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Coral reef-associated brachyuran fauna (Crustacea: Decapoda: Brachyura) from Angria Bank off the west coast of India

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Abstract

Underwater sampling via SCUBA and grab at the Angria Bank coral reefs off the central west coast of India in January 2014 revealed 11 species of Brachyura. Seven species, namely, *Thusaenys irami* (Laurie, 1906), *Tanaocheles bidentata* (Nobili, 1901), *Portunus convexus* De Haan, 1835, *Xiphonectes macrophthalmus* (Rathbun, 1906), *Thalamita gatavakensis* Nobili, 1906, *Serenius ceylonicus* (Laurie, 1906), and *Soliella flava* (Rathbun, 1894) are reported for the first time from Indian waters. Furthermore, the geographical distribution of *T. irami* and *S. ceylonicus* is extended westwards of hitherto known ranges.

Key words: Brachyura, reef-associated, India, new records, range extension

Introduction

The taxonomy of coral reef-associated Brachyura from Indian waters has been studied in great detail by several taxonomists. Alcock (1895, 1896, 1898, 1899a, 1899b, 1900) carried out the most prolific work on reef-associated Brachyura from all the major coral reef ecosystems in the Indian region. Besides these, there were several regional-level taxonomic studies from the Andaman and Nicobar archipelagos (Kemp 1917; Chopra & Das 1930; Chopra 1931; Sankarankutty 1961a, 1962a, b), the Gulf of Mannar and Palk Bay region (Henderson 1893; Gravely 1927; Sankarankutty 1966; Jeyabaskaran *et al.* 2000; Gokul & Venkataraman 2010), the Lakshadweep Islands (Borradaile 1902a, b, 1903a, b, 1903c; Sankarankutty 1961b; Devi *et al.* 2019), and the Coromandel coast (Sethuramalingam & Ajmal Khan 1991).

The Angria Bank is a submarine plateau 1300 km^2 in extent, located 105 km off Malvan, central west coast of India (Sivakumar & Joshi 2015), with an average water depth of 25 m (Untawale *et al.* 1989). The spatial extent of pristine coral reef habitats in this region is approximately 350 km^2 (Sivakumar & Joshi 2015). Despite being a biologically rich ecosystem (Sivakumar & Joshi 2015), only Alcock (1898) has attempted to assess the brachyuran diversity of the Angria Banks and reported two xanthid crabs from there.

The United Nations Development Programme (UNDP) sponsored a project led by the CSIR—National Institute of Oceanography, Goa, India, which carried out biological surveys of the Angria Bank ecosystem on 5–9 January 2014. These surveys revealed eleven species of reef-associated brachyuran crabs, including seven new records from the Indian waters. The present study provides the taxonomic details of these crabs along with comments on their geographical distribution.

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Material and methods

The sampling surveys were carried out in the Angria Bank area of the Eastern Arabian Sea (Fig. 1) during 5–9 January 2014 using the CSIR–NIO-owned RV '*Sindhu Sadhana*' as the mother ship, a fishing trawler as the diving support platform, and an inflatable raft for launching SCUBA diving operations. A Van Veen Grab (0.04 m^2) operated from the mother ship was used to collect the epibenthic macrofauna from mixed sandy, rocky and coralline substrates at depths of 22–42 m. On hauling the grab, all the crab specimens were sorted from the sediment, cleaned to remove debris, and photographed. Subsequently, the samples were preserved in 90 % ethanol solution, stored in pre-labeled plastic containers and transported to the shore laboratory.

In the laboratory, the preserved specimens were identified using the morphometric and meristic parameters following relevant taxonomic literature (Stephenson & Campbell 1959; Crosnier 1962; Stephenson 1972; Guinot 1976; Galil & Lewinsohn 1984; Serène 1984; Griffin & Tranter 1986; Clark & Galil 1993; Wee & Ng 1995; Ng & Clark 2000). Morphometric measurements were taken using ocular micrometer scale and software provided by Olympus stereomicroscope software. Carapace length and width were measured and used to express specimen size. The terminology used for carapace regions of xanthid crabs followed that of Serène (1984). The classification of brachyuran taxa follows Ng *et al.* (2008) and Poore & Ahyong (2023). The specimens examined for this work are deposited in the collections of the CSIR - National Institute of Oceanography, Goa, India.

The map of the study area was created using the trial version of ESRI ArcGIS Online website available at https://www.esri.com/en-us/arcgis/trial. The "Oceans" option was used to create the base-map, and its source is GEBCO, IHO-IOC GEBCO, NGS, DeLorme | Mxd assembled by Corey LaMar.

Abbreviations used: CL, carapace length; CW, carapace width; G1, first gonopod; P, pereopod; RVSS: Research Vessel Sindhu Sadhana. Carapace measurements of material examined are indicated as CW × CL, in millimetres (mm).

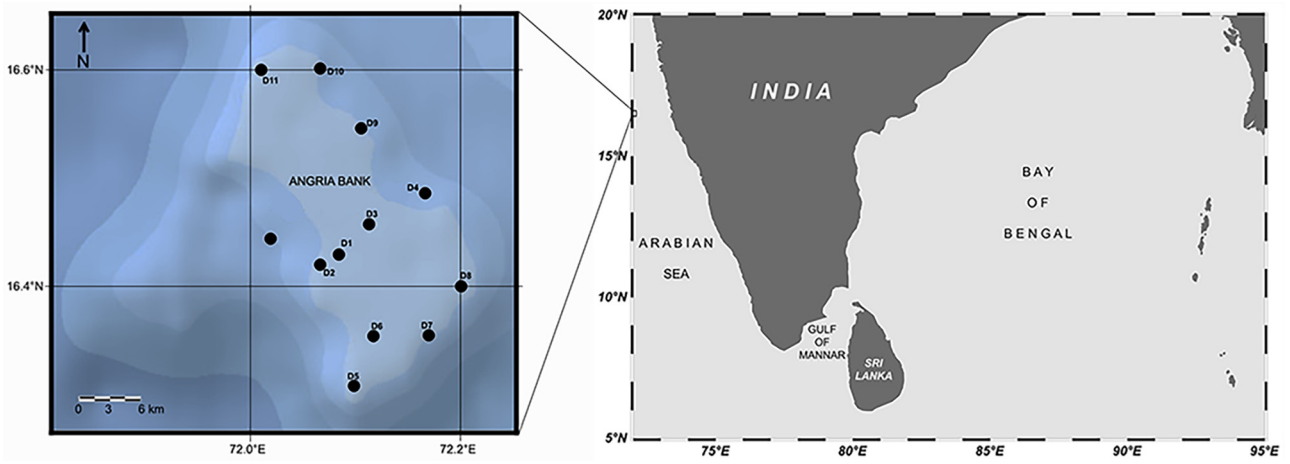

FIGURE 1. Map of the study area indicating sampling locations.

Systematic account

Family Epialtidae MacLeay, 1838

Subfamily Pisinae Dana, 1851a

Genus *Hyastenus* White, 1847

Hyastenus cracentis Griffin & Tranter, 1986

(Fig. 2A–D)

Hyastenus diacanthus.—Griffin & Tranter 1974: 170 [Not *Pisa* (*Naxia*) *diacantha* De Haan, 1839].

Hyastenus cracentis Griffin & Tranter, 1986: 125 (identification key), 138, figs. 44, 47c, d (type locality: Java Sea, Gasper Straits).—Loh & Ng 1999: 64, fig. 4.—Ng *et al*. 2008: 103 [list].—Windsor & Ahyong 2013: 726 (identification key).

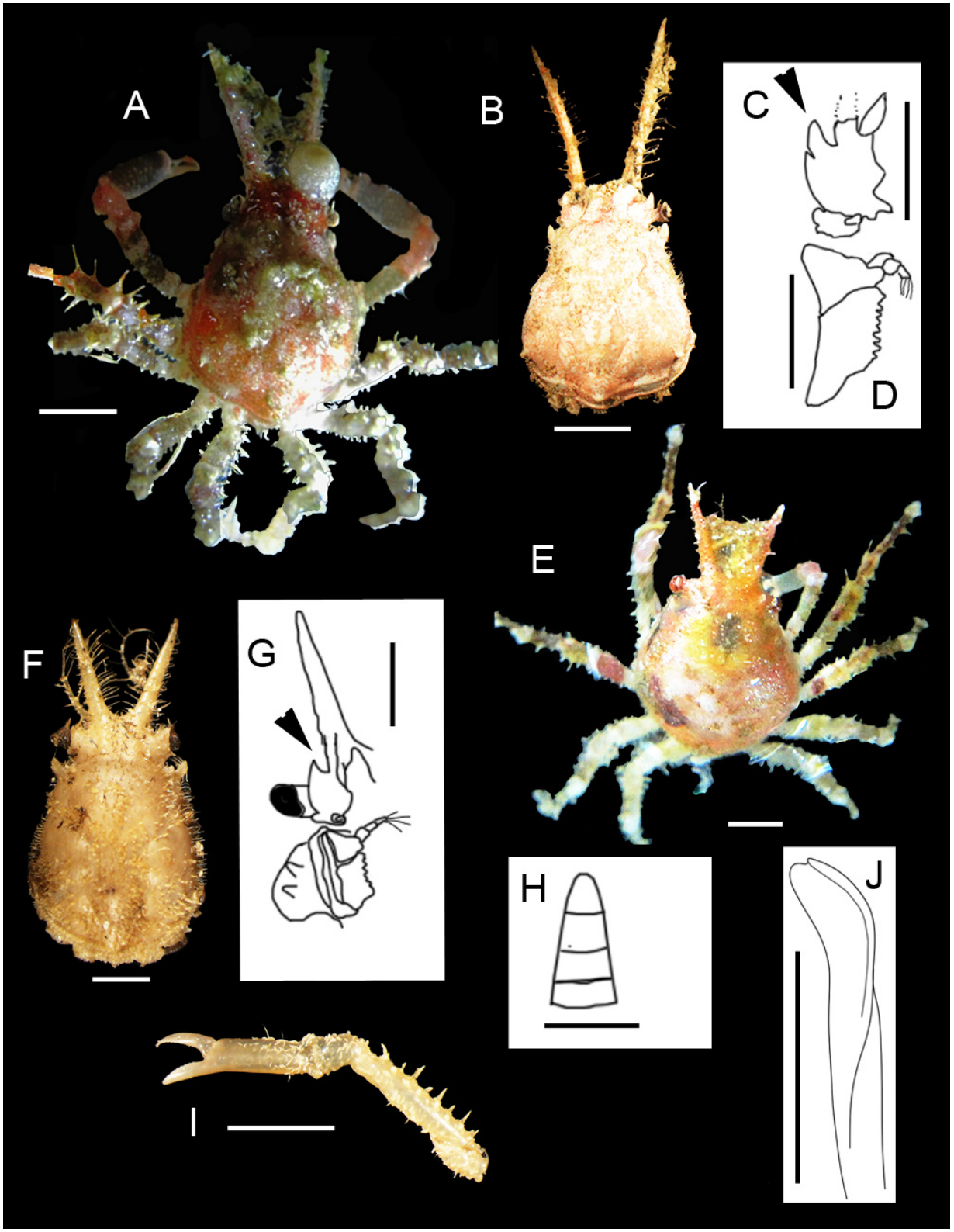

FIGURE 2. *Hyastenus cracentis* Griffin & Tranter, 1986, male (NIO/BOD/AB/BRY/00001, 2.2 × 2.8 mm), eastern Arabian Sea, India: (A) dorsal habitus (fresh colour); (B) carapace, dorsal view; (C) basal antennal article, ventral view (anterolateral spine indicated by arrowhead); (D) maxillipeds 3, ventral view. *Thusaenys irami* (Laurie, 1906), male (NIO/BOD/AB/BRY/00002, 3.0 × 4.3 mm), eastern Arabian Sea, India: (E) dorsal habitus (fresh colour); (F) carapace, dorsal view; (G) basal antennal article and maxilliped 3, ventral view (anterolateral spine indicated by arrowhead); (H) Male pleonal somites 4–6 and telson, ventral view; (I) left cheliped, external view; (J) distal portion of left G1, pleonal view. Scale bars: A–B, E–J, 1 mm, C–D, 0.5 mm.

Material examined. 1 juvenile male (2.2 × 2.8 mm) (NIO/BOD/AB/BRY/00001), RVSS 1, west of Vijaydurg, Arabian Sea, 16.45°N, 72.08°E, 27 m depth, Van Veen grab, coll. R. Periasamy, 5 January 2014.

Diagnosis. Carapace pyriform, longer than wide. Rostrum almost as long as post-rostral CL; rostral spines slender, horizontal, separate from near base, lacking accessory spine (Fig. 2A). Dorsal carapace smooth; protogastric, mesogastric, cardiac and anterior branchial regions lacking tubercles; short epibranchial spine present (Fig. 2A). Orbits reduced, with narrow supraorbital eave (produced into weak, horizontal preorbital spine), a cupped postorbital process; upper orbital hiatus keyhole-shaped (Fig. 2B). Basal antennal article narrow anteriorly or sub-rectangular, almost as broad as long, anterolateral spine separated from flagellar base by notch (indicated by arrowhead in Fig. 2C), proximal portion of lateral margin produced into convex lobe. Maxilliped 3 merus triangular, as long as wide, length 0.5 × ischial length (Fig. 2D). Pterygostomian margin with 2 tubercles. Cheliped slender, dactylus short, curved; propodus sub-cylindrical, merus with 5 or 6 spines on posterior margin (Fig. 2A). Pereopods 2–5 dactyli bearing row of ventral spines (Fig. 2A).

Colouration. Fresh specimen: mottled red, chelae greyish (Fig. 2A). Preserved specimen: light red (Fig. 2B).

Biology. Known to inhabit sandy substrates; 28–52 m **(**Griffin & Tranter 1974, 1986). The present specimen was collected from sandy substrate, at 27 m depth, covered with macroalgae.

Remarks. Griffin & Tranter (1986) described *H. cracentis* from a male from Gaspar Strait, Indonesia. This species closely resembles *H. bispinosus* Buitentijk, 1939, *H. inermis* (Rathbun, 1911) and *H. minutus* Buitentijk, 1939 in the absence of ornamentation on the mesogastric and anterior brachial regions of the carapace, a relatively broad upper orbital hiatus, and the presence of a sharp spine on the anterolateral angle of the basal antennal article. However, *H. cracentis* differs from *H. bispinosus* in having the preorbital and antorbital angles equally produced laterally (vs. distinct preorbital angle of eave in the latter species), and from *H. inermis* and *H. minutus* in relatively longer rostral spines > two-thirds post-rostral carapace length (vs. only half or less in the latter two species). The Indian specimen largely conforms to the description of the holotype (Griffin & Tranter 1986) in the elongated rostrum (> two-thirds of carapace length) keyhole-shaped upper orbital hiatus, absence of mesogastric tubercle on the carapace; and the anterolateral angle of basal antennal article produced forwards and slightly outwards as a short spine. On the other hand, the present specimen of *H. cracentis* differs from the holotype in the absence of a tubercle on the hepatic region of the carapace.

Geographical distribution. Red Sea, Bay of Bengal (India), Java (Indonesia) (Griffin & Tranter 1986); Hong Kong (Loh & Ng 1999); eastern Arabian Sea off India (present study).

Genus *Thusaenys* Griffin & Tranter, 1986

Thusaenys irami (Laurie, 1906)

(Fig. 2E–I)

Halimus irami Laurie, 1906: 379, pl. 1 figs. 4, 4a (type locality: Gulf of Mannar, Muttuvartu Par, Sri Lanka).—Rathbun 1924: 5.

Thusaenys irami.—Griffin & Tranter 1986: 193–196, fig. 66c–d.—Ng *et al*. 2008: 106 [list].

Material examined. Male (3.0 × 4.3 mm) (NIO/BOD/AB/BRY/00002), RVSS 2, west of Vijaydurg, Arabian Sea, 16.44°N, 72.07°E, 37 m depth, Van Veen grab, coll. R. Periasamy, 6 January 2014.

Diagnosis. Carapace pyriform, longer than wide, smooth, covered with short, stiff setae, intestinal region with low tubercle (Fig. 2E, F). Rostrum length nearly 0.5 × post-rostral CL; rostral spines slender, horizontal, divergent from the base, lacking accessory spine; dorsal carapace smooth; Orbits reduced, supraorbital eave produced into indistinct preorbital spine, cupped postorbital process with an extension on posterior margin of upper orbital hiatus (Fig. 2F, G). Supraorbital eave margin weakly concave. Basal antennal article broad, anterolateral angle produced into strong spine separated from flagellar base by notch (indicated by arrowhead in Fig. 2G); lateral margin convex (Fig. 2G). Maxilliped 3 merus quadrilateral, as long as wide, length 0.5 × ischial length (Fig. 2G). Pterygostomian region with 2 tubercles (Fig. 2G). Chelipeds slender (Fig. 2H). Male pleon terminally tapering, telson sub-triangular, not inserted deeply into somite 6 (Fig. 2H). G1 expanded at distal tip, groove present near lateral margin near pleonal surface (Fig. 2I).

Colouration. Fresh specimen: reddish, chelae greyish (Fig. 2E). Preserved specimen: light brown (Fig. 2F).

Biology. Known to occur underneath sub-tidal rocks, inside pearl oysters, over muddy substrates, vicinity of corals and *Lithothamnion*; 36–37 m (Griffin & Tranter 1986; present study). Laurie (1906) reported *Sacculina* infestation from Sri Lanka. The present specimen was collected from rocky substrate, at 37 m depth, in the vicinity of *Favites* corals.

Remarks. Laurie (1906) described *Halimus irami* from an ovigerous female collected from Muttuvartu Par, in the Gulf of Mannar (Sri Lanka). Griffin & Tranter (1986) included *Halimus irami* in a new genus, *Thusaenys*, owing to the strongly produced basal antennal article with anterior notch and the broad, weakly lobed supraorbital eave. *Thusaenys irami* differs from its closest congener *T. calvarius* (Alcock, 1895) in having basal antennal article with weakly convex lateral margin (vs. strongly produced lateral margin in the latter species (cf. Takeda 2023: fig. 1B)), and low tubercle on the intestinal region (compared to short, strong median spine in the latter (cf. Takeda 2023: fig. 1A)). The Indian specimen conforms to the holotype description (Laurie 1906) in the nearly smooth dorsal surface of the carapace, the presence of a low tubercle on the intestinal region, a relatively long rostrum nearly half as long as the remaining carapace, supraorbital eave anteriorly projecting into triangular tooth, and a gently convex lateral margin of the basal antennal article which is produced into strong spine separated from flagellar base by a notch. On the other hand, the present specimen differs from the holotype in the absence of an epibranchial tubercle.

Geographical distribution. Australia, New Guinea, Indonesia, and Gulf of Mannar off Sri Lanka (Griffin & Tranter 1986); eastern Arabian Sea off India (present study). The present observation is the first record from Indian waters indicating westward extension of the known geographical range.

Family Tanaochelidae Ng & Clark, 2000

Genus *Tanaocheles* Kropp, 1984

Tanaocheles bidentata (Nobili, 1901)

(Fig. 3A–E)

Chlorodius sp.—Nobili 1899: 258.
Chlorodius bidentatus Nobili, 1901: 15 (type locality: Red Sea).—Nobili 1906a: 263.—Klunzinger 1913: 219 (123).
Chlorodiella bidentata.—Gordon 1934: 49, fig. 26b.—Balss 1938: 52.—Monod 1938: 131, fig. 20.—Forest & Guinot 1961: 96.—Guinot 1967: 262.—Serène 1968: 81.—Chen & Lan 1978: 269, fig. 3, 7 (8–9), pl. 1, fig. 3.—Serène 1984: 22 (list) 254 (key), fig. 167, pl. 36F.
Tanaocheles bidentata.—Ng & Clark 2000: 209–212, figs. 1a, c–f, 3a–e.

Material examined. 2 males (4.8 × 3.0 mm, 4.7 × 2.9 mm) (NIO/BOD/AB/BRY/00007), RVSS 7, west of Vijaydurg, Arabian Sea, 16.38°N, 72.17°E, 27 m depth, Van Veen grab, coll. R. Periasamy, 7 January 2014.

Diagnosis. Carapace subhexagonal, broader than long, dorsal surface smooth, regions poorly defined; frontal margin sinuous, separated from inner supraorbital tooth by deep notch accommodating antennal flagellum; external orbital tooth small; anterolateral margin (behind external orbital angle) with 1 blunt projection followed by 2 anteriorly directed claw-like teeth, second tooth larger; posterolateral margin strongly converging (Fig. 3A). Endostomial ridges well developed throughout their length. Basal antennal article large, rectangular. Maxilliped 3 merus sub-quadrate, shorter than ischium, antero-external angle rounded (Fig. 3B). Chelipeds unequal, sub-cylindrical, smooth; larger cheliped with acuminate dactylus, carpus with blunt spine at inner angle; merus with blunt sub-distal and sub-proximal spinule on anterior margin (Fig. 3C). Male pleon of 6 somites and telson (Fig. 3D). G1 S-shaped, with proximal half relatively stout, distal part sinuous and slender (Fig. 3E).

Colouration. Preserved specimen: light brown with scattered black spots (Fig. 3A), cheliped brownish, fingers dark brown with white tips (Fig. 3C).

Biology. Known to be a symbiont on the corals *Acropora, Dendrophyllia* (Serène 1984) and *Pocillopora* in littoral and sub-littoral reefs (Ng & Clark 2000); occurs in heterosexual pairs, and probably associated with the xanthid crab, *Chlorodiella nigra* (Ng & Clark 2000). The present specimens were collected from sandy substrate, at 27 m depth, in the vicinity of live corals.

Remarks. Nobili (1901) described *C. bidentatus* from the Red Sea and included it in the Family Xanthidae. Serène (1984) suggested the transfer of *C. bidentata* to a separate genus owing to the differences in carapace, cheliped

and gonopod morphology with its existing congeners. Ng & Clark (2000) reviewed the taxonomy of *T. bidentata* and proposed its transfer from Xanthidae to a new pilumnid subfamily Tanaochelinae owing to differences in larval and adult morphological characters. The Indian specimens conform to the description of the holotype provided by Nobili (1901) in the smooth, flat dorsal carapace without areolated regions, the presence of two spiniform anterolateral teeth, the cheliped with 2 spines on the anterior margin of merus, a large inner carpal spine, smooth elongated propodus and short moderately arched fingers.

Geographical distribution. Red Sea, Singapore, Malaysia, China, Philippines, New Guinea (Serène 1984; Ng & Clark 2000); eastern Arabian Sea off India (present study). The present observation is the first record from Indian waters.

Family Portunidae Rafinesque, 1815

Subfamily Portuninae Rafinesque, 1815

Genus *Cycloachelous* Ward, 1942

Cycloachelous granulatus granulatus (H. Milne Edwards, 1834)

(Fig. 3F–G)

Lupea granulata H. Milne Edwards, 1834: 454 (type locality: Mauritius).
Achelous granulatus.—De Man 1888: 331.—Alcock & Anderson 1894: 201 (list).
Neptunus (*Achelous*) *granulatus*.—Alcock 1899: 45.—Klunzinger 1913: 341, pl. 11, fig. 18.—Bouvier 1915: 257.—Rathbun 1924: 23.—Balss 1938: 31.—Miyake 1939: 203.—Sakai 1939: 397 (part), fig. 8b.
Portunus (*Achelous*) *granulatus*.—Rathbun 1911: 205, pl. 15, fig. 10.—Michel 1964: 17.—Serène 1968: 68.
Cycloachelous granulatus.—Ward 1942: 53 (list), 80, pl. 5, fig. 5.—Barnard 1954: 124, fig. 3a–b.
Portunus granulatus.—Stephenson & Campbell 1959: 108, figs. 2I, 3I, pl. 3, fig. 1, pls. 4I, 5I.—Sankarankutty 1961a: 102 (list), 104.—Stephenson 1961: 108.—Crosnier 1962: 57, figs. 89, 92, 94a, b.—Sakai 1965: 118, pl. 58, fig. 1.—Stephenson & Rees 1967: 25 (part), fig. 5c–e.—Stephenson & Rees 1968: 293.—Stephenson 1972a: 136.—Stephenson 1972b: 15 (key), 39.—Stephenson 1975: 178, 183, figs. 1B, E, H, I, 2B, D, pl. 1, fig. 2.—Stephenson 1976: 16.—Kensley 1981: 42 (list).—Türkay 1981: 51.—Tirmizi & Ghani 1982: 105, fig. 1A–F.—Poupin 1996: 31.—Tirmizi & Kazmi 1996: 23, fig. 10A–F.—Apel & Spiridonov 1998: 286, figs. 97, 109.
Portunus (*Cycloachelous*) *granulatus*.—Sakai 1976: 348, figs. 187a–b, pl. 120, fig. 2.
Non *Portunus* (*Achelous*) *granulatus*.—Rathbun 1906: 871, pl. 12, fig. 2.—Edmondson 1954: 239, fig. 16a–b. [= *Portunus suborbicularis* Stephenson, 1975]
Non *Neptunus (Achelous) granulatus*.—Sakai 1939: 397 (part), pl. 81, fig. 2. [= *Portunus suborbicularis* Stephenson, 1975]
Non *Portunus granulatus*.—Stephenson & Rees 1967: 25 (part), fig. 5a–b. [= *Portunus suborbicularis* Stephenson, 1975]

Material examined. 1 male (damaged specimen, not measured), (NIO/BOD/AB/BRY/00008), RVSS 8, west of Vijaydurg, Arabian Sea, 16.42°N, 72.20°E, 23 m depth, Van Veen grab, coll. R. Periasamy, 7 January 2014.

Diagnosis. Carapace slightly broader than long, anterolateral margins divided into 9 acuminate teeth, first tooth broad, teeth 2–8 curved, ninth tooth longest and laterally directed; posterolateral junction rounded (Fig. 3F). Maxilliped 3 merus with prominent antero-external extension (Fig. 3G). Cheliped merus with 4 spines on anterior margin, 2 spines on posterior margin (Fig. 3F). P2–4 slender; P5 dactylus and propodus flattened (Fig. 3F, G).

Colouration. Fresh specimen: dorsal surface of carapace with orange specks along margins, mesogastric regions with 2 rounded brown blotches that interconnect medially in the cardiac region (Fig. 3F).

Biology. Known from coral reefs (Stephenson 1972), intertidal seagrass beds, and sand or sandy-mud substratum down to 60 m (Crosnier 1962). The present specimen was collected from sandy substratum, at 23 m depth, in the vicinity of *Favites* corals.

Remarks. *Cycloachelous granulatus* was originally described from Mauritius (H. Milne Edwards 1834). Stephenson & Campbell (1959) provided a detailed illustrated description of *P. granulatus* from Australia with emphasis on G1 morphology. Crosnier (1962) commented on the variations in pleonal morphology of this species. Stephenson's (1972b) key to the Indo-West Pacific portunids grouped it with *P. orbicularis, P. dubius* and *P. orbitosinus* owing to a narrow carapace and short ninth anterolateral tooth. The present specimen conforms to the brief description of the holotype (H. Milne Edwards 1834) in the presence of spines on the anterior and posterior

margins of the cheliped merus. The specimen also agrees with the description provided by Stephenson & Campbell (1959) and keys out as *P. granulatus* following the identification key provided by Stephenson (1972b). In the present specimen, the cheliped merus possesses 4 spines on the anterior margin, compared with 5 spines and 2 tubercles reported by Stephenson & Campbell (1959).

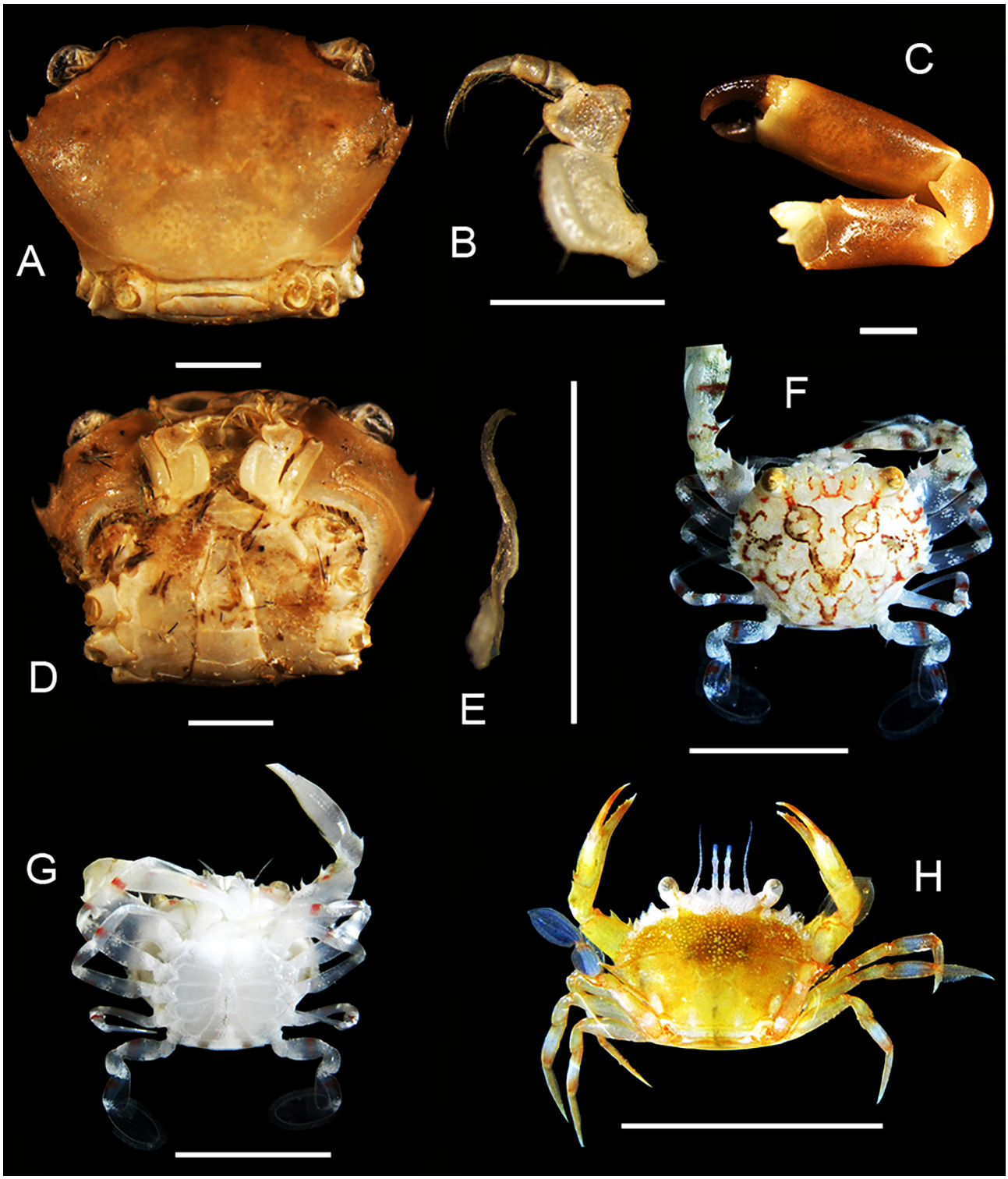

FIGURE 3. *Tanaocheles bidentata* (Nobili, 1901), male (NIO/BOD/AB/BRY/00007, 4.7 × 2.9 mm), eastern Arabian Sea, India: (A) carapace, dorsal view; (B) left maxilliped 3, external view; (C) right cheliped, dorsal view; (D) cephalothorax, ventral view; (E) G1, pleonal view. *Cycloachelous granulatus granulatus* (H. Milne Edwards, 1834), male (NIO/BOD/AB/BRY/00008, damaged specimen), eastern Arabian Sea, India: (F) dorsal habitus (fresh colour); (G) ventral habitus (fresh colour). *Portunus convexus* De Haan, 1835, juvenile (NIO/BOD/AB/BRY/00009, damaged specimen), eastern Arabian Sea, India: (H) dorsal habitus (fresh colour). Scale bars: A–E, 1 mm. F–H, 5 mm.

Geographical distribution. Red Sea and East coast of Africa to Japan, Australia and Hawaii (Stephenson 1972). In India, reported from Andaman and Nicobar archipelagos, Malabar coast (Alcock 1899) and Lakshadweep Islands (Sankarankutty 1961), eastern Arabian Sea off India (present study).

Genus *Portunus* Weber, 1795

Portunus convexus De Haan, 1835

(Fig. 3H)

Portunus (Pontus) convexus De Haan, 1833: 9 (type locality: Japan).
Portunus (Pontus) Convexus.—Herklots 1861: 118.
Neptunus sieboldi A. Milne-Edwards, 1861: 323, pl. XXXV fig. 5.—Henderson 1893: 370.
Neptunus convexus.—de Man 1883: 150.—Nobili 1901: 9.—de Man 1902: 643, pl. 21 figs. 27 a–b.—Nobili 1906a: 193–194.
Portunus convexus.—Crosnier 1962.—47, figs. 60, 64–66, 69–70, pl. 2, fig. 2.—Guinot 1962b: 10.—Stephenson 1972b: 13, 15 (identification key), 38.—Stephenson 1976: 16.—Vannini 1976: 122, 126.—Hogarth 1989: 104 (list).—Holthuis 1993: 614, Fig. 7.—Fransen et al. 1997: 108.—Apel & Spiridonov 1998: 284, figs. 96, 108.—Vannini & Innocenti 2000: 262, figs. 19, 24, 77.

Material examined. 1 juvenile (damaged specimen, not measured), (NIO/BOD/AB/BRY/00009), RVSS 9, west of Vijaydurg, Arabian Sea, 16.57°N, 72.10°E, 27 m depth, Van Veen grab, coll. R. Periasamy, 7 January 2014.

Diagnosis. Carapace broader than long, frontal margin divided into 6 teeth (including inner supra-orbital angles); anterolateral margins divided into 9 acuminate teeth, ninth tooth longest and laterally directed; posterolateral junction rounded (Fig. 5H). Cheliped merus with 3 spines on anterior margin, dactylus as long as propodus (Fig. 5H).

Colouration. Fresh specimen: carapace frontal and orbital margins as well as first 4 antero-lateral teeth white, rest of the carapace brownish yellow, 2 pale spots outlined in brown on the postero-lateral portion (Fig. 3H).

Biology. Known to be an inhabitant of sandy substrata, rock pools, crevices (Vannini & Innocenti 2000) and intertidal sea grass beds (Crosnier 1962); 20–27 m (Stephenson 1976; present study). The present specimen was collected from rocky substratum, at 27 m depth, covered with macroalgae.

Remarks. De Haan (1833) described *Portunus convexus* from Japan. Crosnier (1962) provided an illustrated description of this species from Madagascar. Apel & Spiridonov (1998) provided an illustrated description of material from Arabian Gulf supplemented with notes on habitat and geographical distribution. Vannini & Innocenti (2000) provided a brief illustrated description of Somalian specimens. The present specimen conforms to the description of the carapace being less than twice as wide as long by Crosnier (1962), and that of the live colouration (Stephenson 1972b) in the presence of a pale subcircular spot outlined with brown near each posterolateral margins of carapace. Contrary to Vannini & Innocenti's (2000) observation that this species does not occur in reefs, the present specimens were collected from a coral reef habitat.

Geographical distribution. East coast of Africa, Madagascar, Mascarenes, Persian Gulf, Sri Lanka, Indonesia, Japan (Vannini & Innocenti 2000), Guam (Paulay et al. 2003), French Polynesia (Poupin et al. 2018); eastern Arabian Sea off India (present study). The present observation is the first record from Indian waters.

Genus *Xiphonectes* A. Milne Edwards, 1873b

Xiphonectes macrophthalmus (Rathbun, 1906)

(Fig. 4A–D)

Portunus (*Xiphonectes*) *macrophthalmus* Rathbun, 1906: 871, pl. 12, fig. 5 (type locality: Modu Manu, Hawaii, *Albatross* station 4160, 31–39 fathoms (57–72 m) depth).—Rathbun 1911: 206.—Edmondson 1954: 242, figs. 18d–f, 19b.
Portunus macrophthalmus.—Stephenson & Rees 1967: 30.—Stephenson *et al.* 1968: 23.—Stephenson 1972b: 14 (key), 40.—Crosnier 2002: 410.
Xiphonectes macrophthalmus.—Koch *et al.* 40 (list), tab. 1

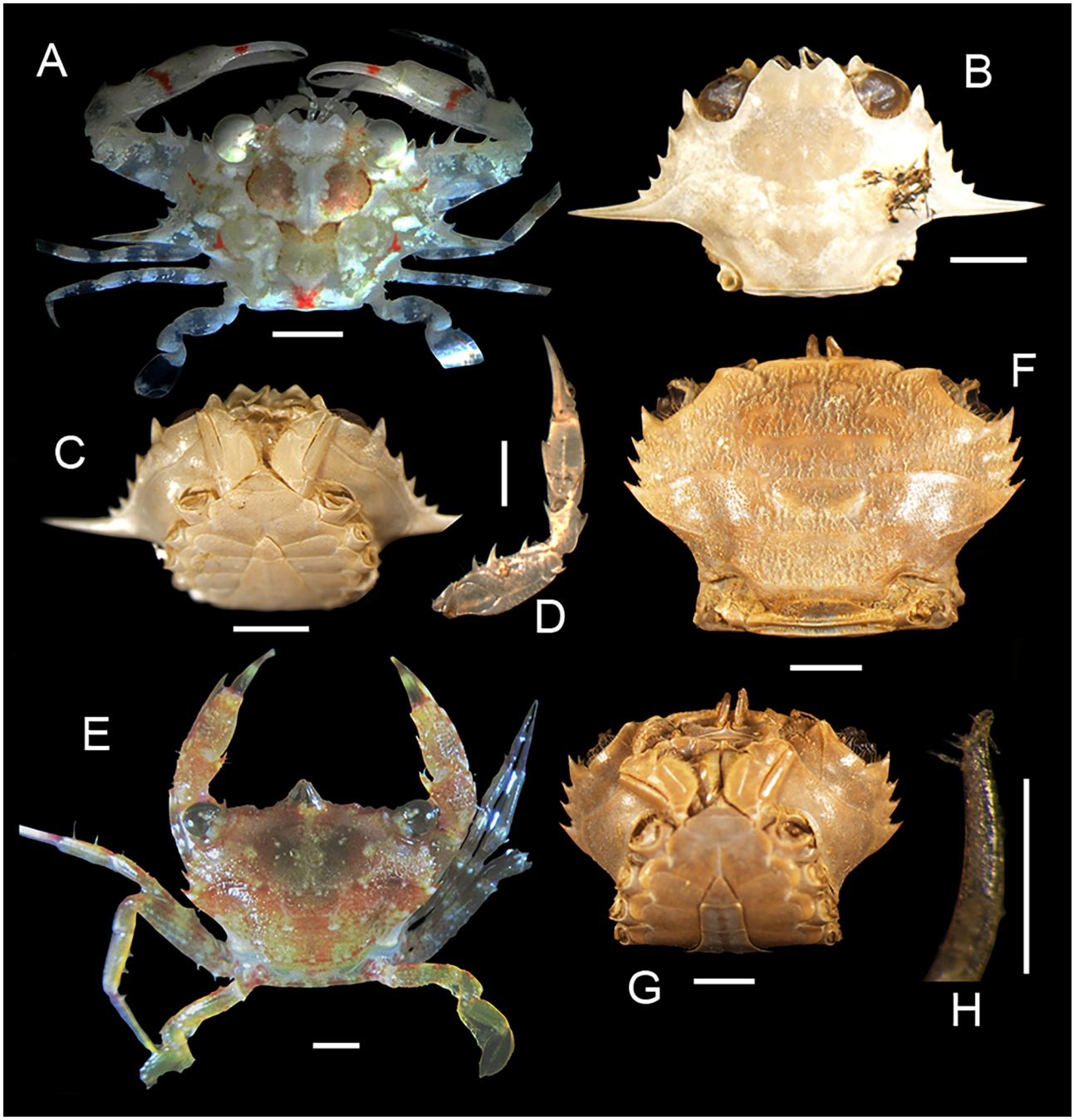

FIGURE 4. *Xiphonectes macrophthalmus* (Rathbun, 1906), female (NIO/BOD/AB/BRY/00010, 6.0 × 2.9 mm), eastern Arabian Sea, India: (A) dorsal habitus (fresh colour); (B) carapace, dorsal view; (C) cephalothorax, ventral view; (D) right cheliped, dorsal view. *Thalamita gatavakensis* Nobili, 1906, male (NIO/BOD/AB/BRY/00011, 5.7 × 3.4 mm), eastern Arabian Sea, India: (E) dorsal habitus (fresh colour); (F) carapace, dorsal view; (G) cephalothorax, ventral view; (H) G1 distal portion, pleonal view. Scale bars: A–G, 1 mm, H, 0.5 mm.

Material examined. 1 female (6.0 × 2.9 mm) (NIO/BOD/AB/BRY/00010), RVSS 10, west of Vijaydurg, Arabian Sea, 16.62°N, 72.06°E, 42 m depth, Van Veen grab, coll. R. Periasamy, 8 January 2014.

Diagnosis. Carapace slightly convex, frontal margin divided into 2 small submedian and 2 sharp, larger lateral teeth (Fig. 4A, B). Orbits deep, partially open, antennal flagellum lying in orbital hiatus (Fig. 4C). Mesogastric, cardiac and mesobranchial regions with short tubercles; anterolateral margins divided into 6 teeth, first 5 teeth acuminate and forward pointing, sixth tooth more than 4.0 × as long as preceding teeth and laterally directed (Fig. 4A, B). Posterolateral carapace margin forming angular junction with posterior margin (Fig. 4B). Maxilliped 3 merus triangular (Fig. 4C). Cheliped merus with 3 spines on anterior margin, 1 distal spine on posterior margin (Fig. 4D).

Colouration. Fresh specimen: carapace with two brown blotches on gastric regions which connect posteriorly in the cardiac region on white background, one red speck each on antero-lateral, postero-lateral and posterior margins.

Biology. Known to occur among corals, 42–101 m (Rathbun 1906); 2–90 m (Crosnier 2002). The present specimen was collected from sandy substratum at 42 m depth in the vicinity of corals.

Remarks. Rathbun (1906) originally described *Portunus (Xiphonectes) macrophthalmus* from Hawaii supplemented by a line illustration of the male pleon and a photograph of the dorsal habitus. Edmondson (1954: figs. 18d–f, 19b) provided a photograph and line illustrations *X. macrophthalmus*, and compared it with *X. longispinosus* (Dana, 1852). The Indian specimen conforms to the description provided by Rathbun (1906) and the identification key of Stephenson (1972b) in the presence of tubercles on the metagastric regions of the carapace, narrow frontal margin with median frontal teeth distinctly smaller than the laterals, anterolateral margin with 6 teeth and the last anterolateral tooth being distinctly longer than the preceding teeth.

Geographical distribution. Mauritius, Seychelles, Philippines and Hawaii (Stephenson 1972); eastern Arabian Sea off India (present study). The present observation is the first record from Indian waters.

Subfamily Thalamitinae Paul'son, 1875

Genus *Thalamita* Latreille, 1829

Thalamita gatavakensis Nobili, 1906

(Fig. 4E–H)

Thalamita pilumnoides var. *gatavakensis* Nobili, 1906b: 262, figs. 30a–b, 31a–e (type locality: Gatavaké, French Polynesia).
Thalamita pilumnoides ssp. *gatavakensis*.—Forest & Guinot 1961: 34, figs. 22a–b, 23–25.
Thalamita gatavakensis.—Crosnier 1962: 106, figs. 177a–d.—Stephenson & Rees 1967: 75.—Stephenson 1972a: 149.—Stephenson 1972b: 20 (key), 47.—Wee & Ng 1995: 82, figs. 43a–d.—Stephenson 1976: 21.
Thalamita granosimana.—Stephenson 1961: 119, figs. 2E, 4A, pl. 3, fig. 4, pls. 4J, 5G. [Not *T. granosimana* Borradaile, 1903)]

Material examined. 2 males (5.1 × 3.1 mm, 5.7 × 3.4 mm) (NIO/BOD/AB/BRY/00011), RVSS 11, west of Vijaydurg, Arabian Sea, 16.62°N, 72.01°E, 24 m depth, Van Veen grab, coll. R. Periasamy, 8 January 2014.

Diagnosis. Carapace hexagonal, tomentose (Fig. 4E); frontal margin bilobed, internal orbital angles narrower than frontal lobes; carapace ridges including 1 pair each of frontals, protogastrics, mesogastrics, mesobranchials and epibranchials, median metagastric and cardiac ridges; anterolateral margins divided into 5 teeth, fourth tooth rudimentary (Fig. 4F). Basal antennal article with 8 tubercles (Fig. 4G). Cheliped merus with 3 spines on anterior margin; manus with 6 spines on dorsal surface (Fig. 4E). G1 distal tip recurved spoon-shaped, with spine on spooned-tip, inner surface with long backwardly directed spine and inner surface with 3–4 bristles (Fig. 4H).

Colouration. Fresh specimen: carapace reddish brown with yellowish speckles (Fig. 4E). Preserved specimen: brown with lighter setae (Fig. 4F).

Biology. Known to inhabit corals (Wee & Ng 1995) in intertidal coralline sand (Crosnier 1962) and lagoons (Forest & Guinot 1961); 20–24 m (Wee & Ng 1995; present study). The present specimens were collected from sandy substratum, at 24 m depth, covered with macroalgae.

Remarks. Nobili (1906b) provided a short description of a new variety (*gatavakensis*) of *T. pilumnoides* from French Polynesia. Forest & Guinot (1961) compared *T. pilumnoides gatavakensis* with *T. pilumnoides* and proposed its elevation to species level. Crosnier (1962) provided a short, illustrated description of *T. gatavakensis* and elevated it to species level based on the differences (with *T. pilumnoides*) in morphologies of male pleon and G1. Stephenson's (1972b) key to the Indo-West Pacific portunids grouped this species along with *T. iranica* Stephensen, 1946*, T. granosimana* Borradaile, 1902*, T. admete* (Herbst, 1803)*, T. auauensis* Rathbun, 1906 and *T. gloriensis* Crosnier, 1962 owing to G1 with moderately curved tip. This species differs from the above-mentioned congeners in having G1 with curved distal tip bearing very few setae. Wee & Ng (1995) provided a short, illustrated description of *T. gatavakensis*. The morphology of the present specimens conformed to the descriptions and illustrations provided by Crosnier (1962) and Wee & Ng (1995) in the bilobed frontal margin of carapace, the presence of cardiac ridge and

mesobranchial ridges in addition to 1 pair each of frontal, protogastric, mesogastric, metagastric and epibranchial ridges, a straight inner supraorbital lobe narrower than the frontal lobe, and a spoon-shaped, recurved distal tip of G1 bearing very few terminal bristles.

Geographical distribution. Madagascar, Seychelles, Malaysia, Philippines, Indonesia, Western Australia, Saipan, Tuamotu (Wee & Ng 1995); eastern Arabian Sea off India (present study). The present observation is the first record from Indian waters.

Family Trapeziidae Miers, 1886

Subfamily Trapeziinae Miers, 1886

Genus *Trapezia* Latreille, 1828

Trapezia tigrina Eydoux & Souleyet, 1842

(Fig. 5A–D)

Trapezia tigrina Eydoux et Souleyet, 1842: 232, pl. 2, fig. 4 (type locality: Hawaii).—Galil & Lewinsohn 1984: 166, fig. 1a–e.—Castro *et al.* 2004: 45 (key), 54, pl. 3E.—Castro 2009: 276, fig. 2B.
Trapezia danae Ward, 1939: 13, figs. 15, 16 (type locality: Samoa).—Serène 1969: 133, 135, fig. 4.
Trapezia wardi Serène 1969: 140, figs. 7, 12, 17, 18, 19.—Serène, 1971: 914, pl. 4C.—Sakai 1976: 509, pl. 181, figs. 3, 4.—Serène *et al.* 1976: 19.—Takeda & Nunomura 1976: 78.—Ribes 1978: 127.
Trapezia maculata Dana 1852: 256 (part).—Dana 1855, pl. 15, fig. 4b, 4c. [Non *T. maculata* (MacLeay, 1838)].—Alcock 1898: 221.
Trapezia ferruginea rufopunctata.—Paul'son 1875: 54, pl. 7, fig. 3, 3a. [Non *T. rufopunctata* (Herbst, 1799)]
Trapezia ferruginea maculata.—Bouvier 1915: 272 (95) (part). [Non *T. maculata* (MacLeay, 1838)]
Trapezia cymodoce maculata.—Edmondson 1962: 300, fig. 31b. [Non *T. maculata* (MacLeay, 1838)]
? Trapezia ferruginea maculata Lenz 1910: 553.
? Trapezia cymodoce maculata Rathbun 1911: 235.
Non *Trapezia tigrina?* Serène 1969: 133, fig. 4. [= *T. flavopunctata* Eydoux & Souleyet, 1842]

Material examined. 1 male (damaged specimen, not measured), 1 female (damaged specimen, not measured) (NIO/BOD/AB/BRY/00006), RVSS 6, west of Vijaydurg, Arabian Sea, 16.38°N, 72.12°E, 23 m depth, Van Veen grab, coll. R. Periasamy, 7 January 2014.

Diagnosis. Carapace trapezoidal, smooth; frontal margins serrated with 2 low rounded median teeth, and larger, but low, lateral teeth; anterolateral margins with 2 long, acute spines (including external orbital angle) (Fig. 5A, C). Chelipeds smooth, slightly unequal, merus with 4 teeth on anterior margin, propodus with serrated lower margin (Fig. 5A, C). Pereopods 2–5 whitish, with large dark red spots (Fig. 5A–D). Male pleon T-shaped (Fig. 5B). Female pleon oval (Fig. 5D).

Colouration. Fresh specimen: carapace with 14 large dark red spots on yellowish background (Fig. 5A, C), chelipeds yellowish with large red spots on outer surfaces of carpus and merus (Fig. 5C, D).

Biology. The present specimens were collected from rocky substratum, at 23 m depth, covered with macroalgae. *Trapezia tigrina* is known to be an obligate symbiont of *Pocillopora elegans* (Castro 1997), inhabits dead corals of the genera *Acropora* (Head *et al*. 2015) and *Stylophora*, as well as coral rubble and sandy substratum (Castro *et al.* 2004); down to 45 m (Castro 1997). Its known predators include the hawkfish, *Paracirrhites arcatus* (Cuvier, 1829) (Leray *et al.* 2012).

Trapeziid crabs protect their host by removing sediment from coral tissue (Stewart *et al.* 2006), repulse predation by seastars (Glynn 1976), and enhance physical growth and mucus production (Glynn 1983).

Remarks. *Trapezia tigrina* was originally described from Hawaii (Eydoux & Souleyet 1842). Galil & Lewinsohn (1984) re-described *T. tigrina* to resolve the taxonomic ambiguities and provided a comprehensive synonymy. Serène (1984) provided a key to the species of the genus *Trapezia*. The present specimens are juveniles and conform to the description provided by Galil & Lewinsohn (1984) in the short, rounded frontal teeth, smooth ventral surfaces of the chelipeds, and the presence of red spots on the carapace, chelipeds and pereopods.

Geographical distribution. Throughout the Indo-West Pacific region (Castro 1997). In India, reported from

Andaman archipelago (Alcock 1898) and Minicoy Island (Borradaile 1902b; Sankarankutty 1961); eastern Arabian Sea off India (present study).

Family Xanthidae MacLeay, 1838

Subfamily Actaeinae Alcock, 1898

Genus *Serenius* Guinot, 1976

Serenius ceylonicus (Laurie, 1906)

(Fig. 5E–H)

Zozymus gemmula var. *ceylonica* Laurie, 1906: 395, pl. 1, fig. 7 (type locality: Trincomalee, Ceylon).
Zozymus gemmula ceylonica.—Sakai 1939: 450, pl. 89, fig. 2.
Zosimus gemmula var. *ceylonica*.—Buitendijk 1960: 290.
Zosimus gemmula ceylonica.—Guinot 1962a: 234, fig. 2 a–c.
Serenius ceylonicus.—Guinot 1976: 276, fig. 46 d, pl. 17, fig. 7.
Zosymus ceylonica.—Sakai 1976: 403, fig. 213.—Muraoka 1998: 38.
Zosimus ceylonicus.—Miyake 1983: 104, pl. 35, fig. 4.

Material examined. 2 males (4.6 × 3.2 mm, 5.9 × 4.1 mm) (NIO/BOD/AB/BRY/00003), RVSS 3, west of Vijaydurg, Arabian Sea, 16.48°N, 72.11°E, 28 m depth, Van Veen grab, coll. R. Periasamy, 6 January 2014.

Diagnosis. Carapace sub-hexagonal, wider than long; regions, except 1L, clearly distinguished by shallow grooves, and lined with short tomentum on their anterior margins; frontal margin horizontal, bilobed; anterolateral margins with 4 flattened lobes behind external orbital angle, not separated by conspicuous grooves; (Fig. 5E). Maxilliped 3 merus with distal margin concave (Fig. 5F). Cheliped propodus tuberculate on outer and upper surfaces, largest tubercle on posterior proximal part flattened and projecting posteriorly inwards, all tubercles surrounded by short thick tomentum, fingers smooth, with acuminate distal tips (Fig. 5E, F, G). Pereopod 2–5 dactyli terminating in claw-shaped spine, propodus triangular; propodus and carpus with prominent ridges; carpus with transverse ridge on posterior surface. P4 merus serrated on upper surface (Fig. 5E, F, H).

Colouration. Preserved specimen: carapace margins whitish, carapace regions 1F, 2F, 1M, inner 2M, 1L–5L, 1R, 2R, 1P and 2P brownish with darker tomentum on their anterior margins (Fig. 5E); cheliped fingers dark brown with white distal tips (Fig. 5F, G)

Biology. Known to inhabit *Pocillopora* coral (Guinot 1962a). The present specimens were collected from rocky substratum, at 28 m depth, in the vicinity of corals and the sponge *Phyllospongia* sp.

Remarks. Laurie (1906) described *Zozymus gemmula var. ceylonica* from 2 males and 1 female from Trincomalee (Sri Lanka). He differentiated it from *Z. gemmula* De Man, 1852 (= *Serenius gemmula* (Dana, 1852)) on the basis of differences in the cheliped and pereopods 2–5. Buitendijk (1960) considered *S. ceylonicus* as a variety of *Z. gemmula*, distinguished from the latter in the presence of sharp-edged, flattened, and much less distinctly granular propodal tubercle on the cheliped projecting backwards and inwards. Guinot (1976) provided line illustrations of G1 and the dorsal view of the habitus to establish *S. ceylonicus* as a distinct species from *S. gemmula*. The Indian specimens conform to the type description of *S. ceylonicus* (Laurie 1906) (and differ from *S. gemmula* (Dana, 1852)) in the presence of a prominent posterior tubercle on the dorsal margin of the cheliped palm with its flattened surface and mesially projecting crest, the denticulated dorsal margins of the pereopod 2–5 meri, and the elevated dorsal crests of the pereopodal carpi and propodi forming a continuous line. Alcock (1898) reported its congener, *Serenius pilosus* (A. Milne Edwards, 1867) from the Angria Bank, Arabian Sea. The present specimens differ from *S. pilosus* in the carapace being less lobulated, with the lobes of the anterolateral margins not separated by distinct grooves (Buitendijk 1960).

Geographical distribution. Gulf of Mannar off Sri Lanka, Japan, Maldives (Guinot 1976); eastern Arabian Sea off India (present study). The present observation is the first record from Indian waters indicating westward extension of the known geographical range.

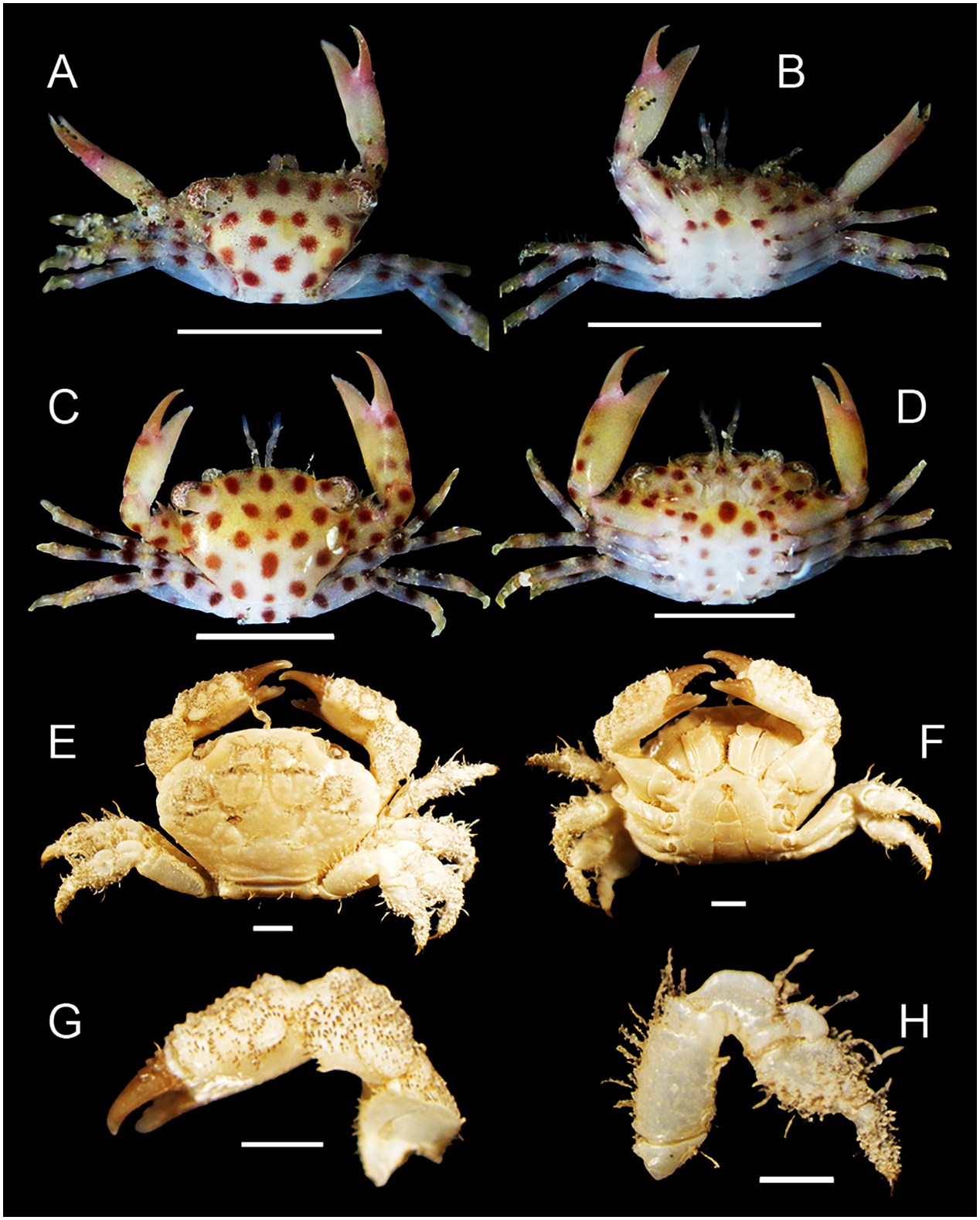

FIGURE 5. *Trapezia tigrina* Eydoux & Souleyet, 1842, 1 male, 1 female (NIO/BOD/AB/BRY/00006, both damaged specimens), eastern Arabian Sea, India: (A) dorsal habitus of male (fresh colour); (B) ventral habitus of male (fresh colour); (C) dorsal habitus of female (fresh colour); (D) ventral habitus of female (fresh colour). *Serenius ceylonicus* (Laurie, 1906), male (NIO/BOD/AB/BRY/00003, 5.9 × 4.1 mm), eastern Arabian Sea, India: (E) dorsal habitus (preserved colour); (F) ventral habitus (preserved colour); (G) right cheliped, dorsal view; (H) P5, dorsal view. Scale bars: A–D, 10 mm, E–H, 1 mm.

Subfamily Chlorodiellinae Ng & Holthuis, 2007

Genus *Soliella* Lasley, Klaus & Ng, 2015

***Soliella flava* (Rathbun, 1894)**
(Fig. 6A–F)

Pilodius flavus Rathbun 1894: 239 (type locality: Eastern Pacific Ocean off the Sandwich Islands, 21°14'51"N, 157°43'39"W, *Albatross* stn. 3469, 14 fathoms (= 26 m) depth, sand, coral.—Rathbun 1906: 860, fig. 21.—Edmondson 1925: 43.—Balss 1938: 57.—Miyake 1939: 215.—Clark & Galil 1993: 1130, figs. 4A–G, 32B, 40D, 41A.
Chlorodopsis flava.—Serène & Luom 1959: 330, figs. 2C, 5F, pl. IB, IIIB.
Pilodius pubescens.—De Man 1902: 619 [Not *Pilodius pubescens* Dana, 1852].
?Pilodius pubescens.—Nobili 1907: 395 [Not *Pilodius pubescens* Dana, 1852].
Chlorodopsis melanodactylus.—Miers 1884: 531 (part).
Chlorodopsis pilumnoides.—Laurie 1906: 406 [Not *C. pilumnoides* White, 1848].
Chlorodopsis hawaiiensis Edmondson, 1962: 273, fig. 21a–e (type locality: Pokai Bay, Oahu, Hawaii).
Soliella flava.—Lasley *et al.* 2015: 168, 174.

Material examined. 2 males (2.8 × 1.8 mm, 5.6 × 3.6 mm), 2 females (3.3 × 2.1 mm, 3.7 × 2.4 mm) (NIO/BOD/AB/BRY/00004), RVSS 4, west of Vijaydurg, Arabian Sea, 16.51°N, 72.17°E, 28 m depth, Van Veen grab, coll. R. Periasamy, 6 January 2014.

Diagnosis. Carapace depressed, transversely oval, regions well defined (region 2M partly divided into two longitudinally), covered with long setae; carapace regions 1L, 3L and 4L areolated, bearing 1 spine each; region 2M partly divided longitudinally; frontal width > 0.34 × CW; frontal margin divided into 2 large submedian lobes and 2 small lateral lobes; anterolateral margins shorter than markedly convergent posterolateral margins, divided into 4 teeth, first tooth short, second and third teeth claw-like, with ancillary spines, fourth tooth claw-like (Fig. 6A). Basal antennal article well developed, entering orbital hiatus and excluding antennal flagellum from orbit. Endostomial ridges restricted to posterior region of buccal cavity. Maxilliped 3 merus with inner distal angle distinctly concave (Fig. 6B). Chelipeds unequal, massive; fingers spoon-tipped (Fig. 6A–C). P2–5 covered with long setae, with spinulate or tuberculate dorsal surfaces; dactylo-propodal articulation well defined, dactylus tip cornute; upper margins of merus, carpus and propodus with long slender spines (Fig. 6D). Male telson sub-triangular (Fig. 6E). G1 gradually curved, distal edge serrated (Fig. 6F).

Colouration. Preserved specimen: Carapace, chelipeds and pereopods light brown, bearing yellow setae (Fig. 6A, B); cheliped fingers chocolate brown (Fig. 6C).

Biology. The present specimens were collected from coralline sand at 28 m depth in the vicinity of macroalgae. Known to inhabit coral reefs over sandy substratum down to 91 m (Edmondson 1925).

Remarks. *Soliella flava* was originally described from an immature female from the Hawaiian Islands (Rathbun 1894). Rathbun (1906) provided a short description supplemented with line illustrations of dorsal habitus and chela. Edmondson (1962) described "*Chlorodopsis hawaiiensis*" from Hawaii and indicated its distinctness as compared to other congeners. He also reported *P. flavus* and commented on the similarities between the genera *Chlorodopsis* and *Pilodius.* Serène's (1984) monograph included this species in the identification key to the species of the genus *Pilodius.* Clark & Galil (1993) revised the genus *Pilodius,* wherein they provided a short diagnosis of *P. flavus* supplemented with line illustrations of carapace frontal margin, anterolateral margin, P5 dactylus and propodus, and gonopods, and photographs of dorsal habitus and chela. The Indian specimens conform to the descriptions of the holotype (Rathbun 1894), the Hawaiian specimens (Rathbun 1906) in the morphology and regions on the dorsal of the carapace, and the ornamentation on the chelipeds and pereopods, as well as the illustrations of the carapace margins and the G1 provided by Clark & Galil (1993).

Lasley *et al.* (2015) transferred *P. flavus* to *Soliella* Lasley, Klaus & Ng, 2015 owing to the presence of arched frontal submedian lobes separated by narrow U-shaped notch (vs. frontal lobes separated by a deep notch in *Pilodius* Dana, 1851), yellow setae on the carapace (vs. dark setae in *Pilodius*), disto-lateral extension of the basal antennal article reaching only halfway into the orbital hiatus (vs. an elongated distolateral extension completely blocking or extending more than halfway into orbital hiatus in *Pilodius*), and a tubular or spatulate G1 tip bearing numerous subdistal stout, proximally directed setae (vs. spatulate, truncate, tubular, curved or hooked G1 tip in *Pilodius*).

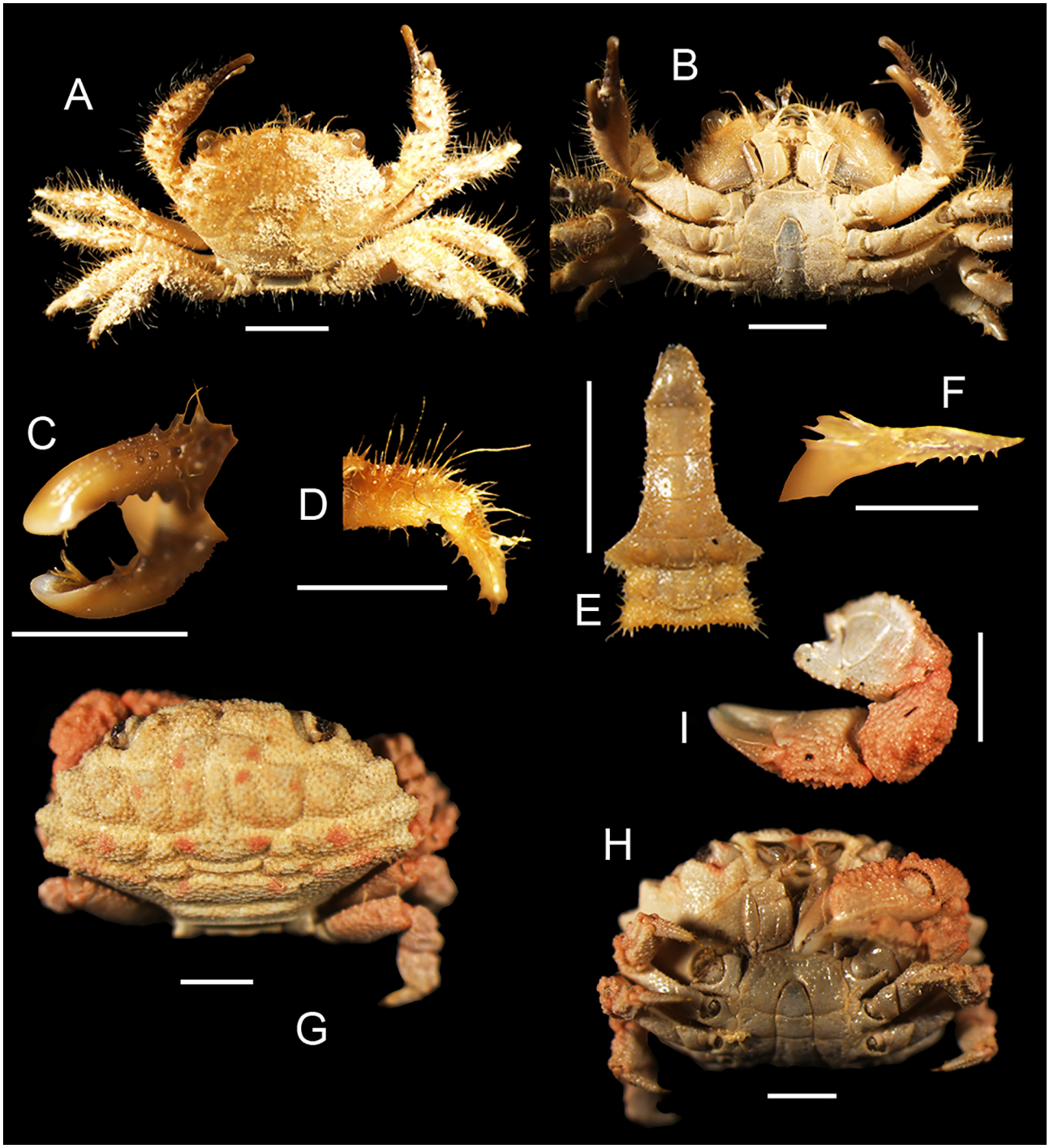

FIGURE 6. *Soliella flava* (Rathbun, 1894), male (NIO/BOD/AB/BRY/00004, 2.8 × 1.8 mm), eastern Arabian Sea, India: (A) dorsal habitus (preserved colour); (B) ventral habitus (preserved colour); (C) left cheliped fingers (disto-external view); (D) right P2 dactylar articulation, dorsal view; (E) male pleon, ventral view; (F) G1, pleonal view. *Liomera monticulosa* (A. Milne Edwards, 1873), male (NIO/BOD/AB/BRY/00005, 2.2 × 1.2 mm), eastern Arabian Sea, India: (G) dorsal habitus (preserved specimen); (H) ventral habitus (preserved specimen); (I) left cheliped, dorsal view. Scale bars: A–E, G–I, 1 mm; C–D, 0.5 mm; F, 0.1 mm.

Geographical distribution. Scattered localities across the Indian Ocean (Etoile Island and Sri Lanka) and Pacific Ocean (Macclesfield Bank in the South China Sea, Ternate Island in the Moluccas, Sulu Archipelago, Philippines, Arafura Sea, Australia, New Caledonia, Micronesia, Polynesia, Marshall Islands and Hawaii) regions (Miers 1884; Nobili 1907; Miyake 1939; Clark & Galil 1993); eastern Arabian Sea off India (present study). The present observation is the first record from Indian waters.

Subfamily Liomerinae Sakai, 1976

Genus *Liomera* Dana, 1851

***Liomera monticulosa* (A. Milne-Edwards, 1873)**
(Fig. 6G–I)

Carpilodes monticulosus A. Milne-Edwards, 1873a: 181, pl. 5, figs. 1, 1a (type locality: New Caledonia).—De Man 1887: 233.—Ortmann 1894: 51.—Nobili 1907: 387.—Odhner 1925, 21, pl. 1, fig. 18.—Sakai 1939: 475, pl. 92, fig. 4.—Ward 1942: 54, 83.—Holthuis 1953: 13.—Serène & Luom 1960: 178 (key), fig. 2c.—Buitendijk 1960: 256, fig. 1d.
Liomera monticulosa.—Barnard 1950: 240, fig. 44c, d.—Guinot 1964, 11.—Guinot 1967: 266.—Serène 1968: 72.—Serène 1977: 50.—Sakai 1976: 396, pl. 141, fig. 1.—Takeda 1976: 81, pl. 9A.—Takeda & Miyake 1976: 109.—Peyrot-Clausade 1977a: 27 (species index).—Peyrot-Clausade 1977b: 212.—Ribes 1978: 127.—Kensley 1981: 44.—Serène 1984: 64.—Galil & Vannini 1990: 28, fig. 7D.
Phymodius rugipes.—Miers 1884: 531. [Non *Liomera rugipes* (Heller, 1861)]
Carpilodes cariosus Alcock 1898: 86.—Alcock 1899c: pl. 36, fig. 7.—Borradaile 1902b: 261.—Calman 1909: 704.—Rathbun 1911: 212.—Bouvier 1915: 294 (117).—Michel 1964: 23.
Carpilodes caelatus.—Guinot 1958: 86. [= Non *Liomera caelata* (Odhner, 1925)]
Non *Carpilodes monticulosus*.—Alcock 1898: 86.—Lenz 1901: 463.—Borradaile 1902b: 260.—Rathbun 1911: 212. [= *Liomera rugata* (H. Milne Edwards, 1834)]

Material examined. 1 juvenile male (2.2 × 1.2 mm) (NIO/BOD/AB/BRY/00005), RVSS 5, west of Vijaydurg, Arabian Sea, 16.33°N, 72.10°E, 25 m depth, Van Veen grab, coll. R. Periasamy, 7 January 2014.

Diagnosis. Carapace sub-hexagonal, much wider than long, convex longitudinally as well as transversely; regions distinctly areolated, prominently pitted, covered with tightly packed sharp granules, devoid of tomentum; frontal margin distinctly bilobed with distinct median notch, separated from inner orbital margin; fronto-orbital width < 0.5 × CW; anterolateral margins shorter than posterolateral margins, divided into 4 granulated teeth (excluding external orbital angle), first 2 teeth appearing worn out (Fig. 6G). Basal antennal article reaching frontal margin, antennal flagellum included in orbital hiatus (Fig. 6H). Endostomial ridges absent. Maxilliped 3 merus wider than long (Fig. 6H). Chelipeds bearing sharp granules on upper and outer surfaces (Fig. 6G, H, I). Pereopods 2–5 with carpus and propodus bearing 2 longitudinal granular rows on upper surfaces (Fig. 6H).

Colouration. Preserved specimen: Carapace off-white with symmetrically arranged red blotches on 2M, 3M, 5L, 1R, 2R, 3R and 1P regions; chelipeds and pereopods bright red, fingers brownish with white tips (Fig. 6G–I).

Biology. Known to inhabit corals (*Acropora variabilis, Tubipora* sp., *Pocillopora verrucosa, P. danae* and *Porites andrewsi*; Galil & Vannini 1990), commonly from 18–34 m (Alcock 1898); also known to inhabit crevices in dead coral blocks or the bottoms of coral and shell debris adjacent to the coral reef from 15–100 m (Serène 1984). The present specimen was collected from rocky substratum in the vicinity of live corals.

Remarks. A. Milne-Edwards (1873a) originally described *Carpilodes monticulosus* from New Caledonia. Alcock (1898) described *Carpilodes cariosus* from Sri Lanka and Andamans. Odhner (1925) transferred this species to the genus *Liomera*. Serène's (1984) monograph included this species in the identification key to the species of the genus *Liomera,* supplemented with a comprehensive synonymy. The present specimen conforms to the line illustrations and morphological description of the type specimens (A. Milne-Edwards (1873a) in the texture and lobulation on the carapace, and the rugose nature of the pereopods. This specimen also keys out as *L. monticulosa* following the identification key provided by Serène (1984) due to the granular carapace with a generally eroded appearance, its colouration, and the nodular nature and colouration of the pereopods. On the other hand, the present specimen (juvenile) did not possess a G1 for comparison with published literature.

Geographical distribution. Throughout the Indo–Pacific regions (Galil & Vannini 1990). In India, Andamans (Dev Roy & Nandi 2012), Nicobar (Alcock 1898), Minicoy Island (Borradaile 1902b), and the Arabian Sea off Konkan coast (present study).

Discussion

The present study examined a total of 18 brachyuran specimens collected from 22–42 m depth in the Angria Bank region off the west coast of India. The crabs represented a total of 11 species belonging to five families and 11 genera. A review of published literature revealed that only Alcock (1898) reported two species, *Zozymus pilosus* (= *Serenius pilosus* (A. Milne Edwards, 1867)) and *Lophozozymus incisus* (H. Milne Edwards, 1834) from the Angria Bank at 27 m depth. Moreover, the present effort revealed seven new geographical records from the Indian region. This suggests a dearth of studies pertaining to the brachyuran biodiversity of the unique offshore ecosystems of the Indian region, thereby necessitating intensive surveys of these regions.

An analysis of the zoogeographical distribution of these species revealed that two species (*H. cracentis* and *T. irami*) are restricted to the Western Pacific, and the remaining nine species are widely distributed across the Indo-West Pacific region.

The present study was carried out in a distant offshore coral reef region with a depth range of 22–42 m. Published reports (Alcock 1898; Rathbun 1906; Edmondson 1925; Crosnier 1962; Stephenson 1976; Griffin & Tranter 1986; Wee & Ng 1995; Castro 1997) reveal that the crabs studied here have been recorded from coral reefs at depths between 20 and 100 m. According to Vora *et al.* (1996), coral reef formation commenced along the west coast of India during the Late Pleistocene or Early Holocene geological periods. However, with the advent of the "Holocene transgression" during Mid to Late Holocene periods, the resultant sea level rise submerged several shallow reef areas, including those off the west coast of India (Vora *et al.* 1996). The above theory corroborates the occurrence of shallow water reef habitats in the Angria Bank region, which have created favourable habitats for shallow water reef-associated Brachyura.

The presently identified crabs are known to inhabit coastal shallow waters including coral reef ecosystems (Rathbun 1906; Edmondson 1925; Crosnier 1962; Guinot 1962a; Griffin & Tranter 1986; Serène 1984; Wee & Ng 1995; Castro 1997; Vannini & Innocenti 2000). Ecologically, they could be broadly categorized as: coral symbionts—*T. punctata* and *T. bidentata* (Serène 1984; Castro 1997); coralline algae-associated—*H. cracentis* and *T. irami* (Griffin & Tranter 1986); seagrass-associated—*C. granulatus* and *P. convexus* (Crosnier 1962); free-living reef-associated species—*L. monticulosa, S. flava, S. ceylonicus, T. gatavakensis* and *X. macrophthalmus* (Guinot 1962a; Serène 1984; Wee & Ng 1995). Coral symbionts use the setal brushes on their posterior pereopods not only to feed upon coral mucus, zooxanthellae and coral tissue (Sorokin 1995), but also to protect the hosts from potential predators (Glynn 1976), and to remove sediment from their surfaces (Stewart *et al.* 2006). Algal-associated crabs possess long slender chelipeds which enable cutting and feeding of plant matter (Coen 1988), which could be result in the reduction of macroalgal cover in reefs, thereby providing an opportunity for the recruitment and growth of corals (Butler & Mojica 2012). Juvenile portunid inhabitants of seagrass beds use these habitats as nurseries for their recruitment (Ralph *et al*. 2013) on account of large food production in terms of plant matter (Saenger *et al.* 2012). Free-living reef-associated crabs often possess various types of chelipeds (such as those with sharp cutting or molariform teeth) that enable them to feed opportunistically on a wide array of benthic invertebrate fauna (Hughes 1993; Fujiwara & Kawai 2016; Shmuel *et al.* 2022) and contribute to detritus formation.

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