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

Ameri Kottarathil Helna\textsuperscript{2,3,*\textcopyright}, Panakkool Thamban Aneesh\textsuperscript{1,*,§}, Appukuttannair Biju Kumar\textsuperscript{3}, and Susumu Ohtsuka\textsuperscript{1,4}

\textsuperscript{1}Fisheries Laboratory, Blue Innovation Division, Seto Inland Sea Carbon-neutral Research Center, Hiroshima University, 5-8-1 Minato-machi, Takehara, Hiroshima 725–0024, Japan. *Correspondence: E-mail: aneesh@hiroshima-u.ac.jp or anee3716@gmail.com (Aneesh)
E-mail: ohtsuka@hiroshima-u.ac.jp (Ohtsuka)
\textsuperscript{2}Regional Forensic Science Laboratory, Kannur, Kerala, India, 670002. *Correspondence: E-mail: helnahere@gmail.com (Helna)
\textsuperscript{3}Department of Aquatic Biology & Fisheries, University of Kerala, Karyavattom, Thiruvananthapuram-695 581, Kerala, India.
E-mail: bijupuzhayoram@gmail.com (Kumar)
\textsuperscript{4}Universiti Sultan Zainal Abidin, Gong Badak Campus, 21300 Kuala Terengganu, Terengganu, Malaysia

\textsuperscript{1}AKH and PTA contributed equally to this work.

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
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 Glytophidiun 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, Mothocyca 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 Glytophidiun 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 Glytophidiun 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

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

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 LC01490 (5’-GGTCAACAAATCATAAAAGATATT GG-3’) and HC02198 (5’-TAACTTCCAGGGTGACC AAAAATCA-3’) (Folmer et al. 1994). PCR reactions were performed with volumes of 25 µl, using 12.5 µl Thermo Scientific DreamTag 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 method (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. (ibisBiosciences, 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 (Cerissa sakuraii); LC159570 (Ichthyoxenus tanganyikae); LC159578 (Ryukyua globosa); Livoneca redmanii MZ208985; MF628260 (Norileca indica); KC896399 (Joryma hilsae); MK652485 (Mothocya renardi); MW002498 (Catoessa bosci). 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 Cymothooidae Leach, 1814**

**Family Cymothoidae Leach, 1814**

**Genus Glyptothoa gen. nov.**


- **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.


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. Pleon 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. Pleonites 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 pleon 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 pleonite 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. *Glyptothea 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,
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.

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. 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

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, spines.

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. Pereonites 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.
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.

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

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).

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

*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)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glyptothoa sagara gen. et sp. nov.</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LC159567 Elthusa sp. female</td>
<td>24</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MK652487Elthusa raynaudii</td>
<td></td>
<td>25</td>
<td>27</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C160320Cerissa sakai</td>
<td>15</td>
<td>39</td>
<td>34</td>
<td>34</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LC159570Ichthyoxenus tanganikae</td>
<td>39</td>
<td>37</td>
<td>37</td>
<td>37</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LC159578Ryukuwa globosa</td>
<td></td>
<td>39</td>
<td>35</td>
<td>39</td>
<td>41</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MZ208955Livoneca redmanii</td>
<td></td>
<td></td>
<td>35</td>
<td></td>
<td></td>
<td>33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MF628260Norileca indica</td>
<td></td>
<td></td>
<td>41</td>
<td>40</td>
<td>35</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KC896399Joryma hilsae</td>
<td></td>
<td></td>
<td></td>
<td>38</td>
<td>33</td>
<td>32</td>
<td>34</td>
<td>32</td>
<td>29</td>
<td>37</td>
<td>29</td>
</tr>
<tr>
<td>MK652485Mothocya renardi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>35</td>
<td>35</td>
<td>32</td>
<td>32</td>
<td>29</td>
<td>26</td>
<td>34</td>
</tr>
<tr>
<td>MW002498Catoessa bosci</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>37</td>
<td>32</td>
<td>31</td>
<td>33</td>
<td>31</td>
<td>28</td>
</tr>
</tbody>
</table>

© 2023 Academia Sinica, Taiwan
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 “chalinaura” (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.

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, pleonites 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 violacea (= 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. propinquus
   - 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 Ryukyuana 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); 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. 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...
Bowman and Tareen 1983; Bruce 1990; Trilles et al. 2012; Aneesh et al. 2020c).

*Motheticya* 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 *Motheticya* 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 Cymothoidae described from India; the previous addition was the description of *Brucethoa* by Aneesh et al. (2020c).

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.

Acknowledgments: This work and the new species names were registered with ZooBank under urn:lsid:zoobank.org:pub:9D2E2E28-A649-4A7F-B410-1962EDD849D7. The authors thank the partial funding support of the Lee Kong Chan Museum of Natural History, National University of Singapore, for the funding support to University of Kerala on deep-sea crustaceans of India. This study was partially supported by grants-in-aid from the Japan Society of Promotion of Science (KAKENHI No. 18J00466, awarded to SO; JSPS Bilateral Partnership Program, No. JPJSBP120209924, awarded to SO).

Authors’ contributions: AKH and PTA conducted the field work, worked on identification, illustrations and pictures and prepared the draft of the manuscript. PTA, AKH, AB, and SO conceived and designed research, and critically reviewed it to improve the quality of the manuscript. All authors read and approved the final manuscript.

Competing interests: All authors declare that they have no competing interests. No potential conflict of interest was reported by the authors.

Availability of data and materials: Type and voucher specimens were deposited in the collections of Western Ghat Field Research Centre of Zoological Survey of India, Kozhikode (ZSI/WGRC) and other additional materials are in PTA’s & AKH’s personal collection, located in India (CAH).

Consent for publication: All the authors consent to the publication of this manuscript.

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

REFERENCES


Aneesh PT, Helna AK, Kumar AB. 2022. Redescription and further report of two buccal attaching fish parasitic cymothoids, *Ceratothoa carinata* (Bianconi, 1869) and *Cymothoa bychowskyi* Avdeev, 1979 (Crustacea: Isopoda) with a new record from the


Pillai NK. 1964. Parasitic isopods of the family Cymothoidae from South Indian fishes. Parasitology 54:211–223. doi:10.1017/S003118200006786X.

Rameshkumar G, Trilles JP, Ravichandran S. 2011. Cymothoidae...