Helgol Mar Res (2010) 64:297–310
DOI 10.1007/s10152-009-0183-6

ORIGINAL ARTICLE

Caprellids (Crustacea: Amphipoda) from India

J. M. Guerra-García · T. Ganesh · M. Jaikumar · A. V. Raman

Received: 24 July 2009 / Revised: 18 November 2009 / Accepted: 20 November 2009 / Published online: 9 December 2009

Abstract The caprellid fauna of India is investigated. A total of 538 samples (including algae, seagrasses, sponges, hydroids, ascidians, bryozoans, encrusted dead corals, coral rubble, fine and coarse sediments) were collected from 39 stations along the coast of India, covering a wide diversity of habitats from intertidal to 12 m water depth. A new species (*Jigurru longimanus* n.sp.) is described, and figures of the 11 valid species reported so far from India are given together with a key for their identification. No caprellids were found in sediments from the northeast (16–20°N) coast of India while they were abundant in the southeast and west coast. Decreases in salinity due to river discharges associated with lower values of oxygen, higher water temperatures and lower nutrient inputs along the east coast could explain these differences in caprellid composition between the two coastlines. Significantly, lower abundance of caprellids in India, as in other tropical ecosystems, is probably related to the lack of species belonging to the genus *Caprella*, which reach very high abundances in temperate waters.

Keywords Amphipoda · Caprellidea · New species · India

Communicated by H.-D. Franke.

J. M. Guerra-García (✉)
Laboratorio de Biología Marina,
Departamento de Fisiología y Zoología,
Facultad de Biología, Universidad de Sevilla,
Avda. Reina Mercedes 6, 41012 Sevilla, Spain
e-mail: jmguerra@us.es

T. Ganesh · M. Jaikumar · A. V. Raman
Marine Biological Laboratory, Department of Zoology,
Andhra University, Visakhapatnam 530003, India

Introduction

In general, there is a lack of studies dealing with the Caprellidea from the Indian Ocean and Indo-Pacific region (McCain and Steinberg 1970). Nevertheless, there is an increasing attempt to improve the knowledge of the Indo-Pacific caprellids, and recent contributions have been published dealing with the Caprellidea from Thailand (Takeuchi and Guerra-García 2002; Guerra-García 2004a), Indonesia (Krapp-Schickel and Guerra-García 2005), Philippines (Guerra-García 2002a), Hong Kong (Guerra-García and Takeuchi 2003), Papua New Guinea (Guerra-García 2003a), northwestern Australia (Guerra-García 2004b), Tanzania and east coast of Africa (Guerra-García 2001, 2002b, c, d) and Mauritius Island (Guerra-García 2003b).

The Caprellidae from India had received only marginal attention in the past. Giles (1888) in his notes on the Amphipoda of Indian waters described two caprellid species for India: *Caprella madrasana* Giles 1888, collected from 11 to 16.4 m, off Madras and Palk's Straits, and *Caprella palkii* Giles 1888, collected from 12.8 m off Palk's Straits. Sivaprakasam (1977) reported that these two species were not recognizable because of poor descriptions and illustrations. In fact, type material of these two species, housed in the Natural History Museum, London, is in a very poor condition, but they seem not to be valid species: *Caprella madrasana* have tiny pereopods 3 and 4 and probably belongs to the genus *Paracaprella*, and *Caprella palki* is originally belonging to the genus *Metaprotella*. After the study of Giles (1888), Mayer (1890) described three new species from Pamban Bridge, Gulf of Mannar: *Metaprotella excentrica* Mayer 1890, *Metaprotella problematica* Mayer 1890 and *Paradeutella bidentata* Mayer 1890, and recorded also *Hemiaegina minuta* Mayer 1890 from Krusadai Island and *Metaprotella haswelliana* *f. taprobanica* Mayer 1890 from Pambam Bridge. Recently, Takeuchi and Lowry (2007) redescribed *Metaprotella haswelliana* based on material from Western Australia and indicated that *M. haswelliana f. taprobanica* is probably a different species from *M. haswelliana* from Western Australia. However, these authors pointed out that in view of the small size of the specimen, probably juvenile, redescription of *M. haswelliana f. taprobanica* should await availability of larger and mature specimens. Mayer (1904) reported four valid species from Sri Lanka (*M. excentrica*, *M. problematica*, *Paradeutella bidentata* and *Monoliropus falcimanus* Mayer 1904). Sundara Raj (1927) listed five species from Pamban: *M. problematica*, *P. bidentatata*, *Hemiaegina quadripunctata* (=*H. minuta*), *Metaprotella haswelliana* (Mayer 1882) and *Pseudocaprellina pambanensis* Sundara Raj 1927. T. E. Sivaprakasam has been the most important contributor to the knowledge of the Caprellidea of India; Sivaprakasam (1969, 1970) reported four species from the Madras coast: *M. falcimanus*, *P. bidentata*, *Paracaprella alata* Mayer, 1903 and *P. barnardi* McCain 1967. Sivaprakasam (1977) represents the best review so far of the Caprellidea from India, reporting nine species of caprellids collected from the Tamil Nadu and Kerala Coasts: *P. pambanensis*, *M. excentrica*, *M. problematica*, *M. falcimanus*, *P. bidentata*, *H. minuta*, *P. alata*, *P. barnardi* and *P. pusilla* Mayer 1890. According to the figures of Sivaprakasam (1977) and the original descriptions of McCain (1967), specimens identified as *P. barnardi* by this author are originally belonging to *P. pusilla*. Recently, Swarupa and Radhakrishna (1983) described the species *Heterocaprella krishnaensis* collected from the Tamil Nadu and Kerala Coasts. Thus, only 10 valid species of caprellids are so far known from Indian waters, viz. *Hemiaegina minuta*, *Heterocaprella krishnaensis*, *Metaprotella excentrica*, *M. haswelliana f. taprobanica*, *M. problematica*, *Monoliropus falcimanus*, *Paracaprella alata*, *P. pusilla*, *Paradeutella bidentata* and *Pseudocaprellina pambanensis*. The present study adds the eleventh, *Jigurru longimanus* n.sp.

During December 2004 and January 2005, the authors conducted a sampling programme targeting caprellids of India, mainly from the East and South coasts. The material contained four species, including *Jigurru longimanus* which is new to science.

Materials and methods

Samples were collected from 39 stations along the Indian coasts (see Station List and Fig. 1), covering a wide diversity of habitats from the intertidal to 12 m depth. A total of 538 samples of potential substrates for the Caprellidae were collected, including algae, seagrasses, sponges, hydroids, ascidians, bryozoans, encrusted dead corals, coral rubble, fine and coarse sediments. The most abundant algae during the study were *Caulerpa taxifolia*, *Caulerpa racemosa*, *Cladophora* spp., *Amphiroa* spp., *Chaetomorpha* spp., *Gracilaria* spp., *Gigartina* spp., *Halarachnion* spp., *Padina* spp. and *Sargassum* spp. The sediment samples were collected by using a van Veen grab (mouth area:

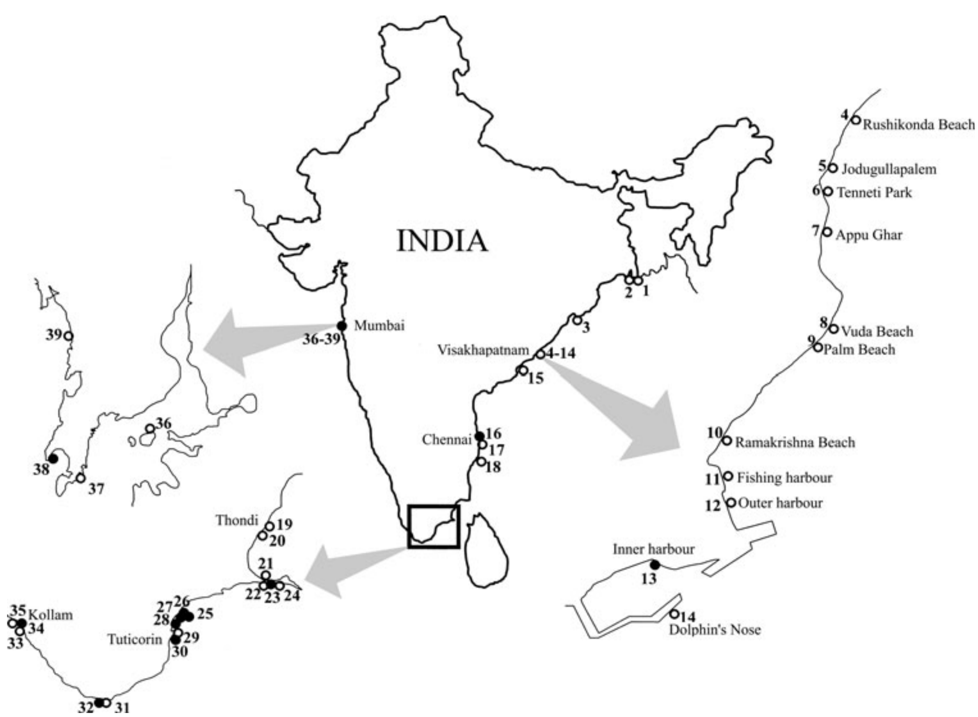

Fig. 1 Study area showing the sampling localities (see station list in the "material and methods" section). *Filled circles*, caprellids present; *open circles*, caprellids absent

0.03 m^2) or manually by dragging fine nylon mesh bags along the bottom. The remaining substrates were collected directly from the intertidal or by snorkelling in shallow waters, and the samples were transferred to labelled polythene bags. The samples were fixed in formalin 4% and then transferred to 70% ethanol. Selected specimens were dissected under a Leica dissecting microscope. Appendages of selected specimens were mounted in polyvinyl lactophenol, and camera *lucida* drawings were made using a Leica compound microscope.

Although the phylogeny and higher classification of the caprellids are still under debate (see Laubitz 1993; Takeuchi 1993; Ito et al. 2008), Myers and Lowry (2003) have recently proposed a new phylogeny and classification for the suborder Corophiidea Leach, 1814. Based on hypothesis of the evolution of different feeding strategies, the Corophiidea is divided into two infraorders, the Corophiida and the Caprellida. In their new classification, the superfamily Caprelloidea contains five families: Caprellidae, Caprogammaridae, Cyamidae, Dulichiidae and Podoceridae. The Caprellidae are subdivided into three subfamilies: Caprellinae, Paracercopinae and Phtisicinae. In the present paper, we have adopted the classification of Myers and Lowry (2003) and have focused our study on members of the family Caprellidae.

The symbols used in the present work are: A1,2 = Antenna 1,2; UL = Upper lip; LL = Lower lip; LMd = Left mandible; RMd = Right mandible; Mx1,2 = Maxilla 1,2; Mxp = Maxilliped; Gn1,2 = Gnathopod 1,2; P5–7 = Pereopods 5–7; Ab = Abdomen; MNCN = Museo Nacional de Ciencias Naturales, Madrid, Spain; LBM = Laboratorio de Biología Marina, Sevilla, Spain. Only an abbreviated list of synonyms is given under each species, since an extensive synonymy is given by McCain and Steinberg (1970).

Station list

Station 1 Diamond harbour beach. Intertidal, sediments (silt and clay). 21 February 2005 (5 samples). No caprellids.

Station 2 Diamond harbour. Fishing harbour. Intertidal, seaweeds. 21 February 2005 (3 samples). No caprellids.

Station 3 Chilika lagoon. Sediments (some areas with the seagrass *Halophila* sp.), 0.3–2 m depth, brackish waters with salinity between 0.55 and 15 psu. September 2004 (54 samples). No caprellids.

Station 4 Rushikonda Beach. Intertidal rocky shore, seaweeds (*Sargassum* sp., *Padina pavonica* among others). 31 January 2005 (12 samples). No caprellids.

Station 5 Jodugulapalem. Intertidal rocky shore, seaweeds (*Gigartina* sp., *Fauchea* sp. among others). 23 January 2005 (8 samples). No caprellids.

Station 6 Tenneti Park. Intertidal rocky shore, seaweeds (*Caulerpa taxifolia*, *Caulerpa racemosa*, *Cladophora* sp., *Chaetomorpha* sp., *Gracilaria* sp. and others). 23 January 2005 (10 samples). No caprellids.

Station 7 Appu Ghar. Intertidal rocky shore, seaweeds (*Enteromorpha* spp., *Amphiroa* spp., and others). 23 January 2005 (5 samples). No caprellids.

Station 8 Vuda Beach (17°43.4′N, 83°20.6′E). Intertidal rocky shores, seaweeds (*Amphiroa* sp., *Caulerpa cf racemosa*, *Ceramium* spp. among others), sponges, tiny hydroids, substrates under boulders. T^a 25–27°C. 14 January 2005 (13 samples). Abundant epiphytic fauna (gammarids, isopods, decapods, tanaids, etc.) but no caprellids.

Station 9 Palm Beach. Intertidal rocky shores, seaweeds (*Sargassum* sp., *Laurencia* spp., *Amphiroa* spp., *Cladophora* spp. among others), sediments 1 m depth, substrates under boulders. 15, 24–25 January 2005 (25 samples). Abundant epiphytic fauna (gammarids, isopods, decapods, tanaids, etc.) but no caprellids.

Station 10 Ramakrishna Beach. Intertidal rocky shores, seaweeds. 16 January 2005 (5 samples). No caprellids.

Station 11 Fishing harbour. Intertidal turf algae, very polluted area. 18 January 2005 (3 samples). No caprellids.

Station 12 Outer harbour. Intertidal seaweeds. 18 January 2005 (3 samples). No caprellids.

Station 13 Harbour. Fouling communities on boats (turf algae, tiny hydroids). 28 January 2005 (5 samples). *Paracaprella pusilla* (42 specimens).

Station 14 Dolphin's Nose. Intertidal seaweeds. 26 January 2005 (10 samples). No caprellids.

Station 15 Kakinada. Mangrove creeks, 1.5 m depth. 1996 (4 samples). No caprellids.

Station 16 Chennai. Fishing harbour (13°7.59′N, 80°17.85′E). Fouling communities on boats (turf algae, tiny hydroids). Salinity 33 psu. 3 February 2005 (15 samples). *Paracaprella pusilla* (10 specimens).

Station 17 Marine Beach (13°3.99′N, 80°17.36′E). Intertidal rocky shore, seaweeds. Salinity 32 psu. 3 February 2005 (5 samples). No caprellids.

Station 18 Mamallapuram (12°36.94′N, 80°11.97′E). Intertidal rocky shores, seaweeds. Salinity 29–30 psu. 11 February 2005 (15 samples). No caprellids.

Station 19 Thondi Beach (9°44.22′N, 79°01.08′E). Fouling communities on boats (turf algae, tiny hydroids). Seaweeds from ropes (*Gelidium* spp and *Gracilaria* spp). Sediments and seagrass *Thalassia* sp., 2–3 m depth. Salinity 25 psu. 4 February 2005 (21 samples). No caprellids.

Station 20 Fishing harbour (9°42.70′N, 78°59.81′E). Fouling communities (seaweeds, sponges, hydroids), 1–2 m depth, snorkelling. Salinity 27 psu. 4 February 2005 (5 samples). Abundant epiphytic fauna (gammarids, isopods, decapods, tanaids, etc.), but no caprellids.

Station 21 Khooni Tharai (9°16.89′N, 79°11.08′E). Seaweeds (*Sargassum* sp., *Padina pavonica*), seagrass (*Thalassia* sp.), hydroids from 1 to 4 m depth, substrates under boulders, sediments (0–2 m depth) collected by hand using mesh bags and a plankton net that was dragged along the bottom after digging up the bottom. Salinity 27–28 psu. 5 February 2005 (45 samples). No caprellids.

Station 22 Near Pamban Bridge (9°15.45′N, 79°12.42′E). Fouling communities on buoys. Salinity 27–28 psu. 5 February 2005 (5 samples). No caprellids.

Station 23 Kurusadai Island (9°14.75′N, 79°13.13′E). Seaweeds (*Turbinaria* among others) and sediments (0–3 m depth) collected by hand using mesh bags and a plankton net that was dragged along the bottom after digging up. Salinity 28–29 psu. 5 February 2005 (20 samples). *Metaprotella excentrica* (1 specimen).

Station 24 Down of Pamban Bridge (9°16.95′N, 79°11.45′E). Seaweeds (*Halimeda*, *Gelidium*, *Caulerpa*), sediments and substrates (hydroids and sponges) under boulders. Salinity 27 psu. 5 February 2005 (55 samples). No caprellids.

Station 25 Vellapatti (8°51.93′N, 78°11.55′E–8°52.13′N, 78°12.29′E). Muddy sediments with *Thalassia* and *Halophila*, 2.5–4 m depth collected with van Veen grab. Salinity 31 psu. 10 February 2005 (10 samples). *Metaprotella excentrica* (8 specimens), *Jigurru longimanus* n.sp. (9 specimens).

Station 26 Kasivari Island (8°52.35′N, 78°13.48′E). Sandy sediments with *Halophila*, coral rubble washed 1–2 m depth collected with van Veen grab and snorkelling. Salinity 31 psu. 10 February 2005 (8 samples). *Metaprotella excentrica* (14 specimens), *Hemiaegina minuta* (1 specimen).

Station 27 Vann Island (8°50.09′N, 78°12.23′E). Coral rubble, 1–3 m depth, snorkelling. Salinity 31 psu. 10 February 2005 (10 samples). *Paracaprella pusilla* (7 specimens), *Hemiaegina minuta* (1 specimen).

Station 28 Near Sugandhi Devadason Marine Research Institute (8°44.95′N, 78°11.32′E). Seaweed culture of *Gracilaria*, abundant bryozoans (*Bugula neritina*), 0–3 m depth, snorkelling. Salinity 32–33 psu. 6 February 2005 (16 samples). *Paracaprella pusilla* (202 specimens).

Station 29 Fishing harbour (8°47.56′N, 78°09.65′E). Fouling communities. Salinity 29 psu. 6 February 2005 (7 samples). No caprellids.

Station 30 Near harbour (8°44.85′N, 78°11.54′E). Sponges, sediments with *Halophila*. Salinity 35 psu. 6 February 2005 (7 samples). *Metaprotella excentrica* (1 specimen).

Station 31 Kanniyakumari (8°05.11′N, 77°33.18′E). Intertidal rocky shore with high diversity and biomass of seaweeds (*Ulva*, *Ceramium*, *Gracilaria*, *Caulerpa*, Corallinacea). Salinity 34 psu. 9 February 2005 (12 samples). No caprellids.

Station 32 Fishing harbour (8°05.831′N, 77°33.84′E). Fouling communities on boats. Salinity 34 psu. 9 February 2005 (8 samples). *Paracaprella pusilla* (1 specimen).

Station 33 Kollam Beach (8°52.13′N, 76°35.17′E). Sediments collected with van Veen grab, 2–12 m depth. Salinity 32 psu. 8 February 2005 (20 samples). No caprellids.

Station 34 Neendakarai, outer harbour (8°56.11′N, 76°32.24′E). Intertidal rocky shore, seaweeds and hydroids. Salinity 26 psu. 8 February 2005 (13 samples). *Paracaprella pusilla* (19 specimens).

Station 35 Fishing harbour (8°56.21′N, 76°32.29′E). Seaweeds and hydroids. Salinity 26 psu. 8 February 2005 (4 samples). No caprellids.

Station 36 Elephanta Island. Intertidal, polluted. 27 February 2005 (5 samples). No caprellids.

Station 37 Near Gateway of India. Fouling communities, polluted. 26 February 2005 (10 samples). No caprellids.

Station 38 Chowpatty Beach. Fouling communities on boats and docks (turf algae, ascidians, hydroids). 25 February 2005 (17 samples). *Paracaprella pusilla* (4 specimens).

Station 39 Juhu Beach. Intertidal, seaweeds, sediments, under boulders. 26 February 2005 (3 samples). No caprellids.

Results

List of species collected during the present study:
Family Caprellidae Leach, 1814

Subfamily Phtisicinae Vassilenko, 1968
Jigurru longimanus n.sp.
Subfamily Caprellinae Leach, 1814
Hemiaegina minuta Mayer 1890

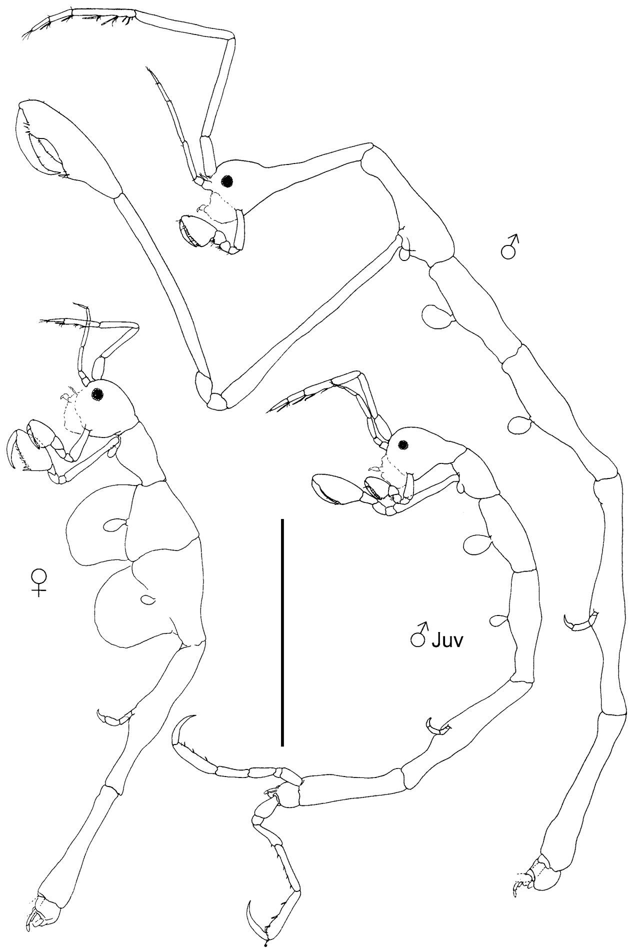

Fig. 2 *Jigurru longimanus* n.sp. Lateral view of holotype male, allotype female and paratype juvenile. *Scale bar*: 1 mm

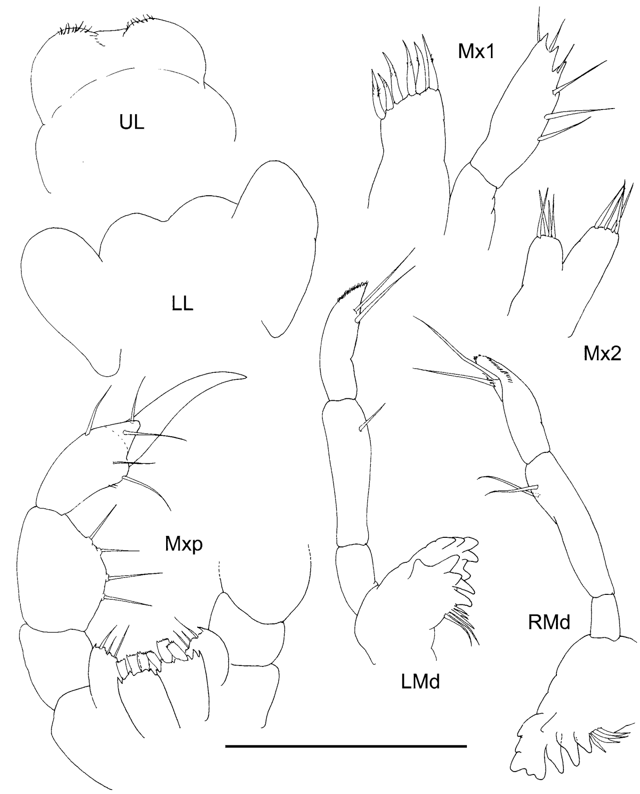

Fig. 3 *Jigurru longimanus* n.sp. Mouthparts of holotype male. *Scale bar*: 0.1 mm

Metaprotella excentrica Mayer 1890
Paracaprella pusilla Mayer 1890

Systematic account

Subfamily Phtisicinae Vassilenko, 1968

Jigurru longimanus n. sp. (Figs. 2, 3, 4, 5)

Type material Holotype male, *sta. 25* (MNCN 20.04/8221). Allotype female (MNCN 20.04/8222) and paratypes (2 males, 1 female, 2 juveniles MNCN 20.04/8223 + 1 male, 1 female, LBM) collected together with holotype.

Type locality Sta. 25. Vellapatti (8°51.93′N, 78°11.55′E–8°52.13′N, 78°12.29′E), near Tuticorin, India. Muddy sediments with *Thalassia* and *Halophila*, 2.5–4 m depth collected with van Veen grab. Salinity 31 psu. 10 February 2005 (10 samples).

Etymology The specific name refers to the long basis and carpus of male gnathopod 2.

Type species of the genus *Jigurru vailhoggett* Guerra-García 2006

Diagnosis Antenna 2 flagellum two-articulate. Gills present on pereonites 2–4, following the size gill 3 > gill 4 > gill 2. Basis and carpus of male gnathopod 2 significantly elongated. Pereopods 3 and 4 absent. Pereopod 5 three-articulate, with basal article almost divided at mid-length. Pereopods 6 and 7 six-articulate. Mandibular palp three-articulate; distal article with two setae. Molar absent. Abdomen with two pairs of appendages.

Gender: Masculine.
Description:
Holotype male (MNCN 20.04/8221)
Body length. 4.2 mm.

Lateral view (Fig. 2) Body smooth without projections; head rounded and elongate; suture between head and pereonite 1 absent.

Gills (Fig. 2) Present on pereonites 2–4, rounded. Gills on pereonite 4 always smaller than those on pereonite 3. The first pair (on pereonite 2) the shortest.

Mouthparts (Fig. 3) Upper lip symmetrically bilobed, small setae apically. Mandibles without molar; left

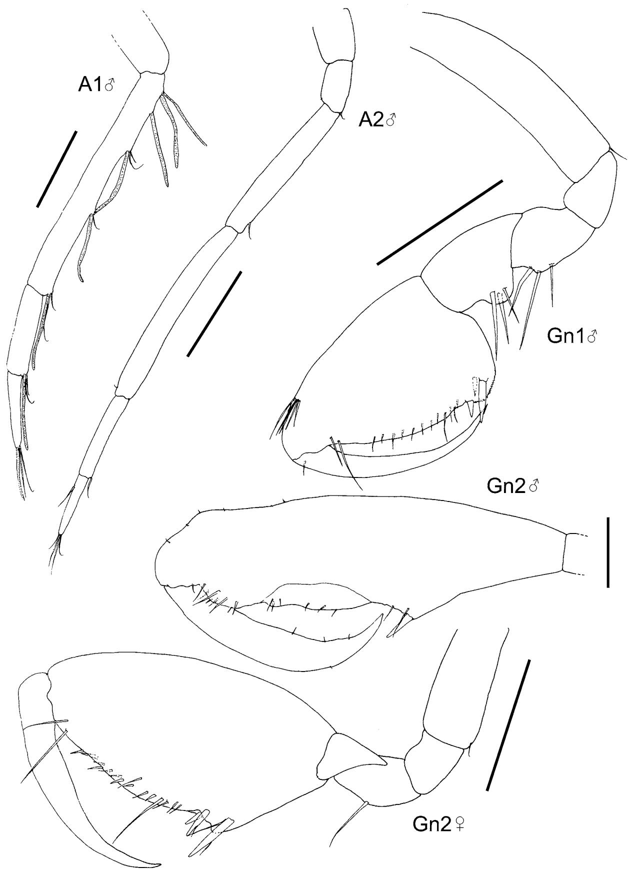

Fig. 4 *Jigurru longimanus* n.sp. Male holotype antenna 1 (detail of flagellum), antenna 2 and gnathopods 1 and 2 (only propodus and dactylus represented). Female allotype gnathopod 2. *Scale bars*: 0.1 mm

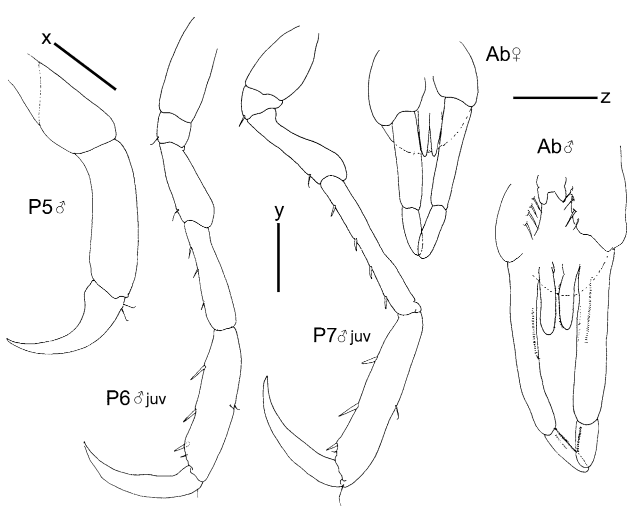

Fig. 5 *Jigurru longimanus* n.sp. Male holotype pereopod 5 in scale $x = 0.05$ mm; Paratype juvenile pereopods 6 and 7 in scale $y = 0.1$ mm; male holotype and female allotype abdomen in scale $z = 0.05$ mm

mandible with incisor 5-toothed, lacinia mobilis 5-toothed followed by a row of plates decreasing in size; right mandible with incisor 5-toothed, lacinia mobilis like a plate, followed by row of plates; palp three-articulate, second article with one or two setae, distal article two apical setae and small setulae. Lower lip without setae; inner lobes poorly demarcated. Maxilla 1 outer lobe with six robust and stout setae; distal article of palp with three setae and three teeth distally and a row of three lateral setae. Maxilla 2 inner lobe rectangular with four setae; outer lobe rectangular with four setae. Maxilliped inner plate with a serrate margin and three apically serrate nodular setae; outer plate with three simple setae; palp four-articulate, article 2 laterally expanded, with four setae; article 3 with distal triangular projection.

Antennae (Figs. 2, 4) Antenna 1 about 1/3 of the body length; flagellum three-articulate. Antenna 2 a little shorter than the half of the antenna 1, non-setose; flagellum two-articulate.

Gnathopods (Figs. 2, 4) Gnathopod 1 basis as long as ischium, merus and carpus combined; propodus triangular, length about 1.5 times width, palm with three proximal grasping spines, grasping margin minutely denticulate on anterior half; dactylus elongate. Gnathopod 2 inserted on the posterior part of pereonite 2; basis twice as long as pereonite 2; ischium rectangular; merus rounded; carpus very elongate, almost as long as the basis; propodus elongate, length about four times width, palm with a proximal grasping spine; dactylus curved on the distal half.

Pereopods (Fig. 5) Pereopods 3 and 4 absent. Pereopod 5 three-articulate, but basal article almost divided into two articles. Pereopods 6 and 7 lacking in the holotype male, described from the juvenile: six-articulate, ischium and merus with one seta, carpus with three (pereopod 6) or four (pereopod 7) spines along the palm, carpus with three spines, dactylus smooth.

Penes (Fig. 5) small, located centrally. Abdomen with two pair of appendages; first pair of appendages two-articulate; second pair uniarticulate.

Allotype female (MNCN 20.04/8222)

Body length 2.7 mm. Oostegites (Fig. 2) without setae. Gnathopod 2 (Figs. 2, 4) inserted on the anterior half of pereonite 2; basis as long as pereonite 2; carpus triangular; propodus oval, length about twice width; three grasping spines proximally

Remarks The genus *Jigurru* shares some characters with *Caprellina* Nicolet, 1849 and *Prellicana* Mayer, 1903. *Jigurru* appears to be closer to *Caprellina* than *Prellicana* on the basis of the presence of three pairs of gills, reduced pereonite 5 and two pairs of appendages in the abdomen. Nevertheless, the small size, general features of the body, the incomplete articulation of the basal article in the pereopod 5, the shape of pereopods 6 and 7, and the partially fused inner plates of the maxilliped strongly resemble *Prellicana*. *Prellicana*, however, has only two pairs of gills and one pair of abdominal appendages, whereas *Jigurru* possesses three pairs of gills and two pairs of abdominal appendages. The genus *Jigurru* includes two species, *Jigurru vailhoggett*, described from Lizard Island, Great Barrier Reef (see Guerra-García 2006) and the new species *Jigurru longimanus*. Both species are morphologically very similar, but can be distinguished by the combination of the following characters: (1) Carpus of adult male gnathopod 2 longer than basis in *J. longimanus* and shorter in *J. vailhoggett*, (2) gills elongate in *J. vailhoggett* (and similar in size) and round in *J. longimanus* (gill3 > gill4 > gill2), (3) projection of article 3 of maxilliped palp rectangular and serrated distally in *J. vailhoggett*, and triangular without serrated margin in *J. longimanus*, (4) distal article of mandibular palp with three long setae in *J. vailhoggett*, and two distal setae and row of tiny setulae in *J. longimanus*, 5) penes larger in *J. vailhoggett* (situated laterally), and shorter in *J. longimanus* (situated medially)

Habitat So far, the species has only been found in muddy sediments with *Thalassia* and *Halophila*.

Distribution So far, found only in the type locality.

Subfamily Caprellinae Leach, 1814

Hemiaegina minuta Mayer 1890 (Fig. 6)

Hemiaegina minuta Mayer 1890: 40, pl. 1, figs. 25–27, pl. 3, figs. 32–35, pl. 5, figs. 52–53, pl. 6, figs. 13, 33–34, pl. 7, fig. 4; McCain 1968: 61–64, figs. 29–30; McCain and Steinberg 1970:51; Gable and Lazo-Wasem 1987: 637; Müller 1990: 836; Serejo 1997: 630–632, fig. 1; Guerra-García 2003a: 105–106, fig. 10; Guerra-García 2003b: 6–7, fig. 3; Guerra-García, 2004: 39–40, fig. 32; Díaz et al. 2005: 5–6, fig. 9; Krapp-Schickel and Guerra-García 2005: 50–51, fig. 3; Guerra-García 2006: 443, fig. 43.

Hemiaegina quadripunctata Sundara Raj 1927: 126–127, pl. 18.

Hemiaegina costai Quitete 1972: 165–168, pls. 1–2.

Material examined 1 female *sta. 26*, 1 juvenile *sta. 27* (used for lateral view figures).

Remarks The material of *H. minuta* found during the present study could be identified as *Hemiaegina minuta* since this species shows very distinctive and clear diagnostic characteristics, which facilitate the identification: third article of antenna 1 short; antenna 2 without swimming setae; gnathopod 1 propodus with a round projection proximally; gnathopod 2 basis elongate and longer than pereonite 2, and propodus large, with a proximal grasping spine and distal U-notch and projection; pereopods 3 and 4 rounded and small, one-articulated; gills elongate; abdomen provided with a very distinctive pair of two-articulate appendages.

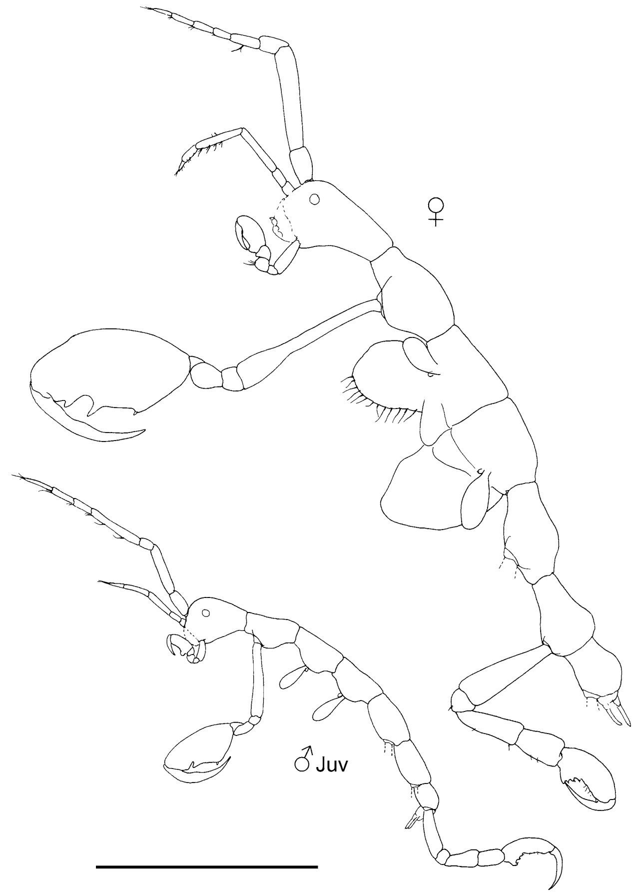

Fig. 6 *Hemiaegina minuta*. Lateral view of female and juvenile male. *Scale bar*: 1 mm

Habitat *Hemiaegina minuta* has been collected from *Sargassum* sp. and taken in plankton tows (McCain and Steinberg 1970). Müller (1990) reported *H. minuta* preferring more or less exposed reef locations. The species has also been collected from *Thalassia testudinium* (Stoner and Lewis 1985). Guerra-García (2003b) found the species associated with *Turbinaria ornata* (Turner) J. Agardh on Mauritius coast, and Guerra-García (2003a) reported *H. minuta* from Papua New Guinea living on *Dictyota* sp., *Halimeda* sp., *Gracilaria* sp., *Galaxaura* sp. and *Amansia glomerata* (Agardh) Norris, 1979. This species has also been found associated with many different substrata in Australia: green algae such as *Halimeda* sp., brown and red algae, sponges, tunicates, seagrasses such as *Posidonia* sp., dead corals encrusted with algal turf, and under small boulders (Guerra-García 2004). In Venezuela, the species has been found on turkey wings (*Arca zebra*) (Díaz et al. 2005), and Krapp-Schickel and Guerra-García (2005) found the species living in algae from shallow waters.

During the present study, the species was collected in sediments with *Halophila*, and among coral rubble.

Distribution Type locality: Off Amoy, China, 15–46 m. depth (McCain 1968). Other records: west coast of United States, Venezuela South Africa, Hawaii, Bora Bora, Japan, Papua New Guinea, Australia, India, Mauritius, South Arabian coast, Indonesia (McCain and Steinberg 1970; Guerra-García 2003a, 2004; Díaz et al. 2005; Krapp-Schickel and Guerra-García 2005; Guerra-García 2006). *Hemiaegina minuta* is widely distributed in tropical and temperate waters of the world oceans (McCain 1968).

Metaprotella excentrica Mayer 1890 (Fig. 7)

Metaprotella excentrica Mayer 1890: 25–26, pl. 1, figs. 20–21; pl. 3; figs. 30–31; pl. 5, fig. 22; Mayer, 1903: 40; Mayer 1904: 224–225; Sundara Raj 1927: 126; Sivaprakasam 1977: 81–84, figs. 3–4.

Material examined *Sta. 23*: 1 juvenile; *Sta. 25*: 2 males, 2 females, 4 juveniles; *Sta. 26*: 3 males, 7 females, 4 juveniles (1 male and 1 female from this station used for lateral view figures); *Sta. 30*: 1 juvenile.

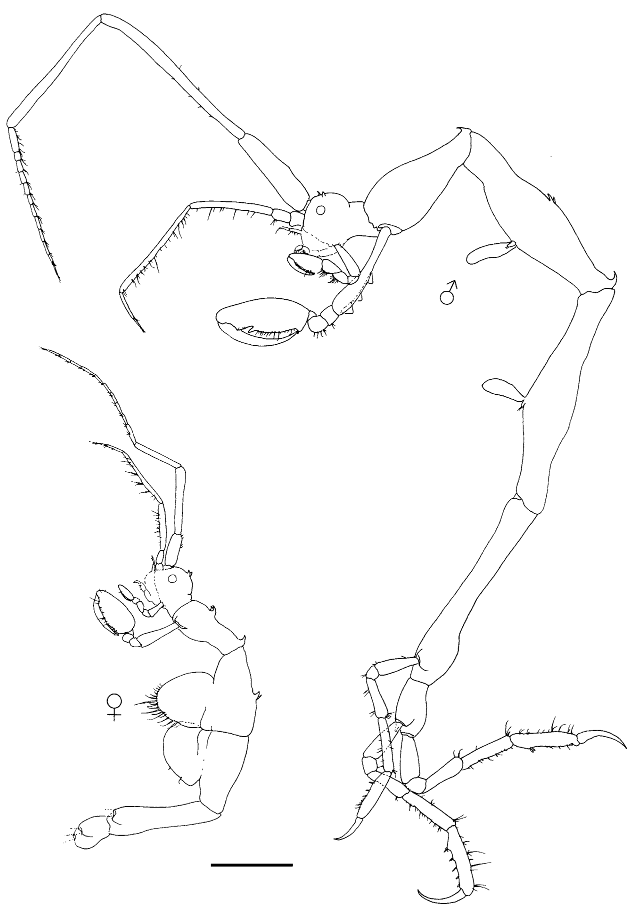

Fig. 7 *Metaprotella excentrica*. Lateral view of male and female. *Scale bar*: 1 mm

Remarks The present material agrees with the original description of Mayer (1890) based on material collected from Pamban Bridge, India (type locality), and with the descriptions and figures of Sivaprakasam (1977). This species can be easily distinguished from the remaining species of *Metaprotella* by the arrangement of dorsal projections and by the presence of triangular projections on the basis of male gnathopod 2.

Habitat The species is usually found clinging on algae (Sivaprakasam 1977). During the present study, *M. excentrica* was collected from seaweeds like *Turbinaria*, sediments with *Thalassia* and *Halophila*, coral rubble and sponges.

Distribution Type locality: Pamban Bridge, India. Other records: Sri Lanka and Australia (McCain and Steinberg 1970) (Fig. 8).

Paracaprella pusilla Mayer 1890 (Fig. 8)

Paracaprella pusilla Mayer 1890: 41, pl. 1, figs. 28–30; pl. 3; figs. 45–47; pl. 5, figs. 48–49; pl. 6, fig. 10; 1903: 67, pl.

Fig. 8 *Paracaprella pusilla*. Lateral view of male and female. *Scale bar*: 1 mm

2, figs. 36–37; pl. 7, fig. 52; Steinberg and Dougherty 1957: 283–284, figs. 16, 19, 24, 30; McCain 1968: 82–86, figs. 41–42; Wakabara et al. 1991: 73; Camp, 1998: 132; Guerra-García and Thiel 2001: 880, fig. 8; Díaz et al. 2005: 6–7, 22, fig. 13; Guerra-García et al. 2006: 175–178, figs. 17–19.

Caprella nigra Reid 1951: 283–284, 289, fig. 58.

Material examined *Sta. 13*: 22 males, 18 females, 2 juveniles; *Sta. 16*: 8 males, 2 females; *Sta. 27*: 2 males, 1 female, 4 juveniles; *Sta. 28*: 79 males, 77 females, 46 juveniles (1 male and 1 female from this station used for lateral view figures); *Sta. 32*: 1 female; *Sta. 34*: 8 males, 11 females; *Sta. 38*: 1 male, 3 juveniles.

*Remark*s Mayer (1890) described *Paracaprella pusilla* based on material collected from Brazil. Later, this species was reported from Venezuela by McCain (1968). *Paracaprella pusilla* is similar to *Paracaprella tenuis* Mayer, 1903; however, males of *P. pusilla* can be distinguished from those of *P. tenuis* by the large sharp-pointed projection on the anteroventral margin of pereonite 2, the proximal knob on the basis of gnathopod 2 and the presence of setae on the dactylus of gnathopod 2 (McCain 1968). Large males of *P. pusilla* are very similar to large males of *Paracaprella barnardi* McCain 1967, in that they both bear a small anterodorsal tubercle on pereonite 2; however, the tubercle is not as well developed in the former as in the later, and the ventrolateral projection on the anterior margin of pereonite 2 is much larger in *P. pusilla* (McCain 1967). Sivaprakasam (1977) reported the species *Paracaprella alata*, *P. barnardi* and *P. pusilla* for Indian coasts. He found only a female of *P. pusilla* from Kerala and several hundred specimens of *P. barnardi* from hydroid colonies of Tamil Nadu, Kerala and Pondicherry. However, Sivaprakasam's figures of *Paracaprella barnardi* (see Fig. 10, Sivaprakasam 1977) show that the specimens figured do not belong to *P. barnardi*; indeed, they probably belong to *P. pusilla* by the shape and size of ventrolateral projection of pereonite 2, the shape of gnathopod 2 and the small size of the anterodorsal tubercle on pereonite 2. On the other hand, the "abnormal male" described by Sivaprakasam (1977) with the large tooth on palmar notch could even belong to the species *Paracaprella digitimanus* (see Díaz et al. 2005).

Habitat *Paracaprella pusilla* has been collected from mangrove roots, seagrasses, hydroids and ascidians (McCain 1968) and also from gravel bottoms, ropes, mussels, oysters, sabellariid worm rock [*Phragmatopoma lapidosa* (Kinberg, 1867)] and hydroids (such as *Halocordyle disticha*) associated with mangrove roots (Díaz et al. 2005). During the present study, the species was mainly not only found associated with fouling communities in harbours (on hydroids, ascidians and turf algae), but also inhabiting hydroids from intertidal rocks and clinging to bryozoans associated with *Gracilaria* cultures. It was the most abundant caprellid found during the present work.

Distribution Type locality: Rio de Janeiro, Brazil. Other records: Western North Atlantic, Tropical West Africa and South Africa, Tanzania, Suez Canal, Hawaii, China, Gulf of Mexico, Venezuela, Cuba, Colombia (McCain and Steinberg 1970; Wakabara et al. 1991; Ortíz and Lalana 1998; Díaz et al. 2005; Winfield et al. 2006).

Key to the caprellids from India (based on adult male specimens; see also Fig. 9).

This key has been prepared trying to select the easiest external characters to be used without need of dissection.

1.	Large ventral projection on pereonite 4	*Heterocaprella krishnaensis*
	Pereonite 4 without projection	2
2.	Body with dorsal projections	3
	Body without dorsal projections	5
3.	Dorsal projections present on pereonite 3	*Metaprotella excentrica*
	Dorsal projections absent on pereonite 3	4
4.	Two dorsal projections on pereonite 2. Pereopods 3 and 4 longer than half of gills	*Metaprotella haswelliana f. taprobanica*
	A single dorsal projection on pereonite 2. Pereopods 3 and 4 shorter than half of gills	*Paradeutella bidentata*
5.	Gills present on pereonites 2, 3 and 4	6
	Gills present on pereonites 3 and 4	7
6.	Gnathopod 2 very elongate, as long as the half of the body	*Jigurru longimanus*
	Gnathopod 2 clearly shorter than half of the body	*Pseudocaprellina pambanensis*
7.	Lateral expansions on pereonites	8
	Pereonites without lateral expansions	9
8.	Lateral expansions on pereonites 2–6, antennae 1 longer than half of the body	*Metaprotella problematica*
	Lateral expansions on pereonite 3 and 4, antennae 1 shorter than half of the body	*Paracaprella alata*
9.	Pereonite 2 without anterolateral projection	*Hemiaegina minuta*
	Anterolateral projection present on pereonite 2	10
10.	Antennae 1 peduncle provided with small setae. Gills rounded. Basis of gnathopod 2 with a proximal knob	*Paracaprella pusilla*
	Antennae 1 peduncle non-setose. Gills elongate. Basis of gnathopod 2 without proximal knob	*Monoliropus falcimanus*

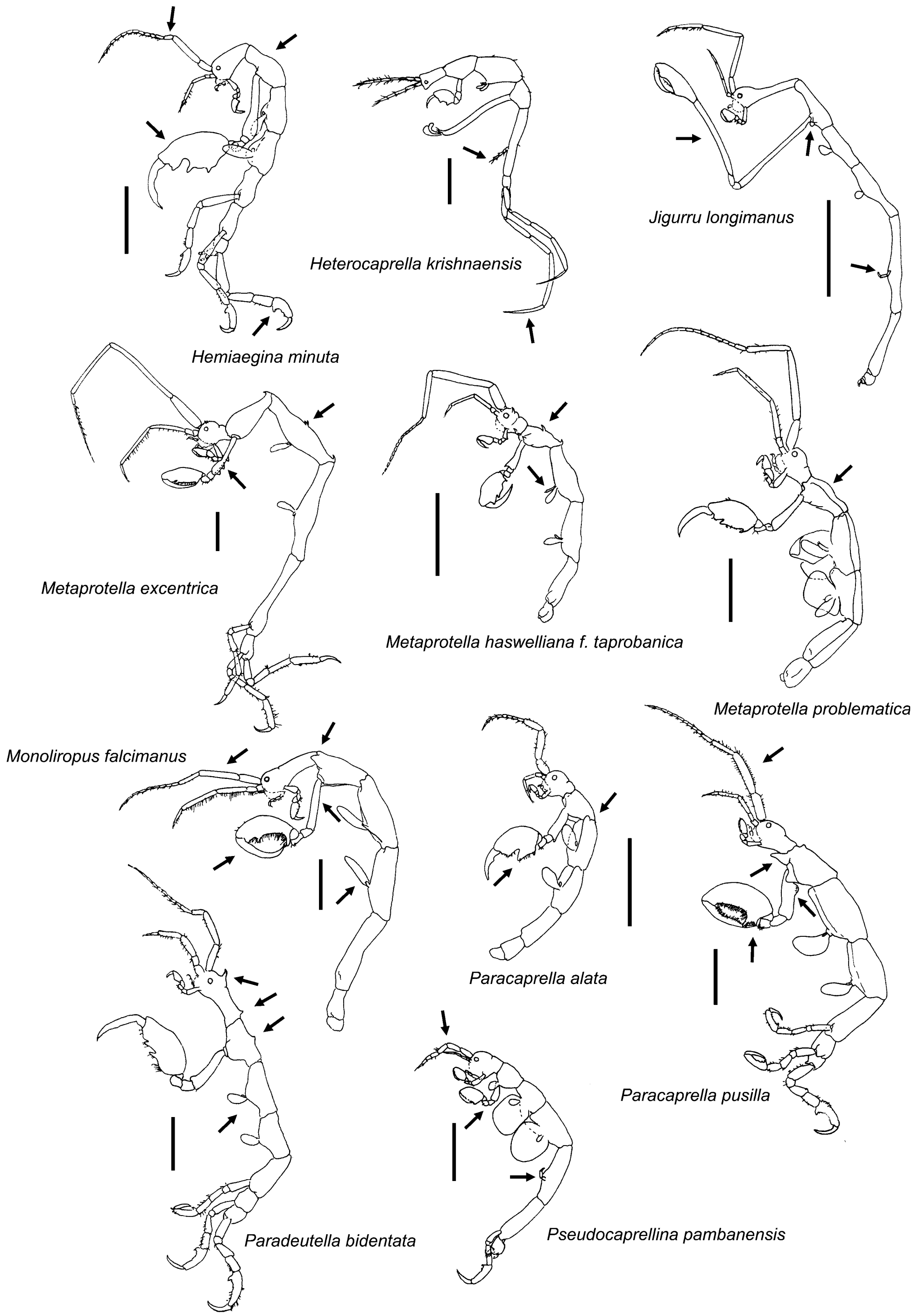

Fig. 9 Lateral view figures of all caprellid species reported so far in Indian waters. All drawings are adult males except for *Metaprotella problematica* and *Pseudocaprellina pambanensis*, which are females. *Arrows* indicate some of the most important characters to distinguish the species without dissection. *Hemiaegina minuta*, *M. problematica*, *M. falcimanus*, *P. alata*, *P. bidentata* and *P. pambanensis* have been redrawn from Sivaprakasam (1977), *H. krishnaensis* from Swarupa and Radhakrishna (1983) and *M. haswelliana f. taprobanica* from Mayer (1890). *Scale bars*: 1 mm

Discussion

Differences between west and east coasts of India

Joydas (2002) studied soft bottom macrobenthic fauna during February 1998 and February 2001 and covered 75 stations, which were distributed along 17 transects on the west coast (Arabian Sea; Fig. 10) extending from off Cape Comorin (i.e. Kanniyakumari) to off Dwaraka. Each transect was sampled at 30, 50, 100 and 200 m depth. Caprellids were present in 76% of the samples, and were one of the dominant groups in some stations. However, the caprellids were not identified up to species or genus level, but to suborder (Joydas 2002). The samples could not be accessed for species-level identification during the present study. Ganesh (2003) and Ganesh and Raman (2007) carried out the study of soft bottoms macrobenthic communities of the northeast coast (Bay of Bengal) during January

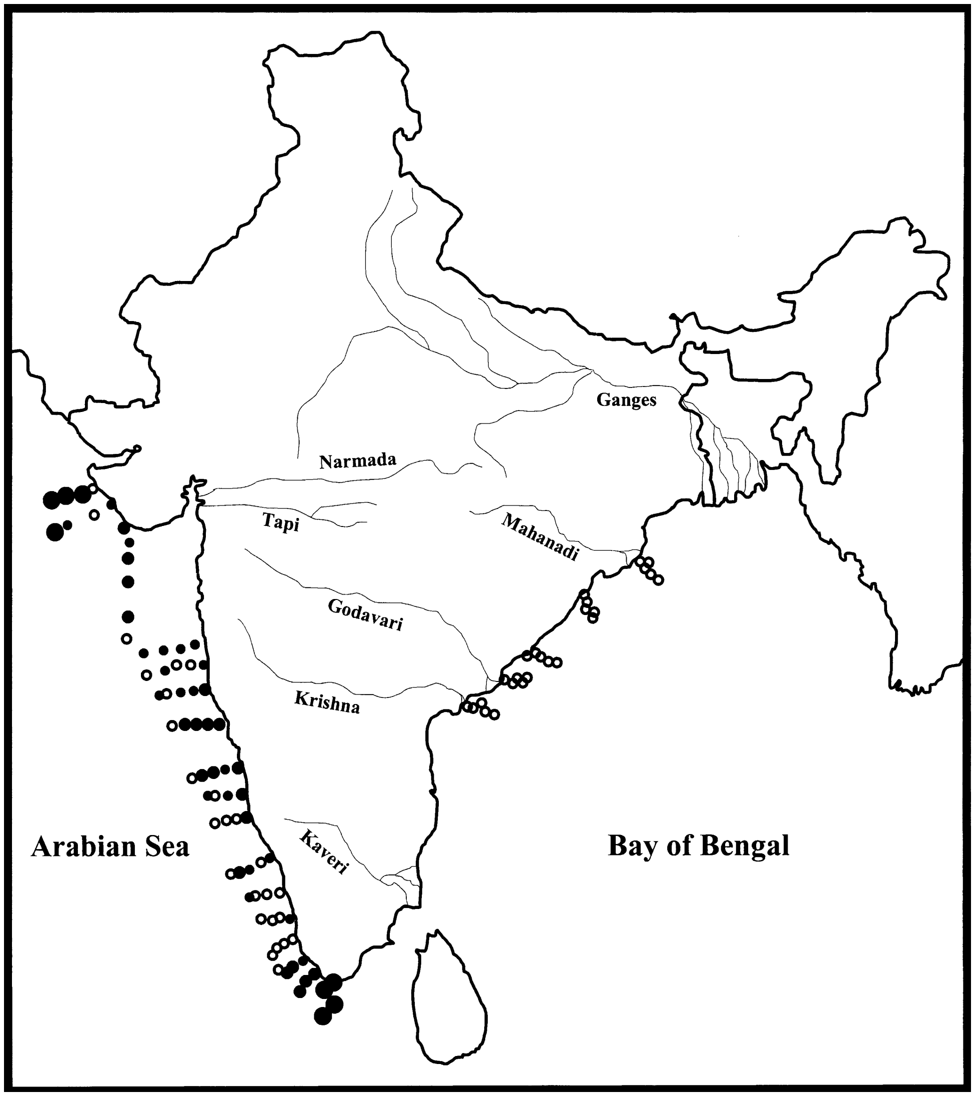

Fig. 10 Map of India showing the main rivers. Locations of the sediment sampling stations selected by Joydas (2002) (*west coast*) and Ganesh (2003) (*east coast*) are indicated with circles. *Filled circles*: caprellids present (*small circles*: 0–10 caprellids m^{-2}; *medium*: 11–50 caprellids m^{-2}; *large*: >50 caprellids m^{-2}); *open circles*: caprellids absent

1999 and July 2000. In their study, a total of 24 stations representing 5 transects on the continental shelf of north-east coast (16°–20° N) of India were covered. At each transect, samples were collected from 30, 50, 100, 150 and 200 m depths; in summary, polychaetes were the most important group (64.9%) followed by amphipods (25.3%), but all of them were gammarids and not even a single caprellid was reported among the 62 samples collected. When physicochemical data of both coasts are compared from the data of Joydas (2002) and Ganesh (2003), we can observe that the salinity of west coast (33.7–37.31) is higher than in east coast (28.7–35.1) and that sediments in the west coast are characterized by a higher content of sand, higher values of oxygen and lower values of organic matter. Both, the Arabian Sea and the Bay of Bengal are tropical basins experiencing monsoonal wind forces that reverses semi annually. This brings changes in physics, chemistry and biology of the upper water column on a seasonal scale and ultimately regulates the sinking fluxes of the region (Gauns et al. 2005). Although the geographical settings of these two basins are somewhat similar, the hydrographic and hydrochemical characteristics differ widely. The west coast receives lower volumes of river runoff (0.3×10^{12} m^{-3} $year^{-1}$) compared to east coast (1.6×10^{12} m^{-3} $year^{-1}$) (Gauns et al. 2005). Rivers Tapi and Narmada are two of the very few major rivers draining along the west coast. On the other hand, a large number of rivers such as the Ganges, Mahanadi, Godavari, Krishna and Kavery discharge along the east coast. As a result, Bay of Bengal surface waters are less saline than the Arabian Sea (Prasanna Kumar et al. 2002). The inundation by such enormous amounts of freshwater renders the surface water of the Bay of Bengal almost estuarine during post-monsoon months (September and October) while marine conditions are present from January to June. In addition, large-scale discharge of silt by the rivers reduces the transparency of the water over large areas, with a consequent fall in the photosynthesis rate (Ganesh 2003; Madhupratap et al. 2003). The copious rainfall and river water reduces salinity of the upper layers of the Bay of Bengal by 3–7 psu during summer, and sea surface temperature is warmer by 1.5–2°C than in the Arabian Sea. This leads to a strongly stratified surface layer. The weaker winds over the Bay are unable to erode the strongly stratified surface layer, thereby restricting the turbulent wind-driven vertical mixing to a shallow depth of <20 m. This inhibits introduction of nutrients from below, situated close to the mixed layer bottom, into the upper layers. While advection of nutrients-rich water into the euphotic zone makes the Arabian Sea highly productive, this process is unlikely in the Bay of Bengal (Prasanna Kumar et al. 2002). All these differences could explain high abundance of caprellids in sediments of the west coast (Joydas 2002) and their absence in the east coast (Ganesh 2003) in spite of the substrates, depths and latitude being similar.

Why so few caprellids in India?

We have already discussed the differences in hydrographic conditions between the Arabian Sea and the Bay of Bengal and how these differences, particularly fluctuations in salinity throughout the year, probably explain the poor caprellid fauna in the east coast. Our sampling programme, specially focused on the east coast (Fig. 1), confirms the extremely poor caprellid fauna. In fact, and although our study did not focus on the west coast, we can state that, in general, the caprellid diversity and abundance in India is low. Although many samples and many substrates were collected along the coast (538), only 4 caprellid species were found during the present study. In total, only 11 species (including the new species *Jigurrus longimanus*) have been reported so far from India. Raut (1997), during a detailed study of the benthic macrofauna of mangrove waterways and the bay environment of Kakinada, East coast of India, reported abundant crustaceans species, including amphipods, but no caprellids were found. Vedavati (1985) studied the benthic macrofauna on the undersurfaces of boulders in the marine intertidal region of the Visakhapatnam coast and reported six amphipod species, all of them were gammarids. Adiseshasai (1992) focused on the littoral macrobenthos off Visakhapatnam, covering 300 km^2 in the sea from Gangavaram in the south to Bheemunipatnam in the north and taking samples at 20, 30, 40 and 50 m, and no caprellids were found. Surya Rao (1972) studied the intertidal amphipods from the Indian coast, and he only reported gammaridean species.

The pattern of lower caprellid diversity and, specially, lower abundance in tropical areas compared with the temperate ecosystems has been already shown in previous studies (Thiel et al. 2003; Guerra-García 2006). During our sampling programme, many algae of different morphology, potential substrates of caprellids, were collected, and in spite of the high abundance of gammarids and other peracaridean crustaceans, no caprellids were present in most of the samples. Why are there so few caprellids on algae in tropical ecosystems? In tropical ecosystems, caprellid abundance is not as high as in temperate ecosystems, and caprellids inhabit mainly coral rubble, sediments and hydroids, rather than algae (see Guerra-García 2006). The exact reasons for these patterns are still unknown, but we could think that a higher rate of predation in tropical ecosystems could be involved, due to a higher abundance of fishes in tropical areas (Guerra-García 2006). Furthermore, species of the genus *Caprella* are clearly the dominant taxa in intertidal and shallow waters of temperate ecosystems, reaching very high densities >5,000 individuals m^{-2} (Guerra-García, unpublished data); and conversely, the genus *Caprella* is scarcely represented in the Indo-Pacific tropical latitudes. The absence of *Caprella* species in the tropics is probably influenced by historical and ecological reasons. This difference in latitudinal distribution of *Caprella* could explain the lower caprellid abundances and diversities in tropical ecosystems in comparison with temperate ones. Guerra-García (2006) compared the caprellid data from Ceuta, North Africa, a typical temperate region, with data from Lizard Island, Great Barrier Reef, a tropical enclave; 17 of the 22 species found in Ceuta belonged to genus *Caprella*, while no *Caprella* species were recorded in Lizard Island. Curiously, the genus *Caprella*, which is one of the few genera provided with abundant setae on antennae 2 ("swimming setae"), includes around 50% (190 species of 400) of described species so far in the Caprellidea excluding the whale lice Cyamidea (Guerra-García unpublished). It seems that the presence of these setae opens a feeding niche for caprellids and, probably, swimming setae have some impact on the species proliferation to the genus *Caprella* (Caine 1979). This could explain the high abundances of these species in regions in which the genus *Caprella* is distributed, such as temperate intertidal and shallow water ecosystems. Anyway, future studies are necessary to explain these patterns and elucidate the ecological distribution and habitat preferences of the Caprellidae, especially dealing with the differences between temperate and tropical ecosystems.

Acknowledgments Financial support of this work was provided by the *Ministerio de Educación y Ciencia* (Project CGL2007-60044/BOS) co-financed by FEDER funds, by the *Consejería de Innovación, Ciencia y Empresa*, *Junta de Andalucía* (Project P07-RNM-02524) and by MoES, Government of India (DOD/10-MLR/1/2002/DT 19.12.2002). Special thanks to M. Lowe for all the arrangements during the visit of JMGG to the Natural History Museum, London

(NHM), supported by SYNTHESYS resources (FPVI European-funded Integrated Infrastructure Initiative grant) provided by the European Community. We wish to place on record our special appreciation to Dr. D.R.K. Sastry, Zoological Survey of India for his critical reading and useful suggestions. We are very grateful to R. Ramkumar (Sugandhi Devadason Marine Research Institute, Tuticorin) for his help during sampling near Tuticorin.

References

Adiseshasai K (1992) Littoral macrobenthos off Visakhapatnam, India. Unpublished Ph.D. thesis, Visakhapatnam, p 105

Caine EA (1979) Functions of swimming setae within caprellid amphipods (Crustacea). Biol Bull 156:169–178

Camp DK (1998) Checklist of shallow-water marine Malacostracan Crustacea of Florida. In: Camp DK, Lyons WG, Perkins TH (eds) Checklists of selected shallow-water marine invertebrates of Florida. Florida Marine Research Institute Technical Report TR-3, pp 123–189 (238 pp)

Díaz YJ, Guerra-García JM, Martín A (2005) The Caprellidea (Crustacea: Amphipoda) from Venezuela. Org Div Evol 5:249–251

Gable MF, Lazo-Wasem EA (1987) The Caprellids (Amphipoda: Caprellida) of Bermuda: a survey of specimens collected from 1876-1987, including cave inhabitants, and the description of Deutella aspiducha, new species. Proc Biol Soc Wash 100(3):629–639

Ganesh T (2003) Macrobenthic communities of North-East Indian Shelf, Bay of Bengal. Unpublished Ph.D. thesis, Andhra University, p 172

Ganesh T, Raman AV (2007) Macrobenthic community structure of shelf sediments of the northeast Indian coast, Bay of Bengal. Mar Ecol Prog Ser 341:59–73

Gauns M, Madhupratap M, Ramaiah N, Jyothibabu R, Fernandes V, Paul JT, Kumar SP (2005) Comparative accounts of biological productivity characteristics and estimates of carbon fluxes in the Arabian Sea and the Bay of Bengal. Deep Sea Res II 52:2003–2017

Giles GM (1888) Further notes on the amphipods of Indian waters. J Asiat Soc Bengal 57:220–255

Guerra-García JM (2001) The caprellidea (Crustacea: Amphipoda) collected by the expedition of “Grigore Antipa” National Museum of Natural History from Tanzania, with the description of a new genus and two new species. Trav Mus Nat d’Hist Nat “Grigore Antipa” 43:23–45

Guerra-García JM (2002a) Littoral caprellids (Crustacea: Amphipoda: Caprellidea) from Philippines, with the description of a new species. Raffles Bull Zool 50:395–406

Guerra-García JM (2002b) *Metaprotella tanzaniensis*, a new caprellid (Crustacea: Amphipoda) from Tanzania, with a key to the species of *Metaprotella* and discussion on the family Protellidae. Bull Mar Sci 70(3):909–918

Guerra-García JM (2002c) Two new species of *Deutella* Mayer, 1890 (Crustacea: Amphipoda: Caprellidea) collected by the R. V. “Anton Bruun” during the International Indian Ocean Expedition. Zootaxa 74:1–18

Guerra-García JM (2002d) Revision of the genus *Noculacia* Mayer, 1903 (Crustacea: Amphipoda) with the description of two new species. Org Div Evol 2:351–352

Guerra-García JM (2003a) Caprellids (Crustacea: Amphipoda) from Papua New Guinea, with the description of a new species. Helgol Mar Res 57:100–109

Guerra-García JM (2003b) The Caprellidea (Crustacea: Amphipoda) from Mauritius Island, Western Indian Ocean. Zootaxa 232:1–24

Guerra-García JM (2004a) Littoral Caprellidea (Crustacea: Amphipoda) from Phuket, Thailand. Steenstrupia 28:159–175

Guerra-García JM (2004b) The Caprellidea (Crustacea: Amphipoda) from Western Australia and Northern Territory, Australia. Hydrobiologia 522:1–74

Guerra-García JM (2006) Caprellidae (Crustacea: Amphipoda) from the Great Barrier Reef and adjacent localities. Rec Aust Mus 58:417–458

Guerra-García JM, Takeuchi I (2003) The Caprellidea (Malacostraca: Amphipoda) from Mirs Bay, Hong Kong, with the description of a new genus and two new species. J Crust Biol 23:154–168

Guerra-García JM, Thiel M (2001) The caprellid fauna (Crustacea: Amphipoda: Caprellidea) from the coast of Coquimbo, Northern-central Chile, with a taxonomic key for species identification. Rev Chil His Nat 74:873–888

Guerra-García JM, Krapp-Schickel T, Müller HG (2006) Caprellids from the Caribbean coast of Colombia, with description of three new species and a key for species identification. Bol Invest Mar Cost 35:149–194

Ito A, Wada H, Aoki MN (2008) Phylogenetic analysis of caprellid and corophioid amphipods (Crustacea) based on the 18S rRNA gen, with special emphasis on the phylogenetic position of the Phtisicidae. Biol Bull 214:176–183

Joydas TV (2002) Macrobenthos of the shelf waters of the west coast of India. Unpublished Ph.D. thesis, Cochin University of Science and Technology, p 151

Krapp-Schickel T, Guerra-García JM (2005) Littoral Caprellidae (Crustacea: Amphipoda) from Indonesia, with the description of a new species. Boll Mus civ St nat Verona 29:47–62

Laubitz D (1993) Caprellidea (Crustacea: Amphipoda): towards a new síntesis. J Nat Hist 27:965–976

Madhupratap M, Gauns M, Ramaiah N, Kumar SP, Muraleedharan PM, de Sousa SN, Sardessai S, Muraleedharan U (2003) Biogeochemistry of the Bay of Bengal: physical, chemical and primary productivity characteristics of the central and western Bay of Bengal during summer monsoon 2001. Deep Sea Res II 50:881–896

Mayer P (1882) Die Caprelliden des Golfes von Neapel under angrenzenden Meeres-Abschnitte. Eine Monographie. Fauna Flora Golfe Neapel 6:1–201

Mayer P (1890) Die Caprelliden des Golfes von Neapel under angrenenden Meeres-Absch-nitte. Nachtrag zur Monographie derselben. Ibid 17:1–157

Mayer P (1904) Report on the Caprellidae collected by Professor Herdan at Ceylon in 1902. Report to Govt of Ceylon on Pearl Oyster Fisheries in the Gulf of Manaar 2:223–227

McCain JC (1967) *Paracaprella barnardi*, a new species of caprellid (Crustacea: Amphipoda) fro the west coast of Panamá. Proc Biol Soc Wash 80:219–222

McCain JC (1968) The Caprellidae (Crustacea: Amphipoda) of the western North Atlantic. Bull US Natn Mus 278:1–147

McCain JC, Steinberg JE (1970) Amphipoda-I, Caprellidea-I, family Caprellidae. In: Gruner HE, Holthuis LB (eds) Crustaceorum Catalogus 2. pp 1–78

Müller HG (1990) New species and records of coral reef inhabiting Caprellidae from Bora Bora and Moorea, Society Islands (Crustacea: Amphipoda). Rev Suisse Zool 97(4):827–842

Myers AA, Lowry JK (2003) A phylogeny and a new classification of the Corophiidea Leach, 1814 (Amphipoda). J Crust Biol 23:443–485

Ortíz M, Lalana R (1998) Lista actualizada de los crustáceos no decápodos de Cuba. Rev Inv Mar 19:92–99

Prasanna Kumar S, Muraleedharan PM, Prasad TG, Gauns M, Ramaiah N, de Souza SN, Sardesai S, Madhupratap M (2002) Why is the Bay of Bengal less productive during summer monsoon compared to the Arabian Sea? Geophys Re Lett 29:2235. doi:10.1029/2002GL016013

Quitete JMPA (1972) *Hemiagina costai*, nova espécie de Caprellidae da costa brasileira (Crustacea: Amphipoda). Atas Soc Biol Rio de Janeiro 15(3):165–168

Raut D (1997) Benthic macrofauna of mangrove waterways and the bay environment of Kakinada, East coast of India. Unpublished Ph.D. thesis, Andhra University, p 118

Reid DM (1951) Report on the Amphipoda (Gammaridea and Caprellidea) of the coast of tropical West Africa. Atlantide Rep 2:189–291

Serejo C (1997) *Hemiaegina costai* Quitete, 1972 a synonym of *Hemiaegina minuta* Mayer, 1890 (Amphipoda: Caprellidae). Crustaceana 70(5):630–632

Sivaprakasam TE (1969) Notes on some amphipods from the south-east coast of India. J mar biol Ass India 9:372–383

Sivaprakasam TE (1970) Amphipoda from the east coast of India. Part 2. J Bombay Nat Hist Soc 67:153–170

Sivaprakasam TE (1977) The skeleton shrimps (Amphipoda: Caprellidea) of the Tamil Nadu and Kerala coasts. J mar biol Ass India 19:78–96

Steinberg JE, Dougherty EC (1957) The skeleton shrimps (Crustacea: Caprellidae) of the Gulf of Mexico. Tulane Stud Zool 5:267–288

Sundara Raj B (1927) Suborder Caprellidea (Laemodipoda). The littoral fauna of Krusadai Island in the Gulf of Mannar. Bull Madras Govt Mus (NSNHS) 1:125–128

Surya Rao KV (1972) Intertidal amphipods from the Indian coast. Proc Indian Natn Sci Acad 38:190–205

Swarupa KMC, Radhakrishna Y (1983) *Heterocaprella krishnaensis* n.sp., a new caprellid from Indian waters (Amphipoda, Caprellidea). Crustaceana 44:54–60

Takeuchi I (1993) Is the Caprellidea a monophyletic group? J Nat Hist 27:947–964

Takeuchi I, Guerra-García JM (2002) *Paraprotella saltatrix*, a new species of the Caprellidea (Crustacea, Amphipoda) from Phuket Island, Thailand. Phuket Marine Biological Center Res Bull 23:273–280

Takeuchi I, Lowry JK (2007) Description of Metaprotella haswelliana (Mayer, 1882) (Crustacea: Amphipoda: Caprellidae) from Western Australia with designation of a neotype. Zootaxa 1466:11–18

Thiel M, Guerra-García JM, Lancellotti DA, Vásquez N (2003) The distribution of littoral caprellids (Crustacea: Amphipoda: Caprellidea) along the Pacific cost of continental Chile. Rev Chil Hist Nat 76:203–218

Vedavati T (1985) Studies on some ecobiological aspects of benthic macrofauna on the undersurfaces of boulders in the marine intertidal region of the Visakhapatnam coast. Unpublished Ph.D. thesis, Andhra University, p 174

Wakabara Y, Tararam AS, Valerio-Berardo MT, Duleba W, Pereira FP (1991) Gammaridean and caprellidean fauna from Brazil. Hydrobiologia 223:69–77

Winfield I, Escobar-Briones E, Morrone JJ (2006) Updated checklist and identification of areas of endemism of benthic amphipods (Caprellidea and Gammaridea) from offshore habitats in the SW Gulf of Mexico. Sci Mar 70:99–108