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The New Zealand and South-east Australian Species of *Aora* Krøyer (Amphipoda, Gammaridea)

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ABSTRACT. Six species of *Aora* are reported from New Zealand and south-east Australia: *Aora typica* Krøyer, *A. maculata* (Thomson), *A. mortoni* (Haswell), *A. hebes* n.sp., *A. hircosa* n.sp., and *A. adpressa* n.sp. A key is given to the males of *Aora* species of the world.

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The genus *Aora* Krøyer was first recorded in New Zealand waters by Thomson (1879), who erected the species *Microdeutopus maculatus* Thomson. In the same year, Haswell recorded the genus from Australian waters under the names *M. mortoni* Haswell and *M. tenuipes* Haswell. Apart from a further paper by Haswell (1882) in which these latter two species were redefined, no further work has been published on Australian species. In New Zealand, Chilton (1885) recorded the occurrence of two 'forms' of male *Aora*, but placed both as forms of *A. typica* Krøyer, a species originally described from Chile. Stebbing (1906) synonymized all the then known world *Aora* species with *A. typica* Krøyer, thereby stifling critical analysis of the genus for over half a century, although Schellenberg (1926) and K.H. Barnard (1932) both erected further 'forms' of *A. typica*. Myers (1969) and J.L. Barnard (1972) both suggested that the variously described 'forms' of *A. typica* warranted specific status, and fourteen species are now recognized in world seas. J.L. Barnard (1972) reported two species of *Aora* from New Zealand waters, but although he attributed one species to *A. maculata* (Thomson), he was unable to allocate the other to a known species, probably owing to his not having fully adult males of the latter species before him. It is clear from his excellent figures of a juvenile male that his latter species was referable to *A. typica* Krøyer.

We have had the opportunity to study several collections of *Aora* from New Zealand and Australia (including Tasmania) and have found six species to be present: *A. mortoni* (Haswell) (of which *M. tenuipes* Haswell represents the female), *A. typica* Krøyer, *A. maculata* (Thomson), *A. hircosa* n.sp., *A. hebes* n.sp., and *A. adpressa* n.sp.

In general, *Aora* species are morphologically very uniform except for the highly diagnostic male gnathopoda. During the course of the present work, the appendages (including the mouthparts) of all six species

were compared and numerous small differences were noted. However, material from a wider range of localities is required before the specific significance of these differences can be ascertained by more detailed morphometric analysis. Many of the differences observable are apparently correlated with size, so that the appendages of small species agree closely in morphology with the corresponding appendages of small specimens of larger species. It is premature to attempt to compare the detailed morphology of the various species but we feel that a valuable contribution can be made by establishing the presence of at least six species in the region, elucidating the synonymy of previously recorded *Aora* material, and facilitating the identification, at least of males, of the New Zealand and SE Australian species. To this end, the paper concentrates on the morphology of the highly diagnostic male gnathopoda, although female gnathopoda and selected mouthparts are also figured, as are lateral views of entire male specimens.

In live material, colour patterns will almost certainly be of great value in segregating the species. Where known, the colour pattern of living material is described, otherwise the pattern observed in preserved material is given. The reader should be aware that because of differential fading of pigments in the pattern mosaic, preserved material may appear very different from live material.

A key to the males of all world species of *Aora* is provided.

Some of the material on which this study is based was collected by one of us (A.A.M.) but the greater part was made available to us by the generosity of Ms M. Drummond, National Museum of Victoria (NMV), Dr J.K. Lowry, Australian Museum (AM), Mr T.M. Walker and Mr G. Edgar, University of Tasmania (UT) and Prof. S. Ruffo, Museo Civico di Storia Naturale, Verona (VM).

Key to Aora Spp. (Males Only) of the World

1. Gnathopod 2 entire anterior margin of carpus and propodus densely clothed in long setae 2.
 - Gnathopod 2 anterior margin of carpus and propodus weakly setiferous; if long setae present, then restricted to distal portion on either carpus or propodus 4.
2. Coxa 2 subtriangular *A. hebes* n.sp.
 - Coxa 2 not subtriangular 3.
3. Gnathopod 1 propodus very short, < ½ carpus *A. inflata* Griffiths, 1976
 - Gnathopod 1 propodus elongate, > ⅔ carpus *A. mortoni* (Haswell, 1879)
4. Gnathopod 1 carpus with postero-distal tooth *A. gibbula* Barnard, 1932
 - Gnathopod 1 carpus without postero-distal tooth 5.
5. Gnathopod 1 basis with postero-distal 'brush' of long setae *A. trichobostrychus* Stebbing, 1888
 - Gnathopod 1 basis without postero-distal 'brush' of long setae 6.
6. Gnathopod 1 basis anterior margin with triangular tooth, antero-distal margin with rounded flange, ischium anterior margin with rounded flange *A. typica* Krøyer, 1845
 - Gnathopod 1 basis and ischium not as above 7.
7. Gnathopod 1 merus densely setose 8.
 - Gnathopod 1 merus weakly setiferous 9.
8. Gnathopod 1 propodus anterior margin with very long setae .. *A. atlantidea* Reid, 1951
 - Gnathopod 1 propodus anterior margin with setae of only moderate length *A. hircosa* n.sp.
9. Gnathopod 1 basis with crenulate antero-proximal process *A. anomala* Schellenberg 1926
 - Gnathopod 1 basis without crenulate antero-proximal process 10.
10. Gnathopod 2 basis anterior margin markedly convex. Pereopod 6 basis postero-distal margin produced into 'heel' *A. gracilis* (Bate, 1857)
 - Gnathopod 2 basis anterior margin straight or concave. Pereopod 6 basis postero-distal margin without 'heel' 11.
11. Gnathopod 2 carpus elongate, nearly parallel-sided, almost twice length of propodus *A. adpressa* n.sp.
 - Gnathopod 2 carpus triangular, equal to or a little longer than propodus 12.
12. Gnathopod 2 propodus short, anterior margin strongly convex *A. spinicornis* Afonso, 1976
 - Gnathopod 2 propodus equal in length to carpus, propodus anterior margin weakly convex 13.
13. Antenna 2 strongly setose *A. maculata* (Thomson, 1879)
 - Antenna 2 weakly setiferous *A. kergueleni* Stebbing, 1888

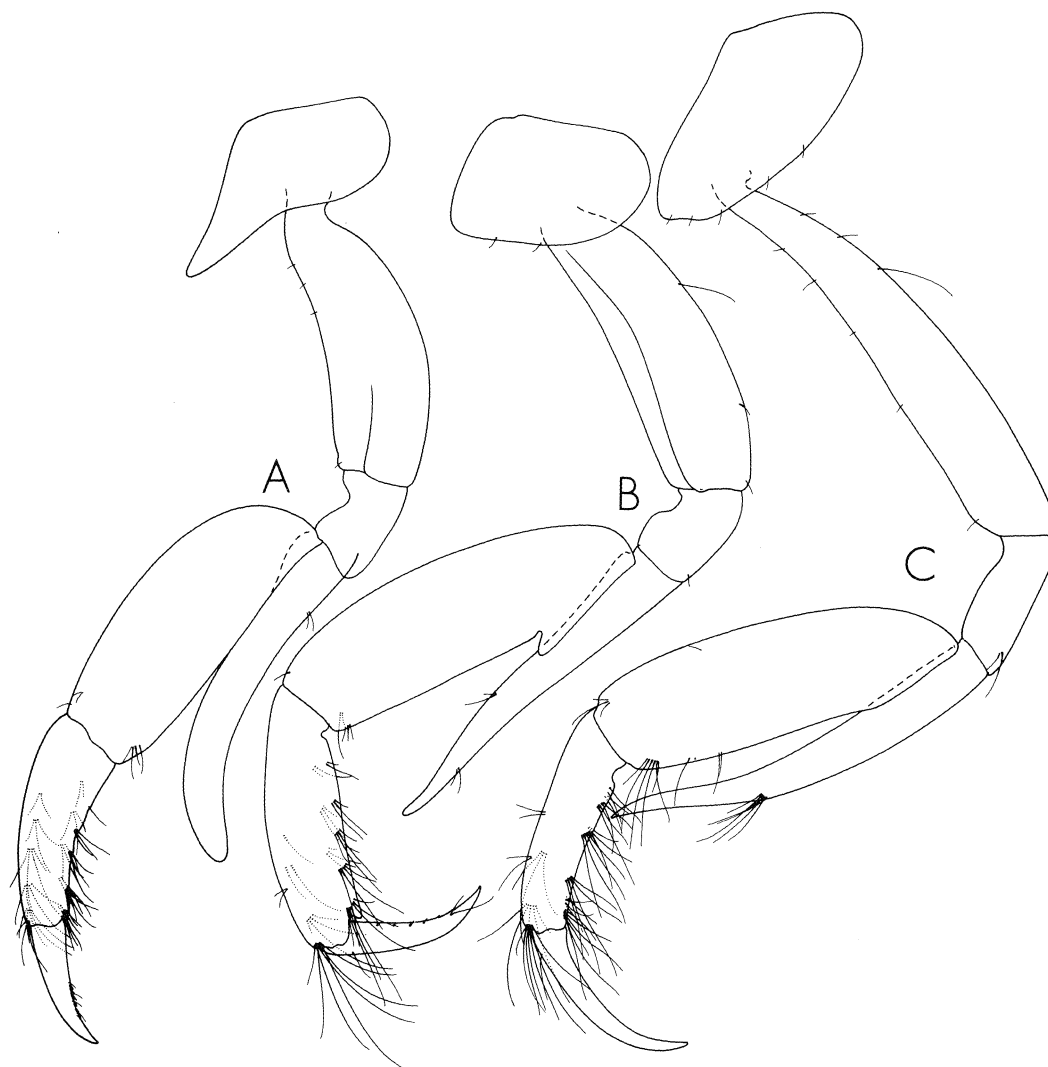


Fig. 1. Hyperadult ♂ gnathopod 1 of A, *A. hebes* (Sydney Harbour); B, *A. mortoni* (Western Port); C, *A. maculata* (Tinderbox).

Aora typica Krøyer, 1845

Figs 2, 3, 4, 13

- Aora typica* Krøyer, 1845, p. 238, pl. 3, fig. 3.—Della Valle, 1893, p. 409, pl. 56, figs 38-40; Chilton, 1909, p. 645; Ledoyer, 1967, p. 131, fig. 15; Myers 1973, p. 287, fig. 14.
Aora typica 'form 1' Chilton, 1885, p. 370.
Aora typica 'form *typica*' Stephensen, 1949, p. 41, fig. 18.
Aora sp. Barnard, 1972, p. 124, fig. 10 i-j.
Lalaria longitarsus Nicolet, 1849, p. 243, pl. 2, fig. 8 a-f.

Type locality: Valparaiso, Chile.

Material examined: 37♂ 46♀ immature, Snares Island (AM); 2♀ 13 immature, Kaikoura (AM); 5♂ 6♀, Lyttelton (VM); 3♂ 14♀, Dunedin (NMV); 1♂, Port Jackson (Sydney Harbour) (AM).

Diagnosis. Maximum length 12.0 mm. Male pereon segments lacking sternal processes. Male gnathopod 1 coxa with anterodistal corner strongly produced, very

acute; basis anterior margin with strong, medial, triangular process and large flap-like distal process; ischium anterior margin with large, rounded, 'wing'; merus shorter than carpus, acute; propodus more than two-thirds length of carpus; dactylus swollen medially. Male gnathopod 2 small, only moderately setose; palm of propodus very oblique. Female gnathopod 1 propodus with palm distinctly excavate.

Colour in life uniformly pinkish without markings (J.K. Lowry, pers. comm.); in alcohol, whitish.

Discussion. The peculiar 'wings' on the basis and ischium, and the triangular anterior marginal process of the male gnathopod 1 immediately distinguish adult and sub-adult males from all other *Aora* species.

World distribution. This species is widely distributed in the Southern Hemisphere between latitudes 20°S and 50°S. However, it is apparently replaced in Tierra del Fuego by *A. anomala* Schellenberg and in South Africa by *A. gibbula* Barnard, *A. anomala*

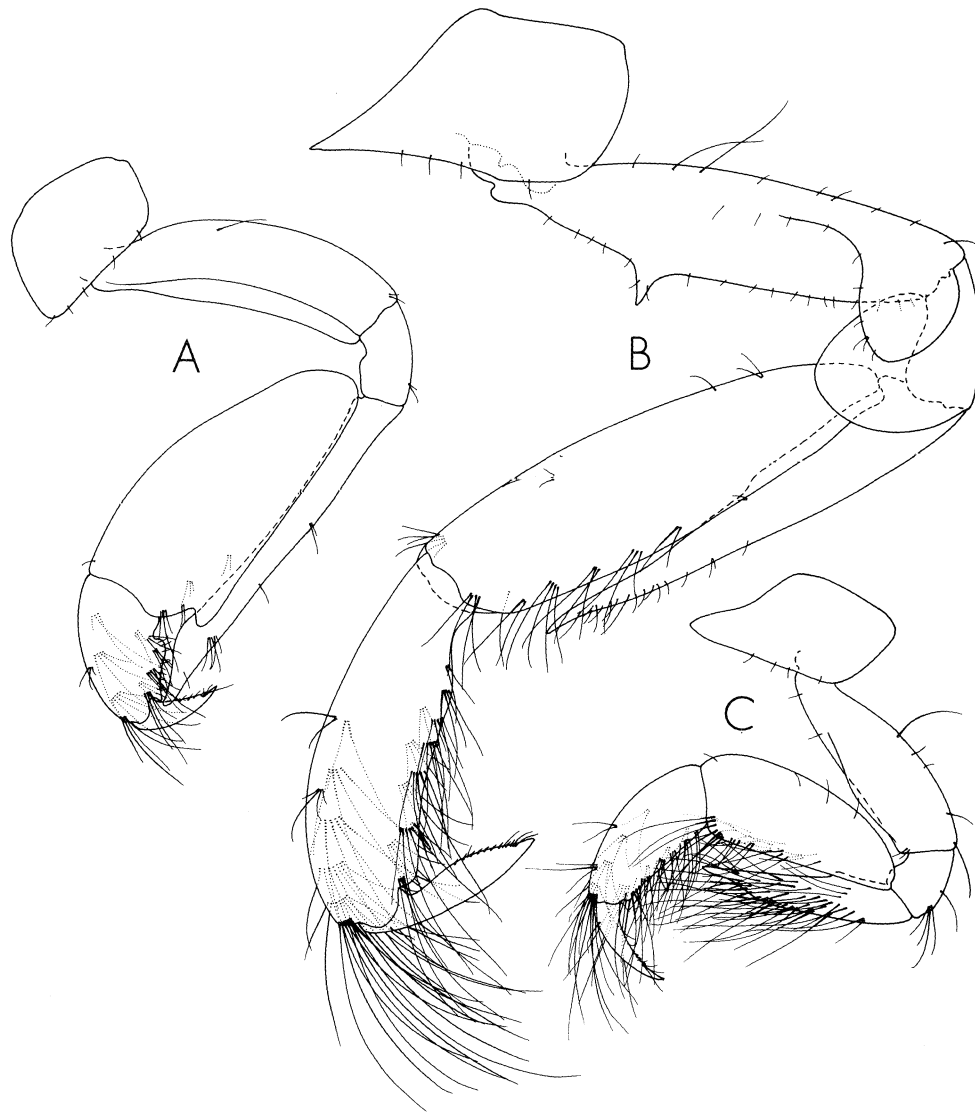


Fig. 2. Hyperadult ♂ gnathopod 1 of A, *A. adpressa* (Western Port); B, *A. typica* (Snares Islands); C, *A. hircosa* (Tinderbox).

Schellenberg, *A. inflata* Griffiths and, according to Griffiths (1975), *A. kergueleni* Stebbing. At Kerguelen Island, two species, *A. kergueleni* and *A. trichobostrychus* Stebbing, are known.

Confirmed records of *A. typica* sensu stricto are Chile (Krøyer, 1845; Nicolet, 1849) Tristan da Cunha, Nightingale, Inaccessible (Stephensen, 1949) New Zealand south to the Snares Islands (Chilton, 1885, 1909, and herein), Madagascar (Ledoyer, 1967) and Sydney, Australia (herein).

Aora maculata (Thomson, 1879)

Figs 1, 5, 6, 13

Microdeutopus maculatus Thomson, 1879, p. 331, pl. 16, figs 5-8.

Microdentopus [sic] *maculatus*.—Thomson, 1880, p. 217, fig. 7 a-c; Chilton, 1882, p. 173, pl. 8, fig. 3a, b.

Aora typica—Thomson, 1879, p. 331; Thomson, 1880, p. 216;

Thomson & Chilton, 1886, p. 147; Thomson, 1889, p. 261; Hutton, 1904, p. 260; Thomson 1913, p. 245.

Aora maculata.—Barnard, 1972, p. 124, fig. 10 f-h; Lowry, 1974, p. 102, 122, fig. 5a.

N.B. The records of Chilton 1909, and of Stephensen, 1927, 1938 (see Lowry, 1976, p. 26) cannot with certainty be attributed to this species.

Type locality. Dunedin, New Zealand.

Material examined. 32♂ 151♀ 79 imm, Snares Island (AM); 2♂ 1♀, Auckland Islands (AM); 21♂ 37♀ 18 imm., Tinderbox, SE Tasmania in algae (UT); 25♂ 23♀, Western Port, Victoria (NMV); 15♂ 32♀ 10 imm., Kiama, N.S.W., in *Hormosira*, intertidal (AAM); 2♂ 12♀ 5 imm., Sydney Harbour, in *Pterocladia*, intertidal (AAM); 6♂ 7♀, Coogee, N.S.W. (AM); 4♂ 3♀ 2 imm., Merimbula, N.S.W. (AM & NMV); 1♂ 1♀, Jiguma, N.S.W. (NMV).

Diagnosis. Maximum length 10.0 mm. Malc pereon segments lacking sternal processes. Male gnathopod 1 coxa much deeper than broad, narrowing distally in

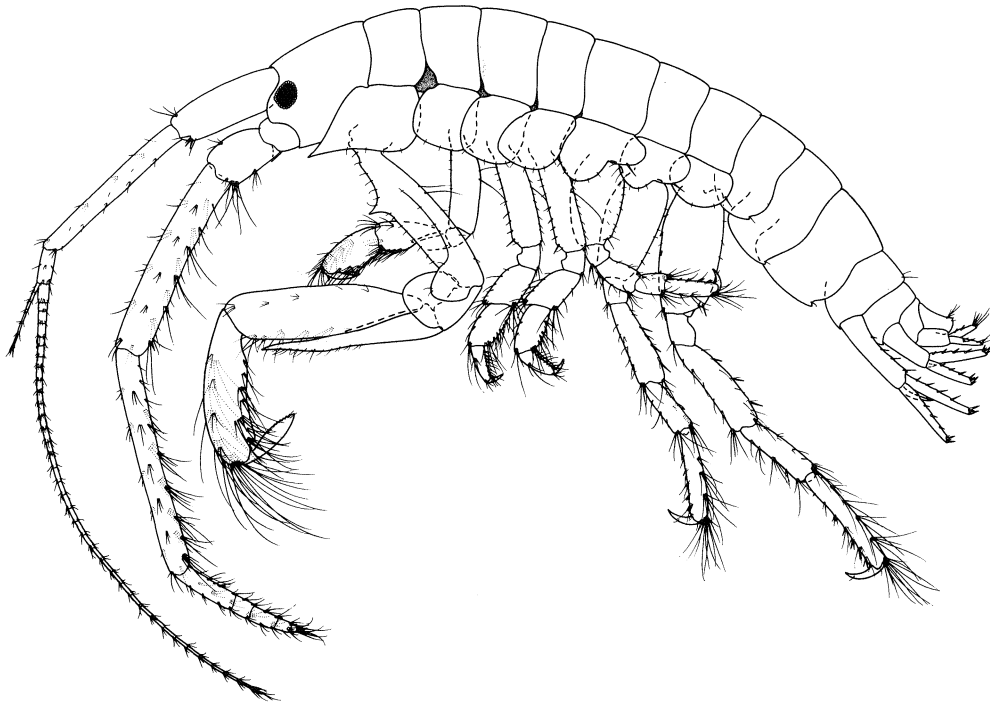


Fig. 3. ♂ *A. typica*, Snares Islands, lateral view.

hyperadults; broader than deep, the anterodistal corner produced, subacute in subadults (Fig. 5B); basis extremely elongate and slender in hyperadults, moderately slender in subadults; ischium elongate; merus longer than and weakly divergent from carpus; propodus little over half length of carpus; dactylus elongate, slender, curved, almost equal in length to propodus. Male gnathopod 2 small, only moderately setose, palm oblique. Female gnathopod 1 propodus subovoid, palm weakly excavate.

Colour in life, tan with discrete black spots; in alcohol white with black spots.

Discussion. This species resembles *A. kergueleni* Stebbing, but in that species the male gnathopod 1 merus is stout and shorter than the carpus, and the dactylus is distinctly serrate, while gnathopod 2 has a swollen palmar region. It also resembles *A. spinicornis* Afonso from which it differs in having the merus of gnathopod 1 extending beyond the end of the carpus and in lacking an inflated gnathopod 2 propodus. Hyperadult male *A. maculata* differ from all known *Aora* spp. in the shape of coxa 1.

World distribution. New Zealand including sub-Antarctic islands, Tasmania and SE Australia.

Aora mortoni (Haswell, 1879)

Figs 1, 7, 8, 13

Microdeuteropus [sic] *mortoni* Haswell, 1879, p. 339, pl. 22, fig. 2.—Chilton, 1884, p. 1040.

Microdeuteropus tenuipes Haswell, 1879, p. 339, pl. 22, fig. 1.—Chilton, 1884, p. 1040.

Microdeuteropus mortoni.—Haswell, 1882, p. 264.

Microdeuteropus tenuipes.—Haswell, 1882, p. 264.

Type locality. Sydney Harbour.

Material examined. 113♂ 138♀ 25 imm., Western Port, Victoria (NMV); 33♂ 68♀ 5 imm., Tinderbox, SE Tasmania in algae (UT); 15♂ 37♀, Sydney Harbour (including ♂ HOLOTYPE *M. mortoni* and ♀ SYNTYPES *M. tenuipes*) (AM).

Diagnosis. Maximum length 8.0 mm. Male pereon segments 2-3 with forward curved, slender, acute, sternal processes. Male gnathopod 1 coxa subrectangular, antero-distal corner unproduced, rounded; basis and ischium stout; merus almost straight, acute, diverging strongly from carpus distally; propodus three-quarters length of carpus, palm in hyperadults produced into a weak tooth; dactylus slender, two-thirds length of propodus. Male gnathopod 2 carpus and propodus anterior margin densely setose, palm oblique. Female gnathopod 1 propodus slender, palm distally excavate.

Colour in alcohol, whitish with brownish blotches on pereon, a particularly strong blotch on dorsum of segment 7. Head with reticulate pattern on dorsal surface.

Discussion. Only two other known world species of *Aora* have the greater length of the margins of both carpus and propodus of male gnathopod 2 densely setose, viz. *A. hebes* and *A. inflata*. *Aora mortoni* is readily distinguished from both by the structure of the male gnathopod 1, notably the unproduced coxa and divergent but almost straight, acute merus. In addition, this species and *A. adpressa* n.sp. are the only *Aora* spp.

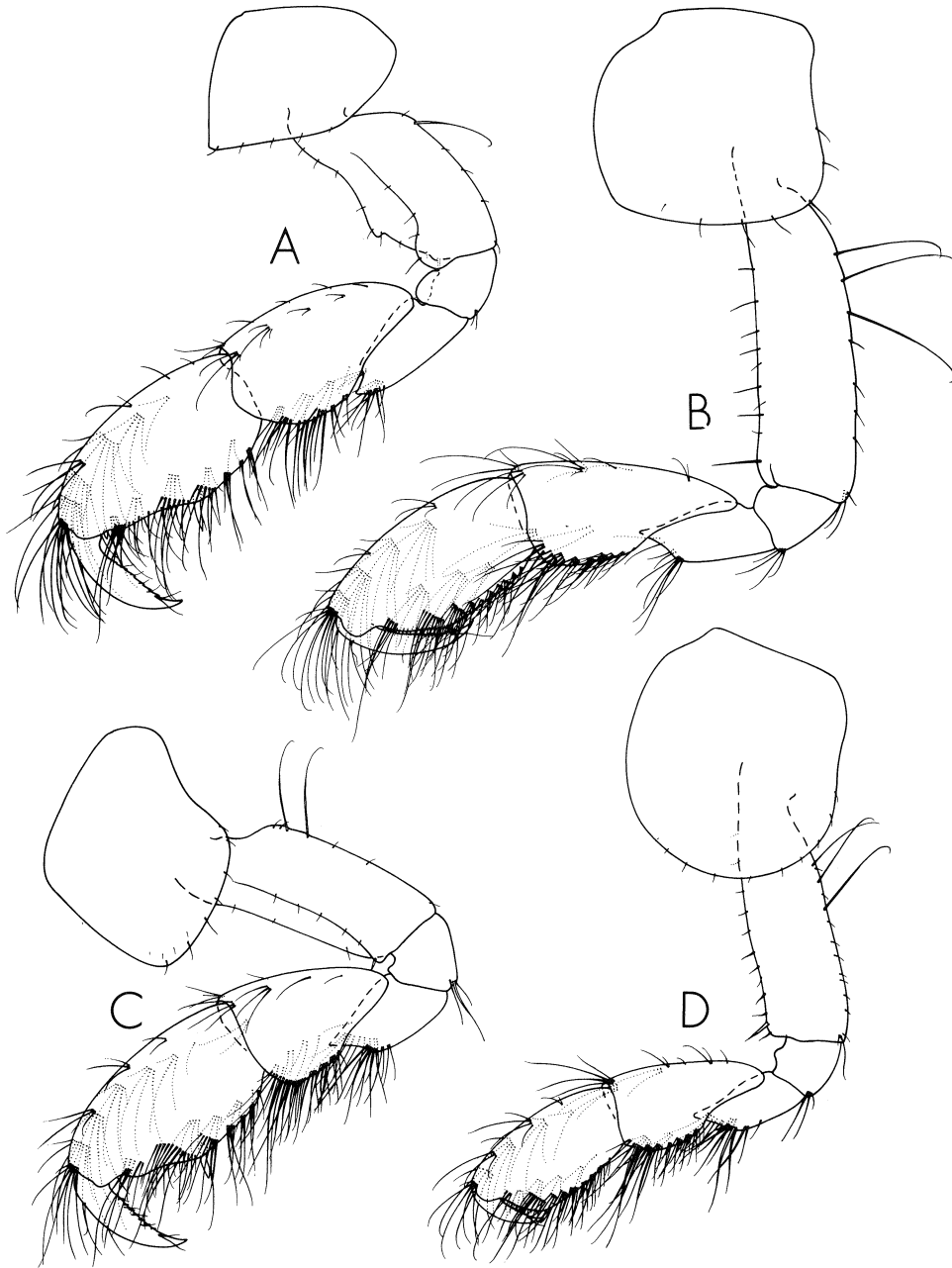


Fig.4. *A. typica*, Snares Islands. **A**, Subadult ♂ gnathopod 1; **B**, hyperadult ♂ gnathopod 2; **C**, ovigerous ♀ gnathopod 1; **D**, ovigerous ♀ gnathopod 2.

known to possess sternal pereon processes in the male, although some species may not have been examined for this character.

World distribution. Tasmania to Sydney.

***Aora hebes* n.sp.**

Figs 1, 9, 10, 13

Type material. HOLOTYPE ♂ 6.5 mm. East of North Head, Sydney, N.S.W. 33° 49'S, 151° 18'E, 21 m, in association with the sponge *Polymastea cratica* February 1973, AM 22411. PARATYPES 18♂ 19♀ 4 imm., same locality and

date, in association with *P. cratica* and *Teichonella labyrinthica*, 19.8-25.9 mm, AM 22411.

Etymology. The name refers to the blunt end of the merus in hyperadult males.

Diagnosis. Maximum length 6.5 mm. Male pereon segments lacking sternal processes. Male gnathopod 1 coxa with anteroventral corner very strongly produced, acute; basis and ischium stout, merus swollen basally and then of almost equal diameter throughout its length, longer than carpus, strongly diverging distally, ending obtusely in hyperadults, acutely in subadults; propodus

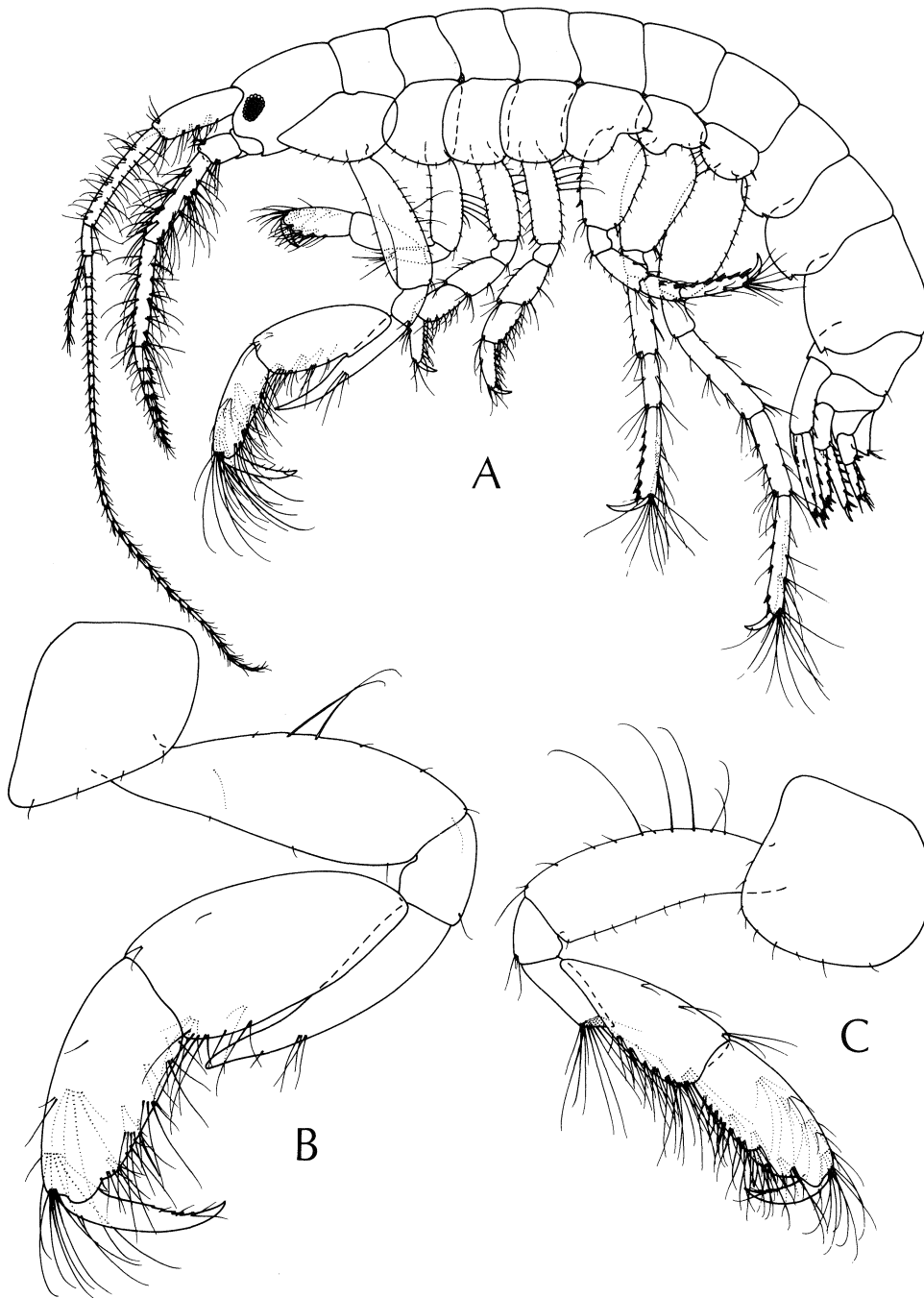


Fig. 5. ♂ *A. maculata*, Snares Islands. A, lateral view; B, subadult gnathopod 1; C, hyperadult gnathopod 2.

about two-thirds length of carpus; dactylus stout, about two-thirds length of propodus. Male gnathopods 2 carpus and propodus with anterior margin densely setose, palm oblique. Female gnathopod 1 propodus with distinct but short palm.

Description. Head ocular lobes moderately produced, obtuse; eye subround. Antenna 1 two-thirds body length, peduncular articles in the ratio 9:10:3, flagellum longer than peduncle with 19 articles; accessory flagellum with 4 articles, the terminal article

rudimentary. Antenna 2 less than two-thirds length of antenna 1, peduncular articles 4 and 5 subequal, flagellum shorter than peduncular article 5 with 8 articles. Male gnathopod 2 coxa subtriangular, deeper than broad, carpus elongate, propodus two-thirds length of carpus, palm oblique; dactylus fitting palm. Pereopods 3-4 coxae deep, dactylus almost half length of propodus. Pereopods 5-7 in length ratios 4:4:5, coxa 5 with deep anterior lobe. Epimera 2-3 with small posterodistal tooth. Uropod 1 peduncle with strong

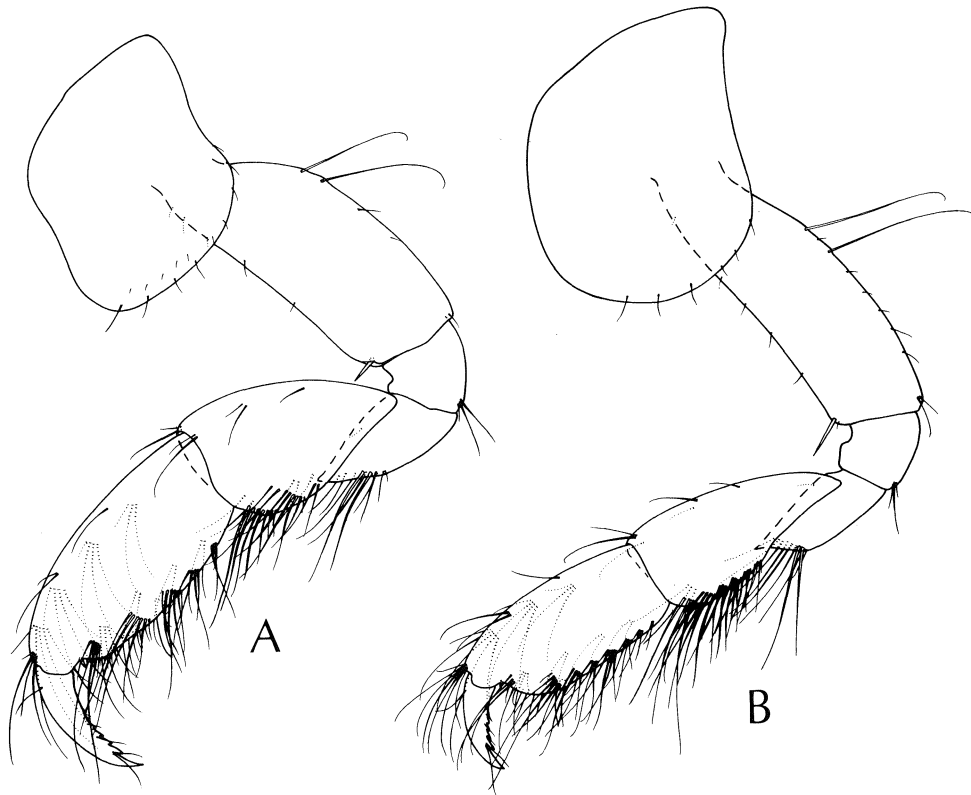


Fig. 6. Ovigerous ♀ *A. maculata*, Snares Islands. A, gnathopod 1; B, gnathopod 2.

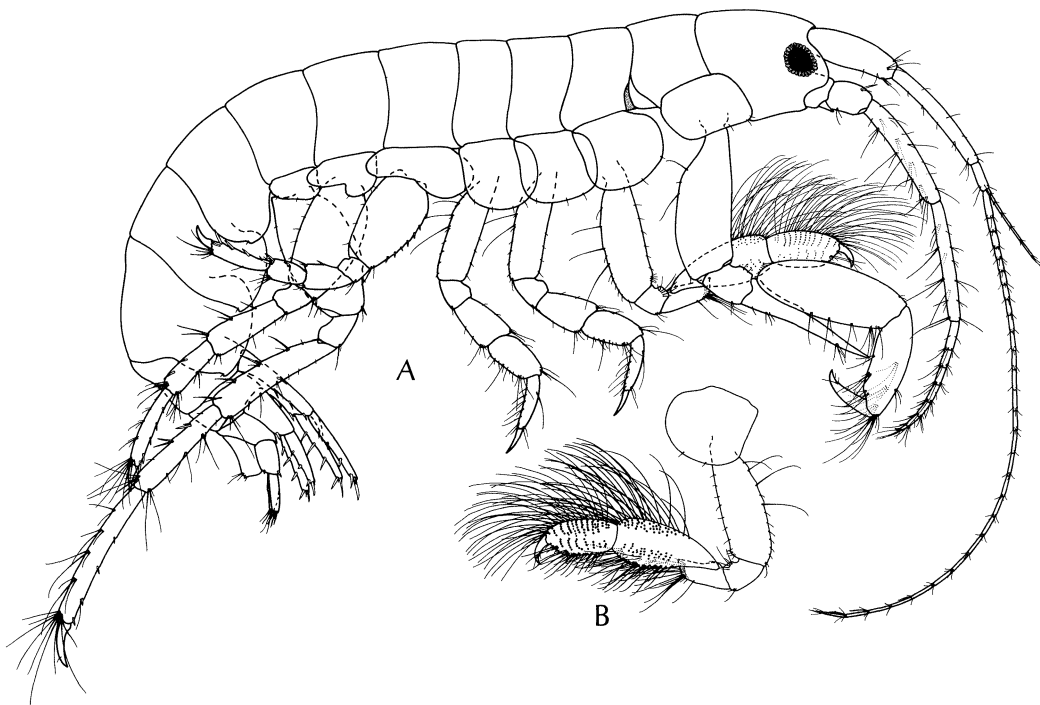


Fig. 7. ♀ *A. mortoni*, Western Port. A, lateral view; B, hyperadult gnathopod 2.

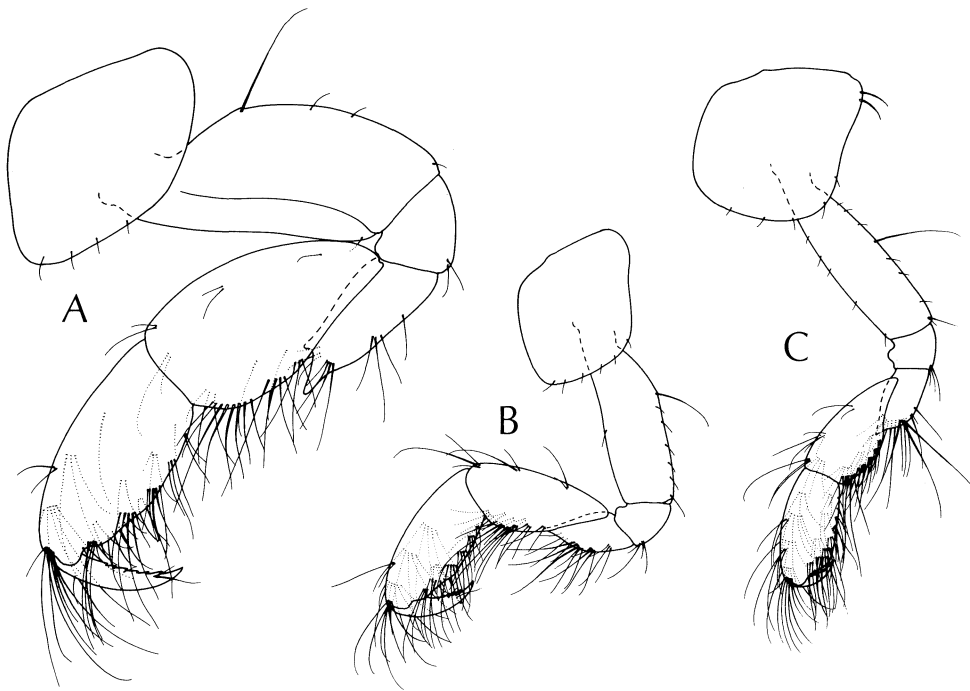


Fig. 8. *A. mortoni*, Western Port. A, subadult ♂ gnathopod 1; B, ovigerous ♀ gnathopod 1; C, ovigerous ♀ gnathopod 2.

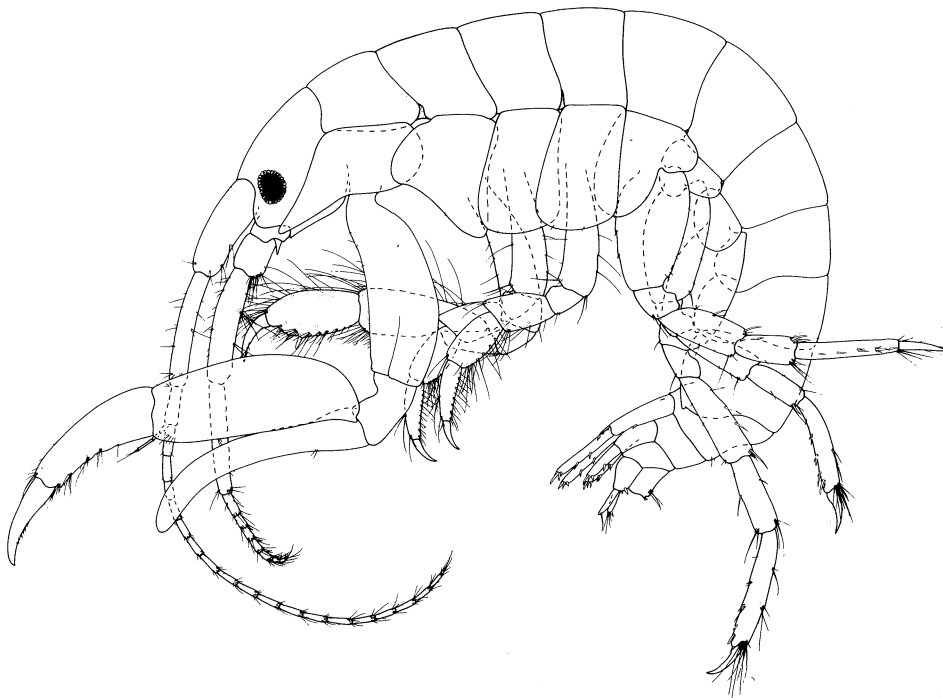


Fig. 9. ♂ *A. hebes*, Sydney Harbour, lateral view.

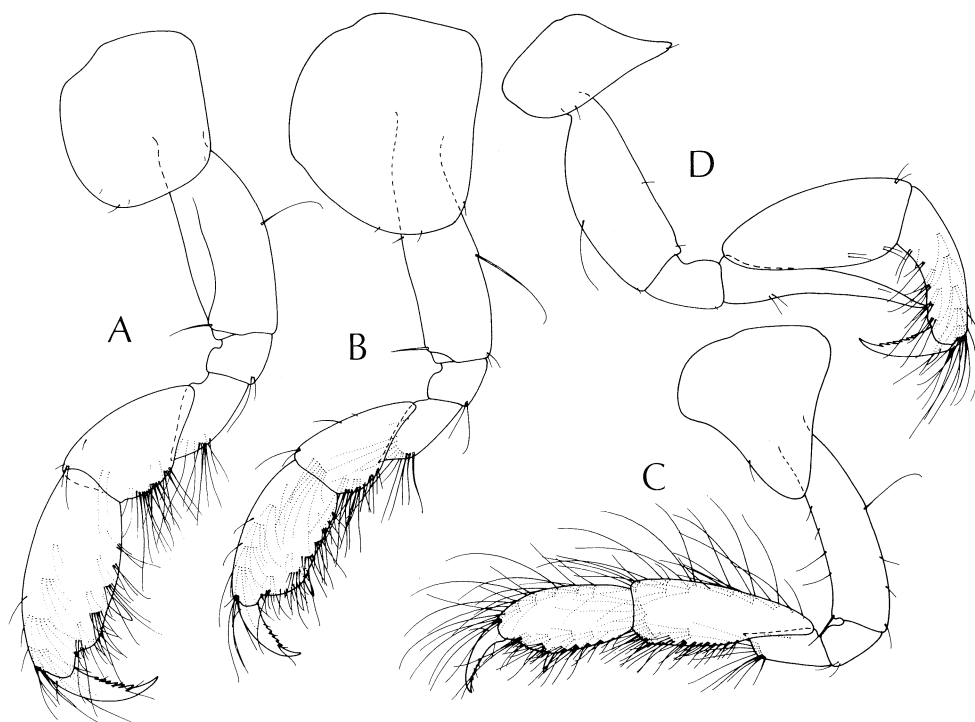


Fig. 10. *A. hebes*, Sydney Harbour. A, ovigerous ♀ gnathopod 1; B, ovigerous ♀ gnathopod 2; C, hyperadult ♂ gnathopod 2; D, subadult ♂ gnathopod 1.

interramal spiniform process. Uropod 2 peduncle lacking an interramal process. Uropod 3 rami subequal, lacking marginal spines, outer ramus with small second article.

Colour in alcohol, pale tan with numerous small reddish-brown spots.

Discussion. The peculiar blunt merus of the male gnathopod 1, the triangular coxa 2 of the male, and the deep coxae 3-5 of the male are unique among known world species of *Aora*.

World distribution. So far known only from Sydney Harbour but possibly overlooked elsewhere owing to its inquilinous habits.

Aora hircosa n.sp.

Figs 2, 12, 13

Type material. HOLOTYPE: 1♂ 6.0 mm. Tinderbox, south-east Tasmania in marine algae, T.M. Walker, 1977: NMV J1324. PARATYPES: 7♂ 18♀ 1 imm. Same data as holotype.

Other material. 4♂ 9♀, Fancy Point, SE Tasmania in algae, 2-3 m (UT); 4♂ 8♀ 2 imm., Western Port, Victoria (NMV).

Diagnosis. Maximum length 6.0 mm. Male pereon segments lacking sternal processes. Male gnathopod 1 coxa with anteroventral corner strongly produced, acute; basis and ischium stout; merus stout, strongly setose, narrow distally, acute, moderately divergent from and reaching end of carpus; carpus and propodus

stout, strongly setose on posterior margin, propodus over three-quarters length of carpus with stout palmar defining spine; dactylus over half length of propodus. Male gnathopod 2 of moderate size, only moderately setose, palm oblique. Female gnathopod 1 propodus with stout but distinct palm.

Description. Head ocular lobes moderately produced, obtuse; eye subround. Antenna 1 two-thirds body length, peduncular articles in the ratios 5:6:2, flagellum longer than peduncle, with 18 articles; accessory flagellum with 4 articles, the terminal article rudimentary. Antenna 2 over half length of antenna 1, peduncular articles 4 and 5 subequal, flagellum a little shorter than peduncular article 5, with 5 articles. Male gnathopod 2 slender, carpus a little longer than propodus, dactylus fitting palm. Pereopods 3-4 dactylus less than half length of propodus. Pereopod 5 normal, pereopods 6-7 unknown. Epimera 1-3 rounded, epimera 2-3 with small posterodistal tooth. Uropod 1 peduncle with strong interramal spiniform process. Uropod 2 peduncle with short, triangular, interramal process. Uropod 3 rami stout, subequal, outer ramus with small second article. Colour in alcohol pale cream with numerous small blackish-brown spots, which tend on the dorsum to form distinct, though weak, bands.

Discussion. The strongly setose merus of the male gnathopod 1 is found in only one other species, *A. atlantidea* Reid. This latter species differs from *A. hircosa* in the presence of very long setae on the anterior margin of the propodus of the male gnathopod 1. In addition, the merus of gnathopod 1 of male *A. hircosa*

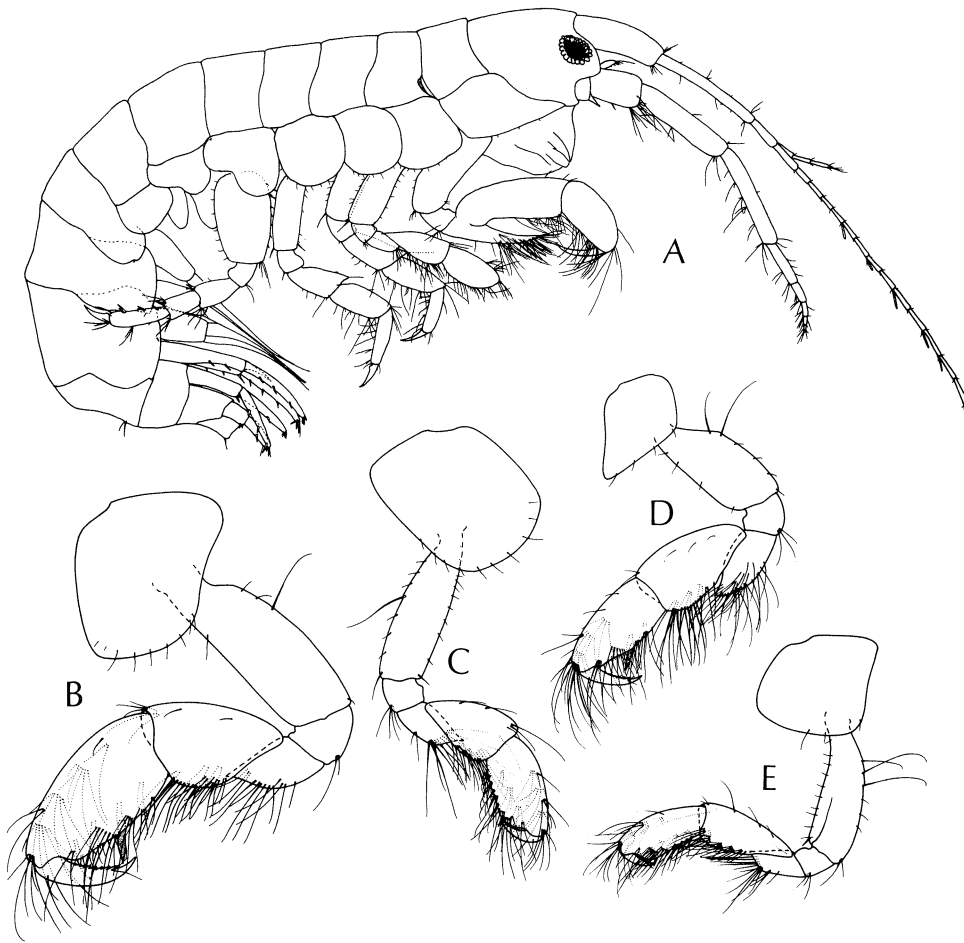


Fig. 11. *A. hircosa*, Tinderbox. A, ♂ lateral view; B, ovigerous ♀ gnathopod 1; C, ovigerous ♀ gnathopod 2; D, subadult ♂ gnathopod 1; E, hyperadult ♂ gnathopod 2.

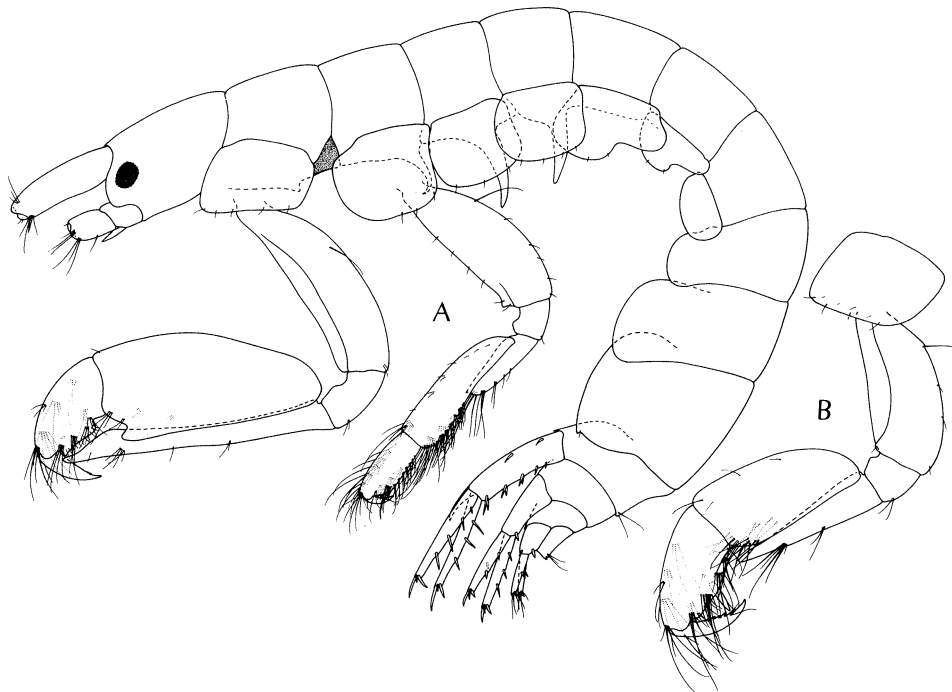


Fig. 12. ♂ *A. adpressa*, Western Port. A, lateral view; B, subadult gnathopod 1.

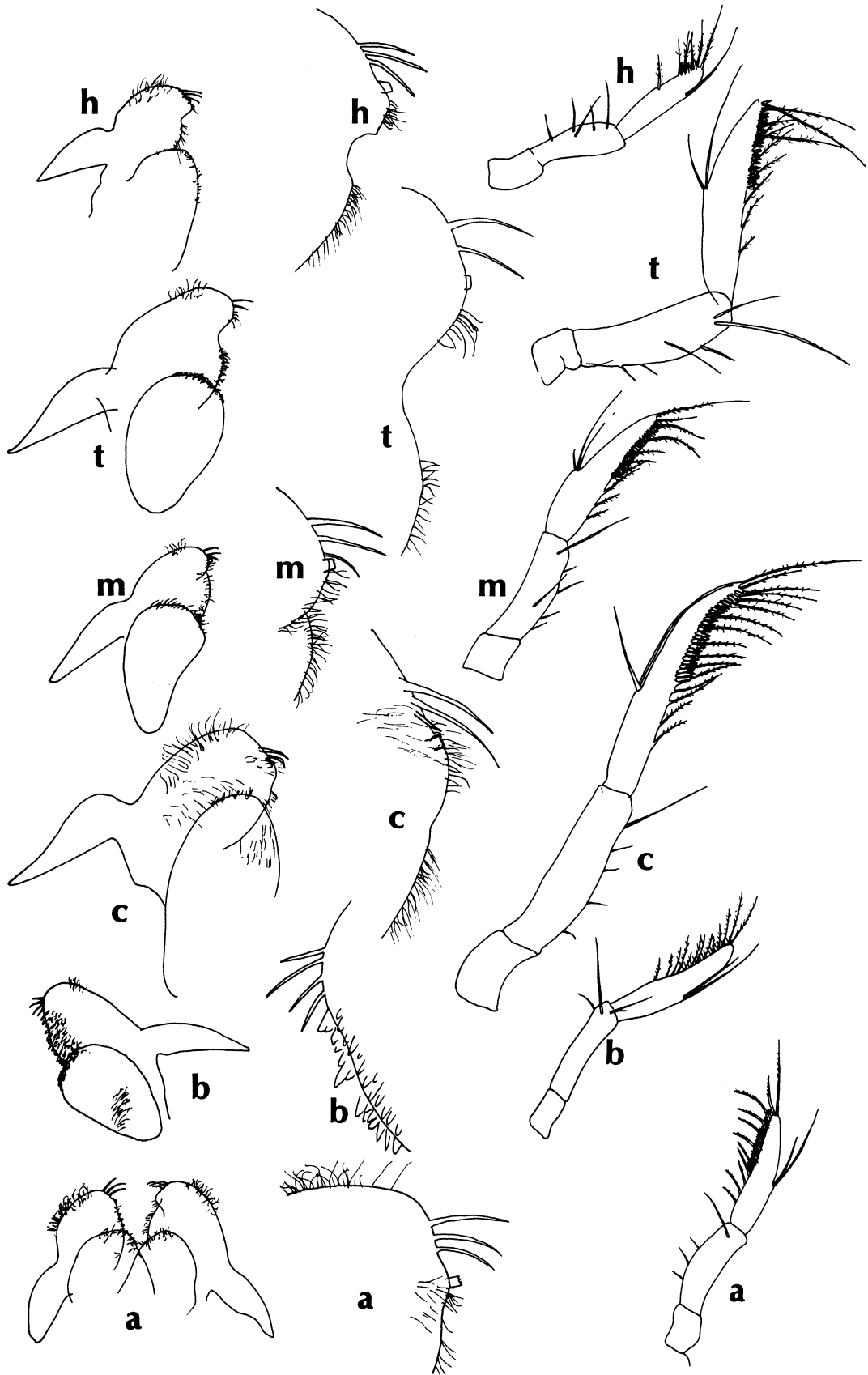


Fig. 13. Labium and mandibular palp of Australian and New Zealand *Aora* spp. h = *A. hircosa*, t = *A. typica*, m = *A. mortoni*, c = *A. maculata*, b = *A. hebes*, a = *A. adpressa*.

reaches the end of the carpus of the same appendage but does not do so in *A. atlantidea*.

World distribution. Tasmania to Victoria.

Aora adpressa n. sp.

Figs 2, 12, 13

Type material. HOLOTYPE: ♂ 6.00 mm. 2 km W of Phillip Island, Western Port, Victoria (Western Port Bay Environmental Study Station 1747), 1973-74. NMV J. 1322. PARATYPES 3♂. Same data as holotype. NMV J1323.

Etymology. The name refers to the fusion of the merus with the posterior margin of the carpus in the male gnathopod 1.

Diagnosis. Maximum length 6.0 mm. Male pereon segments 2-4 with strong sternal processes, on segment 2 slender, strongly curved forward, on segments 3-4 stouter, weakly curved forward. Male gnathopod 1 coxa subrectangular, anterodistal corner unproduced; basis and ischium moderately slender; merus slender, much longer than carpus, fused to posterior margin of carpus throughout the length of the carpus, the free end swollen basally, constricted distally, subacute; propodus less than half length of carpus, posterior margin produced into a broadly bilobed medial flange; dactylus stout, about two-thirds length of propodus, opposable to free end of merus. Male gnathopod 2 elongate only moderately setose, palm very oblique.

Female unknown.

Description. Head ocular lobes moderately produced, obtuse; eye subround. Male gnathopod 2 carpus very elongate and slender, propodus slender, scarcely more than half length of carpus, dactylus fitting palm. Pereopods 3-7 unknown. Epimera 1-2 rounded, epimeron 3 with small posterodistal tooth. Uropod 1 peduncle with strong, spiniform interramal process. Uropod 2 with rudimentary interramal process. Uropod 3 rami subequal, outer ramus with small second article.

Colour in alcohol pale tan without distinct markings.

Discussion. *Aora adpressa* is unique among known *Aora* spp. in having the merus fused to the carpus throughout the latter's length. The opposition of the free end of the merus to the propodus results in a superficial similarity to species of *Microdeutopus*. Myers (1981) described a new genus of Aoridae (*Aorella* Myers) from Fiji, which possesses a male gnathopod 1 extraordinarily like that of *A. adpressa*. His observation that "in all known male *Aora* the merus is fused to the carpus only at the base, being free distally" is clearly no longer tenable. *Aorella* differs from *Aora* in the complexly subchelate male gnathopod 2, strongly produced distoventral cephalic margin, flanged article 3 of antenna 2 and reduced mandibular palp. The present species exhibits none of these characters. The very similar gnathopod 1 of *A. adpressa* and *Aorella*

multiplex may be due to convergence or *A. adpressa* may represent an early stage in the development of *Aorella* from *Aora*.

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