



Two new genera of cyclopinid copepods (Cyclopoida: Cyclopinidae) from anchihaline caves of the Canary and Balearic Islands, with a key to genera of the family

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The presence of an endemic cyclopoid fauna in anchihaline caves is confirmed in this paper after the discovery of two new genera of cyclopinids in caves of the Canary and Balearic Islands. *Oromiina fortunata* **sp. nov.** is described from a flooded lava tube in Lanzarote; it is characterized by the extraordinary length attained by the antennae. *Ginesia longicaudata* **sp. nov.** is described from a flooded karstic cave in Mallorca. The body is ornamented dorsally with conspicuous integumental outgrowths, and along the lateral margins of both the cephalosome and the second pedigerous somite of male, by a linear array of pores. The new taxa are most closely related to forms found in the shallow water hyperbenthos, although one trait of *Ginesia* suggest an affinity with deep water taxa since, for example, the linear arrays of pores were previously known only in *Cyclopicina* within the Cyclopinidae. A key to the 37 genera of the family Cyclopinidae is presented.

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INTRODUCTION

Cyclopoid copepods of the family Cyclopinidae are common inhabitants of marine, shallow-water hyperbenthic habitats, their main adaptative radiation having taken place in the littoral interstitial environment (Herbst, 1986). Reports of cyclopinids from the deep sea are limited to *Cyclopicina longifurcata* (Scott, 1901), a monotypic genus found in the hyperbenthic environment of the North Atlantic down to a depth of 2500 m (Huys & Boxshall, 1990).

Cyclopinids are normally restricted to marine salinities. Only one cyclopinid, *Cryptocyclopina inopinata* Monchenko, 1979, has thus far been reported from continental waters (from the littoral interstitial of the Caspian Sea). However, cyclopinids have recently been reported from anchihaline caves (*sensu* Stock, Iliffe & Williams, 1986) located less than 1 km inland and subject to a significant marine influence, although sometimes in very low salinity waters (Jaume & Boxshall, 1996a,b).

In this paper we describe two new monotypic genera of stygobiont cyclopinids from anchihaline cave lakes in islands of the Balearic (Western Mediterranean) and Canary (Eastern Atlantic) archipelagoes. Both caves surveyed were located in close proximity to the shore; the cave lake on Mallorca was characterised by a distinct halocline at a depth of 20 cm below the surface, whereas the flooded lava tube in Lanzarote contained non-stratified marine waters strongly affected by daily tides.

The two new taxa described here provide further evidence of the existence of a rich endemic assemblage of cyclopoid copepods in the anchihaline environment. This assemblage has only recently been revealed, by the pioneering studies of Rocha & Iliffe (1991, 1993, 1994) and Jaume & Boxshall (1996a).

Samples were taken using a hand-held plankton net in Lanzarote in 1988. Meat-baited traps were used in 1995 during sampling in the Mallorcan cave (see Jaume & Boxshall, 1996a for detailed description of method).

Terminology follows Huys & Boxshall (1991). Material is deposited in the Museu de la Naturalesa de les Illes Balears, Palma de Mallorca (MNCM) and in The Natural History Museum, London (BMNH).

SYSTEMATICS

Family Cyclopinidae Sars, 1913
Subfamily Cyclopininae Kiefer, 1927
Oromiina **gen. nov.**

Diagnosis. Cyclopininae. First pedigerous somite free, concealed beneath posterior extension of dorsal cephalic shield of cephalosome. Caudal rami bearing 6 setae. Antennule 17-segmented in female, 18-segmented in male. Antenna elongate, with exceptionally long and slender distal endopodal segment; exopod absent. Mandibular palp with 2-segmented endopod and 4-segmented exopod. Maxillule bearing discrete coxal endite. Endopod of maxilliped 5-segmented, setation formula 1,2,2,1,4. Legs 1 to 4 with 3-segmented rami; armature formula as described below for type species. Fifth legs 3-segmented in both sexes, comprising coxa, basis and 1-segmented exopod, intercoxal sclerite present; armature formula 0,1,4 in female, 0,1,6 in male. Sixth legs bearing 3 elements in both sexes.

Etymology. The new generic name is dedicated to our colleague Pere Oromí, in recognition of his extensive work on the biology of the cavernicolous organisms of the Canaries.

Type species. *Oromiina fortunata* sp. nov., here designated.

***Oromiina fortunata* sp. nov.**

(Figs 1–6)

Material examined. Jameos del Agua (Lanzarote, Canary Islands), Lago Mayor. Lava tube partially flooded by the sea, located on the NE coast of the island; formed 7000 yr BP. General description of cave environment in Iliffe *et al.* (1994), detailed topography in Oromí *et al.* (1989). HOLOTYPE adult female 1.05 mm long (BMNH Reg. no. 1996.552). PARATYPE adult male 0.90 mm long (BMNH Reg. no. 1996.553). PARATYPES 4 adult males, 12 adult females and 16 copepodids (BMNH Reg. nos. 1996.554–563). Collected by G. Boxshall, J.H. Stock and E. Sánchez, 3 November 1988.

Description

Adult female. Body (Fig. 1A,B) cycloform, colourless, 0.9 to 1.05 mm long, with integument evenly ornamented with tiny tubercles. Nauplius eye absent. Prosome 5-segmented, comprising cephalosome plus 4 free pedigerous somites. Rostrum triangular with rounded apex. First pedigerous somite completely concealed beneath posterior extension of dorsal cephalic shield. Pedigerous somites 1 to 4 with evenly rounded posterolateral angles. Urosome 5-segmented, with genital and first abdominal somites fused to form genital double-somite. Double-somite and free abdominal somites except anal somite ornamented with entire hyaline frill along posterior margin. Genital double-somite (Fig. 1C,D) symmetrical, longer than wide, slightly expanded anteriorly. Single copulatory pore opening mid-ventrally about one third of distance along somite, connected via copulatory duct with large, fused seminal receptacles. Paired gonopores located ventrolaterally, connected to receptacle by wide receptacle ducts. Gonopores covered by transverse plate representing fused sixth legs; each leg armed with 3 unequal setae, dorsalmost reduced, middle longest and lying along surface of somite. Ornamentation of setules present along rim of opercular plate, as figured. Anal somite (Fig. 1E) ornamented dorsally with 2 dorsolateral sensillae and several rows of tiny denticles and setules; anus dorsal, with poorly developed operculum ornamented with entire hyaline frill. Caudal rami about 2.4 times longer than anal somite, 7.5 times as long as wide, slightly curved, symmetrical. Armature consisting of 6 setae; seta I absent; lateral seta II implanted about three-fifths of distance along margin of ramus. Row of long spinules and two small denticles ornamenting dorsal surface of ramus subterminally, as figured; row of long spinules (not shown in figure) located in same position ventrally.

Antennules (Fig. 2A) 17-segmented, symmetrical, not reaching distal margin of cephalosome. Armature as follows: Segment 1 (corresponding to fused ancestral segments I and II), 3 setae; segment 2 (fused ancestral segments III to V), 5 setae; segment 3 (fused ancestral segments VI to IX, although suture marking fusion plane between segments VII and VIII almost complete), 8 setae; segments 4 and 5 (X and XI), 2 setae each; segment 6 (partially fused ancestral segments XII to XIV,

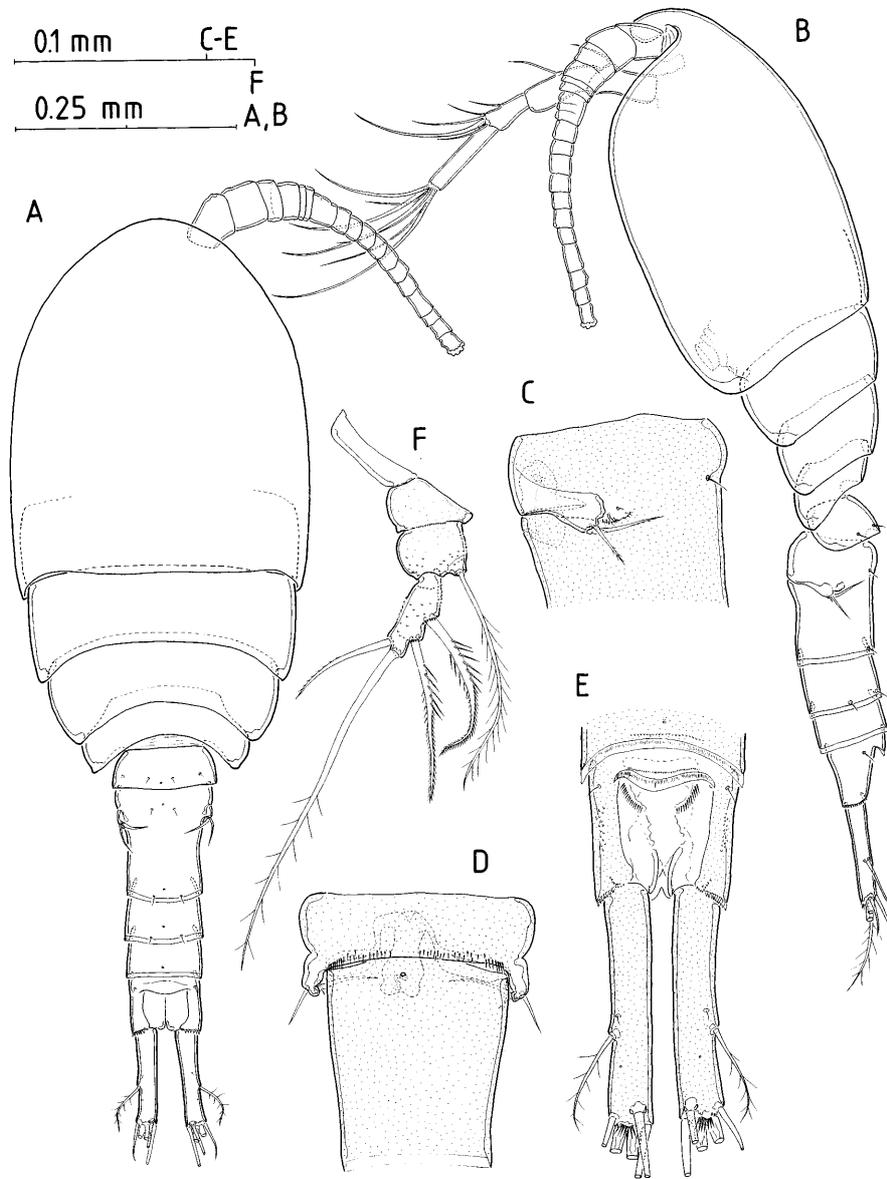


Figure 1. *Oromiina fortunata* gen. et sp. nov.; adult female. A, habitus, dorsal; B, lateral; C, genital double-somite, lateral; D, ventral; E, anal segment and caudal rami, dorsal; F, fifth leg, anterior.

with sutures incompletely separating the ancestral segments), 6 setae; segment 7 (XV), 1 seta; segment 8 (XVI), 1 seta + aesthetasc; segments 9 and 10 (XVII and XVIII), 1 seta each; segment 11 (XIX), naked; segment 12 (XX), 1 seta; segment 13 (XXI), 1 seta + aesthetasc; segment 14 (fused segments XXII and XXIII), 1 seta; segment 15 (XXIV), 2 setae; segment 16 (XXV), 2 setae + aesthetasc; segment 17 (XXVI to XXVIII), 7 setae + aesthetasc. Segments XXIV and XXV with 1 seta located at posterodistal angle. Apical aesthetasc fused at base to adjacent seta.

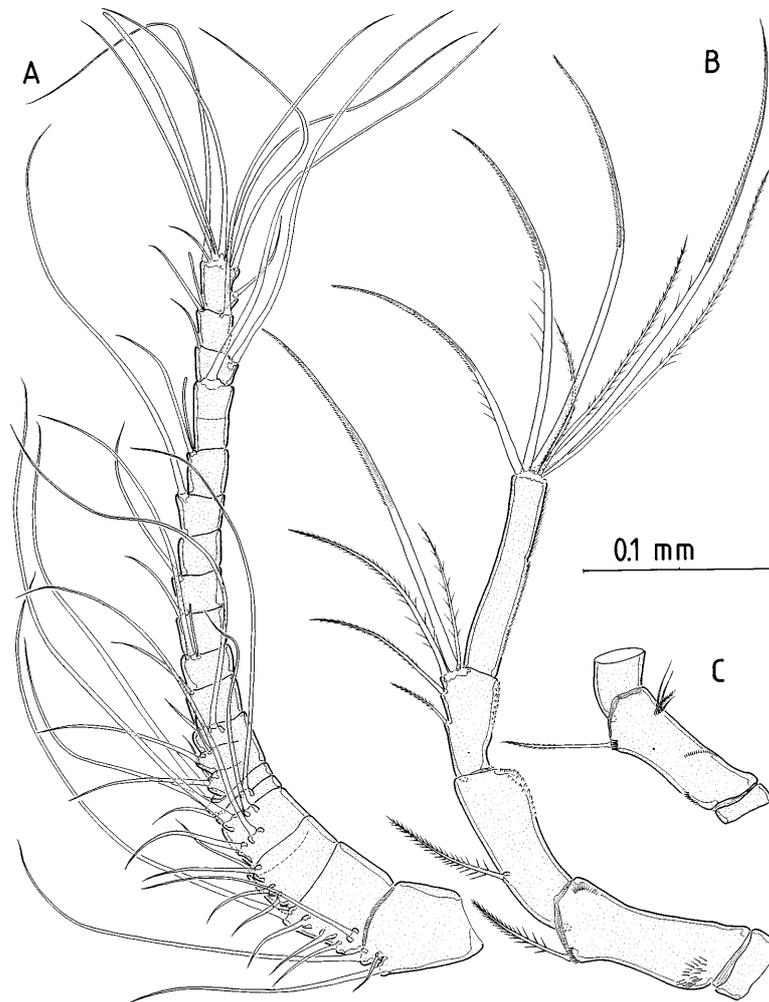


Figure 2. *Oromiina fortunata* gen. et sp. nov. A, adult female antennule, ventral; B, adult female antenna; C, proximal part of antenna of aberrant male, showing 4 (exopodal ?) setae on basis.

Antenna (Fig. 2B) 5-segmented, large, showing characteristic elongation of terminal segment, latter about 6 times longer than wide. Coxa distinct, unarmed. Basis armed with 1 inner seta distally; exopod absent. Endopod 3-segmented, with setal formula 1,5,7. Segments ornamented with several rows of spinules and setules, and patches of denticles, as figured.

Mandible (Fig. 3A) with large coxal gnathobase bearing 8 main cutting blades and 4 spine-like blades plus two subterminal rows of spinules as figured. Mandibular palp well developed, biramous. Basis elongate, bearing single inner seta. Endopod 2-segmented, with setal formula 3, 6. Exopod shorter than endopod, 4-segmented; setal formula 1,1,1,2. Some denticles on basis and exopodal segments, as figured.

Maxillule (Fig. 3B,C) biramous, with praecoxa, coxa and basis partially fused. Praecoxal arthrite well developed, armed with 12 unequal spines/setae; coxal

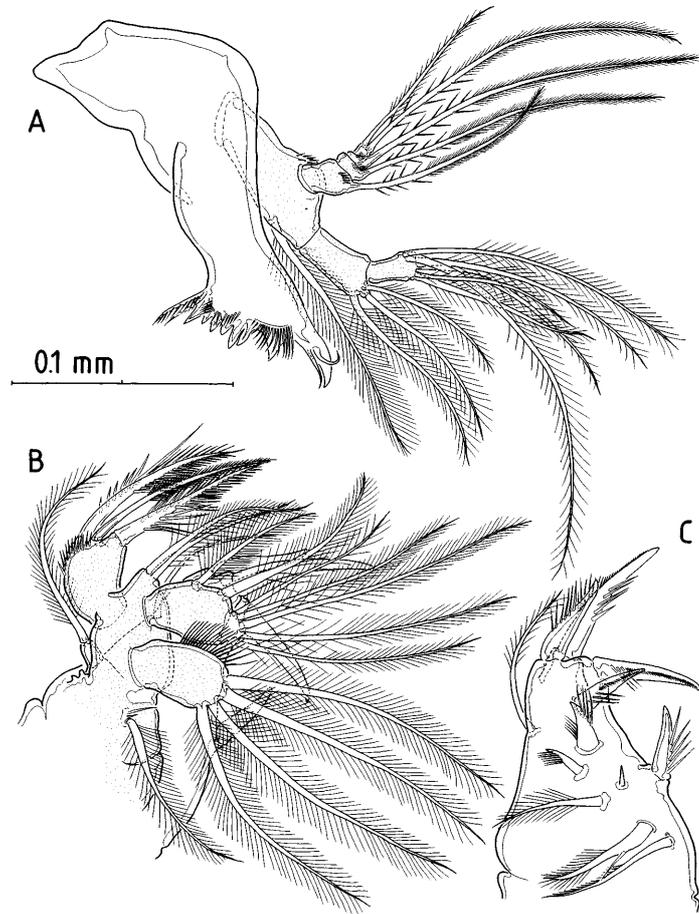


Figure 3. *Oromiina fortunata* gen. et sp. nov.; adult female. A, mandible; B, maxillary palp, posterior; C, detail of maxillary praecoxal arthrite, anterior.

epipodite represented by 3 setae, 2 of which reduced; coxal endite lobate, armed with 1 seta. Proximal and distal endites of basis discrete, bearing 3 and 2 setae respectively; proximal ornamented with patch of long spinules. Endopod unsegmented, armed with 7 setae. Exopod 1-segmented, about same size as endopod, bearing 4 setae distally and row of long setules on inner margin.

Maxilla (Fig. 4A–B) powerfully developed, 5-segmented. Praecoxa and coxa partially fused, setation formula for endites 4,1,3,3; subapical element on proximal coxal endite modified as thick spine with rounded tip, ornamented with cluster of 6 subapical setules. Basis with large endite bearing claw-like spine, articulated at origin, plus 2 unequal setae. Endopod 3-segmented, proximal segment double, representing fused first and second ancestral endopodal segments; setal formula (2+2),2,4.

Maxilliped (Fig. 4C) long and slender, 7-segmented: praecoxa and coxa fused forming syncoxa, with setal formula 1,3,2. Basis with medial margin ornamented

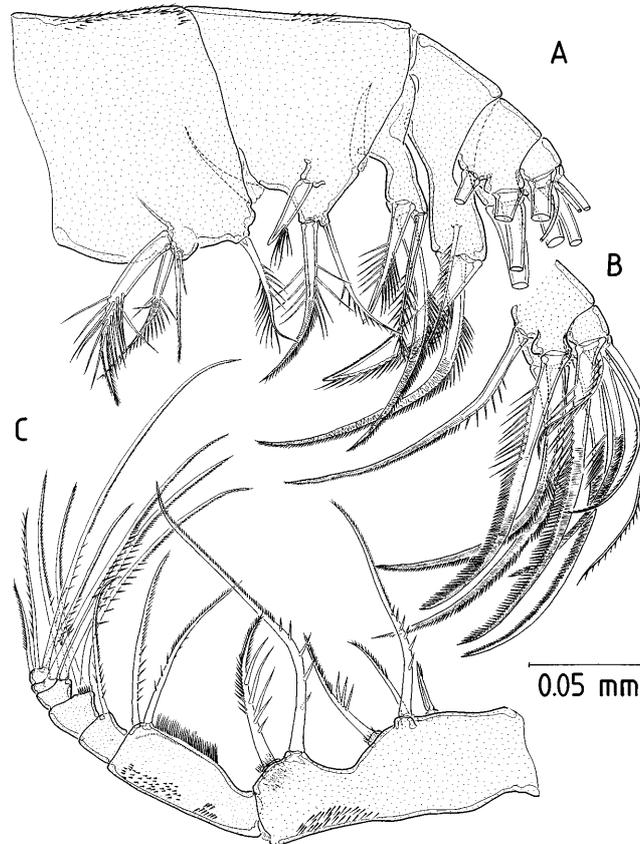


Figure 4. *Oromiina fortunata* gen. et sp. nov.; adult female. A, maxilla; B, detail of maxillary endopod; C, maxilliped.

with row of long setules and bearing 2 setae distally. Endopod 5-segmented, setal formula 1,2,2,1,4. Maxilliped segments ornamented with patches of denticles as figured.

Swimming legs 1 to 4 (Fig. 5A–E) biramous, both rami 3-segmented; praecoxa present; coxae joined by intercoxal sclerite adorned with 2 patches of small denticles. Spine and seta formula as follows:

	Coxa	Basis	Exopodal segment			Endopodal segment		
			1	2	3	1	2	3
Leg 1	0–1	1–I	I–1	I–1	III,I,4	0–1	0–2	1,2,3
Legs 2 & 3	0–1	1–0	I–1	I–1	III,I,5	0–1	0–2	1,2,3
Leg 4	0–1	1–0	I–1	I–1	II,I,5	0–1	0–2	1,2,2

Leg 4 with seta on first endopodal and proximal seta on second endopodal segment reduced; distal seta on second segment, and proximal inner seta on third segment stout, spiniform, ornamented as in figure. All legs richly ornamented with denticles and setules, especially on posterior surfaces (see Fig. 5D). Outer margin of

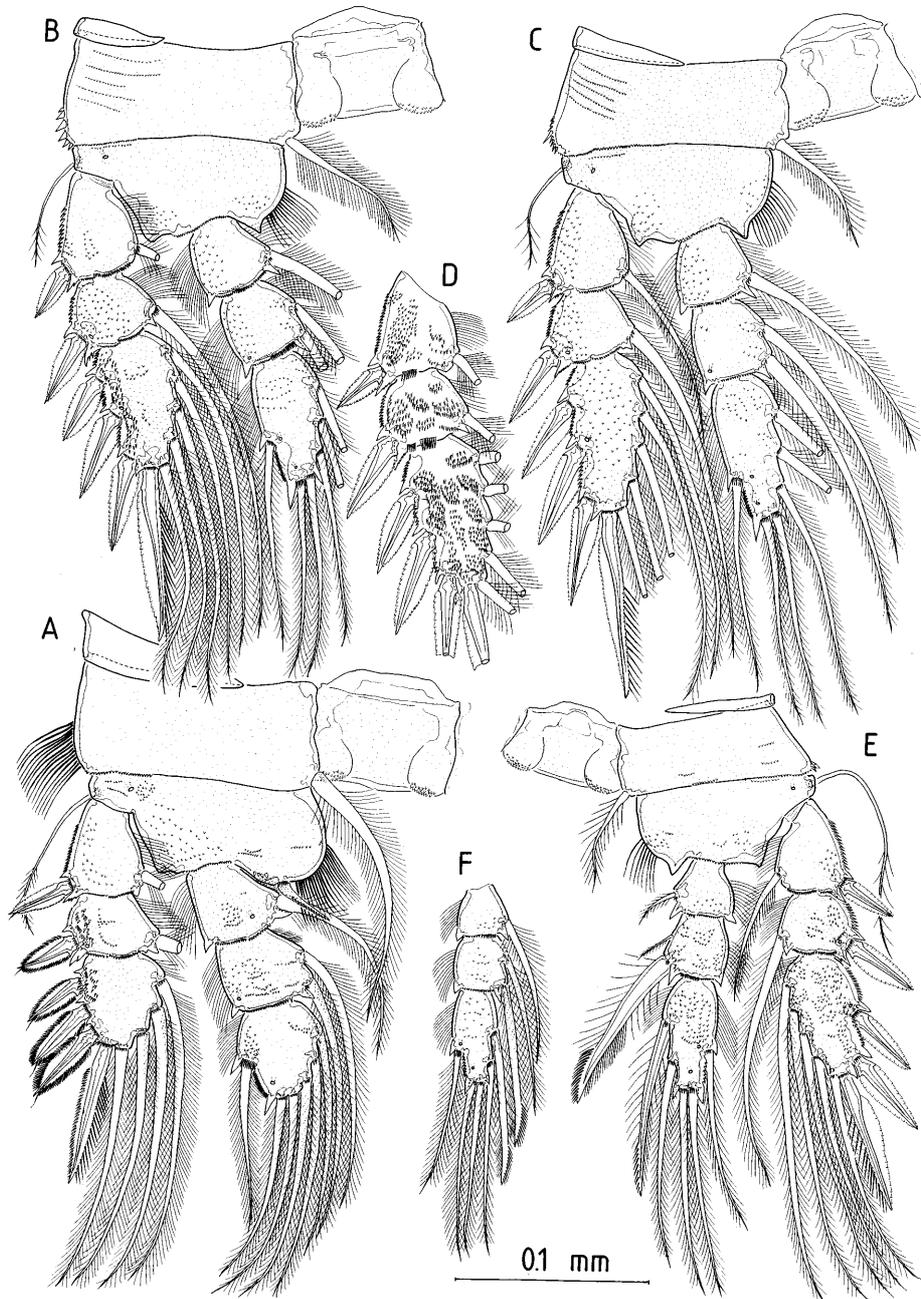


Figure 5. *Oromiina fortunata* gen. et sp. nov.; A–E, adult female; F, adult male. A; leg 1, anterior; B, leg 2, anterior; C, leg 3, anterior; D, leg 3 endopod, posterior; E, leg 4, anterior. F, leg 4 endopod, anterior.

coxa with row of long setules on leg 1, coxal margins with patches of stout denticles on legs 2 to 4, extending onto posterior surface. Integumental pores present on anterior surfaces of swimming legs as figured.

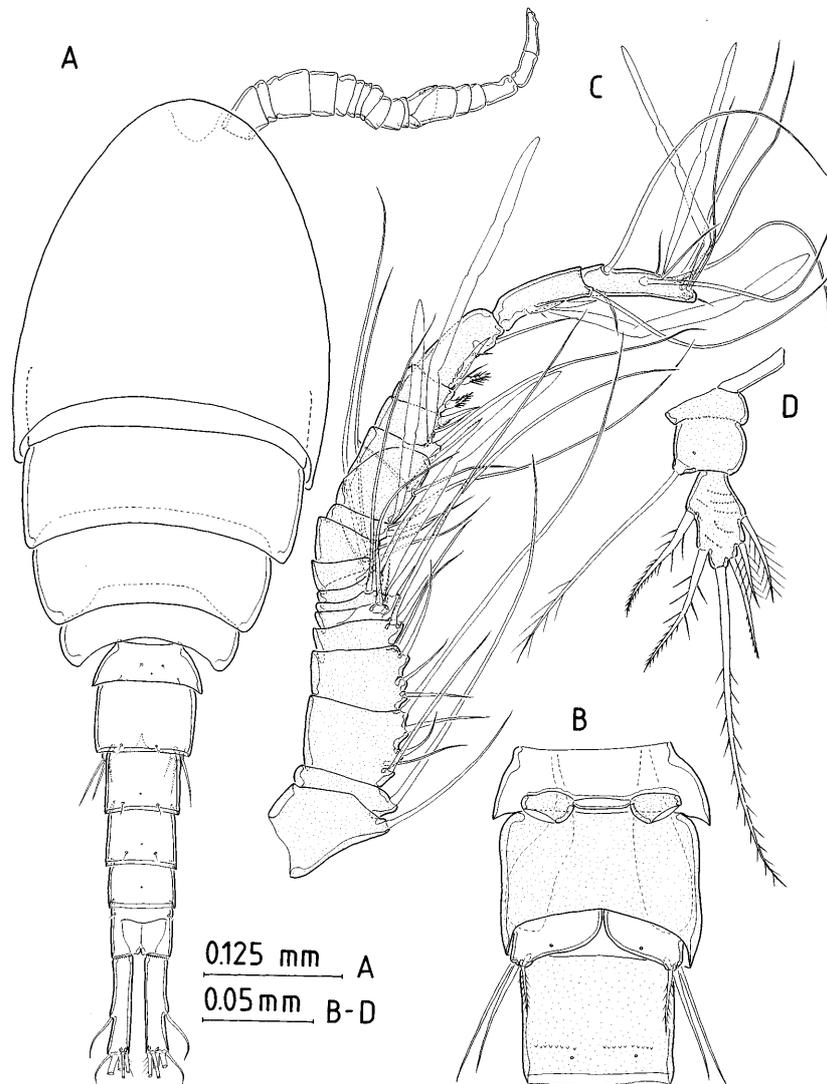


Figure 6. *Oromiina fortunata* gen. et sp. nov.; adult male. A, habitus, dorsal; B, genital region, ventral; C, antennule, ventral; D, fifth leg, anterior.

Fifth legs (Fig. 1F) uniramous, 3-segmented, joined by smooth intercoxal sclerite. Coxa and basis separate; coxa unarmed, basis with outer seta. Exopod slender, about twice as long as wide, armed with 2 stout setae on outer margin, 1 subdistal seta on inner margin, and long apical seta. Tiny denticles ornamenting surface of basis and exopod.

Adult male. Body (Fig. 6A) 0.80 to 0.90 mm long; form as in female. Urosome 6-segmented, with genital somite (Fig. 6B) symmetrical, laterally expanded; pair of gonopores opening ventrolaterally at posterior border of somite. Sixth legs reduced to paired opercular flaps, each armed with 2 long outer setae and short plumose inner seta.

Antennules (Fig. 6C) 18-segmented, symmetrical, digeniculate with geniculations between segments homologous with ancestral segments XV and XVI, and between XX and XXI. Segment XV cup-shaped, forming sheath around proximal half of segment XVI. Setation as follows: segment 1 (corresponding to ancestral segment I), 1 seta; segment 2 (ancestral segment II), 1 seta; segment 3 (corresponding to fused ancestral segments III to V), 5 setae; segment 4 (fused ancestral segments VI and VII), 4 setae; segment 5 (VIII), 2 setae; segment 6 (IX), 2 setae + aesthetasc; segments 7 to 10 (X to XIII), 2 setae each; segment 11 (XIV), 2 setae + aesthetasc; segment 12 (XV), 2 setae; segment 13 (XVI), 2 setae + aesthetasc; segments 14 and 15 (XVII and XVIII), 1 seta and 1 spinulate spine each; segment 16 (fused ancestral segments XIX and XX), 2 setae, 1 spinulate spine, plus 1 modified, flattened spine; segment 17 (fused ancestral segments XXI to XXIII), 2 setae, 2 modified, flattened spines + aesthetasc; segment 18 (fused ancestral segments XXIV to XXVIII), 10 setae + 2 aesthetascs; apical aesthetasc fused at base to adjacent seta.

Other mouthparts and swimming legs 1 to 4 as in female in segmentation and setation. Leg 4 sexually dimorphic: reduced setae on endopod of female well developed (attaining normal size) in males (Fig. 5F). One male, probably an aberrant individual, carried 4 seta-like elements on one of its antennae, in a position corresponding to the exopodal setae of other cyclopinids (Fig. 2C).

Fifth legs (Fig. 6D) 3-segmented, retaining intercoxal sclerite, as in female. Coxa unarmed; basis with outer seta; exopod with 2 setae on outer margin, 3 setae on inner margin, and long apical seta.

Etymology. The species name is derived from the ancient name of the Canary Islands, the 'Fortunate Isles'.

Remarks. The most outstanding feature of *Oromiina* is the length attained by the antennae, which are almost as long as the antennules. The combination of 3-segmented fifth legs in the female with 3-segmented fifth legs in the male is unique among cyclopinids; all other genera displaying a 3-segmented condition in females exhibit the plesiomorphic 4-segmented condition in the male. The number and location of setation elements on the exopodal segment of the male fifth leg of *Oromiina* indicates that the single exopodal segment is homologous with the 2 distal segments of a 4-segmented fifth leg as present in genera such as *Cyclopinoides* Lindberg, 1953, *Muceddina* Jaume & Boxshall, 1996, or *Ginesia* gen. nov.

Oromiina possesses the ancestral state for the Cyclopoida in many characters such as the segmentation of the mandible and maxilliped, the setation of the maxilla, and the setation and segmentation of swimming legs 1 to 4. The presence of a carapace-like, posterior extension of the dorsal cephalic shield overlying the separate first pedigerous somite is also considered to be the ancestral condition for the Cyclopoida by Huys & Boxshall (1991). These plesiomorphic character states are retained in several other genera. The male antennule is 18-segmented. This number of segments is the maximum recorded in the order Cyclopoida and was previously known only in the male of *Cyclopinoides longicornis* (Boeck, 1872) (see Huys & Boxshall, 1991: Fig. 2.8.4B) although *Ginesia* (described below) displays the same condition. *Oromiina* is also notable within the family Cyclopinidae in possessing the most plesiomorphic condition of the maxillule, retaining 12 setation elements on the praecoxal arthrite, 3 setae on the coxal epipodite, and a distinct, unisetose coxal endite. Three setae on the coxal epipodite have been reported only in *Cyclopicina* Lindberg, 1953 and *Muceddina*.

Using the key to genera provided by Huys & Boxshall (1990) for the Cyclopininae, *Oromiina* falls close to *Cyclopinodes* Wilson, 1932. Detailed comparisons, however, reveal numerous differences between *Oromiina* and *C. elegans* (Scott, 1894), as redescribed by Giesbrecht (1900) and Huys & Boxshall (1991). The fifth legs of both sexes retain the inner coxal seta in *Cyclopinodes*, whereas in *Oromiina* this seta is lost. The male fifth leg is 3-segmented in *Oromiina* but 4-segmented in *Cyclopinodes*. The female antennule is 17-segmented in *Oromiina* whereas in *Cyclopinodes* it is 18-segmented and displays a different segmental fusion pattern. The setation of the maxillule differs in the two taxa: the coxal epipodite is represented by 3 setae in *Oromiina*, only 2 in *Cyclopinodes*, and the endopod carries 7 setae in *Oromiina*, but only 6 in *Cyclopinodes*. Finally, the caudal rami of *Oromiina* lack seta I, which is retained in *Cyclopinodes*.

These numerous plesiomorphies exhibited by *Oromiina* place this genus near the base of the Cyclopinidae. The elongation of the antenna, the fusion of the exopodal segments in the male fifth leg, the loss of seta I from the caudal ramus and the 17-segmented antennules are apomorphic character states which together distinguish *Oromiina* from related genera such as *Cyclopinodes*, *Ginesia* and *Muceddina* and provide sufficient justification for the establishment of the new genus.

Ginesia **gen. nov.**

Diagnosis. Cyclopininae. Dorsal and lateral surfaces of prosomal somites ornamented with symmetrical arrangement of integumental tubercles; tubercles rounded in female, horn-like in male. Lateral margins of cephalosome and second pedigerous somite of male bearing linear array of irregular integumental pores. Epimeral plates of prosomal somites well developed in both sexes, more strongly produced in males. First pedigerous somite free, concealed beneath carapace-like posterior extension of dorsal cephalic shield of cephalosome. Caudal rami bearing 7 setae. Antennule 18-segmented in both sexes. Exopod of antenna represented by 2 setae. Mandibular palp with 2-segmented endopod and 4-segmented exopod. Maxillule bearing lobate, unisetose coxal endite. Endopod of maxilliped 5-segmented, setation formula 1,1,1, 1,4. Legs 1 to 4 with 3-segmented rami; spine and seta formula as for type species. Fifth legs 3-segmented in female, 4-segmented in male, retaining intercoxal sclerite; armature formula 0,1,4 in female, 0,1,2,4 in male. Sixth legs armed with 3 elements in both sexes.

Etymology. The new genus honours the Mallorcan speleologists Joaquín and Angel Ginés, who first remarked to us on the potential of Cova de na Barxa for the study of anchihaline fauna.

Type species. *Ginesia longicaudata* sp. nov., here designated.

Ginesia longicaudata **sp. nov.**

(Figs 7–10)

Material examined. Cova de na Barxa (Capdepera, Mallorca, Balearic Islands). UTM coordinates: 539,30; 4393,10. Fossil coastal cave excavated in Triassic fissured

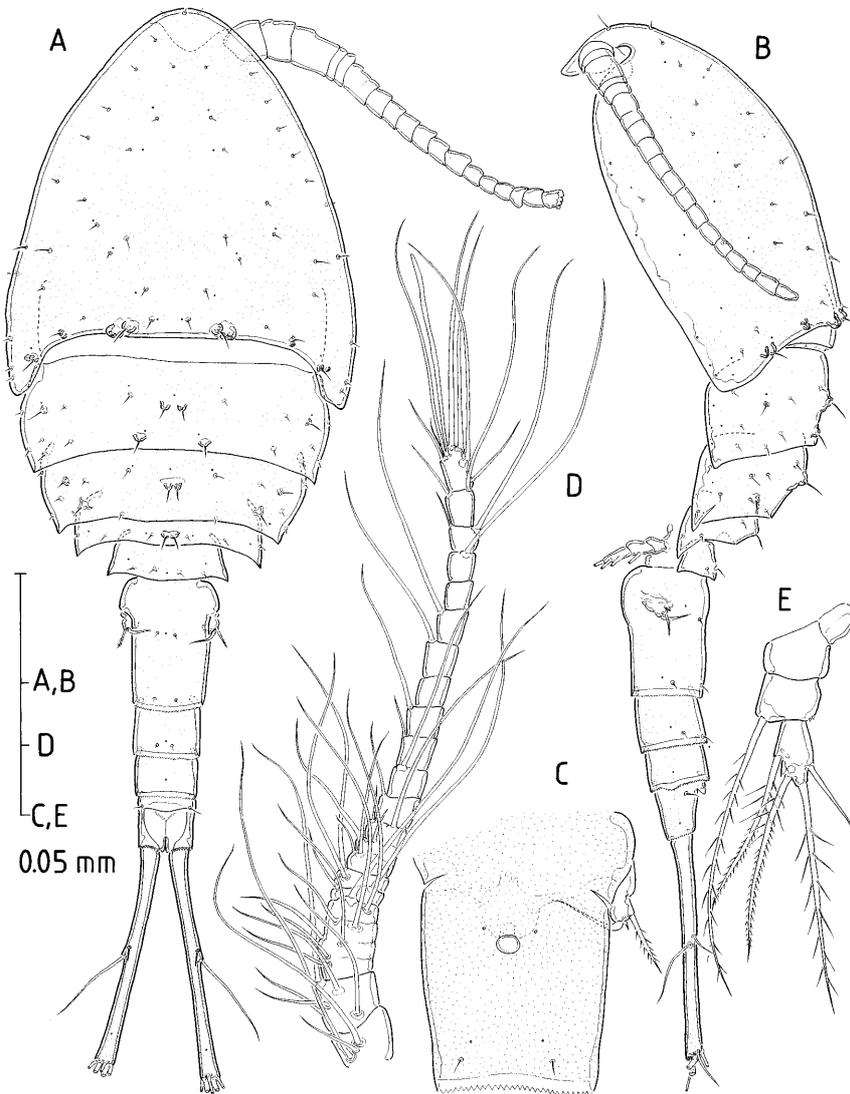


Figure 7. *Ginesia longicaudata* gen. et sp. nov.; adult female. A, habitus, dorsal; B, ventral; C, genital double-somite, ventral; D, antennule, ventral; E, fifth leg, anterior.

limestone. Topography published by Andrews *et al.* (1989). HOLOTYPE adult female dissected and mounted in Lactophenol (series of 6 slides; MNCM 329); PARATYPE adult male partially dissected (entire prosome plus 2 slides containing urosome and fourth and fifth legs; MNCM 330). Collected by authors, 3 April 1995.

Comparative material examined. *Cyclopinoides litoralis* (Brady, 1872); Cova de sa Llumeta (Cabrera, Balearic Islands): Two adult females (MNCM 185); collected by D. Jaume, 10 August 1993. Cova de na Mitjana (Mallorca, Balearic Islands): Single adult female (MNCM 186); collected by authors, 1 April 1995.

Description

Adult female. Body (Fig. 7A,B) cycloform, colourless, 0.49 mm long. Integument of body somites and caudal rami pitted. Nauplius eye absent. Rostrum well developed. Prosome 5-segmented, comprising cephalosome plus 4 free pedigerous somites. First pedigerous somite concealed beneath carapace-like posterior extension of dorsal cephalic shield. Free pedigerous somites 2 to 4 with well developed epimeral plates, with pointed posterolateral angles. Dorsal and lateral surfaces of prosomal somites ornamented with symmetrical pattern of integumental pores, sensillae and epicuticular processes bearing apical sensilla; integumental ornamentation absent from first pedigerous somite.

Urosome 5-segmented. Fifth pedigerous somite with pointed posterolateral angles; surface ornamented as prosomites. Genital and first abdominal somites fused to form genital double-somite (Fig. 7C). Genital double-somite symmetrical, longer than wide, slightly expanded anteriorly. Single copulatory pore large, opening in middle of ventral surface, connected via copulatory duct to fused seminal receptacles. Paired gonopores located laterally, connected to receptacles by receptacle ducts. Gonopores covered by opercula derived from sixth legs, each armed with 3 unequal setae, dorsalmost very reduced, ventralmost longest and lying along surface of somite. Double-somite and free abdominal somites, except anal somite, ornamented with finely serrate hyaline frill along posterior margin. Anal somite ornamented with pair of sensillae and row of spinules along posterior margin; anus located dorsally, with weakly developed operculum. Caudal rami elongate, 12 times as long as wide. Armature consisting of 7 setae; setae I and II originating near middle of lateral margin of ramus; rami ornamented with terminal row of spinules ventrally.

Antennules (Fig. 7D) 18-segmented, slightly longer than cephalosome. Segmentation as follows: segment 1 (corresponding to fused ancestral segments I and II), 3 setae; segment 2 (fused ancestral segments III to V), 5 setae; segment 3 (partially fused segments VI to IX), 8 setae; segments 4 and 5 (X and XI), 2 setae each; segment 6 (partially fused segments XII to XIV), 6 setae; segments 7 to 10 (XV to XVIII), 1 seta each; segment 11 (XIX), naked; segments 12 and 13 (XX and XXI), 1 seta each; segment 14 (XXII), naked; segment 15 (XXIII), 1 seta; segments 16 and 17 (XXIV and XXV), 2 setae each; segment 18 (fused XXVI to XXVIII), 7 setae + aesthetasc. Segments XXIV and XXV with 1 seta located at posterior distal angle. Apical aesthetasc fused at base to adjacent seta.

Antenna (Fig. 8A) 4-segmented; first segment comprising fused coxa and basis, armed with inner basal seta distally, and 2 short, outer setae representing exopod. Endopod 3-segmented, setal formula 1,5,7; surface of all antennal segments ornamented with minute spinules or denticles, as figured.

Mandible (Fig. 8B) with well developed coxal gnathobase as figured. Palp large, biramous. Basis elongate, bearing single seta plus 5 long setules on inner surface. Endopod 2-segmented, setal formula 3,6; single setule present proximally on inner margin of first segment. Exopod 4-segmented, proximal segment double; setal formula 1,1,1,2.

Maxillule (Fig. 8C) biramous. Praecoxal arthrite well developed, armed with 7 stout and 3 slender elements; ornamented with patch of denticles on anterior surface; posterior surface unarmed. Coxal epipodite represented by 2 unequal setae; coxal endite lobate, bearing single seta. Proximal and distal endites of basis discrete, bearing 3 and 2 setae respectively. Endopod unsegmented, bearing 7 setae. Exopod

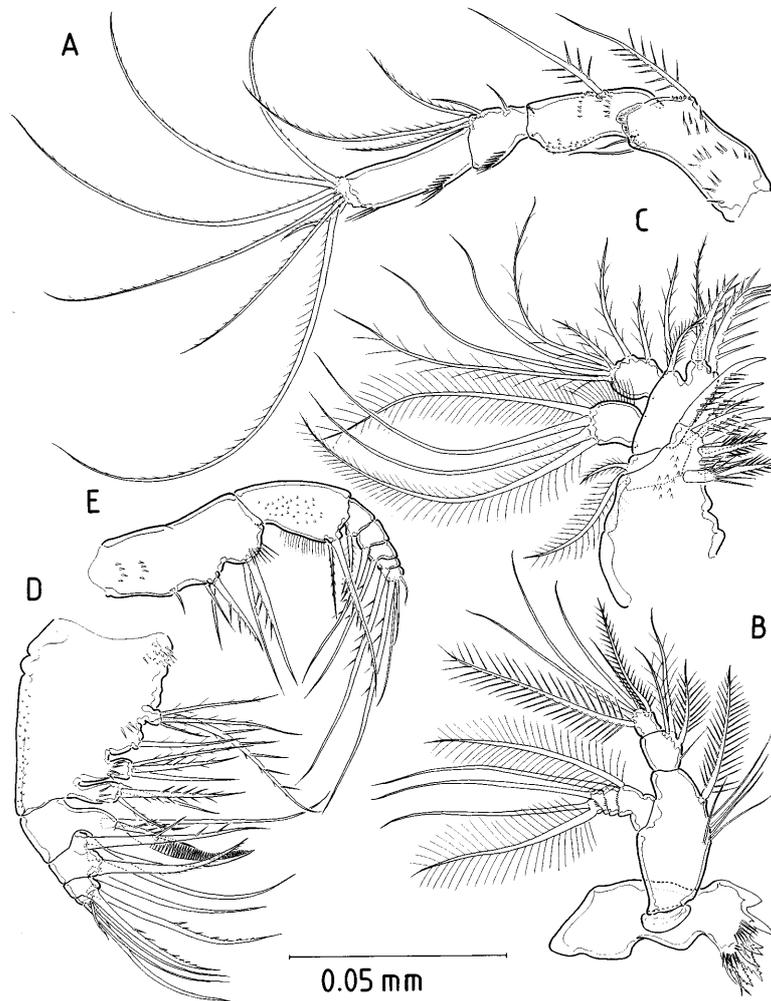


Figure 8. *Ginesia longicaudata* gen. et sp. nov.; adult female. A, antenna; B, mandible; C, maxillule, anterior; D, maxilla; E, maxilliped.

1-segmented, about same size as endopod, armed with 4 setae distally, ornamented with row of long setules on inner margin.

Maxilla (Fig. 8D) 5-segmented; praecoxa and coxa fused, setal formula of endites 4,1,3,3; surface of syncoxa ornamented with patches of denticles. Basis with large endite armed with claw, fused to segment at base, plus 2 unequal setae; claw with row of lamellate spinules. Endopod 3-segmented, proximal segment double; setal formula (2+2),2,4.

Maxilliped (Fig. 8E) slender, 7-segmented; praecoxa and coxa fused; syncoxal endites represented by setation elements with formula 1,3,2; distal endite with row of long setules. Basis with swollen medial margin, bearing 2 distal setae and row of long setules. Surface of syncoxa and basis with patches of denticles, as figured. Endopod 5-segmented; setal formula 1,1,1,1,4.

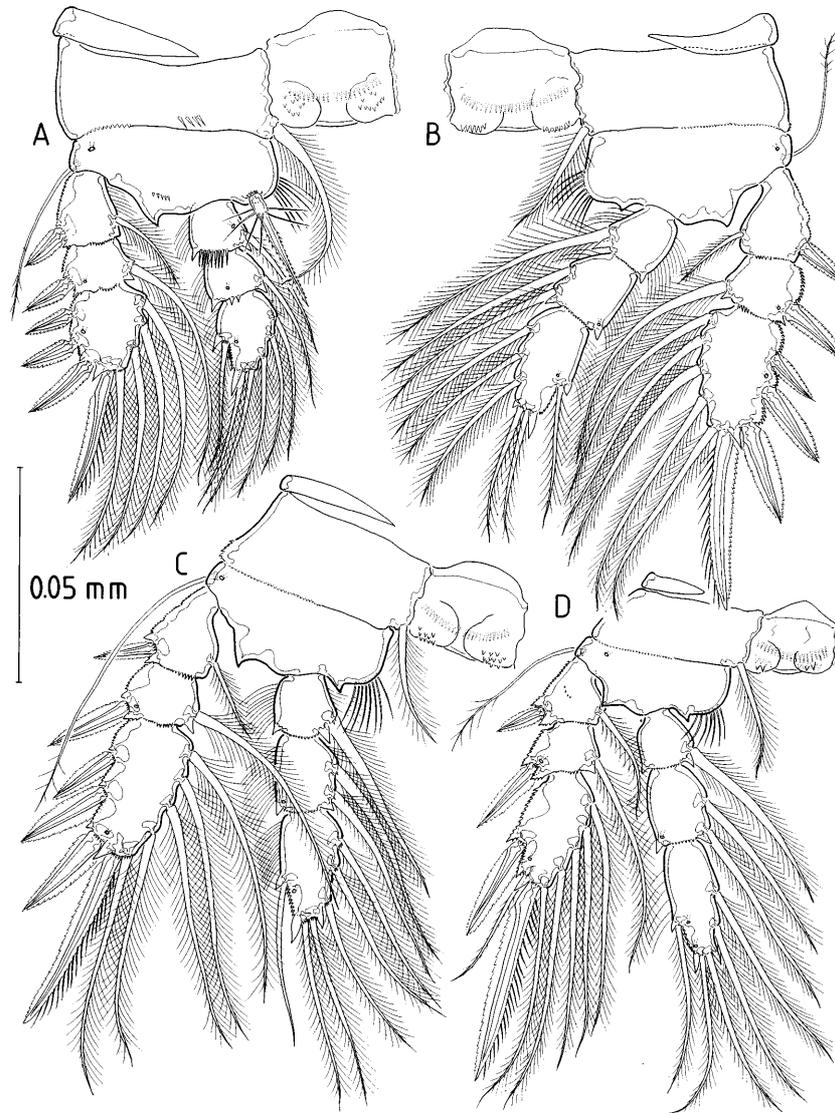


Figure 9. *Ginesia longicaudata* gen. et sp. nov.; A to D, adult female swimming legs 1 to 4, anterior.

Swimming legs 1 to 4 (Fig. 9A–D) biramous, both rami 3-segmented; praecoxa present; coxae joined by intercoxal sclerite ornamented with two patches of small denticles on anterior surface and row of short spinules on posterior surface. Spine and seta formula as follows:

	Coxa	Basis	Exopodal segment			Endopodal segment		
			1	2	3	1	2	3
Leg 1	0-1	1-I	I-1	I-1	III, I, 4	0-1	0-1	1, 2, 3
Legs 2 & 3	0-1	1-0	I-1	I-1	III, I, 5	0-1	0-2	1, 2, 3
Leg 4	0-1	1-0	I-1	I-1	I + 1, I, 5	0-1	0-2	1, 2, 2

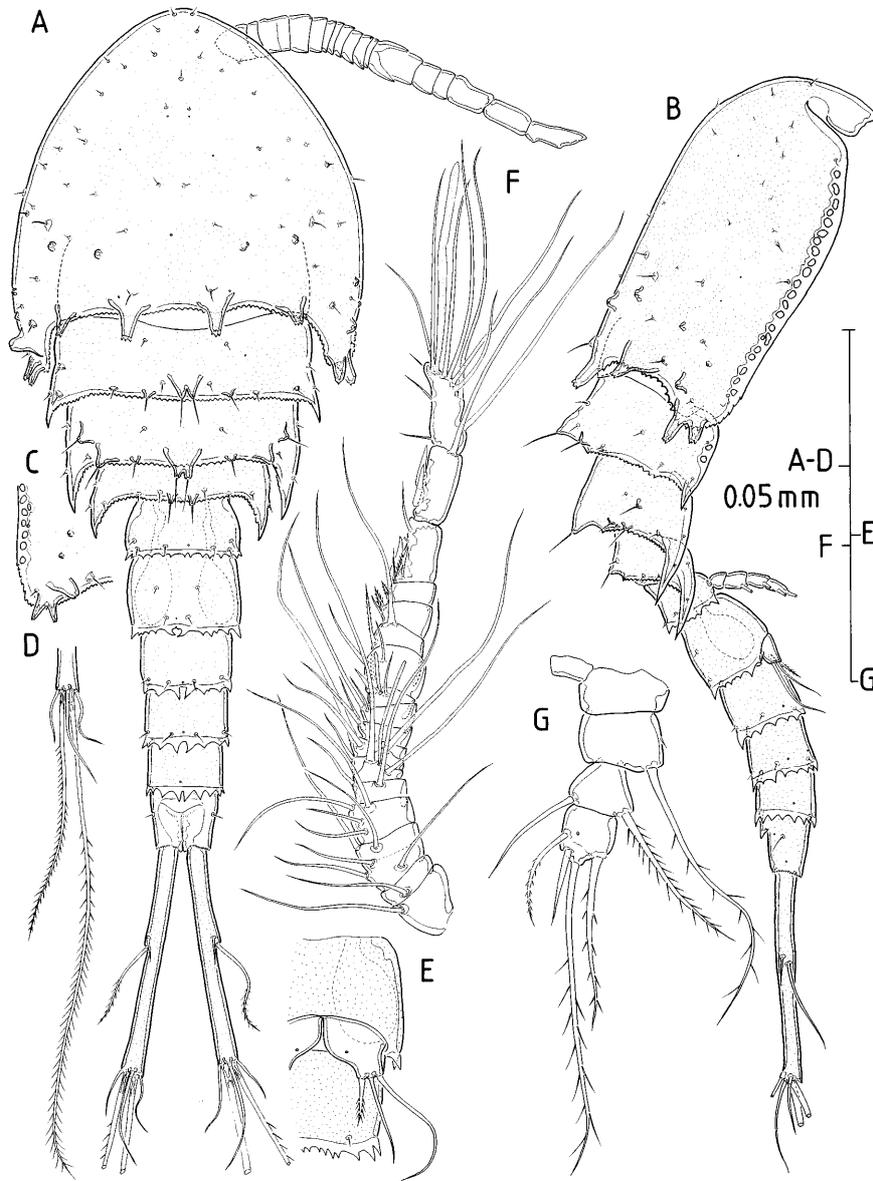


Figure 10. *Ginesia longicaudata* gen. et sp. nov.; adult male. A, habitus, dorsal; B, ventral; C, detail of left posterolateral angle of dorsal cephalic shield; D, tip and distal setae of left caudal ramus, dorsal. E, genital somite, ventral; F, antennule, ventral; G, fifth leg, anterior.

Pattern of integumental pores on anterior surface of swimming legs as figured.

Fifth legs (Fig. 7E) uniramous, 3-segmented, joined by intercoxal sclerite. Coxa and basis separate, coxa unarmed, basis with outer seta. Exopodal segment slender, armed with 2 long setae on outer margin, 1 subdistal short seta on inner margin, and long apical seta.

Adult male. Body (Fig. 10A,B) 0.45 mm long; gross body form similar to that of female. Integumental processes on dorsal and lateral surfaces of prosomites more pronounced than in female: ornamentation pattern basically symmetrical except for processes at posterolateral angles of cephalosome (cf. Fig. 1B and 1D); integumental processes along posterodorsal rim of cephalosome forming blunt, backwardly-directed, horn-like projections. Epimeral plates on second to fourth pedigerous somites strongly developed, with posterior angles produced into falcate processes. Lateral margins of cephalosome bearing linear array of irregular pores; array of pores extending onto lateral margin of second pedigerous somite. Posterodorsal margin of cephalosome and second to fourth pedigerous somites denticulate; margin of first pedigerous somite smooth.

Urosome 6-segmented, with genital somite (Fig. 10E) expanded laterally; paired gonopores opening ventrolaterally at posterior border of somite. Sixth legs reduced to paired opercular flaps, each armed with 2 long outer setae and short plumose inner spine. Posterior margin of urosomites (except anal somite) ornamented with array of irregular denticles.

Antennules (Fig. 10F) 18-segmented, digeniculate: geniculations between segments homologous with ancestral segments XV and XVI, and between XX and XXI. Segment XV cup-shaped, forming sheath around proximal half of segment XVI. Setation as follows: segments 1 and 2 (corresponding to ancestral segments I and II), 1 seta each; segment 3 (fused ancestral segments III to V, fusion between IV and V partial), 5 setae; segment 4 (fused segments VI and VII), 4 setae; segment 5 (VIII), 2 setae; segment 6 (IX), 2 setae + aesthetasc; segments 7 to 10 (X to XIII), 2 setae each; segment 11 (XIV), 1 spine, 1 seta + aesthetasc; segments 12 and 13 (XV and XVI), 2 setae each; segment 14 (XVII), 1 seta and 1 spinulate spine; segment 15 (XVIII), 1 spinulate spine plus 1 seta; segment 16 (fused XIX and XX), 2 setae, 1 spinulate spine, plus 1 flattened, modified spine-like element; segment 17 (fused XXI to XXIII), 1 seta plus 2 flattened, modified spine-like elements; segment 18 (fused XXIV to XXVIII), 11 setae + aesthetasc. Apical aesthetasc fused at base to adjacent seta.

Other mouthparts and swimming legs 1 to 4 as in female in segmentation and setation.

Fifth legs (Fig. 10G) uniramous, 4-segmented, retaining intercoxal sclerite. Coxa and basis separate: coxa unarmed; basis with 1 long outer seta. Exopod 2-segmented; proximal segment with 1 inner and 1 outer seta; distal segment with 4 unequal elements.

Etymology. This species is named after its extraordinarily elongate caudal rami.

Remarks. *Ginesia* gen. nov. is unusual among cyclopoid copepods because of the elaborate ornamentation of the body somites, that is especially apparent in the male. The paired arrangement of tubercles on the prosomites, the strong development of the epimeral plates, and the backwardly-directed, horn-like processes on the cephalosome of the male are all unique features for cyclopoids. Although not equalling the exuberant integumental ornamentation displayed by the members of some deep-sea harpacticoid families, such as the Styraethoracidae Huys, 1993 or the Cerviniidae Sars, 1903, the ornamentation of *Ginesia* contrasts sharply with the typically smooth integument of other cyclopoid taxa.

The linear array of large pores located along the lateral margins of the dorsal cephalic shield and second pedigerous somite of the male of *Ginesia* is similar to the

array reported in the female of *Cyclopicina* within the Cyclopinidae (Huys & Boxshall, 1990), and from males of some representatives of other cyclopoid families, such as the Notodelphyidae (Hipeau-Jacquotte, 1986) and Oithonidae (Nishida, 1986). It has been suggested that this array functions as a chemosensor and is involved in mate recognition (Uchima & Murano, 1988; Huys & Boxshall, 1990).

Ginesia longicaudata exhibits some of the plesiomorphic character states attributed to the hypothetical ancestor of the order Cyclopoida, including the carapace-like, posterior extension of the dorsal cephalic shield, the free first pedigerous somite not incorporated into the cephalosome, the retention of 7 setae on caudal rami, the 18-segmented male antennule (only equalled by the males of *Oromiina fortunata* and *Cyclopinoides longicornis*; see Huys & Boxshall, 1991: fig. 2.8.4B), the setation of the maxilla (although the praecoxa and coxa are fused), the 5-segmented exopod of the maxilliped, and the segmentation of the fifth legs of both sexes, 3-segmented in female, 4-segmented in male.

Excluding its unique integumental outgrowths and linear arrays of pores, *Ginesia* is very similar to *Cyclopinoides*. Comparisons with *Cyclopinoides litoralis* revealed that the females of both taxa have the first pedigerous somite free but concealed by a carapace-like posterior extension of the dorsal cephalic shield and both display identical segmentation and setation patterns for the antennule, antenna, mandible, maxillule and maxilla (although the maxillary praecoxa and coxa are only partly fused in *Cyclopinoides*). The segmentation and setation of swimming legs 1 to 4 are also identical, including the transformation of the distal armature element on the outer margin of the third exopodal segment of leg 4 from a spine into a seta.

Comparison between the detailed illustrations of the male antennule of *Cyclopinoides longicornis* provided by Huys & Boxshall (1991) with *Ginesia* reveals an identical segmentation pattern, but the setation differs in the distal segment: 9 setae + aesthetasc in *Cyclopinoides*, 11 setae + aesthetasc in *Ginesia*. The presence of an aesthetasc on segment X of *Cyclopinoides*, as figured by Huys & Boxshall (1991), requires confirmation since the aesthetasc retained in this region of the male antennule in cyclopoids is usually that on segment IX and aesthetasc retention is highly conservative. The aesthetasc originating on segment IX is retained in *Ginesia* and other taxa, such as *Euryte* Philippi, 1843, *Neocyclops* (*Protoneocyclops*) Petkovski, 1986, *Muceddina* Jaume & Boxshall, 1996, and *Oromiina*, and we suspect that in *C. longicornis* the true origin of the aesthetasc may be on segment IX rather than segment X as figured.

The important diagnostic differences between *Ginesia* and *Cyclopinoides* include the setation of the maxilliped and the caudal rami. The setation formula of the maxillipedal endopod is 1,2,2,1,4 in *Cyclopinoides*, compared to 1,1,1,1,4 in *Ginesia*. In *Cyclopinoides*, the caudal rami have lost seta I, whereas *Ginesia* retains the full complement of 7 setae.

Ginesia also resembles *Muceddina*. Both genera share the derived setation formula of 1,1,1,1,4 for the maxillipedal endopod but they are most readily distinguished by the 15-segmented antennule of female *Muceddina*.

KEY TO GENERA OF THE FAMILY CYCLOPINIDAE

The Cyclopinidae is difficult to define in terms of apomorphies. The single unifying apomorphy of the family reported by Huys & Boxshall (1990, 1991) was

the fully fused genital double-somite of the female, but the value of this character state has been reduced by the discovery of *Muceddina*, which displays partial fusion between genital and first abdominal somites (Jaume & Boxshall, 1996a). The family may be paraphyletic but we consider it possible that new synapomorphies will be revealed as many of the poorly known genera are resdescribed to modern standards.

The family comprises two subfamilies, currently accommodating a total of 37 genera (including those described in the present account). The following key is basically an updated version of the key to genera of Cyclopininae presented by Huys & Boxshall (1990), although expanded to include the 2 genera constituting the Pterinopsyllinae Kiefer, 1927. Abbreviations used in the key are: A1 = antennule, A2 = antenna, Md = mandible, Mx1 = maxillule, Mxp = maxilliped, P1–P6 = legs 1 to 6, exp (1–3) = exopod (segments 1 to 3), enp (1–3) = endopod (segments 1 to 3). The key is applicable to both sexes.

1. A2 with enp (2–3) fused to form double-segment; enp (1) incompletely fused to coxobasis *Pterinopsyllus* Brady, 1880
A2 with enp comprising 2 or 3 free segments 2
2. Enp of P1 2-segmented 3
Enp of P1 3-segmented 11
3. Enp of P2–P4 2-segmented 4
Enp of P2–P3 2-segmented, P4 3-segmented *Microcyclopina* Plesa, 1961
Enp of P2–P4 3-segmented 9
4. Exp of P1 2-segmented 5
Exp of P1 3-segmented 6
5. Exp of P2–P4 2-segmented *Arenocyclopina* Krishnaswamy, 1957
Exp of P2–P3 3-segmented (exp P4 2-segmented in female, 3-segmented in male) *Neocyclopina* Herbst, 1952
6. Exp (2) of P1–P4 with inner seta; enp (1) of P2–P4 with inner seta; enp (2) of P1–P4 with 3, 4 or 5 setae 7
Exp (2) of P1–P4 without inner seta; enp (1) of P2–P4 without inner seta; enp (2) of P1–P4 with 2 setae *Herbstina* Huys & Boxshall, 1990
7. Exp (3) of P1–P4 with 8,9,9,8 spines/setae 8
Exp (3) of P1–P4 with 7,9,7,7 spines/setae; enp (2) of P1–P4 with 4,3,4,4 spines/setae; A1 female 6-segmented *Indocyclopina* Wells, 1967
8. Enp (2) of P1–P4 with 4,5,5,5 spines/setae; A1 female 8-segmented *Erythropolites* Huys & Boxshall, 1990
Enp (2) of P1–P4 with 4,4,4,4 spines/setae; A1 female 9-segmented *Cuipora* Lotufo & da Rocha, 1991
9. Enp (2) of P2–P4 with 1 inner seta; exp (1–2) of P1 without inner seta *Afroscyclopina* Wells, 1967
Enp (2) of P2–P4 with 2 inner setae; exp (1–2) of P1 with inner seta 10
10. A2 with enp (1) and basis fused to form allobasis *Cyclopuella* Por, 1979
A2 with enp (1) not incorporated into basis *Cyclopina* Claus, 1863
11. P5 of both sexes comprising single segment bearing 4 setae/spines *Paracyclopina* Smirnov, 1935
P5 of several segments, or when 1-segmented bearing less than 4 setae/spines 12
12. Enp (2) of P1 with 2 inner setae 13
Enp (2) of P1 with 1 inner seta 16

13. A1 female 26-segmented; exp of A2 represented by 3 setae,
 coxa with inner seta *Cyclopicina* Lindberg, 1953
 A1 female at most 21-segmented; exp of A2 at most represented by 1 seta,
 coxa asetose 14
14. Female A1 with more than 16 segments; md exp 4-segmented 15
 Female A1 11-segmented; md exp
 unsegmented *Pterinopsyllotus* Herbst, 1989
15. P5 2-segmented in female, 3-segmented in male; male exp of P2
 with modified spines *Pseudocyclopina* Lang, 1946
 P5 3-segmented in both sexes; male exp of P2 not
 modified *Oromiina* gen. nov.
 P5 3-segmented in female, 4-segmented in male; male exp of P2
 not modified *Cyclopinodes* Wilson, 1932
16. Palp of md uniramous, represented by a long segment bearing
 2 setae *Psammocyclopina* Wells, 1967
 Palp of md biramous 17
17. Exp of md represented by single seta only *Cyclopinella* Sars, 1913
 Exp of md 3-segmented *Cyclopinopsis* Smirnov, 1935
 Exp of md 1-(in *Heterocyclopina*) or 4-segmented 18
18. Exp of P5 a single segment bearing 2 setae in both sexes; A1
 female 8-segmented *Cryptocyclopina* Monchenko, 1979
 Exp of P5 with at least 3 setae/spines; A1 female at least 9-segmented . . 19
19. P5 3-segmented in female (comprising coxa, basis and exp);
 4-segmented in male (with 2-segmented exp) 20
 P5 at most 2-segmented in female; at most 3-segmented in male 23
20. P1–P4 with 8,9,9,8 spines/setae on exp (3), 6,6,6,5 on enp (3) 21
 P1–P4 with 6,7,7,7 spines/setae on exp (3), 4,4,4,4 on enp (3);
 A1 female 10-segmented *Metacyclopina* Lindberg, 1953
21. A1 18-segmented in both sexes 22
 A1 female 15-segmented; enp of mxp armature formula
 1,1,1,1,4 *Muceddina* Jaume & Boxshall, 1996
22. Enp of mxp armature formula 1,1 or 2,2,1,4 *Cyclopinoides* Lindberg, 1953
 Enp of mxp armature formula 1,1,1,1,4 *Ginesia* gen. nov.
23. A2 with strong plumose setae; basis of md with 2 setae;
 female P5 1-segmented, bearing 3 setae *Cyclopetta* Sars, 1913
 A2 not modified; female P5 2-segmented 24
24. Enp (2) of P4 with 1 inner seta 25
 Enp (2) of P4 with 2 inner setae 26
25. A1 female 18-segmented; P5 male 3-segmented; exp of P5 female
 with 3 setae/spines *Heterocyclopina* Plesa, 1968
 A1 female 10-segmented; P5 male 2-segmented; exp of P5 female
 with 4 setae/spines *Allocyclopina* Kiefer, 1954
26. Enp of mxp 2-segmented 27
 Enp of mxp at least 3-segmented 28
27. Exp (3) of P3 with 8 spines/setae; Exp of A2 represented by 2 setae;
 A1 female 16-segmented *Arctocyclopina* Mohammed & Neuhoof, 1985
 Exp (3) of P3 with 9 spines/setae; exp of A2 absent; A1 female
 9-segmented *Paracyclopetta* Wells, 1967
28. Enp (3) of P1 with 4 spines/setae *Hemicyclopina* Herbst, 1953

- Enp (3) of P1 with 5 spines/setae 29
 Enp (3) of P1 with 6 spines/setae 32
 29. Epipodite of Mx1 represented by 2 setae; exp of P5 with 2 spines
 and 1 seta in female 30
 Epipodite of Mx1 represented by 1 seta or absent; exp of P5 with 3 spines
 and 1 seta in female 31
 30. A1 female 19-segmented; exp A2 absent; exp mxp
 4-segmented *Procyclopina* Herbst, 1955
 A1 female 10-segmented; exp of A2 represented by 2 setae; exp of mxp 3-
 segmented *Troglocyclopina* Jaume & Boxshall, 1996
 31. Enp of mxp 4-segmented; exp (1) of P1 without
 inner seta *Glareolina* Huys & Boxshall, 1990
 Enp of mxp 5-segmented; exp (1) of P1 with inner
 seta *Parapseudocyclopinodes* Lindberg, 1961
 32. Exp of A2 represented by 2 setae; A1 female at least 16-segmented . . . 33
 Exp of A2 observ, or represented by 1 seta or (rarely) 2 setae; A1 female
 10- to 13-segmented *Cyclopina* Claus, 1863
 33. Enp of mxp 4-segmented; A1 female
 19-segmented *Cyclopidina* Steuer, 1940
 Enp of Mxp 3-segmented; A1 female
 16-segmented *Cyclopinotus* Monchenko, 1989

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