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Review of the fish-parasitic genus *Cymothoa* Fabricius, 1793 (Isopoda, Cymothoidae, Crustacea) from the southwestern Indian Ocean, including a new species from South Africa

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Abstract

The genus *Cymothoa* Fabricius, 1793 is revised for southwestern Indian Ocean waters. *Cymothoa borbonica* Schioedte & Meinert, 1884 and *C. eremita* Brünnich, 1783 are redescribed. *Cymothoa rotundifrons* Haller, 1880, from Mauritius lacks type material and the host is unknown, therefore it is here relegated to nomen dubium. *Cymothoa sodwana* **sp. nov**., from *Trachinotus botla* (Carangidae), collected from the Kwazulu-Natal coast of South Africa, is described and is distinguished by the large, ovoid, hunched body with rugose dorsal surfaces; the anterolateral angles of pereonite 1 are narrow and rounded reaching half the length of the cephalon; the ischium of pereopod 7 has a large protrusion and pereonite 7 which laterally overlaps the pleon margins, extending posteriorly to the pleotelson.

Key words: Buccal cavity, fish parasite, Indian Ocean, redescription, *Cymothoa sodwana*

Introduction

The genus *Cymothoa* Fabricius, 1793 can be considered to be relatively poorly known in the southwestern Indian Ocean, with only six species recorded for this vast area. In contrast, Australia has eleven species, and the central Indo-Pacific region has nine species. There is little doubt that the actual diversity will prove higher as new material comes to hand.

As is well known for this family, nomenclatural and identity problems can obscure accurate assessment of past records. This is especially evident with *Cymothoa* which has been described as one of the least studied Cymothoidae genera (Brusca 1981). It is one of the most difficult genera to correctly identify to species level with many species being poorly described and lacking type material.

Fresh collections of cymothoids made at several localities on the eastern coast of South Africa, as well as examination of fish collections held at the South African Institute for Aquatic Biodiversity (SAIAB) and the isopod collections held at the South African Museum, Cape Town (SAM), revealed the presence of several cymothoid species new to South Africa. These new species include representatives of several genera including *Mothocya* Hope, 1851, *Nerocila* Leach, 1818, *Renocila* Miers, 1880, *Ceratothoa* Dana, 1852 and *Cymothoa*. In this present work we review *Cymothoa* for the southwestern Indian Ocean region, and describe a new species of *Cymothoa* from Sodwana, South Africa, on the host *Trachinotus botla* (Shaw, 1803) (Carangidae), commonly known as the Wave Garrick or Large-spotted Pompano, a common surf beach species.

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Material and Methods

Methods follow Hadfield *et al*. (2010; 2011) and the isopods were examined using an Olympus BX41 compound microscope and an Olympus SZX7 dissecting microscope. Species descriptions were prepared in DELTA (Descriptive Language for Taxonomy, see Coleman *et al*. 2010) using a general Cymothoidae character set. Classification follows Brandt and Poore (2003).

Type material for *Cymothoa borbonica* Schioedte & Meinert, 1884, *C. eremita* (Brünnich, 1783),, (and *C. eremita* junior syntypes: *C. mathoei* Leach, 1818 and *C. leschenaultii* Leach, 1818) were borrowed from Muséum National d'Histoire Naturelle, Paris (MNHN); British Museum of Natural History (BMNH); and the Zoological Museum, University of Copenhagen (ZMUC) for comparison to material from southern Africa and confirmation of identity of these specimens. New material was collected from Sodwana Bay, Kwazulu-Natal, South Africa, and additional samples were obtained from fish hosts held in the collections of the South African Institute for Aquatic Biodiversity (SAIAB), Grahamstown, South Africa.

Full references are provided for all isopod authorities, as well as for the host species authorities of the new species described herein. Host nomenclature and distribution are from FishBase (Froese & Pauly 2012).

Synonymies: Those records that we have been unable to confirm directly from specimens or the published figures, or that we otherwise have reasonable doubts about, have been removed from the synonymy. These records are presented at the end of the synonymy preceded by a question mark. Incorrect or re-identified records are presented as such.

Abbreviations used: MNHN—Muséum National d'Histoire Naturelle, Paris; BMNH—British Museum of Natural History; SAIAB—South African Institute for Aquatic Biodiversity, Grahamstown; SAM—South African Museum, Cape Town; SMNH—Swedish Museum of Natural History, Stockholm; ZMUC—Zoological Museum, University of Copenhagen; TL—total length; W—width.

Taxonomy

Suborder Cymothoida Wägele, 1989

Superfamily Cymothooidea Leach, 1814

Family Cymothoidae Leach, 1814

Genus *Cymothoa* Fabricius, 1793

Restricted synonymy: Fabricius, 1793: 503; Milne Edwards, 1840: 264–269; Schioedte & Meinert, 1884: 223–225; Kussakin, 1979: 289; Brusca, 1981: 185; Brusca & Iverson, 1985: 45; Trilles, 1994: 137 (synonymy); Hadfield, Bruce & Smit, 2011: 58.

Type species. *Oniscus oestrum* Fabricius, 1793, by subsequent designation (Kussakin 1979).

Diagnosis. Body dorsally vaulted, 1–2 times as long as wide, widest at pereonite 3. Cephalon with wide rostrum, posterior margin straight. Cephalon deeply immersed in pereonite 1, not completely visible in dorsal view. Antennule widely separated, longer than antenna, not expanded. Eyes not visible. Mandible palp article 2 longer than article 3. Maxilla mesial lobe partly fused, prominent nodulose spines on each lobe. Maxillule with 4 terminal spines. Maxilliped with oostegite lobe article 3 with 3–8 recurved spines. Pereonite 1 often longer than other pereonites, anterolateral angles extensions encompassing cephalon. Pereonites 6 and 7 posterolateral margins not produced, pereonite 7 extends past pleonite 1. Pleon narrower than pereon. Pleonite 1 narrower than other pleonites, pleonite 2–5 width subequal increasing in length from anterior to posterior. Pleotelson wider than pleonites. Coxae 5–7 partially visible, narrow reinform shape, shorter than somite. Brood pouch from coxae 3–6, posterior pocket absent. Pereopods 5–7 basis with large blade-like carina, without robust setae or spines. Pereopod 7 slightly larger than pereopod 1. Pleopods not visible in dorsal view, progressively decreasing in size. Pleopods 3–5 with large fleshy folds, with proximomesial lamellar lobe, peduncle lobes on lateral margin present. Uropods shorter than pleotelson, subequal.

Remarks. *Cymothoa* is most easily identified by the strongly vaulted body; widely separated antennae; cephalon deeply immersed in pereonite 1; pereonite 7 extends past pleonite 1; wide pleotelson; pleonite 1 as wide as other pleonites; and uropod rami which are shorter than the pleotelson. *Cymothoa* has pereonite 1 anterolateral angles encompassing the cephalon, a partly fused maxilla, a large blade-like carina on the basis of pereopods 5–7, and large fleshy fold on pleopods 3–5, but differs from other buccal-inhabiting genera (such as *Ceratothoa*, *Cinusa* Schioedte and Meinert, 1884, *Glossobius* Schioedte and Meinert, 1883 and *Lobothorax* Bleeker, 1857) that have a more triangular anterior margin of the cephalon, and pleopods 3–5 with small pleats or pockets.

The genus *Cymothoa* has not been reviewed for many years; although brief notes on the generic characteristics have been provided by several researchers (Brusca 1981; Brusca & Iverson 1985; Hadfield *et al*. 2011). Brief notes on the generic characteristics have been provided by several researchers over time (Schioedte & Meinert 1884; Monod 1976; Brusca 1981), and most recently Hadfield *et al*. (2011) provided a short revised diagnosis. Monod (1934) stated that the confusion that arises in the systematics of *Cymothoa* is such that determining even the most well-known species becomes difficult to do with certainty. Monod (1976) later provided further notes on *Cymothoa* but emphasised that revision of this genus is necessary. The situation remains unchanged today. The genus has not been comprehensively revised, with many species in need of redescription, and many identifications and synonymies remaining uncertain, consequently *Cymothoa* remains one of the least understood genera in the Cymothoidae (as stated by Brusca 1981).

Currently there are six *Cymothoa* species recorded from the southwestern Indian Ocean, most from tropical or subtropical waters with one species known from South Africa. The six species are *C. borbonica*; *C. epimerica* Avdeev, 1979; *C. eremita*; *C. hermani* Hadfield, Bruce & Smit, 2011; *C. rotundifrons* Haller, 1880; and *C. selari* Avdeev, 1978.

Due to scarcity of records for *Cymothoa*, the distribution of these species is often difficult to accurately judge and vast areas remain unreported. *Cymothoa borbonica* has been recorded from numerous localities in the Western Indian Ocean. *Cymothoa epimerica* has recently been recorded from the Seychelles Islands (Trilles 2008) and *C. eremita* has been recorded from Mauritius, the Seychelles Islands, and Zanzibar (Leach 1818; Milne Edwards 1840; Stebbing 1910). *Cymothoa hermani* and *C. rotundifrons* are known only from their type localities, Zanzibar and Mauritius respectively (Haller 1880; Hadfield *et al*. 2011). *Cymothoa selari* was recently reported from Madagascar by Trilles (2008).

Cymothoa borbonica Schioedte & Meinert, 1884

(Figs 1–2)

Cymothoa Borbonica Schioedte & Meinert, 1884: 226, 282–286, tab. X (Cym. XXVIII), figs. 7–10.

Cymothoa borbonica—Thielemann, 1910: 41; Barnard, 1920: 357; 1926: 121; 1940: 491; 1960: 93; Nierstrasz, 1931: 136–137; Brian & Dartevelle, 1949: 182; Trilles, 1975: 989–990, pl. II (14–15); 1979: 260–261; 1986: 627, tab. 1; 1994: 137–138; Kensley, 1978: 79–80, fig. 32i; 2001: 232.

Uncertain identification:

?*Cymothoa borbonica*.—Stebbing, 1904: 709–710; Chilton, 1924: 887; Monod, 1934: 14, pl. 29–30 (a–c).

Material examined. *Lectotype* [here designated] (Figs 1–2). ♀ (32 mm TL; 17 mm W), from Réunion Island (previously Bourbon Island), unknown host (exMNHN-IU-2007-4163).

Paralectotypes. 2 ♂ (11, 14 mm TL; 5.5, 7 mm W), same data as lectotype (MNHN-IU-2007-5118).

Non-type material. ♀ (23 mm TL; 11 mm W), from Somalia, 29.03.1904, coll. Gravier, det. J.P. Trilles 1975, in the branchial cavity (MNHN-Is540).

Description. *Female*, length 32 mm, width 17 mm.

Body oval, 1.4 times as long as greatest width, dorsal surfaces slightly bumpy, widest at pereonite 4, most narrow at pereonite 1, lateral margins slightly convex. *Cephalon* 0.7 times longer than wide, rounded anterior margin, slightly visible in dorsal view, immersed in pereonite 1. *Frontal margin* rounded to form blunt rostrum and thickened, ventrally folded. *Eyes* not visible. *Pereonite 1* with unique bulbous orientation, anterior border slightly indented, anterolateral angle wide, with inwardly produced point, posterior margins of pereonites smooth and slightly curved laterally. Coxae 2–3 with posteroventral angles acute, posteriorly produced; 4–7 acute, posteriorly pointed. *Pereonites 1–4* increasing in length and width; 5–7 decreasing in length and width; 6 and 7 narrower.

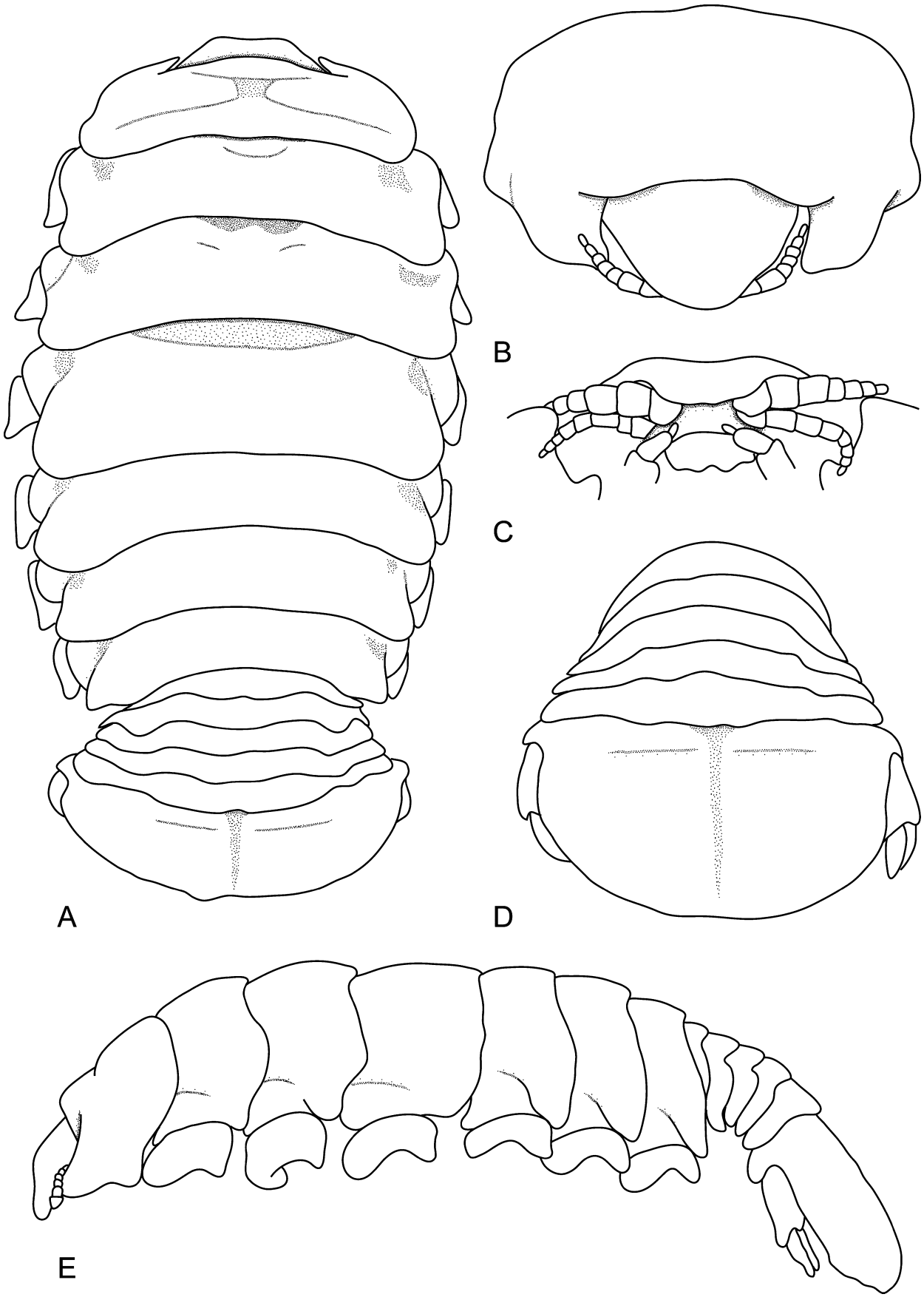

FIGURE 1. *Cymothoa borbonica* Schioedte & Meinert, 1884 female lectotype (32 mm) (MNHN-IU-2007-4163). A, dorsal view; B, anterior view of pereonite 1 and cephalon; C, ventral view of cephalon; D, dorsal view of pleotelson; E, lateral view.

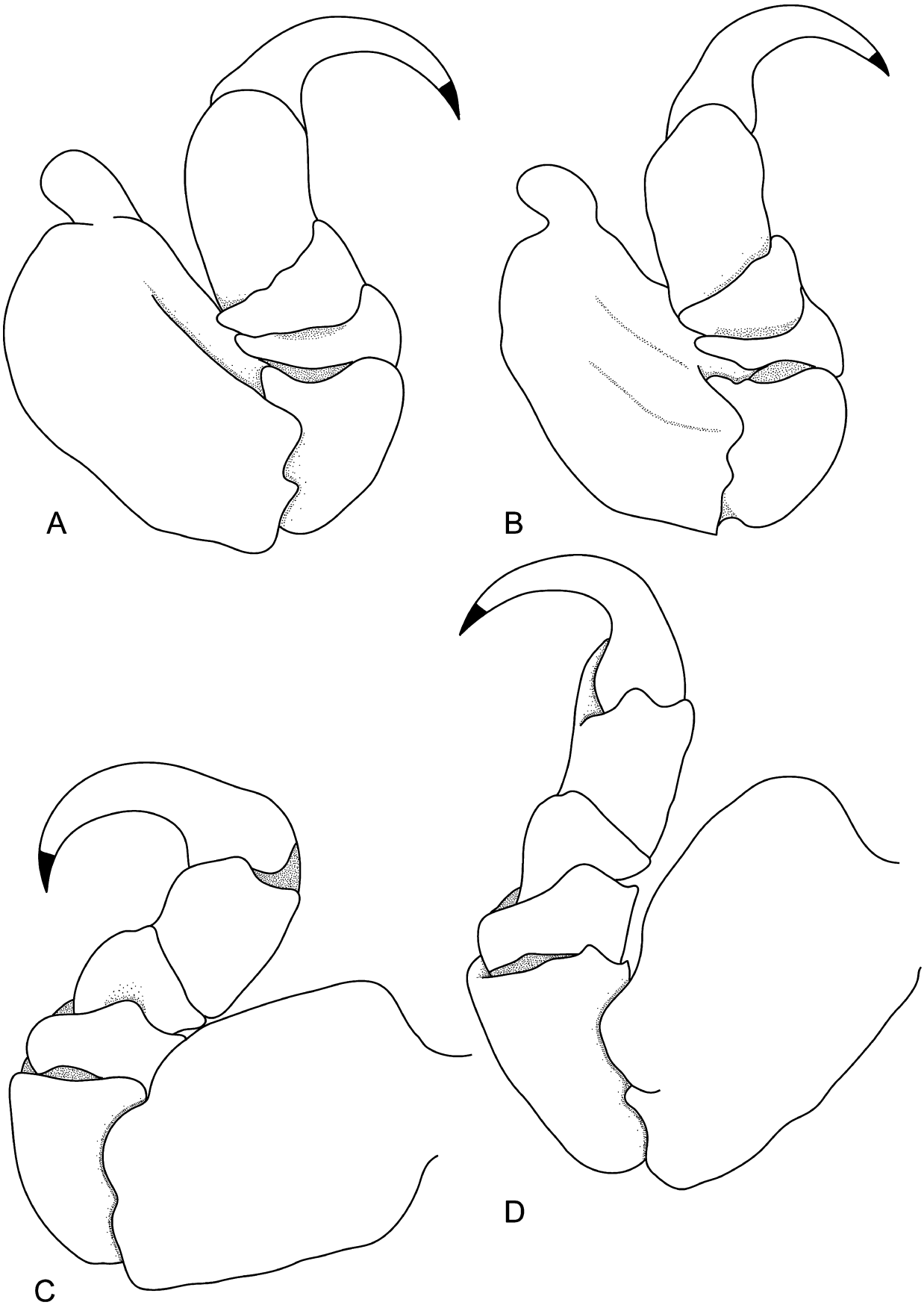

FIGURE 2. *Cymothoa borbonica* Schioedte & Meinert, 1884 female lectotype (32 mm) (MNHN-IU-2007-4163). A, pereopod 1; B, pereopod 2; C, pereopod 6; D, pereopod 7.

Pleon with pleonite 1 most narrow, visible in dorsal view; pleonites posterior margin not smooth, mostly concave; posterolateral angles of pleonite 2 narrowly rounded, not posteriorly produced. *Pleonites 3–5* similar in form to pleonite 2. Pleonite 5 with posterolateral angles free, not overlapped by lateral margins of pleonite 4. *Pleotelson* 0.5 times as long as anterior width (Fig. 1D), dorsal surface with medial furrow, lateral margins convex, posterior margin evenly rounded, without median point. *Pereopod 1* basis 1.7 times as long as greatest width; ischium 0.6 times as long as basis; merus proximal margin without bulbous protrusion; carpus with straight proximal margin; propodus 1.6 times as long as wide; dactylus slender, 1.3 as long as propodus, 2.5 times as long as basal width. *Pereopod 2* propodus 1.4 as long as wide; dactylus 1.3 as long as propodus. *Pereopod 3* similar to pereopod 2. *Pereopod 6* basis 1.2 times as long as greatest width, ischium 0.7 times as long as basis, propodus 1.3 as long as wide, dactylus 1.8 as long as propodus. *Pereopod 7* basis 1.3 times as long as greatest width; ischium 0.8 as long as basis, without protrusions; merus proximal margin with slight bulbous protrusion, merus 0.3 as long as ischium, 0.5 times as long as wide; carpus 1.2 as long as ischium, without bulbous protrusion, 0.8 times as long as wide; propodus 0.6 as long as ischium, 1.5 times as long as wide; dactylus slender, 1.8 as long as propodus, 3 times as long as basal width. *Uropod* more than half the length of pleotelson, peduncle 2.1 times longer than rami, peduncle lateral margin without setae; rami not extending beyond pleotelson, marginal setae absent, apices broadly rounded.

Distribution. Western Indian Ocean: Réunion Island (Schioedte & Meinert 1884; Trilles 1975); South Africa (Barnard 1920; 1940); Mozambique (Barnard 1926); "Sainte-Marie Galande" (Monod 1934; Trilles 1975); Madagascar (Barnard 1960; Trilles 1975; 1979); and Djibouti (Trilles 1975).

We could not find the location "Sainte-Marie Galande"; possibilities are Marie Galante Island, Gaudeloupe, or Sainte Marie Island, Madagascar. We accept that Sainte Marie Island, Madagascar is the logical location. Stebbing (1904) suggested that this species may be located in Maldives but this is unconfirmed.

Hosts. Unidentified Scaridae (see Stebbing 1904); *Epinephelus tauvina* (Forsskål, 1775) (see Barnard 1960); *Ptychochromis oligacanthus* (Bleeker, 1868) (see Trilles 1975); and *Mugil cephalus* Linnaeus, 1758 (see Trilles 1979).

Remarks. Schioedte and Meinert (1884) described *Cymothoa borbonica* from three specimens collected from Réunion Island (as Bourbon Island) and gave descriptions and figures of the non-ovigerous female and the adult male. *Cymothoa borbonica* can be identified by a greatly indented anterior margin of pereonite 1; unique bulbous ornamentation on pereonite 1; wide anterolateral projections of pereonite 1 extending more than half the length of the cephalon; blunt rostrum; large carinae on pereopod 7 and a wide pleotelson, wider than the pleon.

Monod (1934) gave two drawings of *C. borbonica* in comparing that species to *C. eremita* and *C. eximia*. The *C. borbonica* specimen drawn was, according to Monod (1934), labelled as "type" material from Sainte-Marie Galande (Type specimen—"Coll. Museum 6-1862, Coquerel *legit*"). Trilles (1975) also mentioned that this non-ovigerous female of Monod (1934) from Sainte-Marie Galande represents the type of the species. Along with the Sainte-Marie Galande specimen, Trilles (1975) also examined the three specimens that Schioedte and Meinert (1884) used in their original description (Sample No 230 in Trilles 1975), which have corresponding data to that of Schioedte and Meinert's original description, thus these specimens are recognised as the syntypes for the species. As the Sainte-Marie Galande specimen (MNHN-Is540) was not mentioned by Schioedte and Meinert (1884), nor collected from the type locality, it cannot be a type specimen. A lectotype and paralectotypes (from Schioedte and Meinert's examined material) are here designated and described.

The specimen identified as the female specimen *C. borbonica* from Sainte-Marie Galande (MNHN-Is365) did not agree with the type material redescribed here and is excluded from the species synonymy, remaining at present as *Cymothoa* sp.

Trilles (1975) reported *C. borbonica* from freshwater in Madagascar. As *C. borbonica* has only been found in marine environments, this record does require further confirmation. Trilles (1975) stated that the specimens were collected from the mouth of the freshwater fish *Ptychochromis oligacanthus*, a species that is known to occur in estuaries so this record could be valid.

Cymothoa epimerica Avdeev, 1979

Cymothoa epimerica Avdeev, 1979: 225–227, pl. 2–3; Trilles, 1994: 139; 2008: 23, 26.

Remarks. *Cymothoa epimerica* can best be identified by the wide and obtuse body; pleonite 1 mostly concealed in dorsal view by pereonite 7; the short uropods that do not extend to the pleotelson posterior margin; carinae on pereopods 5 and 6 which form a posteriorly directed point; acute coxae; pleon and pleotelson sub-equal in width; and pereonite 1 lateral margins with slight protrusions as well as short, wide anterolateral extensions.

Trilles (2008) recorded *C. epimerica* from the Seychelles and the Red Sea, without illustrations. These records are distant from the original locality off northwestern Australia although the only recorded host fish, *Epinephelus malabaricus* (Bloch & Schneider, 1801) is known from both these localities. Examination of Trilles' (2008) specimens and comparisons to the type material are needed to confirm this distribution. Trilles (2008) further commented that *C. epimerica* is very similar to *C. curta* Schioedte & Meinert, 1884. Comparison of the holotype of *C. epimerica* to the holotype of *C. curta*, would be necessary to confirm this potential synonymy. We were unable to locate or obtain type material for either species during the course of this study.

Hosts. Known only from *Epinephelus malabaricus* (Bloch & Schneider, 1801) (see Avdeev 1979).

Distribution. The type locality is off north-western Australia (Avdeev 1979). Subsequently recorded from the Seychelles and Red Sea (Trilles 2008).

Cymothoa eremita (Brünnich, 1783)

(Figs 3–5)

Oniscus oestrum.—Spengler 1775: 312–315, pl. 7 (figs. i–k) [not *C. oestrum* Leach, 1756].
Oniscus eremita Brünnich, 1783: 319–325.
Cymothoa Leschenaultii Leach, 1818: 352; Desmaret, 1825: 309.
Cymothoa Mathoei Leach, 1818: 353; Desmarest, 1825: 309.
Cymothoa mathoei.—Milne Edwards, 1840: 270–271; Hilgendorf, 1869: 114; Gerstaecker, 1901: 182, 258.
Cymothoa leschenaultii.—White, 1847: 109; Miers, 1880: 461; Ellis, 1981: 124.
Cymothoa matthaei [sic].—White, 1847: 110; Bleeker, 1857: 22.
Cymothoa mathaei.—Lucas, 1850: 248; Kossmann, 1880: 117–118, pl. 10 (figs. 1–3).
Cymothoa edwardsii Bleeker, 1857: 21, 33–35, tab. II, fig. 12; Miers, 1880: 461; Gerstaecker, 1901: 261.
Cymothoa stromatei Bleeker, 1857: 21, 33, 35–36, tab II, fig. 13; Miers, 1880: 461; Gerstaecker, 1901: 181, 261; Lanchester, 1902: 377; Richardson, 1910: 22–23; Hale, 1926: 214–215, fig. 9h; Brian & Dartevelle, 1949: 184; Sachlan, 1952: 41, 50q photo 28; Pillai, 1954: 15.
Cymothoa eremita.—Schioedte & Meinert, 1884: 259–266, tab. VII (Cym. XXV), figs. 3–13; Stebbing, 1893: 354–355; 1910: 102–103; Gerstaecker, 1901: 182; Thielemann, 1910: 39–41, figs. 37–38, tab. 4; Nierstrasz, 1915: 90–91; 1931: 135, pl. 10, fig. 9; Monod, 1924c: 100; 1933: 195; 1976: 859–860, figs. 23–25; Boone, 1935: 215–217, pl. 63; Shiino, 1951: 81, 85, figs. 2 (b–c); Avdeev, 1978: 30; 1982: 69–77; Trilles, 1975: 987–989, pl. II (12–13); 1979: 261–262; 1986: 627, tab. 1; 1994: 139–141; 2008: 23; Bowman & Tareen, 1983: 25–28, fig. 20; Radhakrishnan & Nair, 1983: 96, 105, 107; Saito, Itani & Nunomura, 2000: 65; Shireen, 2000: 21–32, figs. 1–3; Kensley, 2001: 232; Yu & Li, 2003a: 228, fig. 4; 2003b: 267; Williams & Bunkley-Williams, 2009: 557–561; Trilles, Ravichandran & Rameshkumar, 2011: 446–459; Rameshkumar, Ravichandran & Trilles, 2012: 191–193.
Cymothoa edwardsi.—Nierstrasz, 1931: 135.
Cymothoa sp. (an. *eremita* Brünnich, 1783) [sic].—Monod, 1934: 13–14, pl. 27 (a–b), pl. 30 (b).
Cymothoa erimitae (typographical error?).—Sachlan, 1955: 31, 33.
Cymothoa cinerea Bal & Joshi, 1959: 567–569, pl. 2, figs. 1–5; Kensley, 2001: 232.
Cymothoa cinerius.—Joshi & Bal, 1960: 446.
Cymothoa mathieui.—Ellis, 1981: 124.
Cymothoa leaschenaultii [sic].—Kensley, 2001: 232.
Uncertain identification:
? *Cymothoa limbata* Schioedte & Meinert, 1884: 248–250, tab. VII (Cym. XXV), figs. 1–2; Hale, 1926: 214; Nierstrasz, 1931: 136.

Material examined. *Holotype* (Fig. 3). Young ♀ (26 mm TL; 11 mm W) (Fig. 6.15 A–B), found still inside the host fish, *Parastromateus niger* (previously *Coryphaena apus*) (Brünnich, 1783) (ZMUC-CRU-10078).

Syntypes for *Cymothoa mathoei* (Fig. 4) Leach, 1818. Two ♀ (27, 31 mm TL; 12, 14 mm W), collected from Mauritius ("Ile-de-France"), White's MS Cat no. 221 (a, b) (BMNH 1979.407.2). Also noted: the small female (27 mm TL) had oostegites and pleopods missing, as well as pereopod 4. The other female (31 mm) was squashed but drawn for comparison purposes. ♀ (28 mm TL; 13 mm W), presented by J. Banks, labelled as "*Cymothoa nathieui*" (BMNH 1979.408.1).

Holotype for *Cymothoa leschenaultii* (Fig. 5) Leach, 1818. ♀ (36 mm TL; 20 mm W), collected from Pondicherry, India, presented by Leschenault (BMNH 1979.406.1). Also noted: there is a small hole in pereonite 5 (probably a pin hole from dry mount), and a damaged pleotelson.

Description (based on the female holotype). *Female*, length 26 mm, width 11 mm.

Body elongate, 1.9 times as long as greatest width, dorsal surfaces smooth and polished in appearance, widest at pereonite 5, most narrow at pereonite 1, lateral margins slightly convex. *Cephalon* 0.6 times longer than wide, visible from dorsal view, trapezoid shaped. Frontal margin thickened, ventrally folded and medially indented. Eyes not visible. *Pereonite 1* smooth, anterior border straight, anterolateral angle rounded and with small distinct produced point, posterior margin of pereonite smooth and slightly curved laterally. Coxae 2–3 with posteroventral angles acute, posteriorly produced; 4–7 rounded. *Pereonites 1–5* increasing in length and width; 6–7 decreasing in length and width; 6 and 7 narrower and becoming more progressively rounded posteriorly. *Pleon* with pleonite 1 same width as other pleonites, visible in dorsal view; pleonites posterior margin smooth, mostly concave; posterolateral angles of pleonite 2 rounded, not posteriorly produced. *Pleonites 3–5* similar in form to pleonite 2. Pleonite 5 with posterolateral angles free, not overlapped by lateral margins of pleonite 4, posterior margin straight. *Pleotelson* 0.6 times as long as anterior width, dorsal surface with 2 sub-medial depressions, lateral margins convex, posterior margin sub-truncate, without median point.

Antennule more stout than antenna, comprised of 7 articles; peduncle articles 1 and 2 distinct and articulated; article 2 0.9 times as long as article 1; article 3 0.5 times as long as combined lengths of articles 1 and 2, 1.1 times as long as wide; flagellum with 4 articles, extending to middle of pereonite 1. *Antenna* comprised of 8 articles; peduncle article 3 1 times as long as article 2, 1.2 times as long as wide; article 4 1 times as long as wide, 0.7 times as long as article 3; article 5 0.8 times as long as article 4, 0.8 times as long as wide. Antenna flagellum with 3 articles, last article terminating without setae, extending to middle of pereonite 1. *Labrum* lateral margins converging to anterior, anterior margin with median indentation, without small median point.

Pereopod 1 basis 1.7 times as long as greatest width; ischium 0.7 times as long as basis; merus proximal margin without bulbous protrusion; carpus with straight proximal margin; propodus 1.7 times as long as wide; dactylus slender, 1.1 as long as propodus, 2.6 times as long as basal width. *Pereopods* gradually increasing in size towards posterior and all without robust or simple setae. *Pereopod 7* basis 1.8 times as long as greatest width; ischium 0.7 as long as basis, with a large proximal bulbous protrusion; merus proximal margin without bulbous protrusion, merus 0.7 as long as ischium, 0.5 times as long as wide; carpus 1.3 as long as ischium, without bulbous protrusion, 1.1 times as long as wide; propodus 1.1 as long as ischium, 1.3 times as long as wide; dactylus slender, 1.4 as long as propodus, 2.2 times as long as basal width. *Uropod* more than half the length of pleotelson, peduncle 0.6 times longer than rami, peduncle lateral margin without setae; rami not extending beyond pleotelson, marginal setae absent, apices broadly rounded.

Distribution. Recorded from the Indian Ocean and Indo-Pacific regions: from the Western Indian Ocean to the Western Pacific (Philippines to New Caledonia); for a detailed listing of these localities see Trilles (1994). Recent records are from India (Rameshkumar *et al*. 2012; Trilles *et al*. 2011); Japan (Saito *et al*. 2000); and Arabian Gulf (Shireen 2000); South China Sea (Yu & Li 2003b); and Philippines (Trilles 2008).

Hosts. Recorded from *Parastromateus niger* (Bloch, 1795) (as *Stromateus niger*) (see Brünnich 1783; Bleeker 1857; Schioedte & Meinert 1884; Gerstaecker 1901; Nierstrasz 1915; Sachlan 1952; Pillai 1954; Radhakrishnan & Nair 1983; Shireen 2000; Rameshkumar *et al*. 2012); *Psettodes erumei* (Bloch & Schneider, 1801) (see Schioedte & Meinert 1884; Nierstrasz 1915; Monod 1934; Trilles 1979); *Liza vaigiensis* (Quoy & Gaimard, 1825) (as *Mugil waigiensis*) and *Peprilus paru* (Linnaeus, 1758) (as *Stomateus paru*) (see Kossmann 1880; Gerstaecker 1901); "Mouthparts of fish, chiefly of Ikan dalam" (see Lanchester 1902); in a barracuda-like fish and an Iniistius fish (see Richardson 1910); *Psuedanthias evansi* (Smith, 1954) (see Nierstrasz 1915); *Arothron leopardus* (Day, 1878) (as *Tetrodon leopardus*) (see Monod 1924); "*Tetrodon* sp." (see Nierstrasz 1931); *Hime formosana* (Lee & Chao, 1994) (as *Aulopus japonicus*) (see Shiino 1951); *Parastromateus* sp. and *Psettodes* sp. (see Sachlan 1955); *Pampus argenteus* (Euphrasen, 1788) (as *Stromateus cinereus*) (see Bal & Joshi 1959; Bowman & Tareen 1983); *Siganus canaliculatus* (Park, 1797) (as *S. oramin*) (see Monod 1976); *Plectorhinchus nigrus* (Cuvier, 1830) (as *Pseudopristipoma nigrum*) (see Trilles 1979); *Sphyraena obtusata* Cuvier, 1829 (see Bowman & Tareen 1983).

Remarks. *Cymothoa eremita* has anterolateral projections which extend to half the length of the cephalon; truncate anterior margin of the cephalon; pleon as wide as pereon; uropods which do not reach the posterior margin of the pleotelson; ischium on pereopod 7 with a bulbous protrusion; and small lateral projections on the posterolateral margins of pereonite 1 (seen in larger specimens such as the *C. leschenaultii* syntype in Fig. 5A).

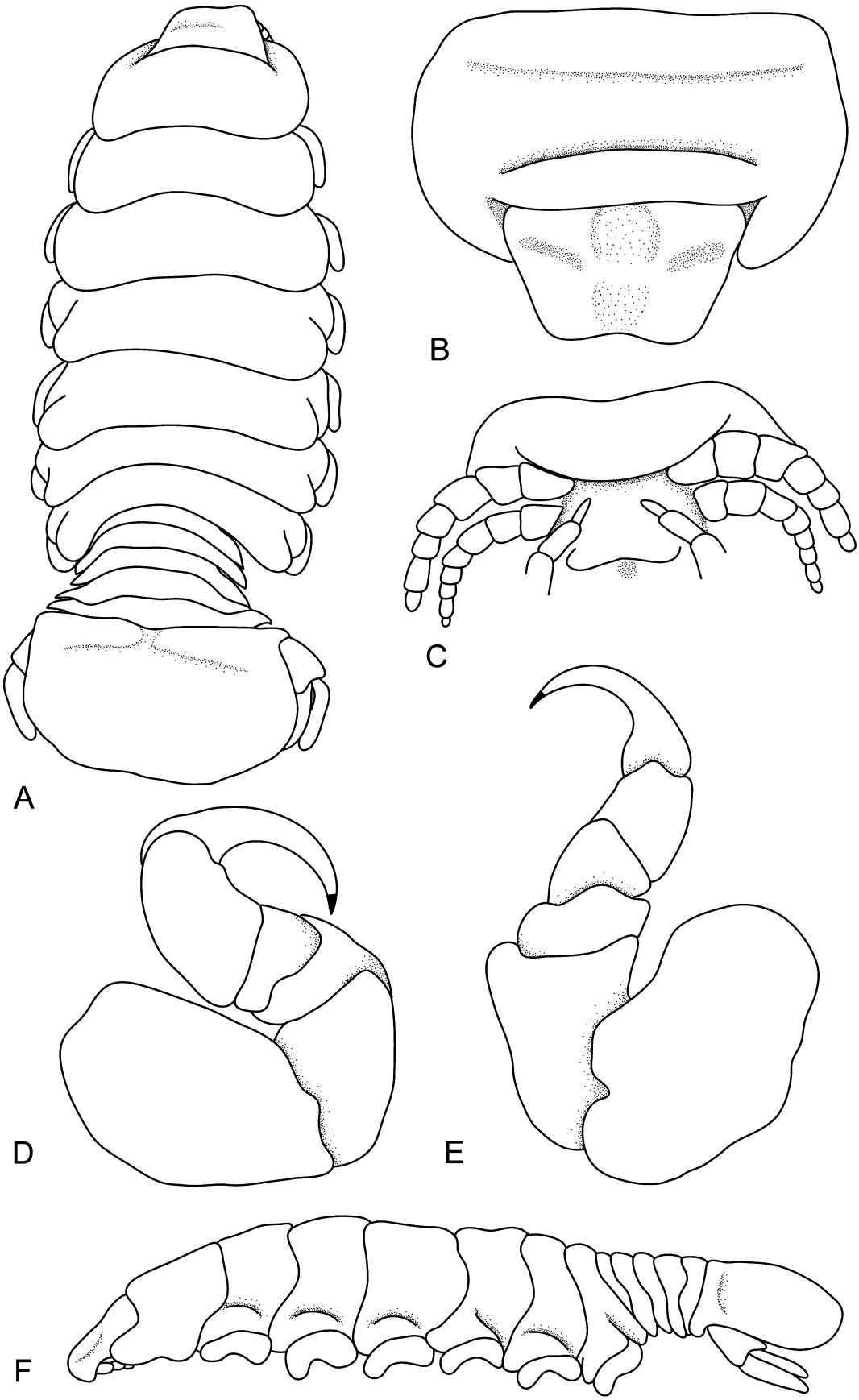

FIGURE 3. *Cymothoa eremita* (Brünnich, 1783), female lectotype (26 mm) (ZMUC-CRU-10078). A, dorsal view; B, antero-dorsal view of pereonite 1 and cephalon; C, ventral view of cephalon; D, pereopod 1; E, pereopod 7; F, lateral view.

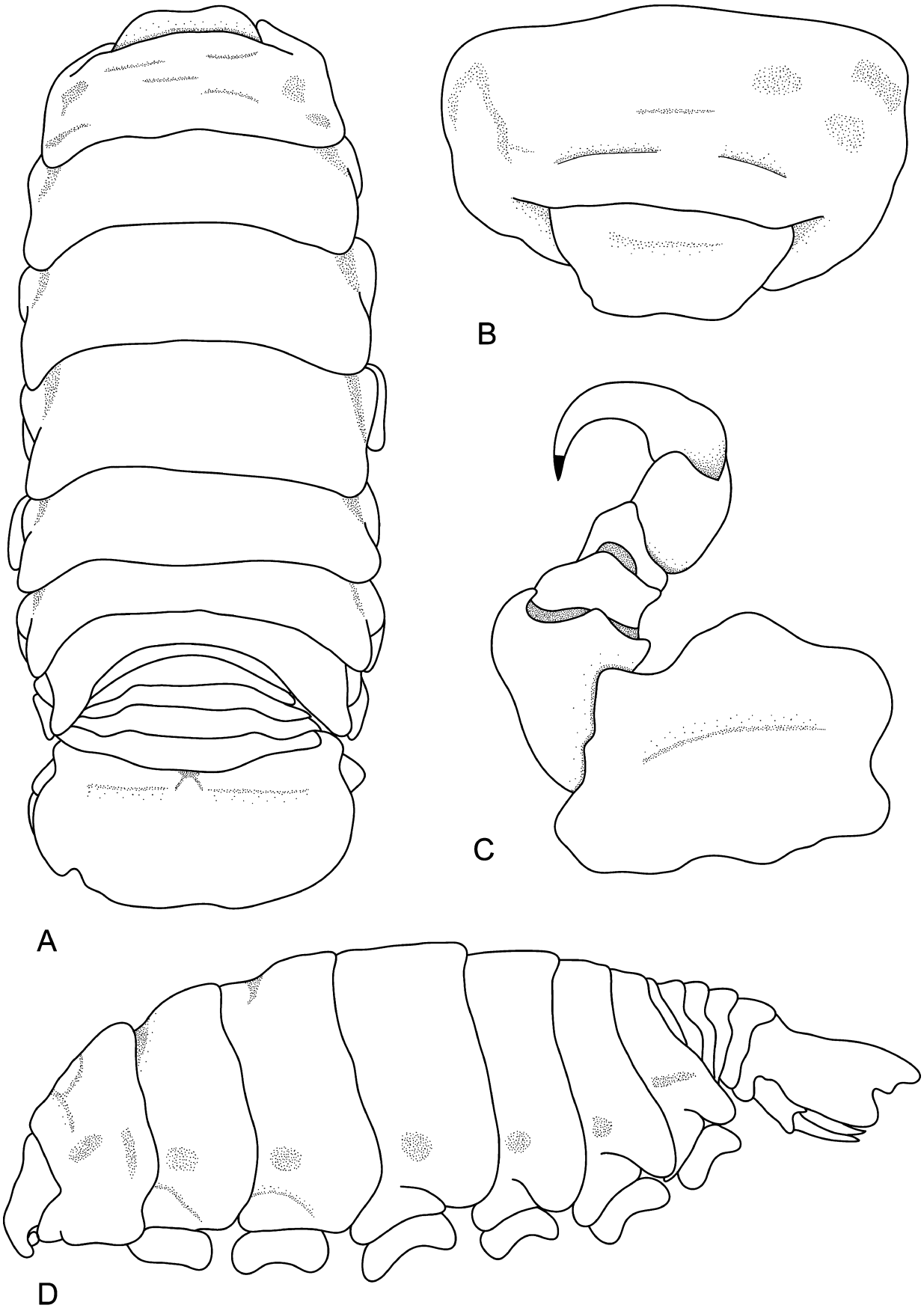

FIGURE 4. *Cymothoa eremita* female (31 mm), syntype of *C. mathoei* Leach, 1818 (BMNH 1979.407.2). A, dorsal view; B, antero-dorsal view of pereonite 1 and cephalon; C, pereopod 7; D, lateral view.

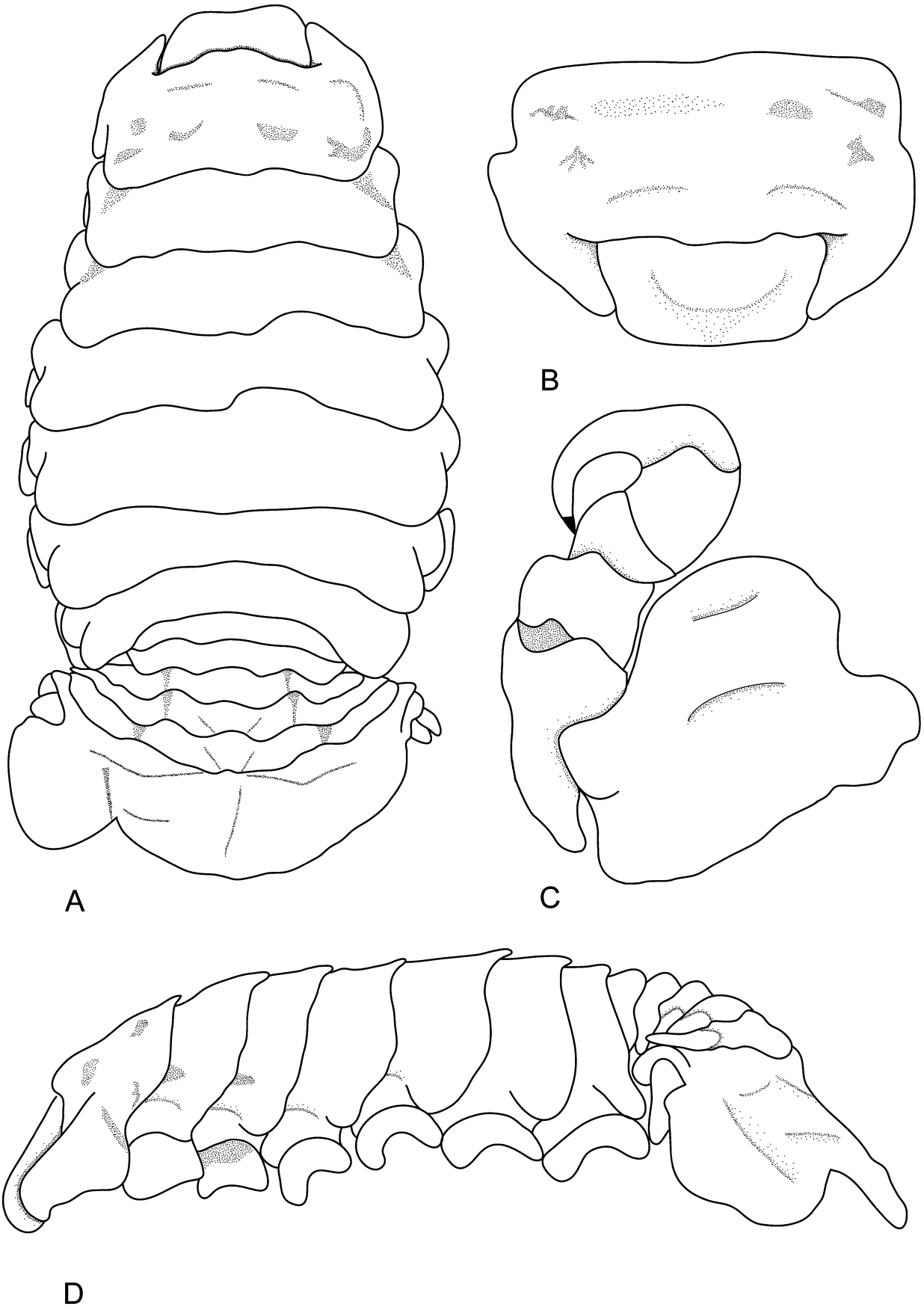

FIGURE 5. *Cymothoa eremita* female (36 mm), holotype of *C. leschenaultii* Leach, 1818 (BMNH 1979.406.1). A, dorsal view; B, antero-dorsal view of pereonite 1 and cephalon; C, pereopod 7; D, lateral view.

The identity of the type host has been subject to some confusion as no species of *Cymothoa* had ever been reported from 'dolphin fish' (assumed to be *Coryphaena apus*, Coryphaenidae). Recently, Williams and Bunkley-Williams (2009) clarified this situation and identified the "barbugede Pampelfisk, *Coryphaena apus*", mentioned by Brünnich (1783) as the host of *Cymothoa eremita*, as the Black Pomfret, *Parastromateus niger*, the misconception arising from an error in translation.

Schioedte and Meinert (1884) mentioned that the type specimens for *C. eremita* were placed in ZMUC and MCZ. They examined Brünnich's (1783) specimen which was still attached to the tongue of the host "*Coryphaena apus*" and stored in ZMUC. Stebbing (1893) also noted that the specimen from ZMUC was still attached to the tongue of the host fish from which it was originally taken. When looking for this specimen at ZMUC, no "type" specimen for *C. eremita* could be found in ZMUC. After further investigations (on site at ZMUC, as part of this study), a fish (*Parastromateus niger*) with the isopod still inside the mouth was discovered and after closer examination was determined to be Brünnich's (1783) holotype material.

Miers (1880) examined a large number of Bleeker's (1857) collection of isopods and noticed a large variation in the anterolateral lobes of the first pereonite and on the basis of the last pereopod. Miers (1880) furthered explained how no difference could be seen between Leach's (1818) *C. leschenaultii* (single specimen from Ponducherry) and Bleeker's (1857) *C. stromatei* and *C. edwardsii*, synonymising all three species. Kossmann (1880) later synonymised *C. mathoei* with *C. eremita* and Schioedte and Meinert (1884) synonymised *C. stromatei* with *C. eremita*.

The holotype for *Cymothoa limbata* Schioedte & Meinert, 1884 (SMNH 4933) from Cape York, Australia, was not examined. A single non-ovigerous female was originally described but no other collections have been made of it since, making comparisons difficult. This species strongly resembles *C. eremita* and *C. oestrum*. *Cymothoa oestrum* has the same uropod length and subtruncate cephalon seen in *C. limbata* but the anterolateral angles of pereonite 1 do not seem as large and as long as those in *C. oestrum* which extend to the anterior margin of the cephalon or further. However, *C. limbata* shares a similar pleon and morphology with *C. eremita*, as well as shorter, more acute anterolateral projections of pereonite 1 similar to *C. eremita*. Trilles (1994) suggested synonymising *C. limbata* with *C. eremita* and after reviewing the type drawings of *C. limbata*, this synonymisation seems viable but a personal observation of the holotype would be necessary for absolute confidence in this regard.

The *Cymothoa* sp. (an. *eremita* Brünnich, 1783) [sic] of Monod (1934) also shows many of the species characteristics of *C. eremita*. Trilles (1994) placed Monod's (1934) record into synonymy with *C. pulchrum* but we disagree as *C. pulchrum* has pleonite 1 less visible, wider anterolateral angles on pereonite 1 and lateral projections on pereonite 1 that Monod's (1934) specimen does not have. These characters correspond with *C. eremita*, where we now place that record.

Cymothoa cinerea Bal and Joshi, 1959 was described from India with the authors noting that the species was very similar to *Cymothoa stromatea* [sic] parasitic on *Parastromateus niger*, differing in having a longer thorax, shorter and tuberculate abdomen and slightly punctuate sides of its body. Both species were collected from the same host species off India. Comparing the figures of *C. cinerea* to *C. eremita*, it is proposed that these *C. cinerea* is a junior synonymy of *Cymothoa eremita*.

It is clear that *Cymothoa eremita* is a common species in the Indian and Pacific Oceans. It has often been repeatedly misidentified or thought to be a new species and a redescription of the syntypes was necessary. A number of species have also already been synonymised with *C. eremita* and two of those (*C. mathoei* and *C. leschenaultii*) were examined as part of this study (Figs 4–5) and their status as junior synonyms confirmed herein.

Cymothoa hermani Hadfield, Bruce & Smit, 2011

Cymothoa hermani Hadfield, Bruce & Smit, 2011: 57–68.

Remarks. *Cymothoa hermani* can be identified by the unique bulbous ornamentation on pereonite 1, anterolateral angles on pereonite 1 rounded and produced past frontal margin of cephalon, long and slender dactyli and the numerous lobes on pleopods 4 and 5 in the ovigerous female.

The only other *Cymothoa* species known from the region, *C. eremita*, differs from *C. hermani* by the lack of the characteristic bulbous ornamentation on pereonite 1 that is present in *C. hermani*. *Cymothoa eremita* also has a

dorsally visible and wider cephalon with the anterolateral margin of pereonite 1 not produced past the cephalon; irregular posterior margins of the pleonites with pleonite 5 appearing to have very distinctly produced sub-medial points; and more acutely produced lateral pereonite margins than in *C. hermani*.

Hosts. Only known from *Leptoscarus vaigiensis* (Quoy & Gaimard, 1824) (see Hadfield *et al*. 2011).

Distribution. Known from the type location, off Miwi Island, Zanzibar, Tanzania (Hadfield *et al*. 2011).

Cymothoa selari Avdeev, 1978

Cymothoa selari Avdeev, 1978: 32–33, pl. 2; 1981: 1160–1167; 1990: 32–42, figs. 1–6; Trilles, 1979: 254–265, pl. 1, fig. 8; 1986: 627, tab 1; 1994: 149; 2008: 23; Kensley, 2001: 233.

Remarks. *Cymothoa selari* is most readily identified by the acute anterolateral margins of pereonite 1; the free cephalon (anterolateral projections not touching the cephalon); the rounded rostrum; short uropods; and large carina on the basis of pereopod 7. Avdeev (1978) described *C. selari* from the Red Sea, comparing it to the South American species *C. ianuarii* and *C. brasiliensis*.

Cymothoa selari was subsequently recorded from Madagascar but without specific data or illustrations (Trilles 2008). This record increases the geographical range of this species substantially. We were unable to locate or obtain type material for this species during the course of this study for a redescription or comparison to Trilles' (2008) material.

Hosts. *Selar crumenophthalmus* (Bloch, 1793) (previously as *Caranx crumenophthalmus*) (see Avdeev 1978; Trilles 1979).

Distribution. Known from the Red Sea (Avdeev 1978; Trilles 1979) and Madagascar (Trilles 2008).

Cymothoa sodwana sp. nov.

(Figs 6–12)

Material examined. ***Holotype*** (Figs. 6–9). ♀ (22 mm TL; 13 mm W), from the buccal cavity of *Trachinotus botla* from Sodwana Bay, South Africa (27°32′S, 32°41′E), 28 March 2010, coll. K.A. Hadfield. (SAMC A45926).

Paratypes (Figs. 10–12). ♀ (21 mm TL; 13 mm W - dissected), two ♂ (12, 13 mm TL; 7 mm W), from the buccal cavity of *Trachinotus botla* from Sodwana Bay, South Africa (27°32′S, 32°41′E), 28 March 2010 (SAMC A45927).

Other material. Four ♀ (27, 25, 23, 17 mm TL; 15, 13, 14, 12 mm W), four ♂ (14, 14, 13, 12 mm TL; 7, 7, 7, 6 mm W), one juvenile (7 mm TL; 3 mm W) removed from the buccal cavity of *Trachinotus botla* (SAIAB 8944; SAIAB 46696) from Sodwana Bay, South Africa (27°32′S, 32°41′E), April 1979 (SAMC A45928).

Type host. *Trachinotus botla* (Shaw, 1803).

Description. *Ovigerous female*, length 17–27 (22.9) mm, width 12–15 (14.2) mm.

Body ovoid, 1.2 times as long as greatest width, dorsal surfaces rugose, widest at pereonite 4, most narrow at pereonite 1, lateral margins posteriorly ovate. *Cephalon* 0.7 times longer than wide, slightly visible in dorsal view. Frontal margin rounded to form blunt rostrum. Eyes not visible. *Pereonite 1* with slight indentations, anterior border slightly indented, anterolateral angle rounded, posterior margins of pereonites smooth and slightly curved laterally. Coxae 2–3 with posteroventral angles rounded; 4–7 rounded. *Pereonites 1–4* increasing in length and width; 5–7 decreasing in length and width; becoming more progressively rounded posteriorly. *Pleon* with pleonite 1 same width as other pleonites (except pleonite 5), visible in dorsal view; pleonites posterior margin smooth, mostly convex; posterolateral angles of pleonite 2 rounded, not posteriorly produced. *Pleonites 3–5* similar in form to pleonite 2. Pleonite 5 posterior margin produced medially. *Pleotelson* 0.5 times as long as anterior width, dorsal surface smooth, lateral margins weakly concave, posterior margin sub-truncate, without median point.

Antennule more stout than antenna, comprised of 8 articles; peduncle articles 1 and 2 distinct and articulated; article 2 1 times as long as article 1; article 3 0.6 times as long as combined lengths of articles 1 and 2, 1.2 times as long as wide; flagellum with 5 articles. *Antenna* comprised of 8 articles; peduncle article 3 1.5 times as long as article 2, 1.8 times as long as wide; article 4 1.1 times as long as wide, 0.7 times as long as article 3; article 5 0.8 times as long as article 4, 0.9 times as long as wide; flagellum with 3 articles, last article terminating in 1–5 short

simple setae. *Labrum* anterior margin anteriorly truncate, without small median point. *Mandibular process* without simple setae, mandible palp article 2 without distolateral setae, article 3 without serrate setae. *Maxillule* simple, with 4 terminal robust setae. *Maxilla* mesial lobe partly fused to lateral lobe; lateral lobe without simple setae, and 4 recurved robust setae; mesial lobe without simple setae, and 3 large recurved robust setae. *Maxilliped* comprised of 3 articles or weakly segmented, with lamellar oostegite lobe, palp article 2 without simple setae, article 3 with 8 recurved robust setae, and no simple setae. *Oostegites* margin covered in numerous plumose setae, attached to pereopods 3–6.

Pereopod 1 basis 2.2 times as long as greatest width; ischium 0.6 times as long as basis; merus proximal margin without bulbous protrusion; carpus with straight proximal margin; propodus 1.5 times as long as wide; dactylus slender, 1.2 as long as propodus, 2.5 times as long as basal width. *Pereopod 2* propodus 1.5 as long as wide; dactylus 1.1 as long as propodus. *Pereopod 3* similar to pereopod 2. *Pereopod 6* basis 1.3 times as long as greatest width, ischium 0.7 times as long as basis, propodus 1.2 as long as wide, dactylus 1.4 as long as propodus. *Pereopod 7* basis 1.2 times as long as greatest width; ischium 0.7 as long as basis, with large proximal bulbous protrusion; merus proximal margin without bulbous protrusion, merus 0.3 as long as ischium, 0.5 times as long as wide; carpus 1.3 as long as ischium, with slight bulbous protrusion, 0.6 times as long as wide; propodus 1.7 as long as ischium, 1.4 times as long as wide; dactylus slender, 1.5 as long as propodus, 2.6 times as long as basal width.

Pleopods without setae, lobes increasing in size from pereonite 1 to 5, exopod larger than endopod. *Pleopod 1* exopod 1 times as long as wide, lateral margin weakly convex, distally broadly rounded, mesial margin straight; endopod 1.2 times as long as wide, lateral margin weakly concave, distally narrowly rounded, mesial margin straight, peduncle 0.4 times as wide as long, without retinaculae. *Pleopods 2–5* similar to pleopod 1 and mesial margins becoming more strongly produced. *Pleopods 3–5* endopods proximal borders extending below exopod to peduncle, with large fleshy folds and medial lobes present and increasing in size from pleopod 1 to 5.

Uropod more than half the length of pleotelson, peduncle 1.1 times longer than rami, peduncle lateral margin without setae; rami not extending beyond pleotelson, marginal setae absent, apices narrowly rounded. *Endopod* apically rounded, 3.1 times as long as greatest width, lateral margin weakly convex, terminating with no setae, mesial margin weakly convex. *Exopod* extending to end of endopod, 3.5 times as long as greatest width, apically rounded, lateral margin weakly convex, terminating with no setae, mesial margin weakly convex.

Male. Length 6.0–14.0 mm (11.8 mm), width 2.0–7.0 mm (5.8 mm).

Males similar to females but smaller, body oval, body 1.3 times as long as wide. *Cephalon* visible in dorsal view, with slightly produced anterolateral margins on pereonite 1. *Pleopods* simple, with less folds on endopod. *Pleopod 2* appendix masculina with parallel margins, 0.9 times as long as endopod, distally acute.

Distribution. Currently only known from the type locality, Sodwana Bay, northeastern South Africa.

Host. *Trachinotus botla* is found in the Western Indian Ocean from Oman to Algoa Bay.

Etymology. The epithet is the name of the type locality, Sodwana Bay; noun in apposition.

Remarks. *Cymothoa sodwana* **sp. nov**. is distinguished by the large, ovoid body and rugose dorsal surfaces; anterolateral angles of pereonite that are narrow and rounded reaching half the length of the cephalon; uropods which do not reach the posterior margin of the pleotelson; pleopods with large fleshy folds as well as proximomedial and peduncle lobes; large protrusion on ischium of pereopod 7; setae on antennae; and pereonite 7 which overlaps the pleon, extending posteriorly to the pleotelson.

Kensley (1978) included one species of *Cymothoa* as known from South Africa, namely *C. borbonica*. When comparing *Cymothoa sodwana* to *C. borbonica*, a number of differences can be seen. *Cymothoa sodwana* has a more robust body, compared to the more elongate shape of *C. borbonica*, and is more dorsally vaulted. *Cymothoa sodwana* also has more produced posterolateral margins on pereonites 5–7 with pereonite 7 overlapping the pleon and reaching the pleotelson. *Cymothoa borbonica* does not have developed posterolateral margins at all. Pereonite 1 of *C. sodwana* is longer and not produced on the lateral margins compared to *C. borbonica*. *Cymothoa borbonica* has a more inwardly produced anterior margin of pereonite 1 with wide and pointed anterolateral margins which are not seen in *Cymothoa sodwana* (almost straight anterior border and bluntly rounded anterolateral margins).

A total of 22 *Trachinotus botla* fish specimens were caught at Sodwana Bay, 16 of which were parasitised by *Cymothoa sodwana* giving a high prevalence of 72.7%. During the sampling of the preserved fish in SAIAB, another 23 *T. botla* were examined but only four were still infested with the isopod (5.9%).

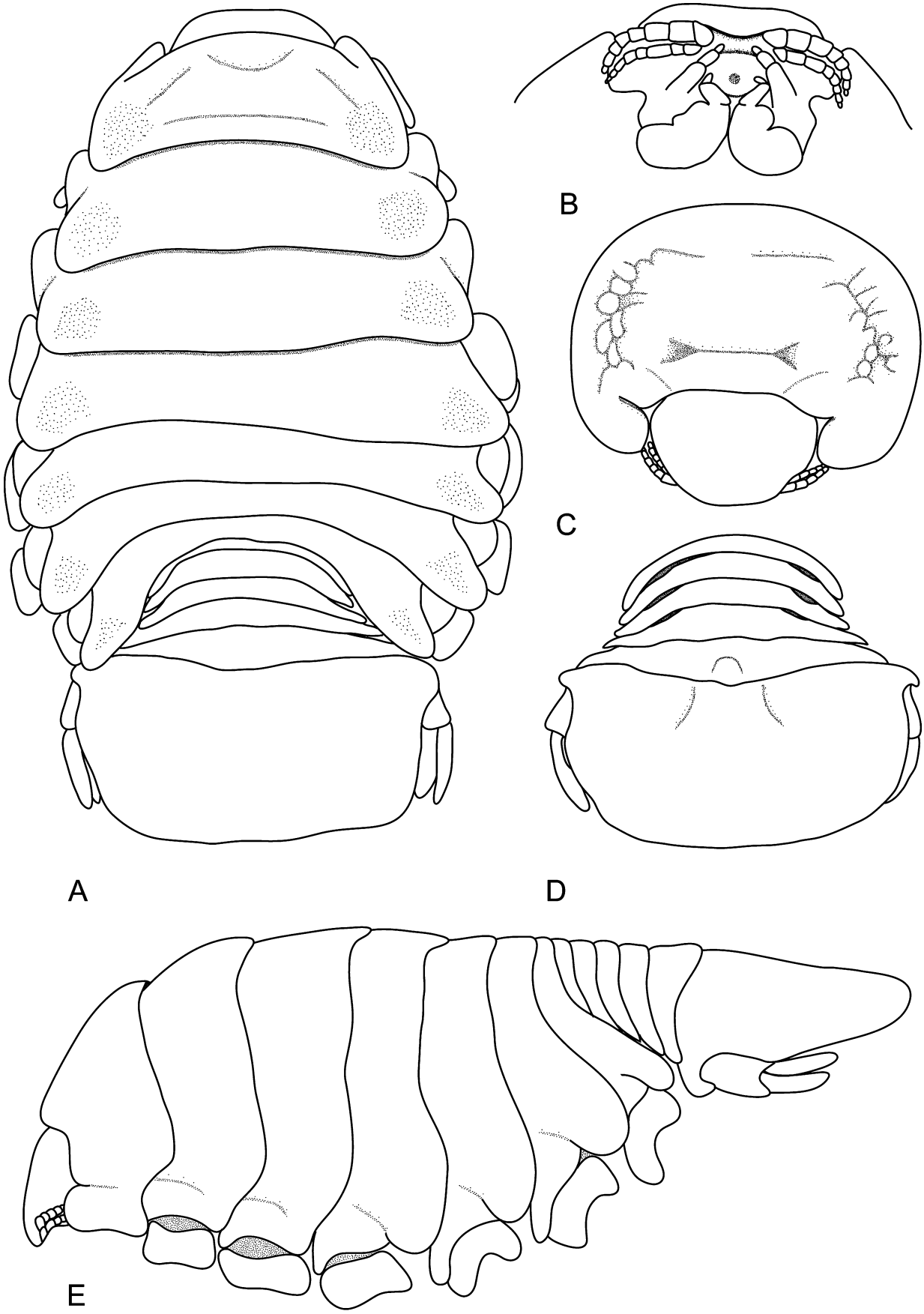

FIGURE 6. *Cymothoa sodwana* **sp. nov**. Female holotype (22 mm) (SAMC A45926). A, dorsal view; B, ventral view of cephalon; C, antero-dorsal view of pereonite 1 and cephalon; D, dorsal view of pleotelson; E, lateral view.

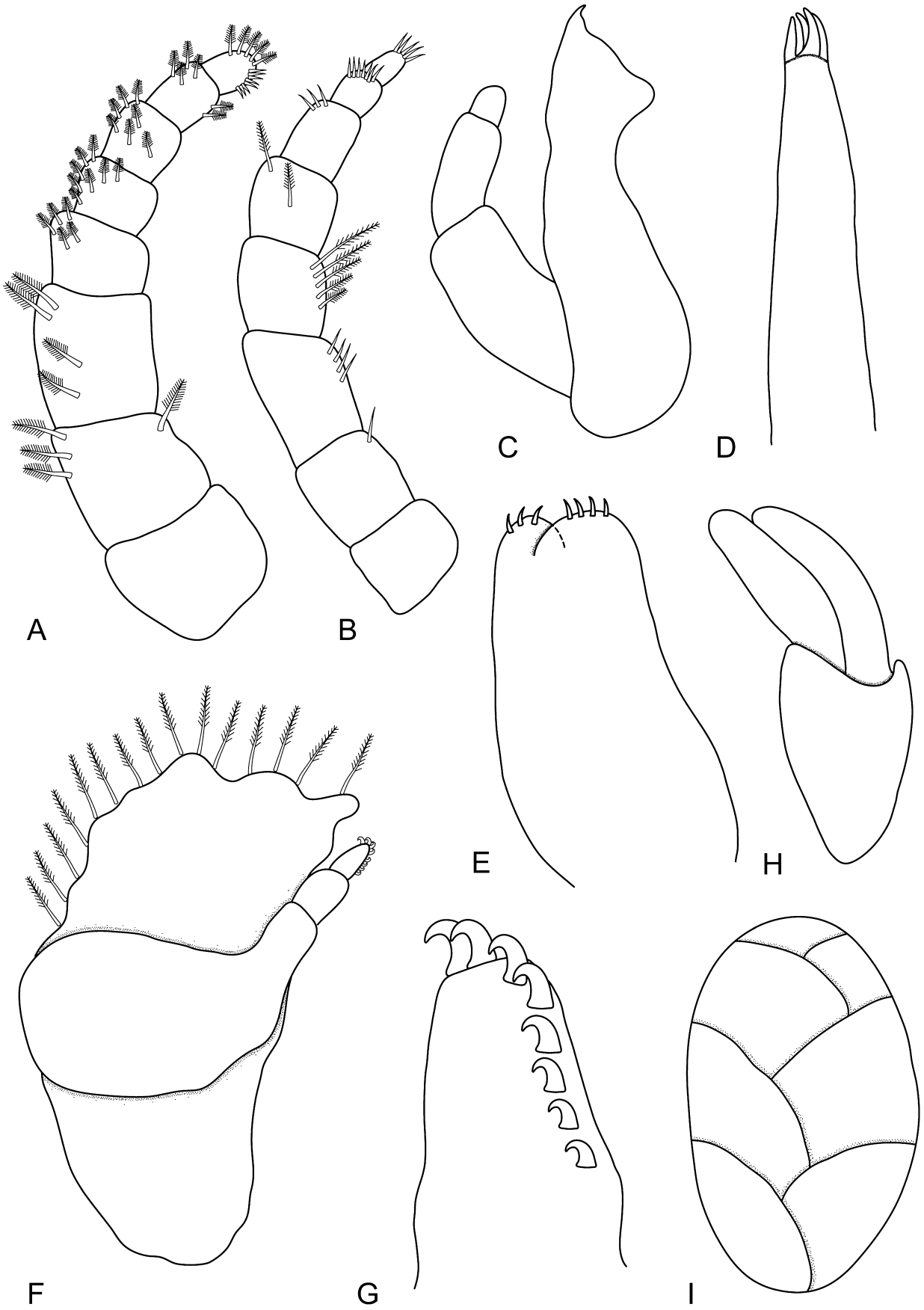

FIGURE 7. *Cymothoa sodwana* **sp. nov**. Female paratype (21 mm) (SAMC A45927). A, antennule; B, antenna; C, mandible; D, maxillule; E, maxilla; F, maxilliped with oostegite; G, tip of maxilliped article 3; H, uropod; I, oostegites.

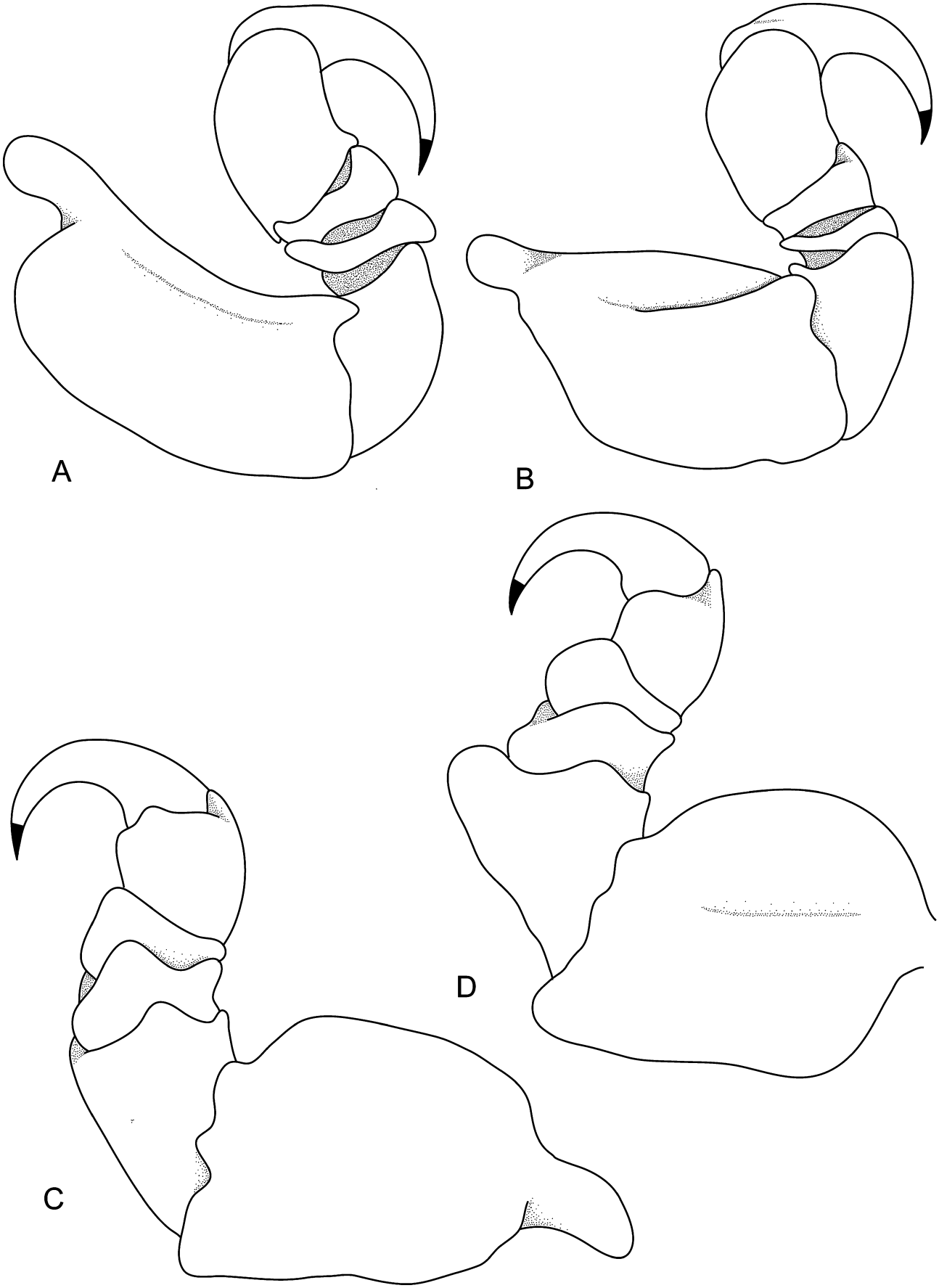

FIGURE 8. *Cymothoa sodwana* **sp. nov**. Female paratype (21 mm) (SAMC A45927). A, pereopod 1; B, pereopod 2; C, pereopod 6; D, pereopod 7.

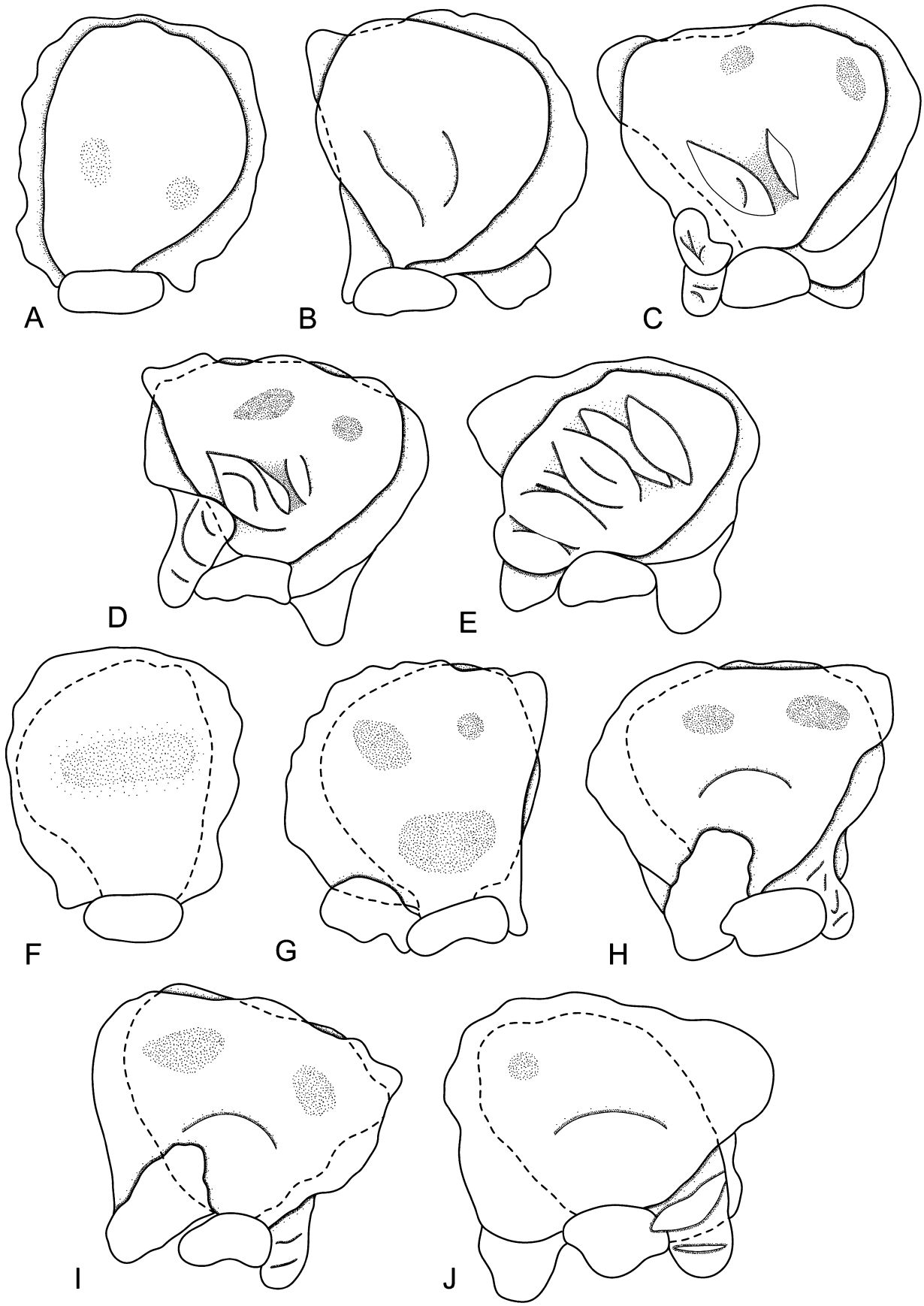

FIGURE 9. *Cymothoa sodwana* **sp. nov**. Female paratype (21 mm) (SAMC A45927). A, dorsal pleopod 1; B; dorsal pleopod 2; C, dorsal pleopod 3; D, dorsal pleopod 4; E, dorsal pleopod 5, F, ventral pleopod 1; G, ventral pleopod 2; H, ventral pleopod 3; I, ventral pleopod 4; J, ventral pleopod 5.

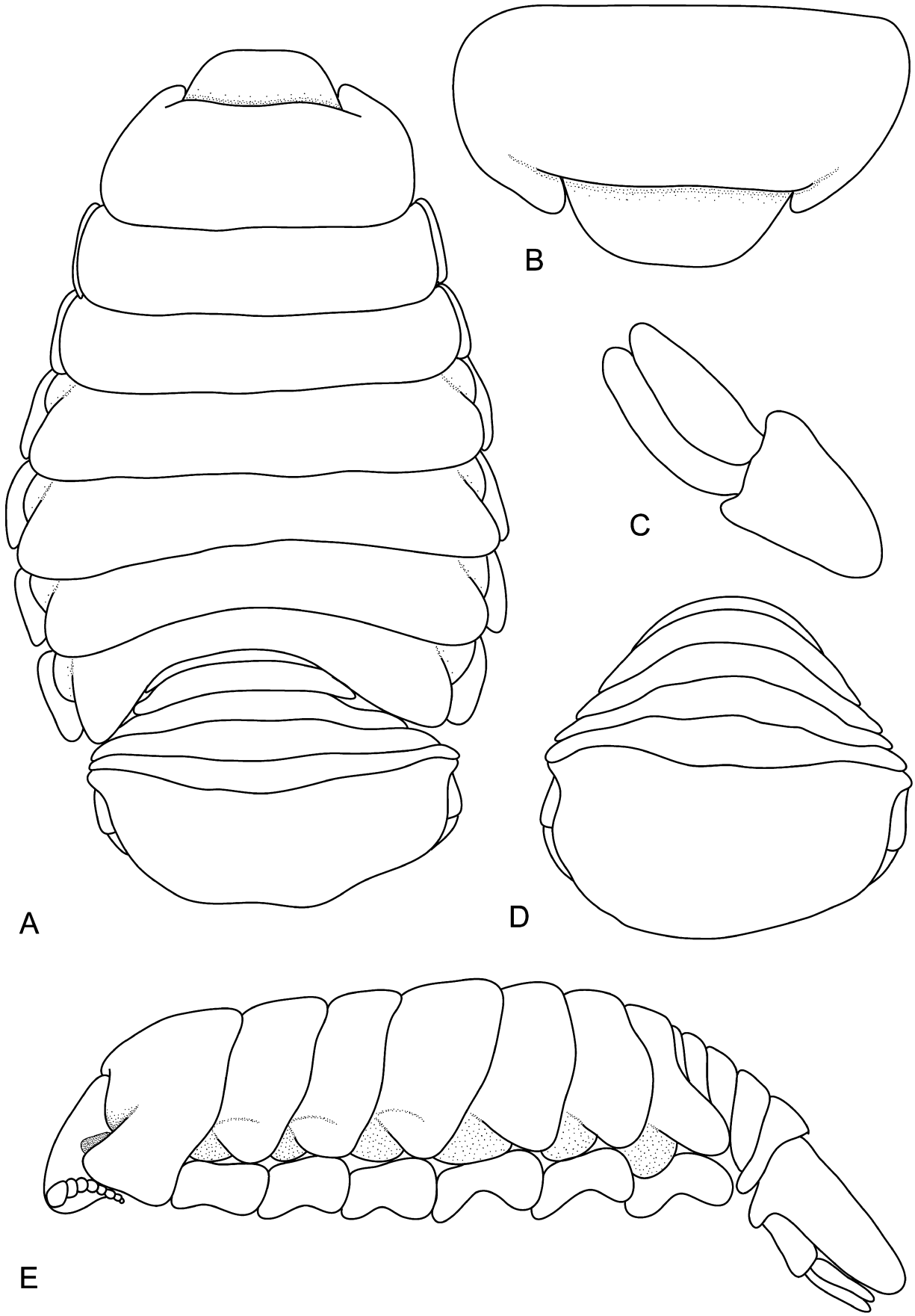

FIGURE 10. *Cymothoa sodwana* **sp. nov**. Male paratype (13 mm) (SAMC A45927). A, dorsal view; B, dorsal view of pleotelson; C, uropod; D, dorsal view of pleotelson; E, lateral view.

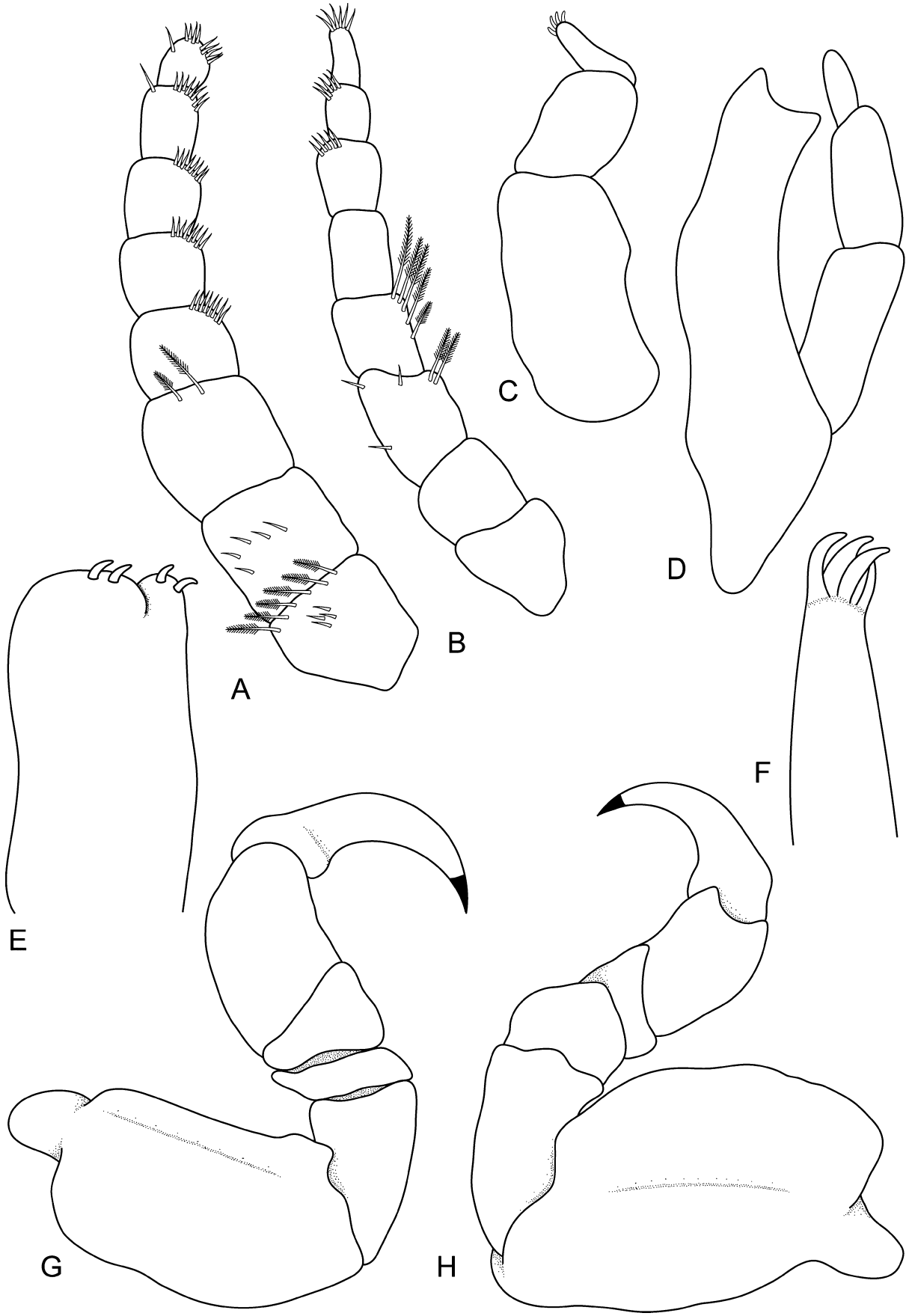

FIGURE 11. *Cymothoa sodwana* **sp. nov**. Male paratype (13 mm) (SAMC A45927). A, antennule; B, antenna; C, maxilliped; D, mandible; E, maxilla; F, tip of maxillule; G, pereopod 1; H, pereopod 7.

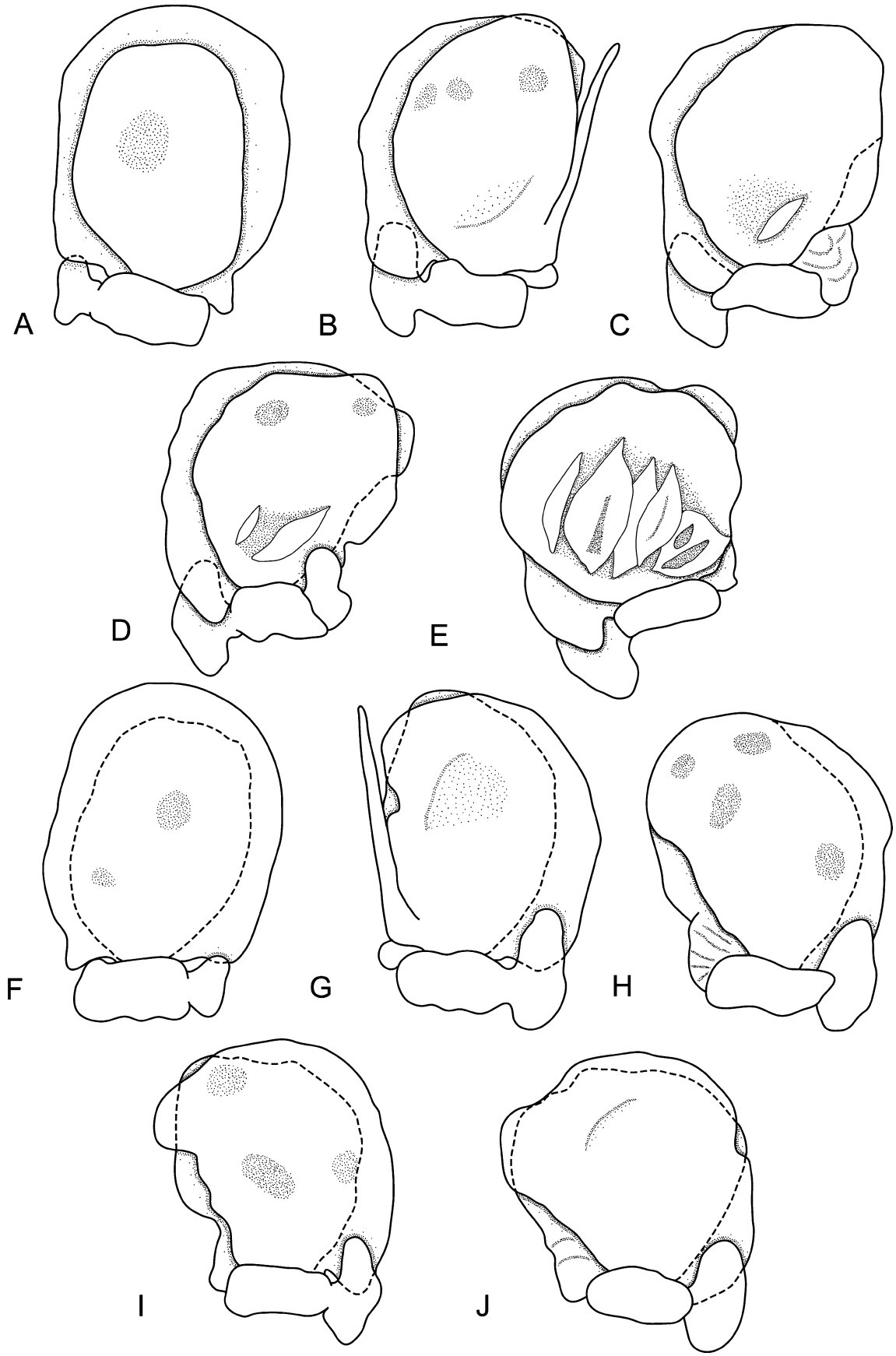

FIGURE 12. *Cymothoa sodwana* **sp. nov**. Male paratype (13 mm) (SAMC A45927). A, dorsal pleopod 1; B; dorsal pleopod 2; C, dorsal pleopod 3; D, dorsal pleopod 4; E, dorsal pleopod 5, F, ventral pleopod 1; G, ventral pleopod 2; H, ventral pleopod 3; I, ventral pleopod 4; J, ventral pleopod 5.

Excluded species

We have been unable to find any evidence of occurrence for the following species in southern African waters, and it is here excluded from the South African marine fauna.

Cymothoa rotundifrons Haller, 1880

Cymothoa rotundifrons Haller, 1880: 375–377, pl. XVIII, figs. 1–4; Nierstrasz, 1931: 136; Trilles, 1994: 137; Kensley, 2001: 233 [nomen dubium].

Remarks. Trilles (1975; 1994) suggested that *Cymothoa rotundifrons* could be placed in synonymy with *C. borbonica* as *C. rotundifrons* is known only from the original record (from Mauritius) and corresponds with the distribution of *C. borbonica*. Deposition of the type material for *C. rotundifrons* is not known, and equally could not be located in any European museum. This species has only been collected once and with no other material to represent the species, discussions on this species are based on the type drawings. Comparison of Haller's (1880) figures to the lectotype of *C. borbonica* show the two species are similar, but cannot be conclusively considered the same species, as the type material for *C. rotundifrons* is most probably destroyed, lost or otherwise misplaced. As the host identity for *C. rotundifrons* is not known and there are multiple species of *Cymothoa* in the Mauritius region, it is unlikely that the identity of this species will ever be established; therefore we here place *Cymothoa rotundifrons* into **nomen dubium**.

Acknowledgements

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