

PARACALLIOPE, A GENUS OF AUSTRALIAN SHORELINES
(CRUSTACEA: AMPHIPODA: PARACALLIOPIIDAE)

BY J. L. BARNARD¹* AND M. M. DRUMMOND²

¹ Department of Invertebrate Zoology, NHB-163, Smithsonian Institution, Washington, DC 20560, USA

² Department of Crustacea, Museum of Victoria, Swanston Street, Melbourne, Victoria 3000, Australia

Abstract

Barnard, J.L. and Drummond, M.M. 1992. *Paracalliope*, a genus of Australian shorelines (Crustacea: Amphipoda: Paracalliopiidae). *Memoirs of the Museum of Victoria* 53: 1–29.

Species of *Paracalliope* are widely distributed along south-eastern open-sea shores, brackish inlets and certain freshwater streams of Australia. We describe here extensive collections ranging from southern Queensland through New South Wales and Tasmania to western Victoria. The identity of *Pherusa australis* Haswell (1880) is now confirmed from numerous topotypic collections, at Cape Banks, as the first species of *Paracalliope* described from Australia and as the senior synonym of *Paroediceropsis raymondi* Fearn-Wannan (1968). *Paracalliope larai* Knott (1975), a freshwater Tasmanian species, is re-examined and partially re-described. A third mostly marine and widespread new species, *P. lowryi*, is described and a fourth species, *P. vicinus*, also new, with quite variable brackish-freshwater habitat, is described in numerous collections from Tasmania.

Introduction

The Paracalliopiidae were established by Barnard and Karaman (1982) to include *Paracalliope* Stebbing, 1899, and *Indocalliope* Barnard and Karaman, 1982. Later, *Katocalliope* Barnard and Drummond (1984), *Doowia* Barnard and Drummond (1987) and *Yhi* Barnard and Thomas (1991) were added to the group. The family is now revised to include species from Australia which heretofore have not been properly examined. The earliest known species from Australia, *Paracalliope australis* (Haswell, 1880), is properly described for the first time, *P. larai* Knott is reviewed and two new species are described.

Most species of the Paracalliopiidae have an affinity for brackish water or occur in freshwater or very shallow marine waters along shores, mainly in high tidepools. Their known distribution extends from India to Australia, New Zealand, New Caledonia, and Fiji.

Most of our material comes from Victorian surveys (Western Port and Port Phillip Bay), from Gippsland lakes or from various brackish lagoons and river mouths in New South Wales, Tasmania and Queensland. Collections are in the Museum of Victoria (NMV), The Australian

Museum (AM), Queensland Museum (QM) and Tasmanian Museum (TM). Many replicate samples have been identified but only one from each locality is reported here. Maps and station localities for most of the Victorian material are found in Barnard and Drummond (1976, 1978, 1979, 1982).

The Paracalliopiidae and *Paracalliope* are newly diagnosed, with lists of their taxa. Three keys to genera of the family were given by Barnard and Thomas (1991) and a key to the species of *Paracalliope* is given here. Numbers in square brackets are geographic codes listed in Barnard and Barnard (1983).

Specimens of *Paracalliope* are frequently very difficult to handle because they break up easily and preserve poorly. For the most part, the manipulation of specimens is very tedious and frustrating because of these difficulties.

Legends

Capital letters in figures refer to parts; lower case letters to left of capital letters refer to specimens and to the right refer to adjectives as described below: A, antenna; B, body; C, coxa; D, dactyl; E, epimeron; F, accessory flagellum; G, gnathopod; H, head; L, labium; M, mandible; P, pereopod; Q, calceolus; R, uropod; S, maxilliped; T, telson; U, upper lip; V, palp; W, pleon; X, maxilla; Y, gill; Z, oostegite; d, dorsal; l, left; o, opposite appendage to nearby figure; r, right;

* Jerry L. Barnard died on 16 August 1991 shortly after this manuscript was accepted for publication.

s, setae removed and marked with circles-ovals.

Paracalliopiidae Barnard and Karaman, 1982

Diagnosis. Body plan ordinary but urosomites 2–3 fused together; shape of head ordinary, rostrum and sinus for antenna 2 ordinary, eyes paired; pereopod 7 elongate and different from shorter pereopods 5–6, dactyl of pereopod 7 elongate and setose; gnathopods sexually diverse, mittenform in female, enlarged mittenform in male, with thin carpi and expanded propodi twisting inward on death. Telson of ordinary length, entire.

Sexual dimorphism. Gnathopods diverse, large in male, small in female.

Relationship. Paracalliopiidae differ from Exoecicerotidae in the lack of apical spines on rami of uropods 1–2; from Oedicerotidae in the paired eyes, fused urosomites (occasionally present in Oedicerotidae), non-galeate head and odd gnathopods; from Eusiridae-Calliopiidae in the fused urosomites 1–2 and odd gnathopods; from Dexaminidae in the greatly elongate pereopod 7 with elongate setose dactyl and the uncleft telson.

List of genera. *Paracalliope* Stebbing, 1899: 210; *Indocalliope* Barnard and Karaman, 1982: 182; *Katocalliope* Barnard and Drummond, 1984: 147; *Doowia* Barnard and Drummond, 1987: 117; *Yhi* Barnard and Thomas, 1991: 284. Keys to the genera were given by Barnard and Thomas (1991).

Paracalliope Stebbing

Paracalliope Stebbing, 1899: 210 (type species, *Calloiope fluviatilis* Thomson, 1879, original designation). — J.L. Barnard, 1972: 70.

Paroediceropsis Fearn-Wannan, 1968: 50 (type species, *Paroediceropsis raymondi* Fearn-Wannan, 1968, original designation).

Diagnosis. Paracalliopiidae bearing mandibular palp; inner plate of maxilla 1 fully setose medially; oostegites diverse, 2–3 expanded, 4–5 slender; epimera with angular posteroventral corners; peduncle of uropod 3 elongate. Calceoli like eusirid kind of Lincoln and Hurley (1980: 111) with distal and proximal element extending beyond bulla and receptacle; distal element linguiform or arrow-head shaped.

Species.

P. australis (Haswell, 1880, 1882) (= *Paroediceropsis raymondi* Fearn-Wannan, 1968) (Della Valle, 1893 as *Pherusa australis*) (? = *P. fluviatilis* det. of Chilton, 1920), marine, SE Australia [784 + E].

P. fluviatilis (Thomson, 1879) (J.L. Barnard, 1972; Hurley, 1975; Lewis, 1976; Chapman and Lewis, 1976), fresh water, New Zealand [935].

P. karitane J.L. Barnard, 1972 (Hurley, 1975; Lewis, 1976; Chapman and Lewis, 1976), brackish, New Zealand [936X].

P. larai Knott, 1975, fresh water, Tasmania [941].

P. lowryi Barnard and Drummond, herein, south-eastern Australia [784].

P. mapela Myers, 1985, marine, Fiji [576].

P. novaecaledoniae Ruffo and Paiotta, 1972, fresh water, New Caledonia [933].

P. novizealandiae (Dana, 1852, 1853) (= *P. neozelanicus* Thomson and Chilton, 1886; Chilton, 1909; J.L. Barnard, 1972), marine, New Zealand [775].

P. vicinus Barnard and Drummond, herein, brackish-fresh water, Tasmania [783EF].

species inquirenda (= *P. fluviatilis* det. of Chilton, 1921), fresh water, Philippines [982].

Habitat and distribution. New Zealand, Australia, New Caledonia, Philippines, Fiji, weakly marine, mostly estuarine to fresh water.

Key to species of *Paracalliope* (adults)

(*P. larai* is cited twice because of possible misinterpretation of epimera)

1. No rami of uropods 1–3 with more than 1 spine each 2
- At least 4 rami of uropods 1–3 each with 2 or more spines 3
2. Female coxa 1 widened distally, coxa 2 tapering distally, carpal lobe of female gnathopod 2 half as long as propodus *P. novaecaledoniae*
- Female coxa 1 tapering distally, coxa 2 broadened distally, carpal lobe of female gnathopod 2 one fourth as long as propodus *P. mapela*
3. Epimera 2–3 with large tooth (fig. 8nW) 4
- Epimera 2–3 with small tooth (fig. 4E) 6

4. Male gnathopod 1 as small as in female, eyes enlarged (mandibular palp article 3 with 1–3 basofacial setae, outer ramus of uropod 1 with 0–1 spine) *P. lowryi*
- Male gnathopod 1 enlarged, eyes medium (other characters mixed) . 5
5. Mandibular palp article 3 with 0–1 basofacial spine-seta, outer ramus of uropod 1 with 2 spines, epimeron 3 without spines in adult .. *P. larai*
- Mandibular palp article 3 with 3 basofacial spine-setae, outer ramus of uropod 1 with 1 spine, epimeron 3 with 3 spines *P. vicinus*
6. Male eyes small, pereopods 3–6 with dactylar slit 7
- Male eyes large, dactylar slits absent 8
7. Male pereopods 3–4 with setae poorly developed, mandibular palp article 3 with 2 basofacial setae *P. karitane*
- Male pereopods 3–4 with setae large and dense, mandibular palp article 3 lacking basofacial setae *P. australis*
8. Epimera 2–3 with widely sweeping posterior concavity directly leading to protuberant posteroventral tooth *P. larai*
- Epimera 2–3 with narrowly contained posterior concavity from which small sharp posteroventral tooth emerges 9
9. Gland cone small, lateral cephalic lobes weak, female gnathopods with medium carpal lobes *P. novizealandiae*
- Gland cone large, lateral cephalic lobes prominent, female gnathopods with large carpal lobes *P. fluviatilis*

***Paracalliope australis* (Haswell) comb. nov.**

Figures 1–4, 10 (part)

Pherusa australis Haswell, 1880: 103, pl. 7 fig. 1. — 1882: 246.

Paroediceropsis raymondi Fearn-Wannan, 1968: 51–58, figs 12–15.

Material examined. Holotype lost, type locality: Botany Bay [NSW].

Neotype. Botany Bay, Cape Banks, 5 Mar 1985, supralittoral, P. Versteiger, AM P.35636 (male “tl” 3.31 mm).

Other type material. Victoria, Gippsland Lakes, Eagle Point, Lake King (37°53'S, 147°41'E), Apr 1957, NMV J157 (1, HOLOTYPE of *Paroediceropsis raymondi*), NMV J158 (44, 21 slides, PARATYPES of *Paroediceropsis raymondi* of which a few examined as follows, newly designated by letters and sizes: female “a” 3.53 mm, female “b” 2.91 mm, male “c” 3.24 mm, male “d” 3.48 mm, male “e” 3.38 mm).

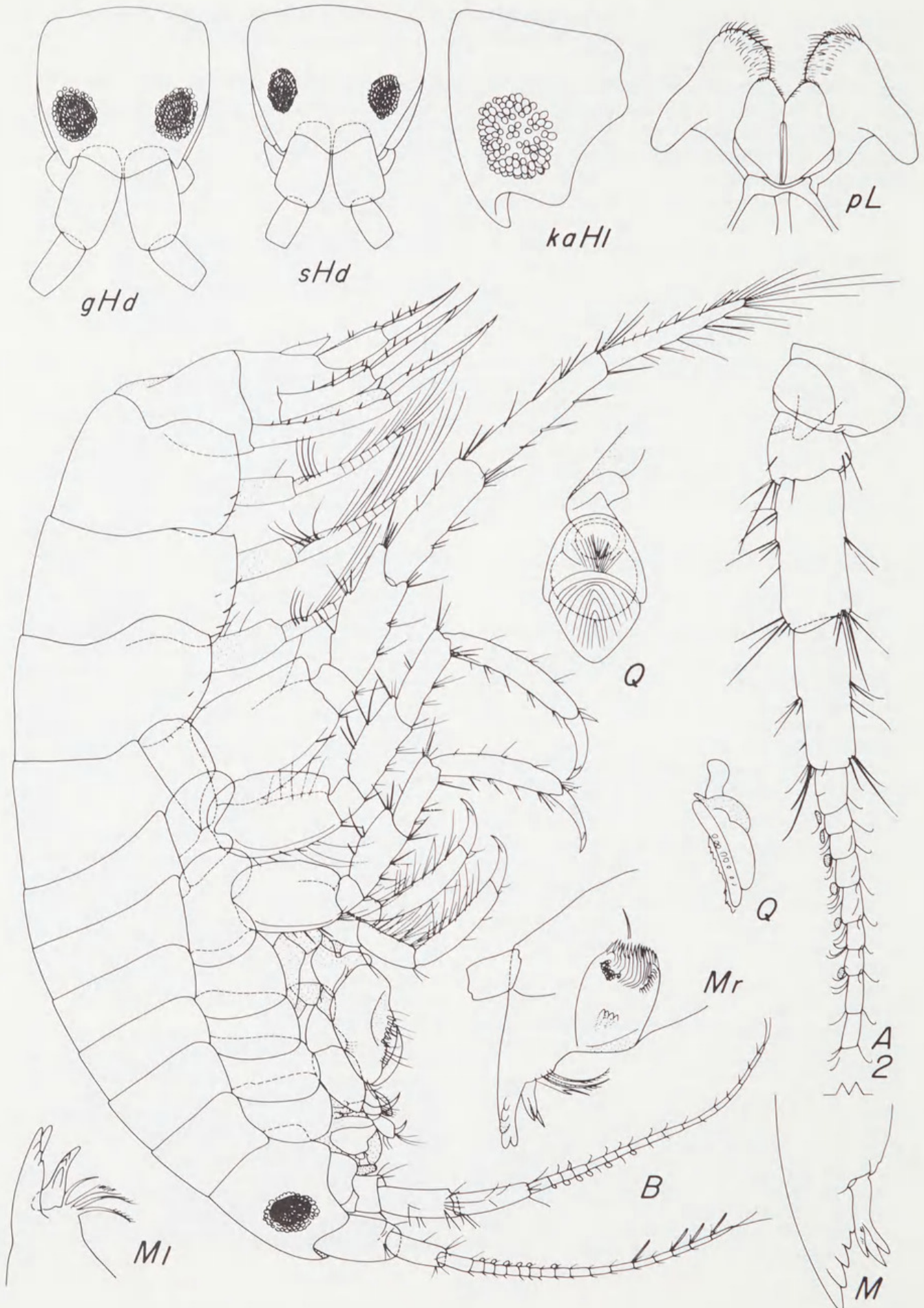
Other material. Central Bass Strait, 28 km E of Cape Farewell, King Island, Tasmania (39°32.8'S, 144°16'E), 18 m, fine sand, WHOI epibenthic sled, M. Gomon and G.C.B. Poore RV *Sarda*, 1 Nov 1980 (stn BSS-S 107), NMV J13088 (1).

New South Wales. Neotype locality, AM P35636 (male “tk” 3.63 mm, male “tm” 2.97 mm, female “tn” 2.60 mm, juvenile “to” 2.48 mm, verifying taxonomy; Twofold Bay, Shadrack Creek, *Zostera*, mud, I. Vander Velde, AM P35637 (5); Twofold Bay, Fisheries Creek, 19 Sep 1984, *Ruppia* bed, mud, AM P35638 (11); Dee Why Lagoon (31°31'S, 149°54'E, 0.75 m, 29 Nov 1988, muddy sand and algae, A. Murray and A.R. Jones, AM P39142 (7); Merimbula (36°54'S,

149°53'E), sand, hand net, M.M. Drummond, 1 Dec 1978, NMV J6904 (juvenile voucher “jb”, 1.78 mm); NMV J6903 (juvenile voucher “ja”, 1.13 mm), Merimbula, Back Lake, M.M. Drummond, 1 Dec 1975, NMV J13090 (many); Lake Illawarra, entrance, NMV J22287 (3).

Tasmania. Nierinna Creek, near Margate (43°02'S, 147°13'E), T. Walker, NMV J13093 (many), NMV J6912 (female voucher “m”, 3.64 mm), NMV J6911 (female voucher “s”, 2.89 mm), NMV J6909 (female voucher “p”, 3.30 mm, illustrated), NMV J6914 (juvenile voucher “l”, 1.86 mm), NMV J6907 (male voucher “h”, 2.70 mm), NMV J6915 (juvenile voucher “j”, 1.60 mm), NMV J6908 (male voucher “g”, 3.71 mm), NMV J6913 (female voucher “u”, 2.60 mm), NMV J6910 (female voucher “w”, 2.68 mm); Swan River, site 6, D. Hoggins, Tasmanian Fisheries Development Authority, Jul 1978, NMV J6905 (juvenile voucher “ka”, 3.23 mm, illustrated), NMV J6906 (female voucher “kb”, 2.66 mm), NMV J13092 (1); Wandle River, on road from Wynyard to Waratah, P. Suter, 26 Aug 1973, NMV J6954 (2); Swanport, estuary mouth, Tasmanian Fisheries Development Authority, NMV J13087 (9).

Victoria. Gippsland Lakes, Lake Victoria, near Red Bluff (38°03.5'S, 147°31'E), G.C.B. Poore et al., SCUBA, MSL preliminary survey, stn G609-5, 15 Nov 1976, NMV J13084 (1); Lake King, near Paynesville (37°55.5'S, 147°43'E), stn G609-29, NMV J6997 (9); Lake King, near Point Jones (37°55'S, 147°45'E), stn G609-28, NMV J6800 (male voucher “i” 3.86 mm), NMV J6902 (female, voucher “k”, 3.51 mm), NMV J13085 (many); Lake King, East of Point Scott, Raymond Island (37°54'S, 147°49'E), stn G609-25, NMV J13086 (1); Lake King, near Kelly Head (37°54'S,



147°55'E), stn G609-41, NMV J13083 (1); NMV J13079 (1); Lake King, near Mosquito Point (37°53.5'S, 147°52'E), stn G609-33, NMV J13081 (1); NMV J6998 (1); Lake King, N of Kelly Head (37°53.5'S, 147°55'E), stn G609-39, NMV J13078 (11); Lake King, near Eagle Point (37°53'S, 147°44'E), stn G609-14, NMV J13077 (2); Lake King, N of Eagle Point (37°52'S, 147°44'E), stn G609-16, NMV J13082 (1); Lake King, near mouth of Tambo River (37°51.5'S, 147°48'E), stn G609-20, NMV J13080 (1); Lake King, NMV J6799 (male voucher "f", 4.55 mm); Altona salt ponds, G. Davey, NMV J6901 (male voucher "ha", 3.29 mm); Merri River, J.D. Kudenov, NMV J6953 (9).

Description of male neotype "tl" 3.31 mm. Rostrum small, lateral cephalic lobe adze-shaped, sinus receiving antenna 2 deep, eyes small (artificially shrunken), widely separate. Antenna 1 scarcely shorter than antenna 2, flagellum with 14 articles, calceoli absent; one aesthetasc each on articles 9, 11, 12, 13, and rudimentary on 14. Gland cone of antenna 2 very prominent, almost reaching apex of article 3 (in lateral view), flagellum with 10 articles, one calceolus each on articles 3, 4.

Epistome flat anteriorly, upper lip articulate and rounded-truncate below, anterior pubescence poorly developed. Mandibles of basic gammaridean plan, incisors toothed, right and left laciniae mobiles toothed, right and left rakers 3 and 4 respectively, first raker on left bifid (possibly 2 rakers fused?); molar triturative, bearing apical seta; palpar hump small, articles 1-2 naked, article 3 especially pubescent, formula of spines = 3D, 5E, with 3 of E setae simple, others penicillate, basofacial setae absent. Inner lobes of lower lip well developed and fleshy. Inner plate of maxilla 1 almost fully setose medially, outer plate with 11 diverse spines, palp 2-articulate, spinose apically, right and left palps alike. Plates of maxilla 2 subequal in size, inner with facial row of setae. Inner and outer plates of maxilliped weakly spinose, palp short, stout, dactyl unguiform, with about 2 accessory setules.

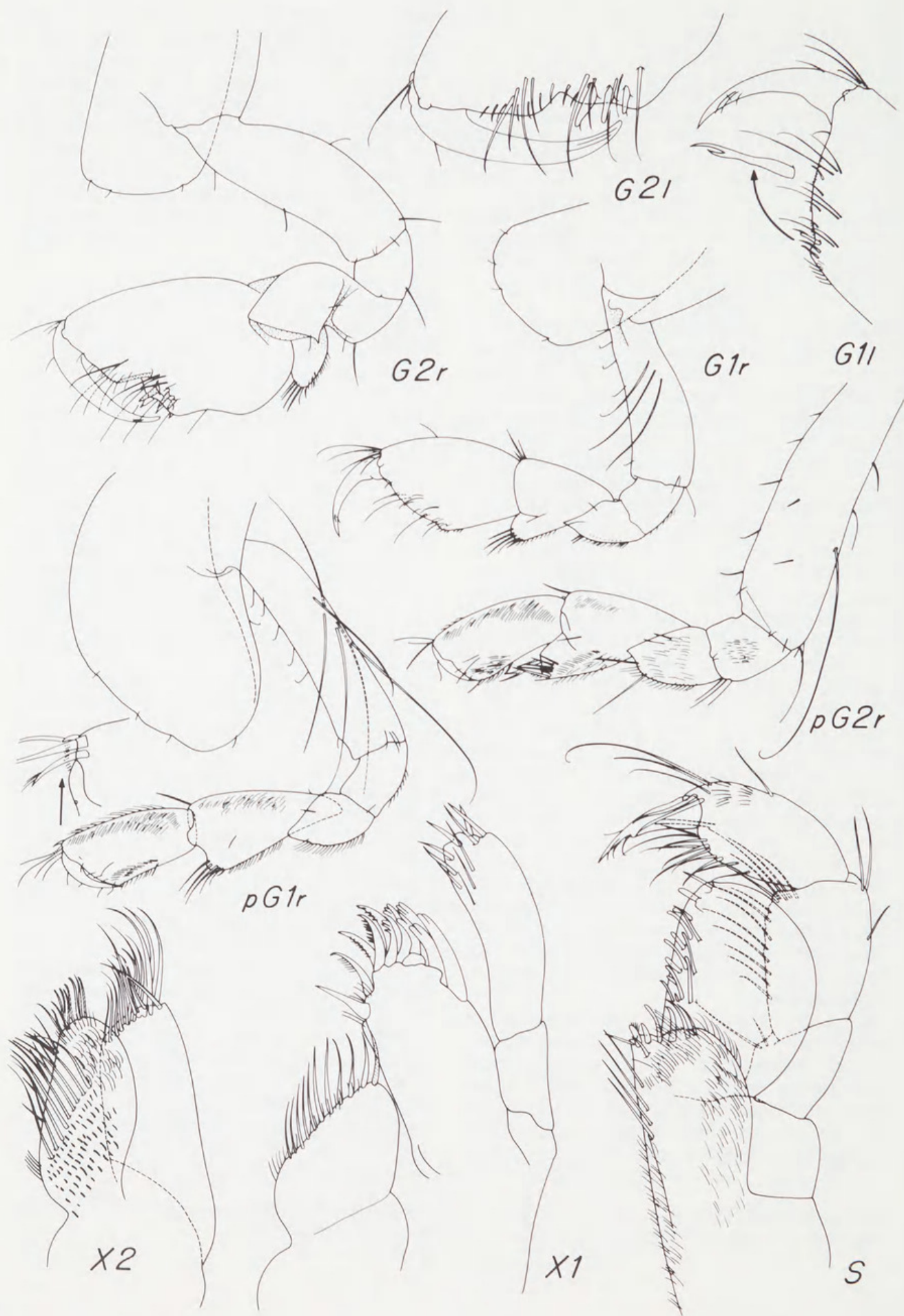
Coxae 1-7 short, almost glabrous, almost of even depth except coxa 7 shortened, coxa 1 scarcely expanded in middle, coxa 4 weakly excavate posteriorly and weakly lobate posteroventrally; coxae 2-6 each with narrow sac-like gill with pediculate base. Medium sized lobe on carpus of gnathopod 1 pointing slightly distad,

propodus ovately expanded, palm about as long as posterior margin of propodus, well defined by change in slope, palm with organized clusters of armaments, dactyl fitting palm, with several subapical setules. Carpus of gnathopod 2 forming complex of 2 basal swellings side by side and thin posterior lobe curving distad, propodus turning inward on death, ovato-rectangular, palm oblique, deeply and raggedly excavate, with 2 lateral and 4 medial facial spines proximal to ragged margin, dactyl slender, fitting palm.

Article 4 of pereopods 3-6 slender, posterior margins of articles 4-6 of pereopods 3-4 with moderately long setae in fascicles, generally fascicle formula number on articles 4-6 = 4-6-5, each fascicle with 1-4 setae (see illustrations). Only one member each of pereopods 3 and 6 with conspicuous slit on dactyls, all with setules. Pereopods 5-6 of ordinary amphipod dimensions, 6 slightly larger than 5, article 2 ovate, poorly produced posteroventrally, almost smooth, each with midfacial ridge, that on pereopod 5 naked, that on pereopod 6 setose. Pereopod 7 enlarged, article 2 broad and subquadrate, weakly and subsharply produced posteroventrally, dactyl over 110% as long as article 6, with about 6 anterior fascicles of setae, numerous single posterior setae in tandem and 10+ apical setae.

Pleopods ordinary, peduncle elongate, rami elongate, subequal and multiarticulate. No pleonal epimeron dominant, each with tiny posteroventral tooth and weakly to strongly convex posterior margin (epimeron 2 weakest), epimeron 1 with 1-2 (L + R) facial spines and 3 anteroventral setae, epimeron 2 with 3-4 (R + L) ventral but submarginal spines in tandem horizontally, epimeron 3 with 1 submarginal spine and 1 setule in tandem horizontally near anteroventral edge. Uropods 1-2 extending subequally, uropod 3 slightly shorter, dorsolateral margin of peduncle on uropod 1 with 7 spines, and discernible apical gap, medial with one apical spine, outer ramus scarcely shorter than inner, outer with 1 dorsal spine, inner with 1. Peduncle of uropod 2 with 2 dorsolateral spines, medial with one apical, outer ramus shorter than inner, outer with 2 dorsal spines, inner with 2. Peduncle of uropod 3 elongate, with 1 dorsomedial spine and basal setule, outer ramus scarcely shorter than inner, as long as ped-

Figure 1. *Paracalliope australis*, unattributed figures = male "m" holotype, 3.64 mm; g = male "g" 3.71 mm; ka = male "ka" 3.23 mm; p = female "p" 3.30 mm; s = female "s" 2.89 mm.



uncle, with 1 dorsal spine, inner with 1 dorsal spine, each ramus with subapical setule. Telson linguiform, entire, with 2 pairs of dorsolateral setules in middle and one apicolateral setule on one side only.

Description of adult male "m". Rostrum small, lateral cephalic lobe adze-shaped, sinus receiving antenna 2 deep, eyes of medium size, widely separate. Antenna 1 scarcely shorter than antenna 2, flagellum with 16 articles, one calceolus each on articles 1, 2, 3, 4, 5, 7; one aesthetasc each on articles 11, 13, 14, 15 and rudimentary on 16. Gland cone of antenna 2 very prominent, almost reaching apex of article 3 (in lateral view), flagellum with 17 articles, one calceolus each on articles 1, 2, 3, 4, 5, 7. Epistome flat anteriorly, upper lip articulate and rounded-truncate below, anterior pubescence poorly developed. Mandibles of basic gammaridean plan, incisors toothed, right and left laciniae mobiles toothed, right and left rakers 3 and 4 respectively, first raker on right bifid (possibly 2 rakers fused?); molar triturative, bearing apical seta; palpar hump small, articles 1–2 naked, article 3 especially pubescent, formula of spines = 4D, 3E, with 2 of E setae simple, others penicillate, basofacial setae absent. Inner lobes of lower lip well developed and fleshy. Inner plate of maxilla 1 almost fully setose medially, outer plate with 11 diverse spines, palp 2-articulate, spinose apically, right and left palps alike. Plates of maxilla 2 subequal in size, inner with facial row of setae. Inner and outer plates of maxilliped weakly spinose, palp short, stout, dactyl unguiform, with about 4 accessory setules.

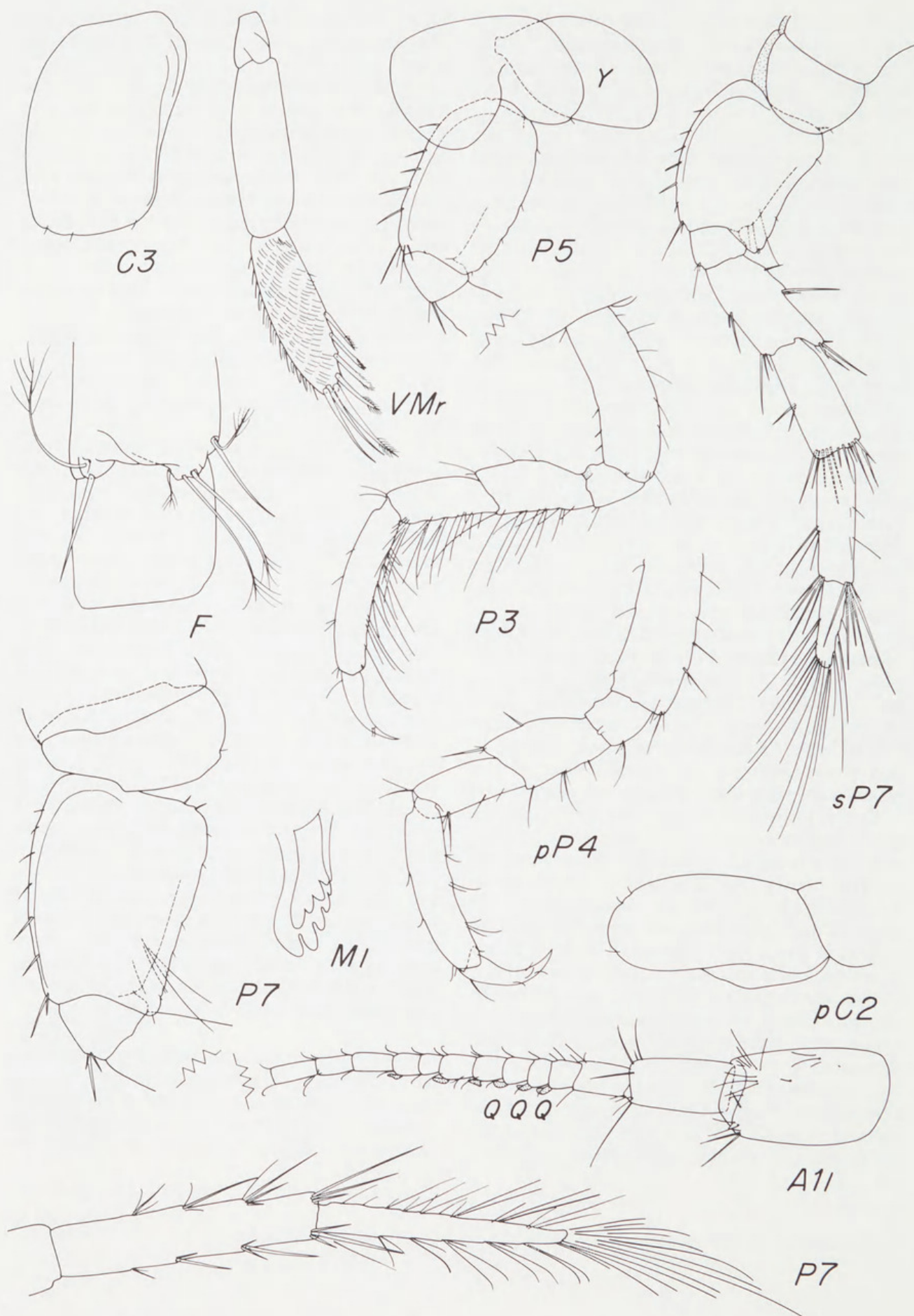
Coxae 1–7 short, almost glabrous, almost of even depth except coxa 7 shortened, coxa 1 scarcely expanded in middle, coxa 4 weakly excavate posteriorly and weakly lobate posteroventrally; coxae 2–6 each with narrow sac-like gill with pediculate base. Medium sized lobe on carpus of gnathopod 1 pointing slightly distad, propodus ovately expanded, palm about as long as posterior margin of propodus, well defined by change in slope, palm with organized clusters of armaments, dactyl fitting palm, with several subapical setules. Carpus of gnathopod 2 forming complex of 2 basal swellings side by side and thin posterior lobe curving distad, propodus turning inward on death, ovatorectangular, palm oblique, deeply and raggedly excavate,

with 3 lateral and 4 medial facial spines proximal to ragged margin, dactyl slender, fitting palm.

Article 4 of pereopods 3–6 slender, posterior margins of articles 4–6 of pereopods 3–4 with long setae in fascicles, generally fascicle formula number on articles 4–6 = 4-5-7, each fascicle with 1–6 setae (see illustrations). Dactyls with conspicuous slit and setules. Pereopods 5–6 of ordinary amphipod dimensions, 6 slightly larger than 5, article 2 ovate, poorly produced posteroventrally, almost smooth, each with midfacial ridge, that on pereopod 5 naked, that on pereopod 6 setose. Pereopod 7 enlarged, article 2 broad and subquadrate, weakly and subsharply produced posteroventrally, dactyl over 90% as long as article 6, with about 5 anterior fascicles of setae, numerous single posterior setae in tandem and 7+ apical setae.

Pleopods ordinary, peduncle elongate, rami elongate, subequal and multiarticulate. No pleonal epimeron dominant, each with tiny posteroventral tooth and weakly to strongly convex posterior margin (epimeron 2 weakest), epimeron 1 with 2 facial spines and 5 anteroventral setae, epimeron 2 with 4 ventral but submarginal spines in tandem horizontally and one strongly facial smaller spines, epimeron 3 with 2 submarginal spines in tandem horizontally near anteroventral edge. Uropods 1–2 extending subequally, uropod 3 slightly failing same extension, dorsolateral margin of peduncle on uropod 1 with 9 spines, medial with one apical spine, outer ramus scarcely shorter than inner, outer with 2 dorsal spines, inner with 3. Peduncle of uropod 2 with 6 dorsolateral spines, medial with one apical, outer ramus shorter than inner, outer with 5 dorsal spines, inner with 3. Peduncle of uropod 3 elongate, with 2 dorsomedial spines and basal setule, outer ramus scarcely shorter than inner, as long as peduncle, with 2 dorsal spines, inner with 2 dorsal spines, each ramus with subapical setule. Telson linguiform, entire, with 2 pairs of dorsolateral setules in middle and one apicolateral setule on each side.

Female paratype "fn" 2.60 mm. Eyes of medium size. Flagellum of antenna 1 with 6 articles, article 5 with one aesthetasc. Flagellum of antenna 2 with 10 articles. Gnathopods, see illustrations. Article 7 of pereopod 7 about 90%



as long as article 6, with 3 anterior setae, 2 pairs of posterior setae and 10 apical setae. Epimeron 1 with 1 facial spine and 2 anteroventral setules; epimeron 2 with 2 facial spines; epimeron 3 lacking spines. Spine formulas on peduncle, outer ramus and inner ramus of uropods: uropod 1 = 1-1-1-1 (slight gap)-1, 1, 1; uropod 2 = 1-1, 2, 2; uropod 3 = 1, 1, 1.

Female "p". Pereopod 7 broken. Like male but antennae lacking calceoli, flagellum of antenna 1 with 11 articles, one aesthetasc each on articles 6, 8, 9, 10, (11 rudimentary); flagellum of antenna 2 with 13 articles. Coxae 1-4 longer than in male, coxa 1 somewhat nasiform and posteroventrally extended, coxae 2-3 narrow, coxa 4 with strongly beveled ventral margin toward posterior side. Oostegites 2-3 broad, 4-5 narrow and setose. Gnathopods feeble, equally slender and almost of same length, carpi as long as propodi, gnathopod 1 much more slender and slightly more elongate than in male, carpus with large lobe pointing distad, propodus subrectangular but weakly expanding apically, palm subtransverse; carpus of gnathopod 2 with weak posterior lobe, palm oblique. Pereopods 3-4 poorly setose compared with male (see illustrations). See female "s" for pereopod 7 distinction below. Differences of epimera probably varietal (see illustration), one spine of epimeron 1 more ventrad, one of epimeron 2 poorly developed, one of epimeron 3 missing and other weak. Some uropods better spined than in male; outer and inner rami respectively with spines as follows: uropod 1 = 3 and 3, uropod 2 = 3 and 3, uropod 3 = 2 and 2.

Female "s". Pereopod 7 showing major female differences from male, pereopod 7 shorter and dactyl much shorter than article 6, anterior and posterior setae fewer but apical setae dense. Flagellum of antenna 1 with 9 articles, one aesthetasc each on articles 6, 7, 8, 9 (rudimentary).

Young male "t". Calceoli absent, flagellum of antenna 1 with 8 articles, one aesthetasc each on articles 5, 6, 7; flagellum of antenna 2 with 7 articles. Epimeron 1 with one facial spine and one anteroventral seta, epimeron 2 with one facial spine, epimeron 3 lacking spines. Spine formula on outer and inner rami of uropod 1 = 0-1, uropod 2 = 1-1, uropod 3 = 1-1, peduncle of

uropod 3 with 3 dorsal spines! (2 medial, 1 lateral).

Juvenile "j". Flagellum of antenna 1 with 6 or 7 articles, aesthetascs present on articles 4-5 or 5-6-7; flagellum of antenna 2 with 7 articles. Slit on dactyls of pereopods 3-6 dim. Epimeron 1 with one facial spine and 2 anteroventral setae, epimeron 2 with 2 facial spines, epimeron 3 without spines. Spine formulas on uropods, peduncle of uropod 1 = 3, both rami = — 0; peduncle of uropod 2 = 1, each ramus with 1; outer ramus of uropod 3 = 0, inner = 1.

Juvenile "ja", smallest available. Flagella of antennae 1-2 with 5 and 6 articles respectively; length ratio of peduncular articles = 5:3:3. Posterior margin of article 6 on pereopods 3-4 with only 1 conjoint pair of setae, slits absent. Epimeron 1 with one tiny facial setae, no other armaments, spine formula of epimeron 2 = 1, of epimeron 3 = 0. Spine formulas of uropod 1 = 3 (gapped)-0-0, of uropod 2 = 1-0-1, of uropod 3 = 0-0-0. Article 2 of pereopod 7 with one posterodistal seta, article 7 of long form, with 3 main apical setae, 2 short posterodistal setae, and 3 other marginal setae.

Variables of males "c, d, e, f, g, h." Sizes between 2.70 and 4.55 mm. Flagellum of antenna 1 with as many as 18 articles, calceoli formulas = 2, 3, 4, 6 or 2, 3, 4, 5, 7 or 2, 3, 4, 5, 6, 7 or 2, 3, 4, 6, 8. Aesthetascs on 10 only on 9-11-13-15-16-17-18, or 10-12-13-14, or 11-13-15-16-17-18. Antenna 2 flagellum with up to 20 articles, calceoli formulae either 1, 2, 3, 4, 5, 6, 8 or 2, 3, 4, 5, 7, 9 or 2, 3, 4, 6, 8 or 3, 4, 6. Eyes enlarged or not. Articles 5 and 6 of pereopods 3-4 with up to 6 or 7 setal fascicles. Epimeron 1 with 1-2 facial spines and 2, 3, 4, 5 or 6 anteroventral setae; epimeron 2 with 3 or 5 or 4 and 1 rudimentary facial spines; epimeron 3 with 1, 2 or 3 facial spines. Teeth of epimera occasionally obsolescent or blunted. Spine formulas on uropods, peduncle of uropod 1 = 5, 6, 9, 10; outer ramus = 1, 2; inner ramus = 2, 3; uropod 2 peduncle = 4, 5, 6; outer ramus = 2, 3, 4, 5; inner ramus = 2, 3, 4; peduncle of uropod 3 = 2, 3; outer ramus = 2, 3; inner ramus = 2, 3.

Variables of females "a, b, k, s, u, w". Sizes between 2.60 and 3.53 mm. Flagellum of antenna 1 with up to 11 articles, of antenna 2 up

to 12 articles; aesthetascs on flagellum of antenna 1 = 6, 7, 8, 9 or 7, 9, 10, 11. Epimeron 1 with 1–2 facial spines and 3, 4, 5, 8 anteroventral setae; epimeron 2 with 2, 3, 5, 6 facial spines; epimeron 3 with 0, 1, 2, 3 facial spines. Spine formulas on uropods, peduncle of uropod 1 = 5, 8, 10, 11; outer ramus = 1, 2; inner ramus = 2, 3; uropod 2 peduncle = 2, 3, 4, 6; outer ramus = 2, 3, 4; inner ramus = 2, 3, 4; peduncle of uropod 3 = 2, 3; outer ramus = 1, 2; inner ramus = 1, 2, 3. Article 7 of pereopod 7 aberrant in female “a” (with 8 eggs), as long as in male.

Aberrant male “ha”, 3.22 mm. Aberrant because of absence of spine on outer ramus of uropod 1 and slight gap present between ultimate and penultimate spines on peduncle of uropod 1, otherwise *P. australis* characters typical: epimera, pereopods 3–4, dactylar slits, head shape, mandibular palp article 3 and eyes.

Aberrant male “ka” and female “kb.” Eyes enlarged (illustrated), ommatidia slightly dispersed, pigment weak; thus intermediate in eye size between ordinary specimens of *P. australis* and specimens of *P. lowryi*; specimens otherwise with scarcely any excessive gap in spines on uropod 1, setae of epimeron 1 weak.

Male of NMV J13088. Identification doubtful because mandibular palps and pereopods 3–4 missing, third uropods aberrant; provisionally identified as *P. australis* because of small teeth of epimera but gnathopod 1 scarcely enlarged (thus like *P. lowryi*); well developed spination of uropods like *P. lowryi*; but epimeron 1 with anteroventral setules unlike *P. lowryi*.

General variables. Specimens of this species often preserve poorly; various appendages fall off or are broken apically, especially pereopod 7 and uropod 3. The internal contents of the head often preserve poorly so that the tissue shrinks and the eyes fall ventrally and occasionally break up. This unfortunately happens also in the companion species *P. lowryi* so that the excellent distinction in eye size between the two species is often obscured by observational anomalies.

The usefulness of analyzing dactylar slits on pereopods 3–6 is very low because so many specimens of *P. australis* that should have the slits well apparent seem to be either poorly preserved or so near their moment of ecdysis that

the slits are so dim as to be useless for identification.

There is considerable variation in the size of posterodorsal setules-spines on article 2 of pereopod 7.

The excessive gap between ultimate and penultimate spines on the peduncle of uropod 1 is about 95% accurate in separating *P. lowryi* from *P. australis* but a few specimens of *P. australis* have a slightly increased gap so that the character is not wholly reliable. In the material at hand, one can state for certainty that lack of the excessive gap is wholly characteristic of *P. australis*.

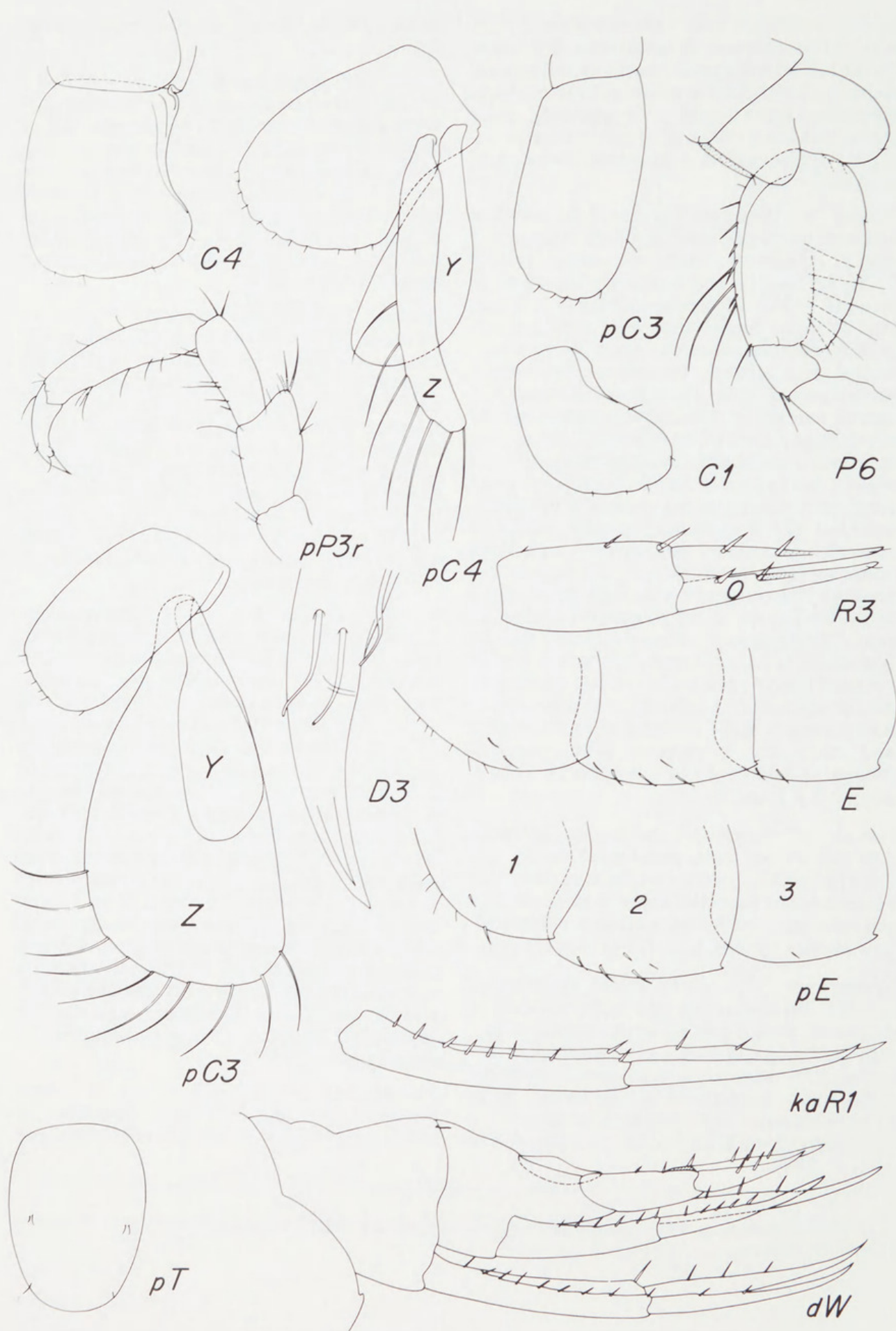
Relationship. This species is very close to the three known species of *Paracalliope* from New Zealand (J.L. Barnard, 1972) but differs from *P. fluviatilis*, *P. karitane* and *P. novizealandiae* in the presence of long setae on articles 5–6 of male pereopods 3–4. Most specimens of *Paracalliope australis* also differ from *P. fluviatilis* and *P. novizealandiae* in the presence of the conspicuous slit in the dactyls of pereopods 3–6, but this slit is occasionally absent in *P. australis*. The Australian species is therefore very similar to *P. karitane* but differs from that species in the lack of basolateral setae on article 3 of the mandibular palp. It also differs from *P. karitane* in the less tumid propodi on male and female gnathopods, smaller teeth on epimera 2–3, and the small carpal lobes of female gnathopod 1.

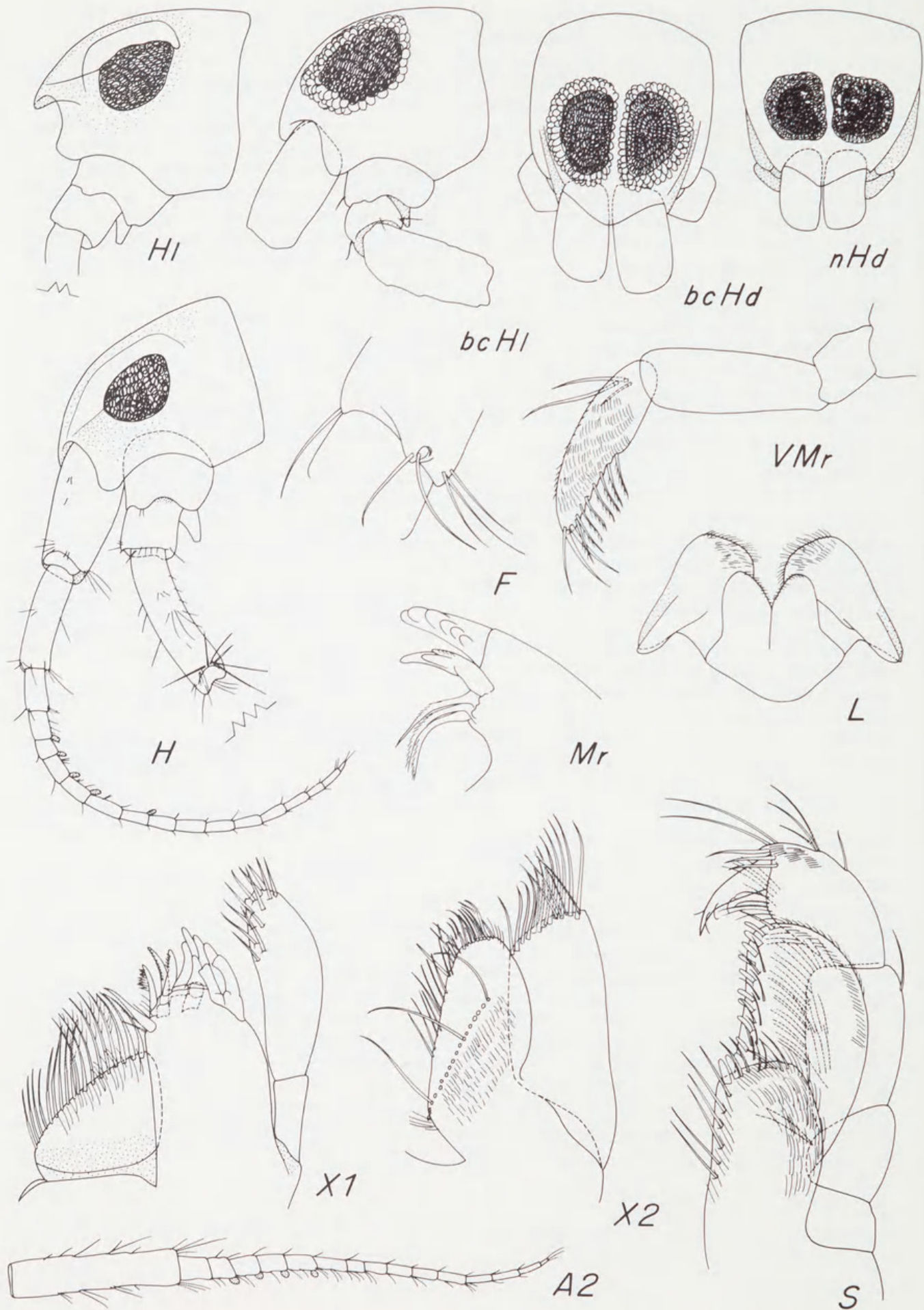
Paracalliope australis differs further from *P. novizealandiae* in the lack of AB setae on the mandibular palp, the presence of more spines on the rami of uropods 1–3, the larger carpal lobe of female gnathopod 2, the smaller carpal lobe of female gnathopod 1, the presence of more spines on epimera 1–2 and the less tumid propodi of male gnathopods 1–2.

Paracalliope australis further differs from *P. fluviatilis* in the smaller carpal lobe of female gnathopod 1, the more slender female gnathopod 1, the more beveled female coxa 1, and the shorter palm on male gnathopod 1.

Although size of eyes, shape of teeth on epimera, and usual lack of excessive gap between spines on uropod 1 are all characteristics of 95% of the specimens of *P. australis* the best characters distinguishing this species from *P. lowryi* is the presence of setules, setae or weak spines on the anteroventral margin (not face) of epimeron 1 and the small teeth of epimera 2–3. This situ-

Figure 4. *Paracalliope australis*, unattributed figures = male “m” holotype, 3.64 mm; d = male “d” 3.48 mm; ka = male “ka” 3.23 mm; p = female “p” 3.30 mm.





ation makes identification rather tedious as these plates are difficult to see in undissected individuals.

Distribution. New South Wales, Victoria, and Tasmania, shoreline tidepools of open sea, 0–18 m, inlets, estuaries and Gippsland Lakes.

***Paracalliope lowryi* sp. nov.**

Figures 5–8

Material. Holotype. Victoria. Gellibrand River mouth (38°35'S, 143°20'E), hand, J.D. Kudenov, 1976, NMV J6916 (male "x", 5.07 mm, illustrated).

Other material. New South Wales. Merimbula, near entrance to inlet (36°54'S, 149°53'E), sand, M.M. Drummond, 10 Feb 1972, NMV J6927 (female voucher "cd", 2.49 mm, illustrated), NMV J6928 (male voucher "bc", 3.00 mm, illustrated). Merimbula, J.H. Day, *et al.*, 9 May 1975, NMV J6929 (aberrant male voucher "mb", 3.49 mm, illustrated), NMV J6930 (female, voucher "ma", 2.46 mm). Bells Point (34°18'S, 150°56'E), sand, D. Dexter, 16 Feb 1981, NMV J6922 (male voucher "aa", 2.26 mm), NMV J6921 (aberrant male voucher "ab", 2.03 mm illustrated), NMV J6921 (12). Black Dolphin Beach, Merimbula, M.M. Drummond, 1 Dec 1978, NMV J6985 (1). Merimbula, weed on sand in channel, M.M. Drummond, 6 Feb 1972, NMV J6991 (2). Narageen Lagoon, D.M. Dexter, 24 Sep 1980, NMV J6983 (4), NMV J6926 (female voucher "z", 2.24 mm), NMV J6924 (female voucher "v", 2.10 mm), NMV J6925 (female, voucher "l", 2.18 mm), NMV J6923 (male voucher "y", 2.55 mm). Dee Why Lagoon (31°31'S, 149°54'E), 0.75 m, 29 Nov 1988, 0.75 m, A. Murray and A.R. Jones, muddy sand and algae, AM P39144.

Tasmania. Kelleve, under main bridge (42°47'S, 147°49'E), B. Knott, 26 Sep 1972, NMV J6961 (many). Derwent River Estuary, A. Schaap, AM P665 (male 665).

Victoria. Gellibrand River mouth (38°35'S, 143°20'E), hand, J. Kudenov, 1976, NMV J6917 (male voucher "o", 3.83 mm, illustrated), NMV J6919 (female voucher "n", 3.48 mm, illustrated), NMV J6918 (male voucher "q", 3.72 mm), NMV J6920 (female, voucher "p", 3.26 mm). Gippsland Lakes, Reeve Channel (38°14.0'S, 147°32.7'E), 5 m, sand, Smith-McIntyre grab, G.C.B. Poore (Marine Studies Group), stn GRES 3060, NMV J6992 (2), NMV J6995 (1). Bancroft Bay (38°11.7'S, 147°33.1'E), 6 m, mud, stn GRES 3059, NMV J6993 (1). Lake Victoria, near Loch Sport (38°03'S, 147°35.5'E), stn G609-8, NMV J13075 (1). Lake Victoria, N of Red Bluff (38°02.5'S, 147°31'E), stn G609-7, NMV J7000 (2). off Pt Turner, Lake Victoria (38°02.0'S, 147°37.0'E), 8 m, mud, stn

GRES 3057, NMV J6994 (1). Lake King, S of Paynesville (37°57'S, 147°45'E), stn G609-31, NMV J13076 (1); stn G609-30, NMV J6999 (1). Lake King, near Point Jones (37°55'S, 147°45'E), stn G609-28, NMV J6986 (1). Lake King, East of Point Scott, Raymond Island (37°54'S, 147°49'E), stn G609-25, NMV J13074 (6). Gippsland Lakes, J.D. Kudenov, 1975, NMV J6990 (1). Gippsland Lakes, J.D. Kudenov, 7 Aug 1975, NMV J6987 (2). Glenelg River, J.D. Kudenov, NMV J13089 (4), NMV J6988 (1).

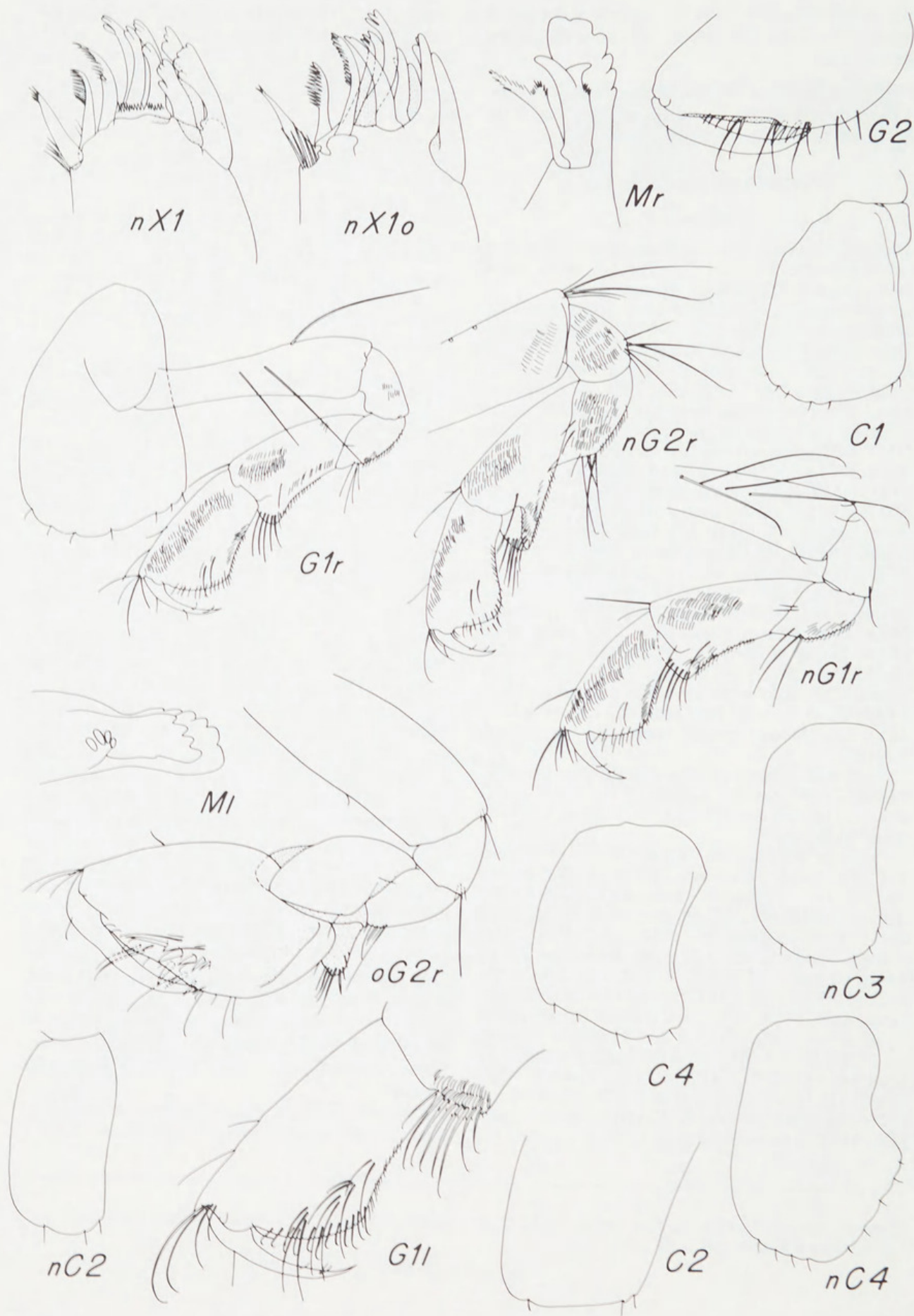
Queensland. Mouth of Jacksons Creek, left bank, site J2/L, sample 287, 19 Jul 1973, T.S. Campbell, QM W4498 (specimen "jd"); midstream, QM W4504 (male "jc" like aberrant male "ab"). Serpentine Branch, left bank, 2.1 km from mouth, site 2B/L, sample 26, 27 Jul 1972, T.S. Campbell, (QM W4078 (specimen "sb")).

Description. *Holotype male "x"*. Rostrum small, lateral cephalic lobe mammilliform, sinus receiving antenna 2 deep, eyes huge, almost touching medially. Antenna 1 scarcely shorter than antenna 2, flagellum with 15 articles, one calceolus each on articles 1, 2, 3, 4, 6; one aesthetasc each on articles 5, 7, 9, 11, 13, 14 and rudimentary on 15. Gland cone of antenna 2 moderately prominent, flagellum with 15 articles, one calceolus each on articles 2, 3, 4, 5. Calceoli like *P. australis* but distal element more rounded and less attenuate apically.

Epistome flat anteriorly, upper lip articulate and rounded-truncate below, with long stiff anterior pubescence. Mandibles of basic gammaridean plan, incisors toothed, right and left laciniae mobiles toothed, right and left rakers 3 and 4 respectively, first raker on right weakly bifid and more strongly feathered than in *P. australis*; molar triturative, bearing apical seta; palpar hump small, articles 1–2 naked, article 3 especially pubescent, formula of spines = 8D, 3E, E setae simple, others serrate or pinnate or penicillate, basofacial setae 1–2. Inner lobes of lower lip well developed, slightly fleshy. Inner plate of maxilla 1 almost fully setose medially, outer plate with 11 diverse spines, palp 2-articulate, spinose apically, right and left palps alike. Plates of maxilla 2 subequal in size, inner with facial row of setae. Inner and outer plates of maxilliped weakly spinose, palp short, stout, dactyl unguiform, with about 4 accessory setules.

Coxae 1–7 short, almost glabrous, almost of even depth except coxa 7 shortened, coxa 1

Figure 5. *Paracalliope lowryi*, new species, unattributed figures = male "x", holotype, 5.07 mm; bc = male "bc" 3.00 mm; n = female "n" 3.48 mm.



scarcely expanded in middle, coxa 4 weakly excavate posteriorly and weakly lobate posteroventrally; coxae 2-6 each with narrow sac-like gill with pediculate base. Gnathopod 1 of small size as in female, medium sized lobe on carpus apically situated and pointing slightly distad, propodus expanding apicad, palm shorter than posterior margin of propodus, well defined by change in slope, palm with organized clusters of armaments, dactyl fitting palm, with several subapical setules. Gnathopod 2 enlarged, carpus forming complex of 2 basal swellings side by side and thin posterior lobe curving distad, propodus turning inward on death, ovatorectangular, palm oblique, poorly excavate, with 3 lateral and 5 medial facial spines, dactyl slender, fitting palm.

Article 4 of pereopods 3-6 slender, posterior margins of articles 4-6 of pereopods 3-4 poorly armed, setae short, sparse, in about 3 groups. Dactyls lacking slit, with conspicuous setules. Pereopods 5-6 of ordinary amphipod dimensions, 6 slightly larger than 5, article 2 ovate, poorly produced posteroventrally, with many posterior setules, each with weakly setose mid-facial ridge. Pereopod 7 enlarged, article 2 broad and subquadrate, weakly and subsharply produced posteroventrally, dactyl [in males unknown, broken on all specimens].

Pleopods ordinary, peduncle elongate, rami elongate, subequal and multiarticulate. No pleonal epimeron dominant, first with obsolescent, second and third each with sharp or subsharp medium tooth, posterior margins strongly convex, epimeron 1 with 3 facial spines and no anteroventral setae, epimeron 2 with 5 ventral but submarginal spines, epimeron 3 with 3 ventrofacial spines, all epimeral spines horizontal and in tandem. Uropods 1-2 extending equally, uropod 3 slightly failing same extension, dorsolateral margin of peduncle on uropod 1 with 6 spines, long gap between ultimate and penultimate, medial with one apical spine, outer ramus scarcely shorter than inner, outer with no dorsal spine, inner with 4. Peduncle of uropod 2 with 4 dorsolateral spines, medial with one apical, outer ramus shorter than inner, outer with 4 dorsal spines, inner with 4. Peduncle of uropod 3 elongate, with 3 dorsomedial spines, outer ramus scarcely shorter than inner, as long as peduncle, with 5 dorsal spines, inner with 3 dorsal

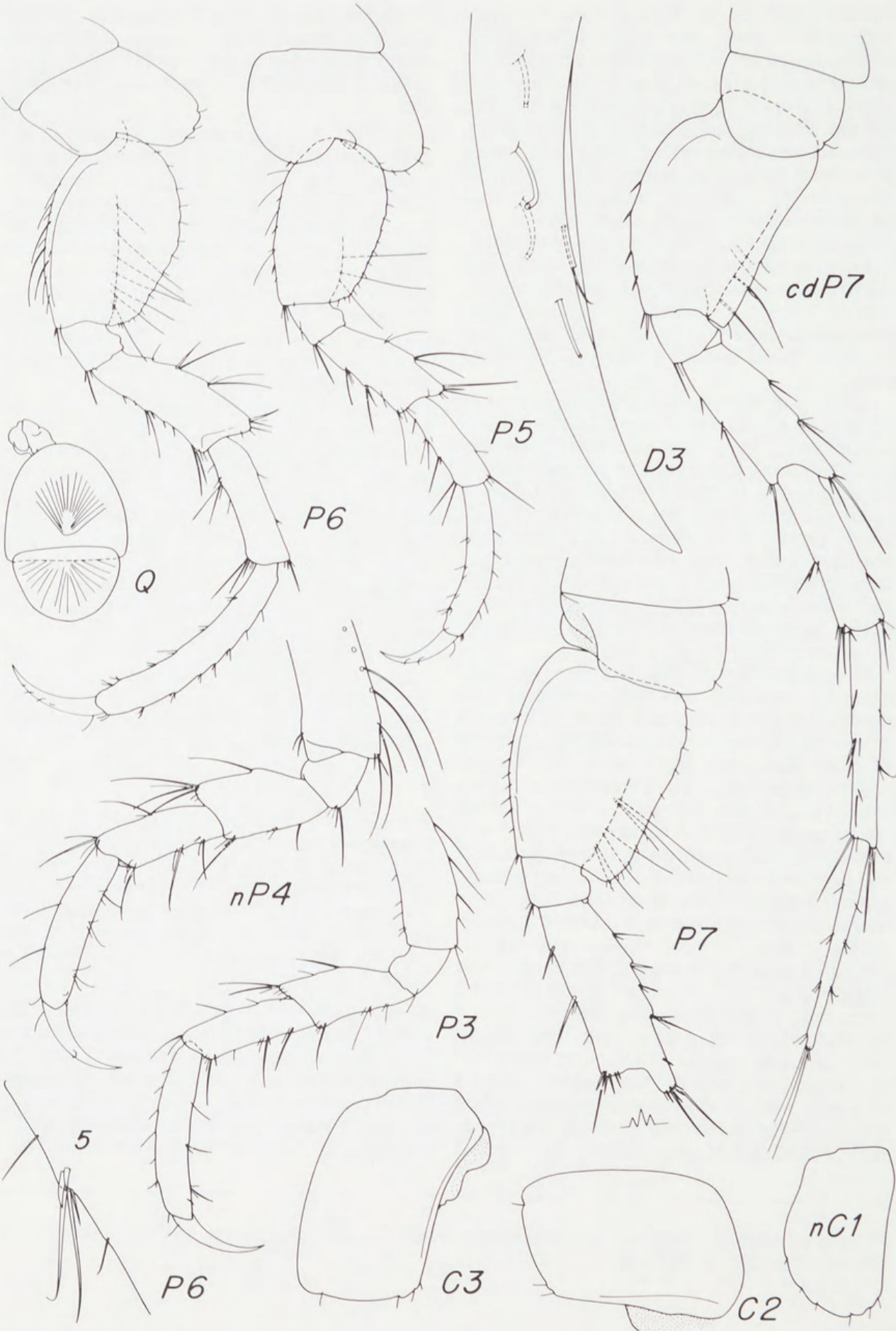
spines, each ramus with subapical setule. Telson linguiform, entire, with 2 pairs of dorsolateral setules in middle and one apicolateral setule on each side and one basolateral setule on each side.

Female "n". Like male but antennae lacking calceoli, eyes smaller than male but much larger than male of *P. australis*, flagellum of antenna 1 with 10 articles, one aesthetasc each on articles 4, 6, 8, 9, rudimentary on 10; flagellum of antenna 2 [broken but presumed to lack calceoli also]. Coxae 1-4 longer than in male, coxa 1 somewhat nasiform and tapering distally, coxae 2-3 narrow, coxa 4 with better defined and quadrate posteroventral lobe. Oostegites 2-3 broad, 4-5 narrow and setose. Gnathopods feeble, equally slender and almost of same length, carpi as long (or longer) than propodi, gnathopod 1 much more slender and slightly more elongate than in male, carpi with weak apical lobe pointing weakly distad, propodus expanding apicad, palm slightly oblique; carpus of gnathopod 2 with strong posterior lobe situated distally and pointing distad, palm less oblique than on gnathopod 1. Pereopods 3-4 like male but article 4 broader. Pereopod 7 [on female "cd" with elongate dactyl bearing 3 long and several short apical setae, anterior and posterior margins each with 4 and 3 sets of short pairs of setae]. Spination on epimera and uropods varietal (probably not sexual), spines on epimera 1, 2, 3 = 2, 4, and 3. Lateral or dorsal spine formulas of peduncles on uropods 1, 2, 3 = 6, 4, 2; outer rami = 1, 4, 2; inner rami = 3, 4, 3.

Female "cd". Pereopod 7 drawn in entirety (most specimens of both sexes losing this appendage on death). Flagellum of antenna 1 with 7 articles, of antenna 2 with 8. Epimera 1-3 spine formula = 1-2-1. Uropodal spine formulas (peduncle, outer and inner rami respectively), uropod 1 = 5-0-1, uropod 2 = 3-2-3, uropod 3 = 2-1-1.

Young male "bc". Top and side of head illustrated because major adults with eyes shrunken after death. Flagellum of antenna 1 with 11 articles, one calceolus only on article 3, one aesthetasc each on articles 5, 7, 9, 10. Flagellum of antenna 2 with 12 articles, one calceolus each on articles 1, 2, 3. Spines on epimera 1-3 = 2-3-1.

Figure 6. *Paracalliope lowryi*, new species, unattributed figures = male "x", holotype, 5.07 mm; n = female "n" 3.48 mm; o = male "o" 3.83 mm.



Uropodal spine formulas (as above), uropod 1 = 7-0-1, uropod 2 = 3-3-3, uropod 3 = 3-1-2.

Aberrant male "ab". Tooth on epimera 2-3 small (illustrated) but epimeron 1 lacking anteroventral setae; spine count on epimera 1-3 = 1-2-0; spine counts on uropods (as above), uropod 1 = 5-0-1, uropod 2 = 2-2-2, uropod 3 = 1-0-1; each main flagellum of antennae 1-2 with 9 articles.

Aberrant male "mb". Tooth on epimera 2-3 especially large and notch above tooth stronger (illustrated); spine count on epimera 1-3 = 2-5-0, no anteroventral setae on epimeron 1; spine count on uropod 1 = 6-0-2, uropod 2 = 3-4-3, uropod 3 = missing; gnathopod 2 of *P. lowryi* form; mandibular palp article 3 normal, thus with 2 basofacial setae.

Aberrant male 665. Epimera 1-3 spine counts = 2-1-2, uropod 1 spine counts, uropod 1 = 7(gap normal)-2-3, uropod outer ramus = 4, inner = 3; uropod 3 outer ramus = 3, inner = 3.

Male "o". Gnathopod 2 illustrated (shrunk on holotype). Pereopod 7 broken. One calceolus each on articles 2, 3, 5 of antenna 1 flagellum. Spines of epimera 1-3 = 2-4-1. Spine formulas of uropods (as above), uropod 1 = 5-0-3, uropod 2 = 3-3-3, uropod 3 = 2-1-2.

Male "q". Pereopod 7 and uropod 3 broken. One calceolus each on articles 1, 3, 4, 5 of antenna 1 flagellum. Spines of epimera 1-3 = 1-3-1. Spine formulas of uropods (as above), uropod 1 = 6-0-3, uropod 2 = 3-4-4.

Female "p". Uropod 3 missing. Flagellum of antenna 1 with 7 articles. Spines of epimera 1-3 = 1-3-1. Spine formulas of uropods (as above), uropod 1 = 5-0-3, uropod 2 = 3-3-3.

Males "cd" and "cc" from P664, Cape Banks and male "jc" from P666, Jacksons Creek, Qld. Characterized by absence of spines on epimeron 3, male "jc" with no spines on outer ramus of uropod 1 and the others with one spine on that ramus. Male "jc" also lacks spines on the inner ramus of uropod 1. Males "cb" and "cc" have one spine on the inner ramus. Male "cc" has only 2 basofacial setae on article 3 of the mandibular palp and female "cf" has none (like *P. larai*). Female "cf" does have one spine on epimeron 3.

Six specimens from P665. Epimeron 3 with 2 spines.

Variations. There is considerable variation in several attributes of *P. lowryi* but we cannot link it to speciation. We are beset with the common dilemma of having material from widely separated localities that shows considerable variation but no morphological basis to divide the material into infraspecies. Much of the variation is expressed in counts of spines and setae which vary with the sizes of the demic members from various localities and with growth stages of both sexes. The samples appear to express a mixture of breeding seasons because fully terminal adults are often lacking.

For example, early in our studies we were able to separate adults of the freshwater *P. larai* from the brackish-marine *P. lowryi* by the presence of 0-1 spine on the outer ramus of *P. lowryi* (versus 2 spines in *P. larai*) but we finally found a specimen of *P. lowryi* from the type locality with the requisite 2 spines. Knott (1975) showed in his table 2 the wide variation in spines even in the limited material he had of a single species from one locality (20 observations). Juveniles and males generally have fewer spines on all 9 positions (counting peduncle and 2 rami for each of 3 uropods) of uropods than do females. We find this generally true of *P. lowryi* and can include similar results on epimera 1-3 but with some demes of *P. lowryi* entirely lacking spines on epimeron 3. Fortunately, all of our reported samples have both males and females; *P. lowryi* is therefore identifiable from the small male gnathopod 1.

Notes on material and illustrations. The material is difficult to analyse because of mostly broken pereopod 7 and antenna 2, often missing uropod 3 and usually shrunk eyes owing to collapse of cephalic tissues; from dorsal view, however, adult eyes are always seen as clearly larger than in *P. australis*. The head of the holotype is shown with collapsed eyes but male "bc" is illustrated with normal eyes. The molar is like that shown for *P. australis*. Spines on outer plate of maxilla 1 are often worn as shown in the holotype, but have normal extension as on female "n". Gills and female oostegites are similar to those shown for *P. australis*.

Etymology. Named for Dr James K. Lowry,

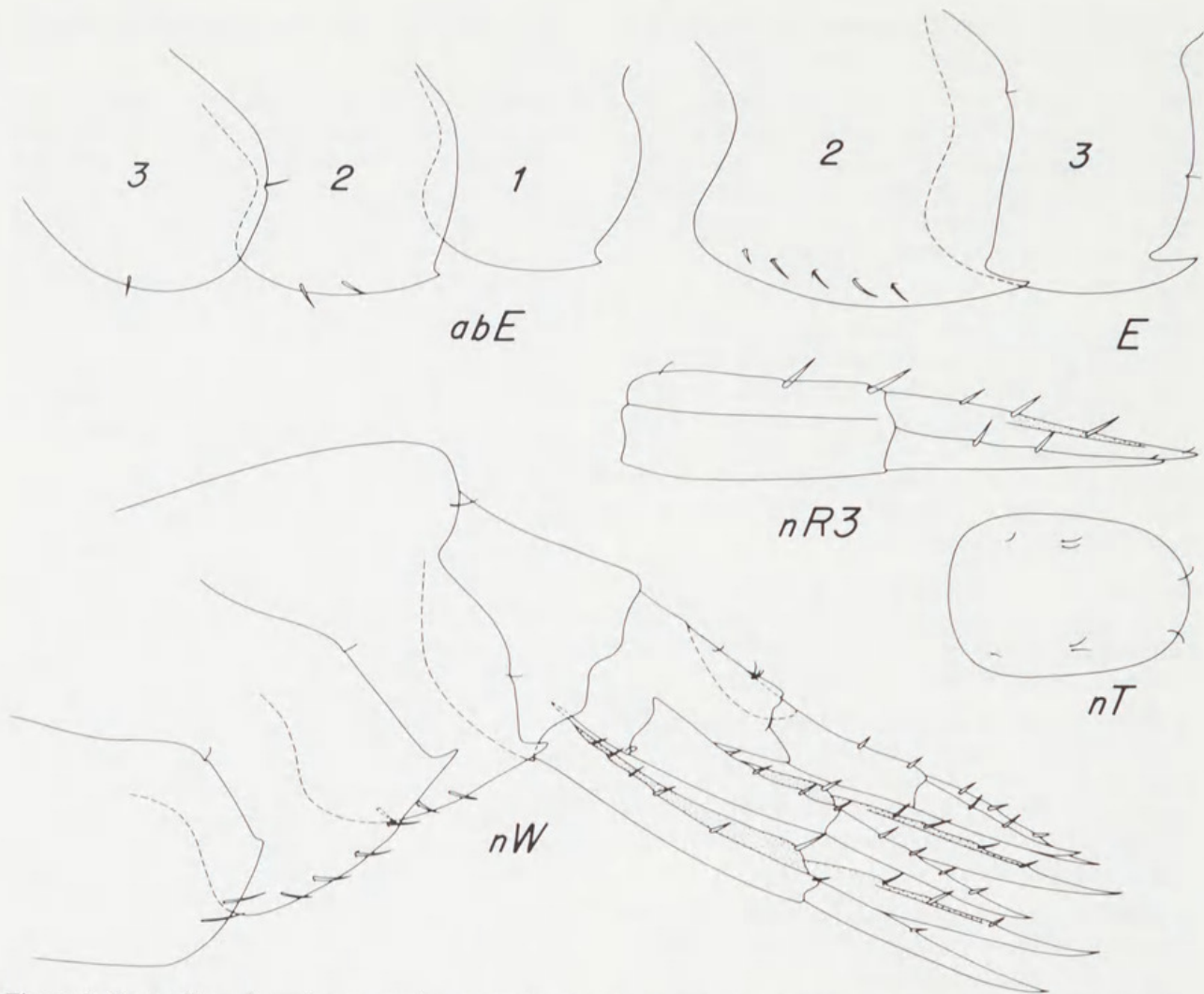


Figure 8. *Paracalliope lowryi*, new species, unattributed figures = male "x", holotype, 5.07 mm; ab = male "ab" 2.03 mm; n = female "n" 3.48 mm.

Curator of Crustacea, The Australian Museum, Sydney.

Relationship. This species is unique in *Paracalliope* for the small male gnathopod 1 which is like female gnathopod 1 in size and shape. This species differs from *P. australis* in: (1) the much larger eyes in both sexes; (2) the slightly different shape of head; (3) the weak setation of pereopods 3–4 in the male; (4) the lack of a slit in the dactyls of pereopods 3–6 (which is a very unreliable character in some of the *P. australis* material); (5) the larger teeth of epimera 2–3; (6) the absence of anteroventral setae on epimeron 1; (7) the long gap between ultimate and penultimate spines on the dorsolateral margin of the peduncle on uropod 1; (8) the reduction of spines on the outer ramus of uropod 1 to the formula 0-1; and (9) the presence of a pair of basofacial setae or a single spine-seta on article 3 of

the mandibular palp. Minor differences found in *P. lowryi* include the stronger pubescence of the upper lip, the weakness of the bifid condition on the first right raker spine on the mandible; the slightly wider male coxa 1 relative to coxa 2; the less comma-shaped female coxa 1; broader female coxa 2; more strongly defined lobe of coxa 4; different shape of lobe on carpus of gnathopod 1; thinner and smaller male gnathopod 1; shorter article 6 relative to articles 4–5 on pereopods 3–4; longer spines on epimeron 1; and the presence of more (3) spines on the inner ramus of uropod 3 in the largest adults.

See *P. larai* and *P. vicinus* for distinctions from this species.

Distribution. Victoria, Tasmania and New South Wales, in estuaries and inlets, Gippsland lakes, intertidal.

***Paracalliope vicinus* sp. nov.**

Figures 9–10

Material. Holotype. Tasmania. Big Waterhouse Lagoon, eastern shore, weeds, A.M.M. Richardson and J. King, 17 Jul 1973, NMV J22300 (male "wg", 5.33 mm).

Other material. Tasmania. Resolution Creek, Adventure Bay (43°21'S, 147°17'E), R. Mewbey, and B. Knott, 30 Sep 1972, NMV J6964 (5). Roger River tributary (41°04'S, 145°03'E), 25 Jan 1974, NMV J6971 (4). Shepherds Bay, in rock pool at N end of bay fed by freshwater draining from sand dunes (40°28'S, 144°47'E), brackish rock pool, 21 May 1974, NMV J6965 (many). Coal River, D. Coleman, 29 Nov 1974, NMV J6958 (mating pairs). Small tributary of Scamander River, T.M. Walker and P. Suter, 6 May 1975, NMV J6978 (6). Moth Creek, Maleleuca, Port Davey, 1 m, mud, plant debris, J.M. Fenton, 12 Apr 1974, NMV J6979 (6). Randys Creek, NMV J6950 (many). Apsley River, at Tasman Highway crossing past Bicheno, T. Walker, 17 Aug 1972, NMV J6975 (2). Camp Creek, Currie, King Island, B. Knott, 31 Jul 1971, NMV J6962 (5). N shore of Narrows, entrance to Bathurst Harbour, under rock, brackish water, J.M. King, 16 Aug 1973, NMV J6966 (7). Jordan River at Apsley, D. Coleman, 6 Jun 1974, NMV J6968 (many). Ettrick River, ti tree clump just above road, saline, B. Knott, 31 Jul 1971, NMV J6972 (21). Big Waterhouse Lagoon, eastern shore, weeds, A.M.M. Richardson and J. King, 17 Jul 1973, NMV J6974 (many). Melton Mowbray, Jordan River, B. Knott, 13 Apr 1972, NMV J6949 (12). Catamaran, creeks draining across sand, P.S. Lake et al., 25 Jun 1972, NMV J6959 (many). Browns River, P.S. Lake, 1 Apr 1978, NMV J6973 (many). Randys Creek, D. Coleman, 4 Dec 1974, NMV J6960 (many). Coal River, near Richmond, V. Thorpe, NMV J6957 (many). Tributary of Drew River, Hamilton – Hollow Tree Road, B. Knott, 10 Oct 1972, NMV J6955 (1). Flowerdale River at Flowerdale, Mewbey et al., 9 Feb 1973, NMV J6963 (2). Creek draining inland through cow paddocks, along road to Temma, just before drop into Arthur River, Mewbey et al., 8 Feb 1973, NMV J6969 (many). Duck River, Smithton, Mewbey et al., 7 Feb 1973, NMV J6970 (many). Moth Creek, Maleleuca, Port Davey, 1 m, mud, plant debris, G.M. Fenton, 12 Apr 1974, NMV J22294 (female voucher "q", 3.22 mm illustrated). Big Waterhouse Lagoon, eastern shore, weeds, A.M.M. Richardson J. King, 17 Jul 1973, NMV J22299 (female voucher "wj", 3.00 mm), NMV J22298 (female voucher "wi", 3.56 mm), NMV J22295 (male voucher "d", 3.81 mm), NMV J22297 (male voucher "wh", 4.90 mm). Camp Creek, Currie, King Island, B. Knott, 31 Jul 1971, NMV J22296 (male voucher "cz", 4.86 mm).

Victoria. Hopkins River, G. Newton, 13 Dec 1985, NMV J6996 (1).

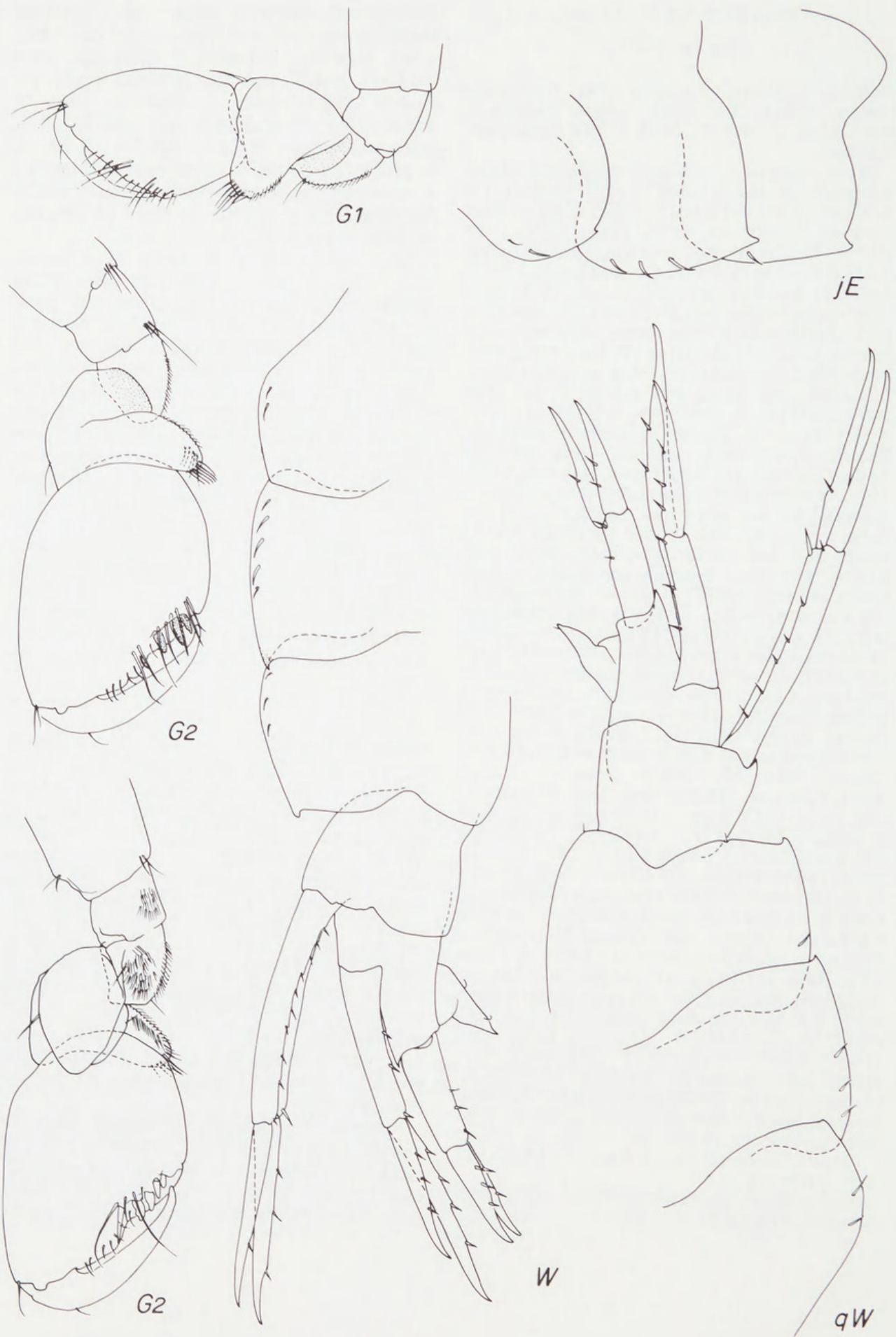
State unknown. Lambert Park Creek, 30 Jun 1972, NMV J6956 (many).

Description. Holotype, male "wg". Rostrum small, lateral cephalic lobe bluntly coniform, sinus receiving antenna 2 moderate, eyes medium, widely separate. Antenna 1 scarcely shorter than antenna 2, flagellum with 14 articles, one calceolus each on articles 2, 3, 4, 5, 7; one aesthetasc each on articles 6, 8, 10, 12, 13, and rudimentary on 14. Gland cone of antenna 2 very prominent, almost reaching apex of article 3 (in lateral view), flagellum with 14 articles, one calceolus each on articles 2, 4, 6, 8.

Epistome flat anteriorly, upper lip articulate and rounded-truncate below, anterior pubescence poorly developed. Mandibles of basic gammaridean plan, incisors toothed, right and left laciniae mobiles toothed, right and left rakers 3 and 4 respectively; molar triturative, bearing apical seta; palpar hump small, articles 1–2 naked, article 3 especially pubescent, formula of spines = 3A, 10D, 4E, with all of E setae simple, others penicillate, basofacial setae present. Inner lobes of lower lip well developed and fleshy. Inner plate of maxilla 1 almost fully setose medially (but left side aberrant, only setose halfway), outer plate with 11 diverse spines, palp 2-articulate, spinose apically, right and left palps alike. Plates of maxilla 2 subequal in size, inner with facial row of setae. Inner and outer plates of maxilliped weakly spinose, palp short, stout, dactyl unguiform, with 5 accessory setules.

Coxae 1–7 short, almost glabrous, almost of even depth except coxa 7 shortened, coxa 1 scarcely expanded in middle, coxa 4 weakly excavate posteriorly and weakly lobate posteroventrally; coxae 2–6 each with narrow sac-like gill with pediculate base. Large lobe on carpus of gnathopod 1 pointing slightly distad, propodus ovately expanded, palm about as long as posterior margin of propodus, well defined by change in slope, palm with organized clusters of armaments, dactyl fitting palm, with several subapical setules. Carpus of gnathopod 2 forming complex of 2 basal swellings side by side and thin posterior lobe curving distad, propodus turning inward on death, ovato-rectangular, palm oblique, moderately and raggedly excavate, with 4 lateral and 4 medial facial spines proximal to ragged margin, dactyl slender, fitting palm.

Article 4 of pereopods 3–6 slender, posterior margins of articles 4–6 of pereopods 3–4 with moderately long setae in fascicles, generally fascicle formula number on articles 4–6 = 3-4-6, each fascicle with 1–4 setae (see illustration).



Each of pereopods 3–6 with conspicuous slit on dactyls, all with setules. Pereopods 5–6 of ordinary amphipod dimensions, 6 slightly larger than 5, article 2 ovate, poorly produced posteroventrally, almost smooth, each with midfacial ridge, that on pereopod 5 naked, that on pereopod 6 setose. Pereopod 7 enlarged, article 2 broad and subquadrate, weakly and subsharply produced posteroventrally, dactyl 95% as long as article 6, with 4 anterior fascicles of setae, numerous single posterior setae in tandem and 8 apical setae.

Pleopods ordinary, peduncle elongate, rami elongate, subequal and multiarticulate. No pleonal epimeron dominant, epimeron 1 with tiny posteroventral tooth, epimera 2–3 each with medium tooth, each with strongly convex posterior margin, epimeron 1 with 2 facial spines and no anteroventral setae, epimeron 2 with 5 ventral but submarginal spines in tandem horizontally, epimeron 3 with 3 submarginal spines in tandem horizontally. Uropods 1–2 extending subequally, uropod 3 slightly failing same extension, dorsolateral margin of peduncle on uropod 1 with 10 spines, no discernible apical gap, medial with one apical spine, outer ramus scarcely shorter than inner, outer with 1 dorsal spine, inner with 3. Peduncle of uropod 2 with 3 dorsolateral spines, medial with one apical, outer ramus shorter than inner, with 3 dorsal spines, inner with 4. Peduncle of uropod 3 elongate, with 2 dorsomedial spines and basal setule, outer ramus as long as inner, slightly shorter than peduncle, with 3 dorsal spines, inner with 2 dorsal spines, each ramus with subapical setule. Telson linguiform, entire, with 2 pairs of dorsolateral setules in middle and one apicolateral setule on each side.

Male "q" 3.22 mm. Teeth of epimera 2–3 slightly enlarged (Fig. 9qW), outer ramus of uropod 1 lacking spine, apical gap present on dorsal spines of peduncle on uropod 1, setae on pereopods 3–4 weak.

Female "wj" 3.00 mm. Like male but eyes much smaller, antennae broken, see female "wi" below. Coxae 1–4 longer than in male. Oostegites 2–3 broad, 4–5 narrow and setose. Gnathopods feeble, equally slender, 2 slightly longer, carpi shorter than propodi, gnathopod 1 much more slender and slightly more elongate than in male, carpus with large lobe pointing distad,

propodus subrectangular but weakly expanding apically, palm subtransverse; carpus of gnathopod 2 with large posterior lobe pointing distad, palm subtransverse. Pereopods 3–4 poorly setose compared with male but setae better developed than in male of *P. lowryi* (see illustration of *P. lowryi*). Pereopod 7 with dactyl 85% as long as article 6. Spines of epimera 1–3 = 2–3–1. Uropods outer and inner rami respectively with spines as follows: uropod 1 = 2 and 3, uropod 2 = 3 and 4, uropod 3 = 2 and 1; peduncle of uropod 1 with spines in formula: 1–1–1–1–gap–1–gap–1, peduncle of uropod 2 with 3 spines, of 3 with 2.

Male "qr" 4.27 mm. Tooth of epimera 2–3 large as in *P. larai* but mandibular palp with 3 A–B setae, epimeron 3 with 3 ventral spines, therefore identified as *P. vicinus*.

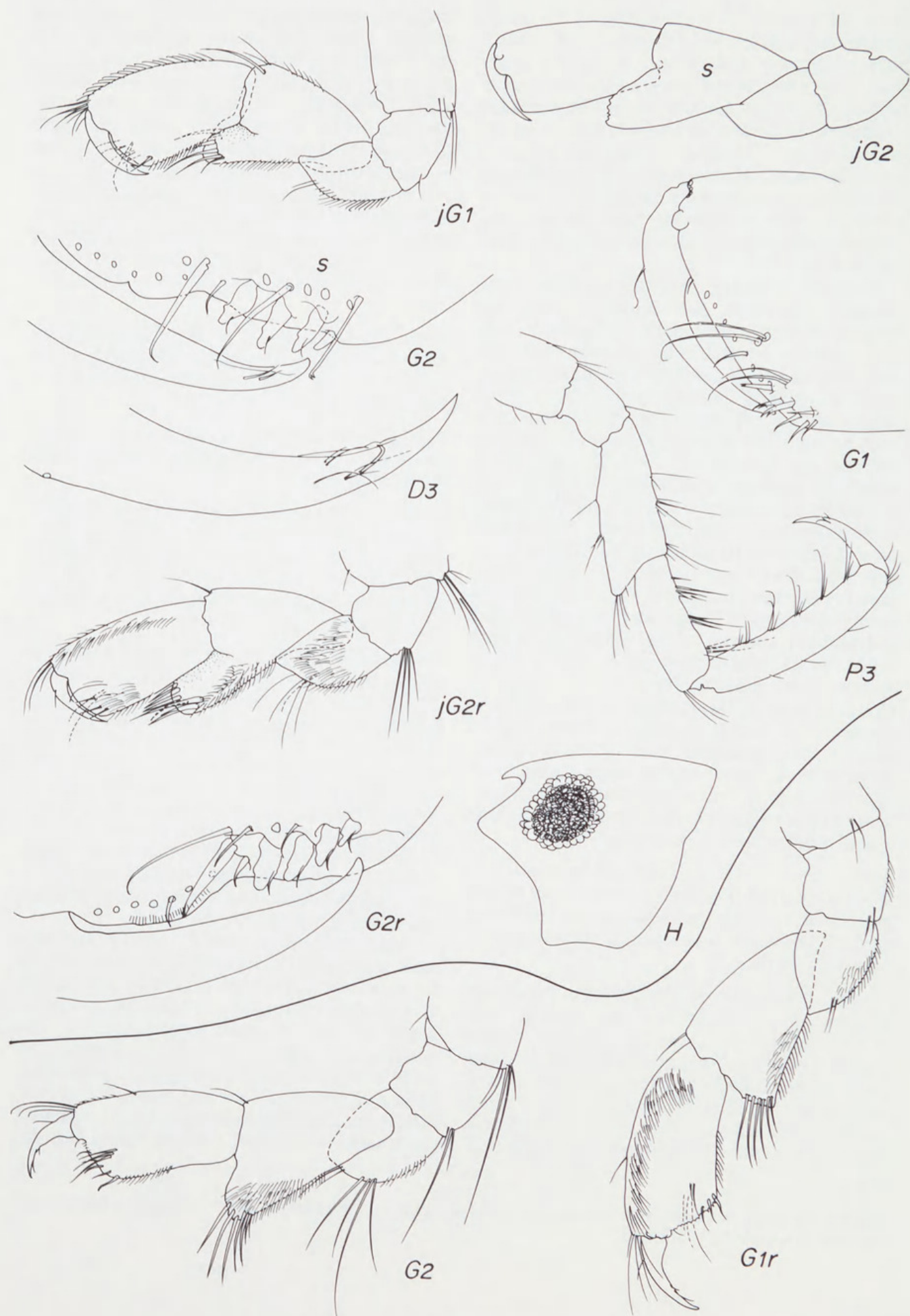
Female "wi" 3.56 mm. Flagella of antennae 1 and 2 with 11 and 12 articles, calceoli and aesthetascs absent.

Specimens from NMV J6961, Kellieville. Tooth of epimera 2–3 as large as in *P. lowryi* but identified as *P. vicinus* because male gnathopod 1 enlarged, male setae of pereopods 3–4 of the longer form, eyes small, outer ramus of uropod 1 without spines.

Relationship. This species is apparently most similar to *P. larai* but differs in the slightly smaller teeth of epimera 2–3, the lack of a significant excessive gap in the spination sequence on the peduncle of uropod 1, the better developed setae on male pereopods 3–4, the presence of 3 spines on epimeron 3 in adults, the presence of only 1 spine (rarely 2) on the outer ramus of male uropod 1, and the fully developed basofacial setae on article 3 of the mandibular palp. The similarity between the two species resides in the almost identical conditions of male gnathopod 1 and female gnathopods 1–2.

This species differs from *P. lowryi* in the large male gnathopod 1, the slightly smaller teeth on epimera 2–3, lack of significant gap in spination on peduncle of uropod 1, slightly better developed setation of male pereopods 3–4, the enlarged gnathopod 1 (like *P. larai*) which is a small replica of male gnathopod 2, with short carpus, deep carpal lobe and expanded propodus; in the stouter female gnathopod 1 with carpus relatively enlarged, its lobe larger and the

Figure 9. *Paracalliope vicinus*, new species, unattributed figures = male holotype "wg" 5.33 mm; j = female "wj" 3.00 mm; q = male "q" 3.22 mm.



propodus more expanded; in female gnathopod 2 with larger carpal lobe and shorter anterior margin of carpus.

It differs from *P. australis* in the slightly larger teeth of epimera 2–3, the slightly lesser development of setae on male pereopods 3–4, the very slightly larger male gnathopod 1 with articles 5–6 slightly more expanded; the much stouter female gnathopod 1 with much larger carpal lobe, shorter carpus, and more expanded articles 5–6; the larger carpal lobe of female gnathopod 2; and the well developed basofacial setae on article 3 of the mandibular palp.

It differs from *P. novizealandiae* in the reduced spination on the outer ramus of uropod 1, the presence of more AB setae on the mandibular palp, and the larger carpal lobes on the female gnathopods.

It differs from *P. fluviatilis* in the stouter propodi of female gnathopod 1, the lack of spines on epimeron 3 and possibly the presence of more posterior setal groups on article 6 of pereopods 3–4 (but we are comparing males with females of the different species). The two species are otherwise virtually identical. The spines on uropods 1–2 were not described in *P. fluviatilis*.

It differs from *P. karitane* in the presence of spines on epimeron 3, the larger carpal lobes on female gnathopods, the presence of more AB setae on the mandibular palp and the reduced spination on uropods 1–3.

Etymology. *Vicinus* (L.), near, in reference to the similarity of this species to *P. larai*.

Distribution. Tasmania, lagoons, estuaries, inlets, creeks, apparently mostly fresh water, in marine localities apparently in trickles of freshwater crossing mudflats, intertidal.

Paracalliope larai Knott

Figures 11–13

Paracalliope larai Knott, 1975: 40–48, figs 1–25b.

Material. Holotype. Tasmania, Dip River above falls, 200 m altitude, 23 km direct line from Bass Strait, 1973–1974, Tasmanian Museum G1625 (male).

Paratypes. Type locality, TM G1626 a, b, G1627 a, b (30 specimens).

Other material. Tasmania. Dip Falls, AMMM, JLH & PS, 30 Nov 1974, NMV J6948 (many), NMV J22288 (male voucher “d”, 2.57 mm, maxilliped illustrated), NMV J22289 (male voucher “a”, 2.54 mm,

J22289 illustrated), NMV J22290 (male voucher “c”, 2.67 mm), NMV J22293 (female voucher “w”, 2.05 mm, J22293 illustrated), NMV J22291 (female voucher “e”, 1.94 mm), NMV J22292 (female voucher “v”, 1.80 mm).

Note. The holotype male and one female were examined by us many years ago and the following descriptions, minus body measurements are presented. New figures were made from topotypic material in the Museum of Victoria, male “a” and female “w” to follow.

Description. *Male holotype.* Rostrum small, lateral cephalic lobe adze-shaped, sinus receiving antenna 2 deep, eyes small (artificially shrunk), widely separate. Antenna 1 scarcely shorter than antenna 2, flagellum with 14 articles, calceoli absent; one aesthetasc each on articles 9, 11, 12, 13, and rudimentary on 14. Gland cone of antenna 2 very prominent, almost reaching apex of article 3 (in lateral view), flagellum with 10 articles, one calceolus each on articles 3, 4.

Epistome flat anteriorly, upper lip articulate and rounded-truncate below, anterior pubescence poorly developed. Mandibles of basic gammaridean plan, incisors toothed, right and left laciniae mobiles toothed, right rakers 4, first raker bifid (possibly 2 rakers fused?); molar triturative, bearing apical seta; palpar hump small, articles 1–2 naked, article 3 especially pubescent, formula of spines = 3D, 5E, with 3 of E setae simple, others penicillate, basofacial setae absent. Inner lobes of lower lip well developed and fleshy. Inner plate of maxilla 1 almost fully setose medially, outer plate with 11 diverse spines, palp 2-articulate, spinose apically, right and left palps alike. Plates of maxilla 2 subequal in size, inner with facial row of setae. Inner and outer plates of maxilliped weakly spinose, palp short, stout, dactyl unguiform, with about 2 accessory setules.

Coxae 1–7 short, almost glabrous, almost of even depth except coxa 7 shortened, coxa 1 scarcely expanded in middle, coxa 4 weakly excavate posteriorly and weakly lobate posteroventrally; coxae 2–6 each with narrow sac-like gill with pediculate base. Medium sized lobe on carpus of gnathopod 1 pointing slightly distad, propodus ovately expanded, palm about as long as posterior margin of propodus, well defined by change in slope, palm with organized clusters of armaments, dactyl fitting palm, with several

Figure 10. Upper, *Paracalliope vicinus*, new species, unattributed figures = holotype male “wg” 5.33 mm; j = female “wj” 3.00 mm. Lower, *Paracalliope australis*, female “tn” 2.60 mm.

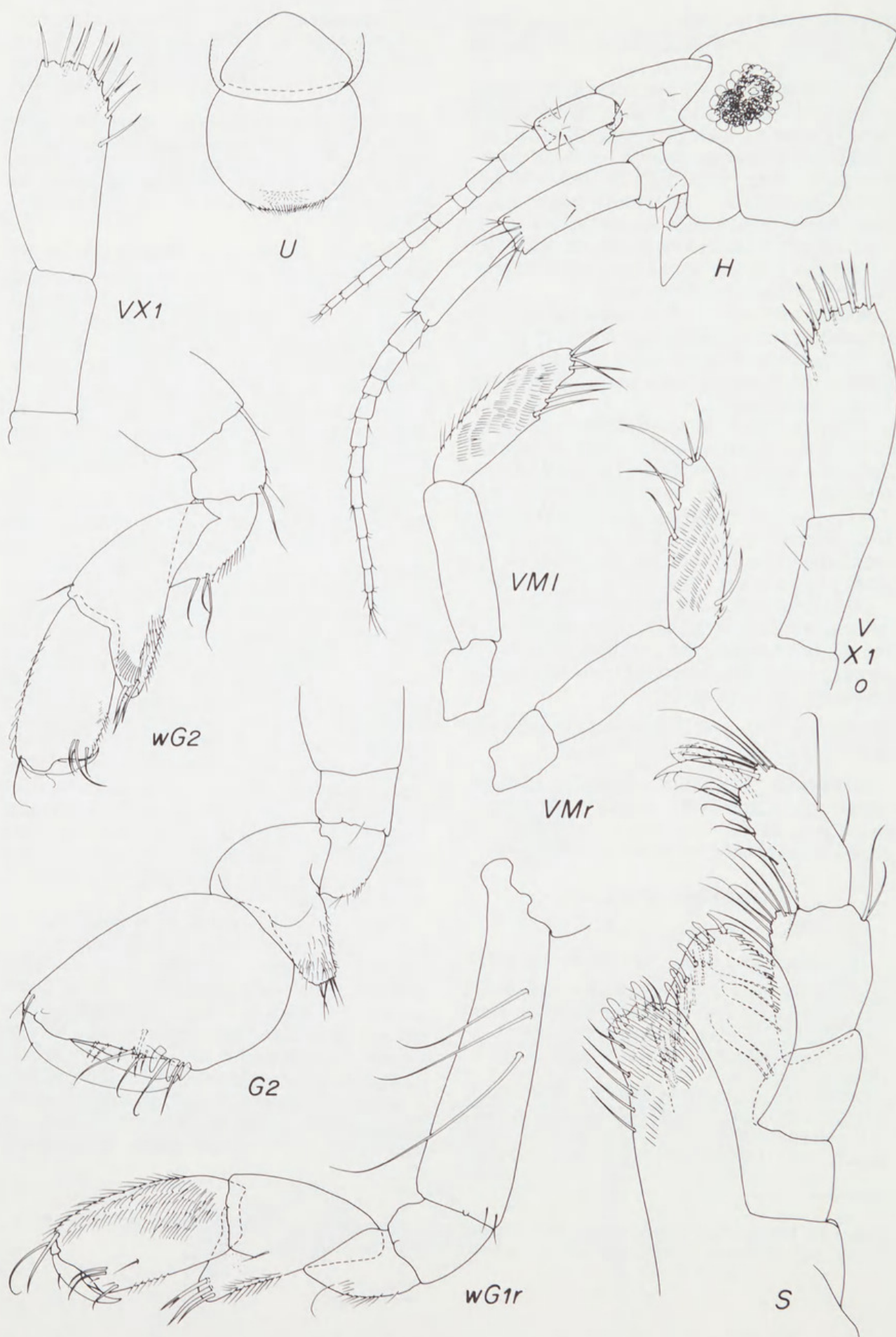


Figure 11. *Paracalliope larai*, unattributed figures = male "a" 2.54 mm; w = female "w" 2.05 mm.

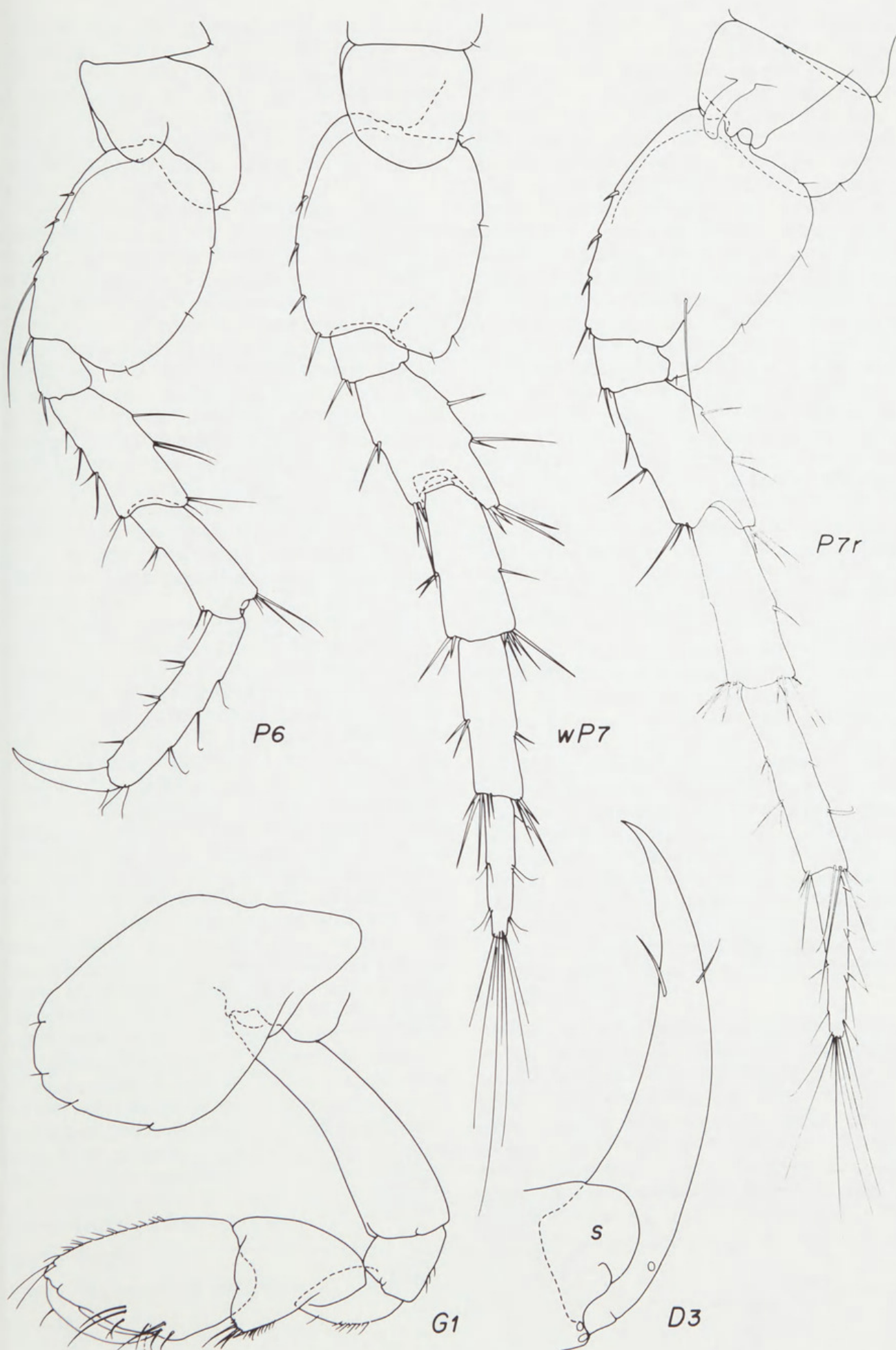
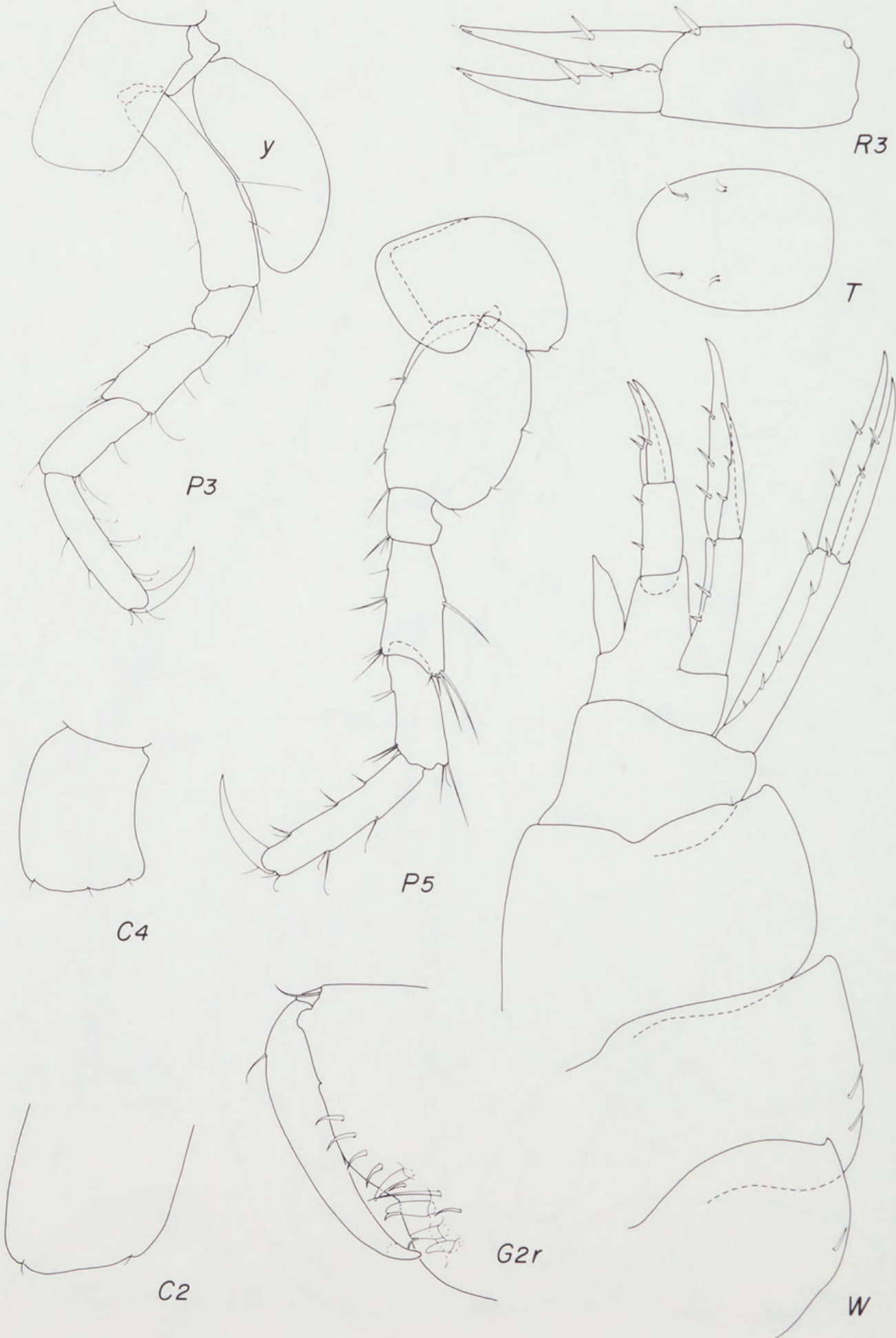


Figure 12. *Paracalliope larai*, unattributed figures = male "a" 2.54 mm; w = female "w" 2.05 mm.



subapical setules. Carpus of gnathopod 2 forming complex of 2 basal swellings side by side and thin posterior lobe curving distad, propodus turning inward on death, ovato-rectangular, palm oblique, deeply and raggedly excavate, with 2 lateral and 4 medial facial spines proximal to ragged margin, dactyl slender, fitting palm.

Article 4 of pereopods 3–6 slender, posterior margins of articles 4–6 of pereopods 3–4 with moderately long setae in fascicles, generally fascicle formula number on articles 4–6 = 4-6-5, each fascicle with 1–4 setae (see illustrations). Only one member each of pereopods 3 and 6 with conspicuous slit on dactyls, all with setules. Pereopods 5–6 of ordinary amphipod dimensions, 6 slightly larger than 5, article 2 ovate, poorly produced posteroventrally, almost smooth, each with midfacial ridge, that on pereopod 5 naked, that on pereopod 6 setose. Pereopod 7 enlarged, article 2 broad and subquadrate, weakly and subsharply produced posteroventrally, dactyl over 110% as long as article 6, with about 6 anterior fascicles of setae, numerous single posterior setae in tandem and 10+ apical setae.

Pleopods ordinary, peduncle elongate, rami elongate, subequal and multiarticulate. No pleonal epimeron dominant, each with tiny posteroventral tooth and weakly to strongly convex posterior margin (epimeron 2 weakest), epimeron 1 with 1–2 (L + R) facial spines and 3 anteroventral setae, epimeron 2 with 3–4 (R + L) ventral but submarginal spines in tandem horizontally, epimeron 3 with 1 submarginal spine and 1 setule in tandem horizontally near anteroventral edge. Uropods 1–2 extending subequally, uropod 3 slightly failing same extension, dorsolateral margin of peduncle on uropod 1 with 7 spines, and discernible apical gap, medial with one apical spine, outer ramus scarcely shorter than inner, outer with 1 dorsal spine, inner with 1. Peduncle of uropod 2 with 2 dorsolateral spines, medial with one apical, outer ramus shorter than inner, outer with 2 dorsal spines, inner with 2. Peduncle of uropod 3 elongate, with 1 dorsomedial spine and basal setule, outer ramus scarcely shorter than inner, as long as peduncle, with 1 dorsal spine, inner with 1 dorsal spine, each ramus with subapical setule. Telson linguiform, entire, with 2 pairs of dorsolateral setules in middle and one apico-lateral setule on one side only.

Female. Pereopod 7 broken. Like male but antennae lacking calceoli, flagellum of antenna 1 with 11 articles, one aesthetasc each on articles 6, 8, 9, 10, 11 (rudimentary); flagellum of antenna 2 with 13 articles. Coxae 1–4 longer than in male, coxa 1 somewhat nasiform and posteroventrally extended, coxae 2–3 narrow, coxa 4 with strongly beveled ventral margin toward posterior side. Oostegites 2–3 broad, 4–5 narrow and setose. Gnathopods feeble, equally slender and almost of same length, carpi as long as propodi, gnathopod 1 much more slender and slightly more elongate than in male, carpus with large lobe pointing distad, propodus subrectangular but weakly expanding apically, palm subtransverse; carpus of gnathopod 2 with weak posterior lobe, palm oblique. Pereopods 3–4 poorly setose compared with male (see illustrations). See female “s” for pereopod 7 distinction below. Differences of epimera probably varietal (see illustration), one spine of epimeron 1 more ventrad, one of epimeron 2 poorly developed, one of epimeron 3 missing and other weak. Some uropods better spined than in male; outer and inner rami respectively with spines as follows: uropod 1 = 3 and 3, uropod 2 = 3 and 3, uropod 3 = 2 and 2.

Male “a”. Topotypic specimen illustrated; written material here describing and clarifying attributes not illustrated; flagellum of antenna 1 with one calceolus each on articles 1 and 2; flagellum of antenna 2 with one calceolus each on articles 2, 4 and 6; following parts like our figures of *P. australis*: accessory flagellum; lower lip; and other mouthparts with following variations: right mandible, except palp (figured); left mandible, except lacinia mobilis with 5 teeth; inner plate of maxilla 1 with 16 setae; inner plate of maxilla 2 with 12 setae in facial row; inner plate of maxilliped with 5 medial setae, no apicofacial medial spinule; pereopod 4 like pereopod 3, size identical; gills of coxae 2, 4, 5, 6 all like figured gill of coxa 3.

Female “w”. Gnathopods and pereopod 7 illustrated; otherwise like male “a” but smaller, armaments fewer; eyes also large as in male; flagellum of antenna 1 with 7 articles, of antenna 2 with 7 articles; calceoli absent; article 2 of gnathopod 2 lacking any enlarged setae; oostegites normal for genus, of coxa 3 largest and broadly ovate, of coxa 2 similar but slightly smaller, of coxa 4 slender, of coxa 5 shorter than 4 but

Figure 13. *Paracalliope larai*, male “a” 2.54 mm.

slightly wider; gills of coxae 2–6 sac-like, longer than broad, generally similar but minor size gradient from large to slightly smaller in this order: 4, 5, 6, 3, 2; epimeron 1 lacking anteroventral setules, epimera 1–3 with 1–2–0 ventral spines, posteroventral tooth as in male; peduncles of uropods 1–3 with 3–2–1 spines, inner and outer rami respectively with 2–2, 2–3, 1–1 spines.

Remarks. We have examined the holotype and paratypes. We have only three corrections to make to Knott's fine description. According to his description the accessory flagellum is absent and no basofacial setae occur on the third article of the mandibular palp. In fact, the holotype has one thick and short basofacial spine whereas many of the paratypes lack this element. An articulate accessory flagellum is present on the holotype and paratypes. The cephalic-ocular lobe is not as sharp as depicted by Knott.

Relationship. The male of *Paracalliope larai* differs from *P. lowryi* in the enlarged gnathopod 1 which is like male gnathopod 2, has larger eyes more closely appressed, and has only 0–1 basofacial seta on mandibular palp article 3; in the female the carpus of gnathopod 1 is shorter and lobe larger compared to *P. lowryi*.

The vast majority of adult specimens of *P. lowryi* have spines on epimeron 3 and less than 2 spines on the outer ramus of uropod 1, whereas all adult specimens of *P. larai* lack spines on epimeron 3 but have 2+ spines on the outer ramus of uropod 1. Unfortunately, to ameliorate absolute characterization, there are a few specimens of *P. larai* from the Dip River above the falls which also lack spines on epimeron 3 and at least one other specimen which has 1 spine on the outer ramus of uropod 1.

The presence (*P. lowryi*) or absence (*P. larai*) of basofacial setae on mandibular palp article 3 would be a good character difference except that the holotype of *P. larai*, in contrast to several of its paratypes, has one basofacial spine-seta.

The rather strong ecological difference between the provenance of *P. larai* (200 m altitude in a freshwater stream above or near a falls) and *P. lowryi* (lagoons and high tide pools) suggests to us that there is a distinction between these two "species" but obviously further studies of specimens in freshwater streams may demonstrate that the weak differences we have found are at best phenotypic.

Paracalliope larai differs from other species of the genus in Australia and New Zealand in the

broadly sweeping posterior concavity leading directly to the posteroventral tooth on epimera 2–3.

Distribution. Tasmania, Dip Falls and stream above falls.

Acknowledgements

We thank the numerous collectors of material and owe special thanks for assistance to Drs G.C.B. Poore, J.K. Lowry, P.B. Berents, and Mr Robin Wilson; and to Mrs E. Harrison-Nelson for help in the laboratory. Carolyn Cox Lyons (Figures 1–8) of New York City and Linda B. Lutz (Figures 9–13) of Vicksburg, Mississippi, inked our illustrations.

References

- Barnard, J.L., 1972. The marine fauna of New Zealand: algae-living littoral Gammaridea (Crustacea Amphipoda). *New Zealand Oceanographic Institute Memoir* 62: 7–216, 109 figs.
- Barnard, J.L. and Barnard, C.M., 1983. *Freshwater Amphipoda of the World, I. Evolutionary Patterns; II. Handbook and Bibliography*. xix, 830 pp., 50 figs, 7 graphs, 98 maps, 12 tables. Hayfield Associates: Mt Vernon.
- Barnard, J.L., and Drummond, M.M., 1976. Clarification of five genera of the Phoxocephalidae (marine Amphipoda). *Proceedings of the Biological Society of Washington* 88: 515–547, 4 figs.
- Barnard, J.L. and Drummond, M.M., 1978. Gammaridean Amphipoda of Australia, part III: the Phoxocephalidae. *Smithsonian Contributions to Zoology* 245: 1–551, 269 figs.
- Barnard, J.L. and Drummond, M.M., 1979. Gammaridean Amphipoda of Australia, part IV. *Smithsonian Contributions to Zoology* 269: 1–69, 38 figs.
- Barnard, J.L. and Drummond, M.M., 1982. Gammaridean Amphipoda of Australia, part V: superfamily Haustorioidea. *Smithsonian Contributions to Zoology* 360: 1–148, 58 figs.
- Barnard, J.L. and Drummond, M.M., 1984. A new paracalliopiid, *Katocalliope kutyeri* gen. et sp. nov. (Crustacea: Amphipoda) from Queensland. *Proceedings of the Royal Society of Victoria* 96: 147–153, 4 figs.
- Barnard, J.L. and Drummond, M.M., 1987. A new marine genus, *Doowia*, from eastern Australia (Amphipoda, Gammaridea). *Proceedings of the Royal Society of Victoria* 99: 117–126, 6 figs.
- Barnard, J.L., and Karaman, G.S., 1982. Classificatory revisions in gammaridean Amphipoda (Crustacea), part 2. *Proceedings of the Biological Society of Washington* 95: 167–187, fig. 1.
- Barnard, J.L. and Thomas, J.D., 1991. *Yhi yindi*, a new genus and species of Paracalliopiidae from the Great Barrier Reef. *Memoirs of the Museum of Victoria* 52: 283–289, figs 1–3.

- Chapman, A. and Lewis, M., 1976. *An introduction to the freshwater Crustacea of New Zealand*. Collins: Auckland. 261 pp., 161 figs., 8 pls.
- Chilton, C., 1909. The Crustacea of the Subantarctic Islands of New Zealand. In: Chilton, C. (Ed.), *Subantarctic Islands of New Zealand* 26: 601–671, 19 figs. John Mackay: Wellington.
- Chilton, C., 1920. The occurrence in Brisbane River of the New Zealand amphipod, *Paracorophium excavatum* (G.M. Thomson). *Memoirs of the Queensland Museum* 7: 44–51, 19 figs.
- Chilton, C., 1921. The occurrence in the Philippine Islands of the fresh-water amphipod *Paracalliope fluviatilis* (G.M. Thomson). *Philippine Journal of Science* 17: 513–514.
- Dana, J.D., 1852. Conspectus crustaceorum quae in orbis terrarum circumnavigatione, Carolo Wilkes e classe Reipublicae Faederatae Duce, lexit et descripsit Jacobus D. Dana. Pars III. [Amphipoda. No. I.]. *Proceedings of the American Academy of Arts and Sciences* 2: 201–220.
- Dana, J.D., 1853. Crustacea. *United States Exploring Expedition during the Years 1838, 1839, 1840, 1841, 1842. Under the command of Charles Wilkes, U.S.N.* 14: 689–1618, atlas of 96 pls.
- Della-Valle, A., 1893. Gammarini del Golfo di Napoli. *Fauna und Flora des Golfes von Neapel und der angrenzenden Meeres-Abschnitte. Monographie* 20: xi, 948 pp., atlas (Atlante) of 61 pls.
- Fearn-Wannan, H.J., 1968. Littoral Amphipoda of Victoria. Part 1. *Proceedings of the Royal Society of Victoria* n.s., 81: 31–58, 18 figs.
- Haswell, W.A., 1880. On some new amphipods from Australia and Tasmania. *Proceedings of the Linnean Society of New South Wales* 5: 97–105, pls 5–7.
- Haswell, W.A., 1882. *Catalogue of the Australian Stalk- and Sessile-Eyed Crustacea*. (plus Addenda et Corrigenda), Australian Museum: Sydney. xxiv, 324 pp., 4 pls.
- Hurley, D.E., 1975. A provisional key and checklist to the New Zealand species of freshwater Amphipoda. *New Zealand Oceanographic Institute, Records* 2: 93–102.
- Knott, B., 1975. A new species of freshwater amphipod, *Paracalliope larai*, (family Eusiridae) from Tasmania. *Papers and Proceedings of The Royal Society of Tasmania* 109: 39–52, 25 figs.
- Lewis, M.H., 1976. Amphipoda. Chapter 11 in Chapman, A. and Lewis, M., *An introduction to the freshwater Crustacea of New Zealand*. Collins: Auckland. 261 pp., 161 figs., 8 pls.
- Lincoln, R.J., and Hurley, D.E., 1981. The calceolus, a sensory structure of gammaridean amphipods (Amphipoda: Gammaridea). *Bulletin of the British Museum of Natural History (Zoology)* 40: 103–116, 4 figs.
- Myers, A.A., 1985. Shallow-water, coral reef and mangrove Amphipoda (Gammaridea) of Fiji. *Records of the Australian Museum Supplement* 5: 1–144, 109 figs.
- Ruffo, S., and Vesentini-Paiotta, G., 1972. Études hydrobiologiques en Nouvelle-Calédonie (Mission 1965 du Premier Institut de Zoologie de l'Université de Vienne). Anfibodi (Crust.) della Nuova Caledonia. *Cahiers ORSTOM, Série Hydrobiologia* 6: 247–260, 8 figs.
- Stebbing, T.R.R., 1899. Revision of Amphipoda (continued). *Annals and Magazine of Natural History* series 7, 4: 205–211.
- Thomson, G.M., 1879. New Zealand Crustacea, with descriptions of new species. *Transactions and Proceedings of the New Zealand Institute* 11: 230–248, pl. 10.
- Thomson, G.M., and Chilton, C., 1886. Critical list of the Crustacea Malacostraca of New Zealand. *Transactions and Proceedings of the New Zealand Institute* 18: 141–159.



1992. "Paracalliope, a genus of Australian shorelines (Crustacea: Amphipoda: Paracalliopiidae)." *Memoirs of the Museum of Victoria* 53, 1–29.

View This Item Online: <https://www.biodiversitylibrary.org/item/122639>

Permalink: <https://www.biodiversitylibrary.org/partpdf/50264>

Holding Institution

Museums Victoria

Sponsored by

Atlas of Living Australia

Copyright & Reuse

Copyright Status: Permissions to digitize granted by rights holder.

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.