Aust. J. Mar. Freshwater Res., 1990, **41**, 657–75

Revision of the Australian Cyclopidae (Copepoda: Cyclopoida). II*. *Eucyclops* Claus and *Ectocyclops* Brady

D. W. Morton

Department of Botany and Zoology, Monash University, Clayton, Vic. 3168, Australia.

Abstract

The Australian species of *Eucyclops* Claus and *Ectocyclops* Brady are revised and the following species are recognized: *Eucyclops spatulatus* sp. nov., *E. australiensis* sp. nov., *E. nichollsi* Brehm, *E. baylyi* sp. nov., *E. ruttneri* Kiefer and *Ectocyclops rubescens* Brady. All are described, figured and discussed, and keys are provided for their identification.

Introduction

This is the second paper of a series designed to revise comprehensively the taxonomy of the Australian Cyclopidae. The first paper in the series, Morton (1985), treated six species attributed to the genera *Acanthocyclops* Kiefer, *Diacyclops* Kiefer and *Australocyclops* gen. nov. This paper considers a further six species belonging to *Eucyclops* Claus and *Ectocyclops* Brady. General procedures and terminology are as described in Morton (1985).

Taxonomy

Genus *Eucyclops* Claus

Eucyclops Claus 1893, p. 82; Kiefer 1927, p. 303 (partim); Kiefer 1928, p. 541 (partim); Kiefer 1929, p. 29 (partim); Rylov 1948, pp. 139–140; Dussart 1969, p. 38.
Leptocyclops Sars 1918, p. 70; Henry 1922, p. 564.
Cyclops (Eucyclops) Gurney 1933, p. 97.

Prosome slightly flattened dorsoventrally. Last 2 prosomal somites conspicuously produced posterolaterally. 1st urosomal somite wider than genital somite, laterally produced, bearing dorsolaterally a series of 20–30 short setae. CR usually with longitudinal row of spinules on outer edges (absent in some species). A1 of female slender, usually 12-segmented (very rarely 11-segmented); sometimes bearing narrow hyaline membrane or denticles on distal segments. A2 4-segmented. Mxp with largest of 3 setae of terminal segment confluent with that segment (see Fig. 5*e*). P1–4 with both rami 3-segmented. Medial lobe of basis of P1–4 conically produced distally; that of P1 bearing a seta; those of P2–4 terminating in an acute spur. Spine formula 3443; complete armature of swimming legs as follows:

P1	1.1.53	1.2.411,
P2	1.1.54	1.2.411,
P3	1.1.54	1.2.411,
P4	1.1.53	1.2.221.

*Part I: *Australian Journal of Marine and Freshwater Research*, 1985, **36**, 615–34.

0067-1940/90/050657$03.00

P4Ri3 with 2 terminal spines; P4Ri3 with proximal inner seta situated 1/3 of way along segment and distal inner seta situated 2/3 of way along segment. P5 1-segmented, rectangular, with conically exserted tip, bearing 3 elements: spine on inner edge and two setae (one situated apically and one on outer edge).

Type species: *Cyclops serrulatus* Fischer 1851.

Key to Females of Australian Species of *Eucyclops*

1. (*a*) Innermost element of P5 is large spine about twice as wide, basally, as accompanying setae 3
   (*b*) Innermost element of P5 is small setiform spine about same width as accompanying setae 2
2. (*a*) Intercoxal plate of P4 with spinules along free edge; distalmost seta of P4Re3 spatulate ..... *nichollsi* Brehm
   (*b*) Intercoxal plate of P4 without spinules along free edge; distalmost seta of P4Re3 normal ..... *baylyi* sp. nov.
3. (*a*) Setae of P4Re3 and P4Ri3 spatulate; 2 median terminal setae of CR bearing short, very close-set setules in distal half ..... *spatulatus* sp. nov.
   (*b*) Setae of P4Re3 and P4Ri3 normal; setules along edges of 2 median terminal setae of CR moderately long and not particularly close-set 4
4. (*a*) Spine of P5 strongly lanceolate; spinule row extending along most of outer edge of CR ..... *australiensis* sp. nov.
   (*b*) Spine of P5 comparatively slender, not lanceolate; spinule row on outer edge of CR most commonly limited to 6–8 spinules near lateral seta (but may be slightly longer or even absent) ..... *ruttneri* Kiefer

Eucyclops spatulatus sp. nov.

(Figs 1*a*–1*d*)

?*Eucyclops speratus* var. *tasmanica* Brehm 1953, p. 60.

Discussion of Synonymy

Brehm (1953) neither figured his var. *tasmanica*, nor did he leave types. Some aspects of his description, particularly the account of the caudal rami, are highly suggestive of *E. spatulatus*, and it is not unlikely that the two are the same. However, it may be significant that he did not mention other equally distinctive features of the latter species, and it seems prudent not to maintain his *nomen*.

Description

Female

Length 0·82–1·20 mm. Prosome elliptical, slender, 1·6 times as long as greatest width and 1·3 times length of urosome. Genital somite slightly longer than greatest width, widest anteriorly. Posterior margins of genital and 2 succeeding somites minutely denticulate dorsally and ventrally. Anal somite with row of spinules around base of each CR ventrally and dorsally. Anal operculum weakly convex. CR (Fig. 1*a*) 4·5–5·2 times as long as maximum width; outer edge bearing long row of very small (sometimes barely visible) spinules extending from a point approximately 1 ramus width from anterior end of ramus to level of lateral seta (actually curving around ramus to meet lateral seta); innermost terminal seta slender, bearing long, sparsely set setules, at most only half as long as ramus and 1·2–1·6 times length of outermost terminal seta; this latter strongly spiniform, with short, sparsely set setules along its inner edge and fine spinules along its outer edge; dorsal seta about as long as innermost terminal seta; of the 2 median terminal setae, the outer is slightly longer than half length of the inner, which is as long as the urosome—inner of these setae naked in its proximal half (very rarely with a few short setules on its inner

edge) and densely plumose (with short, very close-set setules) distally, outer seta similarly ornamented except that the setule row on its outer edge extends considerably further anteriorly.

A1 12-segmented, reaching approximately to end of 2nd prosomal somite; terminal segments slender and without trace of hyaline membrane. A2 and mouthparts not distinctive.

Certain setae of P1–4 (most commonly all setae on P4Ri3 and P4Re3 and the 2 or 3 distal-most setae of P3Re3, P3Ri3 and P2Re3) spatulate (i.e. transformed such that distal half is widened and flattened) (Fig. 1*b*). Intercoxal plate of P4 (Fig. 1*c*) with free edge straight or sinuous, with small rounded prominences on each side, and with two rows of setules (one across middle of plate and one along free edge). P4Ri3 (Fig. 1*b*) 2·4–2·7 times as long as greatest width; inner terminal spine as long as segment and 1·3–1·5 times length of outer terminal spine; setae of this segment not reaching past end of outer spine. Innermost element of P5 a large, dentate spine about twice as wide (basally) as the accompanying setae (Fig. 1*d*).

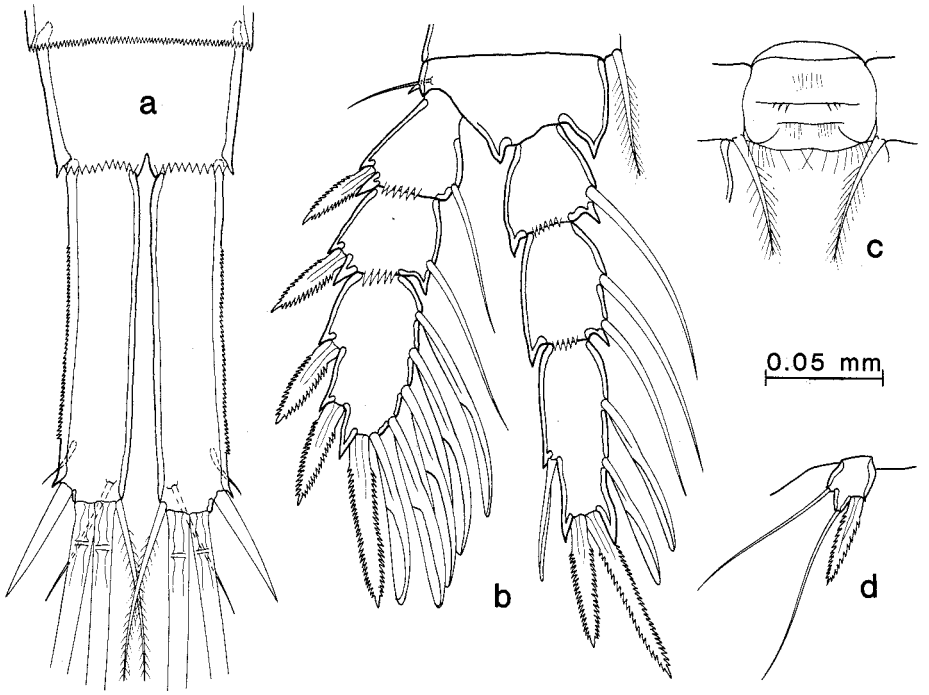

Fig. 1. *Eucyclops spatulatus* sp. nov. Female: (*a*) caudal rami; (*b*) P4; (*c*) intercoxal plate of P4; (*d*) P5.

Male

Length 0·68–0·83 mm. CR shorter than those of female, only about 3·8–4·0 times as long as wide, without spinule row along outer margin; innermost terminal seta longer than in female, about 0·8 times length of ramus.

Inner terminal spine of P4Ri3 longer than that of female, 1·3 times length of segment. P6 comprising inner spine reaching to almost half-way along 4th urosomal somite, median seta no longer than inner spine, and outer seta almost twice as long as median seta.

Etymology

The specific name, *spatulatus*, refers to the spatulate setae found on some segments of the swimming legs.

Type Material

Holotype female, allotype male and 12 paratypes, Valley Lake, Mt Gambier, South Australia, coll. D. W. Morton, 12.vii.74, deposited in Museum of Victoria.

Remarks

In Lindberg's (1957) key to *Eucyclops*, the most recent such key available, this species keys out to *Eucyclops serrulatus* Fischer. However, comparison of *E. spatulatus* with specimens of true *E. serrulatus* (from Hampstead Heath, London, England) has shown several differences between the two:

1. The spinule row of the CR of *E. spatulatus* comprises much smaller spinules and does not start as close to the proximal end of the ramus as it does in *E. serrulatus*.
2. The outermost spine of CR is relatively shorter in *E. spatulatus* than in *E. serrulatus*.
3. The ornamentation patterns on the 2 median caudal setae are quite different in the two species.
4. The setae on P1–4 of *E. serrulatus* show far less tendency to be spatulate than do those of *E. spatulatus*.
5. The intercoxal plate of P4 of *E. spatulatus* is less hirsute than that of *E. serrulatus*.

Material Examined

Victoria: Lake Monibeong, via Nelson, coll. B. V. Timms, 17.xi.70; pool, near Dandenong Creek, Rowville, coll. J. Ischia, Oct. 1975; Hopkins River estuary, near Warrnambool, coll. G. Newton, 29.ix.83. **New South Wales:** Kitchener Colliery Dam, via Cessnock, coll. B. V. Timms, 13.viii.67; Sandy Creek, near Lake Hugendara, via Berridale, coll. B. V. Timms, 12.v.75; unnamed lake, near Murlingbung Creek, via Cooma, coll. B. V. Timms, 13.v.75; swamp, Bega, coll. B. V. Timms, 14.v.75; swamp, Red Rock National Park, coll. B. V. Timms, 24.v.77. **Tasmania:** farm dam, 8 km S of Nabageena, 18.viii.74; small dam, Waratah, 19.viii.74; Lake Leake, 25.viii.74; Cleveland Lagoon, 25.viii.74; Big Lake Waterhouse, 26.viii.74; Walter's Lagoon, Flinders Island, coll. I. A. E. Bayly, 15.v.85. **South Australia:** roadside pool, 32 km SE of Millicent, 12.vii.74; Valley Lake, Mt Gambier, 12.vii.74; unnamed lake, 16 km E of Peterborough, 19.vii.74; Alberga River, 48 km N of Oodnadatta, coll. W. Zeidler, 3.v.76; Torrens River, Adelaide, coll. R. J. Shiel, 17.v.76. **Western Australia:** Gardner River Dam, near Northcliffe, coll. I. A. E. Bayly, 18.vi.77; Lefroy Brook Weir, Pemberton, coll. I. A. E. Bayly, 19.vi.77; Lake Goollelal, Kingsley, coll. J. R. Terni, 26.viii.79; Collie River (southern branch, various sites), via Collie, coll. L. J. Pen, May–Dec. 1984.

Eucyclops australiensis sp. nov.

(Figs 2*a*–2*d*)

Eucyclops sp. nov. Timms & Morton 1988, p. 163.

Description

Female

Length 0·85–1·03 mm. Prosome elliptical, slender, 1·5 times as long as greatest width and 1·1 times length of urosome. Genital segment about 1·3 times as wide as greatest length, widest anteriorly. Posterior margin of genital somite finely denticulate ventrally but unornamented dorsally; that of next somite denticulate ventrally and ornamented dorsally with only about 10 centrally positioned denticles; that of pentultimate urosomal somite finely denticulate ventrally and dorsally. Anal somite with row of spinules around base of each CR ventrally and dorsally. Anal operculum weakly convex. CR (Fig. 2*a*) 4·3–5·8 times as long as maximum width; outer edge bearing row of small (although decidedly larger than in *E. spatulatus*) spinules extending from a point less than 1/2 ramus width from anterior end of ramus to level of lateral seta (curving around ramus to meet this seta dorsally after running along ventral surface for much of its length); innermost terminal seta slender, with long, medium-spaced setules along its entire inner and outer edges, 0·6–0·8

times length of ramus and slightly longer (1·1–1·2 times) than outermost terminal seta; this latter not spiniform, bearing tiny spinules along its outer edge and long setules along its inner edge; dorsal seta nearly as long as outermost seta; of the 2 median terminal setae, outer is 2/3 length of inner which is as long as urosome, both setae naked proximally and then bearing, in distal 3/4 of their lengths, long setules on both inner and outer margins, these setules separated by about width of seta at point of insertion of each setule (i.e. anteriormost setules more widely separated than more posterior ones).

A1 12-segmented, reaching to end of 2nd pedigerous somite; last 2 segments long and slender, showing no trace of hyaline membrane. A2 and mouthparts not distinctive.

Setae of swimming legs showing no tendency towards spatulate character. Intercoxal plate of P4 (Fig. 2*b*) with free edge straight, with small rounded prominences on each side, and with two rows of setules (one across middle of plate and one along free edge). P4Ri3 (Fig. 2*d*) 2·4–2·7 times as long as greatest width; inner terminal spine 1·0–1·2 times as long as segment and 1·2–1·4 times length of outer terminal spine; setae of this segment not reaching past end of outer terminal spine. Innermost element of P5 a large, lanceolate spine about twice as wide (basally) as accompanying setae (Fig. 2*c*).

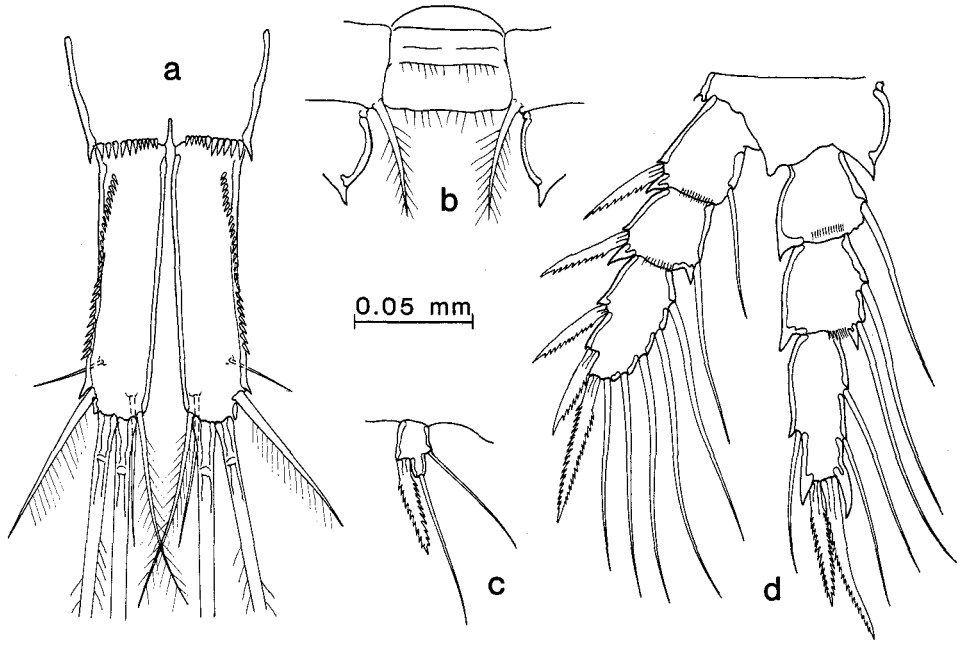

Fig. 2. *Eucyclops australiensis* sp. nov. Female: (*a*) caudal rami; (*b*) intercoxal plate of P4; (*c*) P5; (*d*) P4.

Male

Unknown.

Etymology

The specific name, *australiensis*, alludes to the widespread distribution of the species within Australia.

Type Material

Holotype female, allotype male and 12 paratypes, roadside waterhole, 1·5 km W of Hamilton, Victoria, coll. D. W. Morton, 21.v.74, desposited in Museum of Victoria.

Remarks

As with the previous species, this species also keys out to *E. serrulatus* in Lindberg's (1957) key to the genus. Differences between the two species include:

1. The spinule row of CR of *E. australiensis* does not start as close to the proximal end of the ramus as it does in *E. serrulatus*, and it curves around the ramus distally to meet the lateral seta in *E. australiensis* but not in *E. serrulatus*.
2. The outermost spine of CR of *E. serrulatus* bears short setules along its inner (lower) edge, whereas that of *E. australiensis* bears long setules.
3. The ornamentation patterns on the 2 median caudal setae are very different in the two species.
4. No setae of P1–4 of *E. australiensis* are spatulate, whereas at least some of those of *E. serrulatus* (mainly on P4) are.

Material Examined

Victoria: stream, Kinglake National Park, coll. I. A. E. Bayly, 11.vii.73; roadside waterhole, 1·5 km W of Hamilton, 21.v.74; swamp, Wodonga, coll. R. J. Shiel, 11.viii.76; Acheron River, 5 km E of Narbethong, coll. L. A. Barmuta, 19.xi.80; Blind Creek, Sunbury, coll. B. Roberts, 21.xii.81; Kororoit Creek, Altona, coll. G. Newton, 6.iii.82; artificial pond, Monash University, Clayton, 10.vii.89. **New South Wales:** irrigation dam, Gloucester, coll. B. V. Timms, 25.i.68; Lake Wetherall, via Menindee, coll. P. S. Lake, 21.v.78; roadside pool, Menindee, coll. P. S. Lake, 22.v.78; lagoon, Gosforth, via Maitland, coll. B. V. Timms, 15.x.84. **Queensland:** Lake Clarendon, coll. I. A. E. Bayly, 11.x.59; roadside pool, Barcaldine, coll. B. V. Timms, 18.vii.74; Bloodwood Bore, via Fleetwood Station, via Lake Galilee, coll. B. V. Timms, 23.iv.84; Lake Dunn, via Aramac, coll. B. V. Timms, 21.vii.84; mud spring, 20 km W of Eulo, coll. W. F. Ponder and P. H. Colman, 5.ix.84; spring, Tunga Bore, coll. W. F. Ponder and P. H. Colman, 6.ix.84. **Tasmania:** Lake Dulverton, coll. G. W. Smith, 1908; Lake Pedder, coll. I. A. E. Bayly, 2.iii.66; small unnamed lake, 11 km E of Derwent Bridge, 20.viii.74; farm dam, 3 km N of Rhyndaston, 22.viii.74. **South Australia:** roadside pond, 32 km SE of Millicent, 12.vii.74; Wirreandah Creek, 38 km NE of Quorn, 15.vii.74; temporary pond, 37 km N of Leigh Creek, 16.vii.74; roadside waterhole, 11 km SW of Cockburn, 19.vii.74; Aroona Dam, near Leigh Creek, coll. I. A. E. Bayly, Sept. 1974; creek pool, near Hamilton Station, coll. W. Zeidler, 4.v.76; Antikooloorina Waterhole (Ross River), via Eringa Homestead, coll. W. Zeidler, 6.v.76. **Western Australia:** ditch flowing into Swan River, South Perth, coll. J. R. Terni, 8.iv.81; stream, Stoneville, coll. J. R. Terni, 13.iv.81. **Northern Territory:** artificial pond, Alice Springs, coll. P. A. Tyler, 20.viii.80; Wisley Waterhole, N of Alice Springs, coll. Ling, 15.x.80; pool, Ormiston Gorge, MacDonnell Ranges, coll. B. V. Timms, 28.vi.81; Stokes Creek, George Gill Range, 200 km SW of Alice Springs, coll. J. A. Davis, July 1986; Penny Springs, George Gill Range, 200 km SW of Alice Springs, coll. J. A. Davis, Dec. 1986.

Eucyclops nichollsi Brehm

(Figs 3*a*–3*e*)

Eucyclops Nichollsii Brehm 1950, p. 251.
Eucyclops nichollsi Brehm 1953, pp. 58–60.
Eucyclops euacanthus (Sars). Timms & Morton 1988, p. 163.

Description

Female

Length 0·70–1·05 mm. Prosome elliptical, 1·6 times as long as greatest width and 1·5 times length of urosome. Genital somite slightly wider than long, widest anteriorly. Distal margins of genital and 2 succeeding somites strongly denticulate ventrally, unornamented dorsally. Anal somite with row of large spinules around base of each CR ventrally and dorsally. Anal operculum weakly convex. CR (Fig. 3*a*) 4·2–4·8 times as long as greatest width, widening slightly distally, and longer than last 2 urosomal somites combined; outer margin bearing row of large, obliquely angled spinules extending from a

point approximately 1 ramus width from anterior end of ramus to level of lateral seta (curving around ramus and turning in to meet lateral seta dorsally); innermost terminal seta slender, naked, 0·8–0·9 times length of ramus and 1·7–2·0 times length of outermost terminal seta; this latter strongly spiniform, situated subterminally on ramus and frequently

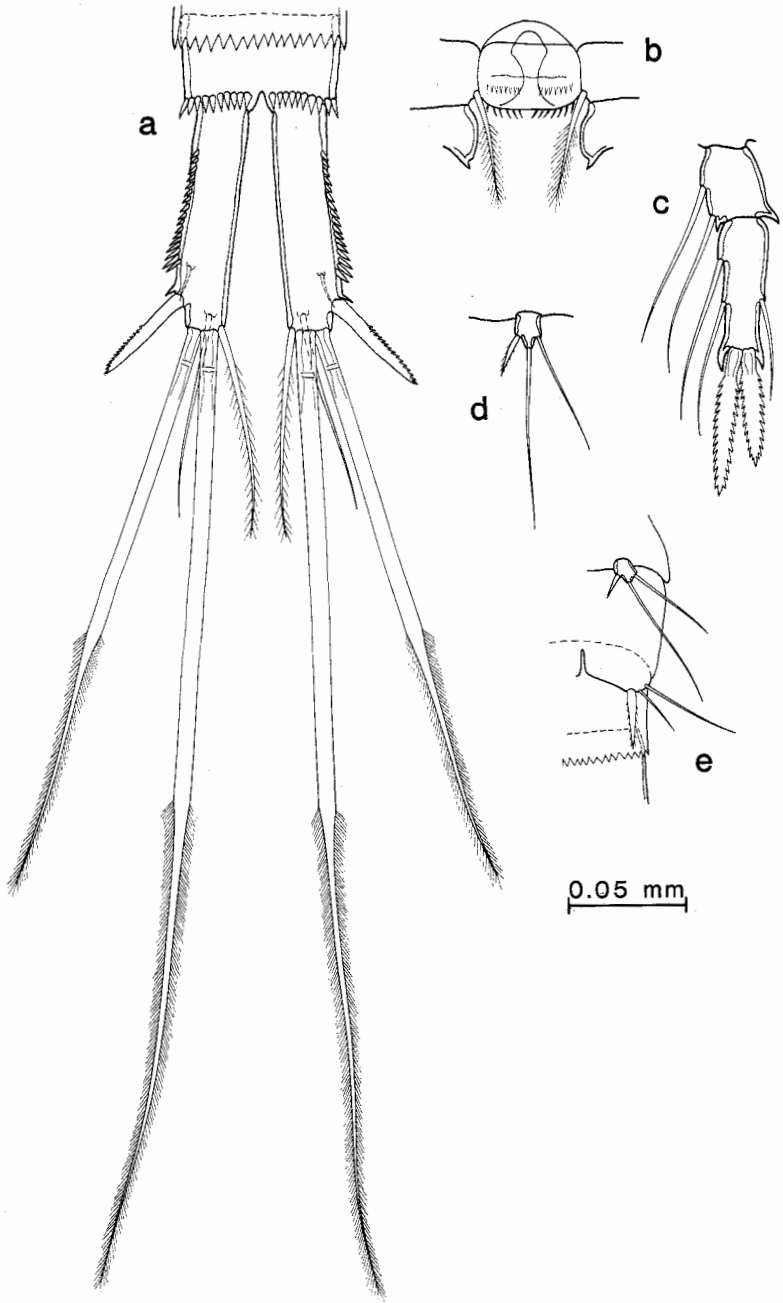

Fig. 3. *Eucyclops nichollsi* Brehm. Female: (*a*) caudal rami; (*b*) intercoxal plate of P4; (*c*) distal segments of P4Ri; (*d*) P5. Male: (*e*) P5 and P6.

oriented at large angle (sometimes perpendicular) to ramus, with minute spinules along distal part of its outer edge and few setules on inner edge terminally; dorsal seta up to same length as innermost terminal seta; of the 2 median terminal setae, inner is nearly twice length of outer and about 1·3 times length of urosome, both setae naked in their proximal halves (although a few isolated spinules may sometimes be present) and distally bearing short, very close-set setules (in many specimens, particularly in southern part of range, these setae also narrow abruptly at point where plumosity begins) (Fig. 3*a*).

A1 12-segmented, reaching to end of cephalothorax; terminal segments apparently without hyaline membrane. A2 and mouthparts not distinctive.

Distalmost seta on P4Re3, P3Re3, P3Ri3 and P2Ri3 spatulate. Outer spines on exopodites of P1–4 usually wide and lanceolate. Intercoxal plate of P4 (Fig. 3*b*) with free edge convex or sinuate and with 3 rows of spinules: one near proximal margin, one half-way along plate, and one a row of strong, inwardly angled spinules along free margin (5–8 on each side). P4Ri3 (Fig. 3*c*) slender, 2·4–3·1 times as long as wide; inner terminal spine 0·9–1·2 times length of segment and 1·2–1·6 times as long as outer spine; inner setae of this segment not reaching to end of outer spine and outer seta reaching barely past end of segment. Innermost element of P5 a short, setiform spine no wider (basally) than accompanying setae (Fig. 3*d*).

Male

Length 0·65–0·70 mm. Distal margins of urosomal somites strongly denticulate ventrally, weakly crenulate dorsally. CR 3·8–4·0 times as long as wide, with spinule row reduced to 2–3 spinules near lateral seta; outermost terminal seta not held at large angle to ramus.

P6 (Fig. 3*e*) comprising strong inner spine reaching almost to end of 3rd urosomal somite, median seta same length as spine, and outer seta twice length of spine.

Remarks

Brehm (1950, 1953) twice described this species as new. In both descriptions, he stated that a narrow, untoothed hyaline membrane was present on the distal segments of the A1. Such a structure has not been observed during the present study, but in all other respects the present material matches Brehm's (admittedly cursory) description and figures so well that there can be no doubt as to the identity of the species.

E. nichollsi bears a strong resemblance to *E. euacanthus* Sars as defined by some authors (Dumont and Van de Velde 1977, for example), and it may well be that an exhaustive investigation would show the two to be synonymous. However, in view of the somewhat confused state of the taxonomy of *E. euacanthus*, I have elected to retain *E. nichollsi* as a separate taxon that may be recognized by the combination of the following characters: the small setiform spine of P5, the characteristic spinule row on the free edge of the intercoxal plate of P4, the spatulate appearance of many setae on P2–4, and the distinctive plumosity and structure of the setae of the CR.

E. nichollsi is widely distributed over the eastern half of Australia. It appears to occur only in permanent, or comparatively permanent, waterbodies, including rivers.

Material Examined

Victoria: Pine Forest Lagoon, via Nelson, coll. B. V. Timms, 17.xi.70; Lake Monibeong, via Nelson, coll. B. V. Timms, 17.xi.70; Sheepwash Lagoon, via Nelson, coll. B. V. Timms, 12.viii.72; Main Bridgewater Lake, via Tarragal, coll. B. V. Timms, 18.viii.72; stream, Kinglake National Park, coll. I. A. E. Bayly, 11.vii.73; billabong, Alexandra, coll. R. J. Shiel, 3.v.74, 13.i.76; Yarra River, Kew, coll. R. Hamond, 23.iv.75; swamps, Botanical Gardens Annexe, Cranbourne, coll. A. Eden, 21.ix.75; swamp, Wodonga, coll. R. J. Shiel, 11.viii.76; lagoons, Wodonga, coll. R. J. Shiel, 11.viii.76. **Tasmania:** small unnamed lake, 11 km E of Derwent Bridge, 20.viii.74; Lake Sorell, Interlaken, 22.viii.74; Lake Crescent, Interlaken, 22.viii.74; Lagoon of Islands, via Steppes, 22.viii.74; unnamed lake, 1 km W of Derby, 26.viii.74; small unnamed lake, 6·5 km W of St Helens, 26.viii.74; Big Lake

Waterhouse, 26.viii.74. **South Australia:** Valley Lake, Mt Gambier, 12.vii.74. **New South Wales:** Llangothlin Lagoon, via Llangothlin, coll. B. V. Timms, 17.viii.67; Darling River, Wilcannia, coll. B. V. Timms, 12.xii.73; farm dam, 10 km N of Holbrook, coll. R. Hamond, 9.iv.75; farm dam, 12 km E of Holbrook, coll. R. Hamond, 10.iv.75; farm dam, Stratford, coll. B. V. Timms, 19.iii.76. **Queensland:** Lake Manchester, coll. I. A. E. Bayly, 15.viii.59; Brown Lake, Stradbroke Island, coll. I. A. E. Bayly, 3.x.59; Sheepstation Lagoon, Ayr, coll. B. V. Timms, 14.vi.74; Payard's Lagoon, via Brandon, coll. B. V. Timms, 17.vi.74; Lake Barrine, via Yungaburra, coll. B. V. Timms, 9.vii.74; Nardellos Lagoon, Mareeba, coll. B. V. Timms, 11.vii.74, coll. I. A. E. Bayly, 16.viii.78; stock dam, Anakie, coll. B. V. Timms, 18.vii.74; Lake Barrine, via Yungaburra, coll. I. A. E. Bayly, 14.viii.78; Lake Euramoo, coll. I. A. E. Bayly, 15.viii.78; Bromfield's Crater, Atherton Tablelands, coll. I. A. E. Bayly, 16.viii.78; farm dams, near Malanda, coll. I. A. E. Bayly, 18.viii.78; Bulimba Creek, Brisbane, coll. A. Arthington, 22.viii.79; TeaTree Waterhole, via Lakefield Homestead, via Cooktown, coll. B. V. Timms, 6.vii.83. **Northern Territory:** Mudjinberri Lagoon, Kakadu, coll. B. V. Timms, 8.vii.81.

Eucyclops baylyi sp. nov.

(Figs 4*a*–4*d*)

Eucyclops nichollsi Brehm. Bayly 1964, p. 68.

Description

Female

Length 0·76–0·88 mm. Prosome elliptical, 1·5 times as long as greatest width and 1·5 times length of urosome. Genital somite about as wide as long, widest anteriorly. Distal margins of genital and 2 succeeding somites moderately finely denticulate ventrally, unornamented dorsally. Anal somite with row of large spinules around base of each CR ventrally and dorsally. Anal operculum weakly convex. CR (Fig. 4*d*) 4·9–5·5 times as long as greatest width and longer than last 2 urosomal somites combined; outer margin bearing row of large, obliquely angled spinules extending from a point about 1/2 ramus width from anterior end of ramus to level of lateral seta; innermost terminal seta slender, 0·9–1·1 times length of ramus and 1·9–2·4 times length of outermost terminal seta, bearing fine setules along its length; outermost terminal seta strongly spiniform, situated subterminally on ramus, with minute spinules along distal part of its outer edge and few setules on inner edge terminally; dorsal seta about 2/3 length of innermost seta; of the 2 median terminal setae, inner one about twice length of outer, and about 1·3 times as long as urosome, both setae tapering regularly over their whole lengths, naked in their proximal halves except for up to 4 short, widely spaced setules on each side distally, and in their distal halves bearing closely spaced setules (these setules larger than, and not as close-set as, those in *E. nichollsi*).

A1 12-segmented, reaching almost to end of cephalothorax; terminal segments without hyaline membrane. A2 and mouthparts not distinctive.

No spatulate setae on any of P1–4. Spines on outer edges of exopodites not particularly wide or lanceolate. Intercoxal plate of P4 (Fig. 4*a*) with free edge convex and with 1 row of spinules near proximal margin and another half-way along plate; no spinule row along free edge. P4Ri3 (Fig. 4*c*) 2·6–3·0 times as long as greatest width; inner terminal spine 0·8–1·1 times length of segment and 1·4–1·7 times length of outer spine; inner setae of this segment reaching almost to end of outer spine. Innermost element of P5 (Fig. 4*b*) a short, setiform spine no wider (basally) than accompanying setae.

Male

Unknown.

Etymology

The species is named for Dr I. A. E. Bayly, copepodologist and limnologist, who collected the type material.

Type Material

Holotype female and 12 paratypes, Lake Boomanjin (formerly Lake Boemingen), Fraser Island, Queensland, coll. I. A. E. Bayly, May 1975, deposited in Museum of Victoria.

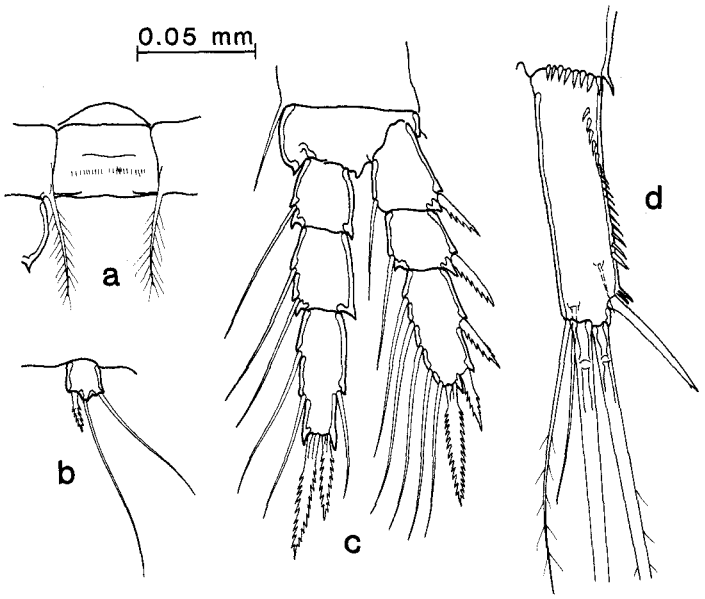

Fig. 4. *Eucyclops baylyi* sp. nov. Female: (*a*) intercoxal plate of P4; (*b*) P5; (*c*) P4; (*d*) caudal ramus.

Remarks

Comparison with published descriptions indicates that this species is most similar to *E. birmanus*, described by Lindberg (1949) from Burma. Dr H. Dumont, University of Ghent, has kindly made available to me some specimens of the latter species, and it is clear that despite their similarities, the two species differ in a number of respects: the relative length/width ratio of CR (4·9–5·5 in *E. baylyi*, 3·3–4·0 in *E. birmanus*), the relative lengths of the inner to the outer apical setae of CR (1·9–2·4 in *E. baylyi*, 1·3–1·8 in *E. birmanus*), the ornamentation of the median apical setae of CR (much more densely 'feathered' in *E. birmanus*), the relative length/width ratio of P4Ri3 (2·6–3·0 in *E. baylyi*, 1·9–2·6 in *E. birmanus*), and the structure of the spines on P1–4 (lanceolate, or flattened and widened, in *E. birmanus* but not in *E. baylyi*).

The species appears to be restricted to acidic, peaty waterbodies, typically low in total dissolved solids (Bayly 1964), close to the coast.

Material Examined

New South Wales: swamps, near Myall Lakes, coll. B. V. Timms, 13.iv.75, 17.x.75. **Queensland:** Lake Wabby, Fraser Island, coll. I. A. E. Bayly, Aug. 1963; Black Lagoon, Fraser Island, coll. I. A. E. Bayly, Aug. 1963; Lake Boomanjin, Fraser Island, coll. I. A. E. Bayly, May 1975.

Eucyclops ruttneri Kiefer

(Figs 5*a*–5*f*)

Eucyclops Ruttneri Kiefer 1933, pp. 554–5.
Eucyclops sp. Bayly 1970, p. 26.

Description

Female

Length 0·76–0·80 mm. Prosome elliptical, 1·6 times as long as greatest width and 1·5 times length of urosome. Genital somite slightly wider than long, widest anteriorly. Posterior margins of genital and 2 succeeding somites minutely denticulate dorsally and ventrally. Anal somite with row of spinules along base of each CR ventrally but not dorsally. Anal operculum convex. CR (Fig. 5*a*) 3·2–3·6 times as long as wide; spinule row on outer edge of each ramus of variable length, most commonly comprising 6–8 small spinules immediately anterior to level of insertion of lateral seta but sometimes a little longer and sometimes (rarely) absent completely; innermost terminal seta slender, bearing long, fine,

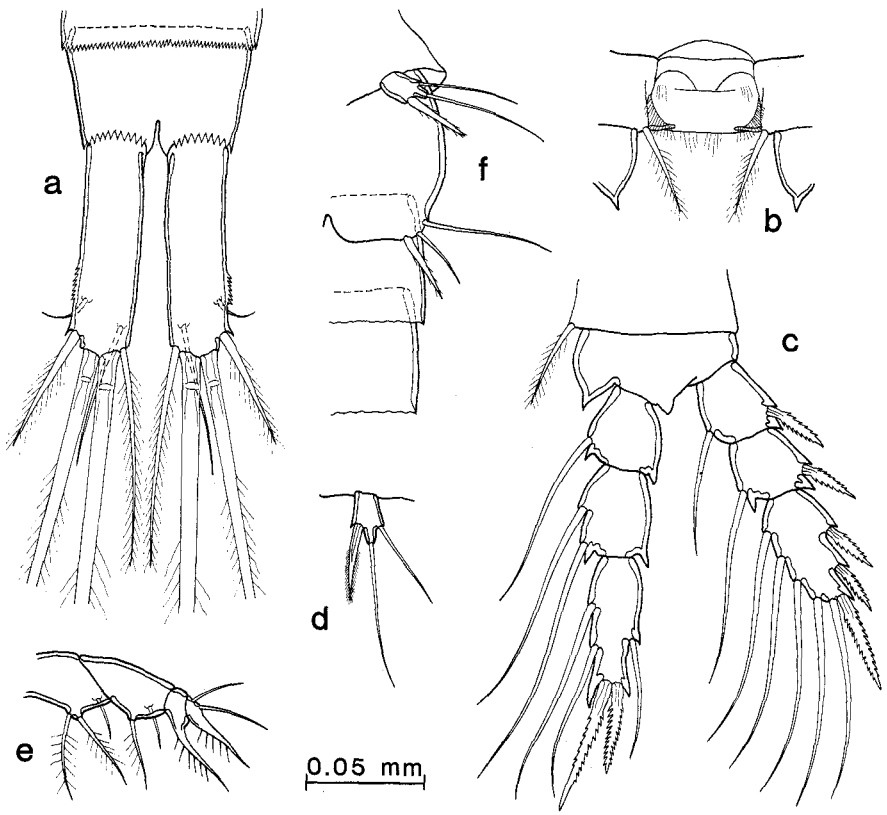

Fig. 5. *Eucyclops ruttneri* Kiefer. Female: (*a*) caudal rami; (*b*) intercoxal plate of P4; (*c*) P4; (*d*) P5; (*e*) Mxp. Male: (*f*) P5 and P6.

sparsely set setules along its length, about as long as length of ramus and 1·5–1·8 times as long as outermost seta; this latter not spiniform, with short setules along both its inner and outer edges; dorsal seta about as long as outermost seta; of the 2 median terminal setae, outer one nearly 2/3 length of inner which is noticeably longer than urosome, inner of these setae bearing long, rather close-set setules in distal 2/3 of its length and being otherwise

naked except for another series of more widely spaced setules on its inner edge, outer seta bearing long, rather close-set setules in distal 3/4 of its length on its outer edge and in distal 1/2 of its length on its inner edge and being otherwise naked.

A1 12-segmented, reaching almost to posterior margin of 2nd prosomal somite; terminal segments without trace of hyaline membrane. A2 and mouthparts not distinctive.

Setae of swimming legs showing no tendency towards spatulate character. Intercoxal plate of P4 (Fig. 5*b*) with free edge straight or slightly sinuate, with minute lateral prominences, and with row of fine setules along free edge, second row of fine setules just in from free edge, and chitinized ridge almost half-way along plate. P4Ri3 (Fig. 5*c*) 2·2–2·4 times as long as greatest width; inner terminal spine slightly longer than segment and about 1·5 times length of outer spine; outer seta of this segment reaching no further than end of outer spine and inner setae reaching to end of inner spine. Innermost element of P5 (Fig. 5*d*) being slender spine nearly twice as wide (basally) as accompanying setae.

Male

Length about 0·66 mm. CR shorter than in female, only about 2·2 times as long as wide; outer margin without spinule row. Innermost and outermost terminal setae longer than in female, innermost 1·5 times length of ramus and twice length of outermost.

P4Ri3 slightly more slender than in female, 2·6 times as long as wide; outer terminal spine proportionately longer. P6 (Fig. 5*f*) comprising inner spine reaching nearly to end of 3rd urosomal somite, median seta as long as spine, and outer seta about twice length of spine.

Remarks

In Australia, the species is known only from alpine localities in the south-eastern part of the continent. The species was originally described by Kiefer from animals taken from lakes and other waterbodies in high mountain regions of southern Sumatra and central Java.

Material Examined

Victoria: Acheron River, coll. L. McMillan, 25.v.75; *Sphagnum* bog, near summit of Mt Baw Baw, coll. I. A. E. Bayly, 30.xii.75; West Tangil River, on top of Mt Baw Baw, coll. I. C. Campbell, Mar. 1978. **New South Wales:** Blue Lake, Mt Kosciusko, coll. I. A. E. Bayly, 22.ii.69.

Species *incertae sedis*

Eucyclops serrulatus auctorum

Sars (1896) and Searle (1918, 1919) recorded *Cyclops serrulatus* Fischer from New South Wales and Victoria respectively. Henry (1919, 1922) noted *Leptocyclops agilis* (Koch) (=*E. serrulatus*) from New South Wales, and, finally, Lindberg (1953) also reported *E. serrulatus* from Western Australia.

True *E. serrulatus* is now known not to occur in Australia, and it is difficult to determine to which species these authors were referring as none provided any figures to their animals. Only in the case of Henry (1922) is it possible to say, from aspects of the description and the distribution records, that her specimens must have been either *E. australiensis* or *E. spatulatus*. Most likely, the records of Sars, Searle and Lindberg also refer to one or both of these two species, but more cannot be said.

Species Transferred to Other Genera

Lindberg (1948) described *Eucyclops linderi* from Mempherston Caves near Mt Gambier, South Australia, and Brehm (1953) described *Eucyclops miser* from Cleveland Lagoon, Tasmania. The former species is, in fact, a *Paracyclops* and the latter a *Tropocyclops*. Both will be considered further in subsequent papers.

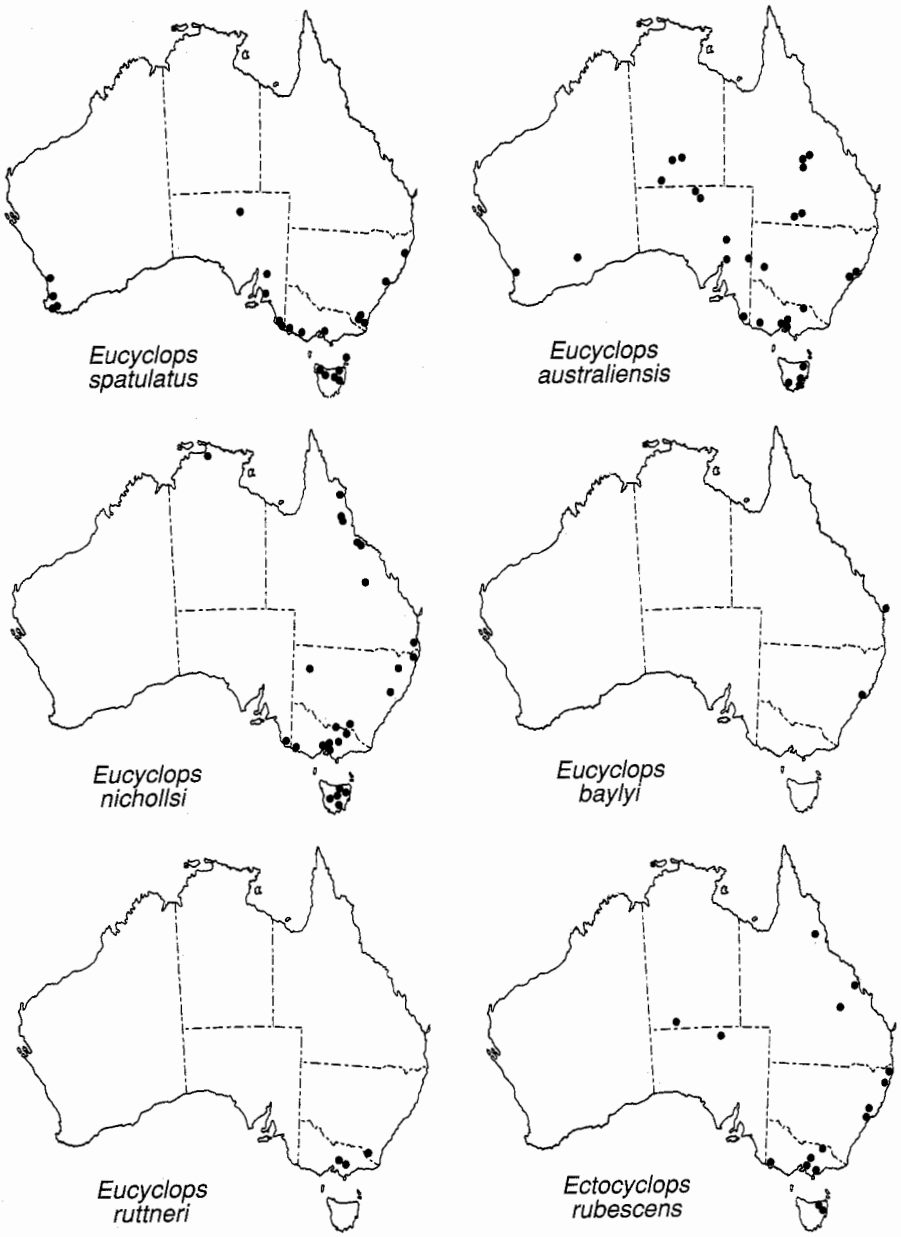

Fig. 6. Distribution of Australian species of *Eucyclops* and *Ectocyclops*.

Genus *Ectocyclops* Brady

Paracyclops (partim) Claus 1893, p. 83.
Ectocyclops Brady 1904, p. 124; Kiefer 1927, p. 304; Kiefer 1929, p. 40; Rylov 1948, p. 165; Fryer 1955, p. 947; Dussart 1969, p. 62.
Platycyclops (partim) Sars 1918, p. 76.
Cyclops (Ectocyclops). Gurney 1933, p. 137.

Body strongly depressed dorsoventrally, without marked constriction between prosome and urosome. CR short, no more than about 3 times as long as wide, frequently heavily ornamented with rows of spinules. A1 of female short, 8–11 segments. A2 with all 4 segments short and stout. Mx short and compressed, with row of large spinules along border between coxa and basis and another transverse row on ventral surface of precoxa. Mxp 3-segmented due to fusion of last 2 segments; 2 largest of 4 setae on terminal segment confluent with that segment (see Fig. 7*g*). P1–4 with both rami 3-segmented; coxa and basis very broad, with rami set wide apart, particularly those of P1–3. Medial lobe of basis of P1 bearing strong, thick seta; those of P2–4 wide and evenly curved, sometimes partially bilobed. Seta at medial corner of coxa long on P1, short on P2–4. In all swimming legs, Ri1 and Ri2 without spiniform process on outer distal corner. P1Ri2 with one seta, P2–4 with 2 setae on this segment. P4Ri3 with 2 terminal spines. Spine formula 3443; complete armature of swimming legs as follows:

P1	1.1.53	1.1.411,
P2	1.1.54	1.2.411,
P3	1.1.54	1.2.411,
P4	1.1.53	1.2.221.

P5 without distinctly articulated segment, represented only by 3 elements arising directly from 1st urosomal somite.

Type species: *Ectocyclops rubescens* Brady 1904 (by monotypy).

Ectocyclops rubescens Brady

(Figs 7*a*–7*h*)

Cyclops phaleratus Koch. Sars 1896, p. 76.
Platycyclops phaleratus (Koch). Henry 1919, pp. 41–2; Henry 1922, p. 565.
Ectocyclops rubescens Brady 1904, p. 124; Kiefer 1939, pp. 356–7; Kiefer 1952, p. 97; Kiefer 1957, p. 97; Herbst 1962, pp. 268–9; Einsle 1971, p. 46; Lim & Fernando 1985, p. 76.
Platycyclops rubescens (Brady). Lowndes 1930, pp. 173–4.
Ectocyclops medius Kiefer 1930, p. 318; Kiefer 1933, p. 563; Lindberg 1939, pp. 51–4; Bayly & Morton 1978, p. 2538.
Ectocyclops phaleratus Koch. Brehm 1953, p. 57.
Ectocyclops phaleratus medius Kiefer. Fryer 1955, pp. 938–45.

Discussion of Synonymy

Brady (1904) described *E. rubescens* from specimens collected in Natal. His description is very short, and nearly everything mentioned is of generic rather than specific importance. Moreover, his accounts and figures of certain structures (A2, Md) are highly questionable, and others (e.g. P5) are described in such a way that they are of limited value. No mention is made of P4, whereas P1 and P3, structures that have received no subsequent recognition as being of specific importance in this genus, are both figured. The illustration of the CR is also very small and shows no details of the ornamentation and the relative lengths of the shorter caudal setae.

Brady's only statements that may be of some use in distinguishing the species are 'furcal segments not much longer than broad' and 'antennules ten-jointed'. However, in themselves, even these features are of little use as the former is shared with a number of other species and the latter has been shown to vary between individuals of the one species and even between antennules of the one individual (Kiefer 1939; Fryer 1955).

Kiefer (1929) synonymized *E. rubescens* with *E. phaleratus*, the well known Palaearctic species, solely on the grounds that Brady's description was poor and his observations and descriptions were known to be frequently inaccurate.

Kiefer (1930) then described *E. medius* very briefly from specimens collected from localities in Africa and India. The species was stated to differ from *E. phaleratus* by the longer setae of P5 (especially the inner one, which is shown in the only accompanying figure as reaching almost to the end of the genital somite) and by the possession of 11-segmented antennules, those of *E. phaleratus* being 10-segmented. No other appendages were mentioned. This meagre description was later (Kiefer 1933) augmented with figures of the A1, CR, P6 and urosome of the male and additional figures of P5. These were drawn from animals collected on Sumatra, Java and Bali and agree well with those of the Australian specimens examined.

Kiefer (1939) reported finding populations of *E. medius* in the vicinity of Nairobi and Lake Victoria, Kenya. The antennule in most cases was 11-segmented but in some specimens was 10-segmented, although the animals agreed in every other respect. On the basis of this and the fact that Brady's (1904) figure of P5 of *E. rubescens* shows one seta longer than the other two, as is the case with *E. medius*, Kiefer synonymized these two species (and reversed his earlier conclusion that *E. rubescens* and *E. phaleratus* were identical).

Kiefer's somewhat dubious (considering his reasons), although probably correct, action has at least given some form of legitimacy to Brady's species (the types of which cannot be located), and subsequent authors (Einsle 1971; Kiefer 1952, 1957) have referred to the species under the name *E. rubescens*. The figures given by these authors of the various appendages of their specimens generally agree well with those of the present specimens. Einsle (1971) also notes that there was marked variability in the animals he examined, particularly in the P5 and the caudal rami.

Fryer (1955) reviewed the genus, but his work is marked by a number of inconsistencies and is obviously based on an incomplete knowledge of the literature. For example, he does not refer to Kiefer's (1939, 1952) papers in which *E. medius* is synonymized with *E. rubescens*. Consequently, despite the fact that he goes to some pains to demonstrate the variability of the segmentation of A1, he still maintains these species as separate taxa (although he reduces them to subspecies of *E. phaleratus*), the segmentation of A1 being the principal means of separating the two; this is clearly untenable in light of his and Kiefer's (1939) findings.

Fryer's reasons for considering *E. medius* to be a subspecies of *E. phaleratus* are not convincing. He admits that the structure of P5 in the two taxa is different but considers this unimportant. Also, while it is true, as he points out, that the segmentation of A1 is variable in *E. medius* and that the 10-segmented condition can occur in both species, this condition is produced differently in the two species: in *E. medius*, the 10-segmented condition, when it occurs, is due to the non-separation of segments 8 and 9 of the primitive 11-segmented condition, whereas in *E. phaleratus* the same condition is due to the non-separation of segments 6 and 7. Also, he does not consider at all the structure of the caudal rami of the two species, which are significantly shorter in *E. medius* (=*E. rubescens*) (1·31–1·54 times as long as wide) than in *E. phaleratus* (1·85–2·10 times as long as wide; Gurney 1933).

The records of Sars (1896) and Henry (1919, 1922) of *Ectocyclops phaleratus* from New South Wales are here assigned to *E. rubescens* on the basis that the latter is the only species of the genus found in Australia during the present study. Nevertheless, it should be noted that the description provided by Henry (1922) includes details that are, in fact, more suggestive of *E. phaleratus* than *E. rubescens*.

Description

Female

Length 0·80–0·92 mm. Prosome wide, ovate, truncated anteriorly, about 1·4 times as long as greatest width and about 1·6 times as long as urosome. 1st urosomal somite with numerous tiny spinules at lateral corners near P5, with row of denticles along dorsodistal edge, and with series of small spinules along ventrodistal edge, interrupted medially

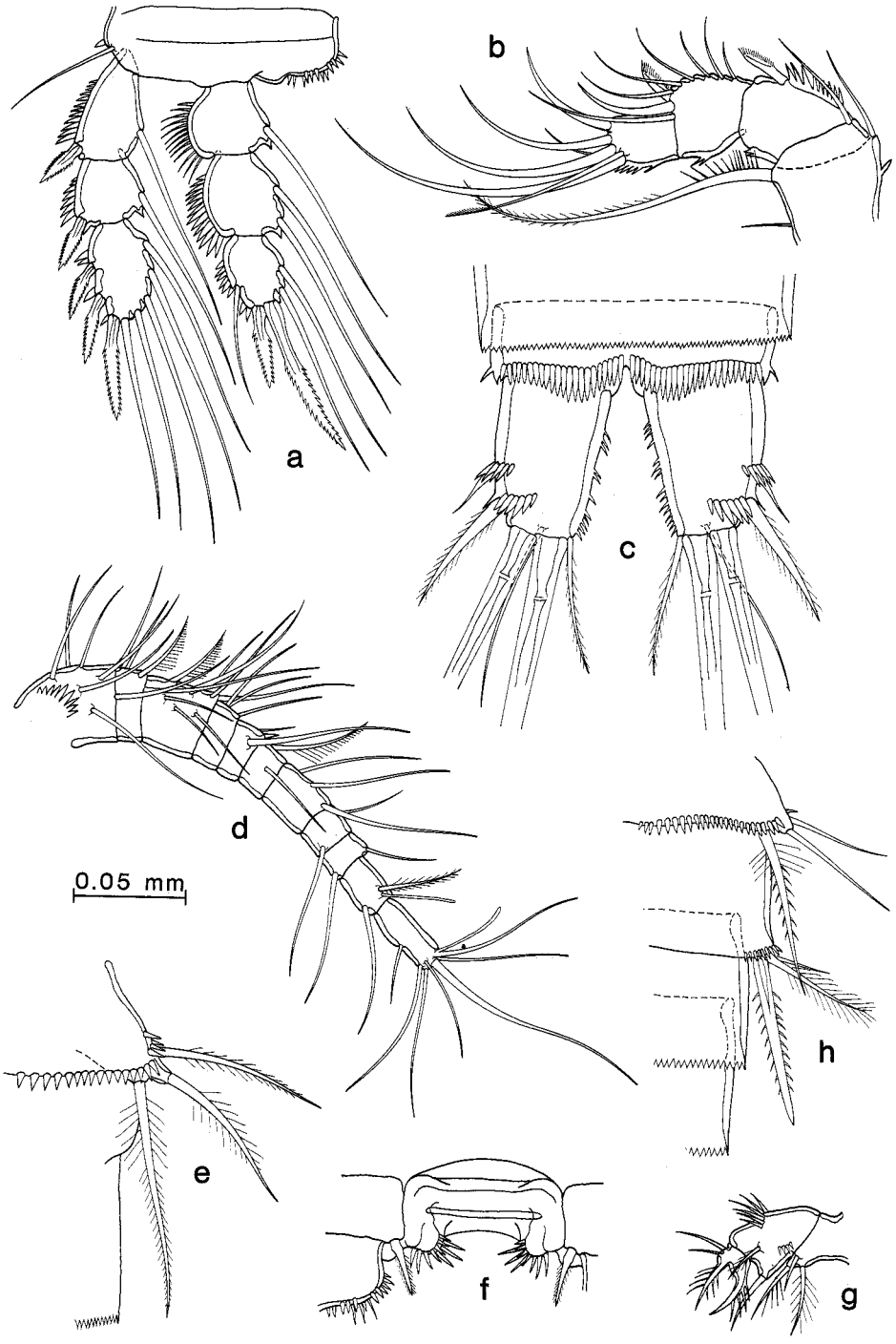

Fig. 7. *Ectocyclops rubescens* Brady. Female: (*a*) P4; (*b*) A2; (*c*) caudal rami; (*d*) A1; (*e*) P5; (*f*) intercoxal plate of P5; (*g*) Mxp. Male: (*h*) P5 and P6.

(Fig. 7*e*). Genital somite about 1·5 times wider than long, widest anteriorly. Posterior margins of genital and 2 succeeding somites finely denticulate ventrally, more coarsely denticulate dorsally. Anal somite with row of large spinules along base of each caudal ramus ventrally and laterally. Anal operculum weakly convex. Caudal rami (Fig. 7*c*) shorter than combined lengths of last 2 urosomal somites, at most 1·5 times as long as greatest width, often narrowing toward apex; ventral surface ornamented with 2 spinule rows, one each immediately anterior to insertion of lateral and outermost setae respectively; dorsal surface with 4 curved, parallel rows of setules; innermost terminal seta thin, slightly shorter than ramus, bearing short setules along its whole length; outermost terminal seta thick, almost spiniform, as long as innermost seta and bearing rather long setules along its whole length; dorsal seta about 1/2 as long again as outermost seta; of 2 median terminal setae, inner one twice length of outer one and about 1·3 times length of ramus, inner seta naked in its proximal half and bearing in its distal half widely spaced spinules that gradually become transformed into longer, finer, more closely spaced setules distally, outer seta bare in its proximal half except for series of 6–10 setules on its outer edge and bearing in its distal half short spinules on its outer edge and longer, finer setules on its inner edge.

A1 (Fig. 7*d*) 10- or 11-segmented (although 10-segmented condition not seen in Australian specimens), short, reaching only about half-way along cephalothorax; all setae naked except for 1 plumose seta on each of 2nd, 3rd, 6th and 10th segments. A2 having 2nd segment ornamented with numerous rows of short spinules (not shown in Fig. 7*b* for clarity); seta of 2nd segment and 1 terminal seta of 3rd segment transformed into short, unilaterally pectinate spines. Mouthparts not distinctive. Outer edges of both rami of P1–4 ornamented with rows of spinules. Intercoxal plate of P4 (Fig. 7*f*) with free edge concave and with rounded prominence on each side, each prominence ornamented with 6–7 short spinules situated just in from free edge. P4Ri3 (Fig. 7*a*) 1·2–1·4 times as long as wide; inner terminal spine slightly more than twice as long as segment and 2·1–2·4 times as long as outer spine; inner setae of this segment reaching past end of inner spine, outer seta at least as long as outer spine. P5 (Fig. 7*e*) represented by 3 long setae; innermost seta longest, reaching to, or almost to, end of genital somite; median and outer setae approximately equal in length and about 3/4 length of inner seta; all three setae strongly plumose.

Male

Length 0·67–0·70 mm. Distal edge of 2nd urosomal somite unornamented ventrally, otherwise ornamentation as in female. Caudal rami slightly shorter than in female, no longer than innermost and outermost terminal setae.

P6 comprising long inner spine reaching to at least half-way along 4th urosomal somite, median seta about 1/2 as long as spine, and outer seta about 1/4 length of spine; both setae sparsely plumose (Fig. 7*h*).

Material Examined

Victoria: Pine Forest Lagoon, via Nelson, coll. B. V. Timms, 17.xi.70; Sheepwash Lagoon, Nelson, coll. B. V. Timms, 12.viii.72; Cain's Hut Swamp, Nelson, coll. B. V. Timms, 12.viii.72; billabong, Alexandra, coll. R. J. Shiel, 3.v.74, 17.v.74, 20.viii.74; farm dam, 1·5 km E of Toora, 9.v.74; pond, 3·2 km E of Kooweerup, 10.v.74; Snowdon's Lagoon, Wodonga, coll. R. J. Shiel, 11.viii.76, 18.iv.77; billabong, Seymour, coll. R. J. Shiel, 22.v.77. **Tasmania:** farm dam, 22·5 km E of Lake Leake, 25.viii.74; Big Lake Waterhouse, 26.viii.74. **New South Wales:** swamps, Myall Lakes National Park, coll. B. V. Timms, 11.iv.75, 13.iv.75, 17.x.75; Lake Minniewater, via Grafton, coll. B. V. Timms, 8.viii.75; farm dam, Stratford, coll. B. V. Timms, 19.iii.76; Blue Lagoon, Red Rock National Park, coll. B. V. Timms, 27.iii.77; swamp, Red Rock National Park, coll. B. V. Timms, 24.v.77; dune pond, 2 km S of Evans Head, coll. B. V. Timms, 11.ix.77. **Queensland:** Goose Lagoon, via Mackay, coll. B. V. Timms, 30.vi.74; stock dam, Anakie, coll. B. V. Timms, 18.vii.74; Nardello's Lagoon, Mareeba, coll. I. A. E. Bayly, 16.viii.78; Bromfield Crater, Atherton Tablelands, coll. I. A. E. Bayly, 16.viii.78; farm dam, near Malanda, coll. I. A. E. Bayly, 18.viii.78; Lake Bronto, Cape York, coll.

B. V. Timms, 1.vii.88. **South Australia:** mound spring, Dalhousie Springs, coll. W. Zeidler and K. L. Gowlett, 13.vi.85. **Northern Territory:** Penny Springs, George Gill Range, 200 km SW of Alice Springs, coll. J. A. Davis, July 1986.

Acknowledgments

This study was conducted during the tenure of an Australian Biological Resources Study Grant, which is gratefully acknowledged. I also thank Dr I. A. E. Bayly for his encouragement and for helpful comments on the manuscript.

References

Bayly, I. A. E. (1964). Chemical and biological studies on some acidic lakes of east Australian sandy coastal lowlands. *Australian Journal of Marine and Freshwater Research* **15**, 56–72.

Bayly, I. A. E. (1970). A note on the zooplankton of the Mt Kosciusko region. *Australian Society for Limnology Bulletin* **3**, 25–8.

Bayly, I. A. E., and Morton, D. W. (1978). Aspects of the zoogeography of Australian microcrustaceans. *Verhandlungen der Internationale Vereinigung für Theoretische und Angewandte Limnologie* **20**, 2537–40.

Brady, G. S. (1904). On Entomostraca collected in Natal. *Proceedings of the Zoological Society of London* **2**, 121–8.

Brehm, V. (1950). Neue Entomostraken aus Tasmanien. *Anzeiger der Österreichischen Akademie der Wissenschaften Mathematisch-Naturwissenschaftliche Klasse* **87**, 250–3.

Brehm, V. (1953). Contributions to the freshwater microfauna of Tasmania. 1. Copepoda. *Papers and Proceedings, Royal Society of Tasmania* **87**, 33–62.

Claus, C. (1893). Über die Antennen der Cyclopiden und die Auflösung der Gattung *Cyclops* in Gattungen und Untergattungen. *Anzeiger der Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche Klasse* **9**, 79–83.

Dumont, H. J., and Van de Velde, I. (1977). Report on a collection of Cladocera and Copepoda from Nepal. *Hydrobiologia* **53**, 55–65.

Dussart, B. H. (1969). 'Les Copépodes des Eaux Continentales d'Europe Occidentale. Tome II. Cyclopoïdes et Biologie.' (Bourbée et Cie: Paris.)

Einsle, U. (1971). Free-living copepods. *Hydrobiological Survey of the Lake Bangweulu, Luapula River Basin* **13**(1), 1–73.

Fischer, S. (1851). Beiträge zur Kenntnis der in der Umgegend von St Petersburg sich findenden Cyclopiden. *Bulletin de la Société Imperiale des Naturalistes de Moscou* **24**, 409–38.

Fryer, G. (1955). A critical review of the genus *Ectocyclops* (Crustacea, Copepoda). *Annals and Magazine of Natural History* **8**, 938–50.

Gurney, R. (1933). 'British Freshwater Copepoda.' vol. 3. (Ray Society: London.)

Henry, M. (1919). On some Australian freshwater Copepoda and Ostracoda. *Proceedings of the Royal Society of New South Wales* **53**, 29–48.

Henry, M. (1922). A monograph of the freshwater Entomostraca of New South Wales. II. Copepoda. *Proceedings of the Linnean Society of New South Wales* **47**, 551–70.

Herbst, H. V. (1962). Crustacea aus dem Amazonasgebiet, gesammelt von Professor Dr H. Sioli und Dr R. Braun. I. Littorale and substratgebundene Cyclopoida Gnathostoma (Copepoda). *Crustaceana (Leiden)* **3**, 259–78.

Kiefer, F. (1927). Versuch eines Systems der Cyclopiden. *Zoologischer Anzeiger* **73**, 302–8.

Kiefer, F. (1928). Über Morphologie und Systematik der Süsswasser-Cyclopiden. *Zoologischer Jahrbuch (Systematik)* **54**, 495–556.

Kiefer, F. (1929). Crustacea Copepoda. II. Cyclopoida Gnathostoma. *Das Tierreich* **53**, 1–102.

Kiefer, F. (1930). Beiträge zur Copepodenkunde (XV). *Zoologischer Anzeiger* **87**, 315–18.

Kiefer, F. (1933). Die freilebenden Copepoden der Binnengewassern von Insulinde. *Archiv für Hydrobiologie Supplementband* **12**, 519–621.

Kiefer, F. (1939). Crustacea. IV. Copepoda: Diaptomidae, Cyclopidae. Mission Scientifique de l'Omo. *Mémoires du Muséum Nationale d'Histoire Naturelle, Paris* **9**, 319–78.

Kiefer, F. (1952). Copepoda, Calanoida und Cyclopoida. *Exploration du Parc National Albert*, Mission H. Damas (1935–36), fasc. 21.

Kiefer, F. (1957). Eine kleine Crustaceenausbeute aus dem Tumbasee (Belgisch-Kongo). *Revue de Zoologie et de Botanique Africaines* **56**, 92–100.

Lim, R. P., and Fernando, C. H. (1985). A review of Malaysian freshwater Copepoda, with notes on new records and little known species. *Hydrobiologia* **128**, 71–89.

Lindberg, K. (1939). Cyclopides (Crustacés Copépodes) de l'Inde. I. *Records, Indian Museum (Calcutta)* **41**, 45–56.

Lindberg, K. (1948). Deux Cyclopides (Crustacés Copépodes) nouveaux de l'Australie. *Bulletin de la Société Zoologique de France* **73**, 71–6.

Lindberg, K. (1949). Cyclopoides (Crustacés Copépodes) de la Birmanie. *Bulletin de la Société Zoologique de France* **74**, 38–46.

Lindberg, K. (1953). Cyclopides (Crustacés Copépodes) de l'Australie. *Acta Universitatis Lundensis, Sectio II* **49**(5), 1–8.

Lindberg, K. (1957). Cyclopides (Crustaceés Copépodes) de la Côte d'Ivoire. *Bulletin Institut Français d'Afrique Noire, Serie A* **19**, 134–79.

Lowndes, A. G. (1930). Freshwater Copepoda from Abyssinia collected by Mr J. Omer Cooper. *Proceedings of the Zoological Society of London* **100**, 161–79.

Morton, D. W. (1985). Revision of the Australian Cyclopidae (Copepoda : Cyclopoida). I. *Acanthocyclops* Kiefer, *Diacyclops* Kiefer and *Australocyclops*, gen. nov. *Australian Journal of Marine and Freshwater Research* **36**, 615–34.

Rylov, V. M. (1948). 'Fauna of U.S.S.R. Crustacea. Vol. III. Freshwater Cyclopoida.' (Israel Program for Scientific Translations: Jerusalem.)

Sars, G. O. (1896). On freshwater Entomostraca from the neighbourhood of Sydney, partly raised from dried mud. *Archiv for Mathematik og Naturvidenskab* **18**, 1–81.

Sars, G. O. (1918). 'An Account of the Crustacea of Norway. Vol. 6. Copepoda, Cyclopoida.' (Bergen Museum: Bergen.)

Searle, J. (1918). Excursion to Heidelberg. *Victorian Naturalist* **34**, 132–3.

Searle, J. (1919). Excursion to Lake Corangamite and district: Crustacea. *Victorian Naturalist* **35**, 22–8.

Timms, B. V., and Morton, D. W. (1988). Crustacean zooplankton assemblages in freshwaters of tropical Australia. *Hydrobiologia* **164**, 161–9.

Manuscript received 19 December 1989, accepted 15 February 1990