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### A new species of portunid crab of the genus *Charybdis* (De Haan, 1833) (Crustacea: Decapoda: Brachyura) from Goa, India

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ORIGINAL ARTICLE

## A new species of portunid crab of the genus *Charybdis* (De Haan, 1833) (Crustacea: Decapoda: Brachyura) from Goa, India

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### Abstract

A new species of portunid crab, *Charybdis (Charybdis) goaensis* sp. nov. is described from Goa, west coast of India. It differs from its closest congener, *Charybdis (Charybdis) philippinensis* in possessing bluntly triangular median frontal teeth, wide U-shaped notches separating the sub-median and lateral frontal teeth, wide notches separating antero-lateral teeth, and granular tuberosity on cardiac region of carapace. A taxonomic key to 43 species of the sub-genus *Charybdis* including the newly described species is also provided.

**Key words:** *Charybdis (Charybdis) goaensis*, Crustacea, Decapoda, India, new species, Portunidae

### Introduction

Swimming crabs (Family Portunidae Rafinesque-Schmaltz, 1815) are crustaceans which inhabit sub-tidal, estuarine and offshore waters, and are widely distributed across the Indo-West Pacific region (Stephenson 1972). *Charybdis* De Haan, 1833, is the second largest genus within the sub-family Thalamitinae Paulson, 1875, with 60 species (*Thalamita* Latreille, 1829 comprises 89 species) (Ng et al. 2008) distributed among four sub-genera (*Charybdis* De Haan, 1833; *Goniohellemus* Alcock, 1899; *Gonio-neptunus* Ortmann, 1893; *Goniosupradens* Leene, 1938).

For the past two centuries, naturalists have contributed immensely to the taxonomy of the genus *Charybdis* (De Haan, 1833) through extensive study of brachyuran fauna collected from deep-sea and coastal expeditions as well as from museum collections. Leene (1938) carried out the first major taxonomic work on crabs of the genus *Charybdis*. She introduced two new sub-genera, namely *Goniosupradens* and *Gonioinfradens*, to the existing three (*Charybdis*, *Goniohellemus* and *Gonio-neptunus*) along

with detailed descriptions of 33 species and 7 varieties. Subsequent taxonomic work on portunid crabs by Stephenson (1972) provided the most extensive taxonomic key to the genus *Charybdis*. Studies pertaining to systematics of crabs of the genus *Charybdis* from the Indian Ocean region were initiated by the 'Discovery' expedition (Stephenson & Rees 1967a) which revealed one previously known species, *C. smithii*. This was followed by six expeditions in the Western Indian Ocean region ('R/V Akademik Petrovsky', 'R/V Odissey', 'R/V Akademik Kurchatov', 'R/V Meteor', 'R/V Professor Mesyatsev', 'R/V Vitiaz') that found nine species in which two (*C. crosnieri* and *C. meteor*) were new to science (Neumann & Spiridonov 1999; Spiridonov & Türkay 2001). Subsequently, the 'Anambas' expedition in the Eastern Indian Ocean region revealed one previously known species, *C. truncata* (Yeo et al. 2004). Recently, Apel & Spiridonov (1998) dealt with portunid crabs of the Arabian Gulf, the Gulf of Oman, southern Oman and Pakistan.

A review of published literature reveals that out of 43 extant species of the sub-genus *Charybdis*, 35

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species inhabit estuarine and offshore shallow waters (Alcock 1899; Leene 1938; Ward 1941; Wee & Ng 1995), 3 inhabit deep-sea as well as shallow coastal environments (Stephenson & Rees 1968; Spiridonov & Türkay 2001) and 5 species inhabit deep-sea environments (Moosa 1995; Spiridonov & Türkay 2001).

In addition to the extant species of the genus *Charybdis*, recent published reports (Hu & Tao 1979, 1985, 1996, 2000; Morris & Collins 1991) described five extinct species (*C. kilmeri* Hu, 1984; *C. monsoonis* Hu & Tao, 1985; *C. feriatus amenia* Hu & Tao, 2000; *C. gigantea* Hu & Tao, 2000; *C. feriata bruneiensis* Morris & Collins, 1991) from East and South-east Asia based on diagrammatic reconstruction of fossilized remnants of crabs. However, these species were not compared with the extant species in view of the ambiguity in their description.

A new species of swimming crab, *Charybdis (Charybdis) goaensis* sp. nov. from the estuarine and offshore waters of Goa, west coast of India is described here (Figure 1). Further, the new species is compared with all the existing congeners and an updated identification key incorporating 43 species of the sub-genus *Charybdis* is provided.

## Material and methods

### Abbreviations

The following abbreviations are used: CL, carapace length; CW, extreme width of carapace; LC, length of left cheliped; RC, length of right cheliped; OD, orbital diameter; IS, inter-orbital space/frontal width; G1, male gonopod/first pleopod.

Terminology used in the morphological description of the new species follows Wee & Ng (1995). In addition, terminology describing thoracic sternum and abdominal cavity follows Ng (2000).

Thirty-nine trawling stations were selected in the estuarine and offshore areas of Goa, west coast of India (Figure 1) to assess the diversity and total community structure of the demersal fauna. Among these, sampling was carried out at six stations from the estuaries during May and December 2005, and September and October 2006, along the navigational channel off Mormugao Port Trust (15°25'N, 73°47'E) region and the southern region of Mormugao Bay (between 15°24'N, 73°48'E and 15°27'N, 73°51'E). The offshore samples were obtained from January to April 2006 and December 2006 to March 2007 between 15°29'6"N and 15°33'15.2"N and between 73°40'6"E and 73°51'11"E. Trawl nets with mesh sizes of 15 mm (mouth end) and 9 mm (cod end) were towed approximately at a speed of 2 knots (4 km h<sup>-1</sup>). The sampling duration was 1–3 h in the offshore region, whereas in the estuaries it lasted for a maximum of 1 h. The catch obtained was sorted into five sub-samples. Uncommon (or rare) specimens were picked out, put on ice and sent to the laboratory for detailed examination. In addition, samples were obtained by operating beach seine (1 h operation) along Betim (15°30'18"N, 73°49'52"E) during December 2005 and two in the vicinity of the Mormugao Port Trust (15°24'16"N, 73°48'56"E) during December 2005 and September 2006 (Figure 1).

At the laboratory, morphological characteristics of the crabs were recorded by camera lucida diagrams and photographs. Seven morphometric parameters

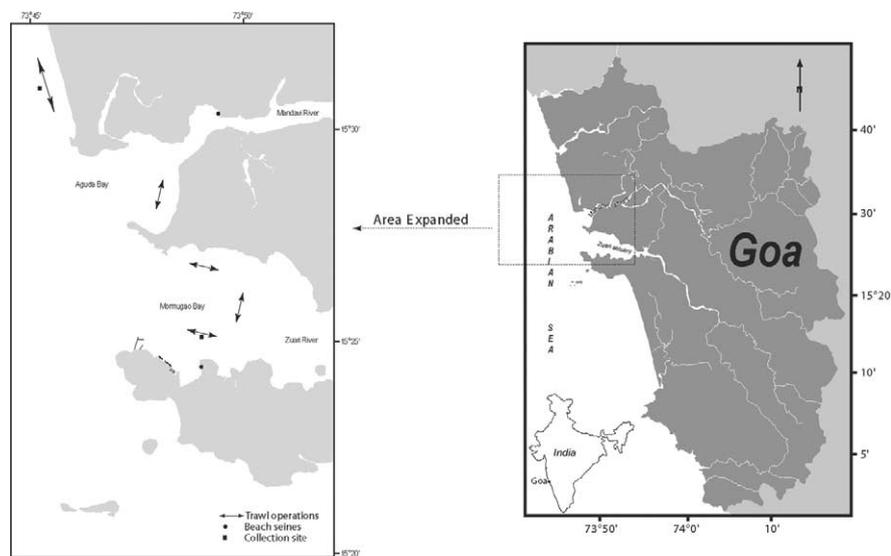


Figure 1. Map illustrating the site of collection of *Charybdis (Charybdis) goaensis* sp. nov. specimens.

were measured using vernier callipers with an accuracy of 0.01 mm. The three ratios (CW/CL, OD/IS and IS/CW) were derived.

In the case of chelipeds, the measurement included segments namely, dactylus, propodus, carpus and merus. Subsequently, gonopods were removed from the paratype male for scanning electron microscope (SEM) photography to ascertain the identity and distinctiveness of the species. In addition, camera lucida diagrams of the ventral surface of male and female specimens were drawn to illustrate the thoracic sternites and the abdominal cavity of male and female specimens, respectively. The specimens were stored in 5% buffered formalin (buffered with hexamethylene tetramine to prevent fragmenting of appendages) solution in transparent plastic bottles. These are deposited at the Marine Biology laboratory, Department of Marine Sciences, Goa University.

### Taxonomy

**Family Portunidae** Rafinesque-Schmaltz, 1815

**Genus *Charybdis*** De Haan, 1833

*Charybdis*, De Haan 1833, pp. 9–10 (type species: *Cancer sexdentatus* Herbst, 1783 (a junior subjective synonym of *Cancer feriatus* Linnaeus, 1758)).

The genus *Charybdis* is characterized by the fronto-orbital border being decidedly less than the greatest width of the carapace; antero-lateral borders oblique and arched, cut into six or seven teeth (Sakai 1976; Wee & Ng 1995; Figure 2A); G1 tubular, curved or bent in distal part, tip usually elongated or truncated, with spines on lateral surfaces and marginal spinules inside opening, along ventral and dorsal margins (Apel & Spiridonov 1998; Figure 2B).

### *Charybdis (Charybdis) goensis* sp. nov.

#### Material examined

Holotype: male (designated here GUMS-1), 29 September 2006, CL 12.80 mm, CW 24.32 mm, Zuari Estuary, Goa, central west coast of India (between 15°24'41.2"N, 73°48'56.6"E and 15°24'41.9"N, 73°51'11.0"E), 6–7 m depth, demersal trawl.

Paratype: Zuari Estuary, Goa: one mature female (GUMS-2), CL 15.10 mm, CW 24.52 mm; one male (GUMS-3), CL 21.88 mm, CW 34.08 mm; one male (GUMS-4), CL 14.02 mm, CW 25.10 mm; one immature female (GUMS-5) CL 11.92 mm, CW 22.12 mm (location and date of collection same as holotype); offshore fishing grounds, Goa: one ovigerous female (GUMS-6) CL 19.40 mm, CW 29.92 mm, offshore trawl catch, Goa, India (between 15°29'43.2"N, 73°44'39.7"E and 15°33'15.2"N, 73°42'41.6"E), 11 March 2007.

#### Diagnosis

Carapace evenly tomentose/pilose, with the exception of transverse ridges and swellings. Median frontal teeth bluntly triangular, sub-medians and lateral frontal teeth separated by wide U-shaped notch. Orbits with strong dorsal inclination; major orbital diameter two-fifths to nearly half the length of the inter-orbital space. Basal antennal joint with smooth granular ridge. Antero-lateral teeth six in number, first slightly notched, sixth greater than twice the length of the preceding five and laterally directed; teeth separated by wide notches. Transverse ridges of carapace distinctly granular, two proto-gastric, one meso-gastric, a medially divided meta-gastric, and epibranchials along the level of the last antero-lateral teeth; no transverse ridges beyond the

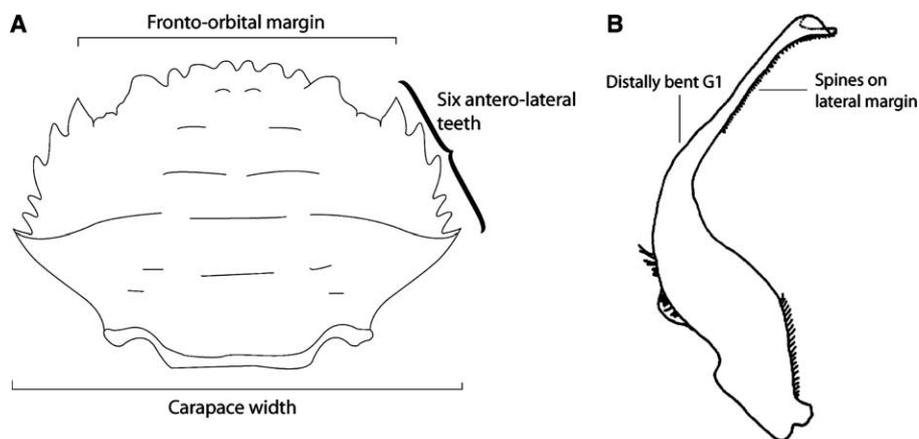


Figure 2. Generalized schematic diagram of *Charybdis* indicating distinguishing morphological characters. A, Dorsal surface of carapace (camera lucida diagram). B, G1.

level of the last antero-lateral teeth; prominent tuberosity on cardiac region covered with densely spaced small granules. Chelipeds subequal in both sexes, rough, unevenly tomentose; merus with two well-developed spines and five to six granules on anterior margin; manus tumid, five-costate, with five spines on upper surface, two on distal margin immediately posterior to articulation with dactylus possess blunt tips; dactylus smooth, strong and slender with curved tips, longer than manus. Propodus of natatory leg smooth, merus bears prominent spine on postero-distal margin. Sixth abdominal segment in male broader than long, its sides parallel over less than half their lengths and gradually converge distally. G1 L-shaped, its distal tip short, stout, with a slight bend; membrane commences shortly behind the tip; inner row of 4–5 bristles very sparsely placed commencing distantly from distal tip and terminate before outer row of bristles. Female gonopore slightly reniform and located on thoracic sternite 6, posterior to suture 5/6 and corresponds to the bases of second pair of pereopods.

### Description

Carapace (CW  $\mu = 26.68 \pm 4.44$  mm; CL  $\mu = 15.85 \pm 3.94$  mm; CW/CL  $\mu = 1.71 \pm 0.16$ ) evenly tomentose/pilose, with the exception of transverse ridges and swellings (Figure 3A,B). Frontal margin cut into six teeth (excluding inner supra-orbital angles), median frontal teeth bluntly triangular, projecting beyond broadly rounded sub-medians, laterals triangular, narrowest, separated from sub-medians by wide, U-shaped notch (Figure 3C). Orbits (OD  $\mu = 3.05 \pm 0.56$  mm) with strong dorsal inclination; major orbital diameter two-fifths to nearly half of the inter-orbital space (IS  $\mu = 6.26 \pm 1.52$  mm; OD/IS  $\mu = 0.49 \pm 0.03$ ). Inter-orbital space almost one-quarter the carapace width (IS/CW  $\mu = 0.23 \pm 0.02$ ). Fronto-orbital margin (FW  $\mu = 12.77 \pm 2.85$  mm) almost half the carapace width; antero-lateral margins oblique and more or less arched. Infra-orbital lobe with row of granules on frontal margin. Antennae fold transversely. Basal antennal joint with smooth granular ridge, its prolongation in contact with front, thus excluding antennal flagellum from orbit. Merus of third maxilliped with outer distal angle produced sideways.

Antero-lateral margin of carapace moderately arched, cut into six serrated teeth separated by wide notches (Figure 3D). First tooth slightly notched, second and third sub-equal, blunt pointed with serrated margins, fourth and fifth wider and spini-form, sixth tooth greater than twice the length of the preceding five and laterally directed (Figure 3D).

Posterior margin of carapace slightly curved, forms a curve with the postero-lateral margins of carapace.

Transverse ridges distinctly granular, two pro-to-gastric, one meso-gastric, a medially divided meta-gastric, and epibranchials along the level of the last antero-lateral teeth; frontal ridge obsolete. No transverse ridges beyond the level of the last antero-lateral teeth; prominent tuberosity on cardiac region covered with densely spaced small granules (Figure 3A,B). Surface of transverse ridges and tuberosities more or less devoid of tomentum.

Chelipeds sub-equal in both sexes (LC  $29.30 \pm 7.36$  mm; RC  $29.04 \pm 8.51$  mm), rough, tomentose, a little less than twice the carapace length (Figure 3E). Right cheliped larger in male, left cheliped larger in ovigerous female. Upper surface of merus granular with two well-developed spines and five to six granules on its anterior margin; no spine on posterior margin. Carpus with tuberculated upper surface bears one large spine on its inner angle and three small spines on outer angle. Manus tumid, five costate, with five spines on its upper surface; two blunt spines on distal margin immediately posterior to articulation with dactylus; two well-developed spines in the middle of upper surface trailed by coarse granular costae; fifth spine on the posterior margin just anterior to articulation with carpus; outer surface with three smooth costae, the lower-most reaches the tip of the dactylus. Dactylus smooth, strong, and slender with curved tips, longer than manus.

Ambulatory legs long, slender; third pair longest, although shorter than the chelipeds. Dactyli and propodi of first three pairs of legs covered with densely packed bristles on both anterior and posterior margins, carpus and merus bear bristles only on posterior margin. Posterior margin of propodus and carpus of natatory leg smooth, merus with prominent spine on its postero-distal margin.

Thoracic sternites and abdominal cavity in male sternum finely granular (Figure 3F). First three thoracic sternites narrow, sutures 1/2 and 2/3 prominent. Suture 3/4 wide and shallow. Sternite 4 widest, medially divided by a shallow anterior extension of abdominal cavity. Abdominal cavity commences from posterior portion of sternite 4 and covers sternites 5–8. Deep groove along abdominal cavity medially divides sternites 5–8. Granule of abdominal lock located immediately anterior to suture 5/6. Thoracic sternites in female specimens similar to those in male (Figure 3G).

Sixth abdominal segment in males broader than long, its sides parallel over less than half their lengths and then gradually converge distally (Figure 3H); basal margin slightly convex, distal margin concave. G1 L-shaped, its distal tip short, stout, with a slight

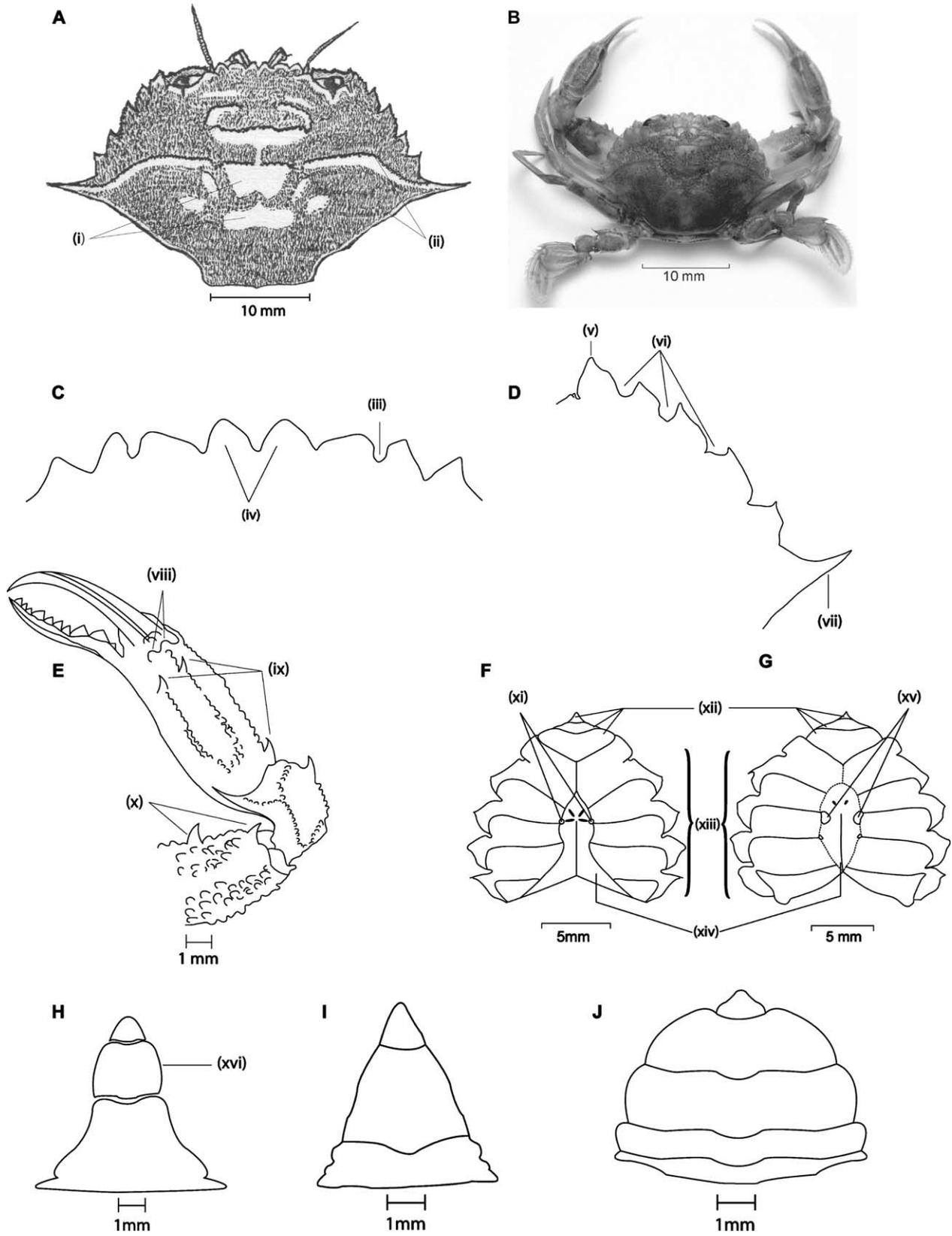


Figure 3 (Continued)

bend (Figure 4A), reaches sixth thoracic sternite; membrane commences shortly behind the tip; outer row of bristles commences close to distal tip and terminates in the neck region; bristles clumped towards the distal end and sparsely placed towards the neck; inner row of 4–5 bristles very sparsely placed commencing distantly from distal tip and terminate before outer row of bristles; bristles on abdominal margin randomly and very widely placed (Figure 4B,C).

Females exhibit dimorphism in abdominal shape; immature females with narrow, triangular abdomen (Figure 3I), wide watch glass-shaped abdomen in ovigerous female (Figure 3J). Female gonopore slightly reniform, located on thoracic sternite 6, posterior to suture 5/6 and corresponding to the bases of second pair of pereopods (Figure 3G).

#### Colour

Carapace light brown over tomentose regions, polished surfaces of granular transverse ridges and regional tuberosities dark brown; pale brown to off-white ventrally. Chelipeds dark brown with whitish tips; other pereopods light brown.

#### Etymology

The species name, *Charybdis (Charybdis) goaensis* is derived from the type locality, Goa, west coast of India.

#### Distribution

*Charybdis goaensis* is currently known only from the type locality (Zuari Estuary) and offshore fishing grounds of Goa, west coast of India.

#### Habitat characteristics

The specimens were collected from 6 to 7 m depth localities from the Zuari Estuary, Goa, west coast of India during September (end of the south-west monsoon). At the time of collection, salinity recorded was in the range of 22–32 ppt. The collection site is in the close vicinity of Mormugao Port Trust, and the waterway is subjected to regular dredging.

#### Habit

*Charybdis goaensis* was mainly collected from a trawl operation in the estuary. However, capture of an ovigerous female specimen in an offshore trawl from a depth of 13–14 m in March 2007 indicates the probability of catadromous habit of the females of this species for spawning.

#### Remarks

Crabs were identified up to the sub-genus level using orthodox taxonomic studies based on morphological characters described by Alcock (1899), Leene (1938), Sakai (1976) and Wee & Ng (1995). The distinguishing morphological characteristics of the sub-genus *Charybdis* are: lobule at external angle of basal antennal joint in contact with front and completely excludes flagellum from orbital hiatus; posterior angles of carapace may be accented or not, but posterior margin forms a curve with postero-lateral margins; four median frontal teeth not dissimilar to lateral frontal teeth; antero-lateral margins cut into six teeth (or seven, in which case there are six large and one small teeth); no spine on posterior margin of cheliped (Leene 1938; Sakai 1976).

The distinctiveness of the new species was ascertained based on the comparison with morphological descriptions of its congeners (Fabricius 1787; Miers 1884; Alcock 1899; Rathbun 1923a, 1923b, 1924; Shen 1934; Leene 1938; Ward 1941; Leene & Buitendijk 1949; Edmondson 1954; Rees & Stephenson 1966; Stephenson & Rees 1967b, 1968; Zarenkov 1970; Sakai 1976; Crosnier 1984; Wee & Ng 1995; Spiridonov & Türkay 2001). Morphological characters such as number of antero-lateral teeth, presence of transverse ridges on carapace, armature of chelipeds and natatory legs were used as criteria to differentiate the new species from its congeners. Based on the above criteria, *C. goaensis* with six antero-lateral teeth differed with *C. heterodon* and *C. demani* with five and seven antero-lateral teeth, respectively. The new species differed with 12 other species (*C. rathbuni*, *C. salehensis*, *C. variegata*, *C. brevispinosa*, *C. granulata*, *C. natator*, *C. seychellensis*, *C. beauforti*, *C. curtilobus*, *C. cookei*,

Figure 3. *Charybdis (Charybdis) goaensis* sp. nov. A, Dorsal surface of carapace (camera lucida diagram). B, Dorsal surface of carapace (photograph). C, Frontal margin of carapace (camera lucida diagram). D, Antero-lateral margin of carapace (camera lucida diagram). E, Dorsal view of right cheliped (camera lucida diagram). F, Ventral surface indicating thoracic sternites and abdominal cavity of male (camera lucida diagram). G, Ventral surface indicating thoracic sternites and abdominal cavity of female (camera lucida diagram). H, Male abdomen (camera lucida diagram). I, Abdomen of immature female (camera lucida diagram). J, Abdomen of mature female (camera lucida diagram). (i) Swellings on carapace devoid of tomentum; (ii) tomentose carapace; (iii) wide U-shaped notch separating sub-median and lateral frontal teeth; (iv) bluntly triangular median frontal teeth; (v) first antero-lateral tooth slightly notched; (vi) wide notches separate the antero-lateral teeth; (vii) last antero-lateral tooth largest and laterally directed; (viii) 2 spines with blunt tips on upper surface of manus; (ix) 3 well-developed spines on upper surface of manus; (x) 2 spines on anterior margin of merus; (xi) grain of abdominal lock (pair); (xii) thoracic sternites 1–3; (xiii) thoracic sternites 4–8; (xiv) abdominal cavity; (xv) female gonopore (pair); (xvi) sixth abdominal segment.

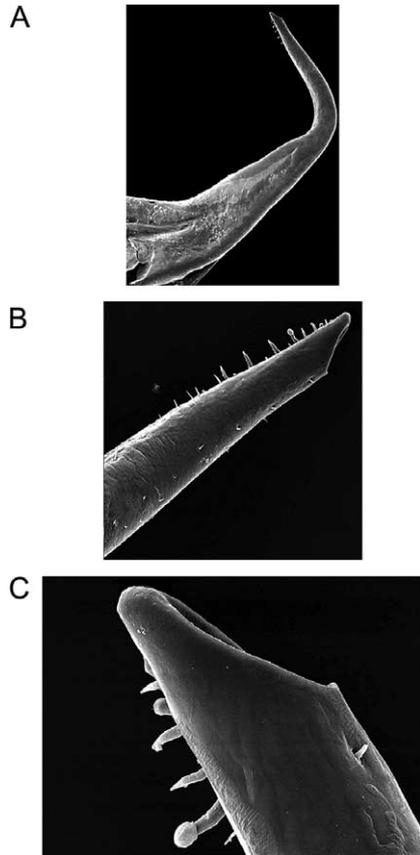


Figure 4. *Charybdis (Charybdis) goaensis* sp. nov. Scanning electron micrographs (SEM) of first pleopod or gonopod (G1) (left). (a) Entire gonopod. (b) Tip of gonopod. (c) Tip of gonopod (enlarged view).

*C. rostrata* and *C. callianassa*) by the absence of transverse ridges posterior to last antero-lateral teeth. Further, *C. goaensis* with two spines on anterior margin of merus of cheliped differed with 24 other species (*C. orientalis*, *C. hawaiiensis*, *C. feriata*, *C. padadiana*, *C. rosaea*, *C. annulata*, *C. hellerii*, *C. vannamei*, *C. spinifera*, *C. acuta*, *C. incisa*, *C. javanensis*, *C. lucifera*, *C. amboinensis*, *C. yaldwyni*, *C. jaubertensis*, *C. japonica*, *C. affinis*, *C. acutidens*, *C. rufodactylus*, *C. sagamiensis*, *C. riversandersoni*, *C. crosnieri*, *C. holosericus*) with three spines, and two species (*C. miles*, *C. meteor*) with four to five spines, respectively.

*C. goaensis* was observed to be morphologically most similar to *C. philippinensis*, *C. ihlei* and *C. anisodon* based on ‘two spines on anterior margin of merus of cheliped’, and ‘absence of spines on posterior margin of propodus of natatory leg’. Further, both *C. goaensis* and *C. philippinensis* possess ‘slightly notched first antero-lateral tooth’ and ‘five spines on cheliped manus’ and differed from ‘obtusely triangular first antero-lateral tooth’ and ‘two spines on cheliped manus’ in *C. anisodon*,

and ‘distinctly bifid first antero-lateral tooth’ and ‘three spines on cheliped manus’ in *C. ihlei*.

The identification of the new species was further confirmed through thorough comparison of its morphological characteristics with those of the holotype (AMNH 8382) and male paratype (AMNH 7893) specimens of its closest congener, *C. philippinensis*, obtained from the American Museum of Natural History. A brief updated description of *C. philippinensis* along with its morphometry and diagnostic morphological illustrations (camera lucida diagrams and photographs) is provided below.

***Charybdis (Charybdis) philippinensis* Ward, 1941**

*Comparison of description of Ward and diagnosis of holotype specimen (Catalogue No. AMNH 8382 obtained from American Museum of Natural History)*  
(The holotype specimen obtained was devoid of the right cheliped and legs on right side)

Carapace (CW  $\mu = 35.65 \pm 2.56$  mm; CL  $\mu = 20.50 \pm 1.30$  mm; CW/CL  $\mu = 1.74 \pm 0.01$  mm) naked, devoid of tomentum (Figure 5A). Median frontal teeth rounded, sub-median and lateral frontal teeth separated by narrow V-shaped notch (Figure 5C). Orbits with strong dorsal inclination; major orbital diameter (OD  $\mu = 3.97 \pm 0.18$  mm) almost half the length of the inter-orbital space (IS  $\mu = 8.46 \pm 0.45$  mm; OD/IS  $\mu = 0.47 \pm 0.00$ ) (Figure 5A). Inter-orbital space almost one-quarter the carapace width (IS/CW  $\mu = 0.24$ ). Antero-lateral teeth six in number, first slightly notched, sixth greater than two times the length of the preceding five and laterally directed; teeth separated by narrow notches (Figure 5D). Transverse ridges of carapace faintly granular, two proto-gastric, one meso-gastric, a medially divided meta-gastric, and epibranchials along the level of the last antero-lateral teeth; no transverse ridges beyond the level of the last antero-lateral teeth (Figure 5A). Cardiac region devoid of tuberosity (Figure 5A). Chelipeds sub-equal (LC  $\mu = 36.30 \pm 3.96$  mm; RC  $\mu = 40.08 \pm 2.15$  mm), smooth; merus with two well-developed spines and five to six granules on its anterior margin; manus tumid, five-costate, with five spines on upper surface, two blunt spines on distal margin immediately posterior to articulation with dactylus; dactylus smooth, strong, and slender with curved tips, longer than manus (Figure 5B). Propodus of natatory legs smooth, merus bears prominent spine on its postero-distal margin. Penultimate abdominal segment broader than long, its sides parallel over less than half their lengths and then gradually converge distally (Figure 5B).

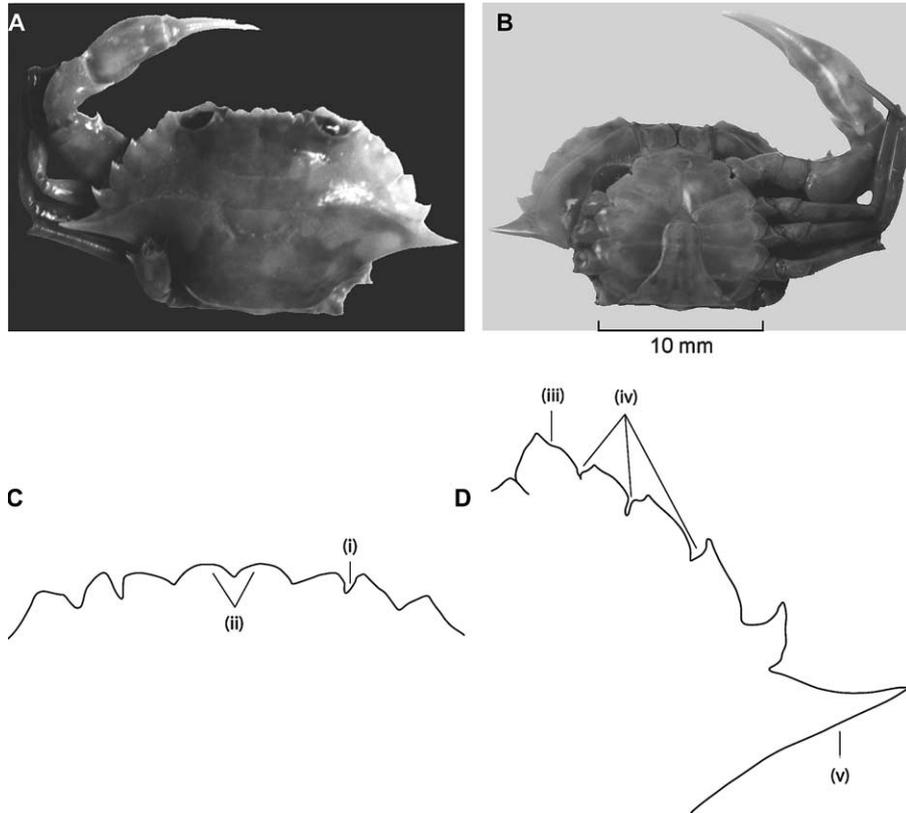


Figure 5. *Charybdis (Charybdis) philippinensis* Ward, 1941. A, Dorsal surface of carapace (photograph). B, Ventral surface of carapace (photograph). C, Frontal margin of carapace (camera lucida diagram). D, Antero-lateral margin of carapace (camera lucida diagram). (i) Narrow V-shaped notch separating sub-median and lateral frontal teeth; (ii) rounded median frontal teeth; (iii) first antero-lateral tooth slightly notched; (iv) narrow notches separate the antero-lateral teeth; (v) last antero-lateral tooth largest and laterally directed.

Comparison between the new species and its closest congener, *C. philippinensis*, revealed that the new species possessed ‘bluntly triangular frontal teeth; wide U-shaped notch separating sub-median and lateral frontal teeth’ as compared to ‘rounded median frontal teeth; narrow V-shaped notch separating sub-median and lateral frontal teeth’ of the latter species. In addition, antero-lateral teeth of *C. goaensis* were separated by ‘wide notches’ as compared to ‘narrow’ ones of *C. philippinensis*. Moreover, *C. goaensis* differed from the latter species by the presence of ‘granular tuberosity’ on cardiac region.

A taxonomic key to 43 species of the subgenus *Charybdis* is provided below to substantiate our claim of identification of a new portunid crab species from Goa, west coast of India.

**Key to the species of swimming crabs of the sub-genus *Charybdis***

1. Transverse ridges on carapace posterior to the last antero-lateral tooth absent . . . . . 2.
- Transverse ridges on carapace posterior to the last antero-lateral tooth present. . . . . 28.

2. Antero-lateral margins of carapace appear to be divided into five teeth as first two teeth are grown together except for distal end rendering ‘bifurcated first tooth’ appearance . . . *Charybdis (Charybdis) heterodon* Nobili, 1906.
  - Antero-lateral margins of carapace appear to be divided into seven teeth due to division of first tooth into larger (anterior) and smaller (posterior) teeth . . . . . *Charybdis (Charybdis) demani* Leene, 1937.
  - Antero-lateral margins of carapace divided into six teeth . . . . . 3.
3. Two spines on the anterior margin of merus of cheliped. First antero-lateral tooth square-cut to obtusely triangular; last tooth greater than twice in length than any of the preceding teeth, and projected laterally. Posterior margin of propodus of natatory (last) leg smooth. . . . . 4.
- Three spines on the anterior margin of merus of cheliped. First antero-lateral tooth usually smaller than succeeding ones, may be truncated; length of last antero-lateral tooth may or may not exceed that of preceding spine, may be projected laterally. Posterior margin of propodus of natatory leg serrated or smooth. . . . . 6.

- Three to five spines on the anterior margin of merus of cheliped. First antero-lateral tooth smallest, may or may not be truncated, last one largest and either forwardly, laterally or backwardly directed. Posterior margin of propodus of natatory leg serrated . . . . . 22.
- 4. First antero-lateral tooth obtusely triangular. Two spines on upper surface of manus of cheliped . . . . . *Charybdis (Charybdis) anisodon* (De Haan, 1833).
- First antero-lateral tooth distinctly bifid. Three spines on upper surface of manus of cheliped . . . . . *Charybdis (Charybdis) ihlei* Leene & Buitendijk, 1949.
- First antero-lateral tooth slightly notched. Five spines on upper surface of manus of cheliped . . . . . 5.
- 5. Median frontal teeth bluntly triangular, sub-medians and laterals separated by wide U-shaped notch. Antero-lateral teeth separated by wide notches. Prominent granular tuberosity on cardiac region. . . . . *Charybdis (Charybdis) goaensis* sp. nov.
- Median frontal teeth rounded, sub-medians and laterals separated by narrow V-shaped notch. Antero-lateral teeth separated by narrow notches. Lack of tuberosity on cardiac region . . . . . *Charybdis (Charybdis) philippinensis* Ward, 1941.
- 6. Upper surface of manus of cheliped with four spines . . . . . 7.
- Upper surface of manus of cheliped with five spines . . . . . 10.
- 7. First antero-lateral tooth spiniform, second rudimentary, attached to posterior margin of first . . . . . 8.
- First antero-lateral tooth notched or blunt, second not rudimentary. . . . . 9.
- 8. Inner surface of manus of cheliped smooth; merus of fifth leg proportionally longer . . . . . *Charybdis (Charybdis) orientalis* Dana, 1852.
- Inner surface of manus of cheliped strongly granular; merus of fifth leg relatively shorter . . . . . *Charybdis (Charybdis) hawaiiensis* Edmondson, 1954.
- 9. First antero-lateral tooth distinctly bifid, second and fifth teeth larger than first, last tooth produced laterally . . . . . *Charybdis (Charybdis) feriata* (Linnaeus, 1758).
- First two antero-lateral teeth blunt, second and fifth teeth smallest, last tooth not produced laterally . . . . . *Charybdis (Charybdis) padadiana* Ward, 1941.
- 10. Manus of cheliped bears five spines on upper surface, two on distal margin tuberculated . . . . . 11.
- All five spines on upper surface of manus of cheliped well developed. . . . . 12.
- 11. Margin of median frontal teeth well in advance of that of sub-medians; presence of faint transverse ridges on frontal region of carapace . . . . . *Charybdis (Charybdis) rosaea* (Hombron & Jacquinot, 1846).
- Margin of median frontal teeth slightly in advance of that of sub-medians; no transverse ridge on frontal region. . . . . *Charybdis (Charybdis) annulata* (Fabricius, 1798).
- 12. Posterior margin of carpus of natatory leg bears spine . . . . . 13.
- Posterior margin of carpus of natatory leg smooth, lacks spine. . . . . 15.
- 13. Last antero-lateral spine elongate, projects beyond preceding spine . . . . . 14.
- Last antero-lateral spine smallest, does not project beyond preceding spine *Charybdis (Charybdis) vannamei* Ward, 1941.
- 14. Median frontal teeth sharp, triangular, projecting beyond narrow sub-medians; posterior margin of propodus of natatory leg denticulated . . . . . *Charybdis (Charybdis) hellerii* (A. Milne Edwards, 1867).
- Median and sub-median frontal teeth broadly rounded, medians project slightly in advance of sub-medians; posterior margin of propodus of natatory leg smooth . . . . . *Charybdis (Charybdis) spinifera* (Miers, 1884).
- 15. Posterior margin of propodus of natatory leg serrated . . . . . 16.
- Posterior margin of propodus of natatory leg smooth . . . . . 21.
- 16. All frontal teeth sharply triangular. . . . . *Charybdis (Charybdis) acuta* (A. Milne Edwards, 1869).
- All frontal teeth rounded. . . . . 17.
- Frontal teeth either bluntly triangular or rounded. . . . . 18.
- 17. Median frontal teeth slightly in advance of sub-medians, laterals least advanced . . . . . *Charybdis (Charybdis) incisa* Rathbun, 1923a.
- Median frontal teeth well in advance of sub-medians, laterals slightly in advance of sub-medians. . . . . *Charybdis (Charybdis) javanensis* Zarenkov, 1970.
- 18. Frontal teeth bluntly triangular; median teeth blunter than sub-medians and laterals. . . . . 19.
- Median and sub-median frontal teeth broadly rounded, laterals broadly triangular. . . . . 20.
- 19. Sub-median frontal teeth separated from the laterals by deep V-shaped incision. Transverse ridges of carapace faintly granular. . . . . *Charybdis (Charybdis) lucifera* (Fabricius, 1798).

- Sub-median frontal teeth separated from the laterals by wide and deep fissure. Transverse ridges of carapace distinctly granular . . . . . *Charybdis (Charybdis) amboimensis* Leene, 1938.
- 20. Cardiac region of carapace with corrugated surface; first antero-lateral tooth markedly truncated; outer surface of manus strongly squamiform throughout; G1 of male short, stout and sharply curved, absence of upper inner spines proximal to lip of G1 . . . . . *Charybdis (Charybdis) yaldwyni* Rees & Stephenson, 1966.
  - Cardiac region of carapace typically granulated; first antero-lateral tooth slightly truncated; outer surface of manus coarsely granular on upper half and squamiform on lower half; G1 of male long, slender with sinuous margin, presence of inconspicuous row of well-spaced spinules proximal to lip. . . . . *Charybdis (Charybdis) jaubertensis* Rathbun, 1924.
- 21. Manus of cheliped with well developed spines; penultimate segment of male abdomen with convex lateral borders; last antero-lateral tooth smallest and spiniform, not projecting beyond preceding tooth . . . . . *Charybdis (Charybdis) japonica* (A. Milne Edwards, 1861).
  - Manus of cheliped with poorly developed spines; penultimate segment of male abdomen with lateral margins parallel for proximal half; last antero-lateral tooth elongated, projecting laterally beyond preceding tooth . . . *Charybdis (Charybdis) affinis* Dana, 1852.
- 22. Carapace pilose and narrow, CW/CL ratio being 1.41, ridges of carapace distinct; lower surface of manus with squamiform marking . . . . . *Charybdis (Charybdis) miles* (De Haan, 1835).
  - Carapace generally lacking pilosity, relatively broad, CW/CL ratio being 1.49-1.67, ridges of carapace faint; squamiform marking on manus, if present may be faint . . . . . 23.
- 23. Ridges on dorsal surface of carapace finely granular, mesogastric ridges distinct; third to fifth antero-lateral teeth with straight edges, others with sinuous edges . . . . . *Charybdis (Charybdis) meteor* Spiridonov & Türkay, 2001.
  - Ridges on carapace finely or distinctly granular; all antero-lateral teeth with sinuous edges . . . . . 24.
- 24. Transverse ridges of carapace distinctly granular; inner sub-orbital lobe broadly triangular; manus massive with faint squamiform marking on lower surface of outer side . . . . . 25.
  - Transverse ridges of carapace finely granular; inner sub-orbital lobe sharply triangular or styliform; manus slender, devoid of squamiform marking on outer side. . . . . 26.
- 25. Carina on inner as well as outer surface of manus in the form of conspicuous ridges; movable finger long, slender and deeply grooved; postero-distal margin of propodus of natatory leg smooth . . . *Charybdis (Charybdis) rufodactylus* Stephenson & Rees, 1968.
  - Carina on inner as well as outer surface of manus in the form of rounded ridges; movable finger short, relatively stout and shallow grooved; two spinules on postero-distal margin of propodus of natatory leg . . . . . *Charybdis (Charybdis) sagamiensis* Parisi, 1916.
- 26. Inner supra-orbital lobe styliform, outer sharpened; dactyli of second to fourth pereopods thin, curved with lancet-shaped tip . . . *Charybdis (Charybdis) acutidens* Türkay, 1986.
  - Inner supra-orbital lobe broadly to sharply triangular; dactyli of second to fourth pereopods moderately wide, slightly curved. . . . 27.
- 27. Median frontal teeth acutely rounded; lateral frontals with outer edge convex; basal antennal joint bearing distinct granules; lip of G1 of male tapering with conspicuous spinules evenly distributed along edges; lateral spines not closely set, extending to about one-fifth of the neck . . . . *Charybdis (Charybdis) riversandersoni* Alcock, 1899.
  - Median frontal teeth sharply granular; lateral frontals with straight edges; basal antennal joint bearing fused granules; lip of G1 of male elongated and bent downward, spinules concentrated on abdominal edge near tip; lateral spines closely set, extending to one-quarter of the neck . . . . . *Charybdis (Charybdis) crosnieri* Spiridonov & Türkay, 2001.
- 28. Transverse ridge on cardiac region interrupted . . . . . 29.
  - Transverse ridge on cardiac region not interrupted. . . . . 36.
- 29. Small-sized species; mesobranchial region of carapace with two pairs of transverse ridges . . . . . 30.
  - Species of a good size; mesobranchial region of carapace with two to three pairs of transverse ridges . . . . . 33.
- 30. Second antero-lateral tooth of carapace smaller than the first, and attached to its posterior margin. . . . . *Charybdis (Charybdis) rathbuni* Leene, 1938.
  - Second antero-lateral tooth as large as the first, not attached to the posterior margin of the latter. . . . . 31.
- 31. Sixth antero-lateral tooth largest, spiniform and laterally projected . . . . . 32.

- Sixth antero-lateral tooth distinctly smaller than preceding tooth, laterally projected. . . . *Charybdis (Charybdis) salehensis* Leene, 1938.
- 32. All frontal teeth acuminate at tip. Sub-distal portion of male gonopod separated as distinct lobe from tip . . . . . *Charybdis (Charybdis) variegata* (Fabricius, 1798).
  - Only lateral frontal teeth acuminate at tip. Sub-distal portion of male gonopod not distinct from tip . . . . . *Charybdis (Charybdis) brevispinosa* Leene, 1937.
- 33. Dorsal surface of carapace even and uniformly covered with soft tomentum. Penultimate segment of male abdomen not convex on lateral margins . . . . . 34.
  - Dorsal surface of carapace somewhat uneven, unevenly tomentose. Penultimate segment of male abdomen convex on lateral margins . . . . . *Charybdis (Charybdis) granulata* (De Haan, 1833).
- 34. First antero-lateral tooth of carapace truncated at tip. Frontal ridge of carapace absent . . . . . *Charybdis (Charybdis) natator* (Herbst, 1789).
  - First antero-lateral tooth not truncated. Frontal ridge present . . . . . 35.
- 35. Carapace with high relief and prominent transverse granular ridges. Granules on chelipeds very prominent and projecting . . . . . *Charybdis (Charybdis) beauforti* Leene & Buitendijk, 1949.
  - Carapace with low relief and less prominent transverse granular ridges. Granules on chelipeds less prominent . . . . . *Charybdis (Charybdis) seychellensis* Crosnier, 1984.
- 36. Mesobranchial region of carapace with two pairs of transverse ridges. Two spines on anterior margin of merus of cheliped . . . . . *Charybdis (Charybdis) curtlobus* (Stephenson & Rees, 1967b).
  - Mesobranchial region of carapace with one pair of transverse ridges. Three spines on anterior margin of merus of cheliped . . . . . *Charybdis (Charybdis) cookei* Rathbun, 1923b.
  - No transverse ridges on mesobranchial region . . . . . 37.
- 37. Carapace about four-fifths as long as broad; two spines on palm of cheliped. Lateral margins of sixth abdominal segment of male curved . . . . . *Charybdis (Charybdis) rostrata* (A. Milne Edwards, 1861).
  - Carapace about two-thirds as long as broad; three spines on palm of cheliped. Lateral margins of sixth abdominal segment of male parallel for half their lengths . . . . . *Charybdis (Charybdis) callianasa* (Herbst, 1801).

## Conclusion

In view of the above description and comparison of morphological characters with its congeners, *Charybdis goaensis* is a new species. The distinguishing characters of the new species are as follows.

1. 'Median frontal teeth bluntly triangular'.
2. 'Sub-median and lateral frontal teeth separated by wide, U-shaped notch'.
3. 'First antero-lateral tooth slightly notched'.
4. 'Last tooth of antero-lateral margin greater than twice the length of the preceding five and laterally directed'.
5. 'Antero-lateral teeth separated by wide notches'.
6. 'Prominent granular tuberosity on cardiac region'.
7. 'Two spines on the anterior margin of merus of cheliped'.
8. 'Five spines on upper surface of manus of cheliped, two on distal margin remain tuberculated'.
9. 'Membrane on tip of G1 of male commences shortly behind the tip; row of sparsely-placed bristles on outer margin starts at some distance from the tip, but anterior to the above membrane; row of 4–5 bristles very sparsely placed on inner margin commencing distantly from distal tip and terminating prior to outer row of bristles; bristles on abdominal margin randomly and very widely placed'.

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