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Nyxis rostrocularis, a new genus and species of Paranannopinae Por, 1986 (Copepoda, Harpacticoida) from the Southern Atlantic deep sea*

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Abstract

The species diversity of Copepoda Harpacticoida at several sampling locations in the Southern Atlantic has been investigated. From the obtained multicorer samples, a new taxon of Paranannopinae Por, 1986, *Nyxis rostrocularis* gen. nov., sp. nov., has been collected, which is described in the present paper. Specimens of the taxon have been encountered in the Angola Basin (DIVA 1 stations 325 and 346), in the Weddell Sea (ANDEEP station 138) and the Cape Basin (DIVA 1I station 36). *Nyxis* gen. nov. belongs to the group of paranannopid taxa bearing mouthpart aesthetascs. It can be characterised by several autapomorphies discussed in this paper, but takes up a quite isolated position within the Paranannopinae bearing mouthpart aethetascs.

Key words: Systematics, mouthpart aesthetascs, deep sea, Southern Atlantic, meiofauna

Introduction

The international deep-sea campaigns DIVA and ANDEEP are integrated into the global deep sea biodiversity programme “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). The stations of the DIVA and ANDEEP expeditions provide a sampling transect of a latitudinal deep-sea gradient from the tropics to the polar waters in the Southern Atlantic. The first DIVA expedition in the Angola Basin took place in July 2000. A comprehensive replicative sampling design was performed for the meiofauna (Rose *et al*. 2005). The expedition ANDEEP II in 2002 surveyed various deep-sea locations in the Antarctic, including the Weddell Sea (station 138). One goal of the campaign was to investigate the influence of sea-floor habitat diversity on species and genetic diversity in the Antarctic deep sea. The DIVA 2 expedition in 2005 transacted from the Cape Basin in the Southern Atlantic up to the Guinea Basin in tropical regions.

Within this framework, the species diversity of Copepoda Harpacticoida in the deep sea of the Angola Basin (DIVA 1) and in the Weddell Sea (ANDEEP II) have been investigated. Among others, one ambition of the whole project is to obtain data on the presence and distribution of harpacticoid higher taxa and species.

Within the DIVA and ANDEEP samples the Pseudotachidiidae Lang, 1936 turned out to be one of the most significant Harpacticoida taxa 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 as well as a worldwide distribution range. Many species are known from the deep sea. Several monophyletic subgroups have already

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been identified (compare Willen 1999, 2000, 2005; Hicks 1988). Starting as a former small “subfamily” of Thalestridae in the traditional system of Harpacticoida published by Lang (1948), they came out as a well-characterised monophyletic higher taxon within the Harpacticoida, being most successful in terms of species number and distribution (Willen 1996, 1999, 2000, 2004).

A well-represented pseudotachidiid subtaxon in the DIVA 1 + 2 and ANDEEP samples are the Paranannopinae Por, 1986. The new taxon *Nyxis* gen. nov., belonging to the lineage bearing mouthpart aesthetascs, is described presently. Specimens have been encountered in the Angola Basin (DIVA 1 station 346) as well as in the Weddell Sea (ANDEEP station 138) and in the Cape Basin (DIVA 1I station 36).

Material and methods

The treatment of the multicorer samples is described in detail by Rose *et al.* (2005). Holotypes and allotypes 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 were mounted on several slides. The terminology is adopted from Lang (1948, 1965) except for the segmental composition of the mandible and maxilliped, and the numbering of the furcal setae, in which cases 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: baseoendopodite of P5; Ro: rostrum; Ceph: Cephalothorax.

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

Taxonomy

Pseudotachidiidae Lang, 1936
Paranannopinae Por, 1986
***Nyxis* gen. nov.**

Diagnosis. Paranannopinae. Cylindrical body shape without clear distinction of prosome and urosome, rostrum with 4 sensillae and 2 conspicuous pores on dorsal surface, antennule 6-segmented, segment II with enlarged and biarticulated posterior seta ornamented with long spinules, Md enp and exp short and 1-segmented, with only 4 and 3 setae, respectively, antenna with 3-segmented exp, swimming legs: P2–P4 exopods and endopods 3-segmented, rami very slender, insertion point of inner setae of P2–P4 enp3 distally displaced, terminal setae of endopods, terminal and inner setae of exopods elongated, female P5 of characteristic shape: exopod narrow, longer than broad, with outer terminal spine elongate. Benp with rounded outer edge, armed with spinules.

Type species: Nyxis rostrocularis gen. nov. sp. nov. by monotypy.

***Nyxis rostrocularis* gen. nov. sp. nov.**
(Figures 1–8)

Material: The female holotype of *Nyxis rostrocularis* was collected in the Weddell Sea during the ANDEEP expedition of RV *Polarstern*, PS 61/138, at 62°58.03'S and 27°54.08'W at a depth of 4541.3 m, on the 18.03.2002, using a multicorer.

Other examined material: 4 female specimens collected in the Angola Basin using a multicorer during the DIVA 1 campaign of the RV *Meteor* M48/1 from 06.07.2000 to 08.08.2000 at the northern station 346:

1 female specimen: 346-1: 16°17.005'S, 005°26.989'E, 27.07.2000, depth 5432m

3 female specimens: 346-5: 16°17.005'S, 005°26.989'E, 27.07.2000, depth 5433m

1 female specimen was collected in the Cape Basin during the DIVA 2 campaign of the RV *Meteor* M63/2 using a multicorer at station 36 (Cape Basin, 28°6.7'S, 7°20.8'E, depth 5038m) sampled on 03.03.2005.

The type material is stored in the collection of the Senckenberg research institute, Germany.

Female holotype: SNG 32235 on 12 slides

5 female paratypes: SNG 32236-32241

Etymology. Nyx personifies the night in Greek mythology, the species name *rostrocularis* refers to the rostral pores looking like eyes.

Description of female (holotype). Body length 450 µm, furcal rami length 25 µm, Ro 48 µm.

Rostrum (figure 1B) demarcated from cephalothorax, longer than broad, margin hyaline, rounded, with one pair of longer sensilla apically and another one pair subapically, dorsal surface with a pair of large pores. Body (figures 1A, B; 4A). No distinct separation between prosome and urosome. Cephalothorax longer than broad, cephalic shield with only a few sensilla visible. Posterior margin of each body somite (excluding penultimate somite) with sensilla. Urosomal somites with ventrolateral and dorsal spinule rows on distal margins (figures 1B, 4A); other somite surfaces dorsally without spinule ornamentation; genital double-somite (free somites 5 and 6) dorsally fused, in ventral view with sclerotized ridge separating both genital somites, genital field as in figure 4A; P6 with 1 long seta. Anal somite completely divided, with two dorsal sensilla, anal operculum absent (figures 1B, 4A). Furcal rami (figures 1B, 4A) almost square, furcal seta I absent, II and III long and slender, II subapically near outer margin, III pinnate and inserting at outer edge, IV and V well developed, VI slender and naked, located on inner edge, VII triarticulated, subterminally on dorsal surface near inner margin.

Antennule (figures 1B; 2A, B). With six segments. Armature: I(1); II(9), setae of various shape and ornamentation: some setae biarticulated, some spine-like and ornamented with large spinules, 1 seta on posterior margin enlarged, biarticulated and ornamented with long spinules; III(8), 1 seta slightly enlarged and with irregular spinule ornamentation; IV(5+aes); V(5); VI(9 + aes).

Antenna (figures 3C, D). Allobasis with abexopodal pinnate seta in proximal half with basal spinule row; exp 3-segmented, with 1-1-(1+2) pinnate setae; enp with subapical row of long spinules, subapical armature consisting of two pinnate spines one of which is geniculate, 1 seta ornamented with long spinules and 1 tiny naked seta; apically with seven setae: one pinnate spine, 4 geniculate setae, the outermost of which fused at base with a tiny naked seta, and one additional small naked seta on abexopodal side.

Mandible (figure 5C). Gnathobase with 1 large and several smaller, fine and pointed teeth, becoming longer again near inner edge, with 1 slender naked seta on inner edge; basis with 3 pinnate setae and a few long spinules; enp and exp of nearly equal length, cylindrical, enp with 1 lateral and 3 apical setae, one of which is modified into a small mouthpart aesthetasc, exp with 1 lateral and 2 apical pinnate setae.

Maxillule (figure 3B). Arthrite of praecoxa with 8 apical spines, 1 slender anterior seta and two juxtaposed setae on anterior surface; coxal endite with 5 setae; basis with two distinguishable endites, bearing 4 + 2 setae, respectively; proximal basal endite with 1 seta modified as a small mouthpart aesthetasc; exp and enp of nearly equal length, with 3 setae each.

Maxilla (figure 3A). Syncoxa with 3 endites; proximal endite bilobed, proximal lobe bulbous with 1 enlarged pinnate spine and another large pinnate spine, distal lobe with 1 slender pinnate spine, middle and distal endites each with 3 setae/spines; basal endite with 1 pinnate claw fused to basis, accompanied by 1 slender spine on posterior and 2 setae on anterior side; enp 1-segmented, bearing 4 setae, one of which is modified as a small mouthpart aesthetasc.

Maxilliped (figure 5B). Syncoxa with few spinule rows and 1 enlarged pinnate seta on distal margin; basis bearing 1 small naked seta medially on inner margin as well as 1 spinule row parallel to inner margin; enp well developed with fused slender claw, 1 small and slender seta inserting “below”.

P1 (figure 4B). Coxa large, of rectangular shape, with spinule rows on margins and anterior surface. Basis with large pinnate outer and pinnate inner spine; terminal margin and base of spines with spinule rows. Exp 3-segmented, outer and distal margins with spinules; exp1 and 2 each with one outer pinnate spine, exp2 with

inner seta; exp3 with 3 outer pinnate spines and 2 pinnate terminal setae; enp 2-segmented, enp1 shorter than enp2 with spinules along outer and distal margins and 1 inner plumose seta inserting near terminal margin; enp2 with pinnate inner seta, short pinnate outer seta and 2 long pinnate terminal setae.

P2–P4 (figures 6A, 7A, 8A). Exps and enps slender and 3-segmented, of nearly equal length. Coxae of almost rectangular shape, with spinule rows on inner and outer margins and anterior surface. Basis with a slender pinnate outer seta and spinule rows at base of outer setae. Inner setae of enp3 slightly displaced distally, segment appearing slightly elongated, as well as terminal swimming and inner setae of exopods. The specimens of the Angola Basin show an inner seta on P2 enp1, whereas this seta is lacking in the holotype and the specimen from the Cape Basin.

Setal formulae (after Lang 1948):

	Exp	*Enp*
P2	0-1-2, 2, 3	0-1-2, 2, 1
P3	0-1-2, 2, 3	0-1-3, 2, 1
P4	0-1-2, 2, 3	0-1-2, 2, 1

P5 (figure 5A). Pair of legs not fused medially, basal part with well developed pinnate outer seta, endopodal lobe slightly flattened but with a rounded outer edge and marginal spinules, with 5 pinnate setae, innermost of which is long and pinnate, second innermost short and pinnate in distal half, middle one shorter and pinnate, and outer 2 setae long and pinnate; exp longer than broad, narrow, setation consisting of 1 shorter and unipinnate inner seta, 2 pinnate terminal setae and 1 pinnate outer seta.

Systematic discussion

Within the Paranannopinae a certain lineage can be clearly characterised by the presence of mouthpart aesthetascs being derived from certain homologous setae. Since this kind of setal modification on the mouthparts is unique even within the Harpacticoida as a whole, it represents a strong autapomorphy to identify a well-defined monophylum. Currently this taxon includes 11 described species assigned to the genera *Micropsammis* Mielke, 1975, *Leptotachidia* Becker, 1974, *Paradanielssenia* Soyer, 1970, *Peltisenia* Huys & Gee, 1996, *Sentiropsis* Huys & Gee, 1996 and *Jonesiella* Brady, 1880. The only species already described from the deep sea (3800 m off the coast of Portugal) is *Leptotachidia iberica* Becker, 1974. Within the DIVA 1 and ANDEEP samples, 23 more species have been encountered. All of them, with the exception of species which have to be placed in *Paradanielssenia*, must be assigned to hitherto unknown taxa. One of these new taxa is *Nyxis* gen. nov., which was collected from both deep-sea locations and also in the Cape Basin (DIVA 1I station 36). Within the taxa enumerated above, *Paradanielssenia*, *Leptotachidia* and *Micropsammis* together form a higher taxon, grouped on the basis of 1) loss of Md exp, 2) reduced setation of Md enp (never more than 3 setae present), 3) outer distal seta of male P2 enp 3 fused to segment, forming a rigid apophysis, and 4) innermost seta of female P5 benp shortened (compare e.g. for paranannopid groundpattern: Willen, 2000). Since *Nyxis* g. nov. does not share these characters, the discussion on closer relationships with other taxa is narrowed to *Jonesiella*, *Peltisenia* and *Sentiropsis*. Only female characters can be considered in the current state of knowledge.

Jonesiella comprises the 2 species *J. fusiformis* Brady, 1880 and *J. eastwardae* (Coull, 1971). The former occurs in the North Sea and Mediterranean in sandy sediments at 15–26 m depth, whereas the latter was found on the North Carolina continental shelf at 43 m depth (Coull 1971; Huys & Gee 1992). Within the Paranannopinae with mouthpart aesthetascs, *Jonesiella* shows a quite primitive morphology considering its complete setation (referring to the paranannopid groundpattern as assumed by Willen 2000), shape and

segmentation of the swimming legs, shape and setation of the female P5, and mouthparts (compare description of Huys & Gee 1992). The mouthpart aesthetascs are not "claviform" as e.g. described for the *Leptotachidia/Micropsammis/Paradanielssenia* group (Gee & Huys 1991), but undifferentiated and more similar to antennular aesthetascs, which is considered the more primitive state. Autapomorphies of *Jonesiella* are 1) the Mxl exp folded under basis and 2) Mx syncoxa with a modified spine on the distal endite (compare Huys & Gee 1992, 1996a).

Sentiropsis Huys & Gee, 1996 was erected to accommodate *Danielssenia minuta* Coull, 1969 which was collected from Harrington Sound, Bermuda from 5 and 20 m depth. Generic apomorphies according to Huys and Gee (1996a) are, among others, 1) A1 with all setae slender and naked, 2) A2 exp 3 with only 2 setae, 3) Mxl exp with only 2 setae, 4) Mx syncoxa middle endite reduced and bearing only 2 setae, and 5) Mxp syncoxa with only 1 naked seta. The mouthpart aesthestascs are of the "primitive" type as in *Jonesiella*. Except for the P2–P4 exp 1 and P2 enp 2 inner setae being absent, the swimming legs have retained their complete setation.

Peltisenia Huys & Gee, 1996 was established to include *Idomene aberrans* Por, 1964, which occurs in the North Sea and Mediterranean (Isles of Scilly, Banyuls, Israel, Huys & Gee, 1996a). Besides a quite primitive setation of the swimming legs and mouthparts the taxon shows a very unique morphology, starting with a dorsoventrally depressed body and a derived and modified shape of swimming leg segments, setae and caudal rami (compare Huys & Gee 1996a).

Nyxis gen. nov. does not share any of the characters stated above for *Sentiropsis*, *Jonesiella* and *Peltisenia*, instead showing several autapomorphies not shared by the other taxa:

1) Antennular segment II with enlarged and biarticulated posterior seta ornamented with long spinules (figures 1B, 2A).
2) Both Md enp and exp short and 1-segmented, with only 4 and 3 setae, respectively.
3) Shape of swimming legs: rami very slender, insertion point of inner setae of P2–P4 enp3 distally displaced, terminal setae of endopods, terminal and inner setae of exopods elongated compared to the condition in the other taxa (figures 1A, 6, 7, 8).
4) Cylindrical body shape without clear distinction of prosome and urosome, almost not tapering posteriad.
5) Rostrum with 2 conspicous pores on dorsal surface.
6) Female P5 exp narrow, longer than broad, with outer terminal spine elongate. Benp with rounded outer edge, armed with spinules (figure 5A).

Nyxis gen. nov. shares with *Sentiropsis* the lack of inner setae on P2–P4 exp1, the presence of only 4 setae on the female P5 exp, and with *Jonesiella* and *Sentiropsis* the presence of only 3 setae on the Md basis. These characters are rather unspecific compared to the above discussed apomorphies, which are not at all shared. *Sentiropsis* does not display any trace of the segmental and setal shape of P5 exp of *Nyxis* gen. nov., only the number of setae. In *Jonesiella/Sentiropsis* one of the basal setae on the Md palp is small and naked whereas in *Nyxis* gen. nov. all 3 setae are of the same length and ornamentation. Therefore, these latter 3 characters are interpreted as convergences for the moment, leaving *Nyxis* gen. nov. in a rather isolated position within the whole group of Paranannopinae with mouthpart aesthetascs. Since only a few taxa of this group are known and described, more data will be made accessible in the future by working on more material.

Acknowledgements

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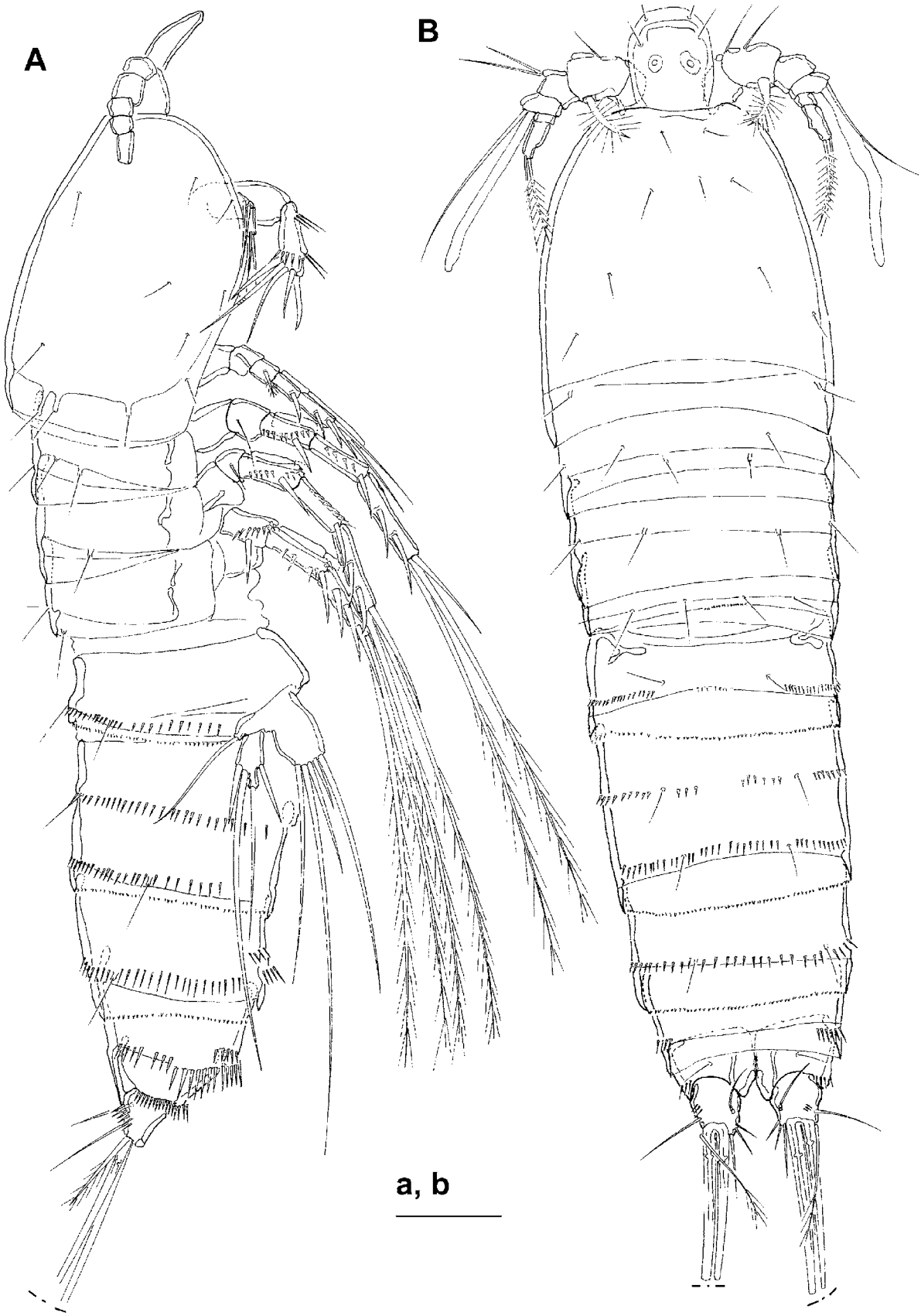

FIGURE 1. *Nyxis rostrocularis* gen. nov., sp. nov., A, female habitus lateral, scale bar = 50 µm; B, female habitus dorsal, scale bar = 50 µm.

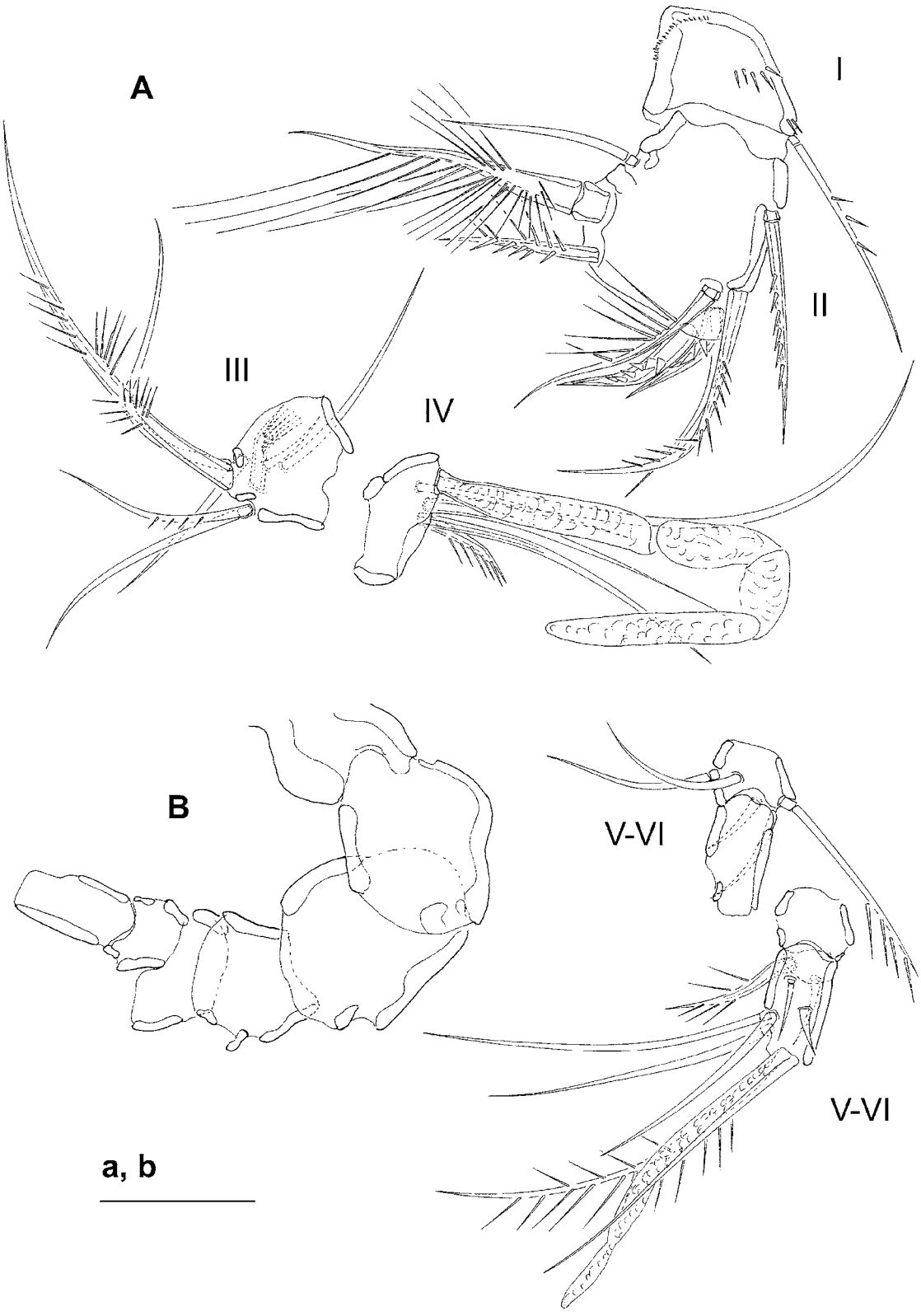

FIGURE 2. *Nyxis rostrocularis* gen. nov., sp. nov., A, female antennule, segments I–VI illustrated separately, scale bar = 20 µm; B, female antennule without setation, scale bar = 20 µm.

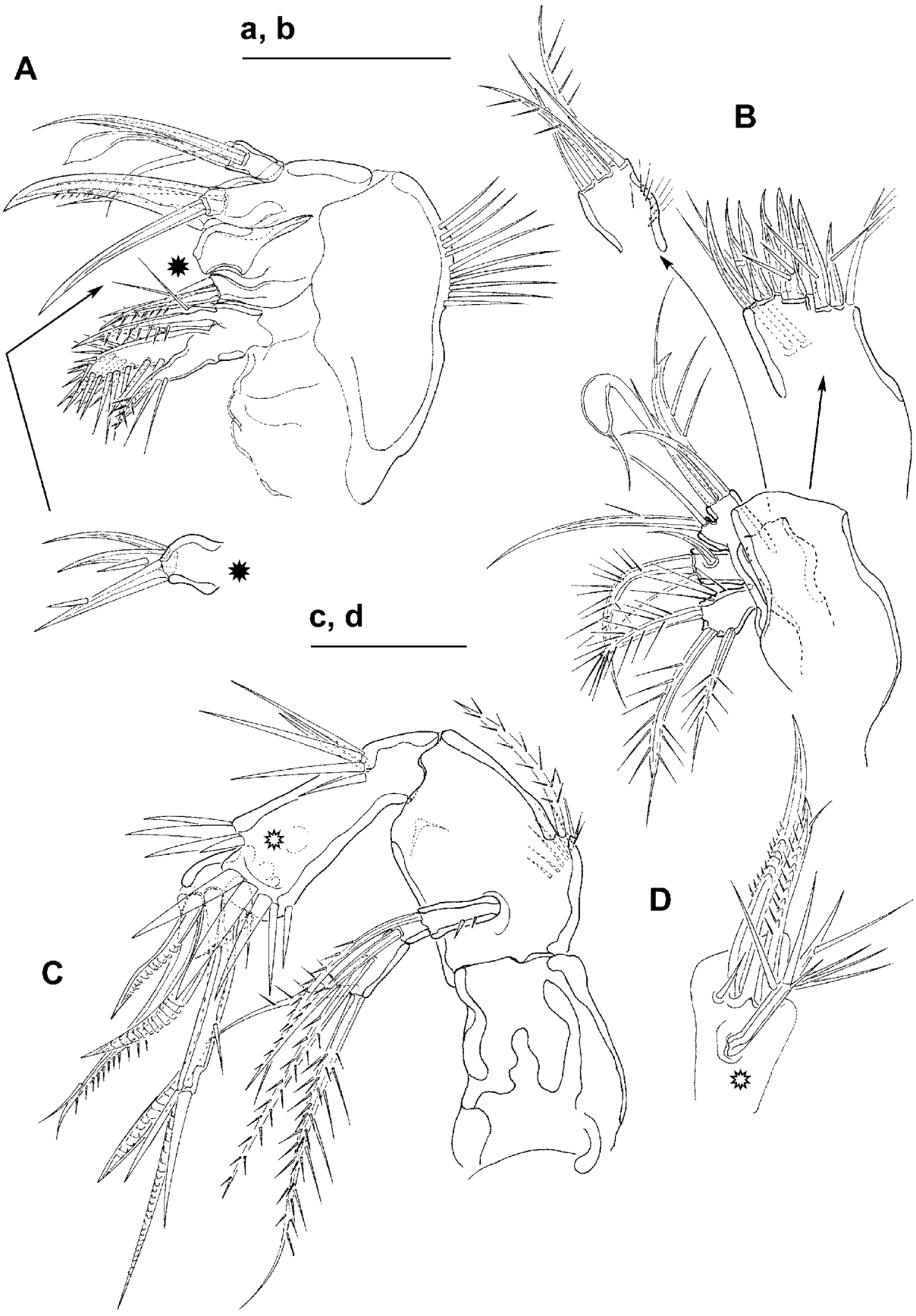

FIGURE 3. *Nyxis rostrocularis* gen. nov., sp. nov., A, maxilla, scale bar = 20 µm; B, maxillule, scale bar = 20 µm; C, antenna, scale bar = 20 µm; D, subterminal setation of antennal endopod, scale bar = 20 µm.

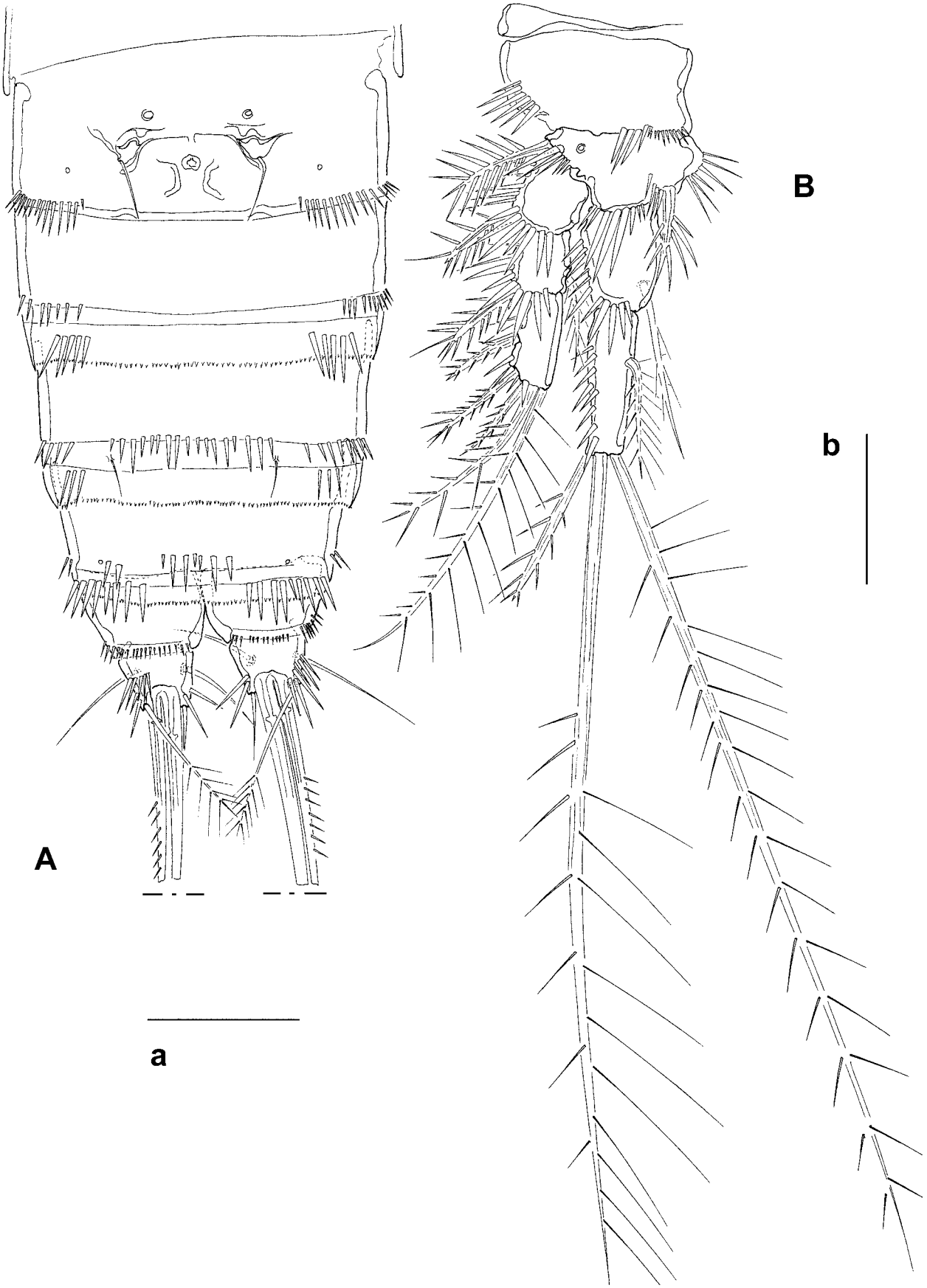

FIGURE 4. *Nyxis rostrocularis* gen. nov., sp. nov., A, female urosome and genital field from ventral view, scale bar = 50 µm; B, P1, scale bar = 30 µm.

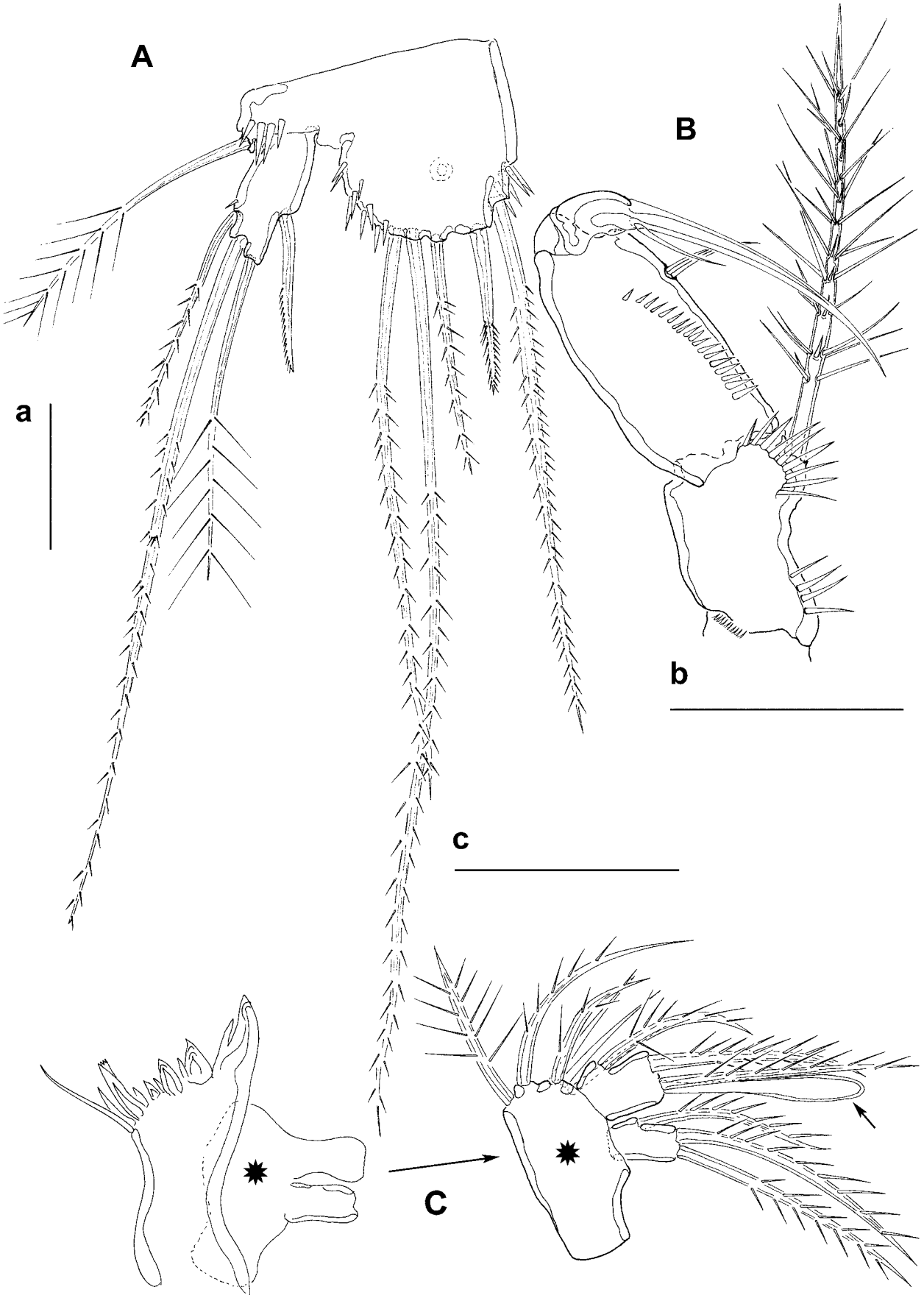

FIGURE 5. *Nyxis rostrocularis* gen. nov., sp. nov., A, female P5, scale bar = 30 µm; B, maxilliped, scale bar = 20 µm; C, mandible, small arrow indicates aesthetasc, scale bar = 20 µm.

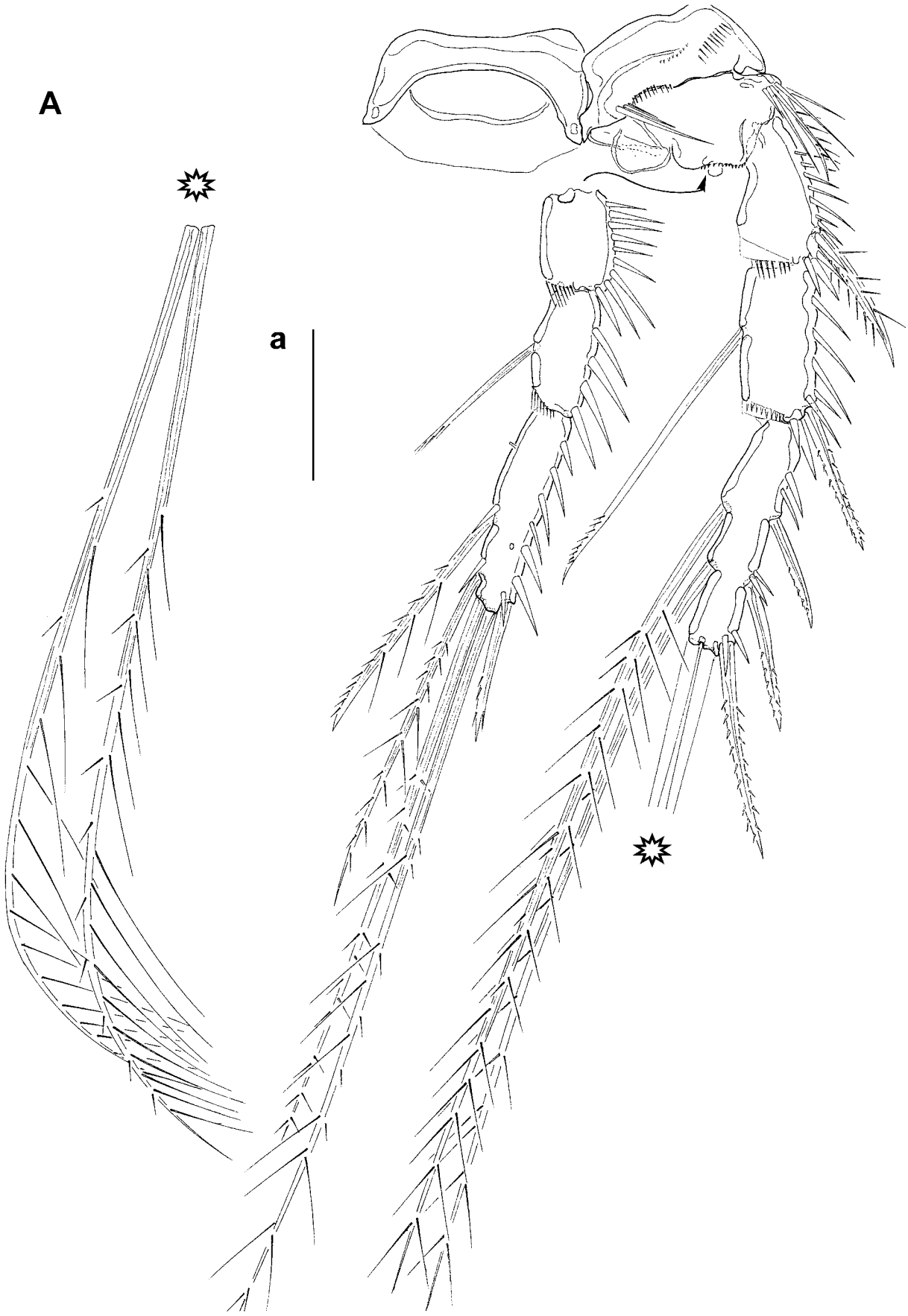

FIGURE 6. *Nyxis rostrocularis* gen. nov., sp. nov., A, female P2, scale bar = 30 µm.

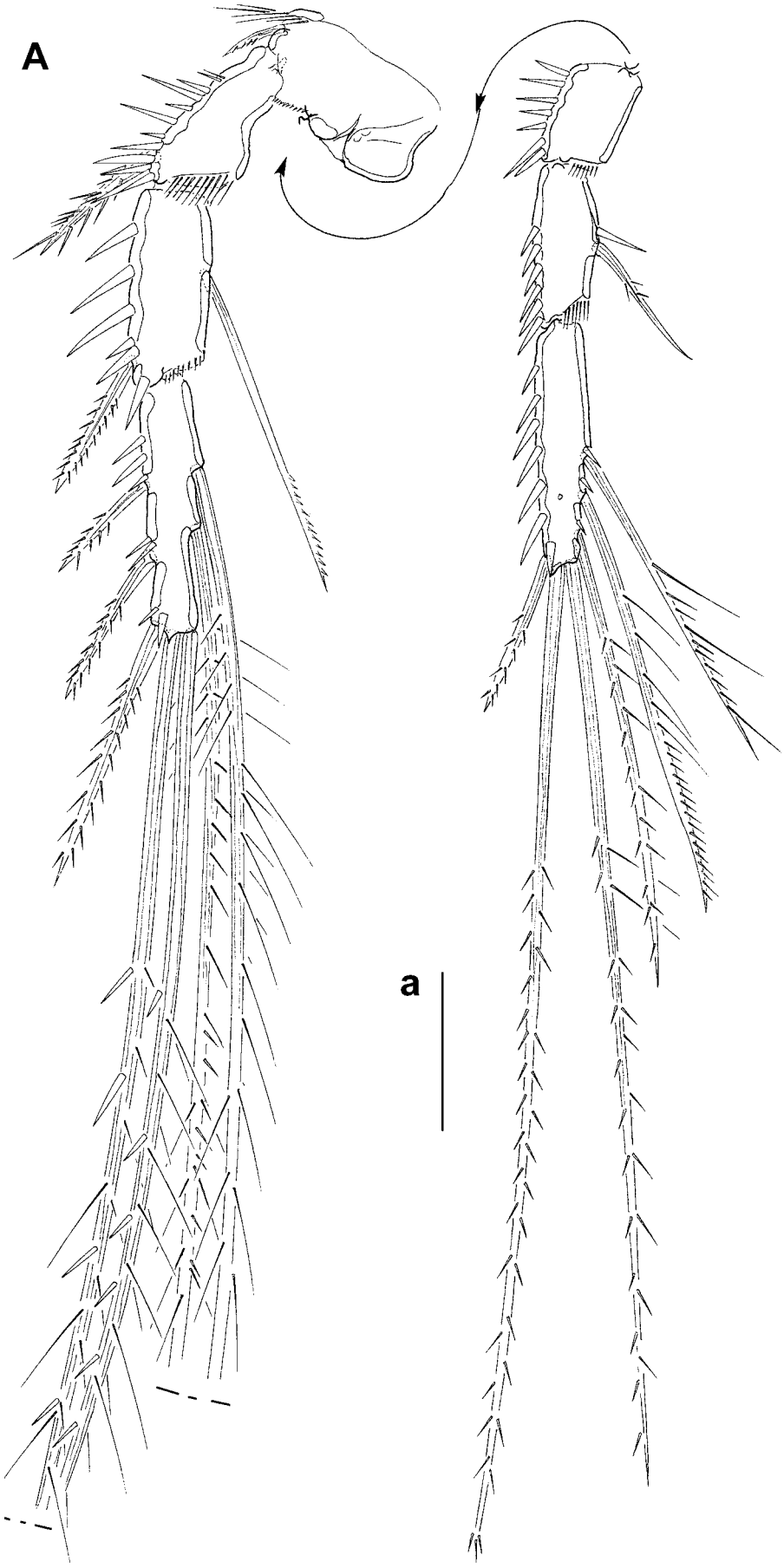

FIGURE 7. *Nyxis rostrocularis* gen. nov., sp. nov., A, female P3, exopod and basis, scale bar = 30 µm, B, female P3, endopod, scale bar = 30 µm.

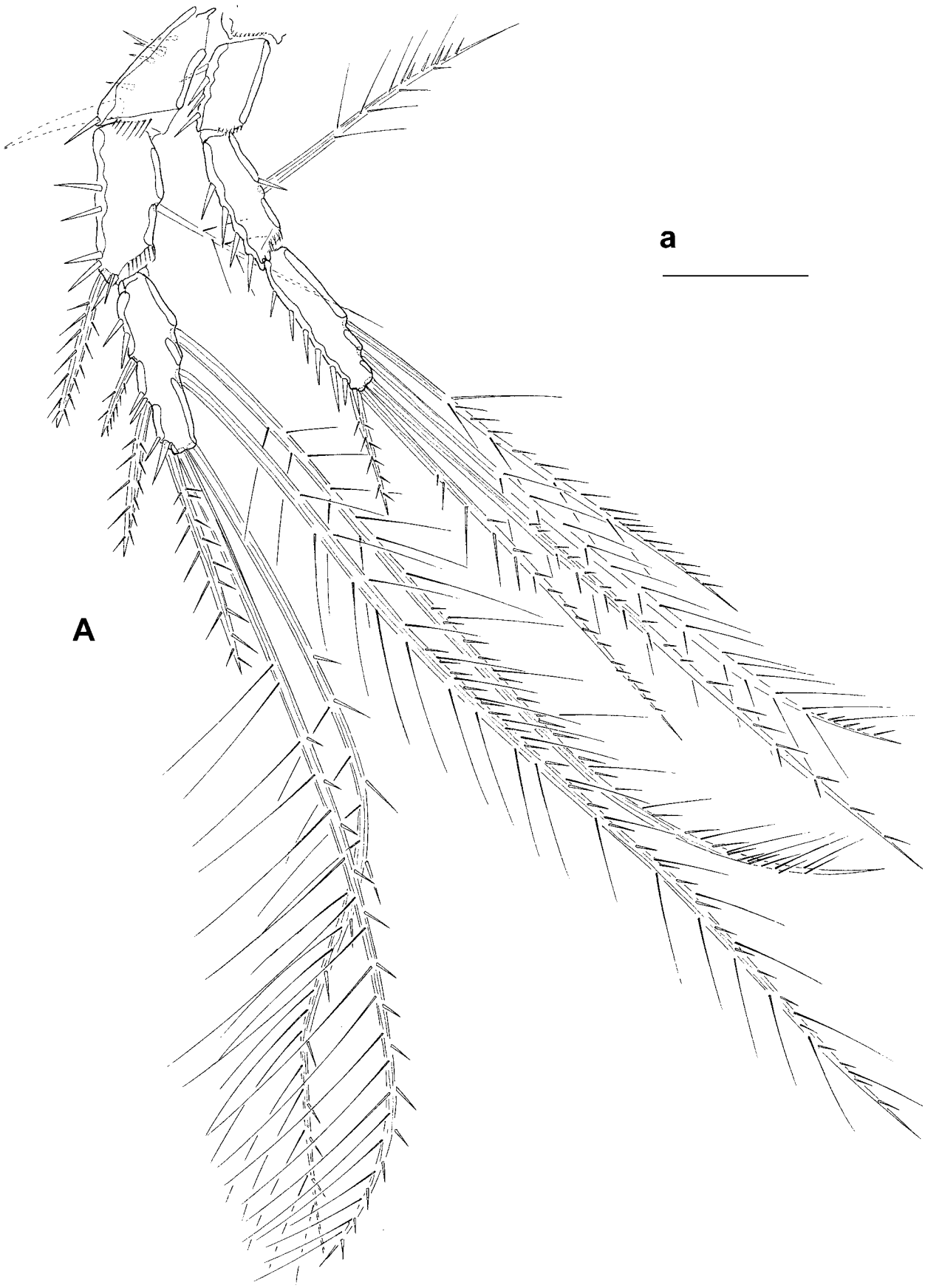

FIGURE 8. *Nyxis rostrocularis* gen. nov., sp. nov., A, female P4 scale bar = 30 µm.

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