

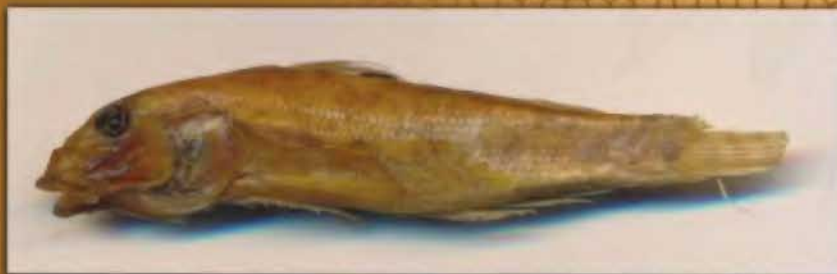


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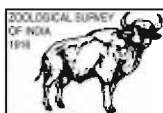
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Dr. K. VENKATARAMAN
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TWO NEW SPECIES AND TEN NEW RECORDS OF THE GENUS *PERGALUMNA* (ACARINA: ORIBATIDA: GALUMNIDAE) FROM INDIA

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Zoological Survey of India, M-Block, New Alipore, Kolkata-700 053, India

INTRODUCTION

The genus *Pergalumna* was established by Grandjean (1936) with *Oribates nervosa* Berlese, 1914 from Italy as the type under the family Galumnidae Jacot, 1925 and the superfamily Galumnoidea Jacot, 1925. Woodring (1962) referred the family as the most advanced pterogasterine group of mites. These mites are commonly known as galumnid mites. The "characteristically shaped" galumnid mites possess a pair of wing like 'pteromorphae' at both the sides of notogaster and most of them are heavily sclerotized and highly pigmented. They inhabit in all types of soil but predominantly found in soil and litter with rich organic matter. Under the family Galumnidae a total of 34 genera are known from the world of which 13 galumnid genera have been reported from India till date. The genus *Pergalumna* Grandjean, 1936 is one of the major genera having 105 species and 14 subspecies reported till date from all over the world except Antarctica (Subias, 2009). In India, a total of 5 species of *Pergalumna* were reported till 2004, of which *Pergalumna andhraense* Raju *et al.*, 1981 was described as new species from Andhra Pradesh. The other pergalumnid species known from India were *P. corolevuensis* Hammer, 1971 (Sarkar, 1986; Tripura), *P. intermedia* Aoki, 1963 (Balakrishnan and Haq, 1985; Kerala), *P. magnipora capensis* Engelbrecht, 1972 (Chakraborti and Bhattacharya, 1991; Tripura), *P. remota* (Hammer, 1968) and *P. taprobanica* Balogh, 1988 (Mondal and Kundu, 1999; West Bengal). In addition, Sanyal (1999, 2004)

recorded the genus with undetermined species from West Bengal and Manipur and Pandit and Bhattacharya (2000) reported from West Bengal.

The present paper records another 12 including two new species of pergalumnid mite from India. These species include *P. pertrichosa* Mahunka, 1995; *P. intermedia retroversa* Aoki and Hu, 1993; *P. incompta* Engelbrecht, 1972; *P. longiporosa* Fujita and Fujikawa, 1987; *P. aegra* Perez-Inigo and Baggio, *P. margaritata* Mahunka, 1989; *P. granulata* Balogh and Mahunka, 1967; *P. hastata* Aoki, 1987; *P. longisetosa* Balogh, 1960; *P. andicola* Hammer, 1961 and the two new species are *P. bhaskari* and *P. sabitai*.

DESCRIPTION OF THE NEW SPECIES

Pergalumna bhaskari sp. nov.
(Figs. 1- 4)

Colour : Light brown.

Measurements (in micron): Length of the body: 351.5; width of the body: 277.5; length of lamellar setae: 74; length of interlamellar setae: 55.5; length of rostral setae: 18.5; length of sensillus: 111.0; distance between lamellar setae: 111.0; distance between rostral setae: 55.5; distance between interlamellar setae: 92.5; length of bothridium: 18.5; distance between sensillus: 166.5; length of anal plate: 70.5; width of anal plate: 70.5; length of genital plate: 47; width of genital plate: 55.5; distance between aggenital setae: 70.5.

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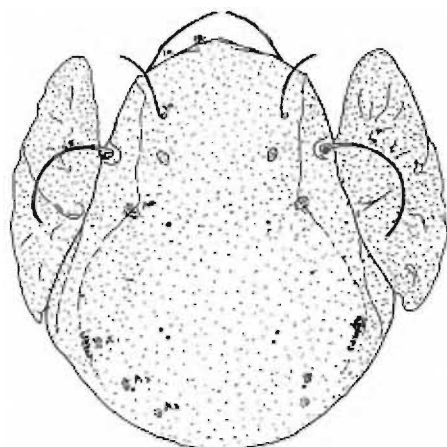


Fig. 1 : Dorsal view of *Pergalumna bhaskari*

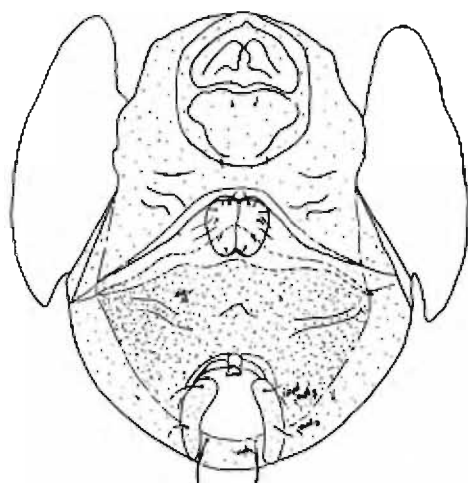


Fig. 2 : Ventral view of *Pergalumna bhaskari*

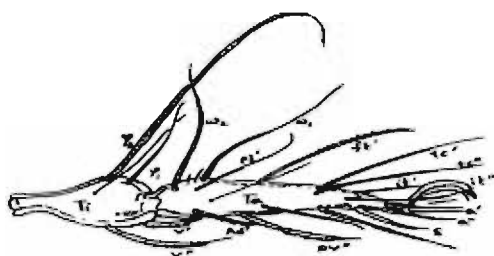


Fig. 3 : Tarsus and tibia of right leg I of *P. bhaskari*

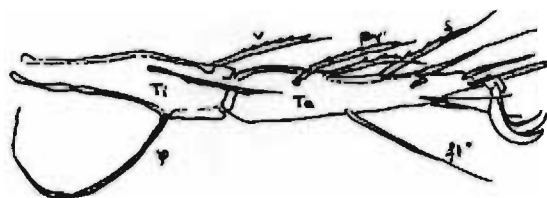


Fig. 4 : Tibia and tarsus of right leg IV of *P. bhaskari*

Prodorsum : The whole prodorsal surface including the pteromorphae with dense granulation. Sensillus very long, directed outwards and having spines mostly on the outer side. Dorsosejugal suture completely absent. Area porosa dorsosejugal very light. Lamellar setae and interlamellar setae longer than rostral setae. The ratio of prodorsal setae: $la > in > ro$. Lamellar setae inserted in between lines 'L'.

Notogaster : Three pairs of area porosae present but A3 not clearly visible. 10 pairs of notogastral alveoli present. All legs are tridactylous and heterodactylous.

Ventral plate : The epimeral, ventral and anal regions with fine cerotegumental punctuation but more punctuation present in between the anal and genital plates. Two prominent bands are present in the ventral plate – one dark chitinized band present in front of the genital plate and a weak chitinized band present along the middle of the genital plate. Both bands extend to the lateral margins of the ventral plate. A pair of unusual ridge present in between anal and genital plates. 6 pairs of genital setae present of which the anterior 1st pair is longer than the others. 2 pairs of anal setae and 3 pairs of adanal setae present. ad_1 is the longest setae in the ventral side.

Material examined : HOLOTYPE: Adult female, INDIA: West Bengal, Purulia, Govt. Girls' High School Compound, from leaf litter, 22.xii.2007, coll. S. Sarkar.

PARATYPES : 2 adult females, data same as for holotype.

Distribution : India: West Bengal (Purulia District).

Remarks : The new species shows close similarities with *P. granulata* Balogh and Mahunka, 1967 in the nature of the granulation on the dorsal surface; position of lamellar and interlamellar setae and the position and size of three pairs of area porosae. But *P. bhaskari* differs from *P. granulata* in shape and size of the prodorsal setae. The ventrally located prominent bands are also absent in *P. granulata*. The present species also comes closer to *P. filifera* Mahunka, 1978 and *P. kotschyl* Mahunka, 1989 in having the broad bridge in front of the genital plate. But the other band through the genital

plates is absent in the two formerly known species. Hence, on the basis of the densely granulated dorsum, long and ciliated prodorsal setae, absence of dorsosejugal suture, ventral chitinized band and long, ciliated ad₁ *P. bhaskari* differs from all other species under the genus *Pergalumna* and described as a species new to science.

***Pergalumna sabitai* sp. nov.**

(Figs. 5 – 8)

Colour : Light brown to yellowish brown.

Measurements (in micron) : Length of body: 333; width of body: 270; length of rostral setae: 37; length of lamellar setae: 62.9; length of inter lamellar setae: 11.1; length of sensillus: 111.0; length of bothridium: 18.5; distance between rostral setae: 59.2; distance between interlamellar setae: 92.5; distance between lamellar setae: 92.5; length of genital plate: 48.1; width of genital plate: 55.5; length of anal plate: 62.9; width of anal plate: 74.0; distance between aggenital setae: 62.9.

Prodorsum : Rostral setae not visible in dorsal view, it is near to the lateral margin of prodorsum. Lamellar setae long, thin, smooth and near to lines 'L'. Interlamellar setae very short. Sensillus long, curved, directly outwards and distinctly pilose.

Notogaster : Whole dorsal plate including the pteromorphae punctated. The punctuation is fine upto the mid dorsal portion of the notogaster but the posterior half of the notogaster is with honeycomb like ornamentation. All legs are tridactylous. Pteromorphae with radiating lines and with prominent pteromorphae setae.

Ventral plate : The epimeral region is punctated and the epimeral setal formula: 1-0-2-2. All epimeral setae comparatively short. Genital plates with 6 pairs of genital setae. 1 pair of aggenital setae present. 2 pairs of anal setae present on anal plates. Anogenital region is alveolated but becoming larger posteriorly. 3 pairs of adanal setae present of which ad₁ and ad₂ longer than ad₃. Postanal area porosa well developed.

Material examined : HOLOTYPE: Adult female, INDIA: West Bengal: North 24-Parganas: Gobardanga, near Sutia market, 16.vi.2007, from a China rose cultivation field, coll. S. Sarkar.

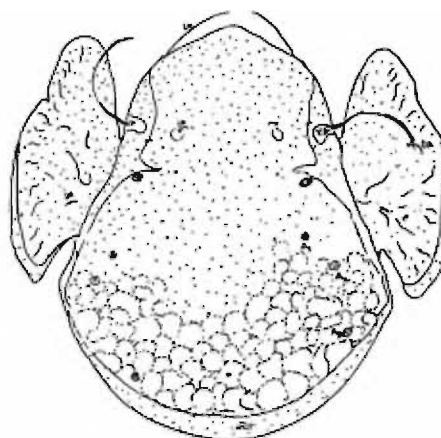


Fig. 5 : Dorsal view of *Pergalumna sabitai*

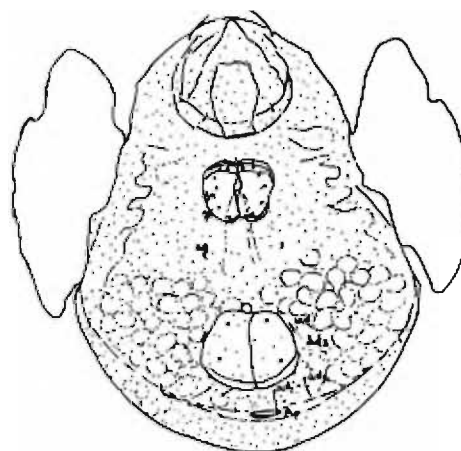


Fig. 6 : Ventral view of *Pergalumna sabitai*

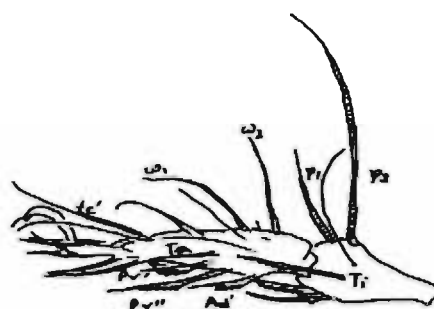


Fig. 7 : Tarsus and tibia of leg I of *P. sabitai*

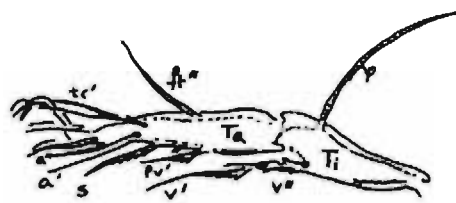


Fig. 8 : Tarsus and tibia of left leg III of *P. sabitai*

PARATYPE : Two adult females, data same as for holotype.

Remarks : The new species *P. sabitai* differs from all known species under *Pergalumna* except one species *P. tsavoensis* Mahunka, 1986. On the basis of the absence of dorsosejugal suture, structure of sensillus and finely punctated dorsal surface and position and structure of ad1 and ad2 the new species shows resemblances with *P. tsavoensis* Mahunka, 1986. But *P. sabitai* is distinguished from *P. tsavoensis* by presence of gradually increasing alveolate structure both on the notogaster and the ventral side, small sized A1, well developed postanal area porosa, wide punctated pteromorphae with pteromorph setae and position of ad3 arising from a little distance of *iad*. *P. sabitai* is therefore described as a new species.

The two new species have been dedicated to Sri Bhaskar Jyoti Sarkar and Smt. Sabita Sarkar, father and mother of the first author.

List of new record of species of the genus *Pergalumna* from India

1. *Pergalumna pertrichosa* Mahunka, 1995

Material examined: 2 adult females, India: West Bengal: North 24-Parganas: Keshtopur, 6.iii.2006, from garden soil, coll: S. Sarkar; 1 adult female, India: West Bengal: North 24 Parganas: Keshtopur, 1.vi.2007, from soil and litter beside Keshtopur canal, coll. S. Sarkar.

Distribution: INDIA: West Bengal: North 24-Parganas; Elsewhere: Borneo.

2. *Pergalumna intermedia retroversa* Aoki and Hu, 1993

Material examined : 3 adult females, India: West Bengal: Barrackpore: CIFRI compound, 5.x.2003, from garden soil, coll. S. Sarkar; 1 adult female, India: Sikkim: 12. i. 2003, from soil and litter, coll, A.K.Sanyal; 2 adult females, India: Uttar Pradesh: Mughalsarai, 21.x.2007, from soil and litter, coll, B.J.Sarkar; 1 adult female, India: Assam: Barak valley, 11.vii.2004, soil from forest, coll, R. B. Gope.

Distribution : INDIA: West Bengal, Sikkim, Uttar Pradesh, Assam; Elsewhere: Yunnan Province of Southern China.

3. *Pergalumna granulata* Balogh and Mahunka, 1967

Material examined : Single adult female, India: Uttarakhand: 15 Km. west of Gobindaghat; 4.xi.2004, from soil and litter, coll, A.K.Sanyal.

Distribution : INDIA: Uttarakhand; Elsewhere: Vietnam.

4. *Pergalumna andicola* Hammer, 1961

Material examined : 2 adult females, India: Jharkhand: Ranchi, 5.ix.2007, from soil and litter near Hundru falls, coll, S. Sarkar; single male, India: West Bengal: Purulia, 22.xii.2007, from soil litter, from Govt. Girls' High School compound, coll, S. Sarkar.

Distribution : INDIA: Jharkhand: Ranchi; West Bengal: Purulia; Elsewhere: Peru.

5. *Pergalumna incompta* Engelbrecht, 1972

Material examined : 4 adult females, India: Uttarakhand: Mayapur, 9.xi.2004, from leaf litter, coll, A.K.Sanyal

Distribution : INDIA: Uttarakhand; Elsewhere: South Africa.

6. *Pergalumna aegra* Perez-Inigo and Baggio, 1986

Material examined : 2 adult females, India: Lakshadweep: Agatti Island, 10.xii.1996, from soil and litter from vegetable fields, coll, S. K. Gupta; single male, India: Karnataka: Bangalore, ISRO compound, from soil litter, 21.ix.1995, coll, A. K. Bhattacharyya.

Distribution : INDIA: Lakshadweep, Karnataka; Elsewhere: Brazil.

7. *Pergalumna margaritata* Mahunka, 1989

Material examined: 2 nymphs and 3 females, India: Uttarakhand: Janakichatti, 14.iv.2006, from soil, coll, B.J.Sarkar; 1 adult female, India: Uttarakhand: Chamba, 15. iv.2006, from soil, coll, B. J. Sarkar.

Distribution : INDIA: Uttarakhand; Elsewhere: Vietnam.

8. *Pergalumna longiporosa* Fujita and Fujikawa, 1987

Material examined: Single female, India: Andaman: Ross Island, 27.ix.2005, from soil and litter, coll, A.K. Sanyal.

Distribution : INDIA: Andaman; Elsewhere: Japan.

9. *Pergalumna hastata* Aoki, 1987

Material examined : 2 adult females, India: West Bengal: Kolkata: near New Alipore railway station, 9.i.2005, from soil and litter, coll, S. Sarkar.

Distribution : INDIA: West Bengal: Kolkata; Elsewhere: Japan: Northern Yoron Island.

10. *Pergalumna longisetosa* Balogh, 1960

Material examined : 3 adult females, India:

Maharashtra: Nagzira wildlife sanctuary, 13.i.2009, from soil and litter, coll, S. Sarkar.

Distribution : INDIA: Maharashtra; Elsewhere: Central Africa.

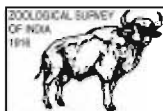
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TWO NEW SPECIES OF MOLLUSCS (NATICIDAE: GASTROPODA) FROM INDIA

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INTRODUCTION

The Naticidae is a cosmopolitan family of burrowing Cenogastropods under the Phylum Mollusca. It is commonly known as moon shell. This family is well represented and morphologically homogenous group of marine gastropods, living in habitats from the intertidal zone to deep sea.

The genus *Natica* was established by Scopoli, 1777 with *Nerita vitellus* Linnaeus, 1758 and subsequent designation given by Anton (1839) as the type. Several authors worked on the genus *Natica* (Sowerby, 1883, Reeve, 1885, Tryon 1886 and recently Cernohorsky, 1971, 1972,) which are distributed in the Indo-Pacific region. In India, Subba Rao and Dey (2000) listed 12 species of the genus *Natica* in their *Catalogue of Marine Molluscs of Andaman and Nicobar Islands*. Subba Rao (2003) enumerated 15 species under this genus in *Indian Sea Shell* (Part-I) Polyplacophora and Gastropoda. Of 91 species under the genus *Natica* reported globally, 41 species are from Indo-Pacific region and 19 species have been listed from various parts of India. While studying the molluscs of the family Naticidae, the authors came across with two new species of Naticidae from India. The type specimens are deposited in the National Zoological Collections, Zoological Survey of India, Kolkata.

Natica gongally sp. nov.

Fig. 1&4 (plate-1)

Diagnosis : Shell moderate in size 41.15 mm, shell width is larger than shell length, spire moderately high, whorls shallowly impressed below suture; suture broadly deep and deeply concave, subsutural area with a milky white band,

protoconch obtuse, white with 1-1/2 whorls, umbilicus partly filled by a callus pad. Parietal callus distinctly divided into anterior and posterior lobes; anterior portion after joining with the columellar lip making a transverse "u" shaped notch; shell white with broad brown orange band, subsutural area with microscopic axial striae, body whorl smooth, umbilicus and callus pad light orange brown; operculum slightly concave with a single marginal rib; inner edge of the operculum with a row of denticles.

Description : Globose, spire moderately raised, shallow concavity between suture and periphery; suture distinct, surface polished with fine growth lines which are especially distinct below suture; body whorl with microscopic axial striation. Aperture and labium very evenly and shallowly concave. Parietal callus distinctly divided by two lobes. Anterior portion of the callus join with the columellar callus by making a transverse "U" shaped notch. Funicle well developed and entering into the umbilical groove vertically; anterior portion of the parietal callus, columellar lip and umbilicus with light orange colour, base of the shell with labium forming lip like appearance. Teleoconch whorls 2, protoconch of about 2 whorls, first whorl fairly large. Ground colour white, protoconch white, started from protoconch a milky-white band encircles along the subsutural area of the penultimate whorl. Angulation with the body whorl is slightly folded and less than 90°.

Operculum : Single marginal rib.

Dimensions : (in mm)

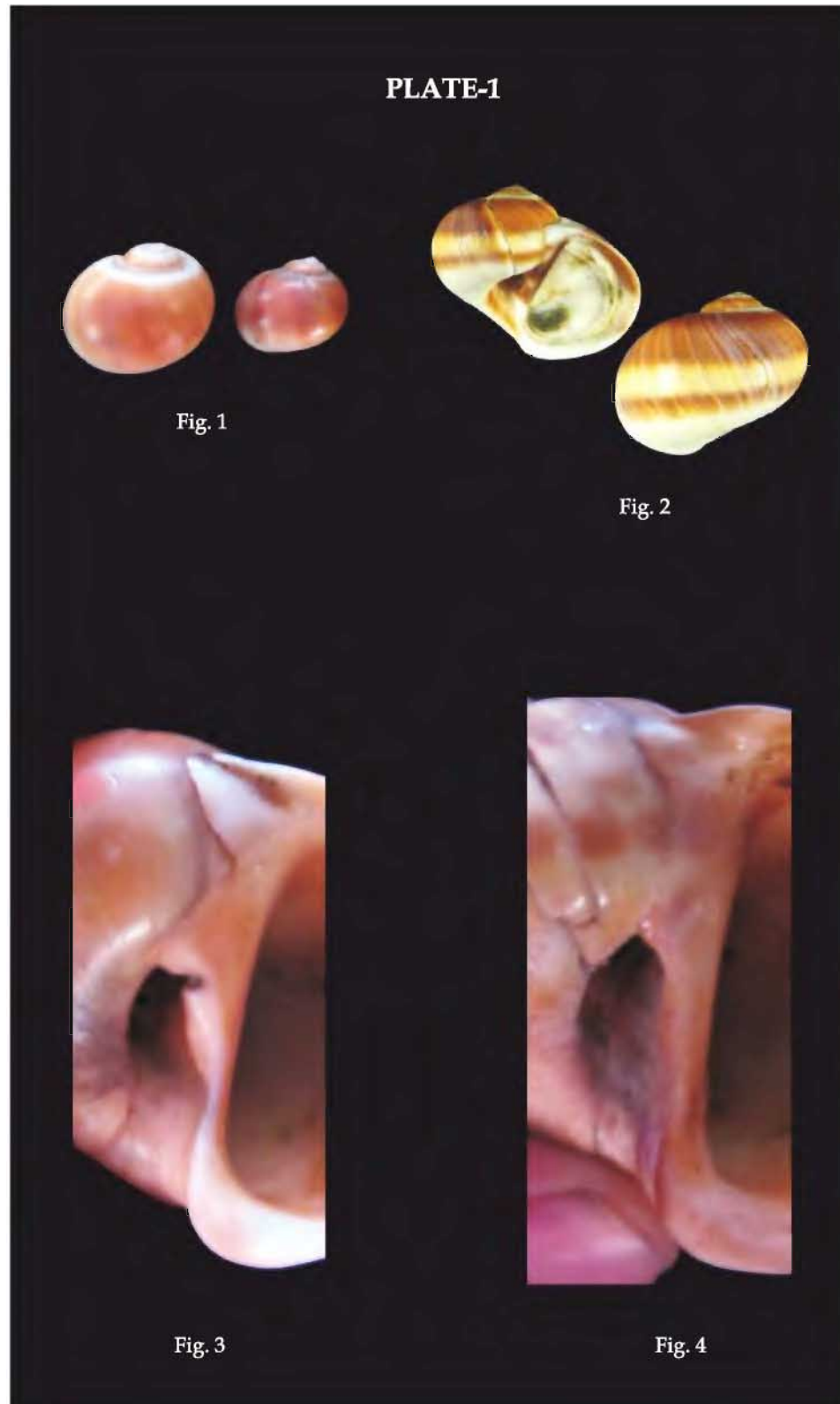


Fig. 1 & 2, *Natica gongally* and *Natica vitellus*. Fig. 3 to Fig. 4 shows the difference of the umbilical region of *N. gongally* and *N. vitellus*.

	Length	Width	Height of Aperture
Holotype	32.15	32.30	22.45
Paratype	41.15	44.10	24.50

Size : Average 36.65 mm.

It is remarkable that the ratio of length and width is directly proportional with the increase in size of the shell. Operculum is slightly concave with a thickened nuclear region, one marginal rib with a series of denticles along the labial edge is another significant character of the shell.

Type material : Holotype- collected from Gongally fishing harbour from trash material near Kundapur, Dist.Udipi, Karnataka, Coll. R. Venkitesan and party, Regd. No. M 26222/5; Paratype, same as above, Regd. No. M 26223/5.

Remarks : This species resembles *Natica vitellus* Linnaeus but differs from this species in several ways which are as follows:

Diagnostic Characters	<i>Natica vitellus</i>	<i>Natica gongally</i>
Shell width & length ratio	Width never exceed the length.	Width exceed the length.
Protoconch	Acuminate and deep chestnut colour.	Obtuse and white colour.
Body whorl	Rough and axial striation is deep and continuous upto the base of the shell.	Smooth with very light axial striation which only restricted to the subsutural area.
Colour of body whorl	Body whorl with concentric white and three brown bands.	Large deep brown bands on the body whorl.
Parietal callus	Parietal callus large not divided and anterior portion joined with the columellar lip; weak funicle, umbilical opening wide, channel like and open obliquely . Inner lip thick, straight and joined with funicle ..	Parietal callus is divided into two anterior and posterior by transverse "V" shaped structure ; anterior portion of the callus is partially covering the umbilical after making a "U" shaped transverse notch.
Umbilical area	Umbilical area completely white	Umbilical area white but light orange brown tint present.
Operculum	Operculum having two marginal ribs.	Operculum having only one rib.
Columellar callus	Columellar callus almost straight and anterior portion of the parietal callus feeble and joining with the wall of the umbilical callus.	Columellar callus slightly arched, funicle present and joining with the inner wall of the umbilical callus.
Angulation	Angulation of the aperture started from the body whorl is 90°.	Angulation of the aperture started from the body whorl is less than 90°.

PLATE-2



Fig. 1



Fig. 2

Fig. 3

Fig. 4



Fig. 5

Fig. 1 *Natica adansoni* Blainville
Fig. 2 to 5 *Natica andamanensis* sp. nov.

***Natica andamanensis* sp. nov.**

Fig. 5 to 9 (Plate-2)

Diagnosis : Shell small in size, penultimate whorls 3; large body whorl, suture deep and encircle with much faint axial striae and restricted only to the subsutural region. Body colour light brown; deep brown maculation or pattern around the body whorl below the suture and it started from the 3rd penultimate whorl. Umbilicus deep almost covering by the funicle leaving a comma shaped area.

Description : Shell nearly globose, nuclear whorl 2- suture distinct, deep, surface polished, with fine growth lines which are especially distinct below suture; body whorl with fine microscopic axial striation that continues only some portion of the body whorl. Anterior portion of the parietal callus

coalescing with the umbilical wall, posterior is very thin, indistinct. Funicle well developed, large, entering into the umbilicus at right angle forming semicircular aperture; anterior portion of the aperture deep. Parietal callus and periostracum deep brown. Operculum is without nucleus , convex with two marginal grooves.

Dimension : (in mm)

	Length	width	Height of Aperture
Holotype :	12.00	11.75	6.65

Type material : 1 ex., Holotype, collected by G.H.Booley from Andaman and Nicobar Islands, Regd. No. M 26224/5.

Remarks : This species having close similarity with *Natica adansoni* Blainville, 1825 but differs from it as follows:

Diagnostic Characters	<i>Natica adansoni</i>	<i>Natica andamanensis</i>
Shell width and Shell length	Length is higher than width.	Shell length and width almost same.
Protoconch	Shell elongate ovate, spire much more elevated.	Shell is nearly globose, spire low.
Body whorl	Rough and axial striation deep and continuous upto the periphery of the shell.	Smooth with very faint axial striation which only restricted to the subsutural area.
Colour of the body whorl	Dark purple tint in the inner part of the mouth, Body surface ornamented with spots and bands and dots of variable colours.	Absent, only white, large, brown spiral maculation is only restricted below suture in the later. Body whorl ornamented with very light yellowish patches.
Umbilical area	Umbilical aperture large with a small ill developed funicle which is obliquely entering in the umbilical aperture (See fig. 94, Sowerby, 1883). Aperture elongate -ovate.	Funicle well developed, prominent, entering into the umbilicus at right angle with prominent sulcus. Aperture semicircular.
Parietal callus	Well developed.	Posterior of parietal callus is thin, rudimentary.
Operculum	Operculum having nucleus with many marginal.	Operculum having one marginal grooves. Slightly concave in the middle of the operculum.

Some authors erroneously included this species (Subba Rao and Dey, 2000) as *N. adamsoni* (misspelt) *adansonii* but a careful observation of the *N. andamanensis* suggested it to be a new species to science and new record from India with geographical distribution from Andaman and Nicobar Islands only.

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SCANNING ELECTRON MICROSCOPE (SEM) STUDIES OF RADULA OF THREE GANGGETIC RIVER MOLLUSCA FROM INDIA

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INTRODUCTION

The most important characteristic feature of the buccal cavity in Mollusca (except Bivalves) is the presence of radula, one of the hallmarks of the phylum (Purchon, 1977). It is a chitinous ribbon bearing many transverse rows of firmly fixed teeth. Each row of teeth on the radula normally repeats precisely the number and shape of the teeth in the rows in front of it and behind. The radular teeth are usually in odd numbers because the row consists of a single tooth centrally placed, which is a central or rachidian teeth, with a series of others on either side broadly known as lateral teeth. The shapes of radular teeth are important for determining the effectiveness of the radula as a tool for feeding (Padilla, 1989).

Radula has been frequently investigated because of its importance as a tool in supra-specific systematic to diagnose the species. Radula has also been recognized as an important morphological criterion for the taxonomic allocation of species. It shows general similarities at family and generic levels with consistent differences at the species level. The respective similarities and differences have been utilized to an increasing extent in the classification of many gastropods as the shape of the radula teeth is directly related to the kind of food, which the gastropods eat, and the way in which it is manipulated. Radular teeth of gastropods are adapted for a variety of feeding methods in different species (Padilla, 1989).

Traditionally, studies have focused on the morphology of hard structures associated with the

radula, especially radular teeth. Hard structures usually do not require chemical fixation, and therefore maintain their shape when removed from the animal. Even most descriptions of the shape and morphology of hard structures however, are qualitative rather than quantitative. In addition to the focus on hard structures, soft structures should be studied, especially the morphology of structures auxiliary to the radula that are essential for function. Soft body morphology, including the muscles, muscle attachments, the chitinous ribbon, and other structures such as the odontophore must be integrated into our understanding of the morphology of this whole structure. In addition, an understanding of their development will aid in our interpretations of evolutionary changes in form and function (Guralnick & Smith, 1999). The scanning Electron microscope (SEM) is one of the powerful tool in the studies of radula. The Scanning Electron Microscope (SEM) permits the examination of radula with higher magnification without elaborate preliminary preparation and without squashing or fragmentation.

The radulae of marine gastropods have been described by Freeman and Silva (1973) using SEM technique. The most obvious use of SEM in the study of gastropod radulae is to investigate the cusp structures and patterns of tooth wear (Carriker, 1961), normal tooth functioning position and chemical composition of the teeth (Runham, 1969) and radular growth (Isarankura & Runham, 1968). The recent study on freshwater molluscs from Western Ghat by Reid *et al.* 2013 given indepth

information on six species of *Cremnoconchus* using SEM. Nevertheless, studies on riverine gastropods viz. *Neritina* and *Assiminea* are limited and the present study on these two genus is the first work on the feeding ecology of freshwater mollusca.

MATERIALS AND METHODS

Specimens of *Neritina (Dostia) violacea* (Gmelin, 1791) of three (3) individuals, *Vittina smithi* (Wood, 1828) of four (4) individuals and *Assiminea francessi* (Wood, 1828) of ten (10) individuals were collected from the river Ganges at Raskhola Ghat, Khardah, North 24 Paraganas (22°43'14"N, 88°21'48"E) in the state of West Bengal, India (Fig. 1).



Fig. 1. Map of collection location



Fig. 2. Dorsal view of *Neritina (Dostia) violacea*

At each sampling site, live specimens of the above species were collected and stored in 7.5 % Magnesium chloride for relaxing or anaesthetizing the animal as per methodology suggested by Reid

(2000). This helps facilitate easy removal of operculum and radula. Subsequently, these were transferred to prelabeled zip-lock bags and temporarily stored in ice. The specimens were subsequently identified up to species level using taxonomic methods based on shell morphology, colour, texture, sculpture and meristic counts of shells those aided by taxonomic literature (Subba Rao, 1989). The shells were subsequently stored in pre-labelled plastic containers.

Morphological analysis : Shell dimensions were measured i.e. shell length (SL) and shell width (SW) with precision calipers to ascertain differentiate between adult and juvenile specimens.

Preparation of Radula for SEM study: The radulae from the specimens were dissected out from their buccal mass with the help of scissors, watchmaker forceps, fine needles and magnifying glass. Dissected radulae were then taken on a drop of water on slides for further clearing with needle and forceps. The cleaned radulae were kept in increasing concentration (15% > 30% > 50% > 70% > 90% > 100%) of alcohol for dehydration. The dehydrated radulae were then stored in absolute alcohol for Scanning Electron Microscopic (SEM) study at University Science Instrumentation Centre (JUSIC), Jadavpur University, Kolkata. SEM photographs of the radulae were taken at the JUSIC using a JEOL JSM 5200 Scanning Electron Microscope (SEM) at 15 to 20 KV accelerating voltage. Initially, the radulae mounted on brass stubs with a double-sided tape were coated with gold and placed into the specimen chamber of the SEM (Roberts, 2000). Subsequently, photographs were taken at various magnifications depending on the size of the radula. Radula length and rachidian width were measured from the photographs. The terminology used in the description of radula follows Kool (1987).

RESULTS

Phylum MOLLUSCA

Class GASTROPODA

Order CYCLONERITIMORPHA

Family NERITIDAE

Neritina (Dostia) violacea (Gmelin, 1791)

Morphometry: Shell length ~7 mm (range 6-9 mm),

width ~ 5 mm (4-6 mm); shell thick, ovate, crepidula shaped, whorl 2, spire minute, anteriorly twisted inwards, protruding out as a beak; aperture broad, columellar plate porcellaneous, operculum semilunar (Fig.2).



Fig.-2. SEM view of *Neritina (Dostia) violacea*'s radula ribbon; scale bar = 100 μ m

Habitat : It is common in creeks and rivers having tidal influence and generally found adhering to the roots and branches of trees within the high water limit and getting exposed during low tide. Sometimes, it may also be found creeping on the mudflats (Subba Rao, 1989).

Description of Radula : The buccal cavity consists of ribbon like compact radula rhipidoglossate with the formula $\acute{a}$ -5-1-5- $\acute{a}$. There are five laterals and teeth are serrated minutely. The first lateral has a concave inner and outer side (Fig. 5,a). The cusps of the R-central are a little broader, without any projection, and the anterior end is strikingly thin, so that the anterior half-ellipse is more transparent than usual. The reflection of the E-central is somewhat more extensive. The cusps are not conspicuous or (Fig. 5,b). There are numerous marginals present.

Order NERITIMORPHA

Family NERITIDAE

Neritina (Vittina) smithi (Wood, 1828)

Morphometry : Shell length ~ 11 mm (range 10-13 mm), width ~ 9 mm (range 8-11 mm); shell solid, oval, higher than broad; whorls 5, rapidly increasing in diameter; spire sub-conical, apex blunt; shell dark yellowish brown in colour, smooth and

glistening with strong black longitudinal undulating lines and bands forming a zigzag pattern; aperture broad, semilunar; columellar callus laterals, small and smooth; outer lip thickened operculum semilunar, black or light flesh colour (Fig. 3).



Fig.3. Dorsal view of *Neritina (Vittina) smithi*

Habitat : It is reported only from the estuaries of Ganges in India and Irrawady in Burma. It is primarily a brackish water species occasionally extending into freshwater systems. This species is mainly attached with hard substratum viz. rocks, banks of the river, bathing Ghats etc. This species also often seen climbing into bricks, stones and cement stones close to water bodies.

Description of Radula : The radula is rhipidoglossate type with the formula $\acute{a}$ -5-1-5- $\acute{a}$ (Fig.6,a). The central tooth (rachis) is with a small middle depression bounded by two small rounded raised heads. Wider than its length [length: width=1:3]. Anterior end forms slop for articulation. The laterals are razor like; 1st laterals are wider than higher, with a flat broad cutting surface. The outer end is broader than their inner (toward rachis) end. The posterior corner of the outer end is recurved toward anterior side and the anterior corner is slightly raised. The 2nd and 3rd laterals are cup shaped. 3rd is longer than 2nd and is with dagger like pointed tip. 2nd and 3rd laterals are arranged concentrically with their concave surface toward the central rachis (Fig. 6,b). The 4th laterals are wider than their length. Their inner end forms a conical trapezoidal 'tusk' like projected tip, which ends in a notch. The outer margin following the notch is serrated with triangular sharp tips. The

gradually tapering outer end curves toward the anterior end. The marginals are long, slender, hook like with the raised pointed tips bent towards anterior side (Fig.6,c). They are numerous in number and arranged in basket like series. The razor/blade like 1st lateral with its wide cutting surface certainly helps to scrape off loose moss or algae from the surfaces of fixed substrates like boulders etc. This can be supported by the fact that these snails were collected from the moist surface of the brick steps along the river. The pointed 2nd and 3rd laterals may aid in tearing the food materials from the adjacent stuff. The 4th laterals and the hook like marginals perhaps used for munching and mincing of food stuff respectively. The 5th lateral is slender and hook shaped bend towards the marginals and embedded partially under the 4th lateral. From the overall diagnostic features of radula structure, the feeding habit of *Neritina* (*Vittina*) *smithi* seems to be of scraping/rasping type.

Order RISSOOIDEA

Family ASSIMINEIDAE

Assiminea francessi (Wood, 1828)

Morphometry : Shell length ~ 7 mm (range 6-9 mm), width ~ 6 mm (range 5-8 mm); approximately ~ 7 mm (range 6-9 mm), ; shell elongated, conical; yellowish brown to brown in colour with brown rings surrounding the body whorls, whorls are 7 in number and gradually increasing in width; aperture oblique, ovate; operculum very thin, brownish and translucent (Fig.4).



Fig.4. - SEM view of *Neritina* (*Vittina*) *smithi*'s radula ribbon; scale bar = 100 µm

Habitat : It is the only species occurs in fresh water ponds, canals having link with Hugli river (Ganges) and extends further north. This species is mainly attached with hard substratum viz. rocks, banks of the river, bathing Ghats etc.



Fig.5. Dorsal view of *Assiminea francessi*



Fig.6. - SEM view of *Neritina* (*Vittina*) *smithi*'s radula ribbon; scale bar = 50 µm.

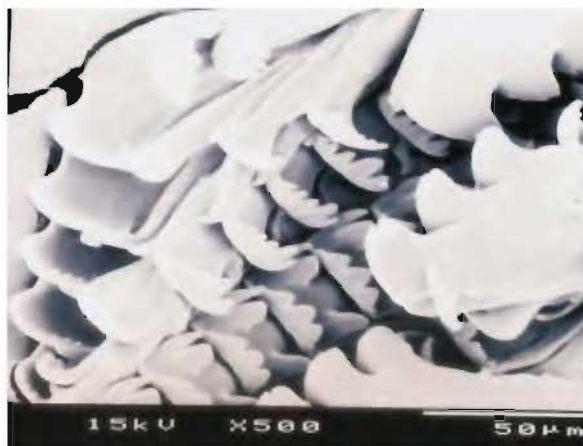


Fig.7. SEM view of radula of *Assiminea francessi*'s radula ribbon; scale bar = 50 µm.

Description of Radula : The radula is taenioglossate type with formula 2-1-1-1-2. The central tooth (rachis) is hollow, half cylindrical in shape (Fig.7,a). The anterior raised margin is with two forked tips (the outer of which is pointed) separated with a low flat region which articulates with the anterior rachis. The posterior raised margin is broad with three triangular blunt projections. The middle of these projections is little longer than the other two. The lateral teeth are spoon shaped with the raised posterior margin curved towards anterior side. The posterior margin is with a 'thumb' like projection towards outer side which is not raised anteriorly. The 'thumb' is followed by 5 anteriorly raised conical projections, of which the outer 4 are gradually increasing in length. The 4th is the longest and with rounded head. The 5th (innermost) projection is smaller than the 4th but taller than the outer three (Fig.7,b). The 'handle' like flat, slender anterior part is inserted below the lateral anterior to it. The marginals are plate like, raised posterior margin is serrated. Middle portion of the plate is broader. The triangular cusps of the central rachis seem to help in piercing (clipping) the vegetation. The multi level projections of the laterals can be well suited for chewing. While the serrated margin plate like marginals indicates ability of through mastication. So the forms and the overall stability of the structure observed in its radula structure may suggest that the feeding habit of *Assiminea francessi* is of grazing type.

DISCUSSION

Of the 409 recognized families of recent gastropods, 26 are almost or entirely restricted to freshwater and only four span freshwater, brackish and marine environments (Strong *et al.*, 2008). Some of the freshwater members of the families raise interesting, but still largely unanswered, questions about their phylogenetic relationships, antiquity, geographical origins, physiological adaptations and the selection regimes under which they evolved (Vermeij & Wesselingh, 2002). The distribution of aquatic gastropods was found to be restricted to a particular zonation of the aquatic habitat indicating that prevailing environmental factors such as degree of exposure to wave impact, duration of wetting by immersion and by splashes from waves, the presence or absence of competitors, predators, food source, air and sea temperatures anomaly and the

duration of exposure (Purchon, 1968). Evidently, the most primitive type of gastropod feeding involved browsing and grazing of algae from rocks (Purchon, 1977). Amongst the most primitive gastropods, the very survival of *Neritina* and *Assiminea* was probably because of their ability to live sympatrically. The species belonging to genus *Neritina* and *Assiminea* are common gastropods in the river systems of Ganges in the Gangetic delta region, although they are brackish water species (Subba Rao, 1989). They are found attached to the substratum, more often seen attached to rocks in the bathing Ghats. They graze on microscopic algae from the substratum by means of radula. SEM observations on the radula of two species of *Neritina* and one species of *Assiminea* elucidated interesting features. The comparison of the radular morphology with the feeding habitats and food preferences of both the genus reflects the fundamental role of radula. The SEM study reveals a significant difference in the structure of centrals and laterals in the radulae of all the three species which indicate the feeding behavior to be different among them, although live sympatrically. Whereas, the *Neritina (Dostia) violacea* is predominantly scrapping and rasping feeder, the *Neritina (Vittina) smithi* is advance than the former with modified laterals in the radula. This also shows the evolutionary significance of the genus *Neritina*. In the case of *Assiminea francessi* the feeding is grazing type due to modification of the central and lateral teeth. In terms of their evolution, from the SEM study of radula, *Assiminea francessi* is seems to be youngest among the three, being developed with advanced structures in the radulae. The SEM study on the radula structure in mollusca is definitely an useful tool for determine the phylogenetics, antiquity, geographical origins and physiological adaptations. Nevertheless, this is a preliminary observation of radula through application of SEM and radula study using SEM is quite recent in India and future malacological research of terrestrial and aquatic gastropods will reveals many important information through such advance techniques.

SUMMARY

The similarities and differences in the feeding organs utilized to an increasing extent in the classification of many gastropods as the shape of the radula teeth is directly related to the kind of

food which they feed. Radular teeth of gastropods are adapted for a variety of feeding methods. Traditionally studies have focused on the morphology of hard structures associated with the radula, especially radular teeth. The Scanning Electron Microscope (SEM) permits the examination of radula with higher magnification without elaborate preliminary preparation and without squashing or fragmentation. This paper discuss about the radula structure and feeding biology of three freshwater gastropods using SEM.

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MACRO INVERTEBRATE FOSSIL FAUNA (MOLLUSCA) FROM QUILON LIMESTONE FORMATION, KERALA STATE: CHARACTERISTICS AND STRATIGRAPHIC IMPLICATIONS

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INTRODUCTION

The Neogene succession, located along the southern coastal stretches of Kerala is represented by the sediments belonging to the Vaikom Formation, Quilon Formation, and the Warkalli Formation (Poulose and Narayanaswamy, 1968; Varadarajan and Madhavan Nair, 1978; Raha *et al.*, 1983, Soman, 1997). These sediments are dated as post Paleocene (Dey, 1962). The Quilon beds bear an important position in Indian stratigraphy as these present evidence of marine transgression along the south-west coast of India during Miocene, similar to the sort of marine deposits along northwestern and western parts of Indian subcontinent (Verma, 1977). The Vaikom and Warkalli Formations are unfossiliferous, while the Quilon limestone Formation bears rich marine fossils belonging to the Miocene (Burdigallian). The carbonate sediments in the Quilon basin rest unconformably over the Vaikom beds (Nair and Rao, 1980).

Geologically, the Quilon beds were referred first by Carter (1854) in connection with reports of fossils from the grey fossiliferous and argillaceous limestones. Later on, W. King in 1882 recognized outcrops of limestones at Padappakara ($8^{\circ} 58' \text{N}$; $76^{\circ} 40' \text{E}$). This is the type area of the Quilon limestone formation. This was again reported by Logan in 1883. The Padappakara village is situated at about 10 Km. NE of Kundara, a town located in the NH 207 at a distance of about 15 Km. from Quilon city (presently Kollam). The type section

at Padappakara is represented by a few small outcrops which are not more than 10-25 sq. m. These are *in situ* exposures of irregular shape and without any stratification. The outcrops are partly weathered. The limestone exposures bear enough molluscan fossils of marine habitats. The limestone here is massive and off-white to light grey in colour. It is hard and compact. The outcrops are spatially separated by thick and extensive weathering profiles of laterite or kaolinite rich clay, or sometimes by variegated clay, locally enriched with iron (Fe). In adjoining areas, the Quilon limestone is encountered in open dug wells of about 8-10 m. deep (Foote, 1883; Menon, 1967).

Earlier workers (*viz.*, Jacob and Sastri, 1951, 1952; Sahni and Sastry, 1958; Dey, 1962; Verma, 1977; Padmalal and Seralathan, 1991) reported several fossil forms from the Quilon limestone beds. However, a detailed account establishing an assemblage zone of fossil fauna of the concerned beds was not available. An assemblage zone is based primarily on the combination of available fossil forms in a rock bed. A study is therefore carried out to explore the macrofossil forms from the area to characterize the assemblage zones.

EXTENT AND STRATIGRAPHY OF QUILON LIMESTONE

The Fig. 1 shows the palinspastic map of the Quilon basin prepared during the present study based on the spatial distribution of bed rocks of limestone encountered in open wells and bore

wells. The Quilon limestone basin presently covers an area of about 1200 sq. km. The basin is elongated but irregular in shape, trending NNW-SSE. The basin is about 115 km. long in the N-S direction, from Alapuzha in the North to Edava in the South, and 23 km. wide in the E-W direction from Cherthala in the West to Thakazhi (Lat:09°22'00" Long:76°25'35") in the East (Sabu Joseph and Thirvikramaji, 2002).

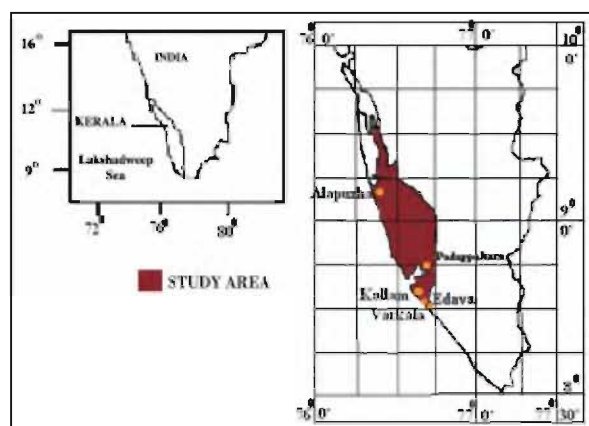


Fig. 1. Schematic map showing the subsurface distribution of the Quilon limestone and the present study area.

A generalized diagram of the succession of Quilon formation prepared from data of bore wells is presented in Fig. 3. The Formation begins with

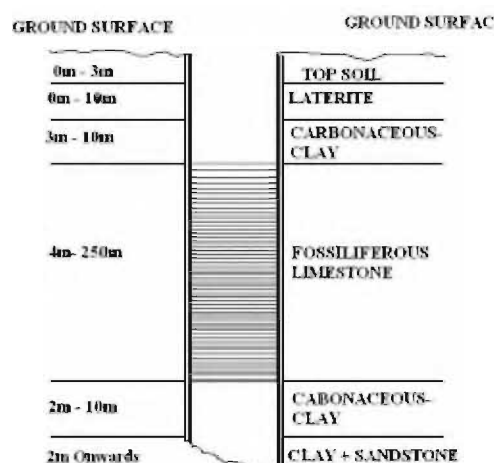


Fig. 2. A generalized diagram of a section of Quilon formation showing fossiliferous Limestone.

coarse sandstone followed by sandy clay and fine clay on top of that. This clay bed of unequal thickness is overlain by limestone beds. The limestone beds show variable thickness with tongues and lenses at several places. The maximum thickness of the limestone is reported at Nirkunnam (Lat: 09°23'30" Long:76°19'30") in Aappuzha district.

MACRO INVERTEBRATE FOSSILS OF QUILON LIMESTONE FORMATION

The Quilon limestone is richly fossiliferous. However, the degree of fossilization has not attained the full extent of petrification. A large number of fossils were collected from open wells and bore-wells dug at places like Mayyanadu (Lat:08°50'00" Long:76°39'00"), Kottiyam (Lat:08°52'00" Long:76°35'00"), Thazhuthala (Lat:08°51'00" Long:76°36'00"), Padappakara (Lat:08°53'02" Long: 76°28'15"), Chavara (Lat:08°58'55" Long:76°31'50"), and Karunagapally (Lat:08°59'45" Long:76°32'35"), Cherthala (Lat:9° 37' 50" Long: 76°19'40") Kalaikode (Lat:08° 47'40" Long: 76°41'05"), and other places.

PROCEDURES

All the fossil specimens including broken ones were collected and the details of depth of occurrence were recorded. Morphologically complete and partially broken but recognizable specimens of invertebrate fossils were sorted out and labelled separately. The fossils were soaked in water and cleaned very carefully with a sharp needle and washed gently with water. The specimens are then dried in air, wrapped with cotton and placed in small boxes. Fossils from open wells show complete morphology while bore well samples are generally recognizable but broken. Fossils were carefully collected and labelled at the site itself recording the depth of occurrence and the count of each species. The samples from open wells alone are taken into consideration for vertical zonation. The percentage abundance of the more dominant fossil species in the upper and lower zones are shown in Table.1

Table 1. The percentage abundance of dominant fossil species recovered from open wells .

Location and Vertical Zonation		Dominant Fossil species in Percentage											
		A	B	C	D	E	F	G	H	I	J	K	Oth ers
Thazhuthala (Open well)	Upper zone						45.5	18.18	9.09	9.09	6.06	6.06	6.06
	Lower zone	55.19	16.51	12.73	7.55	5.18							2.83
Kottiyam-1 (Open well)	Upper zone						46.15	20.51	10.26	7.7	7.7	5.12	2.56
	Lower zone	52.58	16.9	14.08	8.45	4.70							3.28
Kottiyam-2 (Open well)	Upper zone						44.4	19.44	11.11	11.11	7.69	2.56	2.56
	Lower zone	57.41	15.31	12.44	6.70	6.22							1.91

A- Rimella ; B- Turritella; C- Strombus; D- Strombus marginatus; E- Serpularis;
F- Cantharus; G.- Murex; H- Chicoreus; I- Corbula; J- Chlamys; K- Conus.

SYSTEMATICS

The identification of the molluscan macrofossils was carried out by consulting the *Treatise of Invertebrate Palaeontology* (Knight *et al.*, 1964; Cox *et al.*, 1969a,b, 1971), *Compendium of Sea Shells* (Abbott and Dance, 1986) and by comparison of reference material in Zoological Survey of India (ZSI) collection.

Phylum MOLLUSCA,

Class GASTROPODA

Order MESOGASTROPODA,

Family STROMBIDAE

1. *Strombus marginatus* Linnaeus, 1758

(Plate I, Figs. 1, 2)

Diagnosis: Shell ovately conical, spire rather high and acuminate; aperture elongate, outer lip not observed (broken), posterior canal extends straight up and adheres to two or three spiral whorls; sculpture consists of numerous axial riblets on apical whorls; a single nodulose and distinct

knob on shoulder of body whorl dorsally; colour creamy-white.

Measurements (in mm.) : Height- 39.6, height of last whorl- 28.0, height of aperture- 25.1.

Locality : Thazhuthala, Kottiyam

Geological horizon: Lower Miocene (Burdigallian)

2. *Strombus* sp. (Plate I, Figs. 3, 4)

Diagnosis : Shell ovately conical, spire moderately high, apex sharp; aperture slightly oblong, columella smooth, with a short blunt projection at the posterior end; siphonal canal slightly recurved; spire whorls sculptured with axial ribs and sharply angular shoulder; shoulder of body whorl rounded and with a few axially lengthened knobs; colour creamy white.

Measurements (in mm.) : Height- 37.2, height of last whorl- 26.1, diameter of last whorl- 16.2, height of aperture- 23.3, diameter of aperture- 4.1.

Locality : Thazhuthala, Kottiyam

Geological horizon : Lower Miocene (Burdigallian)

3. *Rimella (Varicospira)* sp. nr. *cancellata*
Linnaeus, 1758 (Plate I, Figs. 5, 6)

Diagnosis : Shell moderately large, solid, fusiform, spire acuminate, outer lip thickened, crenulate, flanked by a deep furrow, extends towards apex covering 2-3 spire whorls; columella with callus, extends over whole length of the body whorl and with outer lip forming a long anal canal; siphonal canal short, aperture and lip liriate; sculptured with axial ribs connected by pitted, spiral grooves giving it cancellate appearance and randomly placed varices.

Measurements (in mm.): Height- 22.2, height of last whorl- 13.34, diameter of last whorl- 11.6, height of aperture- 10.0, diameter of aperture- 2.7.

Locality : Kottiyam, Chavara, Paravur, Thazhuthala.

Geological horizon : Lower Miocene (Burdigallian)

Family TURRITELLIDAE

4. *Turritella* sp. (Plate I, Figs. 7, 8)

Diagnosis : Shell long, attenuate with several whorls; earlier whorls convex with many fine spiral ridges, on other whorls two sharp ridges in middle, whorls in the middle sharply angular; aperture somewhat rounded.

Measurements (in mm.): Height- 23.85, height of last whorl- 5.1, diameter of last whorl- 8.4, height of aperture- 4.5, diameter of aperture- 3.3.

Locality : Padappakara, Chavara, Kollam, Paravur, Thazhuthala.

Geological horizon : Lower Miocene (Burdigallian)

Family VERMETIDAE

5. *Vermetes* sp. (Plate II, Fig. 18)

Diagnosis : Shell irregularly coiled tube; surface consists of irregular cords; interior of shell glossy.

Measurements (in mm.): Diameter of shell- 6.0.

Locality : Chavara, Thazhuthala, Padappakara.

Geological horizon : Lower Miocene (Burdigallian)

6. *Serpulorbis* sp. (Plate II, Fig. 19)

Diagnosis : Long, slender, usually coiling shells resembling 'worm tubules' and growing in clumps.

Measurements (in mm.): Diameter of shell- 1.1.

Locality : Thazhuthala, Chavara, Kottiyam, Padappakara.

Geological horizon : Lower Miocene (Burdigallian)

Order NEOGASTROPODA,

Family MURICIDAE

7. *Murex* sp. (Plate I, Figs. 9, 10)

Diagnosis: Shell moderately large, spindle shaped; spire elevated, acute, consists of a few whorls; aperture elongate-ovoid, without anal sulcus, outer lip crenulated, interior slightly liriate, siphonal canal elongate and narrowly open; body whorl large, with low axial ridges; spiral sculpture consists of primary, secondary and tertiary cords.

Measurements (in mm.): Height- 26.69, height of last whorl- 19.55, diameter of last whorl- 8.87, height of aperture- 16.0, diameter of aperture 2.76

Locality : Padappakara, Thazhuthala, Chavara, Karunagapally.

Geological horizon: Lower Miocene (Burdigallian)

8. *Chicoreus* sp. nr. *kilburni* Houart & Pain,
1982 (Plate I, Figs. 11, 12)

Diagnosis: Shell moderately large, broadly rhomboidal, protoconch smooth with two and half whorls, terminally depressed like a cavity, spire elevated with 7-8 post nuclear whorls; body whorl large; aperture large, ovoid-round, anal sulcus inverted V-shaped, outer lip dentate, interior liriate; columella adherent, anteriorly slightly detached; siphonal canal medium-sized, broad narrowly open and recurved upward towards right; body whorl sculptured with three varices, three axial ribs, axial rib on shoulder prominent and knob-like, spiral sculpture with major and minor cords bearing fine nodules, shoulder spine large and branched followed by spines enclosing finer spinelets in between; canal with spines.

Measurements (in mm.): Height- 31.9, height of last whorl- 19.9, diameter of last whorl- 12.75, height of aperture- 18.3, diameter of aperture- 5.3.

Locality : Kollam, Chavara, Mayyanadu, Thazhuthala.

Geological horizon : Lower Miocene (Burdigallian)

Family BUCCINIDAE

9. *Cantharus* sp. (Plate I, Figs. 13, 14)

Diagnosis: Shell moderately large, thick and horny; body whorl higher than spire, constricted towards base; aperture moderately broad, outer lip thickened, with 5-6 strong teeth and anterior most forming a ledge entering the aperture; columella calloused, with lirations on the parietal wall and two prominent teeth on lower half; sculptured with broad axial ribs prominently crossed by sharply raised spiral cords.

Measurements (in mm.): Height- 23.85, height of last whorl- 15.5, diameter of last whorl- 14.4, height of aperture- 13.85, diameter of aperture- 4.95.

Locality: Thazhuthala, Kottiyam,

Geological horizon: Lower Miocene (Burdigallian)

Family CONIDAE

10. *Conus* sp. (Plate I, 15-17)

Diagnosis: Shell moderately large, cone-shaped with an elongate body whorl; spire convexly flat, slightly elevated, distinctly striate, pointed apically; aperture long, narrow and extending along whole body length, inner lip and outer lip run almost parallel.

Measurements (in mm.): Height- 21.4, height of last whorl- 15.5, diameter of whorl- 10.5, height of aperture- 17.5, width of aperture- 1.5.

Locality: Kollam, Chavara, Karunagapally, Thazhuthala.

Geological horizon: Lower Miocene (Burdigallian)

Class BIVALVIA

Subclass PTERIOMORPHA

Order PTERIOIDA

Family PECTINIDAE

11. *Chlamys* sp. (Plate II, Figs. 20, 21)

Diagnosis : Both valves (RV and LV) convex, higher than long, somewhat oblique; auricles clearly delimited, large, byssal notch large; sculpture of radial ribs; margin scalloped.

Measurements (in mm.): Length- 18.0, height- 21.4.

Locality : Thazhuthala.

Geological horizon: Lower Miocene (Burdigallian)

Subclass HETERODONTA,

Order MYOIDA,

Family CORBULIDAE

12. *Corbula* sp. (Plate II, Figs. 22-24)

Diagnosis : Moderate-sized sturdy shell, valves similar in size and shape, moderately inflated, concentrically ribbed, rostrum bordered by keel

Measurements (in mm.): Length- 11.65, height- 7.76, inflation- 5.56.

Locality : Padappakara, Chavara

Geological horizon : Lower Miocene (Burdigallian).

DISCUSSION

The Quilon limestone bears dominantly fossils of molluscs, foraminifers, and occasional corals, crabs, echinoids, etc. The Lower Miocene age for lower stratigraphic horizons and the Upper Miocene age for uppermost stratum indicate the time range of these marine sediments. The prevalence of black clays, sandstone, bluish grey brackish water shell limestone and nodular limestone signify the deposition in a lagoonal condition (Rajan and Kumar, 2005). Borehole data (CGWB, 1999) showed that the basin has variable depth at places suggesting an irregular relief for the floor of the basin. The basin attains maximum depth around Alappuzha and Cherthala and the depth diminishes towards the north, east, south and southeast. The maximum thickness of the limestone bed measuring about 298 m. has been found at a borehole drilled at Nirkunnam (Lat. 09°23'45" Long. 76°21'15") and the average thickness of the limestone deposit is about 30 m. At many places the limestone bed is lens-shaped with tongue-like extensions where the bed shows large perforations of irregular shapes.

The molluscan forms recovered from the Quilon beds are either similar or closely related to species still in existence. They are primarily shallow marine forms and the depth of water may not be more than 40 m. as most of these forms are not generally found below that depth. Verma (1977) on the basis of recovered fossilized crabs stated that the animal forms of the bed were characteristic of near-shore

environment with a temperature range of 25 ° -30 °C, salinity range of 27-40 ppm and bathymetric range of surface to 20 m. The molluscan species show clear similarity with the fauna of the Indo-Pacific region. Dey (1962) demonstrated the affinity of the most molluscan forms with those of the Gaj and Karikal beds of India, and some show similarity with the Miocene and Pliocene forms of Java. According to him the fauna of Quilon and Miocene fauna of Ceylon (Sri Lanka) are of same age.

The molluscan fossils showing high frequency of occurrence in Quilon limestone are: *Strombus marginatus*, *Chicoreus*, *Rimella*, *Turritella*, *Murex* and *Conus*. The distribution of fossils shows systematic variation as the depth increases, but shows remarkable similarity horizontally. Fossils recovered during the present study suggest that on the basis of assemblage the Quilon limestone formation can be divided into an upper and lower biostratigraphic zones (see Tale 1).

It has been seen that the upper division is dominated by *Rimella*, *Turritella*, *Strombus*, *Strombus marginatus*, *Serpulorbis* and the lower zone is marked by the dominance of molluscs represented by *Cantharus*, *Murex*, *Chicoreus*, *Corbula*, *Chlamys*, *Conus*, etc.

During the present study fossils were recovered from several open wells and bore wells. However, for systematic analysis samples from three open wells only are taken. The percentage distribution of dominant fossil species are shown in Figs. 5 to 10.

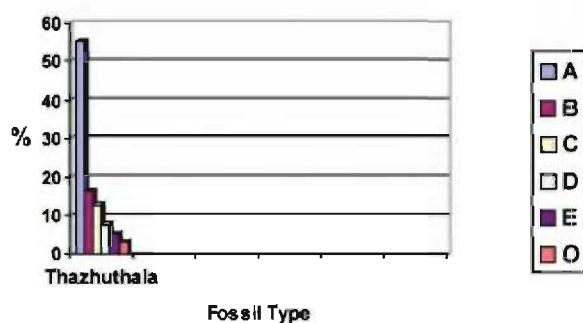


Fig. 5. Histogram showing distribution of dominant fossil species in the lower zone at Thazhuthala

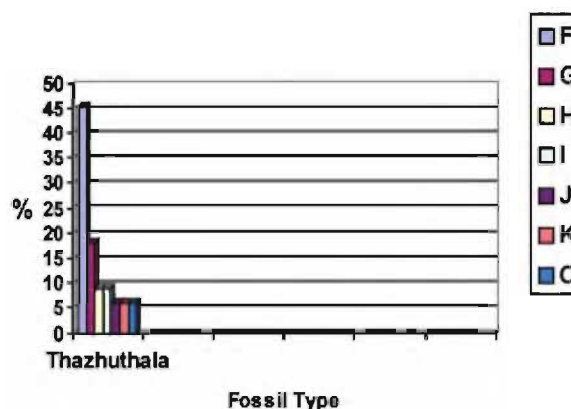


Fig. 6. Histogram showing distribution of dominant fossil species in the upper zone at Thazhuthala

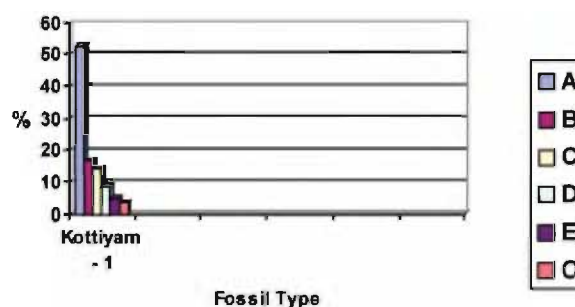


Fig. 7. Histogram showing distribution of dominant fossil species in the lower zone at Kottiyam -1

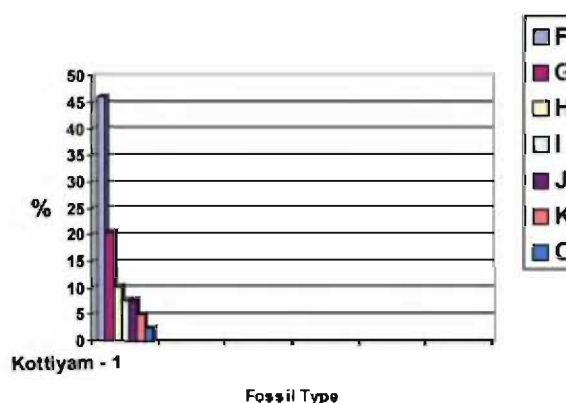


Fig. 8. Histogram showing distribution of dominant fossil species in the upper zone at Kottiyam-1

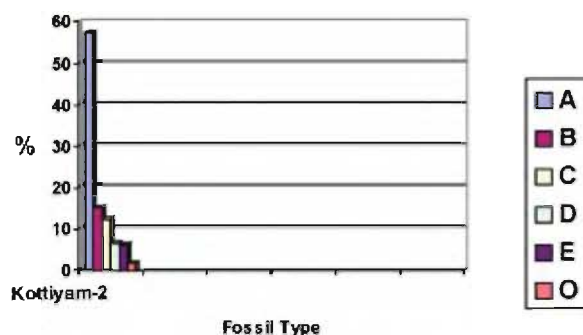


Fig. 9. Histogram showing distribution of dominant fossil species in the lower zone at Kottiyam-2

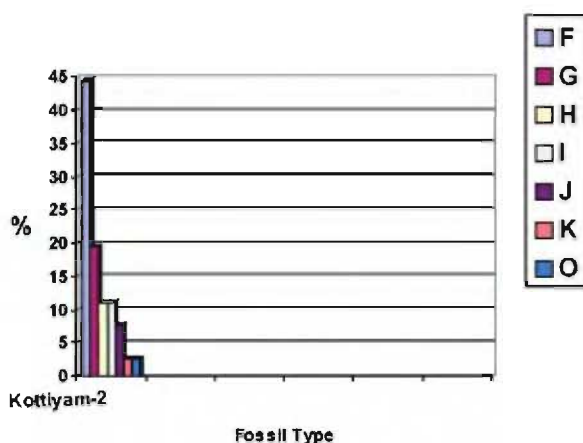


Fig. 10. Histogram showing distribution of dominant fossil species in the upper zone at Kottiyam-2A

One of the remarkable features of the Quilon limestone fauna as noted by Dey (1962) is the predominance of the gastropod molluscs. This is also evident from the samples collected during the present study. There has been a practice of deducing age among the palaeontologists of the Tertiary fauna from the proportion of the extant species and the extinct species. The limitations of the practice has however been pointed out by Dall (1904), Vaughen (1924). Van Der Vlerk (1931) worked out a percentage of the Tertiary fauna of the Indo-Pacific region for different periods.

It is considered that the evolutionary rate since early Tertiary in that region has been slower than in Mediterranean and North American Tertiary provinces. Relying upon Van Der Vlerk's deduction Dey (1962) opined that Quilon bed is of Upper Miocene or Vindobonian in age. Eames (1950) considered Quilon fauna belong to Upper Gaj (Burdigallian) age because of presence of several

typical Gaj species in the fauna. Jacob and Sastri (1952) referred the foraminiferal forms from 170-280 ft. below surface in a borehole at Chavara (near Quilon) to Burdigallian age. These faunal forms are probably from a lower fossiliferous horizon than the Quilon bed exposed on the backwaters.

The diversity and vertical zonation of the fossil molluscs in the Quilon limestone bed shows that the fossil fauna bears biostratigraphic significance for an upper and lower division character. It is presumed that there was significant change in palaeoclimate and ecological factors that supported the fauna. It is interesting to note that associated carbonaceous beds of the Quilon formation are devoid of macroinvertebrate fossils. The rich fossil fauna in the Quilon bed is an indication of favourable oxygen concentration, transparency of the aquatic medium, nutrients, basin stability, etc. existed for a faunal community only during a limited period of time. This shows that the Late Miocene marine transgression during which the Quilon limestone deposited was of a short time span. During this time the basin was perhaps completely isolated from terrigenous sedimentation and that the present drainage pattern of the area developed after the uplift of the basin. It may be inferred that the palaeoclimate during which the limestone deposition took place was without much precipitation and a tendency of dryness and higher palaeo-temperature prevailed.

SUMMARY

The Neogene deposits of South Kerala sedimentary basin located along the southern coastal stretches of Kerala are represented by the sediments belonging to the Vaikom, Quilon and Warkalli Formations. These sediments apparently rest unconformably over the Archaean metamorphosed crystalline basement. While the older Vaikom and the younger Warkalli beds are unfossiliferous the Quilon limestone beds, sandwiched between them, are rich in marine macrofossils. These comprise several species of Mollusca. This fauna and available information of other biota indicate a Burdigallian age for the carbonaceous beds. The present paper incorporates a systematic account of the macro invertebrate fossils recovered from the limestone beds that show dominance of Gastropoda followed by Bivalvia

(Pelecypoda). The biostratigraphic correlation and palaeo-environmental conditions for the growth of these fauna have also been discussed.

Based on the abundance and pattern on distribution of macrofossils species with depth, the Quilon limestone formation can be divided into an upper and a lower zone. In each zone a particular fossil species appears to dominate numerically. The present study identifies and gives morphological description of the available species. The vertical variation in the frequency of major fossil species in the two biozones indicate changes

in the paleo-ecological conditions in the sedimentary basin during the Tertiary period.

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PLATE I



Figs. 1-17. 1-2, *Strombus marginatus* Linnaeus: 1, Adapertural view (1.3X), 2, Apertural view (1.3X); 3-4, *Strombus* sp.: 3, Adapertural view (1.3X), 4, Apertural view (1.3X); 5-6, *Rimella* (*Varicospira*) sp. nr. *cancellata* Linnaeus, 5, Apertural view (2.1X), 6, Adapertural view (2X); 7-8, *Turritella* sp.: 7, Apertural view (1.8X), 8, Adapertural view (1.8X); 9-10, *Murex* sp.: 9, Adapertural view (1.7 X), 10, Apertural view (1.8 X); 11-12, *Chicoreus* sp. nr. *kilburni* Houart & Pain: 11, Adapertural view (1.59X), 12, Apertural view (1.56X); 13-14, *Cantharus* sp.: 13, Adapertural view (1.8X), 14, Apertural view (1.7X); 15-17, *Conus* sp.: 15, Adapertural view (1.6X), 16, Apical view (1.4X), 17, Apertural view (1.8X).

PLATE I



Figs. 18-24. 18, *Vermetes* sp. (2.5X); 19, *Serpulorbis* sp. (3.1X); 20-21, *Chlamys* sp.: 20, External view of left valve (2.9X), 21, Internal view of left valve (3X); 22-24, *Corbula* sp.: 22, External view of right valve (4X), 23, Lateral view, umbonal area (5X), 24, External view of left valve (4.2X).



THE SPECIES OF *MONACON* (HYMENOPTERA: CHALCIDOIDEA: PERILAMPIDAE) FROM INDIA AND ADJACENT COUNTRIES

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ABSTRACT

Monacon species (Hymenoptera: Perilampidae) are reviewed for the Indian subcontinent. A new species is described from Maharashtra, and diagnoses, data on distribution and hosts of known species from the region are given. A key to species of *Monacon* of the Indian subcontinent is also provided.

INTRODUCTION

The South and Southeast Asian species of the perilampid genus *Monacon* Waterston were treated taxonomically in a revision of the world species by Bouček (1980). Mani (1989) gave a modified version of the key to species of *Monacon* published by Hedqvist (1968). Subba Rao (in Subba Rao and Hayat, 1986) gave a catalogue of *Monacon* species of India and adjacent countries. So far only six species of *Monacon* are known from the Indian subcontinent (Noyes, 2013). After studying the Perilampinae and Chrysolampinae (Narendran, 2003 and Narendran and Sudheer 2003), collection made by the second author (PMS) in the Lonar Crater Wildlife Sanctuary (Maharashtra) in 2003 revealed an undescribed species of the genus *Monacon*. This has given us an opportunity to review all the species of the Indian subcontinent, and update the key to species. Diagnoses are provided here of the known species of the Indian subcontinent mainly based on Bouček's (1980) revision. The Indian subcontinent includes countries south of the Himalayas, ie Pakistan, India, Nepal, Bhutan, Bangladesh, Sri Lanka and Myanmar. Most species of *Monacon* develop as

parasites of ambrosia beetles (Coleoptera: Platypodidae). One record mentions Scolytidae as the host.

The holotype of the new species is deposited in the Department of Zoology, University of Calicut (DZUC) pending transfer to the Western Ghat Regional Centre of Zoological survey of India, Kozhikode (ZSIK).

Abbreviations used : AOL = Distance between anterior ocellus and any one posterior ocellus; CC = Costal cell; L = Length; MV = Marginal vein; OOL = Minimum distance between eye and posterior ocellus; PMV = Postmarginal vein; POL = Distance between posterior ocelli; SMV = Submarginal vein; STV = Stigmal vein; T1 to T6 = Gastral tergites 1 to 6; W = width.

Acronyms used : BMNH = The Natural History Museum, London, U.K.; DZUC = Department of Zoology, University of Calicut, Kerala, India; USNM = The United States National Museum of Natural History, Washington, D.C. U.S.A.; ZSIK = The Western Ghat Regional Centre, Zoological survey of India, Kozhikode, Kerala, India.

Monacon Waterston

1922: *Monacon* Waterston, 24. Type species: *Monacon productum* Waterston; designated by Baltazar, 1966.

Diagnosis: Female and Male: Body black, with or without metallic green or blue refringence, including coxae, often femora and antennal scapes; rest of legs testaceous or pale yellow. Wings often slightly infumate especially below veins. Head with a strong median horn between antennae;

Key words : New species, review, key, Hymenoptera, Perilampidae, *Monacon*, India

scrobe delimited dorsally by distinct carina; parascrobal area more or less elevated. Antennal formula 11110; clava not differentiated from funicle, apex pointed with one or two apical bristles. Malar sulcus may be distinct or indistinct; pronotum often with angulate shoulders; mesoscutum mostly very convex or hump like; scutellum at apex forming distinct angle about 60° to 90°, projecting over basal part of propodeum; propodeum with alveolae and large pits, with a median carina and costula; prepectus relatively large with its dorsal margin 2 or more times longer than length of tegula. Metasoma with a transverse petiole, visible mostly on ventrolateral part, with a row of longitudinal fovea posterior to anterior carinate margin; T1 with a large basal sub triangular fovea, fovea sometimes constricted by submedian swellings; posterior margin of T1 angularly emarginated greatly; ovipositor sheath flattened from side to side (Waterston, 1922; Bouèek, 1980).

Hosts: Coleoptera (Platypodidae and Scolytidae)

Distribution: Old World (Africa, Asia, New Guinea and Australia)

Remarks: This genus differs from all other genera of Perilampidae in having the frontal median horn between antennae.

Key to species of *Monacon* of India and Adjacent Countries

(Modified from Bouèek, 1980).

1. Lower face below the horn with a pair of distinct tubercle-like elevations or teeth situated at or on lateral margins of clypeus 2.
- = Lower face with tubercles or elevations absent 5.
2. Tubercles of lower face visible only in certain illumination or light; horn gradually tapering to apex, pointed (Fig.5); clypeus moderately shiny, its lower margin only slightly produced; malar space densely sculptured, dull, femora and tibiae testaceous. India *M. productum* Waterston (in part)
- = Tubercles well distinct, also lateral grooves delimiting clypeus developed at least outside of each tubercle; other characters at least partly different 3.
3. Groove-like lateral margin of clypeus ventrally interrupted at upper side of tubercle; horn in dorsal view distinctly widening to apex (Fig.3); sides of mesosoma before tegulae virtually parallel. Myanmar *M. atkinsoni* Bouèek
- = Grooves delimiting sides of clypeus deep, even above tubercles; horn sometimes scarcely widening at apex; sides of mesosoma slightly converging forwards 4.
4. Scutellum plus axillae combined nearly as broad as medially long; scutellum only as long as broad; narrow part of horn (Fig.1) in dorsal view about 2x as long as wide. India *M. abruptum* Waterston
- = Scutellum plus axillae combined distinctly narrower than its length in middle; scutellum broadly meeting mesoscutum, each axilla strongly sloping laterally; axillulae well delimited even anteriorly; narrow part of horn in dorsal view (Fig.2), about 3x as long as wide. Sri Lanka *M. angustum* Bouèek
5. Horn (Fig.4) very slender, tapering and narrowly rounded at apex; clypeus fairly shiny, in upper half with few scattered hairs only; parascrobal lobes well protruding above plane of face, protruding part 0.35x as long as eye length in profile (Fig.20). Myanmar *M. longispina* Bouèek
- = Horn in dorsal view at least slightly widening at apex which is truncate or emarginate at apex or bidentate; other characters partly different 6
6. Clypeus laterally delimited by short and deep groove which suddenly ends below a slight elevation. India, Philippines *M. productum* Waterston
- = Clypeus completely or almost completely bordered (except anterior margin) by distinct or weak groove, without elevation 7
7. Body (Fig.7) black without metallic refringence; PMV shorter than STV (Fig.10) POL 1.7x OOL; height of eye 1.4x its length in profile. India *M. buldanicum* Narendran & Sureshan, sp. nov.

= Body, especially head and mesosoma dark metallic green; PMV longer than STV; Height of eye (Fig.6) 1.3x its length. Sri Lanka *M. senex* Bouček

For practical reasons the species are arranged alphabetically below :

1. *Monacon abruptum* Waterston
(Fig.1)

1922 : *Monacon abruptum* Waterston, 29-30. Holotype Female, Bangladesh. Khulna, Sunderbans, Tambulbunia (BMNH).

1980 : *Monacon abruptum* Waterston: Bouček, Keyed.

Diagnosis (Based on Waterston, 1922 and Bouček, 1980). Female: Length 2.6mm. Body black with metallic blue refringence; scrobes not extended as deep channels downwards, hardly reaching below level of horn; narrow part of horn in dorsal view about 2x as long as broad; clypeal tubercles distinct; grooves delimiting sides of clypeus deep, even above tubercles; pilosity on clypeus sparse, hairs not longer than space between them; supra clypeal part usually as shiny as clypeal surface; sides of mesosoma slightly converging forwards; scutellum plus axillae combined nearly as broad as median length; scutellum only narrowly meeting mesoscutum.

Male: Unknown

Hosts : *Platypus uncinatus* Blandford (Platypodidae) on *Heritiera littoralis* Dryand & Alton (Malvaceae) (Bouček, 1980).

Distribution : India, Bangladesh [In Bouček's citation (1980) the holotype locality is shown as "Tambulbunia" with India in "?" mark. Tambulbunia is in Bangladesh and hence the type locality is Bangladesh.

Remarks : This species comes near *M. angustum* Bouček in having: 1) grooves delimiting sides of clypeus deep above tubercles; 2) horn scarcely widening to apex and 3) sides of mesosoma slightly converging forwards. However *M. abruptum* differs from *M. angustum* in having: 1) Scutellum plus axillae combined nearly as broad as its median length (In *M. angustum* scutellum plus axillae combined distinctly narrower than its length in middle); 2) Scutellum broadly narrowly meeting mesoscutum (in *M. angustum* scutellum broadly

meeting mesoscutum) and 3) Narrow part of horn in dorsal view about 2x as long as broad (in *M. angustum* narrow part of horn in dorsal view about 3x as long as broad).

2. *Monacon angustum* Bouček
(Fig. 2)

1980 : *Monacon angustum* Bouček, 82. Holotype Female, Sri Lanka (USNM)

Diagnosis (Based on Bouček, 1980): Female: Length 2.2mm. Black; tibiae partly and tarsi wholly testaceous; wings hyaline with veins brown and parastigma dark; vertex (outside ocellar triangle), horn and genae almost smooth; horn not distinctly compressed from side to side at base in dorsal view, hardly wide at apex, flattened, truncate, not hollowed (Fig.2); clypeus completely smooth with well delimited on sides and on dorsal side, with a very few scattered hairs; tooth like tubercles present away from the lower margin of clypeus. POL 1.4x OOL; height of malar space 0.31x height of eye, 0.4x eye length; scutellum with apex blunt; in side view scutellum almost flat. PMV barely longer than STV; T1 with basal fovea narrowed and deepened towards distal part.

Male : Unknown

Host : Unknown

Distribution : Sri Lanka

Remarks : This species resembles *M. abruptum* in having characters mentioned under that species above and can be separated by the points mentioned under 'Remarks' under *M. abruptum* above.

3. *Monacon atkinsoni* Bouček
(Fig. 3)

1980: *Monacon atkinsoni* Bouček, 84. Holotype Female, Myanmar (=Burma) (BMNH)

Diagnosis : (Based on Bouček, 1980). Female: Length 2.7mm. Black; flagellum, tibiae and tarsus testaceous; wings slightly whitish, venation pale. Head with obliterated reticulation, posterior part of malar space smooth; projecting part of parascrobal space 0.33x length of eye in profile (5:15); horn in dorsal view shorter than 2x as long as apical width, constricted in middle, apex truncate, slightly hollowed beneath; clypeus smooth with a few scattered hairs arising on low papillae; facial

tubercle present; upper margin of clypeus not delimited by groove; POL 1.35x OOL; mesosomal dorsum with smooth and narrow interstices; scutellum 1.5x as long as broad, edges of apex converging at hardly more than 60°. Propodeum with weak irregular median carina. PMV shorter than STV.

Male : Unknown.

Host : Unknown

Distribution : Myanmar

Remarks : This is a unique species with large clypeal tubercles and subcylindrical mesosoma which is relatively longer than in other species.

4. *Monacon buldanicum* Narendran & Sureshan,
sp. nov.
(Figs. 7-10)

Male (Holotype) : Length : 3.5mm. Black, coxae black with apices pale; fore and mid trochanters brown with apices pale; fore and mid femora dark brown with apices pale yellow; hind trochanter pale yellow; hind femur blackish brown with base and apex pale yellow; all tibiae and tarsi pale yellow. Wings hyaline without any infumation, with veins pale brown; pubescence on body dirty white.

Head : With raised reticulation on frons and gena; weakly reticulate on vertex, not smooth. Width of head in anterior view 1.41x as broad as high (93:66), width in dorsal view 3.2x its length. Relative measurements: POL = 10; OOL = 6; AOL = 3; minimum width between compound eyes at vertex 3x POL; horn distinctly compressed from side to side at base, in dorsal view widening at apex, slightly bifid at apex, hollowed beneath; clypeus laterally delimited by short and deep groove which is weakly curved above basal margin of clypeus to meet opposite groove below a slight elevation; clypeus with raised coarse reticulation, pilose, its lower margin produced forward slightly and semicircular; labrum with 16-19 radiating digital setae at margin; parascrobal lobes in profile distinctly protruding, protruding part in side view 0.39x as long as eye length, 0.28x eye height; scrobe not reaching downwards to level with centre of clypeus; eye height in profile 1.4x its length (25:18); height of malar space about half length of eye

height (12:25); malar groove weak, partially visible on lower half. Antenna with, scape, pedicel, one anellus plus 10 segmented funicle plus clava (clava not differentiated from funicle); scape slightly exceeding level of vertex; relative L:W of antennal segments: scape = 18:2; pedicel = 5:4; anellus = 3:1; F1 = 4:4; F2 = 4:6; F3 = 3:6; F4 = 3:6; F5 = 3:6; F6 = 3:5; F7 = 3.5; F8 = 2.5:5; F9 = 2.5:4; F9 = 2.5:4; F10 = 4:3.

Mesosoma : Strongly convex; with deep umbilicate setigerous pits; interstices carinate, 1.46x as long as wide; mesoscutum broader than sharp shouldered pronotum (24:22); scutellum plus axillae combined, 1.22x as broad as long; apical edges of scutellum converging a little over 60°. Propodeum alveolate with strong raised median arch like carina, crossed just behind middle by strong costula; convex sides, closely and irregularly punctate with deep alveolate pits; spiracle 2x longer than wide, separated from posterior margin of metanotum by a distance longer than length of spiracle (5:4). Forewing 2x as long as wide; narrow, PMV slightly shorter than STV (8:10), latter slightly knobbed; relative length of CC = 65; SMV = 62; MV = 23; PMV = 8; STV = 10; parastigma = 10. Hind coxa bare on dorsal side except for a bunch of white setae on dorsal margin in posterior half (Fig.11); ventral side fully pubescent.

Gaster : Shorter than mesosoma (64:84); T1 with a subtriangular basal median fovea, exceeding half way to apical margin of T1; maximum length of T1 in dorsal view 1.43x maximum length of visible part of T2; T3 longest, 2x as long as T1; T4 0.25x as long as T3; T5 shorter than T4; T6 shorter than T5; T1 and T2 bare; T3 with a few weak pubescence on posterior admarginal area; T4 with about 32-36 weak setae; T6 18-20 setae.

Variation : Length 3 – 3.5 mm.

Female : Unknown

Hosts: Unknown

Distribution: India (Maharashtra).

Material examined : Holotype Male: INDIA, Maharashtra, Buldana district; Lonar Crater Wild Life Sanctuary, West of Kamalaja Devi temple, 20.xi.2003. P.M.Sureshan. Paratype: Same data of Holotype. [Both types are deposited in DZUC pending transfer to ZSIK].

Etymology : Named after the district Buldana of Maharashtra from where the types are collected.

Remarks : This new species comes near *Monacon senex* Bouček in the key to species of *Monacon* by Bouček (1980) but differs from it in having: 1) Body black without metallic refringence (in *M.senex* body, especially head and mesosoma dark metallic green); 2) head in anterior view 1.41x its height (in *M.senex* head in anterior view 1.3x as long as its height); 3) POL 1.7x OOL (in *M.senex* POL 1.4x OOL); 4) height of malar space 0.5x height of eye in profile (in *M.senex* height of malar space 0.4x height of eye in profile); 5) height of eye 1.4x its length in profile (in *M.senex* height of eye 1.3x its length in profile); and 6) PMV shorter than STV (in *M.senex* PMV longer than STV).

This new species differs from *M.productum* Waterston (which is found in India) in having: 1) body black without metallic refringence (in *M.productum* body black with metallic blue refringence on head and mesosoma); 2) Head with raised reticulation on frons and gena, weakly reticulate on vertex (in *M. productum* head dull shiny except striate on occiput); 3) MV 2.3x as long as STV (in *M.productum* MV 3x as long as STV); 4) height of malar space 0.5x height of eye (in *M.productum* height of malar space 0.3x height of eye in profile) and 5) hind coxa with a bunch of setae on apical half of dorsal margin (in *M.productum* not such distinct bunch of setae on hind coxa).

5. *Monacon longispina* Bouček (Fig. 4)

1980: *Monacon longispina* Bouček, 87. Myanmar, Holotype Female (BMNH)

Diagnosis : (Based on Bouček, 1980): Female: Length 3.6mm. Black; tarsi and part of tibiae dark testaceous; forewing with broad but weak infumation below veins. Projecting part of parascrobal space in side view 0.4x length of eye; horn very slender, tapering and narrowly rounded at apex which is truncate or bidentate; clypeal tubercles indistinct. POL 1.1x OOL; height of malar space 0.27x height of eye, 0.35x length of eye in profile; mesosoma strongly convex, interstices narrow and reticulate on mesoscutum; apex of scutellum blunt; propodeum alveolate with sharp median carina and cross carina; PMV barely as

long as STV. T1 with anterior median fovea hardly reaching half length of T1 medially.

Male : Unknown

Host : Unknown

Distribution : Myanmar

Remarks: This species comes near *M.productum* and *M.senex* in having head without clypeal tubercles. However *M.longispina* differs from them in having: 1) horn slender, tapering and narrowly rounded at apex (in *M.productum* and *M.senex* horn slightly widening at apex in dorsal view). Besides, *M.productum* differs from *M.longispina* in having projected part of parascrobal space 0.32x length of eye in profile (in *M.longispina* projected part of parascrobal space 0.4x length of eye) and in *M.senex* POL 1.4x OOL (in *M.longispina* POL 1.1x OOL).

6. *Monacon productum* Waterston (Fig. 5)

1922: *Monacon productum* Waterston, 25-28. Holotype Female, India, West Bengal (BMNH)

Diagnosis (Based on Waterston, 1922 and Bouček, 1980) : Female: Length 3.2mm. Black with metallic blue refringence on head and mesosoma; antennae blackish brown; coxae black; femora blackish brown; head dull shiny with striate occiput and irregularly striate vertex; projected part of parascrobal space in side view 0.32x eye length; height of malar space 0.2x eye height in side view; clypeus laterally delimited by short and deep groove, not connected with each other on upper margin; clypeal tubercles indistinct; horn gradually tapering to apex, pointed; clypeus moderately shiny; mesoscutum and scutellum with umbilicate punctures, interstices narrower than half diameter of a puncture (except in some areas on sides of scutellum where interstices wider than diameter of a puncture and smooth). MV 3x PMV; STV as long as PMV.

Male : Length 3mm. Similar to female with slight difference in sculpture of propodeum.

Host : *Diacavus furtivus* (Sampson)(Coleoptera: Platypodidae) attacking *Shorea robusta* Gaerten (Dipterocarpaceae)

Distribution : India (West Bengal); Borneo, East Malaysia.

Remarks : This species comes near *M.buldanicum* sp.nov. in having clypeal tubercles indistinct and mesosoma closely and umbilicately punctate. However *M. productum* differs from *M. buldanicum* in having: 1) body black with metallic blue refringence on head and mesosoma (in *M.buldanicum* body black without metallic refringence); 2) Surface of head dull shiny with occiput only striate (in *M.buldanicum* surface of head with raised reticulation on frons and gena, weakly reticulate on vertex, occiput striate-reticulate); 3) MV 3x as long as STV (in *M.buldanicum* MV 2.3x as long as STV); Height of malar space 0.3x height of eye in profile (in *M.buldanicum* height of malar space 0.5x height of eye in profile) and 5) Hind coxa without any distinct bunch of setae on dorsal margin of hind coxa (in *M.buldanicum* hind coxa with a bunch of white seae on posterior half of dorsal margin).

7. *Monacon senex* Bouček
(Fig. 6)

1980 : *Monacon senex* Bouček, 91. Holotype Female, Sri Lanka (BMNH).

Diagnosis : (Based on Bouček, 1980). Male: Length 2.6 – 2.8mm. Body, particularly head and mesosoma dark metallic green; tibiae scarcely infusate, otherwise together with tarsi testaceous; wings subhyaline; veins pale except for darker parastigma. Projecting part of parascrobal space 0.4x as long as eye length in profile; height of malar space 0.4x height of eye, 0.47x length of eye in profile; horn in dorsal view parallel sided, compressed at base, its apex truncate – sub emarginate, slightly hollowed ventrally; vertex slightly shiny, otherwise head distinctly sculptured; clypeus fairly delimited by grooves; scape distinctly exceeding anterior ocellus. Dorsum of mesosoma densely punctured; scutellum (less axillae) 1.23x its width, its apical edges subsinuate. Propodeum with strong median arched carina with strong costula. PMV slightly longer than STV, latter distinctly knobbed.

Female : Unknown

Hosts : Unknown

Distribution : Sri Lanka

Remarks : *M.senex* comes near *M.buldanicum* in having clypeal surface dull, very densely sculptured

and pilose; parascrobal lobes in profile distinctly protruding and interstices on mesoscutum very narrow. However *M.senex* differs from *M.buldanicum* in having: 1) head and mesosoma dark metallic green (in *M.buldanicum* body black without any metallic refringence); 2) head in anterior view 1.3x as long as its height (in *M.buldanicum* head in anterior view 1.41x its height); 3) POL 1.4x OOL (in *M.buldanicum* POL 1.7x OOL); 4) height of malar space 0.4x height of eye in profile (in *M.buldanicum* height of malar space 0.5x height of eye); 5) height of eye 1.3x its length (in *M.buldanicum* height of eye 1.4x its length); and 6) PMV longer than STV (in *M.buldanicum* PMV shorter than STV).

CHECK LIST OF MONACON WATERSTON
SPECIES OF THE WORLD

<i>M.abruptum</i> Waterston, 1922.....	India, Bangladesh
<i>M.atkinsoni</i> Bouček, 1982	Sri Lanka
<i>M.aurantiops</i> Bouček, 1982	Uganda
<i>M.beaveri</i> Bouček, 1982	West Malaysia
<i>M.bifidum</i> Delucchi, 1956	Zaire
<i>M.brevicornis</i> Delucchi, 1956	Zaire
<i>M.canaliculatum</i> Bouček, 1982	Philippines
<i>M.cavifrons</i> Bouček, 1982	Philippines
<i>M.ferrieri</i> Bouček, 1982	Philippines
<i>M.latispina</i> Bouček 1982	Uganda, Nigeria
<i>M.longispina</i> Bouček 1982	West Malaysia
<i>M.malaicum</i> Bouček 1982	West Malaysia
<i>M.modestum</i> Bouček 1982	Papua New Guinea
<i>M.naso</i> Bouček 1982	Papua New Guinea
<i>M.nigrum</i> Delucchi 1956	Zaire
<i>M.onkops</i> Bouček 1982	Kenya
<i>M.platypodis</i> Bouček 1982	Papua New Guinea
<i>M.productum</i> Waterston 1922 ...	India, East Malaysia
<i>M.robertsi</i> Bouček 1982	Papua New Guinea
<i>M.senex</i> Bouček 1982	Sri Lanka
<i>M.simplex</i> Bouček 1982	Papua New Guinea
<i>M.spinifrons</i> (Cameron) (Philomedes), 1909	North Borneo, Kuchin, Sandakan
<i>M.tricorni</i> Bouček 1982	Papua New Guinea, Philippines

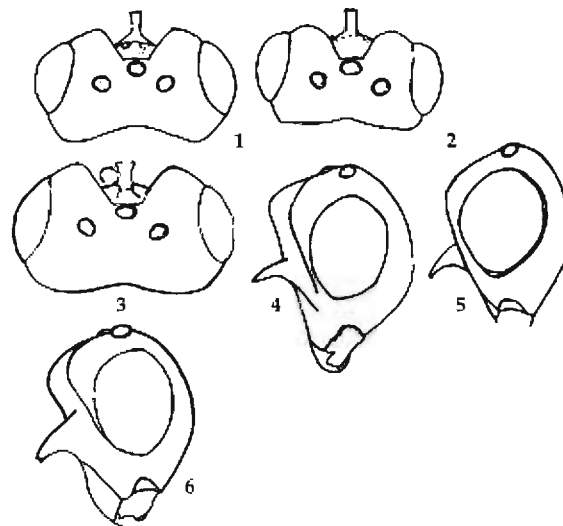


Fig.1-6 : Fig.1 : *Monacon abruptum* Waterston Female(modified from Bouček1980,(Courtesy Bouček) Head dorsal view; Fig.2 : *M.angustum* Bouček, Female.Head dorsal view; Fig.3.*M.atkinsoni* Bouček, Female, head in dorsal view; Fig.4 : *Monaconlongispina* Bouček, head profile; Fig.5.*M.productum*, head profile; Fig.6.*M.senex* Bouček, Male,head profile.



Fig. 7



Fig. 8

Figs. 7 to 8 : *Monacon buldanicum* Narendran and Sureshan sp.nov. Male: 7.body profile, 8.body dorsal view

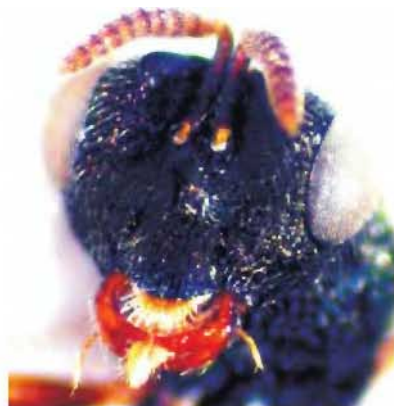


Fig. 9. Head anterior view



Fig.10. Forewing veins

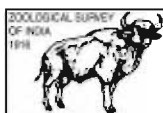
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NEW DISTRIBUTIONAL RECORDS OF PTEROMALIDAE (HYMENOPTERA: CHALCIDOIDEA) FROM LADAKH, INDIA.

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INTRODUCTION

Ladakh region of the Trans-Himalaya is characterized by its peculiar topography, harsh climatic conditions and is usually referred as 'cold desert'. The fauna of the region is very distinct and unique due to its location being at the confluence of two of the world's Zoogeographical Regions i.e. the Palearctic and the Oriental. High levels of endemism and species richness occur in the area and Palearctic elements dominate in the fauna of the Region (Mani 1974). Based on the collections obtained during a rapid assessment survey of faunal resources conducted in Ladakh from July to September 2008, two species of Torymidae (Hymenoptera: Chalcidoidea) viz. *Megastigmus kashmiricus* Sureshan and *Ecdamua lehensis* Sureshan, were described as new to science, earlier from the area (Sureshan, 2009, Sureshan, 2010). In continuation of the above studies, in the present communication ten species of Pteromalidae (Hymenoptera: Chalcidoidea) are being reported from Ladakh. The present collections were made from the north eastern and south eastern parts of the Ladakh, comprising the Ladakh range, Nubra Valley and Changthang valley, using an insect net and aspirator. The specimens are deposited in the Gangetic Plains Regional Centre, Zoological Survey of India, Patna.

The classification by Boucek (1988) is followed in this paper and for the distributional records of the species Noyes (2003) is referred to. Following abbreviations are used in the text: F - Female; M - Male; MV - Marginal vein; OOL - Ocellocular distance; PMV - Postmarginal vein; POL - Postocellar distance; STV - Stigmal vein.

SYSTEMATIC ACCOUNT

Order HYMENOPTERA
Superfamily CHALCIDOIDEA
Family PTEROMALIDAE
Subfamily ASAPHINAE

1. *Asaphes suspensus* (Nees)

(Fig. 6)

1834. *Chrysolampus suspensus* Nees, Hym. Ichneum. Affin. Mono. gen. Europaea sp. illust. 2: 127. (HDEO)
1969. *Asaphes suspensus* (Nees), Graham, Bull. Br. Mus. nat. Hist. Ent. Suppl. 16, 82.
1979. *Asaphes suspensus* (Nees), Boucek et al, Oriental Ins. 12 (4): 436.

Diagnostic characters : Female: Length: 1.5-1.6mm. Body brownish black with metallic blue reflection, propodeum and petiole less bright; antennae black; legs except coxae testaceous, femora more or less infusate. Head and thorax with rather less numerous bristles. Pronotal collar with the



6. *Asaphes suspensus* (Nees), female

shoulders more rounded. Head in dorsal view with temples curved and rather strongly convergent, not angulate posteriorly; speculum of fore wing indistinct or absent.

Material examined : 2 F, Nimmu, N 34°09'35.31" E 77°53' 20", Alt. 3535 m, Ladakh range, 5.vii.2008, coll. P.M.Sureshan (Reg.No. A. 1217, 1218)

Distribution : Palearctic, Nearctic, Neotropical and Oriental Regions. Probably introduced world wide.

Biology : Common hyperparasite of many species of aphids through various aphidinae (Braconidae). Adults are available in July – August.

Remarks : A Palearctic species widely introduced worldwide along with the host and crop plants. In the Indian subcontinent, records are available from India (Kashmir (Sri Nagar), Himachal Pradesh, Uttar Pradesh and Punjab). Pakistan, Nepal. Reported for the first time from Ladakh .

Subfamily PTEROMALINAE

2. *Dibrachys cavus* (Walker)

1835. *Pteromalus cavus* Walker, *Mono. Chalciditum. Ent. Mag.* 2: 477.

1913. *Dibrachys cavus* (Walker): Kudjumov, *Ruska ent.obozr.* 13:11.

1979. *Dibrachys cavus* (Walker): Boucek et al, *Oriental Ins.* 12 (4): 441.

Diagnostic characters : Female: Length 2.5mm. Head and mesosoma bronzy black; antennae brown with scape and pedicel testaceous; legs except coxae testaceous, femora brown; coxae concolorous with thorax. Head 1.8 to 1.9x as broad as its maximum length; clypeus shallowly emarginated. Antennae with second anellus quadrate. Forewing with MV 2.1x STV, PMV as long as STV. Gaster longer than thorax.

Material examined : 1 F, Forest Rest House campus Leh , N 34°10' 04.8" E 77°35' 32.4", Alt. 3540 m , Ladakh range , 4.vii.2008, coll. P.M. Sureshan (Reg. No. A.1219)

Distribution : Widely distributed in the Palearctic Region; also reported from Nearctic and Neotropical Regions, Africa and Australia.

Biology : A widely distributed polyphagous species associated mainly with lepidopteran pupae

and hyperparasitic through Ichneumonidae and Braconidae often via Tachnidae also. Reported as emerged in soil with the pupae of Geometrid moth *Ectropis* in India (Boucek et al, 1979).

Remarks : From the Indian subcontinent records are available only from India (Himachal Pradesh and Kashmir) and Pakistan. First record from Ladakh .

3. *Pachyneuron nelsoni* Girault

1928. *Pachyneuron nelsoni* Girault, *A prodigious dourcure on wild animals*: 2.

1929. *Pachyneuron aeneus* (!) Masi, *Annali Mus. Civ. Stor. Nat. Giacomo Doria*. 53: 229-231. syn. Boucek, 1988: 442.

1974. *Pachyneuron kamathi* Mani & Saraswat. *Mem. School. Ent. Agra.No.3*: 95.Syn. Boucek et al, 1979: 450.

1974. *Pachyneuron deccanensis* Mani & Saraswat. *Mem. School. Ent. Agra. No. 3*: 95. Syn. Boucek et al, 1979: 450.

Diagnosotic characters : Female: Length 2.0mm. Body black with metallic green reflection; antennae dark brown except basal part of scape testaceous. Anterior margin of clypeus weakly emarginated; antenna with scape not reaching median ocellus, thorax finely reticulate; forewing without marginal fringe, discal ciliation very sparse, indistinct, PMV only slightly longer than STV, MV strongly thickened.

Material examined : 1 F, Keshar, N 34°04'3.48." E 77°38' 48.63", Alt. 3246 m Changthang valley, 13.vii.2008, coll. P.M. Sureshan (Reg.No.A. 1214)

Distribution : Widely distributed in warmer parts of Europe, Africa, South Asia and Australia. Introduced in many areas outside Europe.

Biology : Parasitoids of Diptera (Syrphidae) and Hemiptera (Aphididae).

Remarks : In India the species has been reported from Delhi, Himachal Pradesh, Karnataka, Maharashtra and Uttar Pradesh. First record of the species from Ladakh.

4. *Schizonotus latus* (Walker)

(Fig. 8)

1835. *Pteromalus latus* Walker. *Ent. Mag.*, 1: 481.

1907. *Arthrolytus incongruens* Masi, *Boll. Lab. Zool. Gen. agr.R.Scuola Agric. Protici* 252-254.

1956. *Schizonotus latus* (Walker): Graham, *Ent. Mon. Mag.* 92: 260.

1979. *Schizonotus latus* (Walker): Boucek et al, *Oriental Ins.* 12 (4): 455.

Diagnostic characters : Female: Length 2.4-2.5mm. Body brownish black; clypeus not projecting below level of genae; antennae dark brown with scape and pedicel testaceous, anelli together almost equal to width of second anellus; F2 1.2-1.5x as wide as long. Propodeum with distinct median carina and plicae.



8. *Schizonotus latus* (Walker), female.

Material examined : 3 F, Hemis N.P, N 33°54' 51.8'' E 77°42' 46.4'', Alt. 3568 m, Ladakh range, 4.vii.2008, coll. P.M.Sureshan (Reg.No. A.1211, A.1220, A. 1229).

Distribution : Europe, America, North Africa and Pakistan.

Biology : Parasitoids of Chrysomelidae (Coleoptera) and Tachnidae.

Remarks : The species is widely distributed in the Palearctic Region and parts of America and North Africa. In the Oriental Region, records are available only from Pakistan. This is the first record of the species from India.

5. *Pteromalus semotus* (Walker)

1834. *Eutelus semotus* Walker, *Ent. Mag.* 2: 367.

1965. *Habroclytus semotus* (Walker): Boucek, *Sb.faun. Praci ent. Odd.Ndr.Mus.Praze* 11: 8, 35.

1906. *Etroxys marginicollis* Cameron. *J.Bombay Nat. Hist.Soc.* 17: 97.

1978. *Pteromalus semotus* (Walker), Boucek & Graham, *Ent. Gaz.* 29 : 225-235.

Diagnostic characters : Female: Length 2.6mm. Body dark metallic green with golden reflection; antennae brown; POL 1.8x OOL; temple length 0.4x eye length; anterior margin of clypeus weakly emarginated; antennae with pedicel little longer than F1. Propodeum 0.5x as long as scutellum. Forewing with MV short, 1.1x to 1.6x STV. Gaster 1.1 xs as long as head plus thorax combined.

Distribution : Widely distributed in the Palearctic region. Almost cosmopolitan due to introduction.

Material examined : 1F, Sumdho, N 330 13' 51'' E 780 22' 18.8'', Alt. 4427 m, Changthang valley, 12.vii.2008 (Reg.No.A.1226); 1F, Hunder, N 340 34' 48.8'' E 770 28' 45.4'', Alt. 3190 m, Ladakh range, 7.vii.2008 (Reg.No. A. 1227); 1 F, Skidmang, N 330 22' 47.7'' E 780 16' 10.3'', Alt. 4041 m, Ladakh range 13.vii. 2008 (Reg.No.A. 1228); 1F, N 330 37' 09.9'' E 780 05' 0.00'', Alt. 3840 m, 10 km to Hamya on the way to Upshey , Ladakh range, 14.vii.2008 (Reg.No. A.1241), coll. P.M.Sureshan.

Biology : Primary parasite or hyperparasite of various Lepidoptera and some Coleoptera. Adults are available in July – October.

Remarks : Though a widely distributed species, few records are available from India (Kerala, Orissa, and Bihar). First report from Ladakh .

6. *Pteromalus puparum* (Linnaeus) (Fig. 3)

1758. *Ichneumon puparum* Linnaeus. *Syst. Nat.* 10 th Edt. 567.

1795. *Pteromalus puparum* (Linnaeus): Swederus, *K.svenska Vetensk Akad Handl.* 16: 203.

1979. *Pteromalus puparum* (Linnaeus), Boucek et al, *Oriental Ins.* 12 (4): 454.

Diagnostic characters : Female: Length 2.6-3.4mm. Body bright metallic bluish green ; antennae with scape testaceous, remainder brown; coxae concolorous with thorax, remainder testaceous; POL as long as OOL; temple length 0.6x eye length; anterior marign of clypeus shallowly emarginated; antennae with F1 longer than pedicel; funicular segments longer than wide. Propodeum medially 0.7x as long as scutellum; nucha long. Gaster ovate, shorter than head plus thorax combined.



3. *Pteromalus puparum* (Linnaeus), female

Material examined: 1 F, Hemis N.P, N 33°54' 51.8" E 77°42' 46.4", Alt. 3568 m, Ladakh range, 5.vii.2008 (Reg.No. A.1220); 2 F, Hunder, N 34°34' 48.8" E 77°28' 45.4", Alt. 3190 m, Ladakh range, 7.vii.2008 (Reg.No.A.1225, 1227); 1F, Trishak, N 34°28' 40.11" E 77°43' 52.58", Alt. 3236 m, Nubra valley, 8.vii.2008 (Reg.No.A.1223); 2F, Sumdho, N 33°13' 51" E 78°22' 18.8", Alt. 4427 m, Changthang valley, 12.vii.2008 (Reg.No.A. 1222, 1226); 1F, 3 km to Chanthang from Mahe bridge, N 33°21' 32.7" E 78°21' 23.9", Alt. 4051 Metre Changthang valley, 12.vii.2008 (Reg.No. A.1221); 1F, Nimmu, N 34°09' 35.31" E 77°53' 20", Alt. 3535 m, Ladakh range, 5.vii.2008, (Reg.No. A.1224).

Distribution : Widely distributed in Europe, parts of America, Asia, Africa, (probably introduced in all parts of the world).

Biology : Parasitoids in pupae of various butterflies, some times hyperparasitic. Adults available in May – October.

Remarks : A cosmopolitan species introduced in various parts of the world. Reports are also available from India (Kerala, Uttar Pradesh, Assam, Bihar, Uttaranchal, Himachal Pradesh, Meghalaya, Punjab and Tamil Nadu). First record of the species from Ladakh.

Subfamily MISCOGASTERINAE

7. *Halticoptera smaragdina* (Curtis) (Fig. 5)

1832. *Phagonia smaragdina* Curtis, *British entomology* 9: 427.

1832. *Pachylarthrus insignis* Westwood, *Phil.Mag.* (3) 1: 127.

1876. *Halticoptera flavicornis* Spinola Thomson, *Hym. Scand.* 4: 248.

1969. *Halticoptera smaragdina* (Curtis): Graham, *Bull. Br. Mus.nat.Hist.Ent.Suppl.*16,159.



5. *Halticoptera smaragdina* (Curtis), female

Diagnsotic characters : Female: Length: 3.14mm. Body bright metallic green; antennae dark testaceous with scape blackish; coxae concolorous with thorax, femora brownish black, remainder of legs testaceous. Malar space about equal to transverse diameter of eye, and about two thirds as long as an eye. Vertex slightly elevated in middle, beyond the ocelli; temples about half as long as eye. Median area of propodeum strongly reticulate. Gastral petiole as long as or usually slightly longer than broad.

Material examined : 1F, Skidmang, N 33°22' 47.7" E 78°16' 10.3", Alt. 4041 m, Ladakh range 13.vii.2008, coll.P.M.Sureshan (Reg.No. A.1208).

Distribution : Palearctic and Nearctic Regions.

Remarks : First record of the species from the Oriental region.

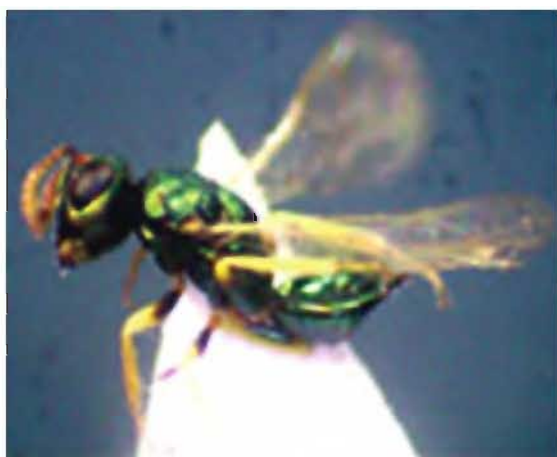
8. *Halticoptera circulus* (Walker) (Fig. 4)

1833. *Dicyclus circulus* Walker, *Ent.Mag.* 1: 456.

1833. *Dicyclus fuscicornis* Walker, *Ent.Mag.*1: 456.

1969. *Halticoptera circulus* (Walker): Graham, *Bull. Br. Mus.nat.Hist.Ent.Suppl.*16, 163.

Diagnostic characters : Female: 1.5-1.9mm. Body dark metallic bluish green; antennae testaceous with scape and pedicel black; coxae concolorous with thorax, femora brown, remainder of legs testaceous. Forewing with apex of basal cell bare or with only a very few hairs. Pronotal collar rounded off anteriorly, reticulate with at most a very narrow shiny strip along its hind margin. Propodeum almost shiny; gastral petiole strongly reticulate with median carina.



4. *Halticoptera circulus* (Walker), female

Male : Length: 1.5-2mm. More metallic green with golden reflection; antennae and legs golden yellow except coxae concolorous with thorax.

Material examined : 1 M, Sumdho, N 33°13' 51" E 78°22' 18.8", Alt. 4427 m, Changthang valley, 12.vii. 2008 (Reg.No.A. 1216); 6 F, Hemis N.P. N 33°54' 51.8" E 77°42' 46.4", Alt. 3568 m, Ladakh range, 4.vii. 2008, (Reg.No. A.1215); 1 M, 10 km to Hamya on the way to Upshey, N 33°37' 09.9" E 78°05' 00", Alt. 3840 m, Ladakh range, 14. vii.2008 (Reg.No.A. 1242), coll. P.M.Sureshan.

Distribution : Widely distributed in the Palearctic region and parts of America, Africa and China.

Biology : Parasitoids of various Diptera mainly mining in the leaves especially family Agromyzidae, Cecidomyiidae and Chloropidae.

Remarks : Recorded for the first time from the Oriental region.

9. *Lamprotatus splendens* Westwood (Fig. 2)

1833. *Lamprotatus splendens* Westwood, *Mag. Nat.Hist.* 6:121.

1955. *Lamprotatus splendens* Westwood: Delucchi, *Acta Univ. lund (n.s.) Avd. 2*, 50(20): 12, 18-19.

1969. *Lamprotatus splendens* Westwood: Graham, *Ent. Mon. Mag.* 92: 260.

Diagnostic characters : Female: Length: 3.9-4mm. Body bright metallic blue; antennae uniformly black; legs except tarsi black with metallic blue reflection, tarsi testaceous; sculptured part of gastral petiole 1.6 to 3 x as broad as long, less than half as long as the propodeum, its front edge with a sharp transverse carina. Mid femora rather stouter, excluding the trochantellus 4 to 4.5x as long as broad. Combined length of pedicellus and flagellum 1.3 to 1.4 x breadth of head, flagellum rather stouter.



2. *Lamprotatus splendens* Westwood, female

Material examined : 1 F, Forest rest house campus, Leh, N 34°10' 04.8" E 77°35' 32.4", Alt. 3540 m, Ladakh range, 4.vii.2008, (Reg.No. A.1210); 1F, Horze, N 34°11' 37.6" E 77°36' 04.9", Alt. 3609 m, Ladakh range, 11.vii.2008, (Reg.No. A.1209), coll.P.M.Sureshan.

Distribution : Widely distributed in the Palearctic Region and parts of America.

Biology : Parasitoids of various leaf mining Diptera.

Remarks : First record of the species from the Oriental region.

10. *Sphaeripalpus lacunosus* Huang (Fig. 7)

1990. *Sphaeripalpus lacunosus* Huang, *Sinozoologia* 7: 253.

Diagnostic characters : Female: Length: 3.1mm. Body bright metallic green; antennae dark brown; coxae and base of femora concolorous with thorax, remainder of legs testaceous; wings hyaline, veins

dark brown. Scutellum with frenum clearly marked; dorsellum punctulate. Gaster punctuate; petiole 2x as broad as long with transverse crests both anteriorly and posteriorly.



7. *Sphaeripalpus lacunosus* Huang, female

Material examined : 1 F, Sumdho, N 33°13' 51'' E 78°22' 18.8'', Alt. 4427 m, Changthang valley, 12.vii. 2008, (Reg.No. A.1212), coll.P.M.Sureshan.

Distribution : China (Xinjiang).

Biology : Not known.

Remarks : First record of the species outside the type locality (China). The identification of the species is only based on the original description which is very poor, with only little information.

SUMMARY

As per the available literature about 33 species of hymenopteran insects are reported from Ladakh

which include one species of Chalcidoidea (Eurytomidae) (Chandra *et al.*, 2009). The fauna of Ladakh region of Trans Himalaya is mainly represented by the Palearctic elements, followed by the local endemics and Oriental elements. High altitude insect life of the Himalaya is also remarkable for the high species endemism (Mani, 1974). Out of the ten species of Pteromalidae dealt here, all are reported for the first time from the Ladakh region of Jammu & Kashmir and four (*Lamprotatus splendens*, *Halticoptera circulus*, *Halticoptera smaragdina* and *Sphaeripalpus lacunosus*) are reported for the first time from the Oriental region. Most of the species are Palearctic in origin and some of them have wider distribution in the Nearctic and Neotropical regions. The species *Pteromalus puparum*, *Pteromalus semotus* and *Pachyneuron nelsoni* have a wider distribution in different parts of the world probably due to their introduction along with the hosts. The species *Sphaeripalpus lacunosus* Huang was described from China (Xinjiang) and reported here subsequently after the original description.

ACKNOWLEDGEMENTS

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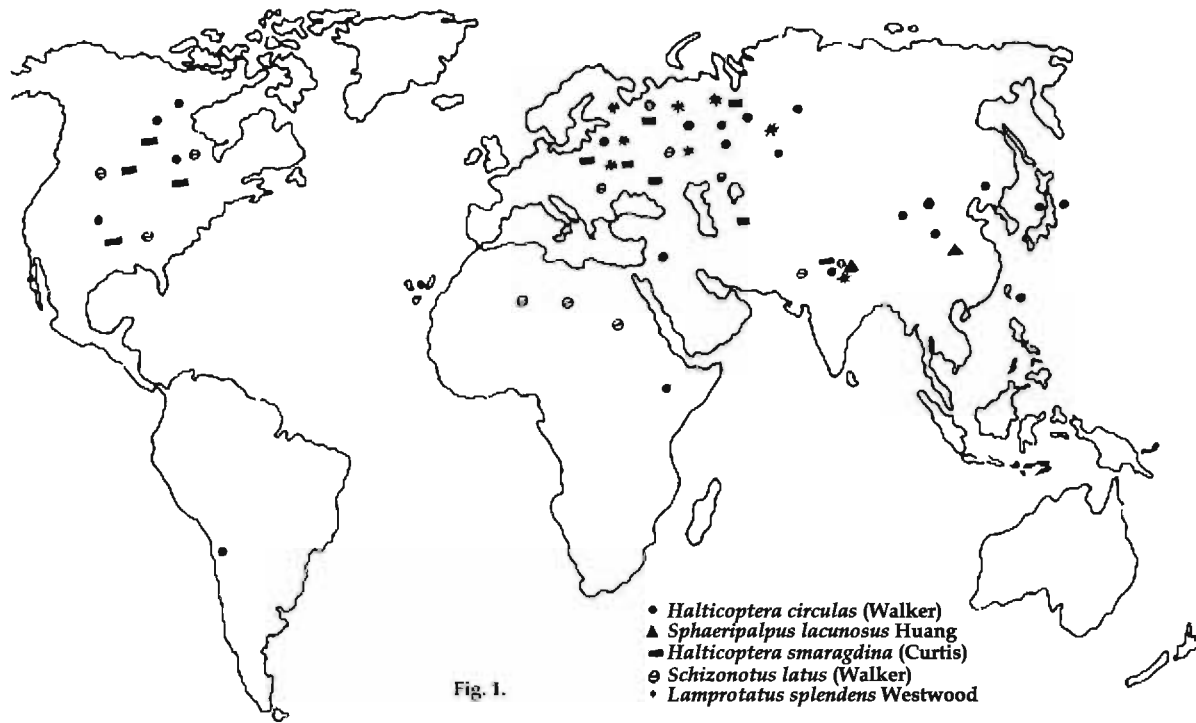


Fig. 1. World map showing the geographical distribution of five species of Pteromalidae (New records from Ladakh, India)





ON A COLLECTION OF ECHINODERMATA FROM KARNATAKA COAST, INDIA

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INTRODUCTION

The Karnataka State of India has a 270 km long coast line bordering Arabian Sea. The habitats are mainly sandy with scattered rocks and rocky islands. The echinoderm fauna of the coast is poorly known. There are several scattered reports of echinoderms from Karnataka (see Sastry, 2007). However, the report of Patil (1953) includes the marine fauna exclusively of Karnataka and only *Temnopleurus* sp. of echinoderms from Karwar coast of Karnataka. Recently Sastry (2007) gave an account of Echinodermata reported from the Indian coast including 27 species mainly from the offshore locations along the Karnataka coast collected years back chiefly by the R. I. M. S. Investigator. The collections made during the recent survey of the coast by Dr. M. K. Dev Roy of ZSI along with JGP and SM of us included seven species. The asteroid *Asterina burtoni* is from the intertidal rocks at St. Mary Island and all the other six species are from the trash collections of the offshore fishing trawlers left on the beach. Of the seven species, the asteroid *Luidia hardwicki* and the two echinoids were reported earlier from the Karnataka. The other four species are additions to the fauna of the State. Further, the finding extends the known distribution of *Comatella stelligera* westward into Arabian Sea. Brief description of the material is given under remarks. The distribution along the Indian coast is from Sastry (2007) and elsewhere is mainly from Clark and Rowe (1971). A list of all the echinoderm species known from Karnataka is appended.

SYSTEMATIC ACCOUNT

Phylum Echinodermata

Class CRINOIDEA

Order COMATULIDA

Family COMATULIDAE

1. *Comatella stelligera* (P. H. Carpenter)
(Pl. I. Fig. 1)

1880. *Actinometra stelligera* P. H. Carpenter, J. Linn. Soc. (Zool.), 15: 198.

1971. *Comatella stelligera*: Clark, A. M. and Rowe, F. W. E. Monograph of shallow-water Indo-West Pacific echinoderms, 6-7 (distribution) and 15 (key).

2007. *Comatella stelligera*: Sastry, D. R. K. Rec. zool. Surv. India, Occ. Paper No. 271: 9

Material : Murudeshwar beach, 17.3.2009, one specimen.

Remarks : Some of the division series are lost or broken. All the division series present are of only two ossicles and without a syzygy. II Br series with two III Br series, or III Br only on the outer side. First brachial syzygy at 3+4.

Distribution : India- Lakshadweep, Tamil Nadu, Andamans. The species newly recorded from Karnataka coast.

Elsewhere : Bay of Bengal to South China Sea and North Australia.

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Class ASTEROIDEA

Order PAXILLOSIDA

Family LUIDIIDAE

2. *Luidia hardwicki* (Gray)

(Pl. I, Fig. 4)

1840. *Petalaster hardwicki* Gray, *Ann. Mag. Nat. Hist.* 6: 183.
1910. *Luidia limbata*: Koehler, R. *Echinoderma of the Indian Museum*, Part VI: 10. Karnataka: 8 miles WSW of Honawar; Tamil Nadu: Gulf of Mannar (Palk Strait), 22 m (12 fms.); Orissa: Gopalpore, 46-51m (25-28 fms.); Andaman Islands, 13-16 m (7-9 fms.); South Andamans: Little Andaman Island. [non. *Luidia limbata* Sladen, 1889 = *Luidia quinaria* von Martens, 1865]
1920. *Petalaster hardwicki* Gray, 1840: Döderlein, L. *Siboga Exped. Monog.* 46b: 246, *indeterminata*
1920. *Luidia* (*Quinaster*) *forcifer*: Döderlein, L. *Siboga Exped. Monog.* 46b: 243, 278, with synonym. *Luidia limbata*: Koehler, R. [non. *Luidia limbata* Sladen, 1889: 251 = *L. quinaria* von Martens, 1865: 352]
1971. *Luidia hardwicki*: Clark, A. M. and Rowe, F. W. E. *Monograph of shallow-water Indo-West Pacific echinoderms*, 30-31 (distribution) and 44 (key).
1989. *Luidia* (*Luidia*) *hardwicki*: Clark, A. M. *Echinoderm Studies*, 3: 242. With synonym *L. forcifer* Sladen, 1889: 258. Indian Ocean, South China Sea to Torres Strait, N Australia, 10-94 m.
2001. *Luidia prionota* Fisher, 1913: Clark, A. M. and Mah, C. *Echinoderm Studies*, 6: 329. A synonym of *L. hardwicki* (Gray, 1840) according to Liao and A. M. Clark, 1995 (1996). Extension of range from Philippines and N Australia to Hawaii by Mah, 1998.
2007. *Luidia hardwicki*: Sastry, D. R. K. *Rec. Zool. Surv. India, Occ. Paper* No. 271: 24 [Information on the status of Koehler's *L. limbata* material was not available.]

Material : Bhatkal Fishing Harbor, 17.3.2009, one spec; Gangoli Fishing Harbor, Kundapura, 20.3.2009, one spec.

Remarks : The specimens are from a trawl waste and not properly preserved. Disc and arms are separate with the armament on oral side completely rubbed off and could not be identified. It appears from the nature of paxillar arrangement that the specimens belong to *Luidia hardwicki* among the five armed species.

Distribution : India- Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, West Bengal and Andaman Islands. Earlier the species was collected by RIMS Investigator from Karnataka coast at 8 miles WSW of Honawar and reported by Koehler (1910) as *L. limbata*.

Elsewhere : SE Arabia, Persian Gulf, Islands of Western Indian Ocean, Bay of Bengal, East Indies, South China Sea, North Australia and Hawaii.

Family ASTROPECTINIDAE

3. *Astropecten hemprichi* Müller and Troschel
(Pl. I, Fig. 2, 3)

1842. *Astropecten hemprichi* Müller, J. And Troschel, F. H. *System der Asteriden*, 1. Asteriae, p. 71.
1971. *Astropecten hemprichi*: Clark, A. M. and Rowe, F. W. E. *Monograph of shallow-water Indo-West Pacific echinoderms*, 30-31 (distribution) and 45 (key).
1989. *Astropecten hemprichi*: Clark, A. M. *Echinoderm Studies*, 3: 259. Red Sea, Arabian Gulf S to Natal.
2007. *Astropecten hemprichi*: Sastry, D. R. K. *Rec. Zool. Surv. India, Occ. Paper* No. 271: 28

Material : Karwar coast, fish trawl collection, 13.3.2009, one spec, R = 23 mm; Bhatkal, 17.3.2009, 13 specs, R = 18-34 mm, R/r of the largest is 34/10 mm; Mangalore coast, Ullal beach, 24.3.2009, 22 specs, R = 20-32 mm.

Remarks : Actinal plates one or two. Superomarginals vertically aligned at the interradius and wider beyond third or fourth plate. Short spinelets not prominent, extending till end of arm, proximally on the inner margin, shifting to outer margin beyond third or fourth plate, two series of spines from third to sixth plates. Inferomarginals with one pointed spine marginally and two unequal spines below it, the smaller is half the length of the other, actinal surface with pointed spinelets. Adambulacrals with three spines in the furrow and two unequal spines in the subambulacral area. About half dozen specimens contained two to eight small gastropods in the stomach.

Distribution : India- Andhra Pradesh and Tamil Nadu. The species newly recorded from Karnataka coast.

Elsewhere : Persian Gulf to Natal coast of South Africa and Bay of Bengal.

Order VALVATIDA

Family ASTERINIDAE

4. *Asterina burtoni* Gray

(Pl. I. Fig. 5)

1840. *Asterina burtoni* Gray, J. E. *Ann. Mag. nat. Hist.* 6 (37): 289.

1971. *Asterina burtoni*: Clark, A. M. and Rowe, F. W. E. *Monograph of shallow-water Indo-West Pacific echinoderms*, 38-39 (distribution) and 68 (key).

2007. *Asterina burtoni*: Sastry, D. R. K. *Rec. zool. Surv. India, Occ. Paper No.* 271: 42

Material : St. Mary Island, 22.3.2009, one specimen.

Remarks : The specimen measures 5 mm in R and 2.5 mm in r. arms five and thick radially, madreporite single. Abactinal plates with up to four short spines. Pore series confluent interradially. Actinal plates with one to three spines. Furrow spines three, subambulacral spines two.

Distribution : India- Gujarat, Lakshadweep, Tamil Nadu, Andaman and Nicobar Islands. The species is newly recorded from Karnataka coast.

Elsewhere : Red Sea and East coast of Africa to north Australia.

Class ECHINOIDEA

Order TEMNOPLEUROIDA

Family TEMNOPLEURIDAE

5. *Temnopleurus toreumaticus* (Leske)

(Pl. II. Fig. 6)

1778. *Cidaris toreumaticus* Klein In: Leske, N. G. *Additamenta ad Kleinii naturalem dispositionem Echinodermatum*, p. 155.

1953. *Temnopleurus* sp. Patil, A. M. J. *Bombay nat. Hist. Soc.* 51: 429-434. Karnataka: Karwar coast. Probably *T. toreumaticus*.

1971. *Temnopleurus toreumaticus*: Clark, A. M. and Rowe, F. W. E. *Monograph of shallow-water Indo-West Pacific echinoderms*, 142-143 (distribution) and 154 (key).

2007. *Temnopleurus toreumaticus*: Sastry, D. R. K. *Rec. zool. Surv. India, Occ. Paper No.* 271: 176

Material : Karwar coast, 13.3.2009, 13 specs, D/H = 11/5-34/16 mm, four specimens with darker spines; Mangalore coast, Bhatkal, 17.3.2009, two specs; Mangalore coast, Murudeshwar Beach,

17.3.2009, three specs, D/H = 27/18, 28/15 and 45/24 mm, the latter two with dark spines; Mangalore coast, Ullal Beach, 24.3.2009, one specimen, D/H = 26/16 mm; Mangalore coast, Panambur, 25.3.2009, two specs, D/H = 34/17 and 37/19 mm.

Remarks : Angular pits on the test plates deep and prominent. The anus is subcentral, spines transparent light olive green banded with reddish brown, as long as the horizontal diameter, five specimens as noted above are with dark spines.

Distribution : India- Gujarat, Maharashtra, Goa, Karnataka, Tamil Nadu, Orissa, Andhra Pradesh, West Bengal and Andaman Islands.

Elsewhere : Persian Gulf and East coast of Africa to South Pacific Islands.

6. *Clypeaster rarispinus* de Meijere

(Pl. II. Figs. 7, 8)

1903. *Clypeaster rarispinus* de Meijere, J. C. H. *Tijdschr. Ned. Dierk. Veeren.* (2) 8: 7.

1971. *Clypeaster rarispinus*: Clark, A. M. and Rowe, F. W. E. *Monograph of shallow-water Indo-West Pacific echinoderms*, 144-145 (distribution) and 160 (key).

2007. *Temnopleurus toreumaticus*: Sastry, D. R. K. *Rec. Zool. Surv. India, Occ. Paper No.* 271: 176

Material : Mangalore coast, off Bhatkal, 17.3.2009, 22 specs; Off Mangalore, Fish trawl collection, 24.3.2009, 10 specs.

Remarks : The specimens measure 20-45 mm in length, l/b = 20/20 in the smallest and 45/42 in the largest. The anus is characteristically abutting the posterior margin.

Distribution : India- Gujarat, Karnataka, Kerala, Tamil Nadu, Orissa, Andhra Pradesh and West Bengal.

Elsewhere : Persian Gulf to the Natal coast and to east Indies.

Class Holothuroidea

Order Dendrochirotida

Family CUCUMARIDAE

7. *Leptopentacta javanicus* (Sluiter)

(Pl. II. Fig. 9)

1880. *Oncus javanicus* Sluiter, C. P. *Tijdschr. Ned-Indie*, 40: 9.

2007. *Leptopentacta javanicus* (Sluiter): Sastry, D. R. K.
Rec. zool. Surv. India, Occ. Paper No. 271: 250

2010. *Leptopentacta javanicus* (Sluiter): Mitra, S.; Chitra, J.
And Pattanayak, J.G. Rec. zool. Surv. India, 110(Part-4): 250

Material : Karwar Coast, Uttara Kannada Dt, 13.3.2009, 18 specs; Bhatkal, 17.3.2009, 15 specs; Tonka, near Honawar, Uttara Kannada Dt, 18.3.2009, 2 specs; Gangoli, Kundapura, 20.3.20 09, 11 specs.

Remarks : Body form small and slender. Pedicles in a double row along each side of the ambulacral areas ventrally. Papillae in three rows, along the dorsal ambulacral areas. Aggregations of spicules in inter ambulacral areas make a reticulate appearance. Spicules smooth nodular buttons with four hole baskets and large lenticulate plates also present.

Distribution : India- Kerala, Tamil Nadu and Andhra Pradesh. The species is recently recorded from Karnataka coast.

Elsewhere : SE Arabia, Maldives, Bay of Bengal and East Indies.

SUMMARY

Recent collections from the Karnataka (Arabian Sea) coast of India contained material of seven species of echinoderms. Of these the Crinoid *Comatella stelligera*, the asteroid *Astropecten hemprichi* and *Asterina burtoni* are new to the fauna of Karnataka coast. In addition, the collection included *Luidia hardwicki*, *Temnopleurus toreumaticus* and *Clypeaster rarispinus* already known from the coast and the holothuroid *Leptopentacta javanicus* which was recently reported from this coast. Further the present record of *Comatella stelligera* extends its distribution westward into the Arabian Sea.

ACKNOWLEDGEMENTS

We are grateful to The Director, Zoological Survey of India, Kolkata for the facilities and encouragement.

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- Patil, A. M. 1953. Study of the marine fauna of the Karwar coast and the neighbouring islands. Part IV. Echinodermata and other groups. *J. Bombay nat. Hist. Soc.* 51: 429-434.
- Sastry, D. R. K. 2007. Echinodermata of India: An Annotated list. *Rec. zool. Surv. India, Occ. Paper No. 271*: 1-387.

APPENDIX

ECHINODERMATA of KARNATAKA COAST

* species new to Karnataka Coast

Phylum ECHINODERMATA

Class CRINOIDEA

Order COMATULIDA

- | | | |
|------------------------|---|--|
| Family Comatulidae | 1 | <i>Comatella stelligera</i> (Carpenter)* |
| Family HIMEROMETRIDAE | 2 | <i>Heterometra compta</i> A. H. Clark |
| Family MARIAMETRIDAE | 3 | <i>Lamprometra palmata</i> (J. Müller) |
| Family COLOBOMETRIDAE | 4 | <i>Oligometra serripinna</i> (P. H. Carpenter) |
| Order BOURGUETICRINIDA | | |
| Family PENTACRINITIDAE | 5 | <i>Comastrocrinus ornatus</i> (A. H. Clark) |
| | 6 | <i>Comastrocrinus springeri</i> (A. H. Clark) |

Class ASTEROIDEA

Order PAXILLOSIDA

- | | | |
|---------------------------|---|---|
| Family LUIDIIDAE | 1 | <i>Luidia (Luidia) hardwicki</i> (Gray) |
| Family ASTROPECTINIDAE | 2 | <i>Astropecten hemprichi</i> Müller and Troschel* |
| | 3 | <i>Astropecten inutilis</i> Döderlein |
| | 4 | <i>Astropecten tamilicus</i> Döderlein |
| Family PORCELLANASTERIDAE | 5 | <i>Sidonaster vaneyi</i> Koehler |
| Order Valvatida | | |
| Family Asterinidae | 6 | <i>Asterina burtoni</i> Gray* |
| Order BRISINGIDA | | |
| Family BRISINGIDAE | 7 | <i>Brisinga gunni</i> Alcock |

Class OPHIUROIDEA

Order OPHIURIDA

- | | | |
|-----------------------|---|-------------------------------------|
| Family OPHIURIDAE | | |
| Subfamily OPHIURINAE | 1 | <i>Ophiura undulata</i> (Lyman) |
| Family HEMIEURYALIDAE | 2 | <i>Ophiomoeris tenera</i> (Koehler) |
| Family OPHIOTHRICIDAE | 3 | <i>Ophiothrix</i> sp. |

Class ECHINOIDEA

Order CIDAROIDA

- | | | |
|-------------------|---|--|
| Family CIDARIIDAE | 1 | <i>Stereocidaris alcocki</i> (A. R. S. Anderson) |
|-------------------|---|--|

Order PHYMOSOMATOIDA

- | | | |
|----------------------|---|---|
| Family STOMECHINIDAE | 2 | <i>Stomopneustes variolaris</i> (Lamarck) |
|----------------------|---|---|

Order **TEMNOPLEUROIDA**Family **TEMNOPLEURIDAE**

- 3 *Salmacis bicolor* L. Agassiz
- 4 *Temnopleurus toreumaticus* (Leske)

Order **CLYPESTEROIDA**Family **CLYPEASTERIDAE**

- 5 *Clypeaster rarispinus* de Meijere
- 6 *Clypeaster reticulatus* (Linnaeus)

Family **FIBULARIIDAE**

- 7 *Echinocyamus crispus* Mazetti

Order **SPATANGOIDA**Family **SPATANGIDAE**

- 8 *Nacospatangus (Pseudomaretia) alta* (A. Agassiz)

Class **HOLOTHUROIDEA**Order **ASPIDOCHIROTIDA**Family **HOLOTHURIIDAE**

- 1 *Holothuria (Halodeima) atra* (A. Agassiz)
- 2 *Holothuria (Mertensiothuria) leucospilota* Brandt

Order **DENDROCHIROTIDA**Family **Cucumaridae**

- 3 *Leptopentacta javanicus* (Sluiter)*

Order **DACTYLOCHIROTIDA**Family **YPSILOTHURIIDAE**

- 4 *Ypsilothuria bitentaculata* (Ludwig)

Order **APODIDA**Family **MYRIOTROCHIDAE**

- 5 *Ankyloderma musculus* (Risso)

Other Holothurians

- 6 *Bathyzona incerta* Koehler and Vaney
- 7 *Pseudothuria duplex* Koehler and Vaney

PLATE I

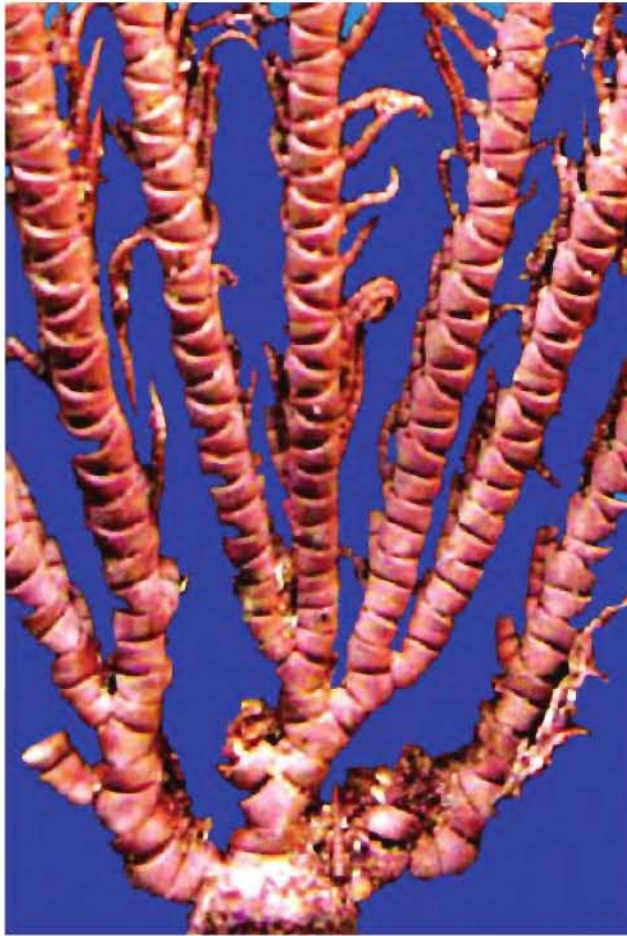


Fig. 1. *Comatella stelligera*



Fig. 2. *Astropecten hemprichi* (6-armed)



Fig. 3. *Astropecten haemprichi* (5-armed)



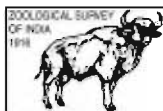
Fig. 4. *Luidia hardwicki*



Fig. 5. *Asterina burtoni*

PLATE II

Fig. 6. *Temnopleurus toreumaticus*Fig. 9. *Leptopentacta javanicus*Fig. 7. *Clypeaster rarispinus* (aboral)Fig. 8. *Clypeaster rarispinus* (oral)



REDESCRIPTION AND NEW DISTRIBUTIONAL RECORDS OF *DELTA ESURIENS* (FABRICIUS) (HYMENOPTERA: VESPIDAE: EUMENINAE) FROM INDIAN STATES

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INTRODUCTION

Though relatively more taxonomic works on the potter wasps have been done on the fauna of Palearctic and Nearctic regions, our information on the fauna of Indian subcontinent is very scanty and fragmentary. Among the species reported from Indian subcontinent many need detailed taxonomic revision and redescription. One such species is *Delta esuriens* (Fabricius), originally described by Fabricius in 1787 as *Vespa esuriens* from India. Original description was very short which is inadequate for the identification at species level. Subsequently Bingham (1897) provided a redescription of it which is also very short. Hence, in this paper a detailed redescription is provided. *Delta esuriens* is a moderately large potter wasp species with 14-25 mm in length. This species is distributed in Palearctic, Oriental and Australian regions. In India, it is so far reported from Arunachal Pradesh, Delhi, Gujarat, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Uttarakhand and West Bengal. In this paper, it is newly recorded from Andhra Pradesh, Chhattisgarh, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Manipur, Meghalaya and Uttar Pradesh.

MATERIAL AND METHODS

This study is based on about 140 specimens present in the Hymenoptera Section of the Zoological Survey of India, Kolkata. All the specimens were properly preserved and registered and added to the 'National Zoological Collections' of the Hymenoptera Section of the Zoological Survey of India, Kolkata (NZSI).

Abbreviations used for the Museums: BMNH = British Museum of Natural History, London, England; NZSI = National Zoological Collections, Zoological Survey of India, Kolkata, India.

Abbreviations used for the terms: H = Head; M = Mesosoma; OOL = Ocellocular length; POL = Postocellar length; T1-T2 = Gastral tergites 1 and 2.

RESULTS

Delta esuriens (Fabricius, 1787) (Images 1-5)

1787. *Vespa esuriens* Fabricius, *Mant. Ins.*, 1: 293, Syntype, Sex not mentioned, India (BMNH).
1791. *Vespa pediculata* Olivier, *Encycl. méth., Ins.*, 6: 671, "Indes orientales".
1804. *Eumenes esuriens*, Fabricius, *Syst. Piez.*: 286.
1855. *Eumenes boscii* de Saussure, *Ét. Fam. Vesp.*, 3: 132 (as a synonym of *E. esuriens*).
1918. *Eumenes caffer* var. *esuriens*: Bequaert, *Bull. Am. Mus. Nat. Hist.*, 39: 275 (cat.; in part; not p. 73).
1926. *Eumenes campaniformis* var. *esuriens*: Bequaert, *Ann. S. Afr. Mus.* 23: 541 (key), 542 (India).
1991. *Delta companiforme esuriens*: Krombein, *Smithsonian Contrib. Zool.*, 515: 6.
1992. *Delta esuriens* (Fabricius): Giordani Soika, *Lavori-Soc. Ven. Sc. Nat.*, 17: 62. Additional citation: Srinivasan and Girish Kumar, 2010, *J. Threatened Taxa*, 2 (12): 1315.
2006. *Delta esuriens esuriens* (Fabricius): Gusenleitner, *Linzer biol. Beitr.*, 38 (1): 694 (India).

Redescription : Female: Body length (H+M+T1+T2) 14-20 mm; Forewing length: 12.5 mm. Head yellow to brownish yellow with following black markings: a broad band on vertex including upper half of frons extending behind vertex to outer side of temple and to occiput, a black mark on anterior tentorial pit extending to subantennal suture to dorsal side of antennal scrobe and touches to the black band on frons and vertex (this black markings highly variable and absent in some specimens); antennae light reddish (in some specimens ventral side of scape brownish yellow; in some specimens a black mark present on scape dorsally and apical antennal segments more dark); visible part of labrum concolorous with the clypeus; mandible yellow except at margins yellowish brown; pronotum almost entirely yellow except at anterior apex of anterior face of pronotum black; mesoscutum black except a large brown area posteriorly; scutellum light red; postscutellum yellow, propleuron black or blackish brown; mesopleuron yellow to brownish yellow except mesepimeron brown to blackish brown and mesosternum black; metapleuron light red to reddish brown; propodeum light red except at basolateral apex near to lateral corner with yellow markings; legs light reddish with highly variable yellow markings (in some specimens with yellow marks on forefemur and foretibia ventrally and mid and hind tibia dorsally at apex; in some specimens fore coxa, all trochanters and mid and hind tarsal segments except basitarsus black); petiole light reddish except at base black, at subapically a black band and then a yellow band; second gastral tergite basally light reddish then a black band and remaining apical half yellow; second gastral sternite light red except at apex with a yellow band; all remaining visible part of gastral segments yellow, with their bases (when drawn out) black. Wings flavohyaline with a narrow subapical dark infumation on forewing.

Head : Width in front view (Image 2) 1.21x as its median length; clypeus smooth, strongly convex, flattened in middle, its anterior margin transversely truncate at apex, width 0.96x its length medially; mandible long and moderately stout with four distinct teeth on inner side; labrum rounded at apex; supraclypeal area smooth; frons and ocular sinus closely and strongly punctured, interspaces less than diameter of punctures; area in front of

median ocellus smooth; vertex with scattered minute punctures; temple almost smooth; occiput with fine scattered minute punctures; cephalic fovea absent; POL 1.64x OOL; diameter of anterior ocellus slightly longer than ($=1.03x$) the distance between anterior ocellus and posterior ocelli; interocular distance slightly greater ($=1.07x$) on vertex than at clypeus; temple (Image 1) distinctly narrower ($0.49x$) than eye in profile (measured through its ocular sinus); occipital carina strong, complete and narrowed ventrally. Antenna 2.62x farther from each other than from eyes; scape length 1.75x length of F1; F1 2x as long as F2, 2.8x as long as wide, flagellar segments slightly widening towards apex; apical antennal segment slightly longer than wide ($1.13x$), $0.61x$ as long as the two penultimate segments combined.

Mesosoma : Pronotum strongly and closely punctured except anterior face almost smooth, anterolateral angle with few scattered punctures; mesoscutum, scutellum and metanotum strongly and closely punctured; propleuron smooth with minute scattered punctures; mesepisternum densely punctate; posterior margin and lower sides of mesopleuron smooth; metapleuron almost smooth; propodeal dorsum strongly punctured except at dorsolateral angle with scattered punctures; ventral area of propodeum strongly punctured except the inner concavity with scattered punctures; lateral areas of propodeum almost smooth; median groove of propodeum distinct, punctured and complete; pronotum with distinct pretegular carina; median length of mesoscutum slightly longer than its maximum width ($1.01x$); parategula exceeding tegulae posteriorly; axillary fossa not slit-like, much broader; metanotum at the same level of scutellum and propodeum, not raised. Midtibia with one spur. Forewing and hind wing as in Image 3; forewing 3.35x as long as broad; fore wing with prestigma $0.74x$ pterostigma, second submarginal cell acute basally.

Metasoma : Petiole length $0.96x$ than mesosoma in lateral view, $1.15x$ second gastral tergite (Image 1); petiole and gaster almost smooth; second gastral tergum without lamellae separated by apical thickening, slightly curved inwards medially at apex, almost straight, $1.37x$ as long as broad; posterior apices of 3rd-5th tergites and sternites distinctly curved inward at middle.

Male : Body length (H+M+T1+T2) 14-17 mm; forewing length 11.5 mm. Head width in front view (Image 4) 1.15x its length medially; median length of clypeus 1.29x its maximum width; teeth of mandible not distinct. Last antennal segment hooked apically, hook long, curved and pointed, in curved position it almost reaches the apex of ninth antennal segment; 3rd-6th gastral sternites with few large hairs; 7th with a deep median longitudinal groove; Genitalia as in Image 5; apical tip of aedeagus bulb-like; parameral spine elongate with moderately large hairs subapically. Other characters almost same as in female.

Behaviour : See Maxwell- Lefroy, 1909 and Dutt, 1912.

Material examined : **INDIA: Andhra Pradesh**: Krishna district, Machilipatnam, 1♀, 5.vi.1908, Coll. C. Paiva, NZSI Regd. No. 12971/H3; Vishakhapatnam district, Aganampudi, 1♂, 6.ii.2004 & Gopalapatnam, 1♀, 8.ii.2004, Coll. D.R. Maulik & Party, 12972/H3 & 12973/H3. **Arunachal Pradesh**: East Siang district, Hill Top, 1♀, 23.ix.2002, Mebo, 1♀, 25.ix.2002 & Pasighat, 1♀, 26.ix.2002, Coll. M. Sil & Party, 12974/H3 to 12976/H3. **Chhattisgarh**: Dhamtari district, Kukrel, 1♀, 22.iv.1975, Coll. S.K. Gupta & Party, 13005/H3; Bastar district, Sonpur, 1♀, 1.i.1981 & Chitrakoot, 1♀, 14.xii.1981, Coll. M.S. Shishodia & Party, 13006/H3 & 13007/H3; **Delhi**: exact locality not known, 1♀, 14.iii.1922, Coll. S. Basil Edwards, 423/H3; Delhi University Campus, Lajpat Nagar & S.J. Flyover, 13♀ & 12♂, 2.x.1961-23.x.1978, Coll. V.K. Gupta & Party, 12977/H3 to 13001/H3. **Gujarat**: Banaskantha district, Deesa, 1♂, 10.iii.1901, Collector Unknown, 13002/H3; Mehsana district, Modhera, 2♂, 24.xi.1974, Coll. B. Dutta & Party, 13003/H3 & 13004/H3. **Himachal Pradesh**: Kangra Valley, 1♀ & 3♂, June, 1899, Coll. Dudgeon, 13008/H3 to 13011/H3; Chamba district, Sarol Garden, 6♀, 20.v.1927, Coll. S.L. Hora, 13012/H3 to 13017/H3; Chamba district, Khajjiar, 1♂, 24.vi.1965, Coll. Tikar, 13018/H3; Solan district, Saproon, 1♂, 17.vi.1979, Coll. V.K. Gupta, 13019/H3. **Jharkhand**: Ranchi, 1♀ & 1♂, date of collection Unknown, Coll. Irvine, 13020/H3 & 13021/H3; Dumka district, Kusumbi, 1♀ & 1♂, 12.xi.2009, Coll. R. Babu & Party, 13022/H3 & 13023/H3; Palamau district, Daltonganj, Nawatoli, 1♀, 14.xii.2010, Coll. R. Babu & Party, 13024/H3.

Karnataka: Bengaluru, 5♀ & 3♂, date of collection and name of collector Unknown, 3215/H3, 13025/H3 to 13031/H3; Bengaluru, 2♀ & 1♂, date of collection Unknown, Coll. Cameron, 3196/H3, 3212/H3 & 3207/H3. **Kerala**: Thiruvananthapuram, 1♂ & 1♀, March-April, 1888, name of collector Unknown, 13032/H3 & 13033/H3. **Maharashtra**: Ratnagiri district, Chiplun, 1♀, 5.v.1912, Coll. F.H. Gravely, 13034/H3; Pune district, Paud, 1♀, 6.iv.1965, Coll. B.S. Lamba, 13035/H3; Nashik district, Deolali, 2♀, 23.iii.1971, Coll. D. Ram, 13036/H3 & 13037/H3; Dhule district, Chaugaan, 1♀, 14.xii.2003, Coll. B.C. Das & Party, 13038/H3; Nagpur district, Borgaon, 2♀, 26.iii.2004, Coll. S.K. Mandal & Party, 13039/H3 & 13040/H3. **Manipur**: Imphal West district, Kangchup, 1♀, 9.x.1976, Coll. Tyagi, 13041/H3. **Meghalaya**: East Garo Hills district, Dainadubi, 1♀ & 1♂, 13.v.1979, Coll. J.K. Jonathan & Party, 13042/H3 & 13043/H3. **Odisha**: Ganjam, 2♂, date of collection and name of collector Unknown, 3205/H3 & 13044/H3; Khordha district, Bhubaneswar, 1♂, date of collection Unknown, Coll. Tusharendu Ray, 13045/H3; Mayurbhanj district, Bangriposi, 2♀ & 1♂, 3.v.1972, Coll. A.R. Bhaumik & Party, 13046/H3 to 13048/H3; Koenjhar district, Keonjhat, 1♀ & 2♂, 23.v.1972, Coll. A.R. Bhaumik & Party, 13049/H3 to 13051/H3; Dhenkanal district, Nimidha, 1♂, 26.iii.1983, Coll. P. Parui, NZSI Regd. No. 13052/H3. **Rajasthan**: Jhunjhunu district, Gudha, 1♀ & 1♂, 11.iv.1958 & 27.v.1958, Coll. T.G. Vazirani, 3123/H3 & 3032/H3; Jodhpur district, Bisalpur, 1♂, 8.vi.1960 & Mandore, 1♀, 21.ix.1963, Coll. R.K. Bhatnagar, 3838/H3 & 3604/H3. **Tamil Nadu**: Coimbatore, 2♀ & 3♂, 9.ix.1963-10.xi.1964, Coll. P.S. Nathan, 13053/H3 to 13057/H3; Coimbatore Rural district, Mettupalayam, 1♂, 12.xii.1975, Coll. A.N.T. Joseph & Party, 13058/H3. **Uttarakhand**: Nainital district, Kaladhungi, 1♀, 6.v.1913, Coll. R. Hodgart, 13059/H3; Chamoli district, Ghangaria, 1♀, 1.vi.1965, Coll. V.K. Gupta, 13060/H3. **Uttar Pradesh**: Sonbhadra district, Rihand, 1♀, 2.iv.1979, Coll. R.L. Choudhury, 13061/H3; Gautam Buddha Nagar district, Solarpur Kalan, 1♀, 6.vi.1989 & Noida, 1♀, 8.vi.1989, Coll. M.S. Shishodia & Party, 13062/H3 & 13063/H3; Aligarh district, Pilkhana, 1♂, 15.xi.2005, Coll. S.I. Kazmi & Party, 13064/H3; Meerut district, Meerut town, 1♀, 22.xi.2005 & Kashi,

1♀, 23.xi.2005, Coll. S.I. Kazmi & Party, 13065/H3 & 13066/H3; Saharanpur, 1♀, 24.ii.2006, Coll. B. Biswas & Party, 13067/H3; Faizabad district, Bikapur, 1♀, 4.iv.2006 & Mumtaznagar, 1♂, 5.iv.2006, Coll. S.I. Kazmi & Party, 13068/H3 & 13069/H3; Sant Ravidas Nagar district, Gopiganj, 1♂, 14.iv.2006, Coll. S.I. Kazmi & Party, 13070/H3; Gautam Buddha Nagar district, Dadri, 1♂, 20.v.2006, Coll. S.I. Kazmi & Party, 13071/H3; Bahraich district, gadadharpur, 1♂, 9.ix.2006, Coll. S.I. Kazmi & Party, 13072/H3; Banda district, Khurhand, 1♂, 31.x.2007, Coll. S.I. Kazmi & Party, 13073/H3; Jalaon district, Orai, Garithan, 1♀, 5.xi.2007, Coll. S.I. Kazmi & Party, 13074/H3; Agra district, Azizpur, 1♀, 11.xi.2007, Coll. S.I. Kazmi & Party, 13075/H3; Aligarh district, Aligarh Muslim University Campus, 1♀ & 1♂, 13.xi.2007, Coll. S.I. Kazmi & Party, 13076/H3 & 13077/H3; Gautam Buddha Nagar district, Chaprola, 1♀, 16.xi.2007, Coll. S.I. Kazmi & Party, 13078/H3. **West Bengal:** Kolkata, 1♀ & 1♂, date of collection and name of collector Unknown, 3192/H3 & 424/H3; Kolkata, 5♀ & 1♂, date of collection and name of collector Unknown, 13079/H3 to 13084/H3; Kolkata, 1♀, date of collection Unknown, Coll. J.B. Richardson, 3209/H3; Kolkata, 1♀ & 2♂, 11.x.1906-24.x.1907, name of collector Unknown, 13085/H3 to 13087/H3; N-24 Parganas district, Salt Lake, 1♂, 10.v.1926, Coll. B.N. Chopra, 13088/H3; Kolkata, 1♀, 1930, date of collection and name of collector Unknown, 13089/H3; Howrah district, Shibpur, Acharya Jagadish Chandra Bose Indian Botanical Garden, 1♀, 28.vi.1965, Coll. P. Parui, 5179/H3; S-24 Parganas district, Matla, Gorosthan Ghor, 1♂, 18.x.1965, Coll. A.N.T. Joseph & Party, 5178/H3; S-24 Parganas district, Agarhati, 1♀, 3.vi.1978, Coll. M. Prasad & Party, 13090/H3; N-24 Parganas district, Salt Lake, Nalban, 1♂, 11.vii.1984, Coll. B. Biswas & Party, 13091/H3; Bankura district,

Bhogpur, 1♂, 14.x.1986, Coll. K.P. Mukherjee & Party, 13092/H3; Jalpaiguri district, Nagrakata, 1♂, 20.vi.1987, Coll. K.P. Mukherjee & Party, 13093/H3; Malda district, Parbati Danga, 1♂, 27.vi.1987, Coll. K.P. Mukherjee & Party, 13094/H3; Howrah district, Chandrapur, 1♂, 25.v.1994, Coll. S.K. Gupta & Party, 13095/H3.

Distribution : India: Andhra Pradesh (new record), Arunachal Pradesh, Chhattisgarh (new record), Delhi, Gujarat, Himachal Pradesh (new record), Jharkhand (new record), Karnataka (new record), Kerala (new record), Maharashtra, Manipur (new record), Meghalaya (new record), Odisha, Rajasthan, Tamil Nadu, Uttarakhand, Uttar Pradesh (new record) and West Bengal.

Elsewhere : Arabia, Australia, Indonesia (Borneo, Java), Iran, Iraq, Laos, Mauritius, Myanmar, Pakistan, Philippines, Sri Lanka, Thailand, Timor.

SUMMARY

The potter wasp species *Delta esuriens* (Fabricius, 1787) is redescribed and newly recorded from the Indian states Andhra Pradesh, Chhattisgarh, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Manipur, Meghalaya and Uttar Pradesh.

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PLATE I

Delta esuriens (Fabricius)

Female 1. Body profile.



Female 2. Head front view.



Female 3. Forewing and Hindwing.



Male 4. Head front view. 5. Genitalia.



Male 5. Genitalia.



ON A COLLECTION OF SILVANIDAE (COLEOPTERA: CUCUJOIDEA) FROM ARUNACHAL PRADESH, INDIA WITH TWO NEW SPECIES AND A LARVA

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INTRODUCTION

The Silvanidae are a moderately large family of the section Clavicornia of the superfamily Cucujoidea of the suborder Polyphaga. The silvanids are usually small (1.3-4.5 mm.) and seldom large (11.5 mm.), often subdepressed and reddish-brown, and occasionally with dorsal spots. They are largely associated with litter or vegetation debris and a good number of species are subcorticolous by habit. The Silvanidae are diversely represented in the tropical and subtropical parts of the world than in the temperate zones. The representatives of the family occur in all the continental areas of the world, but so far only a few species have been recorded from New Zealand and the oceanic islands. After Grouvelle (1908, 1912), the works of Pal & Sengupta (1977, 1979, 1984); Pal (1981, 1985), Pal, Sengupta & Crowson (1984); and Sengupta & Pal (1996) have contributed to the knowledge of the Silvanidae of India. Later, Pal & Halstead (1998) recorded *Acathartus* Grouvelle from Mizoram: India with a new species. Sengupta & Pal (1996) in the *Fauna of India* volume recorded about 8 species under 5 genera from Arunachal Pradesh. The present work is based on the collection made by one author (TKP) since 1988 in different districts of Arunachal Pradesh state, that represent 23 species under 10 genera. A larva of *Uleiota* Latreille is also described.

CHARACTERS OF THE FAMILY SILVANIDAE

Body small to moderately large (1.3-11.5 mm.), usually parallel-sided and somewhat flattened or sometimes ovoid and subconvex, elytral punctation in rows.

Head usually little elongate, sometimes transverse, usually with a transverse impressed line on vertex behind eyes, fronto-clypeal suture present or absent, antennal insertions hidden or exposed but never distinctly dorsal; gular sutures well separated, anterior part of gular region without longitudinal grooves, genal process normal; antenna 11-segmented, often with 3-segmented club and sometimes without club; mandible with two or three apical teeth, well developed mola, sometimes with a large cavity on dorsal side, otherwise cavity reduced to a vestige and without dorsal tubercle; maxilla with distinct lacinia and galea, lacinia narrow and with or without apical spine, galea broad and its apex densely hairy, palpi with apical segment rarely securiform; labium with mentum transverse; palpi with apical segment rarely securiform or transverse or distinctly smaller than segment 2.

Prothorax usually elongated and sometimes transverse, side margins often serrated and sometimes with distinct teeth, pronotum without distinct prebasal impression, prosternum moderately broad with apical margin almost straight, front coxae usually closely and rarely widely situated, trochantins hidden; coxal cavities somewhat rounded, usually externally closed behind and rarely open.

Elytra punctured in regular rows and usually with 9 rows of punctures, rarely with scutellary striae, epipleura usually complete. Wing usually with single anal vein, sometimes with three or five anal veins; devoid of radial cell, R-m cross vein and subcubital fleck.

Mesocoxae often closely situated, sternal fitting between mesocoxae usually in a straight line and sometimes with a narrow projection from metasternum, mesocoxal cavities broadly opened outwardly; hind coxae transverse and moderately widely separated; metendosternite often reduced and without lateral plates, sometimes well developed with anterior tendons.

Legs moderately long, trochanters short and simple, femora swollen towards middle, tibiae slightly broadened at apex and usually with two spurs, tarsal formula 5-5-5 in both sexes, tarsal segments 1-3 usually simple or slightly lobed below.

Abdomen covered by elytra, all ventrites freely articulated, ventrite 1 longest and ventrites 2-5 more or less equal in length, ventrite 1 sometimes with open femoral lines, intercoxal process variable. Aedeagus inverted cucujoid-type, median lobe usually broadly elongated and with a median strut, articulated parameres well developed. Ovipositor well developed with separate paraprocts, valvifers, coxites and styli.

LIST OF TAXA

Family SILVANIDAE

Subfamily SILVANINAE

1. *Silvanus lewisi* Ritter
2. *Silvanus recticollis* Reitter
3. *Silvanus difficilis* Halstead
4. *Silvanus robustus* Halstead
5. *Silvanoprus scuticollis* (Walker)
6. *Silvanoprus indicus* Pal & Sengupta
7. *Silvanoprus cephalotes* (Reitter)
8. *Silvanoprus angusticollis* (Reitter)
9. *Silvanoprus longicollis* (Reitter)
10. *Silvanoides cribricollis* (Grouvelle)
11. *Protosilvanus lateritius* (Reitter)
12. *Protosilvanus granosus* (Grouvelle)
13. *Oryzaephilus surinamensis* (L.)
14. *Acathartus idu* n. sp.
15. *Monanus concinnulus* (Walker)

Subfamily PSAMMOECINAE

16. *Psammoecus harmandi* Grouvelle
17. *Psammoecus triloehana* Pal
18. *Psammoecus simoni* Grouvelle
19. *Psammoecus trimaculatus* Motschulsky

Subfamily CRYPTAMORPHINAE

20. *Cryptamorphus foveicollis* n. sp.

Subfamily ULEIOTINAE

21. *Uleiota spinicollis* (Gory)
22. *Uleiota alticola* Pal, Sengupta & Crowson
23. *Uleiota puberula* (Reitter)

SYSTEMATIC ACCOUNT

Family SILVANIDAE

Subfamily SILVANINAE

Genus *Silvanus* Latreille

1804. *Silvanus* Latreille, *Histoire Naturelle, générale et particulière, des crustacés et des insectes*, 11: 158 [Type-species: *Ips unidentata* Olivier].

Diagnosis : Head devoid of fronto-clypeal suture, eyes moderately large and coarsely faceted, temple often flattened beneath eye, transverse impressed line on vertex behind eyes, 11-segmented antenna with 3-segmented club, antennal insertions hidden under projection of frons, mandible with 3 apical teeth, apical segments of maxillary and labial palpi fusiform; prothorax usually elongate, side margins finely serrated, front coxal cavities closed and prosternal process broad at apex; mesocoxae narrowly separated; wing with single aral vein; each elytron with 9 rows of striae punctures, tarsi of legs simple; intercoxal process of first abdominal ventrite broad and its apical margin broadly pointed, femoral lines closed.

1. *Silvanus lewisi* Reitter

1876. *Silvanus lewisi* Reitter, *Col. Hefte*, 15: 76.
 1973. *Silvanus lewisi*: Halstead, *Bull. Br. Mus. Nat. Hist. (Ent.)*, 29 (2): 52.
 1977. *Silvanus lewisi*: Pal & Sengupta, *Oriental Ins.*, 11 (2): 272.

Diagnosis : Yellowish- to reddish-brown and covered with short pubescence; eyes about half as

long as head, temple shorter than one eye facet and its outer apical angle pointed, puncturation on vertex coarse and dense; elongated prothorax with anterior spine about half as long as eye and its tip pointed, lateral depressions on pronotal disc slightly marked, puncturation on pronotum coarse and dense and almost similar to that of vertex of head, elytra about twice as long as wide, parallel-sided with margins little wavy, punctures deep and large. Length - 2.08-2.47 mm.

Material : 34 ex. INDIA: Arunachal Pradesh, L. Subansiri Distt., 15 km. O-Kimin, 1 ex., 22.ix.1988. T.K. Pal, ex. under bark; L. Subansiri Distt. (currently Papum Pare Distt.), Chimpu, Itanagar, 1 ex., 27.v.1992, T.K. Pal, ex. under bark; W. Siang Distt., Wak, 16 km. O-Along, 12 ex., 3.iii.1989, T.K. Pal, ex. under bark; Changlang Distt., Tengmo, 17 km. O-Nampong, 3 ex., 9.iii.1990, T.K. Pal, ex. under bark; Diyun-Jyotsnapur, 25 km. O-Miao, 7 ex., 4.iii.1990, T.K. Pal, ex. under bark; L. Dibang Valley Distt., Mayu, Roing, 4 ex., 6.iv.2009, T.K. Pal, ex. under bark; Shantipur, 6 ex., 5.iv.2009, T.K. Pal, ex. old log and under bark.

Distribution : INDIA: Arunachal Pradesh (new record), Nagaland, Assam, Meghalaya, Sikkim, West Bengal, Himachal Pradesh, Uttarakhand, Tamil Nadu, Karnataka, Kerala, Andaman Is.

Elsewhere : Sri Lanka; Vietnam; Taiwan; Japan; Malaysia; Singapore; Indonesia; Philippines; New Guinea; Solomon Is.; Australia; Congo; Ghana.

2. *Silvanus recticollis* Reitter

1876. *Silvanus recticollis* Reitter, *Col. Hefte*, 15: 61.
 1879. *Silvanus reflexus* Reitter, *Verh. zool. bot. Ges. Wien*, 29: 85.
 1882. *Silvanus vitulus* Grouvelle, *Annali Mus. civ. Stor. Nat. Giacomo Doria*, 32: 294.
 1912. *Silvanus (Microsilvanus) vitulus*: Grouvelle, *Annl. Soc. ent. Fr.*, 81: 332.
 1912. *Silvanus (Microsilvanus) pumilus* Grouvelle, *Annl. Soc. ent. Fr.*, 81: 332.
 1912. *Silvanus (Microsilvanus) minimus* Grouvelle, *Annl. Soc. ent. Fr.*, 81: 334.
 1973. *Silvanus recticollis*: Halstead, *Bull. Br. Mus. Nat. Hist. (Ent.)*, 29 (2): 55.
 1977. *Silvanus recticollis*: Pal & Sengupta, *Oriental Ins.*, 11 (2): 274.

Diagnosis : Yellowish-brown and covered with short pubescence; eyes about one-third as long as head, temple about half as long as head and its outer margin arcuate, puncturation on vertex coarse and dense; slightly elongate prothorax apparently quadrate, moderately large anterior spine projecting forward and with blunt tip, no distinct lateral depressions on pronotum, puncturation on pronotum almost similar to that of vertex of head; elytra shorter than twice as long as broad, lateral margins slightly sinuate and little explanate, punctures deep and large. Length - 1.60-2.80 mm.

Material : 2 ex. INDIA: Arunachal Pradesh, E. Siang Distt., 6 km. O-Pasighat, 1 ex., 16.ii.1989, T.K. Pal, ex. haystack; Dibang Valley Distt., Mayu, Roing, 1 ex., 6.iv.2009, T.K. Pal, ex. haystack.

Distribution : INDIA: Arunachal Pradesh (new record), West Bengal.

Elsewhere : Thailand; Vietnam; Laos; Sulawesi; Japan; Mauritania; Congo; Zaire; Zimbabwe.

3. *Silvanus difficilis* Halstead

1973. *Silvanus difficilis* Halstead, *Bull. Br. Mus. Nat. Hist. (Ent.)*, 29 (2): 73.
 1977. *Silvanus difficilis*: Pal and Sengupta, *Oriental Ins.*, 11 (2): 279.

Diagnosis : Reddish-brown and covered with short pubescence; eyes slightly shorter than half of length of head, temple about as long as 1.5 to 2 eye facets with broad outer apical angle, puncturation on vertex coarse and dense; elongated prothorax, anterior spine about half as long as eye with slightly blunt tip, well developed lateral depressions on pronotal disc, puncturation on pronotum coarse and dense and almost similar to that of vertex of head; elytra little more than twice as long as broad, side margins little wavy, punctures deep and large. Length- 2.20-2.50 mm.

Material : 16 ex. INDIA: Arunachal Pradesh, L. Subansiri Distt., nr. Pitapol, 10 km. O-Yazali, 1 ex., 19.ix.1988, T.K. Pal, ex. under bark; Banderdewa, 1 ex., 25.vi.1991, T.K. Pal, ex. under bark; W. Siang Distt., Wak, 16 km. O-Along, 3 ex., 3.iii.1989, T.K. Pal, ex. under bark; Changlang Distt., Tengmo, 17 km. O-Nampong, 1 ex., 10.iii.1990, T. K. Pal, ex. under bark; Rima, 7 km. O-Nampong, 1 ex., 11.iii.1990, T.K. Pal, ex. under bark; Diyum-Jyotsnapur, 25 km. O-Miao, 9 ex., 4.iii.1990, T.K. Pal, ex. under bark.

Distribution : INDIA: Arunachal Pradesh, Nagaland, Manipur, Assam, Meghalaya, Mizoram, Sikkim, West Bengal, Himachal Pradesh, Uttarakhand, Madhya Pradesh, Maharashtra, Karnataka, Kerala, Tamil Nadu, Andaman Is.

Elsewhere : Sri Lanka; Myanmar; Vietnam; Taiwan; Malaysia; Singapore; Indonesia; Philippines; Moluccas; I. Delcas; Solomon Is.; Australia; New Ireland; West Africa.

4. *Silvanus robustus* Halstead

1973. *Silvanus robustus* Halstead, *Bull. Br. Mus. Nat. Hist. (Ent.)*, **29** (2): 71.

1977. *Silvanus curvispinus* Pal & Sengupta, *Oriental Ins.* **11** (2): 278.

Diagnosis : Yellowish- to reddish-brown and covered with short pubescence; eye slightly shorter than half as long as head; temple about as long as two eye facets, extended laterally beneath eye with broad apical angle; puncturation on vertex coarse and dense, moderately long antenna with basal and apical segments of club (segments 9 and 11) elongate; elongated prothorax, anterior spine at least half as long as eye and its outer margin curved inward, excluding anterior spines shape somewhat elliptical, lateral depressions on pronotum slightly marked near base, puncturation slightly coarser than that of vertex of head; elytra slightly more than twice as long as broad, sides little wavy, punctures deep and large; in male hind trochanter with a short spine. Length- 2.8-3.0 mm.

Material : 2 ex. INDIA: Arunachal Pradesh, L. Subansiri Distt., 10 km. O-Yazali, nr. Pitapol, 1 ex., 19.ix.1988, T.K. Pal, ex. under bark; Tirap Distt., Hukanjuri, 36 km. O-Khonsa, 1 ex., 14.iii.1990, T.K. Pal, ex. under bark.

Distribution : INDIA: Assam, Arunachal Pradesh, West Bengal, Andaman Is.

Elsewhere : Malaysia; Singapore; Indonesia; Philippines.

Genus *Silvanoprus* Reitter

1911. *Silvanoprus* Reitter, *Fauna Germanica*, **3**: 45 [Type species: *Silvanus fagi* Guérin-Méneville].

Diagnosis : Head devoid of fronto-clypeal suture, eyes moderately large and coarsely faceted, temple usually flattened beneath eye, vertex with a transverse impressed line behind eyes, 11-segmented

antenna with 3-segmented club, antennal insertions hidden under projection of frons, mandible with well developed mola and three apical teeth, apical segments of maxillary and labial palpi fusiform; prothorax usually elongate and rarely transverse, side margins finely serrated, front angles with more or less prominent spines, front coxal cavities closed and prosternal process broad at apex; mesocoxae closely situated; each elytron with nine rows of stria punctures; tarsal segment 3 of legs strongly lobed below; intercoxal process of first abdominal ventrite broad but narrowed towards apex, femoral (coxal) lines closed and usually narrowly separated from margins of hind coxal cavities.

5. *Silvanoprus scuticollis* (Walker)

1859. *Silvanus scuticollis* Walker, *Ann. Mag. Nat. Hist.*, (3) **3**:53.

1886. *Silvanus triangulus* Reitter, *Col. Hefle*, **15**: 60.

1912. *Silvanoprus scuticollis*: Grouvelle, *Annls. Soc. ent. Fr.*, **81**: 342.

1979. *Silvanoprus scuticollis*: Pal and Sengupta, *Entomologica Basiliensia*, **4**:70.

Diagnosis : Yellowish- to reddish-brown and covered with short pubescence; eyes slightly shorter than half of length of head, temple about as long as one eye facet and its outer apical angle slightly pointed, puncturation on vertex coarse and dense; prothorax broader than long and distinctly narrowed posteriorly, widest across anterior spines, anterior spine about two-thirds as long as eye, lateral depressions on pronotum slightly developed, puncturation on pronotum almost similar to that of vertex of head; elytra slightly less than twice as long as broad, side margins little wavy, punctures deep and large. Length- 2.15 - 2.55 mm.

Material : 35 ex. INDIA: Arunachal Pradesh, W. Kameng Distt., Elephant head point, 250 m., 15 km. O-Bhalukpong, 1 ex., 1.xii.1990, T.K. Pal, ex. haystack; W. Siang Distt., Malinithan Forest, 4 km. O-Likabali, 8 ex., 16.iii.1989, ex. haystack; Nilok, 10 km. O-Likabali, 6 ex., 14.iii.1989, T.K. Pal, ex. haystack; Tirap Distt., Namsangmukh, 10 km. O-Deomali, 1 ex., 18.iii.1990, T.K. Pal, ex. vegetable debris; L. Dibang Valley Distt., Roing, 1 ex., 3.iv.2009, T.K. Pal, ex. haystack; Shantipur, 1 ex., 5.iv.2009, T.K. Pal, ex. under bark; Kankong, 17 ex., 12.iv.2009, T.K. Pal, ex. haystack.

Distribution: INDIA: Arunachal Pradesh (new record), Assam, Nagaland, Manipur, Meghalaya, Mizoram, Tripura, Sikkim, West Bengal, Bihar, Uttar Pradesh, Uttarakhand, Tamil Nadu, Andaman Is.

Elsewhere : Sri Lanka; Malaysia; Indonesia; Japan; East Africa; Madagascar; France; Guyana; West Indies.

6. *Silvanoprus indicus* Pal & Sengupta

1979. *Silvanoprus indicus* Pal & Sengupta, *Entomologica Basiliensia*, 4: 71.

Diagnosis : Yellowish- to reddish-brown and covered with short pubescence; eyes less than half as long as head, temple as long as 2 to 3 eye facets and its outer apical margin broad, temple not flattened beneath eye, puncturation on vertex coarse and dense; prothorax elongate, slightly narrowed posteriorly, anterior spine short and its tip broadly pointed, side margins curved and sinuate near extremities, lateral depressions on pronotum slightly developed, puncturation on pronotum almost similar to that of vertex of head; elytra about twice as long as broad, side margins slightly wavy, punctures deep and large. Length- 2.30-2.33 mm.

Material : 27 ex. INDIA: Arunachal Pradesh, W. Siang Distt., Nilok, 10 km. O-Likabali, 2 ex., 14.iii.1989, T.K. Pal, ex. haystack; Lohit Distt., Kheram, 35 km. O-Namsai, 3 ex., 2.iii.1990, ex. haystack of mustard; Yatong (currently Anjaw Distt.), 25 km. O-Hayuliang, 3 ex., 25.ii.1990, T.K. Pal, ex. haystack; Dibang Valley Distt., Kankong, 19 ex., 12.iv.2009, T.K. Pal, ex. haystack.

Distribution : INDIA: Arunachal Pradesh (new record), Nagaland, Manipur, Assam, Meghalaya, Mizoram, Sikkim.

7. *Silvanoprus cephalotes* (Reitter)

1876. *Silvanus cephalotes* Reitter, *Col. Hefte*, 15: 62.

1908. *Silvanus longicollis*: Grouvelle (nec. Reitter), *Annls. Soc. ent. Fr.*, 77: 492.

1912. *Silvanoprus longicollis*: Grouvelle (nec. Reitter), *Annls. Soc. ent. Fr.*, 81: 342.

1979. *Silvanoprus cephalotes*: Pal & Sengupta, *Entomologica Basiliensia*, 4: 70.

Diagnosis : Yellowish- to reddish-brown and covered with short pubescence; eyes slightly shorter than half as long as head, temple about as long as

one eye facets and its outer apical angle slightly pointed, temple flattened beneath eye, puncturation on vertex coarse and dense and not ocellate-type; elongated prothorax widest near middle, anterior spine short, about one-fourth as long as eye or shorter and projected forward, side margins feebly arcuate, lateral depressions on pronotum slightly developed, puncturation on pronotum almost similar to that of vertex of head; elytra more than twice as long as broad, side margins slightly wavy, punctures deep and large. Length- 2.20-2.35 mm.

Material : 203 ex. INDIA: W. Siang Distt., Malinithan Forest, 4 km. O-Likabali, 6 ex., 16.iii.1989, T.K. Pal, ex. haystack; Nilok, 10 km. O-Likabali, 11 ex., 14.iii.1989, T.K. Pal, ex. haystack; E. Siang distt., 6 km. O-Pasighat, 10 ex., 16.ii.1989, T.K. Pal, ex. haystack; Lohit Distt., Kheram, 35 km. O-Namsai, 13 ex., 2.iii.1990, ex. haystack of mustard; Yatong (currently Anjaw Distt.), 25 km. O-Hayuliang, 6 ex., 25.ii.1990, T.K. Pal, ex. haystack; Nara, 14 km. O-Hayuliang, 1 ex., 26.ii.1990, T.K. Pal, ex. haystack; Tirap Distt., Namsangmukh, 10 km. O-Deomali, 13 ex., 18.iii.1990, T.K. Pal, ex. vegetable debris; Dibang Valley Distt., Shantipur, 93 ex., 5.iv.2009, T.K. Pal, ex. haystack; Kankong, 41 ex., 12.iv.2009, T.K. Pal, ex. haystack; Roing, 3 ex., 3.iv.2009, T.K. Pal, ex. beating bush; Mayu, Roing, 6 ex., 6.iv.2009, T.K. Pal, ex. haystack.

Distribution : INDIA: Arunachal Pradesh (new record), Nagaland, Manipur, Assam, Meghalaya, Mizoram, Tripura, Sikkim, West Bengal, Bihar, Uttar Pradesh, Uttarakhand, Delhi, Karnataka, Tamil Nadu.

Elsewhere : Bhuta; Nepal; Sri Lanka; Indonesia; Japan; China.

8. *Silvanoprus angusticollis* (Reitter)

1876. *Silvanus angusticollis* Reitter, *Col. Hefte*, 15: 59.

1912. *Silvanoprus angusticollis*: Grouvelle, *Annls. Soc. ent. Fr.*, 81: 341.

1979. *Silvanoprus angusticollis* : Pal & Sengupta, *Entomologica Basiliensia*, 4: 71.

Diagnosis : Yellowish- to reddish-brown and covered with short pubescence; eyes slightly shorter than half as long as head, temple shorter than one eye facet and its outer apical angle slightly pointed, temple flattened beneath eye, puncturation on vertex coarse and dense; elongated prothorax

widest across anterior spines, slightly narrowed posteriorly behind middle, anterior spine moderately long, slightly shorter than half as long as eye and projected antero-laterally, side margins feebly sinuate near extremities, lateral depressions on pronotum slightly developed, puncturation on pronotum almost similar to that of vertex of head; elytra about twice as long as broad, side margins slightly wavy, punctures deep and large. Length- 2.50-2.70 mm.

Material : 23 ex. INDIA: Arunachal Pradesh, W. Kameng Distt., Bomdila, 2462 m., 2 ex., 25.ix.2004, T.K. Pal, ex. beating bush; Gandhi Colony, Bomdila, 10 ex., 27.iv.2004, T.K. Pal, ex. beating bush; Sangti, 1577 m., 11 ex., 30.ix.2004, T.K. Pal, ex. haystack.

Distribution: INDIA: Arunachal Pradesh (new record), Nagaland, Mizoram, Meghalaya, Sikkim, West Bengal, Uttar Pradesh, Kashmir, Tamil Nadu.

Elsewhere : Bhutan; Nepal; Japan.

9. *Silvanoprus longicollis* (Reitter)

1876. *Silvanus longicollis* Reitter, *Col. Hefte*, 15: 60

1908. *Silvanus longicollis* Grouvelle (nec. Reitter), *Annl. Soc. ent. Fr.*, 77: 491.

1912. *Silvanoprus longicollis* Grouvelle (nec. Reitter), *Annl. Soc. ent. Fr.* 81: 341.

1984. *Silvanoprus longicollis*: Pal, *Rec. zool. Surv. India*, 81(3-4): 339.

Diagnosis : Yellowish- to reddish-brown and covered with short pubescence; eyes short, temple long, slightly longer than length of eye and its outer margin slightly rounded, antennal scape large and about twice as long as broad, antennal segments 2-8 narrow-elongate, club 3-segmented, puncturation on vertex coarse and ocellate; prothorax elongate and almost parallel-sided, anterior spine small, about half as long as eye and projected forward, puncturation on pronotum almost similar to that of vertex of head and little finer anteriorly, lateral depressions on pronotum indistinct; elytra about twice as long as broad, side margins little wavy, punctures deep and large. Length- 2.20 - 2.28 mm.

Material : 4 ex. INDIA: Arunachal Pradesh, W. Kameng Distt., Elephant head point, 250 m., 15 km. O-Bhalukpong, 1 ex., 1.xii.1990, T.K. Pal, ex. haystack; L. Dibang Valley Distt., Kankong, 3 ex., 12.iv.2009, T.K. Pal, ex. haystack.

Distribution : INDIA: Arunachal Pradesh (new record), Nagaland, Manipur, Mizoram, Meghalaya, Assam, Tripura, Sikkim, West Bengal, Uttar Pradesh, Uttarakhand, Tamil Nadu, Andaman Is.

Elsewhere : Sri Lanka; Malaysia; Indonesia; China; Japan; Madagascar; East Africa.

Genus *Silvanoides* Halstead

1973. *Silvanoides* Halstead, *Bull. Br. Mus. Hist. (Ent.)*, 29 (2): 87 [Type-species: *Silvanoides cheesmanae* Halstead].

Diagnosis : Head devoid of fronto-clypeal suture, eyes large and coarsely faceted, temple flattened beneath eye and shelf-like, transverse impressed line on vertex behind eyes indistinctly visible, 11-segmented antenna moderately long, segments 4 to 8 transverse or about as broad as long, club 3-segmented; mandible with well developed mola and 3 apical teeth, apical segments of both maxillary and labial palpi fusiform, maxillary lacinia with apical spine; prothorax elongate, front angles with prominent spines beneath level of anterior margin, side margins finely denticulate, front coxal cavities closed behind and prosternal process broad at apex, mesocoxae moderately widely separated, wing with single anal vein, each elytron with 9 rows of stria punctures; tarsi of legs simple; intercoxal process of first abdominal ventrite broad and broadly pointed at apex, femoral lines opened.

10. *Silvanoides cribricollis* (Grouvelle)

1897. *Silvanus cribricollis* Grouvelle, *Anali. Mus. Civ. Stor. Nat. Giacomo Doria*, 38 (series 2, 18): 397.

1912. *Neosilvanus cribricollis*: Grouvelle, *Annl. Soc. ent. Fr.*, 81: 324.

1985. *Silvanoides cribricollis*: Pal. *Rec. zool. Surv. India*, 82 (1-4): 196.

Diagnosis : Reddish-brown, rather shiny and covered with short pubescence; eyes large and about half as long as head, temple slightly shorter than width of an eye facet and sloped downward, puncturation on vertex fine and sparse; elongated prothorax slightly narrowed posteriorly, anterior spine short, broad and its tips somewhat pointed, side margins curved and slightly sinuate near posterior angles, lateral depressions on pronotal disc moderately developed, puncturation on sides of pronotum coarser than near middle; elytra more than twice as long as broad, side margins feebly

wavy, punctures deep and large. Length- 2.5 - 3.0 mm.

Material : 7 ex. INDIA: Arunachal Pradesh, L. Subansiri Distt., Seven Camp, 27 km. O-Kimin, 1 ex., 21.ix.1988, T.K. Pal, ex. under bark; nr. Pitapol, 10 km. O-Yazali, 1 ex., 19.ix.1988, ex. under bark; W. Siang Distt., Kamki, 26 km. O-Along, 4 ex., 4.iii.1989, T.K. Pal, ex. under bark; Chanlang Distt., Rima, 7 km. O-Nampong, 1 ex., 11.iii. 1990, T.K. Pal, ex. under bark;

Distribution : INDIA: Arunachal Pradesh, Meghalaya, Sikkim, Andaman & Nicobar Is.

Elsewhere : Indonesia.

Genus *Protosilvanus* Grouvelle

1912. *Silvanus* (*Protosilvanus*) Grouvelle, *Annls. Soc ent. Fr.*, **81**: 336.

1973. *Protosilvanus* Grouvelle: Halstead, *Bull. Br. Mus. Hist. (Ent.)*, **29** (2): 89 [Type species: *Silvanus lateritius* Reitter].

Diagnosis : Elongated, parallel-sided, head devoid of fronto-clypeal suture, eyes large and coarsely faceted, temple flattened beneath eye and shelf-like, vertex with a distinct transverse impressed line behind eyes, 11-segmented antenna with 3-segmented club, antennal insertions hidden under projection of frons, mandible with well developed mola and three apical teeth, maxillary without apical spines, segments 2 of both maxillary lacinia and labial palpi longer than apical segments; prothorax elongated, front angles with prominent spines, side margins finely denticulate, front coxae widely separated and coxal cavities closed behind, sterno-pleural suture extending to lateral margin, mesocoxae widely separated; wing with single anal vein; each elytron with 9 rows of striae punctures, interstice 7 more or less carinate; tarsi of legs simple; intercoxal process of first abdominal ventrite broad and broadly pointed at apex, femoral (coxal) lines closed.

11. *Protosilvanus lateritius* (Reitter)

1878. *Silvanus lateritius* Reitter, *Verh. Zool. Bot. Ges. Wien*, **28**: 194.

1908. *Silvanus lateritius*: Grouvelle, *Annls. Soc. ent. Fr.*, **77**: 490.

1912. *Silvanus* (*Protosilvanus*) *lateritius*: Grouvelle, *Annls. Soc ent. Fr.*, **81**: 336.

1973. *Protosilvanus lateritius*: Halstead, *Bull. Br. Mus. nat. Hist. (Ent.)*, **29** (2): 96.

Diagnosis : Dorsally flattened, reddish-brown and covered with short pubescence; eyes about half as long as head, temple shorter than width of an eye facet and sloped downward, antennal segments 9 and 10 with apical spines, puncturation on vertex coarse and dense; elongated prothorax slightly narrowed behind middle, widest across anterior spines, lateral depressions on pronotum rather well developed, puncturation on pronotum almost similar to that of vertex of head; elytra more than twice as long as broad, almost parallel-sided with side margins slightly wavy, punctures deep and large, interstice 7 strongly carinate and extending slightly beyond anterior three-fourths. Length- 2.9-3.5 mm.

Material : 56 ex. INDIA: Arunachal Pradesh, L. Subansiri Distt., Seven Camp, 27 km. O-Kimin, 1 ex., 21.ix.1988, T.K. Pal, ex. under bark; nr. Lichi, 25 km. O-Yazali, 14 ex., ix.1988, T.K. Pal, ex. under bark; Hawa Camp, 15 km. O-Kimin, 5 ex., 22.ix.1988, T.K. Pal, ex. under bark; Chimpu, Itanagar (currently Papum Pare Distt.), 1 ex., 27.v.1992, T.K. Pal, ex. under bark; W. Siang Distt., Doke, 12 km. O-Basar, 1 ex., 8.iii.1989, T.K. Pal, ex. Banana leaf sheath; Likabali, 1 ex. 12.iii.1989, T.K. Pal, ex. under bark; Wak, 16 km. O-Along, 2 ex., 16.iii.1989, T.K. Pal, ex. under bark; E. Siang Distt., Bilat, 30 km. O-Pasighat, 7 ex., 18.ii.1989, T.K. Pal, ex. under bark; Lohit Distt., Lathaw, 14 km. O-Namsai, 8 ex., 1.iii.1990, T.K. Pal, ex. under bark; nr. Parasuram Kund, 20 km. O-Tezu, 3 ex., 23.ii.1990, T.K. Pal, ex. under bark; Kheram, 35 km. O-Namsai, 4 ex., 2.iii.1990, T.K. Pal, ex. under bark; Changlang Distt., 3 mile M.V. Road, 2 ex., 5.iii.1990, T.K. Pal, ex. under bark; Tengmo, 17 km. O-Nampong, 3 ex., 10.iii.1990, T.K. Pal, ex. under bark; Rima, 7 km. O-Nampong, 1 ex., 11.iii.1990, T.K. Pal, ex. under bark; New Yumchum, 8 km. O-Miao, 3 ex., 6.iii.1990, T.K. Pal, ex. under bark; L. Dibang Valley Distt., Parbuk, 1 ex., 11.iv.2009, ex. under bark.

Distribution: India: Arunachal Pradesh, Nagaland, Assam, Meghalaya, Mizoram, Tripura, Sikkim, West Bengal, Bihar, Uttar Pradesh, Uttarakhand, Himachal Pradesh, Kerala, Tamil Nadu, Andaman Is.

Elsewhere : Nepal; Bangladesh; Myanmar; Sri Lanka; Thailand; Vietnam; Malaysia; Singapore; Indonesia; Philippines; Taiwan; China; Japan.

12. *Protosilvanus granosus* (Grouvelle)

1897. *Silvanus granosus* Grouvelle. *Ann. Mus. civ. Stor. nat. G. Doria*, **32** (Series 2 **12**): 396.
1912. *Silvanus (Protosilvanus) granosus*: Grouvelle, *Annls. Soc. ent. Fr.*, **81**: 336.
1973. *Protosilvanus granosus*: Halstead, *Bull. Br. Mus. Nat. Hist. (Ent.)*, **29** (2): 93.

Diagnosis : Elongate, rather parallel-sided, dorsally flattened, reddish-brown, covered with short pubescence; eyes about half as long as head; temple short, thin, extended beneath eye with pointed tip; antenna moderately long, segments 9 and 10 transverse and devoid apical spines on sides, puncturation on vertex coarse and dense; elongate prothorax slightly narrowed behind middle, anterior spine small with slightly pointed tip, lateral depressions on pronotum moderately marked, puncturation on pronotum almost similar to that of vertex of head; elytra more than twice as long as broad, punctures deep and larg, interstice 7 slightly more raised than other interstices and prominent up to anterior three fourths. Length- 2.3- 2.9 mm.

Material : 21 ex. INDIA: Arunachal Pradesh, Papum Pare Distt., Itanagar, Chimpu, 3 ex., 27.v.1992, T.K. Pal, ex. under bark; W. Siang Distt., Doke, 12 km. O-Basar, 1 ex., 8.iii.1989, T.K. Pal, ex. decayed log; E. Siang Distt., Bilat, 30 km. O-Pasighat, 6 ex., 18.ii.1989, T.K. Pal, ex. under bark; Lohit Distt., Lathaw, 14 km. O-Namsai, 3 ex., 1.iii.1990, T.K. Pal, ex. under bark; Kheram, 35 km. O-Namsai, 4 ex., 2.iii.1990, T.K. Pal, ex. under bark; Changlang Distt., Diyun-Jyotsnapur, 25 km. O-Miao, 3 ex., 4.iii.1990, T.K. Pal, ex. under bark; 3 mile M.V. Road, 1 ex., 5.iii.1990, T.K. Pal, ex. under bark;

Distribution : INDIA: Arunachal Pradesh (new record), West Bengal, Andaman Is.

Elsewhere : Sri Lanka; Malaysia, Singapore; Indonesia; Philippines; Solomon Is.

Genus *Oreyaephilus* Ganglbauer

1899. *Silvanus (Oreyaephilus)* Ganglbauer, *Die Käfer von Mitteleuropa*, **3**: 584 [Type- species: *Silvanus surinameus* (Linnaeus)].
1911. *Oreyaephilus* : Reitter, *Fauna Germanica*, **3**: 45.

Diagnosis : Elongated, moderately depressed, somewhat parallel-sided, pronotum with three longitudinal carinae and six lateral teeth on either side. Head elongate, devoid of fronto-clypeal suture, eyes small to large, temple flattened beneath eye, no distinct transverse impressed line on vertex behind eyes; antenna moderately long, antennal insertions hidden under projection of frons, 11-segmented with 3-segmented club; mandible with well developed mola and three apical teeth, apical segments of both maxillary and labial palpi elongate and fusiform. Prothorax elongate, side margin with six distinct teeth, pronotum with a discal area demarcated by a median and two lateral carinae; lateral longitudinal groove on either side of median carina, front coxal cavities closed and prosternal process broad at apex, mesocoxae closely situated, lateral margins of mesosternal process not notched, no coxal lines on metasternum, hind coxae widely separated; each elytron with 9 rows striae punctures, intercoxal process of first abdominal ventrite broad with blunt apical margin, no femoral lines.

13. *Oreyaephilus surinamensis* (Linnaeus)

1758. *Dermestes surinamensis* Linnaeus, *Systema Naturae*, ed. 10, **1**: 357.
1758. *Tenebrio cursor* Linnaeus, *Systema Naturae*, ed. 10, **1**: 418.
1775. *Tenebrio surinamensis*: Degeer, *Memoires pour Servir a l'Histoire des Insectes*, **5**: 54.
1776. nec. *Dermestes sexdentatus* Boerner, *Oekonomische Nachrichten der Patriotischen Gessellschaft in Schlesien*, **4**: 78 [now *Ips sexdentatus* (Boerner): Scolytidae].
1775. *Anobium frumentarium* Fabricius, *Systema Entomologica*: 62.
1783. *Ips sexdentata* Herbst, *Archiv der Insectengeschichte*, **4**: 31.
1790. *Silpha sexdentata*: Gmelin, *Systema Naturae*, **1** (4): 1619.
1790. *Ips frumentaria*: Olivier, *Entomologie, ou Histoire Naturelle des Insectes*, **2** (18) *Ips*: 10.
1792. *Scarites cursor*: Fabricius, *Entomologia Systematica*, **1**: 96.
1792. *Dermestes sexdentatus*: Fabricius, *Entomologia Systematica*, **1**: 232.
1792. *Colydium frumentarium*: Fabricius, *Entomologia Systematica*, **1**: 496.
1794. *Lyctus sexdentatus*: Kugelann, *Schneider's Magazine*, **1**: 566.

1802. *Corticaria frumentaria*: Marsham, *Coleoptera Britannica*: 107.
1813. *Silvanus sexdentatus*: Gyllenhal, *Insecta Suecica Classis, 1, Coleoptera sive Eleuterata* 1 (3): 406.
1829. *Silvanus surinamensis*: Stephens, *A Systematic Catalogue of British Insects*: 92.
1846. *Silvanus bicornis* Erichson, *Naturgeschichte der Insecten Deutschlands. 1, Coleoptera* 3: 357.
1890. *Silvanus surinamensis* var. *bicornis*: Reitter, *Wien. ent. Ztg.*, 9: 255.
1899. *Silvanus* (*Oryzaephilus*) *surinamensis*: Ganglbauer, *Die Käfer von Mitteleuropa*, 3: 584.
1911. *Oryzaephilus surinamensis*: Reitter, *Fauna Germanica*, 3: 46.
1980. *Oryzaephilus surinamensis*: Halstead, *Zool. J. Linn. Soc.*, 69: 286.

Common name : Saw-toothed grain beetle.

Diagnosis : Elongate, moderately elevated carinae of pronotum, short temple, deep brown, covered with short and semisecret pubescence. Head (exposed part) about as broad as long, eye small to moderately large and about one-fourth as long as head, temple about as long as 3.5 to 4 eye facets or about as long as eye ; antenna moderately long, segments 4-8 about as broad as long, basal segments of club (9-10) transverse, apical segment (11) about as broad as long, puncturation on vertex coarse and dense; elongate prothorax with front margin rounded, teeth on margin broad and pointed, anterior tooth more acute, lateral carinae of pronotum slightly convergent towards extremities, longitudinal grooves on either side of median carina well marked, puncturation on pronotum similar to that of vertex of head; elytra more than twice as long as broad, punctures moderately large; interstices 3, 5 and 7 slightly carinate. Length- 2.5-3.0 mm.

Material : 12 ex. INDIA: Arunachal Pradesh, Papum Pare Distt., Itanagar, 2 ex., T.K. Pal, 30.viii.1989, T.K. Pal, ex. stored rice; 9 ex., 14.viii.1990, T.K. Pal, ex. stored rice; Naharlagun, 1 ex., 10.x.2004, T.K. Pal, ex. beating bush.

Distribution : INDIA: Arunachal Pradesh (new record), West Bengal, Jharkhand, Uttarakhand, Tamil Nadu.

Elsewhere : Distributed to many countries in the Old and New world through transport of stored food items.

Genus *Acathartus* Grouvelle

1912. *Acathartus* Grouvelle, *Annls. Soc. ent. Fr.*, 81: 315
[Type species: *Silvanus insignis* Grouvelle].

Diagnosis : Elongated, subparallel; head devoid of fronto-clypeal suture, eyes small and prominent, head sloped to back of eye but not forming a distinct temple, back of head with well marked impressed line, 11-segmented antenna with 2-segmented or indistinctly 3-segmented club, antennal insertions hidden under projection of frons, submentum in male with a large median pit bearing a few setae, mandible with bifid apex, maxillary palpi with segments 2 and 3 subequal, apical segment longest and narrowed apically, apical segment of labial palpi longer than segment 2 and narrowed apically; prothorax elongated, pronotum with anterior margin raised along median part, anterior angles laterally produced and broadly rounded, sides straight or weakly undulating and serrated, front coxae moderately widely separated, sterno-pleural suture markedly impressed and extending to side margin near base of anterior angle; elytra subparallel, each elytron with 9 rows of stria punctures, alternate interstices slightly raised but not carinate; tarsal segment 3 produced apically to form a lobe on which small 4th segment articulated; intercoxal process of first abdominal ventrite narrowly pointed, femoral lines inconspicuous.

14. *Acathartus idu* n. sp.

General appearance (Fig. 1) elongated, dorsally depressed, sides subparallel, somewhat shiny, cuticle punctate and less distinctly pubescent, dark brown, ventral punctation finer than dorsal side.

Head slightly longer than broad, dorsally flattened, with feeble linear depressions over antennal insertions; eyes prominently projected, about one-fifth as long as head; temple extended beneath eye, about one-fourth as long as eye, gradually narrowed exteriorly and outer apical angle pointed; sides finely margined; puncturation on vertex moderately coarse and dense, finer and sparser towards anterior margin of clypeus. Antenna moderately long and slender, about 1.5x as long as head, scape moderately large and elongate, pedicel shorter and narrower than scape, segment 3 longer than pedicel and segments 4-8 shorter elongate and subequal in length, club somewhat 3-segmented (9-11), segment 9 about as



Fig. 1. *Acathartus idu* n. sp., dorsal view.

broad as long and slightly wider than preceding segment, segment 10 distinctly broader than 9 with concave apical margin, apical segment (11) about as broad as long and slightly narrower than 10.

Prothorax elongate (1.3:1.0), nearly subparallel, front margin raised medially, front angles produced laterally and broadly rounded; sides feebly sinuate behind front angles, margin finely serrate; pronotal

disc depressed, with shallow but distinct lateral depressions in basal half; puncturation moderately coarse and dense, coarser laterally than mesally; hind angles short and obtuse. Scutellum moderately large, broader than long, finely punctate.

Elytra elongate (2.4:1.0), subparallel, slightly wider near posterior third, sides very slightly sinuate with narrowly explanate margins, apex

rounded, punctures moderately large and deep; alternate interstices raised, raised interstices with a medial row of posteriorly directed setae and bordered on either side by posteriorly converging setae, pubescence more distinctly visible towards sides than on middle.

On ventral side submentum of head with a large median pit (presumably secondary sexual character of male); prosternum with transverse striations on anterior part. Tarsal segment 3 of legs lobed; hind

tibia (male) bent inwards and with row of denticles on apical part of inner side; metafemur with low ridge near middle of inner side.

Aedeagus (Figs. 2, 3) with median lobe rounded to apex and slightly protuded medially, a row of small setae on either side of middle on dorsal surface; parameres elongate, slender, mostly subparallel and slightly widened above apex, no long apical seta, only two short subapical setae on outer side.



Fig. 2

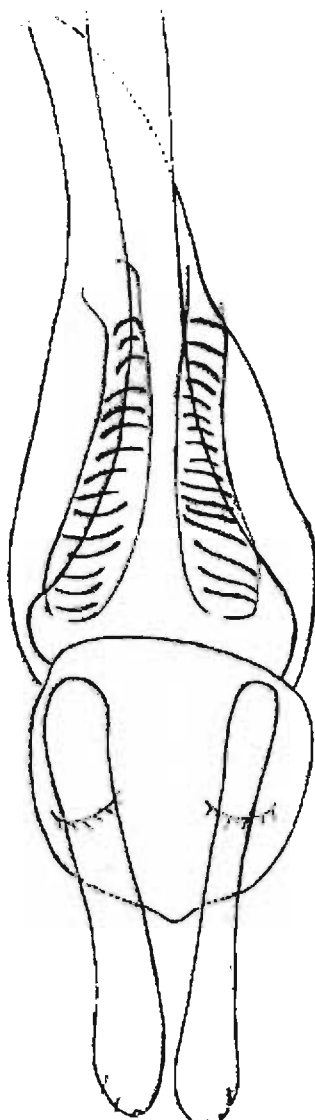


Fig. 3

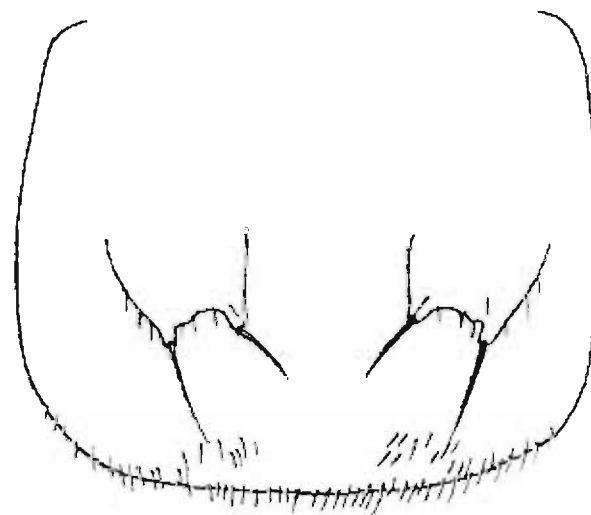


Fig. 4

Figs. 2-4. *Acanthartus idu* n. sp., Male genitalia: 2, Dorsal view of whole; 3, Enlargement to show detail of posterior part; 4, Sternites 8-9, dorsal view.

Measurements : Total length 3.86 mm., width of head across eyes 0.70 mm., length of antenna 0.84mm., length and width of prothorax 1.10 mm. and 0.80 mm., length and width of elytra 2.24 mm. and 0.87 mm.

Holotype : ♂, INDIA: Arunachal Pradesh, Lower Dibang Valley District, Ijingo, Roing, 15.iv.2009, T.K. Pal, ex. sweeping vegetation (Zoological Survey of India, Kolkata).

Etymology : The species is named after the tribe, *Idu* inhabiting Lower Dibang Valley District from where this species is found.

Remarks : The current species is the third species of *Acathartus* Grouvelle, and second one of the genus from India. This species differs from other Indian species, *A. mizoramensis* Pal & Halstead by the sides of prothorax behind anterior angles not weakly undulating, lateral depressions on pronotum are less well marked on basal half and recognisable only close to base, antennal segment 9 slightly transverse. This species shows some resemblances with *A. insignis* Grouvelle [Sumatra] but can be differentiated by the sides of prothorax feebly bisinuate behind anterior angles and not straight as in *insignis*. The male genitalia of this species differs from other two species by the slender parameres slightly widened above apex and devoid of long apical seta.

Genus *Monanus* Sharp

1879. *Monanus* Sharp, *Trans. Ent. Soc. Lond.*, 2: 85 [Type species: *Monanus crenatus* Sharp].

1899. *Emporius* Ganglbauer, *Die Käfer von Mitteleuropa*, 3: 429.

Diagnosis : Head devoid of fronto-clypeal suture, eyes moderately large and coarsely faceted, temple flattened beneath eye, no transverse line on vertex behind eyes; 11-segmented antenna with 3-segmented club, antennal insertions hidden under projection of frons; mandible with well developed mola and three apical teeth, apical segments of maxillary and labial palpi longer than other segments and fusiform, maxillary lacinia without apical spine; prothorax about as broad as long, side margins with a few setose denticles, front coxae contiguous and front coxal cavities closed behind, sterno-pleural suture extending usually to anterior denticle, mesocoxae contiguous; wing with single

anal vein; each elytron with nine rows of striae punctures, alternate interspaces with single and double rows of pubescence; tarsal segments 2 and 3 of legs strongly lobed below; intercoxal process of first abdominal ventrite broad and its apex slightly rounded, femoral (coxal) lines closed.

15. *Monanus concinnulus* (Walker)

1858. *Monanus concinnulus* Walker, *Ann. Mag. Nat. Hist.*, (3) 2: 207.

1867. *Silvanus signatus* Frauenfeld, *Verh. Zool. Bot. Ges. Wien*, 17: 438.

1874. *Cryptamorphus fasciatus* Wollaston, *Entomologist's mon. Mag.*, 10: 169.

1876. *Cryptamorphus concinnulus*: Waterhouse, *Entomologist's mon. Mag.*, 13: 122.

1899. *Emporius signatus*: Ganglbauer, *Die Käfer von Mitteleuropa*, 3: 586.

1908. *Emporius concinnulus*: Grouvelle, *Annl. Soc. ent. Fr.*, 77: 489.

1912. *Monanus* (s. str.) *concinnulus*: Grouvelle, *Annl. Soc. ent. Fr.*, 81: 371.

1981. *Monanus* (s. str.) *concinnulus*: Pal, *Oriental Ins.*, 15 (3): 247.

Diagnosis : Moderately convex, rather shiny, yellowish- to reddish-brown and with black markings on elytra, covered with short pubescence; eyes shorter than one-third as long as head, temple about as long as 1.5 eye facets and its outer apical angle slightly pointed, antenna shorter than head and prothorax together, punctation on vertex coarse and dense; quadrate prothorax slightly rounded anteriorly, side margin with about ten small and blunt denticles and each denticle bear an anteriorly directed seta, punctation on pronotum almost similar to that of vertex of head; elytra shorter than twice as long as broad, side margins almost uniformly curved, a transverse black spot near middle and that extends towards apex along suture, punctures large. Length- 2.00-2.30mm.

Material : 18 ex. INDIA: Arunachal Pradesh, W. Siang Distt., Nilok, 10 km. O-Likabali, 1 ex., 14.iii.1989, ex. haystack; Lohit Distt., Digaru, 19 km. O-Tezu, 1 ex., 22.ii.1990, T.K. Pal, ex. haystack; L. Dibang Valley Distt., Shantipur, 2 ex., 5.iv.2009, T.K. Pal, ex. haystack; Kankong, 14 ex., 12.iv.2009, T.K. Pal, ex. haystack.

Distribution : INDIA: Arunachal Pradesh (new record), Nagaland, Manipur, Meghalaya, Mizoram, Tripura, Sikkim, West Bengal, Bihar, Uttar Pradesh, Uttarakhand, Delhi, Tamil Nadu, Karnataka, Andaman Is.

Elsewhere : Outside India this species is widely distributed in both the Old and New Worlds.

Subfamily PSAMMOECINAE

Genus *Psammoecus* Latreille

1829. *Psammoechus* Latreille, *Cuv. Règne Anim.* ed. 2, 5: 135 [Type species: *Dermestes bipunctatus* (Fabricius)].

1830. *Crypta* Stephen, *Illustration of British Entomology: Mandibulata*, 3: 103.

1846. *Psammoecus*: Erichson, *Naturgeschichte der Insekten Deutschlands* 1, Coleoptera, 3: 329.

Diagnosis : Elongate, slightly ovoid; head with fronto-clypeal suture, two lateral longitudinal striae on vertex originating near bases of antennae, eyes small to moderately large and coarsely faceted, temple may or may not extend beneath eye, transverse impressed line on vertex behind eyes, 11-segmented antenna with no distinguishable club, antennal insertions somewhat dorso-lateral, mandible with large basal mandibular cavity and three apical teeth, apical segments of both maxillary and labial palpi securiform or transverse, maxillary lacinia without apical spine; prothorax usually transverse, side margins with more or less prominent denticles, front coxae contiguous and coxal cavities closed behind, apical margin of prosternal process little sinuate, sterno-pleural suture extending to lateral margin; wing with single anal vein; each elytron with 10 rows of striae punctures; tarsal segments 1-3 of legs lobed below; intercoxal process of first abdominal ventrite broad and its apical margin broadly pointed, femoral lines almost marginal striae of hind coxal cavities.

16. *Psammoecus harmandi* Grouvelle

1912. *Psammoeus harmandi* Grouvelle, *Bull. Mus. Paris*, 28: 413.

1985. *Psammoeus harmandi*: Pal, *Rec. zool. Surv. India, Occ. Pap.*, 71: 19.

Diagnosis : Elongate-ovoid, moderately convex, slightly shiny, yellowish- to reddish-brown with blackish spots on elytra and antennal segments 9 and 10 blackish, covered with moderately long

pubescence; eyes shorter than half of length of head, temple moderately long and slightly flattened beneath eye, antenna long and slender, scape moderately large and about twice as long as broad, segments 3 to 7 longer than pedicel, segments 8 to 11 slightly wider than segment 7, segment 11 elongate and slightly acuminate at apex, puncturation on vertex coarse and dense; prothorax transverse, anteriorly about as wide as head across eyes, front margin and side margins slightly rounded, side margin with six minute teeth, puncturation on pronotum almost similar to that of vertex of head; elytra about one and a half times as long as broad, widest near middle, punctures moderately large, interstices narrower than punctures, a more or less rounded blackish spot on each elytron near middle and a somewhat rounded sutural spot behind them. Length - 3.0 mm.

Material : 11 ex. INDIA: Arunachal Pradesh, W. Kameng Distt., Sera Vill., 2250 m., 7 km. O-Bomdila, 8 ex., 18.xi.1990, T.K. Pal, ex. haystack; Changlang Distt., 3 mile M.V. Road, 2 ex., 5.iii.1990, T.K. Pal, ex. vegetable debris; Tirap Distt., Kheti, 10 km. O-Khonsa, 1 ex., 13.iii. 1990, T.K. Pal, ex. vegetable debris;

Distribution : INDIA: Arunachal Pradesh, Nagaland, West Bengal, Sikkim.

Elsewhere : Nepal.

17. *Psammoecus triloachana* Pal

1985. *Psammoeus triloachana* Pal, *Rec. zool. Surv. India, Occ. Pap.*, 71: 29.

Diagnosis : Elongate-oval, moderately convex, slightly shiny, yellowish-brown, blackish spots on elytra and antennal segments 9 and 10 blackish, covered with moderately long and semierect pubescence; eyes slightly longer than one-third as long as head, temple moderately long and slightly flattened beneath eye, antenna long and slender, scape little longer than twice as long as broad, segments 3- 7 longer than pedicel, segments 8-11 slightly wider than 7, segments 8 and 9 slightly elongate and segment 10 about as broad as long, segment 11 elongate and acuminate at apex, puncturation on vertex coarse and dense; prothorax about as broad as long and narrower posteriorly, anterior margin rounded and with a few small

denticles, side margin slightly sinuate at posterior half and with seven moderately large teeth, teeth about as broad as long and somewhat blunt, anterior and posterior angles obtuse and bearing teeth, puncturation on pronotum almost similar to that of vertex of head; elytra slightly less than one and a half times as long as broad, ovoid, punctures large and interstices narrower than punctures, lateral margin with longer and almost erect setae, a somewhat oblique blackish spot on each elytron near middle with extension along suture. Length- 3.1 mm.

Material : 28 ex. INDIA: Arunachal Pradesh, W. Kameng Distt., Kakaling, Bomdila, 2311 m., 7 ex., 26.ix.2004, T.K. Pal, ex. beating bush; Gandhi Colony, Bomdila, 21 ex., 27.ix.2004, T.K. Pal, ex. beating bush.

Distribution : INDIA: Arunachal Pradesh (new record), Nagaland, Himachal Pradesh.

Elsewhere : Nepal.

18. *Psammoecus simoni* Grouvelle

1892. *Psammoecus simonis* Grouvelle, *Annls. Soc. ent. Fr.*, **61**: 288.

1908. *Psammoecus simoni*: Grouvelle, *Annls. Soc. ent. Fr.*, **77**: 476.

1985. *Psammoecus simoni*: Pal, *Rec. zool. Surv. India, Occ. Pap.*, **71**: 31.

Diagnosis : Elongate-ovoid, moderately convex, slightly shiny, yellowish-brown with two transverse blackish spots on elytra, two large blackish spots near humeral angles, transverse spots and humeral spots connected by sutural blackish band; large round eyes slightly shorter than half as long as head, apical part of antennal segment 6 and segments 7-10 blackish, body covered with moderately long and semierect pubescence; eyes slightly shorter than half as long as head, temple short and slightly flattened beneath eye; antenna long and slender, scape to segment 7 more or less elongate, segments 8-10 as broad as long or slightly transverse, segment 11 elongate and acuminate apically; prothorax transverse, convex, narrowed behind middle, anterior margin rounded, lateral margin outwardly curved and with six more or less distinct teeth, posterior three teeth longer than others, transverse prebasal impression on pronotum well marked; elytra about 1.5x as long as broad,

ovoid and widest near middle, striae punctures moderately large and rounded, interstices about as broad as rows of punctures. Length- 2.5 mm.

Material : 1 ex. INDIA: Arunachal Pradesh, Lohit Distt. (currently Anjaw Distt.), Yatong, 25 km. O-Hayuliang, 1 ex., 25.ii.1990, T.K. Pal, ex. haystack;

Distribution : INDIA: Arunachal Pradesh (new record), West Bengal.

Elsewhere : Sri Lanka; Malaysia; Indonesia; Philippines; Seychelles; Madagascar.

19. *Psammoecus trimaculatus* Motschulsky

1858. *Psammoecus trimaculatus* Motschulsky, *Etud. Ent.*, **7**: 45.

1859.? *Cucujus incommodus* Walker, *Ann. Mag. Nat. Hist.* (3) **3**: 53.

1876. *Psammoecus trimaculatus*: Waterhouse, *Entomologist's mon. Mag.*, **13**: 124.

1876. *Telephanus cruciger* Waterhouse, *Entomologist's mon. Mag.*, **13**: 125.

1906. *Psammoecus trimaculatus*: Grouvelle, *Annls. Soc. ent. Fr.* **75**: 125.

1908. *Psammoecus trimaculatus*: Grouvelle, *Annls. Soc. ent. Fr.*, **77**: 406.

1985. *Psammoecus trimaculatus*: Pal, *Rec. Zoo. Surv. India, Occ. Pap.* **71**: 41.

Diagnosis : Elongate-oval, moderately convex, slightly shiny, yellowish-brown with blackish spots on elytra and antennal segments 7-10 blackish, elytra covered with moderately long pubescence; eyes slightly shorter than half as long as head, temple short and slightly flattened beneath eye, antenna long and slender, scape moderately large and elongate, segments 2-6 shorter, subequal and elongate, segments 7-11 slightly wider than segment 6, segment 7 slightly elongate, segments 8-10 about as broad as long or slightly transverse, segment 11 elongate and acuminate apically; prothorax transverse, anterior margin narrower than head across eyes, front margin and side margins feebly rounded, side margin with six or seven teeth of variable length, longest tooth in posterior half, slightly elongate and blunt apically; puncturation on pronotum coarse and dense, disc setose; elytra shorter than one and a half times as long as broad, widest near middle, punctures moderately large,

interstices about as wide as or wider than punctures, a more or less rounded blackish spot on each elytron in posterior half and a longitudinal sutural spot present behind them. Length- 2.5 mm.

Material : 36 ex. INDIA: Arunachal Pradesh, W. Siang Distt., Nilok 10 km. O-Likabali, 4 ex., 14.iii.1989, T.K. Pal, T.K. Pal, ex. haystack; Malinithan Forest, 4 km. O-Likabali, 1 ex., 16.iii.1989, T.K. Pal, ex. haystack; E. Siang Distt., 6 km. O-Pasighat, 14 ex., 16.ii.1989, T.K. Pal, ex. haystack; Lohit Distt. (currently Anjaw Distt.), Nara, 14 km. O-Hayuliang, 1 ex., 26.ii.1990, T.K. Pal, ex. haystack; Tirap Distt., Namsangmukh, 10 km. O-Deomali, 1 ex., 18.iii. 1990, T.K. Pal, ex. vegetable debris; W. Kameng Distt., Gandhi Colony, Bomdila, 1 ex., 27.ix.2004, T.K. Pal, ex. beating bush; L. Dibang Valley Distt., Shantipur, 6 ex., 5.iv.2009, T.K. Pal, ex. haystack; Kankong, 5 ex., 12.iv.2009, T.K. Pal, ex. haystack; Mayu, Roing, 3 ex., 6.iv.2009, T.K. Pal, ex. haystack.

Distribution : INDIA: Arunachal Pradesh, Assam, Nagaland, Manipur, Mizoram, Meghalaya, Sikkim, West Bengal, Jharkhand, Orissa, Uttarakhand, Uttar Pradesh, Jammu & Kashmir, Delhi, Karnataka, Tamil Nadu, Kerala, Andaman Is.

Elsewhere : Nepal; Bhutan; Sri Lanka; Myanmar; Malaysia; Japan; Madagascar.

Subfamily CRYPTAMORPHINAE

Genus *Cryptamorpha* Wollaston

1854. *Cryptamorpha* Wollaston, *Insecta Maderensia* : 156
[Type-species: *Cryptamorpha musae* Wollaston = *desjardinsi* (Guérin-Meneville)].

1859. *Pseudophanus* Leconte, *Proc. Acad. Philadelphia*: 84.

1867. *Parabrantes* Redtenbacher, *Reise Novara Zool.* 2: 40.

Diagnosis : Elongated, subparallel; head with fronto-clypeal suture, two longitudinal grooves present on lateral sides and often united, additional longitudinal impressed lines originating from lateral grooves and extending posteriorly to outer margin, eyes usually large and coarsely faceted, temple slightly flattened beneath eye, no transverse impressed line on vertex behind eyes, 11-segmented antenna with no distinguishable club, antennal insertions partly hidden under projection of frons, anterior part of gular region with a transverse groove, mandible with a large basal mandibular cavity, right mandible with 3 and left mandible

with 2 apical teeth, apical segments of maxillary and labial palpi elongated and fusiform, maxillary lacinia without apical spine; prothorax elongated to transverse, front coxae contiguous and coxal cavities closed behind, apical margin of prosternal process little sinuate, sterno-pleural suture extending to lateral margin; mesocoxae contiguous; wing with 5 anal veins; each elytron with ten rows of stria punctures and a scutellary stria; tarsal segments 1 and 2 of leg slightly lobed below, segment 3 bilobed; intercoxal process of abdominal ventrite 1 narrow and its apical margin slightly rounded, coxal lines almost marginal striae of hind coxal cavities, ventrites 2-5 shorter than 1 and subequal.

20. *Cryptamorpha foveicollis* n. sp.

General appearance (Fig. 5) elongate, moderately depressed, deeply foveate pronotum, yellowish-brown, with paired blackish spots on posterior half of elytra, dorsal surface punctate and finely pubescent.

Exposed part of head broader than long; eyes moderately large, about one-third as long as head; longitudinal grooves on vertex of head unite posteriorly and U-shaped, an additional longitudinal impressed line from anterior part of longitudinal groove extending posterad towards outer margin of head below eye, vertex of head impunctate and virtually glabrous; clypeus situated at a lower level than that of frons, impunctate-setose. Antenna long, slender, slightly shorter than length of elytra, scape moderately large, pedicel shorter and narrower than scape, segment 3 slightly longer and wider than pedicel; segments 4 and 5 longer and broader than 3, apices characteristically widened inwardly appearing somewhat lobulate; segments 6-9 shorter and subequal, segments 10-11 slightly wider than 9, segment 11 about 1.5x as long as 10 and acuminate at apex.

Prothorax slightly elongate (1.2:1.0), convex, sides arcuate, widest slightly beneath middle, front margin slightly emarginate; disc of pronotum with a deeply excavate, cup-shaped, slightly transverse fovea, apical margin of fovea tri-notched; puncturation on pronotum moderately coarse and dense, finely setose; sides finely margined, transverse impressed line on base of pronotum distinct. Scutellum moderately large, transverse, with a transverse impression and sparse pubescence.



Fig. 5. *Cryptamorpha foveicollis* n. sp., dorsal view.

Elytra more than twice as long as broad (2.2:1.0), somewhat parallel-sided and slightly widened behind middle, lateral margins slightly wavy and not explanate, apex separately rounded and forming a notch; scutellary striole short and consists of 7-8 punctures, punctures on rows deep and large, interstices distinctly narrower than rows of punctures, finely setose, an ovoid blackish spot on

either elytron near posterior third, surural line behind ovoid spots with an elongated darker area. Ventral side with finer punctures.

Aedeagus (Fig. 6): median lobe broad with acuminate apex; parameres broadly elongate, fusiform, slightly broadened medially, with a few apical setae and a few shorter setae on outer margin near middle at broadest part.

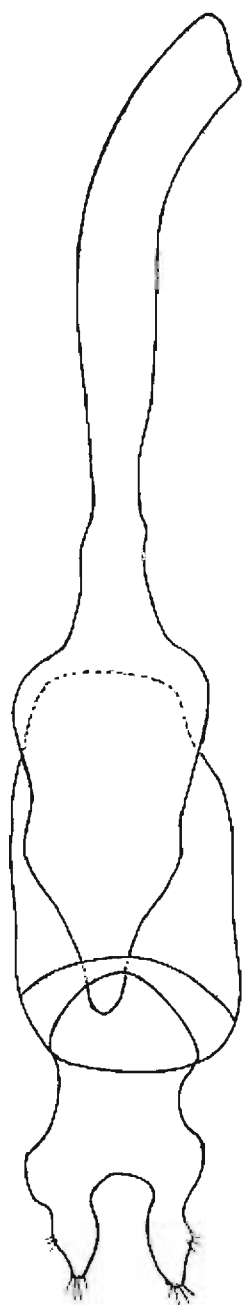


Fig. 6. *Cryptamorpha foveicollis* n. sp., Male genitalia, dorsal view.

Measurements : Total length 4.26 mm., width of head across eyes 0.80 mm., length of antenna 2.58 mm., length and width of prothorax 1.08 mm. and 0.92 mm., length and width of elytra 2.70 mm. and 1.26 mm.

HOLOTYPE : ♂, INDIA: Arunachal Pradesh, West Kameng District, Gandhi Colony, Bomdila, 27.ix.2004, T.K. Pal, ex. beating bush (Zoological Survey of India, Kolkata).

Etymology : The species name refers to the large-deep fovea on the pronotal disc of the species.

Remarks : This species is distinctly different from all other described species of *Cryptamorpha* in having a large excavated pronotum; characteristically widened apices of antennal segments 4 and 5 are also not seen in other species. The aedeagus shows some resemblances with that of *C. kaszabi* Pal & Sengupta in the shape of median lobe and parameres. But apex of median lobe elongated and more acuminate, and parameres are broadly elongate and broadened medially in this species.

Subfamily ULEIOTINAE

Genus *Uleiota* Latreille

1796. *Uleiota* Latreille, *Precis des caracteres generiques des Insectes disposés dans un ordre naturel*: 46.
 1801. *Brontes* Fabricius, *Systema eleutheratorum*, 2: 97.
 1804. *Uleiota* : Latreille, *Histoire Naturelle, générale et particulière, des crustacés et des Insectes*, 11: 257.
 1854. *Brontes* : Latreille, *Histoire Naturelle des Insectes*, 2: 408.
 1858. *Brontes* : Redtenbacher, *Fauna Austriaca- Die Käfer*, ed. 2: 353.
 1879. *Hyliota* : Reitter, *Verh. Zool. bot. Ges. Wien*, 29: 80.
 1885-86. *Hyliota* : Reitter, *Francisque Guillebeau : Tableaux Analytiques Determiner les Coleopteres europeins*, 1: 8.
 1888. *Hyleota* : Seidlitz, *Fauna Baltica*, ed. 2: Gatt p. 55.
 1899. *Uleiota* : Ganglbauer, *Die Käfer von Mitteleuropa*, 3: 592.
 1911. *Uleiota* : Reitter, *Fauna Germanica*, 3: 48.
 1984. *Uleiota* : Pal, Sengupta & Crowson, *Oriental Ins.*, 18: 217.

Diagnosis : Elongate, flat, with long antennae; head broader than long, without fronto-clypeal suture, eyes moderately large, temple flattened beneath eye and shelf-like, transverse impressed line on vertex behind eyes; antenna long, slender and filiform, 11-segmented, antennal insertions partly hidden under projection of frons; mandible with a large basal mandibular cavity and three apical teeth partly exposed and its outer margin with elongated discal area, maxillary lacinia without apical spine, apical segment of maxillary palpi elongate-fisiform, apical segment of labial palpi somewhat securiform; prothorax transverse, lateral

margins finely or distinctly dentate, pronotum flat and usually with lateral carinae; front coxal cavities open, coxae widely separated, prosternal process broad, sterno-pleural suture extending to lateral margin; mesocoxae widely separated and hind coxae slightly closer than mesocoxae; wing with three anal veins; each elytron with 9 rows of striae punctures, without scutellary striae; tarsi simple; intercoxal process of first abdominal ventrite broad at base, slightly narrowed and broadly rounded at apex, coxal lines almost marginal striae of hind coxae, a pair of small glandular cavity-like structure present behind hind coxal cavities.

20. *Uleiota spinicollis* (Gory)

1829-44. *Brontes spinicollis* Gory: In Guérin-Ménéville, *Iconographie du Règne Animal de G. Cuvier. Insectes*: 205.

1877. *Hyliota atrata* Reitter, *Mitt. Munch. Ent. Ver.*, 1: 427.

1901. *Hyliota spinicollis*: Arrow, *Trans. Ent. Soc. Lond.*, 1901: 596.

1984. *Uleiota spinicollis*: Pal, Sengupta & Crowson, *Oriental Ins.*, 18: 219.

Diagnosis : Broadly elongate, rather parallel-sided, markedly flattened, dark brown, sides of prothorax with large and distinct teeth; head broader than long, eyes shorter than one-third as long as head, temple about as long as 4-5 eye facets and its tip broad, an elongated oval area on vertex encircled by a well marked depression, punctation on vertex coarse and dense; antenna long and slender, slightly shorter than body length; prothorax broader than long, front margin straight and sloped downward near extremities, lateral margin with five distinct teeth, anterior tooth distinctly elongate and other teeth less so, pronotal disc with two shallow median and two lateral depressions, punctation on pronotum slightly coarser than vertex of head; elytra more than twice as long as broad, parallel-sided with margins slightly wavy, punctures deep and large, 7th interstice strongly carinate and extending almost up to apex. Length- 9.3 mm.

Material : 2 ex. INDIA: Arunachal Pradesh, L. Subansiri Distt. (currently Papum Pare distt.), Chimpu, Itanagar, 1 ex., 27.v.1992, T.K. Pal, ex. under bark; Lohit Distt., Lathaw, 14 km. O-Namsai, 1 ex., 1.iii.1990, T.K. Pal, ex. under bark.

Distribution : INDIA: Arunachal Pradesh, Nagaland, Meghalaya, West Bengal.

Elsewhere: Myanmar; Indonesia (Java).

22. *Uleiota alticola* Pal, Sengupta & Crowson

1984. *Uleiota alticola*: Pal, Sengupta & Crowson, *Oriental Ins.*, 18: 221.

Diagnosis : Elongated, parallel-sided, dorsally flattened, little shiny, covered with short pubescence; head broader than long, eyes shorter than one-third as long as head, temple about as long as four eye facets and its outer apical angle broad, a short longitudinal depression near base of antenna; antenna long, slender, about as long as the body; punctation on vertex moderately coarse and dense; prothorax broader than long, widest near anterior margin and slightly narrower posteriorly, anterior margin slightly sloped near extremities, lateral margin almost straight with 10-11 denticles, tip of denticles somewhat pointed, pronotum flat with shallow lateral depressions, punctation on pronotum almost similar to that of vertex of head; elytra more than twice as long as broad, nearly parallel-sided, punctures deep and large, interstices narrower than rows of punctures, alternate interstices slightly wider and narrower, 7th interstice strongly carinate. Length- 5.12 mm.

Material : 31 ex. INDIA: Arunachal Pradesh, L. Subansiri Distt., Hapoli, Ziro, 1 ex., 18.ix.1988, T.K. Pal, ex. under bark; Chimpu, Itanagar (currently Papum Pare Distt.), 1 ex., 3.vii.1991, T.K. Pal, ex. under bark; W. Siang Distt., Malinithan Forest, 2 km. O-Likabali, 1 ex., 15.iii.1989, T.K. Pal, ex. under bark; Doke, 12 km. O-Basar, 13 ex., 8.iii.1989, T.K. Pal, ex. banana leaf sheath; Sododoke, 24 km. O-Basar, 1 ex., 10.iii.1989, T.K. Pal, ex. under bark; Darak, 10 km. O-Basar, 4 ex., 19.iii.1989, T.K. Pal, ex. under bark; Kamki, 16 km. O-Along, 1 ex., 4.iii.1989, T.K. Pal, ex. under bark; E. Siang Distt., Gette, 14 km. O-Yingkiong, 3 ex., 1.iii.1989, T.K. Pal, ex. under bark; W. Kameng Distt., Tippi, 163 m., 2 ex., 22.ix.2004, T.K. Pal, ex. under bark; L. Dibang Valley Distt., Hunli, 1250 m., 2 ex., 21.ix.1991, T.K. Pal, ex. under bark; Sally Lake, Roing, 1 ex., 4.iv.2009, T.K. Pal, ex. under bark; Tirap Distt., Tissa, 14 km. O-Longding, 1 ex., 16.iii.1990, T. K. Pal, ex. under bark.

Distribution : INDIA: Arunachal Pradesh, Nagaland, Meghalaya, West Bengal.

23. *Uleiota puberula* (Reitter)

1878. *Uliota puberula* Reitter, *Stettin ent. Ztg.*, **39**: 316.

1888. *Hyliota puberula*: Grouvelle, *Ann. Mus. Civ. Stor. Nat. Giacomo Doria*, (2) **6**: 625.

1984. *Uleiota puberula*: Pal, Sengupta & Crowson, *Oriental Ins.*, **18**: 223.

Diagnosis : Broadly elongate, rather parallel-sided, markedly flattened, reddish-brown, covered with short pubescence; head broader than long, eyes about half as long as head, temple shorter than two eye facets and its tip somewhat pointed, puncturation on vertex fine and moderately dense; antenna long and slender, slightly shorter than body length, scape broadly elongate and wider than other segments, segments 2 and 3 short and subequal, segments 4-11 longer than 3 and subequal; prothorax broader than long, slightly narrower posteriorly, anterior margin straight and slightly sloped near extremities, lateral margin almost straight with 9-10 small denticles, tip of denticles more or less pointed, pronotum flat with prominent sublateral ridges, pronotal disc depressed with well marked depressions near posterior angles, puncturation on pronotum slightly denser than that of vertex of head; elytra more than twice as long as broad, parallel-sided, lateral margins slightly wavy, rows of punctures deep and large, interstices distinctly wider than rows of punctures, 7th elytral interstice strongly carinate and extending almost up to apex. Length- 6.0 mm.

Material : 10 ex. INDIA: Arunachal Pradesh, L. Subansiri Distt. (currently Papum Pare Distt.), Chimpu, Itanagar, 1 ex., 3.vii. 1991, T.K. Pal, ex. under bark; Tirap Distt., Tissa, 14 km. O-Longding, 2 ex., 16.iii.1990, T.K. Pal, ex. under bark; W. Kameng Distt., Tippi, 163 m., 7 ex., 22.ix.2004, T.K. Pal, ex. under bark.

Distribution : INDIA: Arunachal Pradesh (new record), Meghalaya, West Bengal, Jharkhand.

Elsewhere : Myanmar.

KEY TO THE SUBFAMILIES, GENERA AND SPECIES OF SILVANIDAE OF ARUNACHAL PRADESH

1. Front coxal cavities externally widely open behind; tarsi simple; antennal scape markedly long, antenna long and filiform; facies parallel-sided with dorsal surface markedly flattened.
..... ULEIOTINAE: *Uleiota* Latreille 2
- Front coxal cavities externally closed behind; tarsi usually lobed, sometimes simple; antennal scape moderately long, if markedly long and somewhat filiform antenna then body ovoid; facies subconvex or ovoid, if flattened and subparallel then antenna distinctly clubbed.
..... 4
2. Sides of prothorax with large and distinct teeth; size large, about 9-11 mm. long.
..... *Uleiota spinicollis* (Gory)
- Sides of prothorax with small denticles or serrations; size small, less than 6.5 mm. in length.
..... 3
3. Temple of head long, about as long as 4-5 eye facets and its outer apical angle broad. Pronotum flat with shallow lateral depressions, no ridges.
..... *Uleiota alticola* Pal, Sengupta & Crowson
- Temple of head short, about as long as 1-2 eye facets and its outer apical angle somewhat pointed. Pronotum flat with sublateral ridges.
..... *Uleiota puberula* (Reitter)
4. Head with distinct fronto-clypeal suture and a pair of longitudinal grooves or striae; antennal insertions dorso-lateral and somewhat exposed, antennal club not distinguishable.....5
- Head without fronto-clypeal suture and devoid of longitudinal grooves or striae; antennal insertions hidden under projection of frons, antennal club more or less distinct.....
.....(SILVANINAE) 9
5. Apical segments of labial and maxillary palpi elongated and more or less fusiform; elytra more or less parallel-sided with distinct scutellary striae; a curved transverse groove on anterior part of gular region of head; tarsal segment 3 bilobed and segments 1 and 2

- unilobed. Sides of pronotum arcuate and disc of pronotum deeply foveolate.
(CRYPTAMORPHINAE)
..... *Cryptamorphia foveicollis* Pal, n. sp.
- Apical segments of labial and maxillary palpi securiform or strongly transverse; elytra ovoid and without scutellary striae; head devoid of curved transverse groove on anterior part of gular region; tarsal segment 3 lobed below....
PSAMMOECINAE: *Psammoecus* Latreille 6
6. Antennal segments 9-10 blackish. 7
 - Antennal segments 7-10 blackish. 8
 7. Teeth on lateral margin of prothorax minute, indistinct, either broader than long or about as broad as long; sides of prothorax rounded and not sinuate above posterior angles.
..... *Psammoecus harmandi* Grouvelle
 - Teeth on lateral margin of prothorax partly long, distinct and longer than broad; sides of prothorax outwardly curved and slightly sinuate in posterior half.
..... *Psammoecus trilocana* Pal
 8. Elytral pattern of four light patches on blackish base, two on either side. Two well marked transverse blackish spots near humeral angles of elytra.
..... *Psammoecus simoni* Grouvelle
 - Elytra without pattern of four light regions on blackish base, with three blackish spots on yellowish-brown base.
..... *Psammoecus trimaculatus* Motschulsky
 9. Lateral margin of prothorax finely serrated and without large teeth or denticles. 10
 - Lateral margin of prothorax with more or less large teeth or denticles. 22
 10. Form elongate-subparallel; eyes small, about $1/5^{\text{th}}$ as long as head; prothorax with laterally prominent and rounded anterior angles, anterior third of prosternum with distinct transverse striations. Lateral depressions on pronotum less well marked and recognizable only near base *Acathartus idu* Pal, n. sp.
 - Form subparallel or elongate-ovoid; eyes large, distinctly longer than $1/4^{\text{th}}$ as long as head; anterior angles of prothorax either spinous or denticulate, anterior third of prosternum not striate. 11
 11. Species markedly flattened; sterno-pleural suture of prothorax extending to lateral margin, front coxae widely separated; apical segments of maxillary and labial palpi shorter than segment 2; 7^{th} elytral interstice more or less carinate. *Protosilvanus* Grouvelle 12
 - Species moderately flattened; sterno-pleural suture of prothorax extending to base of anterior spine; front coxae nearly contiguous or less widely separated; apical segments of maxillary and labial palpi longest; no elytral interstice carinate. 13
 12. Antennal segments 9 and 10 with apical spines at extremities; median impressed line of metasternum extending anteriorly slightly beyond middle.
..... *Protosilvanus lateritius* (Reitter).
 - Antennal segments 9 and 10 without apical spines; median impressed line of metasternum extending anteriorly up to apex of metasternum.
..... *Protosilvanus granosus* Grouvelle
 13. Apex of anterior spines lying beneath level of front margin of prothorax; antennal segments 4-8 about as broad as long; femoral (coxal) lines of abdominal ventrite 1 opened. Dorsal surface of head and prothorax rather sparsely punctured and somewhat shiny.
..... *Silvanoides cribricollis* (Grouvelle)
 - Apex of anterior spines of prothorax lying in a same level or beyond front margin of prothorax; antennal segments 4-8 elongated; femoral (coxal) lines of abdominal ventrite 1 closed. 14
 14. Tarsi simple.
(*Silvanus* Latreille) 15
 - Tarsal segment 3 strongly lobed below.
(*Silvanoprus* Reitter) 18
 15. Temple not distinctly flattened beneath eye to form a platform, eyes small with fewer facets; anterior spine of prothorax directed towards front and its tip blunt.
..... *Silvanus recticollis* Reitter
 - Temple distinctly flattened beneath eye to form

- a platform, eyes moderately to markedly large and with many facets; anterior spine of prothorax directed slightly outward and its tip more or less pointed. 16
16. Temple markedly short and represented by a thin platform, length of temple shorter than width of one eye facet and its outer apical angle pointed. *Silvanus lewisi* Reitter
- Temple distinct and thick, length of temple longer than width of one eye facet and its outer apical angle somewhat broad. 17
17. Outer margin of anterior spine of prothorax curved inwardly and its tip projected somewhat inwardly and towards front, prothorax somewhat elliptical excluding anterior spines; antennal segment 9 slightly elongate; hind trochanter of male with a short spine.....
..... *Silvanus robustus* Halstead
- Outer margin of anterior spine of prothorax straight and directed more outwardly, prothorax not elliptical excluding anterior spines and narrowed posteriorly; antennal segment 9 distinctly transverse; hind trochanter of male devoid of spine.
..... *Silvanus difficilis* Halstead
18. Prothorax broader than long, width of prothorax across anterior spines more than 1.5x as broad as width across posterior angles, prothorax distinctly narrowed posteriorly, lateral margins almost straight, shape of prothorax somewhat triangular.
..... *Silvanoprus scuticollis* (Walker)
- Prothorax longer than broad, width of prothorax across anterior spines less than 1.25x as broad as width across posterior angles, prothorax slightly narrowed posteriorly behind middle, lateral margin distinctly sinuate, shape of prothorax different..... 19
19. Temple of head moderately long and not flattened beneath eye; temple about as long as 2-3 eye facets and inwardly notched.
..... *Silvanoprus indicus* Pal & Sengupta
- Temple of head very short or long and distinctly flattened beneath eye; temple either short thin with outer apical angle pointed, or long with outer apical margin rounded.....20
20. Temple of head long, about as long as eye or longer than eye and its outer apical margin rounded; puncturation of head and pronotum ocellate-type, coarse and somewhat rugose.
..... *Silvanoprus longicollis* (Reitter)
- Temple of head short, about as long as 1-2 eye facets and its outer apical angle somewhat pointed; puncturation of head and pronotum reticulate-type, coarse and dense..... 21
21. Front and middle femora with a distinct spine near middle ; lateral margin of prothorax more or less uniformly curved outwardly; anterior spine of prothorax small, projected in front and about as long as 1/4th of eye.
..... *Silvanoprus cephalotes* (Reitter)
- Front and middle femora devoid of any spine; lateral margin of prothorax distinctly wavy and sinuate across anterior third; anterior spine of prothorax longer, about half as long as eye and projecting somewhat outwardly.
..... *Silvanoprus angusticollis* (Reitter)
22. Lateral margin of prothorax with six distinct teeth or denticles; pronotum with three distinct longitudinal carinae. Length of temple of head about as long as 3.5-4 eye facets, eyes usually shorter than twice as long as temple.
..... *Oryzaephilus surinamensis* (L.)
- Lateral margin of prothorax with at least 8-10 teeth or denticles; pronotum convex and devoid of longitudinal carinae. Tarsal segments 2 and 3 strongly lobed below; elytra ovoid, moderately convex, with transverse blackish spot near middle of elytra.....*Monanus concinnulus* (Walker)

Larva of *Uleiota alticola* Pal,
Sengupta & Crowson

General body form (Fig. 7) elongated, somewhat depressed dorso-ventrally, nearly subparallel with slightly widened near middle, whitish soft-bodied with long antennae and urogomphi, mouthparts yellowish.



Fig. 7. Larva of *Uleiota alticola* Pal, Seng. & Crowson, dorsal view of whole.

Head (Fig. 8) transverse, side margins rounded, frontal suture indistinct and cucujoid-type, clypeus fused with frons, labrum distinctly separated from clypeus, endocarina and metopic suture absent, arrangement of setae on dorsal side as in figure. Ocelli indistinct and not characterized. Antenna rather long, 3-segmented, segments elongated, segment 2 more than twice as long as 1, segment 3 about as long as 2 but narrower, sensory appendage minute and lying ventrally on tip of segment 2. Mandible (Fig. 13) with three apical teeth, prosthema translucent at base and sharply pointed at apex; mola well developed, chitinated, with about 8 rows of dorsal fine transverse ridges and 15-16 rows of ventral curved asperated ridges.

Maxillary mala (Fig. 14) moderately sharply pointed at apex, at base of apical spine on outer margin with a few setae, a dorsal row of about 14 setae along inner margin of mala, cardo well developed, maxillary articulating area well defined and oval; palpi shorter than mala, length of palpal segments 1:2:2. Labium (Fig. 15) narrowed anteriorly, 2-segmented palpi, basal segment of palpi transverse, apical segment slightly narrower and longer than basal one, hypopharynx well developed, hypopharyngeal bracon present, hypopharyngeal rods and hypostomal margins distinct and diverging posteriorly.

Thorax and abdomen : Tergites with sparsely distributed simple setae. Prothorax (Fig. 9) slightly narrower than head and about as broad as mesothorax, metathorax slightly wider than mesothorax. First abdominal segment slightly shorter than metathorax and second abdominal segment, abdominal segments 4-8 narrower than first three segments, sternite 8 with its posterior angles bearing long setiferous prolongations, segment 9 with short tergite and its sternite forming an elongated tubular pygopod-like projection; urogomphi markedly long, narrow and not chitinated, each urogomphus with a conspicuous long apical seta (Fig. 10).

Spiracles and legs : All spiracles annular and lying on body surface (Fig. 11). Legs narrow and moderately long, coxae small and widely separated; claw simple, elongate, with two tarsungular setae lying one beneath other (Fig. 12).

Measurements : Total length 8.5 mm., length of head including labrum 0.75 mm. and width 1.15 mm, width of metathorax 1.12 mm., width of 9th abdominal segment across front margin 0.70 mm. (n= 1).

Material : 2 ex. INDIA: Arunachal Pradesh, L. Dibang Valley Distt., Hunli, 1250 m., 21.ix.1991, T.K. Pal, ex. under bark.

SUMMARY

The paper deals with 23 species under 10 genera of 4 subfamilies from the State of Arunachal Pradesh. All, except 8 species, are recorded first time from the State; 2 species (*viz.*, *Acathartus idu* and *Cryptamorpha foveicollis*) are described as new. The species are systematically keyed and characterized. The larva of *Uleiota alticola* is described.

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Figs. 8-15. Larva of *Uleiota alticola* Pal, Seng. & Crowson:

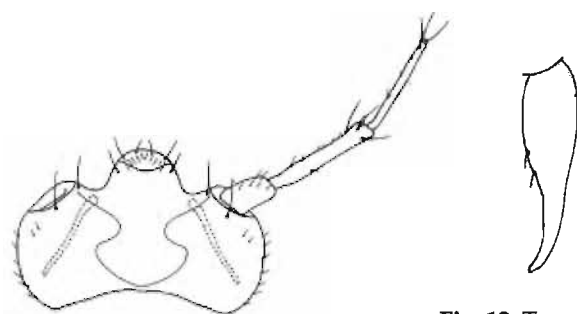


Fig. 8. Head, dorsal view

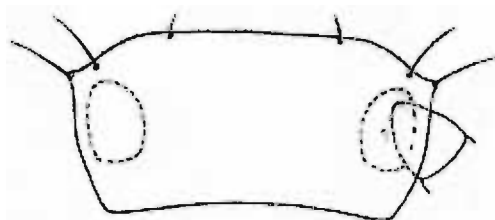


Fig. 9. Prothorax, dorsal view

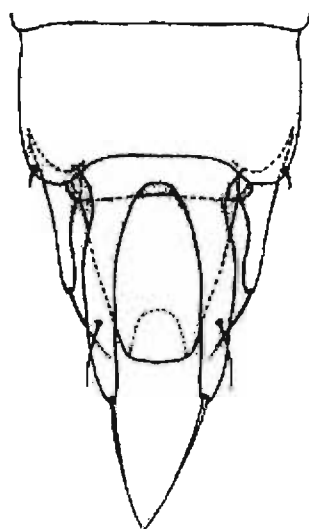


Fig. 10. Posterior abdominal segments, dorsal view



Fig. 11. Abdominal spiracle



Fig. 13. Left mandible, ventral view

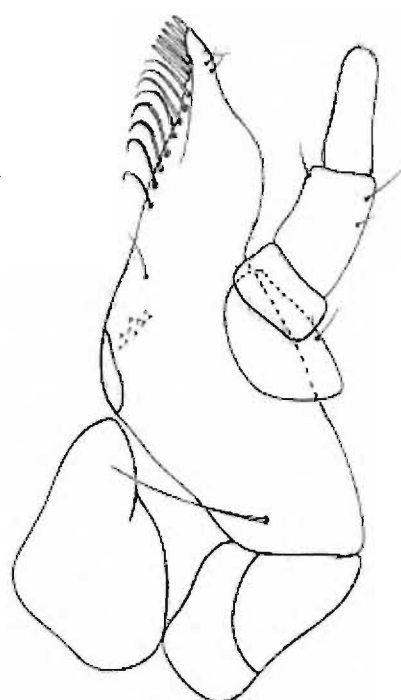


Fig. 14. Left maxilla, ventral view

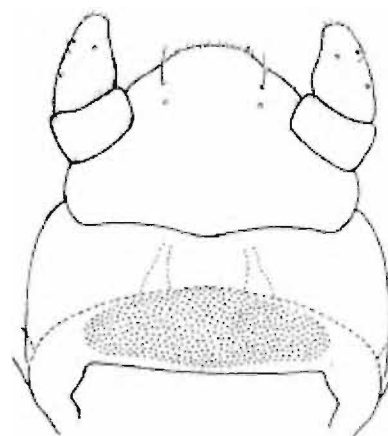


Fig. 15. Labium, ventral view.

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A NEW GENUS AND NEW SPECIES OF GOBIOID FISH (GOBIIDAE: GOBIONELLINAE) FROM SUNDERBANS, INDIA

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INTRODUCTION

Updated information on fish fauna of India resulted in summarising that the Indian waters are represented by 69 genera and 174 species of gobioid fishes (Perciformes, Gobiidae). The subfamily Gobionellinae comprises of 13 genera and 33 species in India. While working on the gobioid fishes of Indian Sunderbans (latitude 21°13' - 22°40' N. and longitude 88°03' - 89°06' E.), the first author came across few specimens of an interesting goby. After careful examination that turned out to be an undescribed species. However, no known genus could accommodate the new species and that warranted erecting a new taxon in generic level. The other gobies of Indian Sunderbans are dealt elsewhere (Chatterjee *et al.*, in press) reporting 44 species and 35 genera from the region. The new genus and the new species have been initially described by the first author (Chatterjee, 1978) in his doctoral thesis and the name is also appeared in Mandal & Nandi (1989) and Talwar *et al.* (1992), but it is not formally published to be treated as 'available' under the provisions of the International Code of Zoological Nomenclature. The new species is hereunder described as *Awaouchthys menoni* sp. nov. with the genus *Awaouchthys* gen. nov.



Awaouchthys menoni sp. nov. Holotype

The studied materials were collected from the Patibonia Island near Frasergunge (21°34' N, 88°16' E), from a tidal channel connected to Edward's creek, in the Gangetic delta, West Bengal. The materials were deposited with the National Zoological Collection, Zoological Survey of India, Kolkata.

Genus *Awaouchthys* gen. nov.

Body covered with ctenoid scales. Head scaled above posterior to the eyes. Preoperculum and operculum naked. Tongue free, anterior margin notched. Anterior nostril tubular. Sensory canal-pores on head absent, except for two interorbital pores. Pit organs in longitudinal as well as transverse lines. Gill-opening extending ventrally, gill membranes united across isthmus forming a free fold. Mouth sub horizontal, lips thick. No teeth on prevomer or palatine bones. Jaw teeth multiserial, close-set, in 5 - 6 rows, outer row somewhat enlarged, no canine. Inner margin of shoulder girdle with some fleshy cirri. First dorsal fin with 6 weak spines. Ventral fins united, basal membrane present. Pectoral fin without free silky rays. Total elements in the second dorsal fin 10-11. Total anal fin elements 9 - 10, caudal fin rounded. Chin and snout without barbels.

Relationship : *Awaouchthys* shows close relationship with the genus *Awaous* Valenciennes in having fleshy cirri in the inner margin of shoulder girdle, very long snout, eyes situated high on head and head with no sensory canal-pore. However, union of gill-membranes across isthmus forming

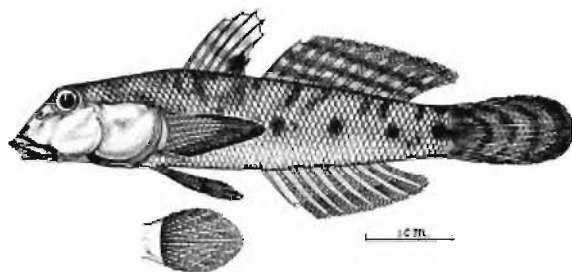


Fig. 1 : Schematic diagram of *Awaouichthys menoni* sp. nov.

a free fold in *Awaouichthys* easily distinguishes it from *Awaous*.

Type species : *Awaouichthys menoni* sp. nov.

Etymology : The genus is named for its close similarities with the genus *Awaous* Valenciennes.

Awaouichthys menoni sp. nov.

1978. *Awaouichthys menoni* Chatterjee, Ph. D. thesis, Calcutta Univ.: 286.

Diagnosis : A gobioid fish distinguished in having fleshy cirri in the inner margin of shoulder girdle; head without sensory canal-pore, except for two interorbital pores; gill membranes of both sides united across isthmus forming a free fold; very long snout, about 37.3% head length; 19 or 20 predorsal scales; 44–46 scales in longitudinal series; scales absent from operculum and preoperculum.

Description : (Based on holotype and 3 paratypes, 34.0 – 49.8 mm SL)

Body elongate, somewhat compressed; depth 20.0–23.5% of standard length. Head sub cylindrical, 31.1–33.8% of standard length. Eye 17.7–21.9%, interorbital space 11.2–12.5%, snout much longer than eye, 34.6–39.2 ($M = 37.3$) per cent of head length. Mouth sub horizontal, posterior end of maxillary in front of anterior margin of eye, 31.2–35.7% of head length. Anterior margin of tongue notched. Gill-opening slightly extending below beyond the level of lowermost pectoral fin-ray, gill membranes fused together across isthmus forming a free fold. Least depth of caudal peduncle 11.1–12.5% of standard length. Predorsal distance 40.0–44.1% and preanal distance 53.3–58.3% of standard length.

Teeth : In the jaws, multiserial, in 5–6 rows, close-set; outer row somewhat enlarged, no canine.

Pit organs : Pair of head pores anteriorly in

interorbital region present, other cephalic pores absent. In infraocular region, there is about 5 transverse lines radiating from the lower margin of eye and 2 longitudinal lines, the upper longitudinal line originates from below the posterior half of the eye and lower line extends anterior to the lower jaw. A single transverse line present on operculum. One line originates in front of eye and curves down to reach anterior nostril. One short line vertically connects the posterior-most infraocular line to the opercular pit line (fig. 2).

Fins : D_1 VI, D_2 I, 9–10; V I, 5; A I, 8–9; P 15–17; C 15.

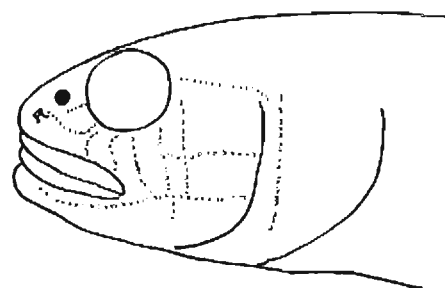


Fig. 2 : Arrangement of sensory papillae on head *Awaouichthys menoni* sp. nov.

First dorsal fin height shorter than body depth, third ray longest. Second dorsal fin lower than body, third ray longest. Second dorsal and anal fin lower than first dorsal fin and pointed posteriorly. Pectoral fin pointed, length of the rays 22.2–26.4% in standard length. Ventral fins united, basal membrane present, well developed. Caudal fin rounded, 29.8–31.4% in standard length.

Scales : Ctenoid. Head scaled above posterior to the eyes. Preoperculum and operculum naked. Scale rows in longitudinal series 44–46, in transverse series 14–16; predorsal scales 19–20.

Colour in alcohol : Light brown. Lateral and dorsal sides of body with darker blotches and irregular streaks. Dorsal side of head with indistinct blackish markings. First dorsal fin with 3 distinct horizontal bands, and a blackish blotch at its posterior extremity; second dorsal fin with about three horizontal bands; caudal fin barred; ventral, pectoral and anal fins yellowish brown.

Locality : Patibonia Island, Fraserganj in the Gangetic delta, West Bengal.

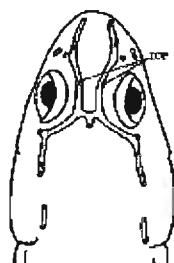


Fig. 3 : General structure of Head pores in Gobionellinae

Type specimens : Holotype: Z.S.I Regd. No. F.7377/2 (49.8 mm. SL), Patibonia Island in the Gangetic delta (West Bengal) near Frasergunge; Lat. 21°34' N., Long. 88°16' E. from a tidal channel connected to Edward's creek; 11.ix.1974; coll. T.K. Chatterjee.

Paratypes : Z.S.I. Regd. No. 7378/2 -7380/2 (3 ex., 34.0 - 45.0 mm SL); other data of all paratypes same as that of holotype.

Etymology : The species is named in the honour of the eminent Ichthyologist of the Zoological Survey of India, Late Dr. A.G.K. Menon, who confirmed the status of the specimens.

DISCUSSIONS

The sensory canal on head and presence of two head pores anteriorly in the interorbital region along with well-developed basal membrane of the pelvic fin prompted us to place it in the subfamily Gobionellinae (Perciformes, Gobiidae). As discussed in the relationship paragraph under the genus character, the new genus is very close to *Awaous* in shape, size and in having fleshy cirri in the inner margin of shoulder girdle, but distinctly differs by the presence of gill-membranes of both sidefused across isthmus forming a free fold, as in case of the genus *Psammogobius*. There is no pore on snout, whereas, the genus *Awaous* is supposed to have two pairs of pores on snout (Larson and Murdy, 2001). Further, presence of 15 segmented rays in the caudal fin distinguishes it from many closely related genera. Distinction of the genus itself makes the described species distinct from all species of Gobioid fishes known in the region and elsewhere.

The subfamily Gobionellinae is distinguished from all other gobies in having dorsal and anal fins separated from caudal fin; both dorsal fins typically separate; lower jaw typically possessing more than

one row of teeth; pelvic frenum simple, not folded forward, frenum without fleshy lobes around pelvic-fin spines; paired anterior interorbital pores present or head pores completely lacking; if head pores absent, then body fully scaly or mostly scaly. A key to the Indian genera (14) of the subfamily is presented here for easy identification of the new genus with *Chiramenu fluviatilis* Rao is treated as an *Awaous* species following Froese and Pauly (2012) and Eschmeyer (2012).

Key to the genera of subfamily Gobionellinae found in India :

- 1a. Shoulder girdle under gill cover with distinct 1 to 4 finger-like flaps 2
- 1b. Shoulder girdle under gill cover smooth or with minute bumps 4
- 2a. Gill membrane fused together forming a free fold across isthmus
..... *Awaoichthys* gen. nov.
- 2b. Gill membrane not fused to form free fold, joined to isthmus 3
- 3a. Head broader than deep; mouth inferior with fleshy lips; predorsal scale count 16 to 42; body with rows of blotches and spots
..... *Awaous*
- 3b. Head compressed, narrower than deep; mouth terminal, lips not particularly fleshy; predorsal scale count 0 to 23; body with variably developed transverse bands *Stenogobius*
- 4a. Head pores absent 5
- 4b. Head pores present 6
- 5a. Head papillae in transverse pattern; body without scales below dorsal fin; body transparent or yellowish translucent
..... *Gobiopterus*
- 5b. Head papillae in longitudinal pattern; body fully scaled; body with dusky bands or spots
..... *Brachygobius*
- 6a. Two pairs of pores present on snout
..... 7
- 6b. None or 1 pair of pores present on snout
..... 9
- 7a. Cheek with large scales; teeth at sides of upper jaw directed medially; anterior interorbital pore paired; mouth horizontal, inferior (coral reefs)
..... *Gnatholepis*

- 7b. Cheek naked; teeth at sides of jaws vertical or directed posteriorly 8
- 8a. Teeth in upper jaw usually in a single row on sides; median membranous crest or ridge usually present on nape; eye with or without fleshy knob or tentacle; tongue rounded *Oxyurichthys*
- 8b. Teeth in upper jaw in 2 or 3 rows; no crest or ridge on nape; typically eye always without fleshy knob or tentacle; tongue truncate *Oligolepis*
- 9a. Mucous canal on cheek with many transverse rows radiating from eye; body distinctly spotted *Stigmatogobius*
- 9b. Mucous canal on cheek in longitudinal rows only; lateral canal over opercle present; body colour variable 10
- 10a. Preopercular pore and posterior portion of oculoscapular canal present; segmented caudal fin rays 17 11
- 10b. Preopercular pore and posterior portion of oculoscapular canal always absent 12
- 11a. Head depressed; second dorsal fin with same number of rays as in anal fin *Pseudogobiopsis*
- 11b. Head compressed; second dorsal fin with one more ray than in anal fin *Redigobius*
- 12a. Segmented caudal fin rays 17; mouth small, lower lip reduced, thin and folded forward *Hemigobius*
- 12a. Segmented caudal fin rays 16; jaws may be greatly enlarged in males, lips not reduced and thin 13
- 13a. Mouth subterminal, upper jaw tip anteriormost, with round snout overhanging mouth; head pores present *Pseudogobius*
- 13b. Mouth terminal, lower jaw tip anteriormost; head pores absent *Eugnathogobius*

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DENSITY AND DISTRIBUTION OF MEIOFAUNA OF TAMILNADU COAST

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INTRODUCTION

The meiofauna inhabiting the different sediment habitat of Tamilnadu was studied. A brief description of the density, sediment characters, total organic carbon and vertical distribution in different sediment habitats, diversity and cluster analysis is given. All the typical meiofauna groups are present. A quantitative estimate of the diverse taxonomic groups encountered is given. The density of total meiofauna individuals in these intertidal sediments ranged from 26 animals/10 cm² to 1440 animals/10 cm². A list of 101 species identified from Tamilnadu Coast is given. Several genera and species regarded as widespread and cosmopolitan were recorded. The evidence that several meiofauna species are widely distributed and any future

investigations of the unexplored areas are likely to indicate a closer meiofaunal relationship is supported. The distribution of meiofauna is discussed in relation to the nature of the substratum.

ENVIRONMENTAL VARIABLES

SEDIMENT CHARACTERISTICS

The median particle size at all stations ranged between 2 ϕ (0.250 mm) and 3 ϕ (0.125 mm) thereby indicating that it contained median sand (Table 1a, b). The median particle size of sandy sediment fluctuated between 2.25 and 2.5 Md ϕ , muddy sediment between 2.3 and 2.75 Md ϕ , muddy sediment with seagrass bed between 2.7 and 2.75 Md ϕ and sandy sediment with rocky environment between 2.0 and 2.25 Md ϕ (Table 1a, b).

Table 1a. Percentage composition of sediment texture (%) and mean densities of meiofauna (n/10 cm²) of Tamil Nadu coast during 2006.

Sediment types & Fauna	Stations											
	1	2	3	4	5	6	7	8	9	10	11	12
Sediment types												
Sand (%)	96.4	92.2	91.1	86.9	81.7	84.6	83.0	88.0	87.2	89.8	90.1	97.2
Silt & clay (%)	3.6	7.8	8.9	13.1	18.4	15.4	17.0	12.0	12.8	10.2	9.9	2.8
Md ϕ	2.3	2.3	2.5	2.65	2.75	2.7	2.7	2.5	2.55	2.6	2.4	2.0
Fauna												
Nematodes	244	326	304	580	269	708	824	217	502	536	210	238
Harpacticoids	109	238	223	166	110	298	212	78	201	193	116	120
Foraminiferans	116	152	144	107	92	124	160	67	135	146	119	85
Polychaetes	49	45	77	47	29	24	32	48	45	56	51	36
Oligochaetes	190	80	45	-	70	314	340	50	-	-	-	12

Ostracods	26	40	30	12	20	20	22	24	24	16	30	42
Gastrotrichs	-	4	15	-	-	-	-	-	-	-	4	8
Turbellarians	-	15	45	-	-	-	-	-	-	-	-	25
Isopods	-	116	122	-	-	-	15	-	-	-	-	22
Total	734	1016	1005	912	590	1488	1605	484	907	947	530	588

The Md ϕ values showed a greater fluctuation in sandy sediments than in muddy sediments. It was also observed that the sediment in stations 4-8, 10-11 had finer sediments than in stations 1-3, 9 and 12 (Table 1a, b).

All stations of sandy environment had little silt and clay content (3.6-8.9%), except station 9

(Mandapam), where high silt and clay content (12.8-13.1%) was observed (Table 1a, b).

Areas with muddy (9.1-18.4%) and muddy with seagrass bed (15.4-18.0%) cover had a higher silt and clay content compared to sandy environment (Table 1a, b). Station 12 which was sandy with rocky environment had very less silt and clay content.

Table 1b. Percentage composition of sediment texture (%) and mean densities of meiofauna (n/10 cm²) of Tamil Nadu coast during 2007.

Sediment types & Fauna	Stations											
	1	2	3	4	5	6	7	8	9	10	11	12
Sediment types												
Sand (%)	96.4	92.2	91.1	86.9	81.7	84.6	83.0	88.0	87.2	89.8	90.1	97.2
Silt & clay (%)	3.6	7.8	8.9	13.1	18.4	15.4	17.0	12.0	12.8	10.2	9.9	2.8
Md ϕ	2.3	2.3	2.5	2.65	2.75	2.7	2.7	2.5	2.55	2.6	2.4	2.0
Fauna												
Nematodes	244	326	304	580	269	708	824	217	502	536	210	238
Harpacticoids	109	238	223	166	110	298	212	78	201	193	116	120
Foraminiferans	116	152	144	107	92	124	160	67	135	146	119	85
Polychaetes	49	45	77	47	29	24	32	48	45	56	51	36
Oligochaetes	190	80	45	-	70	314	340	50	-	-	-	12
Ostracods	26	40	30	12	20	20	22	24	24	16	30	42
Gastrotrichs	-	4	15	-	-	-	-	-	-	-	4	8
Turbellarians	-	15	45	-	-	-	-	-	-	-	-	25
Isopods	-	116	122	-	-	-	15	-	-	-	-	22
Total	734	1016	1005	912	590	1488	1605	484	907	947	530	588

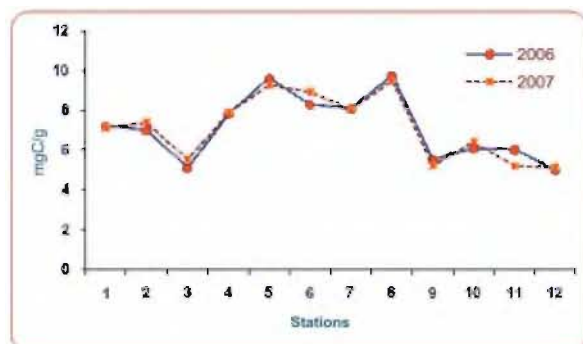
The composition of meiofauna in Tamil Nadu coast is mostly related to grain size. The sediment characteristic of muddy sediments with seagrass bed cover had a high silt and clay content with a corresponding higher density of meiofauna. Sediment with higher silt and clay content is mainly inhabited by burrowers such as nematodes and oligochaetes (Table 1a, b).

TOTAL ORGANIC CARBON CONTENT

The variation in the sediment organic carbon

values in the present study, showed considerable similarity at stations 4 to 8, 10 and 11, which had a muddy sediment (Fig. 1), while stations 1 to 3, 9 and 12 (sandy environment) differed from muddy (stations 4 to 8 and 10 to 11) environment (Fig. 1).

The minimum sediment organic carbon content (5.02-7.42 mg C/g) was observed at sandy sediments and maximum (5.21-9.73 mg C/g) in muddy sediments (Fig. 1).

Fig. 1. Variations in total organic carbon content of Tamil Nadu coast during 2006 and 2007.

The highest value of organic content (9.73 mg C/g and 9.51 mg C/g during 2006 and 2007 respectively) was recorded at station 8 in Tuticorin Port (Fig. 1). In general, the total organic carbon

content increased with increasing silt and clay content.

MEIOFAUNAL TAXA

TOTAL DENSITY OF MEIOFAUN

Nine major meiofaunal taxa were identified, namely nematodes, harpacticoid copepods, foraminiferans, polychaetes, oligochaetes, ostracods, gastrotrichs, turbellarians and isopods from intertidal areas of Tamil Nadu coasts. Among the twelve stations studied, minimum (155 individuals/10 cm²) meiofaunal density was observed at station 4 (Appendix II, Table 5) and maximum (3128 individuals/10 cm²) at station 6. The values are an average of five replicates in each station (Appendix II, Tables 2 to 13).

Appendix II

Table 2. Density of meiofauna communities (individuals/10 cm²) at Station 1 during 2006 and 2007.

2006

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	220	145	225	450	180	1220	244	119.66
2	Harpacticoid copepods	120	145	90	85	105	545	109	24.34
3	Foraminiferans	24	105	56	285	110	580	116	100.97
4	Polychaetes	139	25	45	4	32	245	49	52.45
5	Oligochaetes	259	90	178	345	78	950	190	113.44
6	Ostracods	12	50	64	-	4	130	26	29.05
	Total	774	560	658	1169	509	3670	734	263.39

2007

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	360	130	470	250	90	1300	260	158.11
2	Harpacticoid copepods	60	80	215	85	105	545	109	61.38
3	Foraminiferans	24	105	45	151	110	435	87	51.68
4	Polychaetes	139	25	75	4	32	275	55	53.59
5	Oligochaetes	310	110	462	240	78	1200	240	155.99
6	Ostracods	12	-	59	-	4	75	15	25.08
	Total	905	450	1326	730	419	3830	766	372.32

Table 3. Density of meiofauna communities (individuals/10 cm⁻²) at Station 2 during 2006 and 2007.

2006

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	425	199	135	326	545	1630	326	166.11
2	Harpacticoid copepods	310	157	98	228	397	1190	238	119.09
3	Foraminiferans	150	72	98	220	220	760	152	68.13
4	Polychaetes	19	45	59	12	90	225	45	31.57
5	Oligochaetes	170	23	16	140	51	400	80	70.51
6	Ostracods	64	20	10	32	74	200	40	27.82
7	Gastrotriches	12	8	-	-	-	20	4	5.66
8	Turbellarians	45	24	-	2	4	75	15	19.34
9	Isopods	130	20	48	180	202	580	116	79.89
	Total	1325	568	464	1140	1583	5080	1016	484.19

2007

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	650	750	210	175	325	2110	422	262.17
2	Harpacticoid copepods	120	190	96	45	239	690	138	76.88
3	Foraminiferans	175	160	95	120	110	660	132	34.02
4	Polychaetes	68	12	45	-	75	200	40	33.23
5	Oligochaetes	475	385	150	45	175	1230	246	177.78
6	Ostracods	40	-	32	12	41	125	25	18.19
7	Gastrotriches	12	43	-	5	-	60	12	18.01
8	Isopods	45	175	120	-	135	475	95	70.98
	Total	1585	1715	748	402	1100	5550	1110	553.19

Table 4. Density of meiofauna communities (individuals/10 cm⁻²) at Station 3 during 2006 and 2007.**2006**

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	605	245	95	125	450	1520	304	218.59
2	Harpacticoid copepods	475	180	80	120	260	1115	223	156.35
3	Foraminiferans	340	110	65	90	115	720	144	111.32
4	Polychaetes	165	20	40	55	105	385	77	58.37
5	Oligochaetes	75	45	-	45	60	225	45	28.06
6	Ostracods	63	45	-	8	34	150	30	26.05
7	Gastrotriches	4	12	-	34	25	75	15	14.28
8	Turbellarians	72	33	-	-	120	225	45	51.35
9	Isopods	220	145	45	55	145	610	122	72.59
	Total	2019	835	325	532	1314	5025	1005	677.99

2007

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	120	440	850	175	585	2170	434	300.65
2	Harpacticoid copepods	105	220	520	120	285	1250	250	168.04
3	Foraminiferans	87	180	168	45	120	600	120	56.16
4	Polychaetes	25	40	130	-	80	275	55	50.99
5	Oligochaetes	28	35	75	-	32	170	34	26.82
6	Ostracods	50	55	90	10	20	225	45	31.62
7	Gastrotriches	4	8	63	-	-	75	15	27.04
8	Turbellarians	-	20	6	-	4	30	6	8.25
9	Isopods	40	75	420	45	195	775	155	160.90
	Total	459	1073	2322	395	1321	5570	1114	782.59

Table 5. Density of meiofauna communities (individuals/10 cm⁻²) at Station 4 during 2006 and 2007.

2006

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	1200	175	585	90	850	2900	580	464.07
2	Harpacticoid copepods	285	90	190	45	220	830	166	97.56
3	Foraminiferans	210	55	115	20	135	535	107	73.71
4	Polychaetes	90	12	23	-	110	235	47	49.57
5	Ostracods	28	-	12	-	20	60	12	12.33
	Total	1813	332	925	155	1335	4560	912	689.27

2007

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	210	330	210	450	850	2050	410	265.33
2	Harpacticoid copepods	105	120	70	170	310	775	155	93.81
3	Foraminiferans	80	65	50	75	330	600	120	117.95
4	Polychaetes	70	90	-	55	120	335	67	44.67
5	Oligochaetes	40	25	-	-	10	75	15	17.32
6	Ostracods	40	35	20	30	85	210	42	25.15
7	Isopods	-	20	-	20	60	100	20	24.49
	Total	545	685	350	800	1765	4145	829	549.49

Table 6. Density of meiofauna communities (individuals/10 cm⁻²) at Station 5 during 2006 and 2007.

2006

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	120	145	445	545	90	1345	269	210.22
2	Harpacticoid copepods	80	90	155	180	45	550	110	55.79
3	Foraminiferans	40	60	210	110	40	460	92	71.90
4	Polychaetes	25	30	-	90	-	145	29	36.81
5	Oligochaetes	55	20	10	250	15	350	70	102.16
6	Ostracods	10	10	20	60	-	100	20	23.45
	Total	330	355	840	1235	190	2950	590	436.28

2007

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	110	120	90	310	120	750	150	90.28
2	Harpacticoid copepods	20	80	10	90	25	225	45	37.08
3	Foraminiferans	35	20	5	90	10	160	32	34.39
4	Polychaetes	60	55	40	90	45	290	58	19.56
5	Oligochaetes	45	50	60	220	75	450	90	73.57
6	Ostracods	5	30	-	50	15	100	20	20.31
	Total	275	355	205	850	290	1975	395	259.88

Table 7. Density of meiofauna communities (individuals/10 cm⁻²) at Station 6 during 2006 and 2007.

2006

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	450	650	445	870	1125	3540	708	291.22
2	Harpacticoid copepods	320	175	210	255	530	1490	298	140.56
3	Foraminiferans	90	110	120	110	190	620	124	38.47
4	Polychaetes	-	50	10	20	40	120	24	20.74
5	Oligochaetes	390	280	410	370	120	1570	314	119.29
6	Ostracods	23	17	10	10	40	100	20	12.43
	Total	1273	1282	1205	1635	2045	7440	1488	353.77

2007

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	1200	850	1450	1005	535	5040	1008	346.75
2	Harpacticoid copepods	735	345	950	440	230	2700	540	295.91
3	Foraminiferans	275	120	395	300	80	1170	234	131.02
4	Polychaetes	40	120	125	90	15	390	78	48.81
5	Oligochaetes	40	120	90	155	320	725	145	106.54
6	Ostracods	35	40	93	32	10	210	42	30.73
7	Isopods	-	-	25	-	-	25	5	11.18
	Total	2325	1595	3128	2022	1190	10260	2052	739.10

Table 8. Density of meiofauna communities (individuals/10 cm⁻²) at Station 7 during 2006 and 2007.

2006

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	1125	1200	794	445	556	4120	824	334.79
2	Harpacticoid copepods	320	145	230	120	245	1060	212	80.67
3	Foraminiferans	210	120	235	145	90	800	160	60.93
4	Polychaetes	-	10	40	75	35	160	32	29.28
5	Oligochaetes	50	40	540	420	650	1700	340	281.34
6	Ostracods	40	55	15	-	-	110	22	24.65
7	Isopods	50	25	-	-	-	75	15	22.36
	Total	1795	1595	1854	1205	1576	8025	1605	254.48

2007

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	770	850	1100	410	870	4000	800	250.20
2	Harpacticoid copepods	290	440	680	150	215	1775	355	211.36
3	Foraminiferans	250	320	495	120	190	1375	275	143.44
4	Polychaetes	50	20	75	110	20	275	55	38.41
5	Oligochaetes	90	140	50	280	40	600	120	97.72
6	Ostracods	180	40	100	35	120	475	95	60.21
7	Isopods	50	150	225	-	200	625	125	96.82
	Total	1680	1960	2725	1105	1655	9125	1825	590.88

Table 9. Density of meiofauna communities (individuals/10 cm⁻²) at Station 8 during 2006 and 2007.**2006**

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	340	75	245	175	250	1085	217	98.65
2	Harpacticoid copepods	120	25	90	70	85	390	78	34.75
3	Foraminiferans	140	15	105	40	35	335	67	52.99
4	Polychaetes	40	60	40	40	60	240	48	10.95
5	Oligochaetes	50	90	30	35	45	250	50	23.72
6	Ostracods	30	-	40	-	50	120	24	23.02
	Total	720	265	550	360	525	2420	484	176.83

2007

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	195	440	170	330	90	1225	245	139.10
2	Harpacticoid copepods	45	90	50	70	20	275	55	26.46
3	Foraminiferans	40	20	50	45	70	225	45	18.03
4	Polychaetes	90	30	70	50	110	350	70	31.62
5	Oligochaetes	140	80	125	30	75	450	90	43.73
6	Ostracods	-	20	-	20	-	40	8	10.95
	Total	510	680	465	545	365	2565	513	115.25

Table 10. Density of meiofauna communities (individuals/10 cm⁻²) at Station 9 during 2006 and 2007.**2006**

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	515	425	600	450	520	2510	502	68.43
2	Harpacticoid copepods	205	235	195	215	155	1005	201	29.66
3	Foraminiferans	125	110	130	160	150	675	135	20.00
4	Polychaetes	45	40	40	80	20	225	45	21.79
5	Ostracods	60	20	10	10	20	120	24	20.74
	Total	950	830	975	915	865	4535	907	59.64

2007

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	700	645	550	790	690	3375	675	87.46
2	Harpacticoid copepods	220	180	265	330	205	1200	240	59.06
3	Foraminiferans	105	90	110	140	155	600	120	26.69
4	Polychaetes	10	15	45	35	20	125	25	14.58
5	Oligochaetes	30	10	15	-	20	75	15	11.18
6	Ostracods	40	40	20	20	40	160	32	10.95
7	Isopods	40	10	-	10	-	60	12	16.43
	Total	1145	990	1005	1325	1130	5595	1119	134.97

Table 11. Density of meiofauna communities (individuals/10 cm⁻²) at Station 10 during 2006 and 2007.

2006

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	450	345	475	670	740	2680	536	163.68
2	Harpacticoid copepods	125	140	170	225	305	965	193	73.37
3	Foraminiferans	90	130	90	180	240	730	146	64.27
4	Polychaetes	30	90	60	78	22	280	56	29.53
5	Ostracods	20	20	10	-	30	80	16	11.40
	Total	715	725	805	1153	1337	4735	947	281.87

2007

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	745	225	550	370	985	2875	575	300.89
2	Harpacticoid copepods	160	120	220	270	380	1150	230	101.49
3	Foraminiferans	110	90	110	150	290	750	150	81.24
4	Polychaetes	20	130	40	110	40	340	68	48.68
5	Oligochaetes	-	80	-	45	-	125	25	36.40
6	Ostracods	10	20	20	10	40	100	20	12.25
7	Isopods	35	-	40	-	-	75	15	20.62
	Total	1080	665	980	955	1735	5415	1083	395.86

Table 12. Density of meiofauna communities (individuals/10 cm⁻²) at Station 11 during 2006 and 2007.**2006**

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	225	110	340	270	105	1050	210	102.16
2	Harpacticoid copepods	120	80	230	110	40	580	116	70.92
3	Foraminiferans	110	85	190	90	120	595	119	42.19
4	Polychaetes	40	75	20	40	80	255	51	25.59
5	Ostracods	20	-	80	50	-	150	30	34.64
6	Gastrotriches	-	-	10	10	-	20	4	5.48
	Total	515	350	870	570	345	2650	530	214.51

2007

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	120	230	420	120	510	1400	280	177.62
2	Harpacticoid copepods	60	105	155	60	245	625	125	77.70
3	Foraminiferans	40	90	110	120	180	540	108	50.70
4	Polychaetes	90	80	55	100	50	375	75	21.79
5	Oligochaetes	78	45	10	80	12	225	45	34.01
6	Ostracods	18	12	40	40	10	120	24	14.90
7	Isopods	-	-	12	-	8	20	4	5.66
	Total	406	562	802	520	1015	3305	661	244.90

Table 13. Density of meiofauna communities (individuals/10 cm⁻²) at Station 12 during 2006 and 2007.

2006

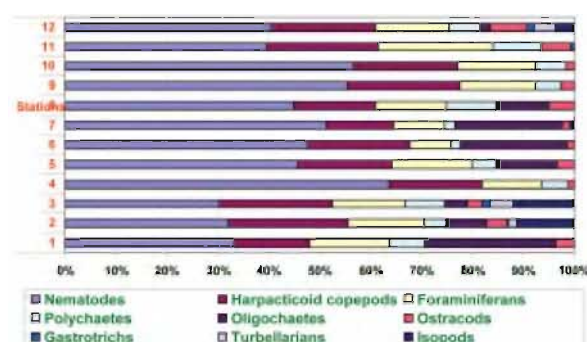
S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	125	320	145	205	395	1190	238	116.06
2	Harpacticoid copepods	90	120	95	100	195	600	120	43.45
3	Foraminiferans	50	90	60	75	150	425	85	39.37
4	Polychaetes	75	30	60	-	15	180	36	31.10
5	Oligochaetes	30	-	20	10	-	60	12	13.04
6	Ostracods	30	60	20	60	40	210	42	17.89
7	Gastrotriches	10	5	-	-	25	40	8	10.37
8	Turbellarians	10	60	-	-	55	125	25	30.00
9	Isopods	25	-	25	20	40	110	22	14.40
	Total	445	685	425	470	915	2940	588	210.52

2007

S. No.	Fauna	Samples					Total	Mean	SD (±)
		1	2	3	4	5			
1	Nematodes	423	345	110	256	356	1490	298	120.73
2	Harpacticoid copepods	180	157	133	75	125	670	134	39.40
3	Foraminiferans	150	72	98	60	110	490	98	35.24
4	Polychaetes	19	45	59	12	90	225	45	31.57
5	Oligochaetes	70	23	16	10	51	170	34	25.52
6	Ostracods	64	20	10	32	34	160	32	20.35
7	Turbellarians	4	12	-	-	4	20	4	4.90
8	Isopods	30	-	12	14	4	60	12	11.58
	Total	940	674	438	459	774	3285	657	212.86

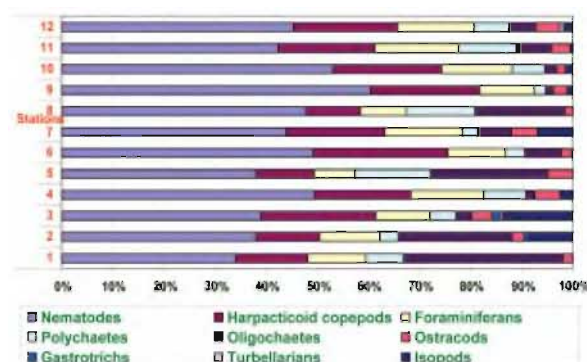
Nematodes were the most dominant group of meiofauna at all the sampling stations of Tamil Nadu coast, constituting from 30.25% to 63.60% of total abundance (Figs. 2 a, b). The next important faunal group was the harpacticoid copepods which contributes 10.72 to 26.32% of the total meiofauna. Nematodes and harpacticoid copepods together comprised about 80% of the meiofauna (Figs. 2 a, b).

Fig. 2a Mean percentage composition of meiofauna communities from intertidal sediments of Tamil Nadu coast during 2006.



The foraminiferans ranked third, with a percentage contribution of 8.1 to 22.45 % of the total meiofauna. However, at station 11 (Rameswaram) alone they ranked second. Polychaetes formed the fourth largest group, with a percentage occurrence of 1.61 to 14.69% of the total fauna. Oligochaetes were observed at all the stations during 2007; nonetheless, it was totally absent at stations 3, 9-11 during 2006. Their percentage was high (31.33 % of the total meiofauna) at station 1 (Chennai) during 2007 (Figs. 2 a, b).

Fig. 2b Mean percentage of meiofauna communities from intertidal sediments of Tamil Nadu coast during 2007.



Ostracods were recorded at all the twelve stations, but their population density was considerably low (1.34 % to 7.14 % of the total abundance).

The other taxa found were gastrotrichs, turbellarians and isopods which made up only less than 5 % of the total meiofauna. However, at station 3 (Cuddalore) isopods constituted the maximum percentage (13.91 %) during 2007 (Figs. 2 a, b).

DISTRIBUTION OF MEIOFAUNA

Sandy sediment

The meiofauna density ranged between 509 and 1169 individuals/10 cm⁻² (Appendix II, Table 2), 464 and 1583 individuals/10 cm⁻² (Appendix II, Table 3), 325 and 2019 individuals/10 cm⁻² (Appendix II, Table 4) and 830 and 975 individuals/10 cm⁻² (Appendix II, Table 10) at stations 1, 2, 3 and 9 respectively during 2006.

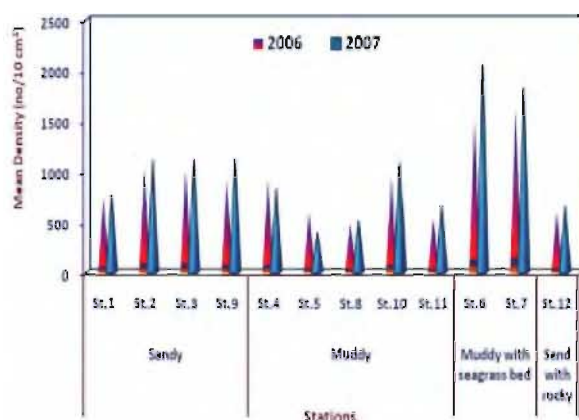
During 2007, ranges of 419 to 1326 individuals/10 cm⁻² (Appendix II, Table 1), 402-1715 individuals/10 cm⁻² (Appendix II, Table 3), 395-2322 individuals/10 cm⁻² (Appendix II, Table 4) and 990-1325 individuals/10 cm⁻² (Appendix II, Table 10) were encountered at stations 1, 2, 3 and 9 respectively.

Muddy sediment

The meiofaunal density ranged from 155 to 1813 individuals/10 cm⁻² (Appendix II, Table 5), 190 to 1235 individuals/10 cm⁻² (Appendix II, Table 6), 265 to 720 individuals/10 cm⁻² (Appendix II, Table 9), 715 to 1337 individuals/10 cm⁻² (Appendix II, Table 11) and 345 to 870 individuals/10 cm⁻² (Appendix II, Table 12) at stations 4, 5, 8, 10 and 11 respectively during 2006.

During 2007, a ranges of 350-1765 individuals/10 cm⁻² (Appendix II, Table 5), 205-850 individuals/10 cm⁻² (Appendix II, Table 6), 365 to 680 individuals/10 cm⁻² (Appendix II, Table 9), 665-1735 individuals/10 cm⁻² (Appendix II, Table 11) and 406-1015 individuals/10 cm⁻² (Appendix II, Table 12) were recorded at stations 4, 5, 8, 10 and 11 respectively.

Fig. 3 Mean total density of meiofauna in relation to substratum from intertidal sediments



Muddy sediment with seagrass bed

The meiofaunal density ranged between 1205 and 2045 individuals/10 cm² (Appendix II, Table 7) and between 1205 and 1854 individuals/10 cm² (Appendix II, Table 8) at stations 6 and 7 respectively during 2006. During 2007, a range of 1190-3128 individuals/10 cm² (Appendix II, Table

7) and 1105-2725 individuals/10 cm² (Appendix II, Table 8) were recorded at stations 6 and 7 respectively.

Sandy sediment with rocky environment

The meiofaunal density varied from 425 to 915 individuals/10 cm² (Appendix II, Table 13) and from 438 to 940 individuals/10 cm² at station 12 during 2006 and 2007 respectively (Appendix II, Table 13). In general, muddy sediments with seagrass bed had relatively higher densities of meiofauna than those with other sediment types (Fig. 3). The gastrotrichs and turbellarians were totally absent in muddy environment.

DIVERSITY INDEX

The diversity indices were lowest at stations 5 (Nagapattinam) and 8 (Tuticorin), which can be considered as indications of the stress at these sites. These sites were very close to the harbor. Station 7, showed higher diversity in addition to a high density of meiofauna. It must be stated that the sediment here was muddy with seagrass (Table 14).

Table 14. Diversity of meiofauna at various stations in Tamil Nadu coast during 2006 and 2007 (*S* = Number of species; *N* = Number of animals; *d* = Margalef Richness; *j'* Evenness; *H* = Shannon - Wiener diversity, *l*- Lambda – Simson richness).

Stations	S	N	d	j'	H'(log2)
1	61	734	9.09296	0.89801	5.32584
2	67	1016	9.53257	0.87700	5.31996
3	64	1005	9.11360	0.88939	5.33635
4	49	912	7.04263	0.91500	5.13748
5	40	590	6.11274	0.91232	4.85530**
6	58	488	7.80267	0.89486	5.24206
7	70	1605	9.34848	0.89436	5.48180*
8	43	484	6.79382	0.84802	4.60156**
9	42	907	6.02043	0.93143	5.02259
10	44	947	6.27435	0.91300	4.98444
11	40	530	6.21724	0.95418	5.07810
12	45	588	6.90009	0.93887	5.15612

(*- higher diversity indices; **- lowest diversity indices)

It could also be seen from the similarity matrix (Fig. 4) and the MDS plot (Fig. 5) that the muddy and seagrass bed environment, muddy environment and sandy environment harboured distinct populations. Few sites of muddy stations are closer to those in other zones of sandy sediment stations. Nonetheless in some stations of muddy environment no such distinctness could be recognized, probably because of the impact of pollution (stations 5 (NAG), 8 (TUT) and 11 (RAM)).

Fig. 4. Cluster analysis for meiofauna from intertidal sediments of Tamil Nadu coast during 2006 and 2007.

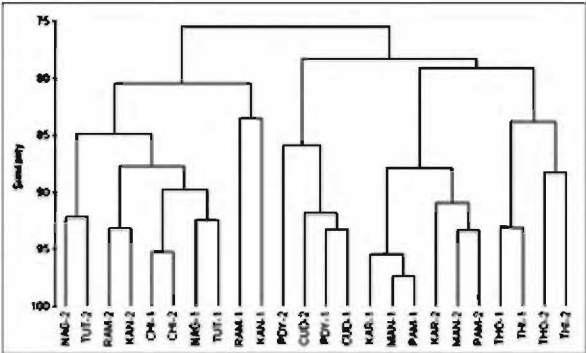
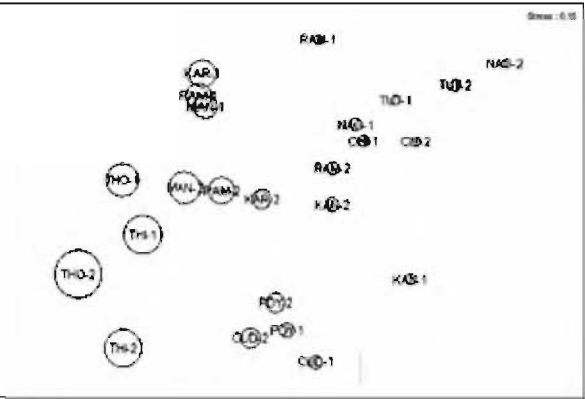


Fig. 5. MDS of meiofauna from intertidal sediments of Tamil Nadu coast during 2006 and 2007.



CHI-Chennai; PDY-Puducherry; CUD-Cuddalore; KAR-Karaikal; NAG-Nagapattinam; THO-Thondi; THI-Thiruchendur; TUT-Tuticorin; MAN-Mandabam; PAM-Pambar; RAM-Rameswaram; KAN-Kanyakumari; 1-2006; 2-2007

The densities of meiofauna varied significantly ($F = 4.895$; $P < 0.001$) between the stations (Table 15), probably due to the variation in environmental parameters like nature of sediment.

Table 15. ANOVA for meiofauna density within stations.

Factor	SS	Df	Ms	F(cal)	P(F<=F(cal))	F(0.05)
A (Between Groups)	13867.38	11	1260.67	4.895 *** (P<=0.001)	1.90E-07	1.797
R(A) (Within Groups)	309048.04	1200	257.54			
AR (Total)	322915.42	1211				

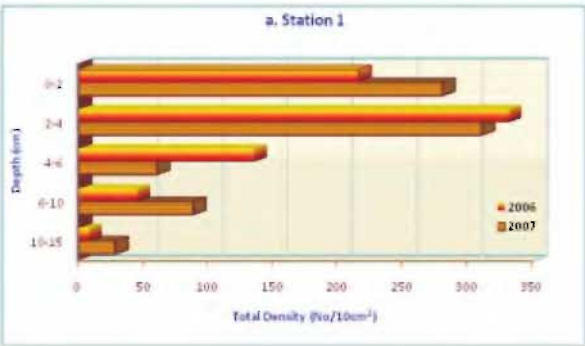
*** (P<=0.001)

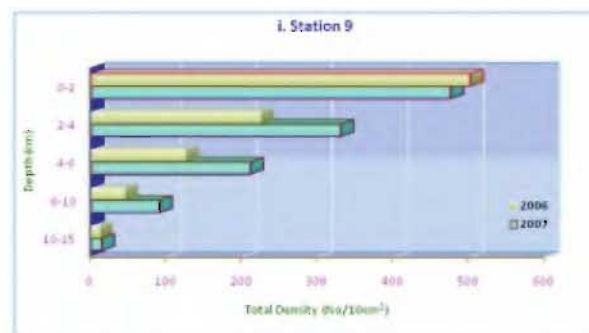
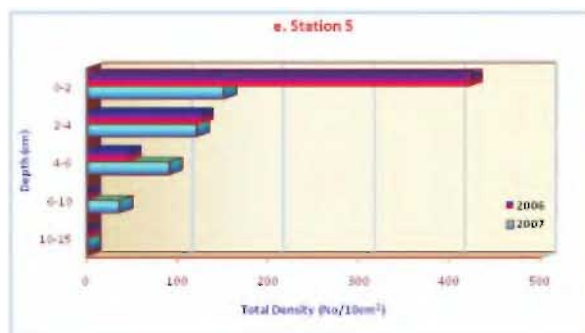
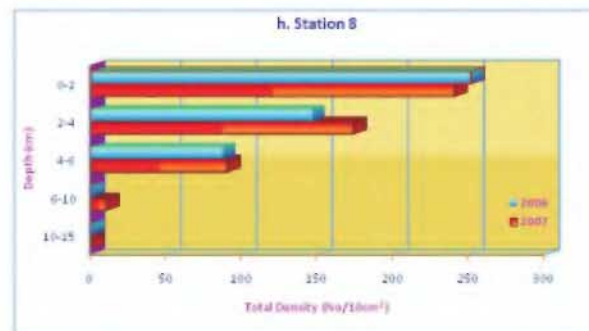
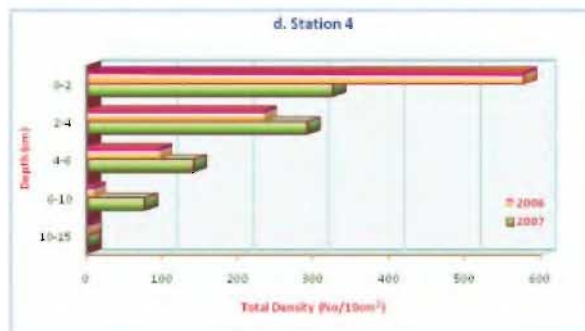
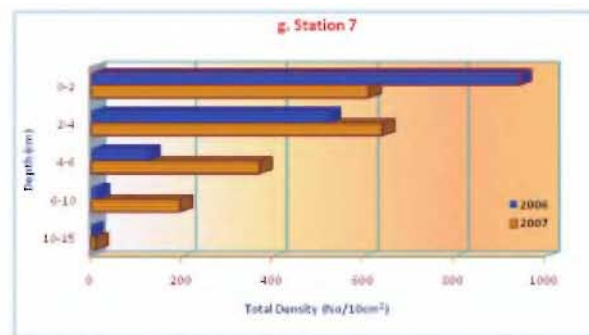
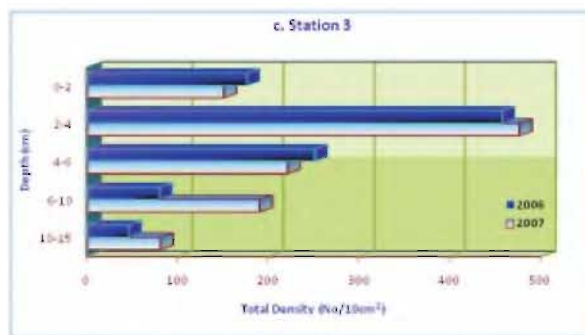
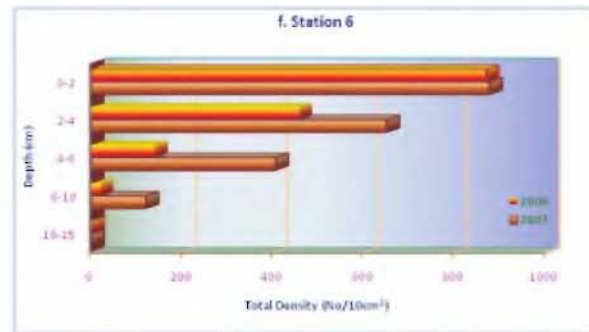
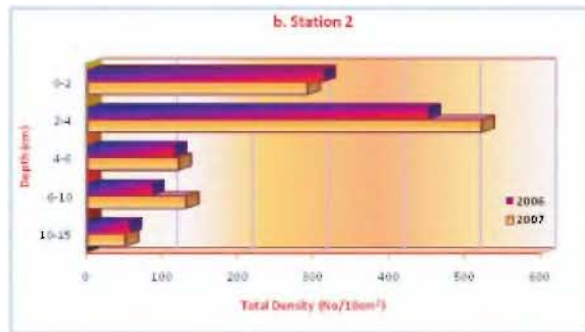
VERTICAL DISTRIBUTION OF MEIOFAUNA

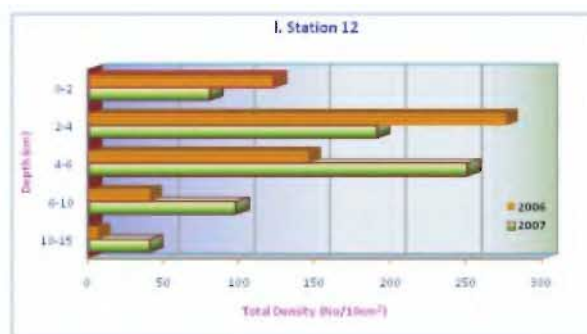
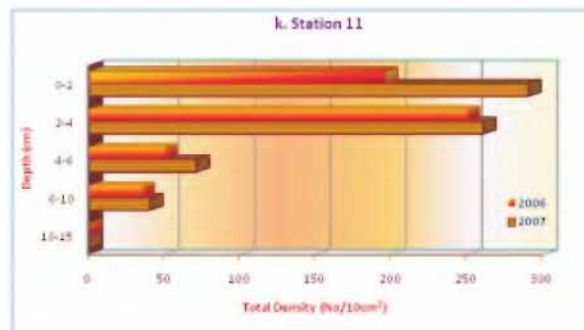
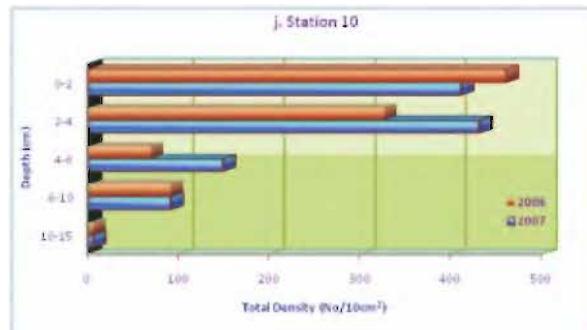
The vertical distribution of meiofauna was quite similar in all the twelve stations. Densities were highest near the sediment surface and especially in muddy sediments, where the upper sediment had up 50% of the total fauna (Fig. 6 d, e, h, i, k).

In sandy sediments, total meiofauna fluctuated with depth, and the maximum was found at 2-6 cm. (Fig. 6 a, b, c, l). In muddy sediment with seagrass bed, again, higher densities occurred in the top portion (Fig. 6f, g).

Fig. 6. Vertical distribution of meiofauna (n/10cm²) at stations1-12 during 2006 and 2007.







COMPOSITION OF MEIOFAUNA

A total of 101 species of meiofauna belonging to 63 families were identified, of which 34 species were nematodes, nine were harpacticoid copepods, 38 were foraminiferans, six each were polychaetes, ostracods and oligochates, one was an isopod and one each of unidentified species of gastrotrichs and turbellarians (Table 16).

Table 16. Occurrence and distribution of meiofaunal community in the intertidal region of Tamil Nadu coast during 2006 and 2007.

S. No	Name of the Family & Species	Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
NEMATODES													
Family: Thoracostomopsidae													
1	<i>Enoploides</i> sp.	+	+	+	-	-	+	+	-	+	+	+	+
Family: Anoplostomatidae													
2	<i>Anoplostoma</i> sp.	-	-	-	-	-	+	+	-	-	-	-	-
Family: Ironidae													
3	<i>Trissonchulus oceanus</i>	+	+	+	-	+	-	+	-	+	+	+	+
Family: Oxystominidae													
4	<i>Halalaimus filum</i>	+	-	-	+	-	-	+	-	-	-	-	-
5	<i>Halalaimus gracilis</i>	+	+	+	+	-	+	+	+	+	+	+	-
Family: Oncholaimidae													
6	<i>Viscosia viscose</i>	+	+	+	+	+	+	+	+	+	+	+	+
7	<i>Adoncholaimus fuscus</i>	+	+	+	-	-	+	+	-	+	+	-	+
8	<i>Onclolaimus</i> sp.	+	+	+	-	+	+	+	+	+	-	+	+

S. No	Name of the Family & Species	Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Family: Enchelidiidae													
9	<i>Polygastrophora septembulba</i>	-	-	-	+	-	+	+	-	-	-	-	-
Family: Tripyloididae													
10	<i>Tripyloides gracilis</i>	-	+	+	+	-	+	+	-	-	-	-	-
Family: Chromadoridae													
11	<i>Ptycholaimellus ponticus</i>	-	-	+	-	-	-	+	-	-	-	-	-
Family: Comesomatidae													
12	<i>Hopperia</i> sp.	-	-	-	+	-	+	+	-	+	-	-	-
13	<i>Dorilaimopsis timmi</i>	-	-	-	+	-	+	+	-	-	-	-	-
14	<i>Paracomesoma dubium</i>	-	-	-	+	-	-	+	-	-	-	-	-
15	<i>Sabatieria falcifera</i>	+	-	+	+	+	+	+	-	-	-	-	-
Family: Cyatholaimidae													
16	<i>Paracanthonchus elongatus</i>	+	-	-	+	-	+	+	+	-	-	-	-
Family: Selachnematidae													
17	<i>Halichoanolaimus dolichurus</i>	+	+	+	+	-	+	+	-	+	+	+	+
Family: Desmodoridae													
18	<i>Metachromadora remanei</i>	+	+	+	+	+	+	+	+	+	+	+	+
19	<i>Desmodora</i> (D.) <i>sanguinea</i>	+	-	+	+	-	-	-	-	-	+	-	-
20	<i>Desmodora</i> (D.) <i>tenuispiculum</i>	+	+	+	-	-	+	+	+	-	+	-	+
21	<i>Spirinia</i> (S.) <i>parasitifera</i>	+	+	-	+	+	+	+	-	-	-	-	-
Family: Microlaimidae													
22	<i>Microlaimus</i> sp.	+	+	-	-	-	-	+	-	-	-	-	-
Family: Ceramononematidae													
23	<i>Pselionema</i> sp.	+	+	+	-	+	+	+	+	+	+	+	+
Family: Leptolaimidae													
24	<i>Camacolaimus barbatus</i>	-	-	-	+	-	+	+	-	-	-	-	-
Family: Desmoscolecidae													
25	<i>Desmoscolex falcatus</i>	+	+	+	+	-	+	+	-	-	-	-	-
Family: Xyalidae													
26	<i>Daptonema conicum</i>	+	+	+	+	+	+	+	+	+	+	+	+
27	<i>Daptonema oxycerca</i>	+	+	-	+	+	+	+	+	+	+	+	+
28	<i>Theristus pertenuis</i>	+	+	+	-	+	+	+	+	+	+	+	+
29	<i>Theristus clax</i>	+	+	+	+	+	+	+	-	+	+	+	+

S. No	Name of the Family & Species	Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Family: Linhomoeidae													
30	<i>Paralinhomoeus brevibucca</i>	-	-	-	+	-	+	+	-	-	-	-	-
31	<i>Metalinhomoeus typicus</i>	+	-	+	+	-	-	+	-	-	-	-	-
32	<i>Terschellingia longicaudata</i>	-	-	-	+	-	+	+	-	-	-	-	-
Family: Axonolaimidae													
33	<i>Paradontophora breviseta</i>	-	-	-	+	-	+	+	-	-	-	-	-
Family: Diplopeltidae													
34	<i>Araeolaimus longicauda</i>	-	-	-	+	-	+	-	-	-	-	-	-
HARPACTICOID COPEPODS													
Family: Canullidae													
35	<i>Canuella</i> sp.	-	+	+	-	-	-	-	-	+	-	+	-
Family: Tachidiidae													
36	<i>Euterpina acutifrons</i>	+	+	+	-	+	+	+	-	+	+	+	+
Family: Thalestridae													
37	<i>Diathrodes</i> sp	+	+	+	+	+	+	+	+	+	+	+	+
Family: Diosaccidae													
38	<i>Stenhelia</i> sp	-	+	+	-	+	+	-	+	+	+	+	-
Family: Cyliindropsyllidae													
39	<i>Leptastacus</i> sp.	+	+	+	+	+	+	+	+	+	+	+	+
40	<i>Cyliindropsyllus</i> sp.	-	+	+	-	-	-	-	-	+	+	+	-
Family: Metidae													
41	<i>Metis</i> sp.	+	+	-	+	+	-	-	-	+	+	-	-
Family: Tisbidae													
42	<i>Tisbe furcata</i>	+	+	+	+	+	+	+	+	+	+	+	+
Family: Tetragonicipitidae													
43	<i>Pyllopodosyllys</i> sp.	+	+	+	-	+	+	+	+	+	+	+	+
FORAMINIFERANS													
Family: Ameridae													
44	<i>America</i> sp.	-	-	-	+	-	-	+	-	-	-	+	-
Family: Soritidae													
45	<i>Amphisorus</i> sp.	+	-	-	-	+	-	+	+	+	+	+	+
Family: Bolivinidae													
46	<i>Bolivina abbreviata</i>	+	+	+	+	-	+	+	+	+	+	-	-

S. No	Name of the Family & Species	Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Family: Cibicidae													
47	<i>Cibicides lobotulus</i>	+	+	+	-	-	+	-	-	-	-	-	-
48	<i>C. refulegens</i>	-	-	-	-	-	-	-	-	-	-	-	+
Family: Cyclamminidae													
49	<i>Cyclammina</i> sp.	-	-	-	-	-	+	-	+	-	-	-	-
Family: Discorbidae													
50	<i>Discorbis</i> sp.	+	+	+	+	-	+	+	+	+	+	+	-
51	<i>Rotalia pulchella</i>	+	+	+	+	+	-	+	-	-	-	-	-
52	<i>R. translucens</i>	-	+	+	-	+	-	-	-	-	-	-	-
Family: Elphidiidae													
53	<i>Elphidium</i> sp.	+	+	+	-	-	-	-	+	-	+	-	+
Family: Eponididae													
54	<i>Eponides repandus</i>	+	+	+	+	+	+	+	+	+	+	+	+
Family: Candeinidae													
55	<i>Globigerina</i> sp.	+	+	+	-	-	-	+	-	+	-	+	+
56	<i>Globigerinita</i> sp.	-	+	+	-	-	-	-	-	-	-	-	-
Family: Vaginulinidae													
57	<i>Legena</i> sp.	+	+	+	-	+	-	+	-	-	+	-	-
Family: Neoconorbinidae													
58	<i>Neoconorbina</i> sp.	-	-	-	-	+	-	-	+	-	-	+	+
Family: Nonionidae													
59	<i>Nonion depressulum</i>	-	+	+	-	-	-	+	+	-	-	-	-
Family: Heterolepidae													
60	<i>Oridosalis umbonatus</i>	-	-	-	+	+	-	-	-	-	-	-	-
Family: Planulinidae													
61	<i>Planulina</i> sp.	-	-	-	-	-	-	-	+	-	-	-	-
62	<i>Planorbullina</i> sp.	-	-	-	-	-	-	-	+	-	-	-	-
Family: Hauerinidae													
63	<i>Quinqueloculina bradyana</i>	+	+	+	+	+	+	+	+	+	+	+	+
64	<i>Q. laevigata</i>	+	+	+	-	-	-	+	-	-	-	-	-
65	<i>Q. agglutianans</i>	+	+	+	-	-	+	-	-	-	-	-	-
66	<i>Q. oblonga</i>	+	+	+	-	-	+	-	-	-	-	-	-
67	<i>Q. lamarkiana</i>	-	-	-	-	-	+	-	-	-	-	-	-

S. No	Name of the Family & Species	Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Family: Rosalinidae													
68	<i>Rosalina agglutinans</i>	+	+	+	+	+	+	+	+	+	+	+	+
69	<i>R. floridana</i>	-	+	-	-	-	-	+	-	-	+	-	-
70	<i>R. globularis</i>	+	+	+	+	+	+	+	+	+	+	+	+
71	<i>R. vilardeboana</i>	+	-	+	-	-	-	-	+	-	-	-	-
72	<i>R. bradyi</i>	+	+	+	+	+	+	+	+	+	+	+	+
Family: Rotaliidae													
73	<i>Ammonia beccarii</i>	-	+	+	+	-	+	+	+	+	+	+	+
Family: Spirillinidae													
74	<i>Spirillina lateseptata</i>	-	-	-	-	-	-	+	+	-	+	-	+
75	<i>S. limbata</i>	+	+	+	+	+	+	+	+	+	+	+	+
Family: Nubeculariidae													
76	<i>Spiroloculina antillarum</i>	-	+	-	-	-	-	-	-	-	-	-	-
Family: Textulariidae													
77	<i>Textularia cuneiformis</i>	+	-	-	-	-	-	-	-	-	+	-	-
78	<i>T. candiana</i>	-	-	-	-	-	-	-	-	-	-	-	+
79	<i>T. agglutinans</i>	-	+	-	+	-	-	-	+	-	+	-	+
Family: Miliolidae													
80	<i>Triloculina</i> sp.	+	+	+	+	+	+	+	+	+	+	+	+
POLYCHAETES													
Family: Pisionidae													
81	<i>Pisione</i> sp.	+	+	+	+	-	-	+	-	+	-	+	+
Family: Capitellidae													
82	<i>Capitella</i> sp.	+	+	+	+	+	+	+	+	+	+	+	+
Family: Nephtyidae													
83	<i>Nephtys</i> sp.	+	+	+	+	+	-	-	+	+	+	+	+
Family: Nerillidae													
84	<i>Nerillidium</i>	+	+	+	-	-	-	-	-	-	-	+	+
85	<i>Nerilla</i>	+	+	+	+	-	-	+	-	+	-	-	-
Family: Protodrilidae													
86	<i>Protodrilus</i> sp.	-	+	+	+	-	-	+	-	+	+	-	-

S. No	Name of the Family & Species	Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
OLIGOCHAETES													
Family: Tubificidae													
87	<i>Limnodriloides</i> sp.	+	+	+	-	+	+	+	-	-	-	-	-
88	<i>Aktedrilus</i> sp.	+	+	+	-	+	+	+	+	-	-	-	-
89	<i>Heterodrilus</i> sp.	-	+	-	-	+	+	+	-	-	-	-	-
90	<i>Olavius</i> sp.	+	-	-	-	+	+	+	-	-	-	-	-
91	<i>Phallodrilus</i> sp.	+	-	-	-	-	+	+	-	-	-	-	-
Family: Enchytracidae													
92	<i>Grania</i> sp.	+	+	+	-	+	+	+	+	-	-	-	+
OSTRACODS													
Family: Cypridae													
93	<i>Cyprideis</i> sp.	+	+	+	+	-	-	-	+	-	-	-	-
Family: Cytherideidae													
94	<i>Cytheridea</i> sp.	-	-	-	-	+	+	+	-	-	-	-	-
Family: Paracytherideidae													
95	<i>Paracytheridea</i> sp.	-	-	-	-	-	-	-	-	-	-	-	+
Family: Cyprididae													
96	<i>Herpetocypris</i> sp.	+	+	+	-	-	+	+	+	+	+	+	+
Family: Cytheruridae													
97	<i>Cytheromorpha</i> sp.	+	+	+	+	+	+	+	+	+	+	+	+
Family: Paracythermidae													
98	<i>Paracythroma</i> sp	-	-	-	-	-	-	-	+	-	-	-	-
ISOPODS													
Family: Microcerberidae													
99	<i>Microcerberus</i> sp.	-	+	+	-	-	-	+	-	-	-	-	+
+ Presence of nematode distribution - Absence of nematode distribution													

Nine major meiofaunal taxa i.e. nematodes, harpacticoid copepods, foraminiferans, polychaetes, ostracods, oligochaetes, gastrotrichs, turbellarians and isopod were recorded at different sediment nature of Tamil Nadu coast. Nematodes were the most abundant group of meiofauna at all the sampling sites. This is generally the case in marine sediments. The abundance of polychaetes was less, which may be due to predominance of sand fraction in sediments at most of the stations. Oligochaetes were second in abundance to nematodes only at stations 1, 6 and 7 (Chennai, Thondi and Thiruchendur), probably because at station 1, situated near the sewage mixing area and sediment here was very fine. In general, oligochaetes are mainly found in the polluted areas. Among the different sampling sites, areas with seagrass bed cover (stations 6 and 7) sediment contained highest density of meiofauna and also mainly inhabited by burrowers such as nematodes and oligochaetes. Nematodes were the most dominant group in the finer sediments. Meiofauna densities in the seagrass

bed were significantly related, with a time log, to change in bacterial standing stock, indicating that microbes may be an important resource. The increase of detritus, which provides the main food for the meiofauna, is suggested to be the reason for the high meiofauna densities observed in the seagrass bed. A lowest density of meiofauna was observed in sandy sediments especially at stations 1 (Chennai), 5 (Nagapattinam), 8 (Tuticorin), 11 (Rameswaram) and 12 (Kanyakumari). Probably because at station 1, situated near the sewage mixing area.

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DISTRIBUTION OF MARINE POLYCHAETES OF INDIA

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INTRODUCTION

Polychaetes are bristle-bearing segmented worms belonging to phylum Annelida, class Polychaeta. Polychaetes being the most dominant groups in benthic infaunal communities contribute about 80% to the total macrobenthic community and their diet include microbial (bacteria, microalgae, protists and fungi), meiobial and organic substance (Shou *et al.*, 2009). In the trophic system, benthic fauna plays a significant role as they exploit all forms of food available in the sediment and form an important link in the energy transfer (Crisp, 1971, Shou *et al.*, 2009). Polychaetes form an important component in the marine food chain especially for bottom fish and some mammals as they form an important source of food for demersal fish (Parulekar *et al.* 1982; Herman *et al.* 2000). Worldwide number of Polychaetes estimated as 8000 species (Bianchi & Morri, 2000; Fredj *et al.*, 1992).

The polychaetous annelids from India are listed in systematic arrangement with references to their occurrences in the northern Indian Ocean. The fauna of the northern Indian Ocean is well documented through numerous works in many journals by scientists from earlier times to the present. The northern Indian Ocean is here defined as extending from Red sea and Gulf of Oman in the west through Arabian Sea and Bay of Bengal to the Western side of the Malay Archipelago to the east. Its southern extension is through the chain of the Andaman Islands south to Sumatra. Voluminous

works by Grube (1878) on the Semper collections in the Philippine Archipelago. A long list of Polychaete names is attributed to Savigny 1818-20; Most of the Polychaetes in the richly diversified fauna in Indo-Pacific regions have been detailed in recent years. The most informative of these is Fauvel, 1932 in which 300 species are named. A more comprehensive work is Fauvel 1953 when 450 Species were named coming from the Persian Gulf, Arabian Sea, Bay of Bengal. Polychaetes are also being used for biomonitoring program as organic pollution indicators to check the health of the marine environment (Remani *et al.*, 1983; Warwick and Ruswahyuni 1987; Jayaraj *et al.*, 2007). It was only after 1970, the work on marine soft bottom macrobenthos along the Indian coast has been carried out by several workers (Parulekar *et al.*, 1975; Ansari *et al.*, 1977; Harkantra *et al.* 1980; Jayaraj *et al.*, 2007). However our knowledge of the Polychaetes fauna from Tamilnadu coast is based on the works of records are also available from Gravely (1927) Ghosh (1953), Balasubramanyan (1960a, 1960b, 1964), Ajmal Khan Vivekanandan and Balasubramanyan (1975) and Chandran *et al.*, (1984).

This paper provides a comprehensive account of the diversity of marine polychaetes of India. Information on polychaetes is available only from 14 marine stations and one estuary on the east coast and west coast. The present paper deals with 330 species of benthic Polychaetes as belonging to 66 families under 163 genera in 15 stations of India.

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ORDER	FAMILY	GENUS	SPECIES	SCIENTIFIC NAME	LOCALITY
Terebellida	Ampharetidae	<i>Ampharete</i>	<i>capensis</i>	<i>Ampharete capensis</i>	Portonovo, Tamilnadu
Amphinomida	Amphinomidae	<i>Amphinome</i> sp.	<i>Amphinome</i> sp.	<i>Amphinome</i> sp.	Chennai
Phyllodocida	Pilargidae	<i>Ancistrosyllis</i>	<i>constricta</i>	<i>Ancistrosyllis constricta</i>	Chilka Lake
Phyllodocida	Pilargidae	<i>Aphrodita</i>	<i>aculeata</i>	<i>Aphrodita aculeata</i> Linnaeus	Madras
Phyllodocida	Pilargidae	<i>Aphrogenia</i>	<i>alba</i>	<i>Aphrogenia alba</i> Kinberg	Andaman Islands
Eunicida	Oeonidae	<i>Arabella</i>	iricolor	<i>Arabella iricolor</i>	Indian Ocean
Eunicida	Capitellidae	<i>Branchiocapetella</i>	<i>singularsi</i>	<i>Branchiocapetella singularsi</i>	Indian Ocean
Eunicida	Capitellidae	<i>Capitella</i>	<i>capitata</i>	<i>Capitella capitata</i> (Fabricius)	Indian Ocean
Terebellida	Cirratulidae	<i>Cirratulus</i>	<i>chrysoderma</i>	<i>Cirratulus chrysoderma</i> Claparede	Indian Ocean
Terebellida	Cirratulidae	<i>Cirratulus</i>	<i>cirratus</i>	<i>Cirratulus cirratus</i> Muller	Indian Ocean
Terebellida	Cirratulidae	<i>Cirratulus</i>	<i>concinus</i>	<i>Cirratulus concinnus</i>	Indian Ocean
Terebellida	Cirratulidae	<i>Cirriformia</i>	<i>afer</i>	<i>Cirriformia afer</i>	Indian Ocean
Terebellida	Cirratulidae	<i>Cirriformia</i>	<i>filigera</i>	<i>Cirriformia filigera</i> Delle Chiaje	Indian Ocean
Terebellida	Cossuridae	<i>Cossura</i>	<i>coasta</i>	<i>Cossura coasta</i>	Vasishta Godavari estuary
Terebellida	Cossuridae	<i>Cossura</i>	<i>longocerrata</i>	<i>Cossura longocerrata</i>	Vasishta Godavari estuary
Phyllodocida	Nereididae	<i>Dendronereis</i>	<i>aesturina</i>	<i>Dendronereis aesturina</i> Southern	Indian Ocean
Eunicida	Onuphidae	<i>Diopatra</i>	<i>cuprea</i>	<i>Diopatra cuprea</i>	Indian Ocean
Eunicida	Onuphidae	<i>Diopatra</i>	<i>neapolitana</i>	<i>Diopatra neapolitana</i> Delle Chiaje	Indian ocean
Eunicida	Nereididae	<i>Drilonereis</i> sp.	<i>Drilonereis</i> sp.	<i>Drilonereis</i> sp.	Indian Ocean
Eunicida	Maldanidae	<i>Euclymene</i>	<i>annandelei</i>	<i>Euclymene annandelei</i>	Mumbai Port
Amphinomida	Euphrosinidae	<i>Euphrosine</i>	<i>capensis</i>	<i>Euphrosine capensis</i>	Mumbai Port
Phyllodocida	Glyceridae	<i>Glycera alba</i>	<i>Cochinensis</i>	<i>Glycera alba Cochinesis</i> Southern	Indian Ocean
Phyllodocida	Glyceridae	<i>Glycera</i>	<i>longipinnis</i>	<i>Glycera longipinnis</i> Grube	Bay of Bengal
Phyllodocida	Glyceridae	<i>Glycera</i>	<i>tesselata</i>	<i>Glycera tessellata</i> Grube	Andaman
Phyllodocida	Capitellidae	<i>Heteromastides</i>	<i>bifidus</i>	<i>Heteromastides bifidus</i> Augener	India
Phyllodocida	Capitellidae	<i>Heteromastides</i>	<i>filiformis</i>	<i>Heteromastides filiformis</i>	Mumbai Port
Phyllodocida	Capitellidae	<i>Heteromastus</i>	<i>similis</i>	<i>Heteromastus similis</i> Southern	Chilka lake

ORDER	FAMILY	GENUS	SPECIES	SCIENTIFIC NAME	LOCALITY
Sabellida	Serpulidae	<i>Hydroides</i>	<i>norvegica</i>	<i>Hydroides norvegica</i> Gunnerus	Indian Ocean
Phyllodocida	Syllidae	<i>Lepidonotus</i>	<i>tenuisetosus</i>	<i>Lepidonotus tenuisetosus</i> Gravier	Orissa and Madras
Eunicida	Lumbrineridae	<i>Lumbriconereis</i>	<i>hartmani</i>	<i>Lumbriconereis hartmani</i>	Maldiva and Laccadive
Eunicida	Lumbrineridae	<i>Lumbriconereis</i>	<i>notocirrata</i>	<i>Lumbriconereis notocirrata</i> Fauvel	India
Eunicida	Lumbrineridae	<i>Lumbriconereis</i>	<i>pseudobifilaris</i>	<i>Lumbriconereis pseudobifilaris</i> Fauvel	Kerala
Eunicida	Lumbrineridae	<i>Lumbriconereis</i>	<i>simplex</i>	<i>Lumbriconereis simplex</i> Southern	India-Chilka Lake
Eunicida	Capitellidae	<i>Notomastus</i>	<i>aberans</i>	<i>Notomastus aberans</i>	Indian Ocean
Eunicida	Capitellidae	<i>Notomastus</i>	<i>fauveli</i>	<i>Notomastus fauveli</i>	Indian Ocean
Eunicida	Capitellidae	<i>Notomastus</i>	<i>latericeus</i>	<i>Notomastus latericeus</i> Sars	India
Opheliida	Opheliidae	<i>Ophelina</i>	<i>acuminate</i>	<i>Ophelina acuminate</i>	India
Opheliida	Orbiniidae	<i>Orbinia</i>	<i>angrapequensis</i>	<i>Orbinia angrapequensis</i>	Indian Ocean
Sabellida	Oweniidae	<i>Owenia</i>	<i>fusiformis</i>	<i>Owenia fusiformis</i> Delle chiaje	Andamans
Capitellida	Capitellidae	<i>Paraheteromastus</i>	<i>tenui</i>	<i>Paraheteromastus tenuis</i> Munro	India
Scolecida	Paraonidae	<i>Paraonella</i> sp.	<i>Paraonella</i> sp.	<i>Paraonella</i> sp.	Mumbai Port
Phyllodocida	Nereididae	<i>Perenereis</i>	<i>cavifrons</i>	<i>Perenereis cavifrons</i>	Mumbai Port
Terebellida	Terebellidae	<i>Pista</i>	<i>herpini</i>	<i>Pista herpini</i> Fauvel	Gulf of Mannar
Terebellida	Terebellidae	<i>Pista</i>	<i>indica</i>	<i>Pista indica</i>	Gulf of Mannar
Terebellida	Terebellidae	<i>Pista</i>	<i>pachybranchiata</i>	<i>Pista pachybranchiata</i> Fauvel	Lakshdweep
Aciculata	Nereidae	<i>Platynereis</i> sp.	<i>Platynereis</i> sp.	<i>Platynereis</i> sp.	Gulf of Mannar
Spionida	Spionidae	<i>Polydora</i>	<i>capensis</i>	<i>Polydora capensis</i>	Cochin backwater
Spionida	Spionidae	<i>Polydora</i>	<i>giardi</i>	<i>Polydora giardi</i>	Cochin backwater
Spionida	Spionidae	<i>Polydora</i>	<i>capensis</i>	<i>Polydora capensis</i>	Cochin backwater
Spionida	Maldanidae	<i>Praxillella</i>	<i>affinis</i>	<i>Praxillella affinis</i> pacifica	Mumbai Port
Spionida	Spionidae	<i>Paraprionospio</i>	<i>pinnata</i>	<i>Paraprionospio pinnata</i>	Ratnagiri Bay
Spionida	Spionidae	<i>Prionospio</i>	<i>polybranchiata</i>	<i>Prionospio polybranchiata</i>	Cochin backwater
Sabellida	Serpulidae	<i>Protula</i>	<i>tubularia</i>	<i>Protula tubularia</i>	Gulf of Mannar
Sabellida	Capitellidae	<i>Pulliella</i>	<i>armata</i>	<i>Pulliella armata</i>	Gulf of Mannar

ORDER	FAMILY	GENUS	SPECIES	SCIENTIFIC NAME	LOCALITY
Sabellida	Serpulidae	<i>Salmacina</i>	<i>dysteri</i>	<i>Salmacina dysteri</i>	Mumbai Port
Scolecida	Serpulidae	<i>Salmacina</i>	<i>dysteri</i>	<i>Salmacina dysteri</i>	Mumbai Port
Scolecida	Orbiniidae	<i>Scoloplella</i>	<i>capensis</i>	<i>Scoloplella capensis</i>	Gulf of Mannar
Scolecida	Capitellidae	<i>Scyhoproctus</i>	<i>djiboutiensis</i>	<i>Scyhoproctus djiboutiensis</i>	Indian Ocean
Scolecida	Capitellidae	<i>Serpula</i>	<i>vermicularis</i>	<i>Serpula vermicularis</i>	Kalpakkam, Chennai
Phyllodocida	Syllidae	<i>Sphaerosyllis</i>	<i>sublaevis</i>	<i>Sphaerosyllis sublaevis</i>	Mumbai Port
Spionida	Spionidae	<i>Spiophanes</i>	<i>bombyx</i>	<i>Spiophanes bombyx</i>	Goa Coast
Terebellida	Sternaspidae	<i>Sternapsis</i>	<i>scutata</i>	<i>Sternapsis scutata</i>	Mumbai Port
Phyllodocida	Sigalionidae	<i>Sthenelais</i>	<i>boa</i>	<i>Sthenelais boa</i>	Krusadai Island
Phyllodocida	Syllidae	<i>Syllis</i>	<i>hyaline</i>	<i>Syllis hyaline</i>	Indian Ocean
Phyllodocida	Syllidae	<i>Syllis</i>	<i>spongicola</i>	<i>Syllis spongicola</i>	Indian Ocean
Terebellida	Cirratulidae	<i>Tharyx</i>	<i>filibranchia</i>	<i>Tharyx filibranchia</i>	Mumbai Port
Phyllodocida	Pilargidae	<i>Ancistrosyllis</i>	<i>parva</i>	<i>Ancistrosyllis parva</i>	Maharastra Coast
Phyllodocida	Pilargidae	<i>Boccardia</i>	<i>polybranchia</i>	<i>Boccardia polybranchia</i>	Maharastra Coast
Phyllodocida	Pilargidae	<i>Cirriformia</i>	<i>tentaculata</i>	<i>Cirriformia tentaculata</i>	Maharastra Coast
Phyllodocida	Cossuridae	<i>Cossura</i>	<i>coasta</i>	<i>Cossura coasta</i>	Maharastra Coast
Eunicida	Onuphidae	<i>Diopatra</i>	<i>cuprea</i>	<i>Diopatra cuprea cuprea</i>	Maharastra Coast
Phyllodocida	Phyllodocidae	<i>Eteone</i>	<i>ornata</i>	<i>Eteone ornata</i>	Maharastra Coast
Sabellida	Sabellidae	<i>Fabricia</i>	<i>bansei</i>	<i>Fabricia bansei</i>	Maharastra Coast
Sabellida	Glyceridae	<i>Glycera</i>	<i>longipinnis</i>	<i>Glycera longipinnis</i>	Maharastra Coast
Sabellida	Capitellidae	<i>Capitella</i>	<i>capitata</i>	<i>Capitella capitata</i>	Goa Coast
Sabellida	Paraonidae	<i>Aricidea</i>	<i>assimilis</i>	<i>Aricidea assimilis</i>	Indian Ocean
Sabellida	Capitellidae	<i>Mediomastus</i>	<i>capensis</i>	<i>Mediomastus capensis</i>	Indian Ocean
Sabellida	Capitellidae	<i>Heteromastus</i>	<i>filiformis</i>	<i>Heteromastus filiformis</i>	Indian Ocean
Sabellida	Orbiniidae	<i>Scoloplos</i> sp.	<i>Scoloplos</i> sp.	<i>Scoloplos</i> sp.	Indian Ocean
Phyllodocida	Phyllodocidae	<i>Phyllodoce</i>	<i>malmgreni</i>	<i>Phyllodoce malmgreni</i>	Indian Ocean
Phyllodocida	Goniadidae	<i>Goniada</i>	<i>emerita</i>	<i>Goniada emerita</i>	Cochin Back waters

ORDER	FAMILY	GENUS	SPECIES	SCIENTIFIC NAME	LOCALITY
Phyllodocida	Polynoidae	<i>Harmethoe</i>	<i>imbricata</i>	<i>Harmethoe imbricata</i>	Indian Ocean
Phyllodocida	APHRODITIDAE Savigny, 1818	<i>Aphrogenia</i>	<i>alba</i> Kinberg	<i>Aphrogenia alba</i> Kinberg	Andaman Islands
Phyllodocida	POLYNOIDAE	<i>Iphion</i>	<i>muricata</i>	<i>Iphion muricata</i> savigny	Andaman Islands
Phyllodocida	CHRYSPETALIDAE	<i>Chrysopetalum</i>	<i>ehlersi</i> Gravier	<i>Chrysopetalum ehlersi</i> Gravier	Bay of Bengal
Phyllodocida	PHYLLODOCIDAE Willium, 1851	<i>Eulalia</i>	<i>viridis</i> Linnaeus, 1767	<i>Eulalia viridis</i> Linnaeus, 1767	Pamban
Phyllodocida	PILARGIDAE	<i>Syllis</i>	<i>gracilis</i> Grube	<i>Syllis gracilis</i> Grube	Gulf of Mannar
Phyllodocida	ONUPHIDAE	<i>Diopatra</i>	<i>neapolitana</i> Delle Ckiae, 1841	<i>Diopatra neapolitana</i> Delle Ckiae, 1841	Arabian sea
Phyllodocida	EUNICIDAE Savigny, 1818	<i>Eunica</i>	<i>tentaculata</i> Quatrefages, 1866	<i>Eunica tentaculata</i> Quatrefages, 1866	Andaman Sea
Phyllodocida	LUMBRINERIDAE	<i>Lumbrineria</i>	<i>unicornis</i> Grube, 1870	<i>Lumbrineria unicornis</i> Grube, 1870	Arabain sea
Phyllodocida	ARABELLIDAE Hartman, 1944	<i>Arabella</i>	<i>iricolor</i> Montagu, 1804	<i>Arabella iricolor</i> Montagu, 1804	India
Phyllodocida	LYSARETIDAE	<i>Aglaurides</i>	<i>fulgida</i> Savigny	<i>Aglaurides fulgida</i> Savigny	India
Phyllodocida	DORVILLEAE	<i>Stauronerreis</i>	<i>incertus</i> Schmarde	<i>Stauronerreis incertus</i> Schmarde	Gulf of Mannar
Phyllodocida	ORBINIDAE Hartman, 1942	<i>Nainercis</i>	<i>laevigata</i> Grube, 1855	<i>Nainercis laevigata</i> Grube, 1855	
Phyllodocida	SPIONIDAE	<i>Prionospio</i>	<i>pinnata</i> Ehlers	<i>Prionospio pinnata</i> Ehlers	India
Phyllodocida	POECILOCHAETIDAE	<i>Poecilochaetus</i>	<i>serpen</i> Allen	<i>Poecilochaetus serpen</i> Allen	Gulf of Mannar
Phyllodocida	CIRRATULIDAE	<i>Ctenotrilus</i>	<i>serratus</i> Schmidt	<i>Ctenotrilus serratus</i> Schmidt	India
Phyllodocida	FLABELLIGERIDAE Saint Joseph, 1794	<i>Pherusa</i>	<i>parmata</i> Grube, 1878	<i>Pherusa parmata</i> Grube, 1878	Madras
Phyllodocida	OPHELIDAE	<i>Polyopthalmus</i>	<i>pictus</i> Dujardin	<i>Polyopthalmus pictus</i> Dujardin	India
Phyllodocida	CAPITELLIDAE	<i>Pulliella</i>	<i>armatta</i> Nanto	<i>Pulliella armatta</i> Nanto	Gulf of Mannar
Phyllodocida	MALDANIDAE	<i>Euclymene</i>	<i>insecta</i> Ehlers	<i>Euclymene insecta</i> Ehlers	Adyar estuary, Madras
Phyllodocida	OWNIDAE	<i>Myriochela</i>	<i>picta</i> Southern	<i>Myriochela picta</i> Southern	Chilka lake
Phyllodocida	SABELLARIDAE Johnston, 1865	<i>Sabellaria</i>	<i>spinulosa</i> Leukart	<i>Sabellaria spinulosa</i> Leukart	Bay of Bengal
Phyllodocida	AMPHARETIDAE	<i>Schistocomus</i>	<i>hiltoni</i> Chamberlin	<i>Schistocomus hiltoni</i> Chamberlin	Madras
Phyllodocida	TEREBELLIDAE Grube, 1851	<i>Loimia</i>	<i>medusa</i> Savigny, 1850	<i>Loimia medusa</i> Savigny, 1850	Arabian Sea
Phyllodocida	TRICHOBRANCHIDAE	<i>Terebellides</i>	<i>stroemii</i> Sars, 1835	<i>Terebellides stroemii</i> Sars, 1835	Kakinada
Phyllodocida	SABELLIDAE Malmgren, 1867	<i>Sabella</i>	<i>porifera</i> Grube, 1870	<i>Sabella porifera</i> Grube, 1870	Andaman
Phyllodocida	CHRYSPETALIDAE	<i>Chrysopetalum</i>	<i>ehlersi</i> Gravier	<i>Chrysopetalum ehlersi</i> Gravier	Indian Ocean

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Phyllodocida	PHYLLODOCIDAE Willium, 1851	<i>Eulalia</i>	<i>viridis</i> Linnaeus, 1767	<i>Eulalia viridis</i> Linnaeus, 1767	
Phyllodocida	ONUPHIDAE	<i>Pharamarphyse</i>	<i>orientalis</i> Willey	<i>Pharamarphyse orientalis</i> Willey	Indian Ocean
Phyllodocida	LUMBRINERIDAE	<i>Lumbrineries</i>	<i>unicornis</i> Grube, 1870	<i>Lumbrineries unicornis</i> Grube, 1870	Indian Ocean
Phyllodocida	ARABELLIDAE Hartman, 1944	<i>Arabella</i>	<i>iricolor</i> Montagu, 1804	<i>Arabella iricolor</i> Montagu, 1804	Indian Ocean
Phyllodocida	MALDANIDAE	<i>Euclymene</i>	<i>insecta</i> Ehlers	<i>Euclymene insecta</i> Ehlers	Indian Ocean
Phyllodocida	OWNIDAE	<i>Myriochela</i>	<i>picta</i> Southern	<i>Myriochela picta</i> Southern	Chilka Lake
Phyllodocida	SABELLARIDAE Johnston, 1865	<i>Sabellaria</i>	<i>spinulosa</i> Leukart	<i>Sabellaria spinulosa</i> Leukart	Indian Ocean
Phyllodocida	AMPHARETIDAE	<i>Schistocomus</i>	<i>hiltoni</i> Chamberlin	<i>Schistocomus hiltoni</i> Chamberlin	
Phyllodocida	TEREBELLIDAE Grube, 1851	<i>Loimia</i>	<i>medusa</i> Savigny, 1850	<i>Loimia medusa</i> Savigny, 1850	Indian Ocean
Phyllodocida	TRICHOBRANCHIDAE	<i>Terebellides</i>	<i>stroemii</i> Sars, 1835	<i>Terebellides stroemii</i> Sars, 1835	Indian Ocean
Phyllodocida	SABELLIDAE Malmgren, 1867	<i>Sabella</i>	<i>porifera</i> Grube, 1870	<i>Sabella porifera</i> Grube, 1870	Off Nicobar
Phyllodocida	SPIRORBIDAE	<i>Spirorbis</i>	<i>pagenstcheri</i> (Quatrefages).	<i>Spirorbis (Dexiospira) pagenstcheri</i> (Quatrefages).	Indian Ocean
Phyllodocida	ONUPHIDAE	<i>Diopatra</i>	<i>neapolitana</i> Delle Chiaje, 1841	<i>Diopatra neapolitana</i> Delle Chiaje, 1841	Goa Coast
Phyllodocida	ARCIIDAE Grube	<i>Scoloplos</i>	<i>marsupialis</i> Southern, 1921	<i>Scoloplos marsupialis</i> Southern, 1921	Indian Ocean
Phyllodocida	LUMBRINERIDAE	<i>Lumbrineries</i>	<i>unicornis</i> Grube, 1870	<i>Lumbrineries unicornis</i> Grube, 1870	Indian Ocean
Phyllodocida	DORVILLEDAE	<i>Stauronerreis</i>	<i>incertus</i> Schmarde	<i>Stauronerreis incertus</i> Schmarde	Indian Ocean
Phyllodocida	ORBINIDAE Hartman, 1942	<i>Nainercis</i>	<i>laevigata</i> Grube, 1855	<i>Nainercis laevigata</i> Grube, 1855	
Phyllodocida	ARABELLIDAE Hartman, 1944	<i>Arabella</i>	<i>iricolor</i> Montagu, 1804	<i>Arabella iricolor</i> Montagu, 1804	Indian Ocean
Phyllodocida	SPIONIDAE	<i>Nerine</i>	<i>cirratus</i> Delle Chiaje	<i>Nerine cirratus</i> Delle Chiaje	Indian Ocean
Phyllodocida	POECILOCHAETIDAE	<i>Poecilochaetus</i>	<i>serpen</i> Allen	<i>Poecilochaetus serpen</i> Allen	Indian Ocean
Phyllodocida	CIRRATULIDAE Carus	<i>Audouinia</i>	<i>anchylochaeta</i> (Schmarda, 1861)	<i>Audouinia anchylochaeta</i> (Schmarda, 1861)	Indian Ocean
Phyllodocida	CHAETOPTERIDAE Aud. & Milne-Edwards	<i>Mesochaetopterus</i>	<i>minutus</i> Potts, 1914	<i>Mesochaetopterus minutus</i> Potts, 1914	Indian Ocean
Phyllodocida	CHLORAEMIDAE Malmgren	<i>Stylarioides</i>	<i>eruca</i>	<i>Stylarioides eruca</i> Claparede var. <i>indica</i> Fauvel, 1927	Indian Ocean
Phyllodocida	SCALIBREGMIDAE Malmgren	<i>Parasclerocheilus</i>	<i>branchiatus</i> Fauvel, 1928	<i>Parasclerocheilus branchiatus</i> Fauvel, 1928	Gulf of Mannar
Phyllodocida	FLABELLICERIDAE Saint Joseph, 1794	<i>Pherusa</i>	<i>parmata</i> Grube, 1878	<i>Pherusa parmata</i> Grube, 1878	Indian Ocean
Phyllodocida	OPHELIIDAE Grube	<i>Armandia</i>	<i>leptocirris</i> Grube	<i>Armandia leptocirris</i> Grube	Gulf of Mannar
Phyllodocida	CAPITELLIDAE Grube	<i>Dasybranchus</i>	<i>caducus</i> Grube, 1867	<i>Dasybranchus caducus</i> Grube, 1867	Indian Ocean
Phyllodocida	MALDANIDAE Malmgren	<i>Axiothella</i>	<i>obockensis</i> (Gravier, 1906)	<i>Axiothella obockensis</i> (Gravier, 1906)	Indian Ocean
Phyllodocida	SABELLARIDAE Johnston, 1865	<i>Sabellaria</i>	<i>cementarium</i> Moore, 1906	<i>Sabellaria cementarium</i> Moore, 1906	Indian Ocean
Phyllodocida	AMPHARETIDAE	<i>Schistocomus</i>	<i>hiltoni</i> Chamberlin	<i>Schistocomus hiltoni</i> Chamberlin	Indian Ocean
Phyllodocida	SERPULIDAE Burmeister	<i>Serpula</i>	<i>vermicularis</i> Linnaeus	<i>Serpula vermicularis</i> Linnaeus	Chennai, Kalpakkam
Phyllodocida	Poecilochaetidae	<i>Spirobranchus</i>	<i>jousseau mei</i> (Gravier, 1908)	<i>Spirobranchus jousseau mei</i> (Gravier, 1908)	Lakshadweep islands

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Phyllo]ocida	SPIRORBIDAE	<i>Spirorbis</i>	<i>pagenstcheri</i> (Quatrefages)	<i>Spirorbis</i> (<i>Dexiospira</i>) <i>pagenstcheri</i> (Quatrefages).	
Phyllodocida	Hesionidae	<i>Dorvillea</i>	<i>mandapamae</i>	<i>Dorvillea mandapamae</i>	
Phyllodocida	Spionidae	<i>Prionospio</i>	<i>malmgreni</i> Claparede	<i>Prionospio malmgreni</i> Claparede	Polychaetes of Mandapam
Phyllodocida	Cirratulidae	<i>Raphidrilus</i>	<i>nemasoma</i> Monticelli	<i>Raphidrilus nemasoma</i> Monticelli	Polychaetes of Mandapam
Phyllodocida	Sabellidae	<i>Oriopsis</i>	<i>armandi</i> (Claparede)	<i>Oriopsis armandi</i> (Claparede)	Polychaetes of Mandapam
Phyllodocida	Sabellidae	<i>Oriopsis</i>	<i>coalescens</i>	<i>Oriopsis coalescens</i>	Polychaetes of Mandapam
Phyllodocida	Polynoidae	<i>Gatta</i>	<i>deludens</i> Fauvel	<i>G.deludens</i> Fauvel	Tamilnadu Coast-Parangipettai
Phyllodocida	Polynoidae	<i>Longi</i>	<i>tenuisetosus</i> (Gravier)	<i>L.tenuisetosus</i> (Gravier)	Tamilnadu Coast-Parangipettai
Phyllodocida	Polynoidae	<i>Hololepidella</i>	<i>maculata</i> Day	<i>Hololepidella maculata</i> Day	Tamilnadu Coast-Parangipettai
Phyllodocida	Sigalionidae	<i>Sthenelais</i>	<i>boa</i> (Johnston)	<i>Sthenelais boa</i> (Johnston)	Tamilnadu Coast-Parangipettai
Phyllodocida	Sigalionidae	<i>S.japonica</i>	(McIntosh)	<i>S.japonica</i> (McIntosh)	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Chrysopetalidae</i>	<i>Bhawania</i>	<i>Bhawania goodie</i> Webster	<i>Bhawania goodie</i> Webster	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Chrysopetalidae</i>	<i>Amphinomid</i> sp	<i>Amphinomid</i> sp	<i>Amphinomid</i> sp	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Chrysopetalidae</i>	<i>Aetideopsis</i>	<i>A.rostrata</i> (Pallas)	<i>A.rostrata</i> (Pallas)	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Chrysopetalidae</i>	<i>Chloeia</i>	<i>Chloeia parva</i> Baird	<i>Chloeia parva</i> Baird	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Chrysopetalidae</i>	<i>C.flava</i>	<i>C.flava</i> (Pallas)	<i>C.flava</i> (Pallas)	Tamilnadu Coast-Parangipettai
Phyllodocida	Alciopidae	<i>Asterophora</i>	<i>parasitica</i>	<i>A.parasitica</i> Claparede and Panceri	Tamilnadu Coast-Parangipettai
Phyllodocida	Tomopteridae	<i>Tomopteris</i>	<i>helgolandica</i> Greeff	<i>Tomopteris helgolandica</i> Greeff	Tamilnadu Coast-Parangipettai
Phyllodocida	Typhloscolecidae	<i>Travisiopsis</i>	<i>lobifera</i> Levinsen	<i>Travisiopsis lobifera</i> Levinsen	Tamilnadu Coast-Parangipettai
Phyllodocida	Iospilidae	<i>Phalacrophorus</i>	<i>pictus</i> Greeff	<i>Phalacrophorus pictus</i> Greeff	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Lacydoniidae</i>	<i>Paralacydonia</i>	<i>weberi</i> Horst	<i>Paralacydonia weberi</i> Horst	Tamilnadu Coast-Parangipettai
Phyllodocida	Phyllodocidae	<i>Eteone</i>	<i>ornate</i> Grube	<i>Eteone ornate</i> Grube	Tamilnadu Coast-Parangipettai
Phyllodocida	Phyllodocidae	<i>Eulalia</i>	<i>sanguinea</i> Oersted	<i>Eulalia sanguinea</i> Oersted	Tamilnadu Coast-Parangipettai
Phyllodocida	Phyllodocidae	<i>Phyllodoce</i>	<i>tenuissima</i> Grube	<i>Phyllodoce tenuissima</i> Grube	Tamilnadu Coast-Parangipettai
Phyllodocida	Phyllodocidae	<i>Phyllodoce</i>	<i>madeirensis</i> Langerhans	<i>P.madeirensis</i> Langerhans	Tamilnadu Coast-Parangipettai
Phyllodocida	Phyllodocidae	<i>Phyllodoce</i>	<i>malmgreni</i> Gravier	<i>P.malmgreni</i> Gravier	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Lopadorhynchidae</i>	<i>Pelagoba</i>	<i>longicirrata</i> Greeff	<i>Pelagoba longicirrata</i> Greeff	Tamilnadu Coast-Parangipettai
Phyllodocida	Pilargidae	<i>Ancistrosyllis</i>	<i>groenlandica</i> McIntosh	<i>Ancistrosyllis groenlandica</i> McIntosh	Tamilnadu Coast-Parangipettai

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Phyllodocida	Pilargidae	<i>Ancistrosyllis</i>	<i>constricta</i> Southern	<i>A.constricta</i> Southern	Tamilnadu Coast-Parangipettai
Phyllodocida	Hesionidae	<i>Hesione</i>	<i>intertexta</i> Grube	<i>Hesione intertexta</i> Grube	Tamilnadu Coast-Parangipettai
Phyllodocida	Hesionidae	<i>Hesionid sp</i>	<i>Hesionid sp</i>	<i>Hesionid sp</i>	Tamilnadu Coast-Parangipettai
Phyllodocida	Hesionidae	<i>Gyptis sp</i>	<i>Gyptis sp</i>	<i>Gyptis sp</i>	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Nereidae</i>	<i>Dendronereis</i>	<i>aestuarina</i> Southern	<i>Dendronereis aestuarina</i> Southern	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Nereidae</i>	<i>Tylonereis</i>	<i>fauveli</i> Southern	<i>Tylonereis fauveli</i> Southern	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Nereidae</i>	<i>Micronereis sp</i>	<i>Micronereis sp</i>	<i>Micronereis sp</i>	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Nereidae</i>	<i>Ceratonereis</i>	<i>costae</i> (Grube)	<i>Ceratonereis costae</i> (Grube)	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Nereidae</i>	<i>Pseudonereis sp</i>	<i>Pseudonereis sp</i>	<i>Pseudonereis sp</i>	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Nereidae</i>	<i>Perinereis</i>	<i>cultrifera</i> (Grube)	<i>Perinereis cultrifera</i> (Grube)	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Nereidae</i>	<i>Exogone</i>	<i>verugera</i> (Claparede)	<i>Exogone verugera</i> (Claparede)	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Nereidae</i>	<i>Syllis</i>	<i>gracilis</i> Grube	<i>Syllis gracilis</i> Grube	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Nereidae</i>	<i>Autolytus sp</i>	<i>Autolytus sp</i>	<i>Autolytus sp</i>	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Nereidae</i>	<i>Nephtyidae</i>	<i>Nephtys</i>	<i>Nephtys</i>	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Nereidae</i>	<i>Nephtys</i>	<i>polybranchia</i> Southern	<i>N.polybranchia</i> Southern	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Nereidae</i>	<i>Nephtys</i>	<i>Nephtys sp</i>	<i>Nephtys sp</i>	Tamilnadu Coast-Parangipettai
Phyllodocida	Glyceridae	<i>Nephtys sp</i>	<i>Glycera alba</i> (Muller)	<i>Glycera alba</i> (Muller)	Tamilnadu Coast-Parangipettai
Phyllodocida	Goniadidae	<i>Glycera</i>	<i>Goniada sp</i>	<i>Goniada sp</i>	Tamilnadu Coast-Parangipettai
Phyllodocida	Goniadidae	<i>Goniada sp</i>	<i>Glycinde</i>	<i>Glycinde</i>	Tamilnadu Coast-Parangipettai
Phyllodocida	Goniadidae	<i>Glycinde</i>	<i>oligodon</i> Southern	<i>G.oligodon</i> Southern	Tamilnadu Coast-Parangipettai
Phyllodocida	Dorvilleidae	<i>Glycinde</i>	<i>incertus</i> (Schmarda)	<i>Dorvillea incertus</i> (Schmarda)	Tamilnadu Coast-Parangipettai
Phyllodocida	Dorvilleidae	<i>Dorvillea</i>	<i>neglecta</i> (Fauvel)	<i>D.neglecta</i> (Fauvel)	Tamilnadu Coast-Parangipettai
Phyllodocida	Dorvilleidae	<i>Dorvillea</i>	<i>Lumbriconereis</i>	<i>Lumbriconereis</i>	Tamilnadu Coast-Parangipettai
Phyllodocida	Dorvilleidae	<i>Lumbriconereis</i>	<i>simplex</i> Southern	<i>L.simplex</i> Southern	Tamilnadu Coast-Parangipettai
Phyllodocida	Dorvilleidae	<i>Lumbrocinereis</i>	<i>pseudobifilaris</i> Fauvel	<i>L.pseudobifilaris</i> Fauvel	Tamilnadu Coast-Parangipettai
Phyllodocida	Dorvilleidae	<i>Lumbrocinereis</i>	<i>latrelli</i> Audouin and Milne Edwards	<i>L.latrelli</i> Audouin and Milne Edwards	Tamilnadu Coast-Parangipettai
Phyllodocida	Dorvilleidae	<i>Lumbrocinereis</i>	<i>polydesma</i> Southern	<i>L.polydesma</i> Southern	Tamilnadu Coast-Parangipettai

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Phyllodocida	Dorvilleidae	<i>Lumbrocinereis</i>	<i>impatiens</i> Claparede	<i>L.impatiens</i> Claparede	Tamilnadu Coast-Parangipetta
Phyllodocida	Pisionidae	<i>Lumbrocinereis</i>	<i>indica</i> (Aiyar and Alikunhi)	<i>Pisionidens indica</i> (Aiyar and Alikunhi)	Tamilnadu Coast-Parangipettai
Phyllodocida	Pisionidae	<i>Pisionidens</i>	<i>Pisione</i> sp	<i>Pisione</i> sp	Tamilnadu Coast-Parangipettai
Phyllodocida	Onuphidae	<i>Pisione</i> sp	<i>neapolitana</i> Delle Chiaje	<i>Diopatra neapolitana</i> Delle Chiaje	Tamilnadu Coast-Parangipettai
Phyllodocida	Onuphidae	<i>Diopatra</i>	<i>eremite</i> Audouin and Milne Edwards	<i>Onuphis eremite</i> Audouin and Milne Edwards	Tamilnadu Coast-Parangipettai
Phyllodocida	Onuphidae	<i>Onuphis</i>	<i>Onuphis</i> sp	<i>Onuphis</i> sp	Tamilnadu Coast-Parangipettai
Phyllodocida	Onuphidae	<i>Onuphis</i> sp	<i>Diopatra</i> sp	<i>Diopatra</i> sp	Tamilnadu Coast-Parangipettai
Phyllodocida	Eunicidae	<i>Diopatra</i> sp	<i>gravely</i> Southern	<i>Marphysa gravely</i> Southern	Tamilnadu Coast-Parangipettai
Phyllodocida	Eunicidae	<i>Marphysa</i>	<i>Eunice</i>	<i>Eunice</i>	Tamilnadu Coast-Parangipettai
Phyllodocida	Eunicidae	<i>Eunice</i>	<i>tubifex</i> Crossland	<i>Eunice tubifex</i> Crossland	Tamilnadu Coast-Parangipettai
Phyllodocida	Eunicidae	<i>Eunice</i>	<i>australis</i> Quatrefages	<i>E.australis</i> Quatrefages	Tamilnadu Coast-Parangipettai
Phyllodocida	Eunicidae	<i>Eunice</i>	<i>indica</i> Kinberg	<i>E.indica</i> Kinberg	Tamilnadu Coast-Parangipettai
Phyllodocida	Sternaspidae	<i>Eunice</i>	<i>Sternaspisscutata</i> (Renier)	<i>Sternaspisscutata</i> (Renier)	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Sedentaria</i>	<i>hoplura</i> Claparede	<i>Polydora hoplura</i> Claparede	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Sternaspisscutata</i> (Renier)	<i>ciliata</i> (Johnston)	<i>P.ciliata</i> (Johnston)	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Polydora</i>	<i>Polydora</i> sp	<i>Polydora</i> sp	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Polydora</i>	<i>kempi</i> (Southern)	<i>Pseudopolydora kempi</i> (Southern)	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Polydora</i> sp	<i>kempi</i> (Southern)	<i>Pseudopolydora kempi</i> (Southern)	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Pseudopolydora</i>	<i>Pseudopolydora</i> sp	<i>Pseudopolydora</i> sp	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Pseudopolydora</i>	<i>Spiophanes</i> sp	<i>Spiophanes</i> sp	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Pseudopolydora</i> sp	<i>indicus</i> (Fauvel)	<i>Malacoceros indicus</i> (Fauvel)	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Spiophanes</i> sp	<i>filicornis</i> (Muller)	<i>Spio filicornis</i> (Muller)	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Malacoceros</i>	<i>squamata</i> (Muller)	<i>Scolecopsis squamata</i> (Muller)	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Spio</i>	<i>Nerinides</i> sp	<i>Nerinides</i> sp	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Scolecopsis</i>	<i>cirrata</i> (Sars)	<i>Laonice cirrata</i> (Sars)	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Nerinides</i> sp	<i>polybranchiata</i> Fauvel	<i>Prionospio polybranchiata</i> Fauvel	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Laonice</i>	<i>cirrobranchiata</i> Day	<i>P.cirrobranchiata</i> Day	Tamilnadu Coast-Parangipettai

ORDER	FAMILY	GENUS	SPECIES	SCIENTIFIC NAME	LOCALITY
Phyllodocida	Spionidae	<i>Prionospio</i>	<i>pinnata</i> Ehlers	<i>P.pinnata</i> Ehlers	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Prionospio</i>	<i>malmgreni</i> Claparede	<i>P.malmgreni</i> Claparede	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Prionospio</i>	<i>saldanha</i> Day	<i>P.saldanha</i> Day	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Prionospio</i>	<i>cincta</i> Ehlers	<i>Magelona cincta</i> Ehlers	Tamilnadu Coast-Parangipettai
Phyllodocida	Spionidae	<i>Prionospio</i>	<i>papillicornis</i> Muller	<i>M.papillicornis</i> Muller	Tamilnadu Coast-Parangipettai
Phyllodocida	Disomidae	<i>Magelona</i>	<i>orissae</i> Fauvel	<i>Disoma orissae</i> Fauvel	Tamilnadu Coast-Parangipettai
Phyllodocida	Cirratulidae	<i>Magelona</i>	<i>setoss</i> Malmgren	<i>Chaetozone setoss</i> Malmgren	Tamilnadu Coast-Parangipettai
Phyllodocida	Cirratulidae	<i>Disoma</i>	<i>Cirratulus</i> sp	<i>Cirratulus</i> sp	Tamilnadu Coast-Parangipettai
Phyllodocida	Trochochaetidae	<i>Chaetozone</i>	<i>serpens</i> Allen	<i>Poecilochaetus serpens</i> Allen	Tamilnadu Coast-Parangipettai
Phyllodocida	Chaetopteridae	<i>Cirratulus</i> sp	<i>costarum</i> (Claparede)	<i>Spiochaetopterus costarum</i> (Claparede)	Tamilnadu Coast-Parangipettai
Phyllodocida	Chaetopteridae	<i>Poecilochaetus</i>	<i>Mesochaetopterus</i> sp.	<i>Mesochaetopterus</i> sp.	Tamilnadu Coast-Parangipettai
Phyllodocida	Chaetopteridae	<i>Spiochaetopterus</i>	<i>varieopedatus</i> (Renier)	<i>Chaetopterus varieopedatus</i> (Renier)	Tamilnadu Coast-Parangipettai
Phyllodocida	Cossuridae	<i>Mesochaetopterus</i> sp.	<i>delta</i> Reish	<i>Cossura delta</i> Reish	Tamilnadu Coast-Parangipettai
Phyllodocida	Opheliidae	<i>Chaetopterus</i>	<i>lanceolata</i> Willey	<i>Armandia lanceolata</i> Willey	Tamilnadu Coast-Parangipettai
Phyllodocida	Orbiniidae	<i>Cossura</i>	<i>marsupialis</i> Southern	<i>Scoloplos marsupialis</i> Southern	Tamilnadu Coast-Parangipettai
Phyllodocida	Capitellidae	<i>Armandia</i>	<i>similis</i> Southern	<i>Heteromastus similis</i> Southern	Tamilnadu Coast-Parangipettai
Phyllodocida	Capitellidae	<i>Scoloplos</i>	<i>giganteus</i> Moore	<i>Notomastus giganteus</i> Moore	Tamilnadu Coast-Parangipettai
Phyllodocida	Flabelligeridae	<i>Heteromastus</i>	<i>singularis</i> Fauvel	<i>Branchiocapitella singularis</i> Fauvel	Tamilnadu Coast-Parangipettai
Phyllodocida	Flabelligeridae	<i>Notomastus</i>	<i>Capitella</i> sp	<i>Capitella</i> sp	Tamilnadu Coast-Parangipettai
Phyllodocida	Maldanidae	<i>Branchiocapitella</i>	<i>sarsi</i> Malmgren	<i>Maldane sarsi</i> Malmgren	Tamilnadu Coast-Parangipettai
Phyllodocida	Euclymene	<i>Capitella</i> sp	<i>annandalei</i> Southern	<i>E.annandalei</i> Southern	Tamilnadu Coast-Parangipettai
Phyllodocida	Euclymene	<i>Maldane</i>	<i>obockensis</i> (Gravier)	<i>Axiiothella obockensis</i> (Gravier)	Tamilnadu Coast-Parangipettai
Phyllodocida	Euclymene	<i>Axiiothella</i>	<i>fusiformis</i> Delle Chiaje	<i>Owenia fusiformis</i> Delle Chiaje	Tamilnadu Coast-Parangipettai
Phyllodocida	Oweniidae	<i>Owenia</i>	<i>Stylarioides</i> sp	<i>Stylarioides</i> sp	Tamilnadu Coast-Parangipettai
Phyllodocida	Oweniidae	<i>Stylarioides</i> sp	<i>villosa</i> (Rathke)	<i>Brada villosa</i> (Rathke)	Tamilnadu Coast-Parangipettai
Phyllodocida	Sabellariidae	<i>Brada</i>	<i>spinulosa</i> Alcocki Gravier	<i>Sabellaria spinulosa</i> Alcocki Gravier	Tamilnadu Coast-Parangipettai
Phyllodocida	Sabellariidae	<i>Sabellaria</i>	<i>cementarium</i> Moore	<i>S.cementarium</i> Moore	Tamilnadu Coast-Parangipettai

ORDER	FAMILY	GENUS	SPECIES	SCIENTIFIC NAME	LOCALITY
Phyllodocida	Sabellariidae	<i>Sabellaria</i>	<i>intoshii</i> Fauvel	<i>S.intoshi</i> Fauvel	Tamilnadu Coast-Parangipettai
Phyllodocida	Sabellariidae	<i>Sabellaria</i>	<i>Sabellaria sp</i>	<i>Sabellaria sp</i>	Tamilnadu Coast-Parangipettai
Phyllodocida	Pectinariidae	<i>Sabellaria sp</i>	<i>crassa</i> Grube	<i>Pectinaria crassa</i> Grube	Tamilnadu Coast-Parangipettai
Phyllodocida	Pmpharetidae	<i>Pectinaria</i>	<i>Auchenoplax sp</i>	<i>Auchenoplax sp</i>	Tamilnadu Coast-Parangipettai
Phyllodocida	Pmpharetidae	<i>Auchenoplax sp</i>	<i>Samytha sp</i>	<i>Samytha sp</i>	Tamilnadu Coast-Parangipettai
Phyllodocida	Pmpharetidae	<i>Samytha sp</i>	<i>Melinna sp</i>	<i>Melinna sp</i>	Tamilnadu Coast-Parangipettai
Phyllodocida	Pmpharetidae	<i>Melinna sp</i>	<i>gunneri</i> (Sars)	<i>Amphicteis gunneri</i> (Sars)	Tamilnadu Coast-Parangipettai Madras harbour
Phyllodocida	Trichobranchidae	<i>Amphicteis</i>	<i>stroemi</i> Sars	<i>Terebellides stroemi</i> Sars	Tamilnadu Coast-Parangipettai Madras harbour
Phyllodocida	Terebellidae	<i>Terebellides</i>	<i>Polymnia sp</i>	<i>Polymnia sp</i>	Tamilnadu Coast-Parangipettai Madras harbour
Phyllodocida	Terebellidae	<i>Polymnia sp</i>	<i>typha</i> Grube	<i>Pisa typha</i> Grube	Tamilnadu Coast-Parangipettai Madras harbour
Phyllodocida	Terebellidae	<i>Pisa</i>	<i>Loimia medusa</i> (Savigny)	<i>Loimia medusa</i> (Savigny)	Tamilnadu Coast-Parangipettai Madras harbour
Phyllodocida	Terebellidae	<i>Loimia</i>	<i>socialis</i> (Willey)	<i>Lanice socialis</i> (Willey)	Tamilnadu Coast-Parangipettai Madras harbour
Phyllodocida	Sabellidae	<i>Lanice</i>	<i>Chone sp</i>	<i>Chone sp</i>	Tamilnadu Coast-Parangipettai Off kakinada
Phyllodocida	Sabellidae	<i>Chone sp</i>	<i>indica</i> Southern	<i>Laonome indica</i> Southern	Tamilnadu Coast-Parangipettai
Phyllodocida	Sabellidae	<i>Laonome</i>	<i>Sabella sp</i>	<i>Sabella sp</i>	Tamilnadu Coast-Parangipettai Off kakinada
Phyllodocida	Sabellidae	<i>Sabella sp</i>	<i>cingulata</i> Grube	<i>Dasychone cingulata</i> Grube	Tamilnadu Coast-Parangipettai
Phyllodocida	Serpulidae	<i>Dasychone</i>	<i>vermicularis</i> Linnaeus	<i>Serpula vermicularis</i> Linnaeus	Tamilnadu Coast-Parangipettai
Phyllodocida	Serpulidae	<i>Serpula</i>	<i>enigmatica</i> Fauvel	<i>Mercierella enigmatica</i> Fauvel	Tamilnadu Coast-Parangipettai
Phyllodocida	Serpulidae	<i>Mercierella</i>	<i>albiceps</i> (Grube)	<i>Hydroides albiceps</i> (Grube)	Tamilnadu Coast-Parangipettai Off kakinada
Phyllodocida	Serpulidae	<i>Hydroides</i>	<i>homoceros</i> Pixell	<i>H.homoceros</i> Pixell	Tamilnadu Coast-Parangipettai
Phyllodocida	Serpulidae	<i>Hydrioides</i>	<i>heteroceros</i> (Grube)	<i>H.heteroceros</i> (Grube)	Tamilnadu Coast-Parangipettai Off kakinada

ORDER	FAMILY	GENUS	SPECIES	SCIENTIFIC NAME	LOCALITY
Phyllodocida	<i>Serpulidae</i>	<i>Hydrioides</i>	<i>tetraceros</i> (Schmarda)	<i>Spirobranchus tetraceros</i> (Schmarda)	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Serpulidae</i>	<i>Spirobranchus</i>	<i>Spirobarnchus sp</i>	<i>Spirobarnchus sp</i>	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Serpulidae</i>	<i>Spirobarnchus sp</i>	<i>kraussii</i> (Baird)	<i>Pomotoleios kraussii</i> (Baird)	Tamilnadu Coast-Parangipettai Off kakinada
Phyllodocida	<i>Serpulidae</i>	<i>Pomotoleios</i>	<i>triqueter</i> (Linnaeus)	<i>Pomatoceros triqueter</i> (Linnaeus)	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Serpulidae</i>	<i>Pomatoceros</i>	<i>caeruleus</i> (Schmarda)	<i>P.caeruleus</i> (Schmarda)	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Spirorbidae</i>	<i>Pomatoceros</i>	<i>foraminosus</i> Busch	<i>Spirorbis foraminosus</i> Busch	Tamilnadu Coast-Parangipettai
Phyllodocida	<i>Pholoidae</i>	<i>Spirorbis</i>	<i>Pholoe sp</i>	<i>Pholoe sp</i>	
Phyllodocida	<i>Pholoidae</i>	<i>Pholoe sp</i>	<i>Anaitides sp</i>	<i>Anaitides sp</i>	Off kakinada
Phyllodocida	<i>Pholoidae</i>	<i>Anaitides sp</i>	<i>Paranaitis sp</i>	<i>Paranaitis sp</i>	Off kakinada
Phyllodocida	<i>Hesionidae</i>	<i>Paranaitis sp</i>	<i>Hesionid sp</i>	<i>Hesionid sp</i>	
Phyllodocida	<i>Syllidae</i>	<i>Hesionid sp</i>	<i>Exogone sp</i>	<i>Exogone sp</i>	Off kakinada
Phyllodocida	<i>Syllidae</i>	<i>Exogone sp</i>	<i>Sphaerosyllis sp</i>	<i>Sphaerosyllis sp</i>	
Phyllodocida	<i>Nereidae</i>	<i>Sphaerosyllis sp</i>	<i>Neanthes sp</i>	<i>Neanthes sp</i>	
Phyllodocida	<i>Nereidae</i>	<i>Neanthes sp</i>	<i>orientalis</i>	<i>Tambalagamia orientalis</i>	Madras harbour
Phyllodocida	<i>Nephtyidae</i>	<i>Tambalagamia</i>	<i>oculate</i>	<i>Aglaophamus oculate</i>	Madras harbour
Phyllodocida	<i>Nephtyidae</i>	<i>Aglaophamus</i>	<i>anoculate</i>	<i>Aglaophamus anoculate</i>	Madras harbour
Phyllodocida	<i>Nephtyidae</i>	<i>Aglaophamus</i>	<i>Aglaophamus sp</i>	<i>Aglaophamus sp</i>	Madras harbour Off Bombay
Spionida	<i>Spionidae</i>	<i>Aglaophamus sp</i>	<i>cirrata</i>	<i>Laonice cirrata</i>	Madras harbour Off Bombay
Spionida	<i>Spionidae</i>	<i>Laonice cirrata</i>	<i>Megelona sp</i>	<i>Megelona sp</i>	Madras harbour
Canalipalpata	<i>Chaetopteridae</i>	<i>Megelona sp</i>	<i>Poecilochaetopterus sp</i>	<i>Poecilochaetopterus sp</i>	Madras harbour
Spionida	<i>Chaetopteridae</i>	<i>Poecilochaetopterus sp</i>	<i>Cirratulus sp</i>	<i>Cirratulus sp</i>	Madras harbour
Terebellida	<i>Flabelligeridae</i>	<i>Cirratulus sp</i>	<i>talehsapia</i>	<i>Brada talehsapia</i>	Madras harbour
Terebellida	<i>Ophelidae</i>	<i>Brada talehsapia</i>	<i>Ammotrypane sp</i>	<i>Ammotrypane sp</i>	Madras harbour
Scolecida	<i>Capitellidae</i>	<i>Ammotrypane sp</i>	<i>branchiatus</i>	<i>Leiochrides branchiatus</i>	Madras harbour
Capitellida	<i>Capitellidae</i>	<i>Leiochrides</i>	<i>Notomastus sp</i>	<i>Notomastus sp</i>	Madras harbour
Terebellida	<i>Capitellidae</i>	<i>Notomastus sp</i>	<i>Amphictene sp</i>	<i>Amphictene sp</i>	Madras harbour
Terebellida	<i>Capitellidae</i>	<i>Amphictene sp</i>	<i>Pista sp</i>	<i>Pista sp</i>	Madras harbour
Terebellida	<i>Sigalionidae</i>	<i>Pista sp</i>	<i>Leanira sp</i>	<i>Leanira sp</i>	Madras harbour

ORDER	FAMILY	GENUS	SPECIES	SCIENTIFIC NAME	LOCALITY
Aciculata	Sigalionidae	<i>Leanira</i> sp	Sthenolepis sp	Sthenolepis sp	Madras harbour
Aciculata	Amphinomidae	<i>Sthenolepis</i> sp	Chloeia sp	Chloeia sp	Madras harbour
Amphinomida	Amphinomidae	<i>Chloeia</i> sp	Linopherus sp	Linopherus sp	Madras harbour
Amphinomida	Amphinomidae	<i>Linopherus</i> sp	Notopygos sp	Notopygos sp	Madras harbour
Phyllodocida	Phyllodocidae	<i>Notopygos</i> sp	Eteone sp	Eteone sp	Madras harbour
Phyllodocida	Syllidae	<i>Eteone</i> sp	Exogone sp	Exogone sp	Madras harbour
Phyllodocida	Syllidae	<i>Exogone</i> sp	Pionosyllis sp	Pionosyllis sp	Madras harbour
Phyllodocida	Syllidae	<i>Pionosyllis</i> sp	Typosyllis sp	Typosyllis sp	Madras harbour
Nereidida	Nereididae	<i>Typosyllis</i> sp	Tylonereis sp	Tylonereis sp	Madras harbour
Aciculata	Nephtyidae	<i>Tylonereis</i> sp	lyrochaetus	Aglaophamus lyrochaetus	Madras harbour
Phyllodocida	Glyceridae	<i>Aglaophamus</i>	prashadi	Glycera prashadi	Madras harbour
Phyllodocida	Glyceridae	<i>Glycera</i>	teselata	Glycera teselata	Madras harbour
Phyllodocida	Goniadidae	<i>Glycera</i>	asiatica	Goniada asiatica	Madras harbour
Phyllodocida	Lumbrineridae	<i>Goniada</i>	Lumbrinereis	Lumbrinereis	Madras harbour
Phyllodocida	Lumbrineridae	<i>Lumbrinereis</i>	Protodorvillea sp	Protodorvillea sp	Madras harbour
Phyllodocida	Paraonidae	<i>Protodorvillea</i> sp	gracilis	Paraonis gracilis	Madras harbour
Phyllodocida	Spionidae	<i>Paraonis</i>	ehlersi	Prionospio ehlersi	Madras harbour
Terebellida	Cirratulidae	<i>Prionospio</i>	tentaculata	Cirriformia tentaculata	
Terebellida	Cirratulidae	<i>Cirriformia</i>	Cossurella sp	Cossurella sp	Madras harbour
Terebellida	Ampharetidae	<i>Cossurella</i> sp	Lysippe sp	Lysippe sp	Madras harbour
Sabellida	Serpulidae	<i>Lysippe</i> sp	arietina monilifera	Ditrupa arietina monilifera	Madras harbour
Aciculata	Sigalinidae	<i>Ditrupa</i>	japonica	Sthenolepis japonica	Off Bombay
Phyllodocida	Hesionidae	<i>Sthenolepis</i>	capensis	Gyptis capensis	Off Bombay
Phyllodocida	Pilargidae	Gyptis	Pilargis sp	Pilargis sp	Off Bombay
Phyllodocida	Ophelidea	Pilargis sp	Maldanella sp	Maldanella sp	Off Bombay
Phyllodocida	Hesionidae	Maldanella sp	Gyptis sp	Gyptis sp	
Phyllodocida	Hesionidae	Gyptis sp	Ophiodromus sp	Ophiodromus sp	Cochin harbour
Phyllodocida	Onuphidae	Ophiodromus sp	Onuphid sp	Onuphid sp	Cochin harbour
Phyllodocida	Onuphidae	Onuphid sp	Gyptis sp	Gyptis sp	Cochin harbour
Phyllodocida	Onuphidae	Gyptis sp	Ophiodromus sp	Ophiodromus sp	Cochin harbour
Phyllodocida	Onuphidae	Ophiodromus sp	Onuphid sp	Onuphid sp	Cochin harbour

**Short Communication****OCCURRENCE OF AMOLOPS ASSAMENSIS SENGUPTA ET. AL., 2008 (AMPHIBIA:ANURA:RANIDAE) AND POLYPEDATES ASSAMENSIS MATHEW AND SEN, 2009 (AMPHIBIA:ANURA:RHACOPHORIDAE) IN MEGHALAYA****INTRODUCTION**

The genus *Amolops* is represented by six species (*A. assamensis*, *A. formosus*, *A. gerbillus*, *A. marmoratus*, *A. monticola* & *A. viridimaculatus*) in North East India (Mathew & Sen, 2010). Sengupta et al. (2008) described *Amolops assamensis* from Assam. The author came across a total of three specimens of *Amolops assamensis* from the unidentified holding of NERC/ZSI, Shillong. Two specimens (V/A/ERS/ZSI/911) were collected from Mawshamok village, near the living root bridge in August, 2009 and one specimen (V/A/ERS/ZSI/901) was collected from Lawbah forest area, 13 kms ahead of Mawsynram, in March, 2010 from East Khasi Hills district of Meghalaya. (Plate-I & II)

These specimens were compared with two examples of *Amolops assamensis* available at the holdings of NERC/ZSI, Shillong, donated by S. Sengupta, for identification.

The genus *Polypedates* has six species (*P. assamensis*, *P. leucomystax*, *P. maculatus*, *P. megacephalus*, *P. subansiriensis* and *P. taeniatus*) in North East India. Mathew & Sen (2009) described *Polypedates assamensis* from a single specimen collected from Gerukamukh, near NHPC main gate, in Dhemaji district of Assam.

From the unidentified holdings of NERC/ZSI, Shillong, the author came across a male specimen (V/A/ERS/ZSI/914) of *Polypedates assamensis* which was collected from Mawsynram, near PWD IB, in March 2012 from East Khasi Hills district, Meghalaya. (Plate-III)

The holotype of *Polypedates assamensis* (V/A/ERSZSI/803) available at the holding of NERC/ZSI, Shillong was examined for identification. However, the specimen identified differs from the holotype in having 4 rows of light longitudinal bands along with spots (versus without longitudinal bands with prominent blotches) on the dorsum and creamy white color without any black blotches on the ventral side. Further collection of specimens will throw more light for these variations.

Occurrence of the above species in Meghalaya extends their range of distribution.

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PLATE - I



A. *Amolops assamensis* Sengupta et al.
Dorsal View



B. *Amolops assamensis* Sengupta et al.
Ventral View

PLATE - II



C. *Amolops assamensis* View of foot showing inner and outer metatarsals

PLATE - III



D. *Polypedates assamensis* Mathew & Sen
Dorsal View



E. *Polypedates assamensis* Mathew & Sen
Ventral View

**Short Communication****FIRST REPORT OF *THELYPHONUS SEPIARIS* (BUTLER, 1873)
(ARACHNIDA: UROPYGI: THELYPHONIDAE) FROM CHHATTISGARH,
CENTRAL INDIA**

The Uropygids, commonly referred as "Whip-scorpions" are moderately sized, tough and striking predators. They are easily separated from scorpions by the presence of a deep constriction between the cephalothorax and abdomen, by the absence of pectines and presence of a long thin multi-segmented whip-like tail instead of a broadly segmented metasoma bearing a poison gland at the tip. These creatures are uncommon and inhabitants of damp places in forests and found under stone, bark, decomposing wood, leaf litter or debris. A few of them excavate burrows for protection of their young (Pocock, 1900). They possess anal glands that they use to spray a chemical to dissuade their predators (Eisner *et al.* 1961). This neglected group has been studied in the past by Rowland and Cooke (1973). The Uropygids are known by 19 species of 6 genera from Indian subcontinent while globally this group contains 103 species under 16 genera (Harvey 2002, 2003).

In India, the Uropygids are so far reported from Assam, Karnataka, Meghalaya, Tamil Nadu and West Bengal (Pocock, 1900); Maharashtra (Bastawade, 1988); Andhra Pradesh (Javed *et al.*, 2009) and Madhya Pradesh (Talmale *et al.*, 2012).

During the course of faunistic survey in Amarkantak Biosphere Reserve (22° 15' to 22° 58' N Latitude and 81° 25' to 82° 5' E Longitude), dist Bilaspur, Chhattisgarh state in Central India, one example (male) of whip-scorpion was collected by Dr. Y.N.Gupta on 10th June from Jaldia village near Chaprwa. The locality harbours southern tropical dry deciduous forest mixed with scrub.

On closer examination the specimen was diagnosed as *Thelyphonus sepiaris* (Butler, 1873). (Plate-I). (Registration No. ZSI/CZRC/A/13893).

This species is endemic to the Oriental region and has been reported earlier from Chennai (formerly Madras) Tamil Nadu and Jaffna and Trincomalee in Sri Lanka (Pocock, 1900). Recently Javed *et al* (2009) have recorded it from different localities in Andhra Pradesh showing its extended distribution to the Eastern Ghats and Godavari river basin. The present record of this species from Central India indicates its wide range of distribution. The description of the specimen on hand perfectly matches with description provided for male by Javed *et al.* (2009) barring the number of segments of caudal flagellum (24 versus 33) and some other minor differences in measurements of body parts.



Fig.1 *Thelyphonus sepiaris* (Butler, 1873) (Arachnida: Uropygi: Thelyphonidae)

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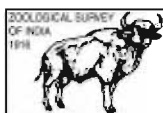
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Short Communication

A REPORT ON POPULATION SURVEY OF HANUMAN LANGURS IN THE DISTRICT OF MIDNAPORE, WEST BENGAL, INDIA

INTRODUCTION

Field Studies on the non-human primates of West Bengal have been carried out earlier by Southwick *et al.* (1964); Oppenheimer (1973); Bhuinya *et al.* (1993); Mukherjee *et al.* (1986); Chaudhuri *et al.* (2004) and Murmu *et al.* (2007). The primate species recorded in West Bengal are Rhesus macaque (*Macaca mulatta*), Assamese macaque (*Macaca assamensis*) and Hanuman langur (*Semnopithecus entellus*). The Assamese macaque is restricted in distribution only in Darjeeling district (Mukherjee *et al.* 1995, Murmu *et al.* 2004). Rhesus is found in the northern districts of West Bengal and Ajodhya hill of Purulia district (Chaudhuri *et al.* 2004, Chaudhuri *et al.* 2006). The Hanuman langur occurs throughout India except in north eastern India. Survey of Hanuman langur (*Semnopithecus entellus*) population of Midnapore district was conducted in 2000-2001, covering almost the entire area surveyed during the year 1978 (Tiwari and Mukherjee, 1992). Mukherjee *et al.* (1986) resurveyed the district selecting 20 langur groups from the population of 1978 survey by representing all the habitats of Midnapore district. The purpose of present survey was to collect information on distribution, abundance and social composition of hanuman langur and also to find out any changes that has occurred over a period of two decades in the district.

STUDY AREA

Midnapore, the largest district of West Bengal is situated 130 km west of Kolkata, and lies between 21°36'-22°57' N and 86°33'-86°11' E. This district is now divided into two separate districts but the field work was initiated before its bifurcations it was regarded as single district here. The total area of the district is about 14,000 km². The district is densely populated with 596 people per sq. km (1991 census) and the population is predominantly

rural. Kasai and Subarnarekha are the main rivers. Laterite soil is the predominant soil group at western part of the district whereas alluvial soil occupies in the eastern and southern parts. Forests occupy a large area of the west Midnapore and trees are mainly Sal (*Shorea robusta*) plantations, Eucalyptus (*Eucalyptus camaldulensis*) and Akashmoni (*Acacia auriculiformis*). Rice (*Oryza sativa*) is the main crop and other cash crops are Cashew nuts, Betel leaves, and Reeds for weaving mats.

METHODOLOGY

Observation reported here was carried out during August 2000 and repeated in July 2001 survey. Analysis of data based on July 2001 survey. The method of survey was similar to that of earlier census of 1978 (Tiwari and Mukherjee, 1992). The observation of langurs was done systematically by four experienced observers, two of them were the team members of the earlier surveys of 1978 and 1985. A slow moving vehicle was used and the areas were combed by using roads around villages, towns and open areas in prefixed localities. The areas included where the monkeys were recorded in 1978 census.

The road side transect 5 km² grids were adopted of the census in villages of agricultural and open areas. A total of 832 census hours were devoted of which 700 hours were spent in the areas of 1978 survey and another 132 hours in other areas for search of additional groups in adjacent areas. After locating the monkeys, their group size, social composition and interaction within the groups and man-monkey relation was recorded.

Individuals of a group were classified depending upon body size and age as adult male > 4 years; adult females > 3 years; juveniles 18-24 months old and infant less than 18 months old.

RESULT

A total of 7000 km² was surveyed which comprised of 50% of the total geographical area of Midnapore district. Forty nine (49) groups of Hanuman langur were recorded in 2001, whereas during 1978 census 58 groups were seen in the same area. There was an overall decline of 15.5 % in the number of groups and 10.9% decline in respect of langur population between 1978 and 2001 census. The group size varied from 4 to 45. The 49 groups consisted of 818 individuals of which 114 were adult males; 423 were adult females; 150 were juveniles and 131 infants (Table-1). The mean group size was 16.69 ± 1.21 (sd 8.4, df 48). This provides population estimate of 0.007 group/km² and 0.11 langur/km². The percentage composition of the population was 13.94% adult males; 51.72% adult females; 18.33 % juveniles and 16.01% infants. The adult males to adult females ratio was 1:3.71 and adult females to juveniles and infants ratio were 1:0.35 and 1:0.31 respectively. About 31% females were carrying infants. In five villages where 5 groups consisting of 85 langurs were sighted during 1978 survey were not found in the present survey. Three (3) all male bands and 1 group consisting of 2 females could not be traced out in the latest survey during this period. The mean density is shown in Fig-1.

During 1978 census a total of 58 groups with 919 langurs were sighted. Out of 58 groups 3 all male groups contained 25 individuals, one group contained only 2 females and one group of 20 unidentified sexes were recorded. So, the remaining 53 social groups contained 872 langurs of which 102 were adult males; 538 adult females; 159 juveniles and 73 infants (table-2). The ratio of adult males to adult females was 1:5.27 and adult females to juveniles and infants were 1:0.29 and 1:0.13 respectively. The adult males represented 11.7% in the population; adult females were 61.7%; juveniles' were 18.2% and infants were 8.4%. Only

13.5% females were recorded having infants in 1978 survey.

Surveys of 2001 and 1978 revealed that 39 groups of Hanuman langurs were observed common in both the occasions. Ninety five percent (95%) of the groups inhabiting in the villages and remaining 5% were observed in towns and forests. Six hundred and seventy (670) langurs recorded in 1978 survey while in 2001 this figure dropped to 653 (Table- 2). The mean group size of 653 langurs was 16.7 ± 1.3 and group size varied 6 to 45 individuals. The social compositions of these 653 langurs were 84 adult males; 341 adult females; 124 juveniles and 104 infants. The 670 langurs consist of 76 adult males; 414 adult females; 45 juveniles and 55 infants; with a mean group size 17.17 ± 1.45 langurs. The group size varied from 2 to 40 individuals.

The district was resurveyed in 1985, when twenty hanuman langur groups were selected from the 1978 survey to study the population change over the period (Mukherjee *et al* 1986). The common 20 groups of 1978 and 1985 surveys revealed that village contained 97% and 91%. langurs respectively. Out of 20 groups village groups were 18, 1 forest and 1 town group. The total population dropped from 299 to 286 langurs from 1978 to 1985. The mean group size of the two surveys calculated to be 14.95 ± 1.44 and 14.5 ± 1.78 respectively. No significant difference in the mean of the group size of these two census was noticed using Paired T-test (0.332) and Chi-Test (3.82, $P > 0.5$). In 1985 census the decline was recorded in male, female and juvenile population whereas the infant population showed a marked increased of 92%. In 1978, 16% females were with infants whereas in 1985, 35% females were having infants; the juveniles composition remained almost the same. The data collected during the present survey revealed that the same 20 groups contained 299 langurs which were also equal to the number of

Table-1. Hanuman langur population of Midnapore district, 1978 & 2001 census.

Year	No.of groups	Total	Male	Female	Juvenile	Infant
1978	58	872+47	102	538	159	73
2001	49	818	114	423	150	131

Table-2. 39 common groups of Hanuman langur of 1978 & 2001 survey.

Year	Total	Male	Female	Juvenile	Infant
1978	670	71	414	125	55
2001	653	84	341	124	104

DISCUSSION

Hanuman langur of Midnapore district was observed mostly inhabiting in and around villages. These langurs were reported to invade the agricultural field, caused damage to the crop. They cause considerable damage to vegetables with the result that at many places the villagers stopped producing vegetables. Villages have good number of trees and majority of roads in this district have big trees which provide shelter the langurs. The demographic pressure and loss to agricultural production by langurs increased considerably in the last two decades, no incidences of killing of langurs were have reported by the villagers in the present survey.

A comparative study of hanuman langur population of Midnapore district revealed no significant decline in population over two and half decades. In 1978 survey 58 groups consisting of 919 monkeys were recorded whereas during present survey in 2001, 818 langurs in 49 groups were found, showing the loss of 9 groups and 101 langurs. While comparing the population of 39 bisexual groups of hanuman langur from the first

survey of 1978 with that of present survey revealed that 95% of the groups inhabited in the villages and agricultural areas. There was no major difference in the total number of langurs of 1978 (670 langurs) and 2001 (653 langurs) surveys. The mean and standard error of the group size of two surveys of 1978 and 2001 were calculated 17.17 ± 1.43 and 16.74 ± 1.33 respectively. There was no significant difference in the mean of the groups size, chi-test was recorded to be 8.024, ($P < 0.5$). A decreasing trend was imminent in male-female ratio in 2001 as compared to 1978 survey, whereas the female-infant ratio has increased considerably. The female population has dropped by to 18% while the infant population increased over 95% in 2001 from 1978. The juveniles showed no change in population in the two surveys. In the last survey it was found that 30% female had infants as against 13% in 1978 survey.

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