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

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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. rutneri 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. 5e). 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:

\[
\begin{align*}
\text{P1} & \quad 1.1.53 & \quad 1.2.411, \\
\text{P2} & \quad 1.1.54 & \quad 1.2.411, \\
\text{P3} & \quad 1.1.54 & \quad 1.2.411, \\
\text{P4} & \quad 1.1.53 & \quad 1.2.221.
\end{align*}
\]

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) Intercocular plate of P4 with spinules along free edge; distalmost seta of P4Re3 spatulate .......................................................................................................... nichollsi Brehm
   (b) Intercocular 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; spine row extending along most of outer edge of CR ......................................................................................................................... australiensis sp. nov.
   (b) Spine of P5 comparatively slender, not lanceolate; spine 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 1a–1d)

*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 denticate dorsally and ventrally. Anal somite with row of spinules around base of each CR ventrally and dorsally. Anal operculum weakly convex. CR (Fig. 1a) 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—inferior 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. 1b). Intercoxal plate of P4 (Fig. 1c) 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. 1b) 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. 1d).

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


*Eucyclops australiensis* sp. nov. (Figs 2a–2d)

**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. 2a) 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. 2b) 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. 2d) 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. 2c).

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

**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, deposited 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.vii.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.i.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.


**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.vii.74.


**Eucyclops nichollsi** Brehm (Figs 3a-3e)


*Eucyclops nichollsi* Brehm 1953, pp. 58-60.


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. 3a) 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 laterai 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 setae 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. 3a).

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. 3b) 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. 3c) 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. 3d).

**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. 3e) 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, unoothed 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.vii.76; lagoons, Wodonga, coll. R. J. Shiel, 11.vii.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
Revision of Australian Cyclopidae. II.


Eucyclops baylyi sp. nov.
(Figs 4a–4d)


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. 4d) 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. 4a) 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. 4c) 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. 4b) 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 baylii* sp. nqv. 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. baylii*, 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. baylii*, 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. baylii*, 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. baylii*).

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

Material Examined

Eucyclops ruttneri Kiefer
(Figs 5a–5f)


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. 5a) 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, 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

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.
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. 5b) 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. 5c) 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. 5d) 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 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. 5f) 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.
Genus *Ectocyclops* Brady

*Paracyclops* (partim) Claus 1893, p. 83.

*Ectocyclops* Brady 1904, p. 124; Kiefer 1927, p. 334; Kiefer 1929, p. 40; Rylov 1948, p. 165; Fryer 1955, p. 947; Dussart 1969, p. 82.

*Platyctlops* (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 precoxæ. Mxp 3-segmented due to fusion of last 2 segments; 2 largest of 4 setae on terminal segment confluent with that segment (see Fig. 7g). 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:

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<th>1.1.53</th>
<th>1.1.411</th>
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<tr>
<td>P1</td>
<td>1.1.54</td>
<td>1.2.411</td>
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<tr>
<td>P2</td>
<td>1.1.54</td>
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<tr>
<td>P3</td>
<td>1.1.53</td>
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P5 without distinctly articulated segment, represented only by 3 elements arising directly from 1st urosomal somite.

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

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**Ectocyclops rubescens** Brady

(Figs 7a–7h)

*Cyclops phaleratus* Koch. Sars 1896, p. 76.


**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 Palaeartic 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.
Revision of Australian Cyclopidae. II.

(Fig. 7e). 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 spines along base of each caudal ramus ventrally and laterally. Anal operculum weakly convex. Caudal rami (Fig. 7c) 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 spine 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 spines 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 in its distal half short spines on its outer edge and longer, finer setules on its inner edge.

A1 (Fig. 7d) 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 spines (not shown in Fig. 7b 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 spines. Intercoxal plate of P4 (Fig. 7f) with free edge concave and with rounded prominence on each side, each prominence ornamented with 6–7 short spines situated just in from free edge. P4Ri3 (Fig. 7a) 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. 7e) 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. 7h).

Material Examined


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References


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


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