

Cirolana and related marine isopod crustacean genera
(family Cirolanidae)
from the coral reefs of Madang,
Papua New Guinea*

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Résumé : Douze espèces de crustacés isopodes cirolanides sont signalées dans les récifs coralliens autour de Madang. Le genre *Cirolana* est représenté par 7 espèces dont *Cirolana pleonastica* et 6 espèces nouvelles qui sont : *C. cristata*, *C. leptanga*, *C. glebula*, *C. grumula*, *C. repigrata*, *C. wongat*. Les autres espèces signalées sont *Excirolana orientalis*, *Pseudolana brevifimbria*, *Natatolana albicaudata*, *Natatolana variguberna*, et l'espèce commensale d'un crinoïde *Cartetolana integra*.

Abstract : Twelve species of cirolanid isopod crustaceans are reported from the coral reefs around Madang. The genus *Cirolana* is represented by 7 species, *Cirolana pleonastica*, and 6 new species : *C. cristata*, *C. leptanga*, *C. glebula*, *C. grumula*, *C. repigrata*, *C. wongat*. Other species recorded are *Excirolana orientalis*, *Pseudolana brevifimbria*, *Natatolana albicaudata*, *Natatolana variguberna*, and the crinoid commensal *Cartetolana integra*.

INTRODUCTION

This paper is the second of a projected series describing the cirolanid and flabelliferan isopods from the coral reefs and adjacent habitats of the Madang region of Papua New Guinea. The first (Bruce, 1993) described two new cirolanid genera, while the present contribution documents the genus *Cirolana* Leach, and the new records for the genera *Natatolana*, *Cartetolana*, *Excirolana* and *Pseudolana*. The cirolanid genera that remain to be treated are *Eurydice* Leach, 1815 (1 species), *Metacirolana* Nierstrasz, 1931 (circa 5 species), *Booralana* Bruce, 1986 (1 species), and *Bathynomus* Mine Edwards, 1879 (1 or 2 species).

One species of *Cirolana*, *C. stenoura* Bruce, 1986, has previously been recorded from the area at Kranket Island, but was not recollected. Species of *Anopsilana* can reasonably be expected to occur in local mangrove and estuarine habitats, two species being common and widespread in the Indo-Pacific (Bruce, 1986), but these habitats were not sampled.

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MATERIAL AND METHODS

The methodology employed here follows that of my earlier publications. Material deposited at the Zoologisk Museum University of Copenhagen, (the holotype and an equal proportion of paratypes or of identified specimens) is to be regarded as being held in trust until such time as its return to Papua New Guinea is requested by the national authorities.

Descriptions in full detail are given for the first species described or redescribed in each "group". Here these are *Cirolana leptanga* sp. nov. and *Cirolana pleonastica* Stebbing. For the remaining species descriptions include species specific characters and always include the first and second pleopods and the penial openings or penial processes. Those species for which only limited material was available (*Cirolana cristata* sp. nov., *C. glebula* sp. nov.) are described rather more briefly.

Abbreviations used : AM - Australian Museum, Sydney, New South Wales, Australia ; CRI - Christensen Research Institute, Madang, Papua New Guinea ; ZMUC - Zoologisk Museum, University of Copenhagen, Denmark ; BL - body length ; CP - circumplumose ; CPS - circumplumose setae ; PMS - plumose marginal setae.

TAXONOMY

Family Cirolanidae Dana
Genus *Cirolana* Leach

Restricted synonymy :

Cirolana Leach, 1818 ; 347. Bruce, 1986 : 139. Kensley and Schotte, 1989 : 132. Brusca, Wetzer and France, 1995 (in press).

The *Cirolana* 'parva-group'

Remarks : The *Cirolana* 'parva-group' was defined by Bruce (1986), and is a readily recognized and characterized group of species within the genus *Cirolana*. All species have smooth polished dorsal body surfaces, and lack heavily calcified pereonites or nodulose and rugose body surfaces. All species have a rostral point which is ventrally reflexed to meet the frontal lamina. All species have continuous marginal setae on the uropod rami, interspersed with acute spines ; all species have apically acute uropods, with bifid or sub-bifid apices, and the rami are never rounded. Males may have a dense setule fringe on the posterior margin of pereopod 1. Penial processes are either small and papillose (may be fused) or absent.

Species of this group occur in all oceans, with the possible exception of the polar regions, and are common within tropical and temperate waters, generally at shallow depths within the continental shelf. Species of the *C. parva* group are a common component of the

isopod fauna of coral reefs, and are usually the commonest cirolanid encountered on the reef flat and shallow hard reef.

Most tropical regions have at least two species of this group present, and many undescribed species are known to exist. The species are difficult to discriminate, and great care must be taken in making identifications. In most cases males are essential to describe a species, and an accurate assessment of pleotelson and uropodal spine counts is also essential.

A list of the species of this group is given here, together with a synoptic distribution and reference to the most recent revision.

1. *Cirolana albidoidea* Kensley and Schotte, 1987. Grand Bahamas, tropical western Atlantic ; 180-220 m.
2. *Cirolana arafurae* Bruce, 1986. Kei Islands, Indonesia ; 15-25 m.
3. *Cirolana australiense* Hale, 1925. Southeastern Australia from Moreton Bay, Queensland to the South Australia coast ; intertidal to "shallow subtidal" (Bruce, 1986).
4. *Cirolana brocha* Bruce, 1986. Queensland coast, Australia, from Hinchinbrook Island to Heron Island ; intertidal.
5. *Cirolana chaloti* Bouvier, 1901. Libreville, Gabon, West Africa ; this species has fine radiating carinae on the pleotelson (Bruce, 1982).
6. *Cirolana diminuta* Menzies, 1962. California ; intertidal to 43 m (Brusca *et al.* 1995).
7. *Cirolana erodiae* Bruce, 1986. Great Barrier Reef, Australia, and Coral Sea reefs ; intertidal to 12 m.
8. *Cirolana hesperia* Bruce, 1986. Southern and southwestern coasts of Western Australia ; 2-60 m.
9. *Cirolana improceros* Bruce, 1986. Tropical northeastern Australia from Cobourg Peninsula, Northern Territory to Hinchinbrook Island, Queensland ; intertidal to a recorded depth of 4 m.
10. *Cirolana kiliani* Müller, 1993. Caribbean coast of Colombia ; 11-30 m.
11. *Cirolana leptanga* sp. nov. Madang, Papua New Guinea ; coral rubble on sand and subtidal sandy bottoms within the barrier reef and outer reef slope to 59 m.
12. *Cirolana mascarenensis* Müller, 1991. Mascarene Islands, southern Indian Ocean ; intertidal.
13. *Cirolana mekista* Bruce, 1986. Tropical Australian mainland coast from Broome, Western Australia, to Gladstone, Queensland ; intertidal to shallow subtidal.
14. *Cirolana meseda* Hobbins and Jones, 1993. Central Red Sea ; 731-1850 m ; the only species with a wide bathymetric distribution. Although regarded as most similar to *Cirolana cranchi* Leach by Hobbins and Jones (1993), the description suggests that it could belong to the *Cirolana parva*-group. The penial processes are more prominent than in the other species, and the remarks given for the species imply that there is no rostral point.
15. *Cirolana* sp. nov. Brusca, Wetzer and France, 1995. Galapagos Islands and Pacific coasts of Colombia ; intertidal and shallow subtidal.

16. *Cirolana* sp. nov. Brusca, Wetzer and France, 1995. Central and southern Gulf of California ; intertidal and shallow subtidal.
17. *Cirolana paraerodiae* Müller, 1993. Bora Bora and Mooréa, French Polynesia ; intertidal.
18. *Cirolana parva* Hansen, 1890. The most frequently recorded species of the group ; tropical Western Atlantic and East Pacific ; intertidal to a depth of 55 m (Bruce and Bowman 1982 ; Brusca *et al.* 1995 ; Müller 1993).
19. *Cirolana portula* Bruce, 1986. Victoria and Tasmania, Australia, 3 localities only ; recorded at depths of 8-12 m.
20. *Cirolana repigrata* sp. nov. Madang, Papua New Guinea ; coral rubble, intertidal to 30 m.
21. *Cirolana stenoura* Bruce, 1986. Northeastern Australia from Darwin, Northern Territory to Lizard Island, Queensland, and northwards to Kranket Island, Madang, Papua New Guinea ; intertidal.
22. *Cirolana solitaria* Bruce, 1986. Solitary Islands, New South Wales, Australia ; intertidal.
23. *Cirolana austaliense* Naylor, 1961. Chatham Island, New Zealand. Naylor proposed the name as a new species, so creating a junior homonym of *Cirolana austaliense* Hale, 1925. The two species are not the same, and Naylor's taxon needs a full redescription to allow its separation from the related species in the southwestern Pacific before it can be usefully renamed. Naylor apparently did not designate type specimens for this species.

Unresolved Indo-Pacific records of this group (usually as *Cirolana parva* or *Cirolana* sp.) are listed here. **Indian Ocean** : Ismailia, Gulf of Suez (Monod 1933) ; Red Sea (Stebbing 1910) ; Kenya (Jones 1976) ; Madagascar (Roman 1970) ; Moçambique (Barnard 1914) ; Chilka Lake, India (Chilton 1924) ; Sri Lanka (Stebbing 1905) ; Andaman Islands (Barnard 1936) ; Thailand (Chilton 1926) ; Misool, Aru Is., and Timor Is. (Nierstrasz 1931, ? = *C. arafurae*, in part). **Pacific Ocean** : Samoa (Hansen 1890) ; Polynesia (Nobili 1907, ? = *C. paraerodiae*) ; Hawaii (Miller 1968).

The record of Hamsa and Nammalwar (1978) is of a species of *Natatolana*.

Cirolana leptanga sp. nov.

(Figs 1-4)

Material examined.

Holotype. ♂ (6.4 mm), south of Tripod Reef, Madang lagoon, 5°09.8'S, 145°51.3'E, 30 Apr 1989, baited trap on sand bottom, 30 m, coll. N.L. Bruce (ZMUC CRU186).

Paratypes. 15 ♂ (5.0-6.4 mm, mean = 5.6 mm [dissected male #1 6.3 mm, #2 6.0 mm]). 22 females (4.9-6.5 mm), same data as holotype (ZMUC CRU187).

Also examined. ♂ (4.3 mm), south of Wongat Is., 5°08.4'S, 145°51.0'E, 3 May 1989, 33 m, outer barrier slope, coral rock on sand, coll. N.L. Bruce and M. Jebb (ZMUC CRU188). ♂ (imm 3.6 mm), manca (2.19 mm), same data as previous, but 21-25 m, coral rock on buttress (ZMUC CRU189). ♂ (5.8 mm), Wongat Is., 5°09.8'S, 145°51.3'E, channel between island and barrier reef, 2 May 1989, 24 m, trapped, sand bottom, coll. N.L. Bruce and M. Jebb (ZMUC CRU191). *Circa* 560 specimens, outer barrier between Rasch Pass and Wongat Is., 5°08.7'S, 145°49.7'E, 31 Jan 1990, trapped, 44 m coarse sand bottom next to rock face, coll. J.K. Lowry and J. Mizeu (AM P40169). Manca, outer barrier, between Rasch Pass and Wongat Is., 5°08.7'S, 145°49.7'E, 31 Jan 1990, trapped, c. 59 m, gently sloping coarse sand next to vertical drop off, coll. J.K. Lowry and J. Mizeu (AM P42559). Manca, Tab Is. reef, 33 m, outer slope, silty coral rubble (ZMUC CRU190).

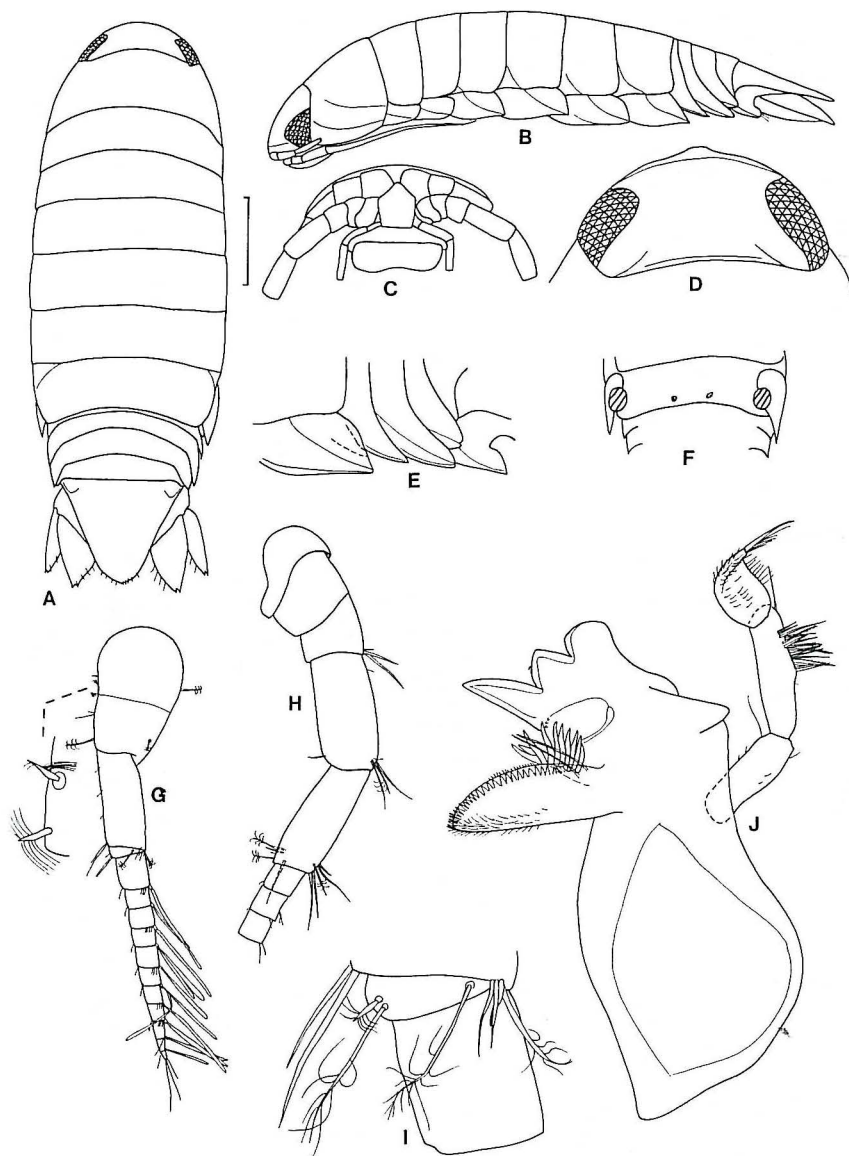


Fig. 1 : *Cirolana leptanga* sp. nov. A-F, holotype, remainder ♂ paratype 6.2 mm. A, dorsal view ; B, lateral view ; C, frons ; D, cephalon, dorsal view ; E, pleonites, lateral detail ; F, sternite 7 showing penial openings ; G, antennule ; H, antennal peduncle ; I, antennule peduncle article 4 ; J, right mandible. Scale for A and B : 1.0 mm.



Fig. 2: *Cirolana leptanga* sp. nov. ♂ paratype 6.2 mm. A, maxilliped ; B, maxilliped endite ; C, maxilla ; D, maxillule lateral lobe ; E, maxillule medial lobe ; F, pereopod 1 ; G, pereopod 1, dactylus ; H, pereopod 2.

Description of male : Body about 2.8 times as long as greatest width ; maximum width at pereonites 5 and 6. Cephalon with submarginal anterior suture, interocular suture lacking. Pereonite 1 each with 2 fine longitudinal lateral sutures ; coxae all with entire carina, posterolateral angles of coxae 5-7 acute. Pleon 11.4 % BL, pleonites 3-4 each with lateral longitudinal suture ; pleonite 1 largely concealed by pereonite 7. Pleotelson about 18.7 % BL, 87 % as long as greatest width, shield shaped, posterior margin provided with about 16 short PMS and 8 spines, each spine set within a serration.

Antennule peduncle articles 1 and 2 not fused, but suture visible ; article 3 longest, articles 1 and 2 combined 1.4 times as long as article 3 ; flagellum slightly shorter than peduncle, with 11 articles, article 1 of which is longest, extending to anterior of pereonite 1. Antenna peduncle articles 1-3 short, article 4 about 88 % as long as combined lengths of articles 1-3, article 5 subequal in length to article 4 ; flagellum extending to pereonite 4.

Frontal lamina about twice as long as basal width, lateral margins weakly diverging. Mandible spine row with 10 spines ; molar process distal and posterior margin setose, with about 26 spines along anterior margin ; 2-3 long setae arise at anteroproximal junction of molar process. Maxillule lateral lobe with 13 spines on gnathal surface, medial lobe with 3 stout CP spines, and 4th short simple spine. Maxilla lateral lobe with 5 seta, middle lobe with 9 in 2 ranks, medial lobe with about 10 CPS and distally 4 simple setae. Maxilliped palp articles 2-5 with both margins setose, those of lateral margins being longer than those of medial margins ; endite with 2 coupling hooks and 6 long CPS.

Pereopod 1 without posterior setose fringe ; ischium with 2 acute spines at anterodistal angle ; merus posterior margin with 5 blunt and 4 acute spines ; carpus with 2 small acute spines at posterodistal angle ; propodus with 2 acute spines on palm and prominent blunt spine opposing dactylus. Pereopod 2 with more numerous and larger and more robust spines than pereopod 1. Pereopod 7 basis with 2 small acute spines at posterodistal angle ; ischium posterior margin with 3 evenly spaced single acute spines, a pair and 3 spines at distal angle, anterodistal angle with 5 larger acute spines ; merus posterior margin with a cluster of 3 short acute spines and a larger cluster of about 7 long and short spines at distal angle, anterodistal angle with cluster of about 10 long acute spines several of which are finely biserrate ; carpus posterior margin with cluster of 4 short acute spines and a larger cluster of about 6 long and short spines at distal angle, anterodistal angle with cluster of about 8 long acute spines several of which are finely biserrate ; propodus posterior margin with 1, 2 and 2 short acute evenly spaced spines, with 2 spines opposing dactylus and 2 spines at anterodistal angle.

Penial openings separated by about 17 % width of sternite 7.

Pleopod 1 exopod with lateral and medial margins evenly rounded ; spines present at sub-basal proximolateral margin, about 24 PMS ; endopod about 0.58 as wide as exopod, lateral margin straight, with about 13 PMS ; peduncle with 5 coupling hooks. Pleopod 2 exopod and endopod with about 34 and 19 PMS respectively, peduncle with 4 coupling hooks ; appendix masculina straight, about 25 times as long as basal width, 1.5 times as long as endopod, narrowing evenly to narrow rounded apex. Pleopods 3 and 4 similar to each other, exopod suture only laterally distinct. Pleopod 3 exopod and endopod with about

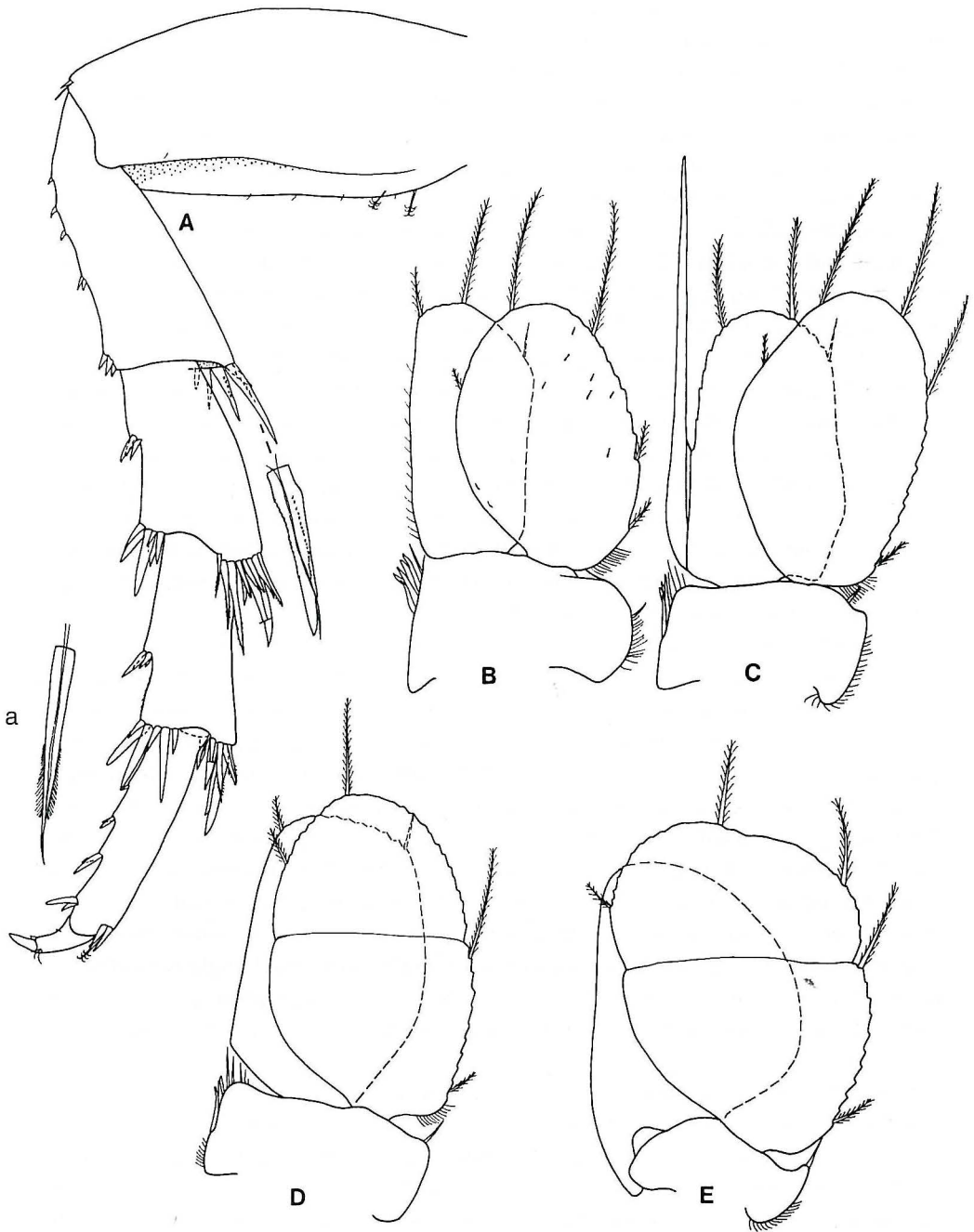


Fig. 3 : *Cirolana leptanga* sp. nov. B, C, holotype, remainder ♂ paratype 6.2 mm. A, pereopod 7, a - spine from distal margin of merus ; B-E, pleopods 1-3, 5 respectively.

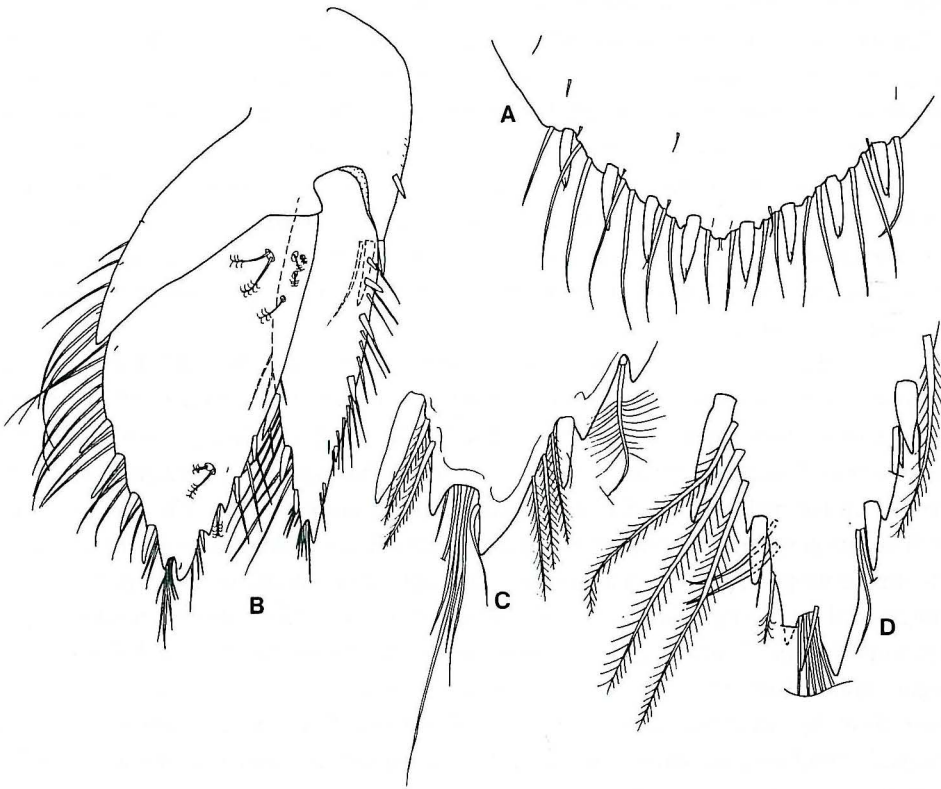


Fig. 4 : *Cirolana leptanga* sp. nov. A, pleotelson posterior margin ; B, uropod ; C, uropod endopod apex ; D, uropod exopod apex.

39 and 12 PMS respectively, peduncle with 4 coupling hooks. Pleopod 5 exopod and endopod with about 35 and 0 PMS respectively, exopod suture fine, entire, peduncle without coupling hooks. Uropod exopod about 3.7 times as long as greatest width, subequal in length with endopod ; exopod lateral margin with 6 spines and about 16 PMS, medial margin with 3 spines and about 12 PMS ; endopod about twice as long as greatest width, lateral margin nearly straight, with 3 spines and about 11 PMS on distal half of margin ; medial margin gently curved, with 4 spines and about 14 PMS ; uropod apices sub-bifid with lateral process distinctly prominent ; peduncle distolateral angle with 2 spines and 1 seta, further short acute spine on lateral margin.

Female : Similar to the male except for the primary sexual characters.

Variation : Pleotelson and uropod spine counts ($n = 20$) : telson : 4:4 - 85 % ; 4:5 - 5 % ; 4:3 - 10 % ; exopod (lateral/medial) : 6/3 - 83.9 % ; 7/3 - 12.9 % ; 6/2 - 3.2 % ; endopod (lateral/medial) : 3/4 - 66.7 % ; 3/3 - 25 % ; 2/4 - 8.3 %.

Colour : Typically clear, with scattered small rust red chromatophores, the colour persisting after preservation.

Size : Males 5.0 to 6.4 mm, females 4.9 to 6.5 mm.

Remarks : Live or freshly preserved specimens of this species can immediately be distinguished from the sympatric *Cirolana repigrata* sp. nov. by having reddish brown rather black-brown chromatophores. Morphological characters that readily separate the two species are the lack of a male pereopod 1 setal fringe in *C. leptanga* (present in *C. repigrata*), lack of complete interocular furrow (versus present), pleopod 1 endopod medial margin weakly concave (versus convex), the appendix masculina being straight with a rounded apex (versus curving laterally with an acute apex), the uropod apices with a more prominent medial process (versus subequally bifid) and differences in the spination of the posterior margin of pereopod 7.

Several other species resemble *Cirolana leptanga* (it could be said that all of the *C. parva*-group "resemble" each other), including *Cirolana arafuræ* Bruce, 1986, *Cirolana erodiae* Bruce, 1986, and *Cirolana paraerodiae* Müller, 1993. *Cirolana paraerodiae*, which is known from French Polynesia, is easily separated by having fused penial papillae, a setose fringe on the male pereopod 1 and subequally bifid uropod apices. *Cirolana arafuræ*, which occurs geographically rather closer at the Kei Islands, Indonesia, is the most similar, with similar uropod apices, penial openings and appendix masculina. That species can be distinguished by having an entire dorsal interocular furrow, and males with a setose fringe on pereopod 1, and 5 and 4 spines respectively on the uropod endopod medial and lateral margins rather than the 4 and 3 spines normal for *Cirolana leptanga*. *Cirolana erodiae*, known from the Great Barrier Reef and Australian Coral Sea, can be distinguished by the subequally bifid uropod apices and the distinctly angled appendix masculina, as well as having the penial openings more closely set.

The females of all of these four species would prove difficult to separate from mixed samples, although it is likely that the species are in fact allopatric.

A single manca was taken from among a large sample of *Cirolana pleonastica*, and is here provisionally identified as *Cirolana leptanga*. This specimen indicates the probable depth limit for the species as the dominant cirolanids at about 100 m are *Cirolana pleonastica* and then at slightly greater depths, *Aatolana rapax* Bruce, 1993.

Distribution : Known only from the Madang area of Papua New Guinea, on sandy substrata, or coral rubble and rocks on inter-reefal sand bottoms and outer reef slope to depths to 59 m.

Etymology : The epithet is derived from the combination of two Greek words *lepto* (fine, slender) and *angon* (type of javelin), and alludes to the appendix masculina.

Cirolana repigrata sp. nov.

(Figures 5, 6)

Material examined.

Holotype. ♂ (5.5 mm), Nagada Harbour, Madang, 5°09.4'S, 145°49.3'E, 25 Apr 1989, baited trap, set intertidally at CRI slipway, coll N.L. Bruce (ZMUC CRU211).

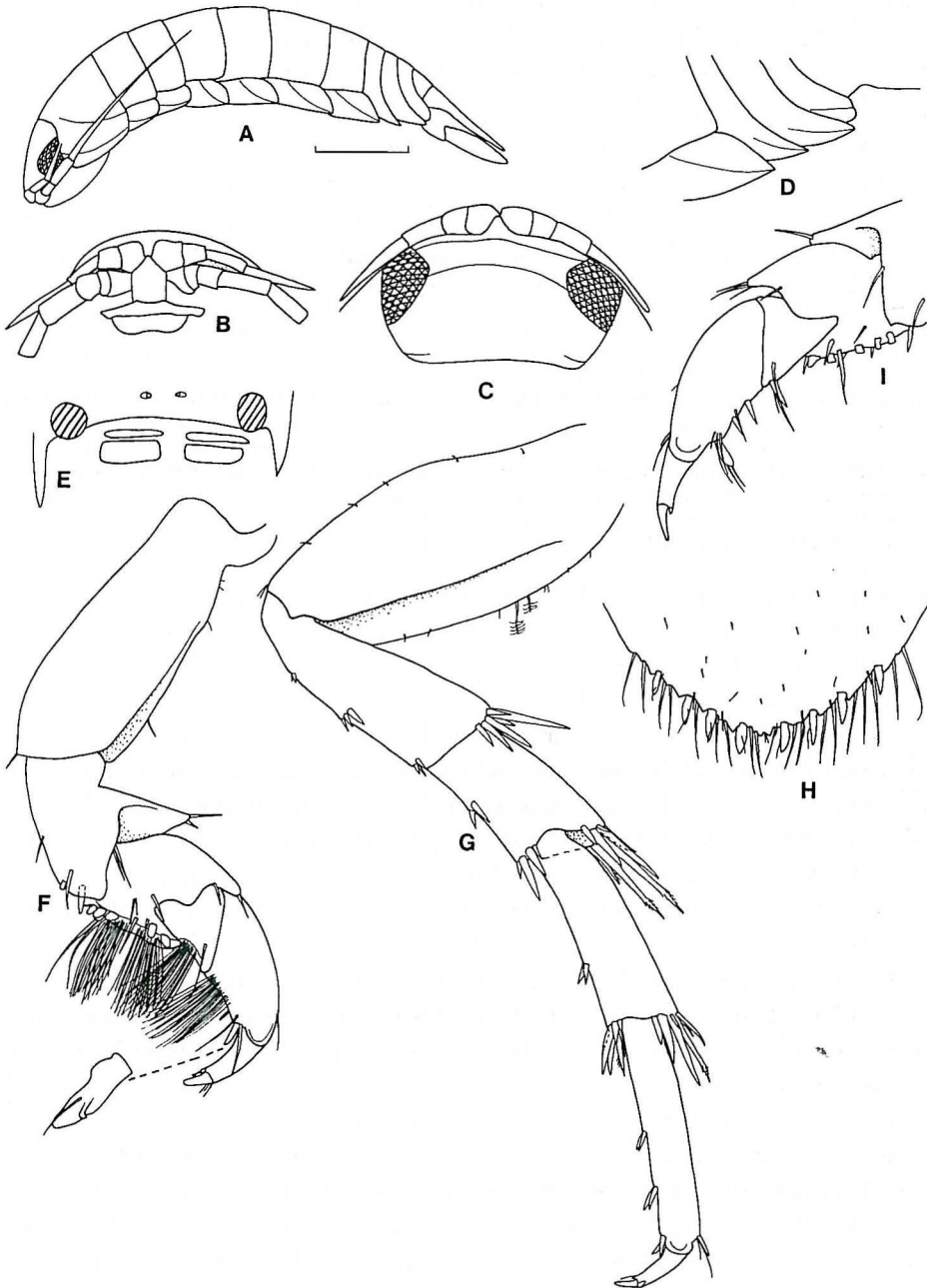


Fig. 5: *Cirolana repigrata* sp. nov. A-E, holotype, remainder ♂ paratype 4.8 mm. A, dorsal view ; B, frons ; C, cephalon, dorsal view ; D, pleonites, lateral detail ; E, sternite 7 showing penial openings ; F, pereopod 1 ; G, pereopod 7 ; H, pleotelson posterior margin ; I, female, pereopod 1. Scale for A and B : 1.0 mm.

Paratypes. 3 ♂ (4.5, 4.7, 4.8 [dissected], imm 3.7 mm), 2 ♀ (non-ovig 4.0, 4.7 mm), 6 imm (2.9 - 3.5 mm), same data as holotype (ZMUC CRU212). 6 ♂ (3.4, 4.0, 4.2, 4.2, 4.5, imm 3.6 mm), 6 ♀ (ovig 3.9, 4.4, non-ovig 3.4, 3.7, 3.7, 4.0 mm), 7 imm (3.0-3.4 mm), imm 3.6 mm), 6 ♀ (ovig 3.9, 4.4, non-ovig 3.4, 3.7, 3.7, 4.0 mm), 7 mm (3.0-3.4 mm), 8 mancas (1.7-2.7 mm), Wongat Is., 5°08.1'S, 145°50.6'E, 25 Apr 1989, at about low tide level, wave cut platform, *Lithothamnion*, coll. N.L. Bruce and M. Jebb (ZMUC CRU213). ♂ (5.9 mm). ♀ (ovig 3.8, non-ovig 3.5 mm), northwest corner of Wongat Is., 5°08.1'S, 145°50.6'E, 1 May 1989, 1-2 m, semi-exposed rubble among alcyonarians, coll. N.L. Bruce (ZMUC CRU219). ♂ (4.4 mm), 3 ♀ (ovig 4.0, non ovig 4.7, 4.9 mm), Wongat Is., 5°08.1'S, 145°50.6'E, 25 Apr 1989, 10 m, seaward reef slope, coll. N.L. Bruce and M. Jebb (ZMUC CRU216). ♀ (non-ovig 4.3 mm), Masamoz Reef., 5°08.1'S, 145°50.3'E, 18 Apr 1989, 18 m, coral rubble at base or reef slope, coll. N.L. Bruce and M. Jebb (ZMUC CRU218). ♀ (ovig 4.7 mm), 2 mancas, Masamoz Reef., 5°08.1'S, 145°50.3'E, 24 Apr 1989, 12 m, *Acropora* rubble, dead plates, coll. N.L. Bruce and M. Jebb (ZMUC CRU214). ♂ (4.2 mm), ♀ (non-ovig 5.3 mm), 8 imm and mancas (unmeasured), south of Wongat Is., 5°08.6'S, 145°51.0'E, 29 Apr 1989, 4 m, coral rock from hard reef crest, coll. N.L. Bruce and M. Jebb (ZMUC CRU217). ♂ (4.4 mm), 1 manca, Rewa Bay, 5°07.8'S, 145°48.5'E, 20 Apr 1989, 0.5 m, dead coral, coll. N.L. Bruce and M. Jebb (ZMUC CRU220). 2 ♂ (4.4, imm 3.7 mm), 3 ♀ (ovig 4.5, 4.7, non-ovig 4.0 mm), 2 imm (unmeasured), south of Wongat Is., 5°08.4'S, 145°50.9'E, 28 Apr 1989, 7 m, barrier reef leeward slope, coarse *Halimeda* covered rubble, coll. N.L. Bruce and Rosella Uweba (ZMUC CRU215).

Other material. Circa 1300 specimens, south of Wongat Is., 5°08.5'S, 145°49.7'E, 31 Jan 1990, 17 m, trapped, transect down front reef face over dense hard coral cover, coll. J.K. Lowry and J. Mizeu (AM P40167). Circa 60 specimens, western tip of Demasa Is., across from Riwo Is., 5°08.9'S, 145°48.6'E, 30 Jan 1990, 1 m, trapped, near coral rubble, coll. J.K. Lowry and J. Mizeu (AM P40163). Immature or mancas, from 9 further stations, including Kranket Island Pass (30 m), Wongat Is., (exposed intertidal algal turf on coral), Masamoz Reef (5 m, coral rubble, and *Halimeda* and coarse sand), outer barrier slope (rubble on *Halimeda* sand, 27-30 m), Cap Croisilles (4°05.1'S, 145°48.0'E, 7 m, coral rubble) (ZMUC CRU222-230).

Description of male : (Only the details that differ from *Cirolana leptanga* are included). Cephalon with submarginal anterior suture, interocular suture present. Pleon about 14.6 % BL. Pleotelson about 19 % BL ; posterior margin with about 18 short PMS.

Antennule peduncle articles 1 and 2 not fused.

Frontal lamina about 1.4 as long as basal width, lateral margins straight.

Pereopod 1 with posterior setose fringe along merus, carpus and propodus ; ischium with 2 acute spines at anterodistal angle. Pereopod 7 ischium posterior margin with 2 clusters of 2 and 3 acute spines, anterodistal angle with 6 larger acute spines ; merus posterior margin with a cluster of 2 short acute spines and a larger of about 5 long and short spines at distal angle, anterodistal angle with cluster of about 8 long acute spines several of which are prominently biserrate ; carpus posterior margin with cluster of 2 short acute spines and a larger cluster of about 7 spines at distal angle, 2 of which are serrate, anterodistal angle with cluster of about 7 short and long acute spines some of which are prominently biserrate ; propodus posterior margin with 2 cluster of 2 short acute spines, with 2 spines opposing dactylus and 2 spines at anterodistal angle.

Penial openings separated by about 12 % width of sternite 7.

Pleopod 1 endopod about 0.85 as wide as exopod, lateral margin weakly convex. Pleopod 2 appendix masculina about 20 times as long as basal width, about 1.3 times as long as endopod, curving slightly to lateral, apex acute. Uropod exopod about 2.7 times as long as greatest width, slightly shorter (0.9) than endopod ; endopod about twice as long as greatest width ; uropod apices subequally bifid with exopod lateral process slightly more prominent.

Female : Similar to the male except for the primary sexual characters and the lack of a setose fringe on pereopod 1.



Fig. 6: *Cirolana repigrata* sp. nov. A, B, holotype remainder as indicated. A, pleopod 1 ; B, pleopod 2 ; C, uropod, ♂ paratype 4.8 mm ; D, oostegite, ♀ 4.7 mm.

Variation : Pleotelson and uropod spine counts ($n = 16$) : telson : 4:4 - 100 % ; exopod (lateral/medial) : 5/3 - 25.0 % ; 6/3 - 75.0 % ; endopod (lateral/medial) : 3/4 - 90.6 % ; 3/3 - 3.1 % ; 3/5 - 6.3 %.

Colour : Typically clear, with scattered dark brown (looking black) chromatophores, colour persisting after preservation.

Size : Males 3.5 to 5.5 mm ; females 3.4 to 4.9 mm.

Remarks : This species, slightly smaller than the sympatric *Cirolana leptanga*, can be distinguished by the characters listed in the remarks for that species.

Other similar species are *Cirolana arafuræ* and *Cirolana erodiae*. *Cirolana arafuræ* is distinguished by having the uropod apices with the lateral process prominent, the appendix masculina straight, and pleopod 1 endopod with a straight lateral margin. *Cirolana erodiae* lacks an interocular furrow, setal fringe on pereopod 1, and has a longer (1.6 vs 1.3 times as long as endopod) and more abruptly angled appendix masculina.

Distribution : Known only from the Madang area and Cap Croisilles, Papua New Guinea, where it is found commonly throughout the area on dead coral rock and rubble substrata on the hard reef ; at depths from the intertidal to 30 m.

Etymology : The epithet is derived from the Latin word *repigratus* meaning slow (witted), in reference to its readiness to enter traps.

Cirolana pleonastica Stebbing, 1900

(Figs 7-10)

Cirolana pleonastica Stebbing, 1900 : 629, Pl. LXVIIA. - Barnard, 1935 : 309, fig. 18a. Bruce, 1986 : 220.

Non *Cirolana pleonastica*.- Nordenstam, 1946 : 9 (part). Bruce, 1980 : 111, figs 2-4 (= *C. capricornica* Bruce, 1986).

Non *Cirolana pleonastica*.- Nordenstam, 1946 : 9 (part = *Cirolana* sp?).

Non *Cirolana pleonastica*.- Barnard, 1936 : 151 (= *Cirolana* sp. ?).

Non *Cirolana pleonastica*.- Chilton, 1924 : 882, fig. 4a-c, pl LV, figs 1, 2 (= *Cirolana* sp. ?).

Non *Cirolana pleonastica*.- Chilton, 1926 : 180, fig. 2a-b (= *Cirolana* sp. ?).

Non *Cirolana pleonastica*.- Jones, 1976 : 215 (= *Cirolana* sp., undescribed).

Material examined

17 mature ♂ (7.0-10.1 mm, mean = 8.3 mm), 4 ♀ (6.8, 7.0, 7.0, 7.4 mm), 13 non-ovig ♀ (6.0-7.7 mm, mean = 7.2 mm) also *circa* 88 unmeasured ♀, Madang, off outer reef slope. 5°08.4'S, 145°51.0'E, 3 May 1989, 150-200 m, baited trap, coll. N.L. Bruce (ZMUC CRU192).

Additional material. *Circa* 600 specimens (largest ♂ 12.1 mm), outer barrier, between Rasch Pass and Wongat Is., 5°08.7'S, 145°49.7'E, 1 Feb 1990, trapped, c. 100 m, gently sloping coarse sand next to vertical drop off, coll. J.K. Lowry and J. Mizeu (AM P40170). *Circa* 30 topotypic specimens, Rabaul, Blanche Bay, New Britain, 27 Jul 1962, 135 m, trapped, coll. *Noona Dan* Expedition (ZMUC CRU193).

Types : Blanche Bay, New Britain, 18 Mar 1895, 60 - 100 fms (=110-182 m), coll. Dr. A. Willey (BMNH 1906.4.19 (part 24-43)). Examined and drawn by this author in 1981.

Type locality : Blanche Bay, New Britain.

Description of male : Body about 2.3 times as long as greatest width ; maximum width at pereonite 5. Cephalon with anterior margin smoothly rounded, without rostral point, with interocular ridge, dorsal interocular suture lacking ; obscure transverse ridge at posterior of cephalon. Pereonites 1-4 without tubercles ; pereonite 1 with 2 fine longitudinal lateral sutures ; pereonites 2-5 each with transverse impressed line at about mid-point of somite, laterally with fine longitudinal impressed line ; pereonites 5-7 with elongate dorsal tubercles, those of pereonite 5 with 5 situated about median point, those of pereonites 6 and 7 running across entire width of segment, numbering about 12 and 14 respectively. Coxae all

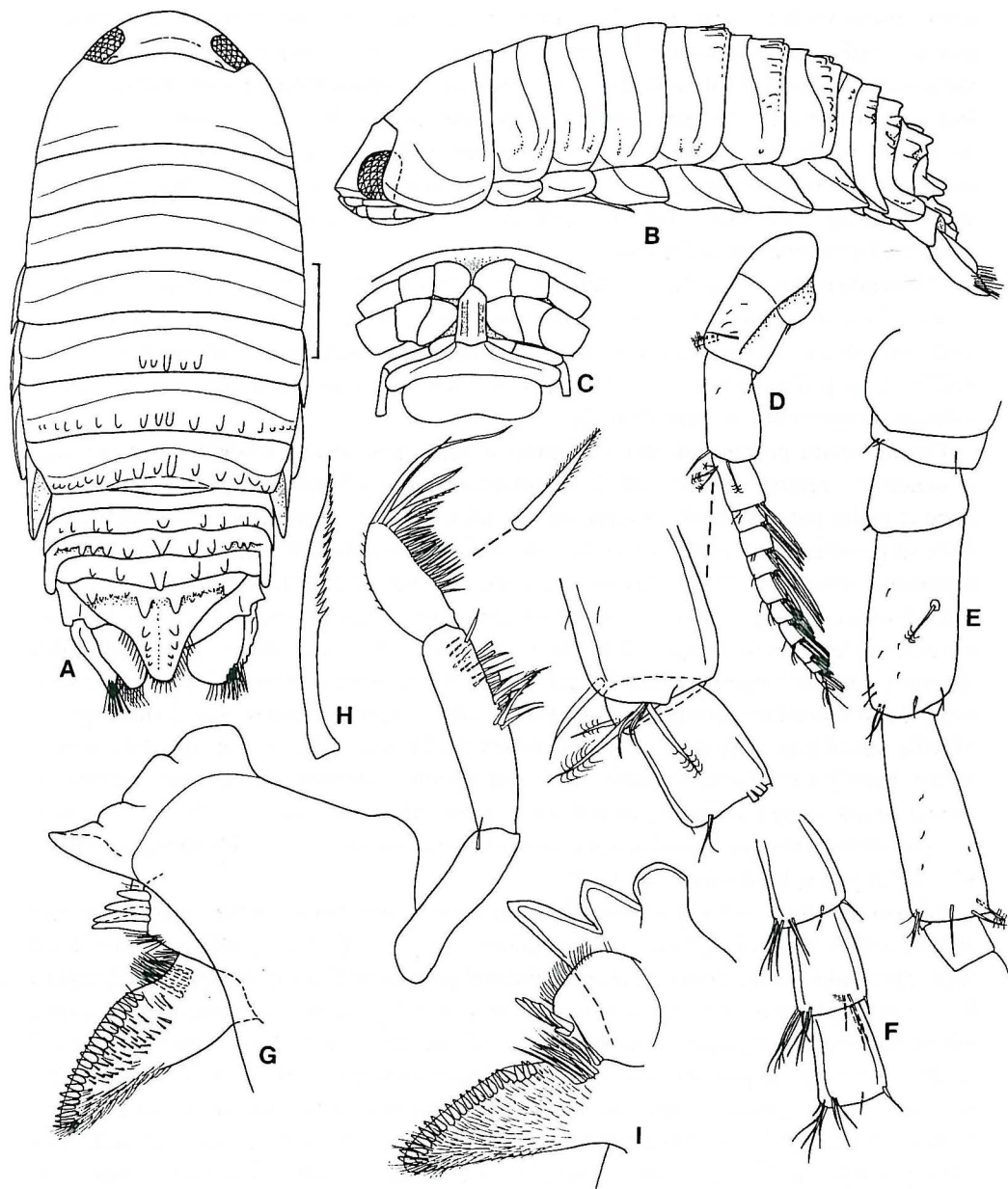


Fig. 7 : *Cirolana pleonastica* Stebbing. ♂, 9.1 mm, Madang, ZMUC. A, dorsal view ; B, lateral view ; C, frons ; D, antennule ; E, antennal peduncle ; F, antennal flagellum, articles 9-11 ; G, right mandible, distal part ; H, left mandible ; I, antennule peduncle article 4. Scale for A and B : 1.0 mm.

with entire carina, posterolateral angles of coxae 5-7 acute. Pleon about 14.3 % BL ; pleonites 1 partly visible, 2 entirely visible ; pleonites 3-5 each with prominent median tubercle, and 8, 5 and 2 tubercles on each side of pleonites 3-5 respectively, the tubercles becoming more clearly defined on posterior pleonites ; posterolateral margins of pleonite 5 project well past posterior margin of pleon. Pleotelson about 13.5 % BL ; about 71 % as long as greatest width, dorsal surface with double row of 5 submedian tubercles, which progressively decrease in size towards posterior ; lateral margins narrowing rapidly to narrow subtruncate apex, posterior margin provided with about 50 PMS extending about half way along the lateral margin, and 8 spines.

Antennule peduncle article 1 slightly shorter (0.93) than 2, article 3 1.2 times as long as 2 ; flagellum slightly shorter (0.96) than peduncle, with 11 articles, article 1 of which is longest, extending to anterior of pereonite 1. Antenna peduncle articles 1-3 short, their combined lengths equal to that of article 5 ; article 4 about 0.87 % as long as article 5 ; flagellum extending to pereonite 4, with about 24 articles.

Frontal lamina pentagonal, about 1.6 times as long as basal width, lateral margins weakly concave ; ventral surface with 2 longitudinal grooves. Mandible spine row with 5-6 spines ; molar process densely covered with setules, those of anterior face more robust than those of posterior face, anterior margin with 20-21 spines, about 6 long setae arise at anteroproximal junction of molar process ; mandible palp article 2 1.2 times as long as article 1 and 1.5 times as long as article 3, distal margin of article 2 with serrate marginal and submarginal spines, lateral margin of article 3 with about 24 serrate spines, distal 3 of which are conspicuously longest. Maxillule lateral lobe with 13 spines on gnathal surface, some of which have secondary serrations, medial lobe with 3 stout CP spines, and 2 short spines. Maxilla lateral lobe with 4 setae, middle lobe with 14 in 2 ranks of 7, medial lobe with 3 robust densely CP spines, 6 weakly CPS, and distally 3 slender simple setae, a further 4 shorter simple setae forming a row anterior to these. Maxilliped palp articles 2-5 with both margins setose, those of lateral margins being longer than those of medial margins ; endite with 2-3 coupling hooks and 5 long CPS.

Pereopod 1 stout, ischium with single acute spine at anterodistal angle ; merus posterior margin with 6 robust blunt and 3 acute spines ; carpus with 1 long seta at posterodistal angle ; propodus with 2 acute spines on palm and prominent blunt spine opposing dactylus. Pereopod 2 with more numerous and larger and more robust spines than pereopod 1 ; with 2 robust blunt spines at posterodistal margin of ischium. Pereopod 7 basis with 4 setae and 2 small acute spines at posterodistal angle ; ischium posterior margin (from proximal to distal) with 2 acute spines, 2 acute and 1 blunt and a further submarginal acute spine, 1 submarginal acute and 3 robust blunt and 1 acute spines at distal angle, anterodistal angle with 9 large simple and biserrate spines ; merus posterior margin with a cluster of 3 stout acute spines and a larger cluster of 2 robust blunt and about 5 stout spines at distal angle, anterodistal angle with cluster of about 12 long acute spines several of which are biserrate ; carpus posterior margin with 1 submarginal acute spine and cluster of 3 stout acute spines, and 2 robust blunt and 4 stout spines at distal angle, anterodistal angle with cluster of about 11 long acute spines several of which are biserrate ; propodus posterior margin with 1, 2 and 2



Fig. 8 : *Cirolana pleonastica* Stebbing. ♂, 9.1 mm, Madang, ZMUC. A, maxilla ; B, maxillule ; C, maxilliped ; D, spines, distal margin, maxilliped article 5 ; E, pereopod 1 ; F, pereopod 2 ; G, pereopod 1, medial margin of merus ; H, pereopod 7 ; I, pereopod 1, dactylus ; J, maxilliped endite.

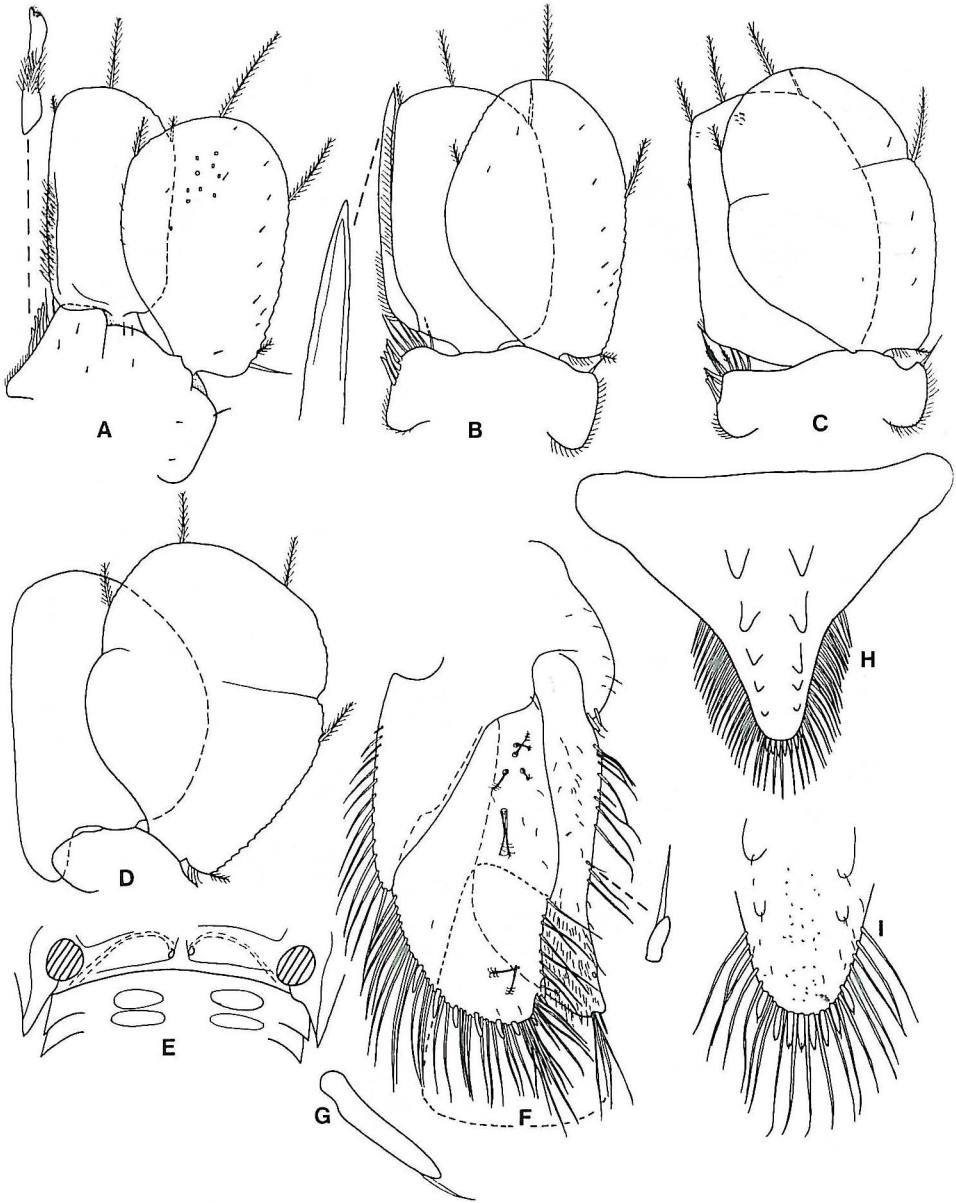


Fig. 9: *Cirolana pleonastica* Stebbing. ♂, 9.1 mm, Madang, ZMUC. A-D, pleopods 1-3, 5 respectively; E, sternite 7, showing penial openings; F, uropod, dashed line indicates limits of setal mass; G, spine from uropod endopod medial margin; H, pleotelson; I, pleotelson apex.

stout acute evenly spaced spines, with 1 spine opposing dactylus and 2 spines at anterodistal angle.

Penial openings separated by about 8 % width of pereonite 7.

Pleopod 1 exopod with lateral and medial margins evenly rounded ; spine present at sub-basal proximolateral, about 39 PMS ; endopod about 0.73 as wide exopod, lateral margin straight, with about 20 PMS ; peduncle with 4 coupling hooks. Pleopod 2 exopod and endopod with about 54 and 20 PMS respectively, peduncle with 4 coupling hooks ; appendix masculina about 12 times as long as basal width, curving very slightly towards lateral, about 0.9 times as long as endopod, narrowing evenly to narrow rounded apex. Pleopods 3 and 4 similar to each other, exopod suture only laterally distinct. Pleopod 3 exopod and endopod with about 60 and 15 PMS respectively, peduncle with 4 coupling hooks. Pleopod 5 exopod and endopod with about 60 and 15 PMS respectively, peduncle with 4 coupling hooks. Pleopod 5 exopod and endopod with about 60 and 0 PMS respectively, exopod suture only laterally distinct, peduncle without coupling hooks. Uropod exopod about 2.8 times as long as greatest width, slightly longer (1.08) than endopod ; exopod lateral margin sinuate with 3 small spines and about 12 MS, medial margin initially straight, then curving strongly, spines not readily visible, usually 4, dorsal distal surface covered by dense mass of setae ; endopod about twice as long as greatest width, lateral margin with distinct convexity along half its length, with 2 spines and about 12 PMS, medial margin curving evenly, with 6 spines and about 24 PMS ; peduncle distolateral angle with 1 spine and 1 seta.

Female : Smaller than the male, with dorsal sculpture weakly developed ; uropod spination similar to male but without the dense setal patch on the exopod, which is also less sinuate than that of the male. Oviparous females with maxillipedal lobes as illustrated.

Variation : Pleotelson and uropod spine counts : Males ($n = 15$), telson : 8 - 100 % ; exopod medial margin always 4, lateral margin 5 - 82.1 %, 6 - 10.7 %, 7 and 8-3.8 % each ; endopod lateral margin always 2, medial margin 6 - 86.7 %, 7 - 6.7 %, 8 and 3-3.3 % each. Females ($n = 15$), telson : 8 - 100 % ; exopod medial margin always 4, lateral margin always 5 ; endopod lateral margin always 2, medial margin 6 - 87.0 %, 7 - 13.0 %.

Colour : White without evident chromatophores.

Size : Males 7.0 to 12.1 mm, females 6.0 to 7.4 mm.

Remarks : *Cirolana pleonastica* has a somewhat complex synonymy, and other than the original description and the record of Barnard (1935), all records are either misidentifications or are unrecognizable. Bruce (1986) redescribed the earlier records from Australia (Nordenstam 1946 ; Bruce 1980) as *Cirolana capricornica* Bruce, 1986, and, comparing Kenyan specimens (Jones 1976, see Bruce 1986, p. 220) to the type material, concluded that record was also a misidentification.

The records of Chilton (1924, 1926) from India and Thailand, and Barnard (1936) from Ceylon are not of *Cirolana pleonastica*, but lack of adequate descriptive data and of access to the specimens precludes their assignment to any existing species, and they are regarded as being of uncertain identity. It is very probable that those records from euryhaline waters are of species belonging to the genus *Anopsilana*.

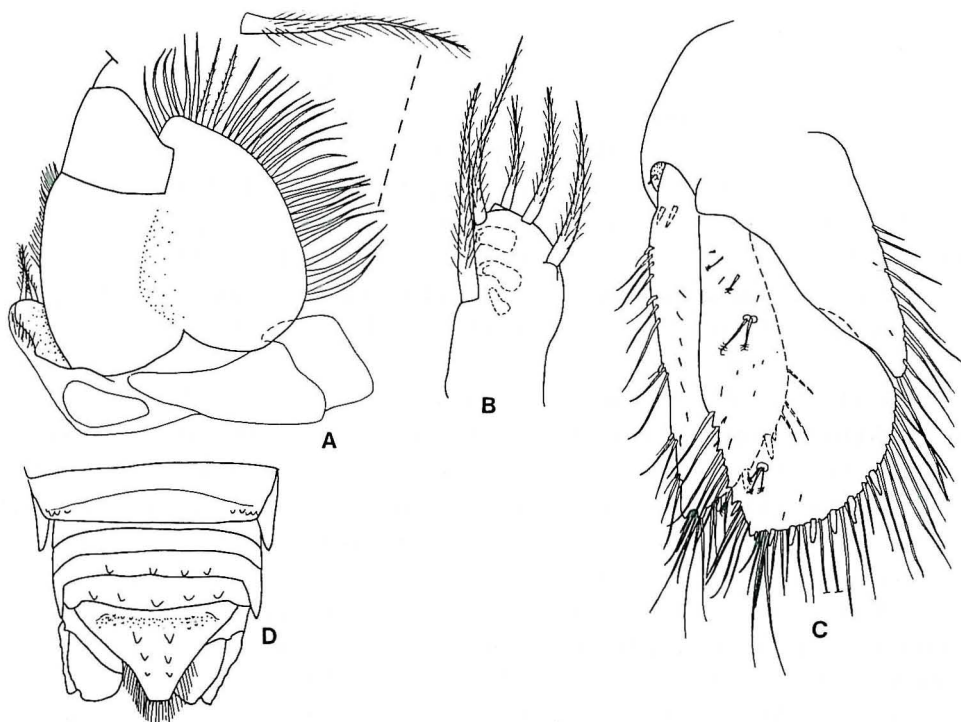


Fig. 10: *Cirolana pleonastica* Stebbing. ♀ ovig., 7.1 mm, Madang, ZMUC. A, maxilliped showing proximal lobes; B, maxilliped endite; C, uropod; D, pleon and pleoteslon, dorsal view.

The species is easily recognized by the shape and setation of the uropods, particularly the male exopod which has a dense mass of setae; the details of the pereonal, pleonal and pleoteslon sculpting in conjunction with the pentagonal frontal lamina and lack of rostral point, serve to further characterise the species.

Distribution: Madang, and Blanche Bay, New Britain, Papua New Guinea, all other records being misidentifications; sublittorally at depths between about 60 to 200 m, at Madang, off the outer slope of the barrier reef, and absent from inter-reef and reef habitats.

Cirolana grumula sp. nov.

(Figs 11, 12)

Material examined

Holotype. ♂ (5.0 mm), Christensen Research Institute slipway, 5°09.4'S, 145°49.3'E, 25 Apr 1989, among rocks at low tide level, trapped, coll. N.L. Bruce (ZMUC CRU194).

Paratypes. ♂ (5.2 mm, pleopods 2 missing), 2♀ (non-ovig 5.4, 5.8 mm), 16 manca, western end of Demasa Is., 29 Jan 1990, 1 m, sand patch among *Porites lobata* in *Enhalus* bed, coll. J.K. Lowry and J.K. Elliot (AM P40165).

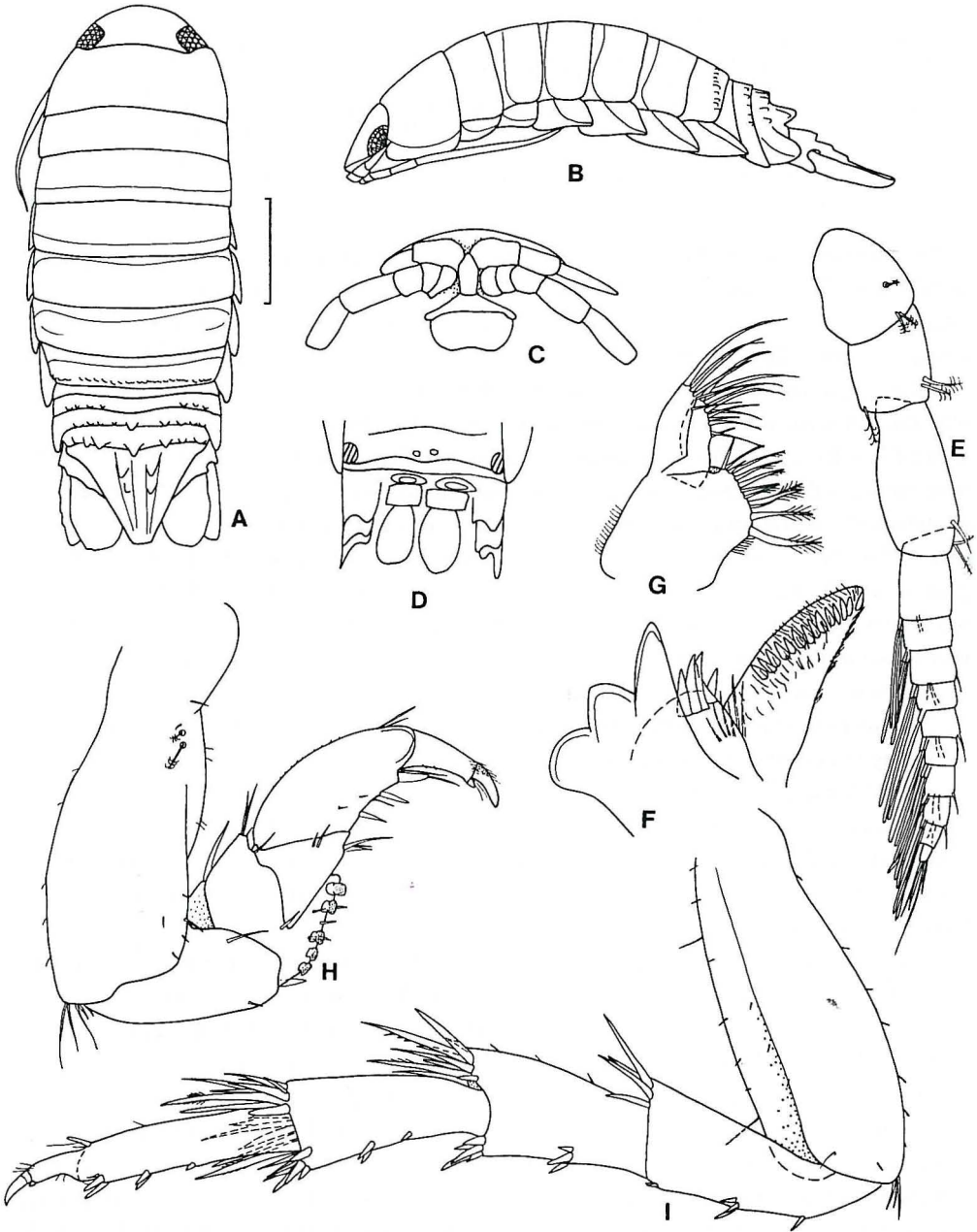


Fig. 11 : *Cirolana grumula* sp. nov. A-D, holotype, remainder ♂ paratype AM P40165. A, dorsal view ; B, lateral view ; C, frons ; D, sternite 7, showing penial papillae ; E, antennule ; F, right mandible ; G, maxilla ; H, pereopod 1 ; I, pereopod 7. Scale for A and B : 1.0 mm.

Additional material. 1 specimen, Tripod Reef, towards north tip of Paeowai Is., 5°09.75'S, 145°49.60'E, 3 Mar 1991, 29 m, sandy mud bottom, coll. J.K. Lowry and S.J. Keable (AM P41415) ; 1 specimen, manca, same as previous, but 34 m (AM P41414) ; *circa* 30 specimens, and 8 specimens, 5 mancas, small beach opposite Jais Aben Resort, 5°09.7'S, 145°48.7'E, 14 Mar 1991, intertidal, *Enhalus* beds, small patch reef, coll. J.K. Lowry and S.J. Keable (AM P41419 and AM P41421 respectively) ; *circa* 40 specimens, beach at Wongat Is., 5°08.5'S, 145°49.7'E, 14 Mar 1991, intertidal sand and rock, coll. J.K. Lowry and S.J. Keable (AM P41420) ; 3 specimens, 8 mancas, unnamed island next to Wongat Is., 5°08.5'S, 145°49.7'E, 14 Mar 1991, intertidal sand and rock, coll. J.K. Lowry and S.J. Keable (AM P41418) ; 1 specimen, 1 manca, Little Padoz and north end Paeowai Is., 5°09.75'S, 145°48.60'E, 18 Mar 1991, 3 m, among *Acropora* plates and soft coral, coll. J.K. Lowry and S.J. Keable (AM P41416, AM P41417).

Description of male : Body about 2.7 times as long as greatest width ; maximum width at pereonite 5. Cephalon anterior margin smoothly rounded, without rostral point, with interocular ridge, dorsal interocular suture lacking. Pereonites 1-6 without tubercules ; pereonite 1 with 2 fine longitudinal lateral sutures ; pereonites 2-7 each with transverse impressed line towards posterior of somite ; pereonite 7 with single row of small dorsal tubercules. Coxae all with entire carina, posterolateral angles of coxae 5-7 acute. Pleon about 13 % BL ; pleonite 1 not visible, 2 entirely visible ; pleonites 3-5 each with prominent median tubercle, and 3, 4 and 3 tubercules on each side of pleonites 3-5 respectively, the tubercules being prominent only on pleonite 5 ; posterolateral margins of pleonite 5 project well past posterior margin of pleon. Pleotelson about 18.6 % BL ; about 80 % as long as greatest width, dorsal surface with 2 submedian longitudinal carinae, each of which has 2 prominent tubercules, the anterior one being largest ; lateral margins straight, converging to narrow subtruncate apex, posterior margin provided with 6 spines set among PMS.

Antennule peduncle article 1 slightly longer (1.5) than 2, article 3 about 2 times as long as 2 ; flagellum slightly shorter (0.89) than peduncle, with 10 articles. Antenna flagellum extending to anterior of pereonite 4.

Frontal lamina pentagonal about 1.6 times as long as basal width, lateral margins subparallel. Mandible molar process anterior margin with about 14 spines. Maxilla lateral lobe with 6 seta, middle lobe with 11 in 2 ranks of 6 and 5, medial lobe with 3 robust densely CP spines, 5 weakly CPS, and distally 2 slender simple setae, a further 3 shorter simple setae forming a row anterior to these.

Pereopod 1 ischium with single acute spine at anterodistal angle ; merus posterior margin with 5 robust blunt and 3 acute spines ; carpus with 1 acute spine and 1 long seta at posterodistal angle ; propodus with 2 acute spines on palm and prominent blunt spine opposing dactylus. Pereopod 7 basis with 3 setae posterodistal angle ; ischium posterior margin (from proximal to distal) with 1 and 3 acute spines and 2 acute spines at distal angle, anterodistal angle with 4 larger simple spines ; merus posterior margin with a cluster of 3 acute spines and about 5 spines at distal angle, anterodistal angle with cluster of about 10 long acute spines several of which are biserrate ; carpus posterior margin with 1 acute and 2 acute spines and 6 spines at distal angle, anterodistal angle with cluster of about 14 long acute spines several of which are biserrate these forming a continuous row with the spines of the posterodistal angle ; propodus posterior margin with 1 and 2 acute spines on palm, with 2 spines opposing dactylus and 2 spines at anterodistal angle.

Penial openings separated by about 10 % width of pereonite 7.

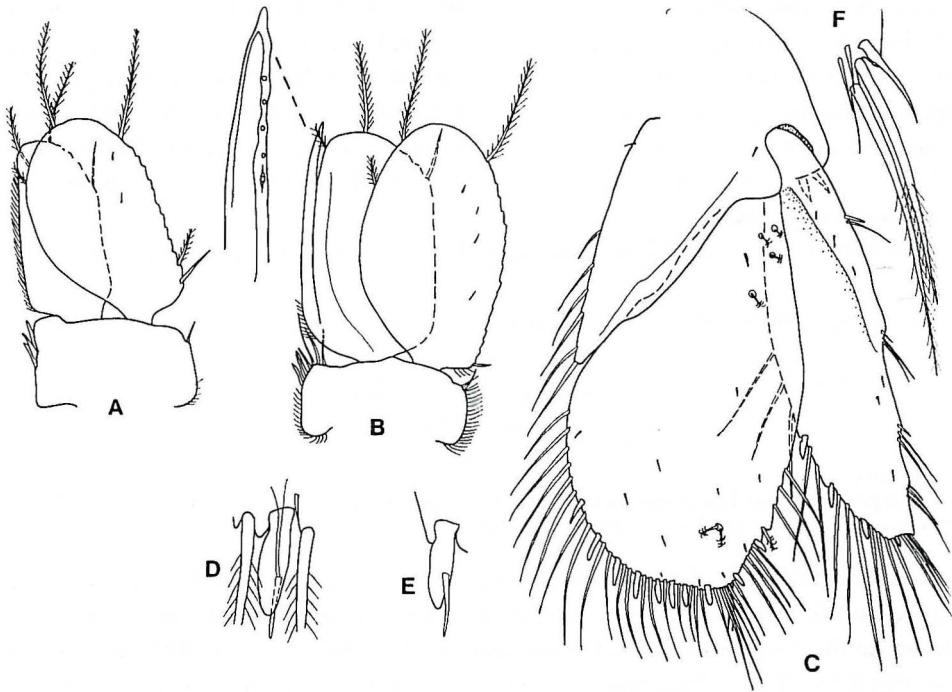


Fig. 12 : *Cirolana grumula* sp. nov. A, B, holotype, remainder ♂ paratype AM P40165. A, pleopod 1 ; B, pleopod 2 ; C, uropod ; D, spine from medial margin, uropod endopod ; E, spine from medial margin, uropod exopod ; F, setae from distolateral margin, uropod exopod.

Pleopod 1 endopod 0.65 as wide as exopod. Pleopod 2 appendix masculina about 14 times as long as basal width, distally curving very slightly towards lateral, about as long as endopod, narrowing evenly to acuminate apex. Uropod exopod about 3.5 times as long as greatest width, about as long as endopod ; exopod lateral margin irregular, without distinct spines, with 4 clusters of PMS and slender spines, medial margin curving smoothly, with 3 and fourth distal smaller spines ; endopod about 1.7 times as long a greatest width, lateral margin weakly convex, with 2 spines and about 7 PMS, medial margin curving evenly, with 8 spines and about 19 PMS ; peduncle distolateral angle with 2 spines.

Female : Similar to male, sculpturing less distinct.

Variation : Pleotelson and uropod spine counts : As for the description, one specimen had the endopod lateral margin with 1 spine, and the endopod medial spine count ranged from 4 to 9, with 8 being commonest (50 %), and one specimen with both uropods with 6, the remainder (4, 5, and 9) occurring only once.

Colour : White to pale brown, without obvious chromatophores.

Size : Males 5.0 to 5.2 mm, females 5.4 to 5.8 mm.

Remarks : This species most closely resemble *Cirolana oreonata* Bruce, 1986, known only from the Torres Strait region. It can be separated from that species by the pleotelson having 6 spines (versus 8 in *C. oreonata*), prominent pleotelson ridges (versus pleotelson ridges not prominent), antennule articles 1 and 2 unfused (versus articles 1 and 2 fused), antennal flagellum extending to pereonite 4 (versus extending to anterior of pereonite 3), and the uropod exopod being more slender and lacking distinct spines (versus uropod exopod with distinct spines).

Distribution : Madang, intertidal and very shallow subtidal, inner reef, on areas of dead coral.

Etymology : The epithet is the Latin word *grumulus*, meaning small mounds or hills.

Cirolana glebula sp. nov.
(Figs 13, 14)

Material examined

Holotype. ♂ (3.8 mm), barrier reef south of Wongat Is., 5°08.4'S, 145°50.9'E, 26 Apr 1989, 6 m, coral rock on bommie, coll. N.L. Bruce and J. Mizeu (ZMUC CRU195).

Description of male : Body about 2.5 times as long as greatest width ; maximum width at pereonite 6. Cephalon anterior margin smoothly rounded, without rostral point, with interocular ridge, dorsal interocular suture lacking. Pereonite 1 without tubercles ; pereonite 1 with 1 fine longitudinal lateral sutures ; pereonites 2-7 without transverse impressed line ; pereonites 2-3 each with very weak dorsal tubercles, pereonites 4-7 each with single row of small dorsal tubercles, becoming more prominent on posterior pereonites. Coxae all with entire carina, posterolateral angles of coxae 5-7 extending posteriorly beyond segment, prominent in dorsal view, posteriorly acute. Pleon about 11.7 % BL ; pleonite 1 not visible, 2 entirely visible ; pleonite 3 with row about 12 tubercles ; pleonites 4 and 5 each with prominent median tubercle, and 4 and 3 tubercles on each side, tubercles being most prominent on pleonite 5 ; posterolateral margins of pleonite 5 project well past posterior margin of pleon. Pleotelson about 20 % BL, about 64 % as long as greatest width, dorsal surface with 2 submedian longitudinal carinae, each of which has 3 tubercles, the anterior one being largest, each anterolateral corner with single tubercle ; lateral margins straight, converging to narrow subtruncate apex, posterior margin provided with 6 spines set among PMS.

Antennule flagellum shorter (0.6) than peduncle. Antenna flagellum extending to posterior of pereonite 2.

Frontal lamina pentagonal about 1.5 times as long as basal width, lateral margins subparallel, ventral surface with indistinct longitudinal ridge.

Pereopod 1 ischium with single acute spine at anterodistal angle ; merus posterior margin with 4 robust blunt and 2 acute spines ; carpus with 1 acute spine and 1 long seta at posterodistal angle ; propodus with 1 acute spine on palm and prominent blunt spine opposing dactylus. Pereopod 7 basis with 2 setae at posterodistal angle ; ischium posterior margin (from proximal to distal) with 1 and 2 acute spines and 1 blunt robust and 2 acute spines at

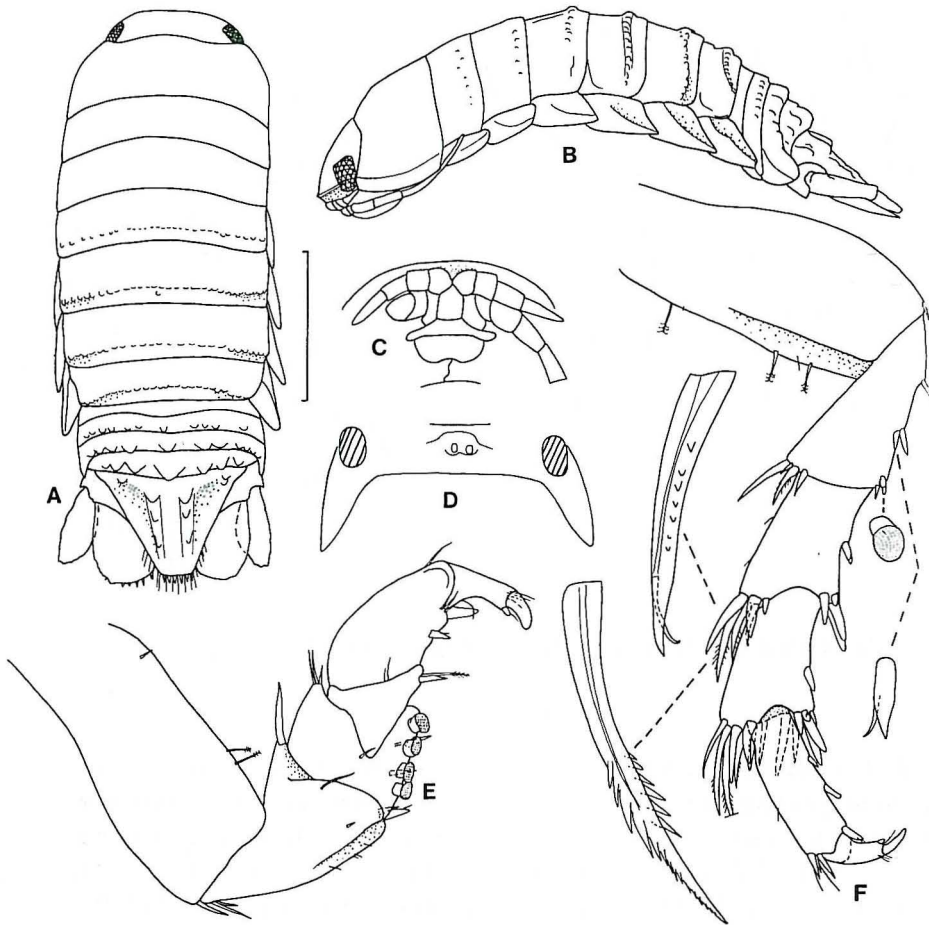


Fig. 13 : *Cirolana glebula* sp. nov. All figs of holotype. A, dorsal view ; B, lateral view ; C, frons ; D, sternite 7, showing penial papillae ; E, pereopod 1 ; F, pereopod 7. Scale for A and B : 1.0 mm.

distal angle, anterodistal angle with 4 acute spines ; merus posterior margin with a cluster of 2 stout acute spines and about 1 blunt and 4 acute spines at distal angle, anterodistal angle with cluster of about 6 acute spines several of which are biserrate ; carpus posterior margin with 1 acute and 7 spines at distal angle, anterodistal angle with cluster of about 10 long acute spines several of which are biserrate ; propodus posterior margin with 1, and 1 acute spines, 2 spines opposing dactylus and 3 spines at anterodistal angle.

Penial openings set on medial lobe, separated by about 7 % width of pereonite.

Pleopod 1 endopod 0.57 as wide as exopod, lateral margin distinctly concave. Pleopod 2 appendix masculina stout, about 11 times as long as basal width, distally curving very

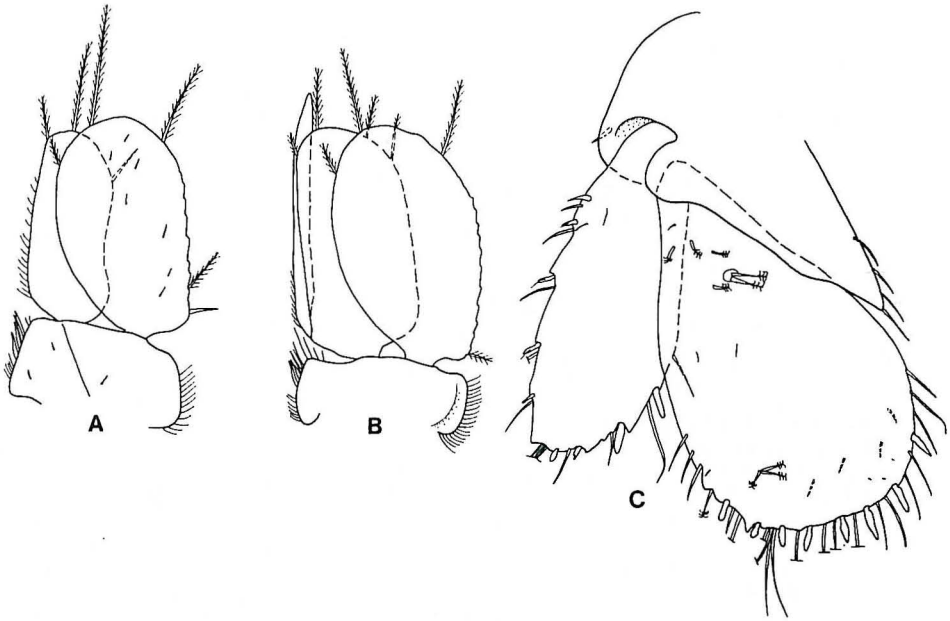


Fig. 14 : *Cirolana glebula* sp. nov. All figs of holotype. A, pleopod 1 ; B, pleopod 2 ; C, uropod.

slightly towards lateral, about as long as endopod, apex blunt. Uropod exopod about 2.4 times as long as greatest width, slightly shorter (0.94) than endopod ; exopod lateral margin irregular, with 4 spines, medial margin curving smoothly, with 4 spines ; endopod broadly rounded, about 1.5 times as long as greatest width, lateral margin weakly convex, with 2 spines and about 5 PMS, medial margin curving with 6 spines and about 11 PMS.

Female : Not known.

Colour : White without obvious chromatophores.

Size : Males 5.0 to 5.2 mm, female 5.4 to 5.8 mm.

Remarks : This species can be identified by the following combination of characters : rostral point absent ; frontal lamina pentagonal ; pereonites 2-7 with single transverse row of tubercles ; long coxae on pereonites 5-7 ; pleonites 4-5 with median tubercle prominent, with 3 tubercles on either side ; pleotelson with 2 submedian longitudinal ridges, each with 3 tubercles ; uropod exopod rounded.

Similar species which also have a pentagonal frontal lamina include *Cirolana grumula* sp. nov., *Cirolana oreonota*, *Cirolana tuberculata* (Richardson, 1910) from the Philippines (Delaney, 1986), and *Cirolana tuberculosa* Bruce, 1986, from the southern Great Barrier Reef. The sympatric *C. grumula* lacks ornamentation on pereonites 1-6, has a longer frontal lamina and a more slender uropod exopod and endopod. *Cirolana tuberculata* lacks ornamentation on all pereonites and pleonites, while *Cirolana oreonota* lacks ornamentation on

pereonites 1-5, and has 8 pleotelsonic spines rather than 6. *Cirolana tuberculosa* is more heavily ornamented, and the frontal lamina anterior margins are concave.

Distribution : Known only from a single specimen.

Etymology : The epithet is the Latin word *glebula*, meaning small lumps.

Cirolana wongat sp. nov.

(Figs 15-17)

Material examined

Holotype. ♂ (5.8 mm), Wongat Is., 5°08.1'S, 145°50.6'E, channel between island and barrier reef, 2 May 1989, 24 m, trapped, sand bottom, coll. N.L. Bruce and M. Jebb (ZMUC CRU196).

Paratypes. 3 ♂ (5.1, 5.5, 5.7 mm), 19 ♀ (ovig 5.5, non-ovig 5.0-6.4 mm, mean = 5.7 mm), same data as holotype (ZMUC CRU197).

Also examined. 3 specimens, south of Tripod Reef, 5°09.7'S, 145°51.3'E, 30 Apr 1989, 22 m, about 50 m from reef edge, on sand, coll. N.L. Bruce (ZMUC CRU198). 18 ♂ and ♀ specimens, same as previous, but : 30 m, about 300 m from reef edge, on sand, coll. N.L. Bruce (ZMUC CRU199) ♂, 4 ♀, 3 manca, south east side of Wongat Is., 5°08.4'S, 145°49.5'E, 27 Jan 1990, 17 m, sandy bottom, trapped, coll. J.K. Lowry and J.K. Elliot (AM P41062). 11 ♂, 58 ♀, 6 manca, same data as previous, except 24 m (AM P40164). 17 ♂, 73 ♀, same as previous, but, 49.7'E, 30 Jan 1990, 17-27 m, sandy mud bottom, some *Halimeda*, trapped, coll. J.K. Lowry and J.K. Elliot (AM P40168). *Circa* 1700 specimens, western tip of Demasa Is., across from Riwo Is., 5°08.9'S, 145°48.6'E, 29 Jan 1990, 3 m, trapped on *Acropora* and *Porites lobata* coral, coll. J.K. Lowry and J.K. Elliot (AM P40166). *Circa* 960 specimens, east of CRI pier, Nagada Harbour, 5°09.6'S, 145°48.2'E, 2 Feb 1990, 16 m, trapped on soft mud bottom, coll. J.K. Lowry and J.K. Elliot (AM P40171).

Description of male : Body about 2.5 times as long a greatest width ; maximum width at pereonite 6. Cephalon with anterior margin smoothly rounded, without rostral point, with interocular ridge and dorsal interocular suture. Pereonites without tubercles ; pereonite 1 with 1 fine longitudinal lateral suture ; pereonites 2-3 with transverse impressed line ; pereonites 3-7 each with 2 transverse impressed lines. Coxae all with entire carina, posterolateral angles of coxae 5-7 extending posteriorly beyond segment, posteriorly acute. Pleon about 14.4 % BL ; pleonite 1 not visible, 2 entirely visible ; pleonite 3 with row 5 small tubercles ; pleonite 4 posterior margin medially indented, with median tubercle and 1-2 indistinct sublateral tubercles ; pleonite 5 with prominent elongate median tubercle, and 2 small tubercles on each side ; posterolateral margins of pleonite 5 project well past posterior margin of pleon. Pleotelson about 19 % BL, about 64 % as long as greatest width, dorsal surface with 2 indistinct submedian longitudinal carinae, each of which has 1 tubercle ; lateral margins straight, converging to narrow subtruncate apex, posterior margin provided with 6 spines set among PMS, the PMS extending along lateral margins by about one third of their length.

Antennule peduncle article 1 and 2 fused, suture not visible, article 3 0.7 times as long as fused articles 1 and 2 ; flagellum shorter (0.96) than peduncle, composed of 9 articles. Antenna peduncle article 1 about half as long as 2, article 3 slightly shorter than 2, article 4 about 3 times as long as 3, article 5 longest, slightly longer (1.1) than 4 ; flagellum with 15 articles, extending to posterior of pereonite 2.

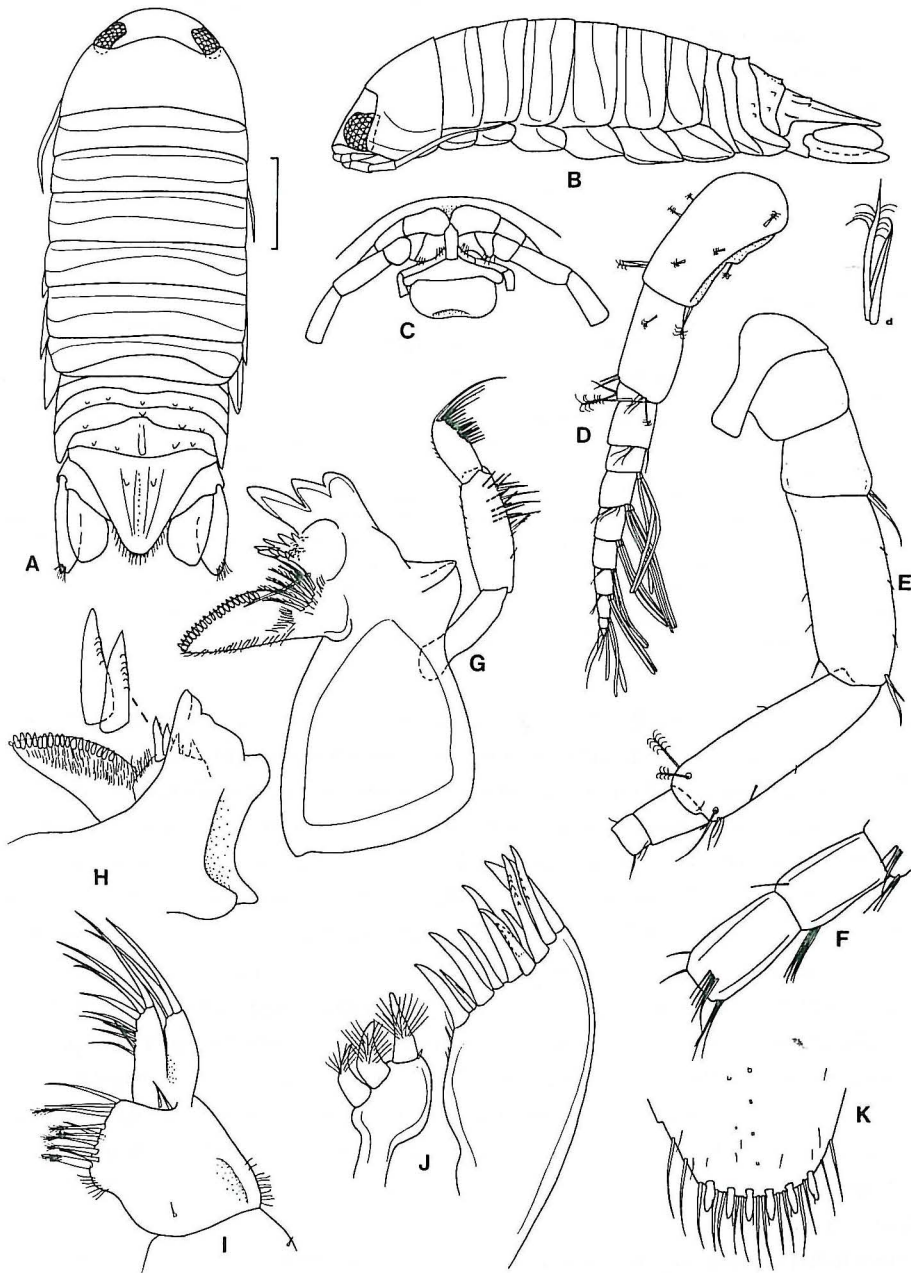


Fig. 15 : *Cirolana wongat* sp. nov. A-C, holotype, remainder ♂ paratype 5.7 mm, ZMUC. A, dorsal view ; B, lateral view ; C, frons ; D, antennule, d - setae from anterodistal angle of peduncular article 1 ; E, antenna peduncle ; F, antenna, flagellar articles 6 and 7 ; right mandible ; G, left mandible ; H, right mandible ; I, maxilla ; J, maxillule ; K, pleotelson posterior margin. Scale for A and B : 1.0 mm.



Fig. 16 : *Cirolana wongat* sp. nov. F, holotype, remainder δ paratype 5.7 mm, ZMUC. A, maxilliped ; B, pereopod 1 ; C, pereopod 1, dactylus ; D, pereopod 2 ; E, pereopod 7, e - spine from distal margin of merus ; F, sternite 7 showing penial openings.

Frontal lamina pentagonal about 3.0 times as long as basal width. Mandible spine row with 8 spines ; molar process with setules along posterior dorsal margin and ventral surface ; anterior margin with about 18 spines, about 6 long setae arise at anteroproximal junction of molar process ; mandible palp article 2 1.4 times as long as article 1 and 2.1 times as long as article 3, distal margin of article 1 with single acute spine, article 2 with about 18 serrate marginal and submarginal spines, lateral margin of article 3 with about 15 serrate

spines, distal 3 of which are conspicuously longest. Maxillule lateral lobe with 12 spines on gnathal surface, some of which have secondary serrations, medial lobe with 3 stout CP spines, and 1 short spine. Maxilla lateral lobe with 3 setae, middle lobe with 12 in 2 ranks of 9 and 3, medial lobe with 6 robust distally CP spines, 4 slender simple setae. Maxilliped endite with 2 coupling hooks and 4 long CPS.

Pereopod 1 ischium with single acute spine at anterodistal angle ; merus posterior margin with 6 robust blunt and 5 acute spines ; carpus with 1 acute spine and 1 long seta at posterodistal angle ; propodus with 2 acute spines on palm and prominent blunt spine opposing dactylus. Pereopod 7 basis with 4 setae at posterodistal angle : ischium posterior margin (from proximal to distal) with 1 acute spine, 1 acute and 1 blunt robust and 1 blunt robust 2 and acute spines at distal angle, anterodistal angle with 7 acute spines, some of which are serrate ; merus posterior margin with a cluster of 2 stout acute spines and 1 blunt and 5 acute spines at distal angle, anterodistal angle with cluster of about 9 acute spines several of which are biserrate and long ; carpus posterior margin with 1 acute, 2 acute spines, distal margin with about 18 spines, those of posterodistal angle being shorter than the long acute biserrate spines of anterodistal margin ; propodus posterior margin with 1, and 2 acute spines, 2 spines opposing dactylus and 3 spines at anterodistal angle.

Penes open flush with surface, separated by about 12.5 % width of pereonite.

Pleopod 1 endopod 0.75 as wide as exopod, lateral margin distinctly concave. Pleopod 2 appendix masculina slender, about 18 times as long as basal width, distally curving very slightly towards lateral, about as long as endopod, apex acute. Uropod exopod about 3.4 times as long as greatest width, longer (1.26) than endopod, apex subtruncate, dorsal distal surface with patch of stiff setae ; exopod lateral margin weakly convex, with 5 spines, each with associated seta, medial margin curving smoothly, with 4 spines ; endopod about 1.7 times as long as greatest width, lateral margin nearly straight, with 1 spine and about 4 PMS, medial margin smoothly curved with 5 spines and about 17 PMS.

Female : Similar to male, but weak pleotelsonic nodules present only on pleonite 5, and uropod exopod not longer than endopod, lacking the dorsal distal patch of setae and also being distally narrow rather than subtruncate.

Colour : White without chromatophores.

Size : Males 5.5 to 5.8 mm, females 5.0 to 6.4 mm.

Remarks : The unique uropod morphology and elongate median tubercule on pleonite 5 immediately identifies the males of this species, and allies this species with *Cirolana pleonastica*, the only other nodular species that has sexually dimorphic uropods. Females can be identified by the details of pleotelson and uropod spination, the elongate frontal lamina, and the distribution of tubercules and transverse impressed lines on the pereon and pleon.

Distribution : Within the Madag barrier reef, sandy and mud bottoms, 3 to 30 m.

Etymology : The epithet is the name of the type locality, to be treated as a noun in apposition.

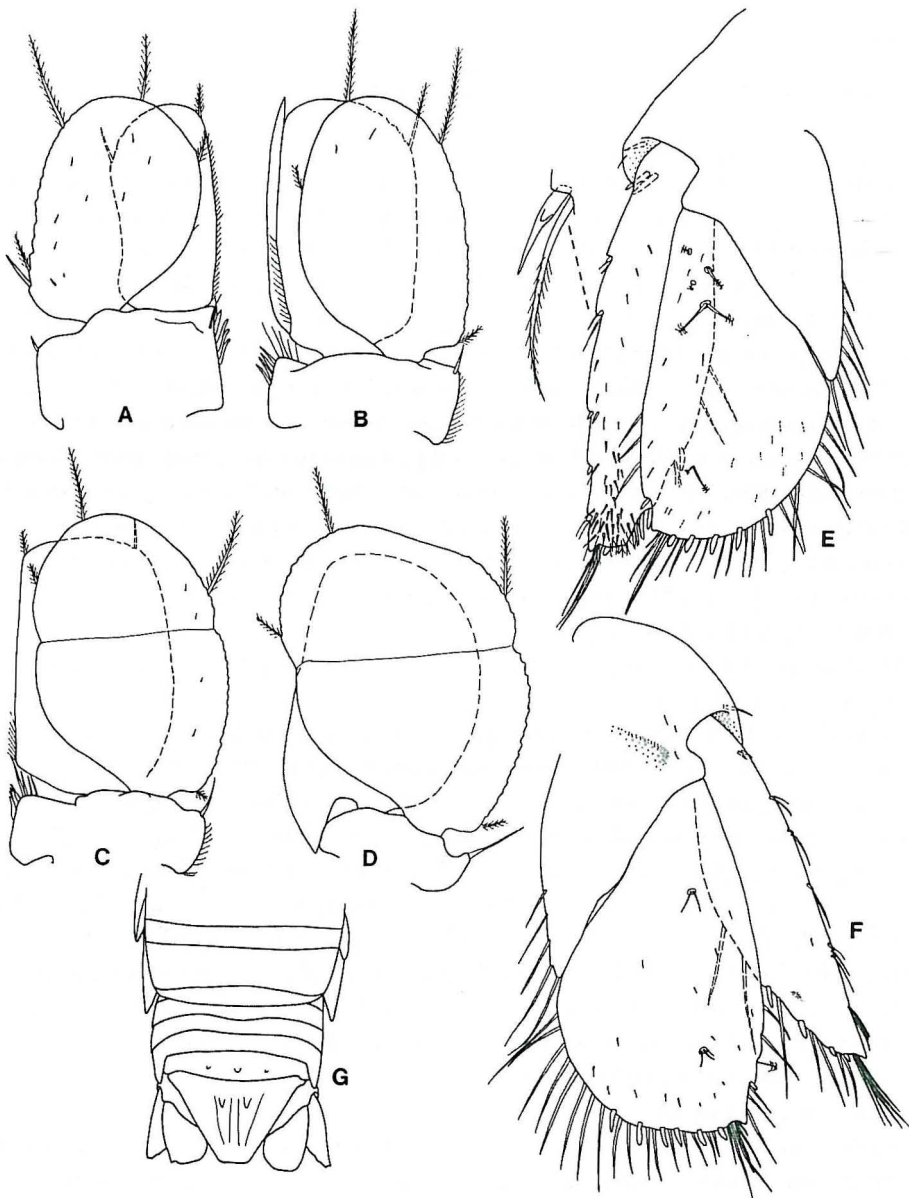


Fig. 17 : *Cirolana wongat* sp. nov. A-E, ♂ paratype 5.7 mm ; F, G, ♀ ovig 5.5 mm, ZMUC. A-D, pleopods 1-3, 5 respectively ; E, uropod ; F, uropod (female) ; G, pleon in dorsal view (female).

Cirolana cristata sp. nov.

(Fig. 18)

Material examined

Holotype. ♂ (3.5 mm), barrier reef south of Wongat Is., 5°08.4'S, 145°51.0'E, 3 May 1989, 33 m, outer reef slope, coral rock on sand, coll N.L. Bruce and M. Jebb (ZMUC CRU200).

Description of male : Body about 2.4 times as long as greatest width ; maximum width at pereonite 6. Cephalon with anterior margin smoothly rounded, without rostral point, with thickened anterior interocular ridge, dorsal interocular suture lacking ; dorsal surface with several indistinct transverse nodules. Pereonites without tubercles ; pereonites all with 2 distinct transverse ridges, posterior ridge being most prominent ; pereonites 4-7 with transverse impressed line ; pereonite 7 posterior ridge laterally weakly crenulate. Coxae all with entire carina, posterolateral angles of coxae 5-7 posteriorly narrowly rounded. Pleon about 14 % BL, pleonite 1 not visible, 2 visible ; pleonites 3-5 with prominent median tubercule and 3 indistinct tubercles on each side, tubercles being most prominent on pleonite 5 ; posterolateral margins of pleonite 5 project well past posterior margin of pleon. Pleotelson about 16 % BL, about 60 % as long a greatest width, dorsal surface with 2 submedian longitudinal carinae, each of which has 2 tubercles, the anterior one being largest, each anterolateral corner with single tubercule ; lateral margins straight, converging to narrow subtruncate apex, posterior margin provided with 6 spines set among PMS.

Antenna flagellum extending to anterior of pereonite 3.

Frontal lamina anterior margin rounded about 1.7 times as long as basal width, lateral margins very weakly sinuate.

Pereopod 1 ischium with single acute spine at anterodistal angle ; merus posterior margin with 4 robust blunt and 2 acute spines ; carpus with 1 acute spine and 1 long seta at posterodistal angle ; propodus with 1 acute spine and prominent blunt spine opposing dactylus. Pereopod 7 basis with scattered small setae and 2 setae at posterodistal angle ; ischium posterior margin (from proximal to distal) with 1 acute spine, anterodistal angle with 2 small acute spines ; merus posterior margin with 1 stout acute spines and 3 acute spines at distal angle, anterodistal angle with cluster of about 7 acute spines several of which are biserrate ; carpus posterior margin with 1 acute and 5 spines at distal angle, anterodistal angle with cluster of about 12 long acute spines several of which are biserrate, longest extending to distal margin of propodus ; propodus posterior margin with 1 acute spine, 2 spines opposing dactylus and 2 spines at anterodistal angle.

Penial openings close set.

Pleopod 1 endopod 0.62 as wide as exopod, margins convergent. Pleopod 2 appendix masculina stout, about 19 times as long as basal width, distally curving very slightly towards lateral, about 1.2 times as long as endopod, apex acuminate, with two subapical setules. Uropod exopod about 2.6 times as long as greatest width, subequal in length to endopod, lateral margin with 3 slender spines, each set within notch with a single seta, medial margin curving smoothly, with 2 distally placed spines ; endopod broadly rounded with small setae scattered over dorsal surface, distally almost subtruncate, about 1.6 times

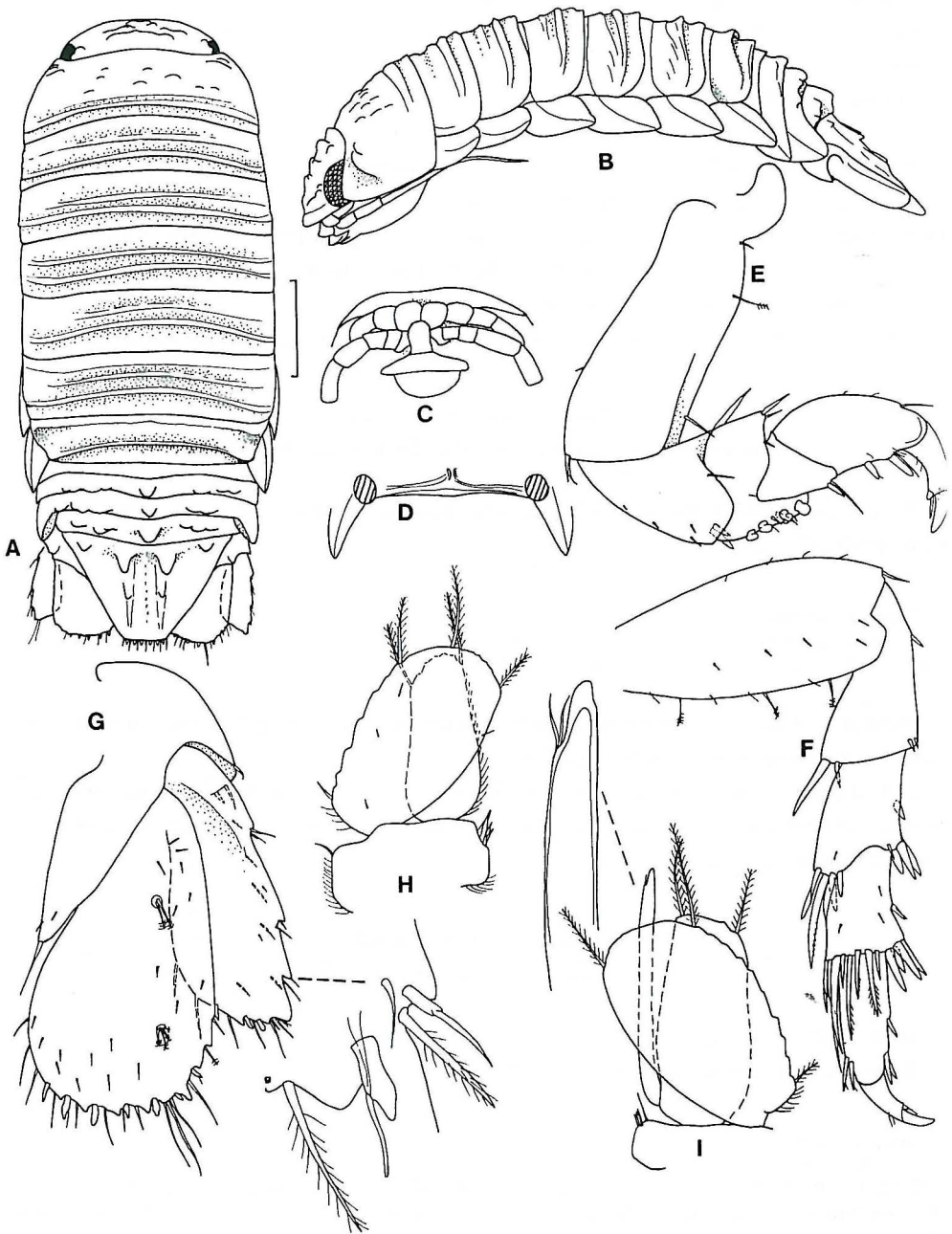


Fig. 18 : *Cirolana cristata* sp. nov. All figs of holotype. A, dorsal view ; B, lateral view ; C, frons ; D, sternite 7, showing penial papillae ; E, pereopod 1 ; F, pereopod 7 ; G, uropod, g, spine from endopod medial margin ; H, pleopod 1 ; I, pleopod 2. Scale for A and B : 0.5 mm.

as long a greatest width, lateral margin weakly convex, with 2 spines and about 2 PMS, medial margin with 5 spines and about 7 PMS, marginal spines each set within distinct serration.

Female : Not known.

Colour : White without chromatophores.

Remarks : This is the only species of *Cirolana* in the Madang area which has an anteriorly rounded frontal lamina. The most striking feature, and the one which allows for immediate recognition of this species, is the presence of prominent transverse ridges on all pereonites, usually with the posterior ridge the most prominent.

Distribution : Known only from a single specimen.

Etymology : The epithet is derived from the Latin word *crista*, meaning ridge.

Genus *Pseudolana* Bruce

Pseudolana brevifimbria Holdich, Harrison and Bruce, 1981

Pseudolana brevifimbria Holdich, Harrison and Bruce, 1981 : 593, fig. 14. Bruce, 1982 : 614 ; 1986 : 47, figs 28, 30E.

Material examined

♀ (non-ovig 4.6 mm), 3 manca (1.7, 2.0, 2.3 mm), Wongat Is., 5°08.1'S, 145°50.5'E, 1 May 1989, leeward beach, intertidal sand, coll. N.L. Bruce (ZMUC CRU201).

Remarks : These specimens agree well with the original description, the rounded fourth pleonites being diagnostic for this species.

Distribution : Previously known from the Townsville area of Australia, and Motupore Island, off Port Moresby, Papua New Guinea, the range is here extended to the northern coast of Papua New Guinea.

Genus *Excirolana* Richardson

Excirolana orientalis (Dana, 1853)

Restricted synonymy :

Excirolana orientalis.- Bruce, 1986 : 41, fig. 24.

Material examined

2 ♂ (5.9, 6.0 mm), 6 ♀ (4.6, 4.7, 4.8, 5.0, 5.9, 10.2 mm), 2 imm (4.0, 4.6 mm), Nagada Plantation Point, 5°09.2'S, 145°48.8'E, 1 May 1989, intertidal sand, low exposure beach, coll. N.L. Bruce (ZMUC CRU203). Manca (2.7 mm), Wongat Is., 5°08.1'S, 145°50.6'E, 1 May 1989, leeward beach, intertidal sand, coll. N.L. Bruce (ZMUC CRU202).

Remarks : The occurrence of this common and widespread Indo-West Pacific intertidal scavenging species (Bruce 1986) in this area is unremarkable.

Genus *Cartetolana* Bruce
Cartetolana integra (Miers, 1884)

Restricted synonymy

Cartetolana integra.- Bruce, 1986 : 212, figs 148, 149.

Material examined

♀ (ovig 6.0 mm), south of Wongat Is, 5°08.1'S, 145°51.0'E, 21 Apr 1989, 1.5 m, outer reef crest, dead coral on bommie, coll. N.L. Bruce and M. Jebb (ZMUC CRU204). ♀ (non-ovig 4.9 mm), Wongat Is, 5°08.1'S, 145°50.6'E, 25 Apr 1989, 10 m, outer reef slope, coll. N.L. Bruce and M. Jebb (ZMUC CRU205). ♀ (ovig 5.4 mm) south of Wongat Is., 5°08.6'S, 145°51.0'E, 29 Apr 1989, 4 m, coral rock from hard reef crest, coll. N.L. Bruce and M. Jebb (ZMUC CRU206).

Distribution : Previous records are all from tropical Australia or to the south of Papua New Guinea at the Kei Islands, Indonesia (Bruce 1986) ; the range is here extended to the northern coast of Papua New Guinea.

Genus *Natatolana* Bruce
Natatolana variguberna (Holdich, Harrison and Bruce, 1981)
(Fig. 19A-E)

Cirolana variguberna Holdich, Harrison and Bruce, 1981 : 655, fig. 5

Natatolana variguberna.- Bruce, 1981 : 959 ; 1986 : 105, fig. 72.

Material examined

3 ♀ (8.7, 10.2, 11.5 mm), Nagada Harbour, opposite CRI jetty, 5°09.4'S, 145°49.3'E, 3 May 1989, 12 m, trap coll. N.L. Bruce (ZMUC CRU207). 5 ♂ (6.7, 7.4, 7.9, 8.5, 9.3 mm), 22 ♀ (non-ovig 7.4-11.4 mm), 6 manca (3.0-3.4 mm), Nagada Harbour, opposite CRI jetty, 5°09.6'S, 145°48.2'E, 2 Feb 1990, 16 m, trapped, J.K. Lowry and J.K. Elliot (AM P40173).

Remarks : Additional illustrative detail is given for pereopods 1 and 2 and the uropods ; these specimens from Madang agree with previous descriptions.

Distribution : Previously known from the tropical and subtropical coasts of eastern Australia from the Cobourg Peninsula to Moreton Bay ; the range is here extended to the northern coast of Papua New Guinea.

Natatolana albicaudata (Stebbing, 1900)
(Fig. 19F, G)

Cirolana albicaudata Stebbing, 1900 : 631, pl. LXVVIB. Richardson, 1910 : 5.

Cirolana albicaudata var *japonica* Thielemann, 1910 : 8, figs 1-4. Nierstrasz, 1931 : 152. Iwasa, 1965 : 14.

Natatolana albicaudata.- Bruce, 1981 : 958 ; 1986 : 71, figs 46, 47.

Non *Cirolana albicaudata*.- Barnard, 1936 : 152, fig. 2a-c (= *Natatolana insignis* Hobbins and Jones, 1993).

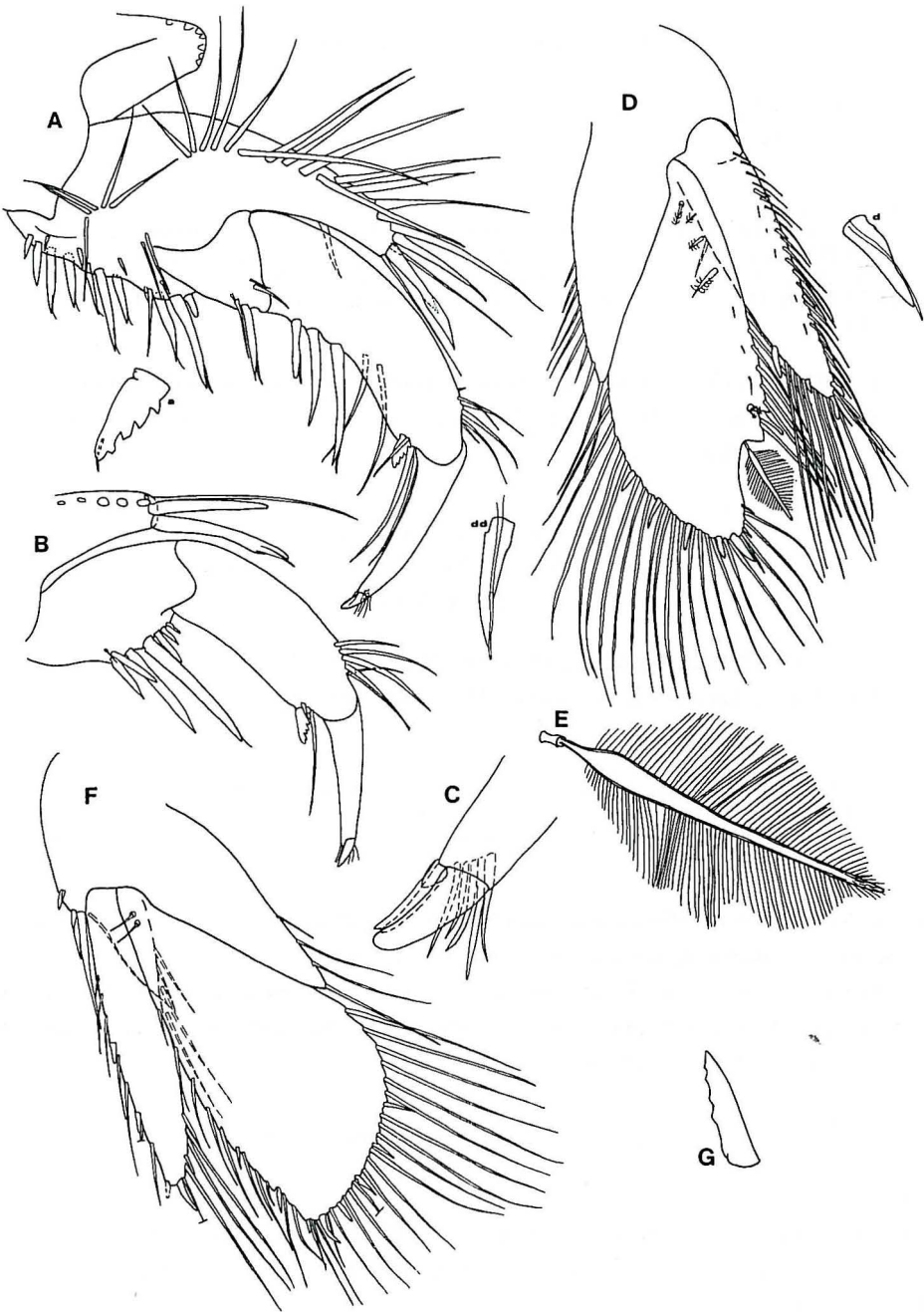


Fig. 19 : *Natatolana variguberna* Holdich, Harrison and Bruce. ♂ 8.5 mm, ZMUC. A, pereopod 1, distal articles ; B, pereopod 2 distal articles ; C, pereopod 1, dactylus unguis ; D, uropod, d - spine from exopod medial margin ; E, plumose sensory seta, uropod endopod lateral margin. *Natatolana albicaudata* Stebbing, syntype, 5.3 mm. F, uropod, syntype ; G, distal propodal spine, opposing dactylus base.

Material examined

♂ (3.0 mm), south of Wongat Is, 5°08.1'S, 145°51.0'E, 21 Apr 1989, 25 m, coral rubble outer reef slope, coll. N.L. Bruce and M. Jebb (ZMUC CRU208). 1 ♂ (3.0 mm), ♀ (non-ovig 3.2, 4.0 mm), 2 manca (2.3, 1.7 mm), south of Wongat Is, 5°08.4'S, 145°51.0'E, 2 May 1989, 21-27 m, outer reef slope, coral rubble on *Halimeda* sand and coral rock, coll. N.L. Bruce and M. Jebb (ZMUC CRU209). 3 ♀ (3.2, 3.4, 4.0 mm), Tab Island reef, 5°09.6'S, 145°49.2'E, 4 May 1989, 33 m, outer reef slope, silty coral rubble among *Turbinaria* plates, coll. N.L. Bruce and M. Jebb (ZMUC CRU210).

Remark : The genus *Natatolana* is large, with many common species being well known as carnivorous scavengers (Bruce 1986 ; Keable in prep). *Natatolana albicaudata* does not enter traps, but has been collected from the nocturnal plankton in the vicinity of coral reefs and also directly from dead coral rubble on hard reef. It is the only species of *Natatolana* that is positively known to live in coral rock and rubble rather than particulate substrata, and the only species that is not a scavenger.

The present material accords well with the accounts given by Bruce (1986) and Stebbing (1910), and is within the recorded range of the species. Hobbins and Jones (1993) listed all subsequent identifications and citations of *Natatolana albicaudata* as not being that species, and in this regard they were in error as all records except that of Barnard (1936) and also possibly those of Thielemann (1910) and Iwasa (1965), are of this species.

Additional figures are given of the uropod and of the spine opposing the dactylus of pereopod 1 from a syntypic specimen.

Distribution: Previous Pacific records are from Japan, Philippines, New Britain and eastern Australia as far south as Heron Island (Bruce 1986) ; the only currently accepted record from the Indian Ocean is from Western Australia (Bruce 1986).

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