

The genus *Pseudocyclopina* Lang in Antarctic waters: Redescription of the type-species, *P. Belgicae* (Giesbrecht, 1902) and the description of four new species (Copepoda: Cyclopinidae)

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THE GENUS *PSEUDOCYCLOPINA* LANG IN
ANTARCTIC WATERS: REDESCRIPTION OF THE
TYPE-SPECIES, *P. BELGICAE* (GIESBRECHT, 1902) AND
THE DESCRIPTION OF FOUR NEW SPECIES

(COPEPODA: CYCLOPINIDAE)

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ABSTRACT

Three new species of the genus *Pseudocyclopina* Lang, 1946, viz. *P. eddatreyae* sp. n., *P. berndtreyi* sp. n., and *P. veitkoehlerae* sp. n., are described from the coastal planktic community and hyperbenthic water layers of Potter Cove, King George Island (Antarctica). A fourth new species, *P. guentheri* sp. n., was discovered in the under-ice planktic community off the German Neumayer-Station in the Weddell Sea. In order to establish a revised generic diagnosis, the type-species, *P. belgicae* (Giesbrecht, 1902) is also redescribed in detail. The three species from Potter Cove are more closely related to each other than to the sister-pair of species: *P. belgicae* and *P. guentheri* sp. n.. The first group differs from the two sister-species in several aspects: 2 setae represent the antennary exopodite; a row of long spinules is found on the lateral margins of the fifth legs tergite, the shape of the maxillipedal endopodite is compact; and modified setae are present on antenna and maxilliped. The male of *P. eddatreyae* sp. n. differs from *P. belgicae* in having an inner coxal seta on fifth leg. The genus *Pseudocyclopina* presently is regarded as endemic to Antarctic waters. Phylogenetically, the genus appears to be the sister-group of a taxon comprising *Cyclopinopsis* Smirnov, 1935 and *Parapseudocyclopinodes* Lindberg, 1961. The sister-group of all three genera together is the genus *Cyclopinodes* Wilson, 1932.

Key Words: *Pseudocyclopina*, redefinition, Cyclopinidae, Copepoda, plankton, Antarctica, phylogenetic systematics.

INTRODUCTION

Most of the relatively primitive genera of cyclopinid copepods, e. g. *Cyclopicina* Lindberg,

1953, *Cyclopinodes* Wilson, 1932, *Cyclopinoides* Lindberg, 1953, and *Smirnovipina* Martínez Arbizu, 1997 are known from hyperbenthic water layers (Sars 1913; Wilson 1932; Herbst 1964; Huys & Boxshall 1990; Martínez Arbizu 1997a, b.). These animals often swim very close to the bottom, but are also able to ascend above the benthos into the surrounding water column. It is not known whether cyclopinids actively migrate to the upper water layers or whether their presence in the planktic community is a result of drift caused by near bottom currents. Reports of several species from plankton samples include : Willey (1920); Wilson (1936); Grandori (1926); Smirnov (1931, 1935); Mohammed & Grainger (1971); and Menshenina & Melnikov (1995). In polar environments, some cyclopinids use the crevicular system of sea ice and the under ice water layers as an up-side down benthic habitat (Giesbrecht 1902; Melnikov & Kulikov 1980; Mohammed & Neuhof 1985; Cross 1982; Grainger & Mohammed 1986, 1991; Werner & Martínez Arbizu 1999; Günther et al. 1999).

Almost one hundred years ago, Giesbrecht (1902) described *Cyclopina belgicae* from the under ice plankton community southwest of the Isle Pierre I, off Antarctica. Males of this species were remarkable in possessing a strongly developed, sexually dimorphic process on the third exopodal segment of leg 2. This characteristic led Lang (1946) to propose a new

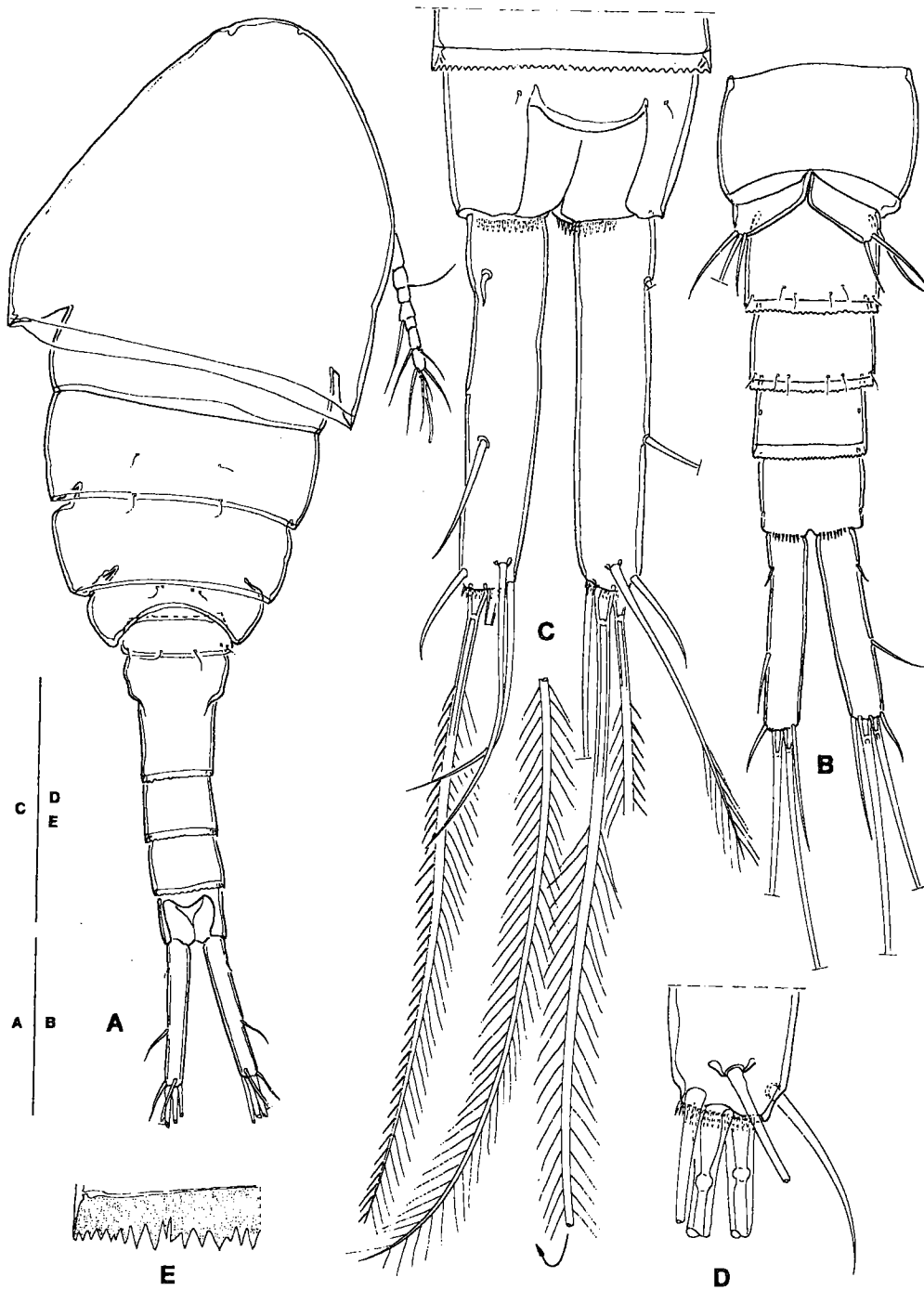


Fig. 1. *Pseudocyclopina belgicae* (Giesbrecht, 1902). A, female habitus, dorsal view. B, male abdominal somites, ventral view. C, female anal somite and furca, dorsal view. D, distal part of female right furca, dorsal view (Note that the rami are flattened, giving the impression that they are shorter than in illustration A). E, part of hyaline frill of 4th urosomal somite of female (A, COP 023, B, COP 021, C-E, COP 020). Scale: A=200 μ m, B-C=100 μ m, D-E=50 μ m.

genus *Pseudocyclopina* for this species, the only Cyclopininae known at that time with sexual dimorphism of the swimming legs.

During an ongoing study of coastal planktic communities in the Potter Cove, King George Island, Antarctica, 3 new species of this remarkable genus were discovered in near bottom samples. In addition, platelet ice layers in Drescher Inlet, German Neumayer Station in the Weddell Sea yielded some cyclopinid specimens which were previously (Günther et al. 1999) identified as *P. belgicae*. They proved to represent a fourth unknown species. The present contribution includes a redescription of the type-species, *P. belgicae* (Giesbrecht, 1902), which permits to present a revised diagnosis of this former monotypic genus. These new findings also necessitate some comments on the phylogenetic position of the genus within the Cyclopinidae.

TAXONOMY

Family Cyclopinidae Sars, 1913

Pseudocyclopina belgicae
(Giesbrecht, 1902)

(Figs. 1-5)

Material. – Lectotype, female, dissected, mounted in glycerine on a single slide, from sample 378, labeled COP 020; paralectotype male, dissected and mounted in glycerine on a single slide, from sample 1083, labeled COP 021; other paralectotypes: 1 female, dissected and mounted in glycerine on a single slide, from sample 521, labeled COP 022; 1 female, undissected, mounted in glycerine on a single slide, from sample 521 (COP 023); 2 females, undissected, mounted in Euparal®, from sample 1083 (COP 024); 2 males, undissected, mounted in Euparal®, from sample 1083 (COP 025). The entire collection has been registered under nr. I.G.: 10.131.

Type-locality. – Antarctica, Bellinghausen Sea. Plankton sample at 400 m depth, 21 May 1898 (71°15'S - 87°27'W: sample 378); plankton sample at 400 m depth, 23 September 1898 (70°24'S - 82°37'W: sample 521); plankton sample at 10 m depth, 21 April 1898 (71°02'S - 92°03'W: sample 1083).

Redescription. – Female. Mean body length, including furcal rami, 1225 µm (undissected paralectotypes). First pedigerous somite not incorporated in head, covered with posteriorly

directed integumental flap of cephalosome. Posterior margins of head and pedigerous somites smooth. Urosomal somites with serrate hyaline fringe (Fig. 1 E). Anal somite with spinules along posterior-ventral margin. Anal operculum smooth and crescentic (Fig. 1 C). Genital double-somite 1.5 times longer than wide.

Furca (Fig. 1A, C) cylindrical, nearly 7 times as long as wide, bearing 7 setae: seta I located at proximal fifth of outer margin, seta II arising in median third. Inner distal seta (VI) as long as dorsal seta (VII), both as long as 2/3 of ramus. Outer principal seta with rigid spinules along outer margin of stem, with fine setules along inner margin. Inner principal seta with fine setules along both sides. Dorsal distal margin of rami without ornaments, ventral margin spinulose (Fig. 1 D).

Rostrum rather large, with rounded apex. Antennule (Fig. 2A) 16-segmented, not reaching further than maxilliped region. Setal complement on right antennule of lectotype and dissected paralectotype as follows (Roman numerals = segment number, Arabic numerals = number of setae, Aesth = aesthetasc, sp = spine): I(3)-II(5)-III(8)-IV(2)-V(2)-VI(4+2sp)-VII(2+Aesth)-VIII(2)-IX(1)-X(1)-XI(1+Aesth)-XII(1)-XIII(1)-XIV(2)-XV(2+Aesth)-XVI(7+Aesth). Left antennule of lectotype with segment I bearing only 2 setae. Aesthetascs long, club-shaped. Integument of segments smooth except for spinule row on segment I.

Antenna (Fig. 2B) without exopodal setae on coxo-basis, and a single distal abexopodal seta. Caudal surface with minute spinules near distal inner edge. Endopodite 3-segmented, with 1, 5, and 7 setae, respectively. Longest seta on penultimate and ultimate segments with spoon-like tips.

Mandible (Fig. 2C) with large gnathobasis. Biting edge with widely spaced teeth, and 2 serrate elements. Medial border complemented with spinule rows parallel with masticatory edge. Basis long apparently with smooth surface, and provided with outer seta. Endopodite 2-segmented with 3 and 6 elements on proximal and distal segment, respectively. Distal-most on terminal segment fused at base. Surface of segments smooth. Exopodite 4-segmented, with setal arrangement 1, 1, 1, 2, all bipinnate. Surface of exopodal segments ornamented with spinule row.

Maxillule (Fig. 3A) with short praecoxal arthritis, bearing 12 setae and spines including 1 anterior and 4 posterior (Fig. 3B). Coxal

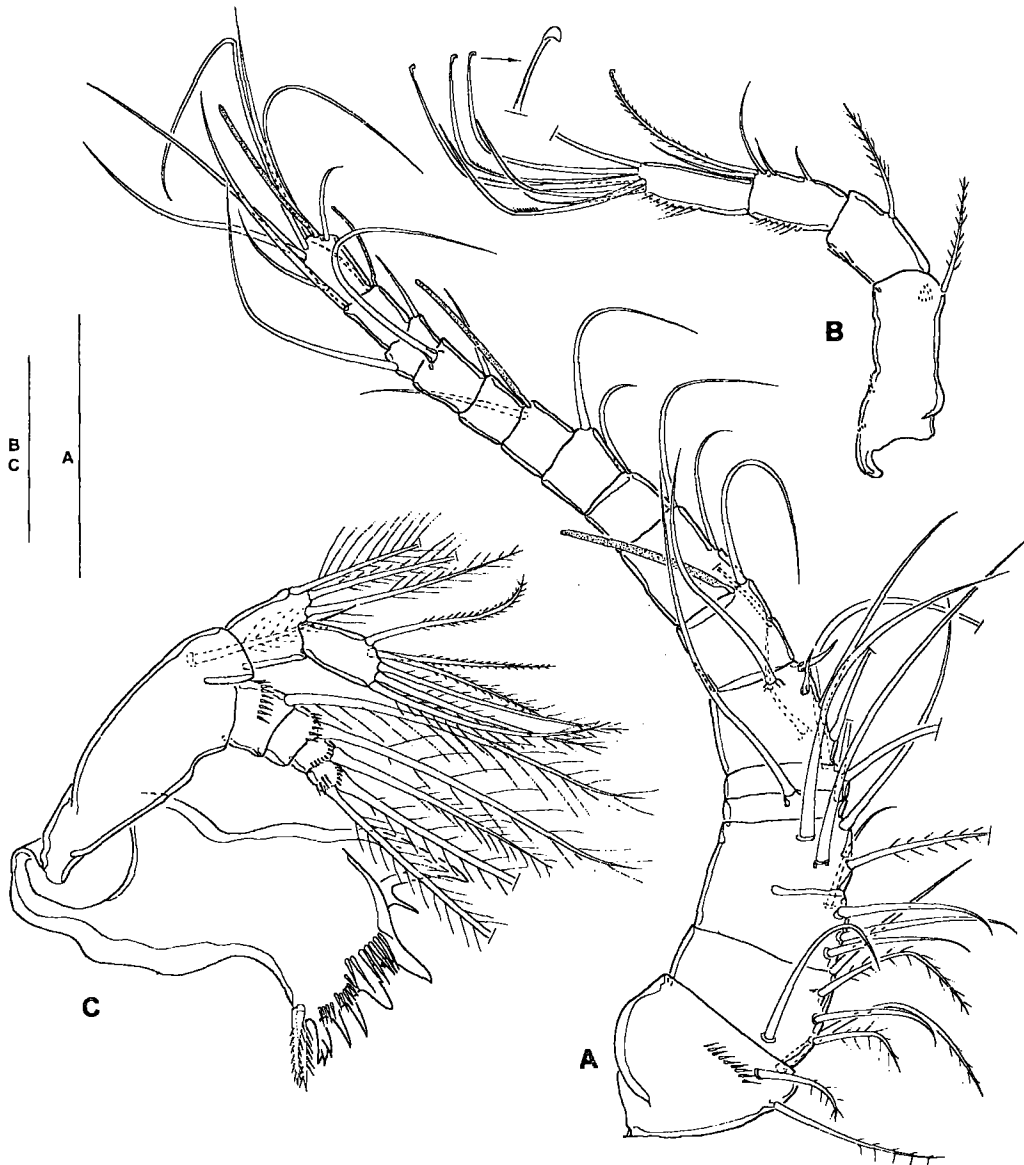


Fig. 2. *Pseudocyclopina belgicae* (Giesbrecht, 1902). A, female antennule. B, antenna (insert out of scale). C, mandible (A - C, COP 020). Scale: A, C=50 μ m, B=100 μ m.

endite with 1 seta, and two (1 long, 1 minute) epipodal setae. Two basal endites: proximal one with 3 and distal one with 2 setae. Exopodite and endopodite 1-segmented, bearing 4 and 7 setae, respectively.

Maxilla (Fig. 3D) 6-segmented. Praecoxa separated from coxa with integumental fold (remnant of ancestral separation) on one side. Opposite side without distinction between coxae. Prae-coxa with 2 endites, bearing 2 setae

and 1 spine on proximal one, and 1 seta on distal one. Coxa with 2 endites, with proximal one bearing 2 setae and 1 spine, and distal one 3 setae. Basis (Fig. 3E) produced in strong serrate claw, accompanied by 2 setae, one of them much longer than claw. First and second endopodal segment (Fig. 3F) with 4 and 2 long serrate setae, respectively, third segment with one apical long serrate element and 3 slender lateral setae.

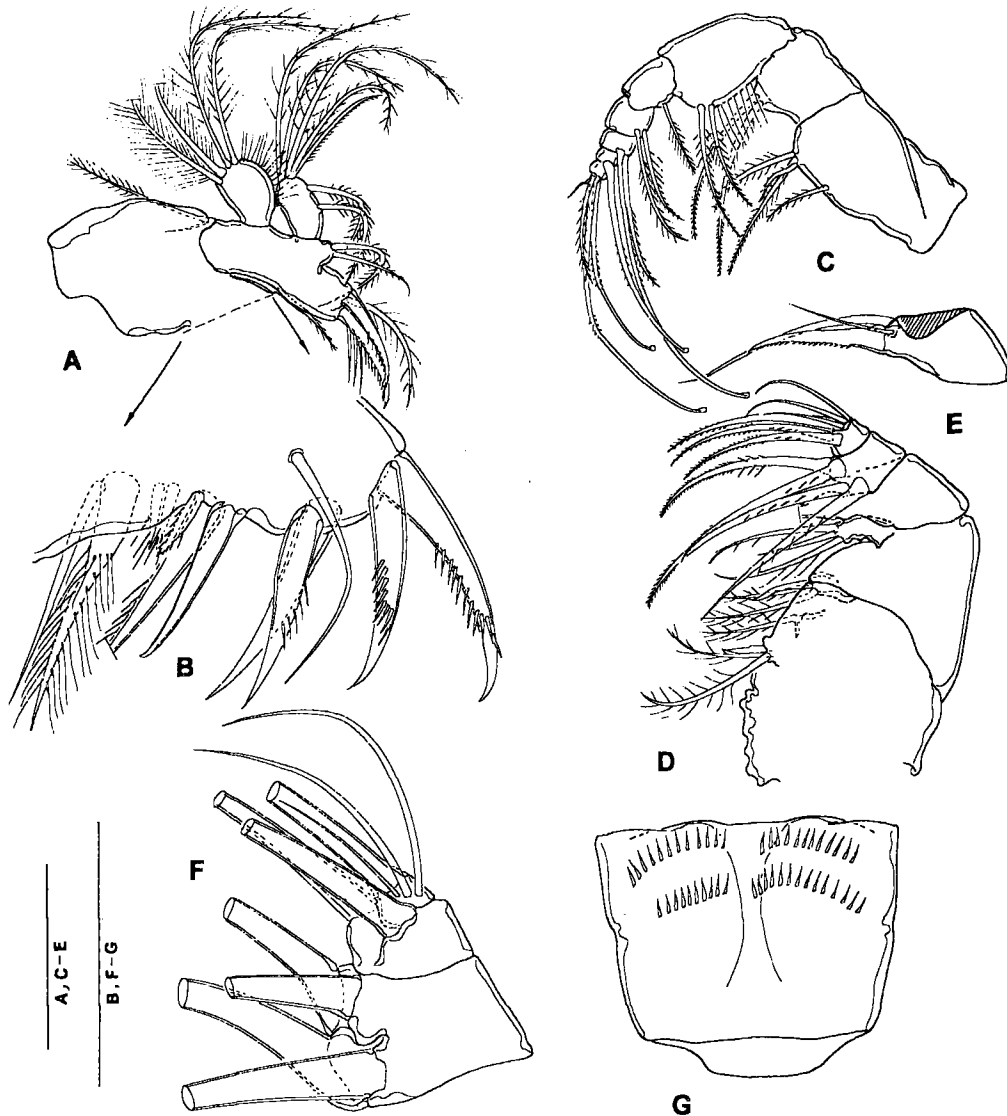


Fig. 3. *Pseudocyclopina belgicae* (Giesbrecht, 1902). A, maxillule (arthrite omitted). B, praecoaxal arthrite of maxillule. C, maxilliped. D, maxilla (claw and setation on basis omitted). E, basis of maxilla. F, endopodite of maxilla, enlarged. G, intercoxal sclerite of leg 4 (posterior view). (A-G, COP 020). Scale: A, C-E=100 μ m, B, F-G=50 μ m.

Maxilliped (Fig. 3C) 8-segmented. Distinction between praecoaxa and coxa present on one surface as integumental fold, opposite surface lacking distinction. Prae-coxa with 2, coxa with 1 endite, bearing 1, 3, and 2 setae, respectively. Basis semi-ovate with 1 endite, bearing 2 setae, and a medial border furnished with long and slender spinules. Endopod 5-segmented, aspect elongated. Endopodal setal complement: 1, 2, 2, 1, 4. Longest setae on endopodal

segments 4-5 with spoon-like tips.

Legs 1-4 with well distinguished coxa, basis and 3 segmented rami. Intercoxal sclerite in leg 1 with smooth caudal surface, in legs 2 and 3 with a single transverse row of minute spinules, and in leg 4 with two parallel transverse rows (Fig. 3G). Armature of rami as follows:

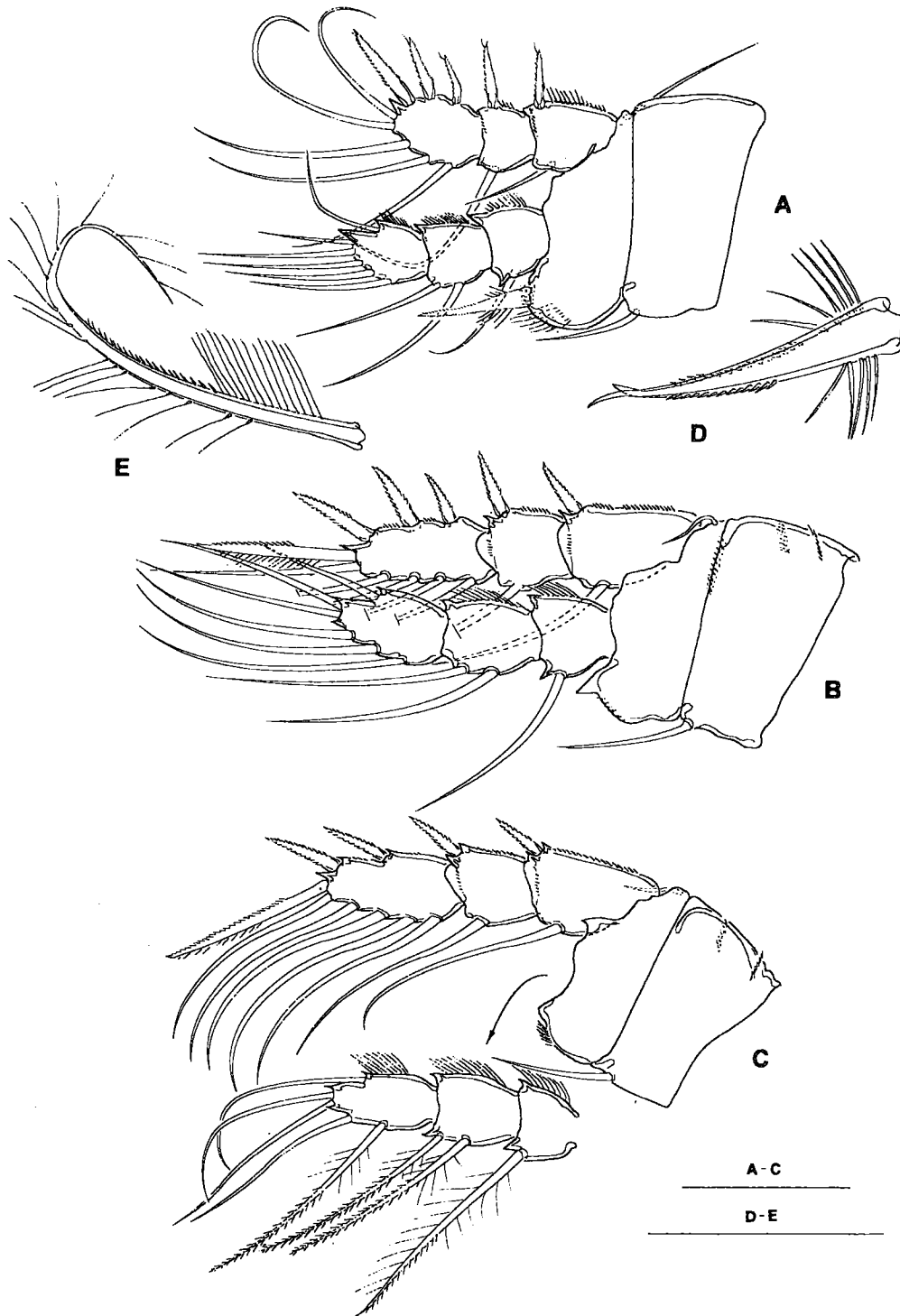


Fig. 4. *Pseudocyclopina belgicae* (Giesbrecht, 1902). A, first leg. B, second leg. C, fourth leg. D, medial spine of leg 1 basis. E, outer distal element of terminal exopodal segment of leg 1. (A-E, COP 020). Scale: A-C= 100 μ m, D-E= 50 μ m.

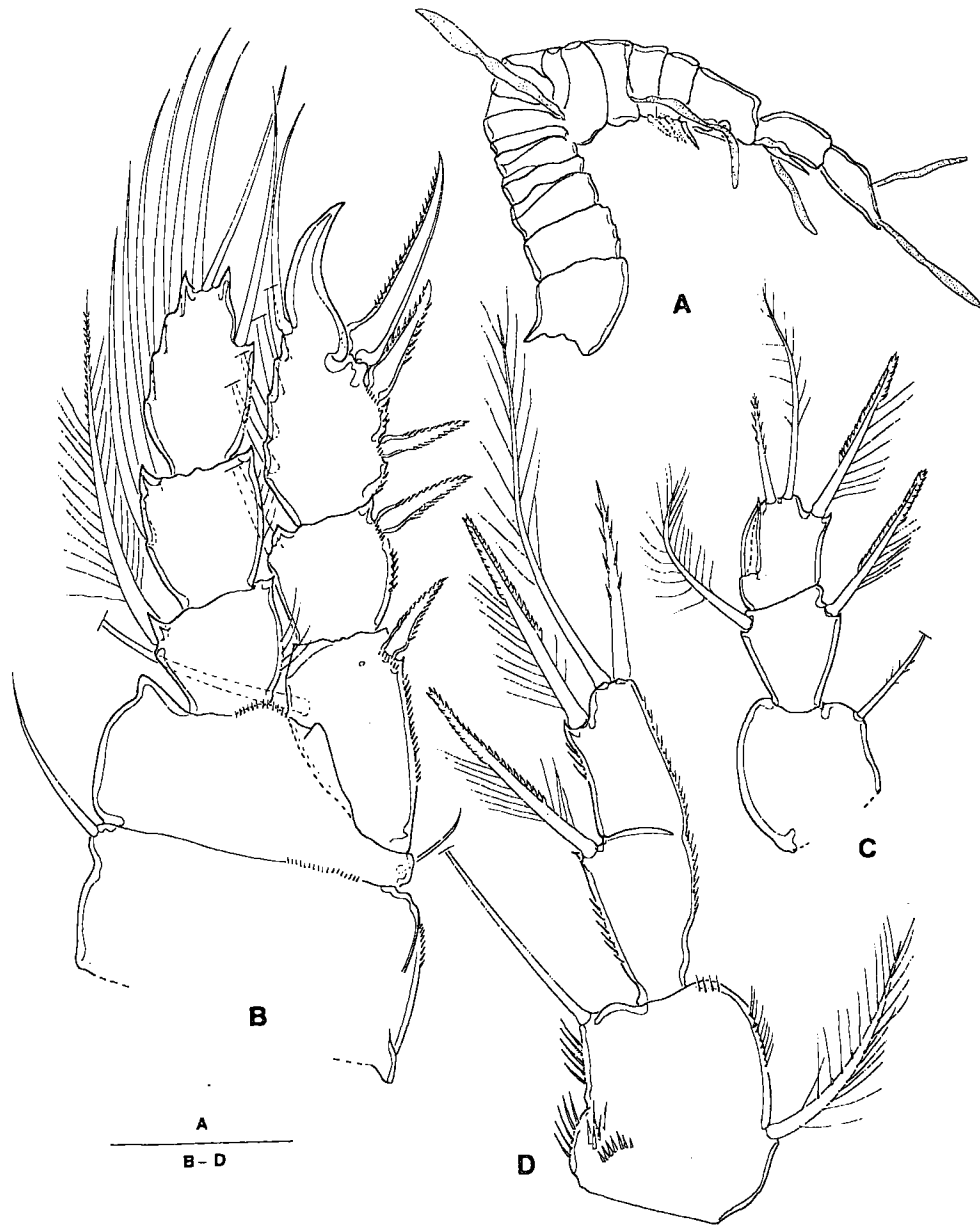


Fig. 5. *Pseudocyclopina belgicae* (Giesbrecht, 1902). A, contour of male antennule. B, second leg of male. C, fifth leg of male. D, fifth leg of female (A-C, COP 021, D, COP 020). Scale A=100 μ m, B-D=50 μ m.

	coxa	basis	exopodite	endopodite
Leg 1	0-1	1-1	I-1; I-1; III,1,4	0-1; 0-2; 1,2,3
Leg 2	0-1	1-0	I-1; I-1; III,1,5	0-1; 0-2; 1,2,3
Leg 3	0-1	1-0	I-1; I-1; III,1,5	0-1; 0-2; 1,2,3
Leg 4	0-1	1-0	I-1; I-1; II,1,5	0-1; 0-2; 1,2,2

Medial seta on coxa of legs 2-4 reaching beyond medial expansion of basis. Medial spine on leg 1 basis stout, bipinnate in proximal third, but serrate in median third (Fig. 4D), and reaching slightly beyond second endopodite segment (Fig. 4A). Outer spines of leg 1 exopodite, and medial spine of basis fla-

gated. Distal element on third exopodite segment of leg 1 bipinnate in proximal third, serrate along outer margin but plumose at inner margin in second third, and unipinnate in distal third (Fig. 4E). Surface ornamentation on coxa and basis of all legs hardly visible. Leg 4 (Fig. 4C) with serrate setae on inner margins of endopodal segments. All other setae plumose.

Leg 5 (Fig. 5D) with fused coxa and basis. Medial and outer margins, and surfae near outer proximal corner ornamented with spinule rows. Medial seta bipinnate, outer one broken (COP 021). Exopodite 1-segmented, with transversal remnant of articulation on anterior surface. Outer elements partially serrate. Distal-most seta plumed and inner distal one spiniform. Medial and outer margins of exopodal segment with spinules.

Leg 6 and genital area impossible to observe in neither specimen.

Male. Habitus as in female, except for separated second and third urosomite. Body length 769-777 μ m (2 specimens). Urosome shorter than half the entire body length (± 0.45 times). Neither pediger of leg 1, nor posteriorly directed integument of cephalosome observed (animals mounted with ventral side up). Furca (Fig. 1B) 4.7 times as long as wide, without detectable spinules along distal border. Integumental fringe of urosomites serrate.

Antennule too compressed under coverglass to reveal exact setal complement. 16-segmented, with a single aesthetasc on segments V-VI, XI, and XV, and 2 aesthetascs on segment XVI (Fig. 5A). Mouthparts and legs 1, 3 and 4 as in female.

Leg 2 (Fig. 5B) protopodite and endopodite as in female, except for the serrate distal parts of the endopodal setae (only 1 illustrated in detail). First and second exopodal segments as in female. Third exopodal segment with outer median and distal spine considerably inclined towards the medial axis. The latter, considerably longer and stouter than in female, serrate along its medial margin, but smooth along the outer one. Distal margin produced into a sinoid, non-articulating claw, slightly longer than half the outer distal spine. Inner exopodal setae plumed.

Leg 5 (Fig. 5C) coxa-basis fused, lacking medial seta. Outer seta broken in lectotype. Exopodite 2-segmented, both segments subequal. Proximal segment with an medial plumose seta and an outer partially serrate element. Distal segment with 4 elements: partially

serrate outer one, 2 apical ones, and a short and thick medial one with hyaline appearance. Surface of segments smooth. Intercoxal sclerite present, well developed, with smooth surface (observed in COP 025).

Leg 6 (Fig. 1B) with three elements on each leg vestige. Surface of valves smooth.

Comments. – Giesbrecht (1902) omitted to specify types among the specimens he described in his report on the Antarctic copepods. However, comparison between his illustrations (Table VII, figs. 1-16) and the position of the appendages of the three dissected specimens clearly revealed that the female appendages were drawn from the specimen found at station 378. His figures 1, 3 and 11 (habitus of the male and female, and female urosome) seem to be made before the animals were dissected. Consequently the dissected female (incorporated in the collection as COP 020) is designated here as the lectotype, and the remaining specimens as paralectotypes (COP 021-025).

Re-examination of the type-series revealed several contradictions between the specimens at hand and the original description. The presence of an individualized first pedigerous somite has been overlooked originally. Apparently, in freshly preserved specimens, the rather large posterior extension of the cephalosome covers nearly completely the first pediger, and probably this extension is less transparent than after nearly 100 years being mounted in Euparal®.

A second difference is the length of the antennule, which was stated as reaching as far as the first pedigerous somite. However, all female specimens here possess a much shorter antennule, reaching to the maxillipedal region of the cephalosome. Two of the four species described below, viz. *P. guentheri* and *P. eddareyae*, exhibit a comparable short antennule.

Giesbrecht (1902: 30) described the female antennule as 17-segmented, but stated that the separation between the proximal segments was indistinct. Re-examination of the antennules of both dissected females revealed however, that the antennule is composed by 16 segments only, although traces of subdivisions are present on segment III (see Fig. 2A). This and the fact that the species described below exhibit 15-segmented antennules in the female, invalidate couplet 14 in the most recent key to the cyclopinid genera (Jaume & Boxshall 1997).

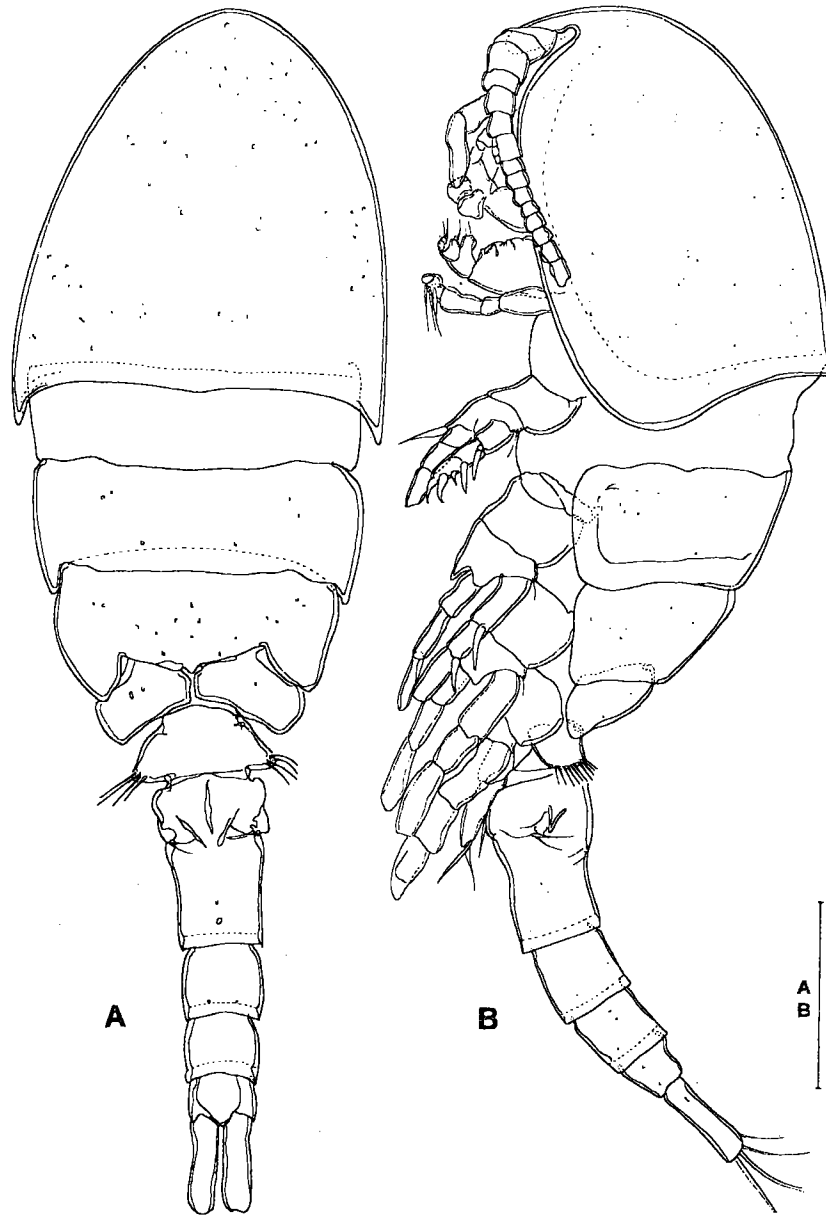


Fig. 6. *Pseudocyclopina eddatreyae* sp. n. Habitus female. A, dorsal view. B, lateral view. Scale A-B= 100 μ m.

Pseudocyclopina eddatreyae sp. n.

(Figs. 6-9; 10A-C; 11-12; 17D,G)

Material. – Holotype, male dissected on 14 slides (coll. no. 1997.028), collected in Potter Cove, King George Island, Antarctica, (62°14'S 58°40'W), depth 0-25 m. Allotype,

female dissected and mounted on 11 slides (Coll. no.: 1997.029); paratypes: 3 males.

Description. – Male. Body cycloform, prosome about 1.8 times as long as urosome. Length measured from anterior border of cephalosome to posterior border of telson 508 μ m (length with furca about 556 μ m). First pedi-



Fig. 7. *Pseudocyclopina eddatreyae* sp. n. A, antennule male. B, antennule female. Scale A- B=50 μ m.

gerous somite well developed, but apparently lacking a tergite. Urosome 6-segmented. Abdominal somites with plain hyaline frill on posterior margin. Furca about 3 times as long as wide, with 7 setae: seta I minute, located at about 1/3 of length of ramus at outer margin; seta II well developed, located within distal 1/3 of ramus at outer margin, slightly shifted to dorsal side; seta III small, located at distal outer

corner; terminal setae IV and V long; seta VI small, located at distal inner corner; seta VII located subterminally on dorsal margin (Fig. 17 D).

Antennule prehensile (Fig. 7 A), indistinctly 16-segmented, with sheath on 10th segment (corresponding to ancestral antennular segment XV), and with articulation between segments V and VI partially expressed. Setation

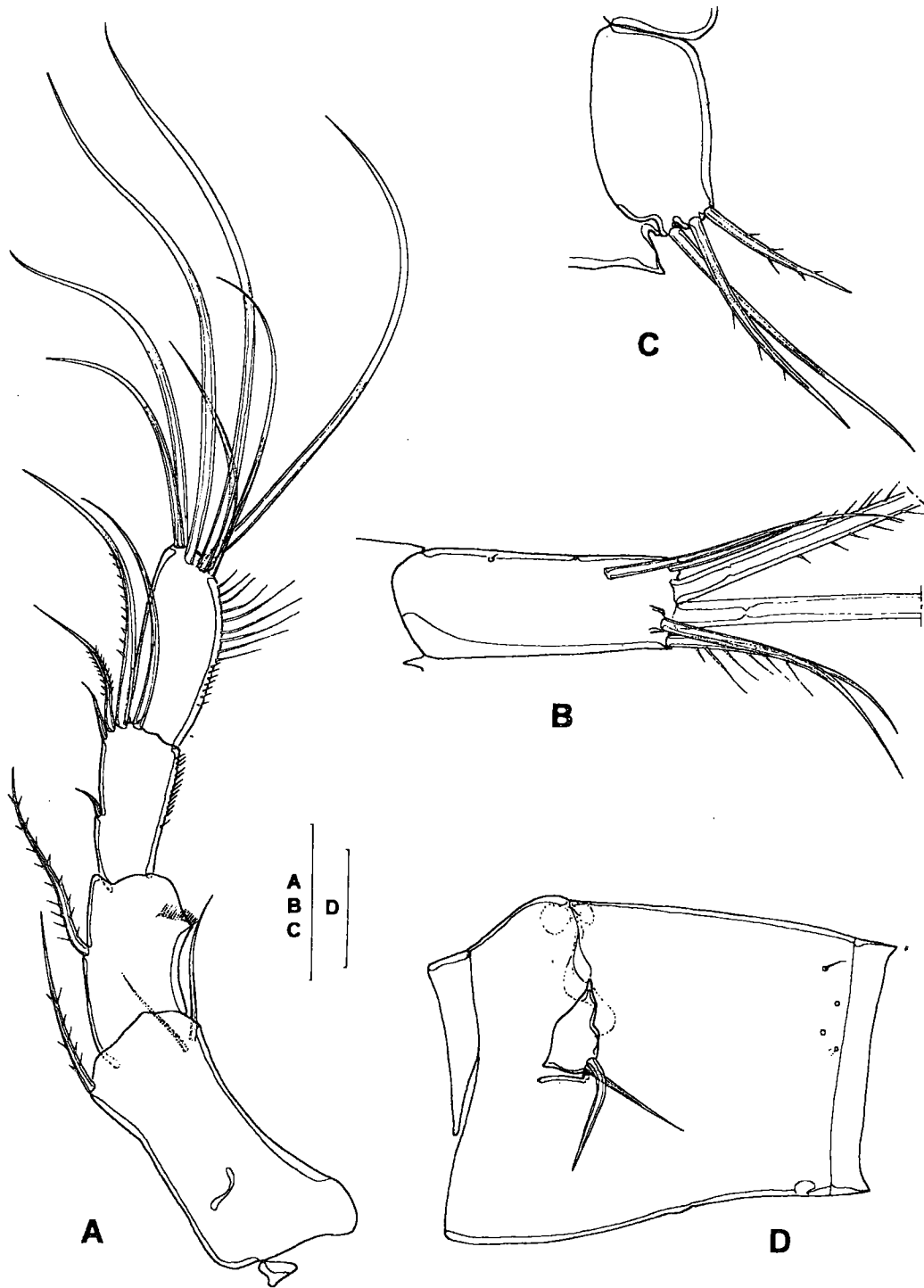


Fig. 8. *Pseudocyclopina eddatreyae* sp. n. Female: A, antenna. B, caudal ramus, dorsal view. Male: C, sixth leg. D, double somite female, lateral view. Scale bars A, B, C and D: 20 μ m.

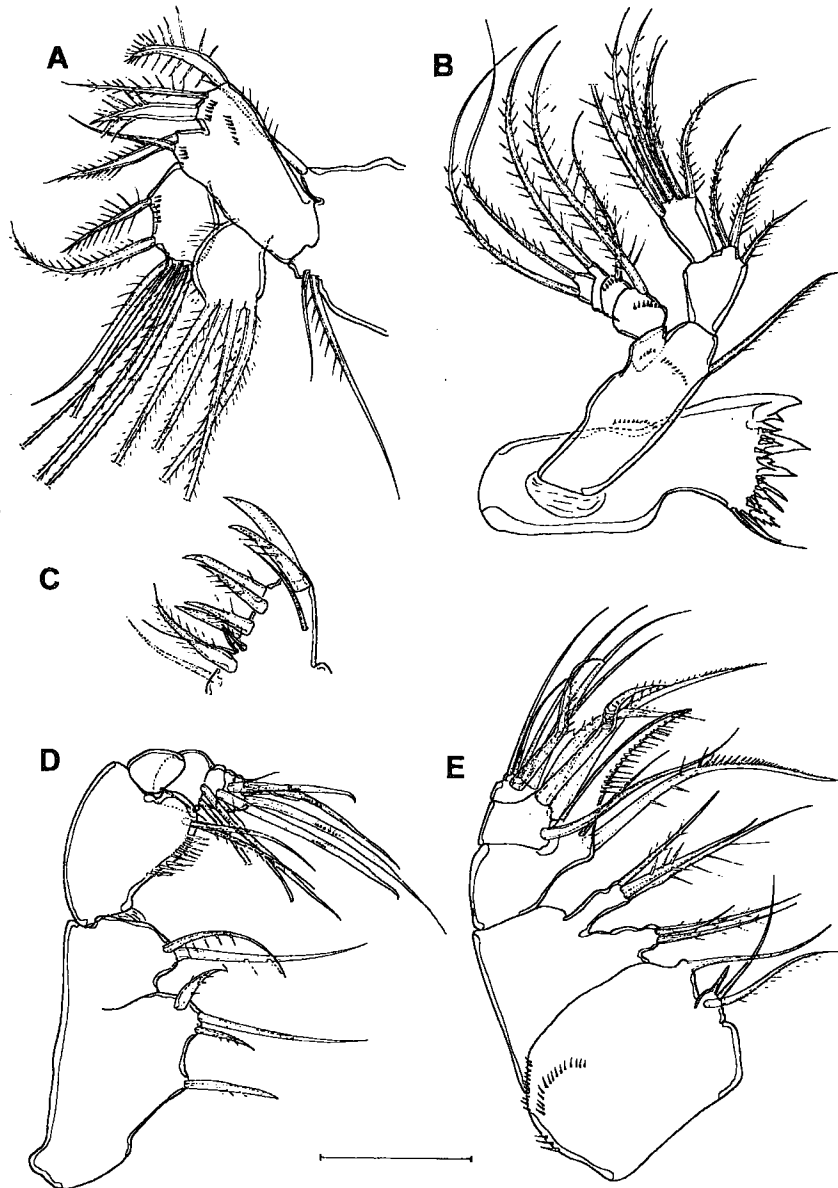


Fig. 9. *Pseudocyclopina eddatreyae* sp. n. Female. A, maxillule. B, mandible. C, maxillary praecoxal arthrite. D, maxilliped. E, maxilla. Scale A-E=20 μ m.

formula beginning with proximal segment as follows: I(2)-II(5)-III(3)-IV(2)-V(5 + Aesth)-VI(2)-VII(0)-VIII(1)-IX(2 + Aesth)-X(3)-XI(2 + Aesth)-XII(2 sp)-XIII(0)-XIV(1 + 1sp+1plate)-XV(1+1plate + Aesth)-XVI (11 + 2 Aesth). Distalmost seta on segment III short and blunt.

Antenna (Fig. 8 A) 4-segmented. Basis with 1 inner seta, and 2 exopodal setae, sub-

distally on anterior surface of outer margin. Endopodite 3-segmented with setal formula 1, 5, 7. Terminal setae on the third endopodal segment normally lanceolate, not spoon-shaped as in the type species and in *P. guentheri*.

Mandible (Fig. 9 B) as in *P. belgicae*, except for the shorter spinules parallel to masticatory edge and the presence of spinule rows on sur-

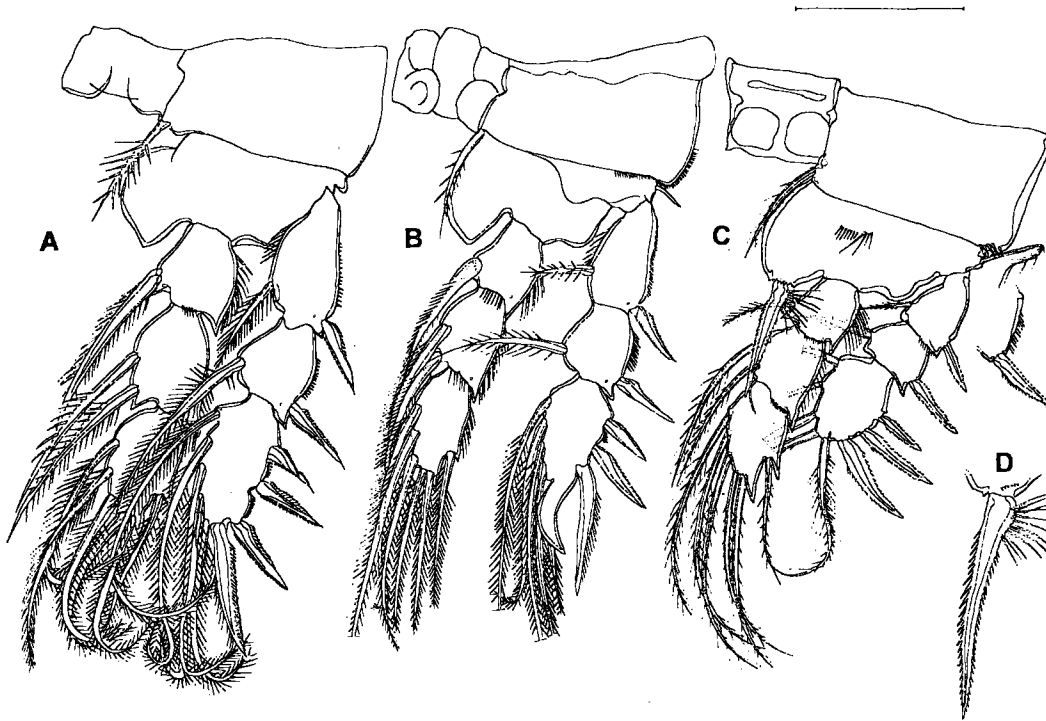


Fig. 10. *Pseudocyclopina eddatreyae* sp. n. A, second leg female. B, second leg male. C, first leg male and outer margin of female's first exopodal segment. D, *P. berndtreyi* sp. n., inner basal spine of female leg 1. Scale A-D=50 μ m.

face of basis. Maxillule (Fig. 9A, C) closely resembling that of *P. belgicae*. Basis with spinule rows on surface (not observed in *P. belgicae*).

Maxilla (Fig. 9 E) 6-segmented; praecoxa with 2 endites, proximal endite with 2 setae and 1 spine, distal endite with 1 seta; coxa with 2 endites with 3 setae each; basis produced into strong claw flanked by 2 setae; first endopodal segment (presumably composed of 2 ancestral segments) with 4 setae, second endopodal segment with 2, third endopodal segment minute with 4 setae.

Maxilliped (Fig. 9 D) syncoxa with 3 endites bearing 1, 3, and 2 setae, basis with 2 inner setae; endopodite 5-segmented, setal formula 0, 2, 2, 1, 4. Several elements on syncoxa with sturdy appearance. Endopodite compact, with entire length only slightly more than largest width of basis, and setae without spoon-shaped tips.

Legs 1 to 4 (Figs. 10C; 11A, B) with well developed coxa, basis and 3-segmented rami. Armature formula as in type-species. Third exopodal segment of leg 1 bears 3 outer spines, 1 terminal seta, and 4 inner setae (Fig. 10 C).

Terminal seta homologous with terminal spine present at this site in other copepods. Third exopodal segment of leg 2 produced terminally into strong curved apophysis (Fig. 10 B).

Leg 5 (Fig. 11 C) 3-segmented; coxo-basis with 1 proximal inner seta (coxal seta) and 1 outer distal seta (basal seta); first exopodal segment with one outer and one inner pinnate seta; second exopodal segment with 1 slender seta terminally flanked at each side by 1 pinnate seta, and an additional small naked seta at inner margin.

Leg 6 (Fig. 8 C) consisting of a plate bearing 3 setae. Paired gonopores, 2 spermatophores present.

Female. Differing from male as follows: body length measured from anterior margin of the cephalothorax to the posterior margin of telson about 600 μ m (length with furca about 650 μ m) (Fig. 6 A, B).

Antennule (Fig. 7 A) 15-segmented, with incomplete arthrodistal membranes between 3rd, 4th, and 5th segments. Setal armament: I(2)-II(5)-III(8)-IV(4)-V(4+2 spines)-VI(2+Aesth)-VII(2)-VIII(1)-IX(1)-X(1+Aesth)-XI(1)-

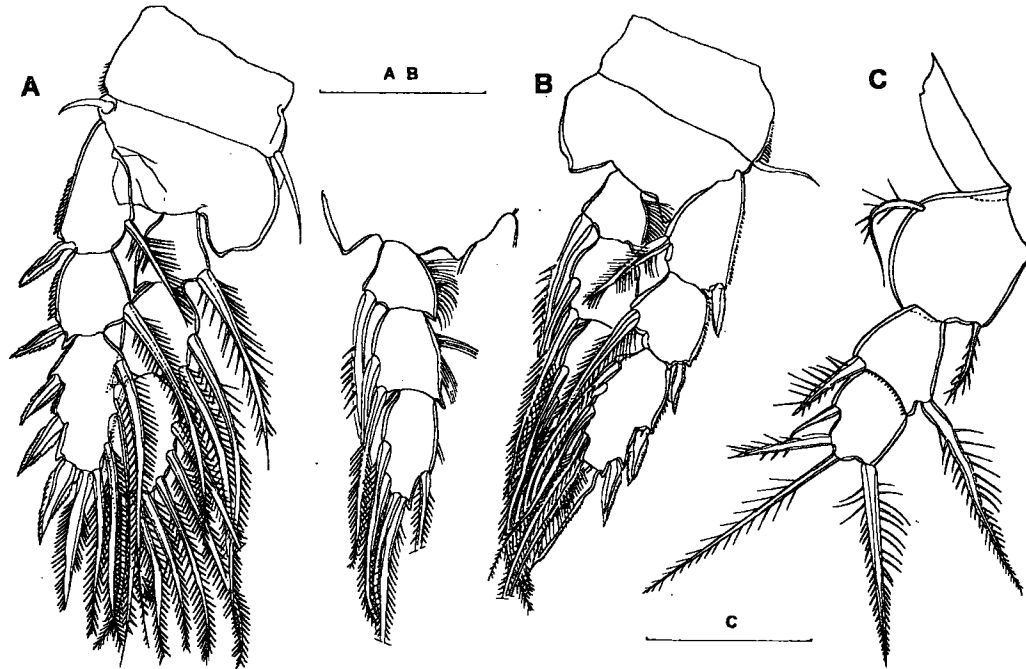


Fig. 11. *Pseudocyclopina eddatreyae* sp. n. A, third leg male. B, fourth leg male. C, fifth leg male. Scale A-B=50 μ m, C=25 μ m.

XII(1)-XIII(2)-XIV(2+Aesth)-XV(7+Aesth). Fourth antennal segment of present species equals segments IV and V segment of *P. belgicae*.

Third exopodal segment of leg 2 (Fig. 10 A) with 3 outer spines, 1 terminal spine and 5 inner setae. Legs 3 and 4 (Figs. 12A, B) as in the male.

Leg 5 (Fig. 12 C) 2-segmented; coxo-basis with 1 inner coxal seta and 1 outer basal seta; exopodite with 4 setae.

Leg 6 consisting of a plate on lateral margin, covering gonopore and bearing 2 setae (Fig. 8 D). Genital double-somite with copulatory pore located medially on ventral surface.

Etymology. – The species is dedicated to Mrs. Edda Trey with acknowledgement of her unlimited support during the studies by the senior author.

Pseudocyclopina berndtreyi sp. n.

(Figs. 10D; 13A; 14B-E; 16B; 17B, H-I)

Material. – Holotype, female collected in the Potter Cove, King George Island, off Antarctica (62°14'S 58°40'W), depth 0-25 m (Coll. no.: 1998.043).

Description. – Female. Body length measured from proximal rim of cephalothorax to poste-

rior rim of telson 831 μ m (with furca 968 μ m) (Fig. 13 A). Hyaline frills of urosomal somites serrate ventrally (Fig. 17 H), almost straight dorsolaterally (Fig. 17 I). Furca about 9 times as long as wide, with 7 setae; seta I well developed, located proximally (Fig. 17 B). Antennule long, 15-segmented, reaching to coxa of first swimming leg. Segmentation and setation as *P. eddatreyae* sp. n.

Antenna 4-segmented. Coxo-basis with 1 inner seta, and 2 exopodal setae, subdistally on outer margin. Endopodite 3-segmented with setal formula 1, 5, 7.

Mandible with well developed coxal gnathobase, basis with 1 seta; endopodite 2-segmented with 3 and 5 setae, exopodite 4-segmented, arising from a pedestal on outer distal margin of basis, setal formula 1, 1, 1, 2.

Maxillule praecoxal arthrite with 12 spines and setae, coxa with 1 seta on endite and 2 setae representing coxal epipodite; basis with 2 endites, proximal endite with 3 setae, distal endite with 2 setae; endopodite 1-segmented with 7 setae; exopodite also 1-segmented with 4 setae.

Maxilla 6-segmented; praecoxa with 2 endites, proximal endite (Fig. 14 E) with 3 setae and 1 spine, distal endite with 1 seta;

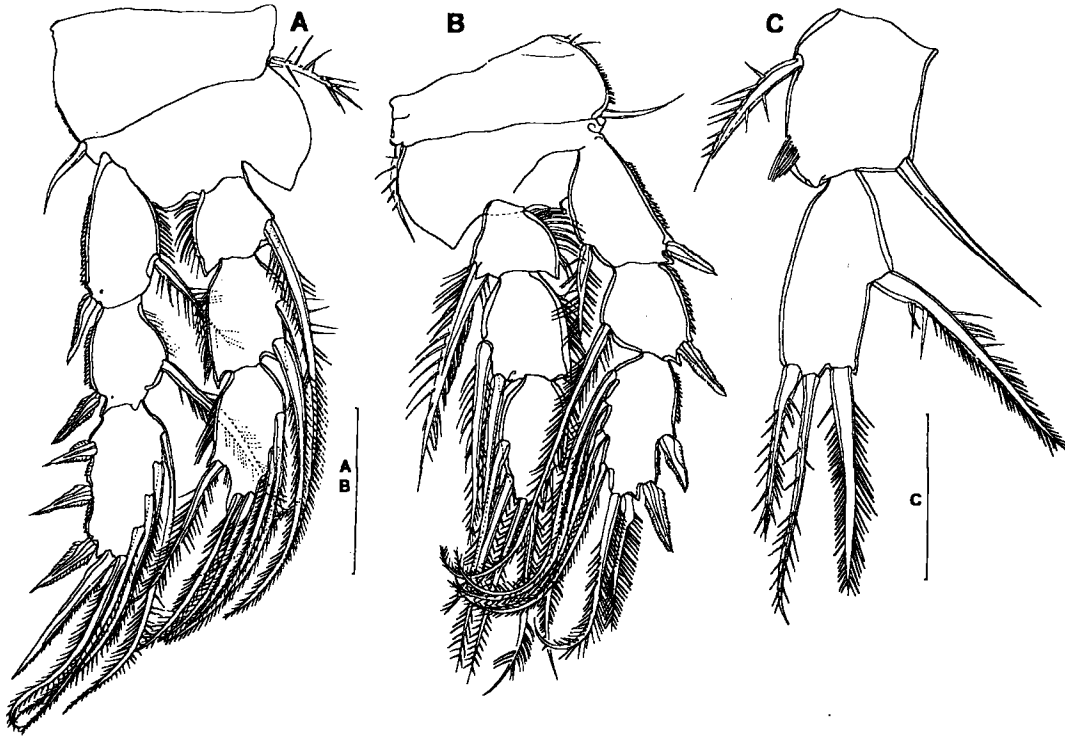


Fig. 12. *Pseudocyclopina eddatreyae* sp. n. A, third leg female. B, fourth leg female. C, fifth leg female. Scale A-B= 50 μ m, C=15 μ m.

coxal, basal, and endopodal segmentation and armature as *P. eddatreyae* sp. n..

Maxilliped (Fig. 14 D) praecoxa and coxa separated: praecoxa with 2 endites, proximal endite bearing 1, distal endite 3 setae; coxa with 1 endite bearing 2 setae, basis with 2 inner setae; endopodite 5-segmented, setal formula 0, 2, 2, 1, 4 (not illustrated in Fig. 14 D).

Armature of legs 1 to 4 as *P. belgicae*. Basal inner spine of leg 1 ornamented as *P. belgicae* with a tuft of spinules on proximal outer margin (Fig. 10 D). Leg 2 with endopodite longer than exopodite (Fig. 14 B). Lateral margins of fifth leg-bearing somite ornamented with a row of about 6 spinules. Fifth leg (Fig 16 B) composed of proximal undivided protopod bearing an inner (coxal) seta and an outer (basal) seta, ornamented with some short spinules on inner margin; 1-segmented exopodite about 1.5 times as long as protopodite, bearing 4 elements in total.

Male. Unknown.

Etymology. – The species is dedicated to Mr. Bernd Trey with acknowledgement of this

unlimited support during the studies by the senior author.

Pseudocyclopina veitkoehlerae sp. n.

(Figs. 14C; 16C; 17A, E)

Material. – Holotype, female (Coll. no.: 1998.044) from a bottom sample collected by scuba diving at about 10 m depth in Potter Cove, King George Island, Antarctica.

Description. – Female. This species differs from *P. berndtrei* sp. n. in the following characters: body length measured from anterior border of cephalosome to posterior border of telson 700 μ m (including furca 805 μ m). Furca about 8.5 times as long as wide (Fig. 17 A). Leg 2 endopodite as long as exopodite. First endopodal segment of leg 4 produced into a short mucroniform apophysis instead of inner seta (Fig. 14 C). Fifth leg exopodite shorter than protopod (Fig 16 C); protopod with a cluster of spinules at inner distal corner, exopodite with row of long spinules along inner margin.

Male. Unknown.

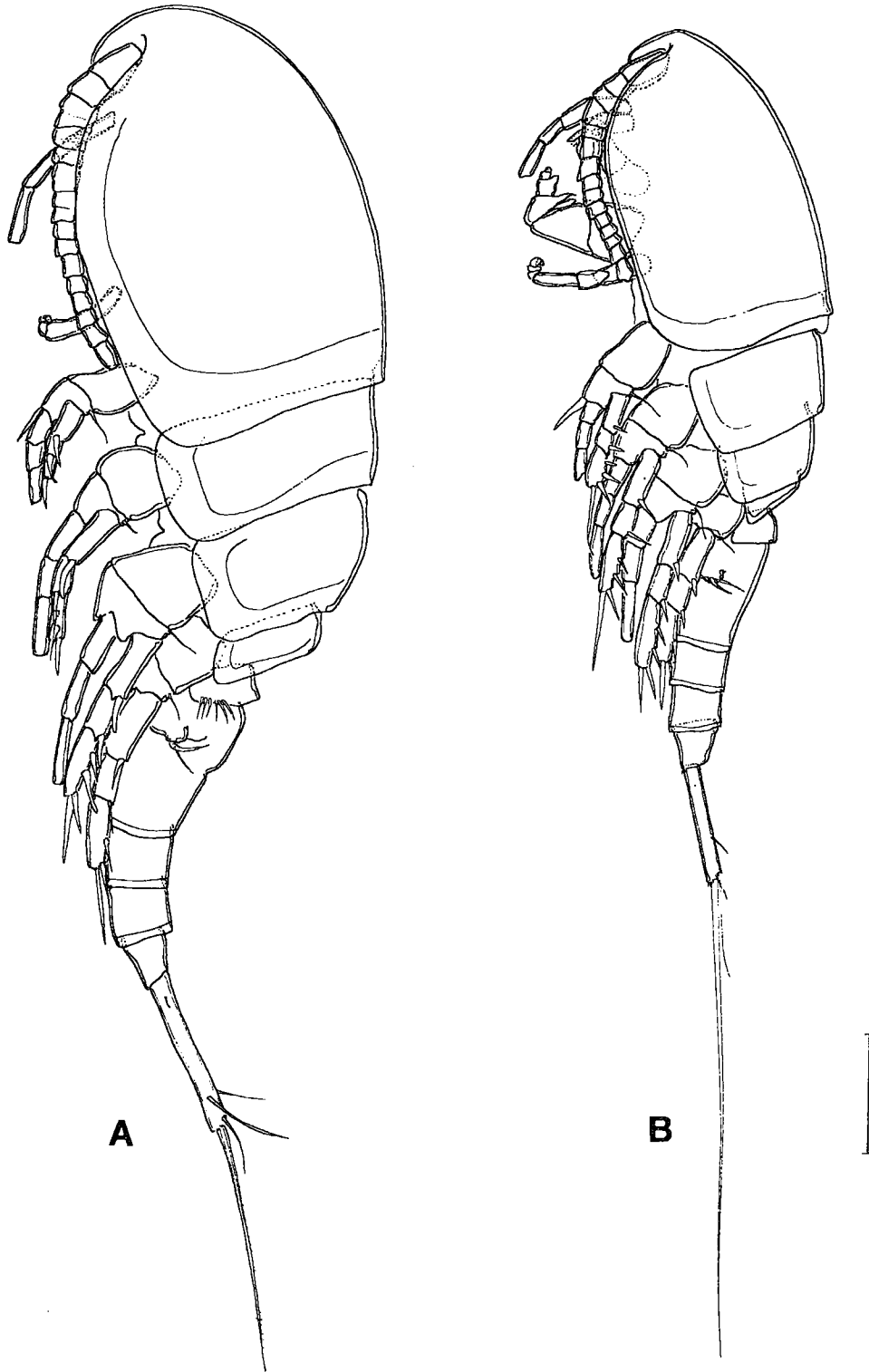


Fig. 13. A, habitus of *Pseudocyclopina berndtreyi* sp. n., lateral view. B, habitus of *Pseudocyclopina guentheri*, lateral view. Scale A and B= 100 μ m.

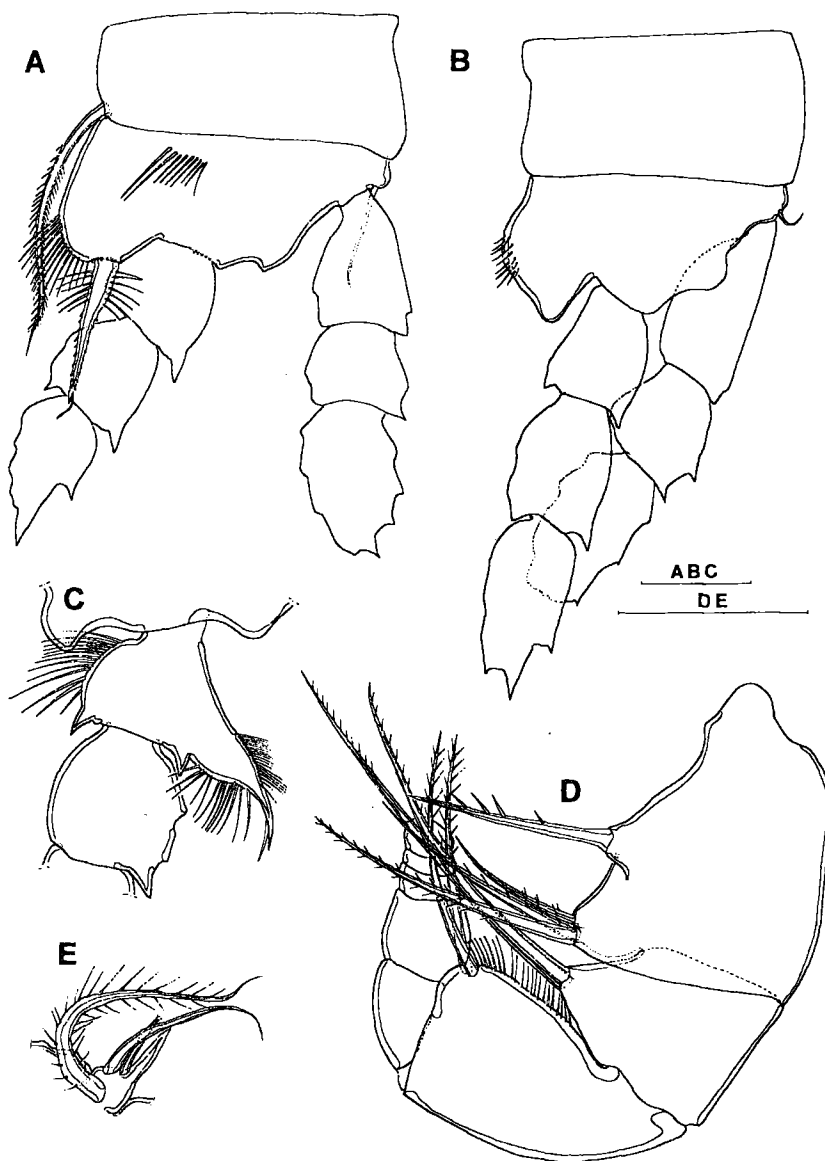


Fig. 14. A, *Pseudocyclopina guentheri* sp. n., first leg, female. B, *Pseudocyclopina berndtreyi* sp. n. second leg female. C, *Pseudocyclopina veitkoehlerae* sp. n., first and second endopodal segments of fourth leg, female. D, *Pseudocyclopina berndtreyi* sp. n., maxilliped (setal complement of endopodite omitted). E, Same, maxilla, proximal praecoxal endite. Scale A-C=20 μ m, D-E=25 μ m.

Etymology. – This species is dedicated to our colleague Gritta Veit-Köhler, who collected the specimen in the Potter Cove and kindly placed it at our disposal for this study.

Pseudocyclopina guentheri sp. n.

(Figs. 13B; 14A; 15; 16A; 17C, F, J)

\approx *Pseudocyclopina belgicae* (Giesbrecht, 1902);
Günther et al. 1999: tpls. 1 & 2.

Material. – 5 females collected with a 5 l plastic jar and filtered through an Apstein net (mesh

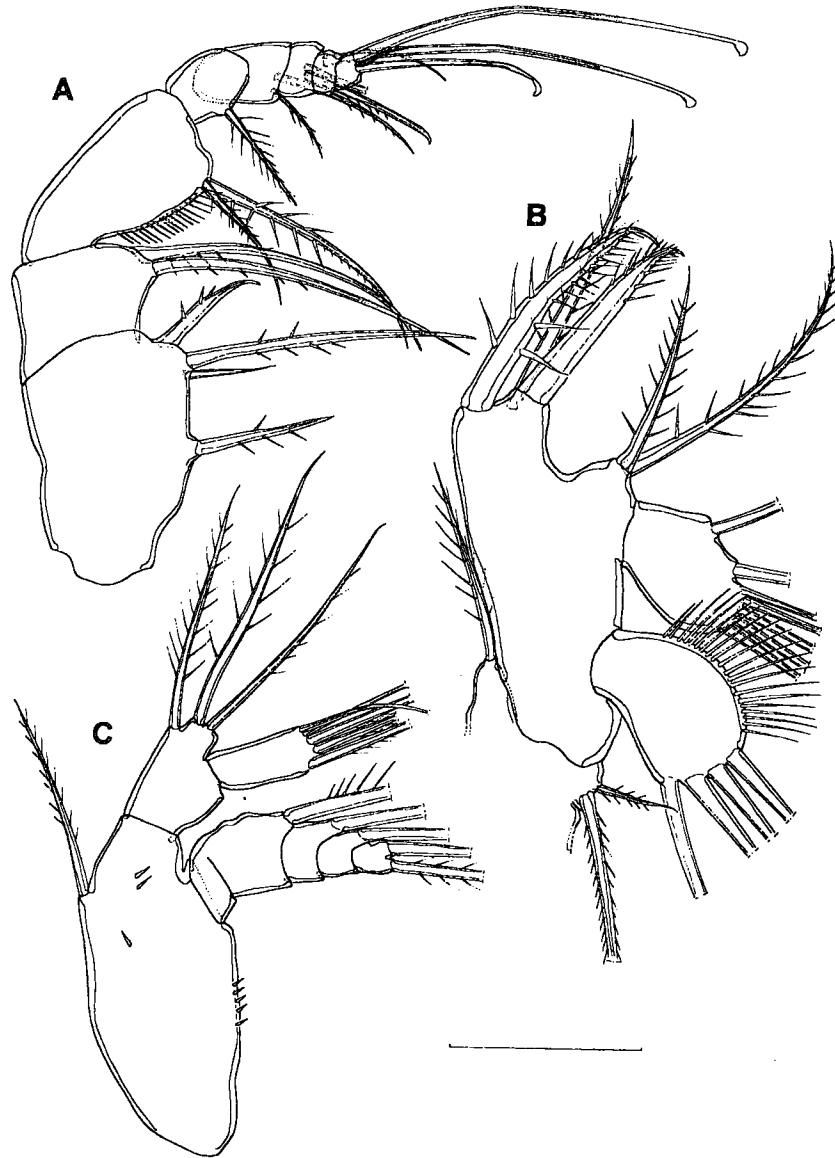


Fig. 15. *Pseudocyclopina guentheri* sp. n. A, maxilliped. B, maxillule. C, mandibular palp. Scale A-C=25 μ m.

size 30 μ m) from the platelet ice community off the German Neumayer Station in the Weddell Sea, Antarctica. One female dissected (Coll. no. 1998.045) and mounted on slides.

Description. – Female. Body length measured from proximal rim of cephalothorax to posterior rim of telson 668 μ m (with furca 760 μ m) (Fig. 13 B). Hyaline frill of urosomal somites serrated ventrally (Fig. 17J). Furca about 8.3 times as long as wide, with 7 setae; seta I

minute located proximally on outer margin (Fig. 17 C, F).

Antennule short, 15-segmented, reaching to the base of the maxilliped. Segmentation and setation as *P. eddatreyae* sp. n.

Antenna 4-segmented, coxo-basis with 1 inner seta, and without exopodal setae, endopodite 3-segmented with setal formula 1, 5, 7.

Mandible with well-developed coxal gnathobase, basis (Fig. 15 C) with 1 seta; endopodite

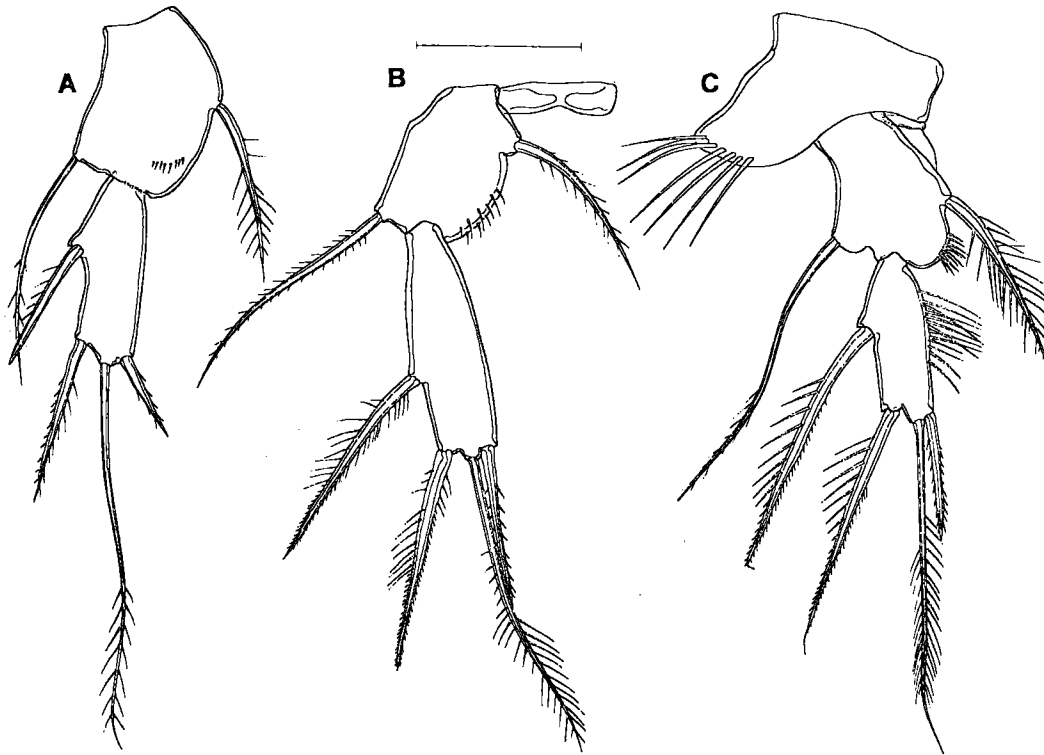


Fig. 16. Fifth leg of female of A, *Pseudocyclopina guentheri* sp. n. B, *P. berndtrei* sp. n.. C, *P. vaithoehlerae* sp. n. Scale A-C=25 μ m.

2-segmented with 3 and 5 setae, exopodite 4-segmented, setal formula 1, 1, 1, 2.

Maxillule praecoxal arthrite with 12 spines and setae, coxa with 1 seta on endite and 2 unequal setae representing coxal epipodite; basis transversally produced (Fig. 15 B) with 2 endites, proximal endite with 2 claw-like setae and 1 slender seta, distal endite with 2 setae; endopodite 1-segmented with 7 setae; exopodite 1-segmented with 4 setae.

Maxilla segmentation and setation as in *P. berndtrei* sp. n.

Maxilliped (Fig. 15 A) praecoxa with 2 endites, proximal endite bearing 1, distal endite 3 setae; coxa with 1 endite bearing 2 setae, basis with 2 inner setae; endopodite long, 5-segmented, setal formula 1, 2, 2, 1, 4. Several setae on endopodite with spoon-shaped tips.

Armature of legs 1 to 4 as in *P. belgicae* sp. n.. Leg 1 (Fig. 14 A) inner coxal seta almost reaching the distal margin of second endopodal segment; medial spine on basis ornamented with spinules on proximal outer and inner margins. Leg 2 with endopodite as long as exopodite. Tergite of fifth leg lacking rows of spinules on

lateral margin (Fig. 13 B). Fifth leg (Fig. 16 A) composed of proximal undivided protopod bearing an inner (coxal) seta and an outer (basal) seta, ornamented with a row of small spinules on anterior margin; 1-segmented exopodite about as long as protopod, bearing 4 elements in total.

Comments. – *P. guentheri* sp. n. is more closely related to *P. belgicae* than to any other species included in the genus. This pair of species differs from the group formed by the other three species in the following features: absence of ornamentation on the tergite of the fifth pediger, antenna without exopodal setae; maxilliped with a long endopodite, and the modified setae on antenna and maxilliped.

Although *P. guentheri* shares many features with *P. belgicae*, it cannot be confused with this because of the following diagnostic characteristics: the considerable shorter body length (760 versus 1225 μ m), the proportionally longer furcal rami (L/W: 8.3 versus 7), the minute seta I on the furcal rami, and the strikingly shorter furcal setae III and VI, but much

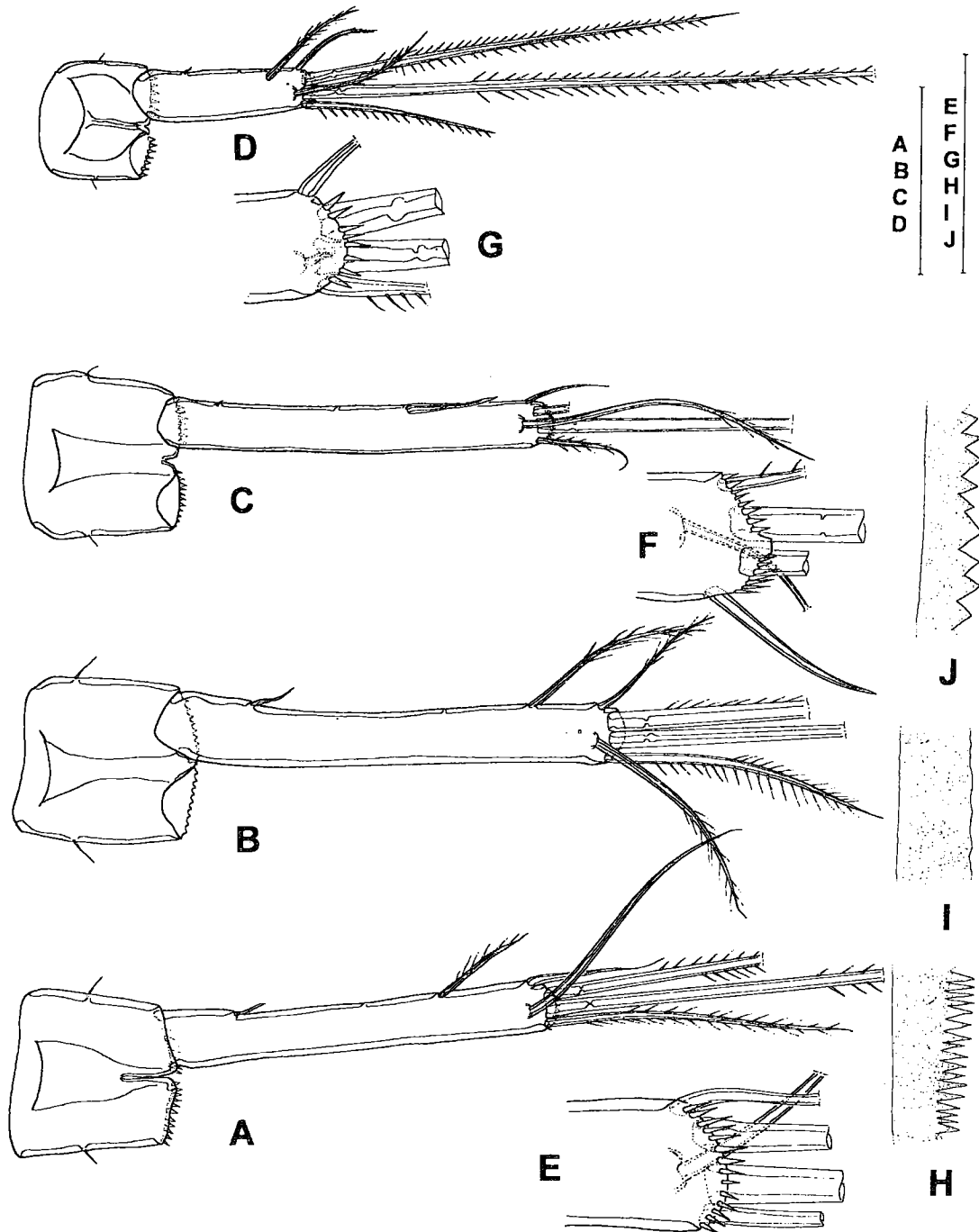


Fig. 17. Furca. A, *Pseudocyclopina veitkoehlerae* sp. n., dorsal view. B, *P. berndtreysi* sp. n., dorsal view. C, *P. guentheri* sp. n., dorsal view. D, *P. eddatreyae* sp. n., dorsal view. E, *P. veitkoehlerae* sp. n. detail, ventral view. F, *P. guentheri* sp. n., detail, ventral view. G, *P. eddatreyae* sp. n., detail, ventral view. Abdominal frills. H, *P. berndtreysi* sp. n., ventral view. I, Dorsolateral view. J, *P. guentheri* sp. n., ventral view. Scale A-D=55 μ m, E-J=25 μ m.

longer seta VII, and the fifth leg morphology with a short exopodite and almost unornamented coxo-basis.

With the discovery of these 4 new species we are able to present the following, amended diagnosis for the genus:

Pseudocyclopina Lang, 1946

Cyclopinids with first pedigerous somite free; furca with 7 setae; antennule 15 or 16-segmented in female, 16-segmented in male; exopodite of antenna represented by 2 setae, or absent; mandible with 2-segmented endopodite and 4-segmented exopodite; endopodite of maxilliped 5-segmented; legs 1 to 4 with 3-segmented rami; terminal exopodal segment of legs 1-4 with 3, 4, 4, 3 spines and 5, 5, 5, 5 setae; first exopodal segment in legs 1-4 with inner seta; terminal endopodal segment of legs 1-4 with 6, 6, 6, 5 setae; leg 2 with sexually dimorphic elements on terminal exopodal segment; leg 5 with fused coxo-basis, bearing inner setae in female; exopodite 1-segmented in female, having 4 elements; male leg 5 with fused protopodal elements, with or without inner seta; exopodite 2-segmented with 2 and 5 elements, respectively; male leg 6 with 3 setae.

Type species: Cyclopina belgicae Giesbrecht, 1902, by designation of Lang (1946).

DISCUSSION

Study of undissected material left no doubt, that we were dealing with four different species. Differences in body length and relative length of furca between the specimens were obvious. Yet, when dissecting specimens and studying them in detail, we discovered that they were almost identical in segmentation and setation of all appendages. This led us to consider them as congeneric, even in the absence of males of some of the species. As *P. eddatreyae* sp. n. unequivocally belongs to the genus *Pseudocyclopina* because of the presence of a sexually dimorphic terminal apophysis on the third exopodal segment of leg 2 (no other cyclopinid genus has this modified structure) the remaining 3 new species are assigned to this genus also.

Yet, one question remains unresolved: is the apical process on the male leg 2 homologous with the outer terminal spine of the female second leg, or is this process an enlargement of the outer terminal attenuation of the segment. The second assumption implies that the outer

terminal element became lost in the male. Future discovery of copepodids, and the study of the leg development, may shed light upon the true homology of this unique structure.

The male fifth leg of *P. eddatreyae* n. sp. is strikingly different from that of *P. belgicae*: the inner coxo-basal seta is well developed in *P. eddatreyae* n. sp., whereas it is absent in *P. belgicae*. Also, the inner seta of the second endopodal segment inserts on the distal third of the segment in the new species, whereas it inserts on the proximal third in *P. belgicae*. In females, the terminal slender seta on the endopodite of the fifth leg is much longer in *P. belgicae* than in *P. eddatreyae* n. sp.

With the exception of *P. eddatreyae* sp. n., all other species exhibit a well-developed maxillipedal praecoxal part which is entirely separated or at least separated on one surface from a short coxa. Such a distinct separation is very rare within Copepoda, but has already been described for Cyclopoida by Ferrari & Ambler (1992).

The three new species of *Pseudocyclopina* described here are remarkable in having retained an inner coxal seta on leg 5 in both sexes. This seta is lost in the majority of the Cyclopininae, but is still present for instance in the genera *Cyclopinodes*, *Cyclopinopsis*, *Parapseudocyclopinodes*, *Psammocyclopina* Wells, 1967, and *Metacyclopina* Lindberg, 1953. Only *P. belgicae* lacks the inner coxal seta on the male leg 5, but has retained this element in the female fifth leg.

Another striking character is the fusion (or lack of division) of coxa and basis of leg 5. *Pseudocyclopina* shares this apomorphic character with *Cyclopinopsis*, and *Parapseudocyclopinodes*. This indicates a close phylogenetic relationship of these genera. *Cyclopinopsis* and *Parapseudocyclopinodes* seem to be more closely related to each other than to *Pseudocyclopina*. They share the loss of one inner seta on the second endopodal segment of leg 1 (2 inner setae present in *Pseudocyclopina*), and the presence of only 2 setae on the first mandibular endopodal segment (instead of 3 in *Pseudocyclopina*).

Cyclopinodes seems to be most closely related to this cluster of genera. The third exopodal segment of *Cyclopinodes elegans* has the terminal spine transformed into a slender plumose seta (Sars 1913), resulting in an III,1,4 armature formula of this segment. This character is also present in *Pseudocyclopina* and *Parapseudocyclopinodes* (Giesbrecht 1902; Herbst 1952;

Lindberg 1961). The presence of a seta at this site is an apomorphic condition, because the presence of a spine is plesiomorphic as shown for the groundplan of Copepoda by Huys & Boxshall (1991). *Cyclopinopsis* has a spine at this site (Smirnov 1935; Herbst 1955). Using this character for uniting *Cyclopinodes*, *Pseudocyclopina*, *Parapseudocyclopinodes* and *Cyclopinopsis* implies the assumption of a character reversal in *Cyclopinopsis*.

Recently, Martínez Arbizu (1997 b) removed *C. barentsiana* (Smirnov, 1931) from *Cyclopinodes*, transferring it to a new genus, *Smirnovipina*. This genus differs from *Cyclopinodes* among other characters in having ancestral antennular segments XII-XIV fused to a triple segment in the female, whereas these segments remain separated in *Cyclopinodes*. In contrast, ancestral female antennular segments XV and XVI are separated in *Smirnovipina*, while they are fused in *Cyclopinodes* (Martínez Arbizu 1997 b). The fusion of ancestral antennular segments XV- XVI is also expressed in the genus *Pseudocyclopina*. Confirmation of this character in *Parapseudocyclopinodes* and *Cyclopinopsis* would lead to the recognition of a monophyletic group consisting of the latter 4 genera.

Species of the genus *Pseudocyclopina* have until now only been found in Antarctic waters. The examination of only a small number of meiobenthic and near bottom planktic samples from the Potter Cove has resulted in the discovery of 4 new species. This may indicate that the radiation of this genus has taken place in the Antarctic Ocean. At the present state of knowledge, the genus can be considered endemic to Antarctic waters.

MATERIAL AND METHODS

The plankton of the Potter Cove was studied during the austral summer (1996) as part of a DFG-project studying the population dynamics of dominant planktic copepod species in an Antarctic coastal environment. Plankton samples were taken with an Apstein net (55 µm mesh size and 0,125 m² net aperture), hauled vertically from a small boat. Samples were fixed with formalin at a final concentration of about 4%. Additional samples containing *Pseudocyclopina* were kindly made available by Gritta Veit-Köhler (University of Oldenburg) from the Potter Cove, and Sven Günther (Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven) from the platelet ice

community off the German Neumayer Station (Weddell Sea). Specimens were sorted out under a dissecting microscope at 25x magnification. Copepods were transferred to glycerine and dissected for slide preparation. All figures have been prepared either with a Leitz Dialux 20 EB phase contrast microscope (K.E. & P. M.-A.), a Leitz Diaplan phase contrast microscope (F.F.) or a Leitz Diaplan interference contrast microscope (antennules, K.E. & P. M.-A.) using a camera lucida.

Terminology is adopted from Huys & Boxshall (1991). The term furca is used according to Schminke (1976); terms of phylogenetic systematics are used *sensu* Hennig (1982).

The type material of the 4 newly discovered species is deposited in the copepod collection of the AG Zoosystematik und Morphologie, University of Oldenburg, Germany, whereas the types of *P. belgicae* form part of the collections of the Royal Belgian Institute of Natural Sciences, Brussels.

This work was supported by the Deutsche Forschungsgemeinschaft (DFG). We are indebted to Dr. H.-U. Dahms who invited the senior author to participate in two Antarctic Expeditions to the German Annex-Station „Dallmann-Laboratory“ (Jubany, King George Island), and to Prof. Dr. H. K. Schminke for critically commenting on the manuscript. We also thank Sven Günther (Alfred-Wegener-Institut) and Gritta Veit-Köhler (Universität Oldenburg) who kindly gave us material for this study.

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