

New species of *Calamoecia* and *Boeckella* (freshwater Copepoda: Calanoida) from Western Australia and Queensland

I A E Bayly

Department of Biological Sciences, Monash University
Clayton, Vic 3168

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Abstract

A small calanoid copepod, *Calamoecia halsei* sp nov, is described from shallow, turbid waters in claypans of the Carnarvon region of Western Australia. The genus *Calamoecia* Brady, which is endemic to the Australasian region, now contains 15 species. A larger calanoid copepod, *Boeckella timmsi* sp nov, is described from a shallow turbid claypan in Currawinya National Park located in Queensland just north of the border with New South Wales. The genus *Boeckella* de Guerne and Richard (which also occurs on sub-Antarctic islands, Antarctica and South America) now contains 21 Australasian species.

Introduction

Most calanoid copepods occurring in Australian inland waters are in the genera *Calamoecia* and *Boeckella*. As a generalization, the smaller calanoids (body length less than ca 1.4 mm, but *C. attenuata* is longer) belong to *Calamoecia* while the larger ones (female body length range ca 1.4 – 4.5 mm, but some including *B. minuta* are shorter) belong to *Boeckella*. Eight species belonging to those genera were described in the late nineteenth century and early twentieth century by the Norwegian carcinologist G O Sars, in some cases after rearing them in Oslo from resting eggs contained in parcels of dried mud consigned from Australia. The latter were part of an historic series of hatching experiments which resulted in the description of a significant portion of the freshwater lower crustacean fauna (Branchiopoda, Cladocera, Ostracoda and Copepoda) of Australia. *Boeckella minuta* was described in this manner in 1896 (Sars 1896).

Calamoecia was revised by Bayly (1961, 1962a) who recognised 12 species, to which were added *C. elongata* (Bayly 1979) and *C. zeidlerii* (Bayly 1984). *Boeckella* was revised by Bayly (1964) with the recognition of 17 Australasian species, to which were added *B. bispinosa* (Bayly 1967), a New Zealand endemic *B. tanea* (Chapman 1973), and *B. shieli* (Bayly 1985). A comprehensive key to these two genera was published by Bayly (1992a). Now, after more than a decade without addition to either genus, a new species of both has come to hand at practically the same time in 1997 and the two are described below.

Methods

Specimens were measured under a Wild M7 stereomicroscope fitted with an eyepiece micrometer and dissected with tungsten needles in PVA-lactophenol mountant on a microslide under the same microscope. Appendages were examined (with bright field and phase-

contrast illumination) and drawn using a Wild M20 microscope fitted with a Treffenberg drawing tube. The system of abbreviations given in full by Bayly (1992a,b) was used in the description of the first and fifth legs.

Taxonomy

Family Centropagidae Giesbrecht

Genus *Calamoecia* Brady

Calamoecia halsei sp nov

(Fig 1A–G)

Specimens examined

WESTERN AUSTRALIA (Carnarvon region): Chagra Well claypan, Jimba Jimba Station, 25° 11.78' S, 114° 57.04' E, 22.viii.1994, 10 female (mean length prosome 0.94 mm, mean length to end of caudal rami 1.35 mm), 10 male (mean lengths 0.73 mm, 1.04 mm); un-named claypan, Jimba Jimba Station, 25° 04.29' S, 115° 03.50' E, 22.viii.1994, 10 female (mean lengths 0.97 mm, 1.37 mm), 10 male (mean lengths 0.76 mm, 1.08 mm); un-named canegrass pan, Wooramel Station, 25° 40.87' S, 114° 13.23' E, 24.viii.1994, 2 female (mean length prosome 0.92 mm), 4 male (mean lengths 0.73 mm, 0.99 mm); un-named claypan, Coolcalalaya Station, 27° 31.49' S, 115° 05.24' E, 30.viii.1994, 7 female (mean length prosome 0.89 mm), 2 male (mean lengths 0.71 mm, 0.95 mm); ephemeral marsh, Brickhouse Station, 24° 57.85' S, 113° 42.27' E, 25.viii.1994, 1 male. All specimens collected by S A Halse.

Type material: Holotype male, allotype female, paratypes 30 male, 30 female. Holotype and allotype mounted on microslides, paratypes unmounted in vial. Western Australian Museum Crustacean Department registration numbers WAM 639–97 to 641–97. Type locality: Chagra Well claypan, 25° 11.78' S, 114° 57.04' E.

Description of male

Size: Length of prosome 0.68 – 0.81 mm, length to end of caudal rami 0.90 – 1.13 mm.

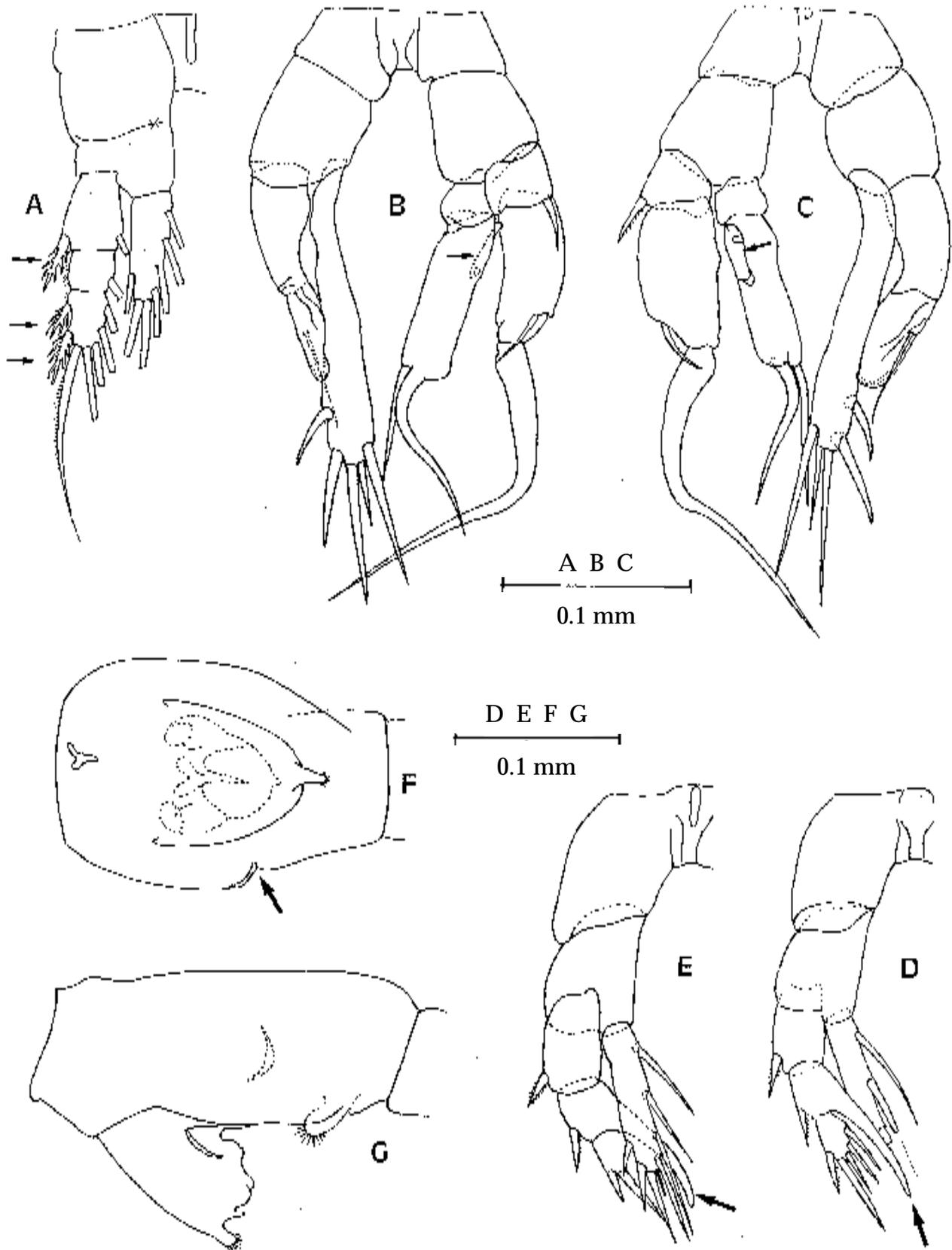


Figure 1. *Calamoecia halsei* sp nov; A, leg of first pair (drawn from male but identical in female except for larger size) [see text regarding arrows]; B & C, posterior and anterior aspects, respectively, of male fifth legs [arrows point to a unique, diagnostic feature]; D, leg of female fifth pair, showing whole of exopodite; E, as for D but showing whole of endopodite [arrows in D and E point to unusually long process from middle exopodite segments]; F, ventral aspect of female genital segment [arrow points to distinctive ridge and furrow on right side]; G, left lateral aspect of female genital segment (position of ridge and furrow located mid-laterally on right side shown by dotted crescent).

First legs (Fig 1A): Outer edge spines on Re1 and Re3 (see arrows Fig 1A) unusual within freshwater Centropagidae in having abnormally large secondary spinules. [These elaborate outer spines not occurring on exopods of legs 2–4].

Fifth legs (Fig 1B,C): Right Re claw bent through almost a right angle, lacking an inner spine. Right Ri 2-segmented with Ri2 four times as long as Ri1; Ri2 with upraised subrectangular thickening near proximal outer corner on anterior face (unique feature – see arrow Fig 1B,C) and typically with two spines at extremity – a large outer curved hook or claw and a smaller inner straight or slightly curved spine [extremity sometimes (observed one specimen in 15 examined) with third small, straight inner spine]. Left Re 2-segmented; Re2 spatulate or spoon-shaped (often bent out of alignment shown in Fig 1B,C because of fragile nature) with smoothly rounded extremity marked with minute pits or dots, and with seta inserted little short of half-way along outer edge. Left Ri 1-segmented, very elongated and exceeding left Re in length, typically armed with five spines of which four are terminal (second from inside shortest with remainder sub-equal) and one sub-terminal on outer edge [sixth spine sometimes (observed one specimen in 15 examined) present on inner edge, short distance from extremity].

Description of female

Size: Length of prosome 0.81 – 1.00 mm, length to end of caudal rami 1.13 – 1.45 mm.

First legs: Outer edge spines on Re1 and Re3 as described for male.

Fifth legs (Fig 1D,E): Outgrowth from inner distal corner of Re2 (the structural feature that is of key importance in defining the family Centropagidae) long, slender and only slightly curved, *extending almost to extremity of long terminal spine on Re3 (and sometimes beyond)*. In several species of *Calamoecia* this outgrowth does not reach past the end of Re3 excluding its terminal spine; *cf C. gibbosa* where this structure is relatively massive and strongly curved (Bayly 1979, Fig 3E,F). Re3 typically with 5 spines (3 subequal on inner edge, 1 long terminal and 1 short on outer edge) but sometimes (1 in 12 legs examined) with only 4 spines (2 only subequal ones on inner edge). Ri 1-segmented, with a total of 7 setae (4 on inner edge, 1 terminal and 2 on outer edge) plus relatively short, thin spine immediately to inside of terminal seta.

Urosome: Genital segment (Fig 1F,G) about 1.3 times as long as maximum width viewed ventrally or dorsally, with thickened ridge and indentation mid-laterally on right side about one third length of segment from posterior edge (see arrow, Fig 1F).

Remarks: If one attempts to key out this species using the dichotomous key given by Bayly (1992a) the following key numbers would apply; 1, 2, 3, 5 and 7. Dichotomy number seven accommodates *C. australica* Sars 1908 and *C. canberra* Bayly 1962, both of which are distinctly different from *C. halsei*. In terms of secondary sexual structures *C. halsei* is most closely related to *C. zeidleri*, *C. australica* and *C. canberra*. This group of four species share the following features in the male fifth legs;

- the right Re claw is without an inner spine
- the right Ri is 2-segmented with Ri2 exceeding Ri1 in length by at least three times
- the left Ri is 1-segmented, very elongated, considerably exceeds the left Re in length, and bears five spines of which four are terminal and one sub-terminal on the outside.

Although I have drawn attention to the unusually elaborate spines on the outer edge of the exopods of the first pair of legs (Fig 1A) of *C. halsei*, it should be noted that these appendages have not been described for all species of *Calamoecia*. However, it can be said confidently that they do not occur in all species; they are absent, for example, in *C. lucasi*, the type species of the genus (New Zealand material of this species examined for this feature by the author in July 1997), *C. australica* (Sars 1908, Plate ii, Fig 13) and *C. tasmanica* [see drawing by Sars (1912, Plate vii, Fig 9) of *Brunella longicornis*, which is a junior synonym of *C. tasmanica*]. The latter drawing of Sars also shows no outer spine on Re1 (formula for outer exopod spines 0.0.2) whereas this spine is present in most species of *Calamoecia* (corresponding formula 1.0.2; Fig 1A).

Most of the material examined here came from very shallow, highly turbid (turbidity 10,000–36,000 NTU) pans that contained decidedly fresh water (TDS 190–550 mg L⁻¹, K₂₅ 140–920 μS cm⁻¹). The ephemeral marsh was a little less turbid (9,100 NTU) and slightly higher in electrolytes (K₂₅ 1,110 μS cm⁻¹) but still fresh. (Chemical data from S A Halse, CALM, unpublished observations.)

Derivation of specific name: Named for Western Australian limnologist S A Halse, who collected all the material of this new species and drew it to my attention.

Family Centropagidae Giesbrecht

Genus *Calamoecia* Brady

Calamoecia cf lucasi Brady

(Gascoyne-Murchison form)

Calamoecia lucasi Brady. The Cue population, Bayly, 1984, pp 149–150, Figs 4A–D.

Specimens examined

WESTERN AUSTRALIA (Carnarvon region): Dywers Pan, 24° 26' 00" S, 114° 27' 18" E, 19.viii.1994, 10 females and 10 males, collected S A Halse.

Preliminary reassessment of taxonomic status

Bayly (1984) referred a form of *Calamoecia* collected from a pond near Cue to *C. lucasi*. In doing so, I pointed out that the Cue form differed significantly from populations in eastern Australia and New Zealand in several features involving secondary sexual structures. I now find that the above Carnarvon material, which agrees exactly with the Cue population in the male and female fifth legs and the female genital segment, can be clearly distinguished from *C. lucasi* *sensu stricto*, by structural features that are not of a secondary sexual

nature. On the terminal exopodite segments of the first pair of legs of the Western Australian forms, the two outer edge spines each have three or four large secondary spinules along both edges, and the outer edge of the stoutest terminal spine has more than 25 large secondary spinules. In brief, these three spines are closely similar to, if not identical with, those in *C. halsei* sp nov (cf Fig 1A). In *C. lucasi* sensu stricto, however, these three spines have more numerous and extremely fine hair-like outgrowths along their edges. I now think it very probable that the "Gascoyne-Murchison form of *C. lucasi*" is, in fact, a new species, but I do not wish to proceed with a formal description at this stage.

Family Centropagidae Giesbrecht

Genus *Boeckella* De Guerne & Richard

Boeckella timmsi sp nov

(Fig 2A–E)

Specimens examined

QUEENSLAND: Claypan, near Coomburra Waterhole, Currawinya National Park, 28° 47' S, 144° 22' E 24.vii.1996; 7 females (mean length prosome [measured mid-dorsally to exclude large "wings" on last prosomal segment] 1.45 mm, mean length to end of caudal rami 1.98 mm), 10 males (mean length prosome [measured mid-laterally] 1.14 mm, mean length to end of caudal rami 1.51 mm). Collected by B V Timms.

Type material: Holotype male, allotype female, paratypes 13 male, 12 female. Holotype and allotype mounted on microslides, paratypes unmounted in vial. Queensland Museum registered numbers QMW22252–4.

Type locality: Claypan 1.5 km north-east of Coomburra Waterhole, Currawinya National Park, 28° 47' S, 144° 22' E.

Description of male

Size: Length of prosome measured mid-laterally 1.00–1.16 mm, length to end of caudal rami 1.45–1.62 mm.

Fifth legs (Fig 2A,B): Right Ri sub-triangular, attached more proximally on inner edge of right B2 than is typically the case, 2-segmented (Fig 2A) or 3-segmented (Fig 2B) with the second, or more distal, line of segmentation being often weak or absent, proximal inner projection commonly somewhat differentiated from remainder of Ri (Fig 2A), distal extremity sharply pointed (Fig 2B) or bluntly rounded (Fig 2A) reaching just less than half-way along inner edge of right Re2. Left B2 with projection at inner distal corner reaching to end of left Ri1 and armed with 10–20 very fine teeth. Left Ri 2-segmented with terminal segment (Ri2) sub-circular and extending about 0.6 times distance along inner edge of left Re1. Left Re1 short relative to right Re, distal extremity lying directly opposite a point only 0.4–0.5 times distance along inner edge of right Re2. Left Re2 (proximal portion of left Re claw) with prominent outer spine inserted at 0.25 times distance along segment and commonly (about one-third of population; Fig. 2B) with second (much smaller) outer spine inserted at 0.75 times distance along segment (this second outer spine on the left Re2 is not a normal feature of any other Australian

species of *Boeckella*, but does occur as an invariable feature in some South American *Boeckella* such as *B. calcaris* and *B. palustris*).

Description of female

Size: Length of prosome measured mid-dorsally 1.42 – 1.49 mm, length to end of caudal rami 1.91 – 2.03 mm.

General body proportions (Fig 2D): More robust than most limnetic congeners; prosome 2.2 times as long mid-dorsally as maximum width (viewed dorsally or ventrally), and 2.35 times as long as urosome excluding caudal setae. Antennules relatively short, not reaching beyond end of prosomal "wings" when extended posteriorly. Last prosomal segment produced posteriorly on both sides into large "wings" or lobes reaching to posterior margin of urosome segment 2.

Fifth legs (Fig 2C): Re3 with 7 spines – 4 on inner edge, 1 terminal (exceeding Re3 in length) and 2 on outer edge. Ri 3-segmented, reaching to end of Re2 excluding inner process, setal formula 1.1.222.

Urosome: Genital segment (Fig 2E) with highly distinctive shape, squarish, length not greater than maximum width viewed ventrally or dorsally, with two rounded outgrowths and concavity between them on both sides.

Remarks: If one attempts to key out this species using the dichotomous key provided by Bayly (1992a) the following key numbers would apply; 1, 2, 5, 6, 7, 8 and 9. This is a pathway that leads to *B. triarticulata* (Thomson), *B. fluvialis* Henry, *B. hamata* Brehm (a New Zealand endemic) and *B. robusta* Sars all of which differ very significantly from *B. timmsi*. The latter lacks the large teeth attached to the inner distal corner of the left B2 and the relatively much longer left Re1 found in *B. triarticulata* and *B. fluvialis*. The left Re1 of *B. timmsi* is relatively much shorter than that in *B. hamata* and *B. robusta*, being more comparable with that in *B. symmetrica* Sars.

The question of the taxonomic value of the size and shape of any posterior "wings" developed from the last prosomal segment of female boeckellas is a somewhat vexed one. In some limnetic species they seem not to occur and in others, such as *B. propinqua* Sars, they are clearly subject to a large amount of intraspecific variation (cf Bayly 1962b, Fig 18). On the other hand, in species associated with shallow bodies of temporary water such as *B. saycei* Sars, *B. nyoraensis* Searle and *B. bispinosa* Bayly these lobes seem always to be large and of some taxonomic importance (cf Bayly 1979, Figs 5C and 6A,C). The large prosomal lobes of *B. timmsi* and the shallow, temporary nature of its habitat are in agreement with this pattern. The extreme shallowness of its habitat, together with its robust body form and relatively short antennules, suggest that this species may be fundamentally littoral or benthic in its habits (cf Timms 1979). This species came from a large (4 ha), very shallow (< 40 cm deep) and highly turbid (turbidity 6000 FTU) claypan that contained fresh water (K_{25} 430 $\mu\text{S cm}^{-1}$).

Derivation of specific name: Named for noted Australian limnologist B V Timms, who collected this new species and drew it to my attention.

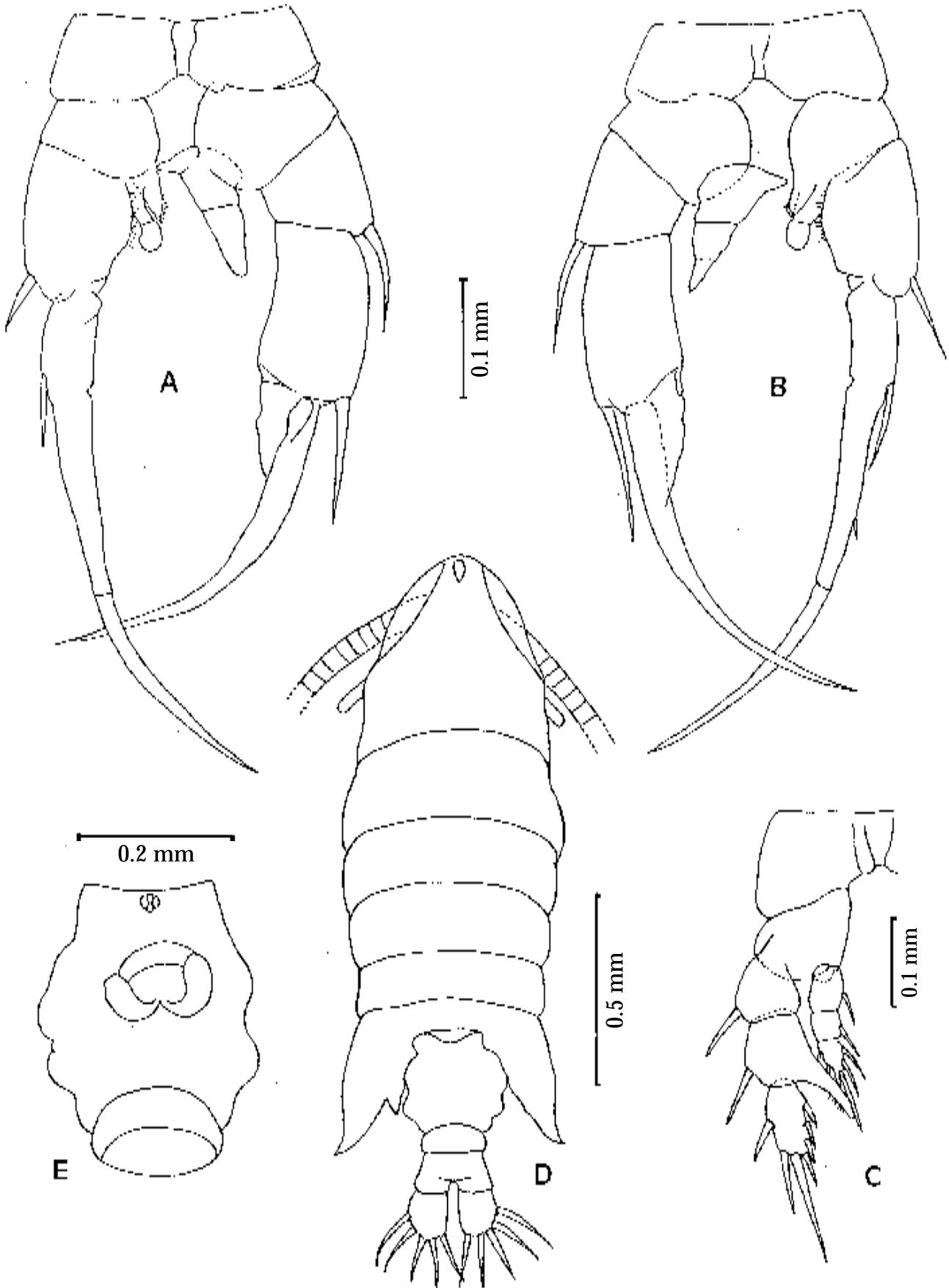


Figure 2. *Boeckella timmsi* sp nov; A & B, posterior and anterior aspects, respectively, of male fifth legs; C, leg of female fifth pair; D, dorsal aspect of female (excluding most of antennules); E, ventral aspect of female genital segment (plus urosome segment 2).

Acknowledgments: I thank S A Halse and B V Timms for providing me with the material on which this paper is based. It is to the credit of both of them that, on the basis of their own preliminary observations, they thought that they were in possession of a new species. I am indebted to C Petersen and C Logan for producing the typescript.

References

- Bayly, I A E 1961 A revision of the inland water genus *Calamoecia* (Copepoda: Calanoida). Australian Journal of Marine and Freshwater Research 12:54–91.
- Bayly I A E 1962a Additions to the inland water genus *Calamoecia* (Copepoda: Calanoida). Australian Journal of Marine and Freshwater Research 13:252–264.
- Bayly, I A E 1962b Ecological studies on New Zealand lacustrine zooplankton with special reference to *Boeckella propinqua* Sars (Copepoda: Calanoida). Australian Journal of Marine and Freshwater Research 13:143–197.
- Bayly I A E 1964 A revision of the Australasian species of the freshwater genera *Boeckella* and *Hemiboeckella* (Copepoda: Calanoida). Australian Journal of Marine and Freshwater Research 15:180–238.
- Bayly I A E 1967 A new species of *Boeckella* (Copepoda: Calanoida) and additional comments on some other species of the genus. Papers and Proceedings of the Royal Society of Tasmania 101:97–101.
- Bayly I A E 1979 Further contributions to a knowledge of the centropagid genera *Boeckella*, *Hemiboeckella* and *Calamoecia* (athalassic calanoid copepods). Australian Journal of Marine and Freshwater Research 30: 103–127.
- Bayly I A E 1984 A new species of *Calamoecia* (Copepoda: Calanoida) from South Australia, and comments on three congeners. Transactions of the Royal Society of South Australia 108:147–154.
- Bayly I A E 1985 A new species of *Boeckella* (Copepoda: Calanoida). from Western Australia, and comments on two other congeners. Records of the Western Australian Museum 12:79–84.
- Bayly I A E 1992a The non-marine Centropagidae (Copepoda: Calanoida) of the World [Guides to the identification of the Microinvertebrates of the Continental Waters of the World No. 2]. SPB Academic Publishing, The Hague.
- Bayly I A E 1992b Fusion of the genera *Boeckella* and *Pseudoboeckella* (Copepoda) and revision of their species from South America and sub-Antarctic islands. Revista Chilena de Historia Natural 65:17–63.
- Chapman M A 1973 A new species of *Boeckella* (Copepoda: Calanoida) from Northland, New Zealand. New Zealand Journal of Marine and Freshwater Research 7:153–157.
- Sars G O 1896 On freshwater Entomostraca from the neighbourhood of Sydney, partly raised from dried mud. Archiv for Mathematik og Naturvidenskab 18(3):1–81.
- Sars G O 1908 Fresh-water Copepoda from Victoria, southern Australia. Archiv for Mathematik og Naturvidenskab 29(7):3–24.
- Sars G O 1912 Additional notes on fresh-water Calanoida from Victoria, southern Australia. Archiv for Mathematik og Naturvidenskab 32(13):3–20.
- Timms B V 1979 Body proportions in limnetic and littoral calanoid copepods. Australian Journal of Marine and Freshwater Research 30:417–419.