



FOUR NEW RECORDS OF BENTHONIC HARPACTICOIDA (COPEPODA, CRUSTACEA) FROM NEW MANGALORE HARBOUR IN INDIAN WATERS

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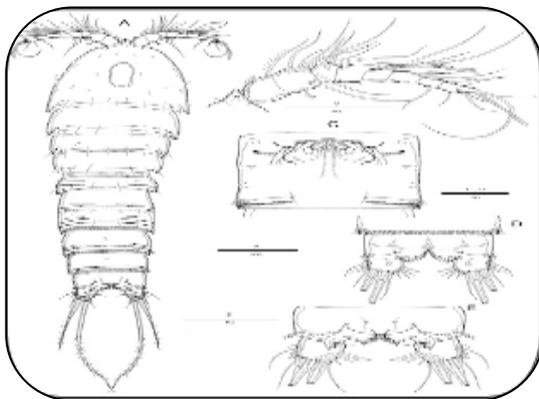
ABSTRACT:

The present study provides information about the systematics of copepods along the New Mangalore Harbour during the period from November 2011 to December 2012. Altogether 23 species belonging to 11 genera and 5 families were identified from the New Mangalore Harbour out of which 4 species were found to be new reports from the Indian waters. Species are described below as *Pseudobradya pectinifera* (Ectinosomidae) and *Dactylopusia crassipes* (Thalestridae), *Delvalia latipes* and *Sarasamphiascus undosus* (Diosaccidae).

Key words: Harpacticoid copepods, marine benthos, New Mangalore Harbour.

INTRODUCTION

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 copepod and some are living on the ocean seafloor called as benthic copepod. The benthic copepods are comes under the harpacticoida order. This order comprises 463 genera and about 3,000 species in the marine environment. This harpacticoida represents the second largest meiofaunal group in the marine sediment after the nematode and serve as major food source to the benthic macrofauna. In marine



environments, the planktonic forms represent as a predominant source of food for jellyfish, basking sharks, and whales [4].

Harpacticoid copepods, a significant component of the meiobenthos, prey on microalgae and bacteria, bioturbate the sediment (with burrowing activities), enhance recycling of bacterial material, and return accumulated nutrients to the benthos when they die [6]. Harpacticoid copepods are also

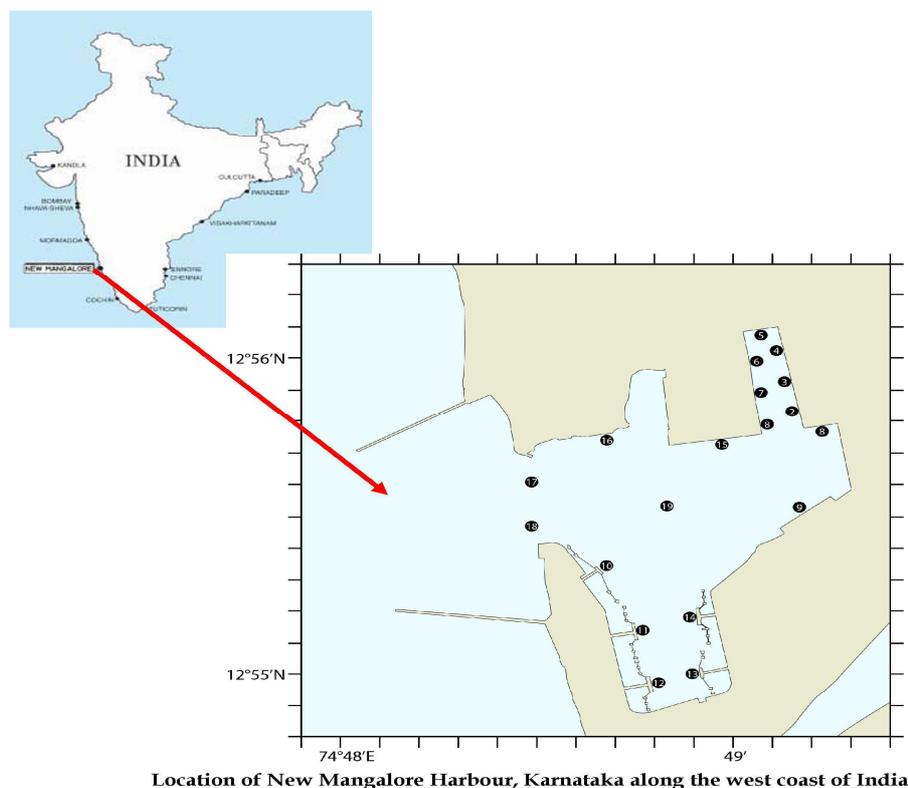
important prey of invertebrate species and for a short time during the early life history of several fish species, the importance of these copepods to the survival of their predators may be crucial [5, 3, 16, 11, 01, 8, 9, 13 and 15]. Moreover, harpacticoids are more sensitive to pollutants than nematodes, which make them good indicators of pollution [2 and 12]. Seasonal and annual variation in abundance of harpacticoid copepods may be related to the growth and survival of populations of commercially important species [7 and 14].

MATERIALS AND METHODS

Study Area

The present study is aimed at obtaining a comprehensive account of meiobenthos in terms of species composition, diversity and assemblage/community structures of New Mangalore Harbour located in Dakshina Kannada district in south western Karnataka. Findings on meiobenthos composition and abundance in New Mangalore Harbour presented in this Paper are based on observations made at 18 pre-determined (GPS fixed) locations in the province of New Mangalore Harbour between latitudes $12^{\circ}55' 44''$ N to $12^{\circ} 55' 30''$ N and longitudes $74^{\circ} 49' 12''$ E to $74^{\circ} 48' 50''$ E .(Figure.1). The observations (228 samples) were made during four seasons namely post-monsoon season (November-2011), pre-monsoon season (May-2012), monsoon season (September-2012) and cold weather season (December-2012). GARMIN E-Trex GPS (Global Positioning System), USA was used for navigation on board.

Figure 1: Schematic map of the sampling location and stations with Latitude and Longitude of New Mangalore Harbour.



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 infaunal 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.

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 cm². Taxonomic classification of constituent species was carried out based on standard literature [10 and 17].

Results and Discussion

In the study area, the overall Bottom water temperature varied with seasons wise ranged between 24.80 °C (Monsoon) and 29.60 °C (Post-Monsoon), salinity ranged from 34.00 PSU (Monsoon) to 36.70 PSU (Pre-Monsoon) and dissolved oxygen ranged from 0.20 ml.l⁻¹ (Monsoon) to 6.20 ml.l⁻¹ (Cold weather season). Sediment organic matter (%) ranged from 0.13 (Cold weather season) to 4.14 (Cold weather season) and most of the study sites were characterized by sand-silt-clay and silty-sand (Table.1).

Table1. Sea water temperature, salinity, dissolved oxygen (DO) and organic carbon (OC) content of New Mangalore Harbour.

	Post Monsoon (Nov-2011)	Pre Monsoon (May-2012)	Monsoon (Sep-2012)	Cold Weather Season (Dec-2012)
Temperature (°C)	29.60-29.20 29.47±0.14	28.40-27.60 28.00±0.25	25.40-24.80 25.05±0.15	29.30-28.60 29.09±0.16
Salinity (PSU)	36.10-35.00 35.90±0.26	36.70-35.70 36.03±0.30	34.90-34.00 34.71±0.24	34.90-34.30 34.75±0.15
DO (ml.l ⁻¹)	4.30-0.60 2.55±1.05	5.10-1.30 2.58±0.78	1.90-0.20 0.77±0.42	6.20-3.10 4.22±0.83
OC (%)	1.75-2.78 2.31±0.33	1.43-2.77 2.06±0.38	0.41-4.12 2.52±0.89	0.13-4.41 2.45±1.18

The values represent the range, mean ±S.D

In the present study, altogether 23 species belonging to 11 genera and 5 families were identified. The members of the sub orders Harpacticoida (*Pseudobradya pectinifera*, *Dactylopusia crassipes*, *Delvalia latipes*, and *Sarasamphiascus undosus*) were found to be new records for Indian waters. The characteristics of these species are described below.

Systematics

Phylum: Arthropoda

Class: Crustacea Brunnich, 1772

Order: Copepoda Maline-Edwards.1840

Sub order: Harpacticoida Sars M., 1903

Family: Ectinosomidae Sars, Olofsson, 1903

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

Species: *Pseudobradya pectinifera* Lang, 1965

1965. *Pseudobradya pectinifera* Karl Lang, Copepoda Harpacticoida from the Californian Pacific Coast. Part. I

Diagnosis: Female (Figure.2a):-

Length 0.65 mm. Body is subfusiform. Cephalothorax fully as long as thoracic somites combined, rostral projection short, obtusely rounded at tip. Abdominal somites spinulose posterior edges, ventro-median spinules very small and hair-like. Pseudopericulum extending end of last somite, pectinal at tip, with seven teeth (the name of the species alludes to this character); Furcal rami divergent, almost twice as long as wide at base, slightly tapering behind, dorsally running out into a hyaline triangular lappet; outer edge with one spine and some spinules near end; distal edge with one moderately strong bare inner spine, and with two well-developed setae, the outer one about as long as last three somites combined.

Antennule (Fig.2b): Short and robust, six-segmented, second segment very short, third segment with a strong sauge-shaped aestheasc. Terminal part about as long as two preceding segments combined.

Antenna (Fig.2c): Coxa is small, bare. Exopodite bimerous, longer than first endopodite-segment; First segment is short with one bare setae; second segment long and slender, with two bare terminal setae of unequal length. First endopodite –segment as long as second, without seta; second segment with two spiniform, one-sided spinulose setae near end of anterior edge; distal edge with six one-sided spinulose setae,

the anterior of which is very short. The oral parts are so overgrown with filiform algae that their construction cannot be made out

Leg-1 (Fig.2d): Coxa with some spinules at outer distal corner. First and third exopodite–segments subequal in length, second segment much shorter, outer edge of each segment more or less spinulose. Endopodite extending for beyond exopodite; first and second segment subequal in length, each with one inner seta, third segment almost long as two preceding segments combined, with two inner setae, outer edge of each segment with long spinules.

Leg-2-4 (Fig.2e-g): Coxa is hairy along outer distal corner. Basis with small dentiform projection between exo-and Endopodite and with a similar projection just inside Endopodite; Middle exopodite-segment shortest, first segment longest; outer edge of each segment spinulose. Enopodites extending beyond exopodites, Endopodite of forth leg shorter than those of second and third legs; outer edge of each segment with long spinules seta and spine formula as:

Leg-2						Leg-3						Leg-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	2.2.1	1	1	3.2.3	1	1	2.2.1

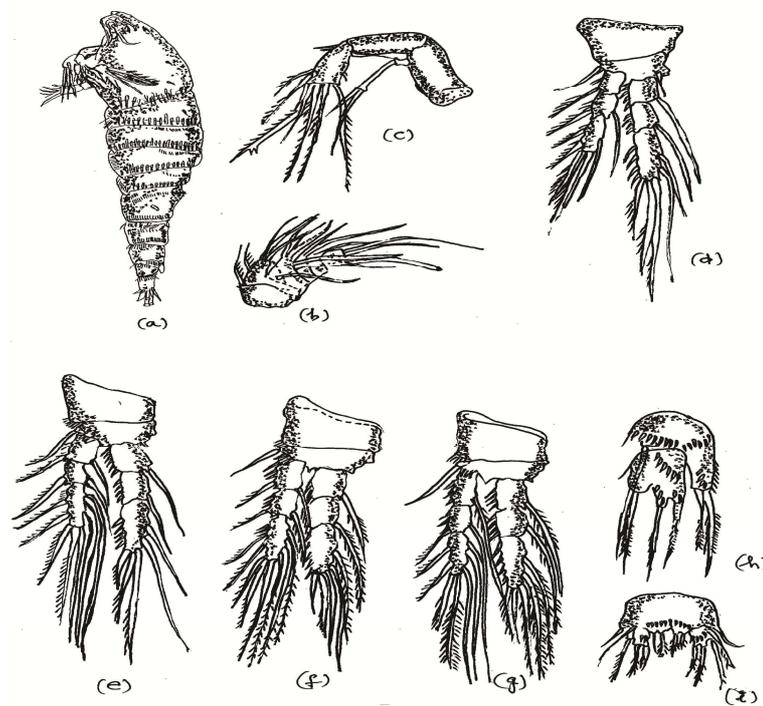


Fig. 2- *Pseudobradya pectinifera* n.sp. female. a. whole animal, dorsal view; b. antennule, c. antenna d. P1 e. P2 f. P3 g. P4 h & i. P5.

Leg-5 (Fig.2h&i): Baseoendopodite remarkably lengthened, with one transverse row of spinules on anterior surface near base of strong surface-seta, and with two longitudinal rows of spinules, one extending from upper inner distal corner to base of exopodite, the other situated in distal part; distal half of inner edge spinulose; distal edge with two at base somewhat thickened setae; outer seta plumose and a little shorter than inner seta, which is one-sided hairy. Exopodite longer than broad, unequally trilobed at end; distal setae strong of moderate length, more or less plumose; anterior surface with a chitinous stripe extending from outer edge of middle lobe to near base of ramus, with one arched row of spinules extending from about middle of base to upper third of inner edge, and with one oblique row of spinules near end of middle as well as of inner lobe.

Distribution: India: New Mangalore Harbour: During cold weather season (St.02).

Elsewhere: Monterey Bay, off Hopkins Marine station, fine sand and detritus, at about 26 m depth.

Material examined: One female.

Remarks: Present specimen from New Mangalore harbour agree well with the original description. The body length of the present specimens ranged from 0.63 mm – 0.65mm; Body is subfusiform, rostral projection short. Antennule Short and robust, six-segmented. Exopodite longer than broad in fifth leg.

Family: Thalestridae Sars, Lang

Genus: *Dactylopusia* Norman, 1903

Species: *Dactylopusia crassipes* Lang, 1965

1965. *Dactylopusia crassipes* Karl Lang, Copepoda Harpacticoidea from the Californian Pacific Coast. Part. I

Diagnosis: Female (Fig.3a):-

Length 0.8 mm. Body is subpyriform in shape, anterior part depressed. Rostrum broadly rounded in front with a minute sensory seta on either side near tip. Genital double-somite tapering behind, subdivided by a chitinous stripe; anterior part with three dorso-lateral sensillae; distal corners of posterior part with a lateral row of spinules, ventrally with four sensillae; Sixth leg with one seta and two diminutive spinules just inside seta. Antepenultimate somite ornamented as posterior part of preceding somite. Penultimate somite bare. Hyaline frill of somites mentioned undulated ventrally. Last somite laterally and ventrally with a row of spinules above furcal rami. Anal operculum triangularly rounded, densely set with diminutive hairs. Furcal rami broader than long, with one spine and two setae at outer distal corner, one short seta at inner distal corner; inner principal terminal setae, about as long as last thoracic somite and abdominal somite combined, and about 1.3 times as long as outer.

Antennule: Antennule (Fig.3b) eight-segmented, comparatively short and robust. First segment spinulose along anterior edge, and with two transverse rows of spinules just inside anterior edge. Fourth and last segments each with an aesthetase. Terminal part fully as long as three preceding segments combined. All segments with bare setae.

Antenna (Fig.3c): Coxa small, bare. Allobasis about of same length as Endopodite, with one very long, plumose seta somewhat in front of middle of anterior edge. Exopodite-segments with two, one and three plumose setae, respectively, counting distad; last segment moreover with one diminutive terminal setula. Endopodite with two strong spines near end of anterior edge, and with two small setae inside base of distal spine; distal edge with two strong spines; four long geniculate bare setae, and one shorter plumose seta, with base in common with the posterior seta.

Leg-1 (Fig.3d): Coxa with two long almost transverse rows of diminutive hairs on anterior surface; distal part of outer edge with slender spinules; posterior surface with one longitudinal row of setulae just inside spinulose part of outer edge; one short row of minute spinules near distal end of inner edge. Basis spinulose along outer edge and above greater part of exopodite; outer spine strong; anterior surface with an arched row of comparatively large spinules just above endopodite, and a similar row of spinules at base of strong inner spine; posterior surface with an arched row of slender spinules or hairs near inner edge. First and second exopodite-segments spinulose along outer edge, first segment moreover with some spinules on distal edge and in distal middle part of anterior surface; second segment about twice as long as first, with a few hairs in proximal part of inner edge; last segment with one geniculate seta, three pectinate claws, one short spine and one diminutive hair. Endopodite comparatively short, about 1.3 times as long as exopodite; outer edge of each segment spinulose; first segment with one strong long-plumose seta about middle of inner edge; last segment terminally with one spinule and two pectinate claws, inner claw about twice as long as outer.

Leg-2-4 (Fig.3e-f): Anterior surface of coxa with one longitudinal row of minute spinules near outer edge. Basis with a few spinules at base of outer seta, and with a row of diminutive hairs on distal edge above endopodite. Segments of exo- and endopodites comparatively short and thick (the species-name alludes to this character). Exopodite spinulose along outer edge, outer distal corner of first and second segments slightly prolonged; first and last segments subequal in length, middle segment shorter; last segment broadly oval in form. Endopodites of second and third legs extending to about middle of last exopodite-segment that of fourth leg a little beyond second exopodite- segment; last segment comparatively broad and short; all segments spinulose along outer edge. Seta and spine formula:

Remarks: Present specimen from New Mangalore harbour agree well with the original description. Body is subpyriform in shape, anterior part depressed. Rostrum broadly rounded in front with a minute sensory seta on either side near tip. Antennule eight-segmented comparatively short and robust. Exopodite rounded with six bare setae, innermost seta longest in fifth leg.

Family: Diosaccidae Sars,

Genus: *Delavalia* Brady, 1868

Species: *Delavalia latipes* Lang, 1965

1965. *Delavalia latipes* Karl Lang, Copepoda Harpacticoidea from the Californian Pacific Coast. Part. I

Diagnosis: Female (Fig.4a):-

Length 0.63 mm. Body Pyriform, about as robust as preceding species. Thoracic somite unornamented. Genital double-somite and succeeding somite each with three spinules, visible in dorsal as well as in lateral view, laterally and ventro-laterally with a sensillae. Cephalothorax tumid, almost as long as the thoracic somites combined. Rostrum prominent, attenuated distally, with the short tip slightly emarginated. Cephalothorax together with thorax twice as long as abdomen. First three abdominal somites ventrally unornamented; posterior lateral and ventral edges of last somite with spinules; for dorsal and lateral ornamentation. Anterior part of genital double-somite conspicuously dilated with rounded lateral edges, dorso-laterally and laterally with a chitinous stripe, dorso-medianly and ventrally undivided. Last somite hardly widened towards end. Operculum is curved, bare. Furcal rami almost parallel, about as long as last two somites combined; principal terminal furcal setae proximally dilated, inner one fully twice as long as outer.

Antennule (Fig.4b): Antennule eight-segmented. First segment twice as long as second. Aesthetasc about as long as last four segments combined. Seventh segment without plumose seta. Terminal part scarcely as long as first two segments combined.

Antenna (Fig.4c): Coxa small, bare. Anterior edge of Allobasis with a few fine spinules and in front of base one long seta. First and second exopodite-segments each with one long seta, third segment with one ventral seta near base, three terminal setae and some hairs on outer edge. Endopodite with some fine spinules and three shorter spiniform setae on anterior edge, and with six terminal setae.

Leg-1 (Fig.4d): Coxa with some hair-like spinules about middle of outer edge, and with two rows hair-like spinules on anterior surface. Basis with some hairs near proximal inner corner, one long row are fine spinules on anterior surface just above inner spine, one row of hair-like spinules about middle of anterior surface, some hair-like spinules above outer seta, in gap between exo-and endopodite, and above base of endopodite. First two exopodite-segments about equal in length, third segment shorter; middle segment with long inner seta,

distal segment with four setae and spines in all. Endopodite remarkably wide (the species-name alludes to this ramus), much shorter than exopodite; first segment with strong inner spine and above this some hair-like spinules, anterior surface with one transverse row of spinules; second segment very short with three strong plumose setae.

Leg-2-4 (Fig.4e-f): Coxa with two rows of spinules on anterior surface, near outer edge. Basis with a dentiform projection between exo- and endopodite and at inner distal corner. Middle exopodite-segment shorter; third segment a little longer than first. Endopodite of second and third legs extending to about end of exopodite that of fourth leg only a little beyond ends of second exopodite-segment. Seta and spine formula:

Leg-2			Leg-3			Leg-4		
Exp		Enp	Exp		Enp	Exp		Enp
1	2	3	1	2	3	1	2	3
1	1	2.2.3	1	1	3.2.3	1	1	3.3.0
1	2	1.3.0	1	1	3.2.3	1	1	3.2.3
1	2	1.3.0	1	1	3.3.0	1	1	2.3.0

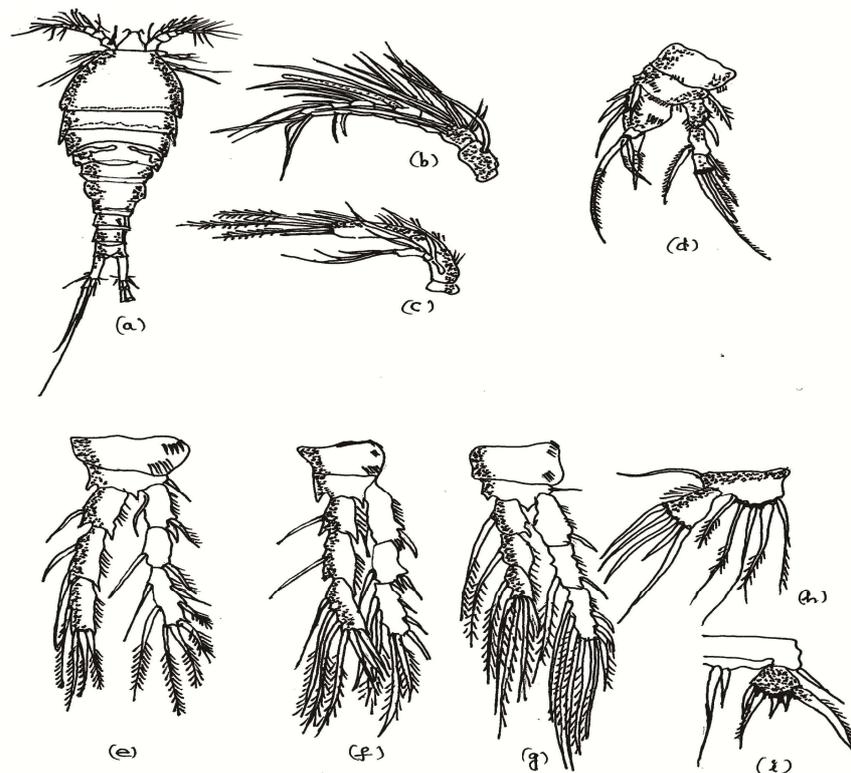


Fig. 4- *Delvalia latipes* n.sp. female. a. whole animal, dorsal view; b. antennule, c. antenna d. P1 e. P2 f. P3 g. P4 h & i. P5.

Leg-5 (Fig.4h): Baseoendopodite wide, slightly prominent with five plumose terminal setae, that middle and outermost but one longest. Exopodite spatulate in form with two setae on outer edge, and with four setae on distal edge, outermost but one very short. Ovisacs with 4-5 eggs.

Distribution: India: New Mangalore Harbour: During pre-monsoon (St.02).

Elsewhere: Monterey Bay, off Hopkins Marine Station, fine sand and detritus at about 26 m depth.

Material examined: One female.

Remarks: Present specimens from New Mangalore harbour agree well with the original description. The body length of the present specimens ranged from 0.61 mm. Body Pyriform, about as robust as preceding species. Antennule is eight-segmented.

Family: Diosaccidae Sars,

Genus: *Sarasamphiascus* Huys, 2009

Species: *Sarasamphiascus undosus* Lang, 1965

1965. *Sarasamphiascus undosus* Karl Lang, Copepoda Harpacticoidea from the Californian Pacific Coast. Part. I

Diagnosis: Female (Fig.5a):-

Length is about 0.75 mm. Body moderately slender, slightly tapering behind. Cephalothorax, rostrum excluded, fully as long as three succeeding somites together, with some scattered hairs on lateral edges, and some sensillae just in front of hyaline frill. Rostrum is prominent, with one sensory seta on each side in some distance from the evenly rounded tip. First two thoracic somites each with one hair near posterior corners, posteriorly ornamented as Cephalothorax. Third and fourth somites without hairs near posterior corners, posteriorly with two and four sensillae, respectively. Abdomen(Fig-1). Genital double-somite subdivided by a chitinous stripe, leaving a gap in the middle of ventral surface; anterior part with two dorso-lateral and two ventro-lateral sensillae just in front of chitinous stripe, and with two ventral rows of hairs on either side of sixth leg; posterior part with some scattered sensillae on posterior edges, and with one continuous dorsal and latero-dorsal row of delicate hairs along the limit of the hyaline frill. Genital area as in Sixth leg with two setae and one outer plumose spinule. Antepenultimate somite with some scattered sensillae just in front of hyaline frill. Penultimate somite with one row of hairs along dorsal limit of hyaline frill, the hairs decreasing in length laterally; hyaline frill forming a broad pseudopericulum. Hyaline frill of somites mentioned not dissected. Last somite with spinules on posterior edge; anal operculum slightly arched, bare. Furcal rami broader than long, each with a few spinules on inner edge, with one strong seta and one plumose spine near outer distal corner, and with one dorsal seta, biarticulate at base just above innermost terminal seta, which is

spiniform and somewhat angularly bent; inner principal terminal seta undulate in proximal part of inner edge (the species-name alludes to this character), about as long as last two thoracic somites and abdominal somites together, and about twice as long as outer principal seta.

Antennule (Fig.5b): Antennule eight-segmented. Second segment about 1.5 times as long as first, and about twice as long as third. Fourth segment about 1.3 times as long as third, with a comparatively strong aesthetase. Terminal part about as long as second and third segments combined.

Antenna (Fig.5c): Coxa small, bare. Allobasis with one plumose seta about middle of anterior edge. Exopodite three-segmented; first segment with, second segment without seta, third segment with one seta near base of inner edge, and two apical setae; all setae plumose. Endopodite with a row of spinules two strong spines on anterior edge; distal edge with one strong spine, four geniculate setae, the posterior one having base in common with a straight slender seta, and with one short slender seta between the two posterior geniculate setae.

Leg-1 (Fig.5d): Coxa with one row of long fine hairs issuing from posterior surface just inside outer edge; anterior surface with three rows of spinules and one row of delicate hairs. Basis with spinules at base inner spine; distal edge with spinules above endopodite; a few spinules between outer spine and exopodite. First two exopodite-segments subequal length, third segment shorter; inner edge of last two segments with some hairs; middle segment without inner seta. First endopodite-segment much longer than exopodite, and about 3.7 times as long as succeeding segments combined, with one row of spinules in proximal part outer edge, and one row of hairs above inner distal seta, the outer one unguiform.

Leg-2-4 (Fig.5e-f): Coxa with row of delicate hairs on proximal edge, three rows of spinules on anterior surface, and hairs along anterior distal corner, issuing from posterior surface. Basis with one small dentiform projection between exo- and endopodite and one at inner distal corner; a short row of delicate spinules above endopodite and some few spinules between outer seta and exopodite; outer seta of second edge spiniform and plumose, of succeeding legs very thin and bare. Last exopodite-segment longest, middle shortest; outer edge of each segment more or less spinulose; outer distal corner of middle segment dentiformly prolonged. Endopodites of second and third legs extending almost to end of exopodites, that of fourth leg to about proximal fourth of last exopodite-segment; outer edge of each segment spinulose; outer distal corner of middle segment dentiformly prolonged. Seta and spine formula:

Leg-2			Leg-3			Leg-4		
Exp		Enp	Exp		Enp	Exp		Enp
1	2	3	1	2	3	1	2	3
1	1	1.2.3	1	1	1.2.3	1	1	3.2.3
1	2	1.2.1	1	1	3.2.1	1	1	2.2.1

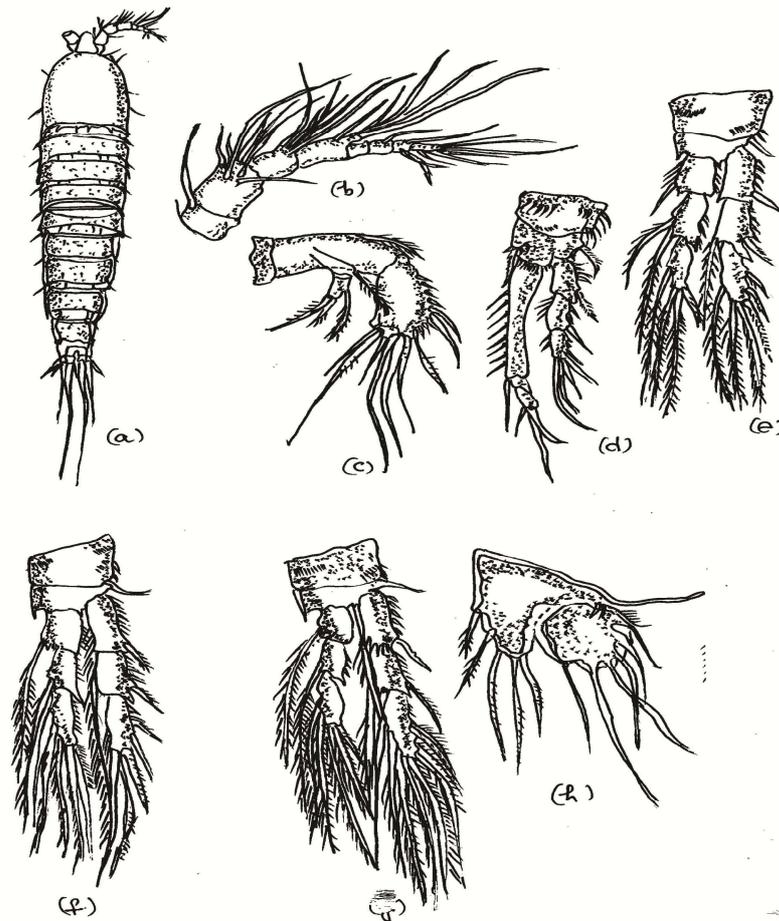


Fig. 5- *Sarasamphiascus undosus* n.sp. female. a. whole animal, dorsal view; b. antennule, c. antenna d. P1 e. P2 f. P3 g. P4 h. P5

Leg-5 (Fig.5h&i): Inner expansion of baseoendopodite extending somewhat beyond middle of exopodite; three setae on inner edge, two proximal ones spiniform and spinulose along distal half of lateral edges, distal one long slender and plumose; two slender plumose terminal setae, the outer one shortest; a great hyaline part inside outer edge. Exopodite broadly rounded, hyaline inside edges, with exception of the parts to which the marginal setae are attached; one inner plumose seta, three outer and two bare terminal setae.

Distribution: India: New Mangalore Harbour: During post-monsoon (Sts.3 and 18), pre-monsoon (St.02) and during monsoon (St.16).

Elsewhere: Monterey Bay, off Hopkins marine Station, fine sand, detritus and algae at about 26 m depth.

Material examined: Three females.

Remarks: Present specimen from New Mangalore harbour agree well with the original description. Body moderately slender. Antennule eight-segmented, Exopodite broadly rounded in fifth leg. Male somewhat smaller and more slender than female.

CONCLUSIONS

This is the first report of species *Pseudobradya pectinifera*, *Dactylopusia crassipes*, *Delvalia latipes*, and *Sarasamphiascus undosus* in Indian waters and contribute to the knowledge about the morphological and ecological features of this species. This record will contribute to the copepod checklist of Indian seas.

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