



Rediscovery of *Bathypsammis* Huys & Gee, 1993 (Copepoda, Harpacticoida, Pseudotachidiidae) with description of a new species from the Antarctic deep sea

ELKE WILLEN* & MAXIMILIAN SCHULZ

AG Zoosystematics and Morphology, Institute for Biology, Faculty 5, University of Oldenburg, D-26111 Oldenburg, Germany

* Corresponding author: ewillen@gmx.de

Abstract

The species diversity of Copepoda Harpacticoida in the deep sea of the Angola Basin (DIVA I expedition with RV *Meteor*) and in the Weddell Sea (ANDEEP II expedition with RV *Polarstern*) have been investigated. From the obtained multicorer samples two female specimens of *Bathypsammis* Huys & Gee, 1993 were collected. The only specimen known before was described as *Psammis longifurca* by Bodin in 1968 from the northern Atlantic. In the present paper a new species *Bathypsammis polaris* sp. n. from the Antarctic Weddell Sea is described. The monophyly of *Bathypsammis* within the Paranannopinae Por, 1986 can be confirmed by several new autapomorphies whereas the relation to other paranannopid taxa must remain open for the moment. The new findings implicate a widespread distribution of *Bathypsammis* from the northern to the southern Atlantic and even to the southern polar regions. Up to now all individuals that have been found occur exclusively at deep-sea sites and in very low abundances.

Key words: *Bathypsammis*, new species, systematics, distribution, deep sea, southern Atlantic, Weddell Sea, Copepoda Harpacticoida, deep sea meiofauna

Introduction

The international deep-sea campaigns DIVA and ANDEEP are integrated into the global deep-sea biodiversity program “Census of the Diversity of Abyssal Marine Life” (CeDAMAR). CeDAMAR aims to produce reliable information on deep-sea diversity and the factors regulating it in the next decades (for more information please visit www.cedamar.org). Eventually, the stations of the DIVA and ANDEEP expeditions will, for the first time, provide a sampling transect of a complete latitudinal deep-sea gradient from the tropics to the pole in the southern Atlantic. The first DIVA expedition into the Angola basin took place in July 2000. For the first time a comprehensive, replicative sampling design was performed for the meiofauna (compare Rose *et al.* 2005).

Within this framework the species diversity of Copepoda Harpacticoida in the deep sea of the Angola Basin (DIVA I) and in the Weddell Sea (ANDEEP II) have been investigated. Among others, one goal of the whole project is to obtain data on the presence and distribution of harpacticoid higher taxa and species. First results for the DIVA I campaign have been already published (Rose *et al.* 2005).

Within the DIVA and the ANDEEP samples the Pseudotachidiidae Lang, 1936 turned out to be one of the most important taxa of Harpacticoida in terms of species and individual numbers, together with the Ectinosomatidae Sars, 1903, Argestidae Por, 1986 and Ameiridae Monard, 1927. They represent a quite significant taxon within the Harpacticoida, concerning the number of species and subtaxa, as well as a worldwide distribution range. Many species are known from the deep sea. Several monophyletic subgroups have already been identified (compare Willen 1999, 2000, 2005; Hicks 1988). A well represented pseudotachidiid subtaxon in

the DIVA I and ANDEEP samples are the Paranannopinae Por, 1986, which contain the up to now monotypic genus *Bathypsammis* Huys & Gee, 1993. At DIVA station 346 and ANDEEP station 138 one female specimen of this genus was encountered. The DIVA specimen concurs with the description of *B. longifurca* (Bodin, 1968) by Bodin (1968) and Huys and Gee (1993). This species was described by Bodin as *Psammis longifurca* from the Golfe of Biscaye from 3950 m depth (Bodin 1968). Later, Huys and Gee (1993) assigned it to their newly erected genus, *Bathypsammis*. The ANDEEP specimen represents a new species and will be described in the present paper. The findings demonstrate a widespread distribution of *Bathypsammis* in the deep sea from the northern and southern Atlantic to the Antarctic region and a widespread presence of *B. longifurca* in the northern and southern Atlantic. Species of the genus seem to occur only in very low abundances since altogether only three specimens have been collected so far.

Methods and material

The treatment of the multicorer samples is described in detail by Rose *et al.* (2005). Specimens were preserved in 5% buffered formalin and subsequently transferred to glycerine. Drawings were made with the aid of a camera lucida on a Leica Diaplan microscope equipped with UCA condenser, IC prism and doubler x 1.5. The dissected parts are mounted on several slides. The terminology is adopted from Lang (Lang 1948; Lang 1965) except for the segmental composition of mandible, maxilliped and the numbering of the furcal setae, where Huys and Boxshall (1991) have been followed.

Abbreviations used in the text—F.R., furcal rami; Aes, aesthetasc; exp, exopodite; enp, endopodite; enp1, first segment of endopodite; Md, mandible; Mxl, maxillula; Mx, maxilla; Mxp, maxilliped; P1–P6: swimming legs 1–6; benp, baseendopodite of P5; Ro, rostrum; Ceph, cephalothorax.

The term groundpattern is used in the sense of "Grundmuster" (Ax 1984, page 156).

Material examined—*Bathypsammis polaris* sp. n. *holotype* (female) reg. no. UNIOI 2006.008. Collected during the ANDEEP expedition of RV *Polarstern*, PS 61/138-11 (corer 2), 18 March 2002, 62°58.03'S, 27°54.08'W, depth 4541.3 m.

Bathypsammis cf. *longifurca*: 1 female (reg. no. UNIOI 2006.009) collected 27 July 2000 during the DIVAI campaign of the RV "Meteor" M48/1 from 06 July 2000 to 08 August 2000 using a multicorer at station 346 (16°17.00'S, 005°27.00'E; depth: 5388 m).

The specimens are stored in the copepod collection UNIOI of the AG Zoosystematik und Morphologie at the C.v.O. Universität Oldenburg, Germany.

Description

Family Pseudotachidiidae Lang, 1936

Genus *Bathypsammis* Huys & Gee, 1993

Bathypsammis polaris sp. n. (Figures 1–9)

Description

Female (*holotype*). Body length: 1221 µm, furcal rami length: 318 µm. *Rostrum* (figure 1 A) demarcated from cephalothorax, slightly broader than long, rounded, with 1 pair of sensilla apically and 1 subapically.

Body (figures 1A–B, 7B). Long and slender, no distinct separation between prosome and urosome. Cephalothorax square, cephalic shield with sensilla and pores, distal lateral edge with tuft of long spinules. Posterior margin of each body somite (excluding penultimate somite) with sensilla. Urosomal somites with ventrolateral spinule rows on distal margins and the 2 somites preceding the anal one (figure 1A) dorsally with spinule rows on distal margins; body dorsally otherwise without spinule ornamentation, hyaline frills smooth;

genital double-somite (free somites 5 and 6) ventrally not completely fused, genital field as in figures 1B, 7B; P6 with 3 setae, innermost longest and middle one short. Anal somite completely divided with 2 dorsal sensilla, anal operculum absent, pseudoperculum present (figure 1A). Furcal rami (figures 1A, 7B–C) approx. 14 times longer than broad, furcal seta I absent, II and III damaged, II subapically at outer edge, III slightly displaced ventrad, IV and V well developed, proximally densely ornamented with spinules, distally tapering into long, flexible tendrils, VI damaged, VII biarticulated, subterminally on dorsal surface.

Antennule (figures 1A, 8A, 9D). With 5 segments. Armature: I(1); II(10); III(13+aes); IV(8); V(damaged); IV with enlarged and pinnate seta on terminal margin.

Antenna (figure 9A–C). Allobasis medially with long abexopodal pinnate seta and proximal row of spinules; exp 3-segmented, with 2-1-(1+2) setae (apical setae on exp3 broken off in holotype); proximal segment with tuft of spinules; enp with subapical spinule row, subapical armature consisting of 1 large pinnate and 1 naked spine, 1 geniculate and 1 well developed pinnate seta; apically with 7 setae: 1 large pinnate spine, 4 geniculate setae, the outermost of which fused at base with another minute seta and 1 additional pinnate spine.

Mandible (figure 2A–B). Gnathobase compact with 3 large and several smaller, fine and pointed teeth, inner edge with 1 large, bipinnate seta and 1 naked seta; basis large and compact, with spinule patch and 4 pinnate setae; enp longer than exp, with 3 lateral and 6 terminal setae; exp much shorter, with 1 lateral and 2 terminal, pinnate setae.

Maxillule (figure 3A). Arthrite of praecoxa with 9 apical spines, 1 small and naked seta posteriorly, 2 juxtaposed setae on anterior surface; coxa demarcated from basis, coxal endite with 6 setae; basis with 1 endite bearing 6 setae; exp and enp demarcated, exp with 3 setae, enp cylindrical with 3 setae.

Maxilla (figure 3B). Syncoxa with 3 endites; proximal endite bilobed, proximal lobe with 1 large, pinnate spine and apical row of long spinules, distal lobe with 2 pinnate setae, middle and distal endites each with pinnate spine and 2 more setae; basal endite with 1 pinnate claw fused to basis, accompanied by 1 slender, naked seta on posterior and 2 setae on anterior side (1 shortened); enp 1-segmented, bearing setae.

Maxilliped (figure 3C). Syncoxa narrow, shorter than basis, with 2 spinule rows and 1 enlarged pinnate seta at distal margin; large basis long and narrow, bearing 1 naked seta near distal edge and 2 spinule rows on inner margin; enp with claw, and 1 naked seta.

P1 (figure 2C). Basis with large, pinnate inner spine and elongate, pinnate outer spine reaching to first half of exp 2; terminal margin, anterior surface and base of spines with spinule rows. Exp 3-segmented, outer and terminal margins with spinules; exp1 enlarged, much broader than the other exopodal segments and almost as long as exp 2 + 3 together, exp1 and 2 each with 1 outer, pinnate spine, exp2 with inner seta; exp3 with 3 stout, outer, pinnate spines, 1 stout, outer, terminal spine and pinnate terminal seta; enp 2-segmented, both segments of equal length, enp1 almost as long as exp 1, with spinules along inner, outer and distal margins and 1 strong, inner, pinnate seta; enp2 with spinule rows on outer, inner and distal margins, with 1 inner, pinnate seta and terminally with short, pinnate, outer seta, longer middle and shorter inner, terminal pinnate setae.

P2–P4 (figures 4, 5, 6). Exps and enps 3-segmented. Coxae of almost rectangular shape, except for P4 being subtriangular, with spinule rows on surface, terminal and outer margins. Basis of P2–P4 each with well developed pinnate outer seta, and spinule rows on surface, distal margin and at base of outer setae, inner margin with rounded projection fringed with long spinules.

Armature formulae for swimming legs: following method of Lang (1948).

	Exp	Enp
P2	1-1-2, 2, 3	1-2-2, 2, 1
P3	1-1-3, 2, 3	1-1-2, 2, 1
P4	1-1-3, 2, 3	1-1-2, 2, 1

P5 (figure 7A). Pair of legs not fused medially, rami fused to single elongate large plate, exopodal and baseoendopodal parts not distinguishable, short basal pinnate seta located at proximal outer edge with basal spinule row, otherwise setation displaced distad, from outer to inner side armed with pinnate, slender spine, 2 long, naked seta, 2 short, thick pinnate spines, 1 long, pinnate seta, 2 very short and thick spines ornamented with spinules, 1 inner pinnate seta.

Male—unknown.

Etymology—The species name *polaris* refers to the type locality in the southern polar region.

Systematic discussion

Bathypsammis polaris sp. n. differs from the only other known species in the genus, *B. longifurca* Bodin, 1968, in the following aspects (*B. polaris* sp. n./ *B. longifurca*):

- 5-segmented A1/ 4-segmented A1
- Md enp with 3 lateral setae/ only 2 lateral setae
- Basis of Mxp long and narrow/ shorter, more “normal shape” (compare fig. 3C with Huys and Gee 1993, fig. 18D)
- P1 basal outer spine reaching to first half of P1 exp 2/ beyond P1 exp 2
- Intercoxal sclerites of P2–P4 not U-shaped but plate-like/ U-shaped as in *Fladenia* Gee & Huys, 1990 according to Huys and Gee (1993)
- P2 enp 3 with 2 inner setae/ with only 1 seta
- P3 enp 3 with 2 inner setae/ with only 1 seta
- P4 enp 3 with 2 inner setae/ with only 1 seta
- P5 elongate, baseoendopodal and exopodal parts barely distinguishable/ P5 shorter, baseoendopodal and exopodal parts more clearly distinguishable
- P5 innermost exopodal and outermost endopodal setae short and thick/ longer, of more “normal” setal shape (compare fig. 7A with Huys and Gee 1993, fig. 17E)
- P5 innermost endopodal seta short/ much longer

With the identification of an additional species of *Bathypsammis* more information on the generic ground-pattern becomes available. Within the Paranannopinae, *Bathypsammis* can be well characterised as monophylum by the following autapomorphies:

- shape of P1: enp 1 and enp 2 are of equal length (enp 1 slightly elongate compared to the condition found in other Paranannopinae), basal outer spine elongate, reaching at least into first half of exp 2, exp1 enlarged and as long as enp1, therefore the enp remains shorter than the exp.
- shape of P5: rami fused to large, rectangular single plate, exopodal and baseoendopodal parts still discernable in the groundpattern, with characteristic setal pattern: basal outer seta short and pinnate, exopodal part with 1 outer, pinnate spine, 1 outer and 1 terminal long seta, innermost exopodal seta shorter and pinnate; baseoendopodal part with innermost short spine and terminal long seta, inner terminal and second innermost setae modified as short, thick spines with peculiar spinule ornamentation, innermost seta long and pinnate.
- furcal rami considerably elongate.
- terminal furcal setae IV and especially V tapering into long, flexible tendril.
- tuft of long fine setules at inner distal corner of furcal rami, (compare Huys and Gee 1993, in holotype of *B. polaris* sp. n. probably broken off).

Further probable autapomorphies are the slightly vermiform appearance with square-shaped cephalothorax, elongate furcal rami and the enormous body-size.

The position of *Bathypsammis* within the Paranannopinae and closer relationships to other paranannopid taxa are difficult to assess because of many plesiomorphic and autapomorphic characters. Furthermore, there is still no phylogenetic system available. The Paranannopinae has been thoroughly revised in the past decade by Gee and Huys (1990, 1991, 1994) and Huys and Gee (1992, 1993, 1996a, b) including redescriptions of old material, establishment of several new genera and discussion of phylogenetic lineages. One of these lineages, comprising six of the 17 hitherto known genera, is convincingly characterised by the unique presence of mouthpart aesthetascs, which are always located on homologous setae on Md, Mxl and Mx (compare Huys & Gee 1996b). Since *Bathypsammis* does not possess such mouthpart aesthetascs the discussion is narrowed to the remaining paranannopid taxa. Male characters turned out to be of major importance for solving paranannopid systematics, making it more difficult to place *Bathypsammis* for which the male is still unknown. Apart from the above detailed autapomorphies, *Bathypsammis* exhibits many plesiomorphic characters in its groundpattern: the swimming leg setation is almost complete, except for 1 inner seta missing on P3 enp3 (refer to the paranannopid groundpattern), and there are no significant setal (shape and number) and segmental (processes, apophysis) modifications which characterise some of the other genera and genera groups (i.e. *Fladenia* Gee & Huys, 1990, *Danielssenia* Boeck, 1872 (see Huys & Gee 1992, 1993, 1996; Gee & Huys 1994), *Prionos* Huys & Gee, 1996, *Mucrosenia* Gee & Huys, 1994, *Archisenia* Huys & Gee, 1993, *Psammis* Huys & Gee, 1993). The same is basically true for the mouthparts.

The general shape of the mandible gnathobase (compare figure 2A, with few large, rounded teeth, more smaller ones and spinule row alongside the cutting edge, 2 setae at outer edge) is considered here as primitive, because it is found in other paranannopid taxa (*Fladenia* and *Anapophysia* compare descriptions of Gee and Huys 1990; Huys and Gee 1996b) as well as in other pseudotachiid taxa beyond the Paranannopinae (*Domnuia* Willen, 2004; compare Willen 2004. Also based on observations of undescribed material). The mandibular exp is reduced in size and setation (only 1 lateral and 2 apical setae) as in *Psammis*. However, no other apomorphies are shared by both taxa but each shows its own unique autapomorphic characters (compare e.g. Huys & Gee 1993).

The enlarged anterior and minute posterior rostral sensilla mentioned by Huys and Gee (1993) do not suggest a closer relationship since they are also present in other paranannopid species (*Prionos* and *Anapophysia*, compare descriptions in Huys & Gee 1996b).

A P5 with fused rami occurs in several paranannopid taxa and this feature alone therefore does not make a good character to solve relationships, more so because the derived unique shape and setal pattern in *Bathypsammis* is not shared by any other taxon.

In one of their conclusive papers on Paranannopinae, Huys and Gee (1996b), recognised two lineages within the taxon: the “paranannopid branch” comprising *Cylindronannopus* Coull, 1973, *Paranannopus* Lang, 1936, *Fladenia*, *Anapophysia* and *Bathypsammis* and on the other hand the “danielsseniid branch” grouping all other genera. Whereas for the latter no apomorphy was explicitly stated, the “paranannopid branch” was “defined” by 1) a modified apical seta on A2 enp, 2) the distal outer spine of P1 exp3 being shorter than the middle one and 3) the fused rami of P5 (which, however, also occurs in the “danielsseniid branch”). Since the peculiar pattern of P1 exp3 could not be observed in the available species of *Bathypsammis* (compare figure 2C) and was not evident from the original description of *B. longifurca* (compare Bodin 1968) the only remaining feature linking *Bathypsammis* to this branch is the modified seta on A2 enp (compare fig. 9 in the present paper).

Furthermore, the authors assumed a sistergroup-relationship of *Bathypsammis* with *Anapophysia* on the base of 1) an additional surface spinule row near the coxa/basis joint of the Mxp (compare Huys & Gee 1996b, figs 8D, 12E) and 2) the loss/reduction of one of the setae of the maxillar allobasis. The former feature is also present in other Paranannopinae (e.g. *Archisenia*, compare Huys & Gee 1993, fig. 4 C) and beyond

them in other Pseudotachidiidae (*Domnuia*, compare Willen 2004, fig. 3C), suggesting it to be plesiomorphic and not indicating phylogenetic closeness. The loss/reduction of the maxillar seta is therefore the only character linking both taxa. Other than that no apomorphies are shared, e.g. *Anapophysia* and *Bathypsammis* each show a uniquely derived female P5.

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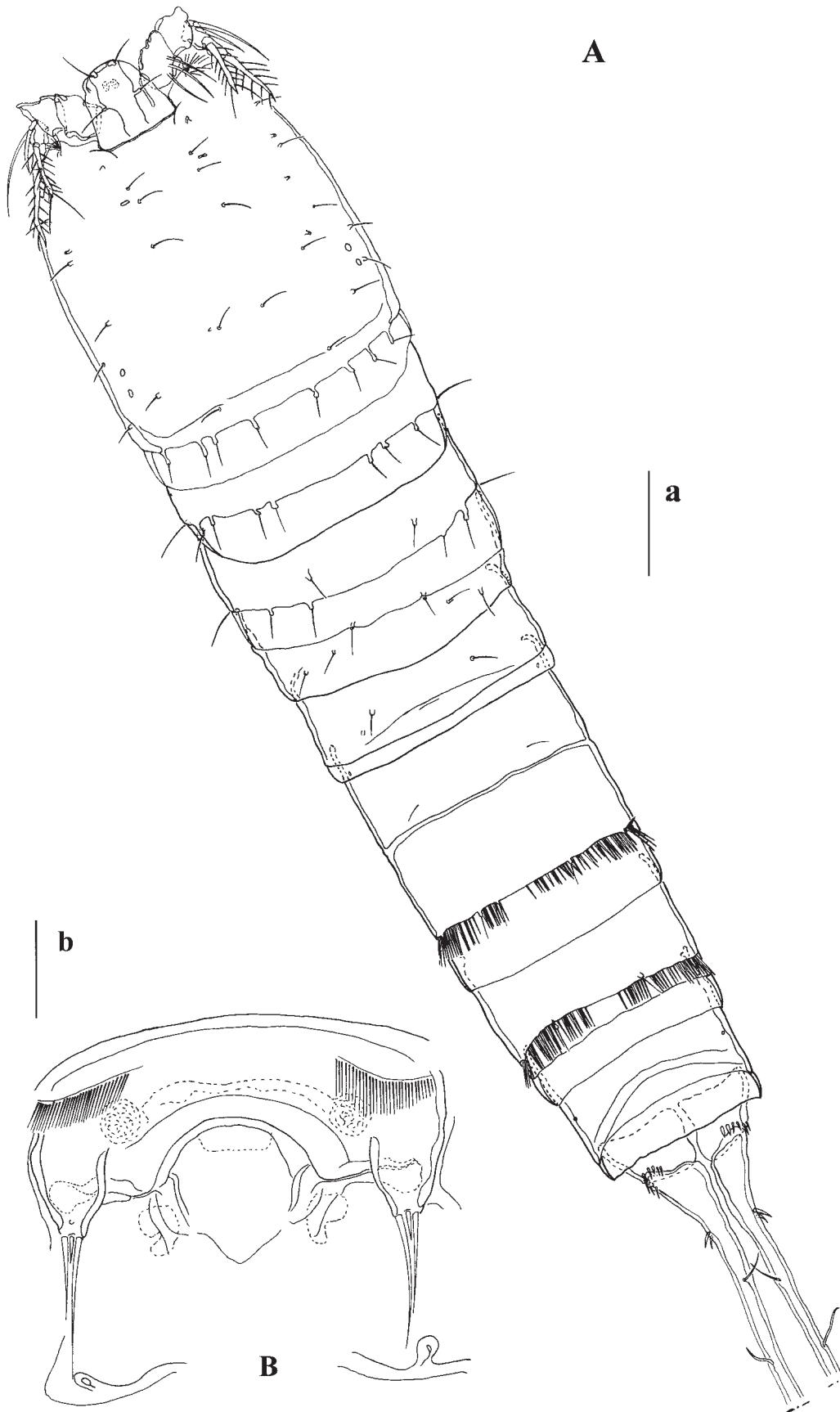


FIGURE 1. *Bathysammis polaris* sp. n., female, holotype (UNIOIOL 2006.008): A, habitus, dorsal; B, female genital field and P6. Scale bars, a=100 μ m, b=30 μ m.

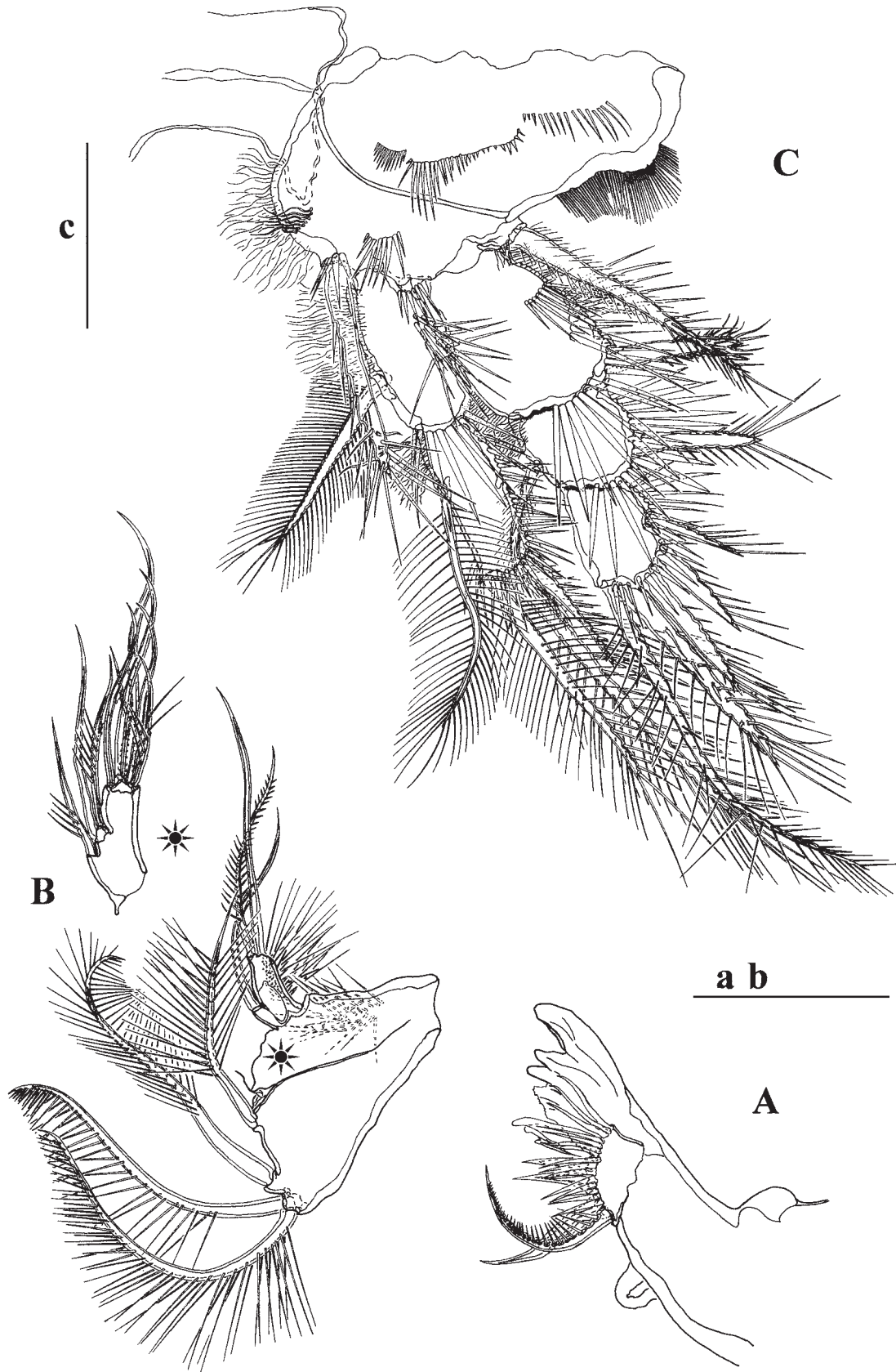


FIGURE 2. *Bathypsammis polaris* sp. n., female, holotype (UNIOI 2006.008): A, mandible gnathobase; B, mandible basis with exo- and endopod; C: P1. Scale bars=50 µm.



FIGURE 3. *Bathypsammis polaris* sp. n., female, holotype (UNIOL 2006.008): A, maxillule; B, maxilla; C, maxilliped. Scale bars=50 μ m.



FIGURE 4. *Bathypsammis polaris* sp. n., female, holotype (UNIOI 2006.008): A, P2. Scale bar=50 μ m.



FIGURE 5. *Bathypsammis polaris* sp. n., female, holotype (UNIO 2006.008): A, P3. Scale bar=50 μ m.

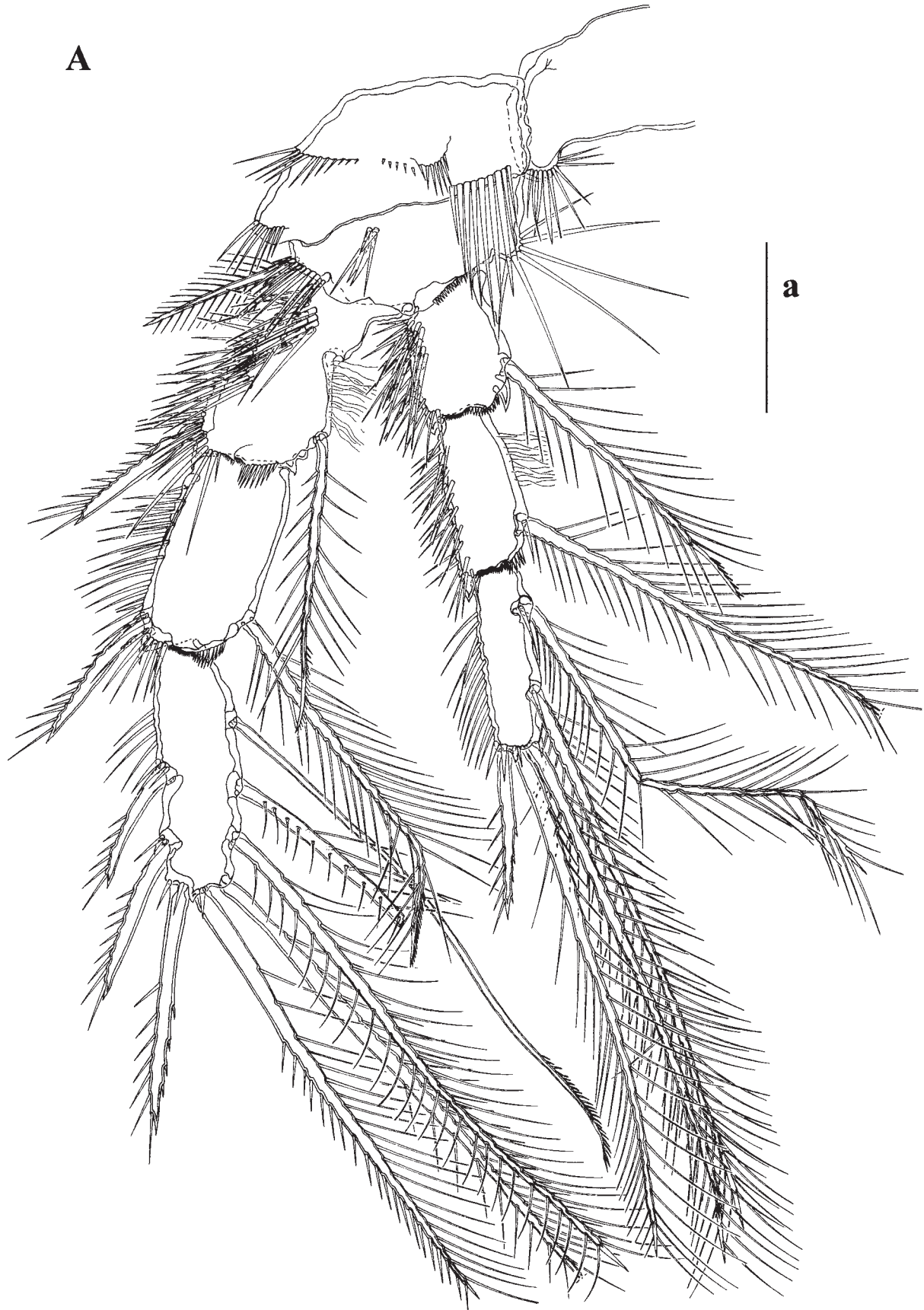


FIGURE 6. *Bathypsammis polaris* sp. n., female, holotype (UNIOL 2006.008): A, P4. Scale bar=50 μ m

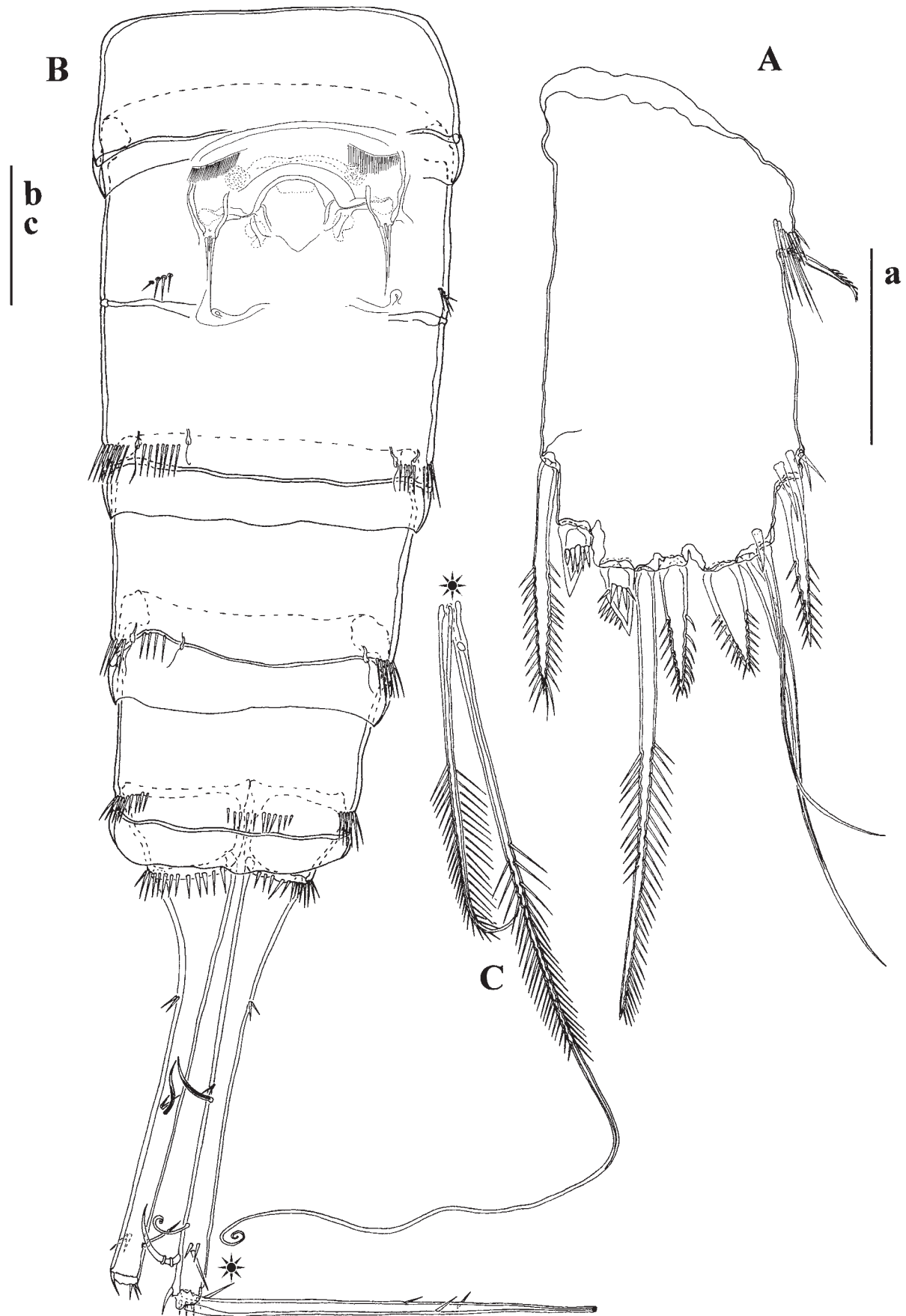


FIGURE 7. *Bathypsammis polaris* sp. n., female, holotype (UNIOI 2006.008): A, female P5; B, female urosome and genital field; C, furcal setae IV and V. Scale bars, a=50 μ m; b-c=100 μ m



FIGURE 8. *Bathypsammis polaris* sp. n., female, holotype (UNIOIOL 2006.008): A, antennule, armature of antennular segments I–IV. Scale bar=30 μ m

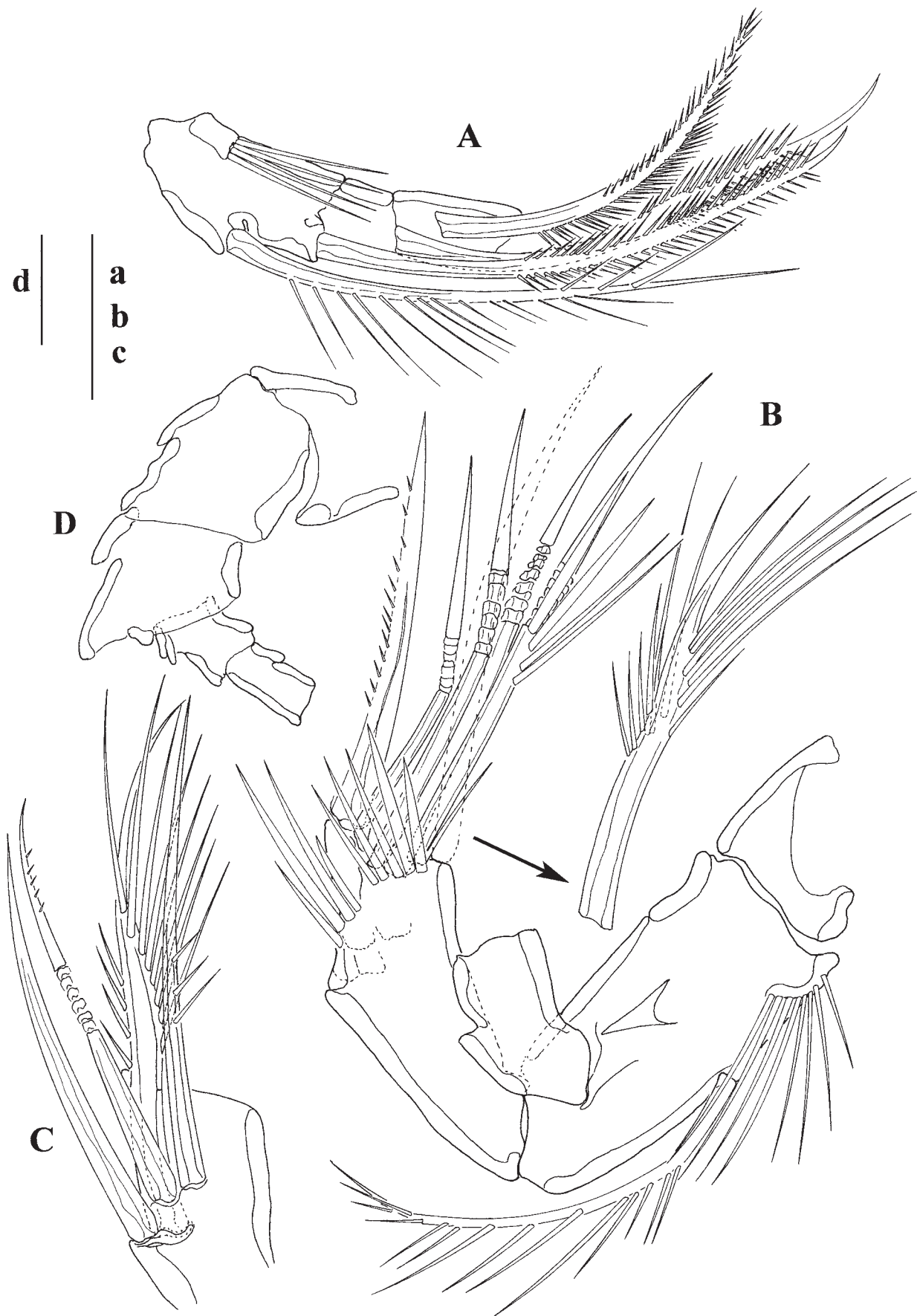


FIGURE 9. *Bathypsammis polaris* sp. n., female, holotype (UNIOLO 2006.008): A, female A2 exp; B, female A2; C, female A2 enp, subapical setation; D, segmentation of female A1. Scale bars=30 μ m.