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RECENT BENTHIC OSTRACODA FROM THE SEDIMENTS OF ENNORE CREEK, CHENNAI, TAMIL NADU, INDIA

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ABSTRACT

Micropalaeontological investigation has been carried out, for the first time to study the systematics of Recent Ostracoda from the Ennore Creek, north of Chennai, particularly in the view of the insufficient information on these tiny organisms from the marginal marine environments of the Indian subcontinent. In the creek, 20 sediment samples were collected during February, 2006. All the sediment samples were subjected to standard micropalaeontological techniques and ostracod fauna was retrieved. In the study area, a total of 30 species belonging to 24 genera, 15 families, 2 superfamilies and 2 suborders of Podocopida, have been identified. Of these, four species belong to Platycopa and the rest to Podocopa. An up-to-date synonymy along with remarks on the taxa has been given. All the species are illustrated with Scanning Electron Microscope photographs. From the zoogeographical distribution of the fauna of the study area, it is observed that the assemblage shows close affinity with the Indo-Pacific faunal province.

Keywords: Recent Ostracoda, Systematic Palaeontology, Zoogeographic distribution, Faunal province, Ennore Creek, Chennai

INTRODUCTION

The presence of two calcified valves known as carapace hinged together dorsally is the characteristic feature of Ostracods, the microcrustacean. They occur in almost all types of aquatic environment, including marine (from deep oceans to shallow seas), brackish water lagoons, estuaries/creeks, mangroves and even freshwater streams, lakes, etc. Ostracods generally live in a marine environment in which the controlling factors are temperature, bottom topography, depth, salinity, dissolved oxygen, substrate, food supply and sediment organic matter content (Puri, 1966). Despite, the major controlling factors in estuarine and continental shelf environments are salinity, water temperature and substrate (Yassini and Jones, 1995). A thorough literature survey on Recent Ostracods reveals that they are little known from coastal margin of the Indian subcontinent (about 7,500 km length). Bhatia (1984) reviewed the Lower Paleozoic to Quaternary Ostracod fauna of India. A detailed checklist of Recent Ostracods from the east and west coasts of India was presented by Hussain and Rajeshwara Rao (1996).

From the coast of Tamil Nadu, there is some work pertaining to the systematics, distribution and ecology of Recent marine Ostracods (length of the coastline about 1076 km) (Misra and Shrivastava, 1979; Hussain, 1998; Hussain *et al.*, 1996a, 1996b, 1998, 2003, 2004; Mohan *et al.*, 2001, 2002; Sridhar *et al.*, 2002). Albeit, the research work with regard to brackish water ostracods from estuary, creek, lagoon and back water environments of this coast is scanty and still in infancy but for these few papers (Kumar and Hussain 1997; Hussain and Mohan 2000, 2001; Arul *et al.*, 2003; Hussain *et al.*, 2005). The present study has been taken up for the first time to elucidate the systematics and zoogeographic relationship of the ostracod fauna from the Ennore creek, north of Chennai.

STUDY AREA AND MATERIALS

The study area under investigation is the creek (13°12'52" - 13°14'43" N and 80°18'32" - 80°19'50 E) of Ennore, Chennai, Tamil Nadu. The region is basically an agricultural area with paddy as the main crop. Apart from the agriculture, marine-based salt panning, fishing and aquaculture are the main professions of the area. The major part of the area consists of alluvial tracts and the remaining, in the eastern part, is occupied by beach dunes, tidal flats and creek. The depth of the creek ranges from 0.5 to 6 m and is shallow near the mouth and on northwestern part merging with the tidal flats. Mangrove swamps are noticed in the area. Due to the depletion of flow of fresh water in the creek, the growth of the mangrove vegetation is deteriorating. The Kosisthalaiar and Kortalaiar Rivers which pass through and also Araniar River that passes north of the study area, are the two main sources for agriculture. The Kortalaiar drains into the backwaters and ultimately reaches the sea through the Ennore creek. The Araniar and Kortalaiar rivers influence the alluvial tract of the area. It is interesting to note that both the rivers do not reach the sea directly but, on the other hand, confluence with brackish water bodies. The Buckingham canal, which runs north south to northeast-southwest, has been constructed along the coast.

The bottom sediment samples were collected from 20 stations during February, 2006 from the Ennore Creek (Fig.1). The sample collection was made by using motor boat with the help of Vanveen grab and GPS (Magellan's eXplorist 500) was used to record the geographical co-ordinates (13°12'52" - 13°14'53" N and 80°18'32"- 80°19'50 E) (Table.1). To obtain lucid illustrations, microphotographs of different views of all the ostracod species were taken using a Scanning Electron Microscope (JEOL JSM-6360) of the Department (Plates I&II).

SYSTEMATIC PALAEONTOLOGY

The classification proposed by Hartmann and Puri (1974) has been followed in the present study through which 30 ostracod taxa (Table 2) belonging to 24 genera, 15 families, 2 superfamilies, and 2 suborders of the order Podocopida have been identified by referreing to standard and relevant publications. Among these, 4 species belong to suborder Platycopa and the remaining to suborder Podocopa. For the sake of brevity, "Synonomy" and "Remarks" for all the taxa have been given.The specimens illustrated in this paper are deposited in

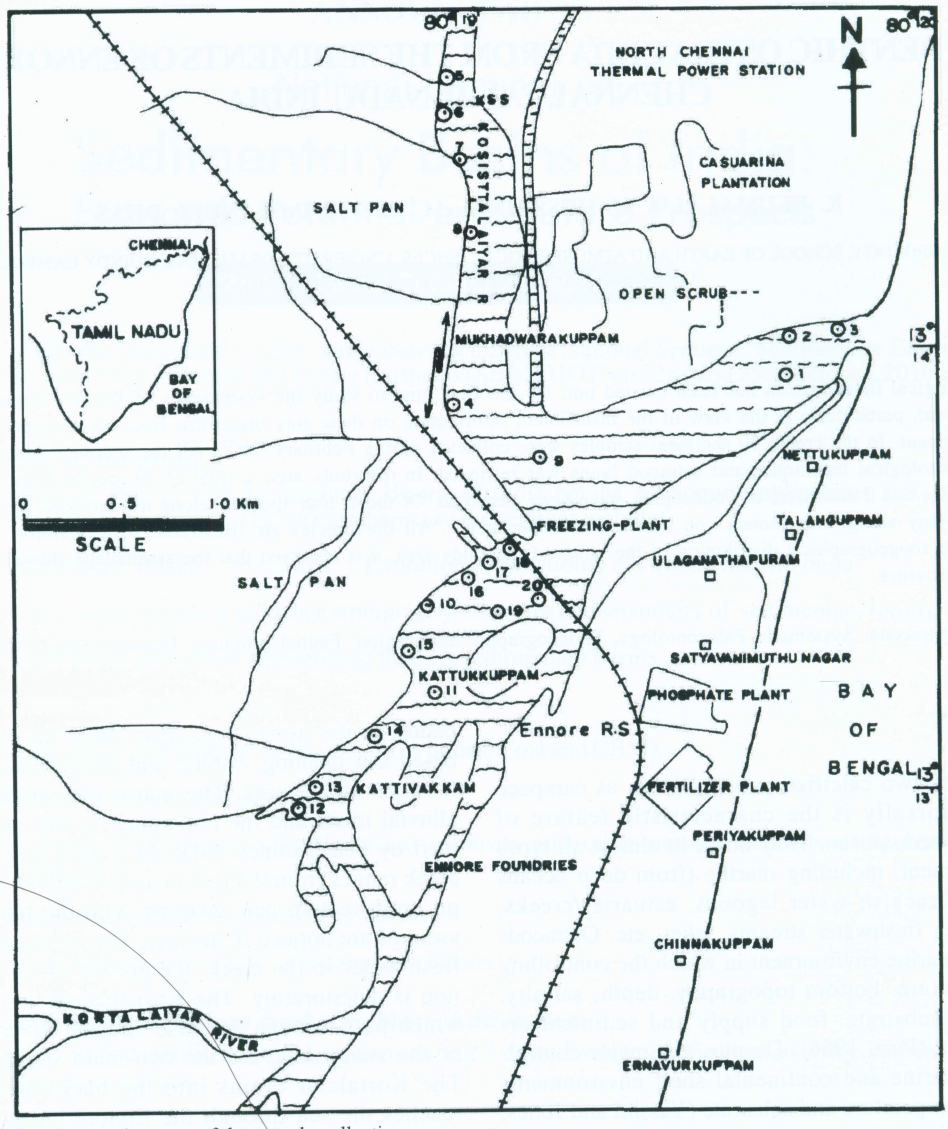

Fig. 1. Location map of the sample collection.

Table 1: Geographic locations of sampling stations.

Sample No	Latitude	Longitude	Depth in meters
1	13° 13' 55" N	80° 19' 43" E	2.0
2	13° 14' 07" N	80° 19' 43" E	2.5
3	13° 14' 04" N	80° 19' 50" E	6.0
4	13° 13' 52" N	80° 19' 06" E	4.0
5	13° 14' 43" N	80° 18' 52" E	1.5
6	13° 14' 38" N	80° 18' 50" E	1.0
7	13° 14' 24" N	80° 18' 55" E	2.0
8	13° 14' 15" N	80° 18' 52" E	1.5
9	13° 13' 43" N	80° 19' 11" E	2.5
10	13° 13' 20" N	80° 18' 47" E	2.5
11	13° 13' 04" N	80° 18' 47" E	0.5
12	13° 12' 52" N	80° 18' 38" E	1.2
13	13° 13' 01" N	80° 18' 38" E	1.2
14	13° 13' 10" N	80° 18' 39" E	1.2
15	13° 13' 17" N	80° 18' 41" E	1.0
16	13° 13' 31" N	80° 18' 56" E	0.5
17	13° 13' 40" N	80° 18' 41" E	0.5
18	13° 13' 42" N	80° 18' 32" E	0.5
19	13° 13' 19" N	80° 19' 04" E	1.5
20	13° 13' 32" N	80° 19' 04" E	2.0

the museum of the Department of Geology, University of Madras, Chennai.

Subclass **Ostracoda** Latreille, 1806

Order **Podocopid** G. W. Muller, 1894

Suborder **Platycopa** Sars, 1866

Family **Cytherellidae** Sars, 1866

Genus ***Cytherella*** Jones, 1849

Cytherela sp. cf. *semitalis* Brady

(Pl. I, fig.1)

Cytherella semitalis - Brady, 1868, p.72, pl.8, figs.23-24; -Kingma, 1948, p.63, pl.6, fig.6; - Jain, 1978, pp. 90-91, fig.2a.

Remarks: This species was originally reported from Java and subsequently reported from the Malayan region. From Indian region, Jain (1978) has reported for the first time from Mandvi beach, west coast of India.

Material: In all, 9 specimens were encountered; All carapaces.

Hypotype: Length 0.61 mm, height 0.32 mm.

Genus ***Cytherelloidea*** Alexander, 1929

Cytherelloidea leroyi Keij

(Pl. I, fig.2)

Table. 2: Check-list of the ostracoda fauna encountered in the Ennore creek.

S. No	Name of the Species	F	EC	WC	IP
1	*Cytherella sp. cf. semitalis (Brady)*	C	X	X	X
2	*Cytherelloidea leroyi (Keij)*	C	X	X	X
3	*Cytherelloidea sp.1*	C	X		
4	*Cytherelloidea sp.2*	R	X		
5	*Hemicytheridea bhatiai (Varma)*	A	X		
6	*Hemicytheridea khoslai (Hussain et al)*	C	X		
7	*Hemicytheridea paiki (Jain)*	C	X	X	X
8	*Neomonoceratina iniqua (Brady)*	A	X	X	X
9	*Neomonoceratina jaini (Varma)*	C	X		
10	*Neomonoceratina porocostata (Howe and McKenzie)*	A	X		X
11	*Neosinocythere dekrooni (Kingma)*	C	X		X
12	*Jankeijcythere mcKenziei (Annapurna and Rama Sarma)*	C	X	X	
13	*Callistocythere flavidofusca intricatoides (Ruggieri)*	C	X	X	X
14	*Tanella gracilis (Kingma)*	A	X		X
15	*Hemikrithe peterseni (Jain)*	C	X	X	X
16	*Cyprideis sp. cf. mandviensis (Jain)*	A	X	X	
17	*Stigmatocythere indica (Jain)*	A	X	X	X
18	*Keijella reticulata (Whatley and Quanhong)*	C	X	X	X
19	*Lankacythere reticulata (Ganesan et al)*	R	X		
20	*Basslerites liebaui (Jain)*	A	X	X	
21	*Mutilus pentoekensis (Kingma)*	C	X	X	X
22	*Caudites javana (Kingma)*	A	X	X	X
23	*Indet Genus et sp. A*	R	X		
24	*Neocytheretta murilineata (Zhao and Whatley)*	C	X		X
25	*Loxoconcha megapora indica (Benson and Maddocks)*	A	X	X	X
26	*Paradoxostoma bhatiai (Shyam Sunder)*	C	X	X	
27	*Kalingella mckenzii (Jain)*	A	X		
28	*Propontocypris (Schedopontocypris) bengalensis (Maddocks)*	C	X	X	
29	*Phlyctenophora orientalis (Brady)*	C	X	X	X
30	*Cyprinotus salinus (Brady)*	C	X	X	

R:Rare 0-5 specimensC:Common 6-15 specimens ; A:Abundant>15specimens

F-Frequency; EC-East Coast; WC-West Coast; IP-Indo-Pacific Area

Cytherelloidea leroyi - Keij, 1964, p.421, pl.2, figs.1-4; - Whatley and Quanhong, 1987, pp.334-335, pl.1, figs.15-18 - Vaidya and Mannikeri, 1994, pp.735-738; - Naidu et al., 1997, p.728, pl.2, fig.7; - Hussain, 1998, p.2, pl.1, fig.1; -Hussain and Mohan, 2000, p.26, pl.1, fig.1-2;

Remarks: C. leroyi was first recorded by Keij (1964) from northwest Borneo. According to him (op.cit) this species is very common on the Recent sea bottom of Brunei and Sabah, in waters ranging from several metres to about 100 m depth. Material: In all, 14 specimens were encountered out of which 2 are living; 12 carapaces and 2 open valves.

Hypotype: Length 0.50 mm, height 0.32 mm.

Cytherelloidea sp.1

(Pl. I, fig.3)

Description: The laterally compressed, medium-sized carapace is rectangular in lateral view. The anterior end is broadly rounded and posterior end is slightly narrowly rounded. The dorsal margin is almost straight. The ventral margin is slightly concave. A marginal ridge runs along the dorsal, anterior and ventral peripheries. Parallel to the marginal ridge there is a second ridge, which joins the marginal ridge along the dorsal margin. The surface is ornamented with several subrounded reticules. The reticules have somewhat deep fossae. All the other internal features are as for the genus. Sexual dimorphism is prominent.

Material: In the study area, 7 specimens were encountered. All are carapaces.

Hypotype: Length 0.56 mm, height 0.25 mm.

Cytherelloidea sp.2

(Pl. I, fig.4)

Description: The medium-sized laterally compressed carapace is subovate to subrectangular in lateral view. The anterior end is broadly rounded and posterior end is slightly narrowly rounded. The dorsal margin is almost straight. The ventral margin is slightly concave. A marginal ridge runs along the anterior periphery. At the posterior end brood pouches are seen. The remaining surface is smooth. All the other internal features are as for the genus. Sexual dimorphism is prominent. Material: In the study area, 5 specimens were encountered. All are carapaces.

Hypotype: Length 0.59 mm, height 0.28 mm.

Suborder **Podocopa** Sars, 1866

Superfamily **Cytheracea** Baird, 1850
Family **Cytheridae** Baird, 1850
Subfamily **Cytherinae** Baird, 1850
Genus ***Hemicytheridea*** Kingma, 1948
Hemicytheridea bhatiai Varma, Shyam Sundar and Naidu
(Pl. I, fig.5)

Hemicytheridea bhatiai Varma et al., 1993, pp.554-555, pl-I, figs.1-4;- ShyamSunder et al., 1995, p.473;- Kumar and Hussain, 1997, p.132, pl. 1, fig. 1;- Arul et al., 2003, pp.64-65, pl. 2, fig. 1-3.

Remarks: H. bhatiai is reported originally from Tekkali Creek (Varma et al., 1993). This species appear to be a typical brackish water species and appears endemic to east coast of India.
Material: In all, 17 specimens were found, of which 3 are living; 16 carapaces and 1 open valve.

Hypotype: Length 0.55 mm, height 0.30 mm.

Hemicytheridea khoslai Hussain *et al.*
(Pl. I, fig.6)

Hemicytheridea khoslai - Hussain et al., 1998, pp.23-24, pl.1, fig.M.

Remarks: The present species is somewhat similar to H. reticulata Kingma (1948), but differs in the larger size of the carapace, in possessing thicker ridges and smaller reticules, in having more number of anterior marginal denticles and also truncated posterior end instead of a subrounded posterior margin as seen in the latter.
Material: In all, 10 specimens were found, of which 3 are living; 10 carapaces.

Hypotype: Length 0.74 mm, height 0.30 mm.

Hemicytheridea paiki Jain
(Pl. I, fig.7)

Hemicytheridea paiki Jain, 1978, pp.94-95, figs. 2F1-4, 6A;- 1981, p. 108, pl. I, fig. 7; - Vaidya and Mannikeri, 1994, p. 736;- Kumar and Hussain, 1997, p.132, pl. 1, fig. 2;

Remarks: *H. paiki* was originally reported from the beach sands of Mandvi by Jain (1978). This species appears to be somewhat similar to H. portjacksonensis Mckenzie (1967) but differs in being bigger in size, in lacking the transverse depression in the muscle scar region and the vestibula. This species also occurs in the Persian Gulf (Paik, 1976, 1977).

Material: In all, 12 specimens were found, of which 3 are living; 10 carapaces and 2 valves.

Hypotype: Length 0.64 mm, height 0.30 mm.

Genus ***Neomonoceratina*** Kingma, 1948
Neomonoceratina iniqua (Brady)
(Pl. I, figs.8-9)

Cytherura iniqua - Brady, 1868, Ostracoda.Les Fonds dela Mer., p.64, pl.8, figs.3-6.

Neomonoceratina iniqua (Brady) - Whatley and Quanhong, 1987, pp.339-340, pl.2, fig.21;- Zhao and Whatley, 1988, pp.566-567, pl.1, figs.7-12;-Nasser Mostafawi,1992, p.138, pl.I, fig.21;- Varma et al., 1993, p.554;- Vaidya and Mannikeri,1994, pp.735-738;- Shyam Sunder et al.,1995, p.473;- Kumar and Hussain, 1997, p.133, pl.1, fig.4;- Hussain, 1998, p.4, pl.1, fig.11;- Hussain and Mohan, 2000, p.26, pl.1, fig.5;- Mohan *et al.*, 2001 p.8, pl.1, fig.6-7;- Sridhar et al., 2002, pp. 20-22, pl.1, fig.11-12;- Anil Bhandari and Singh, 2006, p.660, pl.2, fig.1,2.

Remarks: The original description for this species was given by Brady (1868) who reported it as *Cytherura iniqua*. *Neomonoceratina iniqua* (Brady) has been widely reported from various localities including Batavia, Java (Brady, 1868).

The genus *Neomonoceratina* was first erected by Kingma (1948) in his studies from the Indonesian region. More than 30 species of this genus have been recorded since then from several tropical and subtropical localities worldwide (Zhao and Whatley, 1988).

Material: In all, 18 specimens were found; out of these, 2 are found in living condition in the creek; 14 carapaces and 4 valves.

Hypotype: Length 0.59 mm, height 0.31 mm.

Neomonoceratina jaini Varma, Shyam Sunder and Naidu
(Pl. I, figs.10-12)

Paijenborchella sp. - Jain, 1978, p.96, fig.2H.

Neomonoceratina jaini - Varma *et al.*, 1993, p.555, pl. I, figs.5-8; - Hussain, 1998, p.4, pl.1, fig.12; - Mohan *et al.*, 2001 p.8, pl.1, fig.8.

Remarks: *Neomonoceratina jaini* is conspecific with *Paijenborchella* sp. Jain, 1978, and it is close to *Neomonoceratina cambayensis* Guha, 1979 in shape, outline and nature of the caudal process but differs in size, surface ornamentation and pronounced overlapping. Recent Indian occurrences include those of Varma *et al.* (1993) from the Tekkali creek,

Material: In all 12 specimens were found; out of these, 2 are found in living condition in the creek; 11 carapaces and one valve.

Hypotype: Length 0.48 mm, height 0.22 mm.

Neomonoceratina porocostata Howe and McKenzie

EXPLANATION OF PLATE I

(Bar scale equals 100 μm unless specified)

Fig.1 ***Cythrella*** cf. ***semitalis***-Carapace, left valve, external view (Upside down).
Fig.2 ***Cytherelloidea leroyi*** - Carapace, left valve, external view.
Fig.3 ***Cytherelloidea*** sp.1 - Left valve, external view.
Fig.4 ***Cytherelloidea sp.2*** - Left valve, external view.
Fig.5 ***Hemicytheridea bhatiai*** - Carapace, left valve, external view.
Fig.6 ***Hemicytheridea khoslai*** - Carapace, right valve, external view (broken).
Fig.7. ***Hemicytheridea paiki*** - Carapace, right valve, external view.
Figs.8-9 ***Neomonoceratina iniqua***
Fig.8 Male Carapace, right valve, external view.
Fig.9 Female Carapace, left valve, external view.
Figs.10-12 ***Neomonoceratina jaini***
Fig.10 Carapace, left valve, external view.
Fig.11 Right valve, internal view.
Fig.12 Enlargement of hinge structure.
Fig.14 ***Neomonoceratina porocostata*** -Carapace, left valve, external view.
Figs.13 ***Neosinocythere dekrooni*** 17-19
Fig.13 Female Carapace, right valve, external view.
Fig.17 Enlargement of tubercles (surface ornamentation).
Fig.18 Male Carapace, left valve, external view.
Fig.19 Enlargement of ridge and reticulate ornamentation.
Figs.15-16 ***Jankeijcythere mckenziei***
Fig.15 Male Carapace, right valve, external view.
Fig.16 Female Carapace, left valve, external view.
Fig.20 ***Callistocythere flavidofusca intricatoides*** - Carapace, right valve, external view.

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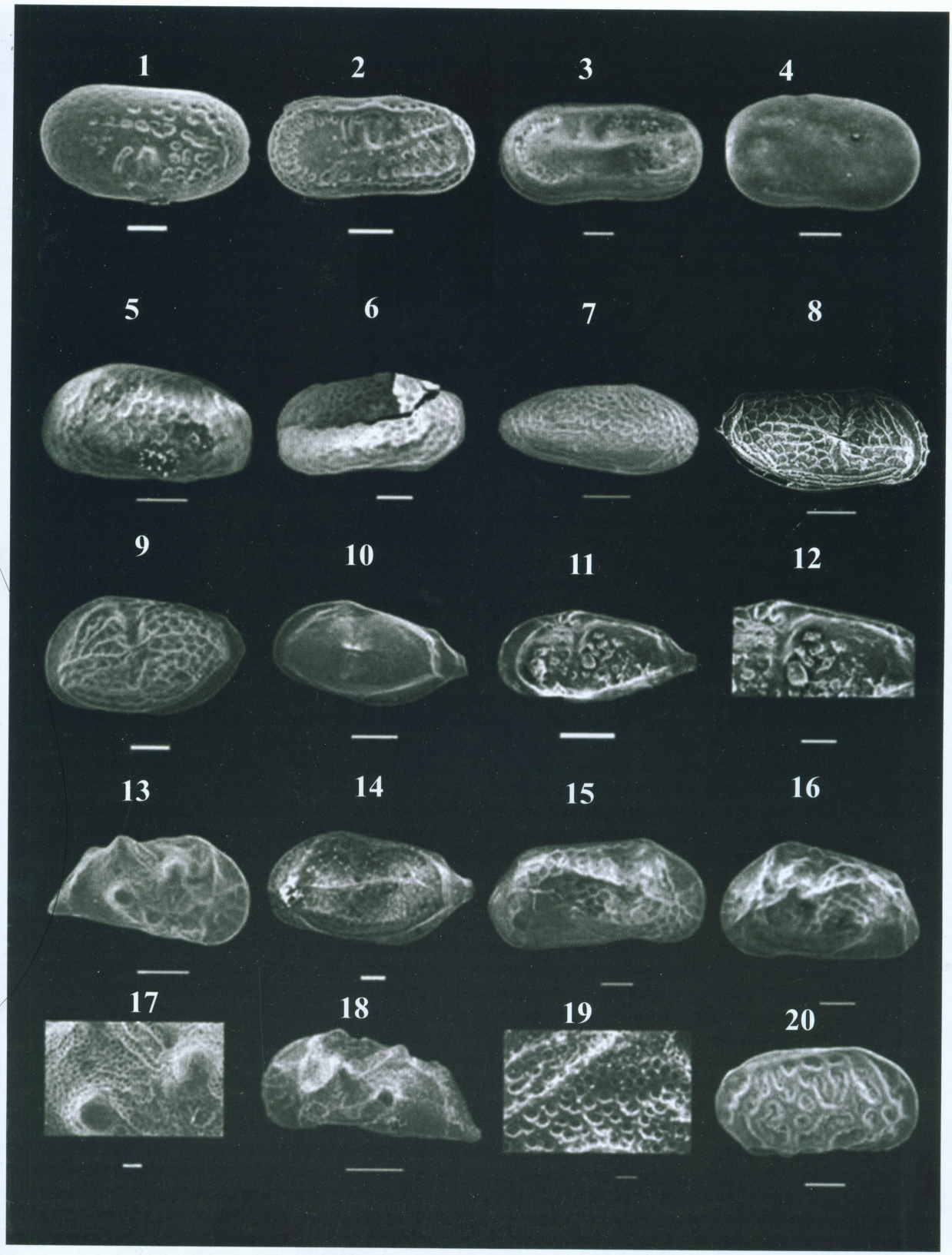
Plate I



(Pl.I, fig.14)

Neomonoceratina porocostata - Howe and McKenzie, 1989, pp.12-14, figs.60-61; - Shyam Sunder *et al.*, 1995, p.473; - Hussain, 1998, pp.4-5, pl.1, fig.13; - Hussain and Mohan, 2000, p.26, pl.1, fig.6; - Mohan *et al.*, 2001 p.8, pl.1, fig.9;

Remarks: This species was first described and illustrated by Howe and McKenzie (1989) from the Recent sediments of Darwin and north-western Australia. Hussain (1998) recorded this taxon for the first time from the Indian waters, off Tuticorin, in the Gulf of Mannar. Later, it was also reported by Sridhar *et al.* (2002) from the bottom sediments of the Palk Bay, off Rameswaram.

Material: In all, 16 specimens were found; out of these, 1 is in living condition; 15 carapaces and 1 open valve.

Hypotype: Length 0.43 mm, height 0.27 mm.

Family **Sinocytheridae** Huang, 1985

Genus ***Neosinocythere*** Huang, 1985

Neosinocythere dekrooni (Kingma)

(Pl.I, figs.13, 17-19)

Cythereis dekrooni Kingma, 1948.

Neosinocythere dekrooni (Kingma) Zhao and Whatley, 1989, pp. 243-244, pI. 4, figs. 9-12;- Varma et al., 1993, p. 557, pI. 1.2, figs. 1-3; Shyam Sunder et al., 1995, p.473;- Kumar and Hussain, 1997, p. 133, pl. I, figs. A-B; - Arul et al., 2003, pp.65-66, pl. 2, fig. 9.

Remarks: *N. dekrooni* was originally reported by Kingma (1948) as *Cytheresis dekrooni* from the Malayan region. Later, Zhao and Whatley (1989b) while revising the species described by Kingma (1948), shifted this species to the genus Neosinocythere Huang. From Indian waters, this species is reported only from brackish water environments (Varma *et al.*, 1993 and Shyam Sunder *et al.*, 1995).

Material: In all, only 6 specimens were found; 5 carapaces and 1 open valve.

Hypotype: Length 0.43 mm, height 0.22 mm.

Subfamily **Perissocytherideinae** Van den Bold,1963

Genus ***Jankeijcythere*** McKenziei

Jankeijcythere mcKenziei (Annapurna and Rama Sarma)

(Pl.I, figs.15-16)

Jankeijcythere mckenziei (Annapurna and Rama Sarma) Varma *et al.*, 1993, p.554; -Vaidya and Mannikeri, 1994, p.736; - Kumar and Hussain, 1997, p. 133, pl. I, figs. A-B; - Arul *et al.*, 2003, pp.65-66, pl. 2, fig. 9.

Remarks: This species is characterized by its ornamentation with tubercles and subrounded fossae. Tubercles are also having fossae, remaining surface is finely pitted and smooth.

Material: A total of 11 specimens were encountered; all are carapaces.

Hypotype: Length 0.63 mm, height 0.29 mm.

Family **Leptocytheridae Hanai**, 1957

Genus ***Callistocythere*** Ruggieri, 1953

Callistocythere flavidofusca intricatoides Ruggieri

(Pl.I, fig.20)

Callistocythere sp. cf. *flavidofusca intricatoides* (Ruggieri)- Paik, 1976, p.35, pl.2, figs.32-34; - 1977, p.40, pl.2, figs.32-34;- Jain, 1978, p.96, fig.2I1-2; - Hussain, 1998, p.6, pl.1, fig.17;- Hussain and Mohan, 2000, p.26, pl.1, fig.9.

Remarks: *C. flavidofusca intricatoides* (Ruggieri) is characterised by its ornamentation in the form of irregularly reticulate ridges and the presence of a ridge that runs from the anterodorsal to posteroventral region. The genus *Callistocythere* was originally erected by Ruggieri (1953) as a subgenus to Leptocythere. Subsequently, it was raised to generic status by Hanai (1957). Callistocythere spp. are much more common in warmer, marine waters.

Material: In all, 7 specimens are only present and all are carapaces. No living forms and open valves.

Hypotype: Length 0.51 mm, height 0.29 mm.

Genus *Tanella* Kingma, 1948

Tanella gracilis Kingma

(Pl. II, fig.1)

Tanella gracilis - Kingma, 1948, pp.87-89, pl. X, fig.7; - Kumar and Hussain, 1997, pp.133-134, pl.1, fig.7;- Hussain and Mohan, 2000, p.26, pl.1, fig.10;- Mohan et al., 2001 p.8, pl.1, fig.18;- Sridhar *et al.*, 2002 p.23, pl.II, fig.2;

Remarks: *T. gracilis* was first described and illustrated by Kingma (1948) from the Malayan region, but is widely distributed in the Indo-Pacific and has also been recorded from the Atlantic and Caribbean. This species has also been recorded from many areas like Australia, Gulf of Oman, as well as west and east coasts of India (Hartmann, 1978; Paik, 1976, 1977; Jain, 1976, 1978; Varma *et al.*, 1993, Shyam Sunder *et al.*, 1995; Hussain *et al.*, 1996a; Sridhar, 1996). Whatley and Quanhong (1988) recorded this taxon from the Malacca Straits.

Jain (1978) recorded T. gracilis from the Mandvi beach and remarked, "This well known species is represented in our material by carapaces of two different types. These are (i) carapaces (Figs.2J1-3) which are almost identical in shape and ornament with the species described by Kingma (1948) and (ii) specimens (Fig.2J4) which have a more arched dorsum, a more

EXPLANATION OF PLATE II

(Bar scale equals 100 µm unless specified)

Fig.1 ***Tanella gracilis*** -Carapace, right valve, external view.
Fig.2 ***Hemikrithe peterseni*** - Carapace, left valve, external view.
Figs.3-4 ***Cyprideis*** sp.cf. ***C. mandviensis***
Fig.3 Carapace, left valve, external view.
Fig.4 Right valve, internal view.
Figs.5-6 ***Stigmatocythere indica***
Fig.5 Carapace, right valve, external view.
Fig.6 Dorsal view.
Figs.7-8 ***Keijella reticulata***
Fig.7 Carapace, Left valve, external view (Juvenile).
Fig.8 Carapace, Right valve, external view (Adult).
Figs.9 ***Lankacythere*** sp.- Carapace, Left valve external view (broken).
Fig.10 ***Basslerites liebaui*** - Carapace, right valve, external view.
Fig.11 ***Mutilus pentoekensis*** - Carapace, Left valve, external view.
Fig.12 ***Caudites javana*** - Carapace, left valve, external view.
Fig.13 Indet genus et sp.A - Carapace, Right valve, external view.
Fig.14 ***Neocytheretta murilineata*** - Carapace, right valve, external view.
Fig.15 ***Loxoconcha megapora indica*** - Carapace, left valve, external view.
Fig.16 ***Paradoxostoma bhatiai*** - Carapace, left valve, external view.
Fig.17 ***Kalingella mckenziei*** -Carapace, right valve, external view.
Fig.18 ***Propontocypris*** (***Schedopontocypris***) ***bengalensis***- Carapace,left valve, external view.
Fig.19 ***Phlyctenophora orientalis*** - Carapace, left valve, external view.
Fig.20 ***Cyprinotus salinus*** - Carapace, left valve, external view.

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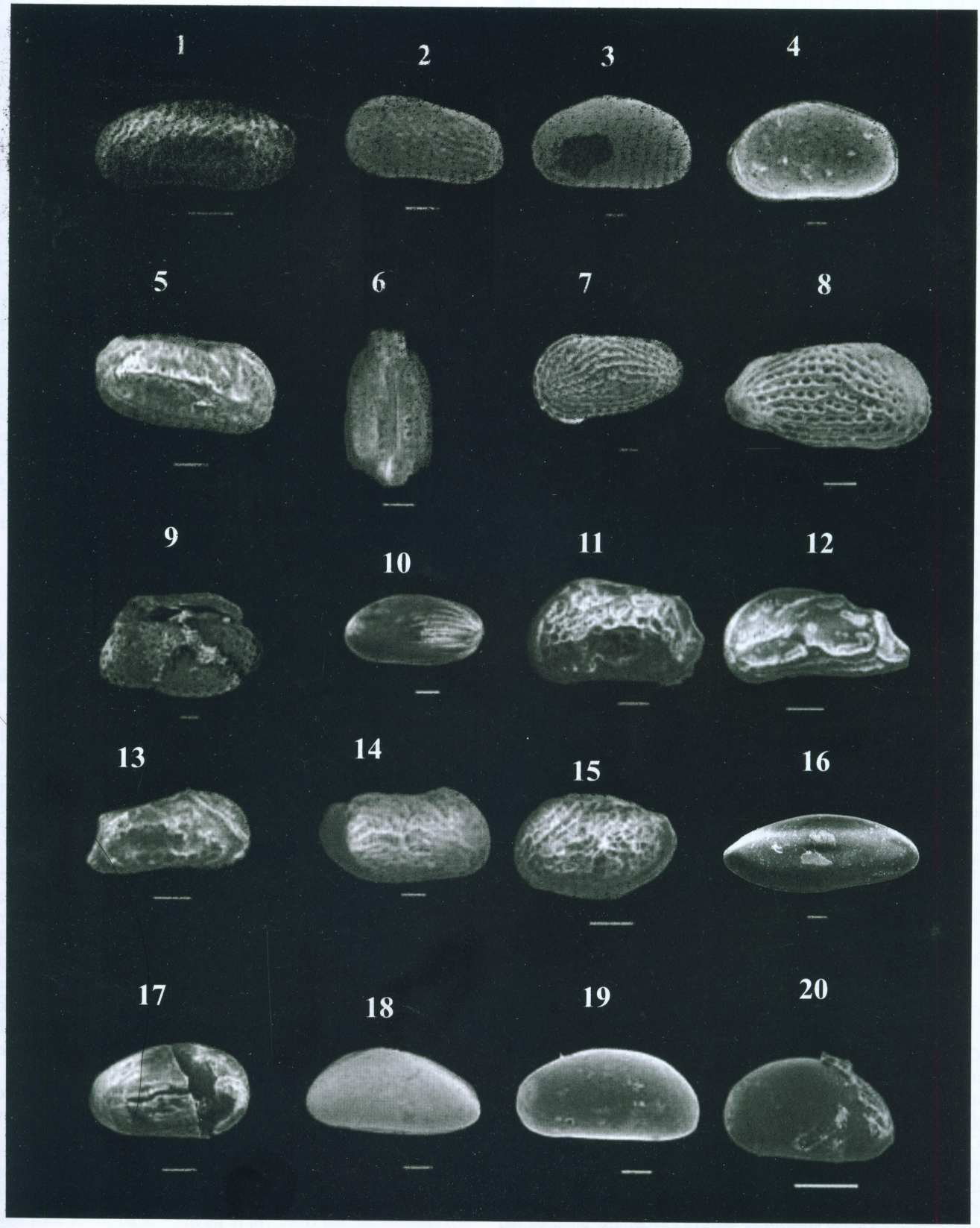
Plate II



sinuate venter and a somewhat different nature of surface ornament". Hartmann (1978) found exactly similar variants of *Tanella gracilis* from the Australian region and assigned them to the same species on the basis of the soft parts. He also pointed out that such a variation in ornamentation may be due to environmental factors. Sridhar (1996) observed different types of carapaces in the Palk Bay material. Similar observations were made by Jain (1978). In their studies on Recent Ostracoda from the Tekkali Creek, Varma *et al.* (1993) considered *Tanella estuarii*, *T. kingmai*, *T. indica* and *T. vasistha* Annapurna and Rama Sarma (1987) to be conspecific with *T. gracilis*.

Material: This is one of the widespread and persistent taxa in the Ennore creek. A total of 25 specimens were encountered of which 13 are living; 18 carapaces and 7 valves.

Hypotype: Length 0.46 mm, height 0.21 mm.

Family **Krithidae** Mandelstam, 1960

Genus ***Hemikrithe*** van den Bold, 1950

Hemikrithe peterseni Jain

(Pl.II, fig.2

Hemikrithe sp. A Paik, 1976, p.45, pl.3, figs.48-50, text-figs.18-19; 1977, p.40, pl.3, figs.48-50; pl.8, fig.154.

Hemikrithe peterseni - Jain, 1978, p.101 and p.104, figs.3B1-2, 6E; 1981, pl.1, fig.16; - Hussain, 1998, p.8, pl.2, fig.4; - Mohan *et al.*, 2001, p.8, pl. II, fig.1.

Atjehella karwarensis - Honnappa and Abrar, 1984, p.499, pl.2, fig.9.

Remarks: This species was originally described and illustrated by Paik (1976, 1977) from the Persian Gulf as *Hemikrithe* sp. A. Later, it was reported as H. peterseni by Jain (1978) from the Mandvi beach, Kutch, Gujarat. This taxon has also been reported by Whatley and Zhao (1988) from the Malacca Straits and by Vaidya (1993) from the Karwar area. Subsequently, it has been recorded by Hussain (1996 b) and Mohan *et al.* (2001) from the inner shelf sediments off Tuticorin and Chennai respectively.

H. peterseni Jain is distinguished from *H.orientalis* van den Bold (1950) in the overall shape of the carapace, in the general absence of ornament and in possessing a peripheral selvage throughout. *Atjehella karwarensis* described by Honnappa and Abrar from the west coast of India is conspecific with *H. peterseni.*

Material: In the study area, 9 specimens were found, of which 3 are living; All are carapaces.

Hypotype: Length 0.43 mm, height 0.21 mm.

Family **Cytherideidae** Sars 1925

Subfamily **Cytherideidae** Sars 1925

Genus ***Cyprideis*** Jones, 1857

Cyprideis sp. cf. *mandviensis* Jain

(Pl.II, figs.3-4)

Cyprideis mandviensis - Jain, 1978, pp.98-99, Fig.2L1-4, 6 B.

Remarks: The present species shows some similarity to *Cyprideis torosa* group of species. It, however, differs in having a slightly narrower anterior and a less pointed posterior margin. It is also characterized by the absence of anterior marginal denticles and in having fewer branched pore canal~. *Cyprideis mandviensis* was also found living in a nearby seasonal stream. The only difference between the two being that the shell in case of the latter is thinner and bas a shallow external sulcus. Another interesting occurrence of this species is in the Upper Oligocene deposits of Kutch. As both the marine and non-marine forms are without nodes, the validity of the hypothesis that the nodes are due exclusively to environmental factors becomes questionable. Sexual dimorphism strong, males more elongate, short and with a more narrowly rounded posterior.

Material: In all, 16 specimens were found; out of these, 1 is in living condition; 14 carapaces and 2 open valves.

Hypotye: Length: 0.86 mm., Height 0.46 mm.

Family **Trachyleberididae**

Sylvester-Bradley, 1948

Subfamily **Trachyleberididae**

Sylvester-Bradley, 1948

Genus ***Stigmatocythere*** Siddiqui, 1971

Stigmatocythere indica (Jain)

(Pl.II, figs.5-6)

Stigmatocythere indica (Jain) - Whatley and Zhao, 1988, p.9, pl.6, figs.20-21;- Varma *et al.*, 1993, p.554; - Hussain and Mohan, 2000, p.26, pl.II, fig.1;- Mohan *et al.*, 2001, p.8, pl.II, fig.16-17;- Sridhar *et al.*, 2002, p.26, pl.II, fig.13-14.

Remarks: The original description for this species was given by Jain (1978), who recorded it as *Carinocythereis* (*Tandonella*) *indica* from the beach sands of Mandvi, Kutch. However, it was transferred to *Stigmatocythere* by Whatley and Zhao (1988) who reported it from the Malacca Straits. This taxon was also recorded from off Karwar by Vaidya and Mannikeri (1994). From the east coast, this form was recorded for the first time by Varma *et al.* (1993) and subsequently by Hussain and Mohan (2000), Mohan *et al.* (2001) and Sridhar *et al.* (2002).

Material: In all, 17 specimens were found, of which 2 are living; 13 carapaces and 4 valves.

Hypotype: Length 0.57 mm, height 0.28 mm.

Genus ***Keijella*** Ruggieri, 1967

Keijella reticulata Whatley and Quanhong

(Pl.II, figs.7-8)

Keijella reticulata - Whatley and Quanhong, 1988, p.15, pl.7, figs.19-23; - Vaidya and Mannikeri, 1994, pp.735-738; - Hussain and Mohan, 2000, p.26, pl. II, fig.3; - Mohan *et al.*, 2001, p.8, pl. III, fig.2-3; - Sridhar *et al.*, 2002, p.27, pl. II, fig.18.

Remarks: This species was originally described by Whatley and Quanhong (1988) from the Malacca Straits. From the Indian region, this species has been recently recorded from the inner shelf sediments of the Gulf of Mannar, off Tuticorin (Hussain, 1996b); Palk Bay, off Rameswaram (Sridhar, 1996); and off Karikkattukuppam (Mohan *et al.*, 2001).

The large size and the reticulate ornamentation dominated by longitudinal muri medianly and ventrally, and rather radial muri dorsally are the characteristic features of *K. reticulata.* This species resembles *K. papuensis* (Brady) in reticulate ornamentation but differs from the latter in the elongate shape and lack of any posteroventral spine. *K. reticulata* also differs from *K. apta* (Guan) as the latter does not possess rod-like denticles in the posterior margin. It is also distinguished from *K. whatleyi* Jain in having reticulation and in the absence of longitudinal ribs.

Material: In study area, 13 specimens were encountered, of which 4 are living; 12 carapaces and one open valve. Few juveniles are recorded

Hypotype: Length 0.97 mm, height 0.51 mm.

Genus ***Lankacythere*** Bhatia and Kumar, 1978

Lankacythere sp.

(Pl.II, fig.9)

Remarks: The present species is closely resembles Lankacythere coralloides (Brady) in general features. But dif-

fers from it in having a different surface ornamentatioin.

Material: In the study area, this species occurs rarely and only 5 specimens are found, all carapaces.

Hypotype: Length 0.70 mm, height 0.40 mm, width 0.20 mm.

Subfamily **Campylocytherinae** Puri, 1960

Genus ***Basslerites*** Howe, 1937

Basslerites liebaui Jain

(Pl.II, fig.10)

Basslerites liebaui - Jain, 1978, pp.116-117, figs.4A1-3, 6L; 1981, pl.2, fig.5; - Vaidya and Mannikeri, 1994, p.736; -Shyam Sunder *et al.*, 1995, p.473; - Hussain and Mohan, 2000, p.26, pl. II, fig.6; - Mohan *et al.*, 2001, p.8, pl. II, fig.20-21.

Remarks: The original description for *B. liebaui* was given by Jain (1978) in his studies on Ostracoda from the beach sands at Mandvi, Kutch. From the east coast of India, this form has been recorded by Mohan *et al.* (2001) from the inner shelf sediments off Mahabalipuram, off Karikkattukuppam, south of Madras, respectively. *B. liebaui* can be distinguished from *B. pentofissurella* Swain (1967) in possessing an ornament of longitudinal ridges and grooves in the posterior half instead of a W-shaped depressed surface.

From its distribution, it is observed that this species is endemic to Indian waters only.

Material: In all, 19 specimens were found and among these, only 5 are living; 14 carapaces and 5 open valves.

Hypotype: Length 0.41 mm, height 0.22 mm.

Family **Hemicytheridae** Puri, 1953

Subfamily **Hemicytheridae** Puri, 1953

Genus ***Mutilus*** Neviani, 1928

Mutilus pentoekensis (Kingma)

(Pl.II, fig.11)

Mutilus pentoekensis (Kingma) - Zhao and Whatley, 1989b, p.245, pl.4, figs.15-18; - Hussain and Mohan, 2000, p.26, pl. II, fig.7-8; - Mohan *et al.*, 2001, p.8, pl. III, fig.8-10;

Remarks: The original description for this species was given by Kingma (1948) who recorded it from Indonesia as *Hemicythere pentoekensis*. Zhao and Whatley (1989b) revised the new species described by Kingma and included this species under the genus *Mutilus*. *Mutilus* sp. and *Radimella* sp., reported by Jain (1978 and 1981, respectively) appear to be conspecific with *Mutilus* pentoekensis. From the Indian region, this species was reported from the Palk Bay, off Rameswaram, by Sridhar *et al.* (2002), and off Karikkattukkuppam by Mohan *et al.* (2001) who observed it to be widespread and abundant. In the study area also, it occurs as persistent taxa.

Material: In all surface samples, 12 specimens were encountered and no living representative is encountered and all carapaces.

Hypotype: Length 0.55 mm, height 0.32 mm.

Subfamily Orioninae Puri, 1973

Genus ***Caudites*** Coryell and Fields, 1937

Caudites javana Kingma

(Pl.II, fig.12)

Caudites javana Kingma - Keij, 1953, no.2, p.159, pl.1, figs.8a-c, 9; 1954, p.358, pl.2, figs.12-13; - Vaidya and Mannikeri, 1994, pp.735-738; - Hussain, 1998, pp.11-12, pl.2, fig.15; - Hussain and Mohan, 2000, p.26, pl. II, fig.9; - Mohan *et al.*, 2001, p.8, pl. III, fig.11; - Sridhar *et al.*, 2002, p.28, pl. III, fig.2.

Remarks: Kingma (1948) established *C. medialis* var. *javana* from a deep bore near Bodjonegoro, east Java, and opined that this species differs from *C. medialis* Coryell and Fields in the absence of median ridge and in the presence of a well developed central swelling. Keij (1953) redescribed this taxon and, after a re-examination of Kingma's material, opined that the aforesaid features are only true in the case of immature specimens. These observations have also been made by the authors in the present material.

C. javana was also reported from the Neogene of Andaman Islands by Guha (1968a); Gulf of Mannar by Hussain (1998); Persian Gulf by Paik (1976, 1977); Mandvi beach by Jain (1978); Recent sediments of Australia by Howe and McKenzie (1989); and the Palk Bay, off Rameswaram by Sridhar (1996).

Material: In the study area, 16 specimens were encountered, of which 4 are living; 14 carapaces and 2 open valves.

Hypotype: Length 0.56 mm, height 0.31 mm.

Indet Genus et sp. A

(Pl.II, fig.13)

Remarks: The present indeterminate species belongs to a hitherto unknown genus. It occurs commonly in estuarine and inner shelf region. Due to paucity of literature, it is left under open nomenclature.

Material: In the creek, only 4 specimens are found, all carapaces. Absence of living forms.

Hypotype: Length 0.61mm, height 0.27 mm, width 0.22 mm.

Family **Cytherettidae** Triebel, 1972

Genus ***Neocytheretta*** van Morkhoven, 1963

Neocytheretta murilineata Zhao and Whatley

(Pl.II, fig.14)

Neocytheretta murilineata - Zhao and Whatley, 1989a, pp.181-182, pl.3, figs.11-15; - Hussain, 1998, p.11, pl.2, fig.18; - Hussain and Mohan, 2000, p.26, pl. II, fig.10; - Mohan *et al.*, 2001, p.8, pl. III, fig.14-16; - Sridhar *et al.*, 2002, p.30, pl. III, fig.4-6.

Remarks: This species was originally reported from the Malay Peninsula by Zhao and Whatley (1989a). Hussain (1998) recorded *N. murilineata* for the first time from Indian waters, from the Gulf of Mannar, off Tuticorin. Subsequent reports of this taxon include those by Sridhar *et al.* (2002) from the Palk Bay, off Rameswaram.

Longitudinal muri, reticulate ornamentation, almost smooth and polished anterior and posterior ends, and the occurrence of a blunt spine in both valves, are the characteristic features of *N.murilineata*. This species is very similar to N.spongiosa but differs from the latter in having obliquely placed muri in the dorsal region, and a smooth surface posteriorly. *N.murilineata* closely resembles *N.ventrocostata* Howe and McKenzie in general outlines inner lamella, etc.

Material: 14 specimens were found in the creek and all the specimens are carapaces. Living forms are absent.

Hypotype: Length 0.67 mm, height 0.38 mm.

Family **Loxoconchidae** Sars,1925

Genus ***Loxoconcha*** Sars, 1866

Loxoconcha megapora indica Benson and Maddocks

(Pl.II, fig.15)

Loxoconcha megapora Benson and Maddocks 1964, p. 24-26, pl. 4, fig.1-6, text-fig. 14.

Loxoconcha megapora indica (Benson and Maddocks) Jain, 1978, p.126, pl.4, fig.4L1-3; - Sreenivas *et al.*, 1991, p.495, pl. I, fig. 9.

Remarks: The present subspecies resembles *L. megapora* Benson and Maddocks (1964) described from the Recent on Knysna Estuary, Cap Province, South Africa, in lateral outline and in having large conspicuous normal pore canals but differs in size in having convex sides when viewed dorsally.

Hartmann (1974) has described a new subspecies *L. megapora magna* from the west coast of Africa, which is bigger in size as compared to the species described by Benson and Maddocks.

Material: In the study area, this species occurs abundantly. In all, 19 specimens are found, of which 6 in living condition. Among these 16 are carapaces and 3 open valves.

Hypotype: Length 0.48 mm, height 0.26 mm.

Family **Paradoxostomatidae**
Brady and Norman, 1889
Subfamily **Paradoxostomatidae**
Brady and Norman, 1889
Genus ***Paradoxostoma*** Fischer, 1855
Paradoxostoma bhatiai Shyam Sunder, Varma and Naidu
(Pl.II, fig.16)

Paradoxostoma sp. - Jain, 1978, p.131, figs.5L1-2.

Paradoxostoma bhatiai - Shyam Sunder *et al.*, 1995, p.476, pl. II, figs.1-2; - Mohan *et al.*, 2001, pl. IV, fig.14-15; - Sridhar *et al.*, 2002, p.33, pl. IV, fig.11.

Remarks: *Paradoxostoma* sp. Jain, 1978, described from the Mandvi beach, west coast of India, is conspecific with P. bhatiai, which has been recorded from Goguleru Creek, east coast of India (Shyam Sunder *et al.*, 1995). This species has been reported from the inner shelf sediments off Chennai (Mohan *et al.*, 2001) and off Rameswaram, Palk Bay (Sridhar *et al.*, 2002) from the east coast of India. *P. bhatiai* resembles *P. limbaughi* Allison and Holden, (1971) in shape, but the former is longer and possesses a short, upturned caudal process at the posterior end. From its distribution, it is observed that this species is endemic to Indian waters only.

Material: This thin, fragile and delicate species occurs rarely. In all, 7 specimens were found.

Hypotype: Length 0.61 mm, height 0.28 mm.

Family **Uncertain**
Genus ***Kalingella*** Jain, 1978
Kalingella mckenziei Jain
(Pl.II, fig.17)

Kalingella mckenziei - Jain, 1976, p.131, pl. 1 figs. I-K; - Varma *et al.*, 1993, p.554; Shyam Sunder *et al.*, 1995, p.473; - Kumar and Hussain, 1997, p.134, pl.1, fig. 8; Arul *et al.*, 2003, pp.68-69, pl.3, figs.3-4;

Remarks: It appears endemic to brackish water environs of east coast of Indian region. *K. mckenziei* was originally described from Chilka Lake by Jain (1976). Subsequently, it has been reported from Tekkali Creek (Varma *et al.*, 1993), Goguleru Creek (Shyam Sundaram *et al.*, 1995), Pitchavaram mangrooves (Kumar and Hussain, 1997 and Arul, *et al.*, 2003) and deltaic sediments of Krishna and Godavari rivers, east coast of India (Anil Bhandari and Singh, 2006)

Material: In the creek sediments, a total of 21 specimens are found, out of these, one specimen in living condition; and all are carapaces.

Hypotype: Length 0.49 mm, Height 0.28 mm.

Family Pontocyprididae Muller, 1894
Genus Propontocypris Sylvester-Bradley, 1947
Propontocypris (*Schedopontocypris*) *bengalensis* Maddocks
(Pl.II, fig.18)

Propontocypris (*Schedopontocypris*) *bengalensis* - Maddocks, 1969a, pp.37-38, figs.31A, C and F.

Propontocypris (*Schedopontocypris*) *bengalensis* Maddocks - Sridhar, 1996, pp.116-117, pl.9, fig.5;- Hussain, 1998, p.14, pl.3, fig.18;- Mohan *et al.*,2001, pl. IV, fig.21;

Remarks: This species was originally described and illustrated by Maddocks (1969a) from the Recent sediments of the Bay of Bengal. Subsequently, it has been recorded by Abrar (1984) from the Karwar-Kasargod area (west coast of India); Sreenivas et al. (1991) from the Pulicat Lake estuary; Sridhar (1996) from the Palk Bay, off Rameswaram; and Hussain (1998) from the Gulf of Mannar, off Tuticorin.

Material: A total of 13 specimens were found, of which 6 are living; and all are carapaces.

Hypotype: Length 0.56 mm, height 0.28 mm.

Family **Candonidae** Kaufmann, 1990
Subfamily **Paracypridinae** Sars, 1923
Genus ***Phlyctenophora*** Brady, 1880
Phlyctenophora orientalis (Brady)
(Pl.II, fig.18)

Phlyctenophora orientalis (Brady) - Whatley and Quanhong, 1987, pp.336-337, pl.2, figs.3-4; - Vaidya and Mannikeri, 1994, p.737; - Hussain and Mohan, 2000, p. 26, pl. II, fig. 12; - Mohan *et al.*, 2001, pl. IV, fig.22; - Sridhar *et al.*, 2002, p.36, pl. IV, fig.16-17.

Remarks: *P. orientalis* (Brady), reported by Whatley and Quanhong (1987), has been variously referred to as *P. zealandica* (by Brady, 1880, Jain, 1978 and Hussain, 1998), *Paracypris zealandica* (by Kingma, 1948 and Guha, 1968b), and *P. bhatiai* (by Jain, 1976). After comparing their specimens from the Malacca Straits with Brady's type material of *Macrocypris orientalis*, Whatley and Quanhong (1987) transferred all the aforesaid species to the genus *Phlyctenophora*. *P. orientalis* has been reported from New Zealand, Australia, China and Indonesia; it is also a commonly occurring species along the east and west coasts of India.

Material: In the creek, a total of 14 specimens were encountered and out of these, 12 are carapaces and 2 open valves.

Hypotype: Length 1.02 mm, height 0.49 mm.

Superfamily **Cypridacea** Baird, 1845
Family **Cyprididae** Baird, 1845
Subfamily **Cyprinotinae** Baird, 1845
Genus ***Cyprinotus*** Brady, 1886
Cyprinotus salinus (Brady)
(Pl.II, fig.20)

Cypris salina - Brady, 1868, pp. 368, pl.26, figs. 8-13.

Cyprinotus salinus (Brady) - Wagner, 1957, pp.30-31, p1.9, figs. 1-6

Remarks: This species was onginally described by Brady (1868) from Sri Lanka.

Material: In all, 12 specimens were found; out of these, 2 are in living condition; 9 carapaces and 3 open valves.

Hypotype: Length 1.14 mm, height 0.69 mm.

CONCLUSIONS

For the first time, a study on the systematics of Recent Ostracoda from the Ennore creek, north of Chennai, has been carried out, particularly in view of the insufficient information on these tiny organisms from the marginal marine environments of the Indian subcontinent.

In the creek, twenty sediment samples were collected during February, 2006. All the sediment samples were subjected to standard micropaleontological techniques and ostracod fauna were retrieved. A total of 30 species belonging to 24 genera, 15 families, 2 superfamilies and 2 suborders of the order Podocopida, have been identified by referring to standard publications and they are illustrated with Scanning Electron Microscope photomicrographs. Of these, four species belong to Platycopa and the rest to Podocopa.

Some ostracod species characteristic of brackish water,

such as *Cyprideis* cf. *mandviensis*, species of *Hemicytheridea*, *Jankeijcythere mckenziei*, *Kalingella mckenziei*, *Loxoconcha megapora indica* and *Neosinocythere dekrooni* occur in the creek. Freshwater species like *Cyprinotus salinus* occur in the outer creek region, i.e. towards riverine side. The molt stages of ostracods are not fully recorded. The ostracod carapaces and valves are clear, pale yellow to white and preservation is good. This shows that the creek is not fully polluted. However, a few species exhibit one or two juvenile stages, which reflect on the deteriorating (polluting) environment of the creek. The occurrence of *Cytherelloidea leroyi*, *Neomonoceratina iniqua*, *Keijella reticulata*, *Neocytheretta murilineata*, *Lankacythere reticulata* and *Mutilus pentoekensis* may be due to the tidal influence. However, *Tanella gracilis* is considered to be cosmopolitan in distribution and occurs in almost all types of environments ranging from marginal marine to shallow marine environment.

The ostracoda fauna of the present area exhibit close affinity with the ostracods assemblage of the Indo-Pacific region, viz., other parts of east and west coasts of India, Persian Gulf, South China Sea, Malacca Straits and Indo-Malayan areas. However, *Basslerites liebaui*, *Jankeijcythere mckenziei*, *Kalingella mckenziei* and *Neomonoceratina jaini* are endemic to Indian waters only. Overall, the recorded ostracod assemblage strongly prefers tropical, shallow and brackish water (Oligohaline to Mesohaline) habitat.

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