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Morphological Description and Molecular Characterisation of *Glyptothoa* gen. nov., a Fish Parasitic Deep-sea Cymothoid (Crustacea: Isopoda) from the Indian Ocean, with Four Species, Including One New Species

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Glyptothoa sagara gen. and sp. nov. is described from the host fish *Glyptophidium macropus* Alcock, 1894 (Ophidiidae), at depths 300 to 650 metres from the southwest coast of India. The mitochondrial cytochrome *c* oxidase subunit I (*COI*) gene of the species was sequenced and compared with other closely related branchial cymothoid genera. Both morphological and molecular data corroborate the inclusion of this parasitic isopod as a new genus, and we describe *Glyptothoa sagara* gen. and sp. nov. The following combinations of characters characterise the genus: cephalon immersed in pereonite 1; dorsum vaulted; all coxae visible in dorsal view; coxae shorter than or as long as pereonites; pereonites 4–7 slightly decrease in width towards one side, slightly asymmetrical, lateral margins slightly constricted, in hunched side; relatively wide pleon, with large lateral gaps between pleonites; antennula narrowly separated by rostrum, slender, shorter than antenna; antenna with 13 articles, buccal cone obscuring antennal bases; brood pouch arising from coxae 1–4, 6; oostegite 1 bilobed; pleopods rami all simple, without proximomedial lamellar lobe, without folds or thickened ridges. The adult life stages, such as females (ovigerous and non-ovigerous), males and transitional stage of the new species are described. The species is currently known only from the type locality and the type host. The ecological remarks of the newly described taxon are also provided. The following species are transferred from *Elthusa* Schioedte and Meinert, 1884: *Glyptothoa myripristae* (Bruce, 1990) comb. nov., *Glyptothoa propinqua* (Richardson, 1904) comb. nov. and *Glyptothoa caudata* (Schioedte and Meinert, 1884) comb. nov.

Key words: Marine fish parasite, Branchial cavity, Cytochrome *c* oxidase subunit I, Cymothoidae, New genus, Indian Ocean, Phylogeny

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BACKGROUND

The deep sea is seen by many as one of the most fascinating ecosystems on earth; it remains one of the least explored eco-regions of the world. The deep-sea ecosystem is also severely hampered by human activities, so there is a great need to document biodiversity, the ecosystem structure, and their functional interactions. Globally, information on parasitic cymothoids infesting commercial fishes is well documented, with over 100 publications since 2000 (Smit et al. 2014; Ravichandran et al. 2019; Aneesh and Kappalli 2020; Aneesh et al. 2022 2023; Fujita et al. 2023). On the other hand, studies specifically on parasitic crustaceans of deep-sea fishes are still meagre, especially at depths greater than 500 metres (Yamauchi 2009; Smit et al. 2014; Aneesh et al. 2020c).

Knowledge of the cymothoid fauna of the Indian coast began with the work of Brunnich (1783), Miers (1880) and Barnard (1936). Later, Pillai (1954 1963 1964) and Tiwari (1952) added further records and described two new genera and seven new species from India. There was then an extended period of nearly five decades when there was no research on Indian cymothoids until Rameshkumar et al. (2011) described two new species from Indian waters, followed by subsequent revision of the Indian Cymothoidae by Ravichandran et al. (2019). Apart from taxonomy, few studies have been done on the seasonal occurrence of cymothoids (Aneesh et al. 2013; Helna et al. 2019).

Since that review (Ravichandran et al. 2019), a further five genera, including one new genus, and ten new species from the southwest coast of India, have been reported by Aneesh et al. (2019 2020a b c 2021a b c 2022 2023). A few attempts have been made to study the reproductive biology and life history of some cymothoids (see Aneesh et al. 2022). The family Cymothoidae currently includes 385 accepted species in 43 genera; of these, only 57 species from 18 genera are known from India (Aneesh et al. 2022; Nashad et al. 2022), with only 12 species known from the deep sea, including the recently described *Brucethoa bharata* Aneesh, Hadfield, Smit, and Kumar, 2020 (Aneesh et al. 2022).

The present study describes a new genus and species of deep-sea fish parasitic cymothoid based on the specimens collected during the recent studies on deep-sea fish parasitic cymothoids of the Indian coast initiated by the authors. The host fish *Glyptophidium macropus* Alcock, 1894 (Ophidiidae), was captured at a depth between 300 to 650 meters from the southwest coast of India, and an undescribed parasitic isopod was recovered from the branchial cavity. During the identification process of this isopod, it was clear that it belonged to the group of genera including *Brucethoa* Aneesh, Hadfield, Smit and Kumar, 2020; *Elthusa* Schioedte and Meinert, 1884, *Mothocya* Costa, in Hope, 1851 and *Ichthyoxenos* Herklots, 1870. Morphological differences excluded the inclusion of the new isopod in any of these genera (see Table 1). Further, of the new Indian specimens and three species of *Elthusa*, two are incertae sedis and one is apparently not so, but all share the following characteristics: cephalon immersed in pereonite 1, pereonites 4–7 slightly decrease in width towards one side, slightly asymmetrical, lateral margins slightly constricted on the hunched side, relatively wide pleon; 1.00 to 1.20 times as wide as greatest pereon width, with lateral gaps between pleonites, buccal cone obscuring antennal bases, pleopods rami all simple, without folds or thickened ridges. The three *Elthusa* species transferred to *Glyptothoa* are: *E. myripristae* Bruce, 1990, *E. propinqua* (Richardson, 1904), and *E. caudata* (Schioedte and Meinert, 1884).

MATERIALS AND METHODS

Sampling site

Fresh specimens were collected from the branchial cavity of the deep-sea fish *Glyptophidium macropus* Alcock, 1894 (Ophidiidae), obtained from the commercial trawlers operating from Neendakara (08°30.0'N, 76°53.30'E), Kollam district, Kerala state, southwest coast of India at a depth between 300 to 650 meters.

Parasite identification

The collected cymothoids were preserved in 95% ethanol for DNA studies, and the remaining specimens were processed following the techniques described in Aneesh et al. (2019 2021c). One ovigerous female was designated as the holotype, and one paratype was minimally dissected to conserve the specimens (the dissected appendages were kept in separate vials along with the said specimen). Methods for dissection, mounting, and drawings of appendages followed the techniques described in Aneesh et al. (2019). The specimens were microphotographed using a multi-focusing dissection microscope Leica-M205A and image capturing software (Leica Application Suit). Drawings were digital-inked using Adobe Illustrator and a WACOM CTL-472/K0-c drawing pad. Sources for the fish taxonomy and host nomenclature were Fish Base (Froese and Pauly 2023) and Catalogue of Fishes (Fricke et al. 2023). Classification of the cymothoid followed Brandt and Poore (2003). The type specimens

Table 1. Character differences between the closely related branchial cymothoid genera, *Glyptothoa* gen. nov., *Brucethoa* Aneesh, Hadfield, Smit & Kumar, 2020, *Elthusa* Schioedte & Meinert, 1884, *Catoessa* Schioedte & Meinert, 1884, *Ichthyoxenos* Herklots, 1870 (marine) and *Mothocya* Costa, in Hope, 1851

Characters	*Glyptothoa* gen. nov.,	*Brucethoa* Aneesh, Hadfield, Smit & Kumar, 2020	*Elthusa* Schioedte & Meinert, 1884	*Catoessa* Schioedte & Meinert, 1884	*Ichthyoxenos* Herklots, 1870 (marine)	*Mothocya* Costa, in Hope, 1851
Cephalon, anterior margin	with acute ventrally directed rostrum	with acute ventrally directed rostrum	truncate (s. str).	truncate	sub-acute or rounded; with acute ventrally directed rostrum	rounded, ventrally folded
Body	pereonites 4–7 slightly decrease in width towards one side, slightly asymmetrical, lateral margins slightly constrict, in hunched side	slightly asymmetrical	asymmetrical (most)	bilaterally symmetrical	bilaterally symmetrical	weakly to moderately asymmetrical
Body, dorsum	moderately vaulted	medially vaulted	not or weakly vaulted	vaulted	not or weakly vaulted	not or weakly vaulted
Buccal "cone"	anteriorly positioned, overriding antennal bases	anteriorly positioned, overriding antennal bases	not anteriorly positioned, not overriding antennal bases	not anteriorly positioned, not overriding antennal bases	not anteriorly positioned, not overriding antennal bases	not anteriorly positioned, not overriding antennal bases
Pereonites 6 and 7	posterolateral margin not much expanded	posterolateral margin laterally expanded	posterolateral margin not expanded	posterolateral margin not expanded	posterolateral margin not expanded	posterolateral margin not expanded
Pereonites 6 and 7, coxae	narrow, visible in dorsal view	not visible in dorsal view	wide, visible in dorsal view	visible in dorsal view	visible in dorsal view	visible in dorsal view; often large
Pleonite 1	the lateral margins of pleonite 1 strongly extend laterally; moderately narrower than pleonite 2	as wide as pleonite 2	as wide or slightly narrower (s. str)	narrower than pleonite 2	narrower than pleonite 2	slightly narrower
Pleonites	all visible	all visible	pleonites partly concealed, or all visible	all visible	all visible	pleonites 2–5 or 3–5 visible
Pleonites, free lateral margins	pleonites 1–5	pleonites 2–5 or 3–5	pleonites 2–5 or 3–5	pleonites 2–5	pleonites 1–5 or 2–5 visible	pleonites 2–5 or 3–5 visible
Pleon width	wider than widest pereon: 1.00 to 1.20 times as wide as pereon max. width	wide: 0.87 pereon max. width	greater than 0.7 pereon max. width (s. str.)	variable: 0.64–0.84	narrow: 0.59–0.69	variable: 0.52–1.01
Pleonite gaps	long gaps (60%; as width of widest pleon) present between all pleonites	long gaps present (50%; as width of widest pleon) between most or all pleonites	without gaps	with short gaps	without gaps	without gaps
Antennula length	shorter than antenna	shorter than antenna	shorter than antenna	longer than antenna	longer than antenna	longer than antenna
Antennula size	slender (= antenna)	slender (= antenna)	slender (= antenna)	slender (= antenna)	slender (= antenna)	robust (thicker than antenna)
Oostegites	proximally thick, oostegite 1(of pereonite 2) bilobed	proximally thick	not proximally thick	not proximally thick	not proximally thick	not proximally thick
Pleopods	not visible in dorsal view	large, conspicuously visible in dorsal view	not large, not visible in dorsal view	not large, not visible in dorsal view	not large, not visible in dorsal view	not large, not or slightly visible in dorsal view
Uropods	short, not reaching posterior of pleotelson	short, not reaching posterior of pleotelson	short, not reaching posterior of pleotelson	variable, reaching to between half-length of pleotelson to posterior margin	short, not reaching posterior of pleotelson	variable, long or short
Maxilliped oostegite lobe	present	present	absent	absent	present	absent

Note: *Elthusa* characters based on *Elthusa* sensu stricto (s. str.) as defined by Aneesh et al. (2020b) and other genera updated based on Aneesh et al. (2020c).

were deposited in the Western Ghat Field Research Centre of the Zoological Survey of India, Kozhikode (ZSI/WGRC) and remaining few non-types were placed in PTA's & AKH's personal collection in India (CAH).

Molecular analysis

Genomic DNA was extracted from the cymothoid pereopods and pleopods following the protocol for animal tissue extraction of the NucleoSpin® Tissue Genomic DNA Tissue Kit (Macherey-Nagel, Düren, Germany). A targeted part of the mitochondrial cytochrome *c* oxidase subunit I (*COI*) gene (approximately 680 bp) of these specimens was subjected to PCR amplification with the aid of a ProFlex™ PCR thermal cycler (Applied Biosystems by Life Technologies) and universal invertebrate primers LCO1490 (5'-GGTCAACAAATCATAAAGATATT GG-3') and HC02198 (5'-TAAACTTCAGGGTGACC AAAAAATCA-3') (Folmer et al. 1994). PCR reactions were performed with volumes of 25 µl, using 12.5 µl Thermo Scientific DreamTaq PCR master mix, 1.25 µl of each primer, 7 µl of PCR-grade nuclease-free water and 3 µl of DNA. Conditions for the PCR were as follows: initial denaturation at 94°C for 5 min; followed by 35 cycles of 94°C denaturation for 30 s, annealing at 47°C for 50 s with an end extension at 72°C for 2 min; and ending with a final extension of 72°C for 10 min. The PCR amplification was performed in a PCR thermal cycler (GeneAmp PCR System 9700, Applied Biosystems). Polymerase chain reaction products were purified for sequencing with USB ExoSAP-IT (GE Healthcare) and sequenced in forward and reverse directions with the PCR primers by Dideoxy Sanger standard method with BigDye Terminator v3.1 cycle sequencing kit (Applied Biosystems Inc., Foster City, USA) on an ABI sequencer (Applied Biosystems Inc., Foster City, USA).

The obtained sequences were edited and aligned with BioEdit v.7.0.9.0. (lbisBiosciences, Carlsbad, USA., Hall, 1999). Phylogenetic analysis and sequence divergence were estimated using the Kimura 2-Parameter distance model of the MEGA (Version 11.0) Package (www.megasoftware.net/, Tamura et al. 2021). The maximum likelihood tree was constructed and was bootstrapped 1,000 times to provide percentage bootstrap values for branch points. The genetic distance of each species was done based on pair-wise distance analysis using the Maximum Composite Likelihood method (MEGA 11, Tamura et al. 2021).

A comparison of the candidate sequence to the most similar sequences was carried out with the available data from GenBank (http://www.ncbi.nlm.nih.gov/genbank/). Comparative sequences of other cymothoids (sequences from each of eight different branchial cymothoid genera) from GenBank were downloaded and aligned to one sequence from the current study. These sequences included: LC159567 (*Elthusa* sp. female); MK652487 (*Elthusa raynaudii*); LC160320 (*Cterissa sakaii*); LC159570 (*Ichthyoxenus tanganyikae*); LC159578 (*Ryukyua globosa*); *Livoneca redmanii* MZ208985; MF628260 (*Norileca indica*); KC896399 (*Joryma hilsae*); MK652485 (*Mothocya renardi*); MW002498 (*Catoessa boscii*). Nucleotide genetic divergence in percentage (*p*-distance) and base-pair differences among the different species were determined using MEGA11 (Tamura et al. 2021).

RESULTS

TAXONOMY

Suborder Cymothoida Wägele, 1989
Superfamily Cymothooidea Leach, 1814
Family Cymothoidae Leach, 1814

Genus *Glyptothoa* gen. nov.

urn:lsid:zoobank.org:act:05AE1C92-B513-41BC-850E-5864488B6EC6

Type species: *Glyptothoa sagara* sp. nov.; original designation.

Etymology: The new generic name is the abbreviation of the host genus name (*Glyptophidium*) – "*Glypto*" combined with the ending – *thoa* indicating the family affinity. Gender is feminine.

Diagnosis: *Ovigerous female (bold = key features)*: Body dorsally vaulted, two times as long as wide, widest at pereonite 3. Cephalon partially immersed in pereonite 1, anterior margin with acute ventrally directed rostral point. Pereonites 2–7 coxae visible in dorsal view, all coxae shorter than pereonite; pereonites 4–7 slightly asymmetrical, lateral margins slightly constricted, in hunched side. Pereonites 4–7 slightly decrease in width towards one side. Pleon short, c. 15% BL, pleonites all visible, the lateral margins of pleonite 1 strongly extend laterally; moderately narrower than pleonite 2, becoming progressively wider posteriorly, with large lateral gaps (0.6 times the pleon width) between pleonites; pleonites 1–4 medially subequal in length, pleonite 5 longest. Pleon at pleonite 5 wider than widest pereon: 1.00 to 1.20 times as wide as greatest pereon width at pereonite 3. Pleotelson 0.9 times as wide as pleonite 5. Antennula narrowly separated by rostrum, slender, with 8 articles, shorter than antenna. Antenna with 13 articles. Buccal cone obscuring antennal bases. Brood pouch arising from

coxae 1–4, 6 proximally thick; oostegite 1 bilobed. Pleopods not visible in dorsal view. Pleopod rami all simple, without proximomedial lamellar lobe, without folds or thickened ridges; peduncle lateral lobes absent. Uropods short, extending about halfway along pleotelson lateral margin.

Additional features: Mandible palp articles all slender, article 2 longer than article 3, both with small spines, Maxilla mesial lobe distinct (not fused), both lobes with two acute apical RS. Maxillula with 1 large and 3 small acuminate terminal RS. Maxilliped with oostegital lobes; mouthparts partially covered by oostegites of pereopod 2. Pereopods basis without prominent carina, without setae; articles not dilated or expanded.

Variation: pleonite 1, narrowest, 2–4 subequal, pleonite 5 widest in most specimens, whereas slight varied in one specimen with pleonite 1 is narrowest and pleonites 2–5 are progressively wider.

Adult male: Similar to females in general morphology. Body lateral margins sub-parallel. Coxae dorsally visible. Pleotelson proportional longer and narrower than female. Penial process acute, separated by 20% width of sternite 7. Pleopods not extending beyond pleotelson margins. Pereopods with acute RS.

Species included: *Glyptothoa sagara* sp. nov.; *Glyptothoa propinqua* (Richardson, 1904) comb. nov., *Glyptothoa myripristae* (Bruce, 1990) comb. nov., and *Glyptothoa caudata* (Schioedte and Meinert, 1884) comb. nov.

Remarks: *Glyptothoa* gen. nov. can be distinguished from all other cymothoid genera and identified by the following combination of ovigerous female characters: cephalon partially immersed in pereonite 1, dorsum vaulted, all coxae shorter than or as long as pereonite, visible in dorsal view; pereonites 4–7 slightly decrease in width towards one side, slightly asymmetrical, lateral margins slightly constricted in hunched side; relatively wide pleon, with large lateral gaps between pleonites; antennula narrowly separated by rostrum, slender, shorter than antenna; antenna with 13 articles; buccal cone obscuring antennal bases; brood pouch arising from coxae 2–6, proximally thick; oostegite 1 (of pereonite 2) bilobed; pleopods large, not visible in dorsal view; pleopod rami all simple, without proximomedial lamellar lobe, without folds or thickened ridges; peduncle lateral lobes absent.

Glyptothoa sagara sp. nov.

(Figs. 1–19)

urn:lsid:zoobank.org:act:505AF3AB-A7D5-4147-B7ED-70A2653FEC10

Type material: *Holotype*: 1 ovigerous female [36.0 mm L, 18.0 mm W (maximum width)], from *Glyptophidium macropus* Alcock, 1894, recorded from ~300 to 650 m depth, off Neendakara coast (08°30.0'N, 76°53.30'E), Kerala, India, 29 December 2019, coll. PT Aneesh & AK Helna (Reg. No. ZSI/WGRC/IR.INV./24781).

Paratypes: Same data as holotype with the following measurements and registration details: 1 mature male (15.0 mm TL; 7.0 mm W), partially dissected (Reg. No. ZSI/WGRC/IR.INV./ 24782); 1 female (non-ovigerous) (31.0 mm TL; 15.5 mm W), partially dissected (Reg. No. ZSI/WGRC/IR.INV./ 24783); 1 female (ovigerous) (28.0 mm TL; 14.0 mm W), partially dissected (Reg. No. ZSI/WGRC/IR.INV./ 24784); 1 late transitional (16.0 mm TL; 8.5 mm W), (Reg. No. ZSI/WGRC/IR. INV./ 24785); 1 female (ovigerous) (27.0 mm TL; 13.5 mm W), (Reg. No. ZSI/ WGRC/IR.INV./ 24786). *Non-types*: 1 young male (12.0 mm TL; 5.5 mm W) (Reg. No. CAH/INV/ISO 0300); 1 early transitional (17.0 mm TL; 8.0 mm W) (Reg. No. CAH/INV/ISO 0301).

Etymology: The specific name is derived from the Sanskrit word "sagara", literally meaning the "gathering together of waters," *i.e.*, the ocean. Further, it is a reminder of the importance of the ocean for the sustainable development of life underwater and its conservation.

Description of ovigerous female (Figs. 1–10): *Body* 2 times as long as greatest width, dorsal surfaces weakly vaulted, widest at pereonite 3, most narrow at pereonite 1. *Cephalon* 1.8 times wider than long, partially immersed in pereonite 1. *Frontal margin* with acute ventrally directed rostral point. *Eyes* oval with distinct margins, one eye 0.15 times the width of cephalon. Pereonite 1 smooth; anterior border medially straight, slightly curved laterally; anterolateral angles with a small distinct produced point. *Coxae* 2–6 narrow, all shorter than respective pereonite, coxae 7 slightly shorter or equal to pereonite 7. *Pereonites* 2–7, posterolateral angles little produced, pereonite 4–7 posterolateral margins slightly asymmetrical, lateral margins slightly constricted in hunched side, pereonite 7 extending posteriorly to pleonite 1 or 2. Pereonites slightly increase the width from 1–3; pereonites 4–7 slightly decrease in width. Pereonite 1 longest, 7 shortest, pereonites decreasing in length from 1–3, pereonites 3–6 sub equal in length. *Pleon* short, ~15% BL, pleon 1.25 times as wide as maximum pereon width; pleonites progressively increasing in width towards posterior; pleonites 1–4 medially subequal in length, pleonite 5 longest. Pleonite 1 slightly narrower, subequal in length to pleonite 2. *Pleotelson* 1.10 times wider than pereonite 7; 1.6 times as wide as long; posterior margin, broadly rounded, lateral margins

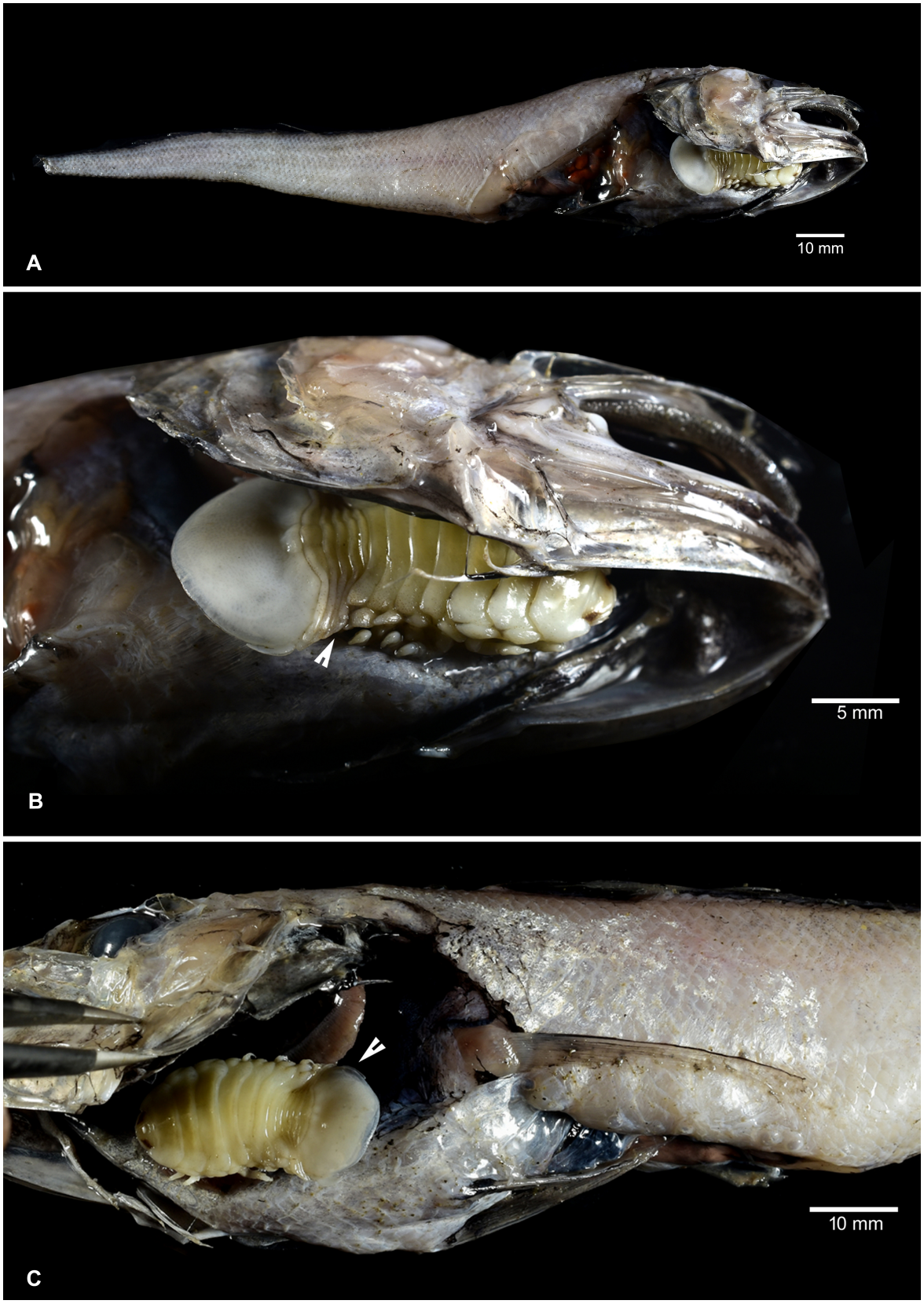

Fig. 1. *Glyptothoa sagara* gen. et sp. nov. A–C, ovigerous female on the branchial cavity of the host fish *Glyptophidium macropus* Alcock, 1894. The arrow indicates ovigerous female.

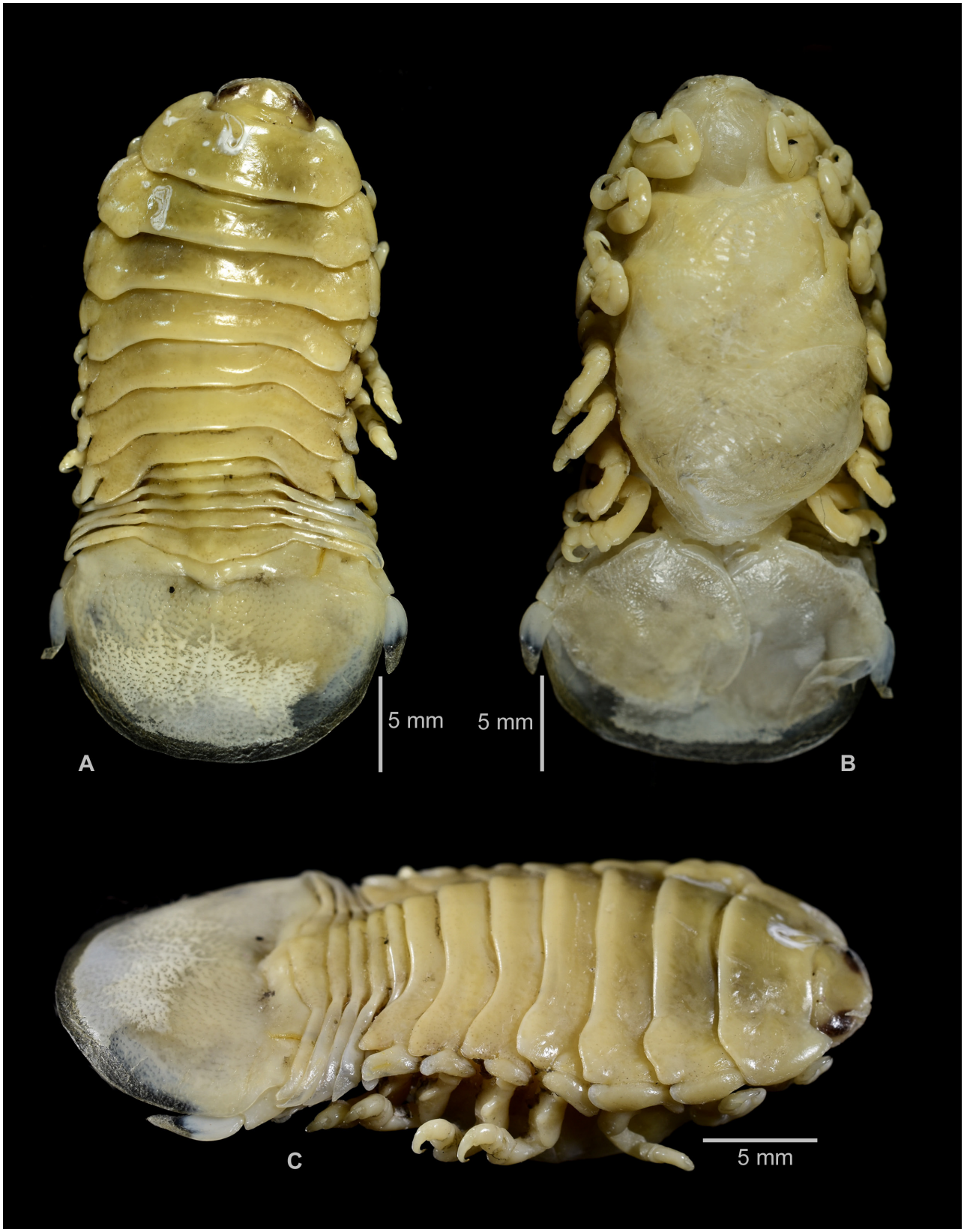

Fig. 2. *Glyptothoa sagara* gen. et sp. nov. ovigerous female holotype (Reg. No. ZSI/WGRC/IR. INV/24781). A, dorsal view. B, ventral view. C, dorso-lateral view.

convex, dorsal proximal surface with medial furrow.

Antennula narrowly separated by rostrum; article 1 widest, 1.2 times as wide as long; article 3 longest; terminal article shortest; 4–7 with 2–3 simple setae, article 8 with few terminal aesthetes. *Antenna*, terminal article shortest, with few short simple setae, extending to anterior margin of pereonite 1; article 1 widest, 1.5 times as wide as long; article 2 as wide as long; article 4 longest; articles 4–5 lateral margin with one plumose seta each; articles 5–13, decreasing the width; articles 10–12 sub-equal in width; terminal article 1.5 times as long as wide. *Mandible* palp article 1 longest, 3.3 times as long as wide; article 2 longer than article 3; palp article 2 with 5–7, article 3 with many 18–25 simple marginal setae. *Maxillula* with 4 unequal acuminate terminal RS. *Maxilla* with distinct mesial lobe and lateral lobe, each with 2 RS. Maxilliped with oostegital lobes, article 3 with three recurved RS; mouthparts not covered by oostegites of *pereopod 2*.

Pereopod 1, basis large, 1.7 times as long as greatest width; ischium, 1.5 times as long as wide, 0.7 times as long as basis; merus 0.4 times as long as wide; carpus 0.7 times as wide as merus; propodus 1.5 times as long as wide, 0.5 times as long as ischium; dactylus 1.3 times as long as propodus, 3.3 times as long as proximal width. Pereopod 2 basis 1.7 times as long as greatest width; ischium, twice as long as wide, 0.7 times as long as basis; propodus 1.6 times as long as wide; dactylus 1.1 times as long as propodus. Pereopods 3 similar to pereopod 2. Pereopod 4 basis 1.2 times as long as greatest width; ischium as long as basis, 1.6 times as long as greatest width; propodus 1.3 times as long as wide; dactylus 1.2 times as long as propodus, 3.0 times as long as greatest width. Pereopods 5 similar to pereopod 4. Pereopod 6 basis 1.6 times as long as greatest width, ischium as long as basis, 1.8 times as long as greatest width; merus 1.2 times wider than ischium; propodus 1.4 times as long as wide; dactylus 1.1 times as long as propodus, 2.9 times as long as greatest width. Pereopod 7 basis 1.9 times as long as greatest width; ischium 0.9 times as long as basis; merus 1.2 times as wide as ischium, 0.4 times as long as wide; carpus 0.5 times as long as wide, 0.4 times as long as ischium; propodus 1.5 times as long as wide, 0.5 times as long as ischium; dactylus 1.4 times as long as propodus, three times as long as basal width.

Brood pouch moderately bulged ventrally.

Pleopod peduncle lateral lobes absent. Pleopod 1,

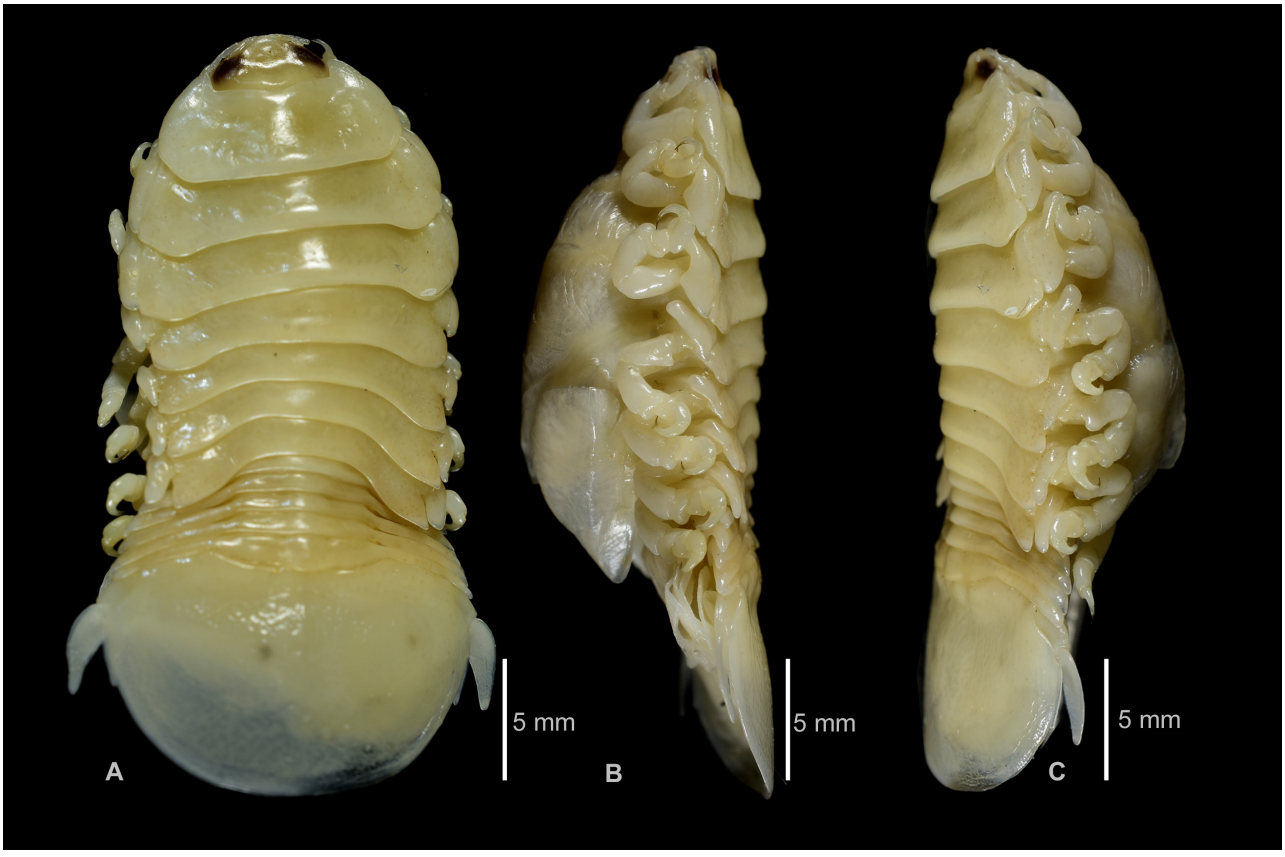

Fig. 3. *Glyptothoa sagara* gen. et sp. nov. ovigerous female paratype (Reg. No. ZSI/WGRC/IR. INV/24786) A, dorsal view. B–C, lateral views.

one side is slightly larger than other side; exopod 1.1 times as long as wide, lateral margin convex, distally broadly rounded, mesial margin convex; endopod 0.9 as long as exopod, 1.3 times as long as wide, lateral margin weakly convex, distally broadly rounded; peduncle twice as wide as long. Pleopod 2 without appendix masculina. Pleopod 2–5, similar. Pleopod 5 exopod as long as wide, lateral margin convex, distally

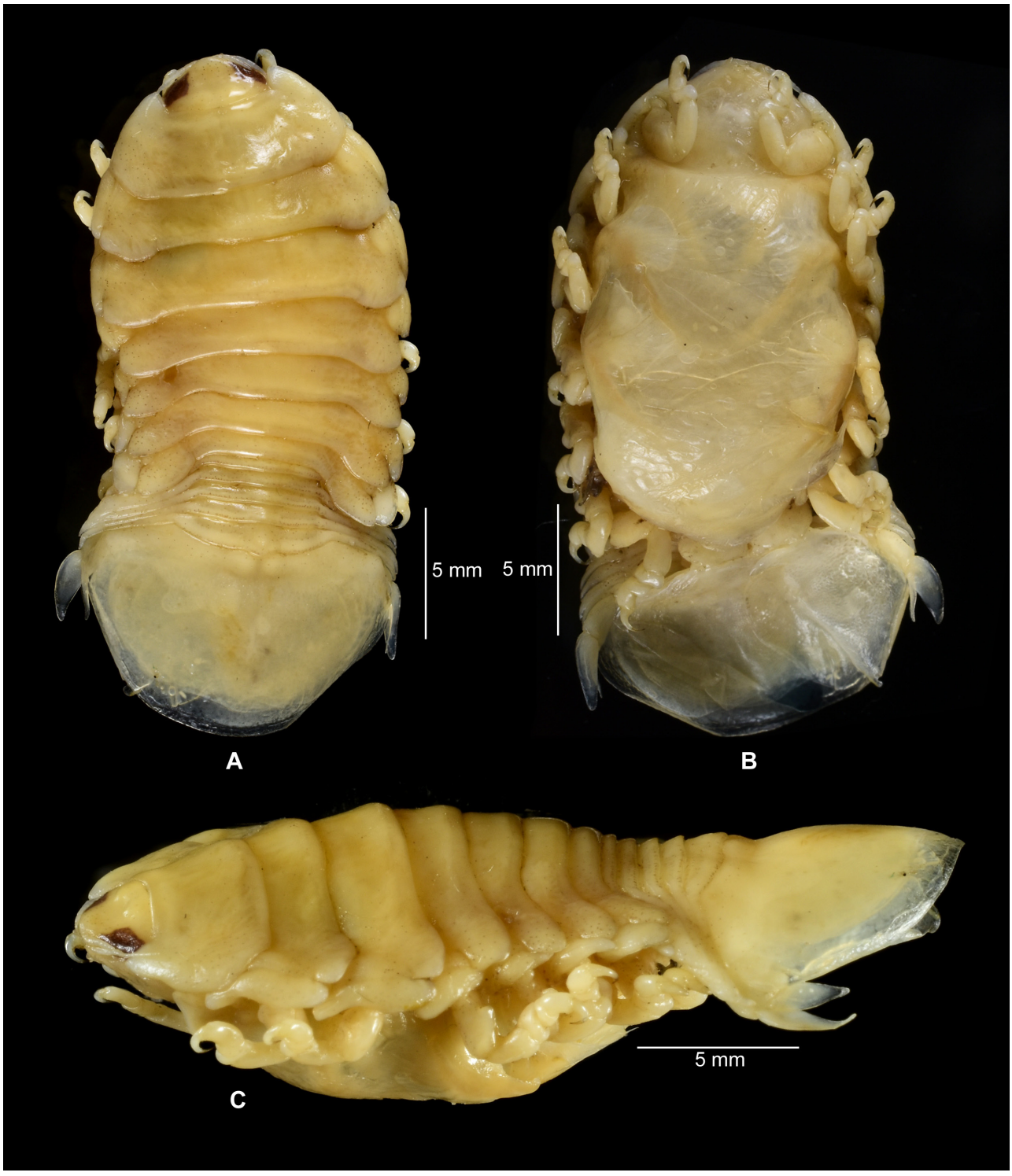

Fig. 4. *Glyptothoa sagara* gen. et sp. nov. ovigerous female paratype (partially dissected) (Reg. No. ZSI/WGRC/IR. INV/24784). A, dorsal view. B, ventral view. C, lateral view.

rounded, mesial margin convex; endopod 0.9 times as long as exopod, 1.1 times as long as wide, distally broadly rounded.

Uropod 0.5 times as long as pleotelson; peduncle 0.6 times as long as exopod, 1.5 times as long as wide, lateral margin without setae; rami without marginal setae, apices narrowly rounded. *Endopod* 2.8 times as long as greatest width, 0.8 times as long as exopod, lateral margin convex. *Exopod* 1.3 times as long as endopod, apically narrowly rounded, exopod curved

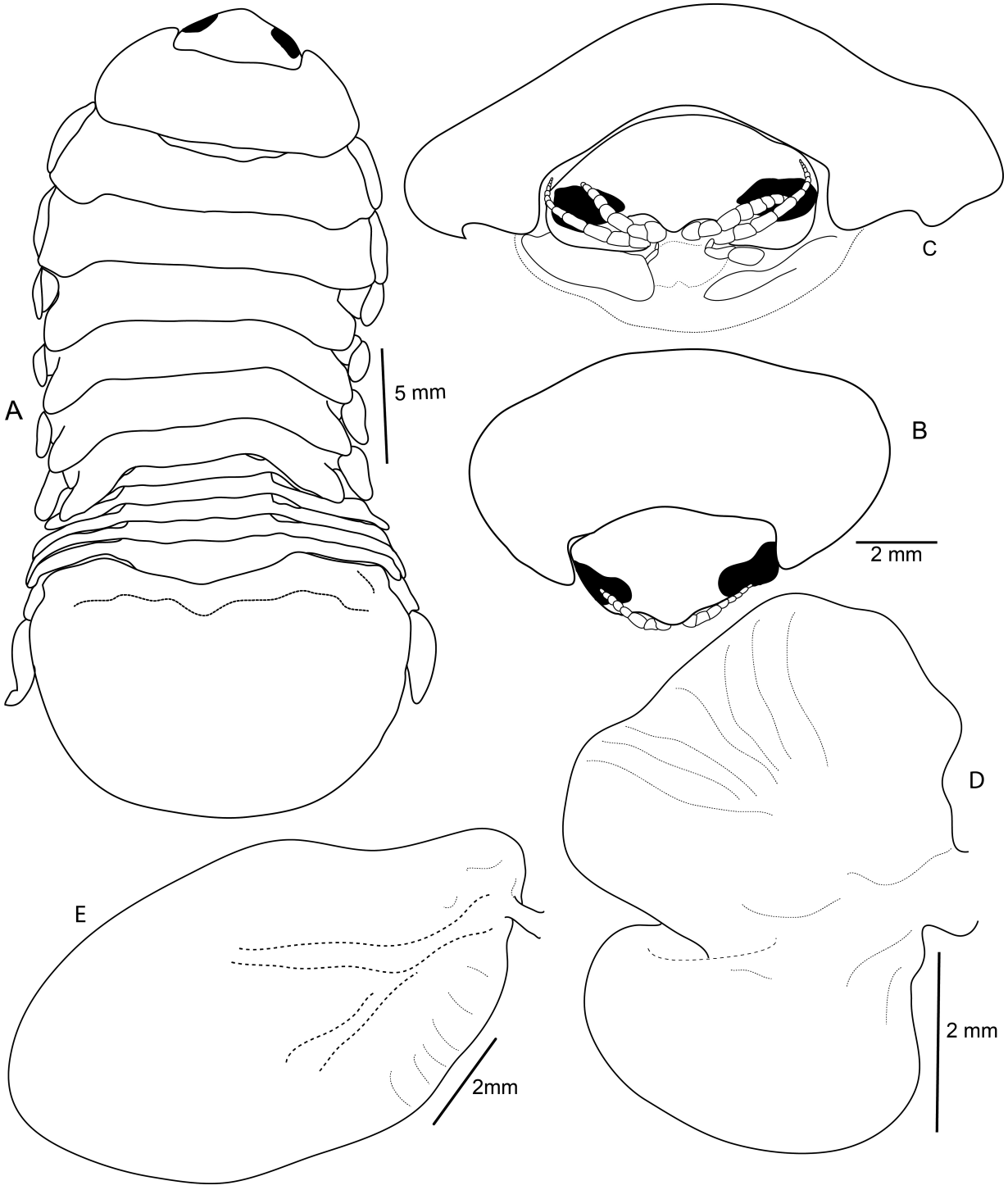

Fig. 5. *Glyptothoa sagara* gen. et sp. nov. ovigerous female. A–C, Holotype. A, dorsal view. B, cephalon dorsal view. C, cephalon frontal view. D–E, paratype (partially dissected) (Reg. No. ZSI/WGRC/IR. INV/24784). D, oostegite of pereonite 2. E, oostegite of pereonite 3.

to mesial, 2.5 times as long as greatest width, mesial margin concave, lateral margin convex.

Description of transitional stage (Figs. 11–13): Body 1.8–2.0 times as long as wide; straight (in early transitional) to slightly curved towards one side (in late transitional), widest at pereonite 3, most narrow at pereonite 1. Eyes distinct, one eye 0.3 times as wide as cephalon. Cephalon 0.5–0.6 times as long as wide, similar to females. Pereonites and pleonites of the late stage similar to those of the ovigerous female.

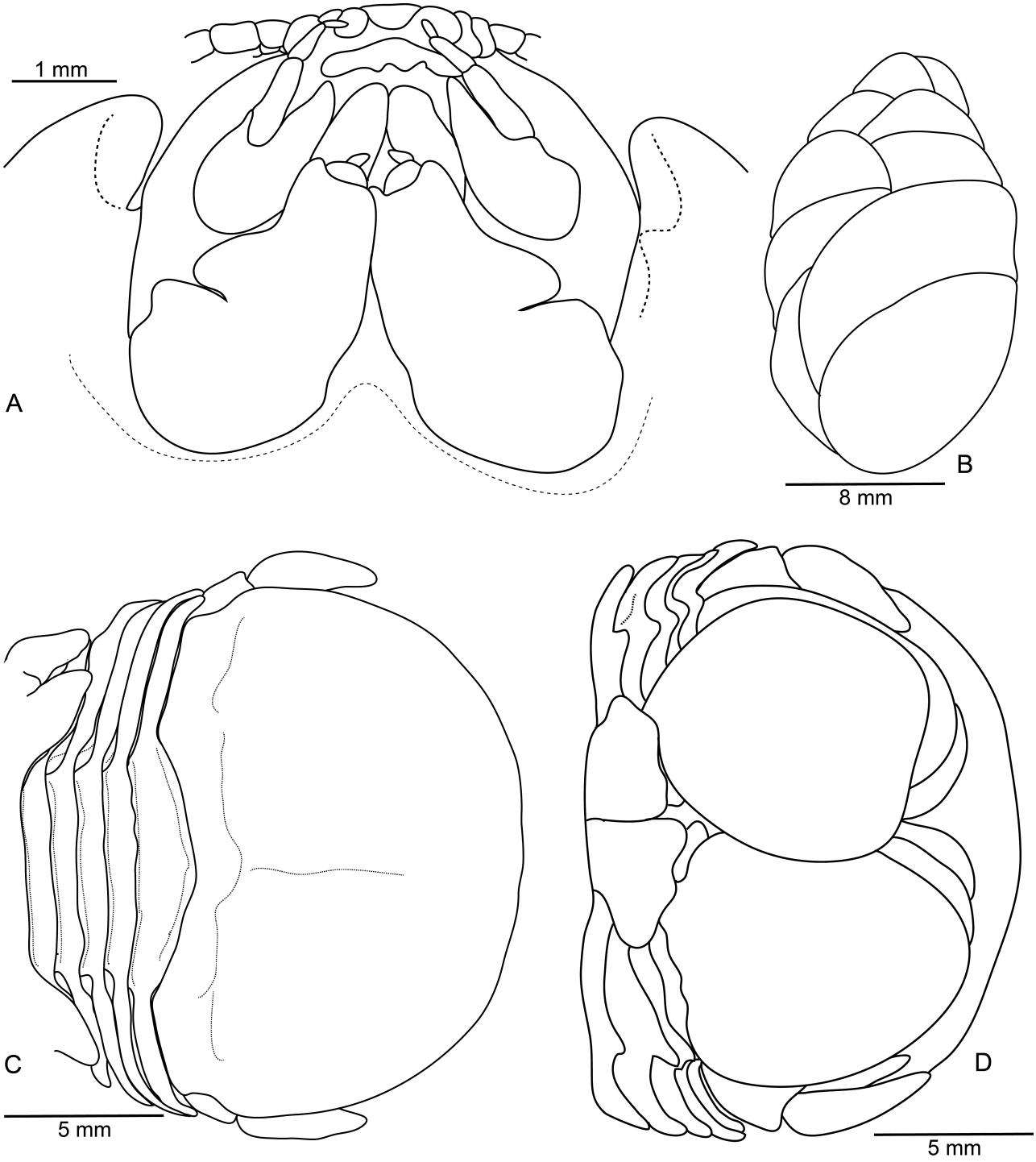

Fig. 6. *Glyptothoa sagara* gen. et sp. nov. A, non-ovigerous female paratype cephalon ventral view (Reg. No. ZSI/WGRC/IR. INV/24783). B–D, holotype. B, brood pouch. C, pleon dorsal view showing pleonite gaps. D, pleon ventral view.

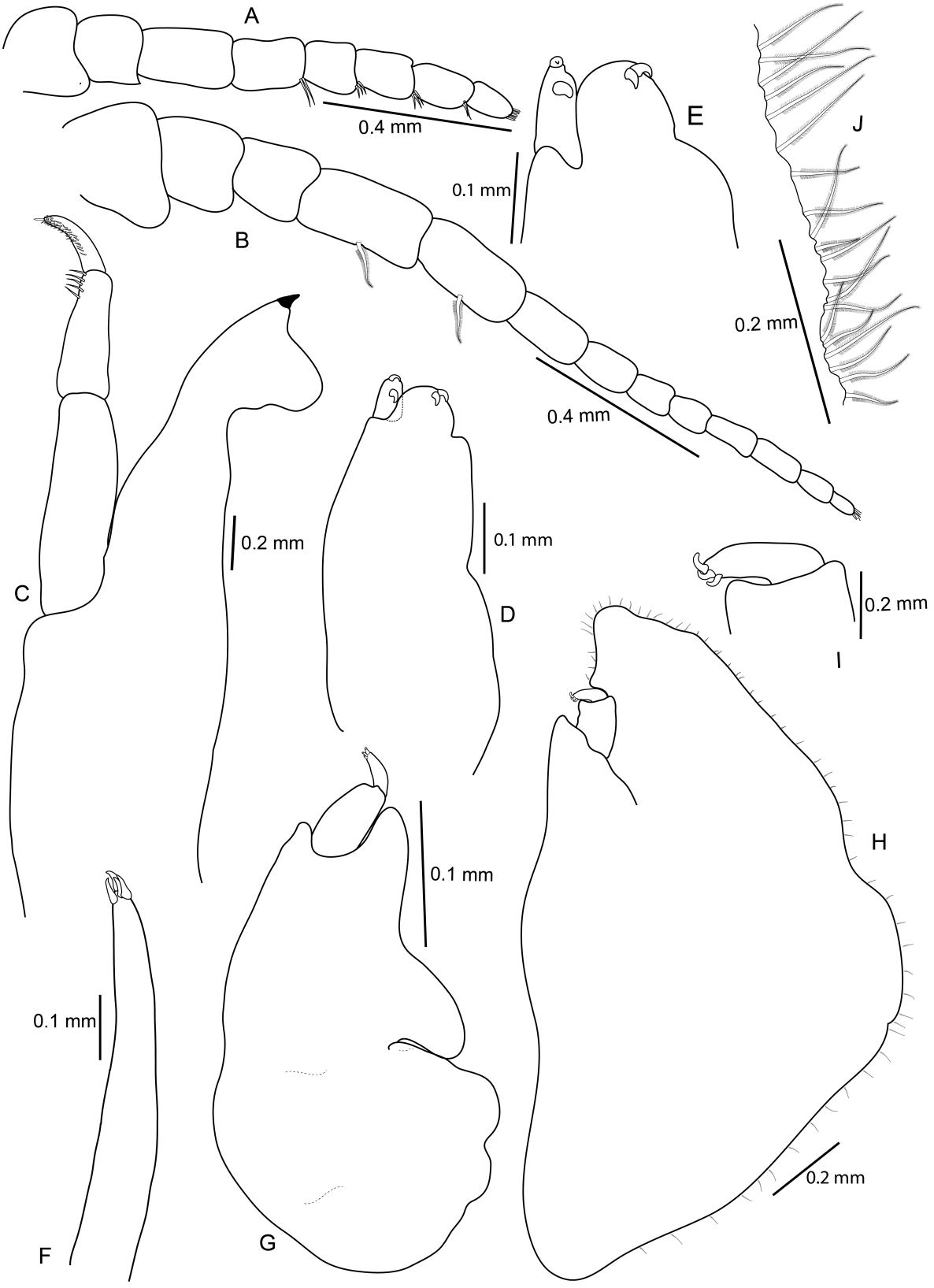

Fig. 7. *Glyptothoa sagara* gen. et sp. nov. ovigerous female paratype (partially dissected) (Reg. No. ZSI/WGRC/IR. INV/24784). A, antennula. B, antenna. C, mandible. D, maxilla. E, maxilla apex. F, maxillula. G, maxilliped of non-ovigerous female (Reg. No. ZSI/WGRC/ IR.INV./ 24783). H, maxilliped of ovigerous female. I, distal segment of maxilliped palp. J, plumose setae of maxilliped.

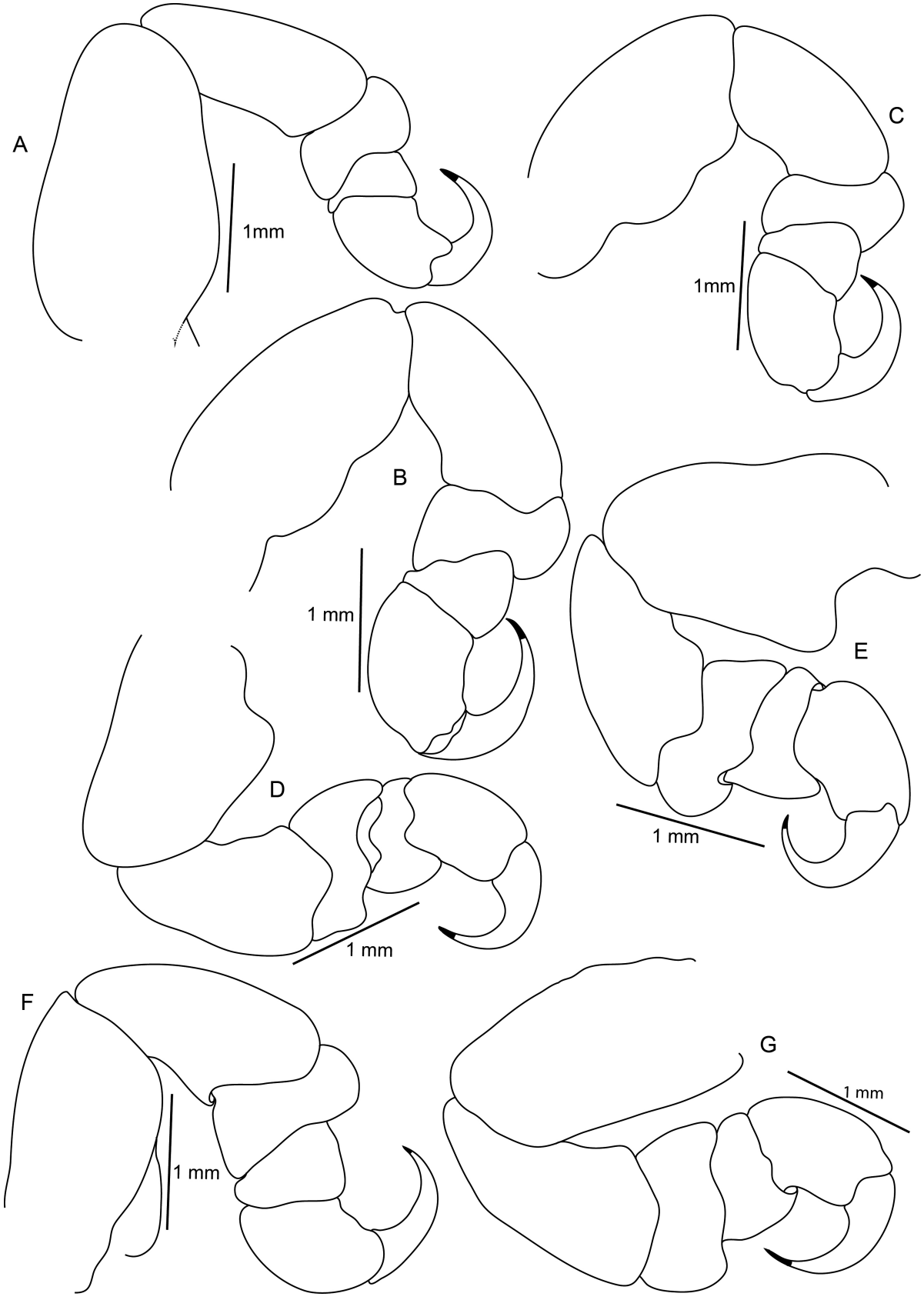

Fig. 8. *Glyptothoa sagara* gen. et sp. nov. ovigerous female paratype (partially dissected) (Reg. No. ZSI/WGRC/IR. INV/24784). A–G, pereopods 1–7.

Antennula, antenna, mandible palp, maxilla, maxilliped similar to those of the male. Coxae similar to that of the female (late transitional). Penial processes rudimentary. Pleotelson early stage 1.9 times wider than long, late stage 1.6 times wider than long. Uropods similar to those of male. Early stage pereopods and pleopods were similar to those of males, and late stage ones were similar to those of females, but possessed rudimentary

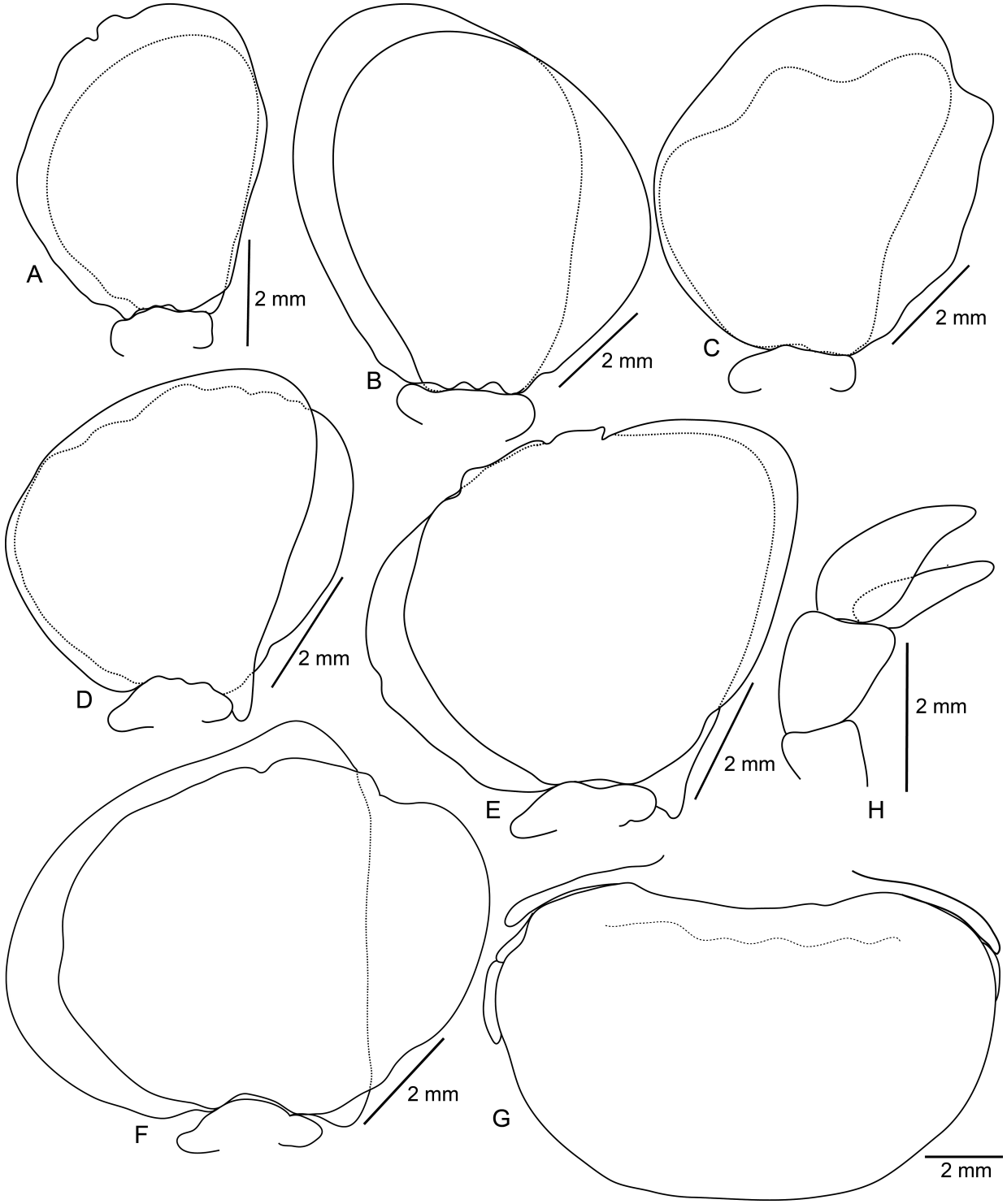

Fig. 9. *Glyptothoa sagara* gen. et sp. nov. ovigerous female paratype (partially dissected) (Reg. No. ZSI/WGRC/IR. INV/24784). A–B, left and right pleopod 1. C–F, pleopods 2–5. G, pleotelson and uropods. H, uropod.

spines.

Description of adult male (Figs. 14–18): *Body* symmetrical, 2.0–2.2 times as long as greatest width, dorsal surfaces smooth, lateral margins sub-parallel, widest at pereonite 3, pereonite 2–4 subequal in width, most narrow at pereonite 7. *Cephalon* 2.4 times wider than long, anterior border slightly triangular. *Frontal margin* similar to that of female. *Eyes* conspicuous,

Fig. 10. *Glyptothoa sagara* gen. et sp. nov. non-ovigerous female paratype (Reg. No. ZSI/WGRC/IR. INV/24783). A, dorsal view. B, ventral view. C, lateral view.

one eye 0.3 times width of cephalon. *Coxae* all dorsally visible, shorter than pereonites. *Pereonite*s 1–6 posterolateral angles not produced. Pereonite 7 posterolateral margin extending beyond the lateral margin of pleonite 1. *Pereonites* 3–5 more or less equal in width, 1 narrower than others. Pereonite 1 longest, 7 shortest. *Pleon* wide, 1.1 times as wide as pereon; pleonites progressively increase in width from 1–5. *Pleotelson* posterior margin broadly rounded, 1.7 times as wide as long.

Antennula length shorter than antenna, with eight articles, narrowly separated by rostrum; article 1 widest, 2.0 times as wide as long; article 3 longest; terminal article shortest, articles 3–8 with few setae. *Antenna* with 13 articles; terminal article shortest, with few short, simple setae; article 1 widest, 1.2 times as wide as long; article 5 longest; articles 5–13, progressively decreasing in length and width. Mandible, maxillula, maxilla similar to that of non-ovigerous female. Maxilliped article 1, basally narrow without lobes; article 2 0.4 times as long as article 1, article 3, 0.8 times as long as article 2.

All pereopods with acute RS. Pereopod 1 basis 1.5 times as long as greatest width; ischium 0.7 times as long as basis; merus 0.4 times as long as wide; propodus 1.6 times as long as wide, inner lateral margin with 3 acute RS; dactylus, 1.2 times as long as propodus, 3.3 times as long as proximal width. Pereopod 2 basis 2.0 times as long as greatest width; ischium 0.4 times as long as basis; merus 0.7 times as long as wide; propodus 1.2 times as long as wide, inner lateral margin with 8 acute RS; dactylus, 1.4 times as long as propodus, 3.2 times as long as proximal width. Pereopod 3 basis 2.0 times as long as greatest width; ischium 0.6 times as long as basis; propodus 1.4 times as long as wide, inner lateral margin with 6 acute RS; dactylus, 1.2 times

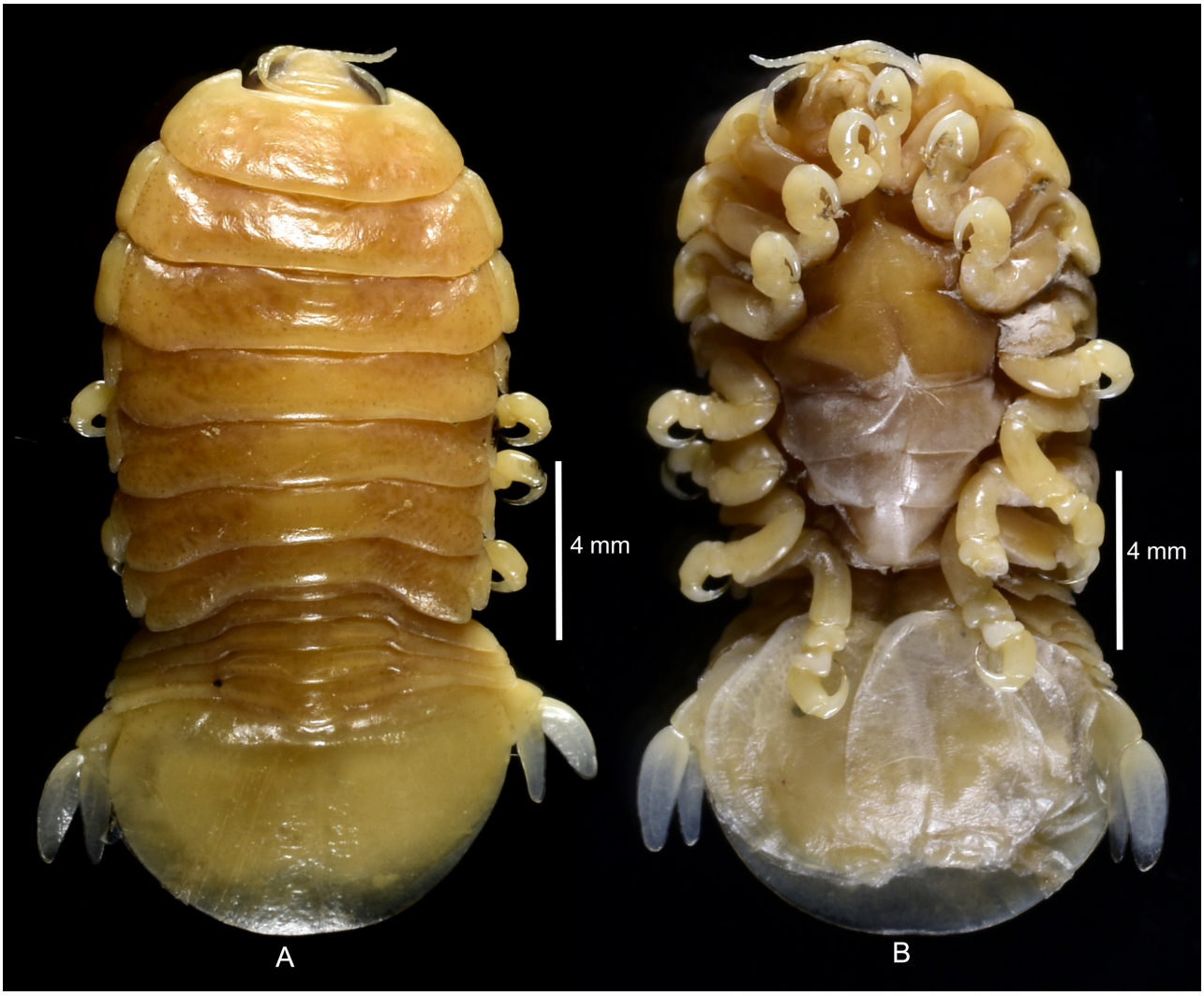

Fig. 11. *Glyptothoa sagara* gen. et sp. nov. early transitional (Reg. No. CAH/INV/ISO 0301) A, dorsal view. B, ventral view.

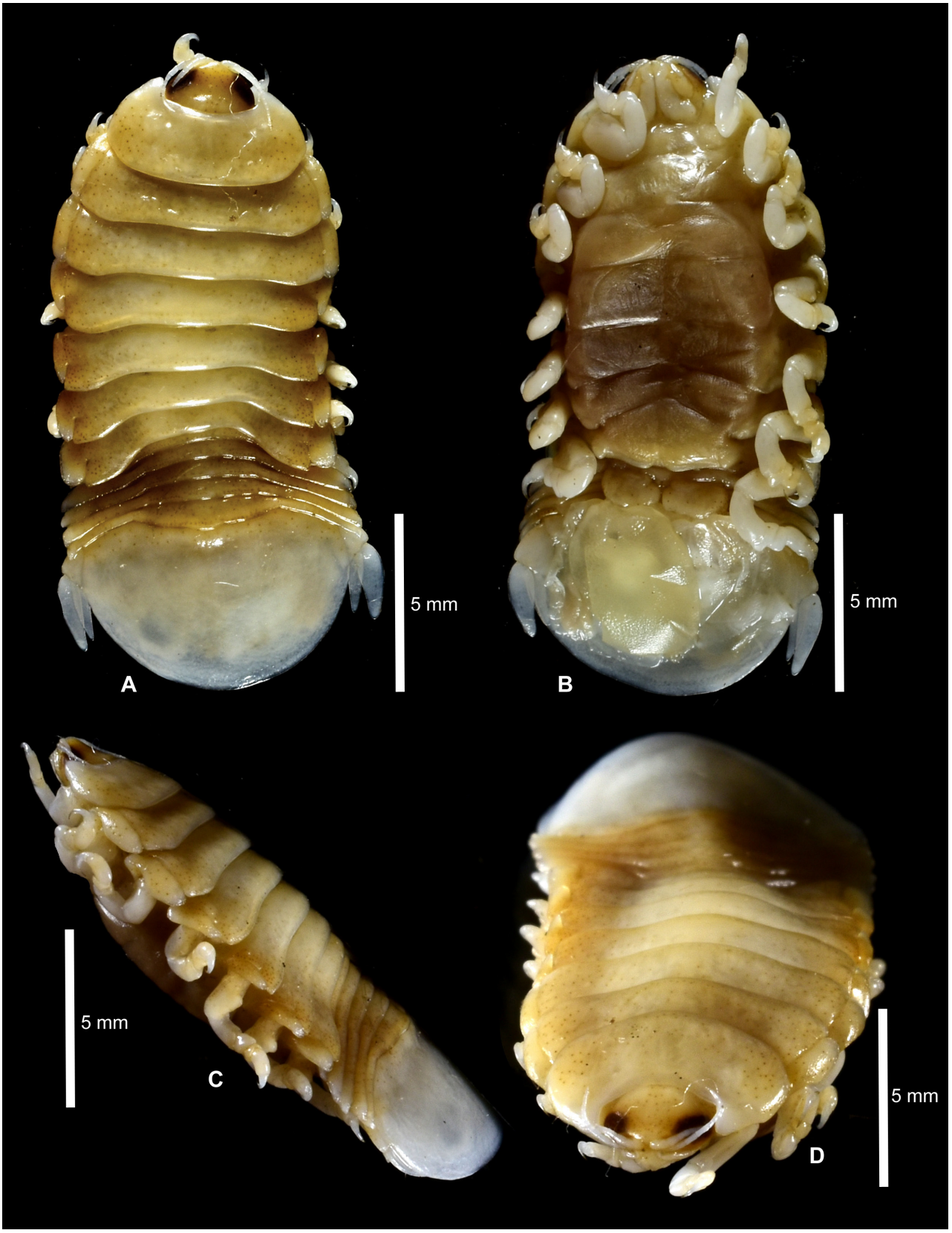

Fig. 12. *Glyptothoa sagara* gen. et sp. nov. late transitional (Reg. No. ZSI/WGRC/IR. INV/24785). A, dorsal view. B, ventral view. C, lateral view. D, dorso-frontal view.

as long as propodus. Pereopod 4 carpus inner lateral margin with 2, propodus with 3 acute RS. Pereopod 5 basis 2.0 times as long as greatest width; ischium 0.8 times as long as basis; carpus inner lateral margin with 2 acute RS; propodus as long as wide, inner lateral margin with 4 acute RS; dactylus 1.4 times as long as propodus. Pereopod 6 2.0 times as long as greatest width; ischium 0.8 times as long as basis; carpus inner lateral margin with 2 acute RS; propodus 1.4 times as long as wide, inner lateral margin with 6 acute RS; dactylus 1.2 times as long as propodus. Pereopod 7 basis 1.8 times as long as greatest width; ischium 0.9 times as long as basis; carpus inner lateral margin with 3 acute RS; propodus 1.7 times as long as wide, inner lateral margin with 5 acute RS; dactylus 1.2 times as long as propodus.

Penial process acute, 1.8 times as long as basal width, separated by 30% width of sternite 7, visible on sternite 7, basally mutually adjacent.

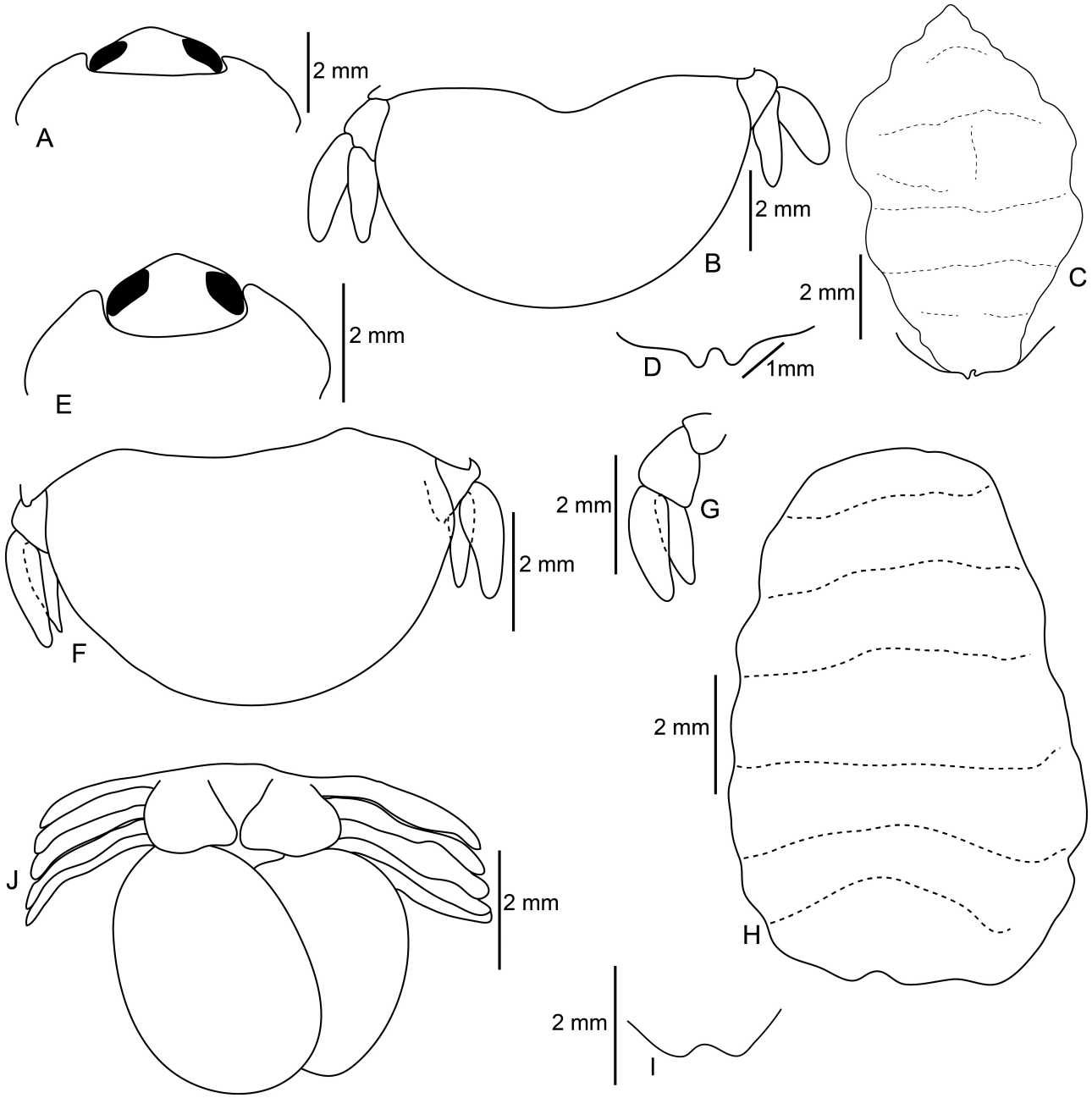

Fig. 13. *Glyptothoa sagara* gen. et sp. nov. transitional (A–D), early transitional (Reg. No. CAH/INV/ISO 0301). A, cephalon dorsal view. B, pleotelson and uropods. C, abdominal sternites with penes. D, penes. (E–J), late transitional (Reg. no ZSI/WGRC/IR. INV/24785). E, cephalon dorsal view. F, pleotelson and uropods. G, uropod. H, abdominal sternites with penes. I, rudimentary penes. J, pleon ventral view.

Pleopods not extending beyond pleotelson margins, not visible in dorsal view. Pleopods 1–5 rami simple, without proximomedial lamellar lobe, folds or thickened ridges; endopod of all pleopods slightly shorter than exopod. Pleopod 1 exopod 1.5 times as long as wide, distally broadly rounded; endopod 0.9 times as long as exopod; peduncle 2.3 times as wide as long. Pleopod 2 exopod 1.1 times as long as endopod; appendix masculina of pleopod 2 straight and narrow, 0.9 as long as endopod. Pleopod 4 exopod as long as endopod.

Uropod 0.9 times as long as pleotelson; peduncle 0.5 times as long as exopod, lateral margin without setae; rami not reaching the distal margin of pleotelson, marginal setae absent, apices narrowly rounded, exopod 1.2 times as long as endopod, 2.7 times as long as

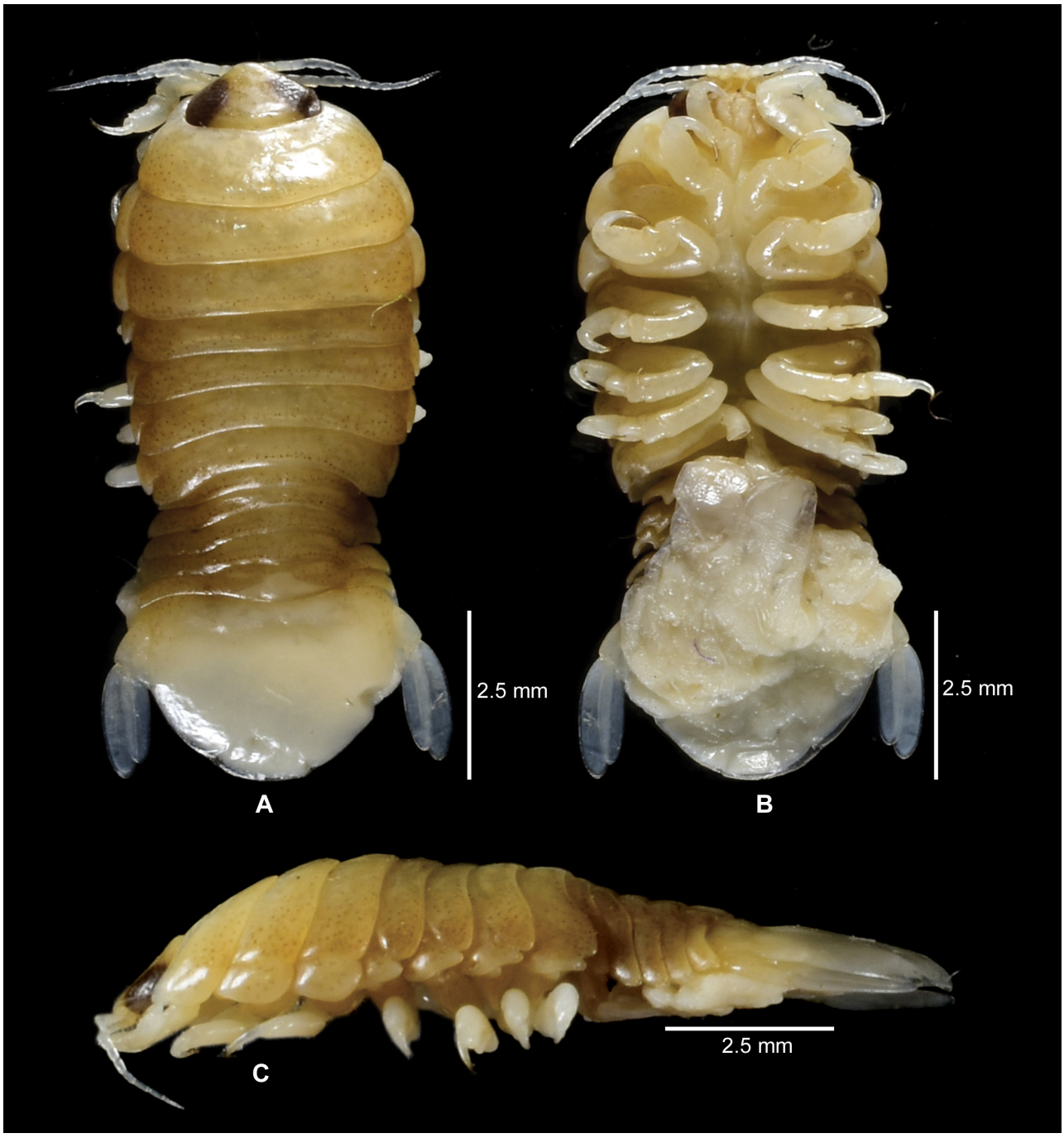

Fig. 14. *Glyptothoa sagara* gen. et sp. nov. young male (Reg. No. CAH/INV/ISO 0300). A, dorsal view. B, ventral view. C, lateral view.

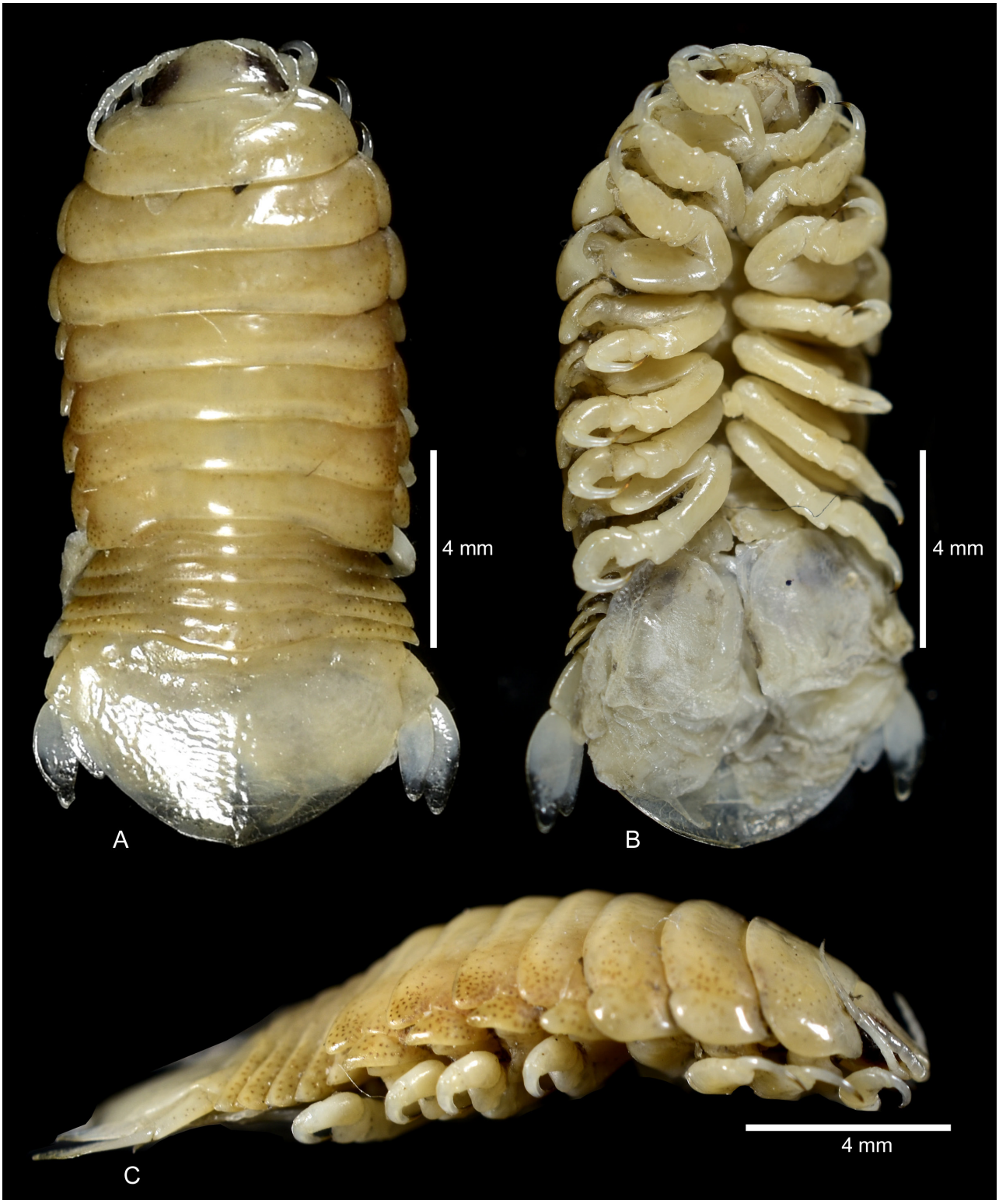

Fig. 15. *Glyptothoa sagara* gen. et sp. nov. male (Reg. No. ZSI/WGRC/IR. INV/24782). A, dorsal view. B, ventral view. C, lateral view.

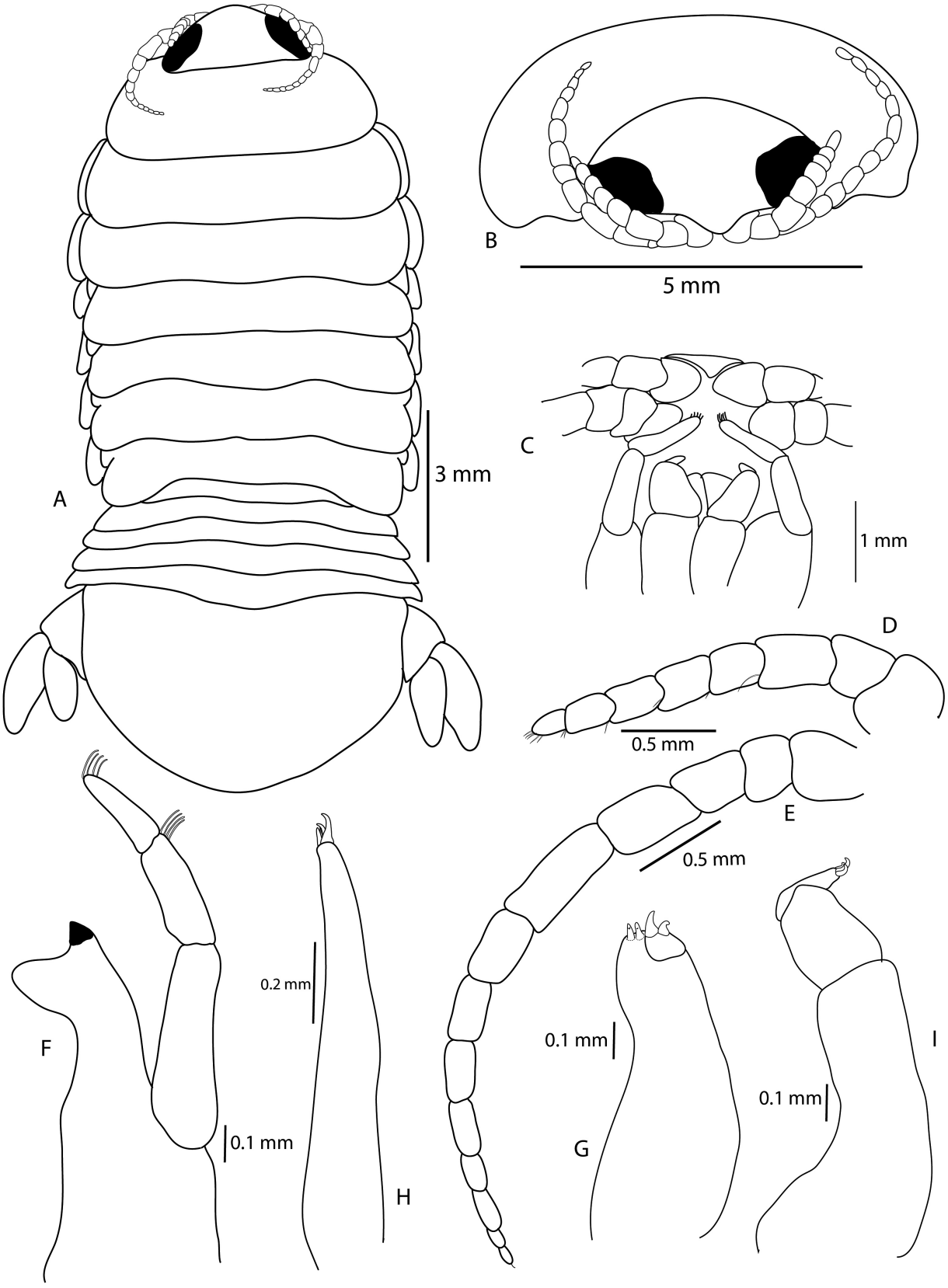

Fig. 16. *Glyptothoa sagara* gen. et sp. nov. male (Reg. No. ZSI/WGRC/IR. INV/24782). A, dorsal view. B, cephalon frontal view. C, cephalon ventral view. D, antennula. E, antenna. F, mandible. G, maxilla. H, maxillule. I, maxilliped.

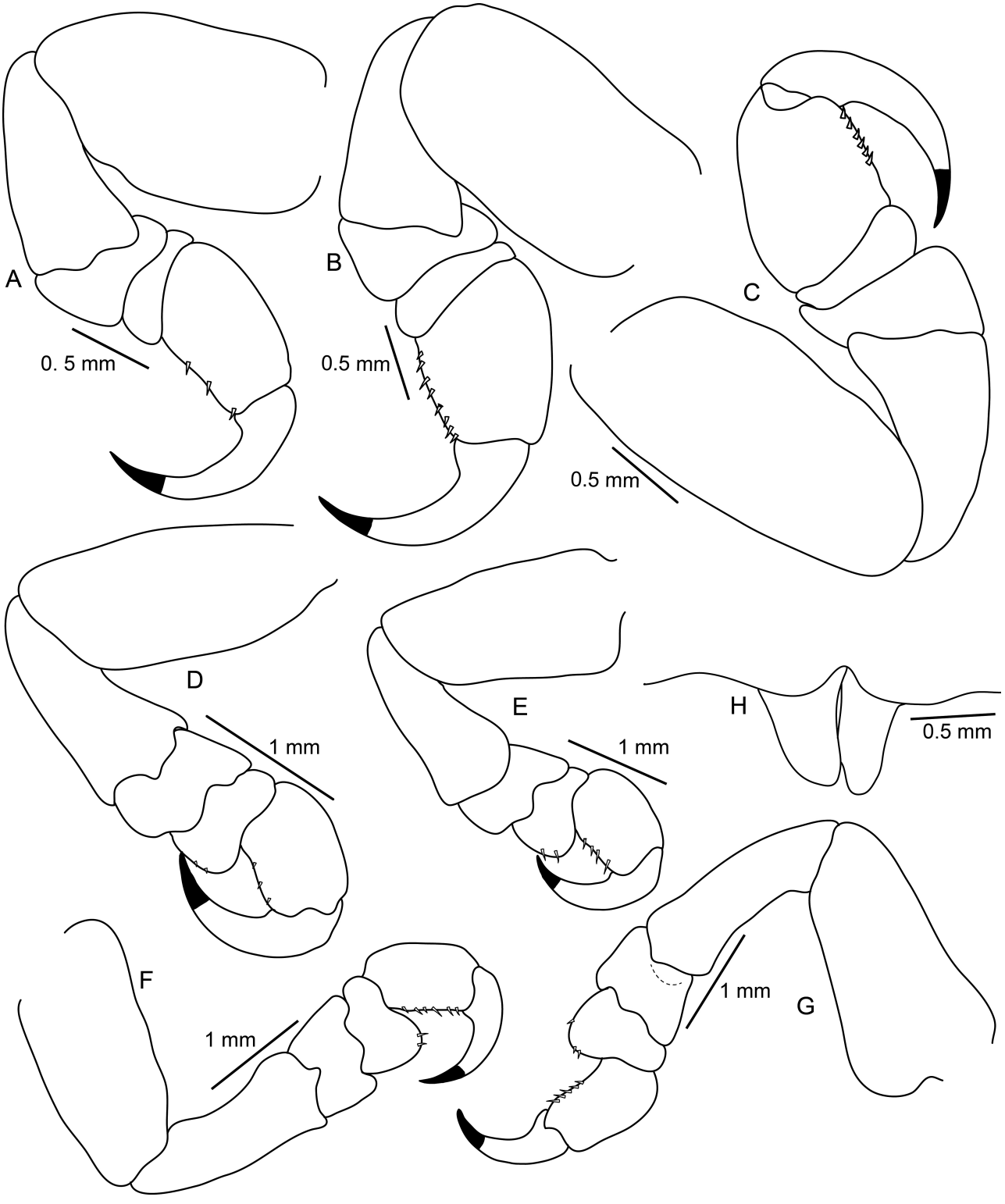

Fig. 17. *Glyptothoa sagara* gen. et sp. nov. male (Reg. No. ZSI/WGRC/IR. INV/24782). A–G, pereopods 1–7. H, penes.

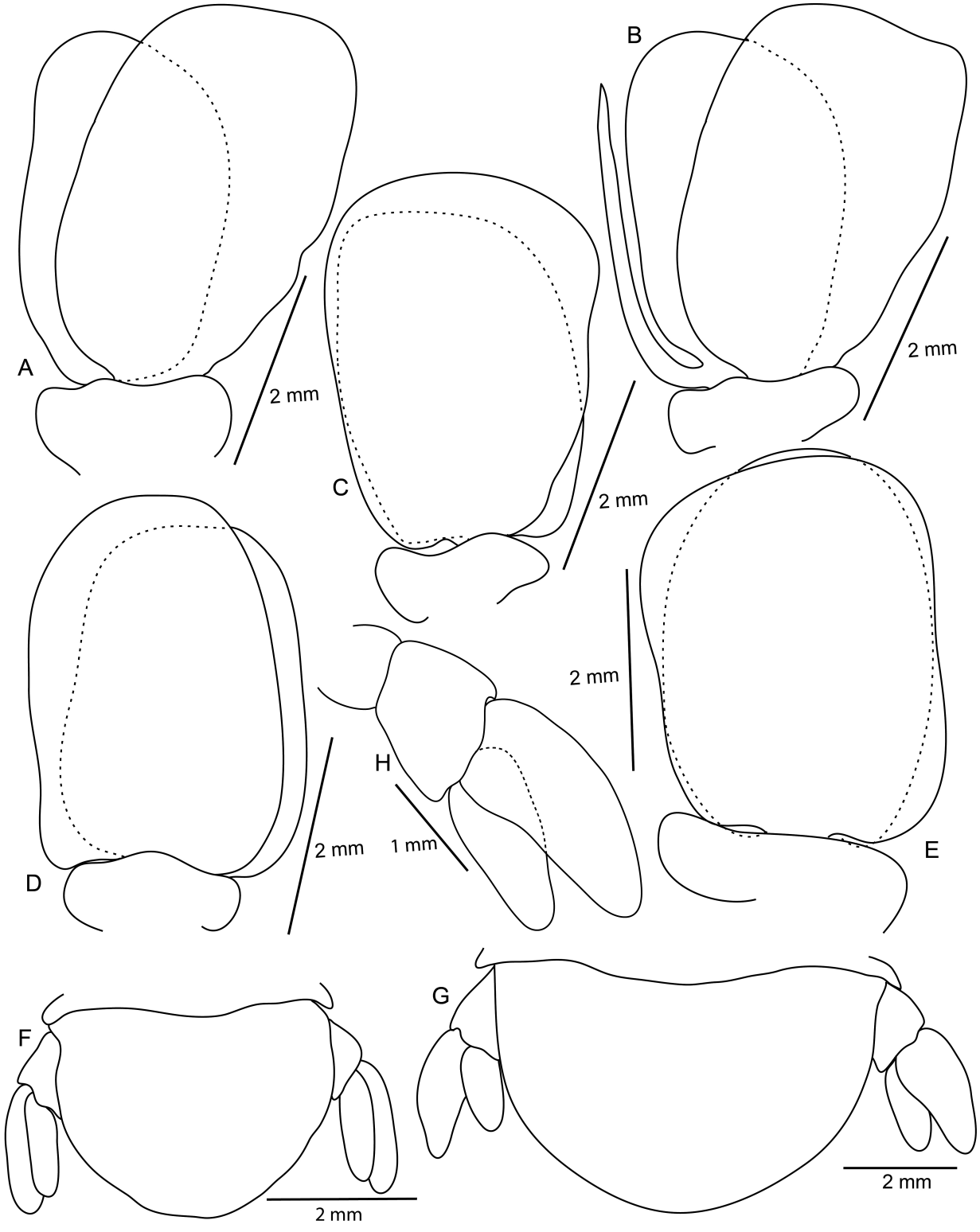

Fig. 18. *Glyptothoa sagara* gen. et sp. nov. male (Reg. No. ZSI/WGRC/IR. INV/24782). A–E, pleopods 1–5. F, uropods and pleotelson of young male. G, uropods and pleotelson. H, uropod.

greatest width. *Endopod* 2.2 times as long as greatest width, lateral margin convex.

Colour: pale tan.

Distribution: Known only from the type locality.

Host: Known only from the type host *Glyptophidium macropus* Alcock, 1894.

Remarks: *Glyptothoa sagara* sp. nov. can be identified by the following features: cephalon partially immersed in pereonite 1; antenna with 13 articles; pleotelson 1.9 times longer than pleon; pleotelson 0.6 times as long as wide; uropod exopod longer than endopod; and uropods extending half the length of pleotelson.

The inter-specific character between *Glyptothoa sagara* sp. nov., and three new combinations are listed in table 2.

Molecular analysis (Table 3; Fig. 19): A 680 bp long *COI* sequence for *Glyptothoa sagara* gen. et sp. nov., was newly generated to maintain a gene library. The sequence was compared to the representatives from other nine branchial cymothoid genera, such as *Elthusa*, *Cterissa*, *Ichthyoxenus*, *Ryukyua*, *Livoneca*, *Norileca*, *Joryma*, *Mothocya* and *Catoessa* sequences available on GenBank (Table 3; Fig. 19). The alignment was 610 bp, no stop codons, translation on frame 2, using invertebrate mitochondrial code. Nucleotide genetic divergence (*p*-distance) among *Glyptothoa sagara* gen. et. sp. nov. and other nine available branchial cymothoid genera is 25.5% (*Elthusa*) to 40.9% (*Norileca*).

Ecological remarks: We have closely examined 45 species of deep-sea fishes (from November 2017 to November 2021) and the parasite *Glyptothoa sagara* gen. et. sp. nov. was recovered only from *Glyptophidium macropus* Alcock, 1894 (family: Ophidiidae) signifying its oligoxenous host specificity. In the present study, we have examined the host fish collected from different localities along the southwest coast of India. A total of 96 individuals of *G. macropus* were examined from four available localities along the southwest coast of India. Of these, 27 individuals were infested with *Glyptothoa sagara* sp. nov. with a prevalence of 28.1%, and all were obtained from the type locality, the Neendakara coast. Twenty females (16 ovigerous and 4 non-ovigerous), 7 transitional stages (4 early and 3 late), and 12 males were recovered from these 27 infested host fish. Parasites were usually found in pairs in the host fish, one in each branchial cavity; mostly male-female pairs were found; the relatively large ovigerous female was found settled in the floor of the branchial cavity, facing the cephalon anteriorly (see Fig. 1). Males were found

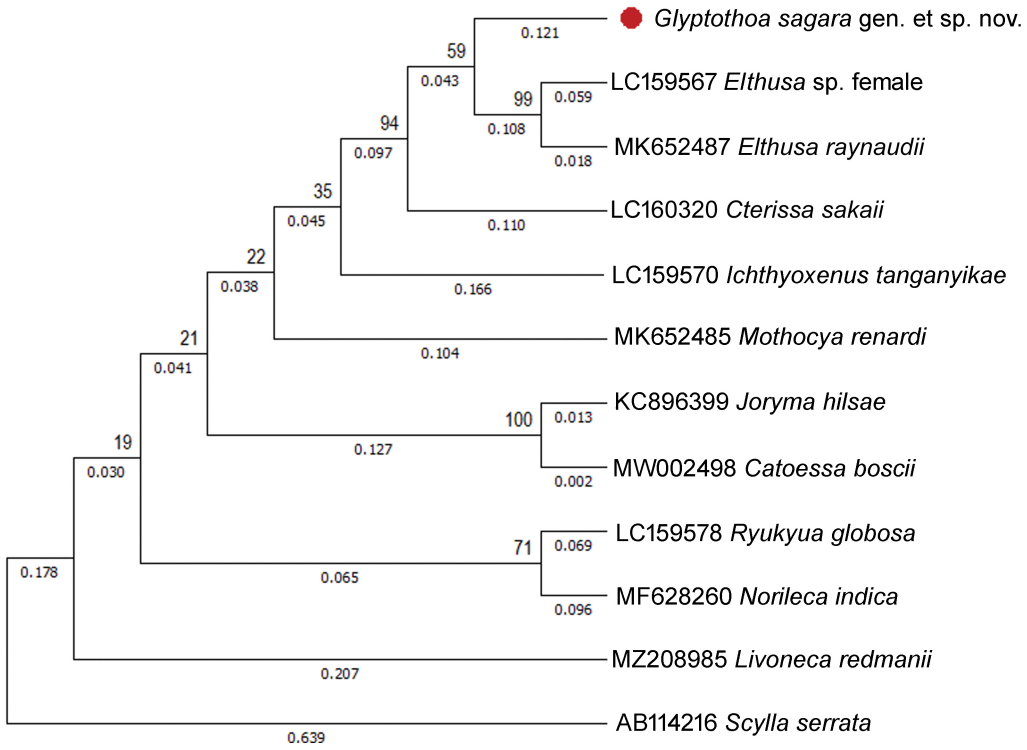

Fig. 19. Maximum likelihood tree of the branchial cymothoids including *Glyptothoa sagara* gen. et sp. nov., based on mitochondrial cytochrome oxidase I (*COI*) gene. Numbers at nodes indicate bootstrap support values. The accession numbers in GenBank are shown before each scientific name.

to occupy the opposite gill chamber in more or less the same position. Similar to our previous observations on other branchial cymothoids, the hunching of the body is also seen in the female and late transitional stage of *Glyptothoa sagara* either towards the left or right according to their occupation of the right and left branchial cavity, respectively.

***Glyptothoa propinqua* (Richardson, 1904) comb. nov.**

(Fig. 20)

urn:lsid:zoobank.org:act:47F8F44F-233C-461B-AEE4-7D3FA0282081

Lironeca propinqua Richardson 1904: 37, figs. 6, 7; Richardson 1909: 87; 1910: 23; Thielemann 1910: 42; Nierstrasz 1931: 43; Barnard 1936: 170.

Elthusa propinqua Bruce 1990: 262–263, figs. 8, 9; Saito and Yamauchi 2016: 64; Kazmi, Schotte and Yousuf, 2002: 102, fig. 85; Ravichandran, Vigneshwaran, and Rameshkumar 2019: 25.

Remarks: *Glyptothoa propinqua* (Richardson, 1904) comb. nov. was described initially from moderately deepwater fishes off Japan as *Lironeca propinqua*. Later Bruce (1990) transferred this species into the genus *Elthusa*. The recent revision of the genus *Elthusa* by Aneesh et al. (2020b) regarded *Elthusa* as *incerta sedis*, since it did not wholly conform to the generic characters of *Elthusa* (see the generic remarks in Aneesh et al. 2020b). Based on the following characters: cephalon immersed in pereonite 1, coxae shorter than or as long as pereonites, pereonites 4–7 slightly decreasing in width towards one side, slightly asymmetrical,

Table 2. Interspecific morphological character comparison between *Glyptothoa sagara* sp. nov., *Glyptothoa propinqua* (Richardson, 1904) comb. nov., *Glyptothoa myripristae* (Bruce, 1990) comb. nov., and *Glyptothoa caudata* (Schioedte & Meinert, 1884) comb. nov. collated from original descriptions and, where applicable, redescriptions (see Schioedte and Meinert 1884; Richardson 1904; Bruce 1990)

Characters	*G. sagara* sp. nov.	*G. propinqua* (Richardson, 1904) comb. nov.	*G. myripristae* (Bruce, 1990) comb. nov.	*G. caudata* (Schioedte & Meinert, 1884) comb. nov.
Cephalon	Partially immersed in pereonite 1	Deeply immersed in pereonite 1	Deeply immersed in pereonite 1	Partially immersed in pereonite 1
Antenna	With 13 articles	With 11 articles	With 11 articles	With 12 articles
Pleonite 1	Visible in dorsal view	Visible in dorsal view	Not visible in dorsal view	Visible in dorsal view
Pleotelson length to pleon length	1.9 times longer than pleon	1.2 times longer than pleon	2.9 times longer than pleon	1.3 times longer than pleon
pleotelson	0.6 times as long as wide	0.46 times as long as wide	0.7 times as long as wide	0.6 times as long as wide
Uropod	Exopod longer than endopod	Exopod longer than endopod	Endopod slightly longer than exopod	Endopod slightly longer than exopod
Uropod length to pleotelson	Uropods extending half the length of pleotelson	Uropods nearly reaching the margin of pleotelson	Uropods less than half the length of pleotelson	Uropods nearly half the length of pleotelson

**Glyptothoa caudata* (Schioedte & Meinert, 1884) comb. nov., characters are based on non-ovigerous female (holotype).

Table 3. Nucleotide genetic divergence among *COI* sequences of *Glyptothoa sagara* gen. et sp. nov., and other branchial cymothoid genera available in GenBank. Values are expressed in percentage (*p*-distance)

		1	2	3	4	5	6	7	8	9	10	11
1	*Glyptothoa sagara* gen. et sp. nov.											
2	LC159567 *Elthusa* sp. female	26										
3	MK652487*Elthusa raynaudii*	24	8									
4	LC160320 *Cterissa sakaii*	25	27	26								
5	LC159570 *Ichthyoxenus tanganyikae*	35	39	34	34							
6	LC159578 *Ryukyua globosa*	39	37	37	37	32						
7	MZ208985 *Livoneca redmanii*	39	39	35	39	41	33					
8	MF628260 *Norileca indica*	41	41	40	35	36	16	36				
9	KC896399 *Joryma hilsae*	38	33	32	34	32	29	37	29			
10	MK652485 *Mothocya renardi*	35	35	32	32	29	26	34	26	27		
11	MW002498 *Catoessa boscii*	37	32	31	33	31	28	35	28	2	25	

lateral margins slightly constricted in the hunched side, relatively wide pleon, with lateral gaps between pleonites, antennula narrowly separated by rostrum, buccal cone obscuring antennal bases, pleopods rami all simple, without folds or thickened ridges; we place the species in combination with *Glyptothoa* gen. nov. Interspecific character are listed in table 2.

Distribution: Japan (Richardson 1904; Saito and Yamauchi 2016), the Philippines (Richardson 1909), and eastern Australia (Bruce 1990). Barnard's report from Lakshadweep Island, India (1936) is an unconfirmed record as there are no figures, descriptions, or voucher specimens.

Hosts: Known from "chalinura" (Richardson 1909) from Japan, "a macrurid" (Richardson 1910) in the Philippines, from the gills of *Macrurus* sp. in India (Barnard 1936), from *Ventrifossa* cf. *nigrodorsalis* (family: Macrouridae) Bruce (1990); from five macrourid fish species from Japan, including the *Coelorinchus jordani* Smith and Pope, 1906, *Coelorinchus longissimus* Matsubara, 1943, *Coelorinchus multispinulosus* Katayama, 1942, *Coelorinchus productus* Gilbert and Hubbs, 1916, and *Ventrifossa garmani* (Jordan and Gilbert, 1904) (Saito and Yamauchi 2016). Present material (fig. 20) was also collected from *Ventrifossa garmani* from Suruga Bay, Japan.

Glyptothoa myripristae (Bruce, 1990) comb. nov.

urn:lsid:zoobank.org:act:05916159-594D-4639-8C53-F27251814670

Elthusa myripristae Bruce 1990: 255–258, figs. 3–5.

Remarks: *Glyptothoa myripristae* (Bruce, 1990) comb. nov. was originally described from Escape Reef, northern Great Barrier Reef by Bruce (1990), in the genus *Elthusa.* It had the following characters: antennula narrowly separated by rostrum, buccal cone obscuring antennal bases, pleopods rami all simple, without folds or thickened ridges, pereonites 4–7 slightly decrease in width towards one side, slightly asymmetrical, lateral margins slightly constrict in hunched side, relatively wide pleon, with lateral gaps between pleonites makes it fit with the new genus *Glyptothoa.* Interspecific characters are listed in table 2.

Distribution: Known only from the type locality, Escape Reef, northern Great Barrier Reef (Bruce 1990).

Host: Known only from the type host *Myripristis violaceus* (= *Myripristis violacea* Bleeker, 1851) (Bruce 1990).

Glyptothoa caudata (Schioedte and Meinert, 1884) comb. nov.

urn:lsid:zoobank.org:act:E456CE5B-EE7C-44AC-8C0E-C27F6B8BC49C

(Fig. 21)

Lironeca caudata Schioedte and Meinert 1884: 860–862, plate 33, figs. 1–2.
Elthusa caudata Bruce 1990: 254.

Remarks: *Glyptothoa caudata* (Schioedte and Meinert, 1884) comb. nov. initially described as *Lironeca caudata* by Schioedte and Meinert (1884), based on a non-ovigerous female holotype (RMNH. CRUS.I.68) (see fig. 21), collected from Japan, without host data. Later Bruce (1990) provisionally transferred it to the genus *Elthusa* along with 19 other species of *Lironeca.* Based on the type specimen and the original description, it is clear that it perfectly fits with the new genus, and we transfer it in combination with the new genus.

Distribution: Japan (Schioedte and Meinert 1884).

Host: Unknown.

Key to the species of Glyptothoa

1. Cephalon deeply immersed in pereonite 1; antenna with 11 articles 2
- Cephalon partially immersed in pereonite 1; antenna with more than 11 articles 3
2. Pleotelson 1.2 times longer than pleon; uropod exopod longer than endopod; uropods nearly reaching the margin of pleotelson ..... *G. propinqua*
- Pleotelson 2.9 times longer than pleon; uropod endopod slightly longer than exopod; uropods less than half the length of pleotelson ..... *G. myripristae*
3. Pleotelson 1.9 times longer than pleon; uropod exopod longer than endopod; uropods extending half the length of pleotelson; antenna with 13 articles ..... *G. sagara* sp. nov.
- Pleotelson 1.3 times longer than pleon; uropod endopod slightly longer than exopod; uropods nearly half the length of pleotelson; antenna with 12 articles ..... *G. caudata*

DISCUSSION

The slightly asymmetrical, not distorted body shape of *Glyptothoa* can be distinguished from the branchial cymothoid genera *Agarna* Schioedte and Meinert, 1884, *Cterissa* Schioedte and Meinert, 1884, *Kuna* Williams and Williams, 1986 and *Ryukyua* Williams and Williams, 1994 (all of which have strongly distorted asymmetric body shapes). The simple pleopods, brood pouch without posterior pockets, slender antennae, and pereopodal morphology places the new genus close to genera such as *Brucethoa* Aneesh, Hadfield, Smit and Kumar, 2020, *Elthusa*, *Ichthyoxenos*

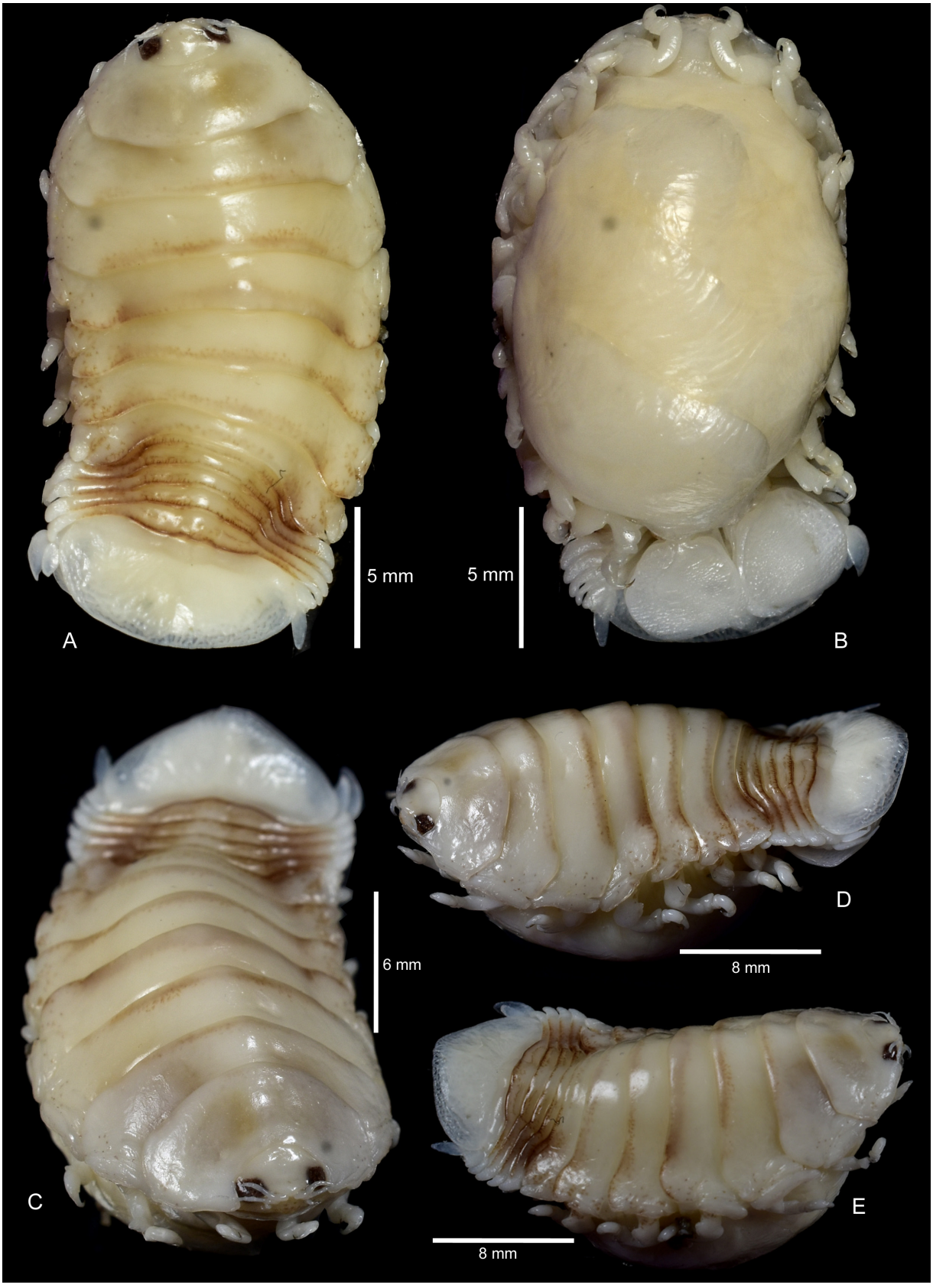

Fig. 20. *Glyptothoa propinqua* (Richardson, 1904) comb. nov. A, dorsal view. B, ventral view. C, dorso-frontal view. D–E, lateral views.

(marine), *Mothocya* and *Catoessa* (Table 1) (Aneesh et al. 2020c).

The cephalon with an acute ventrally directed rostrum, anteriorly positioned buccal cone overriding antennal bases, long gaps between pleonites, and proximally thick oostegites place the new genus close to the recently described deep-sea branchial cymothoid genus *Brucethoa.* Both can be distinguished by the following features: body dorsum weakly vaulted in *Glyptothoa* gen. nov. (vs dorsum highly vaulted in *Brucethoa*); pereonites 6 and 7 posterolateral margins not expanded (vs. posterolateral margin laterally expanded); coxae of pereonites 6 and 7 visible in dorsal view (vs. not visible in dorsal view); pleonite 1 much narrower than pleonite 2 (vs as wide as pleonite 2); pleonites 1–5 with free lateral margins (vs pleonites 2–5 or 3–5 with free lateral margins); pleon wider than widest pereon (1.25 times as wide as pereon max. width) (vs narrower, 0.87 times as wide as pereon max. width); pleopod gaps (60%; as width of widest pleon) (vs 50%; as width of widest pleon); pleopods not visible in dorsal view (vs pleopods visible in dorsal view) (see Aneesh et al. 2020c).

Elthusa, as defined by Aneesh et al. (2020b), differs from *Glyptothoa* gen. nov. in the following features: cephalon anterior margin with acute ventrally directed rostrum in *Glyptothoa* (vs dorsally truncate in *Elthusa*); buccal "cone" anteriorly positioned, overriding antennal bases (vs not anteriorly positioned, not overriding antennal bases); pleonites 1–5 with free lateral margins (vs pleonites 2–5 or 3–5); long gaps are present between all pleonites (vs without gaps); oostegite 1 proximally thick and bilobed (vs not proximally thick, not bilobed) (see Aneesh et al. 2020b c).

The genus *Catoessa* does have some gaps between the pleonites, and it can be separated from *Glyptothoa* gen. nov. by the rotationally twisted pleon with a narrow pleonite 1, the anterior margin of the cephalon lacking a rostral point, while the uropods extend about halfway along to beyond the posterior margin of the pleotelson, oostegites not proximally thick and are not bilobed (see

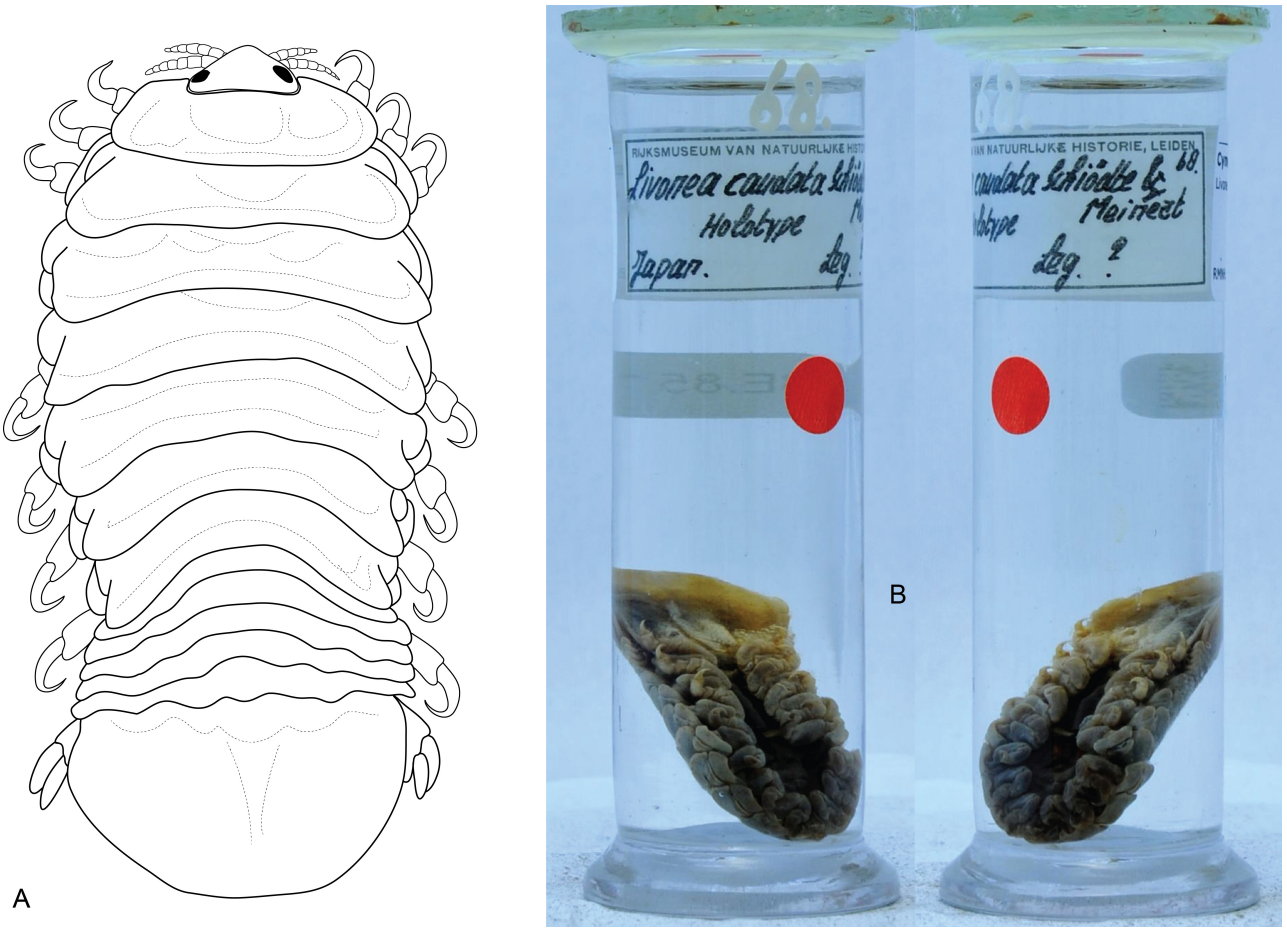

Fig. 21. *Glyptothoa caudata* (Schioedte and Meinert, 1884) comb. nov. non-ovigerous female holotype (RMNH.CRUS.I.68). A, redrawn from Schioedte and Meinert (1884). B, images of type specimen accessed from Naturalis Biodiversity Center, Leiden, Netherlands.

Bowman and Tareen 1983; Bruce 1990; Trilles et al. 2012; Aneesh et al. 2020c).

Mothocya differs from *Glyptothoa* gen. nov. primarily by having the antennula being both distinctly longer and more slender than the antenna, lacking a distinct rostral point, and the uropods extending to or beyond the posterior margin of the pleotelson, absence of a long gap between pleonites and oostegites not proximally thick, not bilobed. In addition, most species of *Mothocya* are moderately asymmetrical and the posterior coxae (5–7) are broad and longer than corresponding pereonites (see Bruce 1986; Hadfield et al. 2015; Aneesh et al. 2020c).

Ichthyoxenos is a primarily freshwater genus that includes both flesh burrowers as well as gill-attaching species (Bruce 1990). The genus consistently differs from *Glyptothoa* gen. nov. in having a pleon that is markedly narrower than pereonite 7 (vs pleon 1.25 times as wide as pereon maximum width in *Glyptothoa*), as well as distinctive pereopods that have a relatively long ischium, short merus and carpus which are often distally expanded or weakly lobed (see Aneesh et al. 2020c). An updated key to the branchial cymothoid genera was provided by Aneesh et al. (2020c).

Both morphological and genetic data clearly indicate the identity of the new genus. The nucleotide genetic divergence (*p*-distance) among the branchial cymothoid genera suggests that the new genus *Glyptothoa* and other nine available branchial cymothoid genera is very distinct, 25.5% (*Elthusa*) to 40.9% (*Norileca*) (see Table 2; Fig. 19). The new genus *Glyptothoa* appears to be the third genus in the family Cymothoidae described from India; the previous addition was the description of *Brucethoa* by Aneesh et al. (2020c).

CONCLUSIONS

The branchial attaching species described here was found to differ consistently from all other known cymothoid genera, and based on the morphological description and molecular characterization, we describe the new genus *Glyptothoa* with the type species *G. sagara* gen. and sp. nov. The new genus *Glyptothoa* is the 43rd genus in the family. Based on the generic characters, three species of *Elthusa* have been transferred into the new genus. *Glyptothoa sagara* gen. and sp. nov. exhibits oligoxenous host specificity and strict site selection for parasitization.

List of abbreviations

RS, robust seta/e.

BL, body length.

W, width.

ZSI/WGRC, Western Ghat Field Research Centre of Zoological Survey of India, Kozhikode.

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Ethics approval consent to participate: The specimen is not under the listed categories of experimental animals which need ethics approval.

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