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ORIGINAL ARTICLE

Pedro Martínez Arbizu

Giselinidae fam. nov., a new monophyletic group of cyclopoid copepods (Copepoda, Crustacea) from the Atlantic deep sea

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Abstract Four new species of Cyclopoida from deep-sea waters are described and placed in two new genera: *Giselina* gen. n. and *Sensogiselina* gen. n. The new genera and species belong to a new monophyletic group within the cyclopinid cyclopoids. A new name, Giselinidae, is proposed for this monophylum. The new family is characterised by the combination of the following characters: (1) tergite of leg 1 fused to cephalosome dorsally, but incompletely fused laterally, (2) absence of aesthetascs on ancestral antennulary segments XVI, XXI and XXV, (3) absence of antennary exopodal setae, (4) presence of only three spines on distal exopodal segment of leg 1, (5) absence of inner setae on first endopodal segments of legs 1–4, (6) outer terminal and distal inner elements of distal endopodal segment of leg 4 transformed into spines, (7) distal outer element of leg 5 exopod transformed into a spine, (8) leg 6 with only one seta, and (9) furcal setae I and III located on dorsal margin.

Keywords Copepoda · Cyclopoida · Giselinidae · *Giselina* · *Sensogiselina*

Introduction

Deep sea is the largest ecosystem on Earth and probably represents one of the greatest sources of its biodiversity. Unfortunately, mainly due to logistic problems, the deep-sea fauna, and in particular the meiofauna, have remained largely unknown until now. Copepoda are the second most important meiobenthic taxon in the deep sea in terms of abundance and diversity. Most copepods inhabiting the deep-sea benthos belong to the order Harpacticoida, but up to 10% of the copepods found in deep-sea samples are Cyclopoida or Misophrioida. Cyclopoid, misophrioid and some calanoid copepods inhabit the water layers immediately above the sediment, forming the hyperbenthic community. The hyperbenthos seems to be the ancestral habitat of the Copepoda and therefore the dwelling place of the most interesting and primitive representatives of several of its orders.

During a German expedition (ANT XIII/5) to study latitudinal deep sea diversity gradients, several specimens of a new monophyletic group of hyperbenthic cyclopoid copepods were discovered. Within Cyclopoida these animals belong to the so-called Cyclopinidae. However, this family is a classical paraphyletic group as has been shown repeatedly by Ho (1986, 1994) and Martínez Arbizu (1997a). The main task, therefore, is to dissolve "Cyclopinidae" into its monophyletic units using the methods of phylogenetic systematics (Hennig 1982). In this paper, a new monophyletic unit is proposed and characterised to accommodate two new genera of deep-sea Cyclopoida.

Materials and methods

Meiobenthic samples were taken during the German expedition ANT XIII/5 (May–June 1996), on board RV *Polarstern*, using a Multicorer (Debenham et al. 1997). The corer was sliced in six sections. The first section included the first 1 cm of sediment and overlaying bottom water. All samples were fixed with buffered formalin at a final concentration of 4%. Meiofauna were extracted by differential flotation and centrifugation using Levasil. Drawings were made using a camera lucida on a Leitz Diaplan interference contrast microscope.

The material is stored in the Copepod Collection of the AG Zoosystematik und Morphologie, University of Oldenburg, Germany (UNIOL).

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P. Martínez Arbizu
FB7/AG Zoosystematik und Morphologie, Universität Oldenburg, Oldenburg, Germany

Present address:
P. Martínez Arbizu, Laboratório de Meiofauna,
Centro de Estudos do Mar – UFPR, Av. Alfredo Bufren 140,
Curitiba – PR 80.020–240, Brazil

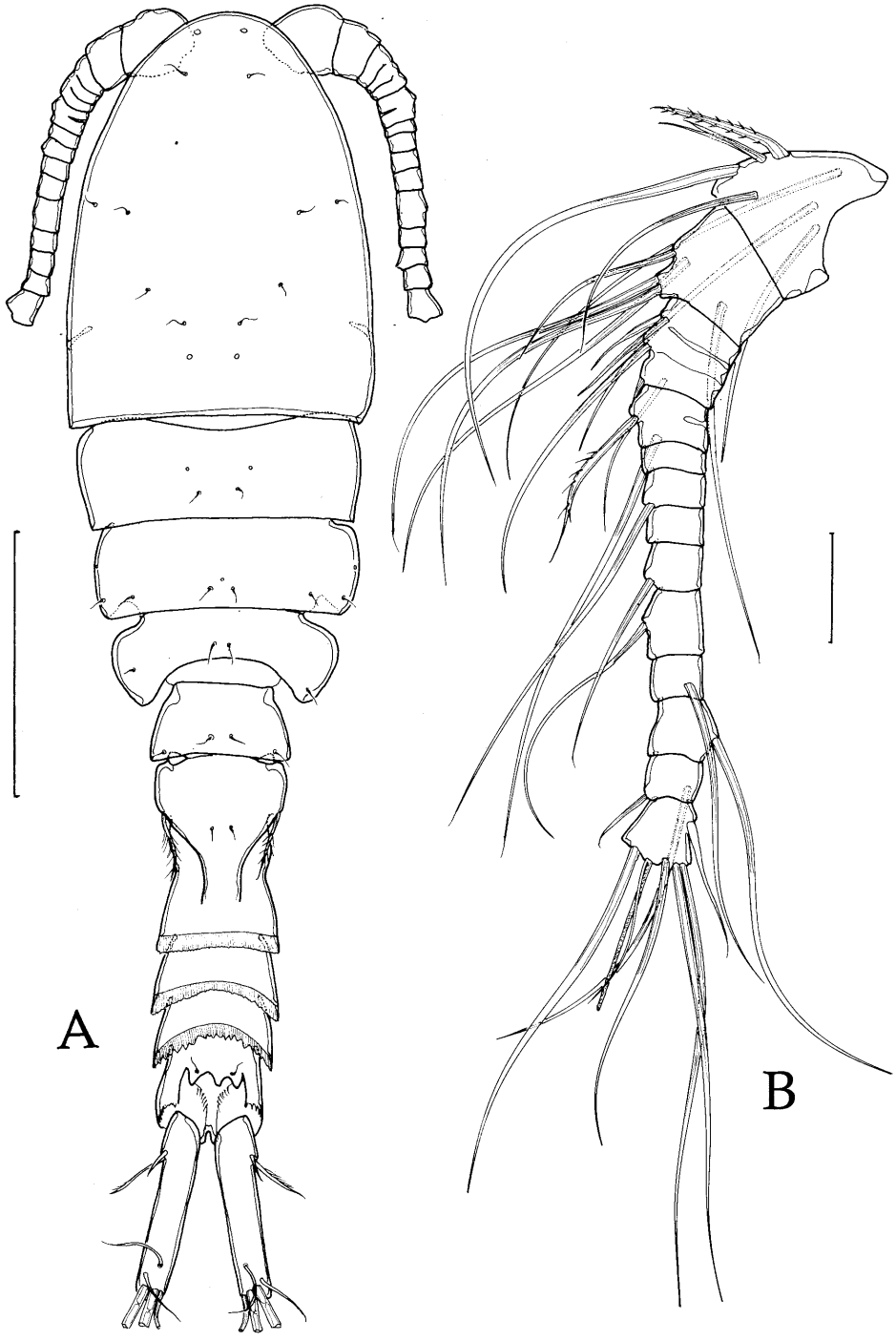


Fig. 1A, B *Giselina cristata* gen. et sp. nov. (female). **A** Habitus dorsal view. Scale bar 100 µm. **B** Antennule. Scale bar 20 µm

Systematics

Ordo Cyclopoida

Family Giselinidae nov

Diagnosis (groundpattern): Cyclopoida. Tergite of first pedigerous somite completely fused to cephalosome dorsally but incompletely fused laterally. First antennulary segment with more than 3 setae in female. Ancestral antennulary segments I–V fused. Ancestral antennulary segments XVI, XXI and XXV without aesthetascs. Antenna without exopodal setae. Labrum with a tuft of spinules medially. Maxillulary endopod with 3 setae at most. Maxillipedal syncoxa bearing only 2 setae. Legs 1–4 without inner seta on first exopodal segment. Leg 1 with only 3 spines on third exopodal segments; second endopodal segment with 1 inner seta, third one with 5 setae at most. Armature on third endopodal segment leg 4 consisting of an outer seta, a terminal outer spine, one terminal inner seta, and two elements along inner margin, the distal one being a spine, the proximal one a bipinnate seta.

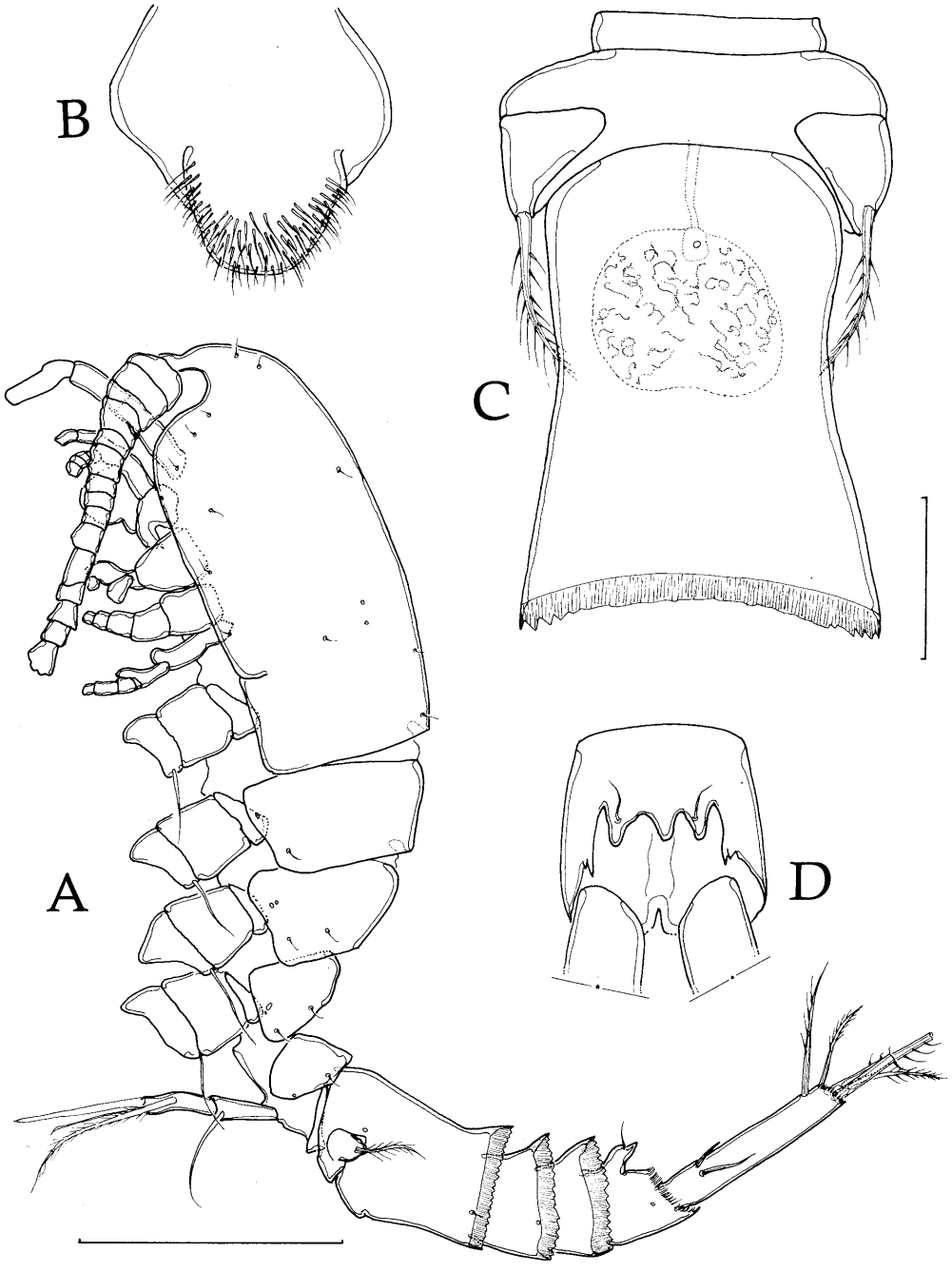


Fig. 2A–D *Giselina cristata* gen. et sp. nov. (female). **A** Habitus, lateral view. Scale bar 100 µm. **B** Labrum, ventral view. **C** Genital double-somite, ventral view. **D** Telson, dorsal view. **B–D** Scale bar 20 µm

Female leg 5 with four elements at most, the outer proximal element being a seta, subdistal outer element a spine, terminal and inner elements being setae. Leg 6 consisting of a plate with 1 seta in both sexes. Furca with 7 setae; seta I inserting closely proximal to seta II on dorso-lateral margin, seta III inserting subterminally on dorsal surface.

Type genus: *Giselina* gen. nov.

Other genus: *Sensogiselina* gen. nov.

Giselina *gen. nov*

Diagnosis (groundpattern): Cyclopoida, Giselinidae. Antenna without coxal and basal setae; second and third endopodal segments fused, portion corresponding to first endopodal segment with only 3 setae on inner margin. Mandible with 5-segmented exopod, first endopodal segment with only 1 seta. Maxillulary endopod with only 2 setae. Distal maxillary endopod with 2 setae. Maxilliped with 3-segmented endopod bearing 1, 1 and 2 setae. Third endopodal segment of leg 3 with outer terminal seta transformed into a lamellate spine.

Type species: *Giselina cristata* gen. et sp. nov.

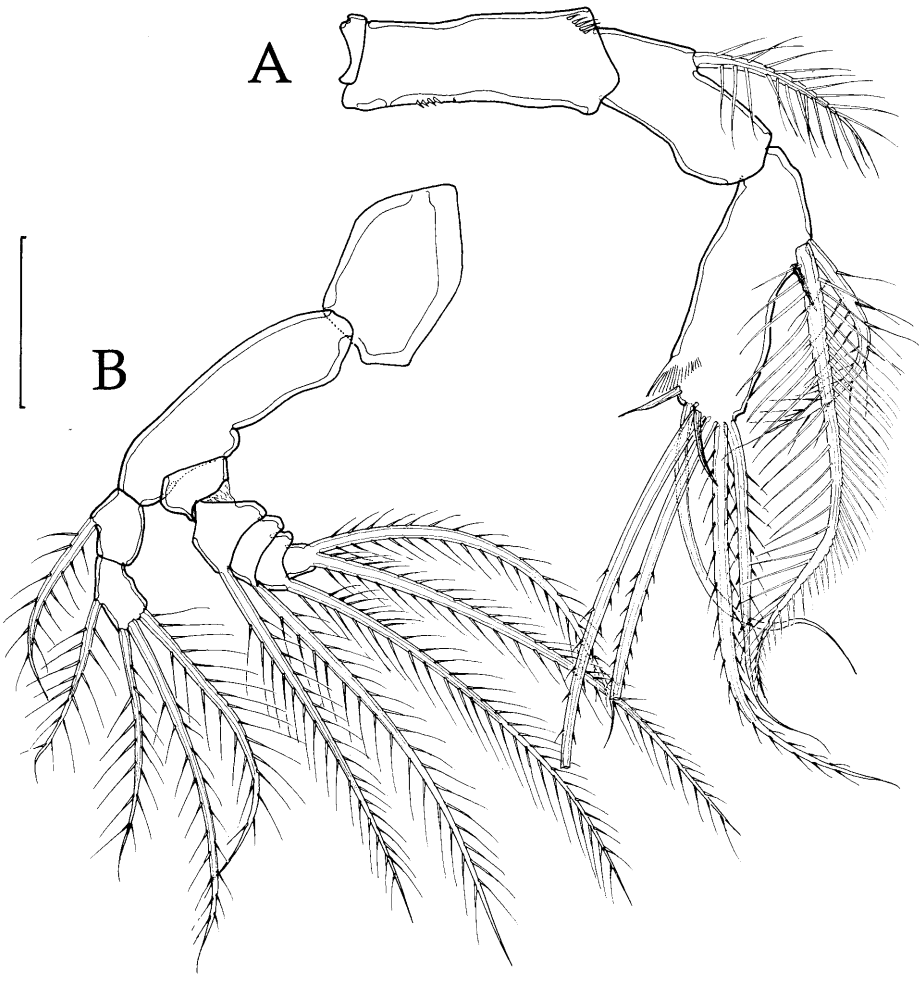


Fig. 3A, B *Giselina cristata* gen. et sp. nov. (female). **A** Antenna. **B** Mandibular palp. Scale bar 20 µm

Other species: *Giselina gerdesi* sp. n.

Etymology. This new genus is named after my wife Gisela Silveira Moura

Giselina cristata *sp. nov*

Material. Holotype, one female dissected and mounted on nine slides (UNIOL collection numbers 1999.011/1–1999.011/9).

Locus typicus. The type material was collected using a Multicorer at 5130 m depth on the Pernambuco Abyssal Plane (Atlantic Ocean), co-ordinates 14°59.9′S, 29°02.7′W, on 3 June 1996. ANT XIII/5, Station 40/120, MUC-Corer No 5.

Description: Female. Body cyclopiniform, prosome elongate, tapering caudally, urosome narrow. Body length (measured from the frontal rim of cephalosome to the caudal rim of telson) 415 µm. Prosome and urosome ornamented dorsally with symmetrical pattern of sensilla and pores (Fig. 1A). Tergite of first pedigerous somite fused to cephalosome dorsally, yet still subdivided on lateral margins (Figs. 1A, 2A). Last thoracic and first abdominal somites completely fused to form a genital double-somite. Well-developed pseudosomite located ventrally between fifth leg bearing somite and genital double-somite (Fig. 2C). Abdominal somites with serrated and striated hyaline frills forming a crest on dorsal margin (Fig. 2A). Anal operculum trilobate (Fig. 2A,D).

Furca about six times as long as wide; with 7 setae. Seta I inserting on dorsal margin in front of seta II at one quarter of length of furca, seta III inserting subterminally on outer dorsal corner, setae IV, V and VI inserting terminally and seta VII subterminally on inner dorsal corner.

Antennule 13-segmented (Fig. 1B), reaching to the base of leg 1. Third and fourth segments with traces of subdivision. Armature formula beginning with proximal segment: 8, 5, 5, 2, 0, 1, 0, 1, 1, 1, 1, 2, 6 + aesthetasc.

Antenna elongate with small praecoxal sclerite, 3-segmented (Fig. 3A). Syncoxa and basis fused, setae on inner margin and exopodal setae lacking; endopod 2-segmented, first segment with 1 bipinnate seta on inner margin; second segment with 2 long bipinnate setae and a small naked seta on inner margin and 7 setae terminally.

Labrum with a densely spinulose area ventrally (Fig. 2B).

Mandible with slender gnathobasis (as in *G. gerdesi* sp. n.), palp (Fig. 3A) consisting of basis without setae,

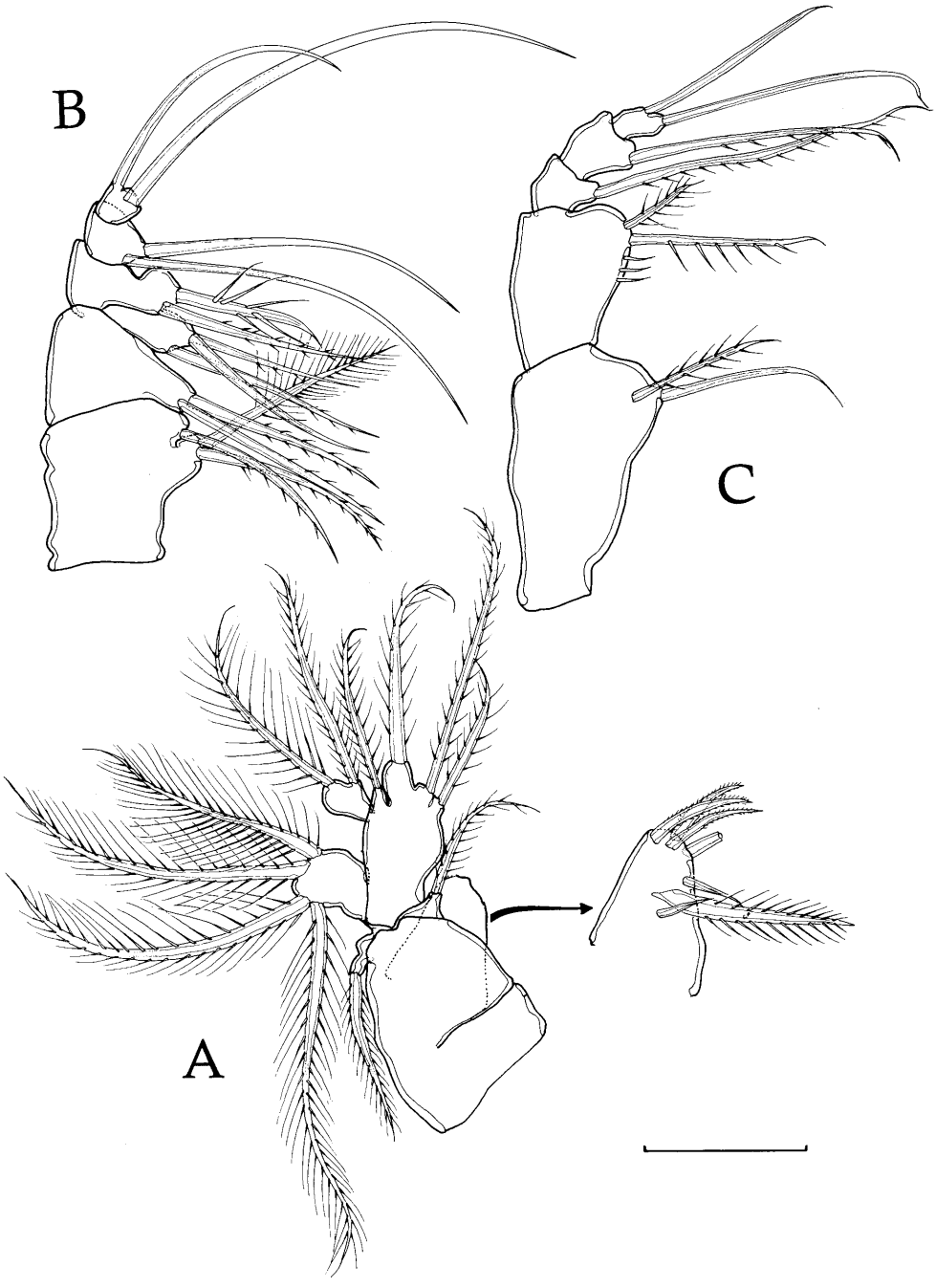


Fig. 4A–C *Giselina cristata* gen. et sp. nov. (female). **A** Maxillule. **B** Maxilla. **C** Maxilliped. Scale bar 20 µm

2-segmented endopod with 1 and 4 setae, and 5-segmented exopod with 0, 1, 1, 1, 2 setae.

Maxillule (Fig. 4A) praecoxal arthrite with seven armature elements, coxa with 1 seta on endite and 1 seta representing epipodite; basis with 2 endites, the proximal one with 3 setae, the distal one with 1 seta; 1-segmented endopod with 2 setae; 1-segmented exopod with 4 setae.

Maxilla (Fig. 4B) with distinct praecoxa and coxa; proximal praecoxal endite with 2 long, and bipinnate setae, distal praecoxal endite with 1 seta; proximal coxal endite with 2 setae, distal endite with 3 setae; basis with 2 robust setae; endopod 2-segmented, each segment with 2 long and naked setae.

Maxilliped (Fig. 4C) consisting of syncoxa, basis, and 3 segmented endopod; syncoxa with 2 setae on subdistal inner margin, basis with 2 setae, endopod 3-segmented with 1, 1, and 2 setae.

Swimming legs 1–4 (Figs. 5A–C, 6A) with small praecoxal sclerite, coxa, basis and 3-segmented rami.

Middle endopodal segment of leg 1 with 1, that of legs 2–4 with 2 inner setae. Legs 1–4 without inner seta on first exopodal segment (Fig. 5A). Outer terminal seta on third endopodal segment of leg 3 transformed into a

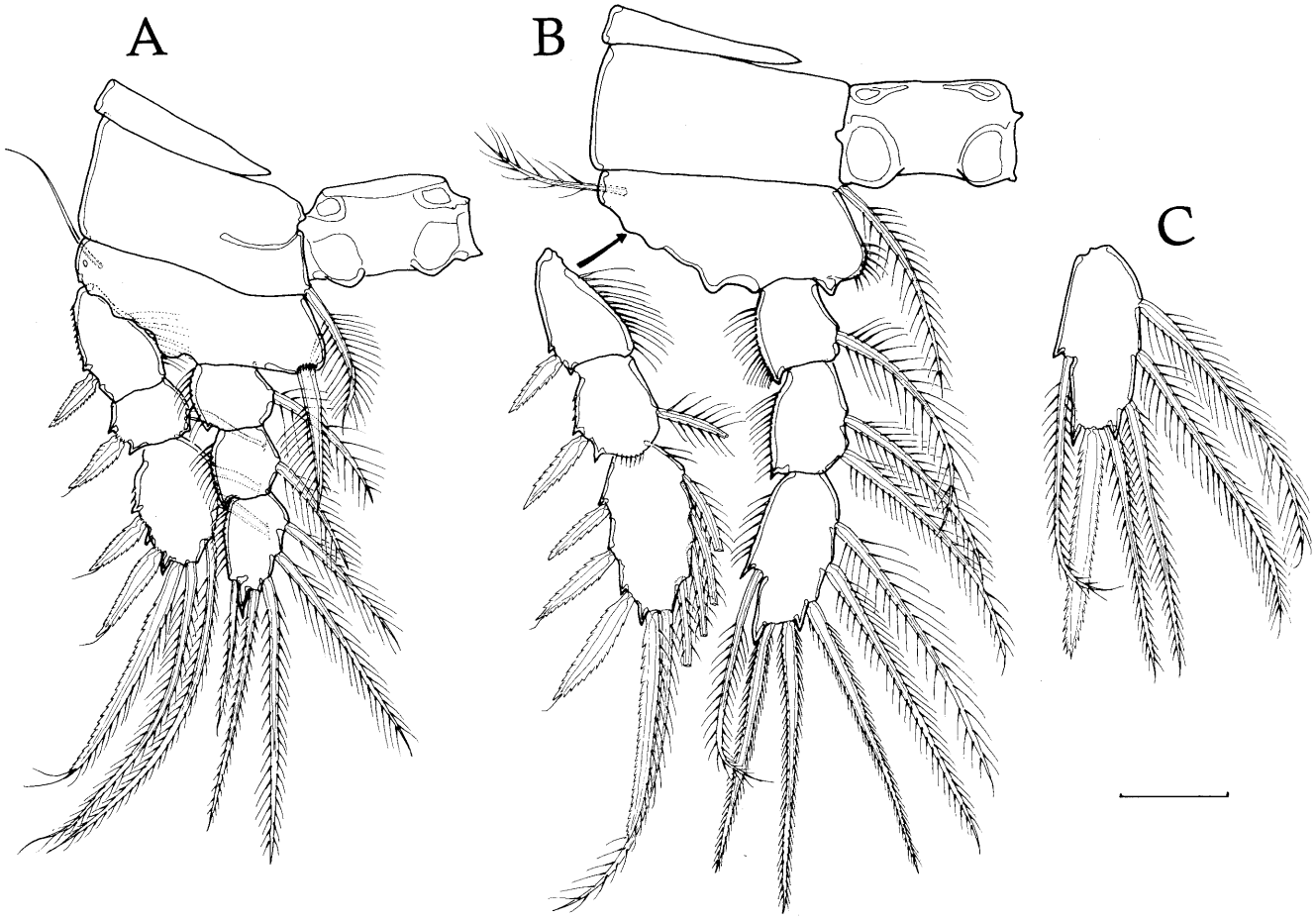


Fig. 5A–C *Giselina cristata* gen. et sp. nov. (female). **A** Leg 1. **B** Leg 2. **C** Third endopodal segment of leg 3. Scale bar 20 µm

lamellate spine (Fig. 5C). Swimming legs armature formula:

	Coxa	Basis	Endopod	Exopod
Leg 1	0–1	1-I	0–1; 0–1; 1,2,2	I-0; I-1; II,I,4
Leg 2	0–1	1–0	0–1; 0–2; 1,2,3	I-0; I-1; III,I,5
Leg 3	0–1	1–0	0–1; 0–2; 1,I1,3	I-0; I-1; III,I,5
Leg 4	0–1	1–0	0–1; 0–2; 1,I1,I1	I-0; I-1; II,I,5

Leg 5 (Fig. 6B), located ventrally, with intercoxal sclerite; coxa and basis fused, bearing 1 outer basal seta; exopod 1-segmented with three well developed elements, an outer bipinnate seta, a terminal outer spine and a smaller terminal inner seta. Inner terminal seta distinctly shorter than terminal spine.

Sixth legs (Fig. 2C), a small operculum covering gonopores and armed with 1 slender bipinnate seta.

Copulatory pore located midventrally on genital double-somite, single medial seminal receptacle discernible on ventral view (Fig. 2C).

Description: Male. Unknown.

Etymology. The specific name alludes to the crests formed by the posterior dorsal rim of the abdominal somites and anal operculum.

Giselina gerdesi *sp. nov*

Material. Holotype, one female dissected and mounted on six slides (UNIOL collection numbers 1999.012/1–1999.012/6).

Locus typicus. The type material was collected using a Multicorer at 5726 m depth in the Argentinian Basin, coordinates 47°04.9′S, 55°05.6′W, on 26 May 1996. ANT XIII/5, Station 40/118.

Description: Female. Body cyclopiniform, prosome elongate, tapering caudally, urosome narrow. Body length (measured from the frontal rim of cephalosome to the caudal rim of telson) 428 µm. Prosome and urosome ornamented dorsally with symmetrical pattern of sensilla and pores (Fig. 7A). Tergite of first pedigerous somite fused to cephalosome dorsally, still subdivided on lateral margins (Figs. 7A, 8A). Last thoracic and first abdominal somites completely fused to form a genital double-somite. Well-developed pseudosomite located ventrally between fifth leg bearing somite and genital double-somite. Abdominal somites with plain hyaline frills (Fig. 12A). Anal operculum plain (Fig. 12C).

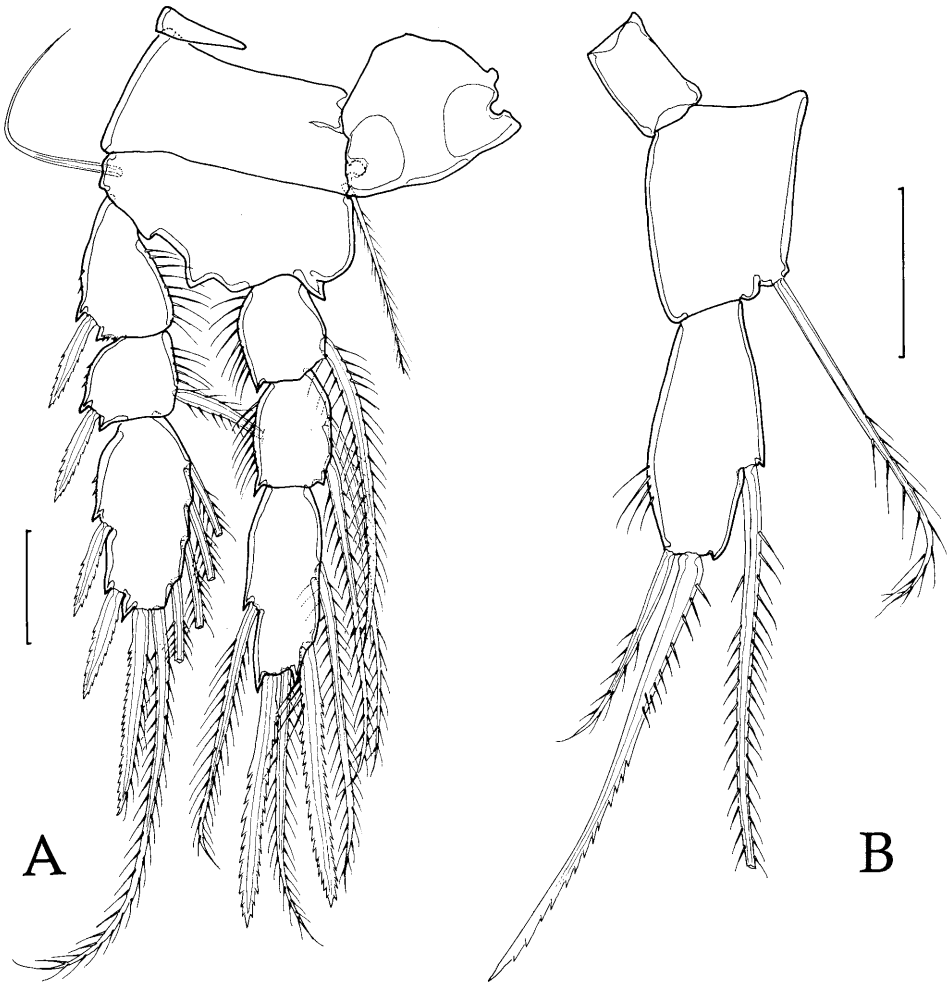


Fig. 6A, B *Giselina cristata* gen. et sp. nov. (female). **A** Leg 4. **B** Leg 5. Scale bars 20 µm

Furca about five times as long as wide; with 7 setae (Fig. 12A,B). Seta I inserting on dorsal margin in front of seta II at one quarter of the length of the furca, seta III inserting subterminally on outer dorsal corner, setae IV, V and VI inserting terminally and seta VII in the distal quarter of the furca on inner dorsal margin.

Antennule indistinctly 9-segmented (Fig. 7B). First, second, third, fifth, and sixth segments with traces of subdivision. Armature formula beginning with proximal segment: 8, 6, 6, 2, 2, 2, 1, 2, 7 + aesthetasc.

Antenna (Fig. 8B) elongate with small praecoxal sclerite, 3-segmented. Syncoxa and basis fused, setae on inner margin, and exopodal setae lacking; endopod 2-segmented, first segment with 1 bipinnate seta on inner margin; second segment with 2 long bipinnate setae and a small naked seta on inner margin and 6 setae terminally.

Labrum with a dense spinulose area ventrally.

Mandible (Fig. 9A) with slender gnathobasis, palp consisting of basis bearing 1 seta, 2-segmented endopod with 1 and 4 setae, and 5-segmented exopod with 0, 1, 1, 1, 2 setae.

Maxillule (Fig. 9D) praecoxal arthrite with 7 armature elements, coxal endite and epipodite with 1 seta each; basis with 4 setae; 1-segmented endopod with 2 setae; 1-segmented exopod with 4 setae.

Maxilla (Fig. 9C) with praecoxa and proximal coxal endite fused; praecoxa with 3 setae, proximal coxal endite with 2 setae, distal coxal endite with 3 setae; basis with 1 seta and a robust claw; endopod 2-segmented, each segment with 2 long and naked setae.

Maxilliped (Fig. 9B) consisting of syncoxa, basis, and 3-segmented endopod; syncoxa with 2 setae on subdistal inner margin, basis with 2 setae, endopod 3-segmented with 1, 1, and 2 setae.

Swimming legs 1–4 (Figs. 10A–C, 11A) with small praecoxal sclerite, coxa, basis and 3-segmented rami.

Middle endopodal segment of legs 1 with 1, that of legs 2–4 with 2 inner setae. Legs 1–4 without inner seta on first exopodal segment. Outer terminal seta on third endopodal segment of leg 3 transformed into a lamellate spine (Fig. 10C). Swimming legs armature formula:

	Coxa	Basis	Endopod	Exopod
Leg 1	0–1	1-I	0–1; 0–1; 1,2,2	I-0; I-1; II,I,4
Leg 2	0–1	1–0	0–1; 0–2; 1,2,3	I-0; I-1; III,I,5
Leg 3	0–1	1–0	0–1; 0–2; 1,I1,3	I-0; I-1; III,I,5
Leg 4	0–1	1–0	0–1; 0–2; 1,I1,I1	I-0; I-1; II,I,5

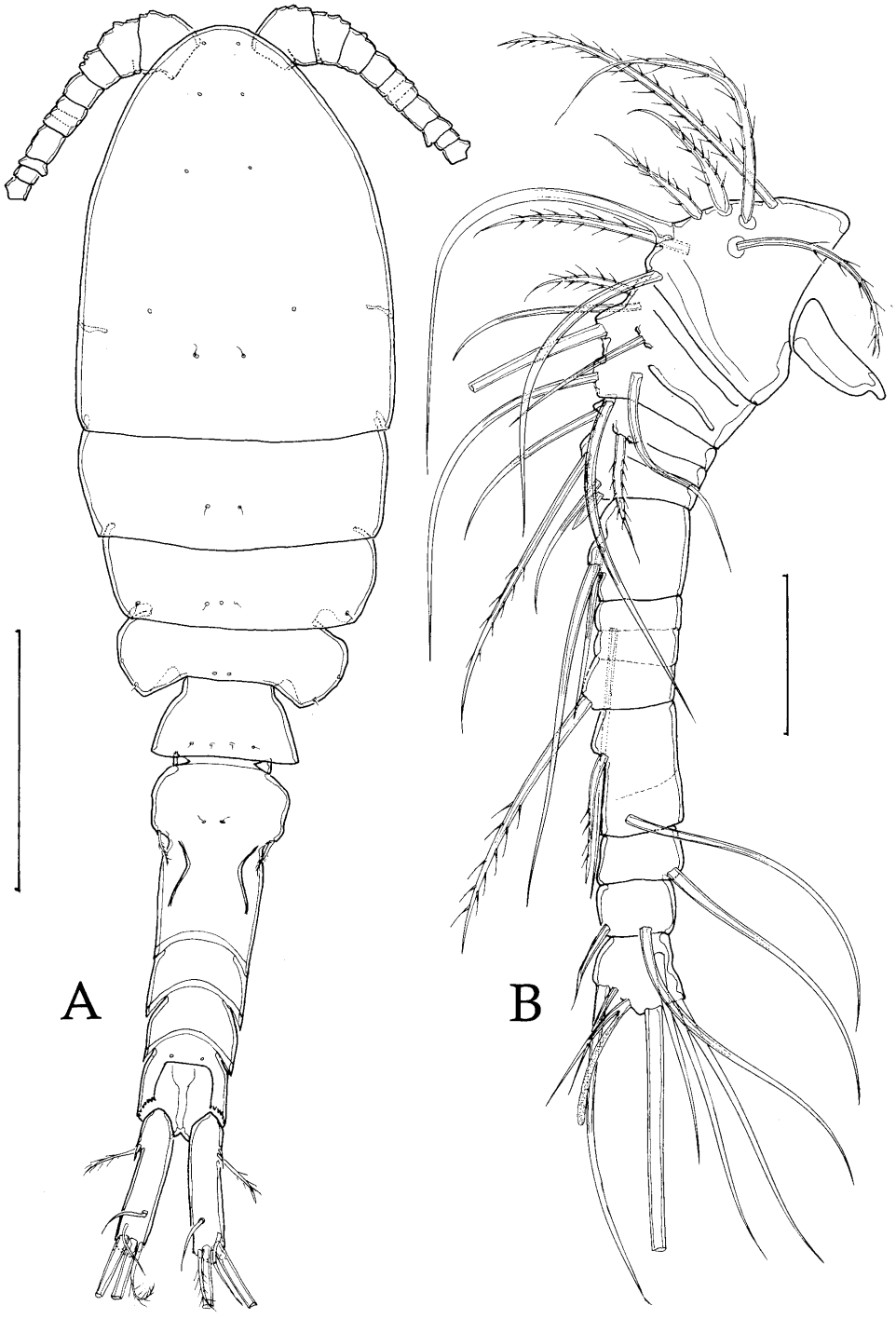


Fig. 7A, B *Giselina gerdesi* sp. nov. (female). **A** Habitus, dorsal view. Scale bar 100 µm. **B** Antennule. Scale bar 20 µm

Leg 5 (Fig. 11B), located ventrally, with intercoxal sclerite; coxa and basis fused, bearing 1 outer basal seta; exopod 1-segmented with three well-developed elements, an outer bipinnate seta, a terminal outer spine and a terminal inner seta only slightly shorter than terminal spine.

Sixth legs (Fig. 12B), a small operculum covering gonopores and armed with 1 slender bipinnate seta.

Copulatory pore located midventrally on genital double-somite, seminal receptacle seemingly paired (Fig. 12A).

Description: Male. Unknown.

Etymology. This species is dedicated to Dr. Dieter Gerdes, who was the chief scientist during ANT XIII/5, in recognition of his friendship and scientific advice.

Sensogiselina *gen. nov*

Diagnosis (groundpattern): Cyclopoida, Giselinidae. First antennary segment with one basal seta on distal inner cor-

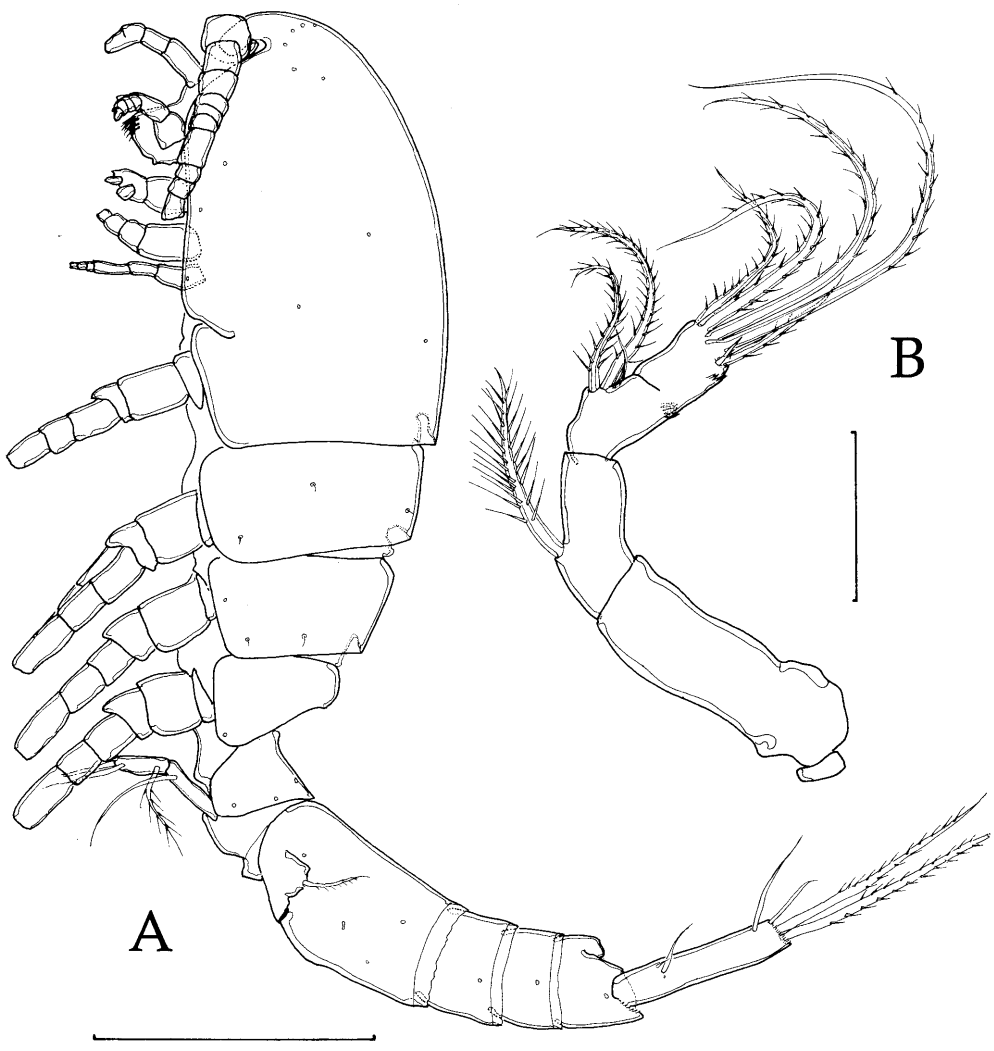


Fig. 8A, B *Giselina gerdesi* sp. nov. (female). **A** Habitus, lateral view. Scale bar 100 µm. **B** Antenna. Scale bar 20 µm

ner; second and third endopodal segments separated, first endopodal segment with 4 setae on inner margin. Mandible with 4-segmented exopod, first endopodal segment with 2 setae, first and second exopodal segments with 1 club-shaped aesthetasc each instead of setae. Maxillulary endopod with 3 setae. Distal maxillary endopodal segment with 4 setae. Maxilliped with 4-segmented endopod bearing 1, 0, 1 and 4 setae. Third endopodal segment of leg 3 with outer terminal seta not transformed into lamellate spines.

Type species: *Sensogiselina potteki* gen. et sp. nov.

Other species: *Sensogiselina reducta* sp. nov.

Etymology. The generic name alludes to the sensorial function of the aesthetascs present on the mandibular exopod.

Sensogiselina potteki *sp. nov*

Material. Holotype, one female dissected and mounted on 11 slides (UNIOL collection numbers 1999.013/1–1999.013/11). Allotype, one male dissected and mounted on three slides (UNIOL collection numbers 1999.014/1–1999.014/3).

Locus typicus. The type material was collected using a Minicorer at 5362 m depth in the Pernambuco Abyssal Plane (Atlantic Ocean), co-ordinates 04°00.9′S, 27°12.2′W, on 6 June 1996. ANT XIII/5 Station 40/121, MIC-Corer No 1 (female) and No 2 (male).

Description: Female. Body cyclopiniform, prosome elongate tapering caudally, urosome narrow, shorter than prosome. Body length (measured from frontal rim of cephalosome to caudal rim of telson) 461 µm. Prosome and urosome ornamented dorsally with symmetrical pattern of sensilla and pores (Fig. 13A). Tergite of first pedigerous somite fused to cephalosome dorsally, still subdivided on lateral margins (Fig. 13A,B). Last thoracic and first abdominal somites completely fused to form a genital double-somite. Well-developed pseudosomite located ventrally between fifth leg bearing somite and genital double-somite. Abdominal somites with plain hyaline frills.

Furca about three times as long as wide; with 7 setae (Fig. 14A,B). Seta I inserting on dorsal margin in front

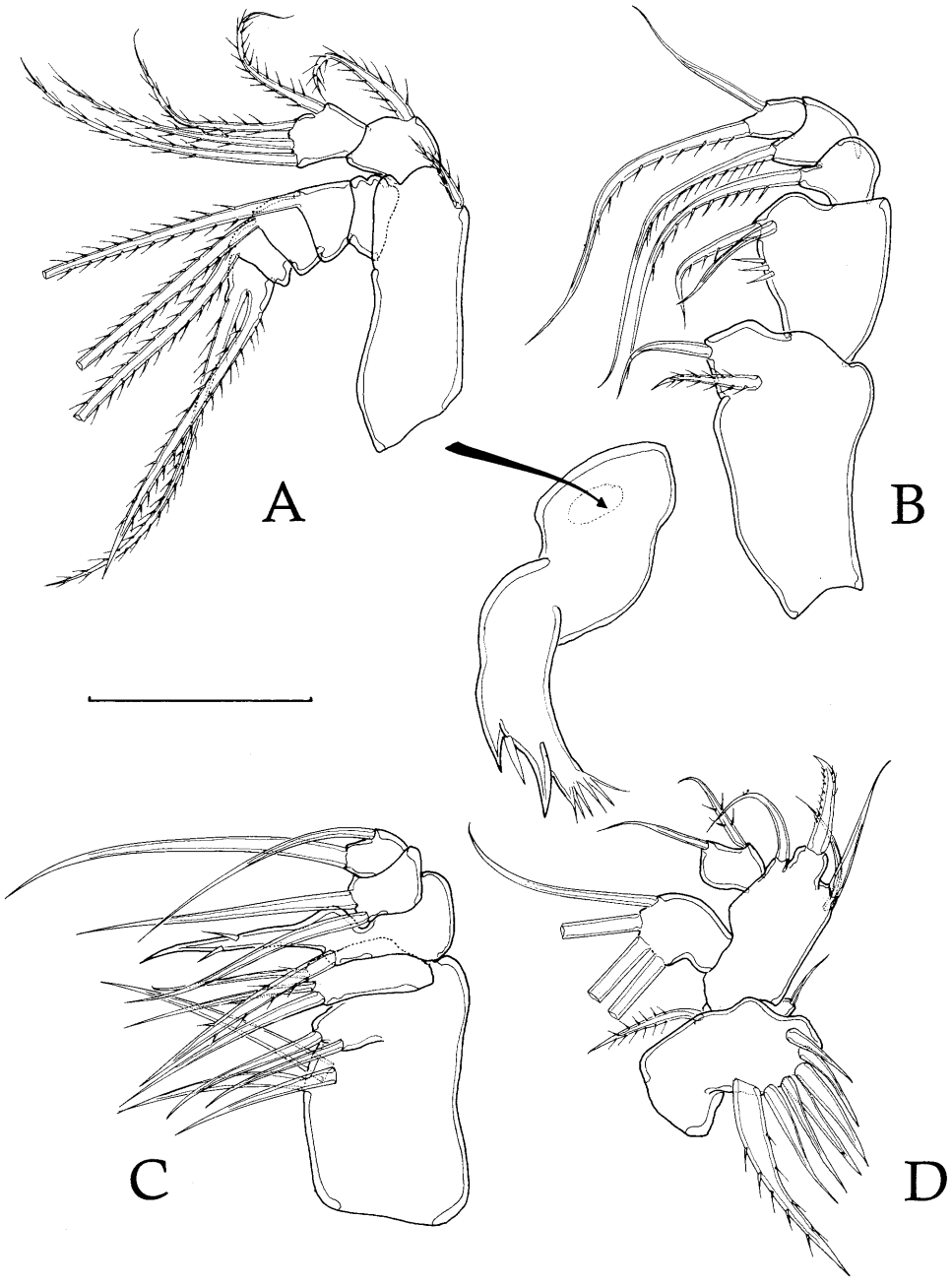


Fig. 9A–D *Giselina gerdesi* sp. nov. (female). **A** Mandibular palp. **B** Maxilliped. **C** Maxilla. **D** Maxillule. Scale bar 20 µm

of seta II at one third of length of furca, seta III inserting subterminally on outer dorsal corner, setae IV, V and VI inserting terminally and seta VII at two thirds of length of furca on inner dorsal margin.

Antennule 18-segmented (Fig. 15A), reaching almost to the base leg 1 when at rest. First, second, third and fifteenth segments with traces of subdivision. Armature formula beginning with proximal segment: 7, 2, 4, 2, 2, 2, 2, 2, 1, 1, 1, 2, 2, 1, 3, 2, 2, 6 + aesthetasc.

Antenna (Fig. 15C) 4-segmented. Syncoxa and basis fused, with 1 (basal) seta on distal inner margin, no exopodal setae; endopod 3-segmented, first segment with 1 bipinnate seta on inner margin; second segment with 4 setae, distal segment with 7 setae.

Labrum (Fig. 16A) with a dense spinulose area ventrally.

Mandible (Fig. 16D) with slender gnathobasis with multicuspid teeth, palp consisting of basis with 1 seta on distal inner corner, 2-segmented endopod with 2 and 5 setae, and 4-segmented exopod with 1 aesthetasc, 1 aesthetasc, 1 seta, and 2 setae on proximal to distal segments.

Maxillule (Fig. 16B) praecoxal arthrite with eight armature elements, coxa with 1 seta on endite and 1 seta representing epipodite; basis with 4 setae; 1-segmented endopod with 3 setae; 1-segmented exopod with 4 setae.

Maxilla (Fig. 16C) with distinct praecoxa and coxa; proximal praecoxal endite with 3 setae, distal praecoxal

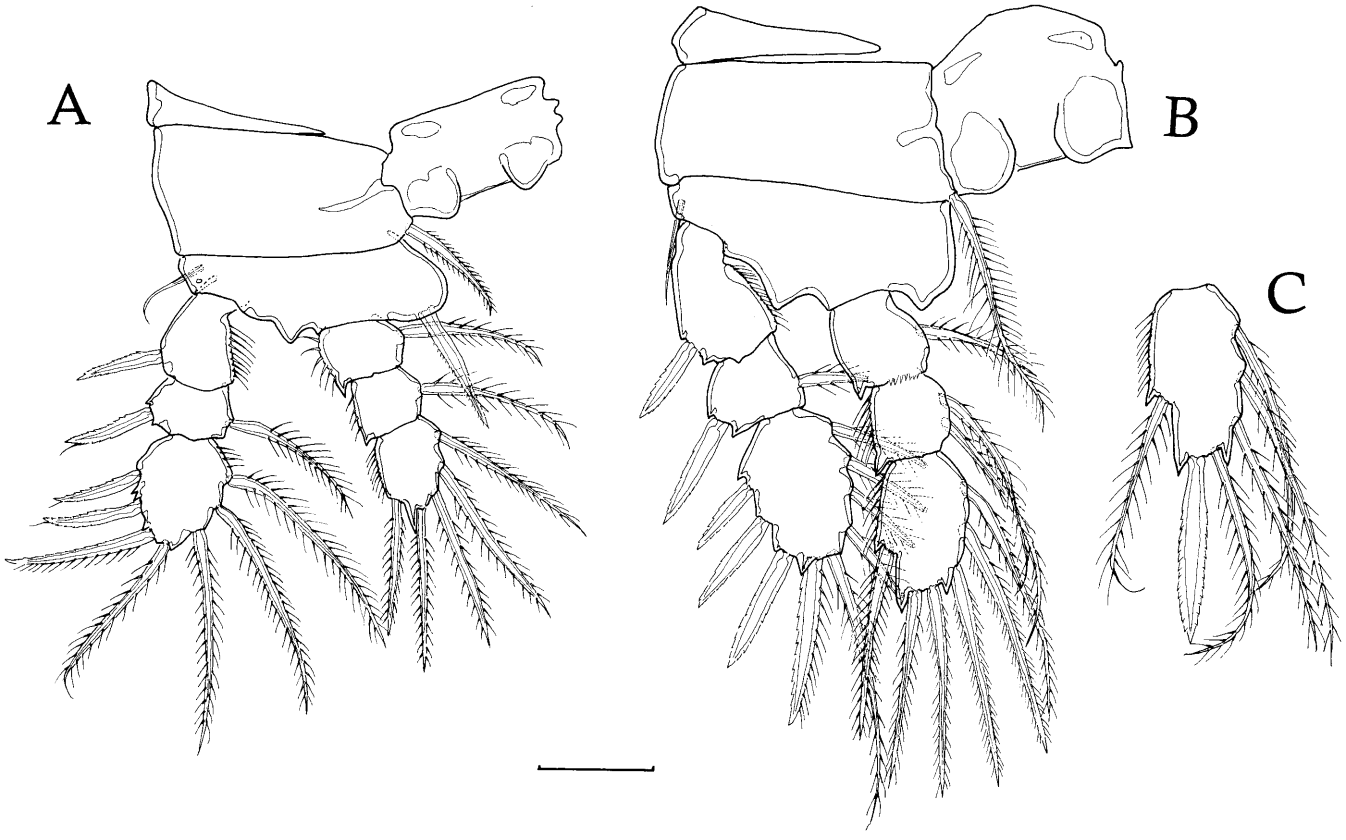
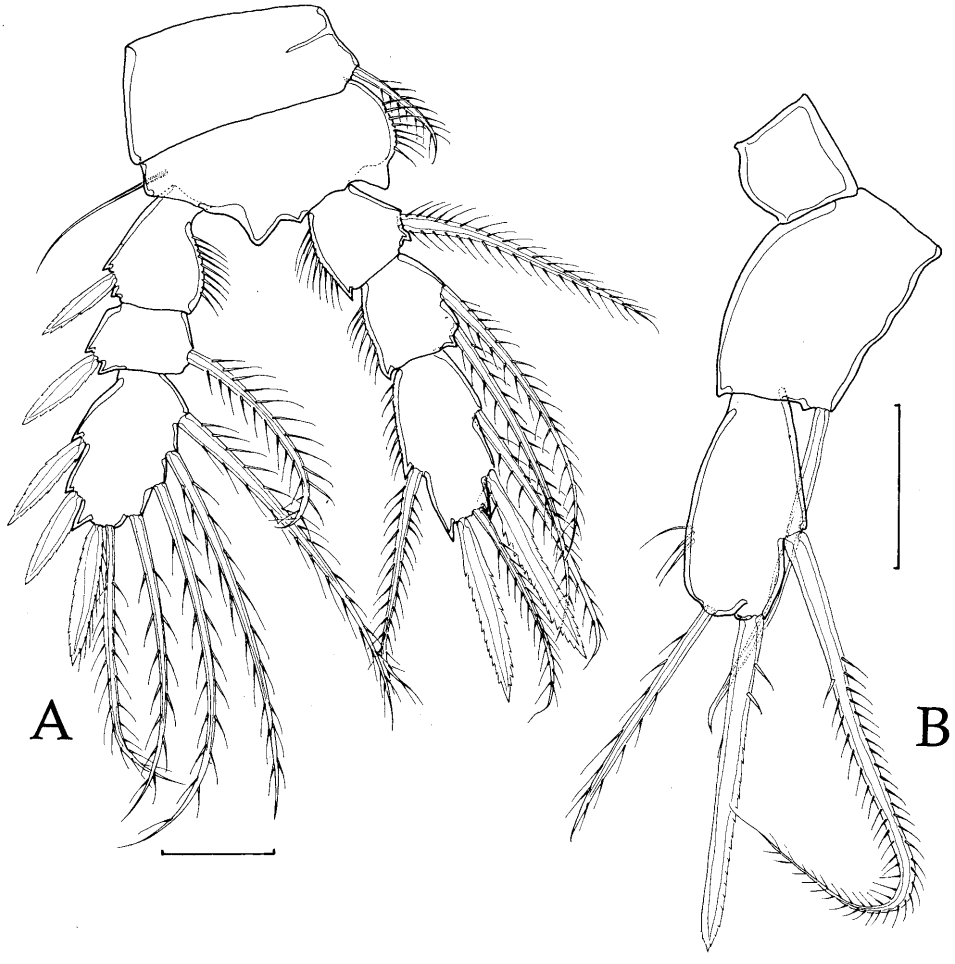


Fig. 10A–C *Giselina gerdesi* sp. nov. (female). **A** Leg 1. **B** Leg 2. **C** Third endopodal segment of leg 3. Scale bar 20 µm

Fig. 11A, B *Giselina gerdesi* sp. nov. (female). **A** Leg 4. **B** Leg 5. Scale bars 20 µm.



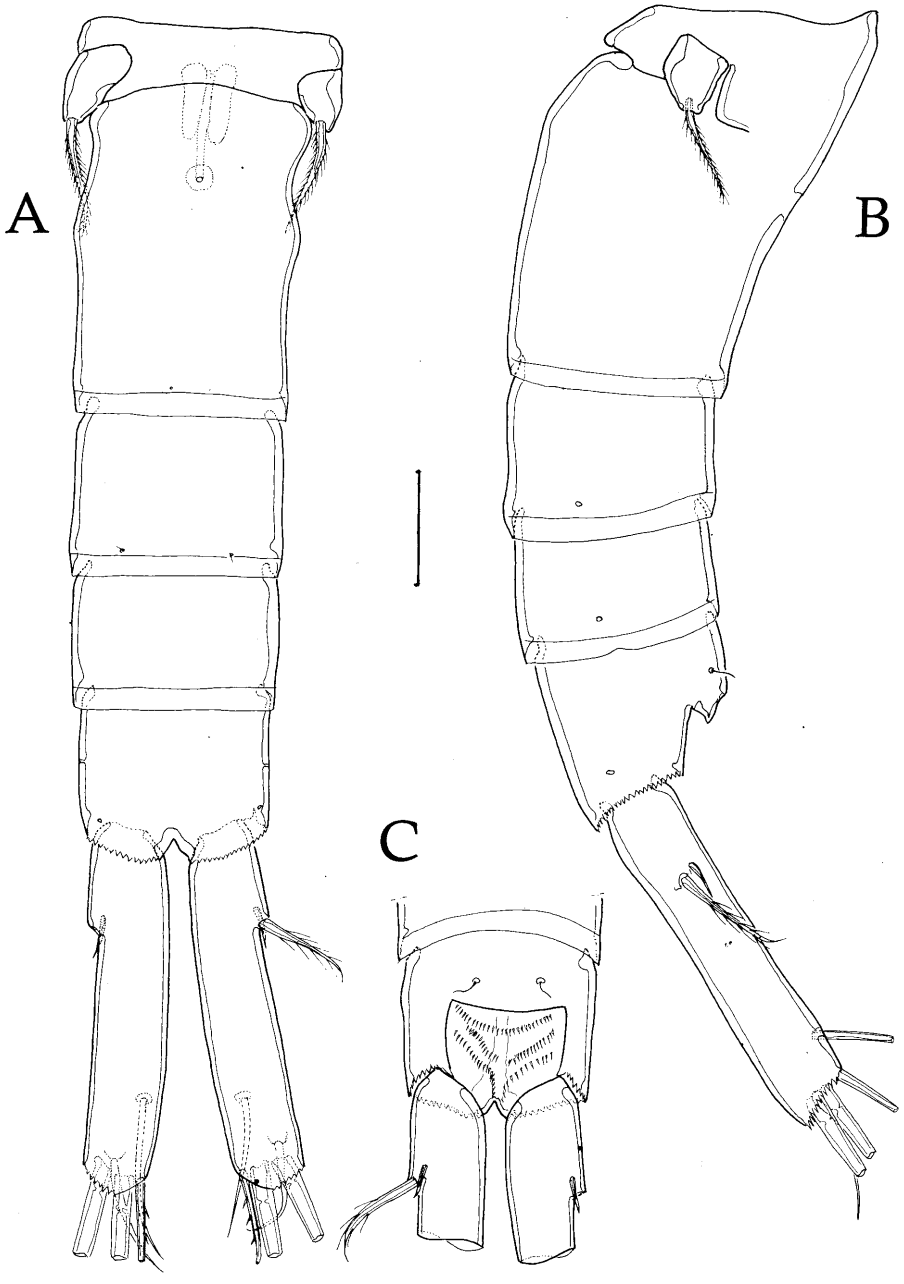


Fig. 12A–C *Giselina gerdesi* sp. nov. (female). **A** Urosome, ventral view. **B** Urosome, lateral view. **C** Telson, dorsal view. Scale bar 20 µm

endite with 1 seta; proximal coxal endite with 2 setae, distal endite with 3 setae; basis with 1 seta and a robust claw fused with basis; endopod 2-segmented, proximal segment with 2 setae, distal segment with 4 setae.

Maxilliped (Fig. 16E) consisting of syncoxa, basis, and 4-segmented endopod; syncoxa with 2 setae on subdistal inner margin, basis with 2 setae, endopod with 1, 0, 1 and 4 setae on proximal to distal segments.

Swimming legs 1–4 (Figs. 17A,B, 18A) with small praecoxal sclerite (not always illustrated), coxa, basis and 3-segmented rami.

Middle endopodal segment of leg 1 with 1, that of legs 2–4 with 2 inner setae. Legs 1–4 without inner seta on first exopodal segment. Outer terminal seta on third endopodal segment of leg 3 not transformed into a lamellate spine. Swimming legs armature formula:

	Coxa	Basis	Endopod	Exopod
Leg 1	0–1	1-I	0–1; 0–1; 1,2,2	I-0; I-1; II,I,4
Leg 2	0–1	1–0	0–1; 0–2; 1,2,3	I-0; I-1; III,I,5
Leg 3	0–1	1–0	0–1; 0–2; 1,2,3	I-0; I-1; III,I,5
Leg 4	0–1	1–0	0–1; 0–2; 1,I1,I1	I-0; I-1; II,I,5

Leg 5 (Fig. 18B), located ventrally, with intercoxal sclerite; coxa and basis fused, with one outer basal seta; exopod 1-segmented with 3 well developed elements, an outer bipinnate seta, a terminal outer spine and a terminal inner seta distinctly longer than terminal spine.

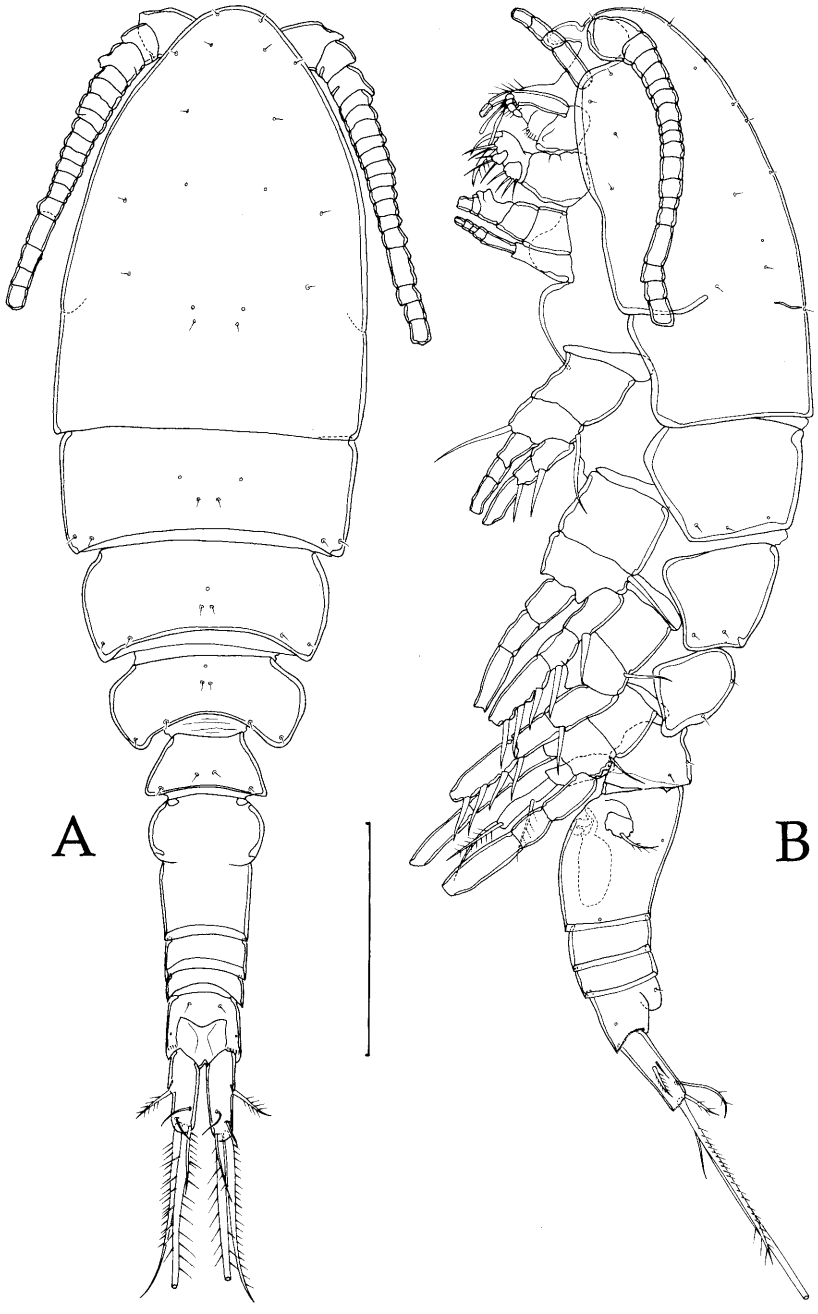


Fig. 13A, B *Sensogiselina potteki* gen. et sp. nov. (female). **A** Habitus, dorsal view. **B** Habitus, lateral view. Scale bar 100 µm

Sixth legs, a small operculum covering gonopores and armed with 1 slender bipinnate seta.

Description: Male. Differing from female in following aspects. Urosome including five somites plus telson.

Antennule prehensile (Fig. 15B), 15-segmented. Armature formula beginning with proximal segment: 7 + 3 aesthetascs, 2, 2, 2 + aesthetasc, 2, 2, 1, 2, 1 aesthetasc, 3 + aesthetasc, 1, 2 + aesthetasc, 2, 2 + aesthetasc, 10 + 2 aesthetascs.

Leg 5 (Fig. 18C) consisting of coxo-basis with 1 outer basal seta, and 2-segmented exopod, proximal segment with 1 outer and 1 inner seta, distal segment with an outer spine, a terminal seta, and an inner seta.

Leg 6 (Fig. 18D) as in female, armed with only 1 bipinnate seta.

Etymology. This species is dedicated to my colleague Mark Pottek (University of Oldenburg), who helped me during the preparation of this work with inking some of the drawings.

Sensogiselina reducta *sp. nov*

Material. Holotype, one female dissected and mounted on six slides (UNIOL collection numbers 1999.015/1–1999.015/6).

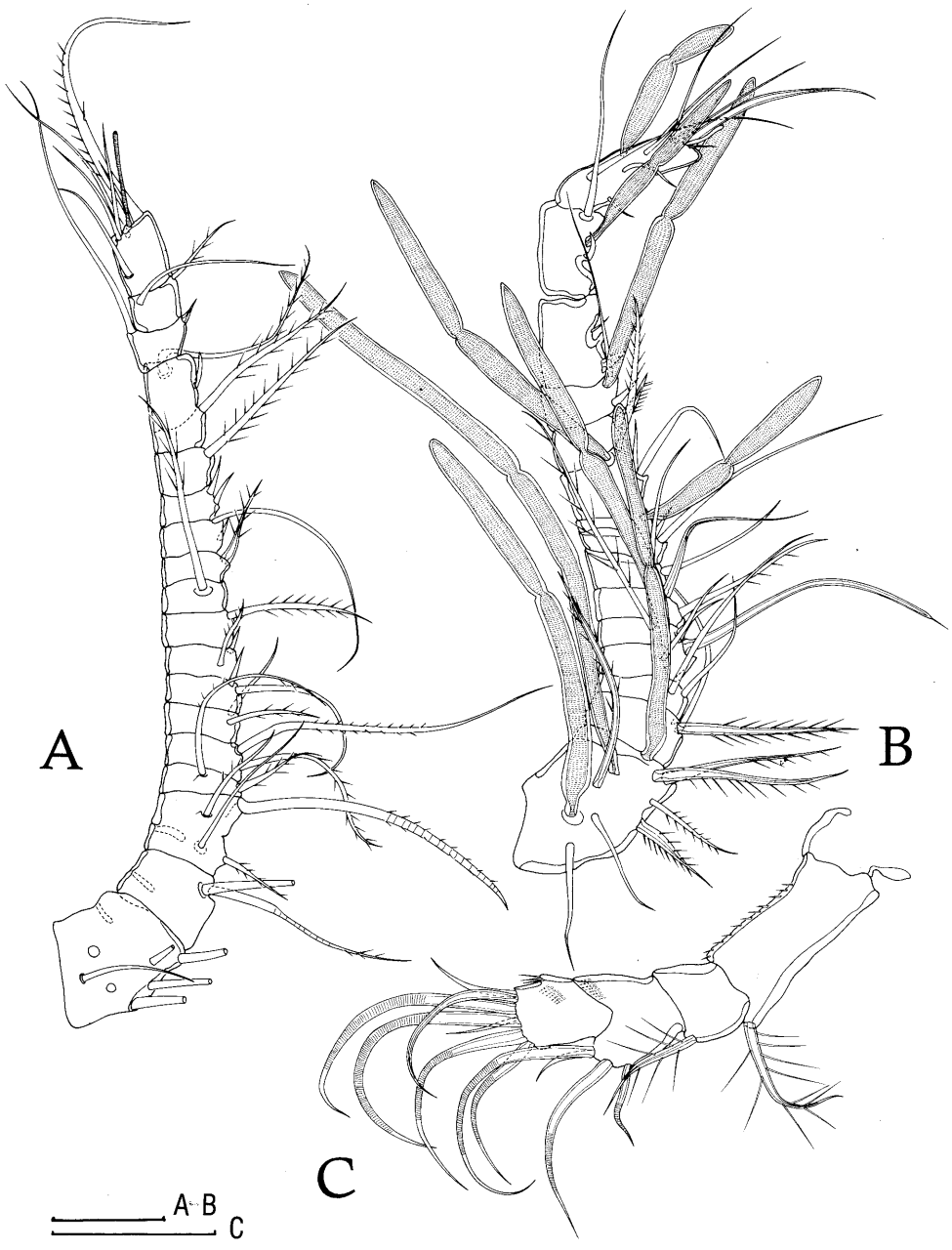


Fig. 14A–C *Sensogiselina potteki* gen. et sp. nov.. **A** Female antennule. **B** Male antennule. **C** Antenna. Scale bars 20 µm

Locus typicus. The type material was collected using a Minicorer at 5362 m depth in the Pernambuco Abyssal Plane (Atlantic Ocean), co-ordinates 04°00.9′S, 27°12.2′W, on 6 June 1996. ANT XIII/5 Station 40/121, MIC-Corer No 1.

Description: Female. Body cyclopiniform, prosome elongate tapering caudally, urosome narrow. Body length (measured from frontal rim of cephalosome to caudal rim of telson) 458 µm. Prosome and urosome ornamented dorsally with symmetrical pattern of sensilla and pores (Fig. 19A). Tergite of first pedigerous fused to cephalosome dorsally, still subdivided on lateral margins (Fig. 19A,B). Last thoracic and first abdominal somites completely fused to form a genital double-somite. Well-developed pseudosomite located ventrally between fifth leg bearing somite and genital double-somite. Abdominal somites with finely serrated hyaline frills.

Furca about 14 times as long as wide; with 7 setae (Fig. 20A,B). Seta I inserting on dorsal margin in front of seta II at one third of length of furca, seta III inserting subterminally on outer dorsal corner, setae IV, V and VI inserting terminally and seta VII subterminally on inner dorsal margin.

Antennule indistinctly 6-segmented (Fig. 21A), almost reaching to the base leg 1. First segment with traces of subdivisions. Armature formula beginning with proximal segment: 10, 3, 2, 1, 1, 6.

Antenna (Fig. 21B) 2-segmented. First segment probably representing fused praecoxa, coxa and basis, with-

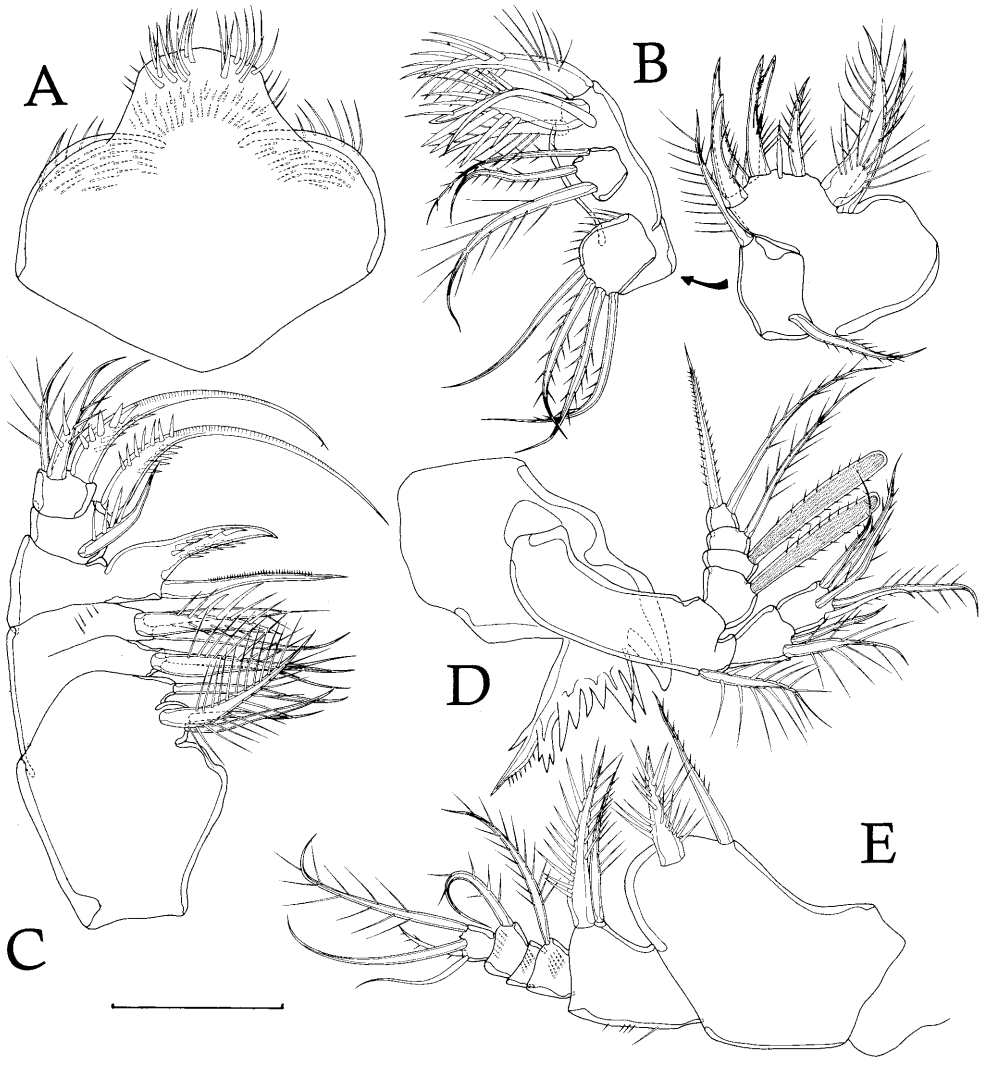


Fig. 15A–E *Sensogiselina potteki* gen. et sp. nov. (female). **A** Labrum, dorsal view. **B** Maxillule. **C** Maxilla. **D** Mandible. **E** Maxilliped. Scale bar 20 µm

out armature elements; second segment probably representing fused endopodal segments 1–3, armed with 1 lateral and 2 apical setae.

Labrum with a dense spinulose area ventrally.

Mandible palp (Fig. 21C) consisting of asetose basis, 1-segmented endopod with 1 seta, and 1-segmented (although traces of subdivisions indicate an original 3-segmented condition) exopod with 2 aesthetascs on inner margin and an apical seta.

Maxillule coxa (Fig. 21D) with 1 seta on endite and no seta representing epipodite; basis, 2 basal endites, the distal one with 3 setae, the proximal with 1 seta and with one additional element on basis probably representing an endopodal rudiment, exopod 1-segmented with 2 setae.

Maxilla (not illustrated) similar to that of *Sensogiselina potteki* sp. nov., but endopod apparently 1-segmented.

Maxilliped (Fig. 21E) consisting of syncoxa, basis, and 1-segmented endopod; syncoxa with 2 setae on subdistal inner margin, basis with 2 setae, endopod with 3 setae.

Swimming legs 1–4 (Figs. 22A,B, 23A) with small praecoxal sclerite (not always illustrated), coxa, basis and 3-segmented rami.

Leg 1 without inner basal seta. Middle endopodal segment of leg 1 with 1, that of legs 2–4 with 2 inner setae. Legs 1–4 without inner seta on first exopodal segment. Outer terminal seta on third endopodal segment of leg 3 not transformed into a lamellate spine. Swimming legs armature formula:

	Coxa	Basis	Endopod	Exopod
Leg 1	0–1	1–0	0–1; 0–1; 0,2,1	I-0; I-1; II,I,3
Leg 2	0–1	1–0	0–1; 0–2; 1,2,2	I-0; I-1; III,I,5
Leg 3	0–1	1–0	0–1; 0–2; 1,2,2	I-0; I-1; III,I,5
Leg 4	0–1	1–0	0–1; 0–2; 1,I1,I1	I-0; I-1; II,I,5

Leg 5 (Fig. 22C), located ventrally, with intercoxal sclerite; coxa and basis fused, armed with one outer basal seta; exopod 1-segmented with three well-developed

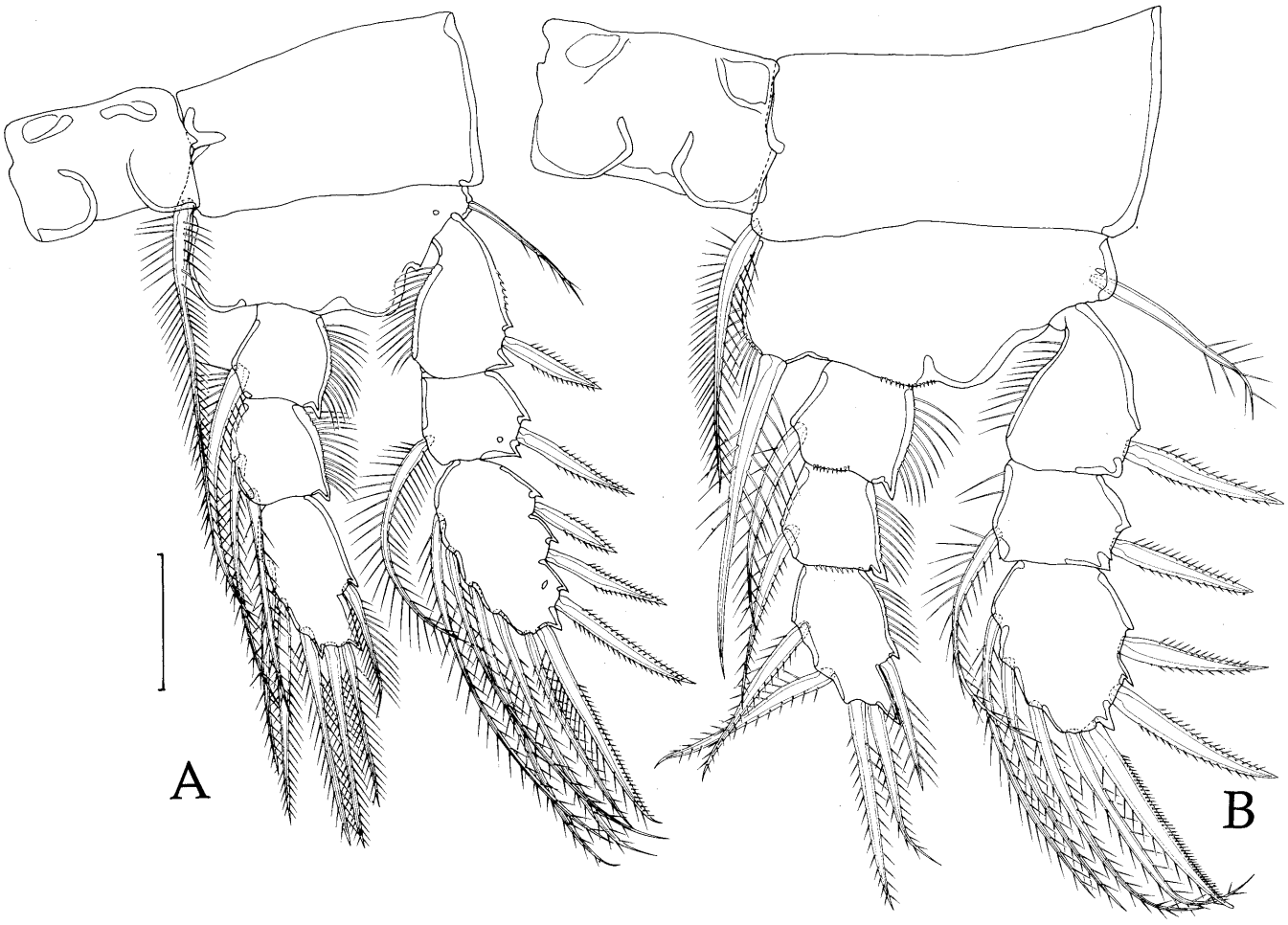


Fig. 16A, B *Sensogiselina potteki* gen. et sp. nov. (female). **A** Leg 1. **B** Leg 2. Scale bar 20 µm

elements, a terminal outer spine, a smaller terminal inner seta, and an inner seta. Inner terminal seta shorter than terminal spine.

Sixth legs (Fig. 23B), a small operculum covering gonopores and armed with 1 slender bipinnate seta.

Single ventrally located copulatory pore and paired seminal receptacles discernible on ventral side (Fig. 23C).

Description: Male. Unknown.

Etymology. The specific name *reducta* alludes to the many reductions affecting antennule, mouthparts and swimming legs.

Discussion

Several additional new species of *Giselina* gen. nov. from the abyssal Atlantic and Arctic Ocean have come to my attention. Table 1 shows the localities where these new additions were found. It is likely that Giselinidae fam. nov. are widely distributed in cold water oligothrophic environments like the deep-sea basins of the world oceans and Polar regions. Variation of characters observed in the additional specimens of *Giselina* gen. nov. will not modify the groundpattern of this genus as defined above. The major diagnostic apomorphies of *Giselina* gen nov. are (plesiomorphic condition in brackets): the fusion or lack of separation of antennary endopodal segments 2 and 3 (well-defined in *Sensogiselina potteki* gen. et sp. nov.); reduction of maxillulary endopod to a small lobe with two setae (three setae); distal endopodal segment of maxilla with only two setae (four setae); reduction of segmentation and setation of maxillipedal endopod which is 3-segmented with a setal formula of 1, 1, and 2 setae (4-segmented, with setal formula 1, 0, 1, 4); and the modification of the outer terminal element on third endopodal segment of leg 3 into a lamellate spine (bipinnate seta).

Giselina cristata gen. et sp. n. differs from *G. gerdesi* sp. n. in several respects, notably the dorsal elevation of the abdominal frills forming a crest which is most striking in lateral view (Fig. 2A) and the trilobate anal operculum (Fig. 2D) which are diagnostic apomorphies of *G. cristata* gen. et sp. nov. In addition, the antennule is 13-segmented in *G. cristata* gen. et sp. nov., while it is only 9-segmented in *G. gerdesi* sp. nov. due to a different fusion pattern (Fig. 24). The whole antennule is shorter in *G. gerdesi* sp. nov., reaching only about the base of the maxilla, while the distal segment of this ap-

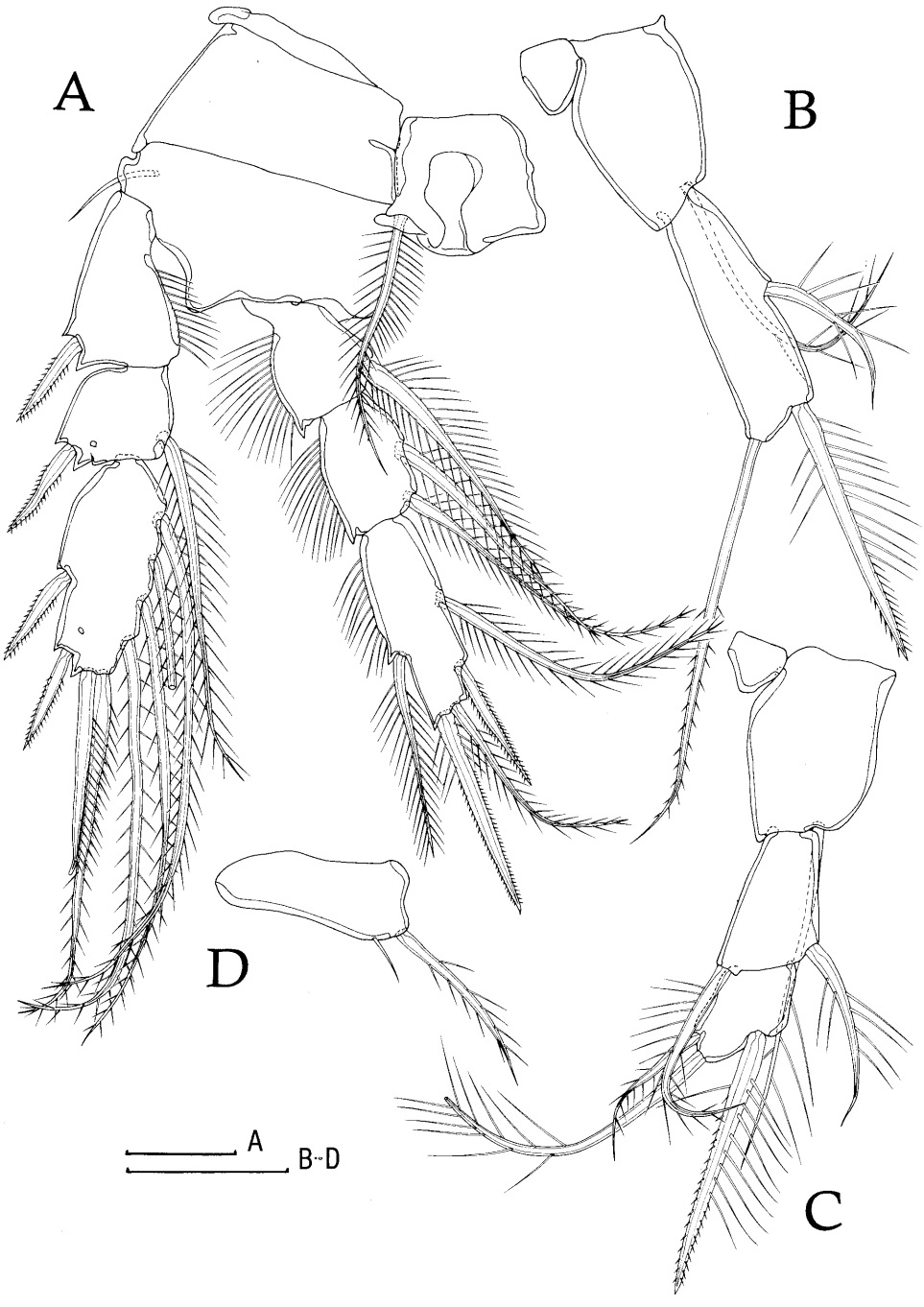


Fig. 17A–D *Sensogiselina potteki* gen. et sp. nov. **A** Female leg 4. **B** Female leg 5. **C** Male leg 5. **D** Male leg 6. Scale bars 20 µm

Table 1 Additional material of Giselinidae

	Expedition	Date	Depth	Locality	Coordinates
Giselina sp. 3	ANT XIII/5	12.06.96	5118 m	Canary Deep Sea Basin	23°11N 24°26W
Giselina sp. 4	ANT XIII/5	12.06.96	5055 m	Canary Deep Sea Basin	23°10N 24°26W
Giselina sp. 5	ARK IX/4	18.08.93	2995 m	Barents Sea, Arctic Ocean	82°45N 40°15E
Giselina sp. 6	ARK IX/4	26.08.93	156 m	Vilkitzky Strait, Arctic Ocean	78°01N 102°18E
Giselina sp. 7	ARK IX/4	21.08.93	529 m	Barents Sea, Arctic Ocean	82°07N 42°32E

pendage reaches the base of the first leg in *G. cristata* gen. et sp. nov.. The mandibular basis lacks a seta in *G. cristata* gen. et sp. nov. while one element is present in *G. gerdesi* sp. nov.. Finally, the terminal inner seta on leg 5 is distinctly shorter than the terminal outer spine in *G. cristata* gen. et sp. nov., while it is almost as long as the spine in *G. gerdesi* sp. nov.

The sister group of *Giselina* gen. nov. is the genus *Sensogiselina* gen. nov. This latter genus is a monophyletic group characterised by the modification of the elements on the first and second mandibular endopodal segments from bipinnate setae into aesthetascs. Aesthetascs are sensorial elements, probably chemoreceptors assisting, for instance, in mate or food recognition. In Cope-

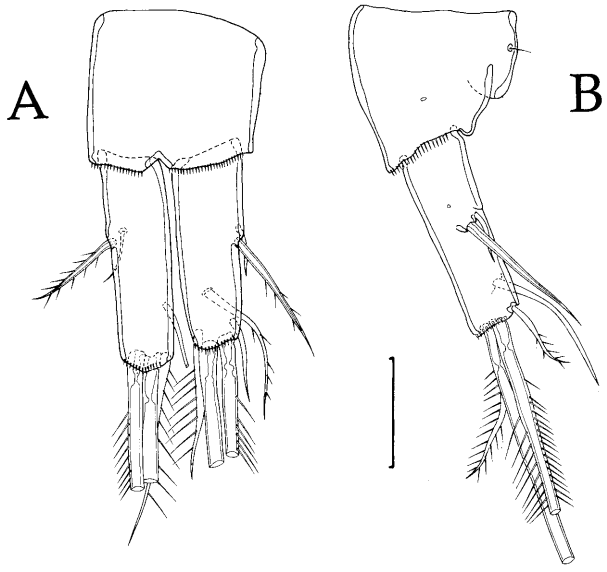


Fig. 18A, B *Sensogiselina potteki* gen. et sp. nov. (female). **A** Telson and furca, ventral view. **B** Telson and furca, lateral view. Scale bar 20 µm ▶

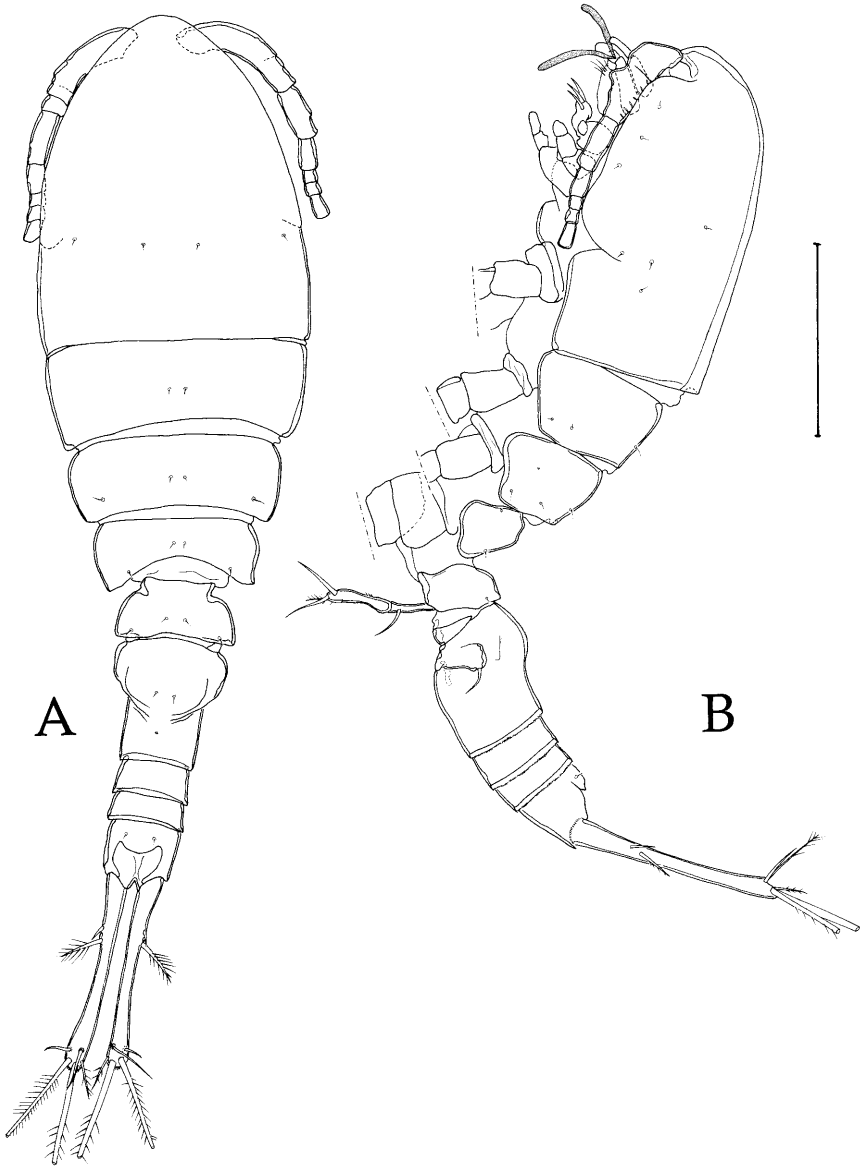


Fig. 19A, B *Sensogiselina reducta* sp. nov. (female). **A** Habitus, dorsal view. **B** Habitus, lateral view. Scale bar 100 µm

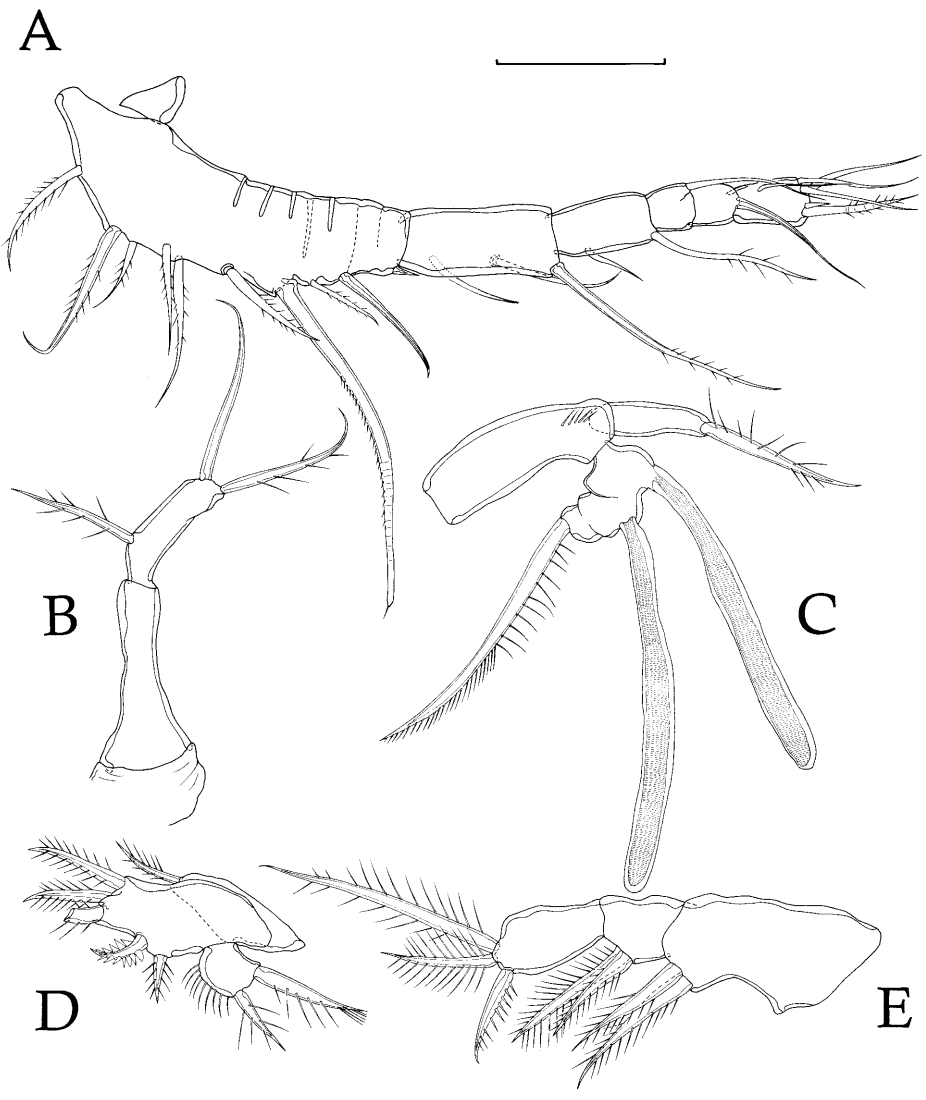


Fig. 20A–E *Sensogiselina reducta* sp. nov. (female). **A** Antennule. **B** Antenna. **C** Mandibular palp. **D** Maxillular coxa, basis and exopod. **E** Maxilliped. Scale bar 20 µm

poda, these structures are typically present on antennulary segments in males and females, although they tend to be more numerous in males. The presence of aesthetascs on mouthparts is reported here for the first time (to my knowledge) for the Cyclopoida. However, aesthetascs on mouthparts have been reported for some species of Siphonostomatoida (Ho 1984) and for some harpacticoid species belonging to the family Parananopidae (Mielke 1975). In parananopids, club-shaped aesthetascs have been described on mandible, maxillule and maxilla. In addition, a new genus related to Marsteiniidae (Harpacticoida), found by myself in several deep-sea samples (unpublished data) has aesthetascs on mandible and maxilliped.

Differences between the species of *Sensogiselina* gen. nov. are considerable, mainly due to several reductions in cephalic appendages and swimming legs of *S. reducta* sp. nov. However, I prefer to keep both species within one genus because virtually nothing is known about intrageneric variability of these characters. Future discoveries of additional species may help in distinguishing monophyletic sub-units within the genus. *Sensogiselina potteki* gen. et sp. nov. can easily be distinguished from its congener by its 18-segmented antennule, which is only 6-segmented in *S. reducta* sp. nov.; the 4-segmented antenna (2-segmented in *S. reducta* sp. nov.); 2-segmented mandibular endopod with two and five setae (1-segmented with one seta in *S. reducta* sp. nov.); 1-segmented maxillulary endopod (incorporated into basis in *S. reducta* sp. nov.); 4-segmented maxillipedal endopod (1-segmented in *S. reducta* sp. nov.); leg 1 with inner basal spine, five elements on distal endopodal segment, and three spines and four setae on distal exopodal segment (no inner basal spine, only three elements on distal endopodal segment, and three spines and three setae on distal exopodal segment in *S. reducta* sp. nov.); absence of seta on inner margin of leg 5 exopod (a seta is present at this site in *S. reducta* sp. nov. and the seta present on the outer margin in *S. potteki* gen. et sp. nov. is absent in this species); finally, the furca is about three times as long as wide, while it is about 14 times as long as wide in *S. reducta* sp. nov.

The closest relatives of the Giselinidae fam. nov. are to be found within the taxon “Cyclopinidae” which is a

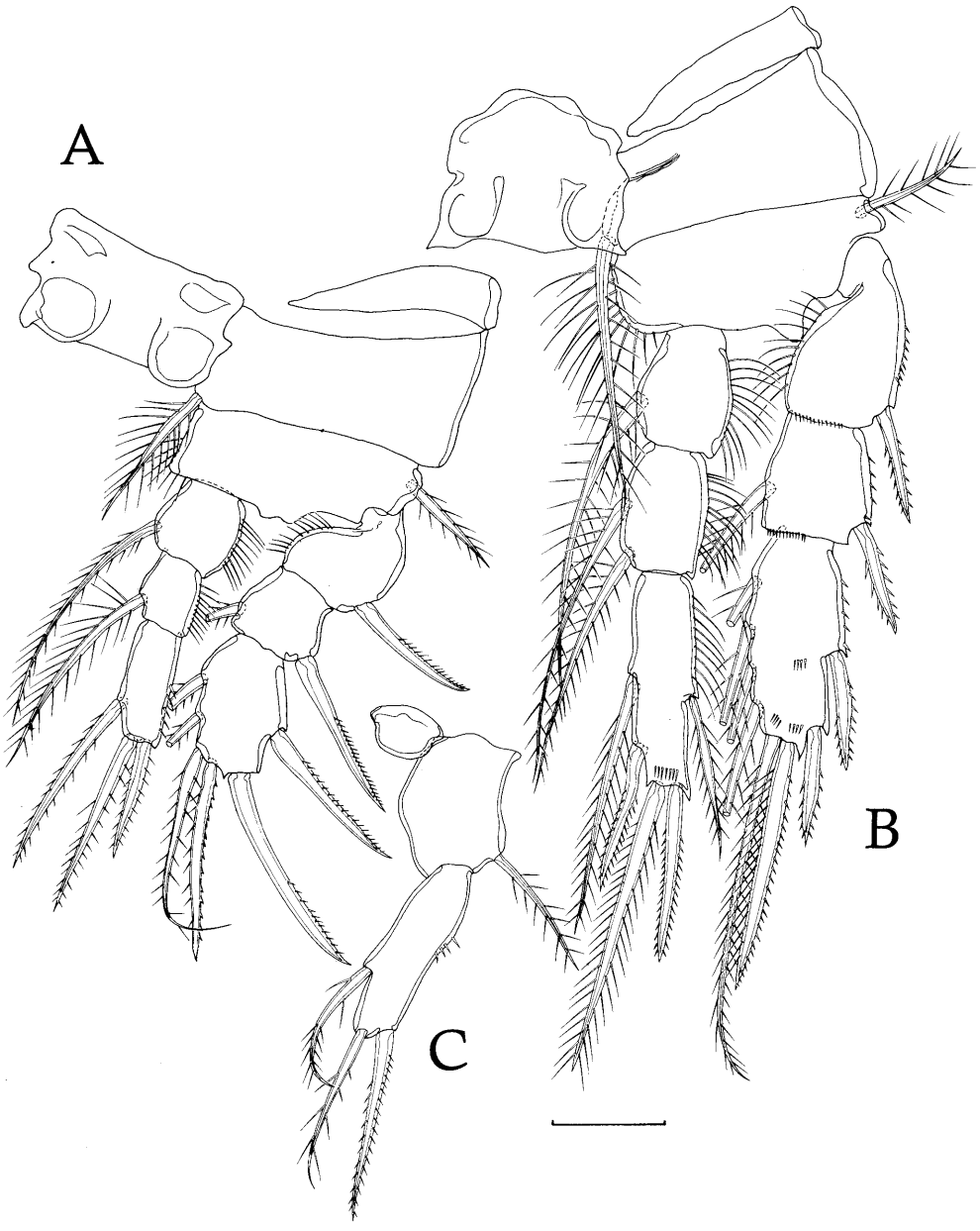


Fig. 21A–C *Sensogiselina reducta* sp. nov. (female). **A** Leg 1. **B** Leg 4. **C** Leg 5. Scale bar 20 µm

paraphyletic group (defined by symplesiomorphies only). Therefore a phylogenetic revision should first attempt to recognise its monophyletic sub-units, one of them being the taxon Giselinidae fam. nov. Taxonomically, I have proposed for it a name of the family-group according to the International Code of Zoological Nomenclature. Family-group names have subfamiliar, familiar or superfamiliar ranks.

This family can be distinguished from other cyclopinids by a combination of the following characters:

1. Tergite of leg 1 fused to cephalosome dorsally, but incompletely fused laterally.
2. Absence of aesthetascs on ancestral antennulary segments XVI, XXI and XXV.
3. Absence of antennary exopodal setae.
4. Presence of only three spines on distal exopodal segment of leg 1.
5. Absence of inner setae on first endopodal segments of legs 1–4.
6. Outer terminal and distal inner elements of distal endopodal segment of leg 4 transformed into spines.
7. Distal outer element of leg 5 exopod transformed into a spine
8. Leg 6 with only one seta.
9. Furcal setae I and III located on dorsal margin.

The first pedigerous somite is free in the groundpattern of Cyclopoida and this plesiomorphic condition has been retained by a large number of marine free-living genera such as *Cyclopicina* Lindberg 1953 (Martínez Arbizu 1997a), *Cyclopinodes* Wilson 1932

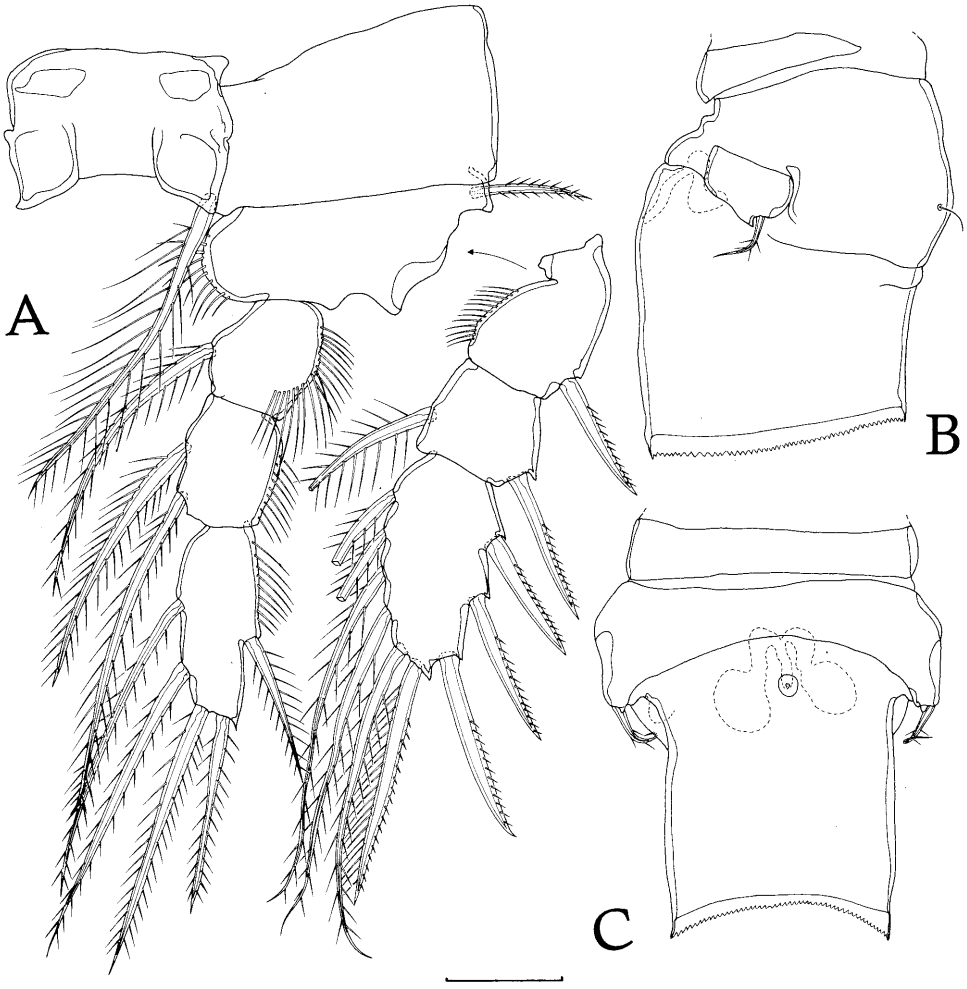


Fig. 22A–C *Sensogiselina reducta* sp. nov. (female). **A** Leg 2. **B** Genital double-somite, lateral view. **C** Genital double somite, ventral view. Scale bar 20 µm

(Sars 1913), *Smirnovipina* Martínez Arbizu 1997 (Martínez Arbizu 1997b), *Pseudocyclopina* Lang 1946 (Giesbrecht 1902), *Arctocyclopina* Mohammed and Neuhof 1985 (Mohammed and Neuhof 1985), *Cyclopina* Claus, 1862 (Monchenko 1977), *Cyclopinella* Sars 1913 (Sars 1913), etc. To my knowledge, the only other cyclopinids with a dorsally fused first pediger, which is still subdivided on lateral margins, are *Paracyclopetta* Wells 1967 (Wells 1967) and *Cyclopetta* Sars 1913 (Martínez Arbizu 2000). These latter genera belong to a different phylogenetic lineage within cyclopinids (Martínez Arbizu 2000) so that sharing this character should be considered a convergence.

Within Copepoda, the presence of aesthetascs on some antennulary segments, notably female ancestral antennulary segments XVI, XXI, XXV and XXVIII, is highly conservative. Within Cyclopoida these aesthetascs are present, for instance, in *Oromiina* Jaume and Boxshall, *Muceddina* Jaume and Boxshall, *Arctocyclopina* Mohammed and Neuhof, and *Pseudocyclopina* Giesbrecht. The loss of these aesthetascs on ancestral segments XVI, XXI and XXV is shared by the genera *Cyclopinoides* Lindberg 1953, *Ginesia* Jaume and Boxshall 1997 and its closest relative *Smirnovipina* (Martínez Arbizu 1997b). Surprisingly, the presumably primitive genus *Cyclopicina* lacks aesthetascs on ancestral antennulary segments XVI and XXI (Fig. 24). Unfortunately many species and genera are improperly known, which thus obscures the significance of this interesting character. The absence of information about ontogenetic development of the antennule in virtually all cyclopinids (except *Cyclopina* (Grainger and Mohammed 1991)) makes it difficult to consider the transformation of aesthetascs on these particular segments. Ontogenetic information is needed to elucidate what kind of heterochronic event determines the presence or absence of aesthetascs and setae on the antennulary segments.

The absence of exopodal setae on the antenna is a derived character shared by Schminkepinellidae (a new taxon that will include the genera *Cyclopinella*, *Muceddina* Jaume and Boxshall 1996, *Barathricola* Humes 1999, and two additional new genera *Einslepinella* and *Schminkepinella*) and the poecilostome families (all families currently ascribed to the copepod order Poecilostomatoida).

To my knowledge the loss of the proximal outer spine on the distal exopodal segment of leg 1 is not expressed

in the groundpattern of any other monophyletic subunit of cyclopinids. Within Psammocyclopinidae (a new family that will include the closely related interstitial genera *Psammocyclopina* Wells and *Metacyclopina* Lindberg) this spine is lost in *Metacyclopina* and in one new species of *Psammocyclopina* from the Magellan region. But *Psammocyclopina hindley* Wells 1967 displays the full armature formula of three spines and five setae on this segment (Wells 1967), which indicates that this reduction is a homoplasy within the interstitial lineage and Giselinidae fam. nov. It has to be noted that in the interstitial genera the outer terminal element is transformed from a lamellopinnate spine into a bipinnate seta. The plesiomorphic condition for Copepoda, and consequently for Cyclopoida, is four spines and four setae. The transformation of the outer terminal lamellopinnate spine into a seta is a constitutive character of a large lineage within cyclopinids including not less than ten genera.

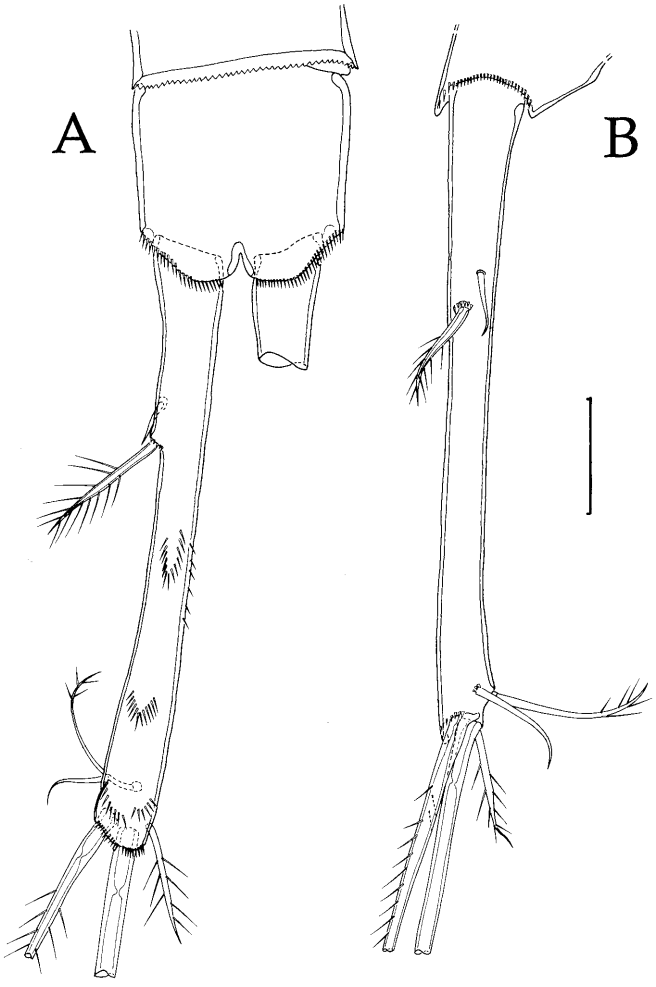


Fig. 23A, B *Sensogiselina reducta* sp. nov. (female). **A** Telson and furca, ventral view. **B** Furca, lateral view. Scale bar 20 µm

An inner seta on the first exopodal segment of legs 1–4 is present in the groundpattern of the Cyclopoida, but it is absent in Psammocyclopinidae, Schminkepinellidae, and poecilostome families. Psammocyclopinidae belong to a different lineage within cyclopinids, but the absence of these setae may be considered a synapomorphy of Giselinidae fam. nov., Schminkepinellidae and the poecilostome families.

The outer terminal element of leg 4 endopod is transformed into a spine in Giselinidae fam. nov., Schminkepinellidae, poecilostome families, and Cyclopidae. This feature may be considered a synapomorphy of these taxa. The transformation of the distal inner endopodal element on this leg from a seta into a spine is also shared by all these taxa, with the exception of the freshwater subfamilies Eucyclopinae and Cyclopinae.

Within cyclopinids only *Psammocyclopina* and *Pterinopsyllus* display three well-developed setae on female leg 6, some other genera have one of the setae reduced to a small knob (usually fused to the segment) and two setae retained. The presence of only one well-developed seta on leg 6 is a derived character shared by Schminkepinellidae, the poecilostome families and Cyclopidae.

In the groundpattern of the Cyclopoida, furcal seta I is located on the lateral margin well separated from furcal seta II. This is the case, for instance, in *Cyclopicina*, *Heterocyclopina* (Plesa 1968) and *Smirnovipina*. The displacement of seta I to a position near seta II, slightly shifted to the dorsal margin, is likely to have occurred several times within Cyclopoida.

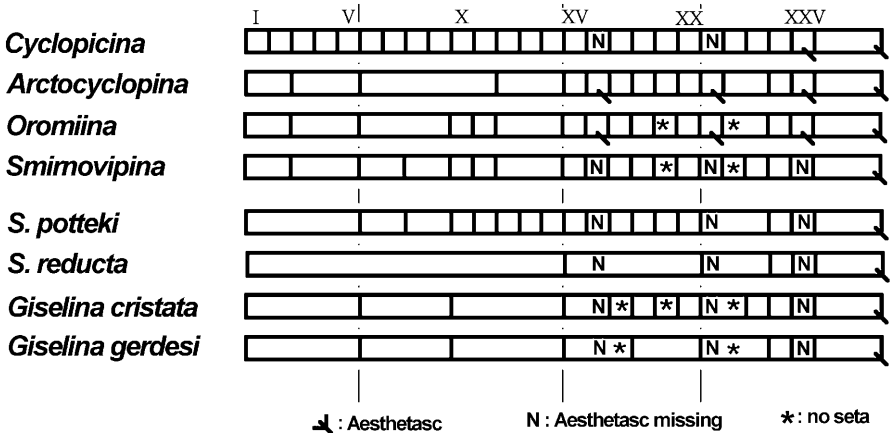


Fig. 24 Homology of antennulary segments of the species of Giselinidae fam. nov., in comparison with other cyclopinids

A detailed phylogenetic analysis of the different monophyletic sub-units of cyclopinid Cyclopoida will be presented elsewhere (Martínez Arbizu, in preparation)

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