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New records of prawns and shrimps (Crustacea: Decapoda) from Gujarat coast, India

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Abstract
In this study, total seven species of prawns and shrimps belonging to 3 infraorders (Penaeidea, Caridea, Gebiidea) are first time recorded from Gujarat coast. The infraorder Penaeidea shows highest diversity (4 species). The Caridea and Gebiidea, with 2 and 1 species respectively follow. Details of morphological characters and distribution records in Indian waters are discussed in the report.

Keywords: Prawn and Shrimps, new record, Penaeidae, Caridea, Gebiidea, Gujarat

1. Introduction
Prawn and shrimp fauna is amongst the highly diverse group of order decapoda consisting about 4048 species throughout the world [1]. They are varying in size and widely distributed in marine, brackish and freshwater. Parwns are one of the most important compositions in the crustacean fishery and tropical marine food chain. Prawn fishery is one of the major resources of India, which includes 3.98 lakh tons (2008-10) of commercially important penaeid and non penaeid prawns [2]. Radhakrishnan *et al.* (2012) listed occurrence of 437 species of prawn belonging to 131 genera and 30 families in Indian waters. Out of 437 species, 19 genera, 73 species under family Penaeidae Rafinesque, 1815; 5 genera, 20 species under family Solenoceridae Wood-Mason, 1891; 9 genera, 17 species under Hippolytidae Spence Bate, 1888 and 11 genera, 81 species under Sub-family Palaemoninae Rafinesque, 1815 (Family Palaemonidae Rafinesque, 1815) are reported from India [3]. Gujarat state, located on the western proximity of India has longest coastline in the country which has rich crustacean diversity [4]. A total of 30 species of prawns belonging to 12 genera, 5 families are reported from coastal water of Gujarat state [3, 4]. The present study was initiated by Gujarat Biodiversity Board, Gandhinagar, to document the crustacean fauna diversity of Gujarat. This study adds 7 more species in the list of prawns and shrimp occurring in Gujarat waters.

2. Material and Methods
The specimens were collected during the survey of crustacean fauna of Gujarat carried out between March 2014 and May 2015. The specimens were collected from intertidal area and commercial fishing trawlers. The specimens were photographed immediately after collection for fresh coloration and then preserved in 70% alcohol for further studies. The specimens were identified up to species level by comparing morphological characters with available illustrative keys, research papers and monograms [2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19]. All the specimens were deposited in the Zoology Museum of the Department of Zoology, The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat, India. Following abbreviation is used: TL (Total Length), Coll. (collectors). All the measurements are recorded in centimetre (cm).

3. Results and Discussion
In the present study seven species viz., *Megokris sedili* (Hall, 1961), *Megokris granulosus* (Haswell, 1879), *Parapenaeus fissuroides indicus* Crosnier, 1986, *Solenocera koelbeli* (De Man, 1911), *Latreutes anoplonyx* Kemp, 1914, *Palaemon serrifer* (Stimpson, 1860) and *Upogebia carinicauda* (Stimpson, 1860) are first time reported from the coastal waters of Gujarat, India.

Systematic account

Suborder : Dendrobranchiata Spence Bate, 1888
Infraorder : Penaeidea Rafinesque, 1815
Family : Penaeidae Rafinesque, 1815
Genus : *Megokris* Pérez Farfante and Kensley, 1997

3.1 *Megokris sedili* (Hall, 1961) (Figure. 1A)

Synonyms

Trachypeneus sedili Hall, 1961.
Trachypenaeus sedili Racek and Dall, 1965.

Material Examined

One male (ZL-AR-PR-29) (1), (TL-9.4 cm), fish landing centre, Porbandar, Gujarat, India, 10th February, 2015, Coll. Barkha Purohit. Two females (ZL-AR-PR-29) (2-3), (TL-9.8cm, TL-10.4 cm), fish landing centre, Porbandar, Gujarat, India, 10th February, 2015, Coll. Barkha Purohit.

Description

Entire body densely pubescent; carapace and abdominal segments highly setose; rostrum distinctly curved upward, armed with 8 + 1 dorsal teeth, reaching up to half of third antennular article; dorsal sulcus short; post ocular, gastro frontal and gastro orbital carina absent; small well defined orbital spine present; hepatic spine present; antennal carina well developed and terminating with a prominent antennal spine; post orbital spine absent; prominent spine present on dorsal side of basal segment of ocular peduncle; no branchiocardiac carina; branchiostegal spine absent; pterygostomian angle straight; stylocerite distally pointed, reaching nearly half of corneal length; scaphocerite disto lateral spine reaching up to end of antennular peduncle; first pereiopod reaching little beyond middle of carpocerite, first and second pereiopods bearing curved long basal spine; second pereiopod reaching middle of scaphocerite; third, fourth and fifth pereiopod length almost similar, reaches little shorter then scaphocerite tip; second antennular segment two times longer than first antennule segment; second to sixth abdominal segments carinated; second abdominal segment elevated and small dorsal tubercle present, mid dorsal crest present on last four segments; sixth segment carina ending with a small spine, postero-ventral angle of sixth abdominal segment produced into spine; in male, petasma long, horn like disto-lateral projection directed laterally, tips slightly curving forward, small disto-median projection, ventrally curved; in female, thylcum with chair like appearance, anterior and lateral margins of anterior plate strongly raised; telson longer than sixth abdominal segment, exceeding the uropod by distal spine, four pairs small movable spine present; dorsal sulcus deep, straight spinule present, marginal spine large and movable.

Remarks

The present specimens of *Megokris sedili* (Hall, 1961) agrees with the description and illustration given by Hall (1961), Muthu (1968) and Thomas (1969) [11, 12, 13]. This species is closely similar to *Trachypenaeus curvirostris* but later species lacks the well-defined carina; also differs in the structure of thylcum and petasma.

Coloration

The fresh specimen, generally yellowish brown with dark yellow patches. Rostrum, posterior margin of the carapace and telson tip is brown. Antennules and pereiopods tip white. Antennae are light pink with dark pink base.

Distribution

The species is so far reported from Singapore [11], Mozambique [21], Sri Lanka [22], Thailand [23] and Malaya [24].
In India, the species is reported from Gulf of Mannar, Palk Bay [12], Visakhapatnam, Kakinada [13] and now from Gujarat.

3.2 *Megokris granulosus* (Haswell, 1879) (Figure. 1B)

Synonyms

Penaeus granulosus Haswell, 1879.
Trachypenaeus granulosus (Haswell, 1879).
Trachypeneus furcilla Hall, 1961.
Trachypeneus salaco de Man, 1907.

Materials Examined

One male (ZL-AR-PR-28) (1), (TL-11.2 cm), fish landing centre, Porbandar, Gujarat, India, 10th February, 2015, Coll. Barkha Purohit. Four females (ZL-AR-PR-29) (2-5), (TL-8.7 cm, TL- 10.5, cm, TL-9.6 cm, TL-8.2 cm), fish landing centre, Porbandar, Gujarat, India, 10th February, 2015, Coll. Barkha Purohit.

Description

Entire body densely pubescent; whole carapace and abdominal segments covered with fine seta and granules; rostrum short, reaching up to 3/4 of the antennular segment, straight in female and up curved in male, armed with 10 dorsal teeth, space between teeth increase from before backwards, last two spine separated by wide distance, ventral teeth absent; hepatic and cervical grooves distinguish; short longitudinal suture present; pterygostomian angle blunt; eyes large; tubercle present on second abdominal segment, mid-dorsal carina present on last four abdominal segments, mid-dorsal carina of sixth segments ends with a blunt spine; epipod present on only third pereiopod; fifth pereiopod reaching beyond antennular peduncle; petasma, with very broad distolateral projection, tips curving forward in a broad sweep and then inwards; in female, thylcum interior plate flat or slightly concave rounded distally with a posterior rounded projection which can be prominent often fused with the posterior plate; telson with one pair of small subapical movable spine and 2 -3 pairs of spinules.

Remarks

Specimens show agreement with the description and illustration provided by Haswell (1879) and Muthu (1968) [7, 12]. This species is closely similar to *M. sedili* and *T. Curvirostris* in general appearance but varies in following characters: epipod is present only on third walking leg and entire carapace is granulated. These three species can easily be distinguished from each other from the coloration of fresh specimens.

Coloration

Generally fresh specimen is light brown. The sides of carapace, abdomen, third and fifth pereiopods are light yellow. Uropod is red with yellow patches. The distal 1/3 part of the telson is yellow with a red tip.

Distribution

The species is so far reported from Philippines, Kuwait, Taiwan, Malaysia and Pakistan [12, 25], Australia (Haswell, 1897) [7], Hong Kong [26], New South Wales, Indonesia [27], Sri Lanka [22].
In India, the species is reported from Kakinada [12], Chennai, Tutucorin, Mandapam [5] and now from Gujarat.

Genus: *Parapenaeus* Smith, 1885

3.3 *Parapenaeus fissuroides indicus* Crosnier, 1986 (Figure. 1C)

Synonyms

Parapenaeus fissurus Stebbing, 1914.
Parapenaeus sextuberculatus, Ivanov et Hassan, 1976.

Material Examined

One male (ZL-AR-PR-33) (1), (TL-8.4 cm), fish landing centre, Porbandar, Gujarat, India, 10th February, 2015, Coll. Barkha Purohit. One male (ZL-AR-PR-33) (2), (TL-8.9 cm), fish landing centre, Porbandar, Gujarat, India, 10th February, 2015, Coll. Barkha Purohit.

Description

Body hairless and smooth; rostrum well developed, armed with 6 to 7 dorsal teeth, ventral teeth absent; eyes well developed; branchiostegal spine present at anterior edge of carapace; longitudinal and transverse suture present on carapace; epigastric spine distinctly behind the hepatic spine; in male (Petasma) sub-distolateral lobes distinctly bifurcate; telson with two fixed lateral spine.

Remarks

This present specimen of this species is showing the similarity with the specimens originally described by Crosnier (1986) [14] from Western Indian Ocean and Dineshbabu (2004) [19] from Mangalore (India).

Coloration

The whole body and appendages are rose colour (Dineshbabu, 2004).

Distribution

The species is so far reported from Madagascar, Gulf of Oman, Mozambique, South Africa, East Africa, off Natal [14], Japan and Indonesia [29].
In India, the species is reported from Mangalore (India) [19] and now reported from Gujarat.

Family : Solenoceridae Wood-Mason in Wood-Mason and Alcock, 1891

Genus: *Solenocera* Lucas, 1849

3.4 *Solenocera koelbeli* (De Man, 1911) (Figure. 1D)

Synonyms

Solenocera depressa Kubo, 1949
Solenocera vietnamensis Starobogatov, 1972
Solenocera melantho Lee and Yu, 1977

Materials Examined

One female (ZL-AR-PR-21) (1), (TL- 11.8), fish landing centre, Porbandar, Gujarat, India, 10th February, 2015, Coll. Barkha Purohit. Two females (ZL-AR-PR-21) (2-3), (TL- 9.8 cm, TL- 9.7 cm), fish landing centre, Porbandar, Gujarat, India, 10th February, 2015, Coll. Barkha Purohit. Two females (ZL-AR-PR-21) (4-5), (TL- 11.4 cm, TL- 11.7 cm), fish landing centre, Porbandar, Gujarat, India, 23 February, 2016, Coll. Barkha Purohit.

Description

Body integument hairless and moderately hard; rostrum short and armed with 7+1 dorsal teeth including epigastric tooth, ventral margin convex, setose present on base of rostrum; postrostral carina extending backward to posterior margin of carapace; postrostral sulcus irregular in width and posteriorly wide; orbital spine blunt; antennal and hepatic spine present; pterygostomian spine absent; pterygostomian angle rounded; cervical sulcus distinct; mid-dorsal carina present on second abdominal somite, distinct mid-dorsal carina continue from posterior half of third somite, ending with a tooth, up to posterior margin of sixth abdominal segment, sixth segment end with acute middorsal tooth; antennular flagella longer than carapace including rostrum; spine present on basis and ischium of first pereiopod, only basis spine present on second pereiopod; fifth pereiopod reaching beyond the tip of antennal scale; in female, thelycum largely excavated, surrounded by anterior and lateral ridges, with two median tubercle, two pair of small rounded processes just anterior to anterior ridges.

Remarks

The morphological characters of the specimens collected in the present study closely agree with the morphological characters described and illustrated by Kim (2006) [20] and Radhakrishnan *et al.*, (2011) [2]. *Solenocera koelbeli* is similar in appearance to *Solenocera choprai*, but distinguished by having continuous post-rostral crest, uninterrupted by cervical furrow (Chan, 1998) where as in *Solenocera choprai* the post-rostral crest plate like interrupted with cervical furrow.

Coloration

In the fresh specimen, generally light brown. The posterior margin of each abdominal segments and carapace are dark. Antennular flagella and distal half of the telson is red.

Distribution

This species is reported from Korea, Japan, Taiwan, South China, Vietnam, Philippines, Indonesia, Northern Western Australia and Hong Kong [20, 30].
In India, the species is reported from Kerala, Andhra Pradesh, Maharashtra (India) [5] and now from Gujarat.

Suborder : Pleocyemata Burkenroad, 1963
Infraorder : Caridea Dana, 1852
Family : Hippolytidae Spence Bate, 1888
Genus : Latreutes Stimpson, 1860

3.5 *Latreutes anoplonyx* Kemp, 1914 (Figure. 1E)

Synonyms

Latreutes anoplonyx Kemp, 1914

Materials Examined

One female (ZL-AR-PR-40) (1), (TL- 3.4 cm), fish landing centre, Jakhau, Gujarat, India, 29th April 2014, Coll. Jignesh Trivedi and Gunjan Soni. Four ovigerous females (ZL-AR-PR-40) (2-5), (TL- 2.9 cm, TL- 3.1 cm, TL- 3.4 cm, TL- 3.5 cm), fish landing centre, Jakhau, Gujarat, India, 29th April 2014, Coll. Barkha Purohit.

Description

Carapace smooth, not carinated mid dorsally; rostrum triangular, overreaching beyond the antennular scale apex, more than ¾ length of carapace; apex sharp and upwards, dorsal margin concave, armed with fourteen dorsal teeth in 2/3 of rostrum length, ventral region evenly curved and armed with nine teeth in distal half; epigastric tooth present behind the level of orbital angle and middle of carapace; antennal spine strong; a series of small spines presents on anterolateral angle which varies between 8-11; eyes small reaching up to the first segment of abdominal peduncle, short, about 1/3

times as long as carapace, small marginal spine present on first article; stylocerite broad and rounded; antennal scale about four times as long as broad; spine present on antero-lateral side of basal segment; third maxilliped overreaching up to middle of antennal scale, ultimate segment more than twice the length of antepenultimate, parapenultimate segment ½ times longer than ultimate segment, ultimate segment with 8-9 hornlike spines at distal end; epipods present on first four pair of pereiopods, first pereiopod robust and shorter than other, reaching upto the first antnnular segment; dactylus shorter then palm; second pereiopod slender and reaching upto the middle of the rostrum; dactylus slightly shorter then palm; carpus subdivide into three segments, first is half of the second segment and slightly longer then third segment; third pereiopod longer than other, reaching little bit more than distal margin of antennal scale; propodus 3.5 times as long as dactylus; 3-5 spinules present on margin, 5-6 spinules present on propodus; spine present on disto-lateral margin of merus; fourth and fifth pereiopods structure similar to third pereiopod; sixth abdominal somite about 0.64 times as long as telson and 1 ½ times of fifth smoites; telson armed with two pairs of dorsal spines, posterior margin acute with two pair of spines, inner spine smaller than outer; uropods longer then telson, movable spine present on exopod of uropods with a suture.

Remarks

The present specimens of *Latreutes anoplonyx* agree with the original description and illustrations provided by Kemp [9, 10]. The shape of the rostrum and armature in present specimen is different from the figured given by Hayashi and Miyake (1968) [31].

Colouration

The whole body light pinkish brown. Rostrum tip and posterior region is colour less. The distal half is dark reddish. Red colour dotes present on pereiopods. Abdominal segment with transvers white bands and dark red dotes present on posterior region. Sixth abdominal segment is colourless.

Distribution

This species is previously reported from Indo Pacific, Pakistan [32], Indonesia [33, 34], Singapore [35], Japan [31], China [36], Philippines, Papua New Guinea, Australia [37], Korea [38], Yemen and Persian Gulf [39].

In India, this species is reported from Bombay [9, 10] and now reported from Jakhau coast of Gujarat.

Family : Palaemonidae Rafinesque, 1815
Subfamily : Palaemoninae Rafinesque, 1815
Genus : *Palaemon* Weber, 1795

3.6 *Palaemon serrifer* (Stimpson, 1860) (Figure. 1F)

Synonyms

Leander serrifer Stimpson, 1860
Leander fagei Yu, 1930
Palaemon serrifer - Holthuis 1950

Materials Examined

1 Male and 1 female (ZL-AR-PR-31) (1-2), (TL-3.2 cm, TL-3.6 cm), Gopnath, Bhavnagar, Gujarat, 2nd May 2014, Coll. Barkha Purohit and Gunjan Soni. 3 Male and 6 ovigerous female (ZL-AR-PR-31) (3-11), (TL-1.6 cm, TL-3.2 cm, TL-2.7 cm; TL-1.3 cm, TL-2.4 cm, TL1.9 cm, TL-1.5 cm, TL-3.1 cm, TL-2.2 cm), Gopnath, Bhavnagar, Gujarat, 29th January 2015, Coll. Barkha Purohit, Jignesh Trivedi, Gunjan Soni and Dhurva Trivedi. 1 Male (ZL-AR-PR-31) (12), (TL- 23.69 cm), Napi, Bhavnagar, Gujarat, 10th October 2016, Coll. Jignesh Trivedi. 4 Ovigerous female (ZL-AR-PR-31), (13-16), (TL- 24.25 cm, TL- 22.45 cm, TL- 24.99 cm, TL- 27.47 cm), Shivrajpur, Dev Bhumi Dwarka, Gujarat, 12th November 2016, Coll. Barkha Purohit. 2 Male and 3 ovigerous female (ZL-AR-PR-31), (17-21), (TL- cm, TL- cm; TL- cm, TL- cm, TL- cm), Shivrajpur, Dev Bhumi Dwarka, Gujarat, 13th December 2016, Coll. Barkha Purohit.

Description

Carapace smooth and glabrous; rostrum well developed, shorter than carapace, slightly upturned distally in females; horizontally straight in males, armed with 8-13 on dorsal region, first two teeth posterior to the level of the post orbital margin; ventral carina well developed with 3-5 teeth armed, deeper than dorsal; epigastric spine well defined and articulated; antirolateral angle blunt and not produced; antennae with stout basicerite, large sharp ventrolateral tooth present; carpocerite short and stout; abdominal segment smooth; all pereiopods reaching up to the apex of scaphocerite except second; first pereiopod subequal and slender; finger of second pereiopod shorter than palm; endopod of third maxilliped slender, penultimate segment 0.6 times longer than antennulate segment, uniform and heavy setae present laterally, in medial spine form setae present; distal part tapering with small spine, transverse rows of short spine present on medial part of penultimate article and setose on lateral portion; sixth segment 1.5 times longer than fifth segment; 1.5 times longer than deeper, compressed; postrolateral and postroventral angles produced acutely; telson almost 1.3 times longer than sixth abdominal segment, strong ventrally and concave; lateral portion convex, two pairs of small spine present on dorsal, lateral spine subequal to dorsal spine; inter-median spine well developed, densely setose; lateral border of uropods straight and sub-marginal row of short setae present on ventrolaterally.

Remarks

Palaemon serrifer (Stimpson, 1860) was previously reported from India based on a single record from Bombay [9] and is here recorded for the first time from Gujarat. This species is superficially similar to *Palaemon pacificus* but the size and number of rostral teeth is variable and the shape of rostrum and antennular basal segment is different. The specimens agree with the description of *Palaemon serrifer* (Stimpson, 1860) given by Holthuis (1950) [40] and Bruce (1990) [17].

Coloration

The entire body is transparent and covered with many unequal and un-patterned red-brown stripes. Black-brown spots present on all abdomen segments. Finger of second pereiopod is light blue.

Distribution

This species has reported from Hong Kong [41], Red Sea [42], South Africa, Taiwan [43], China [44], Australia [45], Japan, Russia, Aburatsubo [46, 47] and Vietnam [48].

In India this species is previously reported from Bombay [49] and now reported from Gujarat.

Infraorder : Gebiidea de Saint Laurent, 1979
Family : Upogebiidae Borradaile, 1903
Genus : *Upogebia* Leach, 1814

3.7 *Upogebia carinicauda* (Stimpson, 1860) (Figure. 1G)

Synonyms

Gebia carinicauda Stimpson, 1860
Upogebia foresti Ngoc-Ho, 1989
Upogebia (Upogebia) carinicauda de Man, 1928
Upogebia rupicola Komai, 2005
Upogebia (Upogebia) kempi Sankolli, 1972

Materials examined

One male (ZL-AR-PR-37) (1), (TL-2.2 cm), Pirotan Island, Marine National Park, Jamnagar, Gujarat, India, 10th April 2015, Coll. Barkha Purohit.

Description

Carapace smooth, pubescent and depressed; rostrum triangular, narrow with rounded frontal margin; six sub-terminal spines present; lateral longitudinal ridges present on carapace with 10-13 denticles; single spine present on anterolateral margin of carapace; linea thalassinica discontinuous, extends backward to posterior margin of carapace; antennular peduncle reaching up to middle part of distal segment; posterior margin of sixth abdominal segment smooth; first pereiopod sub-chelated, with acute spine on ischium, six tubercle and 2-5 proximal spines present, carpus with two sharp dorsal spine on inner and upper distal margin, five meral spines present upper ventral distal margin; fixed finger short, 4-5 teeth present on cutting edge, granulated; movable finger longer than fixed finger, corneous, cutting edges denticulate, a series of tubercles present; sub-distal spine present on merus of second pereiopod, propodus stout; telson wider than longer, lateral margin of posterior half concave and posterior margin broadly convex; endopod broad, reaching up to posterior margin of telson.

Remarks

The specimen of *Upogebia carinicauda* (Stimpson 1860) collected in the present study has similarity with the specimens reported by Stimpson (1860) [6] and Sakai (1983 and 1993) [15, 18]. There is little variation in the number of subterminal rostral spines i.e. six in present specimen.

Coloration

Carapace and first pereiopod is dark brown. Abdominal somites and telson light brown and posterior margin of carapace with black out lines.

Distribution

This species is previously reported from Hong Kong [6], Philippines [50], Australia, Torres Straits [51], Burma, Myanmar [52], Indonesia and New Zealand [53, 54, 55].
In India, this species is reported from Mumbai [56] and now from Pirotan Island (Gujarat) during present study.

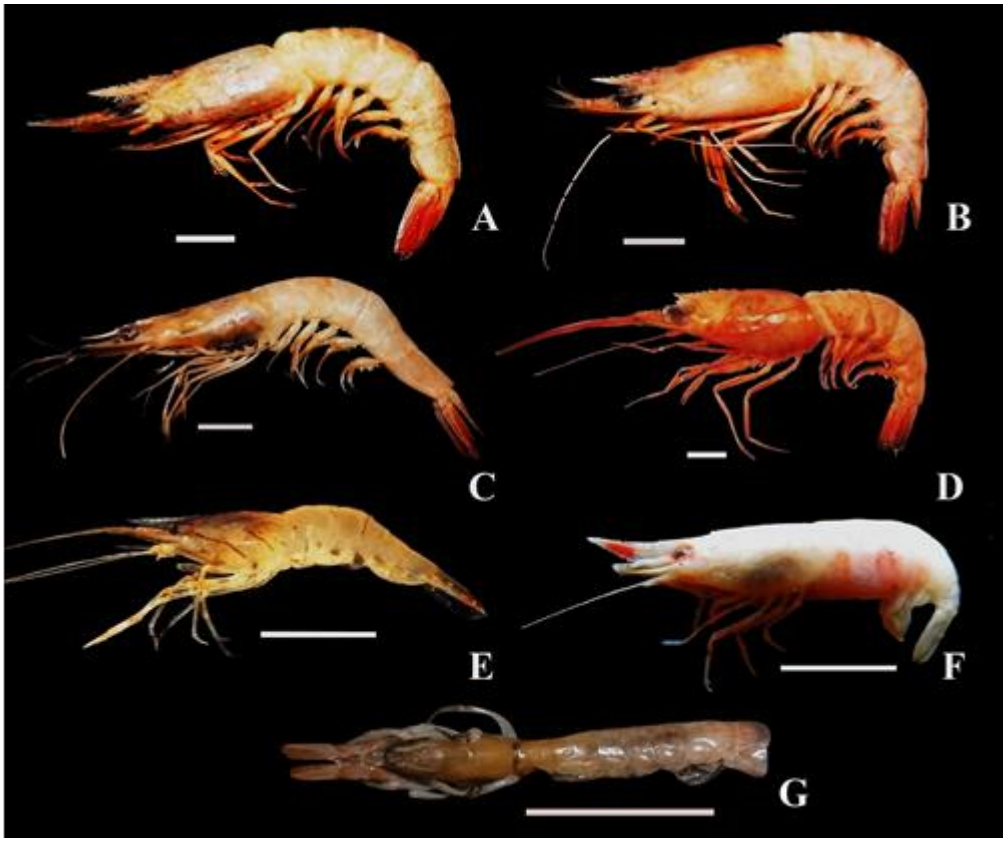

Fig 1: A. *Megokris sedili* (Hall, 1961) (ZL-AR-PR-29) (TL-9.4 cm), B. *Megokris granulosus* (Haswell, 1879) (ZL-AR-PR-28) (TL-11.2 cm), C. *Parapenaeus fissuroides indicus* Crosnier, 1986 (ZL-AR-PR-33) (TL-8.4 cm), D. *Solenocera koelbeli* (De Man, 1911) (ZL-AR-PR-21) (TL-11.8), E. *Latreutes anoplonyx* Kemp, 1914 (TL- 3.4 cm), F. *Palaemon serrifer* (Stimpson, 1860) (TL- 3.2 cm), G. *Upogebia carinicauda* (Stimpson, 1860) (TL- 2.2 cm). (Scale= 1 cm)

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