

FIVE NEW REPORTS OF HARPACTICOID COPEPODS (COPEPODA: HARPACTICOIDA) FROM INDIAN WATERS

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ABSTRACT

The present study provides information about the new reports of copepods along the V.O. Chidambaranar Port, East Coast of India between latitudes 8° 44' to 8° 45' N and longitudes 78° 12' to 78° 13' E. Altogether 45 species were identified, represented by 27 genera and 9 families and 1 order. *Ectinosoma tenuipes* (Ectinosomatidae), *Halectinosoma unicum* (Ectinosomatidae), *Bradya typica* (Ectinosomatidae), *Pseudobradya cornuta* (Ectinosomatidae) and *Zaus spinatus spinatus* (Harpacticidae) were found to be new reports from Indian waters. The detailed descriptions along with drawings of harpacticoid copepod species are presented here.

Keywords: Copepods, V.O. Chidambaranar Port, East Coast of India

INTRODUCTION

Copepods inhabit all available benthic habitats and show considerable species diversity in the sea (Wells, 1976). Harpacticoids are permanent members of meiofauna that always remain within the meiofaunal size range 63-500 µm (Gray and Elliott, 2009). They are highly mobile crustaceans (Hicks and Coull, 1983) which represents second most abundant meiofaunal group in marine sediment, while nematodes were dominant (Olafsson, 1995). The word copepod derived from Greek, often called “oar-feet”. Microscopic, small crustaceans occur in the sea and nearly all aquatic habitats and found in planktonic and benthic forms. Some are drifting in the seawater as planktonic copepods and some are living on the ocean seafloor called as benthic copepods. The benthic copepods come under the harpacticoida order. This order comprises 463 genera and about 3,000 species in the marine environment. In marine environments, the planktonic forms represent a predominant source of food for jellyfish, basking sharks, and whales (Davis, 1955). The worldwide monographic account of the Harpacticoida written by Lang, (1948) is a benchmark in the study of the marine harpacticoid fauna. There are, however, many other valuable taxonomic accounts focused on different regions of the northern hemisphere, including temperate and tropical areas of the Pacific (Lang, 1965) and the Atlantic (Huys *et al.*, 1996).

Knowledge of the harpacticoid copepods distribution and diversity in the Indian shelf is meager except the information that 35 species were recorded by (Kondala Rao, 1984) from Gautami Godavari estuary, 39 species by Ansari *et al.*, (2013) from southeast continental shelf of India, 12 species by (Mantha *et al.*, 2012; Chertoprud *et al.*, 2013; Suarez-Morales and Fuentes-Reines 2015) from Chennai coast and 8 species by (Sajan and Damodaran, 2007) from western continental shelf of India.

The present study was undertaken on the Harpacticoid Copepods of the V.O. Chidambaranar Port, East Coast of India and this paper describes five copepods species from the order Harpacticoida recorded for the first time in Indian waters.

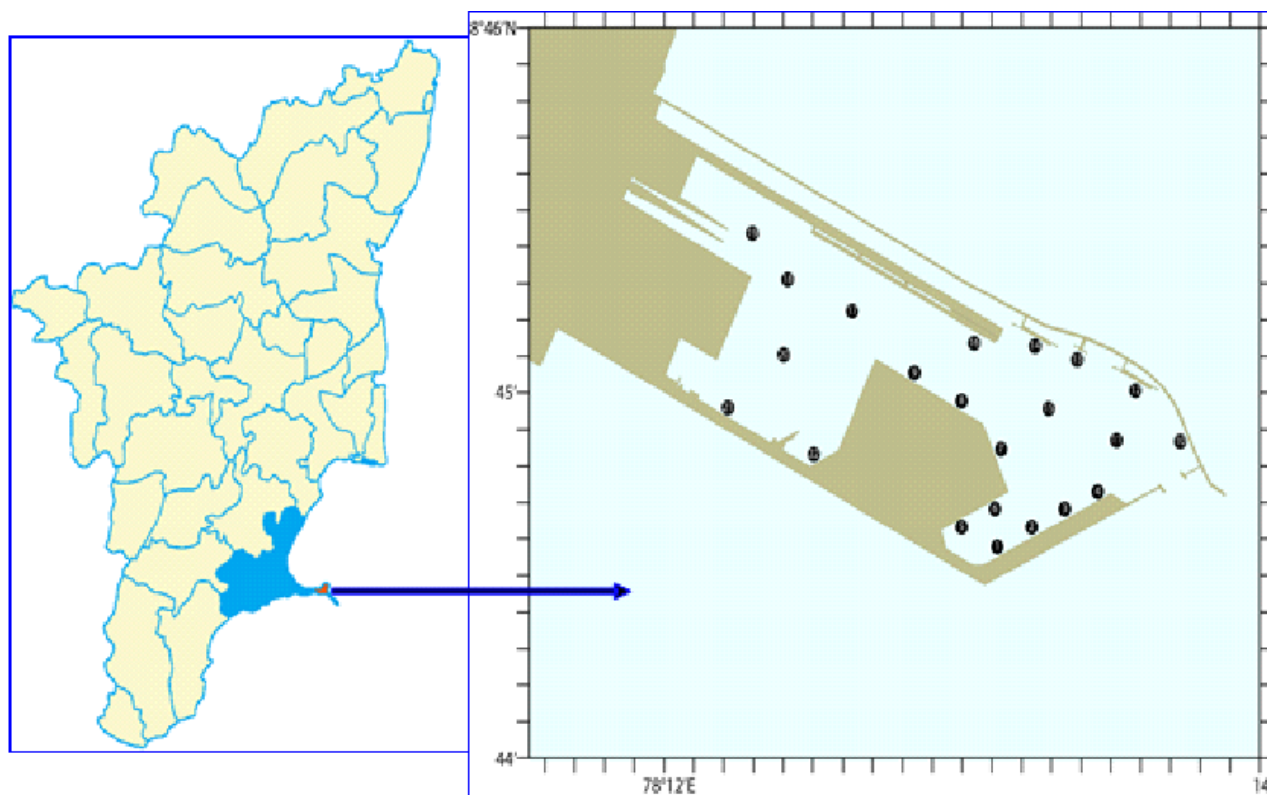


Figure 1: Schematic map of the sampling stations of V.O. Chidambaranar Port.

MATERIALS AND METHODS

Study area

Samples were taken from the 22 predetermined (GPS fixed) locations in the V.O. Chidambaranar Port. The observations (384 samples) were made during four seasons namely monsoon season (July 2012), post-monsoon (October 2012), cold weather season (December 2012) and pre-monsoon (March 2013) between latitudes 8° 44' N-8° 45' N and longitudes 78°12' E - 78°13' E at 22 GPS fixed locations using a Van Veen grab having an area of 0.1m² (see Figure 1) and Table 1). From these, sub samples were collected at each location using a 10 cm long glass corer (3.6cm dia.). The samples were anaesthetized with MgCl₂ and preserved in 4% buffered formalin. Triplicate core samples were processed separately in the laboratory and data were pooled for analyses. About 50 g of sediment was sub-sampled from each grab sample for the analysis of sediment texture and organic matter. Sediment samples were oven-dried (at 60 °C) and stored for further analysis. At each sampling location, bottom water temperature, dissolved oxygen, salinity, pH, sediment texture and organic matter were measured according to standard protocols (Holme, and McIntyre, 1984).

Data collection

Biological observations included collection of quantitative meiobenthic samples. A Van Veen grab (0.1 m² Hydrobios, Kiel, Germany) was used to collect the sediment samples. At each station, a glass corer (3.6 cm inner diameter) was used for collecting sediment samples of 10 cm long cores from grab (Van Veen grab, 0.1m²) hauls. The Van Veen grab has an opening lid at the top, which facilitates the core sample to be taken out without disturbing the sediment. Replicate sub samples were collected from each haul. The samples were in Toto transferred to polythene containers, labeled and material preserved in 70% alcohol for further examination.

Table 1: Station Locations

Stations	Name of station	Depth	Latitude	Longitude
1	TNVOCPB-1	10.8	8°44'35"N	78°13'19"E
2	TNVOCPB-2	10.8	8°44'38"N	78°13'26"E
3	TNVOCPB-3	11.2	8°44'38"N	78°13'30"E
4	TNVOCPB-4	12.5	8°44'45"N	78°13'40"E
5	TNVOCPB-5	10.8	8°44'38"N	78°13'15"E
6	TNVOCPB-6	10.6	8°44'42"N	7°13'19"E
7	TNVOCPB-7	15.2	8°44'57"N	78°13'24"E
8	TNVOCPB-8	15.1	8°44'00"N	78°13'12"E
9	TNVOCPB-9	15.3	8°45'03"N	78°13'01"E
10	No sample			
11	TNVOCMP-1	12.8	8°44'53"N	78°13'44"E
12	TNVOCPCJ-1	15.2	8°45'03"N	78°13'51"E
13	TNVOCPOJ	15.3	8°45'11"N	78°13'37"E
14	TNVOCPCJ-2	14.4	8°45'08"N	78°13'31"E
15	TNVOCMP-2	15.2	8°45'03"N	78°13'19"E
16	TNVOCPCB-1	15	8°45'11"N	78°13'19"E
17	TNVOCMP-3	6.3	8°45'14"N	78°12'50"E
18	TNVOCMP-4	4.2	8°44'18"N	78°12'39"E
19	TNVOCMP-5	3.7	8°45'25"N	78°12'32"E
20	TNVOCMP-6	3.6	8°45'11"N	78°12'33"E
21	TNVOCPLJ	4.2	8°45'00"N	78°12'25"E
22	TNVOCPSB-1	4.8	8°45'53"N	78°12'39"E

Sample processing

The sediment samples were then processed through a set of two sieves with 500 µm and 42 µm mesh size. The residue retained on the 42 µm sieve was stored in glass container and preserved in 4% buffered formalin. Rose Bengal was used as stain prior to sorting and enumeration. Meiobenthos was counted on higher taxonomic level using a binocular microscope. The total number of organisms in the sample represented by different phyla was expressed in individuals per 10 cm⁻².

RESULTS AND DISCUSSION

In the study area, the overall bottom water temperature varied with seasons wise ranged between 27.5 °C (cold weather season) and 29.9 °C (pre-monsoon), salinity ranged from (32.1 PSU (cold weather season) and 36.3 PSU (post-monsoon) and dissolved oxygen ranged from 3.4 ml.l⁻¹ (cold weather season) and 6.7 ml.l⁻¹ (post-monsoon). Sediment organic carbon ranged from 0.874 % (monsoon) and 4.071% (monsoon) and most of the study sites were characterized by clayey silt (Table 2 and Table 3).

Table 2: Ranges of bottom parameters of V.O. Chidambaranar Port during various seasons of study period.

Character	Monsoon	Post-monsoon	Cold weather season	Pre-monsoon
Bottom Temperature(°C)	29.2-29.5	28-28.6	27.5-27.9	29.2- 29.9
	(29.37±0.10)	(28.34±0.20)	(27.72±0.12)	(29.41±0.17)
Bottom Salinity (PSU)	35.3-35.7	36.2- 36.3	32.1 -34.7	33.5-33.6
	(35.48±0.12)	(36.23±0.05)	(33.86±0.77)	(33.55±0.05)
Bottom DO (mg.L ⁻¹)	4.1-6.3	4.5- 6.7	3.4 -6.1	4.2-6
	(5.25±0.57)	(5.87±0.61)	(4.71±0.77)	(5.38±0.53)
Bottom Organic Carbon (%)	0.874-4.071	0.46-3.8065	0.4255-4.0595	0.667-3.542
	(2.07±1.05)	(1.95±1.14)	(1.94±1.19)	(1.82±0.95)
Values in the parenthesis indicate (Mean ± SD)				

Table 3: Ranges of Sediment Characteristics of V.O. Chidambaranar Port during various seasons of study period.

Textural class	Monsoon	Post-monsoon	Cold weather season	Pre-monsoon
Sand (%)	2.72-73.24	1.9338-68.9274	8.9848-75.9154	1.4464-70.5256
	(50.27±21.43)	(36.08±23.16)	(37.08±22.52)	(23.05±20.84)
Silt (%)	2.4-53.12	17.25-61.16	13.92-60.93	27.98-72.95
	(27.09±16.15)	(41.07±13.59)	(38.30±14.76)	(53.92±12.85)
Clay (%)	0.744-94.48	3.5016-42.8296	2.2446-50.3238	1.4944-54.6706
	(22.64±25.33)	(22.84±11.17)	(24.62±11.71)	(23.02±15.74)
Organic carbon	0.874-4.071	0.46-3.8065	0.4255-4.0595	0.667-3.542
	(2.07±1.05)	(1.95±1.14)	(1.94±1.19)	(1.82±0.95)
Values in the parenthesis indicate (Mean ± SD)				

In the present study, altogether 45 copepods species belonging to 1 order, 9 families and 27 genera were identified. The members of the family Ectinosomatidae (*Ectinosoma tenuipes*, *Halectinosoma unicum*, *Bradya typical*, *Pseudobradya cornuta*) and Harpacticidae (*Zaus spinatus spinatus*) major were found to be new records for Indian waters. The characteristics of these species are described below.

New Reports of Harpacticoid Copepods

Phylum: Arthropoda

Class: Crustacea Brunnich, 1772

Order: Copepoda Milne-Edwards. 1840

Suborder: Harpacticoida Sars M., 1903

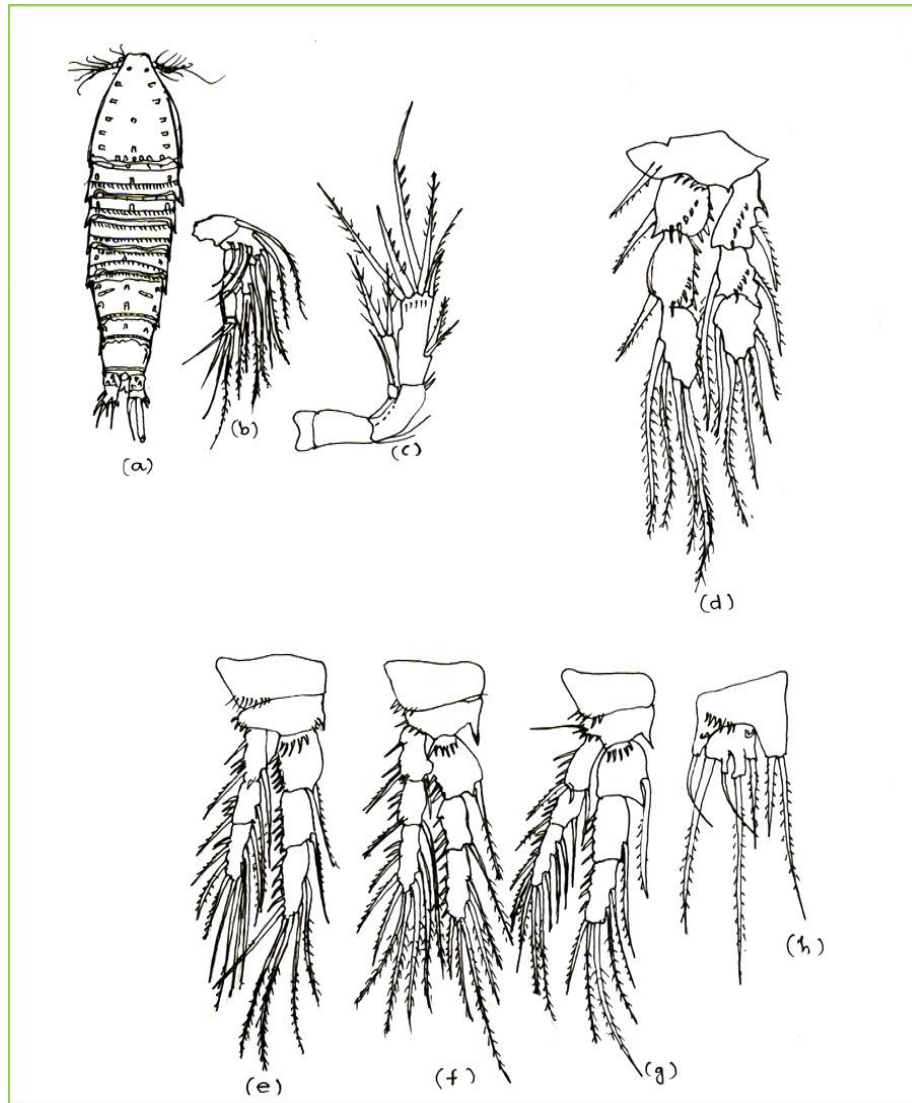
Family: Ectinosomatidae Sars G.O., 1903

Genus: *Ectinosoma* Boeck, 1865

Ectinosoma tenuipes Scott T. & A., 1896

1965. *Ectinosoma tenuipes* Karl Lang, Copepoda Harpacticoida from the Californian Pacific Coast. Part. I Abdominal somites dorsally seemingly unornamented (the dorsal surface of the specimen available so covered with detritus that the ornamentation cannot be made out satisfactorily), ventrally ornamented.

Female (Fig. a). Length about 0.51 mm, Body fusiform. Cephalothorax somewhat longer than three succeeding somites combined; posterior edge bare; a row of spinule-like chitinous stripes just in front of



posterior edge and inside lateral edges; rostral projection short, in dorsal aspect broadly rounded in front. Thoracic somites with out of hairs or spinules; first somite dorsally with four, two succeeding somites each with two sensillae. Furcal rami about as long as wide, with a minute dentiform projection almost in middle of posterior dorsal edge, and ventrally running out into a short.

Antennule (Fig. b). Six-segmented. Posterior edge of second segment short, anterior edge produced into a short, broad lobule. Third segment with a slender aesthetasc, reaching far beyond tip of antennules. Fifth segment about twice as long as fourth and about three times as long as last. Last segment with terminal aesthetasc.

Antenna: (Fig. c). Coxa small, bare. Basis about as long as first endopodite-segment, with two slender setae at anterior distal corner. Exopodite trimerous, much shorter than endopodite; first segment without seta, about twice as long as second; last segment fully three times as long as second; second segment with one long seta, last segment with two comparatively short terminal setae. First endopodite-segment with three spinules at anterior distal corner; second segment with two juxtaposed, one-sided finely spinulose, spiniform

setae about in proximal third of anterior edge, with a transverse row of spinules near distal edge, and with six terminal setae.

Leg 1 (Fig. d). Coxa Basis with a row of spinules along outer distal corner; outer seta very short spinule-like; inner seta strong, spinulose along distal part of outer edge. Exopodite extending to end of second endopodite-segment; first segment longest, middle shortest; first two segments spinulose on outer edge, and with a short longitudinal row of spinules in distal part of anterior surface. Each segment of endopodite spinulose along outer edge; first segment very large, anterior surface with one spinule-row at base and one near end; anterior surface of second segment with one distal spinule-row.

Leg 2-4 (Fig. e, f, g). Coxa spinulose along outer distal corner. Basis spinulose along outermost part of distal edge, hairy between endopodite and inner distal corner, which is dentiformly prolonged. Exopodites extending somewhat beyond end of second endopodite-segment; outer edge of each segment more or less spinulose; first two segments each with some spinules on anterior surface just inside outer spine; proximal outer spine of last segment downward directed in such manner that it coincides with the succeeding spine; inner seta of middle segment widened in proximal part. Outer edge of each endopodite-segment spinulose; first segment large, with a row of comparatively long spinules near base of anterior surface, inner distal corner dentiformly produced. For number of seta and spines.

Leg 5 (Fig. h). Baseoendopodite extending beyond middle of inner edge of exopodite; one pore on outer digitiform process and a row of spinules above the pore; outer distal seta about half as long as inner one, both setae finally spinulose. Exopodite distinctly trilobed; outermost but one seta short, very slender and bare, innermost seta short and thick, two remaining setae long and thick, three last-mentioned setae delicately plumose; one pore near base of inner edge.

Distribution: India: V.O. Chidambaranar Port during Monsoon (st-21), Post-monsoon (sts.14, 19) and Pre-monsoon (sts.7, 20)

Elsewhere: Monterey Bay (off Hopkins Marine station and rinsig of algae); North Atlantic Ocean – European waters ;North Sea- Belgian Exclusive Economic zone.

Material examined: Six females

Remark: Present specimens from V.O. Chidambaranar Port agree well with the original description. Length: 0.51 mm, Body fusiform and ventrally ornamented.

Family: Ectinosomatidae Sars G.O., 1903

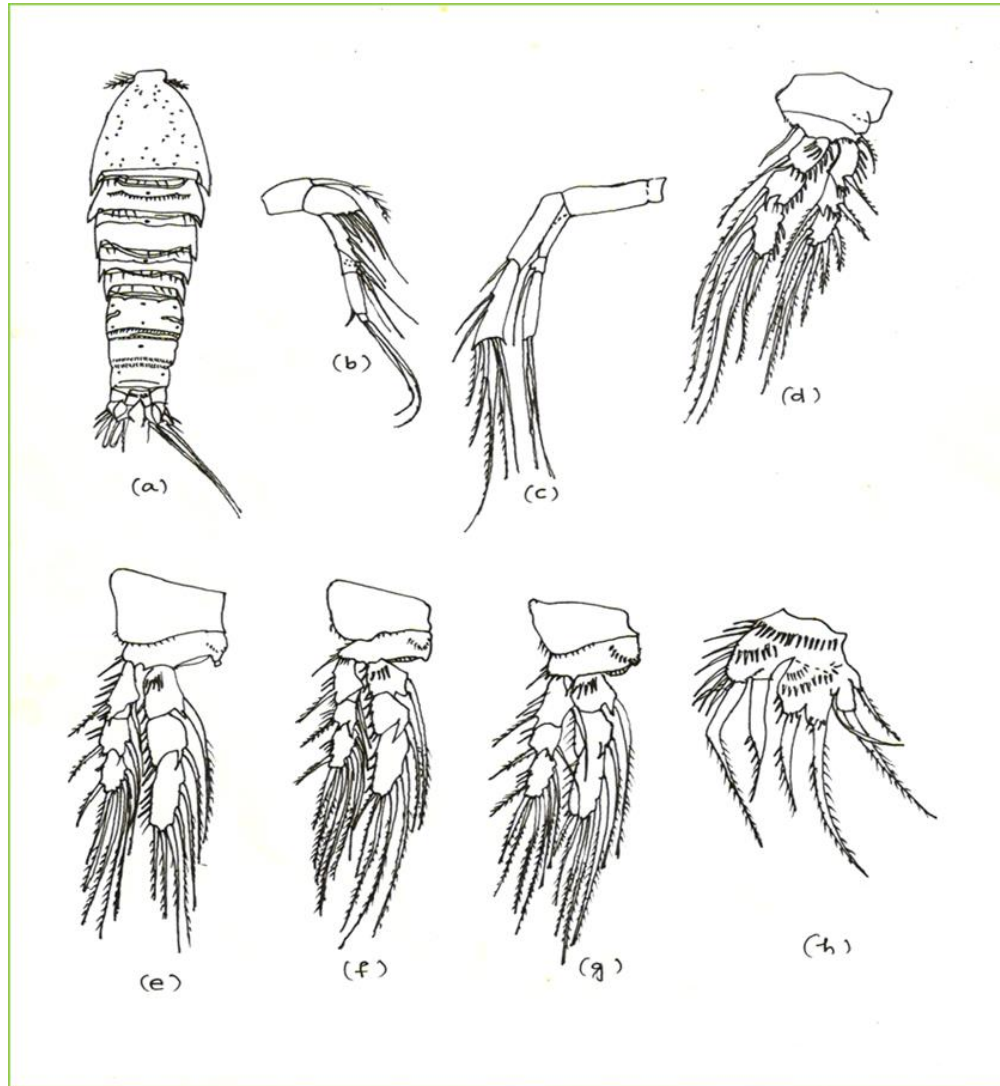
Genus: *Halectinosoma* Vervoort, 1962

Halectinosoma unicum Lang, 1965

1965. *Halectinosoma unicum* Karl Lang, Copepoda Harpacticoidea from the Californian Pacific Coast. Part. I

Female (Fig. a). Length 0.49 mm. Body fusiform, moderately slender, widest in front of middle. Cephalothorax somewhat longer than three succeeding somites combined, evenly constricted in front; rostral production comparatively short, rounded at the downwards bent tip; a great number of small circular pores on dorsal surface. Cephalothorax and three succeeding somites each with a row of sensillae posterior dorsal edge; first thoracic somite has also one dorsal row of minute hairs in anterior part, two following somites each one row of hairs extending to ventral surface; last thoracic somite with minute hairs along posterior dorsal edge, and with some scattered hairs just in front of this edge. Genital double-somite subdivided by a chitinous stripe extending from middle of dorso-lateral surface around rest of somite; posterior edges spinulose, spinules increasing in size ventrally; one row of fine hairs just in front of this edge, hairs decreasing in size ventrally; one oblique ventro-lateral row of hairs just in front of chitinous stripe and one similar row near middle of posterior half. Posterior edge of antepenultimate somite armed as preceding somite; just in front of this margin is a similar row of hairs as in genital double-somite, row, however

interrupted in middle of dorsal surface; abdominal somites mentioned also furnished with some sensillae. Posterior edge of penultimate somite minutely spinulose laterally and ventrally; pseudopericulum irregularly dentate. Terminal setae well developed.



Antennule (Fig. b). Six segmented, last segment, however, indistinctly defined. First and second segment sub equal in length. First segment with one long, plumose seta at anterior distal corner. Second segment anteriorly produced into a sentiferous lobule. Third segment remarkably long, fully as long as preceding segments combined. Fourth segment about half as long as third. Fifth segment somewhat shorter than third. Third and last segments each with an aesthetasc.

Antenna (Fig. c). Coxa short, bare. Basis bare. Exopodite trimerous; first segment half as long as third, bare; second segment about one third as long as first, with one long seta; last segment about five times as long as second, with two long terminal setae. First endopodite-segment bare; anterior edge of second segment with one short fine seta near base and with two juxtaposed setae near middle; distal edge with five setae.

Leg 1 (Fig. d). Coxa bare. Basis with one row of minute hairs below outer seta, and with one row of extremely fine hairs inside inner, base spine. Exopodite extending to about proximal third of last endopodite-

segment; first segment longer than any one of two succeeding segments, which are sub equal in length; outer edge of each segment more or less spinulose; first and second segment each with some few spinules on outer half of distal edge; inner distal edge corner of second segment prolonged into a dentiform protection. Endopodite larger than exopodite; outer edge of each segment spinulose; anterior surface of first segment with one transverse row of spinules near base; inner distal corner prolonged into an acuminate triangular point; distal edge spinulose above base of second segment; inner distal corner of second segment peak-shaped prolonged.

Leg 2-4 (Fig. e, f, g). Coxa with one continuous row of minute spinules along distal part of outer edge and outer half of distal edge. Basis with one row of minutes spinules along outer distal corner, one row on distal edge inside endopodite, and one semi oval row of minute spinules on innermost part of anterior surface. Exopodites extending beyond end of second endopodite segment; second and third exopodites sub equal in length and little longer than fourth; outer edge of each segment more or less spinulose; first segment longest, middle shortest. Each segment of endopodites spinulose along outer edge; anterior surface of first segment with one transverse row of spinules near base, spinules on second and third legs stronger than those of fourth leg; inner distal corner of first two segments prolonged into an acuminate triangular point.

Leg 5 (Fig. h). Anterior surface of baseoendopodite with one transverse row of spinules near base, and one row just above base of inner expansion, and one row of minute spinules just inside outer edge of inner distal lobule; inner edge with comparatively long hairs or fine spinules; inner part of distal edge lobules elongated; terminal setae greatly thickened in proximal part, and hairy along distal part of inner edge. Exopodite indistinctly defined; anterior surface with one arched row of spinules near base, and below this row one irregular transverse row of spinules, and some few spinules in distal part of just inside outer edge; two inner lobules spinulose near distal edge; outer lobule slightly projecting; surface-seta long, issuing from knob near distal edge between two outermost lobules.

Distribution: India: V.O. Chidambaranar Port during Monsoon (st-2)

Elsewhere: Monterey Bay (off Hopkins Marine station and fine sand)

Material examined: Two females

Remarks: Present specimens from V.O.Chidambaranar Port agree well with the original description. Length: 0.49 mm, Body fusiform and ventrally ornamented, moderately slender and widest in front of middle.

Family: Ectinosomidae Sars G.O., 1903

Genus: *Bradya* Boeck, 1873

Bradya typica Boeck, 1873

1965. *Bradya typica* Karl Lang, Copepoda Harpacticoida from the Californian Pacific Coast. Part. I

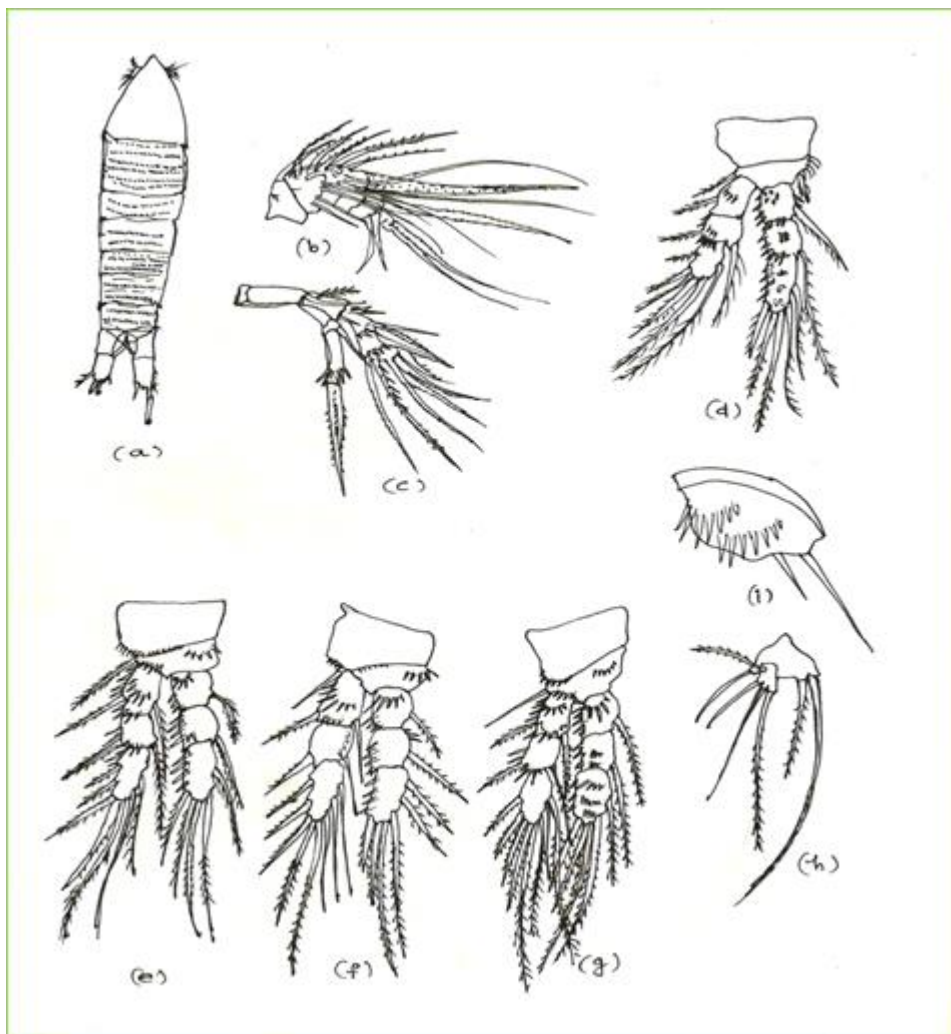
Female (Fig. a). Length 0.1 mm. Body form as in *Bradya typica*. Genital double-somite and succeeding somite have each one row of delicate hairs on posterior ventral edge; hyaline frill of these somites fringed, the fringes increasing in size latero-ventrally and ventrally, and in these parts looking like spinules. Penultimate somite with two rows, last somite with one row diminutive hairs near posterior ventral edge. Furcal rami divergent, a little widened towards base, almost 1.5 times as long as wide, ventrally running out into a triangular hyaline lappet; inner principal terminal seta 1.5 times as long as abdomen and slightly longer than the outer.

Antennule (Fig. b). Short and thick, six segmented. First three segments about equal in length, aesthetasc fully 1.5 times as long as antennules. Penultimate segment with a remarkably strong, minutely plumose seta at anterior distal corner.

Antenna (Fig. c). Coxa small, bare. Basis a little longer than first endopodite-segment, with one strong, one-sided partly spinulose seta at anterior distal corner, and with a few minute hairs just behind this seta. Exopodite trimerous, extending to about end of endopodite. First and third segments sub equal in length, and much longer than second segment; the segments have two, one and two plumose setae, respectively, hunting

distad; third segment moreover with one transverse row of spinules just inside distal edge. First endopodite-segment about as long as second segment, with distal half of anterior edge hairy; second segment proximally with one group of four spinules near anterior edge, and two transverse rows of comparatively strong spinules, one situated near middle, the other near distal end; anterior edge with three setae near middle, two of which are spinulose on one side; distal edge with seven setae, five spinulose on one side.

First leg (Fig. d). Coxa bare. Basis with one row of spinules on anterior surface just inside outer seta and one row of hairs inside inner spine. First and third exopodite-segments sub equal in length and distinctly longer than middle; outer edge of each segment spinulose; anterior surface of first segment with spinules arranged as in the figure; anterior surface of second segment. Anterior surface of second segment with one row of spinules just inside outer edge; posterior surface of second and third segments with two and three rows of spinules, respectively.



Legs 2-4 (Fig. e, f, g). Coxa with some hairs along outer distal corner and along outerpart of distal edge. Basis with one row of spinules inside outer setae and one transverse row of comparatively strong spinules on anterior surface near inner edge. Last segment of exopodites longest, middle shortest; anterior surface of first segment of second and third legs each with three rows, that of fourth leg with two rows of spinules.

Endopodites extending a little beyond exopodites; outer edge of each segment spinulose; first segment with one row of very long hairs at base of anterior surface; posterior surface of second segment with one transverse row of hair-like spinules, last segment and third legs each with three rows, that of fourth leg with two rows of long hairs or spinules. Seta and spine formula:

P- 2						P- 3						P- 4					
Exp.			Enp.			Exp.			Enp.			Exp.			Enp.		
1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	1	2.2.3	1	1	2.2.1	1	1	3.2.3	1	1	3.2.1	1	1	3.2.3	1	1	2.2.1

Leg 5 (Fig. h). Baseoendopodite extending to about middle of exopodite, with two strong setae, outer of which is ensiform. Exopodite almost square; innermost seta much the strongest; surface-seta slender and minutely plumose.

Male: Abdomen ornamented.

Antennule subchirocer

Antenna, oral parts and first four pairs of legs as in female

Sixth leg (Fig. i). With two rows of strong spinules on anterior surface and two marginal setae, inner of which is very short.

Distribution: India: V.O. Chidambaranar Port during Monsoon (sts-9, 17, 18, 21) and Cold weather season (st.21).

Elsewhere: Monterey Bay (off Hopkins Marine station, fine sand and detritus); North Atlantic Ocean – European waters ;North Sea- Belgian Exclusive Economic zone.

Material examined: Three males, two females

Remarks: Present specimens from V.O.Chidambaranar Port agree well with the original description. Length : 0.1 mm. Body fusiform and genital double-somite and succeeding somite have each one row of delicate hairs on posterior ventral edge; hyaline frill of these somites fringed, the fringes increasing in size latero-ventrally and ventrally, and in these parts looking like spinules. Penultimate somite with two rows, last somite with one row diminutive hairs near posterior ventral edge.

Family: Ectinosomidae Sars G.O., 1903

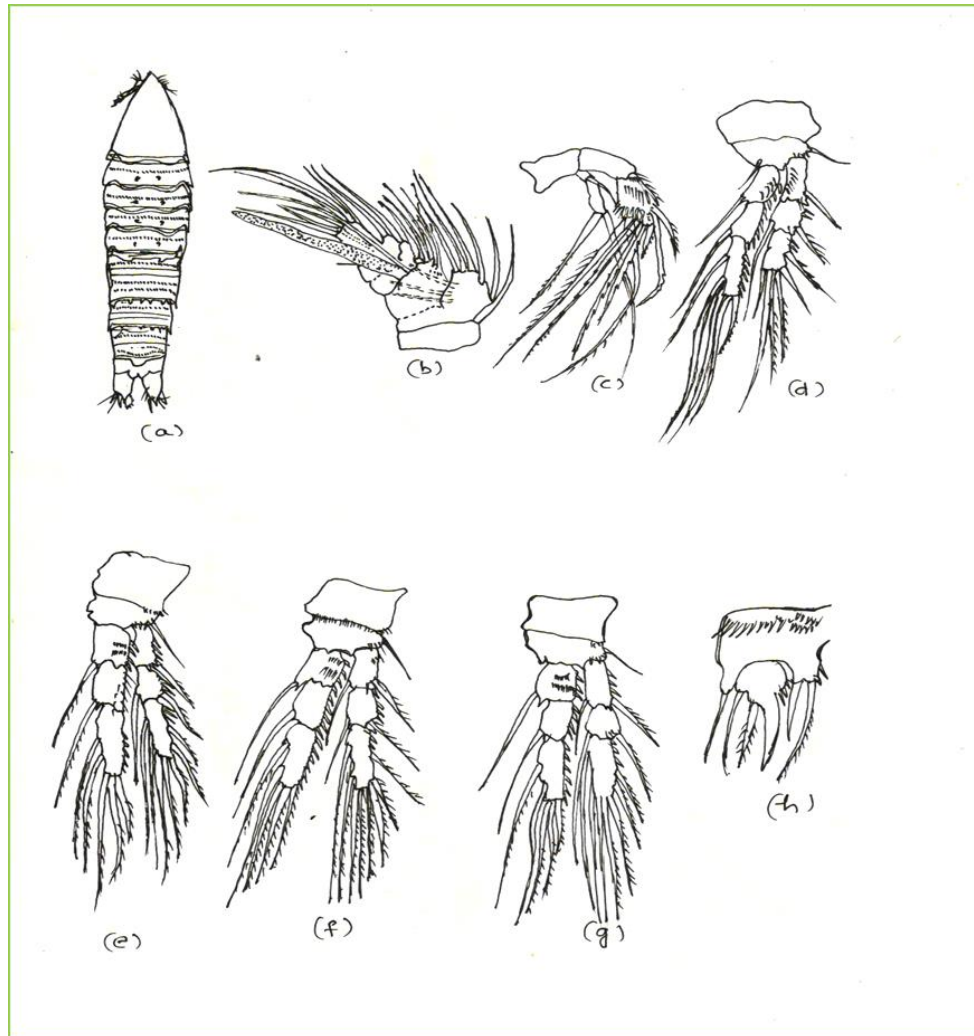
Genus: *Pseudobradya* Sars G.O., 1904

Pseudobradya cornuta Lang, 1965

1965. *Pseudobradya cornuta* Karl Lang, Copepoda Harpacticoidea from the Californian Pacific Coast. Part. I

Female. (Fig. a). Length about 1.1 mm. Body fusiform. Posterior dorsal edge of cephalothorax and thoracic somites closely set with hair-fine spinules, thoracic somites also with one continuous dorsal and lateral row of hair-fine spinules across anterior third, and behind this row, one sensilla on each side of dorsal middle line. Cephalothorax about as long as thoracic somites combined, gradually tapering in front; rostral projection of moderate size, acuminate at tip.Pseudopericulum broadly rounded, bare. Furcal rami about 1.3 times as long as wide at base, slightly tapering behind, each produced at end to one ventral and two dorsal hyaline triangular lappets; outer distal corner with one moderately strong spine and two thin setae; distal dege with one very strong inner spine, hairy on its inner edge, and two setae, the outer dilated proximally and about half as long as the inner.

Antennule (Fig. b) robust, six-segmented. Second and third segments indistinctly defined, each running out into a setiferous lobule. Aesthetasc long and remarkably strong.



Antenna (Fig. c). Basis nearly as long as first endopodite-segment, bare. Exopodite bimerous; first segment short with one seta, second segment long, with two terminal setae of different lengths. First endopodite-segment bare; second segment with three transverse rows of spinules, with two spiniform, one-sided spinulose setae on anterior edge, and with one short and five long setae on distal edge, all setae being more or less spiniform and spinulose on one side.

First leg (Fig. d). Coxa bare. Basis with some few spinules on anterior surface, just inside outer, spiniform seta; inner seta spiniform. First and third exopodite-segments subequal in length, second segment much shorter outer edge of each segment more or less spinulose; first and second segments each with one short longitudinal row of spinules on anterior surface inside outer terminal spine, first segment also with one longitudinal row of spinulose just inside inner edge. Endopodite extending for beyond exopodite; outer edge of each segment spinulose; first two segments subequal in length, each with seta; third segment a little shorter than preceding segments combined; anterior surface of first segment with one longitudinal row of spinules near outer edge.

Legs 2-4 (Fig. e, f, g). Coxa hairy along distal edge, and with some minute spinules at outer distal corner. Basis with one row of spinules on anterior surface just inside outer seta. Middle exopodite-segment shortest, last segment longest; outer edge of each segment more or less spinulose; anterior surface of first

segment with some spinules just inside outer distal corner, anterior surface of second and third leg more over each with one transverse row of hairs near base. Endopodite of second leg extending beyond exopodite, endopodites of third and fourth legs to about end of exopodite; outer edge of each segment spinulose; anterior surface of first segment with two transverse rows of spinules, seta and spine formula:

P- 2			P- 3			P- 4		
Exp.		Enp.	Exp.		Enp.	Exp.		Enp.
1	2	3	1	2	3	1	2	3
1	1	2.2.3	1	1	2.2.1	1	1	2.2.1

Leg 5 (Fig. h). Baseoendopodite remarkably elongated, with four rows and one cluster of strong spinules on anterior surface, with one row of hair-like spinules along inner edge, and with two sub equally long plumose terminal setae, inner edge of exopodite prolonged into a large process (the species name alludes to this character); outer edge with two short bare setae; anterior surface with two transverse rows of spinules in proximal part and one row of spinules just inside middle part of inner edge.

Distribution: India: V.O.Chidambaranar Port during Monsoon (st-2)

Elsewhere: Monterey Bay (off Hopkins Marine station, fine sand and detritus).

Material examined: Two females

Remarks: Present specimens from V.O.Chidambaranar Port agree well with the original description. Length: 1.1 mm, the description body fusiform and Body dorsally ornamented.

Family: Harpacticidae Dana, 1846

Genus: *Zaus* Goodsir, 1845

Zaus spinatus spinatus Goodsir, 1845

1965. *Zaus spinatus spinatus* Karl Lang, Copepoda Harpacticoida from the Californian Pacific Coast. Part. I
Female (Fig. a). Length about 0.56 mm. Cephalothorax and thoracic somites together about 2.5 times as long as abdomen. Cephalothoraxes about 1.5 times as broad as long (in somewhat pressed state), broadly rounded in front, lateral edges with scattered hairs, rostrum slightly prominent, with one sensory seta on each side of broadly rounded tip. Epimeral plates of first three thoracic somites each with one short hair near distal corner, epimeral plates of third somite moreover with one minute hair near middle of edge, no dorsal hairs, genital double – somite subdivided by a chitinous stripe, which dorsally is somewhat diffuse, lateral edges of anterior part and distal corners of posterior part with hairs or minute spinules; no dorsal hairs; posterior ventral edge spinulose. Sixth leg with one very short seta present. Furcal rami divergent, broader than long, with outer distal corner prolonged into a lobule antepenultimate somite, dorsally unornamented.

Antennule (Fig. b). Nine - segmented. Second and third segments subequal in length, and about 1.75 times as long as first, Fourth segment about as long as first, terminal part about as long as third segment. All segments furnished with bare setae, fourth and last segments moreover each with an aesthetic.

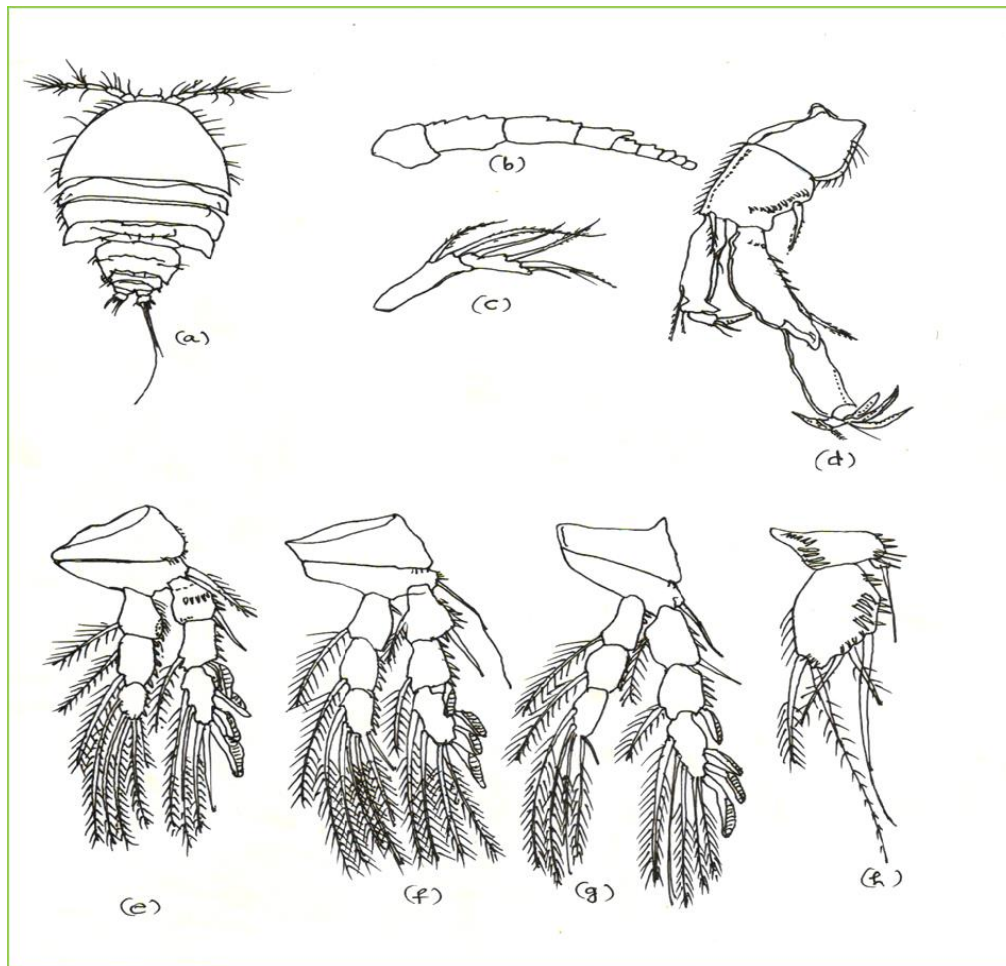
Antenna (Fig. c). Allobasis with one row of spinules one seta on anterior edge and two long terminal setae, the inner as long as thoracic and abdominal somites combined, and about twice as long as outer.

Leg 1 (Fig. d). Coxa a little shorter than basis long haired along distal part of outer edge. Basis without spinules in inner proximal part, and with one longitudinal row of spinules inside outer edge; inner edge long-haired; one minute plumose seta near inner distal corner; outer spine minutely plumose, situated just above middle of edge. First exopodite – segment about as long as second, distally running out into a triangular, hyaline lobule; outer edge with hairs, and with one minutely plumose seta at distal corner; second segment

with one seta in distal part of outer and inner edges, and with one very fine terminal seta and four brush-like terminal claws. Second segment with one brush – like claw, one comparatively strong, bare and almost straight seta, and one very delicate seta.

Leg 2-4 (Fig. e, f, g). Coxa with some minute spinules near outer distal corner, coxa of second leg moreover with one row of long hairs above spinules. First exopodite-segment of fourth leg, however with no transverse row of spinules in upper part of anterior surface.

Leg 5 (Fig. h). Baseoendopodite very broad, densely ciliated along distal edge, except for part between the two outer setae; four terminal setae, the two outer much longer than the two inner; outermost but one seta about 1.7 times as long as outer seta. Exopodite broadly oval in form, spinulose along distal part of edge. Hairy or finely spinulose on inner edge, five setae the middle one shorter and stronger than the others and spinulose along edges.



Male. Male is smaller than female abdomen ventrally ornamented as in female

Antennule as in female

Anatenna oral, parts and first four pair of legs as in female.

Distribution: India: V.O.Chidambaranar Port during Monsoon (sts.5, 13, 17, 21), Post monsoon (st-3) and Cold weather season (st-21)

Elsewhere: Isles Monterey Bay, Point Pinos, great tidal pool and rinsing of algae. North Atlantic Ocean – European waters; North West Atlantic waters.

Material examined: Two males, five females.

Remarks: Present specimens from V.O. Chidambaranar Port agree well with the original description. Length:0.56 mm, Body fusiform and ventrally ornamented, moderately slender and widest in front of middle. Cephalothorax and thoracic somites together about 2.5 times as long as abdomen. Cephalothoraxes about 1.5 times as broad as long (in somewhat pressed state), broadly rounded in front, lateral edges with scattered hairs, Rostrum of same form as in preceding species. Epimeral plates of first three thoracic somites each with one short hair near distal corner, epimeral plates of third somite moreover with one minute hair near middle of edge, no dorsal hairs, and genital double – somite subdivided by a chitinous stripe, which dorsally is somewhat diffuse

CONCLUSIONS

This is the first report of species *Ectinosoma tenuipes*, *Halectinosoma unicum*, *Bradya typica*, *Pseudobradia cornuta* and *Zaus spinatus spinatus* in Indian waters and contributes to the knowledge about the morphological and ecological features of this species. This record will contribute to the copepod checklist of Indian seas.

ACKNOWLEDGEMENTS

This work was carried out with the financial assistance provided by the Ministry of shipping, Road Transport and Highways in collaboration with National Institute of Oceanography, Goa under the Ballast Water Management Project (NIO/BWM/No. A.V (1)/NIO Project/Zoology/30911/2011).

REFERENCES

- Ansari KG, Lyla PS, Khan SA, Manokaran S, Raja S (2013).** Community structure of harpacticoid copepods from the southeast continental shelf of India. *Proceedings of the International Academy of Ecology and Environmental Sciences*, **3**(2) 87-100.
- Chertoprud ES, Gheerardyn H, Gomez S (2013).** Community structure of harpacticoid copepods in intertidal and shallow-water habitats of Cat Ba archipelago (Vietnam, South China Sea). *Marine Biological Association of the United Kingdom. Journal of the Marine Biological Association of the United Kingdom*, **93**(1) 95.
- Davis C (1955).** The Marine and Fresh-water Plankton. Michigan State University press.
- Gray JS, Elliott M (2009).** Ecology of Marine Sediments: From Science to Management. Oxford University, USA, pp: 225.
- Hartzband DJ, Hummon WD (1974).** Sub-community structure in subtidal meiobenthic Harpacticoida. *Oecologia*, **14** 37-51.
- Hicks GRF, Coull BC (1983).** The ecology of marine meiobenthic harpacticoid copepods. *Oceanography and Marine Biology: An Annual Review*, **21** 67-175.
- Holme NA, McIntyre AD (1984).** Methods for the Study of Marine Benthos. Blackwell Scientific Publications, Oxford, pp: 217-244.
- Huys R, Gee JM, Moore CG, Hammond R (1996).** Marine and brackish water harpacticoid copepods. Part 1. *Synopses of the British Fauna (New Series)*, **51** 1–352.
- Ivester MS (1980).** The distribution of meiobenthic copepods along a sediment gradient: factor and niche analysis. *Bulletin of Marine Science*, **30** 634-645.
- Kondalarao B (1984).** Distribution of meiobenthic harpacticoid copepods in Gautami Godavari estuarine system. *Indian Journal of Marine Sciences*, **13**(2) 80-84.
- Lang K (1965).** Copepoda Harpacticoida from the Californian Pacific coast. *Kunglige Svenska Vetenskapsakademiens Handlingar, Fjarde Serien*, **10**(2) 1–560.
- Lang K (1948).** Monographie der Harpacticiden. Nordiska Bokhandeln, Stockholm. Vols. **1, 2**. Vol. **1**:1–896; Vol. **2**: 897–1682.

- Mantha G, Moorthy MSN, Altaff K, Dahms HU (2012).** Community structure of the apacticoida (Crustacea: Copepoda) on the coast of Chennai, India. *Zoological Studies*, **51** 463-475.
- Olafsson E (1995).** Meiobenthos in mangrove areas in eastern Africa with emphasis on assemblage structure of free-living marine nematodes. *Hydrobiology*, **312** 47-57.
- Sajan S, Damodaran R (2007).** Faunal composition of meiobenthos from the shelf region off west coast of India. *Journal of the Marine Biological Association of India*, **49** 19-26.
- Suárez-Morales E, Fuentes-Reinés JM (2015).** Two new species of ectinosomatid copepods Harpacticoida: Ectinosomatidae) from the Caribbean coast of Colombia. *Revista Mexicana de Biodiversidad*, **86**(1) 14-27.
- Thistle D (1978).** Harpacticoid dispersion patterns: implications for deep-sea diversity maintenance. *Journal of Marine Research*, **36** 377-397.
- Wells JBJ (1976).** Key to Aid in the Identification of Marine Harpacticoid Copepods. Department of Zoology, University of Aberdeen, U.K., 215.