

Review of the *Cirolana* ‘pleonastica-group’ (Crustacea: Isopoda: Cirolanidae) with description of four new species from the Indo-Malaysian region

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Abstract. Four new species and *Cirolana curtensis* Bruce, 1986, all of the here diagnosed *Cirolana* ‘pleonastica-group’ (previously known as *Cirolana* ‘tuberculate-group’), are described and redescribed from Singapore, Indonesia, and Australia. All species are coral-reef dwellers. Two of the new species are locally endemic in Singapore and two in Indonesia. The *Cirolana* ‘pleonastica-group’ is characterised by the absence of rostral point; dorsal surface of at least pereonites 6 and or 7, pleonites (usually 3–5) and pleotelson with transverse rows of nodules and tubercles ornamentation; pleotelson lateral margins straight or weakly to moderately sinuate and the posterior margin narrow, truncate or narrowly rounded; penial process mostly opening flush; uropodal exopod lateral margin with widely spaced and acute robust setae. A list of species of *Cirolana* ‘pleonastica-group’ worldwide is provided.

Key words. *Cirolana*, Cirolanidae, Singapore, Indonesia, Raja Ampat, Bitung, Australia, coral reef

INTRODUCTION

Cirolana Leach, 1818 is the largest genus of the Cirolanidae with 144 extant species described to date (Boyko et al., 2008 onwards; Sidabalok & Bruce, 2017, 2018, present work). Bruce (1986) defined three informal species groups within *Cirolana* based on morphological characters originally observed in Australian species of *Cirolana*, which could also be applied to species in other regions. Two of these groups occur in the Indo-Malaysian region, namely *Cirolana* ‘parva-group’ and the *Cirolana* ‘tuberculate-group’ (Bruce, 1986). The third group, the ‘southern group’ is restricted to southern Australia.

The *Cirolana* ‘parva-group’ has been discussed and diagnosed by Bruce (1994, 2004) and a further nine species have since been described (Schotte & Kensley, 2005; Khalaji-Pirbalouty & Wägele, 2011; Rodcharoen et al., 2016; Sidabalok & Bruce, 2017). Rodcharoen et al. (2016) provided an updated list of all species included in the *Cirolana* ‘parva-group’ at that time, Sidabalok & Bruce (2017) later removing two species from the group.

In contrast the original concept of the *Cirolana* ‘tuberculate-group’ (Bruce, 1986), essentially included all species of *Cirolana* with some form of nodular dorsal ornamentation. That group has received little attention with relatively few species described since 1986 (e.g., Bruce & Javed, 1987; Bruce, 1994), and at present remains a largely undefined group of species within *Cirolana* exclusive of the ‘parva-group’ and those species once considered to belong to the subgenus *Anopsilana* Paulian & Delamare Debutteville, 1956. Furthermore, the relationship or distinction between the ‘tuberculate-group’ and the ‘southern-group’ had not hitherto been assessed. The description of new species of the *Cirolana* ‘pleonastica-group’ from the Indo-Malaysian region has provided new data and allowed for an assessment of the concept of the ‘tuberculate group’, resulting in the recognition of a smaller group of related Indo-Pacific shallow-water species, here diagnosed and named the *Cirolana* ‘pleonastica-group’.

The species in this group are primarily from coral-reef habitats, and primarily tropical in distribution. While species of the *Cirolana* ‘pleonastica-group’ have previously been recorded from East Africa (Jones, 1976), Pakistan (Bruce & Javed, 1987; Javed & Yasmeen, 1995), the Philippines (Delaney, 1986), Papua New Guinea (Bruce, 1994) and Australia (Bruce, 1986), only one provisionally identified species (*Cirolana* cf. *oreonota*) had been recorded from the Indo-Malaysian region (Sidabalok, 2013).

MATERIALS AND METHODS

All material was collected using either traps or rectangular dredges. The trapping methods follow Keable (1995), Lowry & Smith (2003), and Manning (1986). The preservation, line and digital drawing methods follow Sidabalok & Bruce

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(2017). A cirolanid character set constructed in DELTA (Coleman et al., 2010; Dallwitz, 1980; Dallwitz et al., 1993) were used for descriptions.

All specimens were collected under the following permits. For Singaporean specimens issued by National Parks Board (NParks) Singapore, permits NP/RP10-093 and NP/RP13-025 dated 17 May 2013; for Indonesian specimens issued by Indonesian Institute of Sciences (LIPI), Research Center for Biology, Indonesia, permits 1467/IPH.1/KS.02.02/VI/2014 (Bitung) and 1715/IPH.1/KS.02.01/VII/2015 and 1716/IPH.1/KS.02.01/VII/2015 (Raja Ampat).

Also examined for comparative purposes, recently collected material of *Cirolana palifrons* Barnard, 1920, *Cirolana sulcata* Hansen, 1890, *Cirolana undulata* Barnard, 1914 and *Cirolana venusticauda* Stebbing, 1902 collected by NLB from South Africa, 2009–2016. *Cirolana halei* Bruce, 1981 from West Papua (Sidabalok, 2013) was examined and here re-identified as *Cirolana improceros* Bruce, 1986 (MZB.Cru. Iso.007), therefore not part of the *Cirolana pleonastica*-group.

Abbreviations. MTQ—Queensland Museum, Museum of Tropical Queensland, Australia; MZB—Museum Zoologicum Bogoriense, Indonesia; QM—Queensland Museum, Australia; ZRC—Zoological Reference Collection—Lee Kong Chian Natural History Museum, Singapore.

CPS—circumplumose setae; LW—length vs width ratio; PMS—plumose marginal setae; RS—robust setae.

Terminology. *Nodules*: small, blunt, low processes, usually forming a fringe on posterior or posterolateral margins of pereonites and pleonites.

Tubercles: larger, often pointed, often with flat sides, triangular in lateral view; usually present on the median part of pleonites; often forming a double row on the pleotelson.

TAXONOMY

Suborder Cymothoidea Wägele, 1989

Family Cirolanidae Dana, 1852

Genus *Cirolana* Leach, 1818

Restricted synonymy. Bruce, 1986: 139.—Kensley & Schotte, 1989: 132.—Brusca et al., 1995: 17.—Schotte & Kensley, 2005: 1218.

Type species. *Cirolana cranchi* Leach, 1818, by monotypy (see Bruce & Ellis, 1983).

Detailed diagnoses have been given by Bruce (1986) and Brusca et al. (1995). The group diagnosis offered below is framed against those diagnoses. The group is named for the first named of the included species.

Diagnosis of *Cirolana* ‘pleonastica-group’. Body surfaces not polished, usually without chromatophores. Head without rostral point, usually anteriorly rounded, sometimes forming weak broadly rounded projection. Frontal lamina pentagonal, quadrate or anteriorly rounded; frontal margin projecting or flush, anteriorly not overlapped by rostrum. Dorsal surface of at least pereonites 6 and or 7, pleonites (usually 3–5) and pleotelson with transverse rows of nodules and tubercles ornamentation. Pleonite 1 largely concealed by pereonite 7, pleonites 3 and 4 weakly produced laterally and posteriorly, with pleonite 3 not extending posteriorly beyond pleonites 4 and 5; pleonite 4 posterolateral margin broadly rounded, extending posteriorly beyond pleonite 5. Pleotelson often with paired submedial longitudinal carinae or paired rows of submedial tubercles; lateral margins straight or weakly to moderately sinuate; posterior margin narrow, truncate or narrowly rounded, with 6–8 RS. Penial process opening flush (only *Cirolana trulla*, new species with low tubercles). Uropodal exopod lateral margin with widely-spaced and acute robust setae (usually 3 robust setae present; a slender base tapering from the flagellum).

Sexes dimorphic. Male uropodal exopod and endopod sometimes with dense mass of setae distally, with the uropodal exopod longer than in the female (e.g., *Cirolana fassfes*, new species, Fig. 9), sometimes a different shape to the uropodal rami; setal brush on antennal flagellum and more strongly dorsal developed ornamentation. Females show less ornamentation than males, lack a setal brush on antenna flagellum, with uropod and pleotelson shape and setation similar to immature individuals.

Remarks. Bruce (1986) defined the *Cirolana* ‘tuberculate group’ with the following characters: the presence of tubercles and or nodules on the pereonites, pleonites or pleotelson, the lack of setose fringe on pereopod 1 of the males, the extension of appendix masculina slightly beyond the endopod of pleopod 2 and the endopod of pleopod 1 not distally narrowed. At that time Bruce (1986) commented that while the *Cirolana* ‘parva-group’ was consistent in the characters that it showed, this was less the case with the ‘tuberculate-group’ with some species that could not clearly be fitted into the group. There has been no further attempt to define this group of species. Equally, while the ‘southern group’ is defined principally by lacking nodular ornamentation (implicit in the key) and the uropodal exopod having widely spaced setae, the latter character is commonplace among coral-reef species in the ‘pleonastica-group’ prompting us to question the validity of those species as a definable group.

The *Cirolana* ‘pleonastica-group’ as defined here occurs primarily on coral-reefs of the Indo-Pacific region (Bruce, 1986, 1994, current paper), and presents a narrower concept than that of Bruce (1986). We refer to this group of species as the ‘pleonastica-group’, using the epithet of the first described species as the group does not include all species of *Cirolana* that have some form of nodular dorsal ornamentation.

There are several species with nodules and tubercles on the pereonites, pleonites and pleotelson yet lacking the defining characters of *Cirolana* 'pleonastica-group' such as the widely spaced setae on uropod exopod. These include most of the ornate South African species, some estuarine species and also the so-called 'southern group' of Bruce (1986). We discuss those differences in turn.

The 'southern-group' shares several of the characters of the *Cirolana* 'pleonastica-group'— rounded anterior margin of the head, uropodal exopod with few widely-spaced robust setae, narrowly truncate pleotelson posterior margin and penial openings that open flush with the sternal surface. Dorsal nodules are weak or absent in this group, and all species have a noticeably distally narrow pleopod 1 endopod. Males have a setose fringe on the inferior margin of pereopod 1, a homoplasious occurrence also seen in some species of the *Cirolana* 'parva-group'. There are five species in this group: *Cirolana furcata* Bruce, 1981; *C. halei* Bruce, 1981; *C. similis* Bruce, 1981; *C. triloba* Bruce, 1981; and *C. victoriae* Bruce, 1981. At present it is unclear what the relationship of this group to others within the genus.

Cirolana kiliani Müller, 1993; *C. meseda* Hobbins & Jones, 1993; *C. comata* Keable, 2001; *C. dissimilis* Keable, 2001; *C. aldabrensis* Schotte & Kensley, 2005; and *C. bambang* Sidabalok & Bruce, 2018 are superficially similar to species of the *C. 'parva-group'*, with bifid uropod apices and linguiform pleotelson; they differ in having prominent penial processes and lack a ventrally produced rostral point that overlaps the frontal lamina.

Several species from South Africa, *Cirolana mclaughlinae* Bruce & Brandt, 2006 and *C. australis* Keable, 2001 from the Southern Ocean (see 'Materials and methods') are dorsally 'rugose' with pitted cuticle and nodules. There are a number of characters that preclude these and similar species from being placed in the *Cirolana* 'pleonastica-group', including prominent penial processes, the uropodal exopod lateral margin with continuous slender setae and robust setae, several species have obvious and dark chromatophores, and the pleotelson marginal plumose setae extend further anteriorly to the robust setae than in the 'pleonastica-group'. Several species have the anterior margin of the frontal lamina with a ventral ridge or projecting strongly. Unfortunately, most South African species (see Kensley, 1978) remain effectively not described by modern standards, so it is impossible at present to evaluate the relationships of those species. *Cirolana mclaughlinae* Bruce & Brandt, 2006 is typical of this group of species.

About half of all species in the genus do not readily fit into any notional 'groups'. These include the type species for *Cirolana*, *C. cranchi* Leach, 1818, and also *C. harfordi* (Lockington, 1877), *C. pustulosa* Hale, 1925, and *C. willeyi* Stebbing, 1904; as previously mentioned the South African species and also species such as *C. coronata* Bruce & Jones, 1981 that show no evident affinity to other species. These species have continuous setae and robust setae on uropodal exopod lateral (vs widely spaced), lack articulated penial

process, some dorsal ornamentation (very fine in *C. cranchi* and *C. harfordi*) and the pleotelson plumose marginal setae extend well to the anterior of the robust setae. These species appear most similar to the South African species, different principally in lacking penial processes.

Characters of taxonomic utility in the *Cirolana* 'pleonastica-group'. *Body.* Length to width proportions and average body length both can be useful, the latter particularly relevant with similar sympatric species. A species averaging 5 mm is unlikely to be the same species as one averaging 8 mm, and such populations will usually also reveal morphological differences.

Head. Number and prominence of transverse ridges or grooves; number of and pattern of nodules when present.

Frontal lamina. Frontal lamina shape is usually critical in identifying species in this group; often pentagonal, but may be quadrate or anteriorly rounded; lateral margins may be straight or concave and may be parallel or divergent; the anterior margin may project or may be laterally indented. The length to posterior width proportion is also useful.

Pereonites. Dorsal ornamentation can be similar between species but generally presents a rich source of species differences. Characters to note are which pereonites are smooth vs. ornamented, the pattern of nodules, the extent of nodules (continuous transverse row or lateral only), and which are largest; the number of transverse carinae and impressed lines. Shape of the coxae may be different between species.

Pleon. Shape of the lateral margins of pleonites 3 and 4; ornamentation of the dorsal surface, pattern of nodules and tubercles; relative size, shape and number of tubercles and nodules.

Pleotelson. Presence and development of longitudinal carinae and or longitudinal rows of tubercles. Shape of the lateral margins—straight, concave or sinuate; extent of marginal setae anterior to the robust setae; shape of the posterior margin—truncate, subtruncate. Number of robust setae is usually six, any number greater than that is significant.

Antennula. The antennula generally offers few obvious characters. Peduncle articles 1 and 2 fused or not; extent of flagellum posteriorly.

Antenna. Similar among species. Flagellum length extension between posterior of pereonite 2 and posterior of pereonite 4. Mature males of some species with a setal brush on the proximal flagellum.

Pereopods. Pereopods are relatively similar among species. Pattern and number of RS differs between species. Some species have blunt molariform RS on the inferior distal margin of ischium pereopod 7.

Penial process. How widely set apart is a useful species characters in adult males.

Pleopods. Pleopods do not much differ within the group. Proximalateral margin of pleopod 1 endopod is concave in some species. Appendix masculina generally similar within the group, as long or slightly longer than endopod.

Uropod. Uropod shape and setation usually provides abundant species-level characters. Shape and setation, and also the relative proportions of both rami. Can be strongly sexually dimorphic, and males specimens must be assessed for maturity if apparently not dimorphic.

List of species of the *Cirolana* 'pleonastica group'

The list includes species with all the diagnostic characters of the group.

- Cirolana brucei* Javed & Yasmeen, 1995. Pakistan; intertidal; not dimorphic.
- Cirolana capricornica* Bruce, 1986. Northern Territory, Queensland [Heron Island, Thursday Island (Bruce, 1986, Keable, 1995)], Western Australia; intertidal, 20 m; female tubercles less developed than male.
- Cirolana carinata* Yu & Li, 2001. South China Sea; shallow-water coral reefs, 28 m; no female record.
- Cirolana corrugis* Jones, 1976. Kenya, Gulf of Aqaba, Red Sea (Bruce & Jones, 1978); shallow water coral reefs; no male record.
- Cirolana cristata* Bruce, 1994. Madang, Papua New Guinea; 33 m; no female record.
- Cirolana curtensis* Bruce, 1986. Gladstone, Queensland; 10 m; dimorphic.
- Cirolana fasfes*, new species Raja Ampat, Indonesia; 10–40 m; dimorphic.
- Cirolana garuwa* Bruce, 1986. Abrolhos Islands, Western Australia; 18 m; no female record.
- Cirolana glebula* Bruce, 1994. Madang, Papua New Guinea; 6 m; no female record.
- Cirolana grumula* Bruce, 1994. Madang, Papua New Guinea; intertidal; female tubercles less developed than male.
- Cirolana kendi* Bruce, 1986. Lizard Island, Queensland (Bruce, 1986); 3–22 m (Keable, 1995); no female record.
- Cirolana kombona* Bruce, 1986. Queensland; 4–9 m; no male record.
- Cirolana lembeh*, new species North Sulawesi, Indonesia; 60 m, dimorphic.
- Cirolana magdalaina* Bruce, 1980. Coral Sea, Australia; intertidal; no female record.
- Cirolana manorae* Bruce & Javed, 1987. Pakistan and Goa, India; shallow water; female tubercles less developed than male.
- Cirolana merlion*, new species Singapore; 13–45 m; not dimorphic.
- Cirolana morilla* Bruce, 1986. Gladstone, Queensland; type locality is off Curtis Island, about midway between Gladstone and Rockhampton; not dimorphic.
- Cirolana oreonota* Bruce, 1986. Torres Strait; intertidal; no female record.
- Cirolana phuketensis* Rodcharoen, Bruce and Pholpunthin, 2017. Andaman Sea coast of Thailand; 1–3 m; dimorphic.
- Cirolana pilosa* Yu & Li, 2001. Gulf of Tonkin; shallow water 36 m; dimorphic.
- Cirolana pleonastica* Stebbing, 1900. Madang, New Britain, Papua New Guinea, all other records are misidentifications; shallow water to a depth of 200 m; dimorphic; see Bruce (1994).
- Cirolana sulcicauda* Stebbing, 1904. Maldives; shallow water; no female record.
- Cirolana trulla*, new species Singapore; 8–22 m; dimorphic.
- Cirolana tuberculata* (Richardson, 1910). Philippines; 53 m; female tubercles less developed than male; redescribed by Delaney (1986).
- Cirolana tuberosa* Bruce, 1986. Queensland; intertidal; female tubercles less developed than male.
- Cirolana tumulosa* Holdich, Harrison, & Bruce, 1981. Queensland; 9 m; female tubercles less developed than male; pleotelson posterior margin with eight robust setae (Bruce 1986).
- Cirolana undata* Schotte & Kensley, 2005. Off Somalia; 47–300 m; female without tubercles on head.
- Cirolana zibrowiusi* Castelló, 2017. Lebanon, eastern Mediterranean; 3–11 m.

Cirolana merlion, new species

(Figs. 1–4)

Material examined. All Singapore. Holotype: male (7.2 mm) (ZRC 2018.0199), between St John's Island and Lazarus Island, 01°13.043'N, 103°51.319'E, OTC0103 OTR356, trap 22.4 m, coll. H. Wong and party, 3 April 2014.

Paratypes. 3 males (6 [dissected], 6.5, 7.6 mm), 1 ♀ (8.5 mm) (ZRC 2018.0200), St John's Island, 1°13.020'N, 103°51.122'E, SW119 SS4934, trap, coll. N.L. Bruce, 30 May 2013; 8 males (5.3, 5.3, 5.4, 5.5, 5.6, 5.7, 6.1, 6.8 mm), 11 females (4.8, 4.9, 5.0, 5.0, 5.0, 5.0, 5.9, 5.9, 6.0, 6.6 mm) (ZRC 2018.0201), same data as holotype; 5 males (7, 7.4, 7.5, 9.0, 10.0 mm), 9 females (6.9, 7.0, 7.5, 8.0, 8.0, 8.0, 8.3, 9.0, 9.0 mm) (ZRC 2018.0202), St John's Island–Lazarus Island, 01°12.958'N, 103°51.316'E, SS4941 SW138, trap 13.5 m, coll. N.L. Bruce and party, 31 May 2013; 4 females (9.0, 9.5, 10.0, 11.0 mm) (ZRC 2018.0203), St John's Island–Lazarus Island, 01°12.958'N, 103°51.316'E, SS4940 SW137, trap 25 m, coll. N.L. Bruce and party, 31 May 2013; 4 males (6.8, 8.0, 8.5, 8.8 mm), 48 females (not measured) (ZRC 2018.0204), St John's Island–Lazarus Island, 01°12.958'N, 103°51.316'E, SW147, trap 45 m, coll. N.L. Bruce, 1 June 2013; 3 males (6.2, 6.4, 6.8 mm) (MTQ W34883), same data as previous; 2 males (4.3, 8.0 mm), 15 females (5.2–9.0 mm, average 6.8 mm) (ZRC 2018.0205), St John's Island–Lazarus Island, 01°12.958'N, 103°51.316'E, SS4942 SW 137, trap 25 m, coll. N.L. Bruce and party, 31 May 2013.

Description. Body (Fig. 1A) 2.9 times as long as greatest width, dorsal surfaces punctate, widest at pereonite 5, lateral margins subparallel. Rostral point absent. Eyes (Fig. 1F) separated by about 82% width of head, eye colour black. Pereonite 1 and coxae 2–3 (Fig. 1B) each with posteroventral

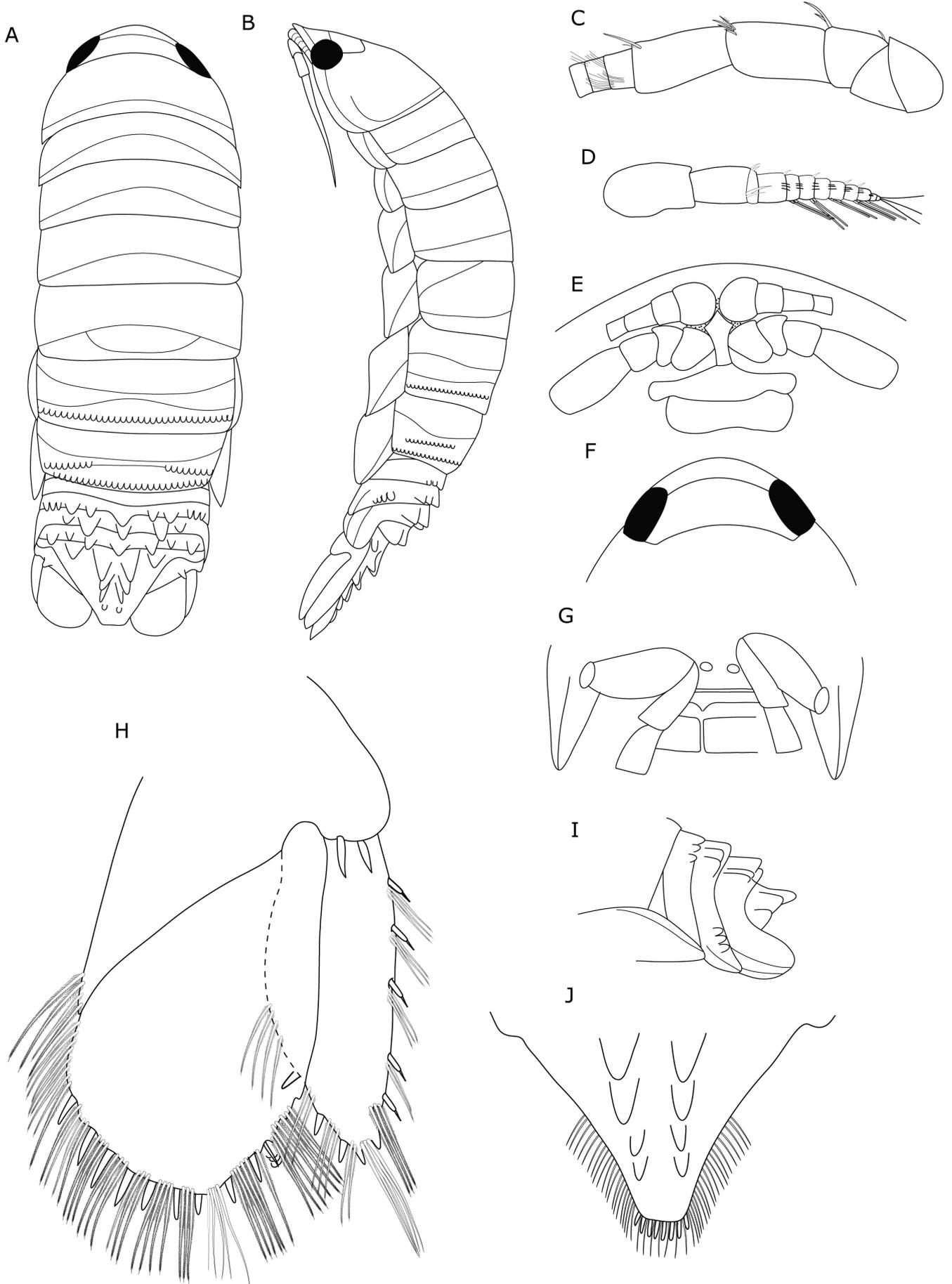


Fig. 1. *Cirolana merlion* n. sp. A, B, E–G, I, holotype male (7.2 mm) (ZRC 2018.0199), Singapore. C–D, H, J, paratype male (6.0 mm) (ZRC 2018.0200), Singapore. A, dorsal view; B, lateral view; C, antennal peduncle; D, antennula; E, frons; F, head; G, penial openings; H, uropod; I, pleon; J, pleotelson.

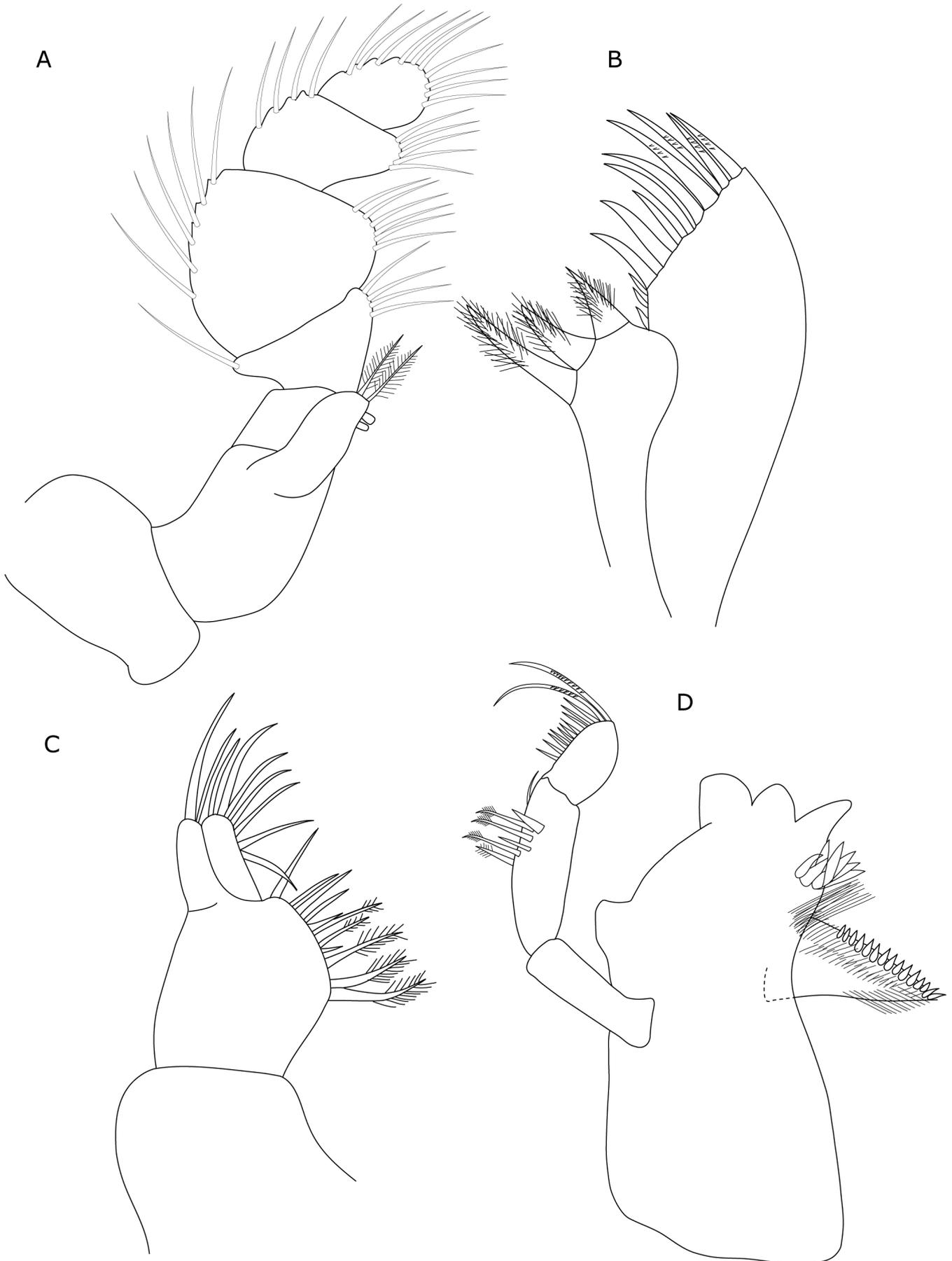


Fig. 2. *Cirolana merlion* n. sp. A–D, paratype male (6.0 mm) (ZRC 2018.0200), Singapore. A, maxilliped; B, maxillule; C, maxilla; D, right mandible.

angle rounded; coxae 5–7 with entire oblique carina; posterior margins of pereonites 6–7 with irregular submarginal nodules. Pleon (Fig. 1I) with pleonite 1 not visible in dorsal view; pleonites 3–5 posterior margin with regular nodules; posterolateral angles of pleonite 2 forming acute point, extending posteriorly to anterior of pleonite 3; pleonite 3 with 1 median tubercle (the largest) and 5 sublateral tubercles on each side, posterolateral margins not extending to posterior margin of pleonite 5, acute; pleonite 4 with 1 median tubercle and 2 sublateral tubercles on each side, posterolateral margin of pleonite 4 rounded, clearly extending beyond posterior margin of pleonite 5; pleonite 5 with 1 median tubercle and 3 sublateral tubercles on each side and posterolateral angles overlapped by lateral margins of pleonite 4. Pleotelson (Fig. 1J) 0.7 times as long as anterior width; with 2 submedian tubercle rows on dorsal surface (4 tubercles each); lateral margins straight, margins smooth, posterior margin truncate, without median point, with 8 robust setae.

Antennula (Fig. 1D) peduncle articles 1 and 2 entirely fused; articles 3 and 4 0.7 times as long as combined lengths of articles 1 and 2, article 3 1.3 times as long as wide; flagellum with 10 articles, extending to anterior of pereonite 1. Antenna (Fig. 1C) peduncle article 4 1.8 times as long as wide, 1.6 times as long as article 3, and 4 short simple setae (distal); article 5 as long as article 4, 1.9 times as long as wide, anterodistal angle with cluster of 2 short simple setae; flagellum with 21 articles, extending to posterior of pereonite 4.

Frontal lamina (Fig. 1E) pentagonal, 1.5 longer than greatest width, lateral margins anteriorly concave, diverging slightly towards anterior, anterior margin concave and acute, forming median point.

Mandible (Fig. 2D) molar process anterior margin with 16 flat teeth; with proximal cluster of long simple setae; right mandible spine row composed of 9 spines; palp article 2 with 10 distolateral setae, palp article 3 with 2 robust biserrate and 13 plumose setae. Maxillule (Fig. 2B) mesial lobe with 3 large and circumplumose RS; lateral lobe with 11 RS. Maxilla (Fig. 2C) lateral lobe with 4 long simple setae; middle lobe with 11 long simple setae; mesial lobe with 8 distal simple setae, with 6 proximal simple and plumose setae. Maxilliped (Fig. 2A) palp article 2 mesial margin with 5 slender setae, lateral margin distally with 1 slender setae; article 3 mesial margin with 14 slender setae, lateral margin with 7 slender setae; article 4 mesial margin with 9 slender setae, lateral margin with 4 slender setae; article 5 distal margin 10 setae, lateral margin with 7 setae; endite with 2 long CPS, and 2 coupling setae.

Pereopod 1 (Fig. 3A) basis 2.2 times as long as greatest width, superior distal angle without cluster of acute setae, inferior distal angle with cluster of 3 acute setae; ischium 0.6 times as long as basis, inferior margin with 2 setae, inferior distal margin with 2 RS, superior distal margin with 2 RS; merus inferior margin with 6 molariform RS, set as 2 and 4, with 3 simple setae, inferior distal margin with 1 RS, superior distal angle with 2 RS; carpus inferior margin

with 1 RS and 1 simple setae; propodus 2.0 times as long as wide, inferior margin with 2 RS, inferior distal margin with 1 large RS and 3 simple setae, superior distal with 2 simple setae; dactylus 0.8 as long as propodus. Pereopod 2 (Fig. 3B) ischium inferior margin with 2 long acute RS, inferior distal margin with 2 RS, superior distal margin with 1 long acute seta and 1 plumose seta; merus inferior margin with 4 stout RS and 1 RS, set as single row, inferior distal margin with 1 stout RS and 2 RS, superior distal margin with 2 long acute RS and 2 plumose setae; carpus inferior distal margin with 3 acute RS; propodus 2.5 as long as wide, with 2 clusters of acute RS, inferior margin with 2 RS, inferior distal margin with 1 large RS and 2 simple setae; dactylus 0.8 as long as propodus. Pereopod 3 similar to pereopod 2. Pereopod 6 (Fig. 3C) similar to pereopod 7. Pereopod 7 (Fig. 3D) basis 2.3 times as long as greatest width, superior margin weakly convex, inferior margin with 4 palmate setae; ischium 0.5 as long as basis, inferior margin with 3 RS (set in group of 2 and 1), inferior distal angle with 3 RS, superior distal angle with 4 RS (2 biserrate); merus 0.9 as long as ischium, 1.6 times as long as wide, inferior margin with 3 RS, superior distal angle with 7 RS (2 biserrate), inferior distal angle with 6 RS; carpus as long as ischium, 2 times as long as wide, inferior margin with 2 RS, superior distal angle with 12 RS (10 biserrate), inferior distal angle with 11 RS (5 biserrate); propodus as long as ischium, 4.3 times as long as wide, inferior margin with 2 clusters of RS (set as 1 and 1), superior distal angle with 1 slender seta, 1 plumose seta and 2 RS, inferior distal angle with 2 RS; dactylus 0.5 as long as propodus.

Penes (Fig. 1G) opening flush, penial openings separated by 5.7% of sternal width.

Pleopod 1 (Fig. 4A) exopod 1.4 times as long as wide, lateral margin straight, distally narrowly rounded, medial margin weakly oblique, mesial margin strongly convex, with PMS from distal one-third, with ~30 PMS; endopod 2.1 times as long as wide, distally narrowly rounded, lateral proximal margin convex, with PMS on distal margin only, mesial margin with PMS one third of mesial margin, endopod with ~13 PMS; peduncle 0.7 times as wide as long. Pleopod 2 (Fig. 4B) exopod with ~41 PMS, endopod with ~13 PMS; appendix masculina with parallel margins, 0.9 times as long as endopod, distally narrowly rounded. Pleopod 3 (Fig. 4C) exopod with ~43 PMS, endopod with ~12 PMS. Pleopod 4 (Fig. 4D) exopod with ~41 PMS, endopod with ~10 PMS. Pleopod 5 (Fig. 4E) exopod with ~40 PMS. Pleopods 2–5 peduncle distolateral margin with prominent acute RS, 3–5 endopods with distomesial serrate scales.

Uropod (Fig. 1H) peduncle ventrolateral margin with 2 RS, lateral margin with 1 medial short acute RS, posterior lobe about as long as endopod; rami extending beyond pleotelson, marginal setae in single tier, apices not bifid. Endopod apically not bifid; lateral margin weakly convex and proximally straight, proximal lateral margin without RS; distal lateral margin with 2 RS, mesial margin weakly convex, with 7 RS. Exopod not extending to end of endopod, 2.5 times as long as greatest width, apically not bifid, medial

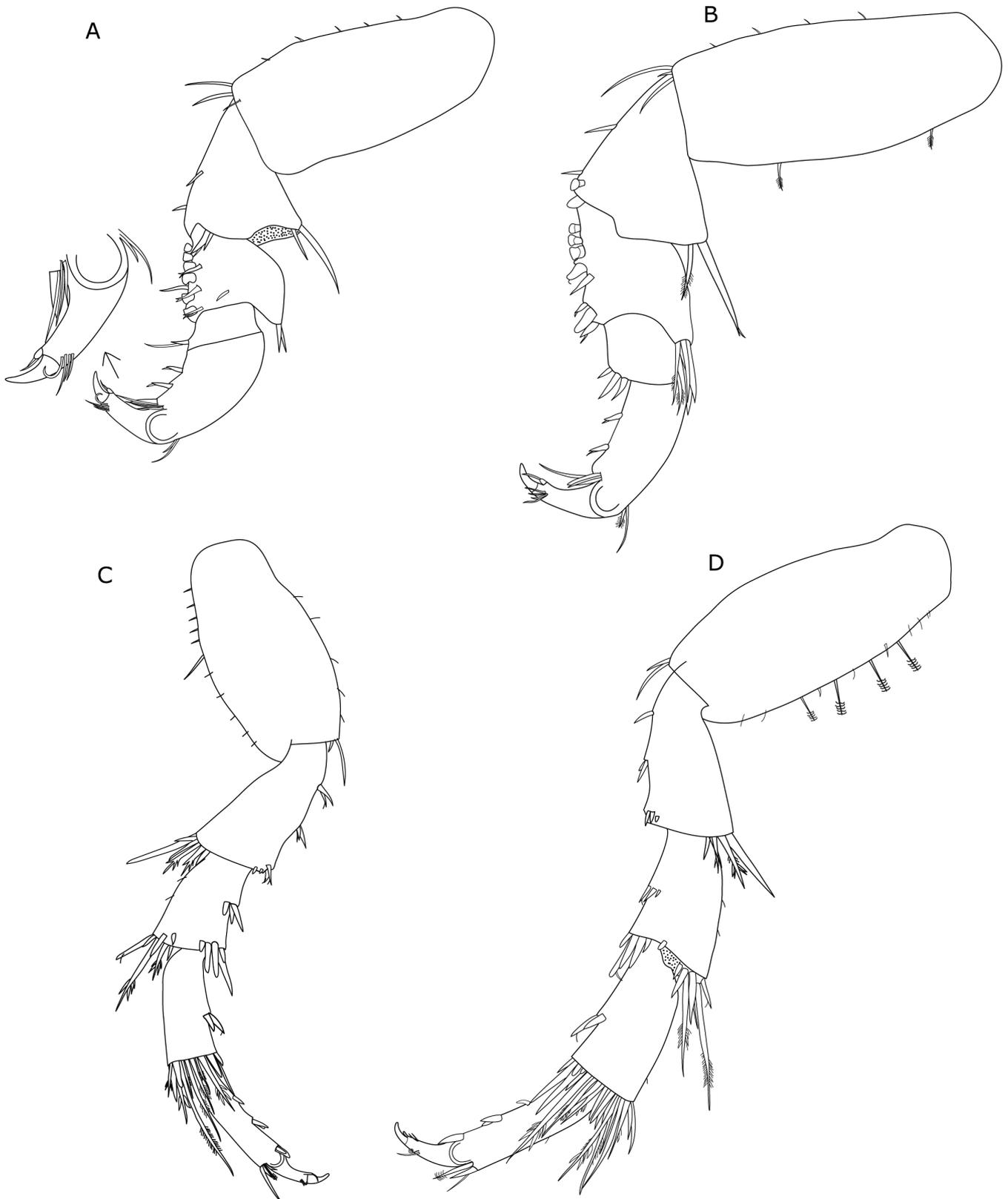


Fig. 3. *Cirolana merlion* n. sp. A–D, paratype male (6.0 mm) (ZRC 2018.0200), Singapore. A, pereopod 1; B, pereopod 2; C, pereopod 6; D, pereopod 7.

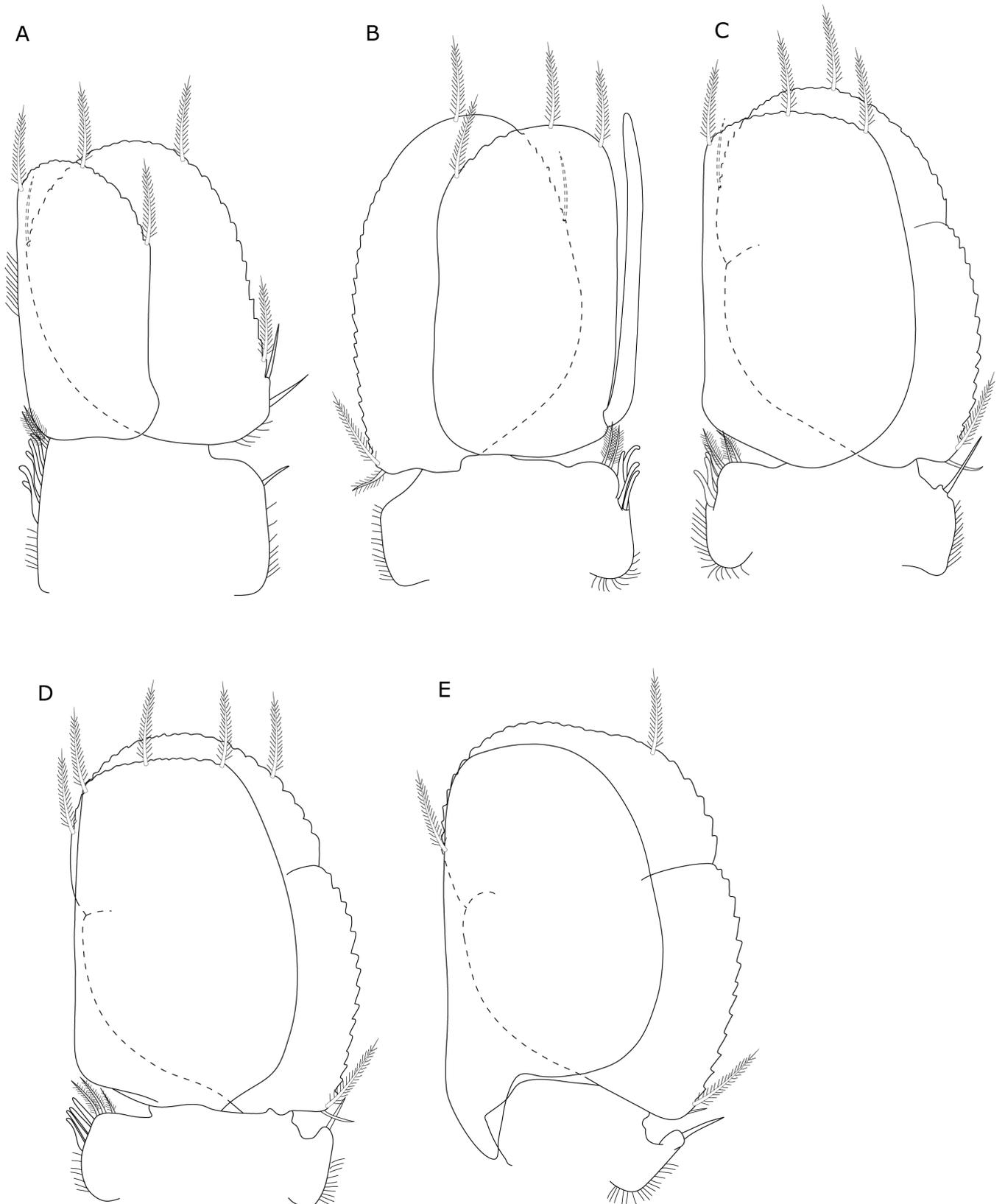


Fig. 4. *Cirolana merlion* n. sp. A–E, paratype male (6.0 mm) (ZRC 2018.0200), Singapore. A, pleopod 1; B, pleopod 2; C, pleopod 3; D, pleopod 4; E, pleopod 5.

process sub-acute and prominent; lateral margin weakly convex, with 5 visible widely separated RS; mesial margin convex, with 4 RS.

Female. Similar to the male.

Size. Males 4.3–10.0 mm, mean 6.8 mm (n=26); non-ovigerous females 5.0–11.0 mm, mean 7.1 mm (n=38); all from type series.

Variation. RS count was measured from 82 specimens of type series. Uropod exopod lateral: 4 = 15.8%, 5 = 79.3%, 6 = 4.9%; mesial: 2 = 11%, 3 = 87.8%, 4 = 1.2%. Uropod endopod lateral: 2 = 91.5%, 3 = 8.5%; mesial: 6 = 13.4%, 7 = 26.8%, 8 = 52.5%, 9 = 7.3%. Pleotelson: 6 = 8.5%, 7 = 15.9%, 8 = 75.6%.

Remarks. *Cirolana merlion*, new species, is characterised by the frontal lamina having concave lateral margins, two transverse impressed lines on pereonites 5–7, three prominent median tubercles on pleonites 4 and 5, two transverse distinct impressed carinae on the lateral margin of pleonite 4 and two submedian longitudinal rows of tubercles on the pleotelson; the exopod of uropod has 5 robust setae on the lateral margin (vs. 3 on most species of the group).

Species similar to *C. merlion* are *C. oreonota* Bruce, 1986, *C. kombona* Bruce, 1986, and *C. capricornica* Bruce, 1986 all with antennula peduncle articles 1 and 2 fused (with distinct suture) and the pattern of nodules on pleonites 3–5 and on pleotelson (several sublateral nodules with one median tubercle). The last three species differ in having a broader frontal lamina with straight lateral margins (vs. slender and concave) and smaller size lateral nodules on pleonites 3–5, and four (vs. five) robust setae on the exopod of uropod. Furthermore, *Cirolana oreonota* also differs in having a more rounded uropodal endopod mesial margin and more rounded lateral margin of uropodal exopod. *Cirolana kombona* has two transverse impressed lines on pereonites 2–3 (vs. 1) and three on pereonites 4–7 (vs. 1–2) and a straight lateral margin of endopod of pleopod 1 (vs. lateral proximal margin convex). *Cirolana capricornica* has the frontal lamina with straight lateral margins, absence of submarginal nodules on posterior margin of pereonite 6, the presence of submarginal nodules only at the edges of posterior margin of pereonite 7, smaller median tubercles on pleonites 4–5 and on pleotelson, pleotelson lateral margins sinuate, posteriorly narrowly rounded (not truncate).

Distribution. Known only from Singapore; intertidal to 45 metres.

Etymology. Named after a famous Singapore landmark, the Merlion (noun in apposition).

***Cirolana trulla*, new species**

(Figs. 5–8)

Material examined. All Singapore. Holotype, male (7.4 mm) (ZRC 2018.0206), between St John's Island and Lazarus

Island, 01°13.043'N, 103°51.319'E, OTC0103 OTR356, trap 22.4 m, coll. H. Wong and party, 3 April 2014.

Paratypes. 4 males (6.0 [dissected], 6.3, 6.6, 6.9 mm), 1 female (6.3 [dissected] mm) (ZRC 2018.0207), same data as holotype; 1 male (7.8 mm) (ZRC 2018.0208), Pulau Ubin, Beting Bronok, 01°26.423'N, 104°02.702'E, CMBS SEA 1273 DR214, rectangular dredge 8.7 m, coll. S. Cheng and party, 7 October 2013; 1 male (5.2 mm) (MTQ W34884), near Changi Naval Base, 01°18.492'N, 104°02.935'E, CMBS SEA 6139 DR361, rectangular dredge 19.2 m, coll. T. Tay and party, 8 April 2014.

Description. Body (Fig. 5A) 4.3 times as long as greatest width, dorsal surfaces punctate, widest at pereonite 4, lateral margins subparallel. Rostral point absent. Eyes (Fig. 5C) separated by about 79% width of head, eye colour black. Pereonite 1 and coxae 2–3 (Fig. 5B) each with posteroventral angle rounded; coxae 5–7 with entire oblique carina; posterior margins of pereonites 6–7 with irregular submarginal nodules. Pleon (Fig. 5F) with pleonite 1 not visible in dorsal view; pleonites 3–5 posterior margin with row of small, regularly spaced nodules; posterolateral angles of pleonite 2 forming acute point, extending posteriorly to anterior of pleonite 3; pleonite 3 without median tubercle and 4 small sublateral tubercles on each side, posterolateral margins not extending to posterior margin of pleonite 4 or 5, acute; pleonite 4 without median tubercle and 4 sublateral tubercles on each side, posterolateral margin of pleonite 4 rounded, clearly extending beyond posterior margin of pleonite 5; pleonite 5 without median tubercle and 1 sublateral tubercle on each side and posterolateral angles overlapped by lateral margins of pleonite 4. Pleotelson (Fig. 6F) 0.9 times as long as anterior width; with 2 tubercles on posterior of dorsal surface; lateral margins straight, margins smooth, posterior margin sub-truncate, without median point, with 8 robust setae.

Antennula (Fig. 5D) peduncle articles 1 and 2 fused; articles 3 and 4 0.8 times as long as combined lengths of articles 1 and 2, article 3 1.9 times as long as wide; flagellum with 9 articles, extending to anterior of pereonite 1. Antenna (Fig. 5G) peduncle article 4 1.6 times as long as wide, 1.3 times as long as article 3, and 6 short simple setae (distal); article 5 1.3 as long as article 4, 2.5 times as long as wide, anterodistal angle with cluster of 1 short simple setae; flagellum with 19 articles, extending to posterior of pereonite 4.

Frontal lamina (Fig. 5E) pentagonal, 1.9 longer than greatest width, lateral margins straight and parallel, anterior margin straight and acute, forming median point.

Mandible (Fig. 6D) molar process anterior margin with 15 flat teeth; with proximal cluster of long simple setae; right mandible spine row composed of 4 spines; palp article 2 with 12 distolateral setae, palp article 3 with 4 robust biserrate and 11 plumose setae. Maxillule (Fig. 6C) mesial lobe with 3 large and circumplumose RS; lateral lobe with 13 RS. Maxilla (Fig. 6B) lateral lobe with 4 long simple setae; middle lobe with 8 long simple setae; mesial lobe with 4 distal simple setae, with 2 proximal simple and 4 plumose

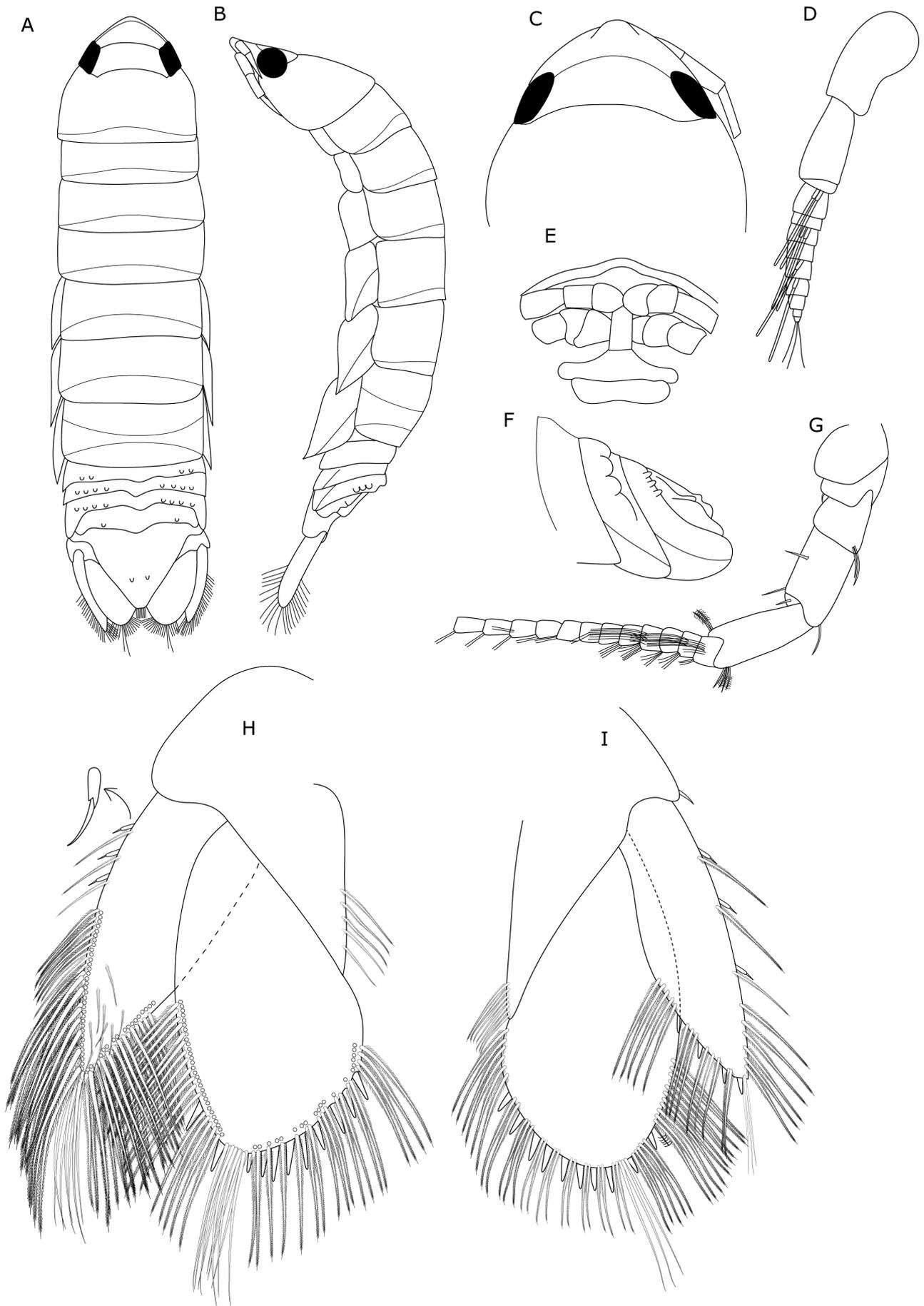


Fig. 5. *Cirolana trulla* n. sp. A–C, E–F, holotype male (7.4 mm) (ZRC 2018.0206), Singapore. D, G, H, paratype male (6.0 mm) (ZRC 2018.0207), Singapore. I, paratype female (6.3 mm) (ZRC 2018.0207), Singapore. A, dorsal view; B, lateral view; C, head; D, antennula; E, frons; F, pleon; G, antenna peduncle; H, uropod male; I, uropod female.

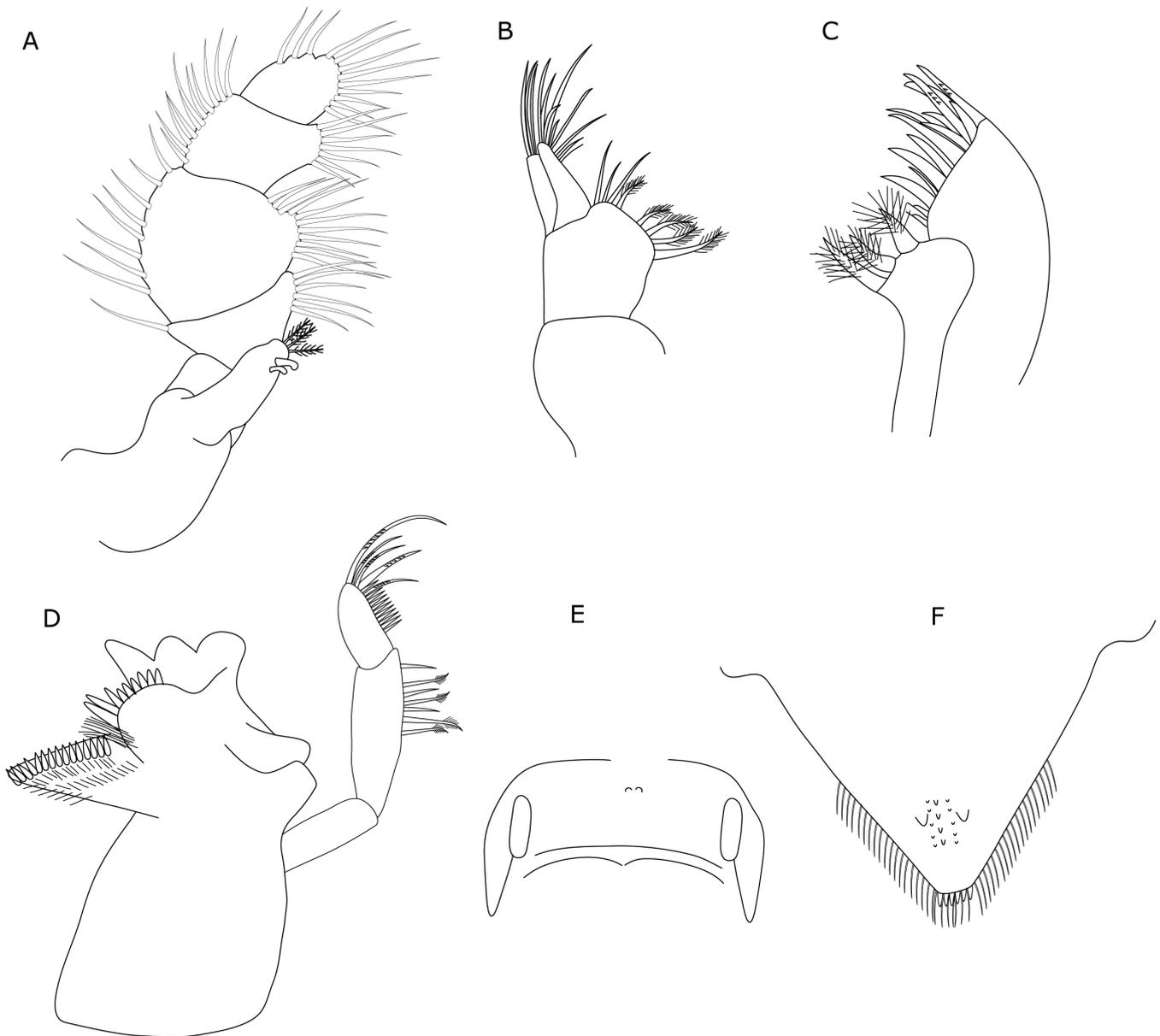


Fig. 6. *Cirolana trulla* n. sp. E, holotype male (7.4 mm) (ZRC 2018.0206), Singapore. A–D, F, paratype male (6.0 mm) (ZRC 2018.0207), Singapore. A, maxilliped; B, maxilla; C, maxillule; D, right mandible; E, penial process; F, pleotelson.

setae. Maxilliped (Fig. 6A) palp article 2 mesial margin with 9 slender setae, lateral margin distally with 1 slender setae; article 3 mesial margin with 16 slender setae, lateral margin with 10 slender setae; article 4 mesial margin with 11 slender setae, lateral margin with 5 slender setae; article 5 distal margin 12 setae, lateral margin with 6 setae; endite with 4 long CPS, and 2 coupling setae.

Pereopod 1 (Fig. 7A) basis 2.2 times as long as greatest width, superior distal angle without cluster of acute setae, inferior distal angle with a cluster of 4 acute setae; ischium 0.6 times as long as basis, inferior margin with 2 setae, inferior distal margin with 2 RS, superior distal margin with 4 long RS; merus inferior margin with 6 molariform RS, set as 4 and 2, with 5 simple setae, superior distal angle with 3 RS; carpus inferior margin with 1 RS and 1 simple seta; propodus 1.7 times as long as wide, inferior margin with 2 RS, inferior distal margin with 1 large RS and 1 simple

seta, superior distal with 2 simple setae; dactylus 0.9 as long as propodus. Pereopod 2 (Fig. 7B) ischium inferior margin with 1 long acute RS, inferior distal margin with 2 RS, 1 acute RS, 1 simple seta, superior distal margin with 2 long acute setae and 3 plumose setae; merus inferior margin with 4 stout RS and 2 simple setae, set as single row, inferior distal margin with 1 stout RS, 2 acute RS and 1 simple seta, superior distal margin with 1 long acute RS and 4 simple setae; carpus inferior distal margin with 2 acute RS; propodus 2.7 as long as wide, with 2 clusters of acute RS, inferior margin with 2 RS, inferior distal margin with 1 large RS and 1 simple seta; dactylus 0.7 as long as propodus. Pereopod 3 similar to pereopod 2. Pereopod 6 (Fig. 7C) similar to pereopod 7. Pereopod 7 (Fig. 7D) basis 2.5 times as long as greatest width, superior margin straight, with 3 palmate setae; ischium 0.5 as long as basis, inferior margin with 4 long simple setae (set in group of 2 and 2), with 3 triangular processes, inferior distal angle with 2 long

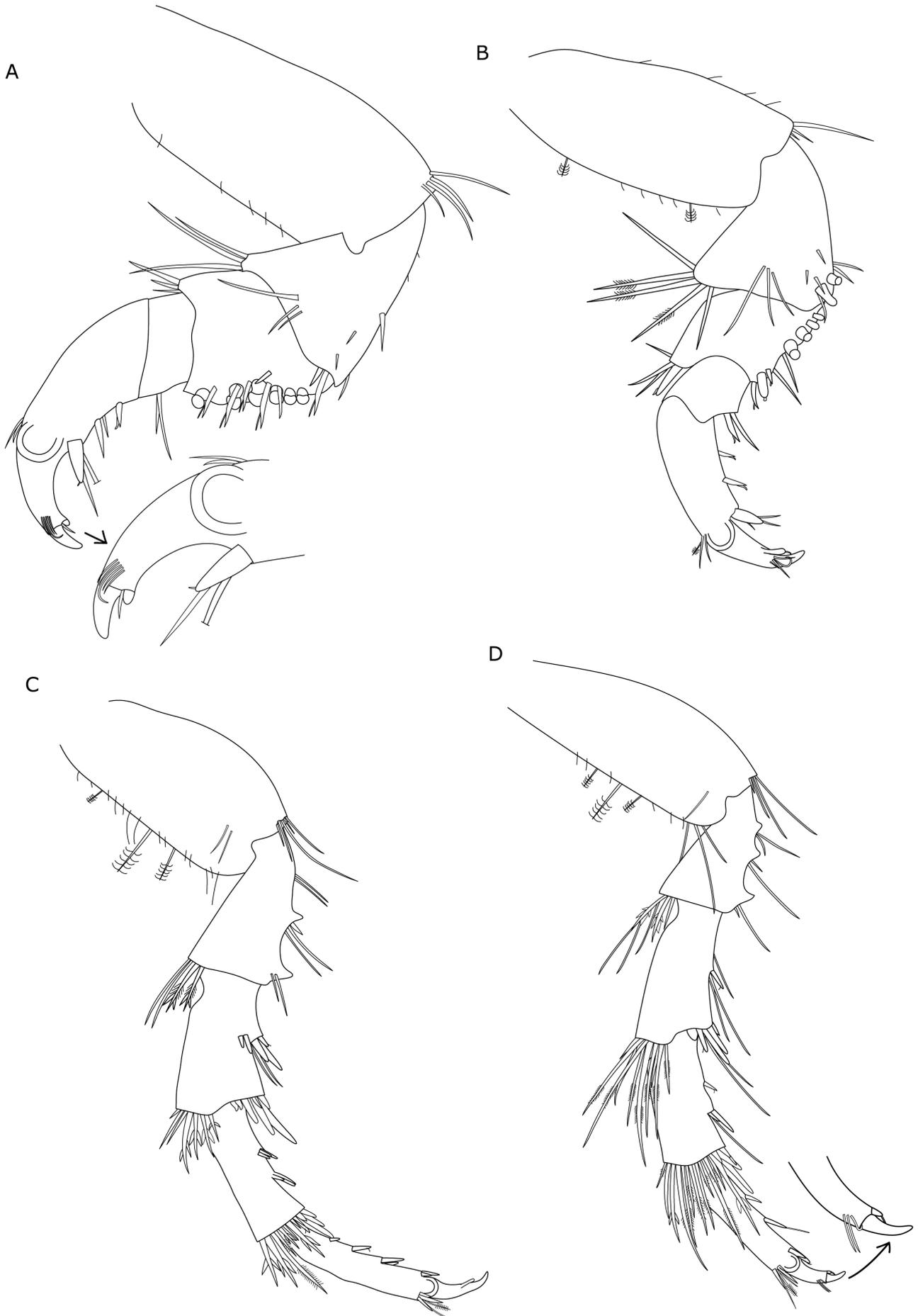


Fig. 7. *Cirolana trulla* n. sp. A–D, paratype male (6.0 mm) (ZRC 2018.0207), Singapore. A, pereopod 1; B, pereopod 2; C, pereopod 6; D, pereopod 7.

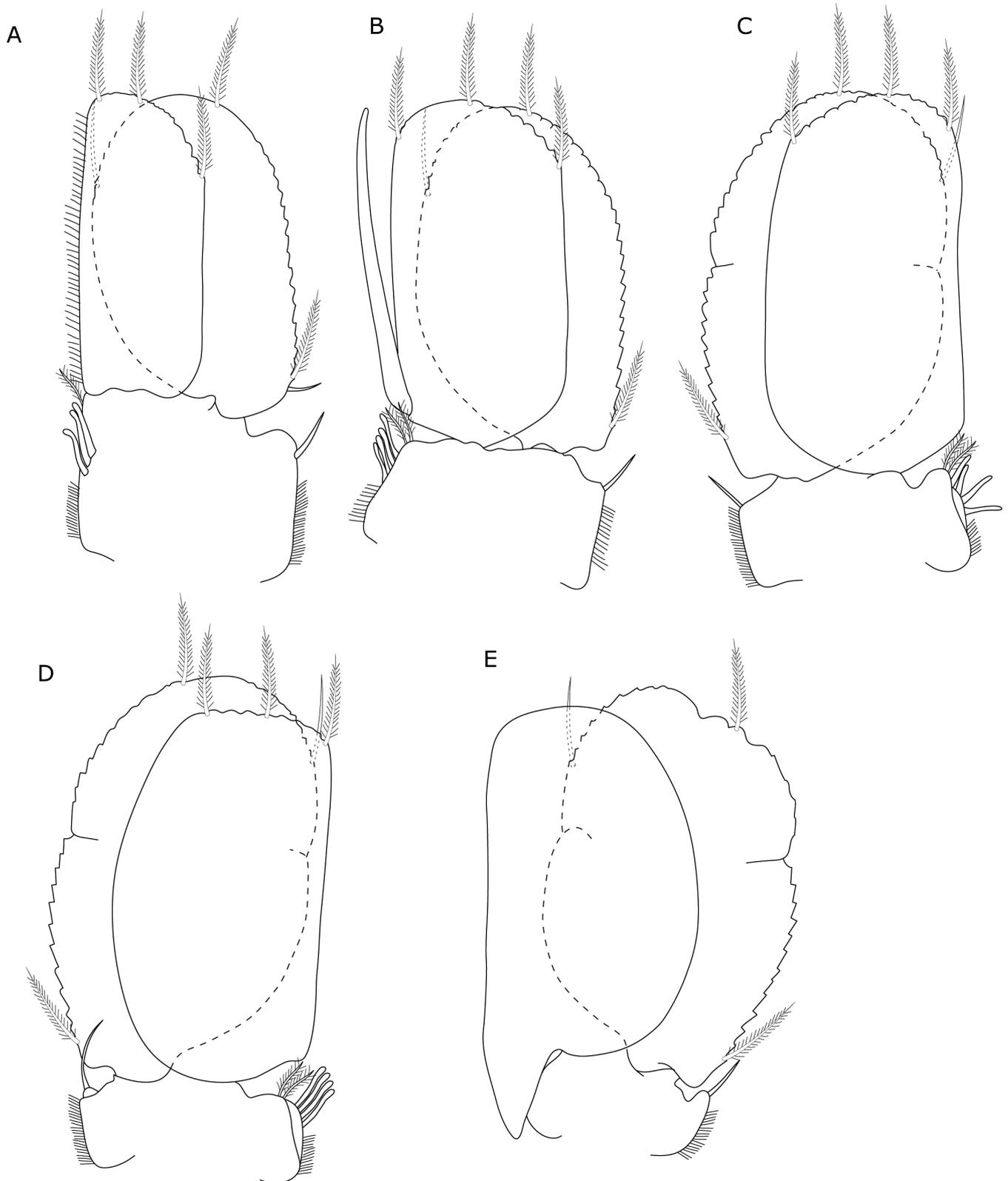


Fig. 8. *Cirolana trulla* n. sp. A–E, paratype male (6.0 mm) (ZRC 2018.0207), Singapore. A, pleopod 1; B, pleopod 2; C, pleopod 3; D, pleopod 4; E, pleopod 5.

simple setae, superior distal angle with 5 long setae and 2 biserrate setae; merus 1.1 as long as ischium, 1.9 times as long as wide, inferior margin with 1 acute RS and 3 simple setae, superior distal angle with 11 RS (10 biserrate), inferior distal angle with 5 RS and 3 simple setae; carpus as long as ischium, 0.4 times as long as wide, inferior margin with 3 RS and 1 simple seta, superior distal angle with 8 biserrate RS, inferior distal angle with 9 RS (5 biserrate); propodus as long as ischium, 3.8 times as long as wide, inferior margin with 2 clusters of RS (set as 1 and 1), superior distal angle with 1 slender seta, 1 plumose seta and 3 RS, inferior distal angle with 2 RS; dactylus 0.5 as long as propodus.

Penes (Fig. 6E) low tubercles, penial openings separated by 2.9% of sternal width.

Pleopod 1 (Fig. 8A) exopod 1.7 times as long as wide, lateral margin straight, distally narrowly rounded, medial margin weakly oblique, mesial margin strongly convex, with PMS from distal one-third, with ~38 PMS; endopod 2.4 times as long as wide, distally narrowly rounded, lateral margin straight, with PMS on distal margin only, mesial margin with PMS from distal one-third, endopod with ~13 PMS; peduncle 1.3 times as wide as long. Pleopod 2 (Fig. 8B) exopod with ~40 PMS, endopod with ~16 PMS; appendix masculina with parallel margins, 0.9 times as long as endopod, distally acute. Pleopod 3 (Fig. 8C) exopod with ~43 PMS, endopod with ~12 PMS. Pleopod 4 (Fig. 8D) exopod with ~37 PMS, endopod with ~9 PMS. Pleopod 5 (Fig. 8E) exopod with ~38 PMS. Pleopods 2–5 peduncle distolateral margin with prominent acute RS, 3–5 endopods with distomesial serrate scales.

Uropod (Fig. 5H–5I) peduncle ventrolateral margin with 1 RS, lateral margin with medial short acute RS, posterior lobe about 0.9 as long as endopod; rami extending beyond pleotelson, marginal setae dense, in two tiers, apices not bifid. Endopod lateral margin proximally convex, without prominent excision, proximal lateral margin with 1 RS, distal lateral margin with 1 RS; mesial margin strongly convex, with 9 RS. Exopod not extending to end of endopod, 1.8 times as long as greatest width; lateral margin weakly convex with setal fringe on the posterior, with 3 visible widely separated RS; mesial margin straight, proximally convex, with 4 RS.

Female. The uropodal exopod lacks the dense setal fringe on the posterior lateral margin.

Size. Males 5.2–7.8 mm, mean 6.6 mm (n=7); non-ovigerous female 6.3 mm (n=1); all from type series.

Variation. RS count was measured from all type series (n = 8). Uropod exopod lateral: 3 = 75%, 4 = 25%; mesial: 3 = 50%, 4 = 50%. Uropod endopod lateral: 2 = 87.5%, 3 = 12.5%; mesial: 7 = 12.5%, 8 = 62.5%, 9 = 25%. Pleotelson: 8 = 100%.

Remarks. *Cirolana trulla*, new species, is characterised by having a more elongate body than most *Cirolana* (4.3 vs. ~3.0 times as long as wide), a triangular rostrum in dorsal

view, the presence of three triangular processes (= broad-based spines) on the inferior margin of ischium of pereopods 6–7, low tubercle-like penial openings (not processes) and the presence of two small posteriorly positioned nodules on of pleotelson. The male uropodal rami are distinctive in shape, but especially distinctive in terms of their setation, with a two-tier and dense setal fringe on the posterior of lateral and mesial margins of exopod.

Cirolana trulla, new species, is most similar to *C. bruscai* Bruce & Olesen, 2002, both species having a relatively elongate body, the head anteriorly produced and overriding the antennular bases, a few sublateral tubercles on pereonites 3–5, scattered nodules on posterior of pleotelson, long simple setae on superior distal angle of the ischium–merus of pereopods 1–2 and on the inferior margin of the ischium–merus of pereopods 6–7, the triangular processes on the ischium of pereopods 6–7, the two tiered-setae that form dense mass of setae on the posterior lateral margin of uropod exopod and endopod. Despite these similarities there are numerous differences between the two species: *Cirolana trulla* is 4.3 times as long as greatest width (vs. 3.1 in *C. bruscai*), has 8 robust setae on the pleotelson (vs. 6), the anterior of the head is strongly produced (vs. weakly produced), pleopod 1 endopod and exopod lateral margins are straight (vs. convex); uropodal exopod not extending to end of endopod (vs. beyond) with a narrow apex (vs. semi-truncate), the mesial margin is distinctly angled mid-length (vs. evenly convex) and the second submarginal tier of setae (distal one-third vs. distal three-quarters), and two small submedian tubercles on pleotelson (vs. absent). The body length-to-width ratio (2.5) of *Cirolana bruscai* in the original description is inaccurate owing to the curved state of the holotype; we recalculated the ratio, which is 3.1.

Distribution. Singapore; 8 to 24 metres.

Etymology. The epithet is the Latin word for shovel, alluding to the shovel-shaped rostrum.

Cirolana fasfes, new species

(Figs. 9–12)

Material examined. All Indonesia: Holotype, male (7.4 mm) (MZB Cru.Iso 090), Saunek, Raja Ampat, West Papua, 00°27'58.9'S, 130°46'32.5'E, trap 40 m, coll. M. Mofu and E. Mamberaku, 9 August 2015.

Paratypes. 8 males (6.9, 7.0, 7.2 [dissected], 7.3, 7.3, 7.4, 7.4, 7.5 mm) (MZB Cru.Iso 091), same data as holotype; 4 males (6.5, 6.6, 6.7, 6.9 mm), 41 females (4.9–7.4, 5.9 [dissected], average 6.1 mm) (MZB Cru.Iso 092), Saunek Monde, Raja Ampat, 00°27'04.9'S, 130°48'14.0'E, trap 40 m, coll. M. Mofu and E. Mamberaku, 11 August 2015; 3 males (5.9, 6.3, 6.4 mm) (MTQ W34885), same data as previous; 5 females (6.3, 6.4, 6.4, 6.6, 6.9 mm) (MZB Cru.Iso 093), Saprok Bakdi, Raja Ampat, 00°26'36.2'S, 130°47'22.8'E, trap 10 m, coll. M. Mofu and E. Mamberaku, 12 August 2015; 3 females (5.7, 5.9, 6.0) (MTQ W34887), same data as previous.

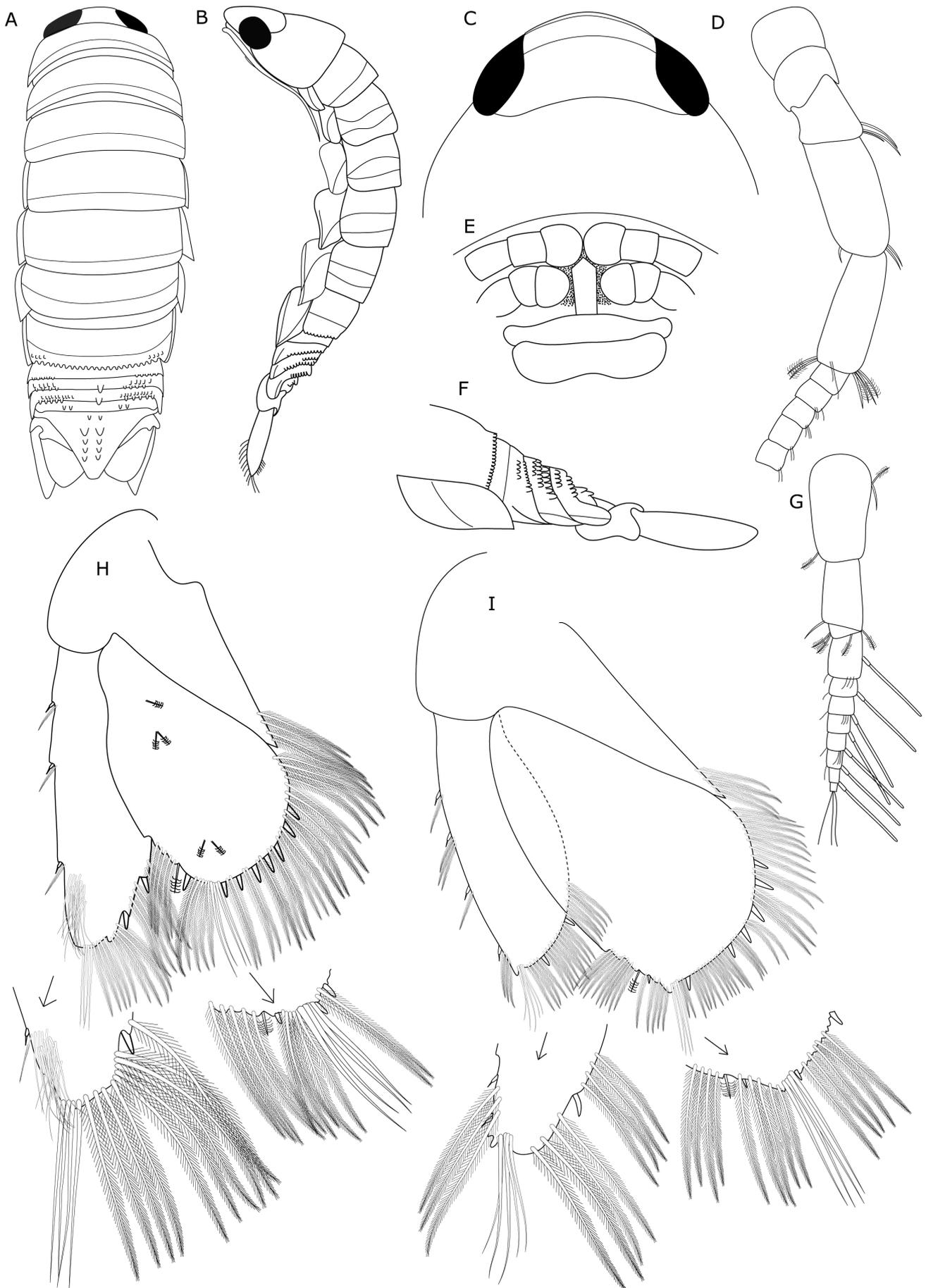


Fig. 9. *Cirolana fasztes* n. sp. A–C, E–F, holotype male (7.4 mm) (MZB Cru.Iso 090), Raja Ampat, Indonesia. D, G, H, paratype male (7.2 mm) (MZB Cru.Iso 091), Raja Ampat, Indonesia. I, paratype female (5.9 mm) (MZB Cru.Iso 091), Raja Ampat, Indonesia. A, dorsal view; B, lateral view; C, head; D, antenna peduncle; E, frons; F, pleon; G, antennule; H, uropod male; I, uropod female.

Description. Body (Fig. 9A) 3.1 times as long as greatest width, dorsal surfaces punctate, widest at pereonite 5, lateral margins subparallel. Rostral point absent. Eyes (Fig. 9C) separated by about 83% width of head, eye colour black. Pereonite 1 and coxae 2–3 (Fig. 9B) each with posteroventral angle rounded; coxae 5–7 with entire oblique carina; posterior margins of pereonite 7 with irregular submarginal nodules. Pleon (Fig. 9F) with pleonite 1 not visible in dorsal view; pleonites 2–5 posterior margin with regular small nodules; posterolateral angles of pleonite 2 forming acute point, extending posteriorly to anterior of pleonite 3; pleonite 3 with 1 median tubercle (the largest) and 10 sublateral tubercles on each side (set as two rows), posterolateral margins not extending to posterior margin of pleonite 5, acute; pleonite 4 with 1 median tubercle (the largest) and 10 sublateral tubercles on each side (set as two rows), posterolateral margin of pleonite 4 rounded, clearly extending beyond posterior margin of pleonite 5; pleonite 5 with 2 submedian and 2 sublateral tubercles on each side and posterolateral angles overlapped by lateral margins of pleonite 4. Pleotelson (Fig. 10E) 0.8 times as long as anterior width; with 2 submedian tubercle rows on dorsal surface (4 tubercles each) and a median row of small palmate setae; lateral margins straight, middle margins with wave-like nodules, posterior margin narrowly rounded, without median point, with 6 RS.

Antennula (Fig. 9G) peduncle articles 1 and 2 fused; articles 3 and 4 0.7 times as long as combined lengths of articles 1 and 2, article 3 1.8 times as long as wide; flagellum with 8 articles, extending to anterior of pereonite 1. Antenna (Fig. 9D) peduncle article 4 2.0 times as long as wide, 1.7 times as long as article 3, and 2 short simple setae and 1 palmate seta (distal); article 5 as long as article 4, 2.6 times as long as wide, anterodistal angle with cluster of 3 short simple and 2 palmate setae; flagellum with 19 articles, extending to posterior of pereonite 4.

Frontal lamina (Fig. 9E) pentagonal, 2.4 longer than greatest width, lateral margins anteriorly straight, diverging slightly towards anterior, anterior margin straight and acute, forming median point.

Mandible (Fig. 10C) molar process anterior margin with 21 flat teeth; with proximal cluster of long simple setae; right mandible spine row composed of 9 spines; palp article 2 with 13 distolateral setae, palp article 3 with 5 robust biserrate and 12 plumose setae. Maxillule (Fig. 10B) mesial lobe with 3 large and circumplumose RS; lateral lobe with 11 RS. Maxilla (Fig. 10D) lateral lobe with 5 long simple setae; middle lobe with 16 long simple setae; mesial lobe with 8 distal simple setae, with 4 proximal simple and plumose setae. Maxilliped (Fig. 10A) palp article 2 mesial margin with 5 slender setae, lateral margin distally with 1 slender seta; article 3 mesial margin with 11 slender setae, lateral margin with 8 slender setae; article 4 mesial margin with 10 slender setae, lateral margin with 4 slender setae; article 5 distal margin 11 setae, lateral margin with 3 setae; endite with 3 long CPS, and 2 coupling setae.

Pereopod 1 (Fig. 11A) basis 1.9 times as long as greatest width, superior distal angle without cluster of acute setae, inferior distal angle with cluster of 3 acute setae; ischium 0.6 times as long as basis, inferior margin with 2 setae, inferior distal margin with 1 RS, superior distal margin with 2 RS; merus inferior margin with 6 molariform RS, set as 2 and 4, with 2 simple setae, inferior distal margin without RS, superior distal angle with 2 RS; carpus inferior margin with 1 RS and 1 simple seta; propodus 1.9 times as long as wide, inferior margin with 2 RS, inferior distal margin with 1 large RS and 1 simple seta, superior distal with 2 simple setae; dactylus 0.8 as long as propodus. Pereopod 2 (Fig. 11B) ischium inferior margin with 1 long acute RS, inferior distal margin with 3 RS and 1 simple seta, superior distal margin with 1 long acute seta and 1 plumose seta; merus inferior margin with 4 stout RS and 1 RS, set as single row, inferior distal margin with 1 stout RS and 2 RS, superior distal margin with 1 long acute RS, 1 small RS and 1 plumose seta; carpus inferior distal margin with 2 RS and 1 acute RS; propodus 2.6 as long as wide, with 2 clusters of acute RS, inferior margin with 2 RS, inferior distal margin with 1 large RS and 2 simple setae; dactylus 0.8 as long as propodus. Pereopod 3 similar to pereopod 2. Pereopod 6 (Fig. 11C) similar to pereopod 7. Pereopod 7 (Fig. 11D) basis 1.9 times as long as greatest width, superior margin convex with 3 palmate setae, inferior margin convex; ischium 0.6 as long as basis, inferior margin with 7 RS (set in group of 3 and 4), inferior distal angle with 2 acute and 2 blunt RS, superior distal angle with 4 RS (1 biserrate); merus 0.8 as long as ischium, 1.9 times as long as wide, inferior margin with 3 RS, superior distal angle with 9 RS (2 biserrate), inferior distal angle with 7 RS (1 blunt); carpus 0.8 as long as ischium, 2.4 times as long as wide, inferior margin with 2 RS, superior distal angle with 16 biserrate RS, inferior distal angle with 8 RS (2 biserrate); propodus 1.1 as long as ischium, 4.2 times as long as wide, inferior margin with 2 clusters of RS (set as 1 and 2), superior distal angle with 2 slender setae, 1 plumose seta and 2 RS, inferior distal angle with 2 RS; dactylus 0.5 as long as propodus.

Penes (Fig. 10G) opening flush, penial openings separated by 11% of sternal width.

Pleopod 1 (Fig. 12A) exopod 1.4 times as long as wide, lateral margin straight, distally broadly rounded, mesial margin strongly convex, with PMS from distal one-third, with ~33 PMS; endopod 2.1 times as long as wide, distally narrowly rounded, lateral margin proximally concave, with PMS from distal one-third, mesial margin with PMS on distal margin only, endopod with ~17 PMS; peduncle 1.7 times as wide as long. Pleopod 2 (Fig. 12B) exopod with ~45 PMS, endopod with ~19 PMS; appendix masculina with parallel margins, as long as endopod, distally acute. Pleopod 3 (Fig. 12C) exopod with ~51 PMS, endopod with ~14 PMS. Pleopod 4 (Fig. 12D) exopod with ~52 PMS, endopod with ~12 PMS. Pleopod 5 (Fig. 12E) exopod with ~50 PMS. Pleopods 2–5 peduncle distolateral margin with prominent acute RS, 3–5 endopods with distomesial serrate scales.

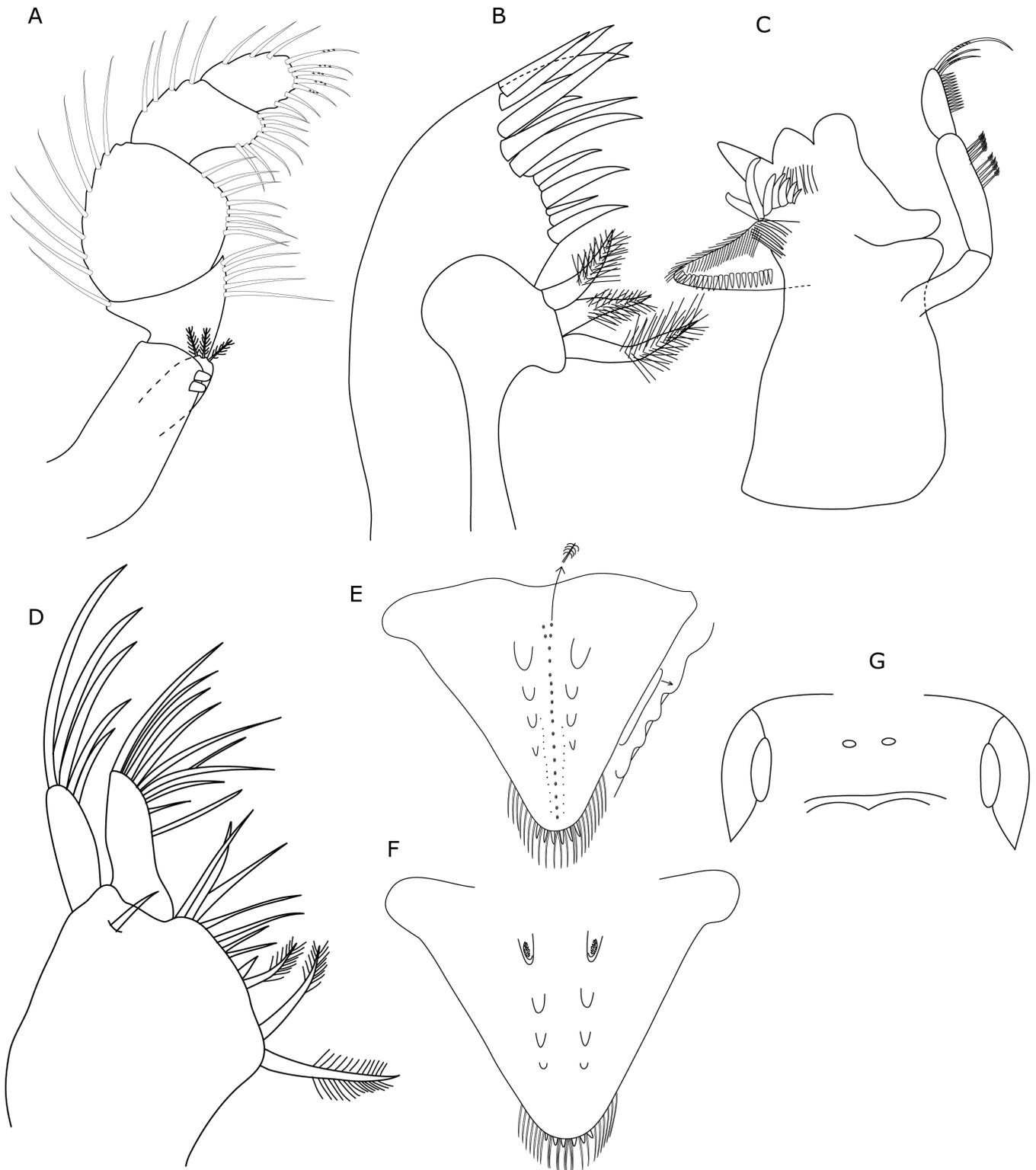


Fig. 10. *Cirolana fasztes* n. sp. A–E, G, paratype male (7.2 mm) (MZB Cru.Iso 091), Raja Ampat, Indonesia. F, paratype female (5.9 mm) (MZB Cru.Iso 091), Raja Ampat, Indonesia. A, maxilliped; B, maxillule; C, right mandible; D, maxilla; E, pleotelson male; F, pleotelson female; G, penial openings.

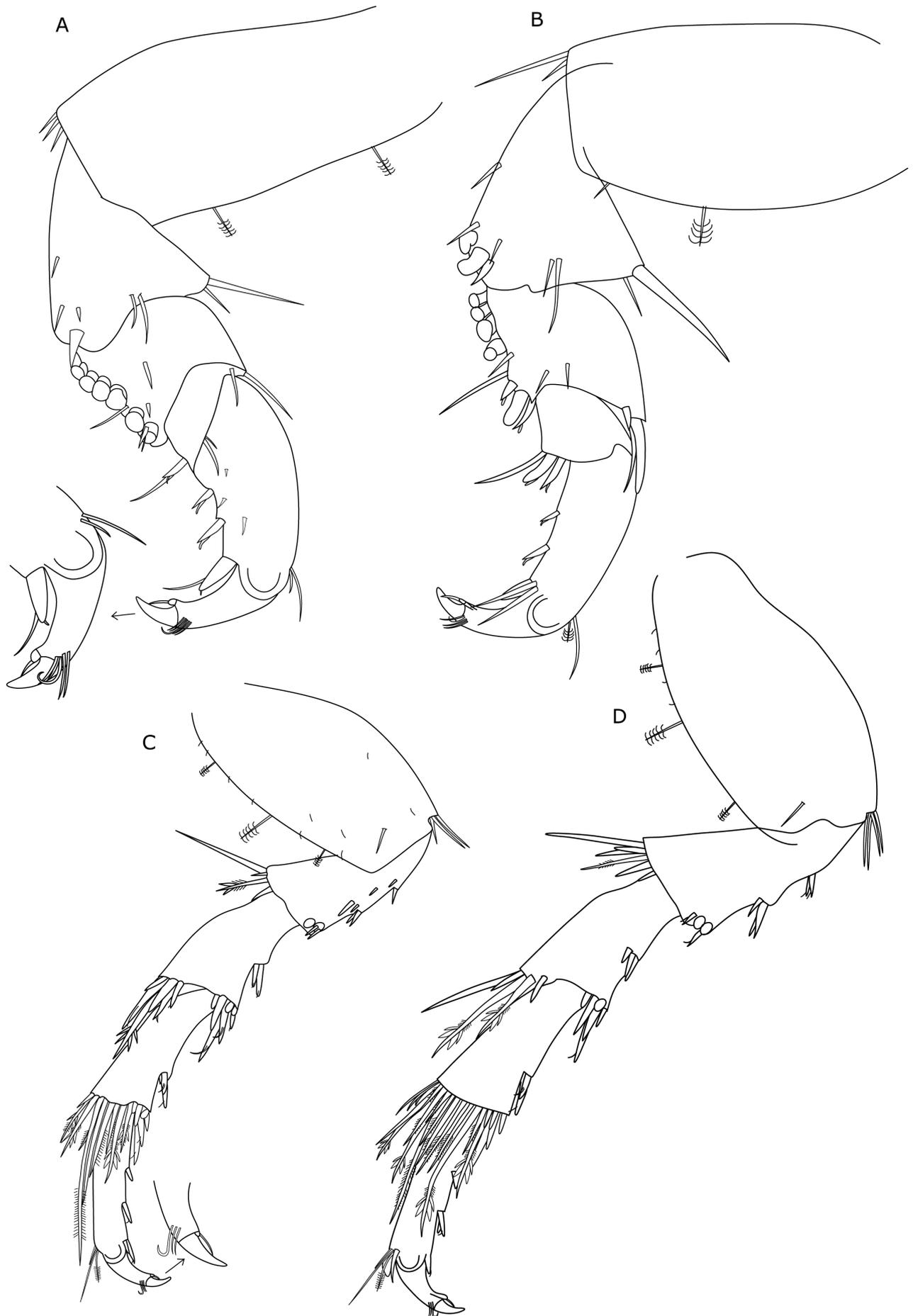


Fig. 11. *Cirolana fassfes* n. sp. A–D, paratype male (7.2 mm) (MZB Cru.Iso 091), Raja Ampat, Indonesia. A, pereopod 1; B, pereopod 2; C, pereopod 6; D, pereopod 7.

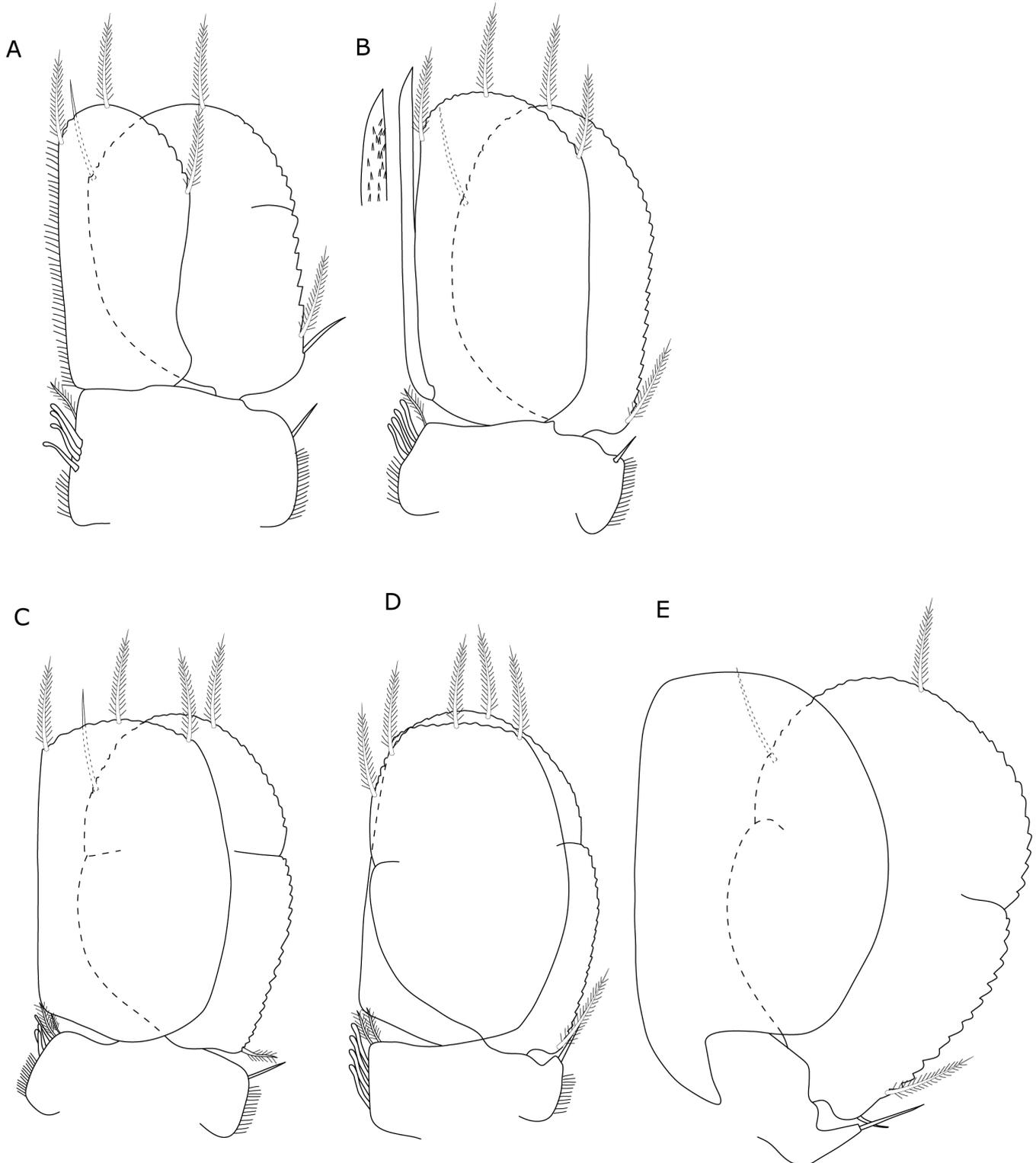


Fig. 12. *Cirolana fasztes* n. sp. A–E, paratype male (7.2 mm) (MZB Cru.Iso 091), Raja Ampat, Indonesia. A, pleopod 1; B, pleopod 2; C, pleopod 3; D, pleopod 4; E, pleopod 5.

Uropod (Fig. 9H–9I) peduncle ventrolateral margin without RS, lateral margin with medial short acute RS, posterior lobe about 1.1 as long as endopod; rami extending beyond pleotelson, marginal setae in single tier, apices not bifid with lateral process. Endopod apically rounded in male and not bifid in female with lateral process; lateral margin distally straight, proximal lateral margin without RS; distal lateral margin with 1 RS, mesial margin convex, with 7 RS. Exopod extending beyond end of endopod, 1.1 (0.8 in female) times as long as endopod, 3.2 (2.6 in female) times as long as greatest width, apically subtruncate (in male) and not bifid (in female) with lateral process; lateral margin straight, proximally convex, with 3 visible widely separated RS, distal with setal fringe; mesial margin straight, with 2 RS.

Female. Female differs in lacking a median row of small setae on the pleotelson (Fig. 10F). The uropodal exopod is shorter than the male (0.8 vs. 1.1 LW) and narrower (2.6 vs. 3.2 LW) with a narrower apex and lacks the setal mass on the posterior lateral margin.

Size. Males 5.9–7.5 mm, mean 6.9 mm (n=16); non-ovigerous females 4.9–7.4 mm, mean 6.2 mm (n=49); all from type series.

Variation. RS count was measured from 9 specimens of type series. Uropod exopod lateral: 3 = 77.8%, 4 = 22.2%; mesial: 2 = 22.2%, 3 = 77.8%. Uropod endopod lateral: 1 = 11.1%, 2 = 88.9%; mesial: 6 = 22.2%, 7 = 77.8%. Pleotelson: 6 = 100%.

Remarks. *Cirolana fasfes*, new species, is characterised by the presence of small irregular submarginal nodules on posterior margins of pereonites 7 only; pleonites 3 and 4 with 1 large median tubercle and sublateral tubercles; and 4 submedial tubercles and wave-shaped nodules on lateral margins of the pleotelson. The wave-like series of nodules on lateral margin of pleotelson are not easy to observe, needing critical lighting to be seen clearly at a magnification of 20 times or higher. *Cirolana curtensis* Bruce, 1986 shows similar marginal nodules on the pleotelson but is proportionally more slender (0.7 vs. 0.8 LW), has only two small submedial tubercles on the pleotelson (vs. two rows with four prominent tubercles each), has truncate pleotelson (vs. narrowly rounded), has more close set penial openings (7% vs. 11% in *C. fasfes*), and lacks of setal fringe on posterior of the uropodal exopod.

Distribution. Raja Ampat, West Papua, Indonesia; 10 to 40 metres.

Etymology. Fasfes is the Biak language for curly, alluded to the wavy shape of the nodules on the lateral margin of pleotelson; noun in apposition.

Cirolana lembeh, new species
(Figs. 13–16)

Material examined. All Indonesia. Holotype, male (4.8 mm) (MZB Cru.Iso 094), Lembah Strait, Bitung, North Sulawesi,

01°27'31.7"N, 125°14'02.2"E, trap 60 m, coll. B. Hermanto and C. Sidabalok, 24 July 2014.

Paratypes. 2 males (4.9 [dissected], 5.2 mm), 1 female (6.3 mm [dissected]) (MZB Cru.Iso 095), same data as holotype; 2 males (4.8, 4.9 mm) (MTQ W34886), same data as holotype.

Description. Body 3.0 (Fig. 13A) times as long as greatest width, dorsal surfaces punctate, widest at pereonite 5, lateral margins subparallel. Rostral point absent. Eyes (Fig. 13E) separated by about 75% width of head, eye colour black. Pereonite 1 and coxae 2–3 (Fig. 13B) each with posteroventral angle rounded; coxae 5–7 with entire oblique carina; posterior margins of pereonites 5–7 without irregular submarginal nodules. Pleon (Fig. 14E) with pleonite 1 largely concealed by pereonite 7; pleonites 3–5 posterior margin with regular nodules; posterolateral angles of pleonite 2 forming acute point, extending posteriorly to anterior of pleonite 3; pleonite 3 without median tubercle and 2 sublateral tubercles on each side, posterolateral margins not extending to posterior margin of pleonite 5, acute; pleonite 4 without median tubercle and 4 sublateral tubercles on each side, posterolateral margin of pleonite 4 rounded, clearly extending beyond posterior margin of pleonite 5; pleonite 5 without median tubercle and 2 sublateral tubercles on each side and posterolateral angles overlapped by lateral margins of pleonite 4. Pleotelson (Fig. 14F) 0.7 times as long as anterior width; with a median row of fine setae; lateral margins straight, slightly convex towards posterior, margins smooth, posterior margin subtruncate, without median point, with 6 robust setae.

Antennula (Fig. 13C) peduncle articles 1 and 2 fused (suture present); articles 3 and 4 0.7 times as long as combined lengths of articles 1 and 2, article 3 1.4 times as long as wide; flagellum with 9 articles, extending to anterior of pereonite 1. Antenna (Fig. 13D) peduncle article 4 2.4 times as long as wide, 1.7 times as long as article 3, and 2 short simple setae and 1 palmate seta (distal); article 5 as long as article 4, 2.6 times as long as wide, anterodistal angle with cluster of 2 short simple and 2 palmate setae; flagellum with 18 articles, extending to posterior of pereonite 4.

Frontal lamina (Fig. 13F) pentagonal, 2.0 longer than greatest width, lateral margins straight, diverging slightly towards anterior, anterior margin concave and acute, forming median point.

Mandible (Fig. 14A) molar process anterior margin with 15 flat teeth; with proximal cluster of long simple setae; right mandible spine row composed of 6 spines; palp article 2 with 10 distolateral setae, palp article 3 with 14 plumose setae. Maxillule (Fig. 14B) mesial lobe with 3 large and circumplumose RS; lateral lobe with 12 RS. Maxilla (Fig. 14C) lateral lobe with 4 long simple setae; middle lobe with 11 long simple setae; mesial lobe with 4 distal simple setae, proximally with 5 proximal simple and plumose setae. Maxilliped (Fig. 14D) palp article 2 mesial margin with 4 slender setae, lateral margin distally with 1 slender seta; article 3 mesial margin with 12 slender setae, lateral margin with 4 slender setae; article 4 mesial margin with

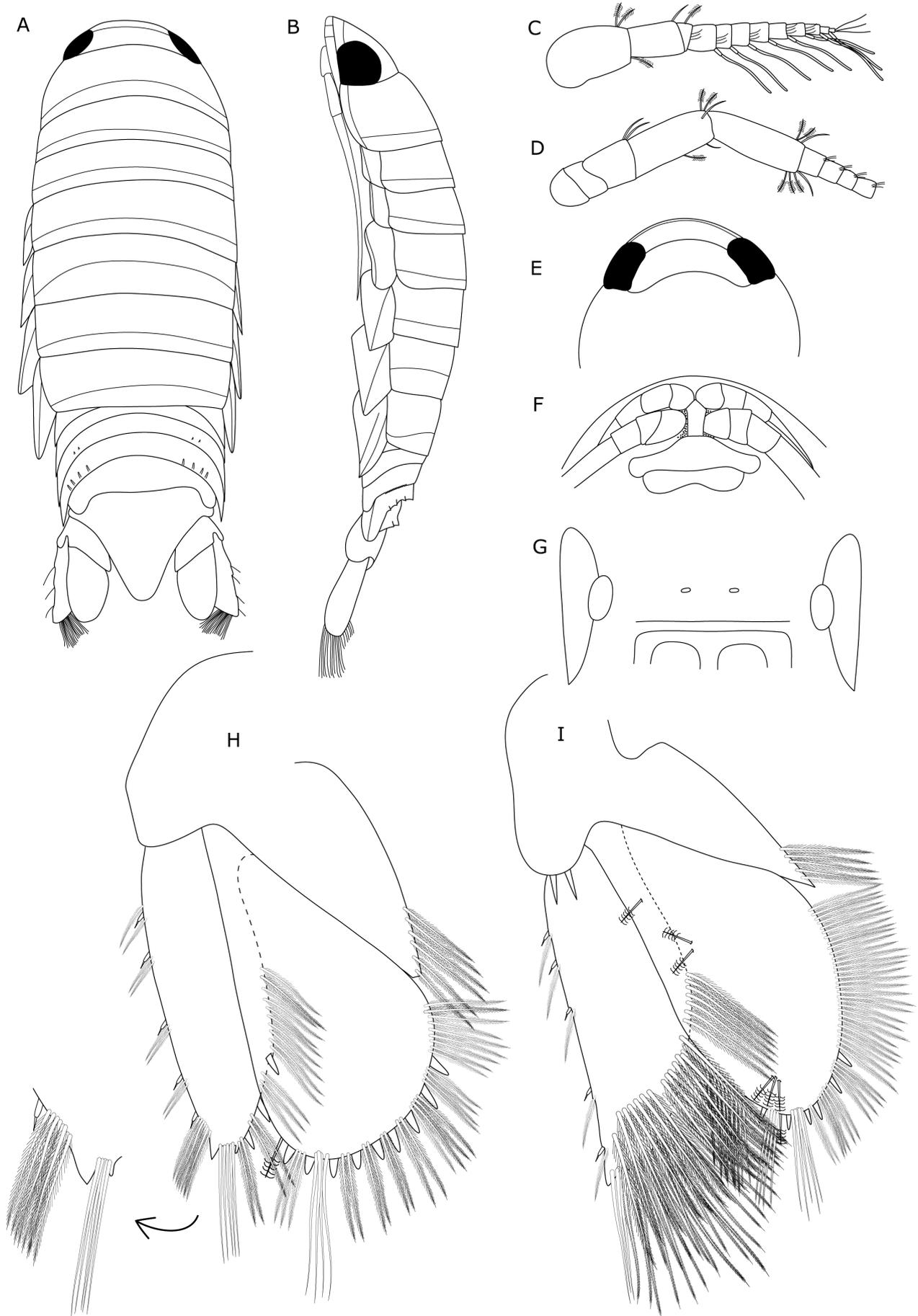


Fig. 13. *Cirolana lembeh* n. sp. A–B, E–G, holotype male (4.8 mm) (MZB Cru.Iso 094), Bitung, Indonesia. C, D, I, paratype male (4.9 mm) (MZB Cru.Iso 095), Bitung, Indonesia. H, paratype female (6.3 mm) (MZB Cru.Iso 095). A, dorsal view; B, lateral view; C, antennula; D, antenna peduncle; E, head; F, frontal lamina; G, penial openings; H; uropod female; I, uropod male.

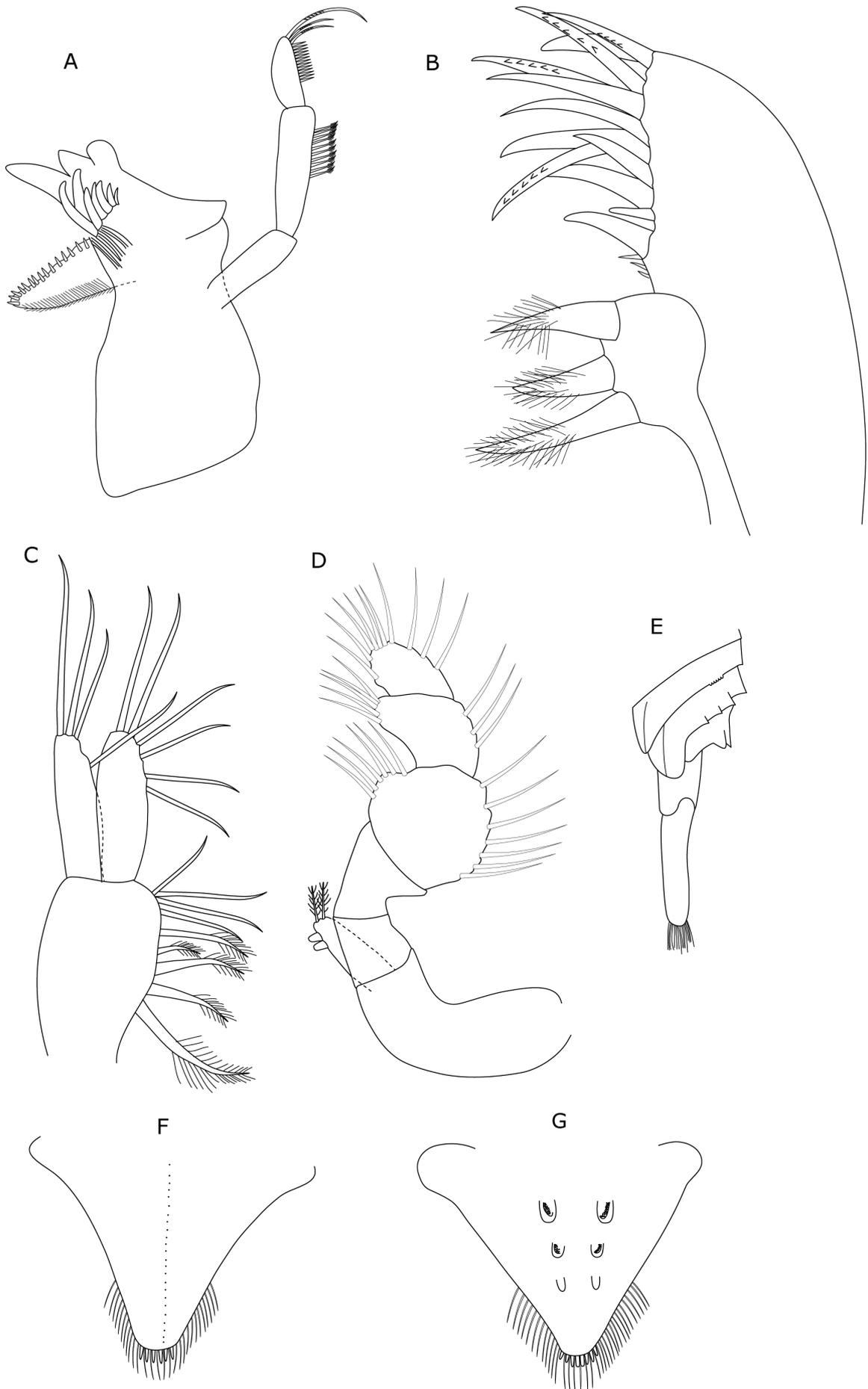


Fig. 14. *Cirolana lembeh* n. sp. A–F, paratype male (4.9 mm) (MZB Cru.Iso 095), Bitung, Indonesia. G, paratype female (6.3 mm) (MZB Cru.Iso 095). A, right mandible; B, maxillule; C, maxilla; D, maxilliped; E, pleon; F, pleotelson male; G, pleotelson female.

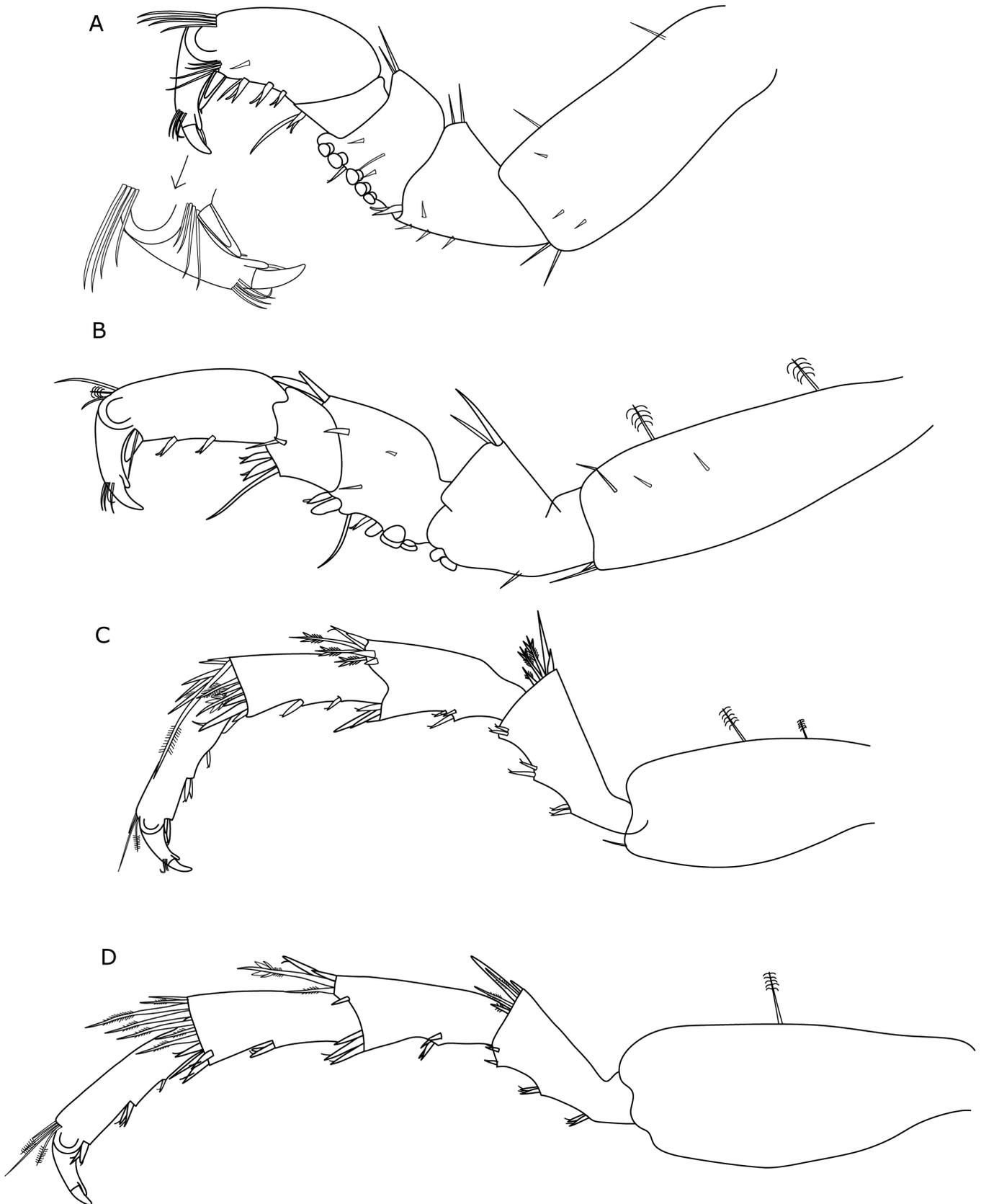


Fig. 15. *Cirolana lembeh* n. sp. A–D, paratype male (4.9 mm) (MZB Cru.Iso 095), Bitung, Indonesia. A, pereopod 1; B, pereopod 2; C, pereopod 6; D, pereopod 7.

11 slender setae, lateral margin with 4 slender setae; article 5 distal margin 17 setae, lateral margin with 5 setae; endite with 3 long CPS, and 2 coupling setae.

Pereopod 1 (Fig. 15A) basis 2.3 times as long as greatest width, superior distal angle without cluster of acute setae, inferior distal angle with cluster of 2 acute setae; ischium 0.5 times as long as basis, inferior margin with 3 setae, inferior distal margin with 1 RS, superior distal margin with 2 RS; merus inferior margin with 5 molariform RS, set as 2 and 3, with 3 simple setae, inferior distal margin with 1 RS, superior distal angle with 1 RS; carpus inferior margin with 1 RS and 1 simple seta; propodus 2.1 times as long as wide, inferior margin with 3 RS, inferior distal margin with 2 large RS and 4 simple setae, superior distal with 4 simple setae; dactylus 0.8 as long as propodus. Pereopod 2 (Fig. 15B) ischium inferior margin with 2 simple setae, inferior distal margin with 2 RS, superior distal margin with 2 long acute setae; merus inferior margin with 3 stout RS and 1 RS, set as single row, inferior distal margin with 1 stout RS and 1 acute RS, superior distal margin with 2 long acute RS; carpus inferior distal margin with 3 acute RS and 1 long simple seta; propodus 3.3 as long as wide, with 2 clusters of acute RS, inferior margin with 2 RS, inferior distal margin with 1 large RS and 1 simple seta; dactylus 0.8 as long as propodus. Pereopod 3 similar to pereopod 2. Pereopod 6 (Fig. 15C) similar to pereopod 7. Pereopod 7 (Fig. 15D) basis 2.4 times as long as greatest width, superior margin straight with 1 palmate seta; ischium 0.5 as long as basis, inferior margin with 4 RS (set in group of 2 and 2), inferior distal angle with 2 RS (1 blunt), superior distal angle with 6 RS (3 biserrate); merus as long as ischium, 2.2 times as long as wide, inferior margin with 3 RS, superior distal angle with 6 RS (2 biserrate), inferior distal angle with 4 RS; carpus 0.9 as long as ischium, 2.3 times as long as wide, inferior margin with 2 RS, superior distal angle with 8 RS (4 biserrate), inferior distal angle with 8 RS (2 biserrate); propodus as long as ischium, 4 times as long as wide, inferior margin with 2 clusters of RS (set as 2 and 1), superior distal angle with 1 slender seta, 1 plumose seta and 2 RS, inferior distal angle with 2 RS; dactylus 0.5 as long as propodus.

Penes (Fig. 13G) opening flush, penial openings separated by 19% of sternal width.

Pleopod 1 (Fig. 16A) exopod 1.3 times as long as wide, lateral margin straight, distally broadly rounded, mesial margin strongly convex, with PMS from distal one-third, with ~25 PMS; endopod 1.9 times as long as wide, distally broadly rounded, lateral margin straight and proximal weakly convex, with PMS from distal one-third, mesial margin with PMS on distal margin only, endopod with ~12 PMS; peduncle 1.4 times as wide as long. Pleopod 2 (Fig. 16B) exopod with ~31 PMS, endopod with ~12 PMS; appendix masculina with parallel margins, as long as endopod, distally acute. Pleopod 3 (Fig. 16C) exopod with ~38 PMS, endopod with ~11 PMS. Pleopod 4 (Fig. 16D) exopod with ~36 PMS, endopod with ~10 PMS. Pleopod 5 (Fig. 16E) exopod with ~42 PMS. Pleopods 2–5 peduncle distolateral margin

with prominent acute RS, 3–5 endopods with distomesial serrate scales.

Uropod (Fig. 13H–13I) peduncle ventrolateral margin with 2 RS, lateral margin with medial short acute RS, posterior lobe about as long as endopod; rami extending beyond pleotelson, marginal setae in three tiers, apices not bifid. Endopod apically narrowly rounded; lateral margin weakly convex, proximal lateral margin with 1 RS; distal lateral margin with 1 RS, mesial margin convex, with 4 RS. Exopod as long as endopod both in male and female, 2.8 (2.9 in female) times as long as greatest width, apically not bifid; lateral margin straight with setal fringe on the posterior, with 5 visible widely separated RS; mesial margin convex, with 3 RS (female).

Female. Female differs with male in having two submedian tubercles rows on dorsal surface (3 tubercles each) (vs. a median row of fine setae) and 8 RS (vs. 6 RS) of the pleotelson (Fig. 14G). The exopod lacks the dense setal fringe on the posterior lateral margin and has a more convex lateral margin and less convex mesial margin (with the similar LW proportion), while the endopod mesial margin is more convex.

Size. Males 4.8–5.2 mm, mean 4.9 mm (n=5); non-ovigerous female 6.3 mm (n=1); all from type series.

Variation. RS count was measured from all type series (n=6). Uropod exopod lateral: 4 = 16.7%, 5 = 83.3%; mesial: 3 = 100% (n=1 female, cannot be observed from males). Uropod endopod lateral: 2 = 83.3%, 3 = 16.7%; mesial: 4 = 66.7%, 5 = 33.3%. Pleotelson: 6 = 83.3%, 8 = 16.7%.

Remarks. The defining characters of *Cirolana lembeh*, new species, are the lack of submarginal nodules on the posterior of pereonite 6, the submedian row of fine setae on dorsal surface of pleotelson, and in the male the large mass of setae on the mesial margin of the uropodal exopod; the penial openings are notably wide apart, separated by 19% sternal width. Similar pattern on male pleotelson is also found in *C. curtensis* Bruce, 1986. **Distribution.** Lembeh Strait, Bitung, North Sulawesi, Indonesia.

Etymology. Named for the type locality; noun in apposition.

***Cirolana curtensis* Bruce, 1986**
(Figs. 16–17)

Cirolana curtensis Bruce, 1986: 152, fig 103.—Keable, 1995: 36.—Bruce, Lew Ton & Poore, 1992: 142.

Material examined. All Australia. Holotype, male (6.3 mm) (QM W9805), Calliope River mouth, Gladstone, Queensland, 23°50'S, 151°15'E, Van Veen grab, coll. P. Saenger & J. Moverley, between 1975 and 1980.

Paratypes. 1 male (7.5 mm [dissected and illustrated]), 1 female (7.9 mm [dissected and illustrated]), same data as holotype. Unexamined paratypes: 35 males and females (QM W9806); also QM W9808 and W9809.

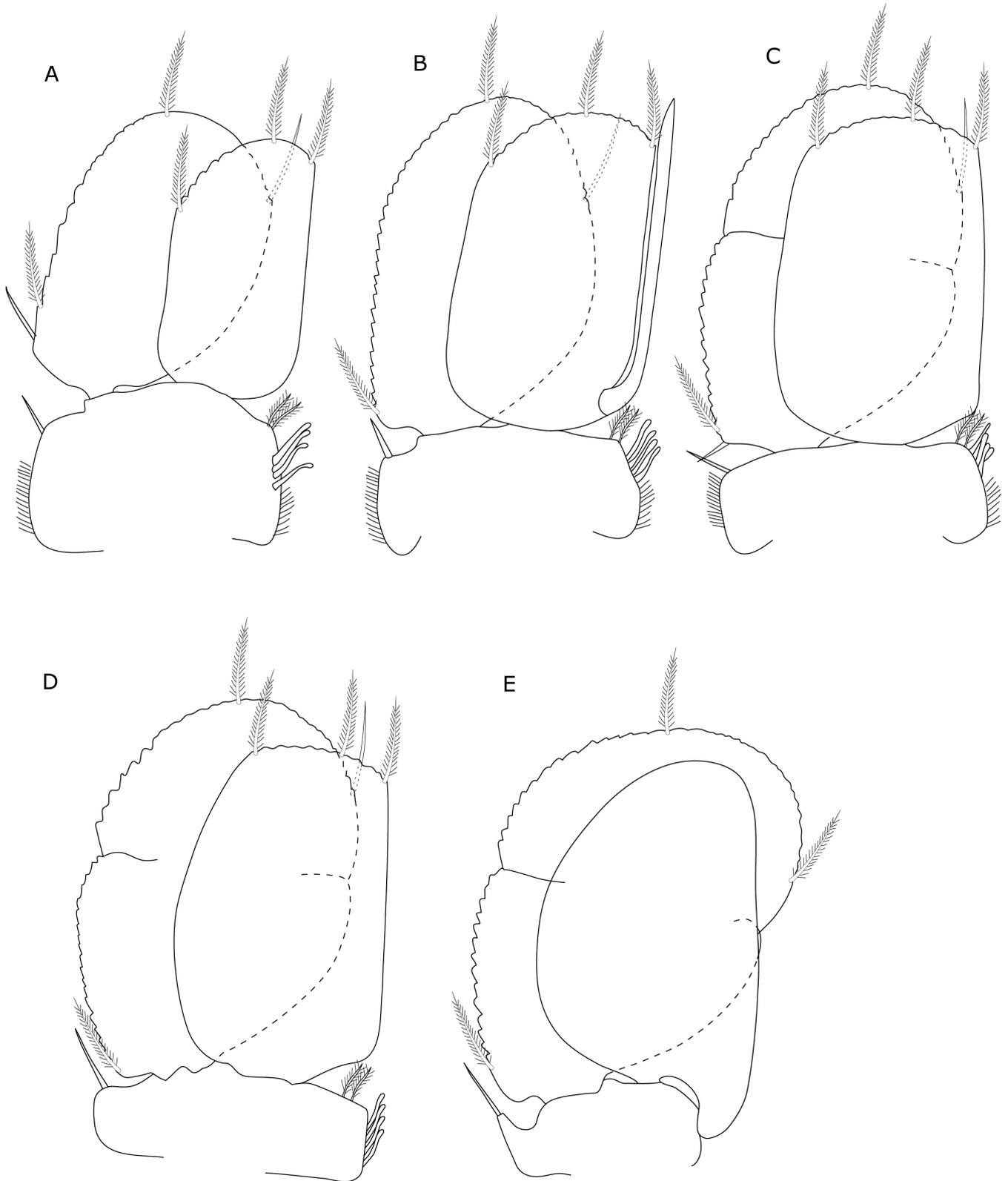


Fig. 16. *Cirolana lembeh* n. sp. A–E, paratype male (4.9 mm) (MZB Cru.Iso 095), Bitung, Indonesia. A, pleopod 1; B, pleopod 2; C, pleopod 3; D, pleopod 4; E, pleopod 5.

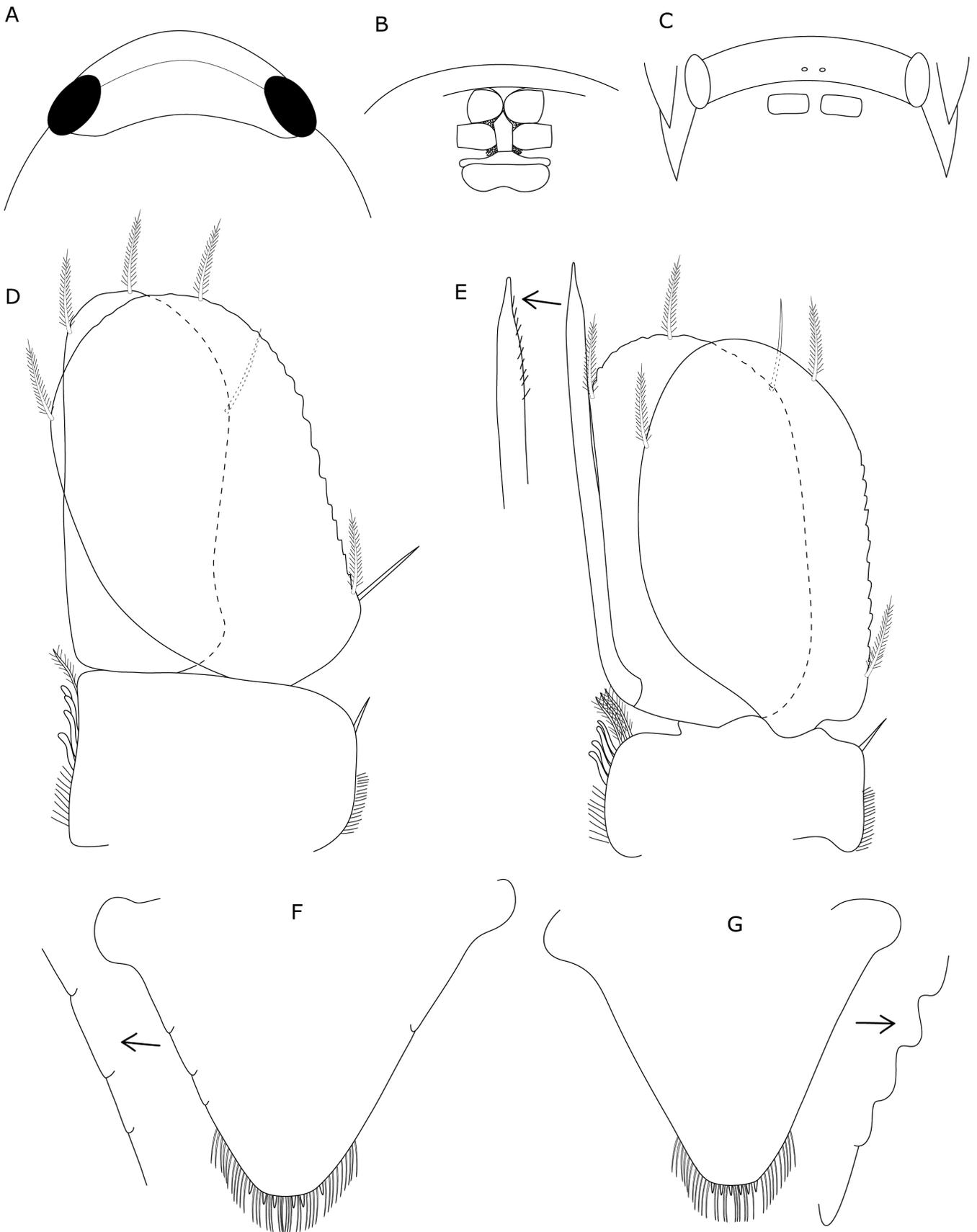


Fig. 17. *Cirolana curtensis* Bruce, 1986. A–C, holotype male (6.3 mm) (QM W9805), Queensland, Australia. D–F paratype male (7.5 mm) (QM W9806), Queensland, Australia. G, paratype female (7.9 mm) (QM W9806), Queensland, Australia. A, head; B, frontal lamina; C, penial openings; D, pleopod 1; E, pleopod 2; F, pleotelson male; G, pleotelson female.



Fig. 18. *Cirolana curtensis* Bruce, 1986. A–D, paratype male (7.5 mm) (QM W9806), Queensland, Australia. A, pereopod 1; B, pereopod 7; C, uropod male; D, uropod female.

Supplementary description. Body 2.5 times as long as greatest width, dorsal surfaces punctate, widest at pereonite 5, lateral margins subparallel. Rostral point absent. Eyes (Fig. 17A) separated by about 85% width of head, eye colour black. Pereonite 1 and coxae 2–3 each with posteroventral angle rounded; coxae 5–7 with entire oblique carina; posterior margins of pereonites 7 with irregular submarginal nodules. Pleon with pleonite 1 largely concealed by pereonite 7; pleonites 3–5 posterior margin with regular small nodules; posterolateral angles of pleonite 2 forming acute point, extending posteriorly to anterior of pleonite 3; pleonite 3 without median tubercle and 9 sublateral tubercles on each side, posterolateral margins not extending to posterior margin of pleonite 5, acute; pleonite 4 with 1 median tubercle and 10 sublateral tubercles on each side, posterolateral margin of pleonite 4 rounded, clearly extending beyond posterior margin of pleonite 5; pleonite 5 with 1 median tubercle and 5 sublateral tubercles on each side and posterolateral angles overlapped by lateral margins of pleonite 4. Pleotelson (Fig. 17F, 17G) 0.7 times as long as anterior width; with 2 submedian tubercle rows on dorsal surface (1 tubercle each); lateral margins straight, margins smooth, posterior margin truncate, without median point, with 6 robust setae.

Frontal lamina (Fig. 17B) pentagonal, 2.3 longer than greatest width, lateral margins straight, diverging slightly towards anterior, anterior margin acute, forming median point.

Pereopod 1 (Fig. 18A) basis 2.5 times as long as greatest width, superior distal angle without cluster of acute setae, inferior distal angle with cluster of 2 acute setae; ischium 0.6 times as long as basis, inferior margin without seta, inferior distal margin with 2 RS, superior distal margin with 2 RS; merus inferior margin with 6 molariform RS, set as 2 and 4, with 1 simple seta, inferior distal margin without RS, superior distal angle with 3 RS; carpus inferior margin with 1 RS and 1 simple seta; propodus 2.5 times as long as wide, inferior margin with 2 RS, inferior distal margin with 1 large RS and 1 simple seta, superior distal with 3 simple setae; dactylus 0.7 as long as propodus. Pereopod 7 (Fig. 18B) basis 1.8 times as long as greatest width, superior margin convex, inferior margin without palmate seta; ischium 0.6 as long as basis, inferior margin with 2 RS (set in group of 3 and 3), inferior distal angle with 4 RS, superior distal angle with 5 RS (1 biserrate); merus 0.8 as long as ischium, 1.9 times as long as wide, inferior margin with 2 RS, superior distal angle with 8 RS (5 biserrate), inferior distal angle with 6 RS; carpus as long as ischium, 0.7 times as long as wide, inferior margin with 2 RS, superior distal angle with 10 RS (7 biserrate), inferior distal angle with 9 RS (4 biserrate); propodus as long as ischium, 4.3 times as long as wide, inferior margin with 2 clusters of RS (set as 1 and 2), superior distal angle with 3 slender setae, 1 plumose seta and 1 RS, inferior distal angle with 2 RS; dactylus 0.6 as long as propodus.

Penes (Fig. 17C) opening flush, penial openings separated by 7.0% of sternal width.

Pleopod 1 (Fig. 17D) exopod 1.6 times as long as wide, lateral margin straight, distally narrowly rounded, mesial margin weakly convex, with PMS from distal one-third, with ~35 PMS; endopod 2.3 times as long as wide, distally narrowly rounded, lateral margin strongly concave, with PMS from distal one-third, mesial margin with PMS on distal margin only, endopod with ~17 PMS; peduncle 1.6 times as wide as long. Pleopod 2 (Fig. 17E) exopod with ~46 PMS, endopod with ~17 PMS; appendix masculina with parallel margins, 1.1 times as long as endopod, distally acute. Pleopods 2–5 peduncle distolateral margin with prominent acute RS, 3–5 endopods with distomesial serrate scales.

Uropod (Fig. 18C, 18D) peduncle ventrolateral margin with 2 RS, lateral margin with medial short acute RS, posterior lobe about as long as endopod; rami extending beyond pleotelson, marginal setae in single tier, apices not bifid. Endopod apically not bifid; lateral margin proximally convex, distally straight, proximal lateral margin without RS; distal lateral margin with 1 RS, mesial margin straight and weakly convex, with 7 RS. Exopod extending to end of endopod, 3.3 times as long as greatest width, apically not bifid; lateral margin straight, with 3 sparse RS; mesial margin convex, with 3 RS.

Female. The uropodal exopod is lacking the setal fringe on the posterior lateral margin, otherwise similar of male.

Remarks. *Cirolana curtensis* is most similar to *C. fasfes*, new species, in having a similarly shaped uropod, pattern of nodules on dorsal of pleotelson (with female of *C. fasfes*), the presence of the wavy nodules on pleotelson margin. See the remarks on *Cirolana fasfes* for the differences. In the original description the holotype was stated to be as female whereas it is actually male, and the size is 6.3 mm (not 7.3 mm).

Distribution. Only known from the Calliope River, Gladstone, Queensland.

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