm long (head region partially dissected); 8. Head of the holotype : Lateral view (the Left suprapharyngeal pouch, externally visible through the overlying head-integument); 9. Head of the holotype : Ventral view of the branchial region.

CONTRIBUTION TO THE KNOWLEDGE OF ANTS (HYMENOPTERA : FORMICIDAE) OF CHANDAKA-DAMPARA WILDLIFE SANCTUARY, ORISSA

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INTRODUCTION

Ants have greater degree of adaptability, which has ensured their survival since Oligocene period. They range from pests to predators. Besides this, they have also been utilized as a source of biological control to check the menace of agricultural pests, for example, *Oecophylla smaragdina* (Fab.) against control of citrus fruit, *Solenopsis germinata* (Fab.) on natural enemies of lac insects and *Camponotus sericeus* (Fab.) found very effective in control of cutworms in lawns.

In terrestrial ecosystem, ants biomass and energy consumption is greater than all the vertebrate fauna taken together (Wilson, 1990) and hence, they have got direct impact on terrestrial ecosystem. "Ants can be seen to dominate ecosystems in a way unequaled by any other organism. In addition to their sheer biomass, greater degree of mutualistic ant-plant associations have been observed, which ensure the survival of many plant species, and ant mosaics have been noticed in which dominant ant species cannot only affect and control the destruction of non-dominant ant species, but also influence both the species composition and abundance of other arthropods" (LaSalle and Gauld, 1993).

Present work deals with the study of ants, collected from Chandaka-Dampara Wildlife Sanctuary. The entire collection was made by the second author, during his research work on elephants in Chandaka during the period 1995-1999. Ants particularly attracted the attention of the collector while making observation of elephants dung, leaf litters, bark left over by elephants while feeding in the forest area. The ants were found devouring on cow and elephant dungs, carrying undigested food particles from the dung to their nests. While studying the feeding behaviour of elephants, the author noticed how carefully the elephants avoided the ants while eating the twigs and barks of the plants, by forceful shaking of the plant's parts or blowing of air through the nostril of the trunk. The collection was made from various spots, frequently visited by elephants and some other localities of the Sanctuary during tracking for elephants by the second author during his study period.

After thorough literature consultation and enquiry of Official records, it was found that no list of this social insect from the Sanctuary is available till date. Besides this, efforts were also made to make biological observations of these ants while collecting. This is the first attempt by the authors to contribute towards ants fauna of the Sanctuary.

Altogether 29 species under 15 genera spread over 4 subfamilies have been reported in this paper from Chandaka-Dampara Wildlife Sanctuary, Orissa. All the 29 species are recorded here for the first time from the Sanctuary.

History of work on Indian ants

Rothney (1889, '90, 1903) worked on Indian ants and later on Forel (1885, '86, '90, '92, '93a, '93b, '94, '95, 1900a, 1900b, 1901, 1902a, 1902b, 1903a, 1903b, 1913) contributed comprehensive work on Formicidae of India and Ceylon. Bingham (1903) published his valuable work in *Fauna of British India*, Hymenoptera, Vol. 2, including Burma and Ceylon and gave details about distribution of species included.

Successive workers like Ali (1981), Brown Jr. (1954a, '54b, '54c, '57, '59, '86, '88), Bolton (1977, '95a, '95b), Baroni Urbani (1973, '77a, '77b, '77c), Chapman and Capco (1951), Chhotani and Maity (1970), Collingwood (1970, '82), Dutta and Raychaudhuri (1983), Devi and Singh (1987), Donisthorpe (1930, '33, '42a, '42b, '42c, '43), Gadagkar *et al.* (1993), Ghosh (1999), Imai *et al.* (1984), Jerdon (1851, '54, '65a, '65b), Kugler (1987), Kurian (1955), Karavaiev (1926, '27, '28), Mathew (1980, '83, '84), Mathew and Tiwari (2000), Reddy *et al.* (1981a, '81b), Roonwal (1954, '75), Ramdas *et al.* (1961), Saunders (1842), Smith, F. (1852, '71a, '71b, '73, '75, '78), Smith, M. R. (1949), Sykes (1835), Sheela and Narendran (1997, '98a, '98b), Shivashankar (1985), Sheela, Narendran and Tiwari (2000), Taylor (1965, 68), Tiwari (1977a, '77c, '86a, '86b, '94, '96, '97, '99a, '99b, 2001a, 2001b), Verghese *et al.* (1981), Veeresh *et al.* (1990) and Wilson (1964).

Bingham (1903) recorded 12 species under 10 genera from Orissa. No comprehensive work on ants fauna of Orissa has been done since then, except a few scattered work.

Study area

Chandaka-Dampara Wildlife Sanctuary, situated in Khurdha and Cuttack district of Orissa lies between the new capital Bhubaneswar and old capital Cuttack, covering an area of 193.39 sq. km. It lies between 20° 16' 05" to 20° 26' 03" N and 85° 34' 42" to 85° 49' 30" E. It is very close (25 km north west) to the capital city of Bhubaneswar in Orissa and can be approached by road via Khandagiri (Fig. 1).

Topography

The terrain is generally undulating which is broken by small low hills. North-western and South-western portions of the reserve are generally hilly with moderate to steep slopes, whereas

the mid-eastern portion is mostly gentle to moderately sloppy with abrupt steep slopes at places. North-eastern and Central portions are relatively flat with little undulation. The altitude varies and is 42 m at Chandaka, 46 m at Dampara, 100 m at Nuakua and 217 m at Pandari mundia (the highest peak in the reserve) above mean sea level (Mishra and Sarangi, 1984).

Climate

Chandaka has a sub-tropical climate. Temperature, relative humidity and rainfall are the three important parameters that have been recorded from 1995 to 1998.

Temperature

The average maximum temperature recorded was during May, being around 37.1°C in Godibari and around 35.5°C in Kumarkhunti. The maximum temperature recorded was 45.9°C in May, 1998.

The average minimum temperature is around December-January being 14°C in the core area and 16°C in Godibari. The absolute minimum temperature recorded in the core area was 8.5°C in 1997 and 12°C in 1996. The temperature thus varies between 10°C to 45°C.

Humidity

The average relative humidity of the study area is generally very high. The maximum average relative humidity is between 80-90% during July-September. The average minimum relative humidity is around 50-60% during December-February.

Rainfall

The state of Orissa is the point of convergence of monsoon currents of the Bay of Bengal and the Arabian Sea. Here the monsoon is brought about by the Southwesterly wind, commonly called the SW-monsoon in summer months and to a little extent by northeasterly wind called the NE-monsoon.

The rainy season in the study area generally starts from mid June. The rain bearing SW-monsoon reaches its peak in the month of August. The average rainfall between June to September was recorded to be 40 cm. Northeast rain is also recorded in this area during October-November. Average rainfall per month during this period was 80 cm in 1998.

The average annual rainfall recorded in this area was 97.76 cm, 108 cm, 190.7 cm and 195.7 cm between 1995-1998.

Vegetation

The vegetation of Chandaka is of the semi evergreen type according to Champion and Seth's classification (1968). But due to severe biotic pressure, edaphic factors and relative humidity, the

existing vegetation has lost its original characters (Choudhury, 1975; Panda, 1992; Roy *et al.*, 1992; Biswal, 1993; Swain, 2000). The Sanctuary is presently covered mostly by bushy/shrubby vegetation. Woodlands are present in mostly coppice growth form. Based on species composition, the forest is classified into following types :

- 1) Semi evergreen forest dominated by *Xylia xylocarpa*.
- 2) Dry mixed deciduous forest
- 3) Bamboo brakes.

MATERIAL AND METHODS

Ants were mostly collected by hand picking with fine forceps and with the help of aspirator. They were also collected by sweeping method with the help of insect nets along with other insects from foliage of bushes. Ants were also collected by using bates in the form of sugar granules, jaggery and rotten mutton placed near ants nests.

Specimens were mostly preserved in 70% alcohol in glass vials. Larger specimens were preserved in insect envelopes with preservatives. Observations were made in field where ants were found moving on the soil surface, twigs and foliages and biological notes made that of.

The specimens were relaxed and setting and pinning done in laboratory of Zoological Survey of India, Kolkata. The larger ants were directly pinned through the thorax and smaller were mounted on triangular paper boards with the help of water soluble adhesives.

Identification of ants are mainly based on worker caste. During study, mandibles and mouth parts were dissected for specific identification.

SYSTEMATIC ACCOUNT

Ants belonging to family Formicidae of Order Hymenoptera are widely distributed through out the world, because of its cosmopolitan nature, 9538 species of ants under 11 subfamilies, 59 tribes and 296 genera have been reported till date from the world (Hölldobler and Wilson, 1990), of these altogether 2479 species have been reported from the classical Oriental regions, which includes Oriental and Indo-Australian regions. The splitted species 770 are recorded from Oriental region and 1709 from Indo-Australian region (Bolton, 1995a). Approximately 600 species of ants have been reported from India.

LIST OF TAXA INCORPORATED IN SYSTEMATIC ACCOUNT

Family FORMICIDAE

I. Subfamily DORYLINAE Forel

1. Genus *Dorylus* Fabricius, 1793Subgenus *Typhlopone* Westwood1. *Dorylus (Typhlopone) labiatus* Schuckard, 1840Subgenus *Alaopone* Emery, 18812. *Dorylus (Alaopone) orientalis* Westwood, 1835

II. Subfamily PONERINAE Lepeletier

2. Genus *Diacamma* Mayr, 18623. *Diacamma rugosum* (Le Guillou)3. Genus *Leptogenys* Roges, 18614. *Leptogenys processionalis* (Jerdon, 1851)5. *Leptogenys chinensis* Mayr, 18704. Genus *Pachycondyla* Smith F., 18586. *Pachycondyla rufipes* (Jerdon, 1851)7. *Pachycondyla sulcata* (Frauenfeld, 1867)

III. Subfamily PSEUDOMYRMECINAE Emery

5. Genus *Tetraponera* Smith, 18528. *Tetraponera allaborans* Walker, 18599. *Tetraponera rufonigra* (Jerdon, 1851)

IV. Subfamily MYRMICINAE Lepeletier

6. Genus *Pheidole* Westwood, 1841Subgenus *Pheidole* s. str.10. *Pheidole spathifera* Forel, 190211. *Pheidole sulcaticeps* Roger, 1863

7. Genus *Myrmicaria* Saunders, 1841

12. *Myrmicaria brunnea* Saunders, 1841

8. Genus *Crematogaster* Lund, 1831

13. *Crematogaster politula* Forel, 1902
14. *Crematogaster rothneyi* Mayr, 1878

9. Genus *Monomorium* Mayr, 1855

15. *Monomorium floricola* (Jerdon, 1851)
16. *Monomorium latinode* Mayr, 1872
17. *Monomorium scabriceps* (Mayr, 1878)

10. Genus *Solenopsis* Westwood, 1841

18. *Solenopsis geminata* (Fabricius, 1804)

11. Genus *Lophomyrmex* Emery, 1892

19. *Lophomyrmex quadrispinosus* (Jerdon, 1851)

12. Genus *Meranoplus* Smith, 1854

20. *Meranoplus bicolor* (Guérin, 1838)

V. Subfamily FORMICINAE Lepeletier

13. Genus *Oecophylla* Smith, 1861

21. *Oecophylla smaragdina* (Fabricius, 1775)

14. Genus *Paratrechina* Motschoulsky, 1863

22. *Paratrechina longicornis* (Latreille, 1802)

15. Genus *Camponotus* Mayr, 1861

23. *Camponotus angusticollis* (Jerdon, 1851)
24. *Camponotus compressus* (Fabricius, 1787)
25. *Camponotus invidus* Forel, 1802
26. *Camponotus rufoglaucus* (Jerdon, 1851)
27. *Camponotus sericeus* (Fabricius, 1789)

16. Genus *Polyrhachis* Smith, 1858

28. *Polyrhachis dives* Smith, 1857
29. *Polyrhachis illaudata* Walker, 1859

SYSTEMATIC ACCOUNT

Subfamily DORYLINAE Forel

1. Genus *Dorylus* Fabricius

1793. *Dorylus* Fabricius, *Ent. Syst.*, **2** : 194.

Type-species : *Vespa helvola* ♂ (Linnaeus, 1764) from South Africa.

Subgenus *Typhlopone*

1839. *Typhlopone* Westwood, *Introd. Classif. Ins.*, **2** : 219.

Type species : *Typhlopone fulva* Westwood, 1839 from North Africa.

1. *Dorylus (Typhlopone) labiatus* Shuckard

1840. *Dorylus labiatus* Shuckard, *Ann. Mag. Nat. Hist.*, **5** : 319, M.

1995. *Dorylus (Typhlopone) labiatus*, Bolton, *A New Genl. Cat. Ants World*, Harvard Univ. Press, : 179.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary, 6 workers, Ambakhali, 2.i.1996, 4 workers, Nuakua, 17.vii.1997.

Distribution : INDIA : Orissa and whole of continent of India, particularly from Sikkim, Manipur, West Bengal, Uttar Pradesh, Himachal Pradesh, Maharashtra, Gujarat and Delhi.

Remarks : These ants are golden yellow in colour with strong mandibles and are found hovering on dead animals. They are carnivorous in nature. These specimens were collected near Ambakhali feeding on Lepidopteran larvae.

Subgenus *Alaopone* Emery

1881. *Alaopone* Emery, *Ann. Mus. Civ. Stor. Nat. Genova*, **16** : 274.

Type species : *Dorylus (Alaopone) orientalis* Westwood, 1835 = (*Alaopone oberthueri* Emery, 1881) from India.

2. *Dorylus (Alaopone) orientalis* Westwood

1835. *Dorylus orientalis* Westwood, *Proc. Zool. Soc. Lond.*, **3** : 72, Male

1999. *Dorylus (Alaopone) orientalis*, Tiwari, *Memoir, Zool. Surv. India*, **18**(4) : 16

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary, 5 workers, at Godibar, 9.ii.1996, 1 worker, Kochilaberna, 11.vii.1997, ex. Banana root.

Distribution : INDIA : Orissa, Kerala, Maharashtra, West Bengal. Elsewhere : Burma, China, Malayan Peninsula, Indonesia (Java, Sumatra, Borneo), Nepal, Sri Lanka.

Remarks : This species is commonly known as root eating ant, the workers feed on soft parts of root and the tuberous roots are hollowed out.

Green (1903) also agreed with above vegetation behaviour of the said species, but Mukherjee (1933), doubted this. He studied the worker's mouth parts in detail and found them "better adapted for feeding on animal food than on plants. The sharp pointed bristle, spines and setae on the 1st/2nd maxillae, can well pierce the skin of the victim and draw out the nutritive fluid from the body of their prey, which they suck by their mobile tongue"

3. Genus *Diacamma* Mayr

1862. *Diacamma* Mayr, *Verh. zool-bot. Ges. Wien*, **12** : 718, worker.

Type-species : *Ponera rugosa* Le Guillou, 1841 from Borneo (Indonesia).

3. *Diacamma rugosum* (Le Guillou)

1842. *Ponera rugosa* Le Guillou, *Ann. Soc. Ent. Fr.*, **10** : 318

1995. *Diacamma rugosum*, Bolton, *A new Genl. Cat. Ants World*, Harvard Univ. Press, : 170.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 4 Workers, 1 km from Kochilaberna tower towards Ambakhali, 22.vi.1997; 2 workers near Ambilo tower, 11.ix.1998; 3 exs. from Dahanagadia village, 4.vii.1997.

Distribution : INDIA : Orissa, Tamil Nadu, Karnataka, Maharashtra, West Bengal, Meghalaya, Sikkim, Assam, Andaman and Nicobar Islands. Elsewhere : Myanmar, Sri Lanka, Malaysia, Singapore, Phillippines, Vietnam, Taiwan, New Guinea, Batchian Is (Pacific), Nepal.

Remarks : It nests in the soil at the base of trees (Seeson, 1941). In Chandaka, it was collected from mango tree, may be the specimens were ascending on the tree for search of mango fruits. This species is known by a number of subspecies (Bolton, 1995).

4. Genus *Leptogenys* Roger

1861. *Leptogenys* Roger, *Berl. ent. Zeitschr.*, **5** : 41, worker.

Type-species : *Leptogenys falcigera* Roger, 1861 from Sri Lanka (formerly Ceylon).

4. *Leptogenys processionalis* (Jerdon)

1851. *Ponera processionalis* Jerdon, Madras, *J. Lit..Sic.*, **17** : 118

1995. *Leptogenys processionalis*, Bolton, *A New Genl. Cat. Ants World*, Harvard Univ. Press., : 233.

1999. *Leptogenys (Lobopelta) ocellifera*, Tiwari, *Memoirs Zool. Surv. India*, **18**(4) : 22

Material examined : India: Orissa:, Chandaka-Dampara Wildlife Sanctuary : several workers on southeast slopes of Ambilo tower, 30.v.1998; 7 workers at Kodalimundia 28.xii.1998 on leaf litter.

Distribution : INDIA : Orissa, Tamil Nadu, Kerala, West Bengal, Meghalaya and nearly whole of Peninsular India. Elsewhere : Sri Lanka.

Remarks : The second author while moving near Ambilo tower noticed a long que of ants moving very fast in zig zag manner making a procession of ants, carrying the eggs in their mouth, most probably taking the eggs to some safer place.

Tiwari (1995) reported this species as *Leptogenys (Lobopelta) ocellifera* (Roger, 1861) but Emery (1913) has synonymised this species under *Leptogenys proceionalis* (Jerdon) which was supported by Bolton (1995b).

5. *Leptogenys chinensis* Mayr

1870. *Lobopelta chinensis* Mayr, *Verh. zool-bot. Ges. Wein*, 20 : 965.

1995. *Leptogenys chinensis*, Bolton, *A New Genl Cat Ants World*, Harvard Univ. Press, : 230

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary, 2 workers, near Kheluachua, 16.xi.1997.

Distribution : INDIA : Orissa, West Bengal, more or less whole India, except drier part of Central India and Western India. Elsewhere : China, Japan, Philippines, Sri Lanka.

5. Genus *Pachycondyla* Smith

1858. *Pachycondyla* Smith, *Cat. Hym. Brit. Mus.*, 6 : 105.

Type-species : *Formica crassinoda* Latreille, 1802 from Surinam (S. America).

6. *Pachycondyla rufipes* (Jerdon)

1851. *Ponera rufipes* Jerdon, *Madras J. Lit. Sci.*, 17 : 119, worker

1995. *Pachycondyla rufipes*, Bolton, *A. new. Genl. Cat. Ants World*, Harvard Univ. Press, : 309.

Material examined : India : Orissa, Chandaka-Dampara Wildlife Sanctuary, 3 exs, near Godabhangatangaro, 2.i.1997, under wood logs.

Distribution : INDIA : Orissa, Sikkim, Assam, Meghalaya, West Bengal, Western India, Karnataka, Kerala, Andaman and Nicobar Islands. Elsewhere : Sri Lanka, Myanmar.

Remarks : This ant is a robust ponerine ant and while being picked up for collection, was found to emit a thick white frothy fluid from their mouth, of very offensive nature containing formic acid smell—which seems to be a defensive mechanism.

7. *Pachycondyle sulcata* (Frauenfeld)

1867. *Ponera sulcata* Frauenfeld, *Verh. zool-bot. Ges. Wein*, 17 : 441.

1995. *Pachycondyla sulcata*, Bolton, *A new Genl. Cat. Ants World*, Harvard Univ. Press, : 310.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary, 4 workers, Dampara, 13.viii.1995, from rotten wood.

Distribution : INDIA Orissa, Andhra Pradesh, Tamil Nadu, West Bengal, Central and Western India.

Subfamily PSEUDOMYRMECINAE Emery

5. Genus *Tetraponera* Smith

1852 *Tetraponera* Smith, *Ann. Mag. Nat. Hist.*, 9(2) : 44.

Type-species : *Eciton nigrum* Jerdon, 1851 (= *Tetraponera atrata* Smith, 1852) from India.

8. *Tetraponera allaborans* Walker

1859. *Pseudomyrma allaborans* Walker, *Ann. Mag. Nat. Hist.*, 4(3) : 375, Male.

1999. *Tetraponera* (*Tetraponera*) *allaborans*, Tiwari, *Memoirs Zool. Surv. India*, 18(4) : 34.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 3 workers, Minchinpatna, 21.ix.1998; 2 workers, Nuakua, 21.ix.1998, ex.twigs of bushy plants.

Distribution : INDIA : Orissa, Tamil Nadu, West Bengal, Meghalaya, Western India. Elsewhere : Sri Lanka, Myanmar, Indonesia (Sumatra), Kalimantan, China.

Remarks : These ants are black, highly polished and shining with metallic blackish colour and were found moving in scattered forms at bushy plant of *Eupatorium odonatum*. The stings were protruded and situated at the tip of last gaster segment.

9. *Tetraponera rufonigra* (Jerdon)

1851. *Eciton rufonigram* Jerdon, *Madras J. Lit. Sci.* 17 : 111, Worker.

1999. *Tetraponera* (*Tetraponera*) *rufonigra*, Tiwari, *Memoirs Zool. Surv. India* 18(4) : 35.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 7 workers, Godibaru gate, 9.xii, 1995, ex. Trunk of Sal tree; 6 workers, Chatiani, 11.xi.1997, ex. heaps of twigs of plants left over by elephant.

Distribution INDIA Orissa, Tamil Nadu, Karnataka, Kerala, Meghalaya and most widely distributed species in India. Elsewhere : Myanmar, Sri Lanka, Singapore, Indonesia (Java, Sumatra), China.

Remarks : This species is most virulent, its sting is most painful and causes considerable inflammation (Bingham, 1903).

Subfamily MYRMICINAE Lepeletier

6. Genus *Pheidole* Westwood

1841. *Pheidole* Westwood, *Ann. Mag. Nat. Hist.*, **6** : 87.

Type-species : *Atta providens* Sykes, 1835 from India.

10. *Pheidole spathifera* Forel

1902. *Pheidole spathifera* Forel, *Rev. Suisse. Zool.*, **10** : 168 & 187, soldier, worker, female and male.

1999. *Pheidole (Pheidole) spathifera*, Tiwari, *Memoirs Zool. Surv. India*, **18** (4) : 39.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 2 workers, Dholkat village, 11.ii.1998.

Distribution : INDIA : Orissa, Tamil Nadu, Andhra Pradesh, Kerala, Western India (the Nilgiris), Assam, West Bengal. Elsewhere : Sri Lanka, Myanmar.

11. *Pheidole sulcaticeps* Roger

1863. *Pheidole sulcaticeps* Roger, *Berl. ent. Zeit.*, **7** : 193, Soldier.

1995. *Pheidole sulcaticeps*, Bolton, *New Genl. Cat. Ants world*, Harvard Univ. Press, : 331

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 5 Workers, Bualigarh, 6.vii.1998.

Distribution : INDIA : Orissa : West Bengal, North-west provinces and western India. Elsewhere : Sri Lanka

7. Genus *Myrmicaria* Saunders

1841. *Myrmicaria brunnea* Saunders, *Trans. Ent. Soc. Lond.*, **3** : 57, Male.

Type-species : *Myrmicaria brunnea* Saunders, 1841 from India.

12. *Myrmicaria brunnea* Saunders

1841. *Myrmicaria brunnea* Saunders, *Trans. Ent. Soc. Lond.* **3** : 57, Male.

1999. *Myrmicaria brunnea*, Tiwari, *Memoirs Zool. Surv. India* **18** (4) : 41-42.

Material examined : India : Orissa : Chandaka-dampara Wildlife Sanctuary : 3 workers, Kumarkhunti tower, 8.vi.1998.

Distribution : INDIA : Orissa, Tamil Nadu, Kerala, Meghalaya, West Bengal, and throughout India except drier and more desert parts of the country. Elsewhere : Myanmar, Sri Lanka, Indonesia (Java, Sumatra), Indo-China.

8. Genus *Crematogaster* Lund

1831. *Crematogaster* Lund. *Ann. Sci. Nat.*, **23** : 132.

Type-species : *Formica scutellaris* Olivier, 1791 from France.

13. *Crematogaster politula* Forel

1902. *Crematogaster subnuda* Mayr, 1879, race *politula* Forel, *Rev. Suisse Zool.*, **10** : 207.

2000. *Crematogaster politula* Mathew and Tiwari, *State Fauna Series 4, Fauna of Meghalaya Part 7* : 326.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 2 workers, Kodalnundia, 7.iii.1997.

Distribution INDIA : Orissa, Meghalaya, Assam, Sikkim. Elsewhere : Myanmar.

Remarks : Datta and Raychaudhuri (1983) reported this species as one of the aphidoculous ants from Sikkim.

14. *Crematogaster rothneyi* Mayr

1879. *Crematogaster rothneyi* Mayr, *Verh. zool.- bot. Ges. Wien*, **28** : 681 & 685, Female.

2000. *Crematogaster rothneyi*, Mathew and Tiwari, *State Fauna series 4, Fauna of Meghalaya, Part 7* : 327.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 11 workers, Guptapara, 11.ii.1996.

Distribution : INDIA : Orissa, Meghalaya, Maharashtra, Sikkim, West Bengal, Gujarat and Tamil Nadu.

9. Genus *Monomorium* Mayr

1855. *Monomorium* Mayr, *Verb. zool-bot. Ges. Wein*, **5** : 452.

Type-species : *Formica pharaonis* Linnaeus, 1758 (= *Monomorium minutum* Mayr, 1855) from Egypt.

15. *Monomorium floricola* (Jerdon)

1851. *Atta floricola*, *Madras J. Lit. Sci.*, **17** : 107, Worker.

1999. *Monomorium floricola*, Tiwari, *Memoirs. Zool. Surv. India*, **18** (4) : 54.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 8 workers, Ambilo tower, 7.v.1996.

Distribution INDIA : Orissa, Tamil Nadu, Kerala, West Bengal, Meghalaya, Manipur, Andaman and Nicobar Islands. Elsewhere : Sri Lanka, Oceania.

Remarks : This is a common house ant in India and is found damaging food stuffs.

16. *Monomorium latinode* Mayr

1872. *Monomorium latinode* Mayr, *Ann. Mus. Civ. Stor. Nat. Genova*, **2** : 152, worker.

1999. *Monomorium latinode*, Tiwari, *Memoirs Zool. Surv. India*, **18** (4) : 54.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 2 workers, Nuakua, 2.viii.1996; 6 workers, Kheluachua, 11.ix.1998.

Distribution : INDIA : Orissa, Tamil Nadu, West Bengal and spread throughout India. Elsewhere : Sri Lanka, Myanmar, Indonesia (Borneo), Formosa (Taiwan).

Remarks : Bingham (1903) mentioned its distribution throughout India. However, Ettershank (1966) has restricted the distribution of *latinode* to Borneo only.

17. *Monomorium scabriceps* Mayr

1879. *Holcomyrme scabriceps* Mayr, *Verh. zool-bot. Ges. Wien*, **28** : 672, Worker.

1995. *Monomorium scabriceps*, Bolton, *A New Genl. Cat. Ants World*, Harvard Univ. Press, : 266.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 4 workers, Godibari, 11.ix.1996; 3 workers Baramundia, 7.viii.1998.

Distribution : INDIA : Orissa, distributed irregularly throughout India from Pubjab to Cochin.

Remarks : This is the first record of this specis from the state of Orissa.

10. Genus *Solenopsis* Westwood

1841. *Solenopsis* Westwood, *Ann. Mag. Nat. Hist.*, **6** : 86.

Type-species : *Atta geminata* Fabricius, 1804 from Central America (= *Solenopsis mandibularis* Westwood, 1841).

18. *Solenopsis geminata* (Fabricius)

1804. *Atta geminata* Fabricius, *Syst. Piez.* : 423.

1999. *Solenopsis geminata*, Tiwari, *Memoirs Zool. Surv. India*, **18** (4) : 58-59.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 7 workers, Dholkat village, 11.viii.1997; 1 worker, Ambilo tower, 11.viii.1997.

Distribution : INDIA : Orissa, Tamil Nadu, Kerala, Karnataka, West Bengal.

Elsewhere : Spread pretty nearly over the tropics of the two hemispheres.

Remarks : This speciemen is collected from resting site of elephants from the soil surface. The elephants were seen blowing air through nostril to remove these ants from the area and this prompted the second author to search for these ants in the resting site.

S. geminata commonly known as “Brown fire ants” has severe sting. It makes its nest on soil surface making tunnel and is reported to be injurious to seedlings, buds and leaves. It is reported to be an important enemy of aphids, soft scales, termites, bed bugs and moth larvae and caterpillars of *Eublemma amabilia* and *Holococera pulvereana* in the lac godowns (Beeson, 1941).

11. Genus *Lophomyrmex* Emery

1892. *Lophomyrmex* Emery, *Ann. Mus. Civ. Stor. Nat. Genova*, **22** : 114.

Type-species : *Ocodoma quadrispinosa* Jerdon, 1851 from Malabar, India.

19. *Lophomyrmex quadrispinosus* (Jerdon)

1851. *Ocodoma quadrispinosa* Jerdon, *Madras J. Lit. Sci.*, **17** : 111.

1999. *Lophomyrmex quadrispinosus*, Tiwari, *Memoirs Zool. Surv. India*, **18** (4) : 59.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 2 workers, Godibari, 2.i.1996; 3 workers, Ambakhali, 2.i.1996.

Distribution : INDIA : Orissa, Tamil Nadu, Kerala, Karnataka, Meghalaya, Uttar Pradesh, Sikkim, West Bengal. Elsewhere : Sri Lanka.

Remarks : Jerdon (1951) reported its feeding behaviour and noted that it feeds on vegetable secretion surrounding the seeds. The author also collected it from flower of *Madhuca indica*.

12. Genus *Meranoplus* Smith, 1853

1853. *Meranoplus* Smith, *Trans. Ent. Soc. Lond.*, **2** (2) : 224.

Type-species : *Cryptocerus bicolor* Guérin, 1838 from India.

20. *Meranoplus bicolor* (Guérin)

1844. *Cryptocerus bicolor* Guérin, *Cuv. Iconog. Regn. Anim. Ins.*, **3** : 425, Worker.

2000. *Meranoplus bicolor*, Mathew and Tiwari, *Zool. Surv. India*, *State Fauna Series 4, Fauna of Meghalaya*, Part 7 : 332.

Material examined : India, Orissa : Chandaka-Dampara Wildlife Sanctuary : 7 workers, Ambakhali, 7.viii.1996; 2 workers, Dahanagiria, 11.vii.1998.

Distribution : INDIA : Orissa, West Bengal, Assam, Meghalaya, Maharashtra, Uttar Pradesh, Delhi, Karnataka, Kerala, Tamil Nadu and mostly throughout India, except the hot dry plains in the North-Western Provinces and Central India. Elsewhere : Nepal, Myanmar, Sri Lanka, Pakistan, Bhutan, Thailand, Vietnam, China, Singapore, Malaysia, Indonesia (Sumatra) and extending to the Malayan subregion.

Subfamily FORMICINAE Lepeletier

13. Genus *Oecophylla* Smith

1861. *Oecophylla* Smith, *J. Proc. Linn. Soc. Lond. Zool.*, **5** : 101, worker, female.

Type-species : *Formica smaragdina* Fabricius, 1775 from India (= *Formica virescens* Fabricius, 1775).

21. *Oecophylla smaragdina* (Fabricius)

1775. *Formica smaragdina* Fabricius, *Syst. Ent.*, : 828, Female.

1999. *Oecophylla smaragdina*, Tiwari, *Memoirs Zool. Surv. India*, **18** (4); 66.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 15 workers, Sanchuria mundia, 11.xi.1998

Distribution : INDIA : Orissa, Meghalaya, Tamil Nadu, Karnataka, Kerala, West Bengal Sikkim, Meghalaya, Manipur, Andaman and Nicobar Islands and mostly the whole of India, except desert parts. Elsewhere : Sri Lanka, Myanmar, South China, Malaya, New Guinea, Australia.

Remarks : The specimens of this species were collected from Jackfruit plant. These ants make a specialised type of nest which hang from the twigs of the trees. The nest is made up of leaves which are bound together by fine membranous tissue paper made by the ants by chewing leaves and converting it to synthetic tissue.

The eggs of the species have been found to contain high protein and fat and as such, it is used as a suplliment to combat the condition of avitaminosis, particularly in case of marasemus condition. It is widely used as a supplement for protein and fat in tribal people and the eggs are sold in weekly market for this purpose.

14. Genus *Paratrechina* Motschoulsky 1863

1863. *Paratrechina* Motschoulsky, *Bull. Soc. Imp. Nat. Moscou.*, **36** : 13.

Type-species : *Formica longicornis* Latreille, 1802 from Senegal (= *Paratrechina currens* Motschoulsky, 1863) from Senegal.

22. *Paratrechina longicornis* (Latreille)

1802. *Formica longicornis* Latreille, *Nat. Hist. Fourmis*, 113

2000. *Paratrechina longicornis*, Mathew and Tiwari, *Zool, Surv. India, State Fauna Series 4, Fauna of Meghalaya, part 7* : 349.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 1 worker, Ambilo tower, 2.i.1996; 5 workers, Godabhangatangaro, 7.iv.1998.

Distribution : INDIA : Orissa, West Bengal, Meghalaya, manipur, Tamil Nadu and mostly throughout India. Elsewhere : Senegal, Australia, New Caledonia, Sri Lanka.

15. Genus *Camponotus* Mayr

1861. *Camponotus* Mayr. *Europ Formicid.* : 35.

Type-species : *Formica ligniperda* Latreille, 1798 from Europe.

23. *Camponotus compressus* (Fabricius)

1787. *Formica compressa* Fabricius, *Mant. Insect.* 1 : 307, worker

1999. *Camponotus compressus*, Tiwari, *Memoirs Zool. Surv. India*, 18 (4) : 69.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 3 workers, Guptapar, 11.xi.1996; 7 workers, Minchinpatna, 11.xi.1996; 3 workers, Goyalbanka, 12.xii.1998.

Distribution : INDIA : Orissa, Tamil Nadu, Assam, Meghalaya, West Bengal, Manipur, Sikkim, Andaman and Nicobar Island. Elsewhere : Sri Lanka, Nepal, Myanmar, Philippines, Borneo, Russia, Arabia and Africa.

Remarks : This is the common black ant, spread all over India, the nests are made in soil and heaps of earth are brought in the form of small files,. Their food is chiefly vegetable secretion and sugar in any form. They bite rather severely but the pain is quite momentary.

24. *Camponotus refoglaucus* (Jerdon)

1851. *Formica rufoglaucus* Jerdon, *Madras J. Lit. Sci.*, 17 : 124.

1999. *Componotus rufoglaucus*, Tiwari, *Memoirs Zool. Surv. India*, 18 (4) : 70.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 2 workers, Ambilo, 15.xii.1996; 12 Workers, Jhalara, 21.viii.1997.

Distribution : INDIA : Orissa, Tamil Nadu, Karnataka, Kerala, Delhi, Central India, Assam, Meghalaya, Deccan Plateau. Elsewhere : Nepal, Myanmar and Sri Lanka.

25. *Camponotus sericeus* (Fabricius)

1798. *Formica sericeus* Fabricius, *Ent. Syst. Suppl.* : 97.

2000. *Camponotus sericeus*, Mathew & Tiwari, *Zool. Surv. India, State fauna series 4, Fauna of Meghalaya, part 7* : 356.

Material examined : India Orissa, Chandaka-Dampara Wildlife Sanctuary 5 workers, Dampara, 7.iii.1998.

Distribution INDIA : Orissa, Tamil Nadu, Karnataka, West Bengal, Manipur, Meghalaya, Delhi and more or less common throughout India. Elsewhere : Myanmar, Sri Lanka, Indo-China, Arabia, Egypt and Tropical Africa.

Remarks : This ant is easily differentiated from other species because of basal portion of the metanotum forming a horizontal and flat surface with rest of the metanotum; usually it is black out certain specimens from Myanmar and Ceylone have been reported having head blood-red, a special

variation in colour pattern. Tiwari (1999) while examining the ant fauna of Delhi came across the species with blood-red head.

26. *Camponotus angusticollis* (Jerdon)

1851. *Formica angusticollis* Jerdon, *Madras J. Lit. Sci.*, **17** : 120, Worker, Female.

2000. *Camponotus angusticollis*, Mathew and Tiwari, *Zool. Surv. India, State Fauna Series 4, Fauna of Meghalaya, Part 7* : 352

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 2 workers. Dhobabandha, 21.xi.1996; 7 workers, Bualigarh, 7.iii.1998.

Distribution : INDIA : Orissa, Tamil Nadu, Kerala, Western and Central India, Assam, West Bengal, Meghalaya, Andaman and Nicobar Islands. Elsewhere : Nepal, Myanmar.

27. *Camponotus invidus* Forel

1892. *Camponotus invidus* Forel, *J. Bombay Nat. Hist. Soc.*, **7** : 225 and 234, Worker.

1995. *Camponotus invidus*, Bolton, *A New Genl. Cat. Ants World*, Harvard Univ. Press : 105.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 11 workers, Mincinpatna, 19.v.1997; 8 workers, Dalua, 16.ix.1998.

Distribution : INDIA : Orissa, Sikkim, West Bengal, Andaman and Nicobar Islands.

16. Genus *Polyrhachis* Smith

1858. *Polyrhachis* Smith, *J. Proc. Linn. Soc. Lond. Zool.*, **2** : 58.

1862. *Polyrhachis* Mayr, *Verh. zool-bot. Ges. Wien.*, **12** : 677.

Type-species : *Formica bihamata* Drury, 1773 from Madagascar.

28. *Polyrhachis illaudatus* Walker

1859. *Polyrhachis illaudatus*, Walker, *Ann. Mag. Nat. Hist.*, (3) **4** : 373, Worker.

1995. *Polyrhachis illaudata*, Bolton, *A New Genl. Cat. Ants World*, Harvard Univ. Press, : 350.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 3 workers, near Pitagadia tower, 6.vi.1997.

Distribution : INDIA : Orissa, Tamilnadu, Kerala, Karnataka, Assam, Sikkim, West Bengal. Elsewhere : Sri Lanka, Nepal, Myanmar, China, Philippines, Formosa, Gulf of Siam, Indonesia (Java, Sumatra, Borneo, Celebes). This distribution is mainly for *P. mayris* synonymised under *P. illaudata*.

Remarks : Donisthorpe (1943) treated *P. mayri* Roger, 1863 as a synonym of *P. illaudata* Walker, 1859 but Collingwood (1970) considered *mayri* as a valid species under *Polyrhachis*. Bolton (1995b) agrees with Donisthorpe (1943). As the authors have no access to type of this species, it is not

possible to give any opinion in this respect. The present specimens come to *mayri* when run through Bingham's key (1903). But as because, the *P. mayri* has been synonymised under *P. illaudata*, the authors treated *P. mayri* as *P. illaudata*.

29. *Polyrhachis dives* Smith

1857. *Polyrhachis dives*, Smith, *J. Proc. Linn. Soc. London Zool*, **2** : 64, Worker.

2000. *Polyrhachis dives*, Mathew and Tiwari, *Zool. Surv. India, State Fauna Series 4, Fauna of Meghalaya, Part 7*, 361.

Material examined : India : Orissa : Chandaka-Dampara Wildlife Sanctuary : 1 worker, Jhalara, 8.ii.1998; 3 workers, Ambilo, 8.ii.1998.

Distribution : INDIA : Orissa, Tamil Nadu, Sikkim, Meghalaya and Eastern India. Elsewhere : Sri Lanka, Myanmar, Thailand, Indo-China, China, Philippines, Malay, Siam, Formosa, Mainan, Japan, Indonesia (Java, Sumatra, Celebes), New Guinea, Singapore.

SUMMARY

The paper deals with the ants (Hymenoptera : Formicidae) collected from different localities of Chandaka Wildlife Sanctuary, Orissa by second author, during his study period (1995-1998) on the ecology and behaviour of elephants. Altogether 29 species pertaining to 17 genera and 5 subfamilies have been reported. There is no mention of any ant species in forest record of the Sanctuary. Hence, this is the first record of these ants species from this Sanctuary. Besides this, *Monomorium scabriceps* Mayr is the first record from the state of Orissa. A separate map of the Sanctuary showing the localities of collection has been incorporated. Notes on topography and methodology have been provided to delineate the basic concept of the family.

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NIDIFICATION OF PLAIN WREN WARBLER, *PRINIA SUBFLAVA* (GMELIN) IN RURAL SOUTH 24 PARGANAS IN THE VICINITY OF KOLKATA, WEST BENGAL

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INTRODUCTION

Of the 1200 species of birds in India, nearly 85% of them are either wholly or partially insectivorous (CSIR 1990). On the other hand, 30,000 species of insects have been identified in the subcontinent, the fecundity and voracity of them are phenomenal. Some caterpillars can eat leaves upto twice their own weight each day; and there are certain larvae which can consume food 20 times of their own weight in a single day. Agricultural science has paid attention to the insect pests and their control. Most of those studies were carried out either in natural-ecosystem or in man made systems. Importance of birds as biocontrolling agent of the insect pests has long been established. The present study while stretching upon the nidification of a particular bird species in a selected habitat which is rapidly shifting from rural to urban system, aiming to explore the adaptibilities of the species under the changing context, simultaneously collected the data on its prey species of insects particularly the larvae, which may indicate the array of pests related to variable crops and may help in adopting strategies for protecting our precious crops. This study of the nidification of Plain Wren Warbler, *Prinia subflava* (Gmelin) is based on field work conducted during April to September 1999.

The study area primarily being rural comprising of 4 or 5 villages rapidly changing into urban conglomerate in the vicinity of the metropolis of Kolkata (former Calcutta) under the administrative jurisdiction of South 24 Parganas District, West Bengal. It is some 17 km south from the heart of the city. Geographical bearings are 22°34' N & 88°22' E. The area under extensive studies spread over roughly 3.5 sq.km area consisting agricultural plots, grassland, big and small waterbodies and settlements of hamlets and houses.

The present study emphasising nest building and nesting, food and feeding of the species, specially of its youngs, eggs, incubation, and care of the nestlings.

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Lists of the important flora, crops, plants used in nest building, vertebrate and insect fauna of the area have been appended. Stages of development of the nest and nest building process have been elaborated in this study.

KEY WORDS Nidification : *Prinia subflava*, Vicinity of Kolkata, West Bengal, India.

Table 1. Local flora occurring in and around the Nesting Ground of *Prinia subflava* (Gmelin) at Ramchandrapur village, South 24 Parganas. Plant specimen collection & observation : August to September 1999.

Legends – S = Summer, Ps = Post summer, M = Monsoon.

Scientific name	Family	Season	Local name
LIST OF VEGETABLE CROPS			
<i>Cucumis sativus</i>	Cucurbitaceae	Ps. M.	Shosha
<i>Cucurbita moschata</i>	Cucurbitaceae	S. Ps.	Kumro
<i>Basella alba</i>	Basellaceae	S. Ps.	Sada pui
<i>Basella rubra</i>	Basellaceae	S. Ps.	Lal pui
<i>Lagenaria siceraria</i>	Cucurbitaceae	S. Ps.	Lau
<i>Dolichos lablab</i>	Leguminosae	S. Ps.	Shim
<i>Lycopersicon esculentum</i>	Solanaceae	S.	Tomato
<i>Brassica oleracea</i>	Cruciferae	S.	Badhakopi
<i>Solanum melongena</i>	Solanaceae	S. Ps.	Begoon
<i>Abelmoschus esculentus</i>	Malvaceae	Ps. M.	Dherosh
<i>Momordica charantia</i>	Cucurbitaceae	S. Ps. M.	Korola
<i>Capsicum annuum</i>	Solanaceae	S. Ps. M.	Lanka
<i>Beta vulgaris</i>	Chenopodiaceae	Ps.	Palang shak
<i>Amaranthus</i> spp.	Amaranthaceae	Ps.	Lal notey
<i>Cucumis melo</i>	Cucurbitaceae	S. Ps.	Kakur
LIST OF SEED CROPS			
<i>Oryza sativa</i>		S. M.	Dhan
<i>Phaseolus mungo</i>		S. Ps.	Kalai dal
OTHER COMMON FLORA			
<i>Cyperus rotundus</i>		S. Ps. M.	Mutha
<i>Imperata arundinacea</i>		S. Ps. M.	Ulu
<i>Ficus hispida</i>		S. Ps. M.	Kak dumur
<i>Cocos nucifera</i>		S. Ps. M.	Narikel

Table 1 : Contd. :

Scientific name	Family	Season	Local name
<i>Karika papaya</i>		S. Ps. M.	Peypey
<i>Musa esculentum</i>		S. Ps. M.	Kala
<i>Sesbania</i> sp.		Ps. M.	Dhonchey
LIST OF TYPICAL NESTING FLORA			
<i>Eragrostis cynosuroides</i>		S. Ps. M.	Kush
<i>Andropogon squarossus</i>		S. Ps. M.	Bena
<i>Lippia geminata</i>		S. Ps. M.	Bhut-beurey

Table 2. Local flora (wild plants) occurring in and around the Nesting Ground of *Prinia subflava* at Ramchandrapur village, South 24 Parganas.

Plant specimen collection and observation : During Summer-Post summer.

Summer-10.4.1999 to 20.5.'99 to 20.5.'99, Post summer-21.5.'99 to 30.6.'99.

Flora of Nesting Ground.

Scientific name	Family
<i>Blumea lacera</i>	Asteraceae
<i>Hemigraphis hirta</i>	Acanthaceae
<i>Herpestis monniera</i>	Scrophulariaceae
<i>Cardenthera triflora</i>	Acanthaceae
<i>Achyranthes aspera</i>	Achyranthes aspera
<i>Ludwigia adscendens</i>	Onagraceae
<i>Hygrophila spinosa</i>	Acanthaceae
<i>Chrozophora rottleri</i>	Euphorbiaceae
<i>Ludwigia perrenis</i>	Onagraceae
<i>Euphorbia microphylla</i>	Euphorbiaceae
<i>Commelina obliqua</i>	Commelinaceae
<i>Xanthium strumarium</i>	Asteraceae
<i>Polygonum plabejum</i>	Polygonaceae
<i>Alternanthera philoxeroides</i>	Amaranthaceae
<i>Ottelia alismoides</i>	Hydrocharitaceae
<i>Eichhornia crassipes</i>	

Table 2. *Contd.*

Scientific name	Family
<i>Monochoria hastata</i>	
<i>Eclipta alba</i>	Asteraceae
<i>Clerodendrum viscosum</i>	Verbenaceae
<i>Amaranthus spinosus</i>	Amaranthaceae
<i>Centella asiatica</i>	Umbelliferae
<i>Scoparia dulcis</i>	Scrophulariaceae
<i>Heliotropium supinum</i>	Boraginaceae
<i>Euphorbia hirta</i>	Euphorbiaceae
<i>Ammannia baccifera</i>	Lythraceae
<i>Alternanthera paronychioides</i>	Amaranthaceae
<i>Dentella repens</i>	
<i>Cucumis pignonus</i>	Cucurbitaceae
<i>Typhonium trilobatum</i>	Araceae
<i>Cassia tora</i>	Caesalpiniaceae
<i>Seseli indicum</i>	Umbelliferae
<i>Erythraea roxburghii</i>	Gentianaceae
<i>Jussiaea repens</i>	Onagraceae
<i>Lindernia</i> sp.	Scrophulariaceae
<i>Lippia geminata</i>	Verbenaceae

Table 3. Local reptiles and amphibians recorded in and around the Nesting Ground of *Prinia subflava* at Ramchandrapur village, South 24 Parganas.

Sl. No.	Scientific name	English name
	Order : REPTILIA	
1.	<i>Typhlina bramina</i>	Common worm snake
2.	<i>Lycodon aulicus</i>	Common wolf snake
3.	<i>Amphiesma stolata</i>	Striped keelback
4.	<i>Xenochropis piscator</i>	Checkered keelback watersnake
5.	<i>Ptyas mucosus</i>	Rat snake
6.	<i>Chrysopelea ornata</i>	Flying snake
7.	<i>Naja naja</i>	Spectacled & Monocled cobra (both found)

Table 3. *Contd.* :

Sl. No.	Scientific name	English name
8.	<i>Vipera russellii</i>	Russells viper
9.	<i>Varanus bengalensis</i>	Common Indian Monitor
10.	<i>Varanus salvator</i>	Water Monitor
11.	<i>Varanus flavescens</i>	Yellow Monitor
Order : AMPHIBIA		
Family : Microhylidae		
1.	<i>Bufo melanostictus</i>	Common Indian Toad
Family : Ranidae		
2.*	<i>Rana tigerina</i>	Indian Bull Frog
3.*	<i>Rana hexadactyla</i>	Green Pond Frog
4.*	<i>Rana limnocharis</i>	Cricket Frog
5.*	<i>Rana crassa</i>	Jerdon's Bull Frog
6.	<i>Rana erythraea</i>	Leaping Frog
Family : Rhacophoridae		
7.	<i>Polypedates leucomystax</i>	Bamboo Tree Frog

Change in generic name :

2* *Limnonectes tigerinus*. 3* *Occidozyga hexadactyla*

4* *Limnonectes limnocharis* 5* *Limnonectes crassus*

Table 4. Local avifauna recorded in and around the nesting ground of *Prinia subflava* at Ramchandrapur village, South 24 Parganas.

Observation spell (= Climatic spell) : Summer-(S), Post summer-(Ps), Monsoon-(M).

Sl. No.	Scientific name	English name	Climatic spell	Population max.	min.
Order : PICIFORMES					
Family : Picidae					
1.	<i>Dinopium benghalense</i>	Lesser Goldenbacked Woodpecker	S	2	2
			Ps	1	—
			M	—	—
Family : Megalaimidae					
2.	<i>Megalaima asiatica</i>	Bluethroated Barbet	S	3	1
			Ps	3	1
			M	1	—

Table 4. *Contd.* :

Sl. No.	Scientific name	English name	Climatic spell	Population max.	min.
Order : PICIFORMES					
3.	<i>Megalaima haemacephala</i>	Crimsonbreasted	S	—	—
		Barbet	Ps	2	1
			M	2	1
Order : CORACIIFORMES					
Family : Coraciidae					
4.	<i>Coracias benghalensis</i>	Indian Roller	S	—	—
			Ps	—	—
			M	1	—
Family : Alcedinidae					
5.	<i>Alcedo atthis</i>	Common	S	2	—
		Kingfisher	Ps	2	1
			M	3	2
Family : Dacelonidae					
6.	<i>Halcyon smyrnensis</i>	Whitebreasted	S	2	1
		Kingfisher	Ps	2	1
			M	3	2
Family : Cerylidae					
7.	<i>Ceryle rudis</i>	Pied Kingfisher	S	—	—
			Ps	—	—
			M	2	1
Family : Meropidae					
8.	<i>Merops orientalis</i>	Green Bee-eater	S	—	—
			Ps	13	6
			M	—	—
Order : CUCULIFORMES					
Family : Cuculidae					
9.	<i>Cuculus varius</i>	Hawk Cuckoo	S	2	1
			Ps	1	—
			M	—	—

Table 4. Contd. :

Sl. No.	Scientific name	English name	Climatic spell	Population max.	min.
Order : CUCULIFORMES					
10.	<i>Eudynamys scolopacea</i>	Koel	S	3	1
			Ps	3	1
			M	5	1
Family : Centropodidae					
11.	<i>Centropus sinensis</i>	Coucal	S	2	1
			Ps	4	1
			M	1	—
Order : PSITTACIFORMES					
Family : Psittacidae					
12.	<i>Psittacula krameri</i>	Roseringed	S	4	1
		Parakeet	Ps	9	3
			M	6	3
Order : APODIFORMES					
Family : Apodidae					
13.	<i>Cypsiurus parvus</i>	Palm Swift	S	13	2
			Ps	7	1
			M	10	1
14.	<i>Apus affinis</i>	House Swift	S	5	1
			Ps	1	—
			M	—	—
Order : STRIGIFORMES					
Family : Tytonidae					
15.	<i>Tyto alba</i>	Barn Owl	S	?	?
			Ps	?	?
			M	?	?
Order : COLUMBIFORMES					
Family : Columbidae					
16.	<i>Streptopelia chinensis</i>	Spotted Dove	S	4	2
			Ps	2	1
			M	2	1

Table 4. Contd. :

Sl. No.	Scientific name	English name	Climatic spell	Population max.	min.
	Order : CICONIIFORMES				
	Family Scolopacidae				
17.	<i>Gallinago gallinago</i>	Common Snipe	S	2	1
			Ps	1	—
			M	—	—
	Family : Rostratulidae				
18.	<i>Rostratula benghalensis</i>	Painted Snipe	S	1	—
			Ps	—	—
			M	—	—
	Family : Jacanidae				
19.	<i>Hydrophasianus chirurgus</i>	Pheasant-Tailed Jacana	S	—	—
			Ps	2	1
			M	—	—
	Family : Jacanidae				
20.	<i>Metopidius indicus</i>	Bronzewinged Jacana	S	3	1
			Ps	4	1
			M	7	1
	Family : Accipitridae				
21.	<i>Elanus caeruleus</i>	Blackwinged Kite	S	—	—
			Ps	—	—
			M	2	1
22.	<i>Milvus migrans</i>	Pariah Kite	S	2	1
			Ps	2	1
			M	2	1
23.	<i>Gyps bengalensis</i>	Whitebacked Vulture	S	14	3
			Ps	8	3
			M	8	3
	Family : Podicipedidae				
24.	<i>Podiceps ruficollis</i>	Little Grebe	S	2	1
			Ps	2	1
			M	4	2

Table 4. Contd. :

Sl. No.	Scientific name	English name	Climatic spell	Population max.	min.
Order : CICONIIFORMES					
Family : Phalacrocoracidae					
25.	<i>Phalacrocorax niger</i>	Little Cormorant	S	4	2
			Ps	4	2
			M	6	2
Family : Ardeidae					
26.	<i>Ardea purpurea</i>	Purple Heron	S	1	—
			Ps	—	—
			M	—	—
27.	<i>Bubulcus ibis</i>	Cattle Egret	S	4	2
			Ps	8	5
			M	22	9
28.	<i>Ardeola grayii</i>	Pond Heron	S	5	2
			Ps	3	2
			M	15	7
29.	<i>Ixobrychus sinensis</i>	Yellow Bittern	S	1	—
			Ps	1	—
			M	—	—
30.	<i>Ixobrychus cinnamomeus</i>	Chestnut Bittern	S	—	—
			Ps	1	—
			M	—	—
Family : Ciconidae					
31.	<i>Anastomus oscitans</i>	Openbill Stork	S	—	—
			Ps	9	2
			M	1	—
Order : PASSERIFORMES					
Family : Laniidae					
32.	<i>Lanius cristatus</i>	Brown Shrike	S	—	—
			Ps	1	—
			M	—	—

Table 4. *Contd.* :

Sl. No.	Scientific name	English name	Climatic spell	Population max.	min.
	Order : PASSERIFORMES				
33.	<i>Lanius schach</i>	Rufousbacked Shrike	S	2	1
			Ps	2	1
			M	1	–
	Family : Corvidae				
34.	<i>Dendrocitta vagabunda</i>	Tree Pie	S	1	–
			Ps	1	–
			M	2	1
35.	<i>Corvus splendens</i>	House Crow	S	3	1
			Ps	3	1
			M	1	–
36.	<i>Artamus fuscus</i>	Ashy Swallow-Shrike	S	–	–
			Ps	5	2
			M	2	1
37.	<i>Oriolus xanthornus</i>	Blackheaded Oriole	S	2	1
			Ps	3	1
			M	1	–
38.	<i>Dicrurus macrocercus</i>	Black Drongo	S	4	2
			Ps	8	4
			M	3	2
39.	<i>Aegithina tiphia</i>	Common Iora	S	3	1
			Ps	–	–
			M	–	–
	Family : Muscicapidae				
40.	<i>Copsychus saularis</i>	Magpie Robin	S	2	1
			Ps	2	1
			M	4	2
	Family : Sturnidae				
41.	<i>Sturnus malabaricus</i>	Greyheaded Myna	S	6	3
			Ps	–	–
			M	–	–

Table 4. Contd. :

Sl. No.	Scientific name	English name	Climatic spell	Population max.	min.
Order : PASSERIFORMES					
Family : Sturnidae					
42.	<i>Sturnus contra</i>	Pied Myna	S	7	4
			Ps	8	4
			M	15	3
43.	<i>Acridotheres tristis</i>	Common Myna	S	4	2
			Ps	9	3
			M	6	3
44.	<i>Acridotheres fuscus</i>	Jungle Myna	S	—	—
			Ps	—	—
			M	3	1
Family : Pycnonotidae					
45.	<i>Pycnonotus cafer</i>	Redvented Bulbul	S	3	2
			Ps	4	2
			M	10	4
Family : Cisticolidae					
46.	<i>Cisticola juncidis</i>	Streaked Fantail Warbler	S	3	2
			Ps	6	2
			M	4	1
47.	<i>Prinia subflava</i>	Plain Wren Warbler	S	4	2
			Ps	4	2
			M	7	2
Family : Sylviidae					
48.	<i>Orthotomus sutorius</i>	Tailor Bird	S		
			Ps		
			M		
49.	<i>Turdoides striatus</i>	Jungle Babbler	S	4	3
			Ps	3	3
			M	8	3

Table 4. *Contd.* :

Sl. No.	Scientific name	English name	Climatic spell	Population max.	min.
	Order : PASSERIFORMES				
	Family : Alaudidae				
50.	<i>Mirafra erythroptera</i>	Redwinged	S	—	—
		Bush Lark	Ps	1	—
			M	1	—
51.	<i>Galerida cristata</i>	Crested Lark	S	—	—
			Ps	2	1
			M	1	—
	Family : Nectariniidae				
52.	<i>Nectarinia zeylonica</i>	Purplerumped	S	2	1
		Sunbird	Ps	2	1
			M	—	—
53.	<i>Nectarinia asiatica</i>	Purple Sunbird	S	1	—
			Ps	1	—
			M	—	—
	Family : Passeridae				
54.	<i>Passer domesticus</i>	House Sparrow	S	16	5
			Ps	9	6
			M	10	6
55.	<i>Motacilla flava</i>	Yellow Wagtail	S	1	—
			Ps	—	—
			M	—	—
56.	<i>Anthus novaeseelandiae</i>	Paddyfield	S	4	2
		Pipit	Ps	4	2
			M	2	1
57.	<i>Ploceus manyar</i>	Streaked Weaver	S	4	1
		Bird	Ps	7	2
			M	28	16

Table 4. Contd. :

Sl. No.	Scientific name	English name	Climatic spell	Population max.	min.
Order : PASSERIFORMES					
58.	<i>Estrilda amandava</i>	Red Munia	S	—	—
			Ps	4	2
			M	2	1
59.	<i>Lonchura punctulata</i>	Spotted Munia	S	8	2
			Ps	13	4
			M	—	—
60.	<i>Lonchura malacca</i>	Blackheaded	S	—	—
		Munia	Ps	2	1
			M	5	2

Total number of Bird species - Sixty.

Total number of Families - Thirtyone.

Total number of Orders - Nine.

Observed upper and lower limit have been expressed in the column 'Population' as - max. and min. numbers.

Table 5. Local mammals recorded in and around the Nesting Ground of *Prini subflava* at Ramchandrapur village, South 24 Parganas. Observation : April to Sept 1999.

Sl. No.	Scientific name	English name
Order : CARNIVORA		
Family : Viverridae		
1.	<i>Viverra zibetha</i> (?)	Large Indian Civet
2.	<i>Viverricula indica</i>	Small Indian Civet
3.	<i>Paradoxurus hermaphroditus</i>	Common Palm Civet
Family : Felidae		
4.	<i>Felis chaus</i>	Jungle Cat
Family : Canidae		
5.	<i>Vulpes bengalensis</i>	Indian Fox
6.	<i>Canis aureus</i>	Jackal

Table 5. *Contd.* :

Sl. No.	Scientific name	English name
	Family : Herpestidae	
7.	<i>Herpestes auropunctuatus</i>	Small Indian Mongoose
	Order : RODENTIA	
	Family : Sciuridae	
8.	<i>Funambulus pennanti</i>	Fivestriped Palm Squirrel
	Family : Muridae	
9.	<i>Bandicota bengalensis</i>	Indian Mole Rat
10.	<i>Bandicota indica</i>	Bandicoot Rat
11.	<i>Mus booduga</i>	Indian Field Mouse
12.	<i>Mus musculus</i>	House Mouse
13.	<i>Golunda ellioti</i>	Indian Bush Rat

METHODOLOGY

The nidification of Plain Wren Warbler (*Prinia subflava*) was observed in a rural area in the district of South 24 Parganas in the state of West Bengal. The observation continued from April to September of 1999. The study was carried in two phases. In the first phase, one pair of *P. subflava* was selected. The pair was detected while they were engaged in selecting their nest site. The first date of spotting the pair was April 10th. Immediately, after two days from the morning of April 12th, the pair started nest-building. From 12th April to 14th May the observation continued on the nest building, egg laying, incubation, nestling feeding. The selection of this pair was based on observations made on its behaviour. The nest bush was detected by following the birds and observing as on which bush the pair was investing their maximum time and giving calls while sitting on the bush top. When the nest site was detected, the nest was at its initial stage of construction. One of the birds was found carrying nesting materials to their nest site. The observation was carried out from 0900 hrs to 1500 hrs daily. The observers were positioned at a distance of $50 \pm$ feet from the nest bush.

The other phase of observation started from April 10th and continued till September 28th 1999. In this phase, the study area was visited every day to locate new nests of the same species and to observe the nidification process. Changes in the nesting flora were also noted. Observations were continued to collect data on the changes taking place in the nesting-habitats with the change of climatic spells. All the nests were visited & observations noted daily from and in between 0700 hrs to 0900 hrs and from 1500 hrs to 1600 hrs. The nests were located mainly by visual observations—the birds carrying the nesting materials and nestling foods and also by following their calls & the

striking behaviours they exhibited on their nesting bushes. Super Zenith binoculars of 8×30 and 20×50 magnifications were used for observations. The measurements of the nest bushes, nest-heights and different parts of the nest were found out with the help of a 2 mt. measuring tape and a millimeter scale. Nestlings were weighed with Pesola spring balance and the eggs were marked with Indian ink and fledglings were measured with vernier callipers. A maximum and minimum count of birds per sighting was noted during the daily observations. Calculations from these datas have been utilized to achieve the population range (max./min.) of birds per season.

DISCUSSION

Breeding territory : Breeding territory of *P. subflava* in two different seasons (summer & monsoon) at the same spot (distance between the two nests was 82 feet) : In summer there was no Bhindi (=Dherosh) cultivation in the north-east corner of the pond. Hence, in summer the bird of nest type : (A) selected the vegetable orchards of the north-west corner of the pond that occupies 43% of the whole area (Fig : 3). Paddy field occupies 40% of the land, the remaining consists of grass land and waterbody. In monsoon the vegetable orchards of the north-west corner got flooded and Bhindi was cultivated on the north-east corner. Hence, the *Prinia* of nest type : (B) in monsoon selected that Bhindi grown field and nearby wet grassland (46% and 12% respectively of the whole area) whereas only 8% was paddy field—newly cultivated. 2% of land was marshy and remaining area covered by waterbody.

Both the birds of a pair were observed not equally sharing the task of defending their nesting territory. Instead, one of the birds would remain in territory defending while the other would be helper to its mate. *Prinia subflava* exhibited inter-species tolerance in sharing its nesting territory allowing others (birds) to be its cousin nesters. But intra-species intolerance was marked during observation even with the foraging grounds during the period of nest building and nestling feeding, shown in Fig : 2, 14, 15, 16. In the case of nest no : 1 the breeding territory was measured 354 sqm, 2 days before the commencement of nest building (Fig : 2). In 75% cases the nests were observed constructed on the margin of the breeding territory (Fig : 3).

Nest site : Nesting height & Nesting vegetation.

P. subflava was observed to be preferring 3 types of vegetations for nesting. Bena grass (*Andropogon squarossus*) appeared to be the most preferred nesting vegetation, of the total nests 71.5% were in Bena grass. The nest height varied from 46 cm to 84 cm. In summer the pairs selected (*Lippia geminata*) locally called Bhut-beurey and (*A. squarossus*) Bena grass for nesting. The nesting bushes have been found with heights ranging from 90 cm to 128 cm. The nesting heights varied from 46 cm to 60 cm (Table : 8). During the hot summer days (mid April to mid May) the species was observed selecting their nesting heights so as to reach and retain their required nest temperature keeping under attention factors as—suitable nesting coverage and possibilities of

predation (Fig : 2). In the summer phase nest height was correlated with the bush height following Student's T method and found : $r = 0.97$, $Sr = 0.09$, $t = 10.64$.001 (Table : 8). In the post summer season, *P. subflava* was found to be using only Bena bushes (*A. squarossus*) with the bush heights and nest heights ranging from 100 cm to 140 cm & 60 cm to 77 cm respectively. From post summer period the water level of the waterbodies start rising and consequently the nest heights are raised (increased) by the species, although the bush heights remain nearly same as that of summer. In this phase the nest height was not correlated with nesting bush height : $r = 0.11$, $Sr = 0.70$, $t = 0.16$. (Table : 8). It was observed that in post summer the pairs considered the factor of rising water level in their nesting area. Besides, an important factor was the day by day change of water-level of the wetlands near to which the nesting had been done.

It was presumed that for this reason, the species had rejected 50% of their nests done in the post summer season. During the monsoon months the species was found to be using two types of vegetation for nesting, namely, Bena grass (*A. squarossus*) and Kush grass (*Eragrostis cynosuroides*). The nest height and bush height varied from 70 cm to 84 cm and 130 cm to 170 cm.

Nesting area : The species used both small & long stretches of bushes for nesting but always preferred dense bushes or the highly dense portion of a long bush. The bush stretch varied from 6.3 ft to 100 ft. From observations it has been found that a typical nesting area needs the nesting vegetation very close to a waterbody and there must be agricultural lands near to the nesting spot. In 71.5% cases it was observed that the species selected such areas for successful nesting. Other than this, in areas which were dry or wet grasslands with ample nesting-vegetation but away from the waterbodies nesting was also found to have been done. It was found that 28.5% nestings were done in such grounds. Of this 28.5% nestings, 75.3% nests were either discarded or abandoned as shown in Fig : 1.

Nest building : Nesting pattern : The species was found following two types of nest building patterns. During their nesting in Bena (*A. squarossus*) and Kush (*E. cynosuroides*) grasses, the pairs used ten and more grass blades from the nesting bush as main-beams on which the nest actually stands. The bird then stitches the collected nest materials such as—thin strips of Bena leaves, with the main beams to construct the nest (Plate : 1 stage 1). Day by day the pair introduced one by one the main beams and the construction proceeded. The birds took 5 to 8 days to complete the sac shaped nest. This phase of construction is denoted here as the **Actual nest building phase** (Plate : 1 Stage : 6). After the completion of the sac shaped nest which is by now ready to carry the eggs, the pair started joining the anchors and supporting beams to with the nest (Plate : 1 Stage : 7, 8). This part of work took another 3 to 5 days and is indicated as **Partial nest building phase**. However, construction of anchors and supporting beams were also noted during nestling feeding period and on stormy days of post summer and monsoon in several nests. Table : 6 shows the rate of nest building in Actual and Partial nest building phases in nest no : 1 where nesting was done

in Bena grass (*A. squarossus*). When constructing the nests in *Lippia geminata* bushes the birds used 3 to 4 closely growing shoots to give them support as main beams and more 2 to 3 *Lippia* shoots sometimes with grass blades from adjacent grass bushes to help as supporting beams. While nesting in Lippin bushes, the birds used to stitch the nesting materials through the bark of the stem of *Lippia* to give a supporting anchorage to the nest. Sometimes, the birds placed the leaves of *Lippia* to cover the outer side wall of the nest. This is shown (Plate : 2). The birds also stitched the nesting materials through the leaves of *Lippia* to give the nest an anchoring support. Generally, the species at first used to do the nest floor with the help of 3 to 4 rims (Plate : 1 Stage 3). Then continued to the side walls. The nest had larger side walls on the back side and smaller side walls on the front side (Table : 7). This is front side from where the birds took entry to the nest. Always the birds started constructing the larger side wall at first and the same was always facing the direction from where the maximum wind thrust came.

Table 8. Corelation between Nest Height and Bush Height of *Prinia subflava*, following Student's 'T' method.

Location—Ramchandrapur village, South 24 Parganas.

Period of Observation : April to August 1999.

Summer				
Nest number	Bush height		Nest height	
	Mean	± SD	Mean	± SD
	cm		cm	
1	128	17	59	1.4
4	95	7.1	46	2.8
5	124	85	60	7.1
6	121	15.6	57	2.8
2	100	14.14	51	8.48
3	90	8.48	46	8.48
7	105	21.2	52	7.07
$r = 0.97$ $Sr = 0.09$ $t = 10.64$ $\text{sig} \rightarrow t < .001$				
Post Summer				
Nest number	Bush height		Nest height	
	Mean	± SD	Mean	± SD
	cm		cm	
8	140	17	68	5.7
9	100	14.1	60	4.2

Table 8. *Contd. :*

Nest number	Bush height		Nest height	
	Mean	$\pm$ SD	Mean	$\pm$ SD
	cm		cm	
10	127	12.7	73	4.2
11	102	7.1	77	8.5
	$r = 0.11$	$Sr = 0.70$	$t = 0.16$	Insignificant.
Monsoon				
Nest number	Bush height		Nest height	
	Mean	$\pm$ SD	Mean	$\pm$ SD
	cm		cm	
13	130	14.1	70	5.7
14	150	11.3	80	5.7
12	170	22.6	84	7/07
	$r = 0.97$	$Sr = .24$	$t = 4.04$	Insignificant.

All measurements are in Centimeter.

Table 6. Reference sheet of Plate 1 (Nest Building) of *P. subflava* in the summer season. Nest under discussion—Nest No : 1.

Date	Observation Hour	No : of visit for nest building	Time spell of nest building in minutes	Development of nest refer to stage no :
12.4.99	0931 – 1230	5	52	1 & 2
13.4.99	0945 – 1245	10	37	2 & 3
14.4.99	0930 – 1230	18	57	3 & 4
15.4.99	0930 – 1230	6	16	4
16.4.99	0918 – 1218	7	40	5
17.4.99	0930 – 1230	5	57	6
18.4.99	0930 – 1230	4	16	7
19.4.99	0930 – 1230	3	10	7 & 8
20.4.99	0930 – 1230	5	20	7
21.4.99	0930 – 1230	5	26	8

*Pairing and participation of partners :**Before nest building :*

One of the partners always used to defend its nest site or the nesting area throughout the breeding season and some of the individuals used to do so throughout the year. But the extension of the span of defending the breeding territory and the nesting site in the non breeding seasons varied according to the wealth of the area. The breeding season starts from March. Before the commencement of the breeding season one the birds would arrive in its preferred nesting area and start surveying and marking its breeding territory.

During this phase, we found that the bird which was then busy in marking its territory, would chase all intruders of its species but would allow some individuals to come closer and perch within the nesting area. This territory marking phase varied from 6 to 39 days. After this period during which pair formation takes place, the pair starts selecting the nest site in the grass patches and *Lippia* bushes available in the breeding territory.

During nest building :

Sharing the nest building work by both sexes varied from pair to pair.

In nest no : 1 it was observed that a single bird constructed the whole nest, while the other partner was found busy in feeding, watching, vocally communicating (with the builder) and engaged with other general activities. Within our observation period of 10 days on nest no : 1 (for 3 hrs daily) it was observed that the species utilised only on an average 11.03 minutes within an hour (60 mins observation) for the nest building during the hottest time of the day (Table : 6).

MATING

During the observation period, only once a pair was seen to copulate in the post summer season. It was a cloudy day without rain and atmospheric temperature was in between 29°C & 31°C within 1000 hrs and 1200 hrs. At 11 : 25 hrs a pair of *P. subflava* was observed perched on a single grass blade of Bena bush (*A. squarossus*). Both the partners were silent and in no state of activity. Suddenly, the male bird turned very excited and after another silent pause of 2 minutes, mounted on the back of the female followed by constant fluttering of wings. Time counted from mounting to dismounting was about 4 seconds. Soon after dismounting the male bird hopped around the area still in same excitement while the female rested silent inside the bush on which they were. To avoid causing further disturbance to the mating pair I shifted from the spot along with the companion observer.

Eggs & egg laying : Eggs were pale green in colour with dark reddish brown blotches. Density of the blotch marks varied in between individual eggs of a clutch. In nest no : 1, it was observed that blotch marks are greater in the first egg and the markings were very fine whereas the last egg had sparsely spread blotches and the marks were bigger in size. It was observed that the birds never laid egg in between 0900 hrs & 1500 hrs (according to field-observation it was the hottest part of the day). *P. subflava* laid egg every day to complete the full clutch. Out of 3 used nests in summer clutch size remained 5 (in 2 nests) and 4 (in 1 nest). In post summer and monsoon clutch size remained between 4 and 3.

Incubation : Incubation period varied from 11 to 13 days. The Handbook (Ali & Ripley) Vol. VIII states that incubation period ranges between 11 to 12 days. In case of nest no : 1 it was found that after laying the 4th egg (clutch size 5), the bird started attending the eggs for incubation (Figure : 10). During the hottest part of the day in summer the rate of incubation was found almost nil before completion of the clutch. During the post summer season, it was observed that despite sudden occurrence of rainfall the bird would not leave the nest while incubating the eggs. Ignoring the rainfall it continued to attend. Whereas in monsoon, in 90% of the nests studied, the eggs remained totally unattended when it was raining. During incubation (inattentive period) in the summer season, the inside nest temperature ranges from 34°C to 39°C in between 0930 hrs and 1430 hrs (Figure : 10). Both sexes incubate. When one bird attended the eggs the partner would never be in the vicinity. It was observed either feeding or resting on a bush somewhere away. But these activities would always be within the territory of the pair. However, sometimes the unattending birds would go out of its territory to take a look in and around the nest of another pair, but this absence from its territory never crossed 15 to 20 minutes. *P. subflava* have a habit of watching their nest in turns and at intervals till the end of the incubation period. During incubation* both the partners remained less vocal and both of them would spend very little time in the nesting bush. They were observed on nearby bushes watching the nest in the inattentive periods of the day. *(incubation period covering both attentive & inattentive periods). As they start laying eggs one of the partner starts giving a totally different call than noted previously. The call is very much unheard or little heard in the days of nest building. It was also noted that only one bird of the pair was in a habit of producing such call. The call was a continuous trit-trit-trit-trew-trew-trew-trew-trew-trit-trit-trit uttered loudly. In nest no : 1 during the early phase of incubation this call produced by the partner would always bring out the incubating bird from the nest. And it was found uttered whenever domestic cattle or dogs came in the direction of the nest. The call was also produced on arrival of the village folk towards the nest, and the same was noted on the observer's approach towards the nest (whenever the observers were within 30 feet of the nest).

Young & their development : Hatchling : Eggs were hatched according to sequence of eggs laid. The egg shells and dead hatchlings were carried away & discarded at a distance of 30 feet to 70 feet from the nest site by the attending bird. In most cases the birds would drop the egg shells and dead hatchlings in the nearby pond. The hatchlings had no down, bare pinkish body, intestine almost visible through the thin abdominal skin. The eyes remain closed and in some cases a colourless fluid was found on the edge of the eyelids on the first day. The gape is yellow, average length of gape of 14 hatchlings was 2 mm. The average weight being 1.5 grams.

NESTLINGS : From the second day the bluish black line appeared along the feather tracts of the bare wings and the mid of the back over the vertebral column. Eyes open on the 3rd day. From this day we noted feather sheath emerging on the wings, head, back-along the vertebral line and on the sides of the abdomen & throat. The feather sheaths are white in colour on the abdomen and throat parts. Sometimes orangish yellow & buff on the flanks. On the 4th day feathers emerged out of the black feather sheath. The length of the feathers were $3 \pm$ mm. From the 5th day the nestlings started activating their locomotory organ—feet. If removed from nest, they will at once catch hold of the nest bed with their claws. They have been found preferring to put their heads down inside the darkness of our folded palms—when handled. From 5th day the weight of individuals were noted & measurements taken. 5th day observation shows average weight of 4 nestlings—4.3 grams. Average length of gape of these 4 nestlings—5 mm (Table : 9).

From 6th day nestlings start screaming. The beak still then soft but the tarsus had turned hard. Between 7th & 10th day the growth rate was steady and nestlings now remain silent at nest than before. On the 9th day the nestlings were able to understand the presence of their parents. On the 11th day, in nest number : 1 (5 eggs had hatched—later one was missing the other dead, remained 3 hatchlings) the elder one—now 10 days old, was attempting to fly out. Observations on other nests show nestlings attempting to fly out after 13th day. In nest : 1 two nestlings emerged out on the 11th day, the other on 13th day. Other nests show nestling period as 12 to 15 days. (As per our average observation).

Nestling food of *Prinia subflava* : From May 2nd to 13th (1999) a total of 12 days, observation was made on a single nest (no : 1) of *P. subflava* from 0900 hrs to 1600 hrs to find the types of nestling food, the changes taking place in the nature of the food, the frequency of feeding, the participation of the partners in feeding activity—in different stages of the nestling period. Out of 5 nestlings 3 survived in this nest. The parents fed their nestlings with insects varying in size from 5 mm to 40 mm. The colour of the insects were brown, black, green, chocolate, white, yellow and muddy colour. For the first 2–3 days of the nestlings the parents depended on the larvae as big as 5 mm to 8 mm of white and light green colour. From the 4th day the parents began to give slightly bigger insects as Grasshoppers (*Atractomorpha* sp.) and insects of chocolate brown colour.

From the 6th day the parents brought Spiders (*Pardosa* sp.), medium sized Grasshoppers, and larvae measuring from 10 mm to 30 mm. Along with these they also began to introduce Moths (*Ophideres* sp.) in the nestling diet from the 8th day. On the 11th day a species of orthoptera (black-coloured) was found brought to be fed to the nestlings. A fly or a sort of bee was brought to feed on the 12th day along with regular food materials. In case of 2 nestlings the nestling period was 11 days and for 1 it was 13 days. From the above observation it can be said that *P. subflava* used 3 to 4 types of larvae from 1st to 13th day which were mostly white, green, yellow. However, the larvae was only 11.48% of the total diet. The remaining portion being other insects. Grasshopper was introduced from 4th day and continued till 13th day occupying 55.02% of the total diet (Figure : 12). The parent birds exhibited a trend to choose green & brown coloured grasshopper within 10 mm to 40 mm length.

Table : 9. Weight of Nestlings in *Prinia subflava* nest no : 1. The nest was found containing 5 eggs. After 14 days of incubation hatchlings emerged on 1st, 2nd, 3rd, 4th, 5th of May 1999. Nestlings were numbered according to their weights, i.e., Age $\propto$ Weight. Nestling no : 1 was subsequently lost and no : 5 found dead.

Date 1999	Nestling number	Weight gms	Wing mm	Bill mm	Tarsus mm	Tail mm
05 May	2	5	7.5	4	7.5	nil
	3	4	9	4	9.5	"
	4	4	6	3.5	6	"
	5	1	4.5	3	4.5	"
06	2	5.5	18	5	15	1.5
	3	5	11.5	5	9.5	nil
	4	4.5	8.5	4	8.5	"
	5	2.2	6	3.5	5.5	"
08	2	9	27	6.5	16	5
	3	7	19	5	11	1
	4	5	13	5	10.5	nil
10	2	9	33	8	19	7
	3	7	26	7	15	3
	4	6	21	6	12.5	2
12	2	10	35	9.5	20	13
	3	9	33	8.5	18.5	7.5
	4	8	29	8.5	17.5	5.5
13	2	9	41	9.5	22	16
	3	9	32	8	17.5	7
	4	7.5	35	8	18	10

From May 14, 1999 all the nestlings emerges out of the nest.

Territory of *P. subflava* during nestling feeding period in : summer, post-summer, monsoon.

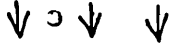
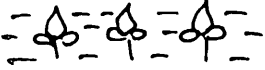
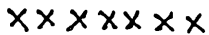
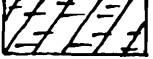
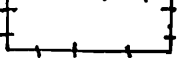
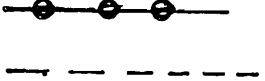
Prinia nest	
Brick kiln	
Village	
Ripe paddy ready to harvest	
Bhindi fields	
Cucumber fields	
Newly sown paddy	
Hyacinth choked waterbody	
Cabbage cultivation	
Gourd orchard	
Bitter melon	
Hyacinth bean	
Mud track	
Ridges	
Dry grass field	
Wet grass field	
Waterbody	
Territory of <i>P. subflava</i> during nestling feeding	
Breeding territory of summer & monsoon season of <i>P. subflava</i> .	

Table 10. Conventions used in the Territory Map of *Prinia subflava*.

1. Territory of *P. subflava* in summer : 80% of the area consist of Paddy cultivated fields. 2% occupied with vegetable orchards and 18% by grasslands and waterbody. Nearest discarded nest of the species was 467 ft. away from this nest (= nest 1). Nest of *Cisticola juncidis* was within 337 ft and of *Anthus novaeseelandiae* was within 112 ft. from (▲) marked nest—Figure : 14.
2. Territory of *P. subflava* in post-summer : 60% of the area were covered with waterbody choked with hyacinth. 25% occupied by wet-grasslands and vegetable orchards occupied 19.5%. Remaining 0.5% was covered with dense ridges of Kush grass (*E. cynosuroides*). Another nest of the same species was found 856 ft. away from the nest under discussion. Inter-species nesting within a radius of 500 ft. approximately was absent (Figure : 15).
3. Territory of *P. subflava* in monsoon : Area consists of vegetable orchards, wet-grasslands and waterbody with dense ridges of Bena grass (*A. squarossus*) of 45%, 35% and 20% respectively. Nest of *C. juncidis* was 64.5 ft away and of *L. malacca* was 117 ft away from the *P. subflava* nest under consideration. No other Prinia nest was found within 700 ft. from this nest (Figure : 16).

Nest sanitation : The parent bird after delivering the food, always waited to collect the faecal sacs and carried them away to drop on the fields while flying for food collection. Sometimes, the parent would swallow the faecal droppings. Such behaviour was noted when the hatchlings were a day or two old.

Fledglings : Fledglings left the nest one by one following the sequence of first hatched first left. In one nest of post-summer season 2 nestlings emerged from the nest one after another in a single day. Observation show maximum nestlings under normal condition tend to emerge from nest in the early morning. However, it was also found that a nestling prepared to leave the nest the nest day, when disturbed, left the nest a day earlier. In the summer season it was observed (in nest : 1) that fledglings remained within the nesting bush or in the nearby bush—within a distance of 30 feet for at least the consecutive 3 days from the day of emergence from nest. But in monsoon the observation showed that fledglings remained in the nesting bush or the nearby bushes for at least the next 6 days from the date of emergence. Both the parents fed the fledglings during this time. The water level from ground had a rise of 2.5 ft. during this time. A loss of weight was also noted in every bird at the start of fledgling period (Table : 9).

Fledgling & Interaction with Parents :

Observation : 1.

In summer and monsoon it was observed that the feeder parent would feed both the nestlings and the fledglings simultaneously and sometimes with the assistance of the partner. But in post-summer the feeder bird would ignore the fledgling (observed in one nest) begging to be fed. Sometimes the fledgling would chase the feeder carrying food, but the food carrying parent would

rush to the nest only to feed the nestlings. Ultimately the helper parent would take charge of feeding the fledgling that had already left the nest.

Observation : 2.

While observing nest : 1 it was found that fledgling period began with the end of harvesting of paddy. The parent birds in need to feed the youngs had to travel long distances of 400 to 450 feet to reach other unharvested fields still teeming with insects. The 3 nestlings (of nest 1) emerged from nest on 12th, 13th and 16th of May 1999 successively. They were hatched on the 2nd, 3rd and 4th of May respectively. On the 16th of May when the youngest one flew out of nest the feeding parent was observed following an unique art of giving first lessons to the new chicks. Since the food collection site was at a great distance from the nest-site the feeder bird instead of bringing food to the elder fledgling began to give calls with food in its beak from the site of collection. The fledgling which was 14 days old on hearing the call covered a distance of 27 feet by flight to reach the food holding parent. But the feeder parent flew away to the 12 days old fledgling and the former one chased the parent to get the food hopping from one bush to another. Similarly, the 13 day's old one also started following the parent to reach the food. It covered a distance of 42 ft. in its first flight. However, the youngest one was still waiting in the nesting bush. The feeder parent went to it. The next day only 2 fledglings were found in the small paddy field still green and unharvested. The feeder parent was there, travelling 70 to 100 ft. to collect food for its youngs. Sometimes food was available close at hand. The fledglings awaited in the food-collection site. The 3rd fledgling was however missing.

***P. subflava* & Competitors :** As foraging competitors of *P. subflava* the other two species of birds that appeared are the : Streaked Fantail Warbler (*Cisticola juncidis*) and Paddyfield Pipit (*Anthus novaeseelandiae*). The presence of the nests of these competitors are indicated in Figure : 14, 15 and 16.

Breeding success :

1. Observation period was 4 months and 11 days, or 131 days.
2. The span was from April 10th to August 18th of 1999.
3. 14 nests were observed within the observation period.
4. Of the total nests 20.25% nests were discarded by the birds. 22.60% nests were destroyed by local population.
5. 57.15% of nests remained, in which the species laid 31 eggs.
6. The hatching success was 100%.
7. 70.96% of hatchlings survived.

8. Observation period consists of : summer, post-summer, monsoon, in which 70.96% survived and 29.04% died or destroyed.
9. In summer the survival of hatchling was 57.14%, in post-summer 100%, in monsoon it was 70%.
10. Out of 70.96% of hatchlings 50% of nestlings survived all through the observation period.
11. In summer 37.5% nestlings survived, in post-summer 57.14%, and in monsoon 57.14% nestlings survived.
12. Total fledgling success of the observation period was 72.72%.
13. In summer 66.66% of fledgling survived, in post-summer 50% and in monsoon 100% of fledgling survived.

SUMMARY

The nidification of Plain Wren Warbler (*Prinia subflava*) was studied in rural South 24 Parganas in the vicinity of Kolkata, West Bengal. The study was conducted from April to September of 1999. 14 nests of Plain Wren Warbler were available for study. The preferred nesting vegetations were found as follows : Bhut-beurey (*Lippia geminata*), Bena grass (*Andropogon squarossus*), Kush grass (*Eragrestis cynosuroides*). The species constructed 2 types of nests according to availability of nesting materials, which differed due to change of vegetation. Abandoning of nest was observed in case of some pairs after completion of nest building or in the mid-phase of construction. Nest building period varied from 5 to 11 days. 2 clutches were occasionally laid despite nesting ground grossly inundated with rain water. Both sexes incubate. Nestling period varied from 10 to 15 days. Every partner do not share all the duties equally on the domestic part. The breeding success was found to be 25.80%. Larvae—a basic food item continued to be used throughout the nesting period. Grasshopper (*Atractomorpha* sp.) although not basic occupied 55.02% of the total nestling diet.

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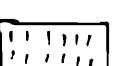
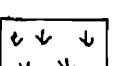
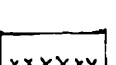
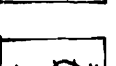
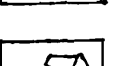
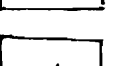
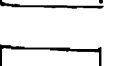
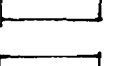
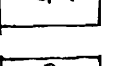
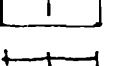
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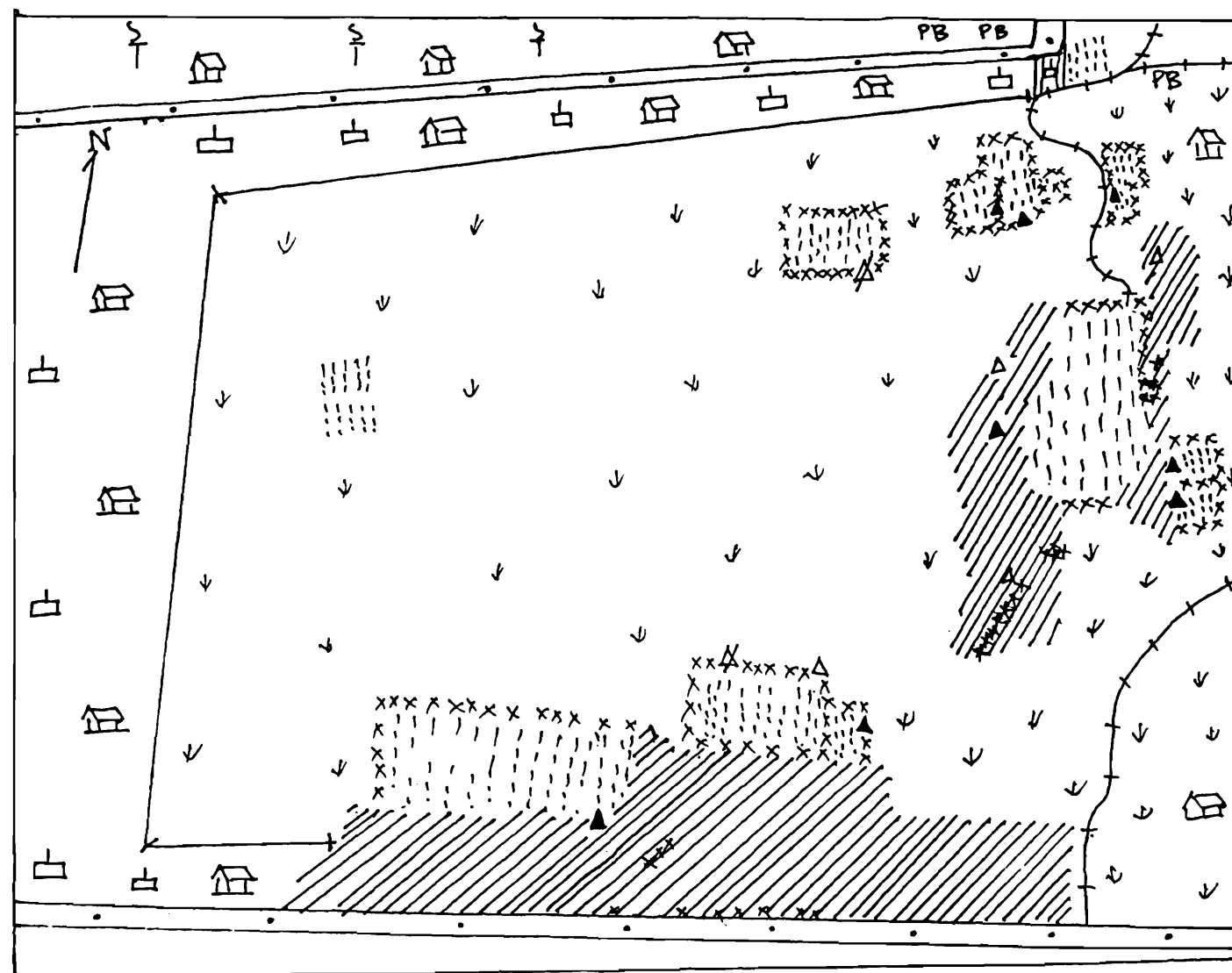
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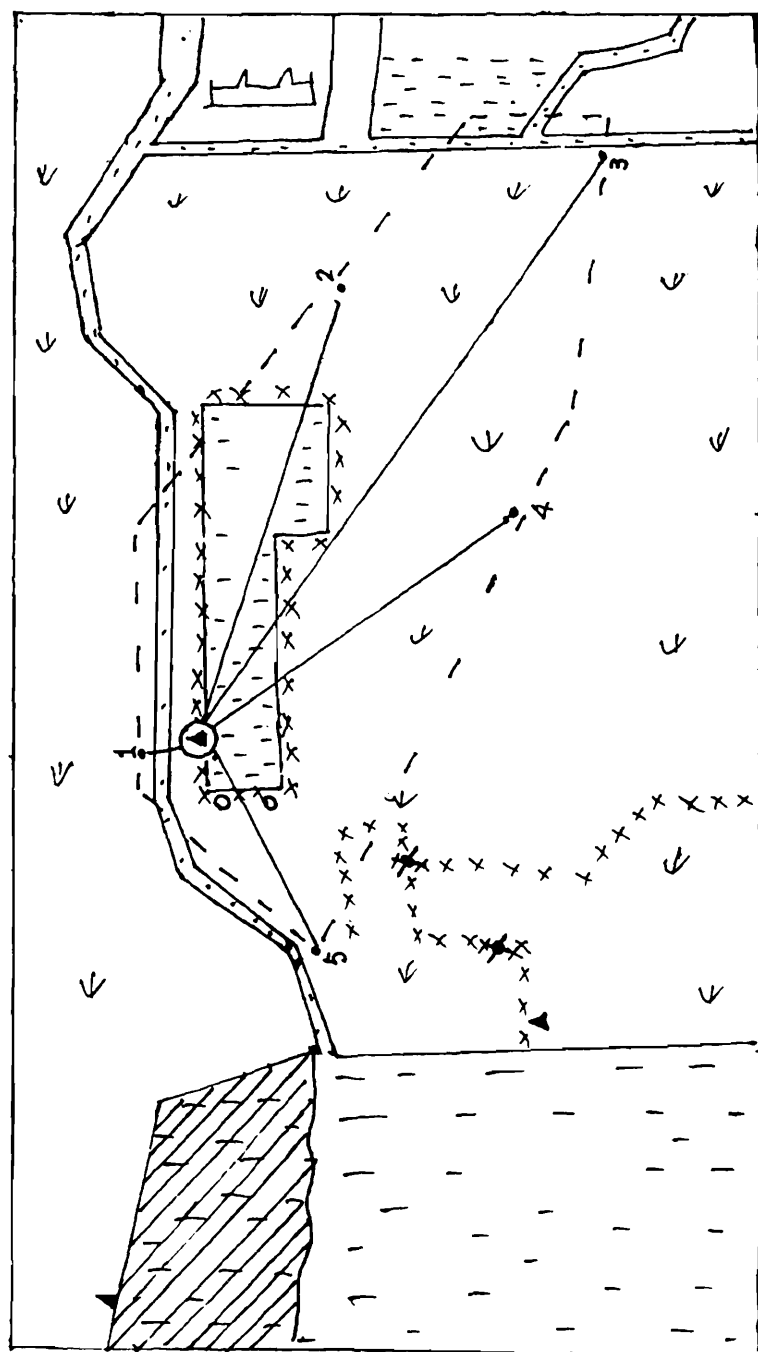
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L E G E N D

- | | |
|---|------------------------|
|  | Nests destroyed |
|  | Nests utilised |
|  | Nests discarded |
|  | Grasslands |
|  | Waterbody |
|  | Cultivated lands |
|  | Ridges |
|  | Nud track |
|  | Village area |
|  | Factory |
|  | Metal road |
|  | Lead factory |
|  | Brick kilns |
|  | Margin of village area |

Fig. 1. The Study area with the vegetation and nests of *Prinia subflava*.



L E G E N D

Nest number 1	
Neighbouring Prinia nests	
Nest of <i>Aethya novaeseelandiae</i>	
Nest of <i>Cisticola juncidis</i>	
Paddy Fields	
Waterbodies	
Mud track	
Wet grassland	
Factory	
Ridges	
Boundary of Territory	

The straight lines 1 to 5 drawn from the nest spot to the boundary of the territory showing various distances :

Straight line	1 – nest to boundary	– 55 feet.
	2 " "	– 600 "
	3 " "	– 850 "
	4 " "	– 665 "
	5 " "	– 304 "

Fig. 2. Territory of *Prinia subflava* before nest building.

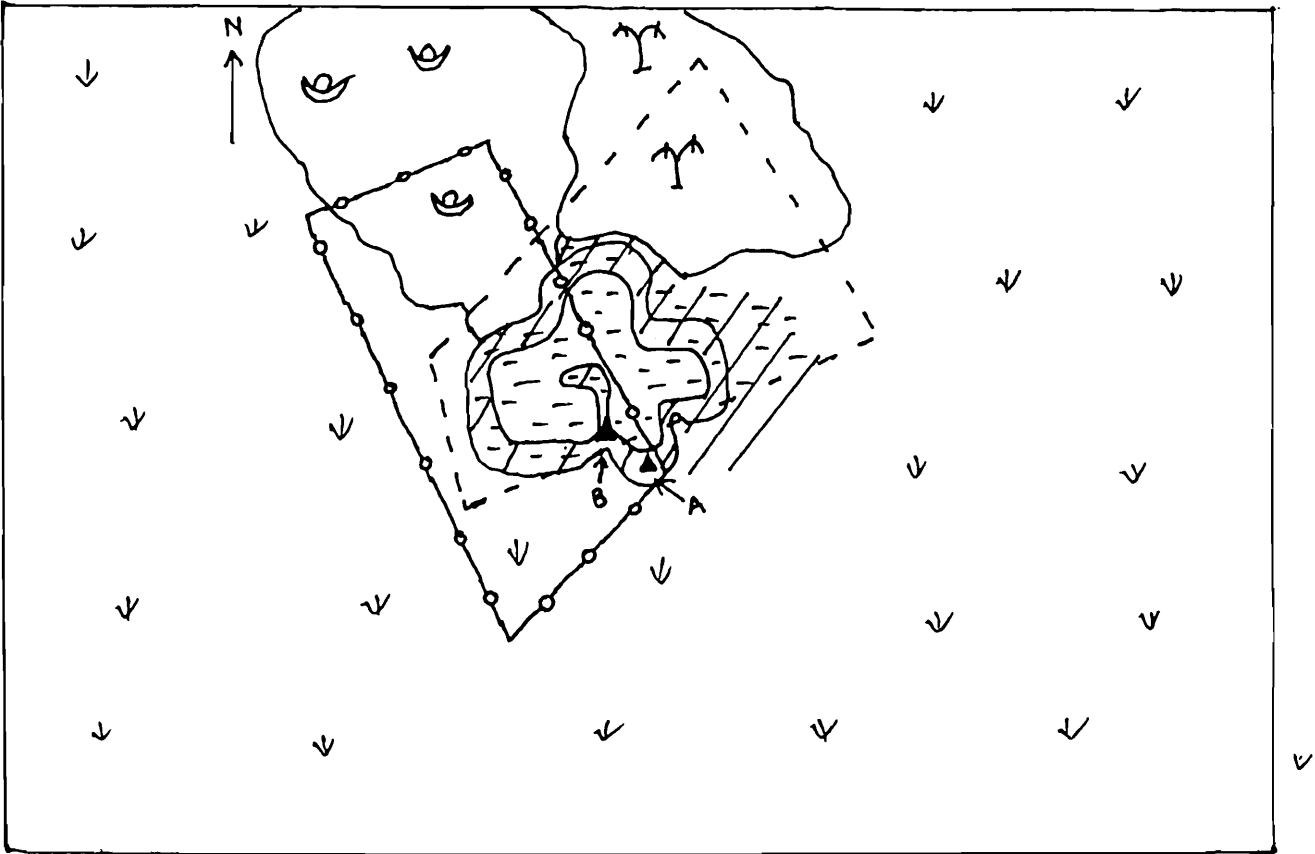
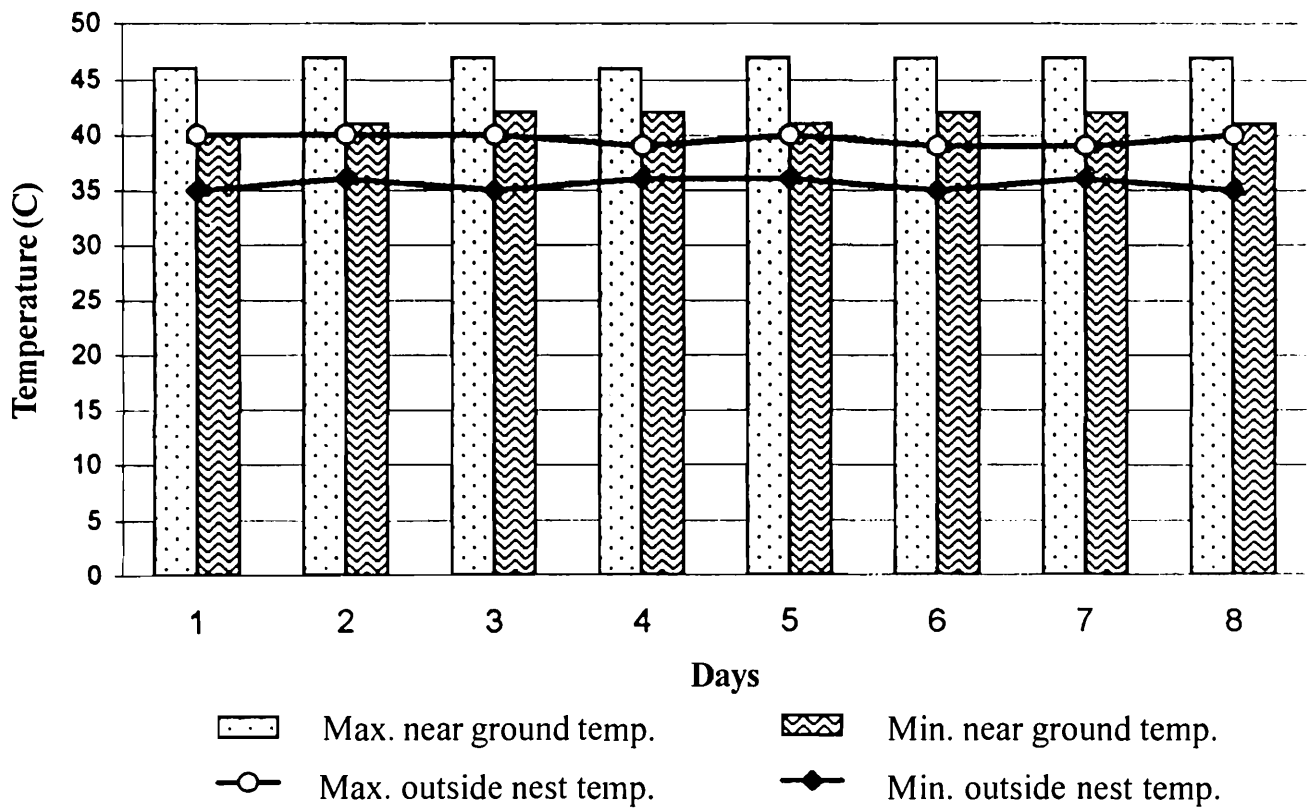


Fig. 3. Breeding Territory of *Prinia subflava* in two different seasons (summer and monsoon).

For Legend see Table : 10

Fig. 4 : Temperature variation in nest site and ground level



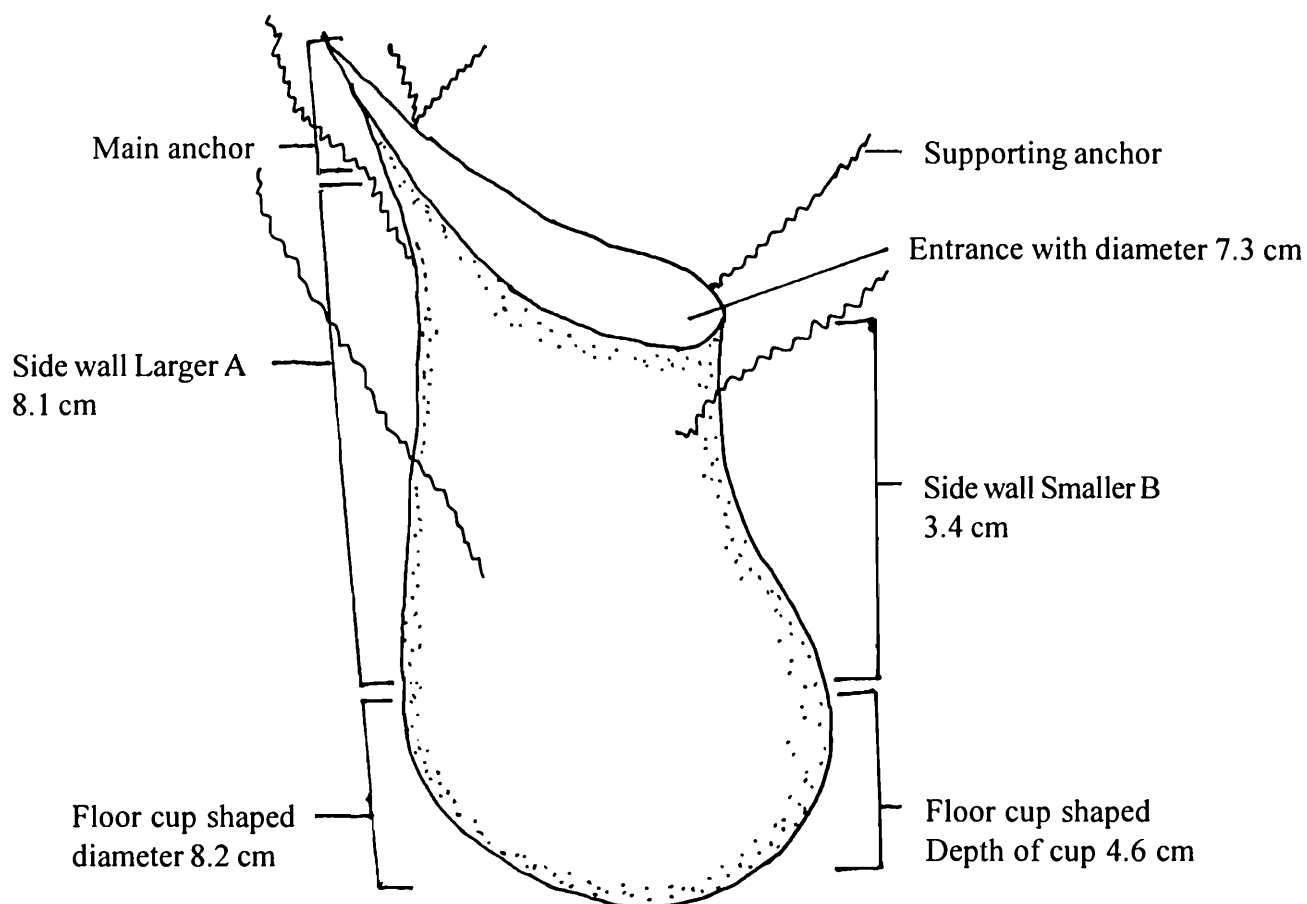


Fig. 5. Nest of *Prinia subflava* – Nest No : 1 constructed in Bena grass (*A. squarossus*).

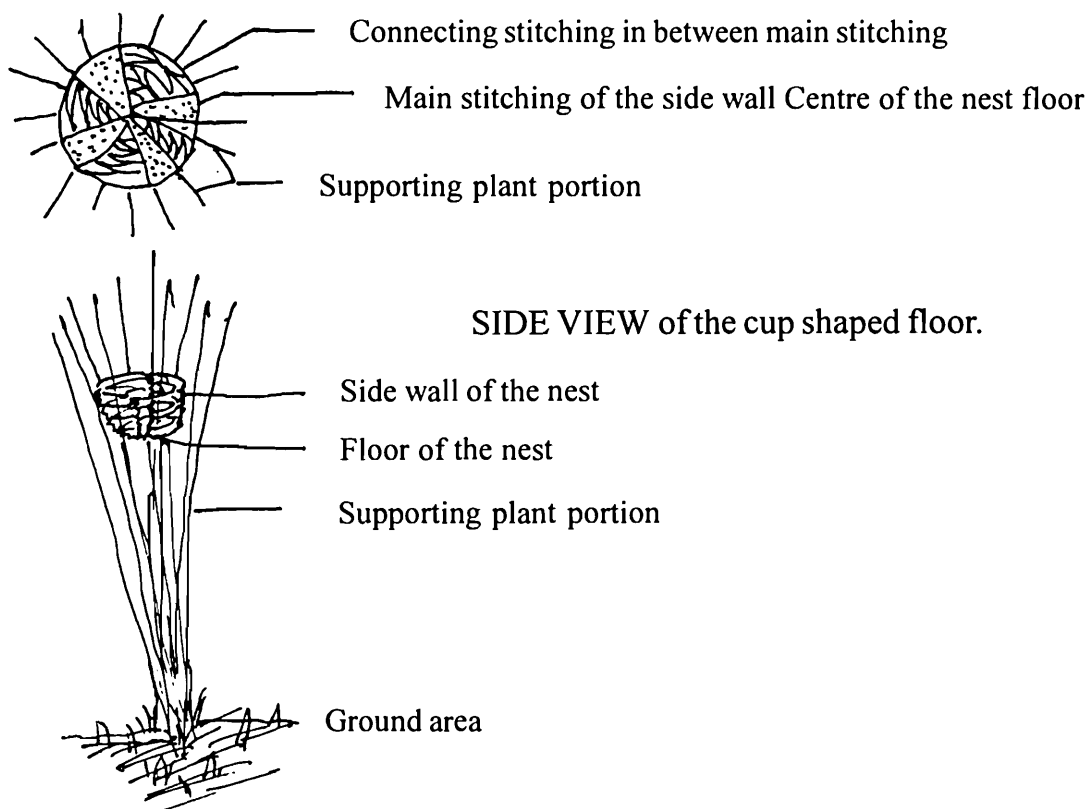


Fig. 6. Nest of *Prinia subflava* TOP VIEW of the cup shaped floor.

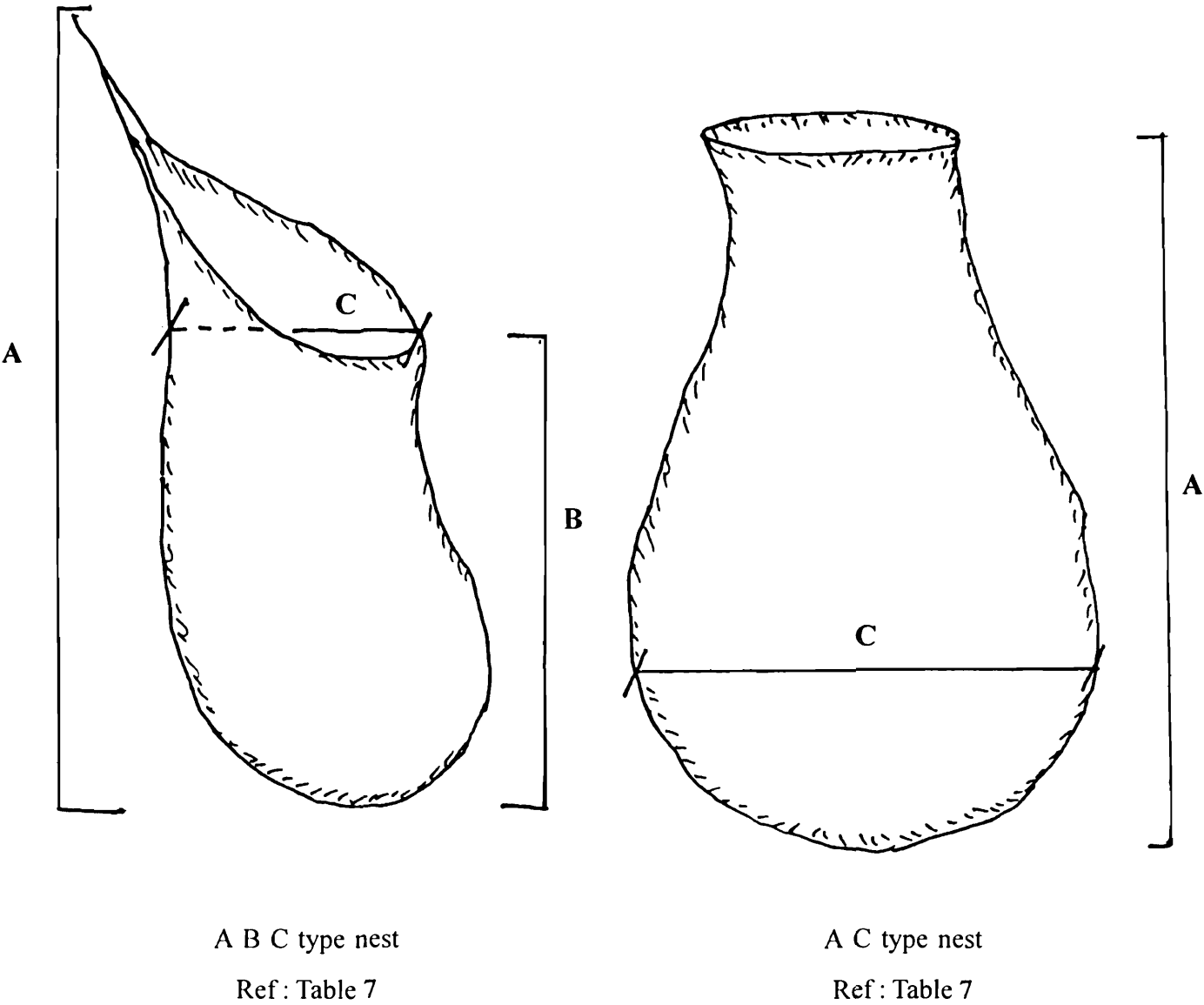
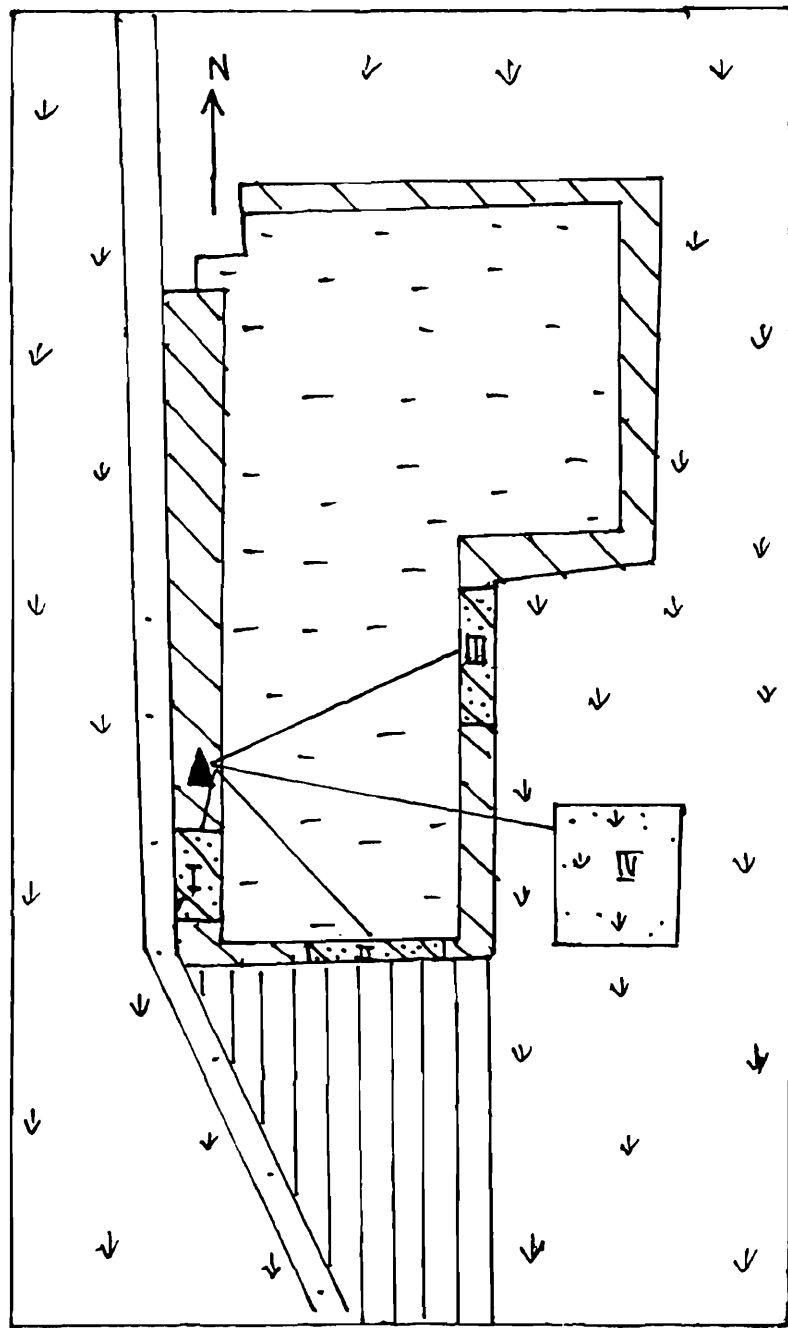


Fig. 7. Diagramatic representation of two types of nests of *Prinia subflava*.



MATERIALS COLLECTED

Site	Material
I	Bena & Kush grass
II	
III	Same as above
IV	Cobweb (?)

Total time taken for nest construction – 6 days.

Average visit to collection site during the observation period – 2.83 times per hour (visits during actual nest building period only considered).

LEGEND

Mud track

Dal cultivation

Bena bushes

Waterbody

Paddy cultivation

Boundary of collection site

Nest No : 1

Length Breadth Site No :

18 feet 7 feet I

27 " 8 " II

32 " 7 " III

Undetermined IV

Distance between Nest and Site

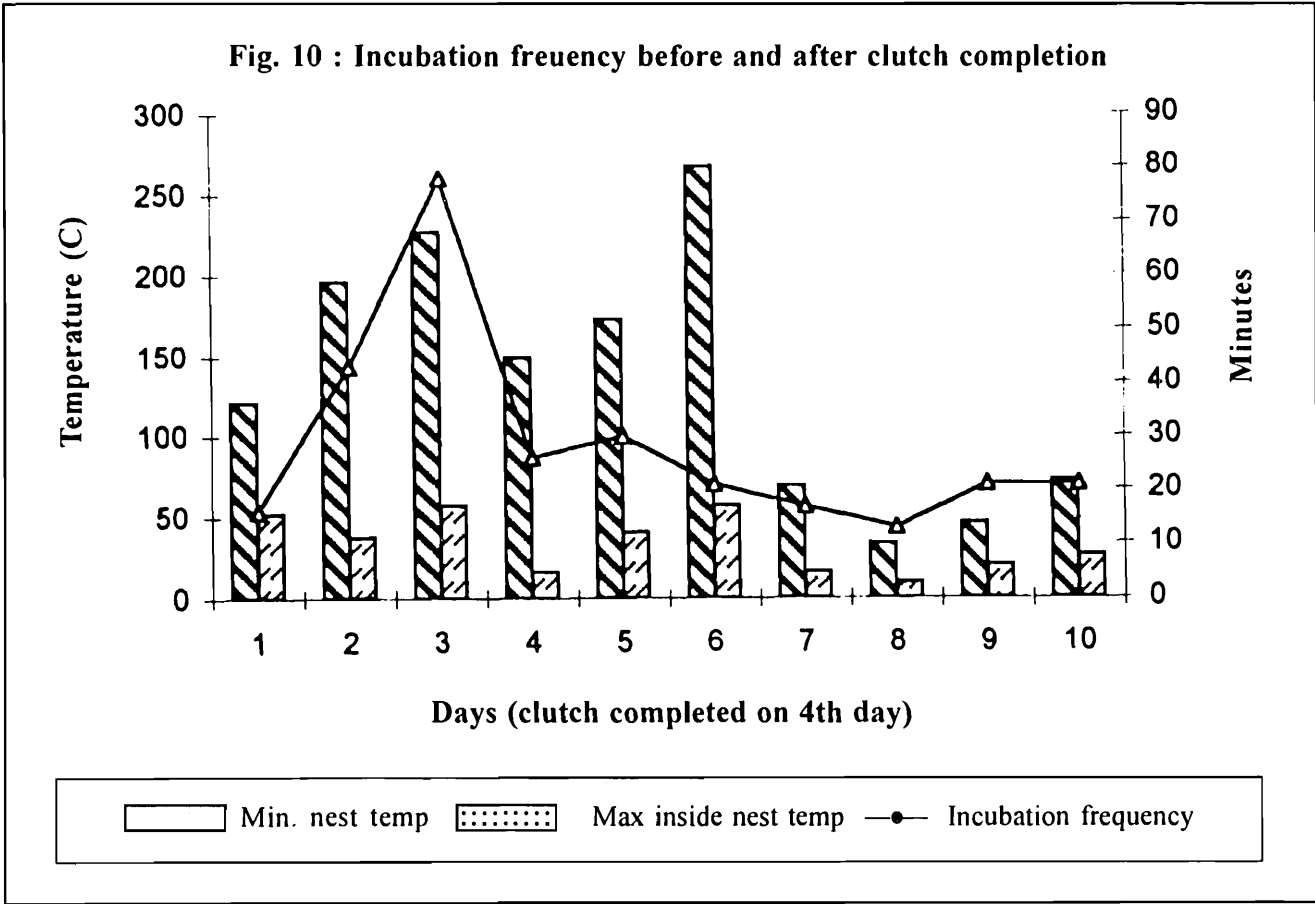
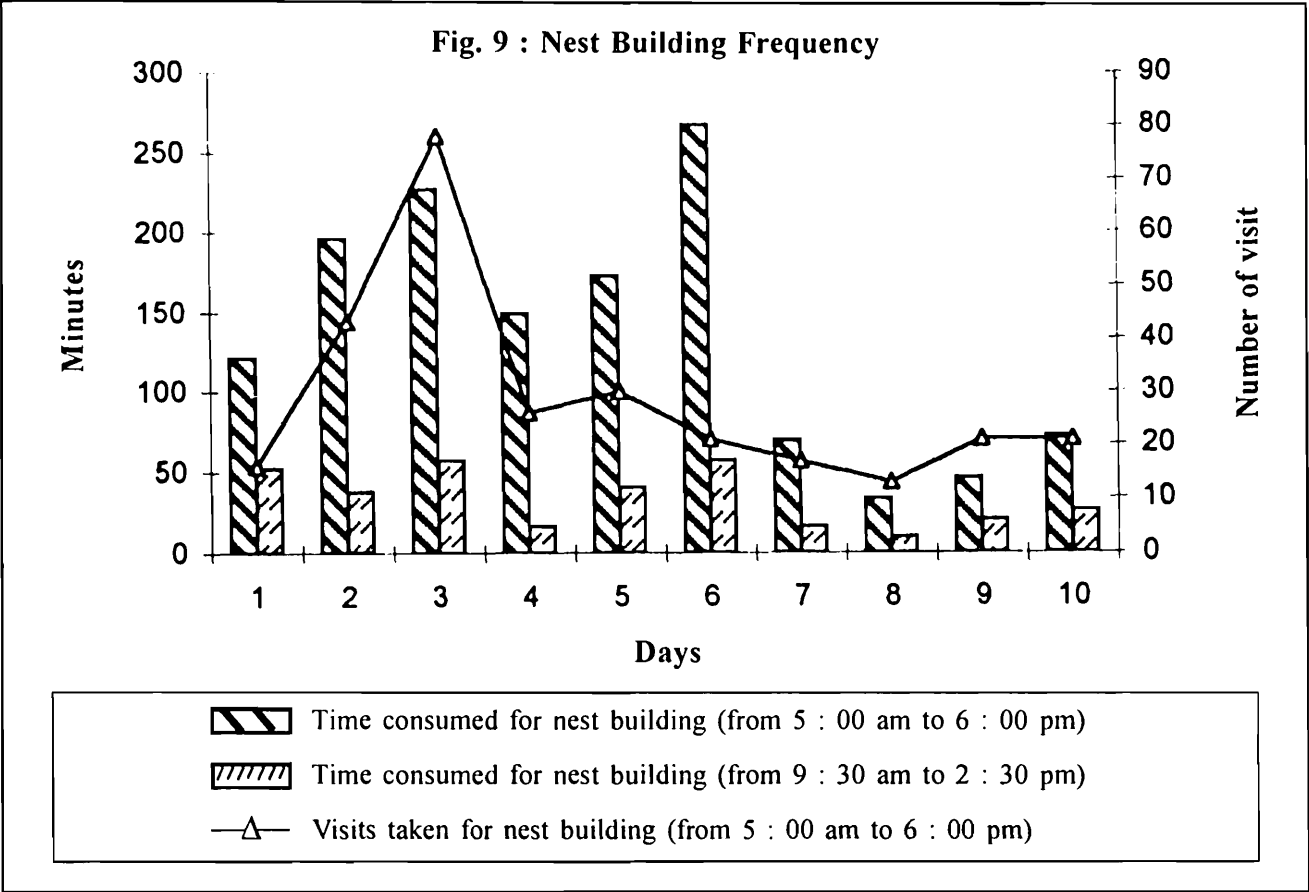
50 feet " 1 " I

131 " " 1 " II

148 " " 1 " III

149 " " 1 " IV

Fig. 8. Nest material collection sites of *Prinia subflava*. Nest under consideration—Nest No : 1. Observation : 12. 4. 99 to 17. 4. 1999.



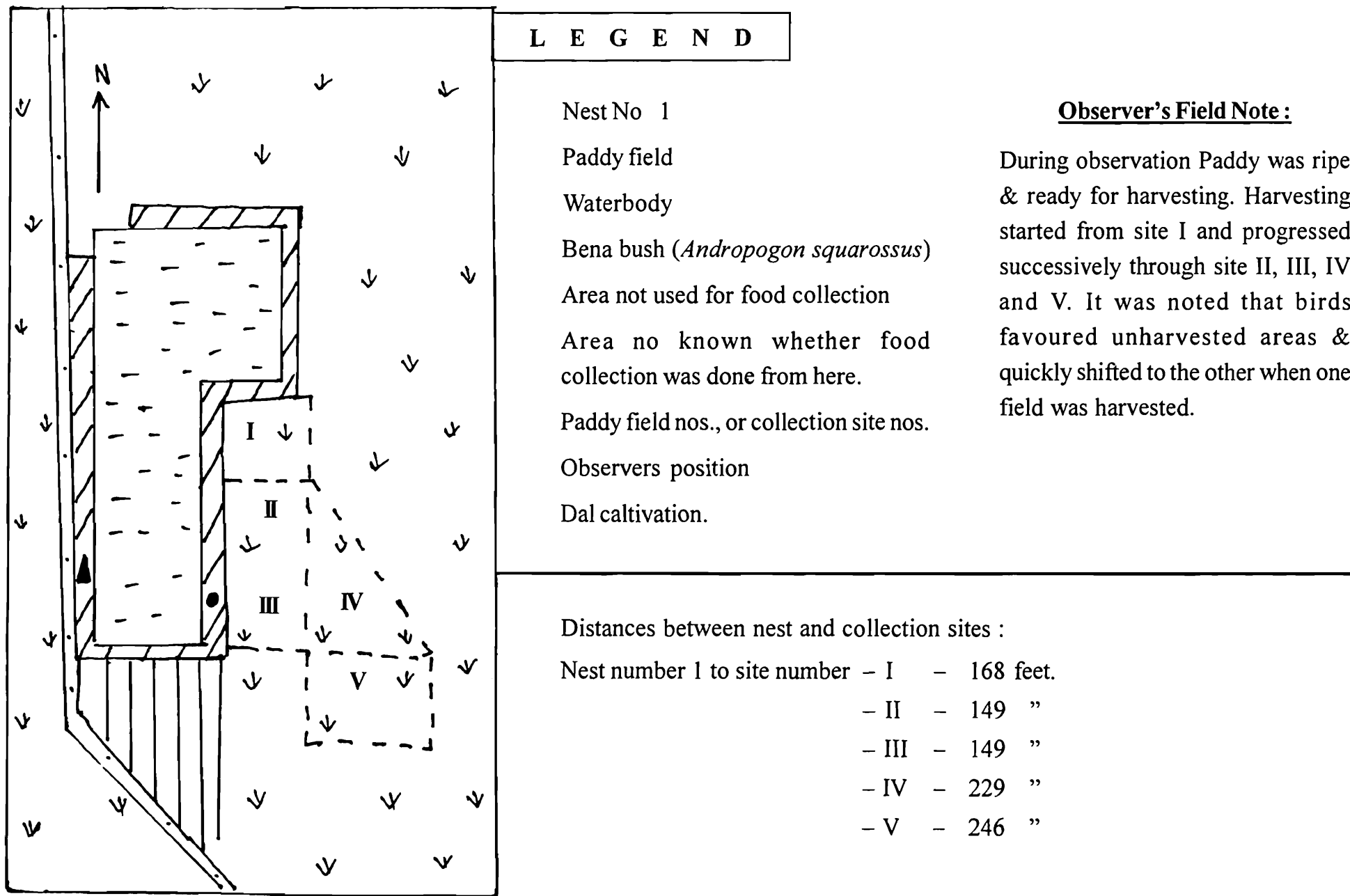


Fig. 11. Food collection site for Nestling Feeding of *Prinia subflava*.

Nest under consideration – Nest No : 1. Location – Ramchandrapur Village, South 24 Parganas.

Date of observation – 2.5.1999 to 13.5.1999. Food collection by – Individual/Pair/Male/Female/Not known.

Figure : 12. % of used Nestling Food of *Prinia subflava*.

Serial No.	Food Items	Colours	Description & Size
1.	Fly or Bee	Black	Wings transparent
2.	<i>Modicogryllys confirmatus</i> (Orthoptera/Gryllidae)	Black & Brown	Pin like tail Antenna Prominent
3.	Unidentified	Green & Muddy	not known
4.	Moths	White & Brown	10 mm to 20 mm >
5.	Larvae	White & Green	5 mm to 8 mm
6.	<i>Pardosa</i> sp.	Green & Muddy	Roundish body with scattered legs
7.	Larvae	Yellow & Green	10 mm < to 30 mm ±
8.	Mealworm	Chocolate	Slender, Small
9.	Mud chips (?)	Muddy	Collected from the ground. Half sft. of that area from where the food was collected was devoid of any vegetation.
10.	<i>Atractomorpha</i> sp. (Orthoptera/Pyrgomorphidae)	Brown & Green	10 mm to 40 mm±

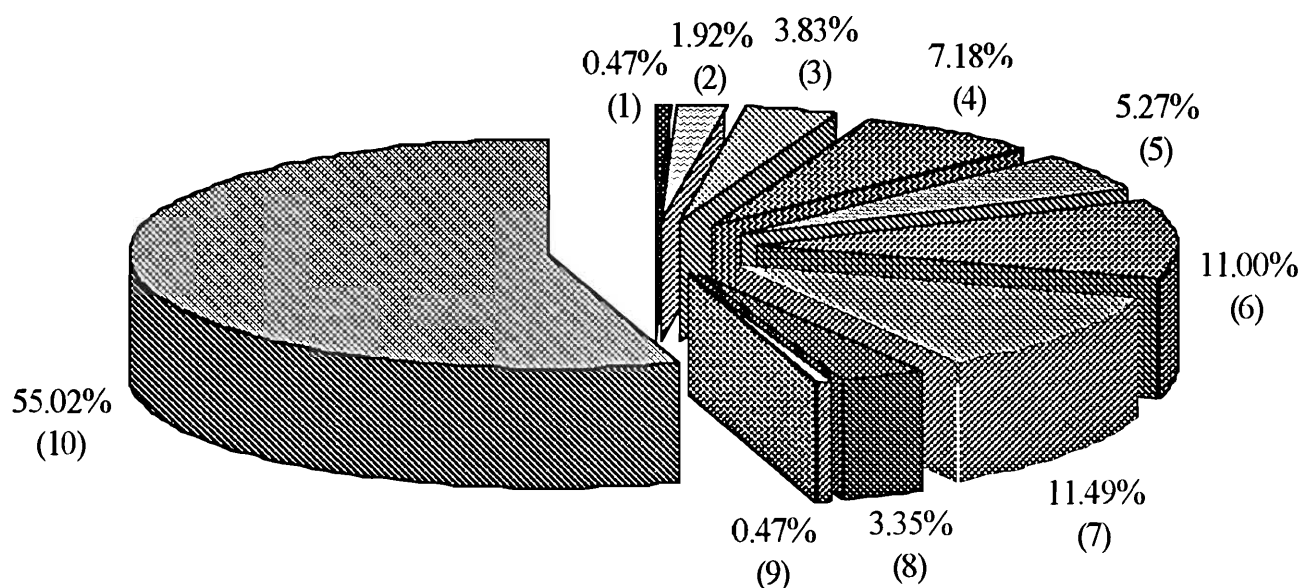


Figure 13. Feeding frequency of *Prinia subflava* nestling (During the hottest period of the day).

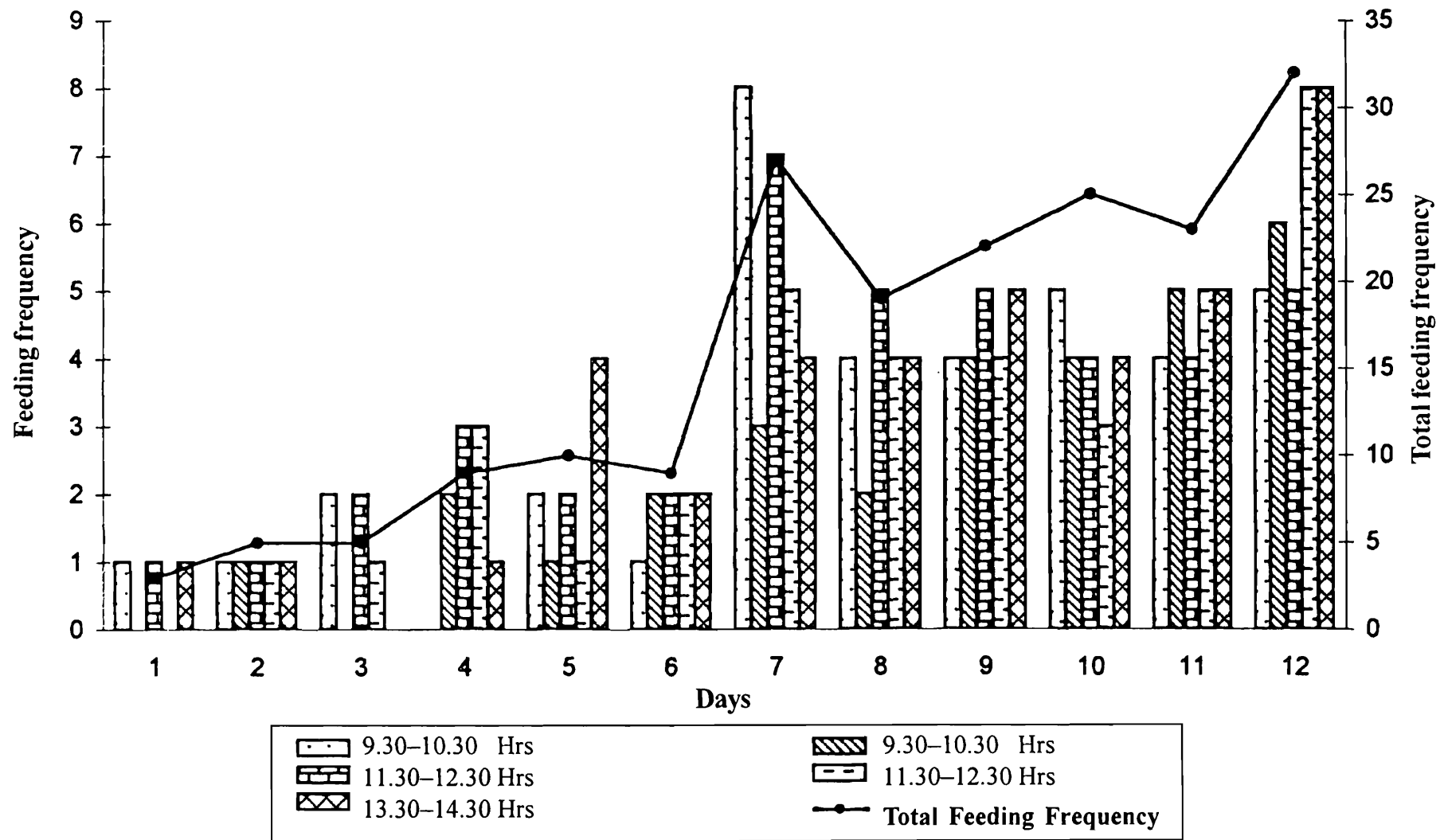


Fig. 13. Feeding frequency of *Prinia subflava* nestling (During the hottest period of the day).

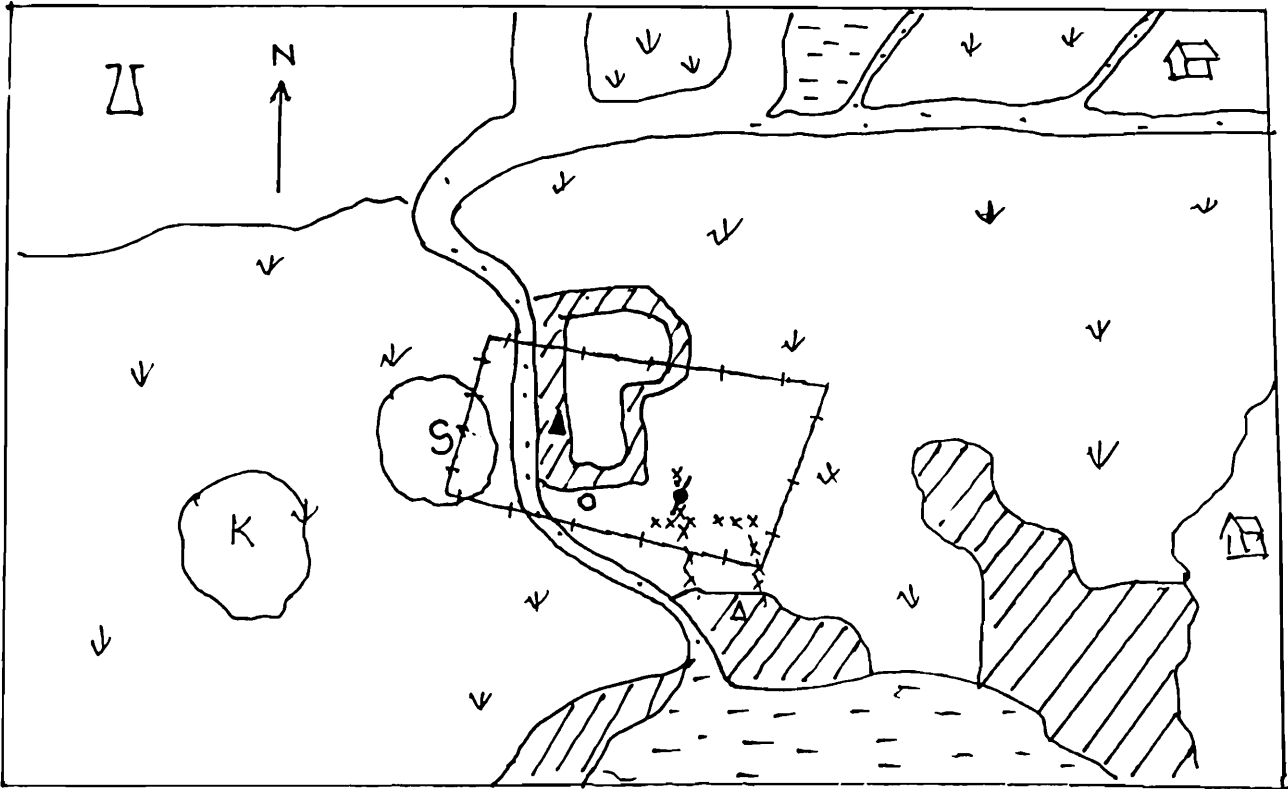


Fig. 14. Territory of *Prinia subflava* during nestling feeding period in Summer.

For Legend see Table : 10

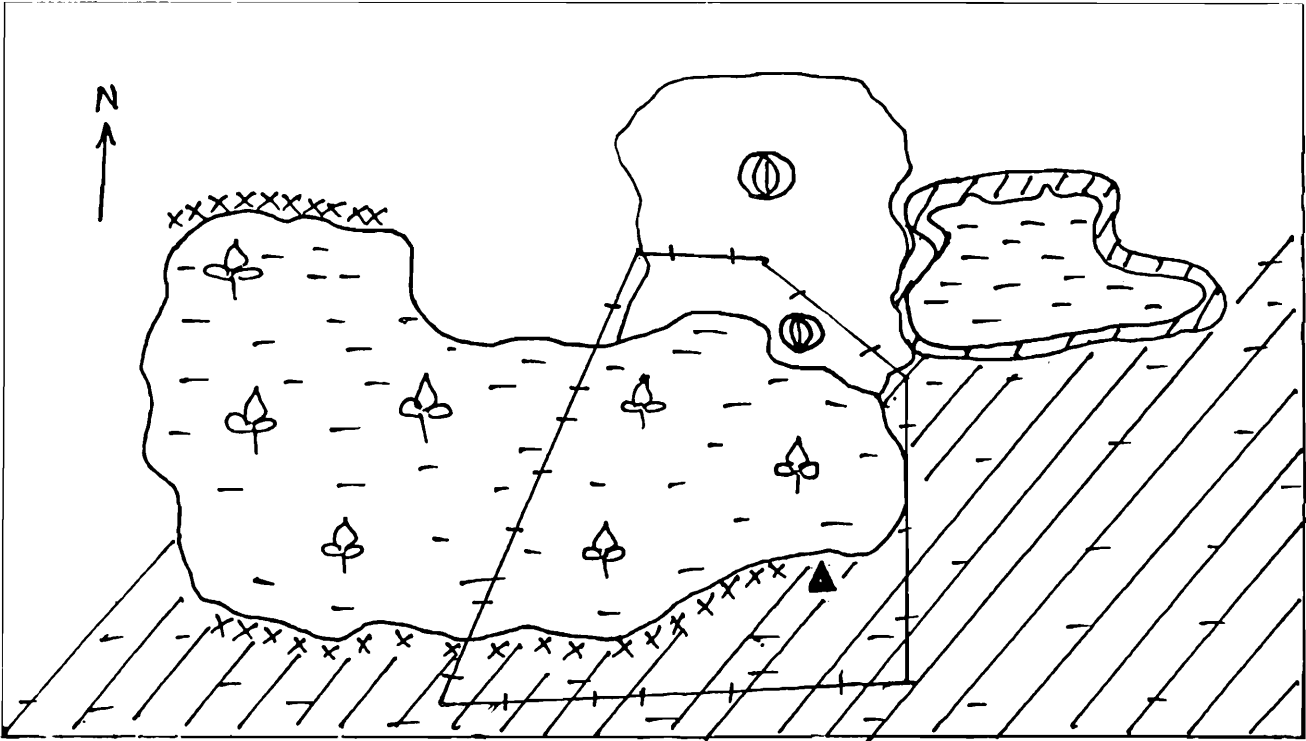


Fig. 15. Territory of *Prinia subflava* during nestling feeding in Post Summer season.

For Legend see Table : 10

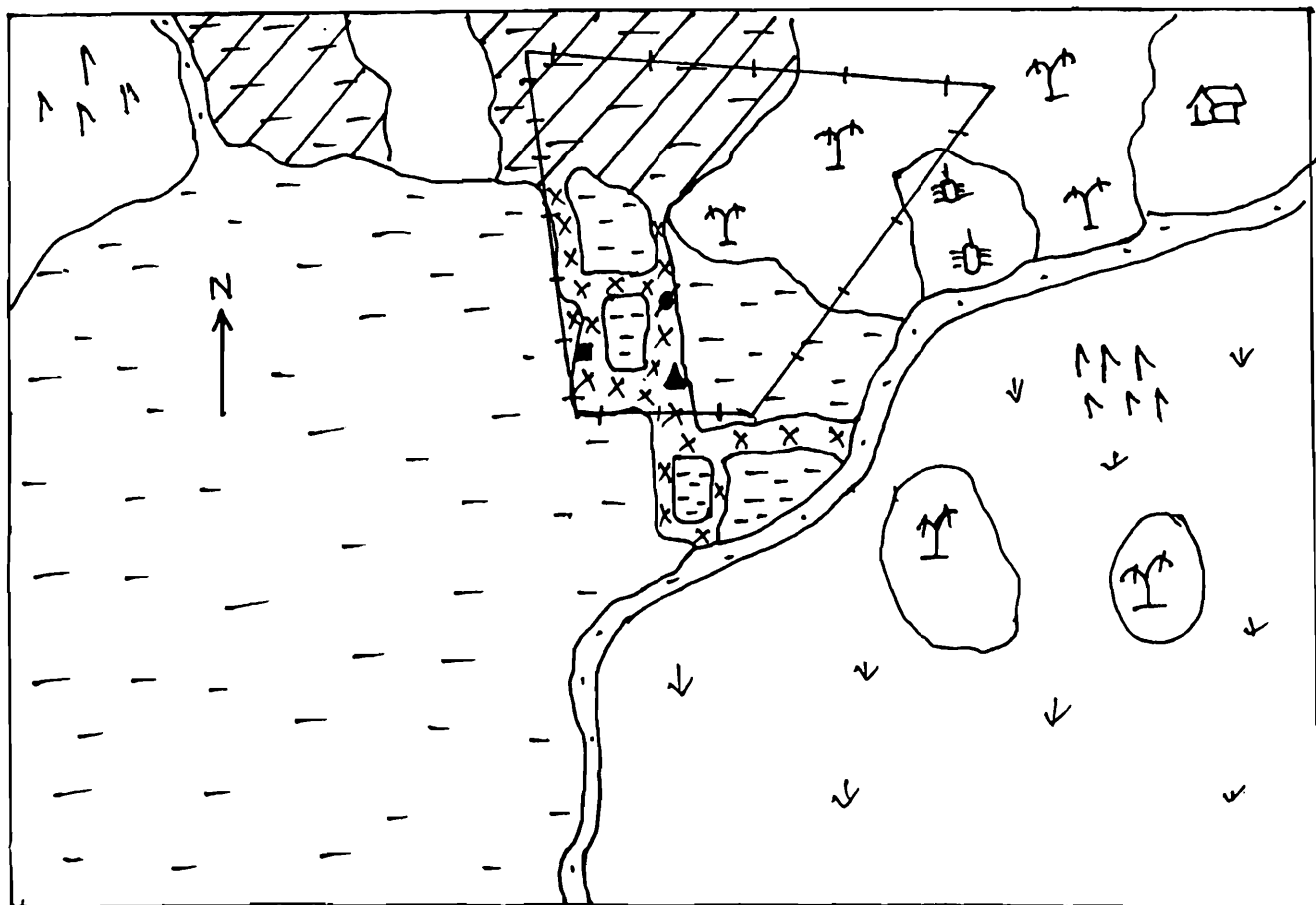


Fig. 16. Territory of *Prinia subflava* during nestling feeding in Monsoon season.

For Legend see Table : 10

PLATE I

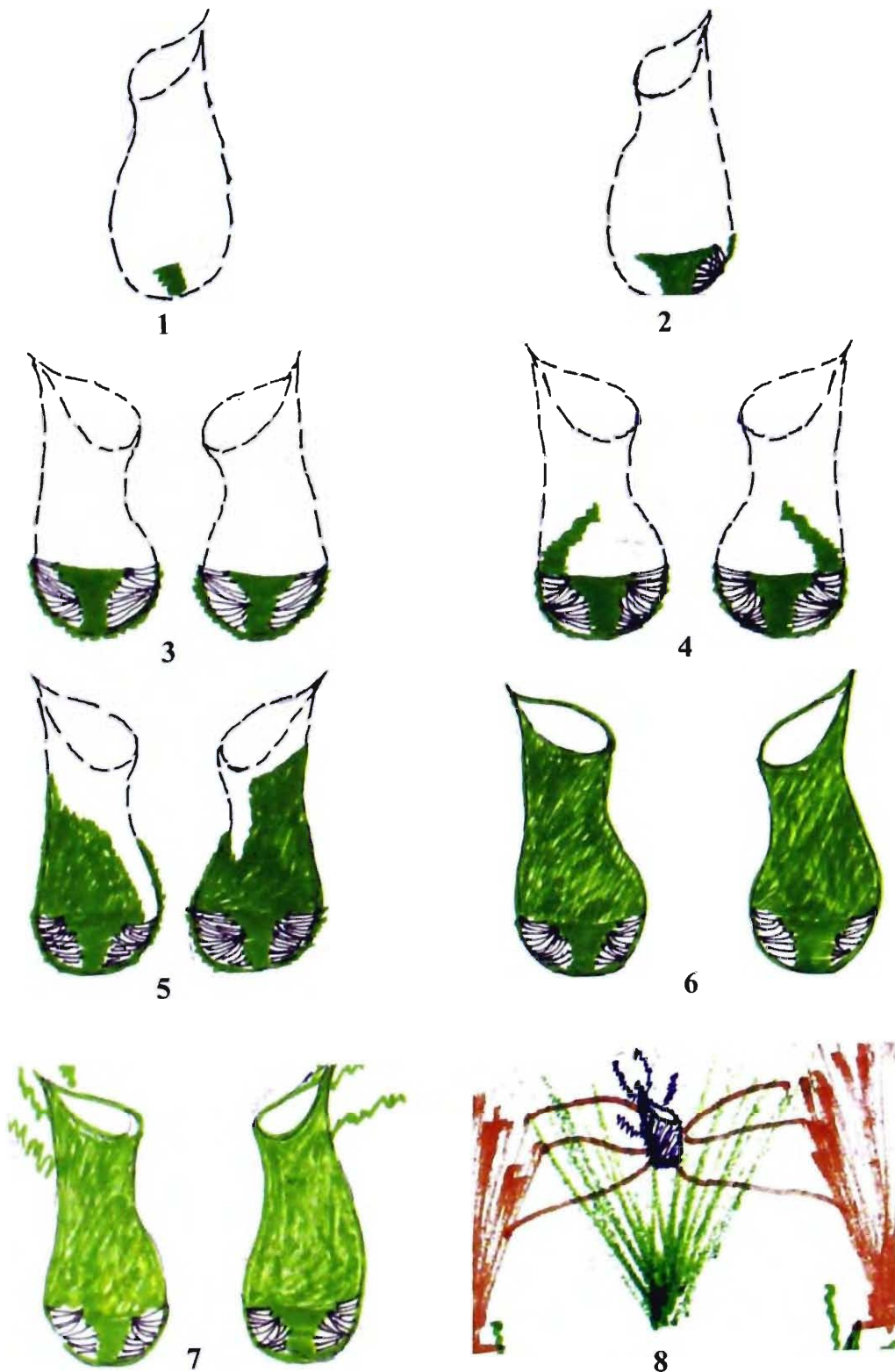


Plate 1. Progressive account of the stages & mechanics of nest building of (*Prinia subflava*). Plain Wren Warbler, at Ramchandrapur village, South 24 Pgs.

Colour Index : Green—Nest Material, Nesting bush (for no : 8)

Orange—Supporting bush.

Black lines—Nest material used for the floor area, black lines showing pattern of stitching.

PLATE II & III



Fig. 2. Plain Wren Warbler (*P. subflava*) nest constructed in Bhut-beurey (*Lippia geminata*) bush.

Fig. 3. Nesting habitat of Plain Wren Warbler (*P. subflava*) along a waterbody. The first author is seen in work.

DIVERSITY OF FRESHWATER MACRO-INVERTEBRATE COMMUNITIES ASSOCIATED WITH MACROPHYTES

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INTRODUCTION

Floating and submerged macrophytes in freshwater lakes, reservoirs and ponds, besides playing important roles in the energy dynamics of the ecosystem, also provide shelter to a large number of invertebrate species. It has been reported that the species diversity of macro-fauna associated with submerged plants is significantly greater than those of benthos. While detailed studies on the diversity and density of such communities have been carried out in different parts of the world (Rosine, 1955; Harrod, 1964; Soszka, 1975; Junk, 1976; Rook, 1984; Scheffer *et al.*, 1984; Chilton *et al.*, 1986; Schramm, *et al.*, 1987; Kornijow, 1989 and Kornijow and Gulati, 1992), and the knowledge so obtained has been employed to formulate management strategies for biomanipulation, in India, practically very little attention has been given to this community specifically, as most of the earlier works on such lines deal with general macrobenthos of freshwaters (Srivastava, 1956; Krishnamurthy, 1966; Dev *et al.*, 1993; Mandal and Moitra, 1975; Raman, *et al.*, 1976; Gupta, 1976; Misra *et al.*, 1981; Gupta and Pant, 1983 and Barbhuiyan and Khan, 1992). The earlier attempt in this direction is mainly confined to the works of Michael (1968) on a fishpond in Bengal, Sarma *et al.*, (1975) on ponds of Vishakhapatnam and Sarma *et al.* (1983) on Dal Lake of Kashmir.

The present report, which is a part of the detailed studies on the structure and dynamics of aquatic fauna in some lakes and ponds of southern West Bengal, deals with the species diversity, community structure, numerical density and biomass of macro-invertebrate fauna associated with submerged and floating vegetation in a large man made lake and a medium sized pond of Calcutta, with the analyses of species diversity and the extent of similarity between the two wetlands.

MATERIAL AND METHOD

1. Description of the study area :

The large man made lake, Rabindra sarovar (lake) situated in the southern part of the city of Calcutta, is meant chiefly for recreational purpose. It was constructed some 70 years ago. The main lake is elongated in shape and covers an approximate area of 72 acres. Its maximum length is about 1776 m and width at broadest point is 286 m. Depth varies between 9.3 and 10.5 m. It is mainly fed

by rain water during monsoon. The lake contains abundant macrophytes belonging to several species. Four sampling stations covering the entire lake on northern side were fixed.

The Manohar Das Pukur (Pond) is a medium sized pond situated in the heart of the city. This is also meant for recreational/aesthetic purposes but due to excessive and undesirable use by surrounding human population of the metropolis, it has become highly polluted. During the period of investigation, the pond was completely filled up by monospecific strand of water hyacinth, *Eichhornia sp.* Two sampling stations one on northern end and the other on southern end were fixed. The detail description of these two water bodies has already been given (Khan, 1979).

Sampling and analyses :

The studies were carried out for three consecutive years, 1994-95, 1995-96 and 1996-97 during different seasons. The seasons were defined as Pre-monsoon (PRM, March to June), Monsoon (MON, July to October) and Postmonsoon (POM, November to February). All data were pooled under these three seasons. The samples were collected from all stations with a hand net of the size of 50 cm x 50 cm from littoral zone only. A wooden frame of this size was attached to a large net made up of fine malma cloth with mesh size of approximately 200 μ . The net was fixed on a long pole. The design and operation of the net was roughly based on those described by Junk (1977). For collection of fauna, the net was slowly pushed upside down to the bottom of littoral zone and quickly lifted after turning the mouth of the net. After pulling the net near the shore, the vegetation projecting outward from the marginal area of the net frame, were cut off. The distance from the bottom to surface which ranged between 100 and 125 cm, was measured and total area covered by the net was calculated. Three replicate samples from each of the four stations of lake and two of pond were collected.

The macrophyte leaves and roots were then washed thoroughly several times in the net itself, removing all attached faunas manually from each strand with the help of a magnifying glass. The contents of the net as well as macrophytes were again washed on a sieve of 0.5 mm and all fauna retained on the sieve were collected. Animals were first killed or narcotized slowly by putting few drops of 5% formaldehyde solution and then preserved in either in 70% alcohol or 5% formalin. The animals were then sorted out into different taxonomic groups and identified up to lowest possible taxon under low powered stereo binocular microscopes. Enumeration and size measurements were carried out simultaneously. For biomass determination, the wet weight of several individuals of each species were taken after broadly dividing into various size groups and mean individual weight of each species was worked out. For dry weight biomass, the animals were dried for 3 days at 65°C. and weighed. This was done only once in the beginning.

The chemical analysis of water were carried out as per Standard Methods (APHA, 1975). The water samples were collected only from littoral zone. The temperature and pH were determined with electronic probes (HANA, Japan) and light penetration (transparency) by Secchi disc.

Measurement of Diversity :

The number of species, density of individual species and total macrofaunal density were used to compute following diversity indices :

1. **Species Richness** : Total number of species recorded from a water body over the entire period of study.
2. **Menhinick's Index** : $S/\sqrt{N}$ (Menhinick, 1964)
3. **Margalef's Index** : $\frac{S-1}{\log N}$ (Margalef, 1951)
4. **Simpson's Measure of Diversity** : $D = 1 - \frac{N_i(n_i - 1)}{N(N - 1)}$
5. **Shannon-Weiner Index** : $H = -\{n_i/N \log_2 n_i/N\}$ (Shannon-Weiner, 1949)
6. **Evenness** : $J = \frac{H}{H_{\max}}$ (Pielow, 1969)

S = total number of species, N = total density, n_i = density of individual species

Similarity Analysis :

Qualitative : $C \times 100 / A + B - C$ (Greig-Smith, 1964)

A and B are number of species in two waterbodies and C is the number of species common to both.

Quantitative : $S = \frac{W}{a + b - c}$ (Romaniszyn, 1970)

W = sum of density minima of each species irrespective of waterbody and a and b are sum of total densities of all taxa in waterbody A and B respectively.

RESULTS

1. Physico-chemical characteristics of water :

The variations in physico-chemical characteristics of the two wetlands are shown in Table 1. The seasonal mean values of water temperature varied very little in the two wetlands and ranged between 22.5 and 32.0°C in lake and between 22.5 and 32.5°C in the pond, lowest during premonsoon and highest in monsoon. Transparency values differed considerably between lake and pond, it was always higher in lake than in pond. Monsoon season was characterized by lowest values in both, lake and pond. While the range of pH was much different in the two systems, it fluctuated very narrowly between seasons. Considerable variations occurred in dissolved oxygen contents of the two wetlands during different seasons. The DO content was lower in pond throughout the year than the lake. Further, the periods of maxima and minima also differed significantly. While the lowest

values were observed during monsoon in lake, premonsoon was the period of minimal DO concentration in pond. While the chlorides were considerably high in pond as compared to lake, its total alkalinity contents were significantly low.

Table 1. : Physicochemical characteristics water in the two wetlands.

Parameters	Lake (Rabindra sarovar)			Pond (Manohar das pond)		
Water Temperature °C	32.0	31.5	23.5	32.5	30.5	22.5
Transparency (cm)	40.0	22.5	45.0	30.0	25.0	36.5
PH	8.0	7.5	7.8	8.5	7.9	8.3
Dissolved Oxygen (mg/l)	7.0	6.5	7.8	6.5	6.0	6.8
Alkalinity (Total) (mg/l)	210.0	195.0	180.0	310.0	160.0	270.5
Chloride (mg/l)	80.5	70.0	76.4	95.0	60.0	65.0

2. Macrophytes :

The lake harbored a variety of floras (Table 2). Seventeen commonly occurring species were recorded which included 11 species of floating forms and 6 of submerged forms. The free floating forms were represented mainly by *Pistia sp*, *Lemna sp*, *Utricularia sp*, and *Wolffia sp*. The submerged hydrophytic genera like *Chara*, *Ceratophyllum*, *Vallisneria*, *Naja*, and *Hydrilla* were of common occurrence. *Ceratophyllum sp*. dominated the submerged macrophyte community quantitatively. At several points its monospecific strands were recorded. Among rooted plants, *Typha sp* was recorded at several places. The condition of pond was entirely different. This was completely filled up by monospecific strands of water hyacinth, *Eichhornia sp*.

3. Faunal diversity :

Altogether 49 commonly occurring taxa of macrophyte associated macroinvertebrate fauna were recorded during the period of study from the two wetlands (Table 3). These belonged to Mollusca : Gastropoda (11 species) Oligochaeta (2 species) and Hirudinea (3 species), Hydroacarina (2 species) Crustacea : Decapoda (3 species) Odonata (6 species), Hemiptera (8 species), Coleoptera (10 species) and Diptera (4 species). Gastropods were represented by the largest number of taxa followed closely by Coleoptera and Hemiptera (Fig. 1).

Wetland wise, the faunal diversity was considerably high in lake throughout the period of investigation, where 43 species were recorded, but it was significantly low in pond where only 25 species were noticed. Many of the species were common to both wetlands. Out of 25 species that

Table 2. : List of Macrophyte taxa recorded from Rabindra Sarovar.

FLOATING	SUBMERGED
Rooted floating Family : Nymphaeaceae <i>Nymphaea sp.</i> <i>Nymphoides indicum</i> Family : Scrophularineae <i>Limnophila sp.</i>	Rooted Submerged Family : Characeae <i>Chara sp.</i> Family : Hydrochorideae <i>Hydrilla sp.</i> <i>Vallisneria sp.</i>
Free Floating Family : Aroideae <i>Pistia sp.</i> Family : Lemnaceae <i>Lemna sp.</i> <i>Spirodella sp.</i> <i>Wolffia sp.</i>	Family : Najadaceae <i>Najas sp.</i> Free submerged Family Lentibullariaceae <i>Utricularia sp.</i>
Family : Onagraceae <i>Trapa sp.</i> Family : Pontederiaceae <i>Eichhornia sp.</i> Family : Salviniaceae <i>Azolla sp.</i> Family : Hydrocharidae <i>Hydrocharis cellulosa</i>	Family : Ceratophyllaceae <i>Ceratophyllum sp.</i>

occurred in pond, 17 also occurred in the lake. However, lake harboured many more species, which were never recorded from the pond. The Decapoda was totally absent from the pond and Hydroacarina and Hirudinea were recorded in small numbers. The common fauna belonged mainly to gastropoda (4 species), oligochaeta (both species), Diptera (all 4 species), Hemiptera (4 species) and Odonata (3 species). It may be seen that all the species of oligochaeta and Diptera (Chironomidae and Culicidae) were represented in both wetlands (Table 3) and except these two groups, significant differences were recorded in the faunal diversity of the two wetlands. In fact all taxa occurring in the pond were the most abundant aquatic fauna of this region, which have fully adapted to all types of freshwaters, including the highly polluted ones.

Highest number of species was recorded during postmonsoon in both wetlands. Marked seasonal variations were recorded in the species richness of the lake, where number of species decreased

considerably during monsoon months (Fig. 1). However, the seasonal impact on the pond fauna was not severe, as the reduction in the number of species was not very significant.

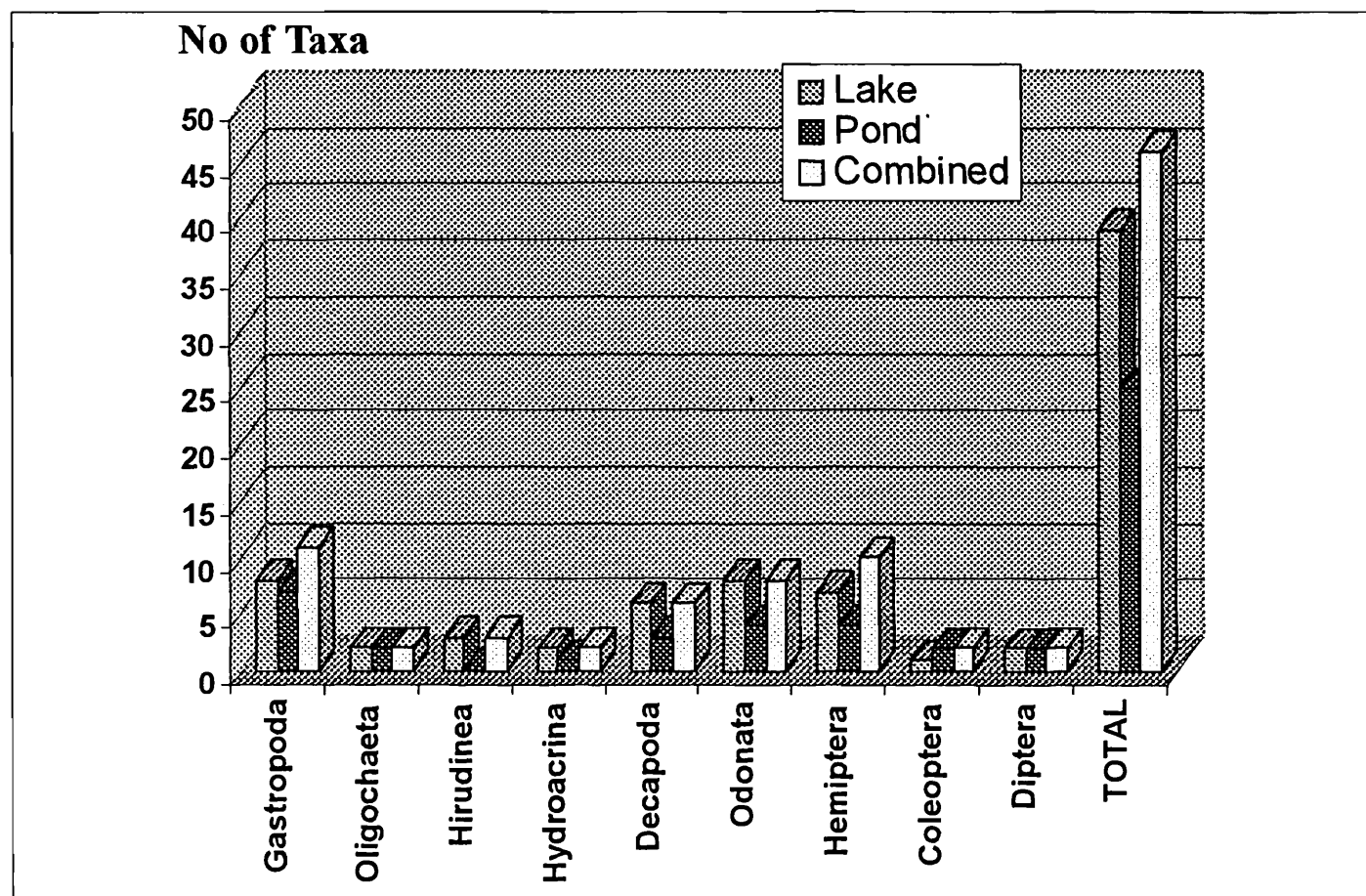


Fig. 1. Number of taxa of each group in the two wetlands and combined.

4. Density :

The total density of macrophyte associated macroinvertebrates varied between 3225/m² and 5993/m² with a mean of 4644.0 in lake and between 2198/m² and 6510/m² with a mean of 4344. In pond (Tables 4 and 5). Three groups, Oligochaeta, Gastropoda, and Diptera-Chironomidae formed the bulk of density in both, lake and pond. While total density in the two wetlands did not differ much, the contribution of individual groups varied greatly (Fig. 2). The contribution of oligochaetes was only 29.54% in lake but their share in pond was more than half (52.39%). Contrary to this the contribution of gastropod was considerably higher in lake (33%) than pond (7.5%). The dipteran larvae, especially chironomidae also contributed differently in the two wetlands. Variations were also recorded in other groups too.

Pronounced seasonal variations occurred in the density. In general lowest density in both the systems was observed during monsoon and highest in premonsoon. The high density during

Table 3. Occurrence of different species of Macrophyte associated macro-invertebrate during different seasons in the lake and pond. + Present, – Absent.

MACROINVERTEBRATE GROUPS		Lake (Rabindra Sarovar)			Pond (Monohar Das Pond)		
		PRM	MON	POM	PRM	MON	POM
MOLLUSCA- GASTROPODA							
Family : Bellamyidae							
<i>Bellamyia bengalensis</i> (Lamarck)		+	+	+	+	+	+
Family : Pilidae							
<i>Pila globosa</i> (Swainson)		–	–	–	–	–	+
Family : Bithyniidae							
<i>Gabbia orcula</i> Frauenfeld		+	+	+	–	–	–
<i>Digoniostoma cerameopoma</i> (Benson)		+	+	+	+	+	+
Family : Thiaridae							
<i>Thiara (Tarebia) granifera</i> (Lamarck)		+	–	+	–	–	–
<i>Thiara (Thiara) lineata</i> (Gray)		–	–	–	+	+	+
<i>Thiara (Melanoides) tuberculata</i> (Muller)		+	+	+			–
Family : Lymnaeidae							
<i>Lymnaea (P.) accuminata</i> Lamarck		+	–	+	–	–	–
<i>Lymnaea (P.) luteola</i> Lamarck		+	+	+	+	+	+
Family : Planorbidae							
<i>Indoplanorbis exustus</i> (Deshayes)		–	–	–	+	+	+
<i>Gyraulus convexiusculus</i> (Hutton)		+	+	+	+	+	+
ANNELIDA : OLIGOCHAETA							
<i>Branchiura sowerbyi</i> Beddart		+	–	+	+	–	+
<i>Limnodrillus hoffmeisteri</i> Claparede		+	+	+	+	+	+
ANNELIDA : HIRUDINEA							
<i>Glossophonia weberi</i> (Blanchard)		–	+	+	–	–	–
<i>Helobdella nociva</i> Harding		–	+	–	–	–	–
<i>Hemiclepsis marginata</i> Muller		–	+	+	–	+	–
HYDROACARINA							
<i>Arrenurus sp.</i>		+	–	+	–	–	–
<i>Hydrachna sp.</i>		+	+	+	+	+	+
CRUSTACEA : DECAPODA							
<i>Sartoriana spinigera</i> Wood-Mason		+	–	+	–	–	–
<i>Macrobrachium lamarrei</i> (H.M. Edwards)		+	+	+	+	–	–
<i>Macrobrachium dyanum</i> (Henderson)		+	–	+	–	–	–
INSECTA							
ODONATA							
Family : Coegrionoidae							
<i>Ceriagrion coromandelianum</i> Fabricius		–	+	+	–	–	–

<i>Pseudagrion microcephalum</i> Rambur		+	+	+	-	+	-
Family : Gomphidae							
<i>Ictinogomphus rapax</i> Rambur)		-	+	+	-	-	-
Family : Libellulidae							
<i>Brachythemis contaminata</i> (Fabricius)		+	+	+	-	+	-
<i>Crocothemis servilla</i> (Drury)		-	+	+	+	-	+
<i>Orthetrum sabina</i> (Drury)		+	+	+	-	-	-
HEMIPTERA							
Family : Corixidae							
<i>Micronecta scutellaris</i> (Stal)		+	-	+	-	-	-
Family : Notonectidae							
<i>Anisops bouvieri</i> Kirkaldy		+	+	+	-	+	+
Family : Nepidae							
<i>Ranatra filiformis</i> Fabricius		+	-	+	-	-	+
Family : Belostomatidae							
<i>Diplonychus annulatum</i> (Fabricius)		+	+	+	+	+	+
Family : Mesoveliidae							
<i>Mesovelia vittigera</i> Horvath		-	-	+	-	-	-
Family : Hydrometridae							
<i>Hydrometra Vittata</i> Stal		+	-	+	-	-	-
Family : Gerridae							
<i>Limnogonus (L.) fossarum</i> (Fabricius)		+	+	+	+	+	+
<i>Limnogonus (L.) nitidus</i> (Mayr)		+	-	+	-	-	-
COLEOPTERA							
Family : Dystiscidae							
<i>Hydrocoptus subvittulus</i> Motschhulsky		-	-	-	+	+	+
<i>Canthydrus laetabilis</i> (Walker)		+	-	+	-	-	-
<i>Laccophilus anticatus</i> Sharp		+	-	+			-
<i>Guignotus flammulatus</i> (Sharp)		-	-	-	+	-	+
Family : Gyrinidae							
<i>Dineutus indicus</i> Aube		+	+	+	-	-	-
Family : Halipidae							
<i>Halipus angustifrons</i> Regimbart		-	-	+	-	-	-
Family : Hydrophilidae							
<i>Helochaeres ancholaris</i> Sharp		-	-	-	+	+	+
<i>Hydrophilus rufocinctus</i> (Bedel)		+	-	+	-	-	-
<i>Sternolophus rufipes</i> (Fabricius)		+	-	+	+	-	+
<i>Amphiops pedestris</i> Sharp		+	-	+	-	-	-

DIPTERA : CHIRONOMIDAE							
<i>Chironomus sp.A</i>		+	+	+	+	+	+
<i>Chironomus sp. B</i>		-	-	-	+	+	+
DIPTERA : CULICINAE							
<i>Culex sp</i>		+	+	+	+	+	+
<i>Anophles sp.</i>		+	+	+	+	+	+
TOTAL NO. OF SPECIES	49	33	25	41	22	19	23

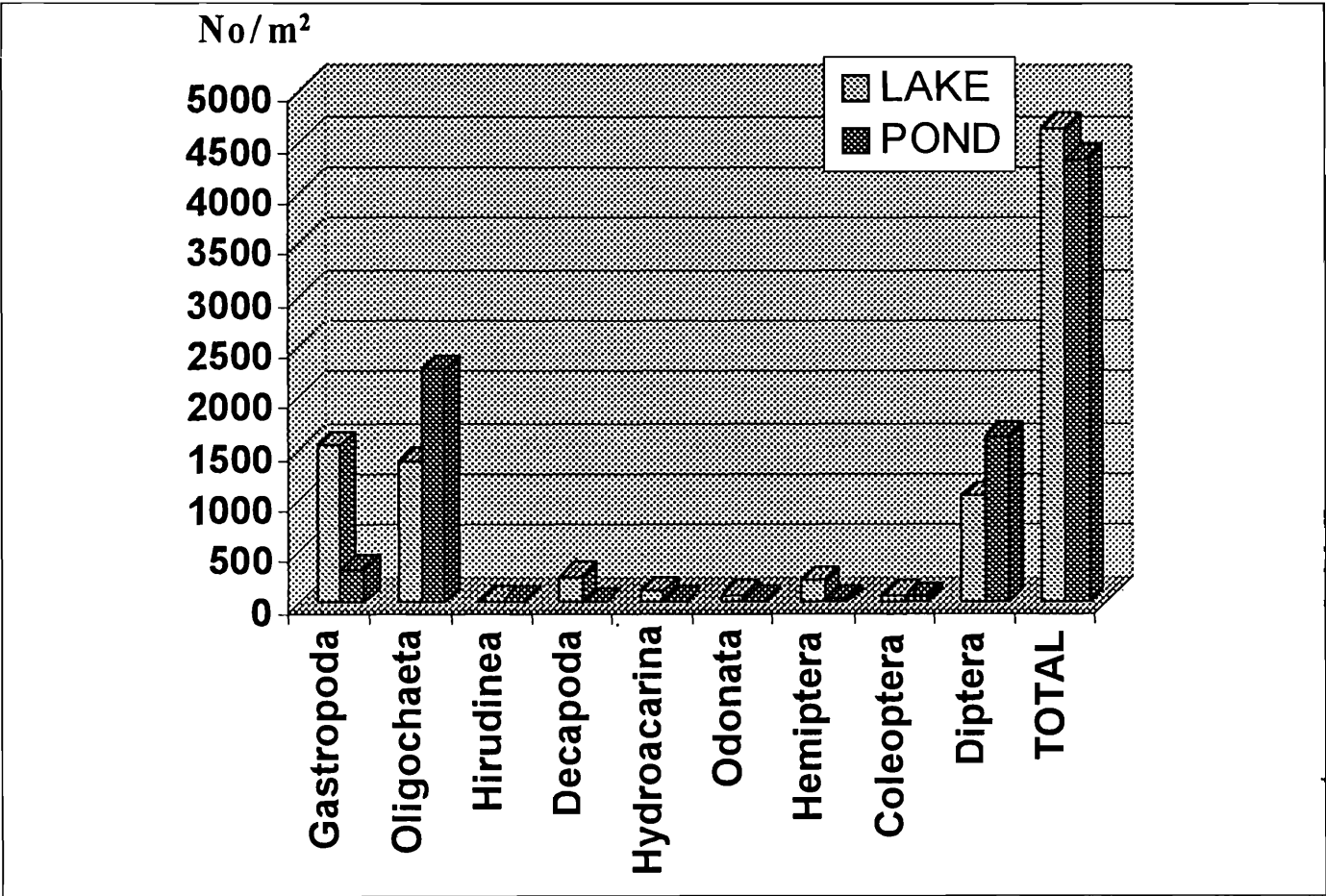


Fig. 2. Mean density of different groups of macrophyte associated macroinvertebrates in the two wetlands.

premonsoon was contributed mainly by extraordinary increase in the population of oligochaetes and chironomids (Tables 4 and 5).

5. Biomass :

The dry weight biomass of the macrophyte associated macroinvertebrates in the two wetlands varied from 174.8 g/m² to 244.5 g/m² with a mean of 174.8 g/m² in lake and from 69.0 g/m² to 201 g/m² with a mean of 130 g/m² in pond (Tables 6 and 7). The contribution of gastropods was highest

Table 4. : Seasonal variations in the density of macrophyte associated macroinvertebrate fauna in lake.

GROUP	PRM	MON	POM	MEAN	PERCENT
	Number per square meter				
Oligochaeta	2080.5	795.5	1240.5	1372.20	29.54
Hirudinea	15.0	23.0	0.0	8.16	0.18
Decapoda	65.0	397.5	276.2	246.20	5.30
Odonata	52.5	60.0	90.0	67.50	1.45
Hemiptera	80.0	420.0	114.5	204.66	4.40
Coleoptera	63.5	99.0	38.5	67.00	1.40
Diptera	1608.5	448.5	1056.0	1037.70	22.40
Hydroacarina	75.0	15.5	235.0	108.33	2.33
Gastropoda	1967.0	966.5	1664.0	1532.00	32.99
TOTAL	5993.5	3225.5	4714.7	4643.70	

Table 5. : Seasonal variations in the density of macrophyte associated macroinvertebrate fauna in pond.

GROUP	PRM	MON	POM	MEAN	PERCENT
	Number per square meter				
Oligochaeta	3420.0	1055.0	2352.5	2276.00	52.39
Hirudinea	2.5	17.5	5.0	8.30	0.19
Odonata	5.0	23.0	10.0	12.70	0.29
Hemiptera	32.5	17.5	41.0	30.40	0.70
Coleoptera	26.7	115.0	23.5	55.06	1.26
Diptera	2641.0	820.0	1410.0	1624.00	37.38
Hydroacarina	17.5	–	12.5	10.00	0.23
Gastropoda	365.0	150.0	468.0	327.70	7.54
TOTAL	6510.2	2198.0	4322.5	4344.50	

in both wetlands (Fig. 3). Their contribution to biomass was markedly higher in comparison to their numerical density. It may be seen that in pond while the share of their numerical density was only 7.54%, the contribution to biomass was 27.47%. In lake they contributed to nearly 65% of total biomass as compared to density contribution of 33%. The oligochates and chironomids, inspite of their considerably high densities, contributed very little to the biomass in both wetlands (Fig. 3).

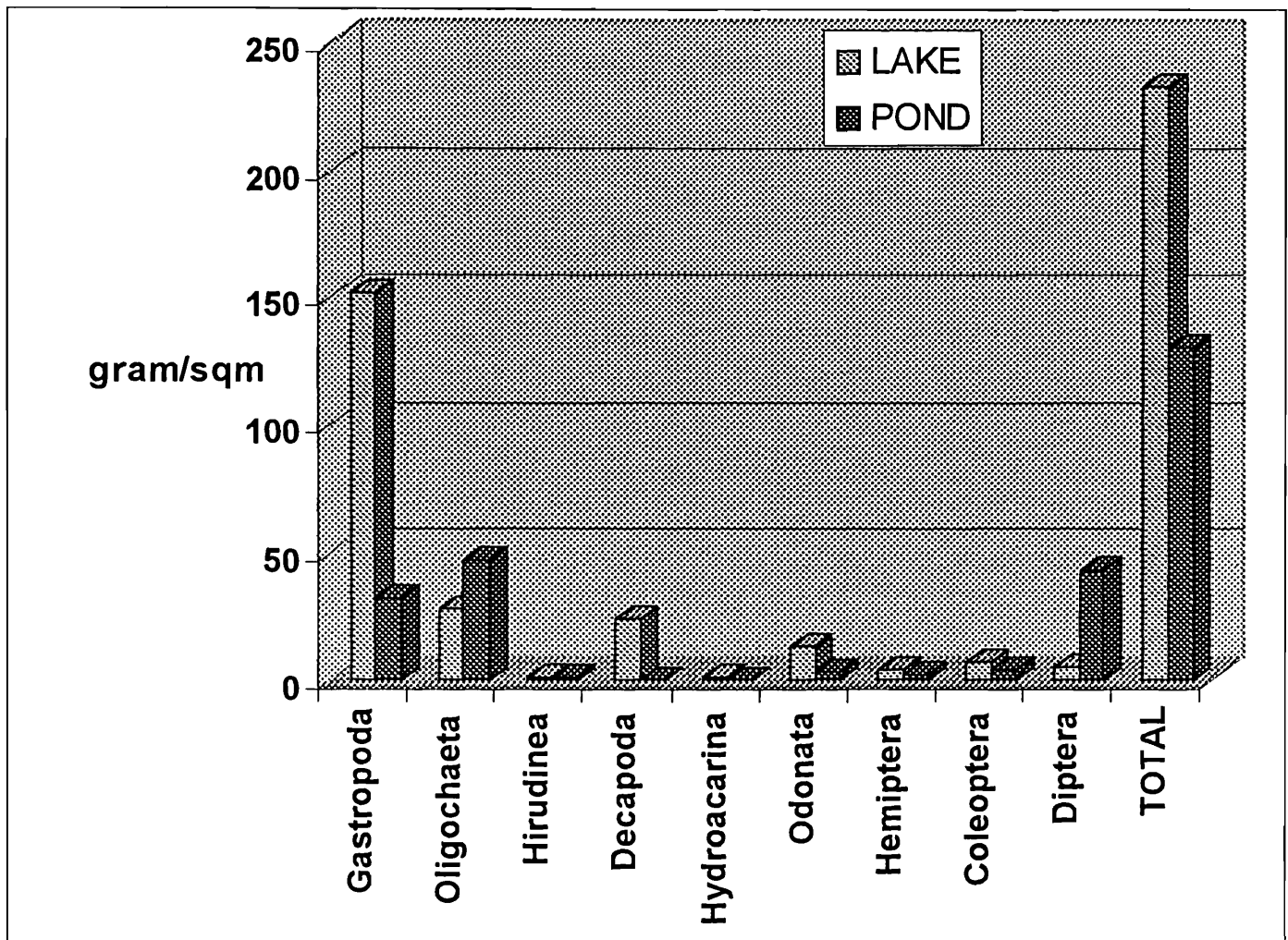


Fig. 3. Mean Biomass of different groups of macrophyte associated macroinvertebrates in the two wetlands.

The seasonal variations in the biomass followed the pattern of density, highest during premonsoon and lowest in monsoon (Tables 6 and 7)

6. Density : Biomass ratio :

Distinct variations were recorded in the density biomass ratio of macrophyte associated macroinvertebrates in the two wetlands. The ratio was considerably higher in lake than in ponds in all seasons. While the values ranged between 0.0469 and 0.5420 with a mean of 0.0502 in lake these were 0.0278 and 0.0314 with a mean of 0.0299 in pond. While highest values were observed during monsoon in both wetlands, the periods of lowest ratio was different, which were premonsoon in lake and postmonsoon in pond (Tables 6 and 7).

7. Diversity and Similarity indices :

Table 8a shows the values of various diversity indices applied. While the values of different indices varied according to their characteristics, it was clearly visible that all of these gave similar

information, excepting a slight deviation noted in case of Menhinick's index. These indices revealed that faunal diversity was considerably higher in lake than pond.

Table 6. : Seasonal variations in the biomass of macrophyte associated macroinvertebrate fauna in lake.

GROUP	PRM	MON	POM	MEAN	PERCENT
	Gram per square meter				
Oligochaeta	43.06	16.46	25.65	28.39	12.16
Hirudinea	0.11	1.80	–	0.64	0.27
Decapoda	16.90	25.63	29.90	24.14	10.34
Odonata	8.82	14.02	16.83	13.22	5.66
Hemiptera	3.36	1.78	4.83	3.32	1.40
Coleoptera	6.64	10.29	3.99	6.97	3.00
Diptera	3.35	8.25	1.92	4.50	1.92
Hydroacarina	0.03	0.65	0.11	0.26	0.11
Gastropoda	198.75	95.93	161.23	151.97	65.10
TOTAL	281.02	174.81	244.46	233.42	
DENSITY : BIOMASS RATIO	0.0469	0.0542	0.5186	0.0502	

Table 7. : Seasonal variations in the biomass of macrophyte associated macroinvertebrate fauna in pond.

GROUP	PRM	MON	POM	MEAN	PERCENT
	Gram per square meter				
Oligochaeta	70.80	21.80	48.70	47.10	38.73
Hirudinea	0.21	1.99	0.42	0.87	0.58
Odonata	0.94	4.30	1.87	2.37	1.94
Hemiptera	1.36	0.73	1.72	1.27	1.04
Coleoptera	2.62	6.82	2.36	3.93	3.23
Diptera	88.10	18.00	22.20	42.80	26.94
Hydroacarina	0.08	0.00	0.05	0.05	0.04
Gastropoda	37.20	15.30	42.70	31.80	27.47
TOTAL	201.34	69.01	120.07	130.14	
DENSITY : BIOMASS RATIO	0.0308	0.0314	0.0278	0.0299	

Table 8a. :Mean value of different diversity indices of Macrophyte associated macro-invertebrate fauna in lake and pond.

Indices	Lake	Pond
Species Richness	27	18
Menhinick (Menhinick (1964))	0.2868	0.1965
Maargalef's (Margalef, 1957)	2.8600	1.8824
Simpson Measure of Diversity D (Pielow, 1969)	0.8356	0.6219
Shannon-Wiener diversity index ($\bar{H}$) Shanon and Weiner (1949)	2.8085	1.0922
Evenness (J) (Pielow, 1969)	0.6487	0.5002
Dominance Index D1 (Berger and Parker, 1970)	0.2400	0.5308
Dominance Index D2 (McNaughton, 1967)	0.4690	0.8358

The analyses of qualitative and quantitative similarity indices are given in Table 8b. There were marked differences in the values obtained by qualitative and quantitative indices. The qualitative index of Greig-Smith (1984), indicated comparatively larger extent of similarity between the lake and pond (33.33) but the quantitative index based both on number of species and their density found very little similarity between the two (6.48).

Table 8b. : Indices of similarity between lake and pond.

INDICES	Values
Greig-Smith (1964) Qualitative	33.33
Romanizyn (1970) Quantitative	6.48

DISCUSSION

The studies revealed significant differences in the diversity of macrophytes associated macroinvertebrate fauna in the two wetlands. The comparatively higher species richness of the lake can be safely related to a diverse macrophytic community consisting of 17 commonly occurring taxa. The significance of diverse macrophyte flora in the distribution of freshwater macro-invertebrate

fauna has been well documented (Pieczynska and Ozimek, 1976) and it has been stated that diverse flora are responsible for greater faunal assemblage and the establishment of stable communities, especially of insects (Boyd, 1971). The lower species diversity in the pond was mainly due to dense growth of the water hyacinth, *Eichhornea sp.*, which covered the entire pond and did not allow the other macrophytes to grow. The water hyacinths are known to survive well in extremely degraded (polluted/eutrophicated) waters.

Out of 49 taxa recorded during the course of present studies, only few were of regular occurrence contributing substantially to density and biomass in both wetlands. These included 5–6 species of gastropods, both species of oligochaetes and all the four species of Diptera. While other groups like crustaceans, odonates, hemipterans and coleopterans were represented by several species in the lake, their occurrence and abundance were extremely restricted in the pond. In fact these species of gastropods, oligochaetes and chironomids comprise the typical macroinvertebrate communities of highly polluted and eutrophic water bodies of the region. The oligochaetes and chironomids are well known to flourish in eutrophic or organically polluted waters and their increased density represent increasing levels of eutrophication. In pond, the oligochaetes and chironomids together contributed nearly 90% of the total macrophyte associated macroinvertebrate density. Gastropods contributed only 7.5% and rest 2.5 % was contributed by all other species. The considerably high density of chironomids and oligochaetes alongwith the abundance of macrophyte *Eichhornea sp.* are indicative of highly eutrophic/polluted condition of the pond. Similar conclusion based on phytoplankton primary productivity (Khan, 1981) has already been drawn.

Although these two groups also contributed significantly to the lake macroinvertebrate fauna, the contribution was considerably lesser, which was only 52% of the total density. The gastropods represented by a number of species contributed nearly 33% of the total density. The lesser contribution of oligochaetes and chironomids, significantly higher density of gastropods, occurrence of several species of insects and crustaceans alongwith diverse macrophyte flora exhibited a comparatively lower degree of eutrophication of the lake. Nevertheless, the lake too exhibited eutrophic conditions. In fact most of the waterbodies in this region are eutrophic but the degree varies, depending on the local conditions. The uniformly high temperature, greater intensity of solar radiation and absence of critical winter in this region of the country, result in high biological productivity resulting in rapid decay and consequent eutrophication (Khan, 1979, 1981).

The occurrence of gastropods was of some interest. The group was not only represented by largest number of species but also by highest density in the lake. The drastic reduction in their diversity and density in pond was probably due to monospecific strands of the macrophyte, *Eichhornia sp.*, which was probably not preferred by many gastropod species.

The overall drop in the diversity and density of macrophyte associated macroinvertebrates in both lake and pond during monsoon season was probably due to flooding which resulted in

dislocation of macrophyte strands. This instability of macrophytes affected the colonisation of macrofauna.

A preliminary analysis of habitat preference in lake, where a variety of macrophyte species were available, revealed no significant preference of any plant species by any group of macrofauna. While a number of workers have reported that plants do not support specific faunal associations (Rook, 1984, Schramn *et al.*, 1987 and Korinjow, 1989), Kornijow and Gulati (1992) observed that species diversity and abundance of animal communities inhabiting the different plant species differed markedly. This requires further detailed investigations.

Excepting dissolved oxygen concentration, none of the physico-chemical parameters of water quality studied could be related to the variations in faunal abundance. The D.O. content of the pond during hot premonsoon months was very low, sometimes creating almost anoxic conditions. This has resulted in the reduction of many susceptible species and abundance of few tolerant ones belonging to Chironomidae and Gastropoda. This exhibited the tenacity of some species to tolerate the extremes of the condition in an eutrophic or organically polluted environment.

The suitability of diversity indices for the analysis of macroinvertebrate communities of freshwaters has been discussed by several workers (Whilm and Dorris, 1968; Eberhardt, 1969, Pielow, 1969, Chandler, 1970, Whilm, 1970, Cook, 1976) but none of the indices has yet been able to provide universal information. However, the community diversity index of Shannon -Wiener (Pielow, 1969) has been able to convey comparatively satisfactory information. During present investigations eight different indices were applied to draw parallel conclusions. Almost all indices pointed towards the significantly lower diversity in the pond, placing it in grossly polluted category. The analyses revealed comparatively cleaner condition of the lake.

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SUMMARY

Qualitative and quantitative diversity of macroinvertebrate fauna associated with submerged macrophytes of a large man-made lake and a medium sized highly polluted pond of Calcutta were studied for three years (1994-95, 1995-96 and 1996-97). While macrophyte flora of the lake were diverse, comprising 17 commonly occurring taxa (11 floating and 6 submerged), the pond was fully covered by monospecific strands of *Eichhornia sp.* The pond was also characterised by low dissolved oxygen and high chlorides.

Altogether 49 commonly occurring taxa of macrophyte associated macroinvertebrate fauna were recorded during the period of study from the two wetlands. These belonged to Mollusca : Gastropoda (11 species) Oligochaeta (2 species) and Hirudinea (3 species), Hydroacarina (2 species), Crustacea : Decapoda (3 species), Odonata (6 species), Hemiptera (8 species), Coleoptera (10 species) and Diptera (4 species). Gastropods were represented by the largest number of taxa followed closely by Coleoptera and Hemiptera. Wetland wise, the faunal diversity was considerably high in lake throughout the period of investigation, where 43 species were recorded, but it was significantly low in pond where only 25 species were noticed. Most of the species were common to both wetlands. Out of 25 species which occurred in pond, 17 also occurred in the lake

The total density varied between 3225/m² and 5993/m² with a mean of 4644.0 in lake and between 2198/m² and 6510/m² with a mean of 4344 in pond. Three groups, Oligochaeta, Gastropoda, and Diptera-Chironomidae formed the bulk of density in both, lake and pond. While total density in the two wetlands did not differ much, the contribution of individual group varied greatly. The contribution of oligochaetes was only 29.54% in lake but their share in pond was more than half (52.39%). Contrary to this the contribution of gastropod was considerably higher in lake (33%) than pond (7.5%). The chironomids also contributed differently in the two wetlands. The dry weight biomass in the two wetlands varied from 174.8 g/m² to 244.5 g/m² with a mean of 174.8 g/m² in lake and from 69.0 g/m² to 201 g/m² with a mean of 130 g/m² in pond. The contribution of gastropods was highest in both wetlands.

The application of diversity indices revealed considerably high diversity of lake fauna and very poor diversity of pond fauna. Very little similarity (6.48) was found between the two wetlands.

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