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New Species belonging to the Family Porcellidiidae (Harpacticoida: Copepoda) from Kioloa, New South Wales, Australia

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ABSTRACT. Six new species referred to four new genera and one new species of *Porcellidium* belonging to the family Porcellidiidae (Harpacticoida: Copepoda) are described from Kioloa, a locality on the southern coast of New South Wales, Australia. Characteristic features defining the following new genera are given together with descriptions of new species: *Brevifrons* n.gen., *B. faviolatum* n.sp., *Kioloaria* n.gen., *K. sesquimaculata* n.sp., *Murramia* n.gen., *M. magna* n.sp., *M. bicincta* n.sp., *Tectacingulum* n.gen., *T. tumidum* n.sp. and *T. nigrum* n.sp. A new species of *Porcellidium*, *P. londonii* n.sp., is described and referred to the 'Fimbriatum' group. The structure and taxonomic significance of the hyaline fringe and male antennule are discussed together with other characters that have been used to define new genera.

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The family Porcellidiidae has been regarded as monotypic with all species being referred to the one genus, *Porcellidium* (Lang, 1948). In their description of eight new species from New South Wales, Harris & Robertson (1994) pointed out the need for revision of the family. Using a wider database, built upon a more detailed knowledge of the Australian species, they discussed the most suitable features upon which the family could be defined and new genera created. The taxonomic characters of *Porcellidium* were redefined and a new genus, *Acutiramus*, established to take two of the new species.

The present paper deals with a collection of seven new species from Kioloa, a locality on the southern coast of New South Wales. Six of these belong to the southern assemblage (Harris & Robertson, 1994). One species has been referred to *Porcellidium*; the other six show features which immediately exclude them from

that genus. To accommodate them four new genera have been erected and their characteristics defined. None of the previously described species fall into these new genera.

The methods of study, measurement and selection of type material, together with terminology used to describe setae, follows the procedures described by Harris & Robertson (1994). Numbers on illustrations refer to the slide from which they were drawn. On drawings of the whole animal the delicate hyaline border or fringe has been omitted. SEM photographs of formalin fixed material were taken on an Hitachi S225 ON scanning electron microscope after gold coating.

Holotypes, allotypes and paratype material have been deposited in the Australian Museum, Sydney, and paratype material deposited in the British Museum (Natural History). The remaining paratype material and

prepared slides are currently held in the Division of Botany and Zoology, School of Life Sciences, Australian National University, Canberra, Australia (ZANU) by the author.

Systematics

Porcellidiidae Sars, 1904

For diagnostic characters of the family see Harris & Robertson (1994).

Generic composition. *Acutiramus* Harris & Robertson,

1994; *Brevifrons* n.gen.; *Kioloaria* n.gen.; *Murramia* n.gen.; *Porcellidium* Claus, 1860; *Tectacingulum* n.gen.

Tectacingulum n.gen.

Diagnosis. Anterior of female cephalosome semicircular, male truncated; edge of cephalosome reflexed ventrally, striated false border, no true hyaline border, dorsal pits present; urosome broad, with epimeral expansions to form anterior and posterior lobes, caudal rami included in caudal arch of urosome; caudal rami rectangular not emarginate, α and β setae not close

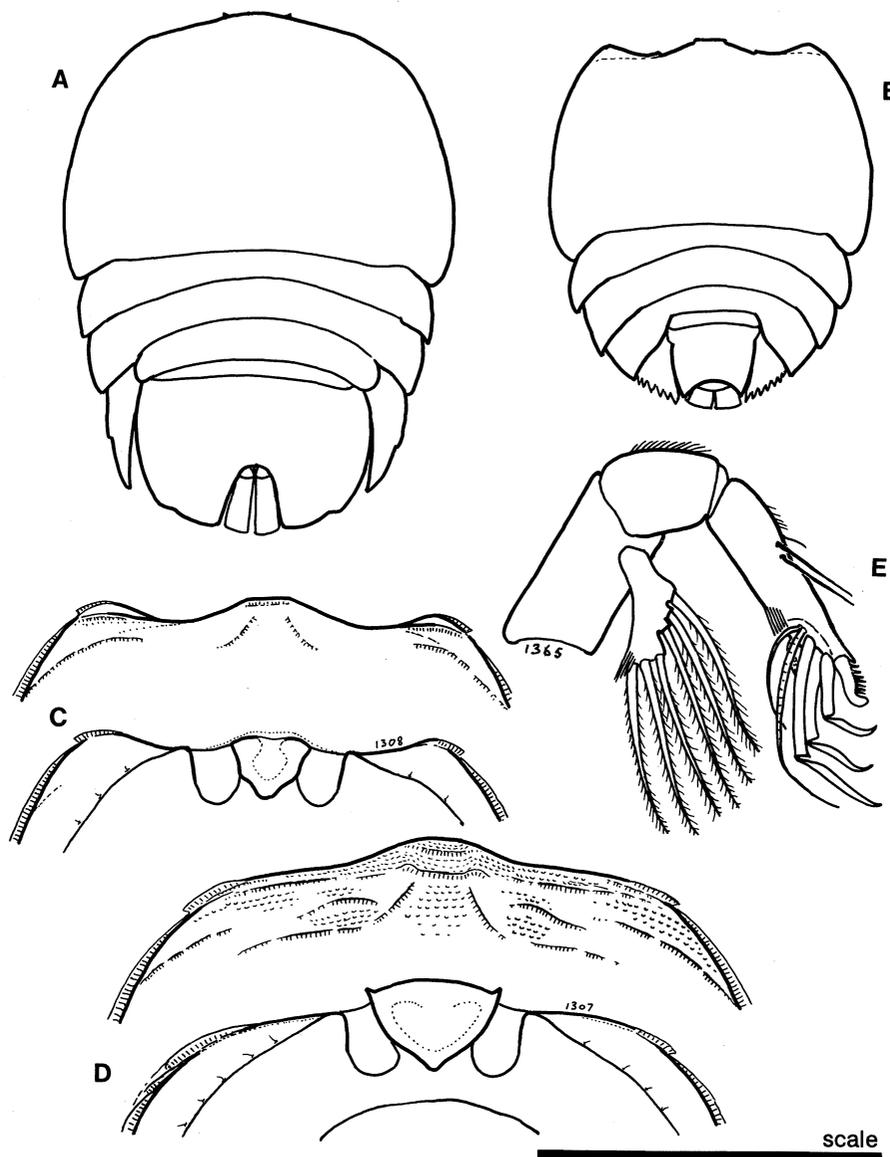


Fig. 1. *Tectacingulum tumidum*. A – adult female; B – adult male; C – male rostrum and anterior border of cephalosome (dorsal and ventral view); D – female anterior border of cephalosome and rostrum (dorsal and ventral view); E – antenna. Scale bar: A,B = 0.72 mm; C,D = 0.45 mm; E = 0.12 mm.

together; maxillule endopod with 6 setae; maxilliped basis with fimbriate process, coxal lobe fimbriate; male P2 endopod with 2 terminal setae; male P5 with 6 terminal setae; female P5 does not extend beyond the urosome or touch its fellow posteriorly.

Species composition. *Tectacingulum tumidum* n.sp.;
T. nigrum n.sp.

Remarks. This genus differs from all other members of the family Porcellidiidae by the absence of a true hyaline border to the cephalosome. The lateral margin is reflexed ventrally and can only be seen from the

ventral side (see Fig. 2); the generic name refers to this unusual feature (*L. tectus* = hidden + *cingula* = a girdle). Consequently sensory setae, not normally found on the ventral side, are present in that position.

The two species are known from Kioloa and the southern New South Wales coast.

Tectacingulum tumidum n.sp.

Figs 1-5

Type material. HOLOTYPE adult female with egg mass,

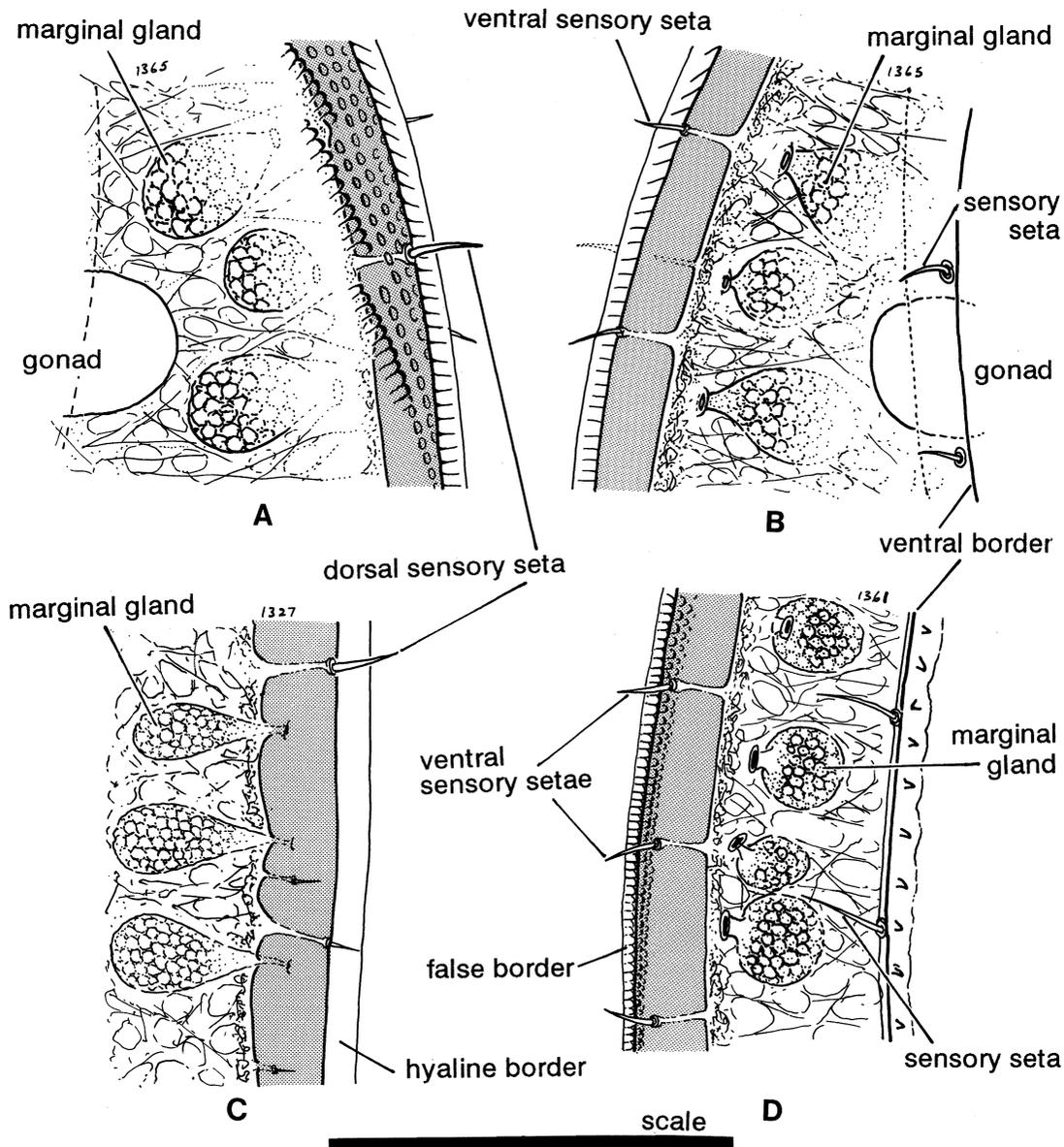


Fig. 2. *Tectacingulum tumidum*: A – edge of cephalosome (dorsal view) showing striated false border and absence of true hyaline fringe; B – same (ventral view) showing portion of reflexed border and ventral opening of marginal glands. *Murramia bicincta*: C – hyaline border of cephalosome (dorsal view) showing dorsal opening of marginal glands. *Tectacingulum nigrum*: D – edge of cephalosome (ventral view) showing ventral sensory setae and ventral opening of marginal glands. Scale bar: A-D = 0.1 mm.

AM P42302; ALLOTYPE adult male, AM P42303; PARATYPES 1 female, 1 male BM(NH) 1992.534-535. Dissected paratypes (slides 1307 female, 1308 male), and remaining type population, held at ZANU, registration Po.X. [Ki.35] [total type population 12 females (6 carrying eggs), 8 males 5 coupled to juveniles]. Washed from stones encrusted with pink 'Lithothamnion', infralittoral fringe, sheltered bay on north side of O'Hara Head, Kioloa, NSW (35°30'S 150°22'E), 19 Jan. 1977, V.A.P. Harris.

Diagnosis. *Adult female.* Translucent pale pink; mean length 1.1 mm; cephalosome noticeably wider than

metasome, rostrum 0.18 mm, ratio of width to rostrum 4.6; dorsal surface conspicuously pitted, edge of cephalosome with radiating ridges; urosome broad, semicircular, caudal arch deep, slight notch and scar; caudal rami rectangular, not emarginate, wider distally, β seta closer to γ than to α , terminal setae pinnate, similar in size; extensive peg fields on P1 endopod and exopod.

Adult male. Cephalosome noticeably wider than metasome, shoulders rounded, project forward; antennule with ventral blade.

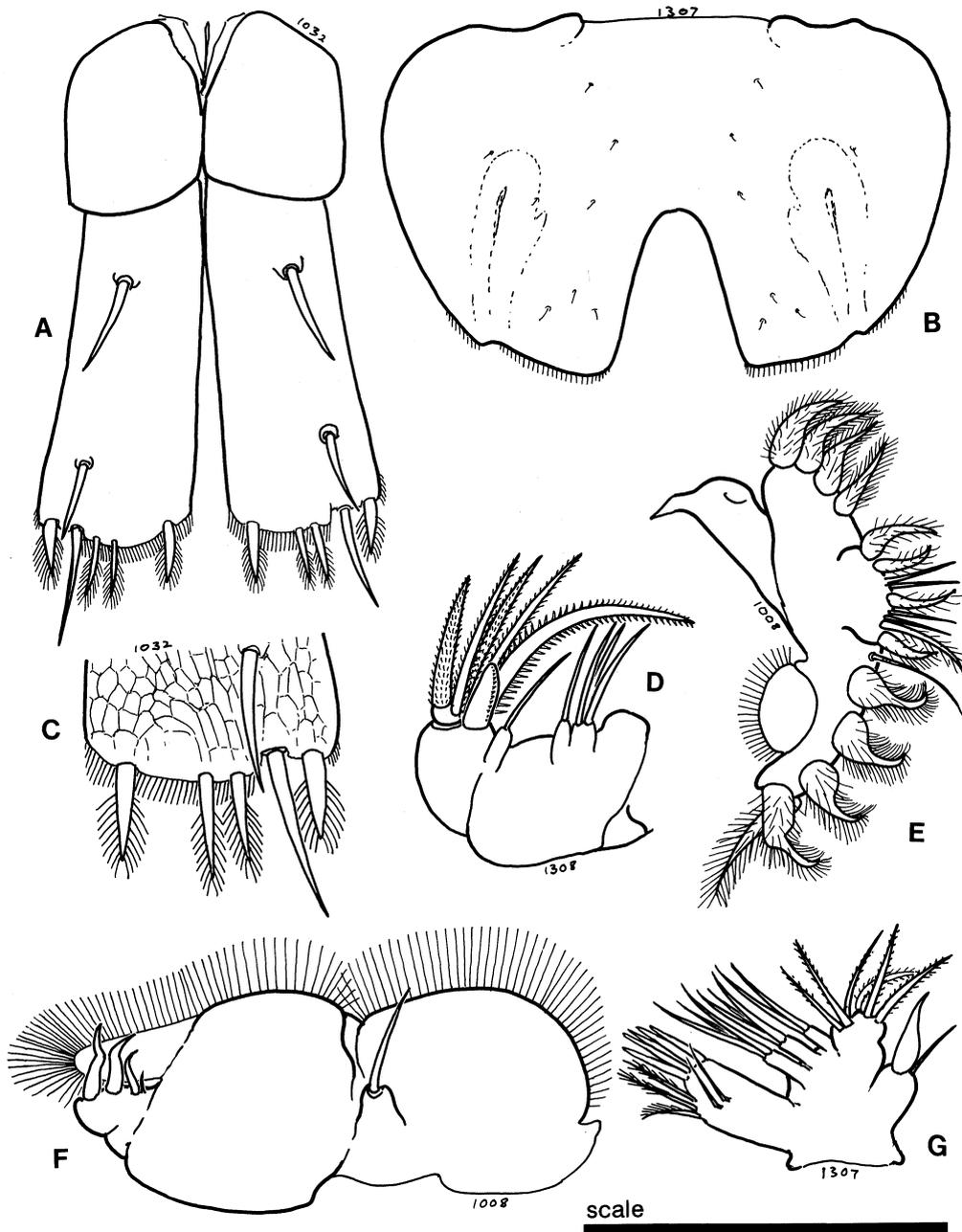


Fig. 3. *Tectacingulum tumidum*. A – female caudal rami; B – female urosome; C – female caudal ramus showing detail of terminal setae; D – maxilla; E – female mandible; F – maxilliped; G – maxillule. Scale bar: A,D = 0.12 mm; B,C = 0.33 mm; E = 0.22 mm; F,G = 0.1 mm.

Dimensions. Females. Mean length 1.14 mm (SD = 0.032, N = 9), cephalosome width 0.85 mm (SD = 0.021), height 0.15 mm, body length to width ratio 1.34. Rostrum 0.18 mm, ratio of cephalosome width to rostrum 4.6. Urosome width to length ratio 1.8. Caudal ramus length to width ratio 2.65.

Males. Mean length 0.76 mm (SD = 0.021, N = 7), cephalosome length 0.48 mm, width 0.66 mm (SD = 0.02), ratio of body length to width 1.15.

Adult female (Fig. 1A). Cephalosome very broad (about 14% wider than first metasomal segment), anterior outline semicircular with convex bulge in midline. Rostrum projects slightly (Fig. 1D). Edge of cephalosome reflexed ventrally resulting in true boundary between tergum and sternum lying ventrally. Marginal glands open ventrally and sensory setae occur on the underside (Fig. 2A,B). A true hyaline border or fringe is absent, but the thin cuticular edge of the carapace forms a false

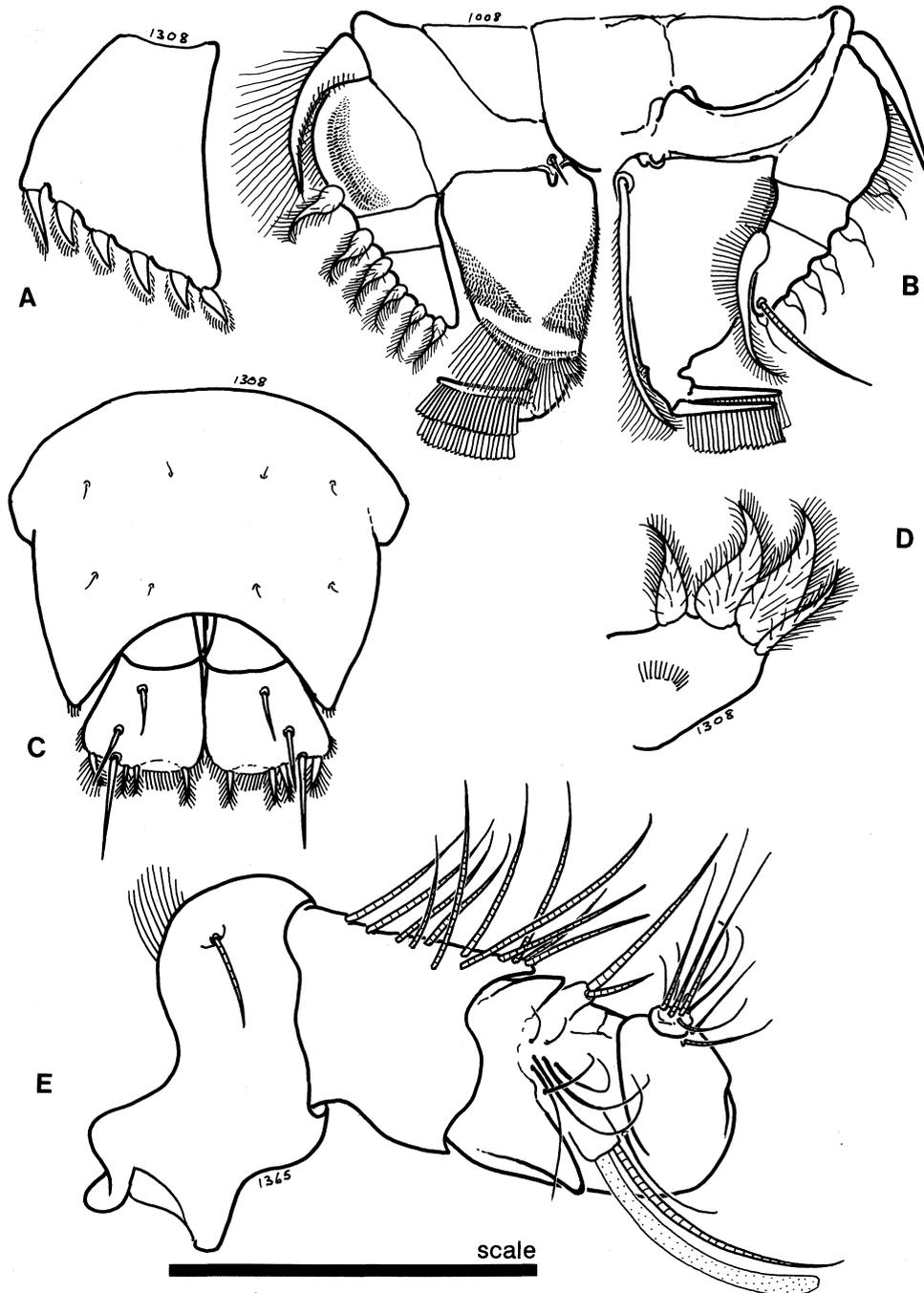


Fig. 4. *Tectacingulum tumidum*. A – male P5; B – P1 (left ventral, right dorsal); C – male urosome and caudal rami; D – male mandibular palp; E – male antennule (distal segment adducted and obscuring coupling denticles). Scale bar: A,C,D = 0.19 mm; B = 0.22 mm; E = 0.1 mm.

border with radiating striations (Fig. 2A,B). Dorsal surface of cephalosome, metasome, urosome and caudal rami conspicuously pitted. Numerous dorsal sensory setae.

Urosome very broad, semicircular in outline (Fig. 3B), with slight lateral notch and scar, posterior lobe bordered with fine setules. Caudal arch deep, slightly less than half urosome length.

Caudal rami long, rectangular, not emarginate, slightly wider distally (Fig. 3A). α seta one-third, and β seta three-quarters way down ramus; terminal setae all pinnate, 2 and 3 close, 4 set in slightly from medial

corner; terminal fringe of very fine setules (Fig. 3C). Caudal rami do not project beyond caudal arch in natural position.

Limbs with typical setation (Figs 1, 3-5). Spatulate claw of antenna pectinate, geniculate setae articulate (Fig. 1E). Incisor process of mandible chisel-like at right angles to body of mandible (Fig. 3E). Maxillule exopod with 2 setae, endopod with 6 setae (Fig. 3G). Maxilla as shown in Figure 3D. Medial lobe of maxilliped semicircular with coxal seta and fimbriate border, basis with fimbriate border and fimbriate process (Fig. 3F). First pereopod (P1, Fig. 4B), with broad band of

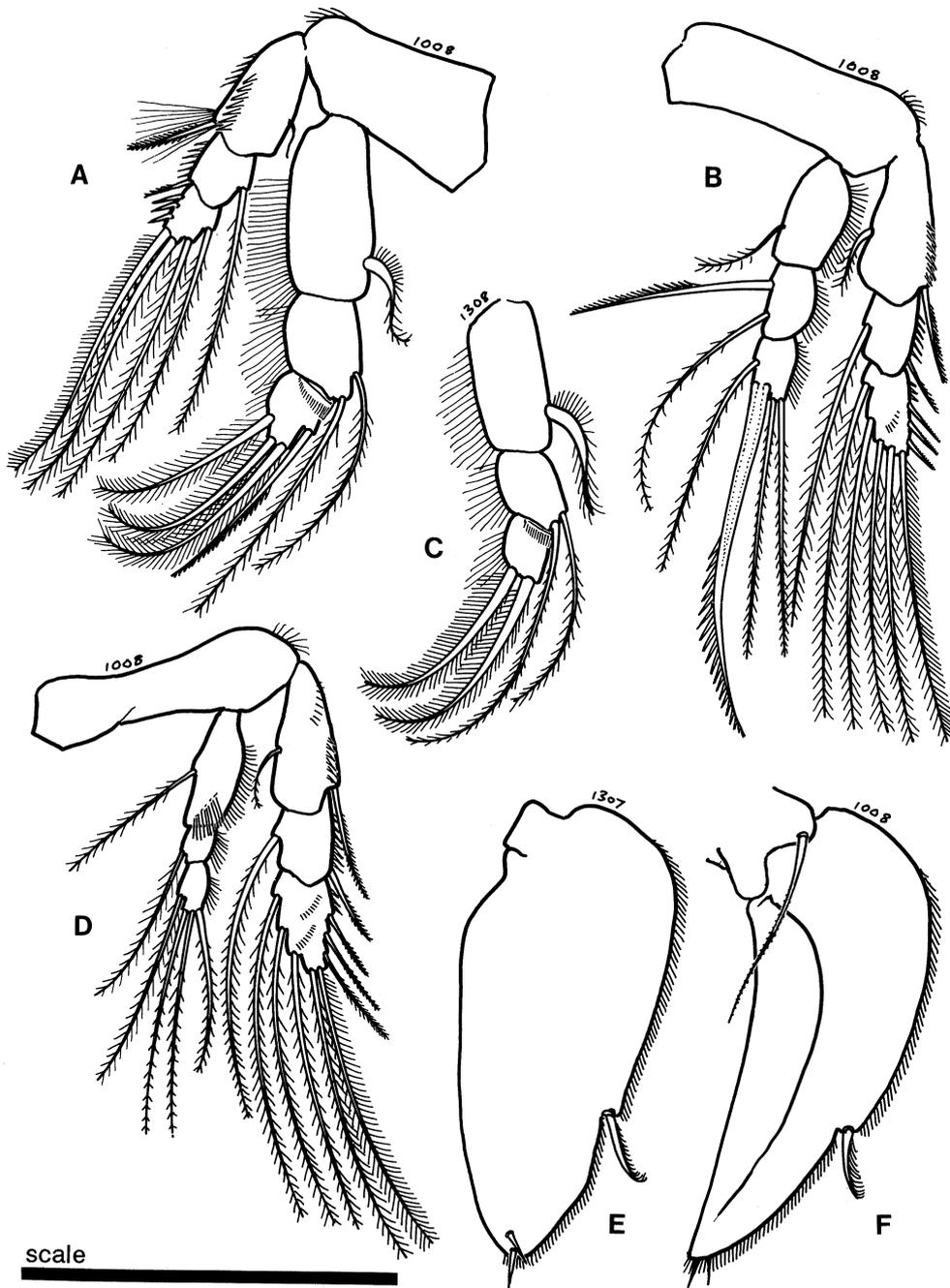


Fig. 5. *Tectacingulum tumidum*. A – female P2; B – P3; C – male P2 endopod; D – P4; E – female P5 (dorsal); F – female P5 in natural position (ventral). Scale bar: A-F = 0.22 mm.

denticulate pegs parallel to border on article 1 of exopod; field of denticulate pegs along medial border of endopod broadens distally and joins another triangular peg field lateral and proximal to fimbriate crescent. Terminal article of P2 endopod with 1 serrulate spinous seta and 3 plumose setae (Fig. 5A). Serrate sabre-like seta of P3 endopod (Fig. 5B) considerably longer than endopod (1.6 : 1). All setae of P4 endopod plumulose (Fig. 5D). Distal article of P5 lanceolate, apex rounded with 2 setae (Fig. 5E,F).

Adult male (Fig. 1B). Cephalosome broader than metasome, truncated anteriorly, strongly convex in midline, angle of antennule socket just visible from above, shoulders project forward, rounded with 'epaulet' (Fig. 1C). Border of cephalosome, ornamentation of pits and sensory setae as for female.

Urosome (Fig. 4C) with small group of apical setules. Caudal rami quadrate, expanding distally, setation as for female (Fig. 4C).

Antennule prehensile (Fig. 4E), short ventral blade and anterior spine on accessory lobe of compound segment, coupling denticles not known (observed in dissected specimen); first pilose seta on mandibular palp thin (Fig. 4D); maxilliped, P1, P3 and P4 as for female, P2 with 2 plumose setae on distal article of endopod (Fig. 5C); P5 with 6 setae as shown in Figure 4A.

Remarks. The ratio of body length to width of this species ($l/w = 1.3$) is the lowest known. The greater width of the cephalosome compared to the metasome gives this species a swollen appearance (*L. tumidus* = swollen). Freshly collected specimens are a pale translucent pink, but this fades on preservation.

Distribution and abundance. *Tectacingulum tumidum* has only been recorded from Kioloa, NSW. Numbers collected are small (the type population is the largest encountered). It has been washed from stones and

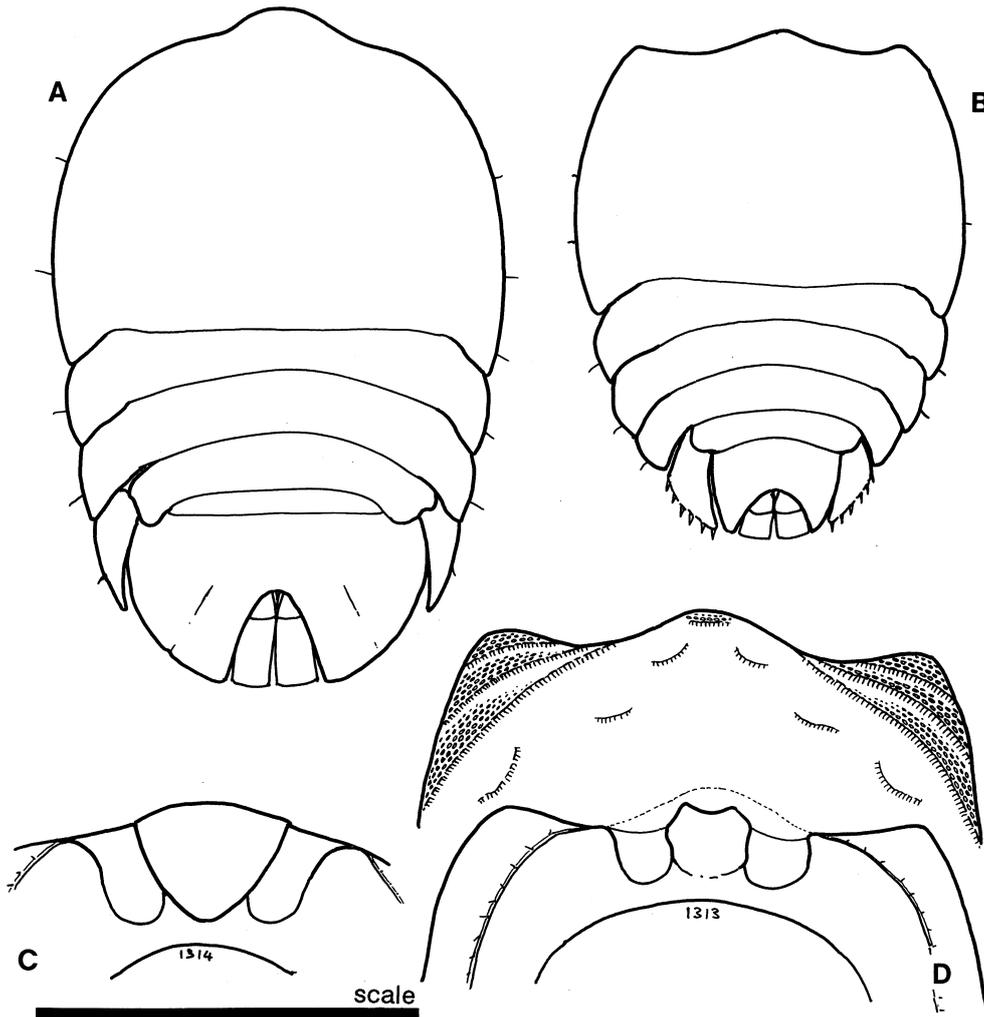


Fig. 6. *Tectacingulum nigrum*. A – adult female; B – adult male; C – female rostrum (ventral view); D – male anterior border of cephalosome and rostrum (dorsal and ventral view). Scale bar: A,B = 0.55 mm; C,D = 0.35 mm.

boulders encrusted with *Lithothamnion* and grazed by the sea urchin, *Centrostephanus rodgersii*, in the infralittoral fringe in a sheltered bay.

***Tectacingulum nigrum* n.sp.**

Figs 6-9

Type material. HOLOTYPE adult female with egg mass,

AM P42304; ALLOTYPE adult male, AM P42305; PARATYPES 2 adult females, 2 adult males, 3 copepodides, dissected female (slide 1314), dissected male (slide 1313). Paratype material held at ZANU, registration Po.W. [Mb.4] [total type population 4 females carrying eggs, 4 males (1 coupled to juvenile female)]. Collected from seaweed in infralittoral fringe on rocky shore, Merimbula Head, NSW (36°55'S 149°55'E), 2 Dec. 1982, V.A.P. Harris.

Diagnosis. *Adult female.* Indigo blue or black;

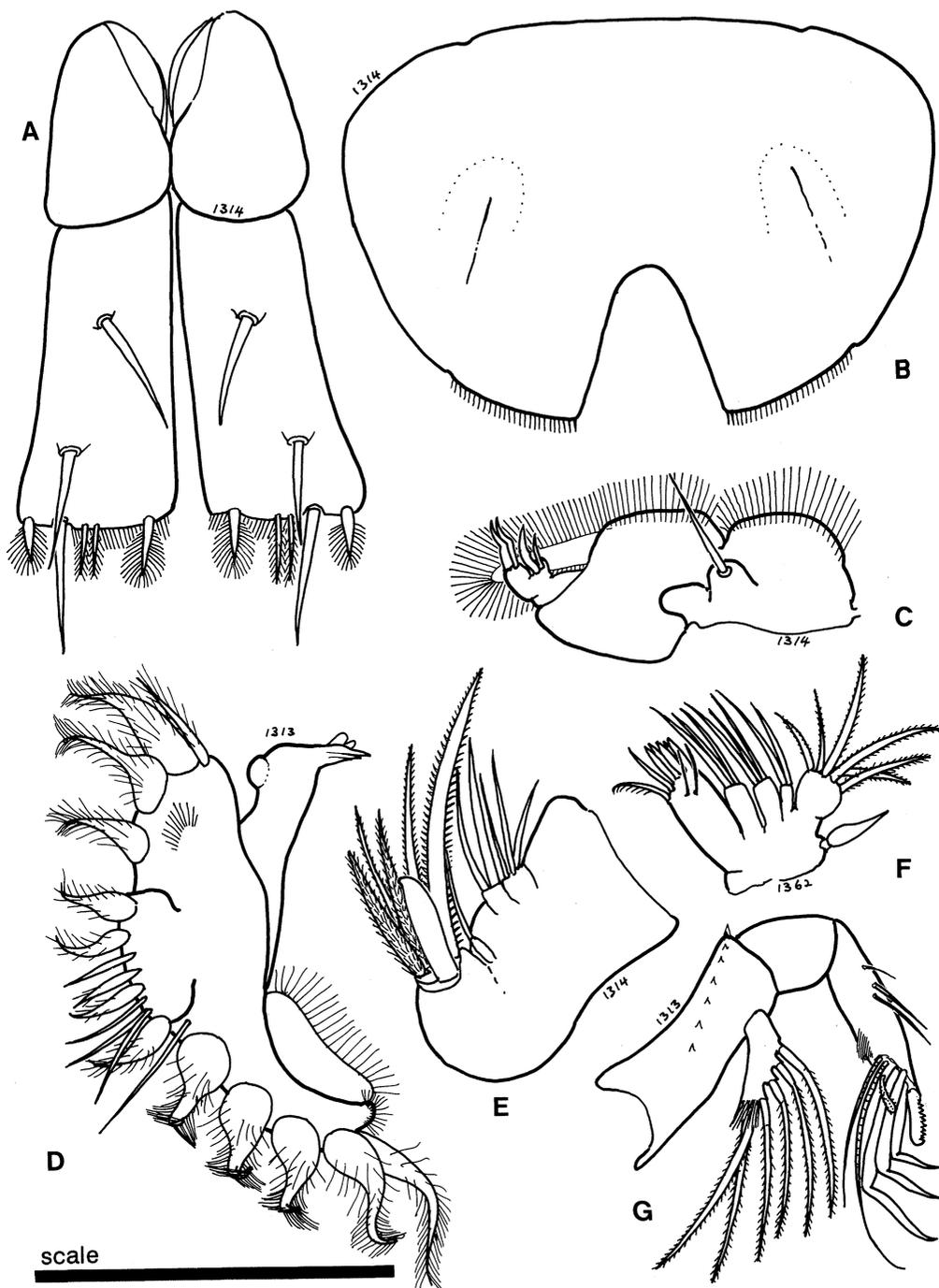


Fig. 7. *Tectacingulum nigrum*. A – female caudal rami; B – female urosome; C – maxilliped; D – male mandible; E – maxilla; F – maxillule; G – antenna. Scale bar: A,C,D,G = 0.12 mm; B = 0.26 mm; E,F = 0.1 mm.

cephalosome only slightly wider than metasome; length 0.9-1.0 mm; rostrum width 0.13 mm, not visible from above, ratio of cephalosome width to rostrum 4.7-5.0; dorsal surface conspicuously pitted, edge of cephalosome with striated false border; urosome broad, semicircular, caudal arch V-shaped, no notch, conspicuous colourless scar; caudal rami rectangular, widen distally, not emarginate, β seta midway between α and γ , all terminal setae pinnate; large peg fields on endopod and exopod of P1; P5 short, reaches halfway down urosome.

Adult male. Indigo blue or black, anterior of cephalosome convex in midline, antennule sockets obscured, shoulders rounded, project forward with 'epaulet'; antennule with ventral blade.

Dimensions. *Females.* Length 0.92-0.98 mm (N = 4), cephalosome width 0.61-0.66 mm, height 0.14 mm, body length to width ratio 1.47-1.5. Rostrum 0.13 mm, ratio of cephalosome width to rostrum 4.7-5.0. Urosome width to length ratio 1.54. Caudal ramus length to width

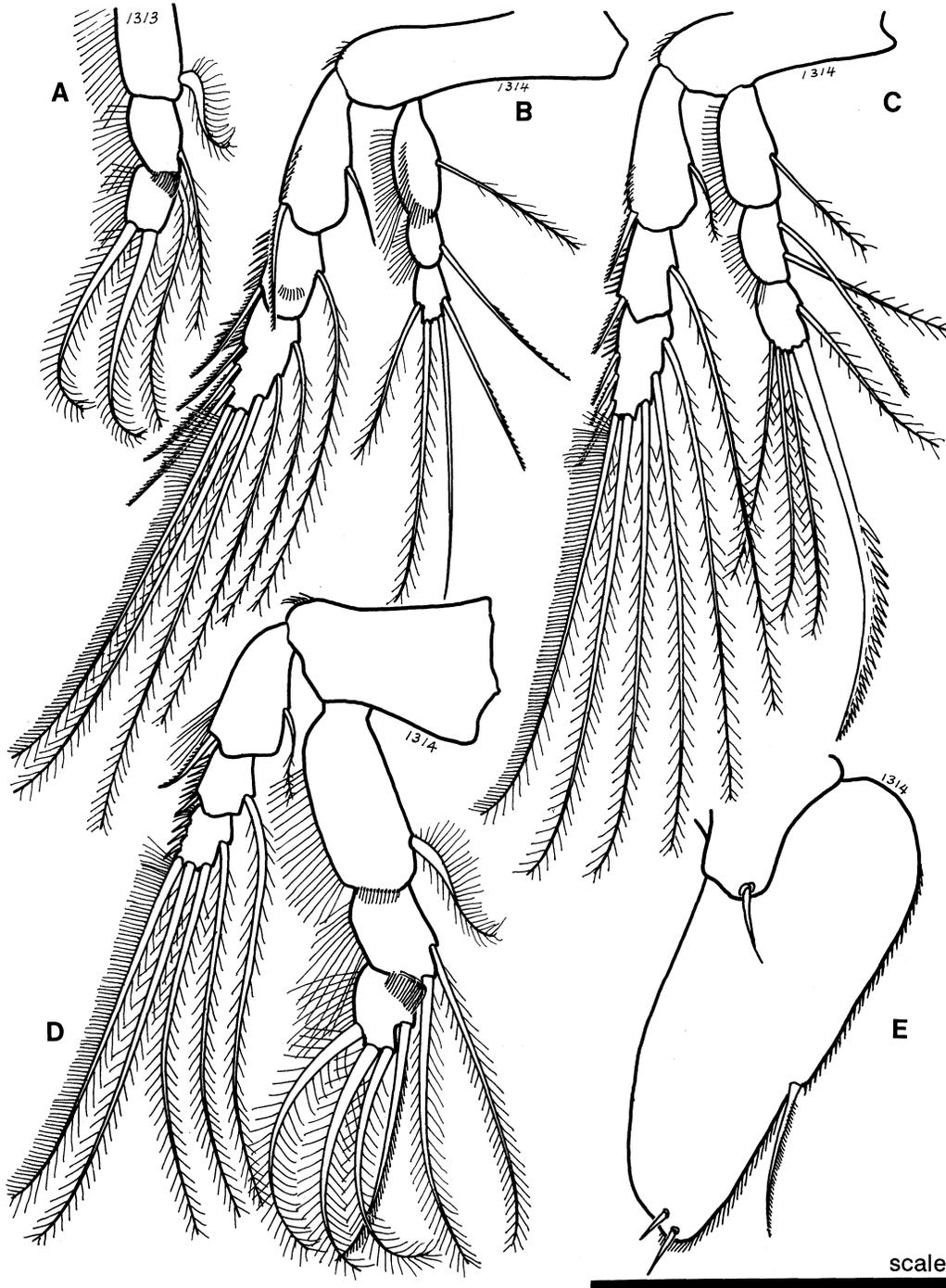


Fig. 8. *Tectacingulum nigrum*. A - male P2 endopod; B - P4; C - P3; D - female P2; E - female P5. Scale bar: A-D = 0.19 mm; E = 0.16 mm.

(maximum) ratio 2.0.

Males. Length 0.65-0.71 mm (N = 3), cephalosome length 0.4 mm, width 0.5-0.56 mm, ratio of body length to width 1.25-1.3.

Adult female (Fig. 6A). Anterior outline of cephalosome semicircular, lateral edge folded under ventrally, false border with radial striations (Fig. 2D). Hyaline border absent. Rostrum obscured from dorsal

view by medial bulge of cephalosome (Fig. 6C). Dorsal surface of cephalosome, metasome, urosome and caudal rami conspicuously pitted. Numerous sensory setae dorsally and at edge of cephalosome.

Urosome broad, semicircular in outline (Fig. 7B), lateral notch absent, conspicuous scar (colourless in live animal) indicating position of fused anterior and posterior lobe, posterior lobe bordered with fine setules. Caudal arch V-shaped, slightly less than half urosome

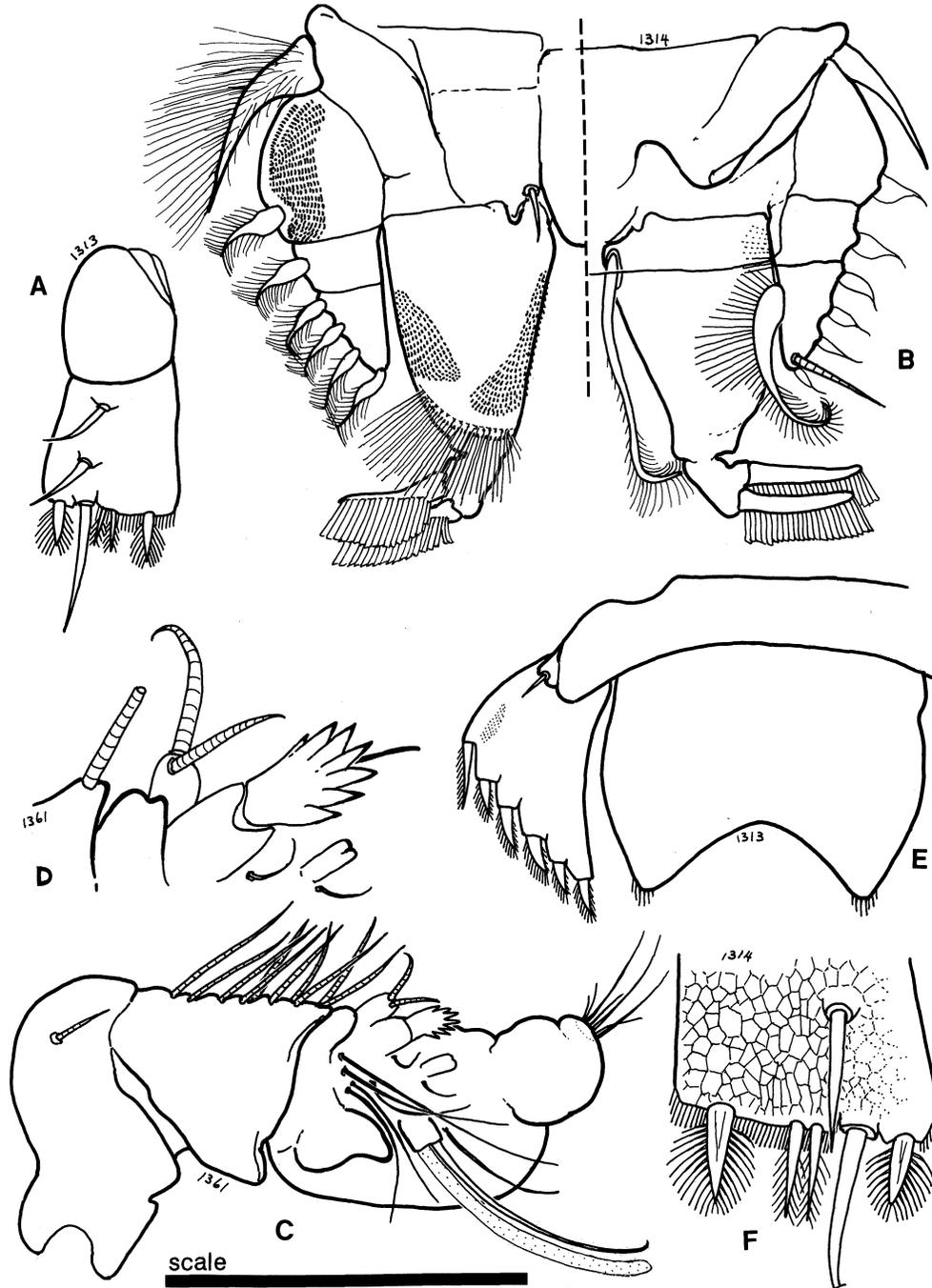


Fig. 9. *Tectacingulum nigrum*. A - left male caudal ramus; B - P1 (left ventral, right dorsal); C - male antennule (distal segment extended); D - detail of coupling denticles on male antennule; E - male urosome and P5; F - female caudal ramus showing detail of terminal setae. Scale bar: A,B = 0.12 mm; C = 0.1 mm; D not to scale; E = 0.19 mm; F = 0.075 mm.

length.

Caudal rami long rectangular, broaden distally (Fig. 7A), not emarginate. α seta about one-third, and β seta three-quarters way down ramus; terminal setae all strongly pinnate, 1 and 4 thicker than 2 and 3, 4 set in from corner; terminal fringe of very fine setules present (Fig. 9F). Caudal rami do not project beyond caudal arch in natural position.

Limbs with typical setation (Figs 7-9). Spatulate claw on endopod of antenna pectinate, terminal portion of geniculate claws plain (Fig. 7G). Maxillule with 1 seta on exopod and 6 setae on endopod (Fig. 7F). Maxilla as shown in Figure 7E. Maxilliped medial lobe semicircular with fimbriate edge (Fig. 7C), basis with fimbriate edge and fimbriate process. First pereopod (P1, Fig. 9B) with very large field of denticulate pegs on article 1 of exopod, large triangular medial peg field plus large lateral peg field on endopod. Fimbriate crescent on endopod composed of 2 rows of filiform setules. Terminal article of P2 endopod with 1 serrulate spinous and 3 plumose setae (Fig. 8D). Serrate sabre-like seta of P3 endopod (Fig. 8C) considerably longer than endopod (1.5 : 1). External marginal setae of P4 exopod long (equal to length of individual articles), serrulate spinous setae on second and third articles of endopod (Fig. 8B). Distal article of P5 (Fig. 8E) lanceolate, apex obliquely truncated, rounded with 2 apical setae, lateral seta long; P5 short relative to urosome (Fig. 6A).

Adult male (Fig. 6B). Cephalosome truncated anteriorly, strongly convex in midline obscuring lateral angle of antennule socket, shoulders acutely rounded, project forward with conspicuous tangential rows of pits (Fig. 6D). Edge of cephalosome folded under as in female. Ornamentation of pits and sensory setae as for female.

Urosome (Fig. 9E) with no clear demarcation between anterior and posterior lobes, small group of setules at posterior apex, caudal arch shallow. Caudal rami quadrate, slightly wider distally (Fig. 9A); setation as for female.

Antennule prehensile (Fig. 9C); ventral blade short, coupling denticle palmate (Fig. 9D), terminal segment very short. First pilose seta of mandibular palp thin. P1, P3 and P4 as for female. P2 with 2 plumose setae on distal article of endopod (Fig. 8A). P5 with 6 terminal setae as shown in Figure 9E.

Remarks. *Tectacingulum nigrum* is indigo blue or black with a red eye. The limbs and scar on the urosome are colourless, the latter appears as a white streak. Under certain light conditions parts of the body show an iridescent blue. This is the only black species described for the family (*L. nigra* = black).

Tectacingulum nigrum closely resembles *T. tumidum*, especially in the shape of urosome, setation of caudal rami and peg fields on P1, but the species are distinguished on colour, size, projection of rostrum, striated border to cephalosome, and body ratios.

Distribution and abundance. Only isolated specimens have been found, suggesting that the seaweed on which it normally lives has not been sampled or that it is a sublittoral species. The type material was collected at the one locality from various seaweeds (*Cystophora*, *Ecklonia*, *Phyllospora* and encrusted stones) on the same occasion. It has been recorded from Kioloa and Merimbula, NSW.

Murramia n.gen.

Diagnosis. Anterior of female cephalosome semicircular, male only slightly truncated; hyaline border and dorsal pits present; urosome broad, with epimeral expansions to form anterior and posterior lobes, caudal rami included in caudal arch of urosome; caudal rami long rectangular not emarginate, α and β setae not close together, terminal setae 2 and 3 slender, close together; maxillule endopod with 6 setae; maxilliped basis with fimbriate process, coxal lobe fimbriate; male P2 endopod with 3 terminal setae (1 serrulate spinose + 2 plumose); male P5 with 6 terminal setae; female P5 does not extend beyond the urosome or touch its fellow posteriorly.

Species composition. *Murramia magna* n.sp.; *M. bicincta* n.sp.

Remarks. This genus is characterised by the absence of a ventral blade on the male antennule and the presence of three terminal setae on the endopod of male P2. The generic name is taken from an aboriginal word, Murrami, meaning 'crayfish'.

The two species are known from Kioloa and the southern coast of New South Wales.

Murramia magna n.sp.

Figs 10-14

Type material. HOLOTYPE adult female with egg-mass, AM P42306; ALLOTYPE adult male, AM P42307; PARATYPES 3 ovigerous females, 4 males, AM P42308; 15 females, 10 males [Br.21] designated paratypes BM(NH) 1992.536-560. Dissections from which illustrations were made have been designated paratype material (slides 1006, 1078, 1395 male, 1007 female); these and remaining type population held at ZANU, registration Po.Q [Br.71] [total type population 32 females (16 carrying eggs), 43 males (1 coupled to juvenile female)]. Taken from *Ecklonia radiata* in the infralittoral fringe at edge of Broulee rock platform, Broulee, NSW (35°52'S 150°11'E), 21 Jan. 1977, V.A.P. Harris.

Diagnosis. *Adult female.* Orange-brown; mean length 1.37 mm, rostrum width 0.26 mm, ratio of cephalosome width to rostrum 3.4; dorsal surface conspicuously pitted; anterior and posterior lobes of urosome equal in length, small lateral notch with scar, no cleft, caudal

arch deep; caudal rami long rectangular, slightly emarginate, β seta near posterior border, terminal seta 1 unipinnate, 2 and 3 plain close together, 4 set in from medial corner; small peg field on endopod of P1.

Adult male. Antennule socket obscured, shoulders rounded; no ventral blade on antennule.

Dimensions. Females. Mean length 1.38 mm (SD = 0.026, N = 15), cephalosome length 0.9 mm, width 0.9 mm (SD = 0.018), height 0.2 mm, body length to width ratio 1.53. Rostrum 0.26 mm wide, projects 0.08 mm, ratio of body width to rostrum 3.46. Urosome width

to length ratio 1.3. Caudal ramus length to width ratio 2.75.

Males. Mean length 1.21 mm (SD = 0.022, N = 15), Cephalosome length 0.7 mm, width 0.86 mm (SD = 0.019), body length to width ratio 1.4.

Adult female (Fig. 10A). Anterior outline of cephalosome semicircular. Rostrum prominent, convex with hyaline edge (Fig. 10C). Hyaline border of cephalosome and epimeral lobes 15-17 μ m wide, marginal glands open just dorsal to hyaline border (Fig. 10E). Dorsal surface of cephalosome, epimera, urosome, P5

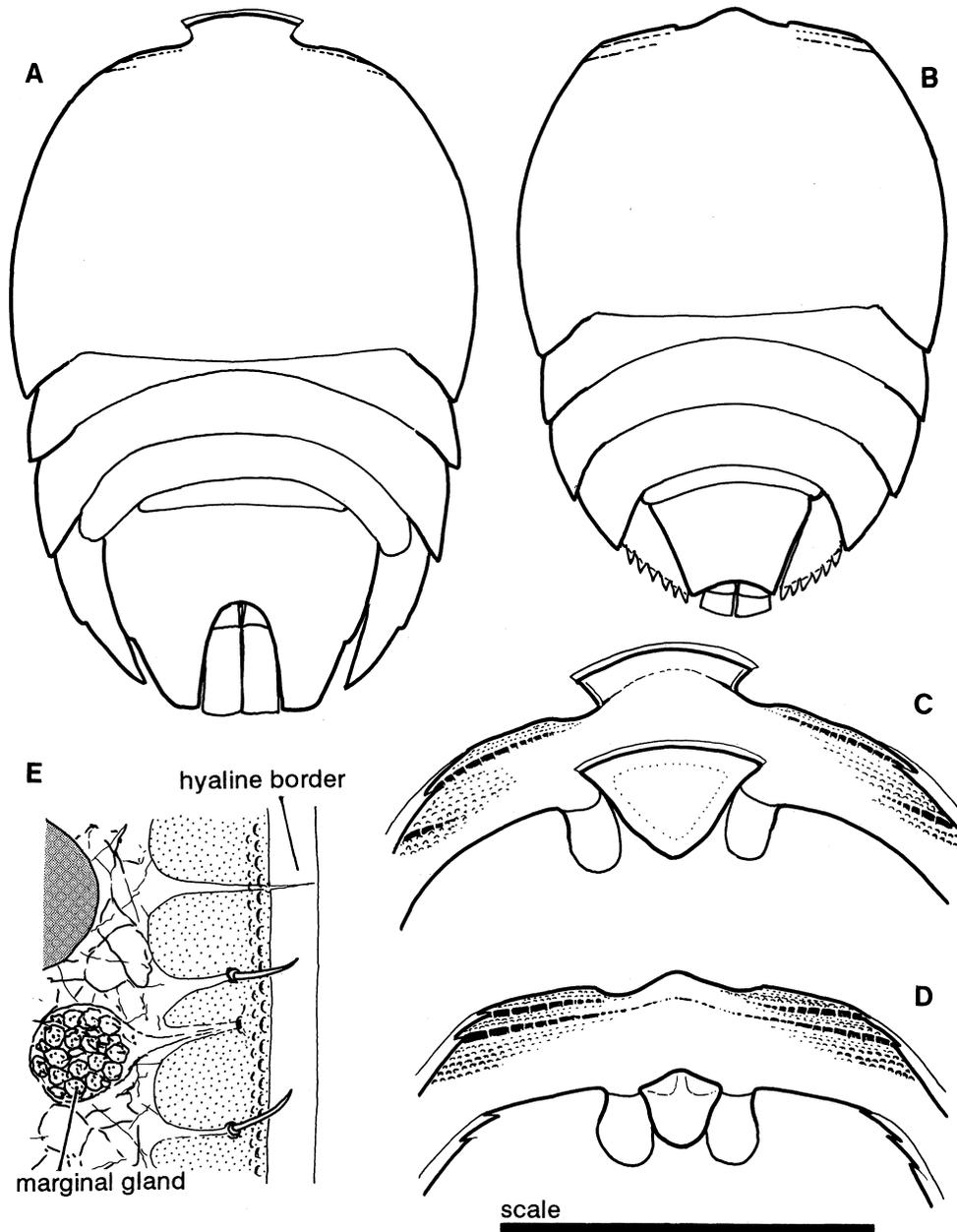


Fig. 10. *Murramia magna*. A – adult female; B – adult male; C – female rostrum (dorsal and ventral views); D – male anterior border of cephalosome and rostrum (dorsal and ventral views); E – hyaline fringe of cephalosome showing dorsal opening of marginal glands. Scale bar: A,B = 0.72 mm; C,D = 0.55 mm; E = 0.1 mm.

and caudal rami conspicuously pitted, pits 3-5 μm with raised crescentic edge.

Urosome (Fig. 11B) resembling a truncated triangle with almost straight sides, fine setules along posterior border of posterior lobe, small lateral notch and scar, caudal arch very deep (almost half length of urosome).

Caudal ramus (Fig. 11A) elongate rectangular, slightly wider posteriorly, medial and lateral edges straight, external corner slightly emarginate. α seta quarter way

down ramus, β seta close to posterior border; terminal seta 1 unipinnate, 2 and 3 plain, close together, 4 plain, set in from medial corner; terminal fringe of fine setules present (Fig. 11C).

Limbs (Figs 11-13) with typical setation. Antennule as shown in Figure 14D. Antenna (Fig. 13B) with pectinate spatulate claw on endopod, terminal portions of geniculate claws plain. Maxillule with single seta on exopod, 6 setae on endopod and 4 setae on each of the 3 endites, gnathobase bears 2 geniculate setae,

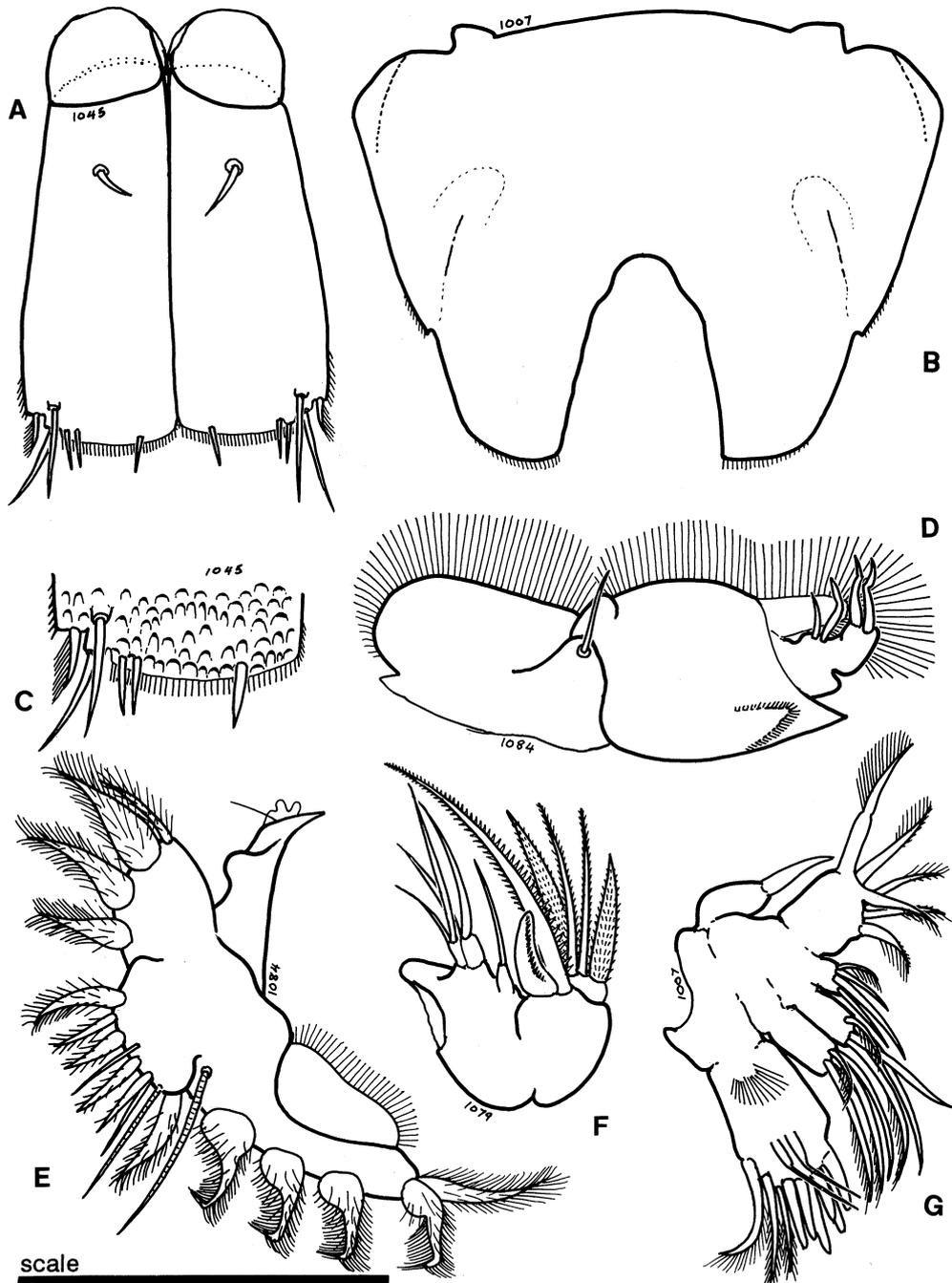


Fig. 11. *Murramia magna*. A - female caudal rami; B - female urosome; C - female caudal ramus showing detail of terminal setae; D - maxilliped; E - male mandible; F - maxilla; G - maxillule. Scale bar: A, F = 0.16 mm; B = 0.35 mm; C, G = 0.1 mm; D = 0.12 mm; E = 0.22 mm.

3 pinnate and 6 stout plain setae (Fig. 11G). Maxilla as shown in Figure 11F. Semicircular medial lobe of maxilliped with fimbriate border, basis elongate with fimbriate border, oblong fimbriate process and >-shaped group of setules (Fig. 11D). First pereopod (P1, Fig. 12A) with crescentic field of denticulate pegs on article 1 of exopod; fimbriate crescent on endopod ends laterally in small oval denticulate peg field. P2 endopod with 1 serrulate spinous seta and 3 plumose setae on terminal article (Fig. 13A). Serrate sabre-like

seta on article 3 of P3 endopod slightly longer than endopod (1.1 : 1) (Fig. 13D). P4 with 2 serrulate spinous setae on endopod (Fig. 12C). Distal article of P5 lanceolate with strong falciform ventral ridge, 1 dorsal and 2 apical setae (Fig. 12E). Apex of P5 reaches as far as lateral notch of urosome.

Adult male (Fig. 10B). Anterior outline of cephalosome not sharply truncated, obtusely pointed in midline, antennule socket obscured, shoulders broadly rounded



Fig. 12. *Murramia magna*. A - P1 (left ventral, right dorsal); B - male P5; C - P4; D - male caudal rami; E - female P5; F - male urosome. Scale bar: A,E = 0.26 mm; B,D = 0.19 mm; C = 0.22 mm; F = 0.35 mm.

(Fig. 10D). Hyaline border and dorsal pits as for female.

Urosome (Fig. 12F) with single apical setule. Caudal rami short (length to width ratio 0.7), setation as for female (Fig. 12D).

Antennule (Fig. 14B) prehensile; small denticulate tubercle on accessory lobe, no ventral blade; coupling denticles (Fig. 14A), large oval proximal denticle covered with pegs, small medial and distal denticles with serrated edges; prehensile terminal segment as long as compound segment. P1, P3 and P4 as for female. P2 with 1 serrulate spinous seta and 2 plumose setae on

distal article of endopod (Fig. 13C). First terminal seta on P5 slender unipinnate, remaining 5 setae deltoid with pinnate lateral border (Fig. 12B).

Remarks. *Murramia magna* is the largest species within the family described to date, hence the trivial name (*L. magna* = great). The orange-brown colour of adults matches their seaweed substratum.

Distribution and abundance. Populations of this species have been recorded only from Broulee, NSW

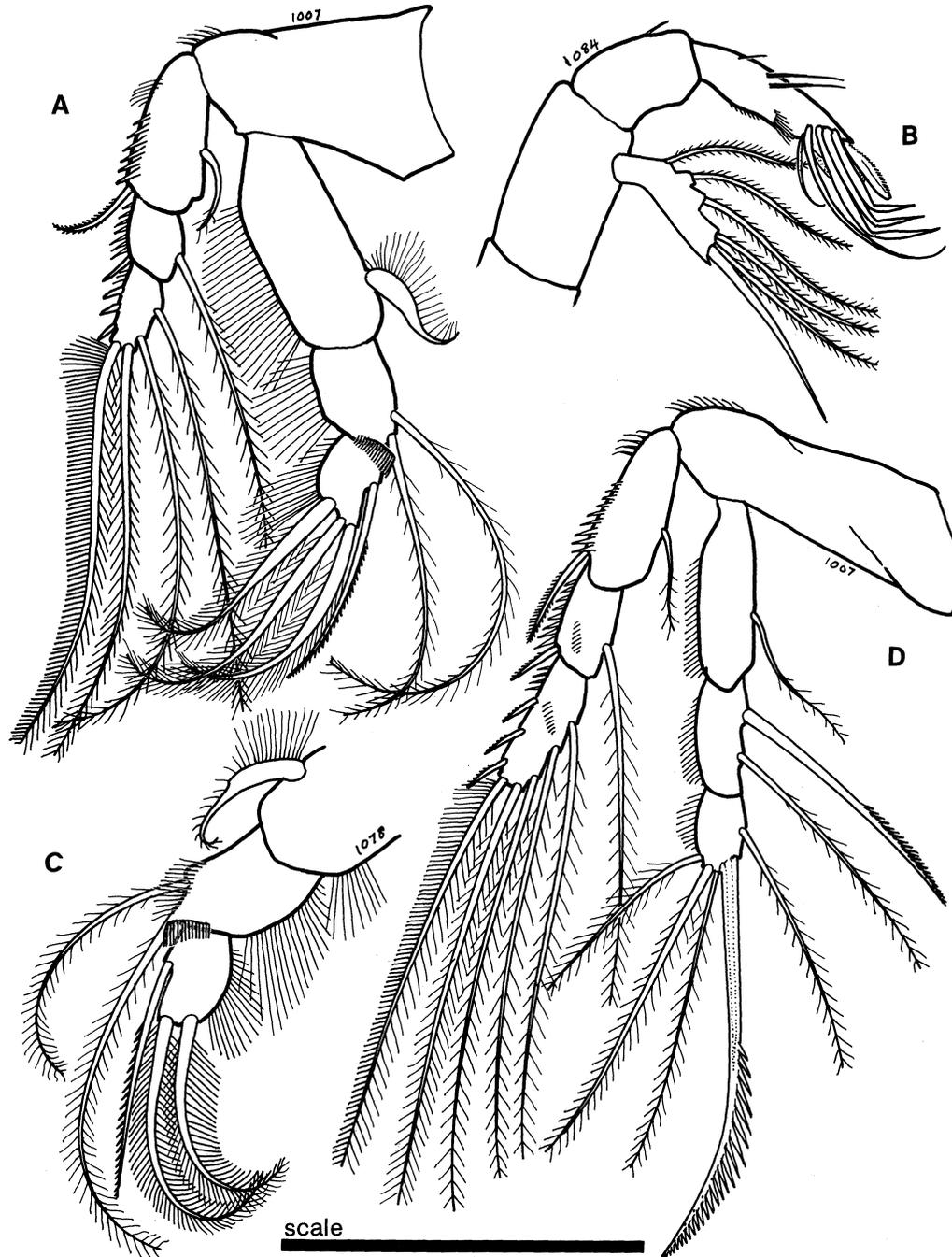


Fig. 13. *Murramia magna*. A – female P2; B – antenna; C – male P2 endopod; D – P3. Scale bar: A,D = 0.22 mm; B,C = 0.19 mm.

although two specimens were collected on *Ecklonia* at Twofold Bay, Eden, NSW. It invariably occurs on *Ecklonia radiata* where modest populations (50-100) are not uncommon.

***Murramia bicincta* n.sp.**

Figs 15-18

Type material. HOLOTYPE adult female with egg-mass, AM P42309; ALLOTYPE adult male, AM P42310; PARATYPES 2 females, 2 males, AM P42311; 3 females, 2 males [Ki.55, Br.85] designated paratypes, BM(NH) 1992.523-527. Dissections from which illustrations were made have been designated paratype material (slides 1326 female, 1327, 1358 male), remaining type population held at ZANU, registration Po.S. [Ki.40] [total type population 11 females (7 carrying eggs), 18 males plus 1 male coupled to juvenile]. Washed from *Cystophora* sp., north side of O'Hara Head, Kioloa, NSW (35°30'S 150°22'E), 19 Jan. 1977, V.A.P. Harris.

Diagnosis. *Adult female.* Yellow with 2 brown transverse bands; mean length 1.07 mm; rostrum width

0.18 mm, ratio of cephalosome width to rostrum 3.67; dorsal pits not conspicuous; urosome broad with scar and notch, posterior lobe large, caudal arch deep; caudal rami rectangular, not emarginate, β seta near posterior border, terminal 1 seta unipinnate, 2 and 3 plain, slender, 4 set in from medial corner; small peg field on P1 endopod.

Adult male. Antennule socket just visible, shoulders rounded; no ventral blade on antennule.

Dimensions. *Females.* Mean length 1.07 mm (SD = 0.039, N = 10), cephalosome width 0.67 (SD = 0.020), height 0.16 mm, body length to width ratio 1.6, rostrum width 0.18 mm, ratio of cephalosome width to rostrum 3.7. Urosome width to length ratio 1.5. Caudal ramus length to width ratio 2.0.

Males. Mean length 0.86 mm (SD = 0.017, N = 11), cephalosome length 0.47 mm, width 0.6 mm (SD = 0.011), ratio of body length to width 1.4.

Adult female (Fig. 15A). Anterior outline of cephalosome semicircular with 2 ridges parallel to edge which end laterally where hyaline border begins

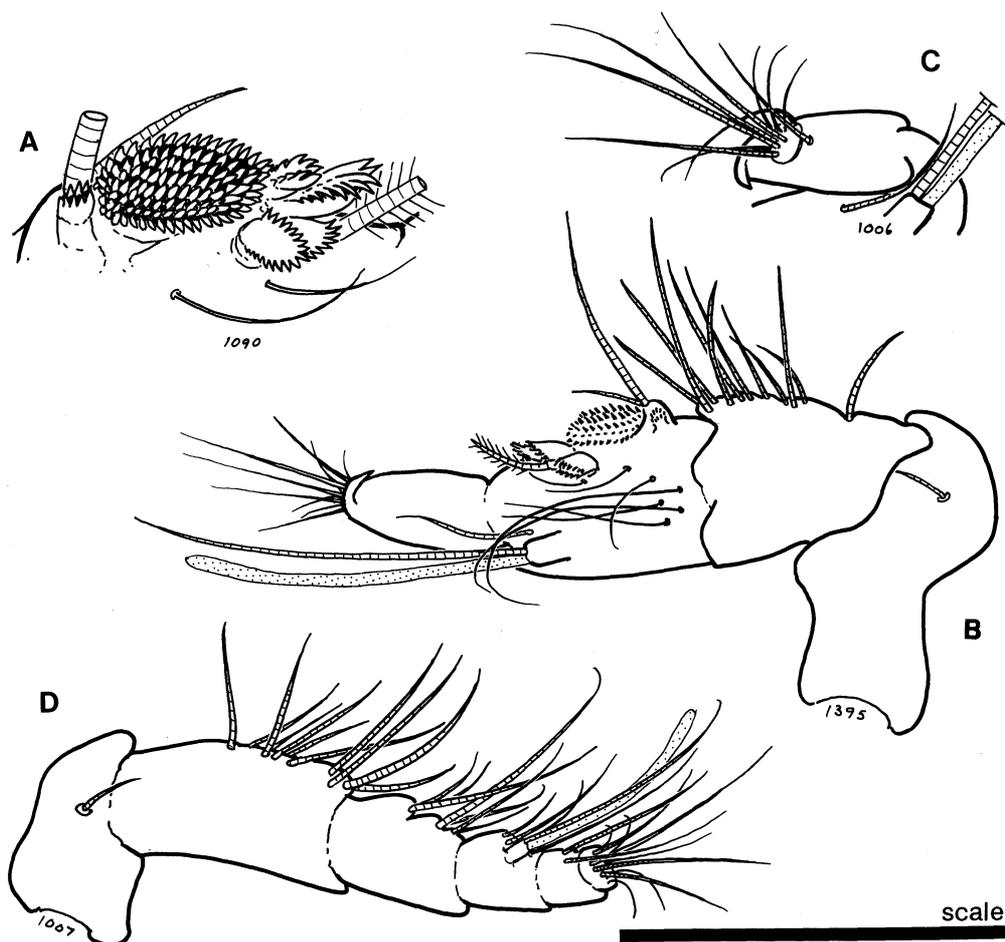


Fig. 14. *Murramia magna*. A – detail of coupling denticles on male antennule; B – male antennule with terminal segment extended (ventral view); C – same, with distal segment adducted; D – female antennule. Scale bar: A not to scale; B,C,D = 0.16 mm.

(Fig. 15C). Rostrum prominent, projects by about one-third of its width, with narrow hyaline border. Hyaline border of cephalosome and epimeral lobes $10\ \mu\text{m}$ wide. Dorsal surface pitted with rows of pits along anterior ridges.

Urosome broad (Fig. 16B), edge of anterior lobe straight, posterior lobe large, rounded, medial corner not rounded, notch and prominent scar between lobes, border setules fine, short. Caudal arch deep (about half

urosome length).

Caudal rami (Fig. 15E) long, rectangular, sides straight, slightly broader distally, slightly emarginate. Beta seta close to posterior border, terminal seta 1 unipinnate, 2 and 3 plain close together, 4 plain, set in from medial corner; terminal fringe of fine setules present (Fig. 18C). Caudal rami do not project beyond caudal arch in natural position.

Limbs (Figs 16-18) with typical setation. Spatulate

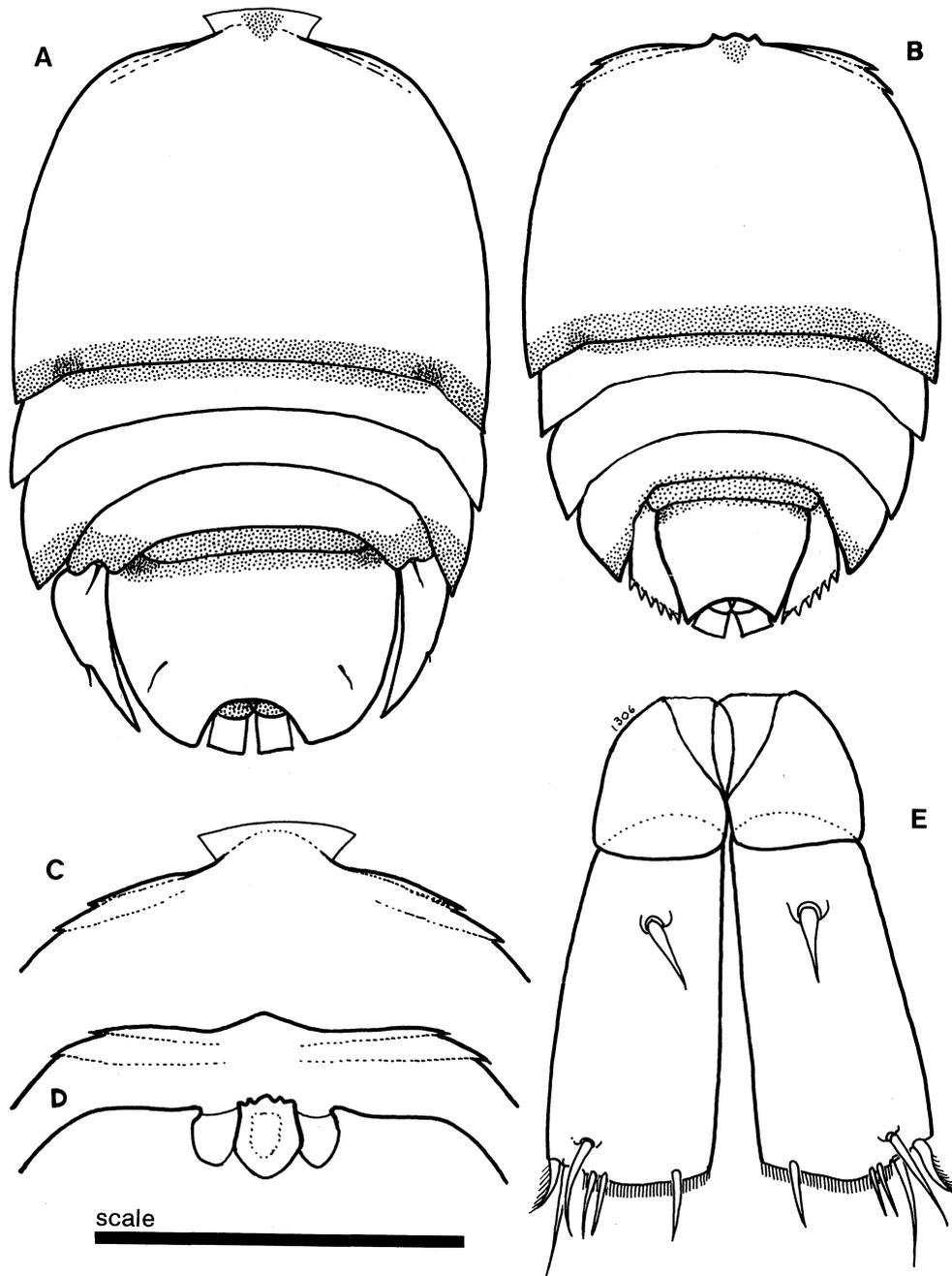


Fig. 15. *Murramia bicincta*. A – adult female, stippling represents brown colouration; B – adult male; C – female rostrum and anterior border of cephalosome (dorsal view); D – male rostrum and anterior border of cephalosome (dorsal and ventral views); E – female caudal rami and anal segment. Scale bar: A,B = 0.55 mm; C,D = 0.45 mm; E = 0.12 mm.

claw of antenna pectinate, geniculate setae articulated (Fig. 16A). Mandible as shown in Figure 16F. Maxillule with single seta on exopod, 6 setae on endopod, 4 setae on each of the endites (Fig. 16G). Maxilla as shown in Figure 16D. Maxilliped (Fig. 16H) with fimbriate rounded medial lobe, basis with fimbriate border continued as fimbriate process. First peraeopod (P1, Fig. 18B) with band of fine denticulate pegs on article

1 of exopod, small oval field of fine pegs at lateral extremity of fimbriate crescent on endopod. P2 with 1 serrulate and 3 plumose setae on terminal article of endopod (Fig. 17C). Serrate sabre-like seta on P3 endopod (Fig. 17B) slightly longer than endopod (1.2 : 1). P4 endopod with 2 spinous setae. Apex of P5 rounded with 1 dorsal and 2 apical setae, edge bordered with fine setules (Fig. 16E). P5 reaches as far as notch



Fig. 16. *Murramia bicincta*. A – antenna; B – female urosome; C – male urosome; D – maxilla; E – female P5 (detached, dorsal view); F – female mandible (ventral view); G – maxillule; H – maxilliped. Scale bar: A = 0.19 mm; B,C = 0.26 mm; D,E,F,H = 0.16 mm; G = 0.1 mm.

on urosome.

Adult male (Fig. 15B). Anterior outline of cephalosome not markedly truncated, slightly bowed forward in mid-line, lateral angle of antennule socket just visible from dorsal view, shoulders rounded (Fig. 15D). Hyaline border and dorsal pits as for female.

Urosome as shown in Figure 16C. Caudal rami shorter than their width, setation as for female (Fig. 18A).

Antennules prehensile (Fig. 18E); accessory lobe of compound segment with small denticulate tubercle but no ventral blade. proximal coupling denticle large, oval in shape, covered with denticulate pegs, medial and distal denticles with serrated edges (Fig. 18F); prehensile terminal segment half length of compound segment, expanded distally. First seta on mandibular palp slender (Fig. 18D). P1, P3 and P4 as for female. P2 bears 3 setae on terminal article of endopod (1 serrulate spinous

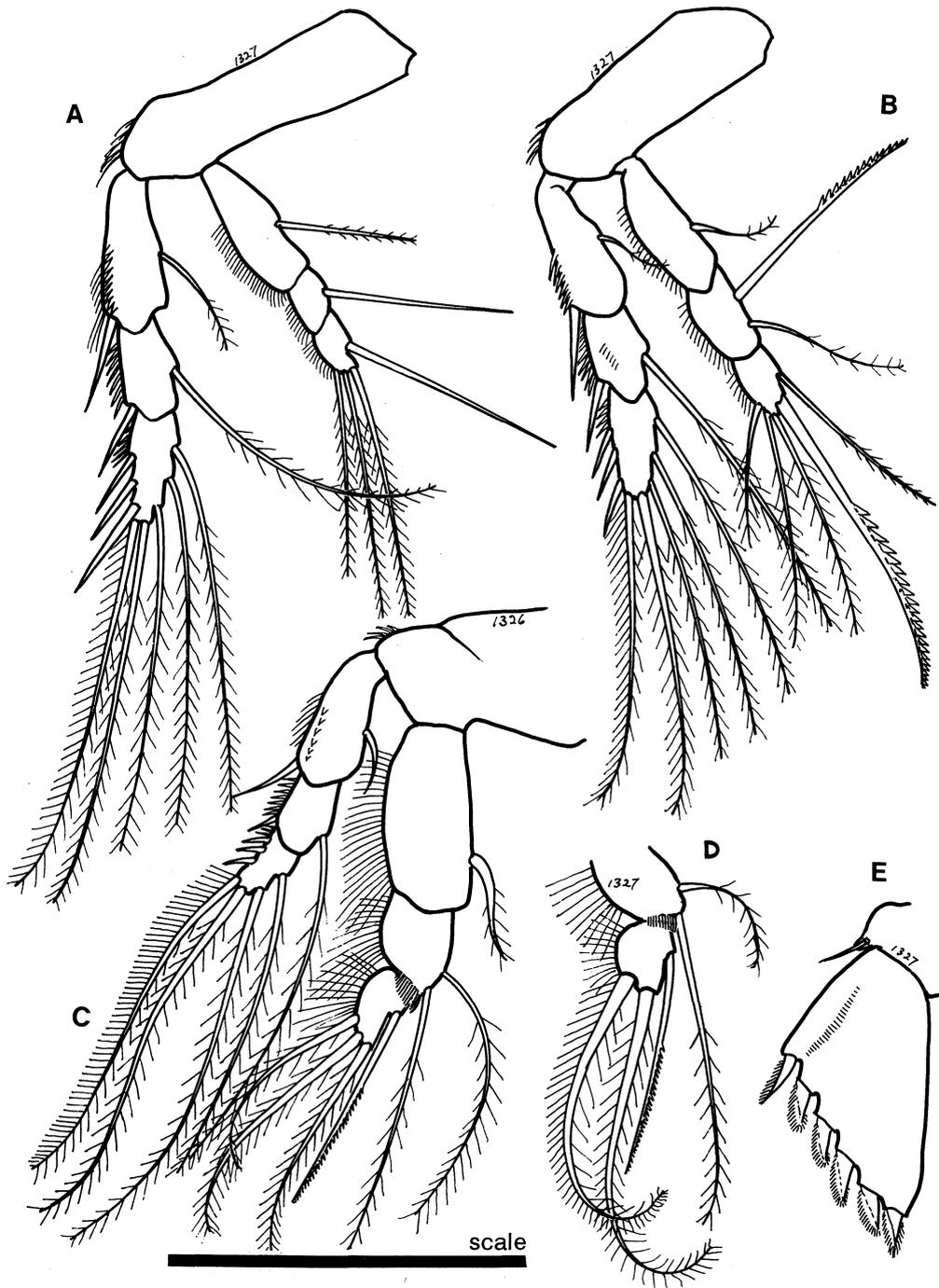


Fig. 17. *Murramia bicincta*. A - P4; B - P3; C - female P2; D - male P2 endopod; E - male P5. Scale bar: A,B,C,E = 0.19 mm; D = 0.16 mm.

seta plus 2 short plumose setae (Fig. 17D). P5 (Fig. 17E) triangular with 6 unipinnate deltoid terminal setae.

Remarks. The colour pattern of this species is distinctive. Living animals are yellow with reddish brown antennae, rostrum and anal segments. Two conspicuous bands of the same colour run across the body at the joint between cephalosome and first metasomal segment, and between the third metasomal

segment and urosome (see Fig. 15A,B). The specific name refers to this pattern (L. *bi* = two + *cinctus* = a belt or girdle).

Distribution and abundance. *Murramia bicincta* has been found only at Kioloa and Broulee, NSW living on *Cystophora moniliformis* and *C. platylobium* in the infralittoral fringe. Population samples have been small (10 - 30).

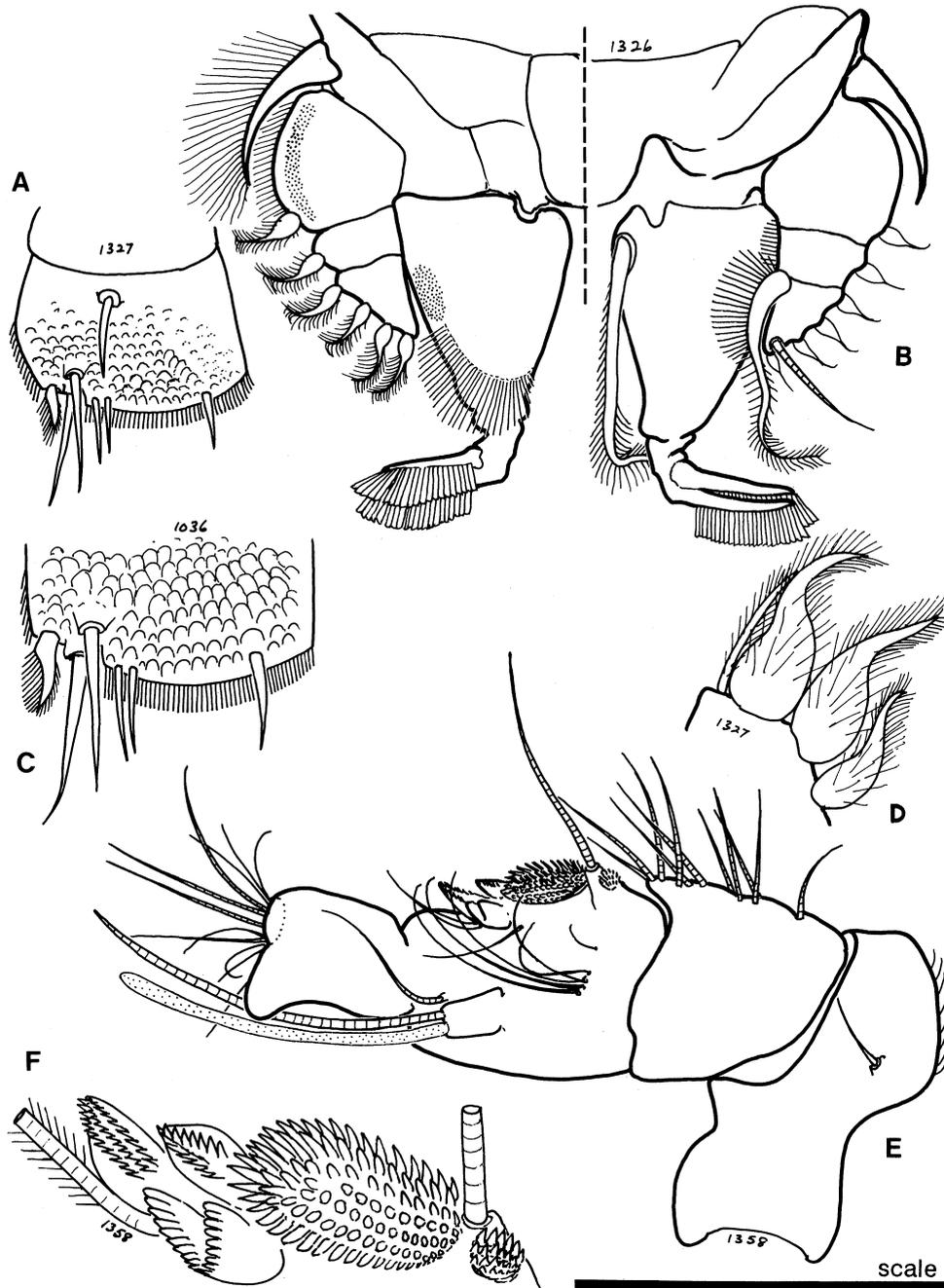


Fig. 18. *Murramia bicincta*. A - male left caudal ramus; B - P1 (left ventral, right dorsal); C - terminal edge of female left caudal ramus; D - male anterior mandibular palp; E - male antennule with terminal segment extended (ventral view); F - detail of coupling denticles. Scale bar: A = 0.1 mm; B = 0.19 mm; C = 0.075 mm; D and F not to scale; E = 0.12 mm.

Kioloaria n.gen.

Diagnosis. Anterior of female cephalosome semicircular, male truncated; hyaline border and dorsal pits present; urosome broad, with epimeral expansions to form anterior and posterior lobes, caudal rami included in caudal arch of urosome; caudal rami rhomboidal with oblique posterior border, α and β

setae close together, terminal seta 4 large, apical, 2 and 3 slender, close together; maxillule endopod with 6 setae; maxilliped basis with fimbriate process, coxal lobe fimbriate; male P2 endopod with 3 terminal setae (1 serrulate spinose + 2 plumose); male P5 with 6 terminal setae; female P5 extends beyond urosome and caudal rami, may touch its fellow posteriorly.

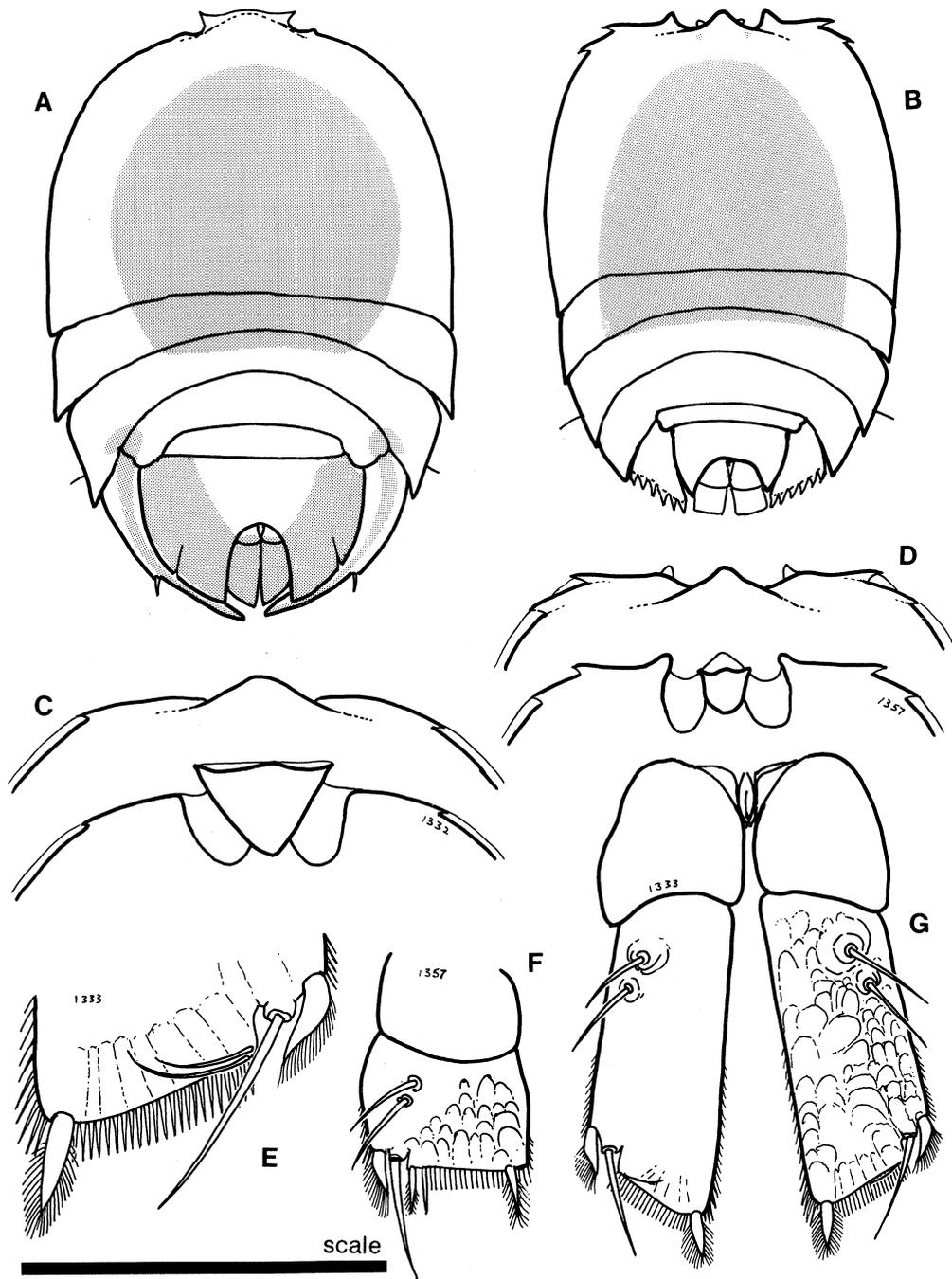


Fig. 19. *Kioloaria sesquimaculata*. A – adult female, shading indicates carmine red colour pattern; B – adult male; C – female rostrum (dorsal and ventral view); D – male anterior border of cephalosome (dorsal and ventral view); E – female detail of terminal setae on caudal ramus; F – male left caudal ramus; G – female caudal rami and anal segment. Scale bar: A,B = 0.45 mm; C,D = 0.33 mm; E = 0.055 mm; F = 0.1 mm; G = 0.12 mm.

Species composition. *Kioloaria sesquimaculata* n.sp.

Remarks. The rhomboidal caudal rami and the long P5 which meets its fellow posteriorly resemble *Acutiramus*, but *Kioloaria* is distinguished by having three setae on the terminal article of the male P2 endopod.

The genus has been named from the locality of the type species.

Kioloaria sesquimaculata n.sp.

Figs 19-22

Type material. HOLOTYPE adult female with egg mass, AM P42312; ALLOTYPE adult male, AM P42313; PARATYPES 1 female, 1 male AM P42314; 4 females, 2 males [Ki.54] designated paratypes BM(NH) 1992.528-533. Dissected paratypes from which illustrations were made (slides 1333 female, 1334 male) together with remaining type population held at ZANU, registration Po.Y. [Ki.35] [total type population

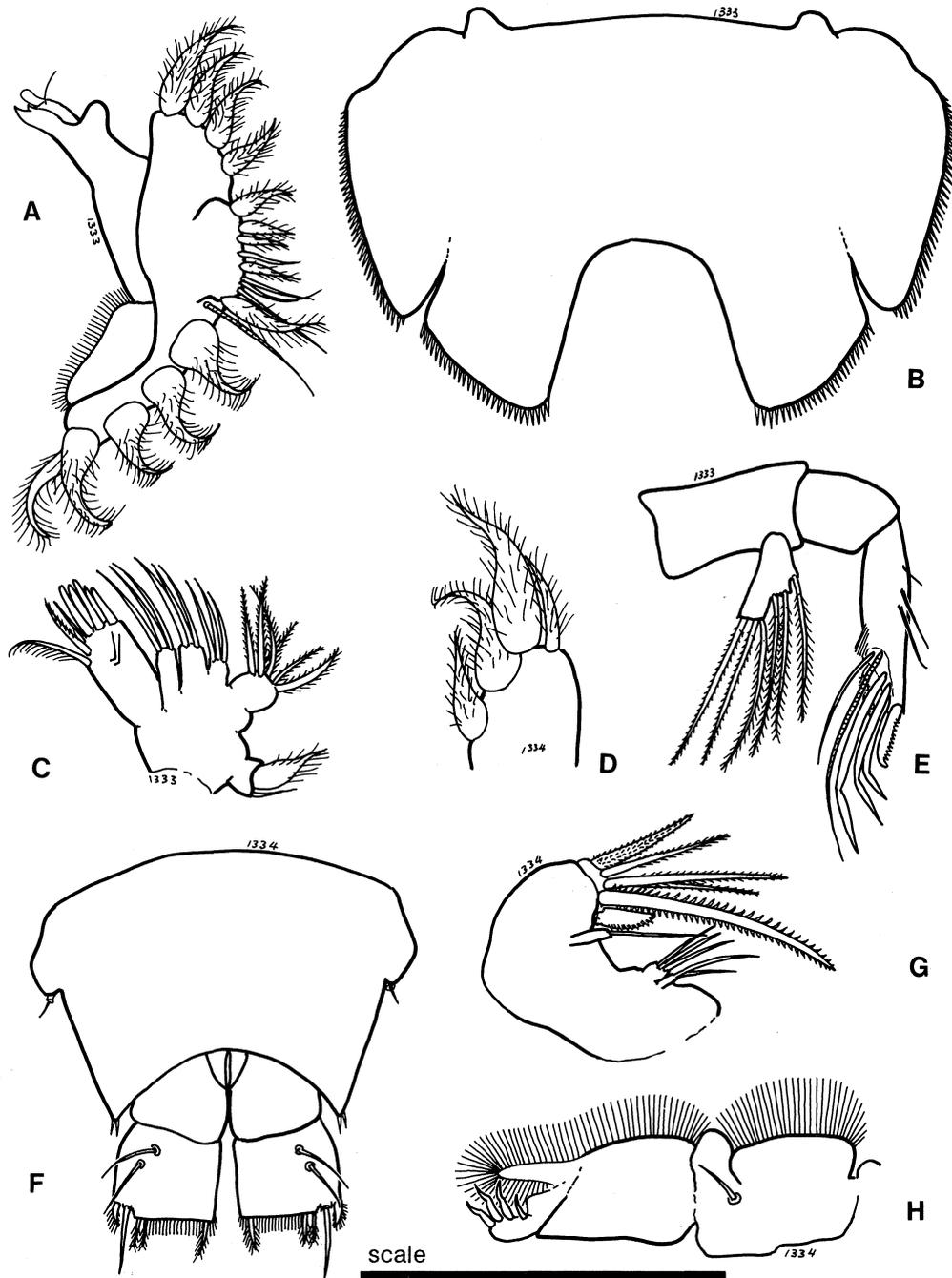


Fig. 20. *Kioloaria sesquimaculata*. A – female mandible; B – female urosome; C – maxillule; D – male anterior mandibular palp; E – antenna; F – male urosome and caudal rami; G – maxilla; H – maxilliped. Scale bar: A,F = 0.165 mm; B = 0.19 mm; C,D,G,H = 0.1 mm; E = 0.12 mm.

21 females (17 carrying eggs), 29 males (1 coupled to juvenile female)]. Washed from stones encrusted with pink 'Lithothamnion' in infralittoral fringe, sheltered bay on north side of O'Hara Head, Kioloa, NSW (35°30'S 150°22'E), 19 Jan. 1977, V.A.P. Harris.

Diagnosis. *Adult female.* Colourless with 2 large red patches, one on cephalosome the other on urosome; mean length 0.76 mm; rostrum width 0.12 mm, ratio of cephalosome width to rostrum 4.25; dorsal surface pitted;

urosome broad, semicircular with lateral cleft; caudal rami rhomboidal, α and β setae close together, terminal seta 4 large, pinnate, situated at apex, 2 and 3 fine, close together and parallel to posterior border; no peg field on endopod of P1.

Adult male. No red patch on urosome, corner of antennule socket obscured, shoulder with 'epaulet'; antennule with ventral blade.

Dimensions. *Females.* Mean length 0.76 mm (SD =

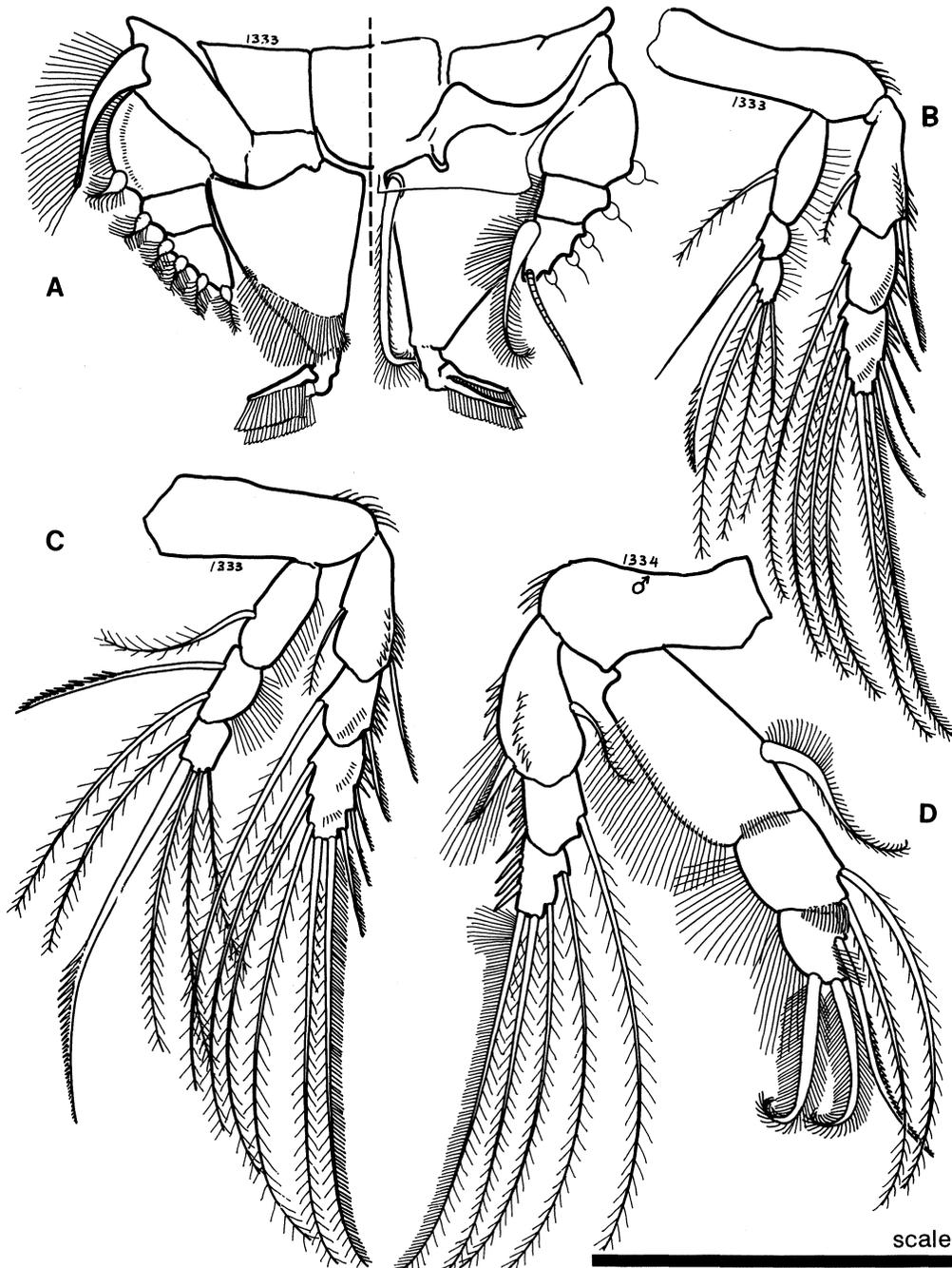


Fig. 21. *Kioloaria sesquimaculata*. A - P1 (left ventral, right dorsal); B - P4; C - P3; D - male P2. Scale bar: A = 0.19 mm; B,C = 0.165 mm; D = 0.12 mm.

0.015, $N = 18$), cephalosome width 0.51 mm ($SD = 0.012$), height 0.12 mm, body length to width ratio 1.49. Rostrum 0.12 mm, ratio of cephalosome width to rostrum 4.25. Urosome width to length ratio 1.52. Caudal ramus length to width ratio 2.48.]

Males. Mean length 0.59 mm ($SD = 0.009$), $N = 20$), cephalosome length 0.36 mm, width 0.44 mm ($SD = 0.007$), ratio of body length to width 1.34.

Adult female (Fig. 19A). Cephalosome with dorsal hump in midline above rostrum (Fig. 19C). Rostrum

prominent with anterior hyaline border. Dorsal surface of body pitted. Hyaline border to cephalosome and metasome $10 \mu\text{m}$ wide.

Urosome broad (Fig. 20B), anterior and posterior lobes separated by deep cleft, bordered with setules, medial corner of posterior lobe rounded. Caudal arch deep (almost half length of urosome).

Caudal rami rhomboidal with oblique posterior border slightly emarginate (Fig. 19G). α and β setae proximal, close together; terminal seta 1 crescentic, unipinnate, terminal seta 4 large, pinnate, situated at

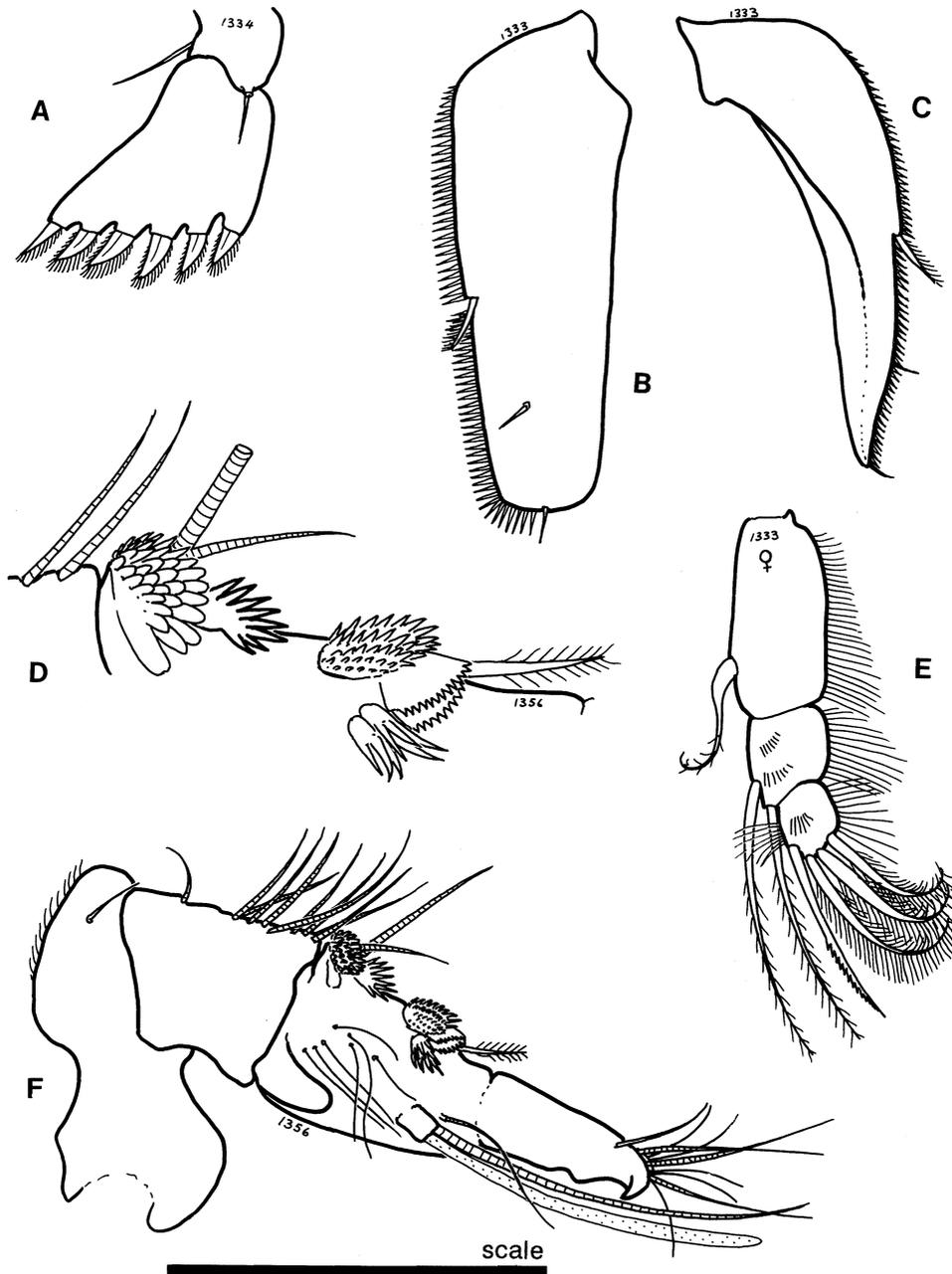


Fig. 22. *Kioloaria sesquimaculata*. A – male P5; B – female P5 laid flat; C – female P5 ventral view in natural position; D – coupling denticles of male antennule; E – female P2 endopod; F – male antennule with terminal segment extended (ventral view). Scale bar: A = 0.165 mm; B,C = 0.22 mm; D = 0.045 mm; E = 0.19 mm; F = 0.1 mm.

apex, 2 and 3 fine, close together, lying parallel and dorsal to posterior border (Fig. 19E); fine setules present along medial and lateral edges and are continuous with a terminal fringe of very fine setules.

Limbs (Figs 20-22) show typical setation. Antenna with pectinate spatulate claw on endopod, terminal portion of geniculate setae plain (Fig. 20E). Mandible as shown in Figure 20A. Maxillule with 2 setae on exopod, 6 setae on endopod, endites each bear 3 setae (Fig. 20C). Maxilla as shown in Figure 20G. Medial lobe of maxilliped rounded with fimbriate border, prominent coxal seta, basis with fimbriate border and fimbriate process (Fig. 20H). First pereopod (P1, Fig. 21A) with a row of fine denticulate ridges on article 1 of exopod, no field of denticulate pegs on endopod. P2 with serrulate spinous seta plus 3 plumose setae on article 3 of endopod (Fig. 22E). Serrate sabre-like seta on P3 endopod (Fig. 21C) considerably longer than endopod (1.6 : 1). External serrulate spinous setae on P3 and P4 exopod unusually long (Fig. 21B,C). Distal article of P5 falciform in natural position (Fig. 22C), oblong, truncated posteriorly with rounded corners when laid flat (Fig. 22B), bordered with setules, 1 dorsal and 1 apical seta; the P5s touch posteriorly and completely enclose the urosome and caudal rami (Fig. 19A).

Adult male (Fig. 19B). Anterior outline of cephalosome a truncated oval, bluntly pointed in midline, lateral angle of antennule socket visible from dorsal view, shoulders rounded with double 'epaulets' (Fig. 19D). Surface pits and hyaline border as for female.

Urosome (Fig. 20F) with seta between small anterior lobe and posterior lobe, 2 setules at apex of posterior lobe.

Caudal rami quadrate (Fig. 19F). α and β seta close together, terminal setae 2 and 3 close together, not parallel to posterior border.

Antennule prehensile (Fig. 22F); accessory lobe with very large denticulate tubercle and small ventral blade (Fig. 22D); proximal coupling denticle serrate palmate, medial denticle oval covered in pointed denticulations, distal denticle with serrate edge, associated with plumose seta; distal segment of antennule long (equal in length to compound segment), with hook-like distal end. First pilose seta of mandibular palp slender (Fig. 20D). P1, P3 and P4 as for female. P2 with 3 setae (1 serrulate spinous, 2 plumose) on article 3 of endopod (Fig. 21D). P5 broad with 6 pinnate terminal setae (Fig. 22A).

Remarks. Living animals are sexually dimorphic in their colouration. Females have a large carmine red patch on the dorsal part of the cephalosome and a smaller crescentic patch on the urosome, caudal rami and falciform ridge of P5, the rest of the body is colourless. Males have only a red patch on the cephalosome and first metasome, the rest of the body is colourless. The specific name refers to the smaller red patch at the

rear of the female (*L. sesqui* = one half more + *macula* = a spot).

Distribution and abundance. Small populations (15+) of *Kioloaria sesquimaculata* have been found only at Kioloa, NSW where they occur on stones covered in pink *Lithothamnion* from the infralittoral fringe. Isolated specimens have been recorded from Cronulla, Sydney, NSW.

Brevifrons n.gen.

Diagnosis. Anterior of female cephalosome truncated, rostrum obscured; hyaline border present, dorsal pits absent, honeycomb-like ridges present; urosome broad, with epimeral expansions to form anterior and posterior lobes, caudal ramus included in caudal arch of urosome; caudal rami rectangular, deeply emarginate, α and β setae close together, all terminal setae similar, equally spaced; maxillule endopod with 2 setae; maxilliped basis with fimbriate process, coxal lobe fimbriate; male P2 endopod with 2 plumose terminal setae; male P5 with 6 terminal setae; female P5s do not touch one another posteriorly.

Species composition. *Brevifrons faviolatum* n.sp.

Remarks. This genus is characterised by a number of unusual features of which the presence of only two setae on the endopod of the maxillule, a honeycomb-like pattern of raised ridges on the dorsal surface and the absence of pits are the most significant. The anterior outline of the female cephalosome is truncated and the ventral rostrum obscured from view (features usually associated with male animals; this gives rise to the generic name (*L. brevis* = short + *frons* = forehead). Another unusual feature is their ability to roll up into a ball (conglobate).

One species is described with a wide distribution in New South Wales.

Brevifrons faviolatum n.sp.

Figs 23-26

Type material. HOLOTYPE adult female with egg mass, AM P42315; ALLOTYPE adult male, AM P42316; PARATYPES 2 females, 3 males (2 coupled to female copepodides), AM P42317; 3 females, 3 males [Cr.32] designated paratypes BM(NH) 1992.567-572. Dissected paratype specimens (slides 1152, 1154, 1342 female, 1344 male) from which illustrations were made, together with remaining type population held at ZANU, registration Po.D. [Ki.54] [total type population 17 females, 11 males plus 8 males coupled with juvenile females]. Washed from loose stones in the infralittoral fringe, north side of O'Hara Head, Kioloa, NSW (35°30'S 150°22'E), 27 Apr. 1979, V.A.P. Harris.

Diagnosis. *Adult female.* Yellow with brown border to cephalosome; mean length 1.0 mm; cephalosome truncated anteriorly, extended in midline as triangular bulge which completely obscures rostrum; rostrum width 0.11 mm, ratio of cephalosome width to rostrum 6.0; dorsal surface with honeycomb pattern, pits absent; urosome broad, without notch or scar; caudal rami rectangular, widening posteriorly, strongly emarginate, α and β seta close together, terminal setae all pinnate, equally spaced; small peg field on P1 endopod.

Adult male. Colouration as for female; cephalosome concave anteriorly with triangular projection in midline, shoulder with double 'epaulet'; no ventral blade on antennule.

Dimensions. *Females.* Mean length 1.0 mm (SD = 0.011, N = 11), cephalosome width 0.7 mm (SD = 0.008), height 0.3 mm, body length to width ratio 1.43. Rostrum 0.11 mm, ratio of cephalosome width to rostrum 6.0. Urosome width to length ratio 1.48. Caudal length

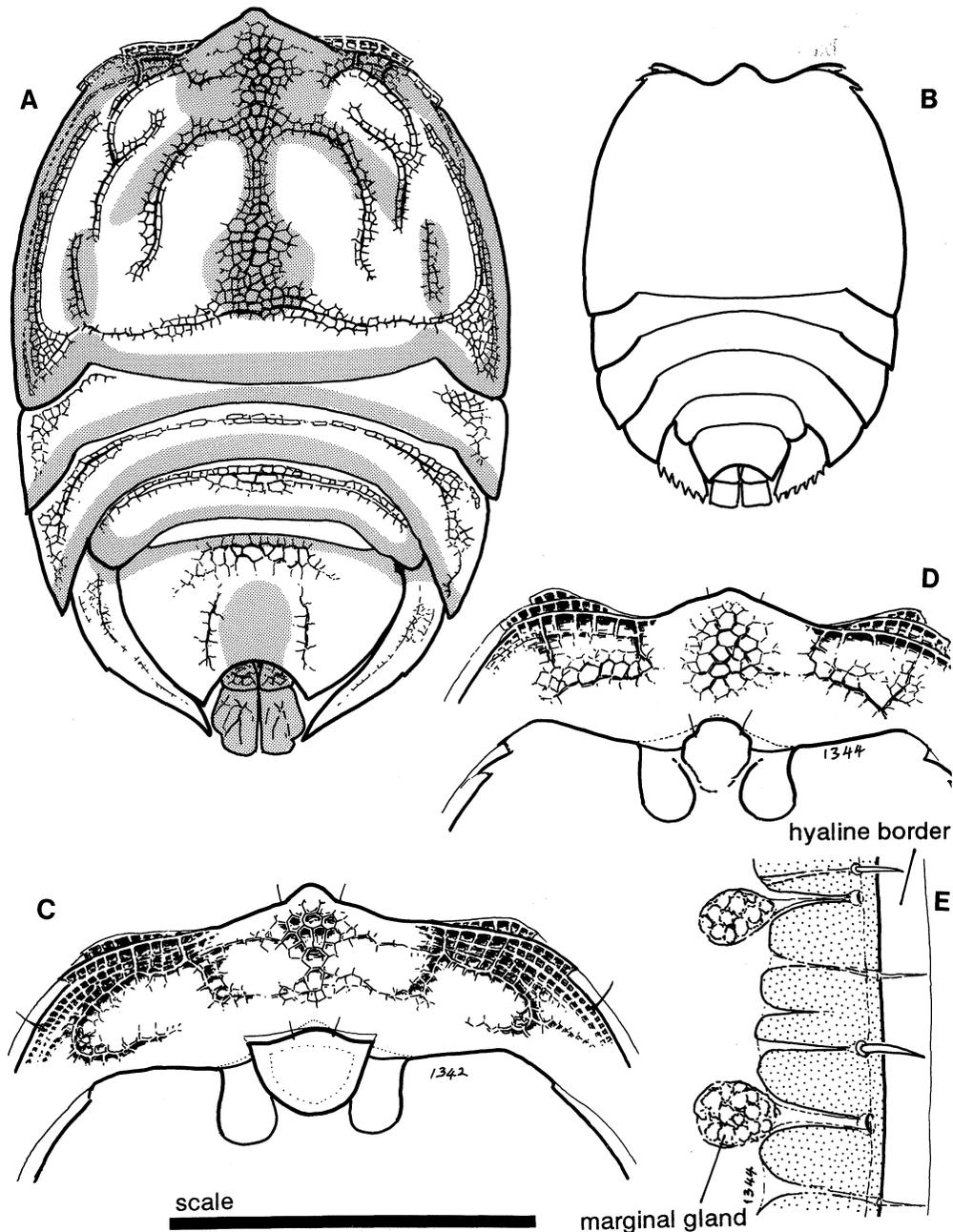


Fig. 23. *Brevifrons faviolatum.* A – adult female, shaded areas represent brown colouration; B – adult male (note reduced scale); C – female rostrum and anterior border of cephalosome (dorsal and ventral views); D – male rostrum and anterior border of cephalosome (dorsal and ventral views); E – edge of cephalosome showing hyaline fringe, marginal glands and sensory setae. Scale bar: A = 0.55 mm; B = 0.72 mm; C, D = 0.35 mm; E = 0.1 mm.

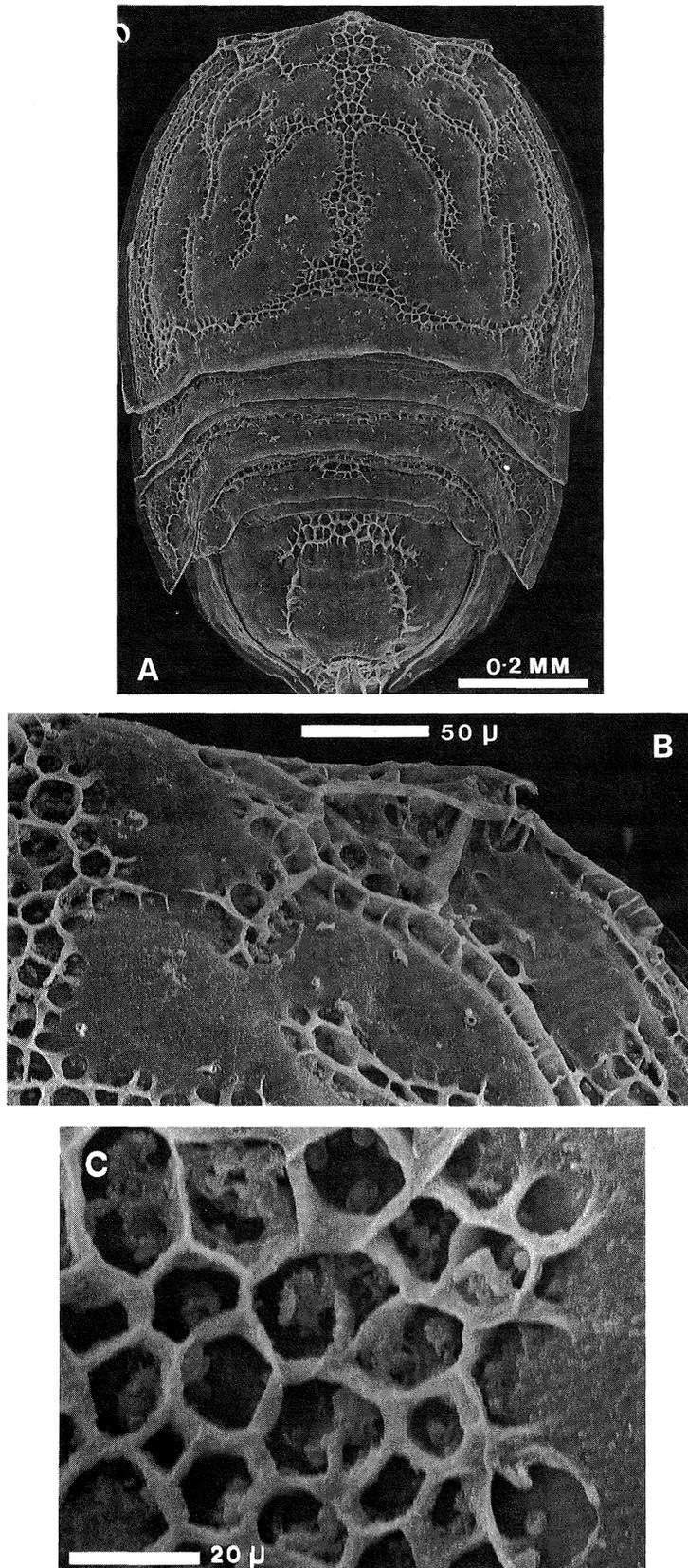


Plate 1. *Brevifrons faviolatum* (female). A – dorsal pattern of reticulate ridges. SEM micrograph. Scale bar = 0.2 mm. B – right shoulder showing absence of pits. SEM micrograph. Scale bar = 50 μm. C – reticulate ridges from dorsal midline. SEM micrograph. Scale bar = 20 μm.

to width ratio 1.62.

Males. Mean length 0.83 mm (SD = 0.011, N = 7), cephalosome length 0.52 mm, width 0.62 mm (SD = 0.007), ratio of body length to width 1.3.

Adult female (Fig. 23A). Cephalosome truncated anteriorly, extended forwards in midline as a triangular bulge which completely obscures the rostrum from dorsal view. Shoulders rounded with double 'epaulet' (Fig. 23C). Rostrum ventral, with hyaline border. Dorsal

surface of cephalosome, metasome, urosome and caudal rami ornamented with ridges and areas of honeycomb pattern (Fig. 23A,C and Pl. 1); dorsal sensory setae present but circular pits absent. Hyaline border 15 μ m wide, marginal glands open dorsal to hyaline border (Fig. 23E).

Urosome broad (Fig. 24A), no trace of division into anterior and posterior lobes, no lateral notch or scar, no border setules except at posterior apex. Caudal arch shallow (about one-third length of urosome).

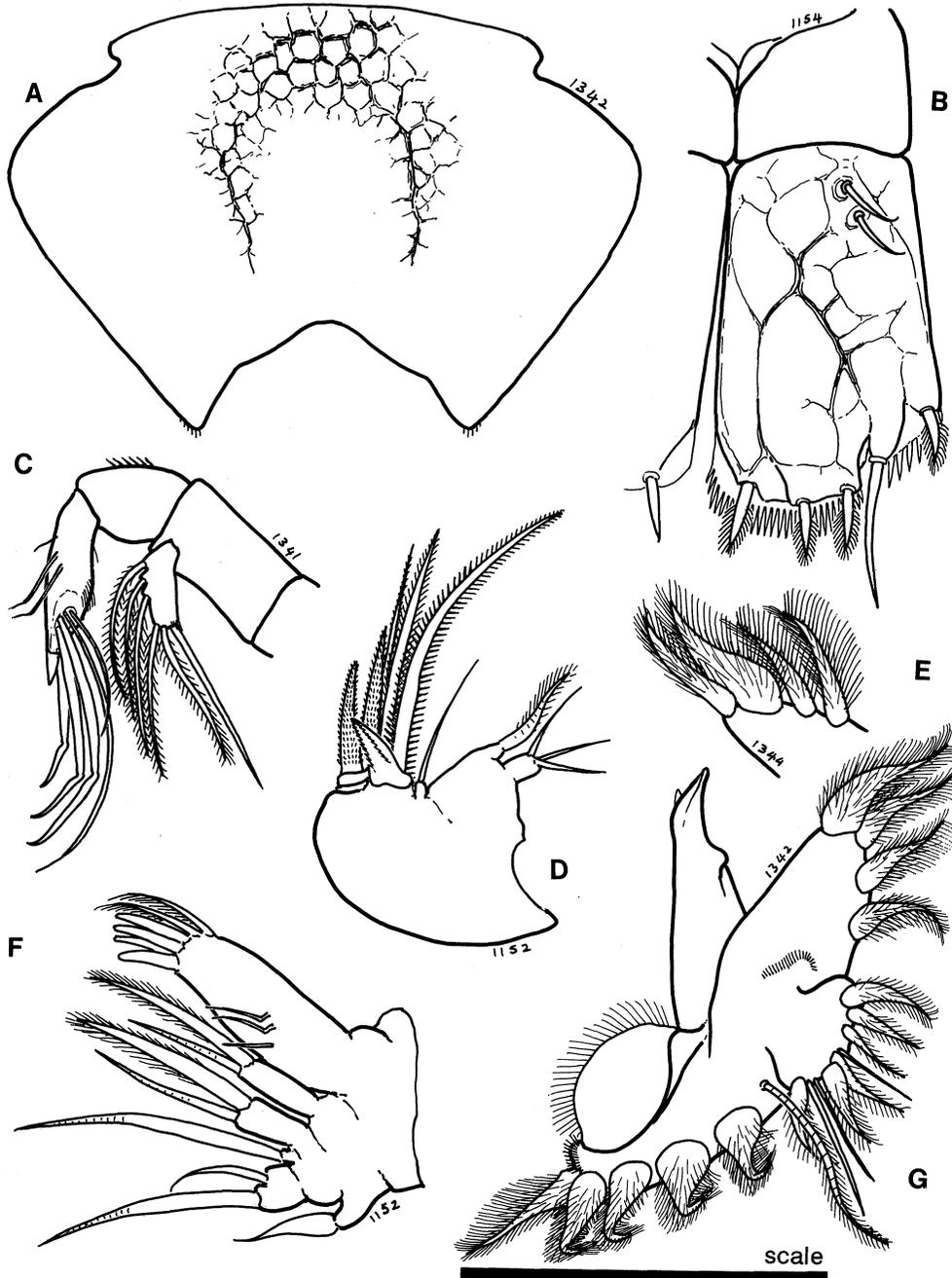


Fig. 24. *Brevifrons faviolatum*. A – female urosome; B – female right caudal ramus; C – antenna; D – maxilla; E – male anterior palp of mandible; F – maxillule; G – female mandible. Scale bar: A = 0.26 mm; B,D = 0.12 mm; C = 0.165 mm; E not to scale; F = 0.075 mm; G = 0.19 mm.

Caudal rami rectangular (Fig. 24B), widening slightly posteriorly (maximum width three-quarters way down ramus), strongly emarginate. α and β setae proximal, close together, γ seta in emargination; terminal setae all pinnate, equal in size and equally spaced (2 and 3 not close together); wide terminal fringe of setules. More than half length of caudal ramus projects beyond urosome (Fig. 23A).

Limbs with typical setation (Figs 24-26). Spatulate

claw on endopod of antenna (Fig. 24C) very small, not pectinate, geniculate setae plain, exopod with 1 plain and 5 plumulose setae. Anterior lobe of mandibular palp large with row of ventral setules, incisor process narrow, chisel-like (Fig. 24G). Maxillule (Fig. 24F) with single seta on exopod, 2 setae on endopod, 1 seta on distal endite, 2 setae (1 plumose) on each of the proximal endites, gnathobase very long (about 3 times width). Maxilla (Fig. 24D) with single plumose seta on medial

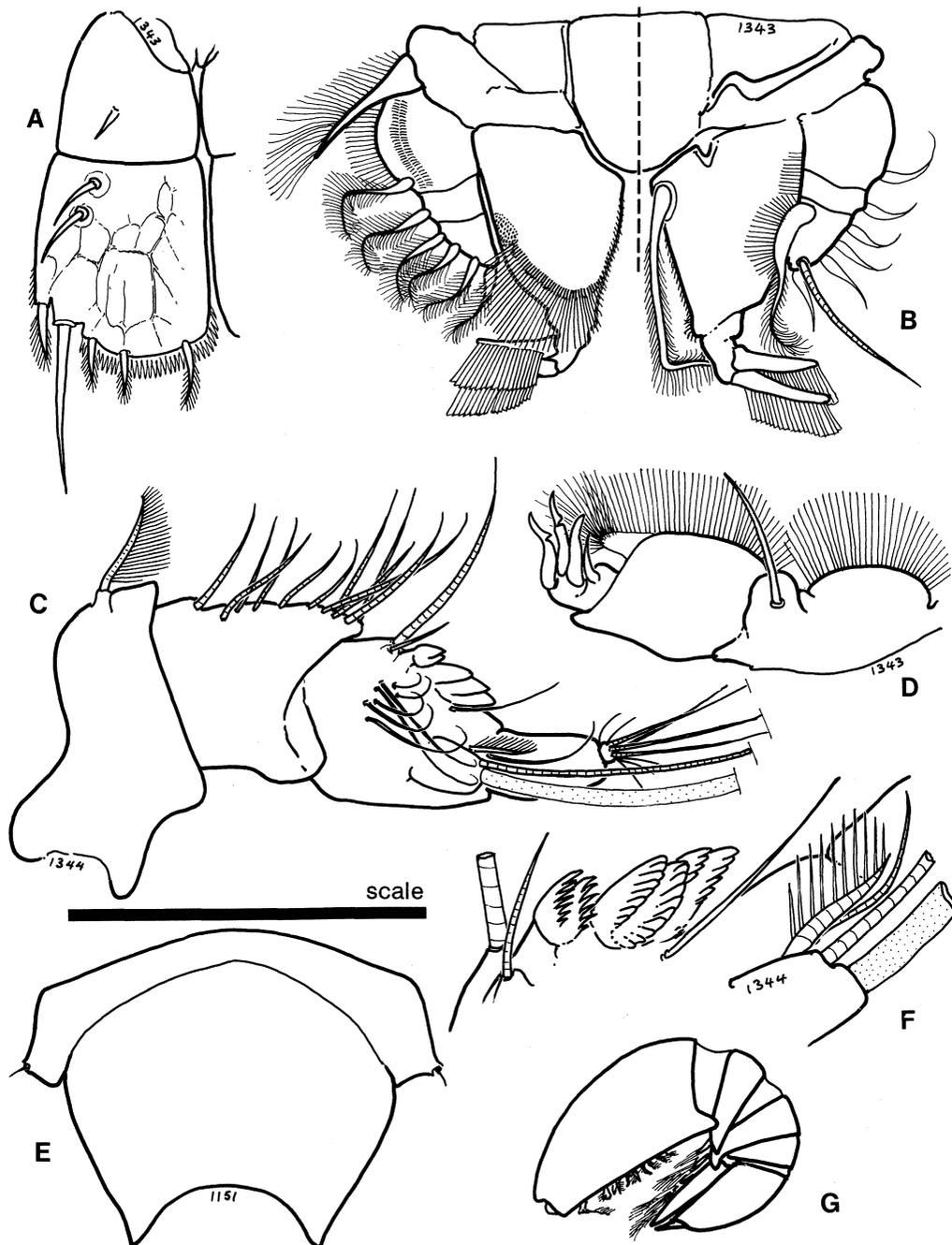


Fig. 25. *Brevifrons faviolatum*. A – male left caudal ramus; B – P1 (left ventral, right dorsal); C – male antennule with terminal segment extended (ventral view); D – maxilliped; E – male urosome; F – coupling denticles of male antennule; G – adult female in conglobating posture viewed from left side. Scale bar: A,D = 0.12 mm; B,E = 0.22 mm; C = 0.1 mm; F = 0.045 mm; G not to scale.

endite, spatulate claw with 2 serrate edges. Medial lobe of maxilliped rounded with fimbriate edge (Fig. 25D), basis with fimbriate border and short fimbriate process. First peraeopod (P1, Fig. 25B) with double row of denticulate pegs on article 1 of exopod, small lateral field of denticulate pegs beyond fimbriate crescent on endopod. P2 endopod slender with row of spinous setules on proximal article, 1 serrulate spinous seta and 3 plumose setae on distal article (Fig. 26E). Serrate sabre-like seta on P3 endopod short (1.2:1), (Fig. 26A).

P4 with 3 serrulate spinous setae on endopod (Fig. 26C). P5 bluntly lanceolate with terminal seta, fringe of spinous setules (Fig. 26F), P5s reach beyond urosome as far as emarginate indentation on caudal rami, but do not touch posteriorly (see Fig. 23A).

Adult male (Fig. 23B). Anterior of cephalosome concave with triangular bulge in midline, shoulders angular with double 'epaulet' (Fig. 23D). Colouration, reticulate ornamentation and hyaline border as for female.

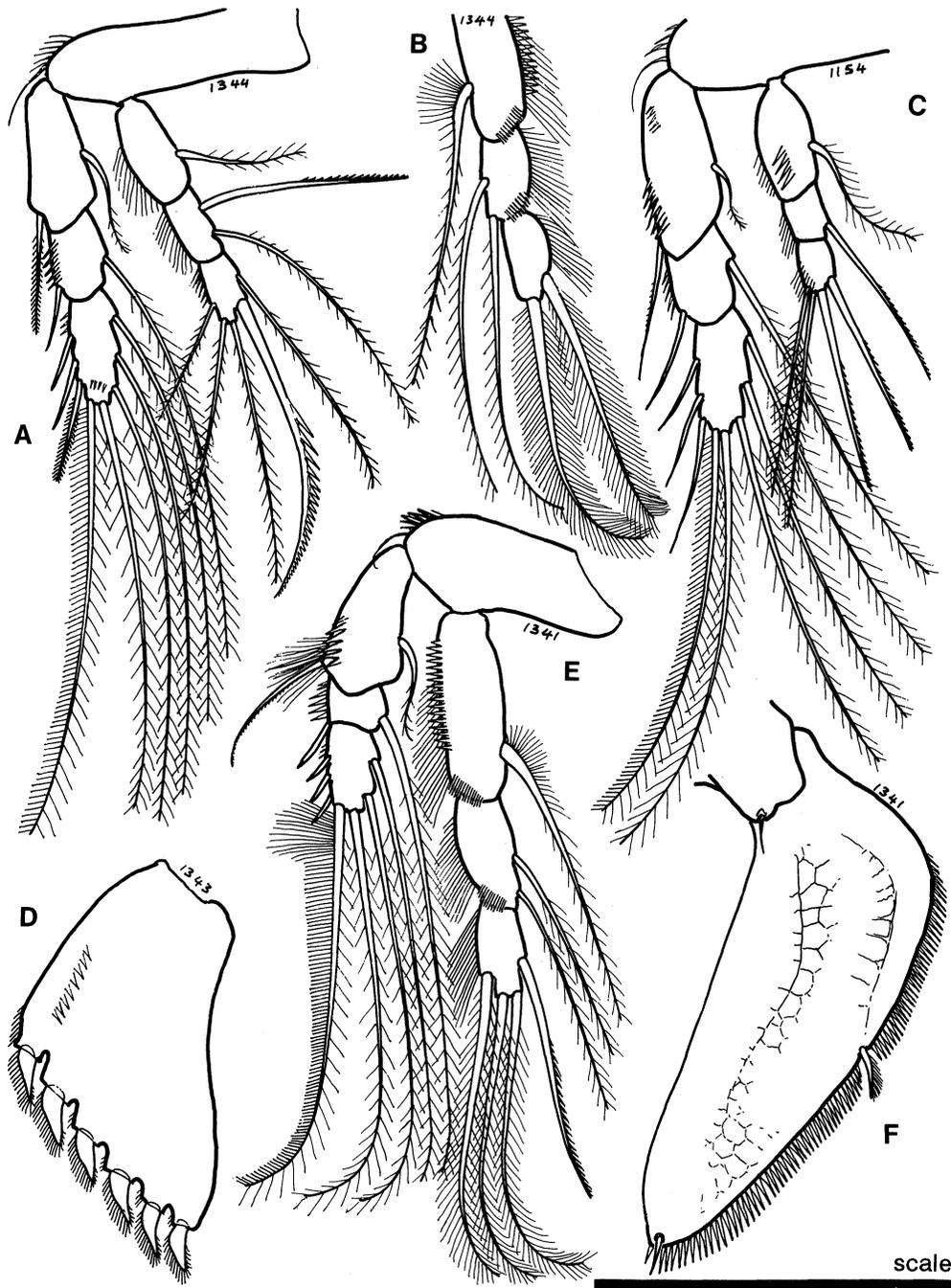


Fig. 26. *Brevifrons faviolatum*. A - P3; B - male P2 endopod; C - P4; D - male P5; E - female P2; F - female P5 (dorsal view). Scale bar: A,B,C,E = 0.19 mm; D = 0.165 mm; F = 0.22 mm.

Urosome as in Figure 25E, no apical setules. Caudal rami rectangular with emargination, setation similar to female (Fig. 25A).

Antennule prehensile (Fig. 25C); seta on article 1 plumose; ventral blade absent; coupling denticles with serrate edges (Fig. 25F), seta associated with distal denticle plain; articulate plumose seta situated near base of ventral sensory lobe bearing aesthetasc (Fig. 25F); terminal segment about half length of compound segment. First pilose seta on mandibular palp not greatly swollen (Fig. 24E). P1, P3, P4 as for female, P2 endopod with 2 plumose setae on terminal article (Fig. 26B). P5 as shown in Figure 26D.

Remarks. Adults are yellow with a reddish-brown border to the cephalosome and along joints between metasomal segments. A more diffuse pattern occupies midline of the cephalosome and urosome (Fig. 23A). The anal segment and caudal rami are also reddish-brown. The specific name is descriptive of the honeycomb reticular pattern on dorsal parts of the body (*L. favus* = honeycomb).

Modest populations (25+) have been collected only from Kioloa and Cronulla, Sydney. All specimens from

Kioloa have been collected from small stones (some sparsely encrusted with coralline algae or stunted *Lobophora*) under large boulders in rockpools below Chart Datum, and associated with the ophiuroid/*Phascolosoma* (Sipunculida) community. At Cronulla specimens were collected from stones encrusted with stunted *Sargassum* or *Lobophora* in rock gullies about Chart Datum.

Distribution and abundance. Occasional isolated individuals of *Brevifrons faviolatum* have been washed from *Lobophora* at Broulee in the south and as far north as Nambucca and Arrawarra Headlands, NSW.

Porcellidium Claus 1860

The genus *Porcellidium* has been divided into three sub-groups (Harris & Robertson, 1994) on the presence or absence of a ventral blade to the male antennule and the position of setae 2 and 3 on the caudal ramus.

Species possessing a ventral blade were subdivided as follows:

Terminal setae 2 and 3 very close together, plain, fine Hormosirii subgroup

Terminal setae 2 and 3 not very close, resemble 1 and 4, thick, pinnate
..... Fimbriatum subgroup

'Fimbriatum' subgroup

Porcellidium londonii n.sp.

Figs 27-30

Type material. HOLOTYPE adult female with egg mass, AM P42318; ALLOTYPE adult male, AM P42319; PARATYPES 2 females, 2 males (1 coupled to female copepodede), AM P42320; 4 females, 2 males [Cr.27, Mb.4] designated paratypes BM(NH) 1992.516-522. A second population [Ki.1] with 9 females and 8 males, taken from the same locality (21 Nov. 1972, V.A.P. Harris), has been designated paratype material. Illustrations were made from dissections of paratypes (slides 1328, 1329 female, 1330, 1331 male). These and the remaining type population held at ZANU, registration Po.SA. [Ki.35, Ki.1] [total type population 13 females (9 carrying eggs), 14 males plus 6 males coupled with juvenile females]. Washed from stones encrusted with pink 'Lithothamnion' in the infralittoral fringe, sheltered bay on north side of O'Hara Head, Kioloa, NSW (35°30'S 150°22'E), 19 Jan. 1977, V.A.P. Harris.

Diagnosis. *Adult female.* Pink with 4 pale blue iridescent spots on the cephalosome and iridescent blue scar on the urosome; mean length 0.75 mm; rostrum width 0.1 mm, hardly visible from above, ratio of cephalosome width to rostrum 5.0; dorsal surface pitted; urosome broad semicircular with prominent scar, no

lateral notch; caudal rami rectangular, β seta near γ , terminal setae all pinnate; small lateral triangular peg field on P1 endopod.

Adult male. Colouration as for female; corners of antennule sockets just visible from above, shoulders tightly rounded; ventral blade present on antennule.

Dimensions. *Females.* Mean length 0.75 mm (SD = 0.015, N = 13), cephalosome width 0.51 mm (SD = 0.019), height 0.11 mm, body length to width ratio 1.47. Rostrum width 0.1 mm, ratio of cephalosome width to rostrum 5.0. Urosome width to length ratio 1.4. Caudal ramus length to width ratio 2.2.

Males. Mean length 0.57 mm (SD = 0.008, N = 13), cephalosome length 0.33 mm, width 0.43 mm (SD = 0.011), ratio of body length to width 1.32.

Adult female (Fig. 27A). Cephalosome extended forward in the midline as a bulge which almost obscures the rostrum (Fig. 27C). Rostrum with narrow hyaline anterior edge. Hyaline border to cephalosome and epimeral lobes 8 μ m wide. Dorsal surface of body pitted. On the caudal rami there is a reticulate pattern of ridges (Fig. 28A).

Urosome broad, semicircular in outline (Fig. 28B), very small notch between anterior and posterior lobes, prominent scar, both lobes bordered with fine setules.

Caudal arch of urosome deep (about half urosome length).

Caudal rami (Fig. 28A) long, rectangular, slightly wider distally, not emarginate. α seta close to anal segment, β seta close to γ seta; all terminal setae thick, pinnate, 2 and 3 close together, 4 set in slightly from medial corner; terminal fringe of very fine setules present. Caudal rami project slightly beyond caudal arch.

Limbs with typical setation (Figs 28-30). Spatulate claw on endopod of antenna pectinate, terminal portion of geniculate setae plain (Fig. 29A). Mandible with strong incisor process (Fig. 28G). Maxillule exopod with 2 setae (1 very fine), endopod with 6 setae, endites each bear 3 setae (Fig. 28F). Maxilla as shown in Figure 28D,E. Medial lobe of maxilliped rounded with fimbriate border, basis with fimbriate border and fimbriate process (Fig. 29E). First pereopod (P1, Fig. 29B) with crescentic row of denticles on article 1 of exopod, small triangular peg field at lateral end of fimbriate crescent on endopod. P2 endopod with 1 serrulate seta and 3 plumose setae on terminal article (Fig. 30E). Serrate sabre-like seta of P3 endopod considerably longer than

endopod (1.5 : 1) (Fig. 30F). Distal article of P5 (Fig. 30B) ovate, bluntly pointed laid flat, falciform in natural position (Fig. 30A), 1 dorsal plus 1 terminal seta. P5 does not reach as far as posterior lobe of urosome (Fig. 27A).

Adult male (Fig. 27B). Cephalosome truncated anteriorly, convex in midline, lateral angle of antennule socket just visible from above, shoulders angular (Fig. 27D). Hyaline border and pits of cephalosome as for female.

Urosome anterior lobe bulges laterally, prominent seta between anterior and posterior lobes, single apical setule (Fig. 28H).

Caudal rami quadrate, wider posteriorly, lateral and medial corner bevelled (Fig. 29C). β seta midway between α and γ , terminal setae pinnate, 4 set in from medial corner.

Antennule prehensile (Fig. 29F); accessory lobe with anterior spine and ventral blade; proximal and medial coupling denticles with toothed edges, distal denticle with double serrate edge (Fig. 29G); distal segment of antennule with concave anterior (medial) border and

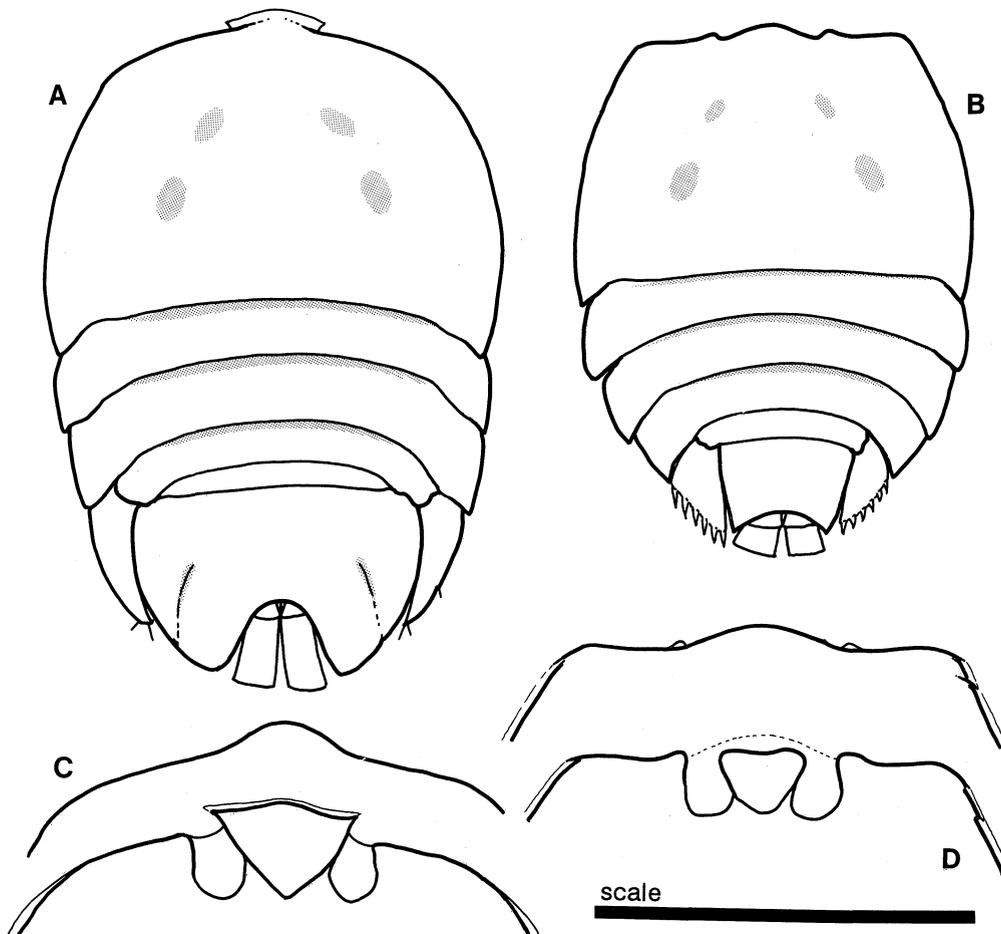


Fig. 27. *Porcellidium londonii*. A – adult female, shaded areas iridescent pale blue, body colour magenta pink; B – adult male; C – female rostrum and anterior border of cephalosome (dorsal and ventral views); D – male rostrum and anterior border of cephalosome (dorsal and ventral views). Scale bar: A,B = 0.45 mm; C,D = 0.33 mm.

hook-like terminal portion (Fig. 29F). First pilose seta of mandibular palp slender (Fig. 28C). P1, P3 and P4 as for female. P2 with 2 plumose setae on distal article of endopod (Fig. 30D). P5 broad with 6 terminal setae (Fig. 29D).

Remarks. Adult animals are carmine pink with four pale blue iridescent patches near the trabeculae, along joints between segments and on the urosome scar. This iridescence is distinctive and appears to be a structural

colour for its intensity depends on the angle of illumination, however, SEM studies have not revealed any surface structures which might give rise to the colour. It is interesting to note that the colour of this species accurately matches the colour of rocks on which it lives.

Porcellidium londonii has been named after Edith and Joy London, benefactors to the Australian National University. Their property, donated to the University, has become the London Foundation Field

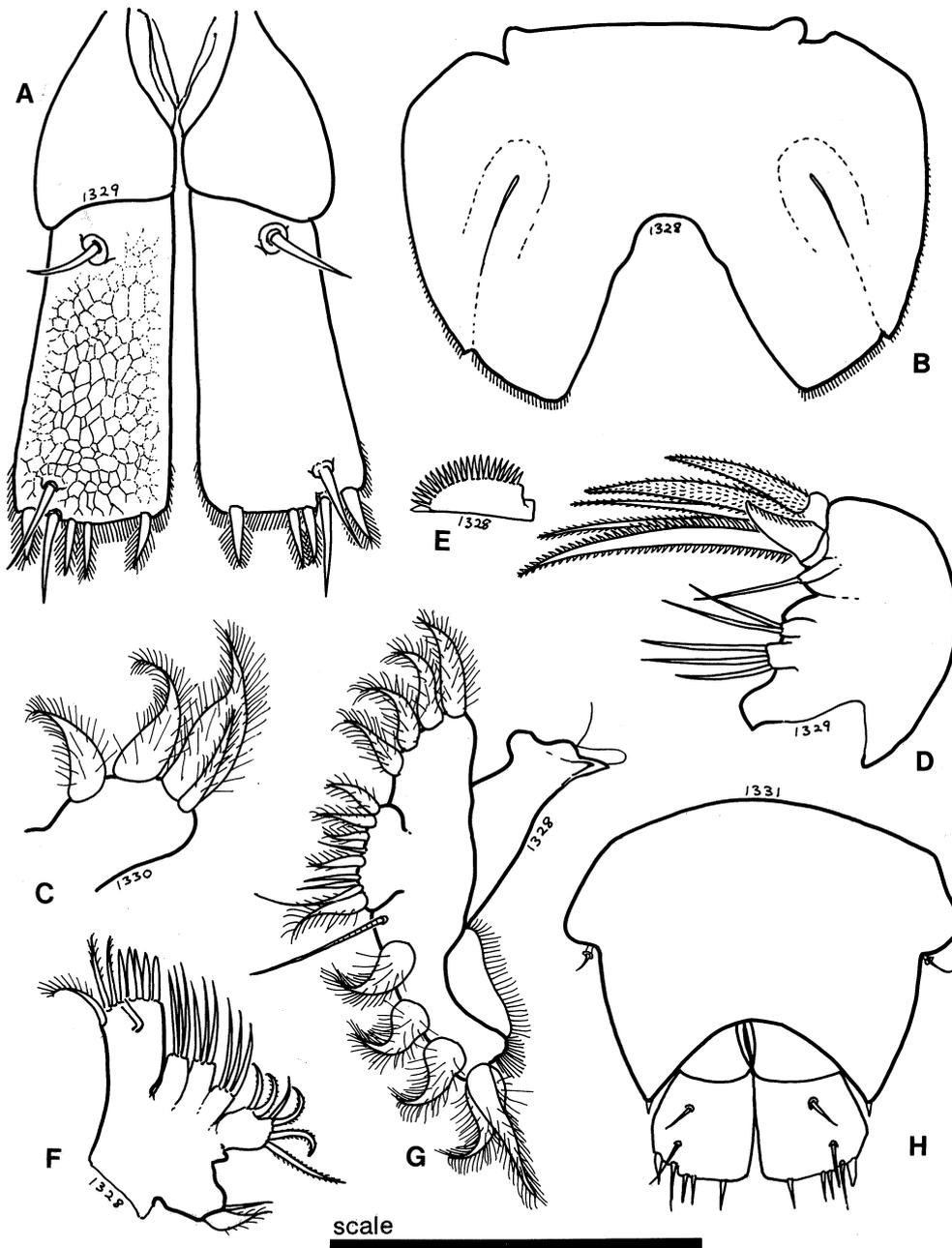


Fig. 28. *Porcellidium londonii*. A – female caudal rami and anal segment; B – female urosome; C – male anterior mandibular palp; D – maxilla; E – spatulate seta of maxilla; F – maxillule; G – female mandible; H – male urosome and caudal rami. Scale bar: A = 0.12 mm; B = 0.26 mm; C and E not to scale; D, F = 0.1 mm; G, H = 0.165 mm.

Station, Kioloa, NSW.

Discussion

Distribution and abundance. The type population was washed from stones and boulders covered with a thin encrustation of 'Lithothamnion' and regularly browsed by the sea urchin *Centrostephanus rogersii* in the infralittoral fringe. It has only been found in small numbers or isolated individuals. It has been recorded from Merimbula and Broulee in the south, and as far north as Cronulla, Sydney, NSW.

Several features in the foregoing descriptions have not received adequate explanation.

A hyaline fringe or border to the cephalosome and epimeral lobes of the metasome, a feature common to most of the Porcellidiidae, is not unique to that family for it is found in other species with a depressed body form, for example, *Zaus spinatus* (Harpacticidae) and *Aspidiscus littoralis* (Tisbidae).

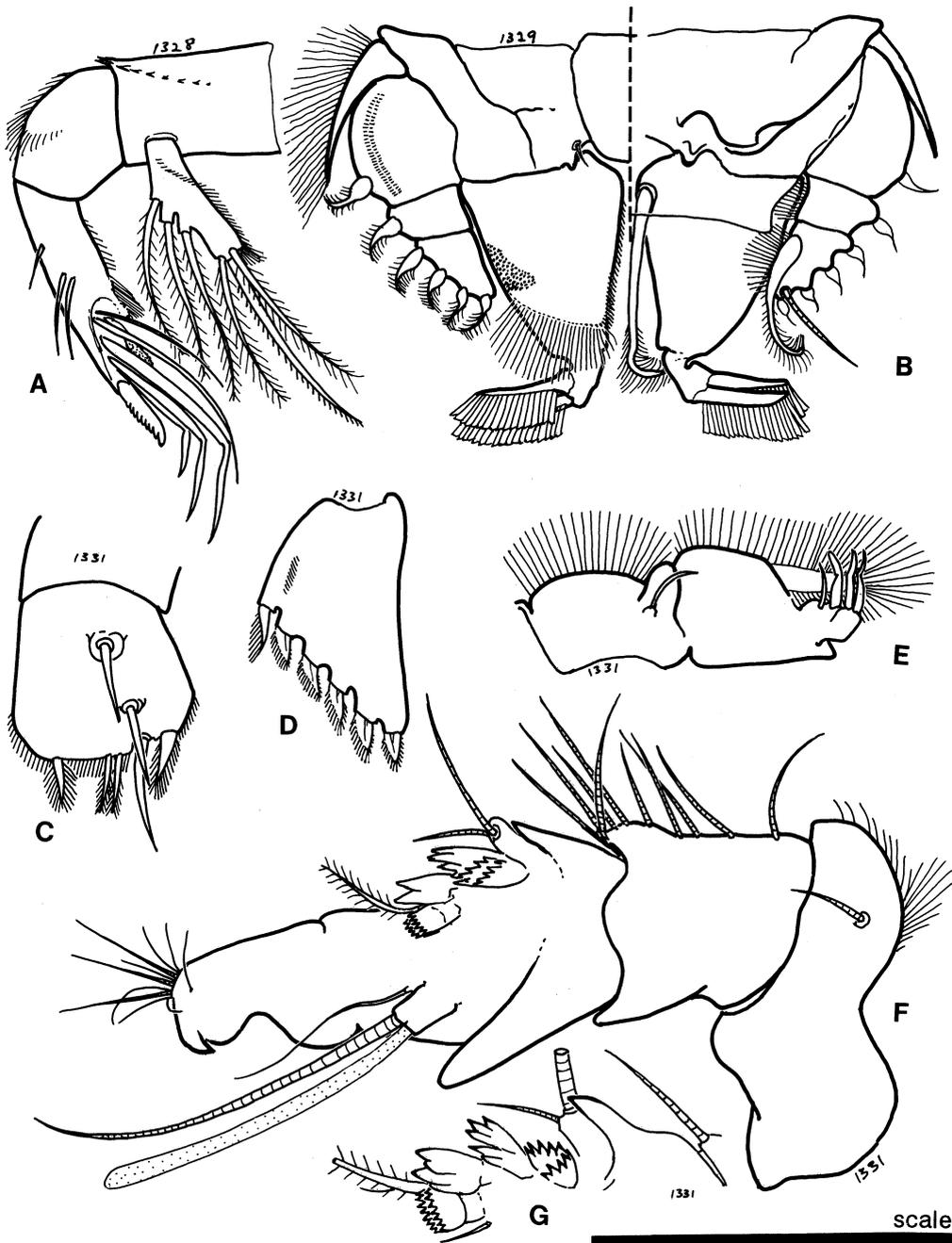


Fig. 29. *Porcellidium londonii*. A – antenna; B – P1 (left ventral, right dorsal); C – male right caudal ramus; D – male P5; E – maxilliped; F – male antennule with terminal segment extended (ventral view, π setae omitted); G – coupling denticles of male antennule. Scale bar: A,C,E = 0.1 mm; B = 0.19 mm; D = 0.165 mm; F = 0.09 mm; G = 0.075 mm.

This hyaline border is colourless and does not stain with the chitin stain chlorazol black, indicating that it is non-chitinous. In some instances fine sensory setae appear to lie in the plane of the hyaline border.

The functional significance of the hyaline border has not been satisfactorily explained, but it is probable that it forms a seal round the edge of the body. The shape of the body is such that water of moderate or high velocity flowing over it will reduce pressure

above the animal relative to the periphery. With an efficient seal round the perimeter this would allow the animal to adhere passively by suction to the substratum (seaweed surface) without expenditure of energy. The tenacity with which specimens adhere to the surface in a jet of water from a pipette was noted by Bocquet (1948) who attributed this ability to a 'dispositif en ventrouse' or sucker formed by the mouthparts and anterior thoracic limbs. The success with which the Porcellidiidae have colonised the surface of seaweed

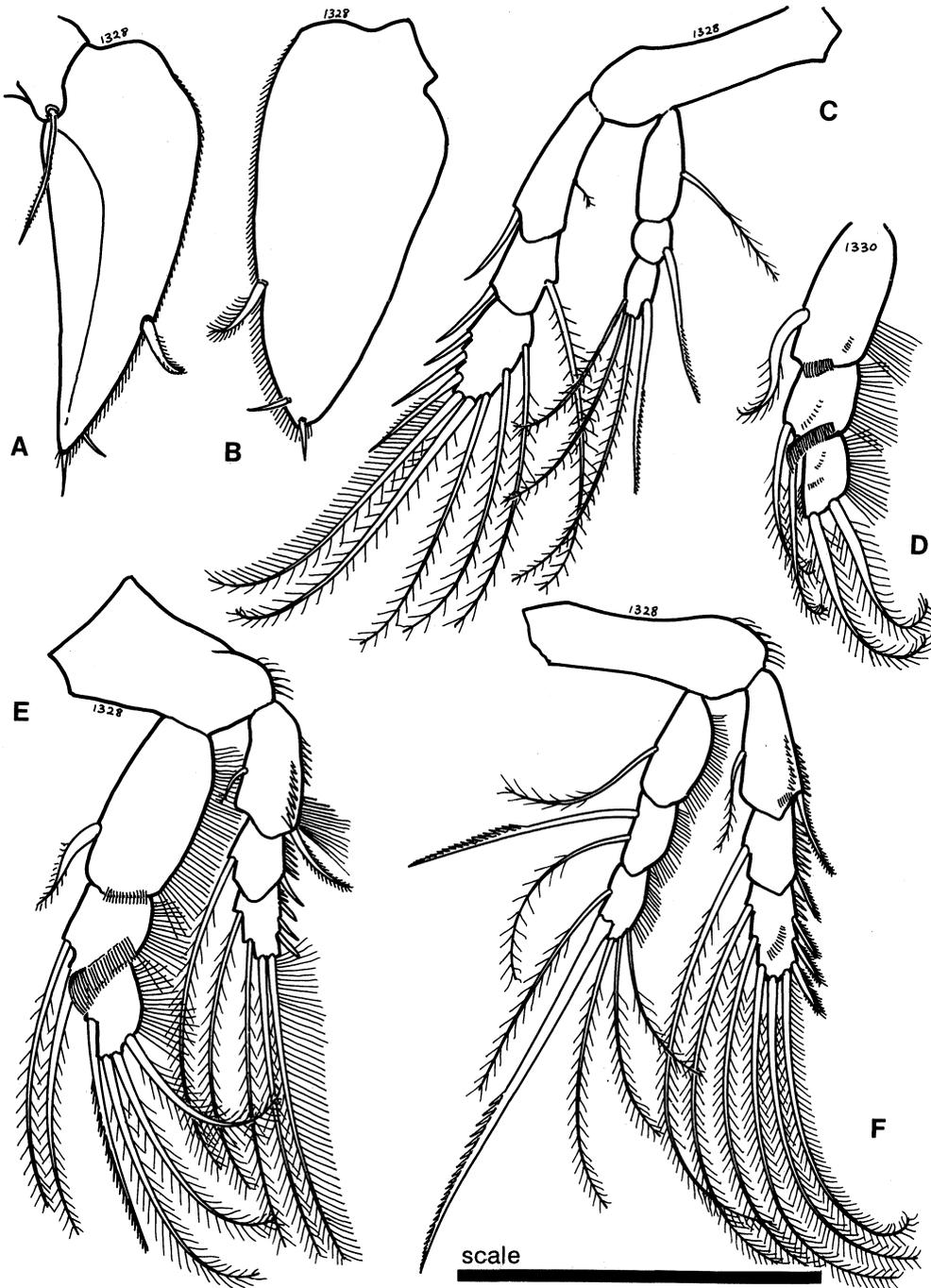


Fig. 30. *Porcellidium londonii*. A - female P5 in natural position (ventral view); B - female P5 laid flat (dorsal view); C - P4; D - male P2 endopod; E - female P2; F - P3. Scale bar: A-F = 0.165 mm.

under conditions of fast or turbulent water flow may well be due to possession of this hyaline border.

Towards the edge of the cephalosome and wedged between the lobes of the gonads, there are a variable number of marginal glands (between 5 and 12) that appear to be of holocrine type with a short duct that opens near to, but just above, the hyaline border (Figs 2C, 23E).

In the genus *Tectacingulum* the lateral border of the cephalosome has migrated ventrally to form a new ventral border (Fig. 2B). This results in the disappearance of the true hyaline fringe. Sensory setae are not normally found on the ventral (sternal) surface of the cephalosome, but with the edge being reflexed in *Tectacingulum*, both sensory setae and the opening of the marginal glands come to lie on the underside of the body (Fig. 2B,D). The ornamentation of ridges between pits on the dorsal surface gives the false impression of a hyaline border where it passes over the edge of the cephalosome, but this false border is chitinous, not hyaline, and has radial striations which are clearly related to the surface ridges (Fig. 2A,D, compare with 2C).

The dorsal surface of the cephalosome, metasomal segments, urosome, caudal rami and in some cases the fifth limbs (P5) show a wide range of surface ornamentation. The commonest takes the form of round, oval or crescent shaped pits which may have a raised rim or anterior border (see Harris & Robertson, 1994, pl. 1A). Ginneken & Bouligand (1975) have likened these to a lunar landscape with craters. Their electron micrographs of *Porcellidium viride* show surface microvilli and bacteria in the pits. Bacteria are commonly found in the pits on SEM photographs, but the significance of this and the function of the microvilli remains unanswered.

The cuticle between pits may be raised as a reticulate pattern of ridges; this is particularly noticeable on the caudal rami of some species (Figs 3C, 9F, 19G), or the anterior-lateral edge of the cephalosome (Figs 1D, 6D) where the rows of pits run tangential to the border. In *Brevifrons faviolatum* dorsal pits are absent. Their place is taken by prominent surface ridges which form a honeycomb pattern or rows of cubical recesses more or less parallel to the edge of the cephalosome (Figs 23A,C,D, 24A,B, Pl. 1).

Sensory setae, typically surrounded by a collar at their base, are a characteristic feature of the dorsal integument. They are always arranged in a symmetrical pattern characteristic of the species, but are much more numerous and obvious in some species than others.

Two pairs of limbs show important differences in structure which are of taxonomic value, but have received little comment in the past.

In the majority of species the endopod on the maxillule bears six plumulose setae and three or four setae on each of the three endites, but in *Brevifrons* there are only two setae on the endopod, two on each of the first two endites and only one on the third endite (Fig. 24F). This feature has been used as one of

the characters defining the genus *Brevifrons*.

Males of most species show a reduction in the number of setae on the last article of the second pereopod (P2) when compared with females. In females the endopod of P2 invariably terminates in four setae (3 plumose plus 1 serrulate spinose seta). In male animals, this condition has only been recorded for *Porcellidium tristanense* (Hicks, 1982). In males of *Murramia magna*, *M. bicincta*, *Kioloaria sesquimaculata*, *Porcellidium echinophilum* (Humes & Gelerman, 1962), and presumably all the 'clavigerum complex' (Hicks, 1982), one of the plumose setae has been lost leaving one spinose and two plumose setae. In the males of *Porcellidium* (*sensu* Harris & Robertson), *Acutiramus*, *Tectacingulum*, and *Brevifrons*, the terminal setae of P2 are further reduced by the loss of the spinose seta leaving only two plumose setae. This feature has been used to separate genera.

Hicks (1982) has pointed out the potentially useful nature of the male antennule in porcellidid taxonomy, but no detailed study of this organ appears to have been undertaken.

The male antennule is a difficult structure to study because the terminal segment is usually adducted in the 'clasping' position and this obscures the chitinous protuberances or coupling denticles which form such a valuable taxonomic character. The following account is based on SEM studies of Australian material using specimens in which the male antennules were extended in the 'hunting' position (ie, with terminal segment fully extended as shown in Figs 14B, 18E, 22F, 25C, 29F and 31A). This is a rare occurrence, being found in less than 1% of preserved specimens.

The antennule of male Porcellidiidae comprises four segments. The third (referred to as the compound segment) is greatly enlarged to accommodate the massive adductor muscle used to adduct the finger-like fourth segment (Fig. 31). At the base of the compound segment (ie, between it and segment 2) on the ventral side, many species have what will be referred to as an accessory lobe. Typically this bears two annulated setae on a short anterior prominence. One of these setae (δ) is usually much longer and held out at right angles to the antennule (ie, straight ahead); in *Porcellidium ulvum* Hicks, the δ seta is whip-like and longer than the entire antennule (Hicks, 1982). The prominence on which these setae are carried may have an anterior spine or tubercle covered in small denticles (Fig. 31 bottom row). Ventrally and closer to the posterior border, the accessory lobe may be extended as a sclerotised process – the ventral blade. The ventral blade is easily seen if present and can be a useful taxonomic character. A second lobe (the sensory lobe) is located on the ventral surface distal to the ventral blade. It bears a long annulated seta (σ) and the aesthete. Some species have two or three annulated setae inserted near the base of the sensory lobe. In *Brevifrons faviolatum* one of these setae is short and unipinnate (Fig. 25F).

Along the anterior edge of the compound segment there are typically one or more (usually 3) chitinous

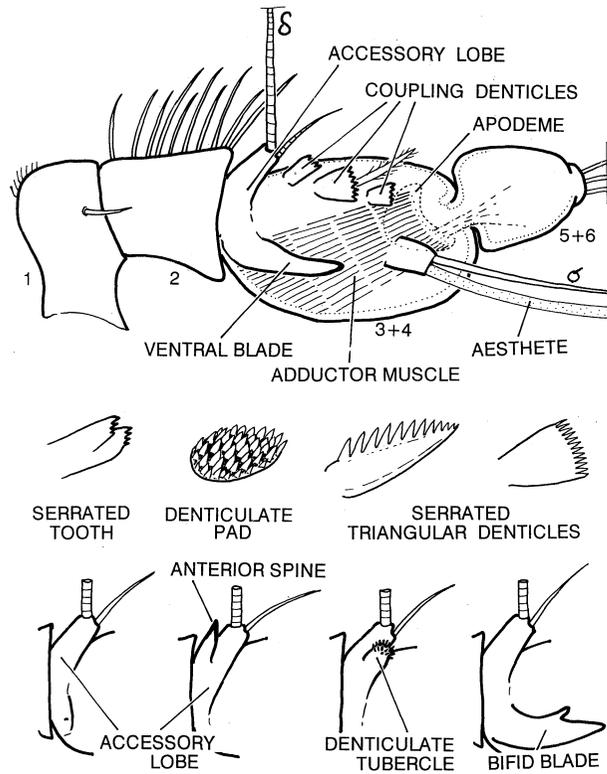


Fig. 31. Diagram showing structure of male antennule in the family Porcellidiidae. Forms of coupling denticles (middle row) and accessory lobe (bottom row) shown in lower half of figure.

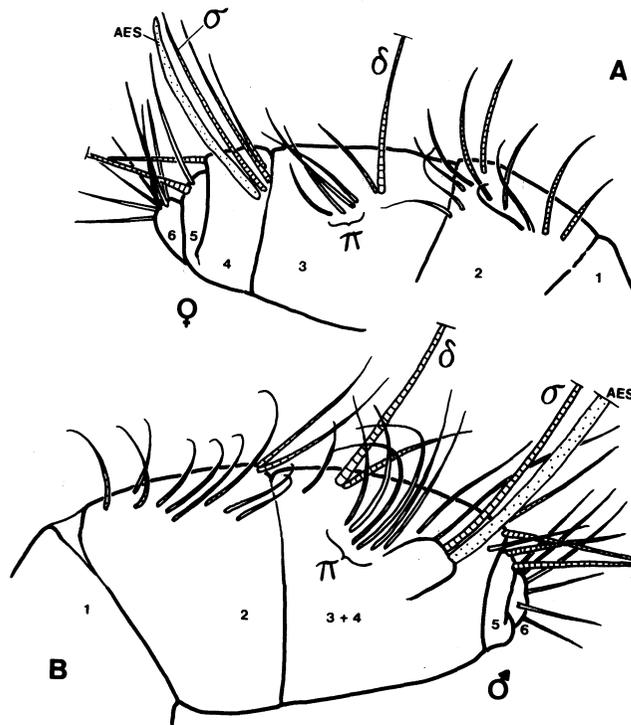


Fig. 32. *Porcellidium hormosirii*. A – antennule of fifth stage juvenile female showing segmentation and δ , π and σ setae; B – antennule of fifth stage juvenile male showing fusion of segments 3 and 4, setae δ , π and σ and absence of coupling denticles or ventral blade. Aes – aesthetasc.

protuberances, hereafter called the coupling denticles. They exhibit a wide variety of shape and are highly characteristic of each species. They range from a tooth-like structure to oval pads covered in peg-like denticulations. A common form is a triangular structure terminating in a serrated edge. In many cases the triangle is folded so that there appears to be a double row of distal serrations. In other cases the triangular structure is elongated with a serrated or pectinate (comb-like) lateral edge (Fig. 31 middle row). A short plumose seta is often found associated with one of the coupling denticles. On the ventral (palmar) side of the compound segment between the ventral blade (if present) and the coupling denticles there are typically seven, sometimes more, short plain setae (the π series, Figs 4E, 32B).

The terminal segment of the antennule varies in shape among species. It may range from long (up to two-thirds length of compound segment) to short (less than one-quarter length of compound segment), and bears a group of ten or 12 terminal setae. In certain species there may be a hook-like sclerotisation of the anterior distal edge or a c-shaped embayment.

The functional significance of all these structures is not well understood. The coupling denticles would increase the frictional grip of the male antennule on the juvenile female, but the function of the ventral blade is less obvious. Clearly it is not essential for coupling for it is absent from some species. The antennule of juvenile males (Fig. 32B) is short, thick and its distal segments are not modified for clasping, consequently it would be impossible for juvenile males to couple with females. Transformation of the antennule to a prehensile organ occurs at the metamorphosis from stage V to adult. Adult males couple with stage III, IV and V female copepodides by clasping the posterior region of the body. Segments 1, 2 and the compound segment of the male's antennules lie above the last metasomal segment, urosome and caudal rami of the juvenile female, but the terminal segment of the antennule folds under to grip the female ventrally. A C-shaped epimeral lobe of stage III and IV females or a gap between the epimeral lobe and the P5 of stage V, provides a notch into which the male antennule can lock.

Homologies of the setae and coupling denticles can be inferred from a study of the juvenile stages. Six segments can be discerned in the juvenile female antennule with a prominent δ seta and a group of seven setae (π series) on the third segment (Fig. 32A). On segment 4 there is a sensory lobe bearing σ + aesthetasc. Male stage IV and V juveniles, on the other hand, only have five segments; the third bearing δ , the π series and the sensory lobe with σ + aesthete (Fig. 32B). This segment must represent the fusion of 3 and 4; the same condition that is found in the transformed (metamorphosed) male antennule.

Although there is a close correspondence between the setation of juvenile and adult male antennules, there is nothing in the juvenile that corresponds to the coupling denticles and ventral blade; these structures cannot represent modified setae and must arise *de novo* at the time of metamorphosis as sclerotisation of

special areas of the antennule integument.

The coupling denticles show a high degree of specificity and clearly distinguish species, but their practical value in identification is limited if they are obscured by the terminal segment of the antennule. Their value in defining genera is less certain. Denticulate pads (Figs 14A, 18F, 31) have not been found in any members of *Porcellidium*. They occur in *Murramia* but are not exclusive to that genus. Similarly the shape and presence of the ventral blade, although highly specific, does not show a clear distinction between genera. It is, for example, present in some species of *Porcellidium* (*sensu* Harris & Robertson, 1994), but not in others, moreover, there is a continuous range of shapes from a small incipient blade to one as long as the compound segment. At this stage in our understanding of Porcellidid taxonomy it is best to regard antennule structure as providing valuable taxonomic characters at the specific level only.

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