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ORIGINAL ARTICLE

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New hyperbenthic species of *Misophriopsis* and *Misophriella*, first record of misophrioid copepods (Crustacea) from Antarctic waters

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Abstract Misophrioid copepods are reported for the first time from Antarctic waters. A species of each of the genera *Misophriopsis* and *Misophriella* is described from hyperbenthic layers of the continental shelf of the eastern Weddell Sea. The genus *Misophria* is also reported from these waters. *Misophriopsis australis* sp. nov. is the fifth representative of this widely distributed genus, previously reported from the North Atlantic, the China Sea, and both NW and NE quadrants of the Pacific Ocean. *Misophriella schminkei* sp. nov. is the second representative of the genus, known to date only from a single female caught in North Atlantic bathyal depths. Traces of subdivisions on antennary exopodal segments of the latter species suggest that the first segment may be a triple segment, while the second and terminal segments may be double segments. In addition, the mandibular exopod of this taxon indicates that a six-segmented ramus with setal formula 0, 1, 1, 1, 1, 2 may represent the ground pattern in Copepoda. The presence of parts of a cyclopinid copepod in the gut of *M. schminkei* sp. nov. indicates that this species may be carnivorous.

Key words Misophrioid copepods · Antarctic waters · *Misophriopsis* · *Misophriella* · Crustacea

Introduction

Studies on copepods from Antarctic waters date back to the end of the last century (Brady 1883; Giesbrecht 1902; Wolfenden 1911). However, copepods belonging to the order Misophrioida had never been reported from the high Southern Ocean. Misophrioids are seldom found (most are known only from the type locality and have never been reported again after their original description) and are primarily tied to hyperbenthic oceanic layers or anchialine cave environments. Recently, Boxshall and Jaume (in press) have proposed two separate families for the anchialine cave lineage of Misophrioida. Thus, Misophriidae is currently composed of seven genera, four of them, viz. *Misophria* Boeck (Arctic Ocean, North Atlantic, Mediterranean Sea, Red Sea), *Stygomisophria* Ohtsuka, Huys, Boxshall and Itô (West Pacific), *Misophriella* Boxshall (North Atlantic), and *Fosshageniella* Jaume and Boxshall (North Atlantic), are monotypic (see Gurney, 1927; Boxshall 1983; Ohtsuka et al. 1992; Jaume and Boxshall 1997). *Arcticomisophria* Martínez Arbizu and Seifried contains two species from the Arctic Ocean and the North Atlantic, respectively (Martínez Arbizu and Seifried 1996; Jaume and Boxshall 1997), as does *Benthomisophria* Sars, of which each species is distributed in both the North Atlantic and the north-west Pacific (Boxshall and Roe 1980). *Misophriopsis* Boxshall is the most speciose genus of the family, with four species distributed in the North Atlantic, the China Sea, and the north-west and north-east Pacific Ocean, respectively (Humes, 1999).

Members of the family seem to be limited to either the deep-sea or shallow water hyperbenthos except for *Benthomisophria*, which is bathypelagic. The presence of *Stygomisophria* in a littoral cave has been interpreted as a mere inland, horizontal extension of a primarily marine hyperbenthic shallow-water habitat (see Boxshall and Jaume, in press).

In this paper we report for the first time the presence of misophrioid copepods in austral latitudes. A new species of both *Misophriopsis* and *Misophriella* is described and the presence of *Misophria* is reported from the continental shelf of the eastern Weddell Sea. Some notes on the feeding habits of *Misophriella* are added.

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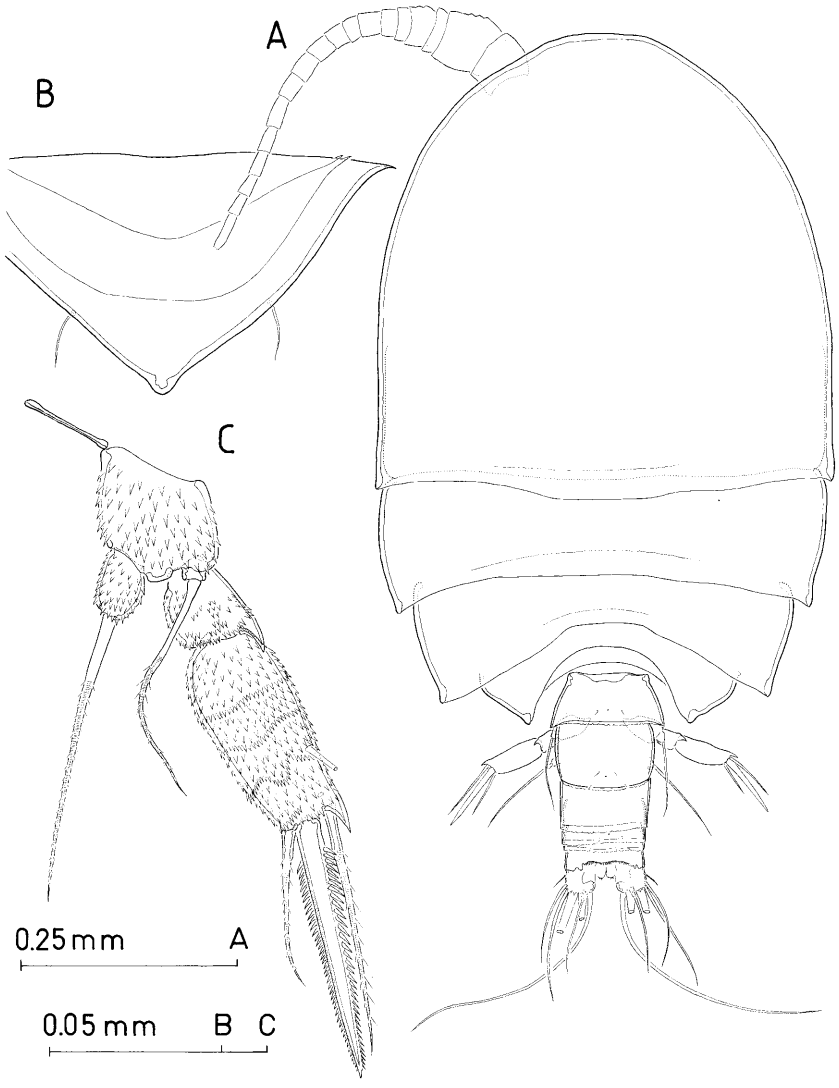

Fig. 1 *Misophriopsis australis* sp. nov., adult female. **A** Body, dorsal; **B** rostrum, anterior; **C** fifth leg, posterior

Material and methods

Material was collected by Dr. Hans-Uwe Dahms (University of Oldenburg) during the German expedition ANT V/3 on board R/V *Polarstern* in 1986. For details of this expedition see Schnack-Schiel (1987). Meiofauna was collected as described in Brady (1883), viz. after having removed macrofauna and coarse parts of the dredging (Agassiz-Trawl) the fine residue was plunged into a quantity of filtered sea water. Subsequently, the meiofauna was extracted by decantation, secured on a 40-µm sieve, and fixed with buffered formalin at a final concentration of about 4%.

The sample from station 10/585 contained two adult females and three copepodids of *Misophriopsis australis* sp. nov., as well as one damaged female specimen of *Misophria* sp. The sample from station 10/528 contained one adult female of *Misophriella schminkei* sp. nov., as well as two adult females of *Misophriopsis australis* sp. nov.

Specimens were examined with a differential interference contrast microscope (Olympus BH-2 and Leitz Diaplan). The terminology used in the descriptions follows Huys and Boxshall (1991), except for the terms ‘furca’ and ‘telson’ that are used following Schminke (1976) instead of ‘caudal ramus’ and ‘anal somite’. The type material is deposited in the copepod collection of the Arbeitsgruppe Zoosystematik und Morphologie, University of Oldenburg.

Results

Order Misophrioida Gurney, 1933 – Family Misophriidae Brady, 1878 – Genus *Misophriopsis* Boxshall, 1983

Misophriopsis australis *sp. nov.*

Material examined. Holotype, adult female dissected and mounted on ten slides (Coll. no. 1998.046/1–1998.046/10). Paratypes: one disarticulated adult female and three copepodids from the type locality, and two adult females from station 10/528, all preserved in formalin.

Type locality. Ant V/3 station 10/585, Agassiz-Trawl from 11.11.86; 332-m depth; coordinates 76°00.9’S 28°15.9’W.

Description. Adult female. Body (Fig. 1A) compact, subspherical both in dorsal and lateral aspect. Body length 790 µm. Naupliar eye absent. Body surface almost

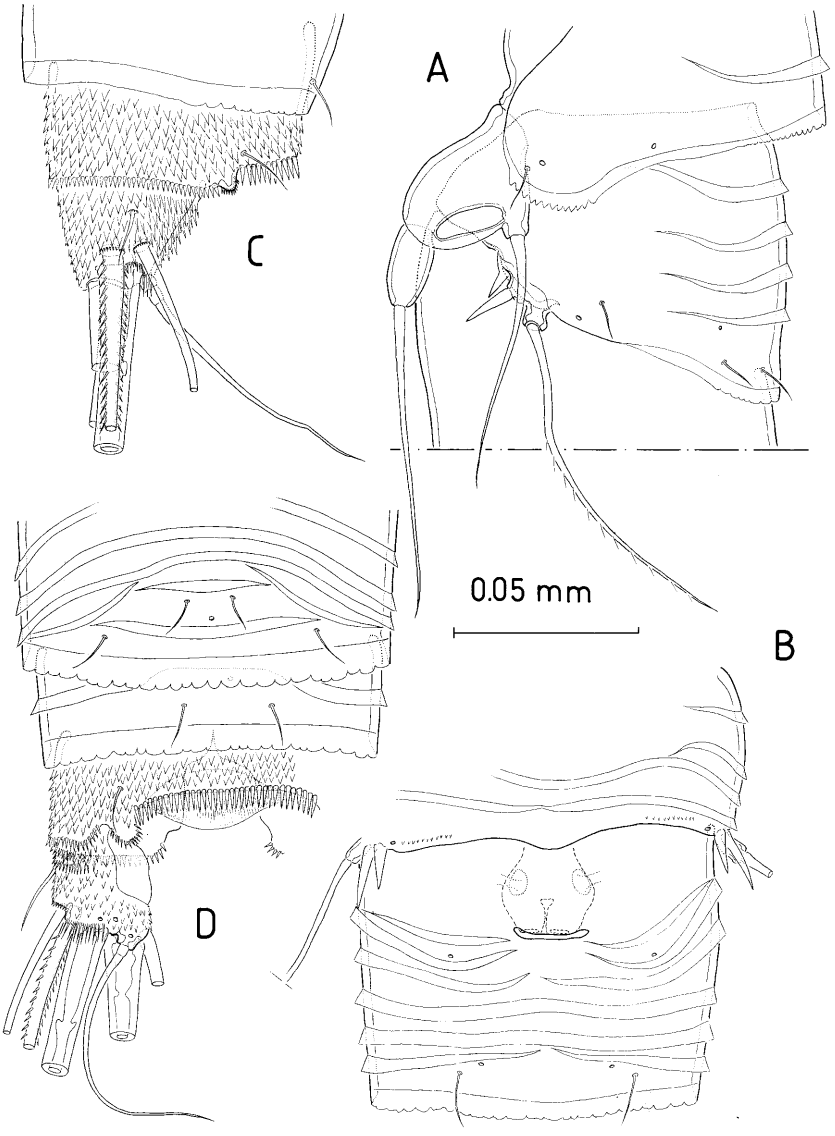

Fig. 2 *Misophriopsis australis* sp. nov., adult female. **A** Fifth pedigerous somite and proximal part of genital double-somite, lateral (exopod of fifth leg omitted); **B** genital double-somite, ventral; **C** third abdominal somite, telson and left furcal ramus, lateral; **D** second abdominal somite to furca, dorsal

entirely covered with epicuticular hyaline ridges except for anterior part of dorsal cephalic shield (although ridges appear again on rostrum), telson, and furca (see Fig. 1B, but notice that ridges have been omitted from Fig. 1A). Prosome five-segmented, with first pedigerous somite free although completely covered by posterior, carapace-like extension of dorsal cephalic shield. Rostrum (Fig. 1B) short, pointed, completely fused to cephalosome, with one marginal sensilla on each side. Labrum (not figured) large, partially fused to rostrum. Second to fourth pedigerous somites with lateral margins slightly produced posteriorly.

Urosome five-segmented. Fifth pedigerous somite with posterolateral margins acutely produced posteriorly in dorsal aspect; posterolateral angles broadly rounded and fringed with serrate hyaline frill (see Fig. 2A). Genital and first abdominal somites partly fused to form genital double-somite; dorsal articulation partly separating somites (Fig. 2A,B); articulation fringed with hyaline frill belonging to posterodorsal margin of genital somite. Pair of gonopores located ventrolaterally at about one-third of distance along double-somite; each covered by operculum derived from sixth legs; armature of latter consisting of one long, outer seta implanted on discrete pedestal, plus two short, inner spines; sixth legs confluent medially. Pair of copulatory pores in small mid-ventral transverse slit at about midlength of double-somite. Pores leading via separate copulatory ducts to common seminal receptacle; other internal structures of reproductive system unresolved. Integument of telson and furca covered by densely set, short spinules (Fig. 2C,D). Posterodorsal margin of telson fringed with row of sharp spinules; faint, hyaline anal operculum visible below. Furca short, about as long as wide, armed with seven setae.

Antennule (Figs. 1A and 3A) 18-segmented, short, not reaching posterior margin of cephalosome. Segmentation pattern and armature as follows: segment 1 (corresponding to ancestral segment I), 1 seta; segment 2 (compound segment II–VII), 12 setae; segment 3 (VIII),

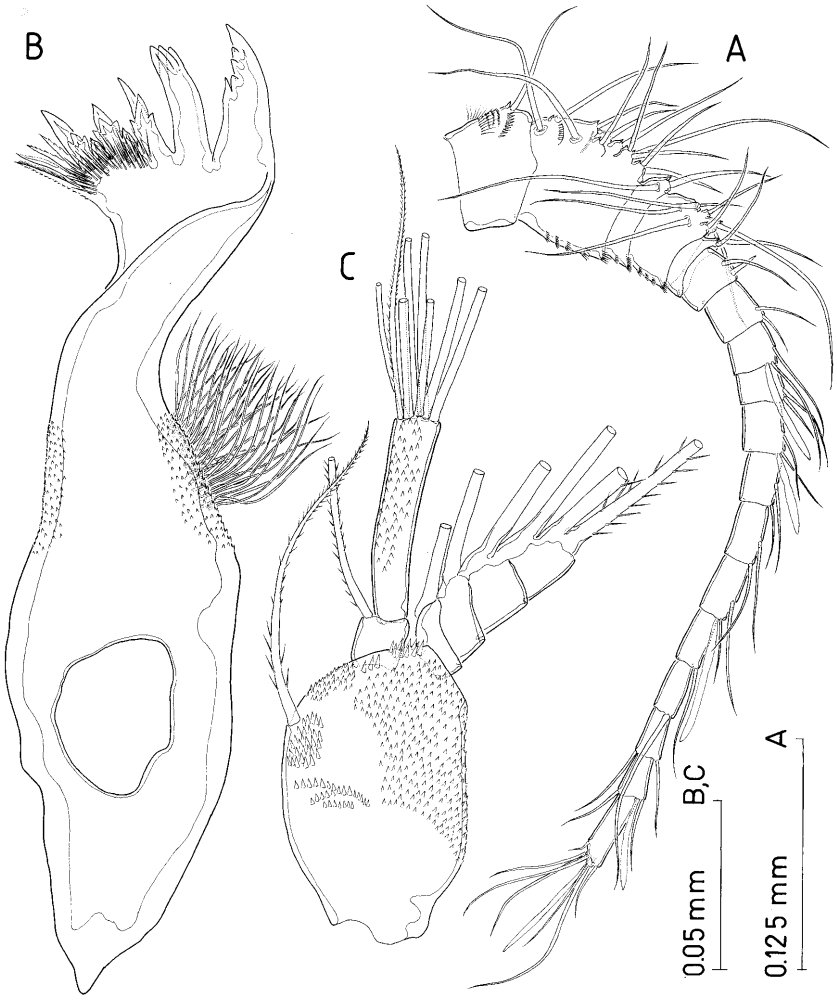

Fig. 3 *Misophriopsis australis* sp. nov., adult female. **A** Antennule, medial; **B** mandibular coxal gnathobase; **C** mandibular palp

2 setae; segment 4 (IX–XII), 8 setae; segment 5 (XIII), 2 setae; segment 6 (XIV), 1 short spine plus 1 seta; segment 7 (XV), 2 setae; segment 8 (XVI), 2 setae + aesthetasc; segment 9 (XVII), 2 setae; segment 10 (XVIII), 2 + aesthetasc; segments 11 and 12 (XIX and XX), 2 setae each; segment 13 (XXI), 2 + aesthetasc; segments 14 and 15 (XXII and XXIII), 1 seta each; segment 16 (XXIV), 1+1 setae; segment 17 (XXV), 1+1 setae plus aesthetasc; segment 18 (XXVI–XXVIII), 6 setae plus acrothek, consisting of aesthetasc and basally fused seta. Segments 2 to 4 with transverse rows of short spinules along posterior margin. Several rows of tiny spinules and setules disposed as figured on anteromedial margin of segments 1 and 2. Short, pointed protuberance close to insertion of some setae on segments 1 to 5.

Antenna (Fig. 4A) biramous. Coxa discrete, unarmed, bearing patch of long spinules on medial margin. Basis with two long, unequal setae subdistally on medial margin. Endopod three-segmented, setal formula 2, 2+3, 7; one of terminal setae reduced. Exopod 5-segmented, with setal formula (0+2), 1, 1, 1, 3; presumed homologies of segments as follows: (I–V), VI, VII, VIII, IX-X. Antennal segments ornamented with heterogeneous array of short spinules and setules.

Mandible with stout coxal gnathobase bearing patch of long spinules (Fig. 3B); gnathobase with five main, multicuspid unequal teeth, plus two more slender, spine-like teeth and two stout setae dorsally; tuft of long setules disposed close to dorsal angle of gnathobase. Mandibular palp (Fig. 3C) biramous, with surfaces of both basis and distal endopod segment densely ornamented with short spinules. Basis massive, ovoid, with single seta at about three-fourths of distance along medial margin. Endopod two-segmented, setal formula 1, 8; distal segment slender, elongate. Exopod indistinctly four-segmented, setal formula 1, 1, 1, 3.

Maxillule (Fig. 4B) with discrete praecoxa; praecoxal arthrite provided with seven thorn-like spines plus one slender spine distally; five unequal setae subdistally on medial margin and two on anterior surface of arthrite. Coxa discrete, with coxal epipodite bearing eight unequal setae; coxal endite with six stout setae distally. Basal endites each with four setae, distal endite largely incorporated into segment. Endopod comprising single compound segment representing ancestral segments I–II, plus partially incorporated segment III; armature divided into three groups representing ancestral segmental elements, setal formula 3, 3, 6. Exopod unsegmented, with

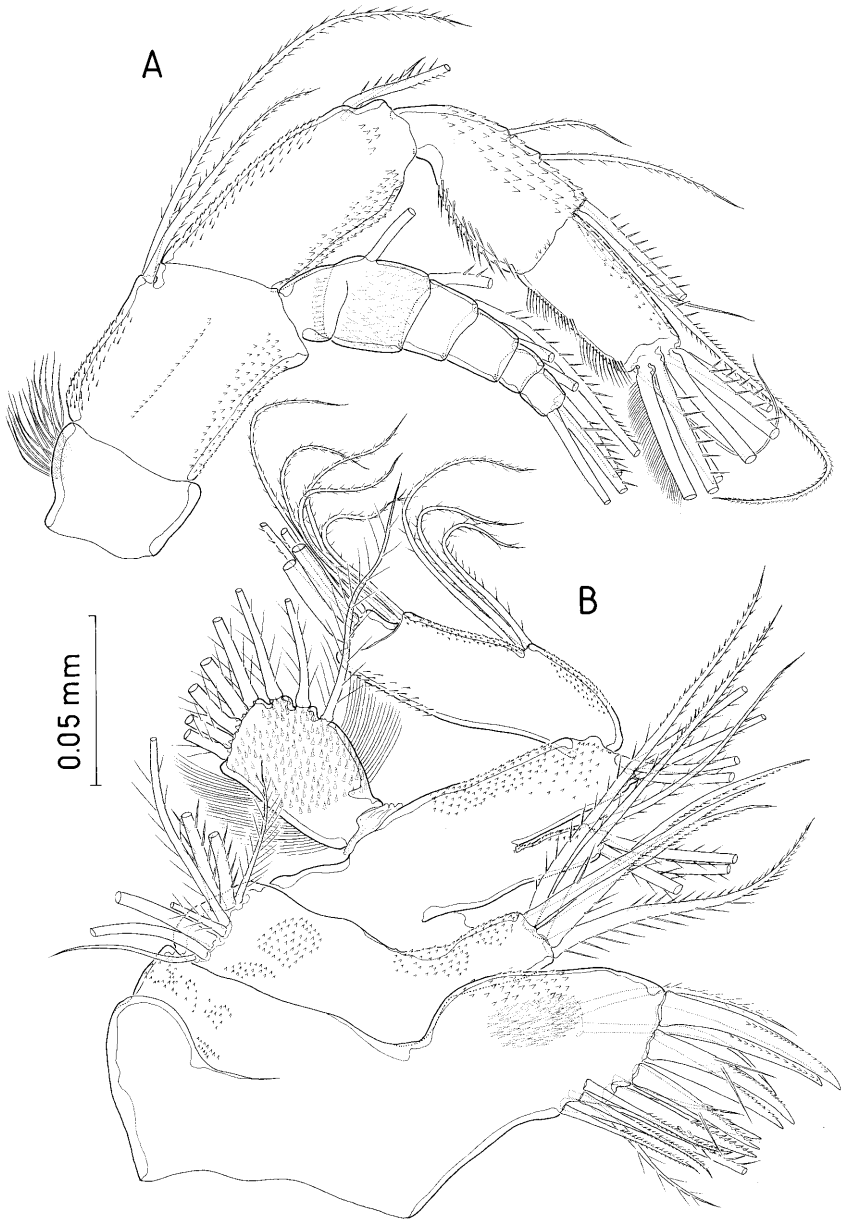

Fig. 4 *Misophriopsis australis* sp. nov., adult female. **A** Antenna, lateral; **B** maxillule, posterior

eight distal setae; row of long slender spinules along each side of segment. Maxillulary segmental surfaces ornamented profusely with short spinules.

Maxilla (Fig. 5A) five-segmented. Articulation between praecoxa and coxa partially expressed resulting in syncoxa; endites with setal formula 6, 3, 3, 3. First ancestral endopodal segment incorporated into basis to form allobasis; latter displaying distally three setae as remnants of armature of incorporated segment (one implanted on posterior surface, whereas other two, smaller, on anterior surface of segment). Basal endite powerfully developed, drawn out into stout, curved medial claw bearing two basal setae at each side. Free endopod three-segmented, setal formula 2, 2, 4; segments one and two horseshoe-shaped, with posterior side displaced distally. Surfaces of syncoxa, syncoxal endites and allobasis profusely ornamented with heterogeneous array of spinules and setules.

Maxilliped (Fig. 5B,C) slender, seven-segmented. Syncoxa with three small endites, setal formula 1, 3, 2. Basis about as long as syncoxa, with three marginal setae. Surface of syncoxa and basis ornamented with short spinules. Endopod five-segmented, setal formula 2, 2, 2, 2, 5.

Swimming legs 1 to 4 (Figs. 6 and 7), each comprising coxa, basis, and three-segmented rami. No trace of praecoxa retained in any leg. Armature formula is shown in Table 1.

Inner basal spine of first leg implanted on protruding pedestal; this spine and distal spine on third exopod segment both with long setules proximally. Outer basal spine of second leg with soft, filiform extension on tip. Inner distal angle of basis of legs 2 to 4 with sharp, pointed process. Outer distal angle of first and second endopod segments of legs 1 to 4 bifid. Integument of

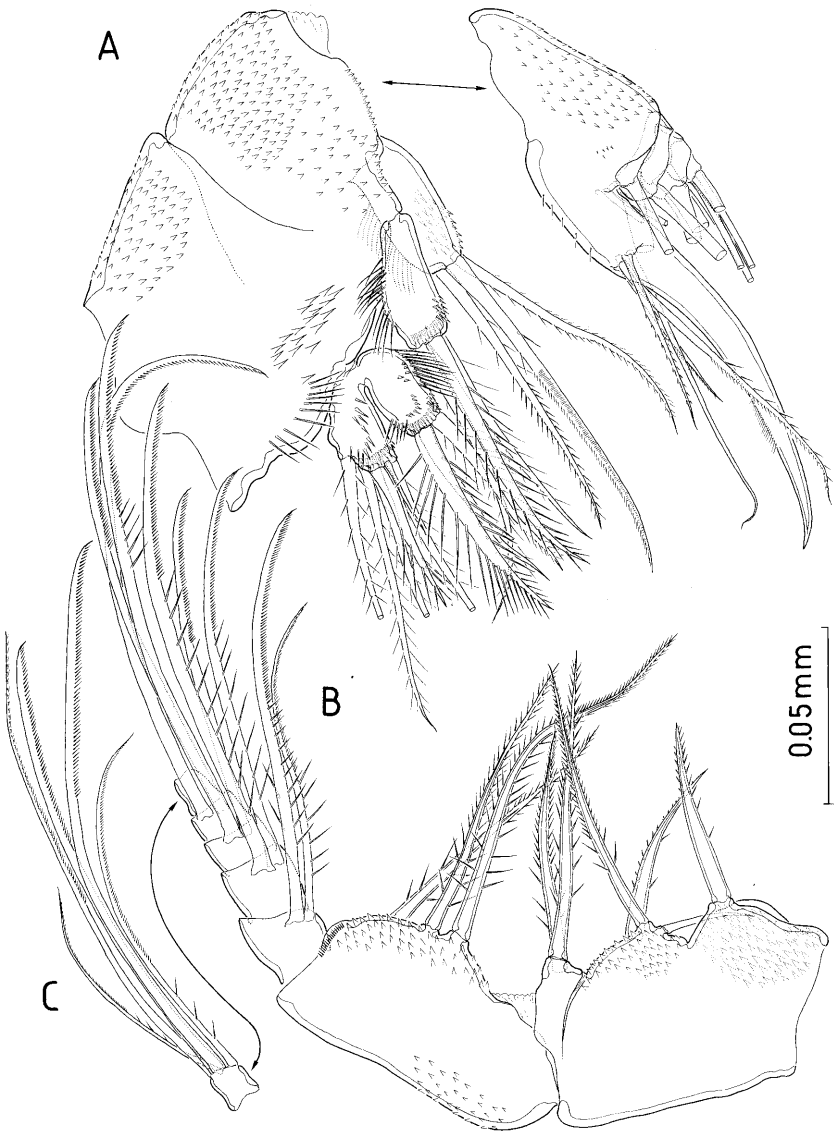

Fig. 5 *Misophriopsis australis* sp. nov., adult female. **A** Maxilla, posterior; **B** maxilliped; **C** detail of armature of distal segment of its endopod

Table 1 Armature formula of *Misophriopsis australis* sp. nov., adult female

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

legs and corresponding intercoxal sclerites richly adorned with short spinules distributed to form complex patterns.

Leg 5 (Fig. 1C) biramous, comprising narrow intercoxal sclerite, coxobasis, two-segmented exopod and discrete, unsegmented endopod. Integument of segments richly adorned with short spinules. Coxobasis with single, outer seta disposed posterodistally on pedestal. Endopod with single seta on tip. Proximal exopod segment unarmed, with outer distal angle produced into sharp, pointed process. Distal segment about twice as long as wide, with armature comprising one terminal, stout serrate spine flanged with one seta at each side; relative lengths of spine and setae as figured. Outer distal angle of segment produced into sharp, pointed process. Ordinary pore opening close to insertion of outer seta on anterior surface of segment, whereas tube pore opening submarginally on posterior surface, at about two thirds of distance along outer margin of segment.

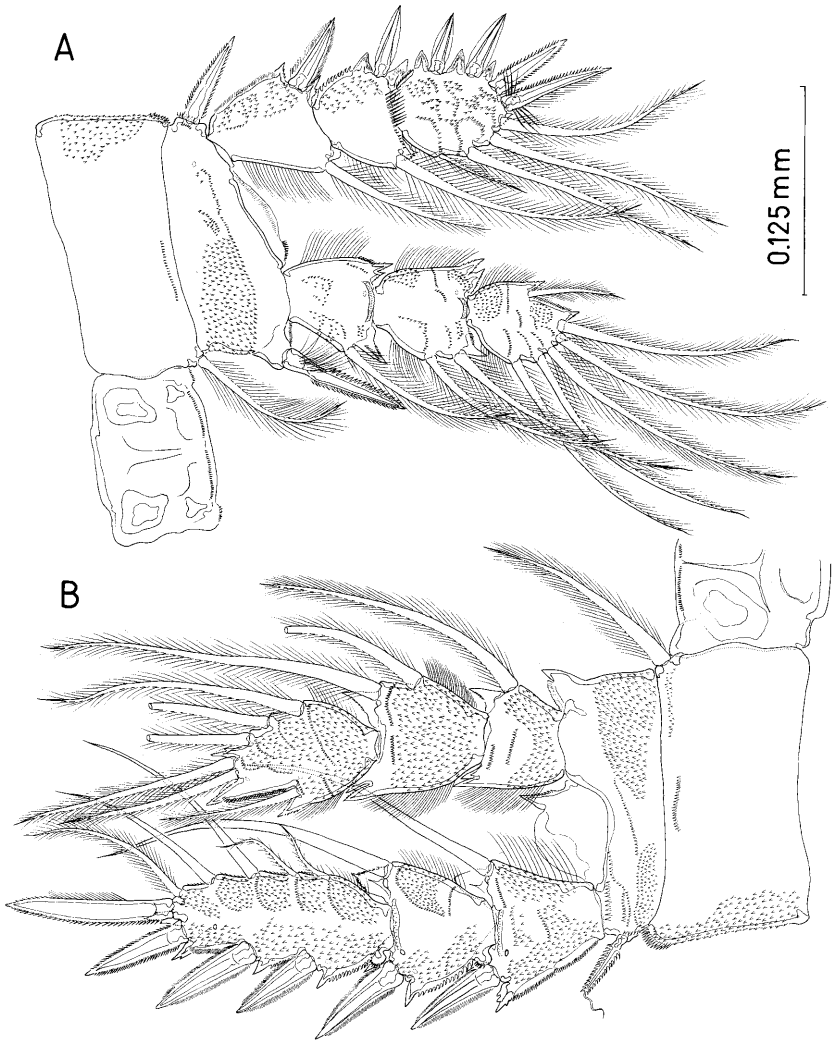

Fig. 6 *Misophriopsis australis* sp. nov., adult female. **A** First leg, posterior; **B** second leg, posterior

Adult male. Unknown.

Etymology. Specific name derived from the Latin '*Terra Australis*', one of the ancient denominations of its type locality, the Antarctic continent.

Variability. The female holotype displays a teratologic right antennule, where the ancestral segment VII – ordinarily incorporated completely into the compound (II–VI) to comprise the second segment of the antennule – is only partially incorporated. This antennule shows also the articulation between segments 8 and 9 (XVI and XVII) only partially expressed; both segments are completely separate in the ordinary condition.

Remarks. A new genus and species, *Misophriopsis dichotoma*, was established by Boxshall (1983) for a specimen collected SW of the Azores, 23–56 m off the bottom in a water depth of 3000 m. Later, Ohtsuka et al. (1992) amended the diagnosis of the genus, described a second species, *M. okinawensis*, from the shallow water hyperbenthos (170-m depth) off Okinawa (North Pacific) and transferred *Misophria sinensis* Boxshall, 1990 from shallow-water hyperbenthic habitats (5- to 15-m depth) off Hong Kong to the genus *Misophriopsis.* A fourth species, *M. longicauda* Humes, has recently been described from a deep-sea (2254-m depth) hydrothermal site in the north-eastern Pacific (Humes, 1999). *Misophriopsis* is also represented in the Mediterranean by as yet undescribed species inhabiting both littoral caves and the shallow-water hyperbenthos of the Balearic Islands and the South-east coast of the Iberian Peninsula (D. Jaume, personal observations). This wide distributional range of the genus is shown here to reach even as far as the waters around Antarctica.

Misophriopsis australis sp. nov. shows two character states that require the amendment of the diagnosis of the genus, viz. the retention of the intercoxal sclerite between the fifth legs, and the armature formula 5+3 for the maxillary allobasis. The absence of the intercoxal sclerite of the fifth legs in *Misophriopsis* was used by Ohtsuka et al. (1992) as one of the distinctive characters of the genus to distinguish it from the closely related *Stygomisophria* Ohtsuka, Huys, Boxshall and Itô, 1992. In the present paper it is shown that this character is not suitable to separate these genera.

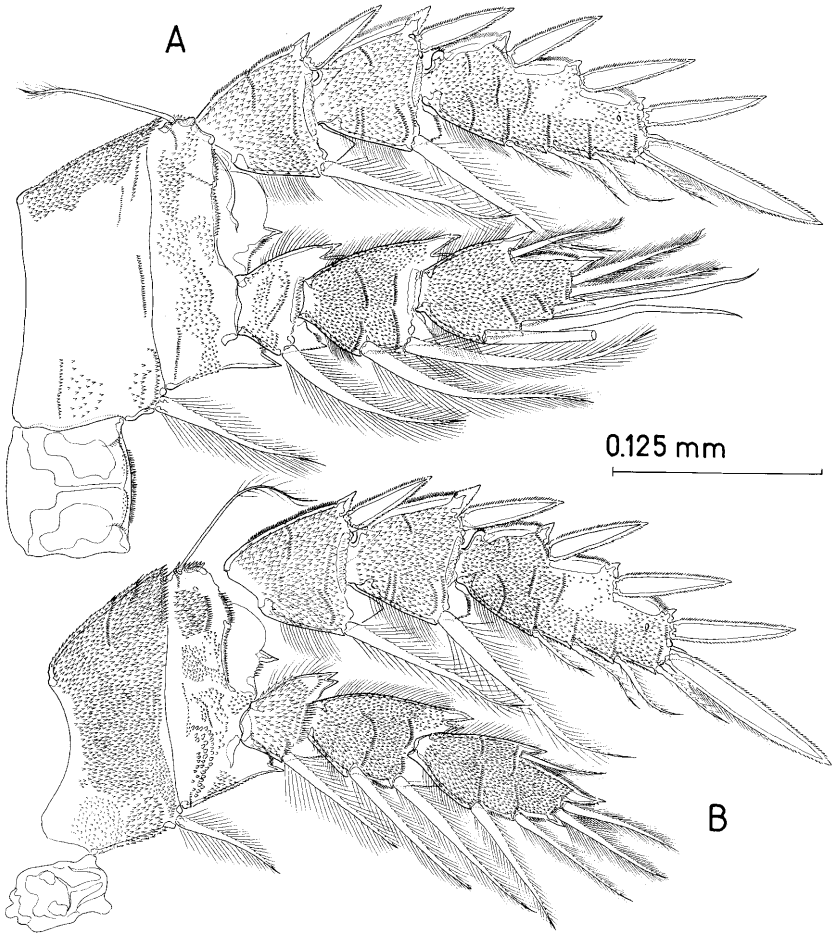

Fig. 7 *Misophriopsis australis* sp. nov., adult female. **A** Third leg, posterior; **B** fourth leg, posterior

Table 2 Diagnostic features for identification of *Misophriopsis* species. exp. 2=Exopod segment 2; exp. 3=exopod segment 3

	M. dichotoma	*M. okinawensis*	*M. sinensis*	*M. longicauda*	*M. australis*
Body length (mm)	0.90	0.73	0.33	1.86	0.79
Armature on antennulary segment 3	2 setae	2 setae	2 setae	Seta + spine	2 setae
Tuft of setules on mandibular gnathobase	Absent	Present	Absent	Absent	Present
Setae on maxillulary coxal epipodite	8	7	4	6	8
Inner setae on exp. 3 of leg 1	4	3	4	4	4
Outer armature of basis of leg 2	Seta	Spine	Seta	Seta	Spine
Inner setae on exp. 3 of leg 2	5	4	5	5	5
Inner setae on exp. 3 of leg 3	5	5	?	5	4
Inner setae of exp. 3 of leg 4	5	5	?	5	4
Leg 5 endopod incorporated into basis	No	Yes	Yes	No	No
Leg 5 (apical spine/exp. 2) length ratio	<1	<1	<1	<1	>1
Armature (setae + spines) of leg 6	1+2	1+2	1+0	1+2	1+2
Rami of furca	Subquadratic	Subquadratic	Subquadratic	Longer than wide	Subquadratic

The 5+3 condition for the armature of the maxillary allobasis was first noticed by Jaume and Boxshall (1996) in the misophrioids *Speleophria* Boxshall and Iliffe, 1986, and *Speleophriopsis* Jaume and Boxshall, 1996, and later by Jaume et al. (1998) in two additional misophrioid genera described by them, viz. *Huysia* and *Protospeleophria*. This armature is unusual, since the proposed ancestral copepod setation is 4, 4 for the basal endite and first endopodal segment of the maxilla (see Huys and Boxshall 1991). As suggested by Jaume and Boxshall (1996), this unusual 5+3 pattern could be the result of a migration of one of the endopodal elements to the basis or alternatively it could be derived from loss of one endopodal seta from an ancestral 5, 4 condition. The discovery of this allobasis armature pattern in the maxilla of *Misophriopsis australis* sp. nov. (but also in *M. okinawensis*; see Ohtsuka et al. 1992: Fig. 5b, despite a contradiction between figure and text) casts doubts on its real value for characterising, as indicated by Jaume et al. (1998), a cluster of very primitive gen-

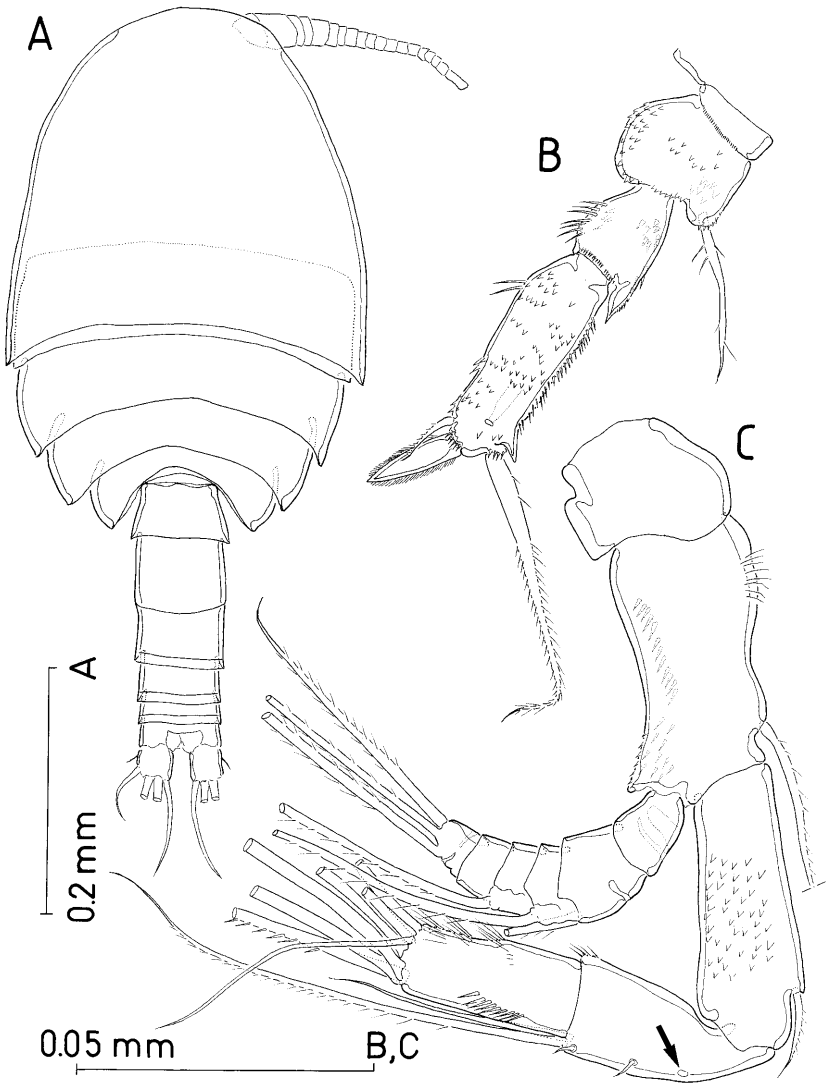

Fig. 8 *Misophriella schminkei* sp. nov., adult female. **A** Body, dorsal; **B** fifth leg, anterior; **C** antenna (*arrow* pointing to insertion of accidentally lost seta)

era inside the so-called *Archimisophria*-line (cf. Boxshall 1989). Nevertheless, in the *Speleophriopsis*/*Speleophria*/*Huysia*/*Protospeleophria* cluster, the three (endopodal) setae are grouped together on a distal (endopodal) endite, whereas in *Misophriopsis* this endite is not developed, and the three setae are located near the distal margin of the allobasis, two on its anterior and one on its posterior surface.

Apart from the retention of the intercoxal sclerite between the fifth legs, *Misophriopsis australis* sp. nov. can be distinguished from the other species of the genus according to the features listed in Table 2. The unevenness of detail in the descriptions available for the different species makes a detailed comparison between them almost impossible. Nevertheless, characters involving the ornamentation of the epicuticle of segments can be used to complement the differential diagnosis for particular taxa. Thus, it is noteworthy that the cluster of long spinules on the outer (=lateral) margin of the syncoxa of both the maxilla and the maxilliped of *M. okinawensis* (see Ohtsuka et al. 1992: Fig. 5a,c) is absent in *M. australis*, or that the same holds true for the patch of spinules on the sixth legs (Ohtsuka et al. 1992: Fig. 2c). Similarly, the position of the tube pore on the posterior surface of the distal exopod segment of the fifth leg in *M. australis* (located three-quarters of distance along the segment) differs from *M. dichotoma*, where such pore is located only one-quarter of distance along the segment (see Huys and Boxshall 1991: Fig. 2.3.11d).

Genus *Misophriella* Boxshall, 1983

Misophriella schminkei *sp. nov.*

Material examined. Holotype, adult female dissected and mounted on 12 slides (Coll. no. 1998.047/1–1998.047/12).

Comparative material examined. *Misophriella tetraspina* Boxshall, 1983, holotype (BMNH Reg. no. 1982.138).

Type locality. Ant V/3 station 10/528, Agassiz-Trawl from 22.10.86; 300-m depth; coordinates 72°28.0’S 17°23.5’W.

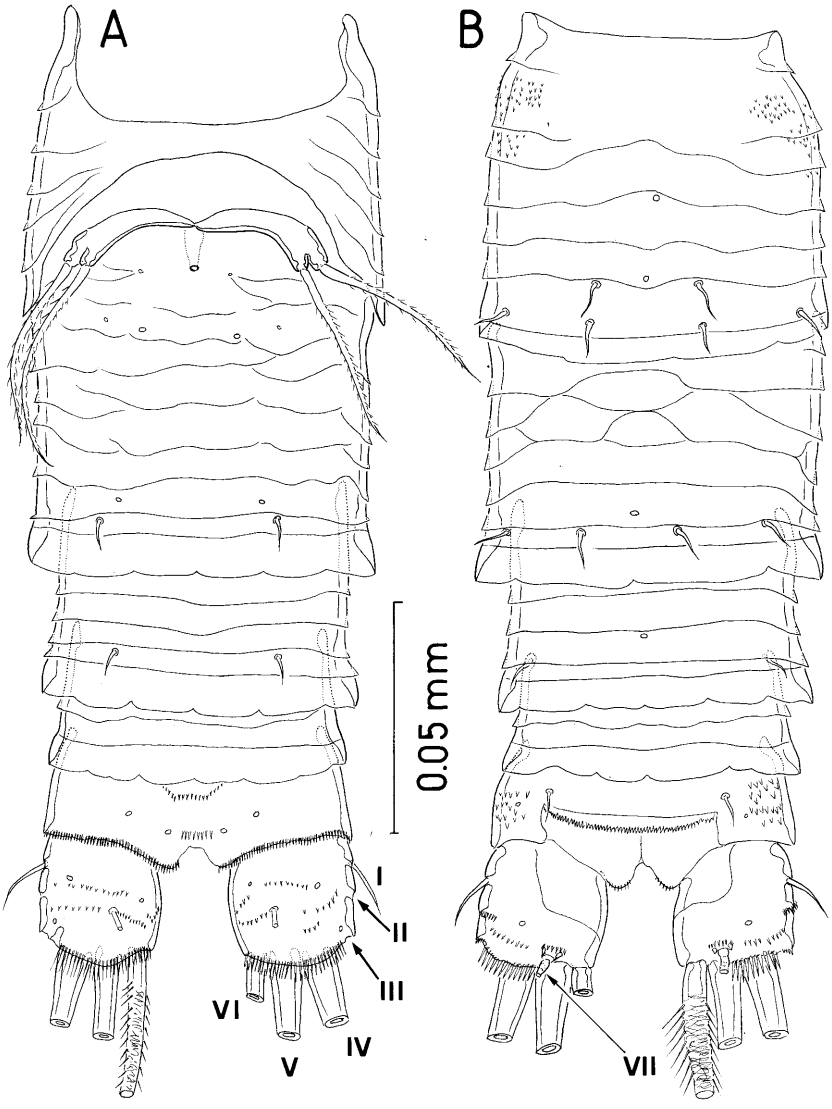

Fig. 9 *Misophriella schminkei* sp. nov., adult female. **A** Urosome with fifth pedigerous somite omitted, ventral; **B** same, dorsal. *Roman numerals* identify furcal setae

Description. Adult female. Body (Fig. 8A) subspherical, compact. Body length 610 µm. Naupliar eye absent. Prosome five-segmented, having first pedigerous somite not incorporated into cephalothorax but completely covered by posterior, carapace-like extension of dorsal cephalic shield. Rostrum (Fig. 10B) completely fused to cephalosome, triangular in anterior aspect, with one marginal sensilla at each side and central pore on anterior surface.

Urosome (Fig. 8A) five-segmented, with surface of both genital double-somite and abdominal somites covered with epicuticular hyaline ridges (see Fig. 9A,B). Genital and first abdominal segment partially fused to form genital double-somite retaining articulation dorsally about midway of somite; articulation fringed with hyaline frill belonging to posterodorsal margin of genital somite; patch of short spinules dorsolaterally at each side of genital somite. Pair of gonopores located ventrally at about two-fifths of distance along double-somite; each closed off by operculum derived from sixth legs; armature of latter consisting of two long setae implanted on discrete pedestals. Single copulatory pore located mid-ventrally. Internal structure of reproductive system unresolved. Integument of telson and furca adorned with heterogeneous array of short spinules. Anal operculum ornamented with finely serrated frill on posterior margin. Furca short, about as long as wide, armed with seven setae (see Fig. 9A,B); tube pore located mid-ventrally.

Antennules (Fig. 10A) short, 19-segmented, not reaching posterior margin of cephalosome. Segmentation and armature pattern as follows: segment 1 (corresponding to ancestral segment I), 1 seta; segment 2 (compound segment II–VI), 9 setae; segments 3 and 4 (VII and VIII), 2 setae each; segment 5 (IX–XII), 6 setae; segment 6 (XIII), 2 setae; segment 7 (XIV), 1 seta plus short spine; segment 8 (XV), 1 seta; segment 9 (XVI), 2 setae + aesthetasc; segment 10 (XVII), 1 seta; segment 11 (XVIII), 2 setae + aesthetasc; segments 12 and 13 (XIX and XX), 2 setae each; segment 14 (XXI), 2 setae + aesthetasc; segments 15 and 16 (XXII and XXIII), 1 seta each; segment 17 (XXIV), 1+1 setae; segment 18 (XXV), 1+1 setae plus aesthetasc; segment 19

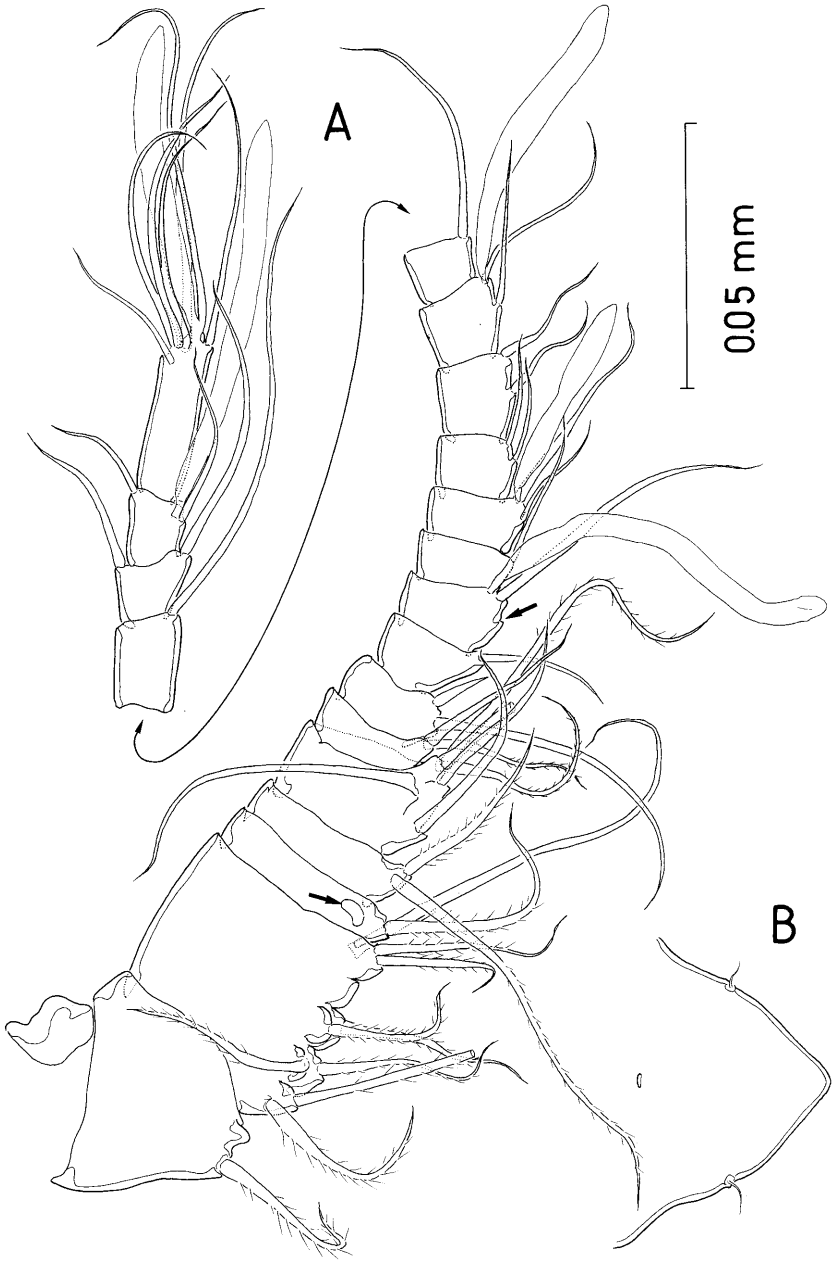

Fig. 10 *Misophriella schminkei* sp. nov., adult female. **A** Right antennule, medial (*arrows* pointing to insertion of accidentally lost setae on segments 3 and 9); **B** rostrum, anterior

(XXVI–XXVIII), 6 setae plus acrothek, consisting of aesthetasc and basally fused seta.

Antenna (Fig. 8C) biramous. Coxa discrete, unarmed. Basis with one seta subdistally on inner margin. Endopod three-segmented, setal formula 1, 2+3, 7; one of setae on third segment reduced; two setae on inner margin of second segment, plus one out of three distal setae of same segment, very reduced. Exopod indistinctly six-segmented, with setal formula 0, 1, 1, 1, 0, 3; partially expressed suture lines on first, second and distal segments. Antennal segments ornamented with heterogeneous array of short spinules and setules.

Mandibles with well-developed, elongate coxal gnathobase (Fig. 11 A); cutting blade with seven unequal, sharp teeth plus three dorsal-most slender spines; first and fifth ventral-most teeth both bicuspid. Palp (Fig. 11B) biramous, with elongate, unarmed basis. Endopod two-segmented, setal formula 1, 5. Exopod indistinctly four-segmented, setal formula 0, (1, 2 or 3, 2).

Maxillule (Fig. 12A) with discrete praecoxa. Praecoxal arthrite with eight stout spines plus one seta distally; two setae subdistally on medial margin and other two on anterior surface of arthrite. Coxal epipodite with six setae, three of them reduced; coxal endite with six setae distally. Basal endites each with four setae; distal endite largely incorporated into segment. Endopod unsegmented, elongate, with armature distributed in three groups of two, one, and five setae, respectively. Exopod unsegmented, about twice as long as wide, with six distal setae. Surface of maxillulary segments ornamented with spinules, denticles and setules as figured.

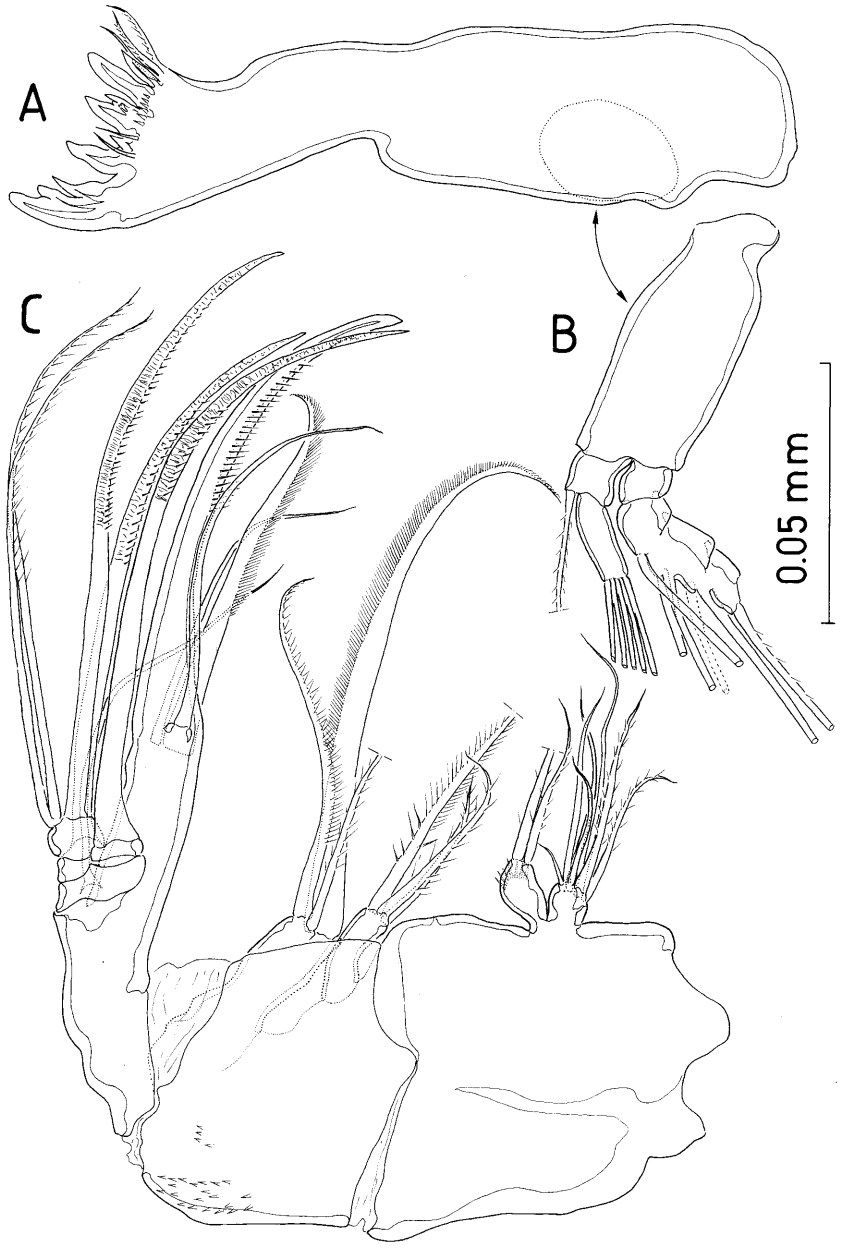

Fig. 11 *Misophriella schminkei* sp. nov., adult female. **A** Right mandibular coxal gnathobase; **B** right mandibular palp (dashed seta on exopod present only on left mandibular palp); **C** maxilla

Maxilla (Fig. 11C) six-segmented. Praecoxa and coxa separate; patch of short spinules on lateral margin of latter; endite formula 7, 2, 3, 3; one seta on distal coxal endite hypertrophied; distal praecoxal endite with transverse row of long spinules. Basal endite drawn out into stout, curved medial claw basally incorporated into segment; three setae (one of them hypertrophied) subdistally on endite. Endopod three-segmented, setal formula 1, 2, 3; seta on first segment smooth and reduced; pair of distal setae on segment 3 plumose and slender, fused basally; remaining endopodal setae claw-like, with internal tissue finely granulated.

Maxilliped (Fig. 12B) slender, comprising syncoxa, basis and five-segmented endopod. Syncoxa with coxal endites hardly developed, setal formula 1, 3, 2; seta corresponding to proximal endite short and robust. Basis as long as syncoxa, with three setae along medial margin. Surface of both syncoxa and basis adorned with short spinules as figured. Endopod setal formula 1, 2, 2, 1, 5.

Swimming legs (Figs. 13 and 14) each comprising coxa, basis, and three-segmented rami. Armature formula is shown in Table 3. Inner basal spine of first leg bearing three hypertrophied, filiform setules on outer margin; distal spine on third exopod segment with very long setules along inner margin. Inner distal angle of basis of second and third legs with sharp, pointed process. Outer distal angle of first endopod segment of third and fourth legs bifid, as that of second segment of legs 1 to 4. Surface of segments of each leg and corresponding intercoxal sclerites ornamented with heterogeneous array of setules, spinules and denticles, as figured.

Fifth legs (Fig. 8B) uniramous, joined by very narrow intercoxal sclerite. Legs four-segmented, comprising coxa,

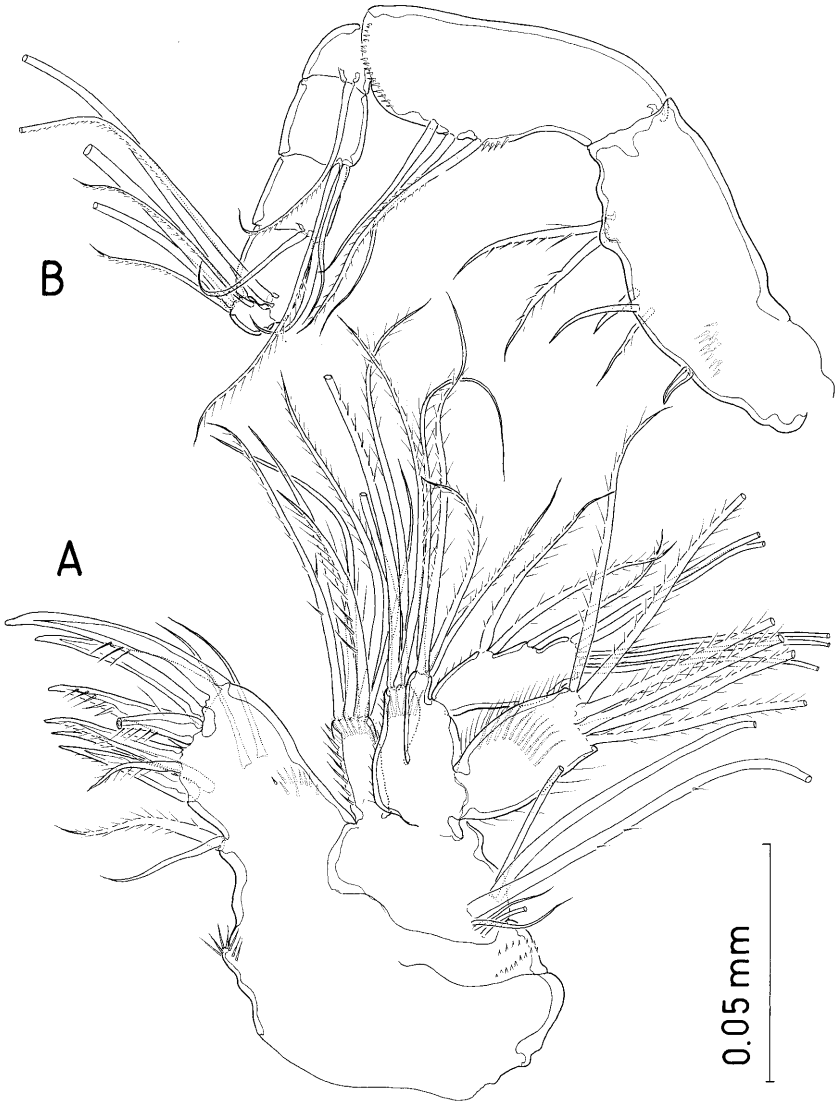

Fig. 12 *Misophriella schminkei* sp. nov., adult female. **A** Maxillule; **B** maxilliped

Table 3 Armature formula of *Misophriella schminkei* sp. nov., adult female

Leg	Coxa	Basis	Exopod segment			Endopod segment		
			1	2	3	1	2	3
1	0-1	I-I	I-1	I-1	III,I,4	0–1	0–2	1,2,3
2	0-1	1-0	I-1	I-1	III,I,3	0–1	0–2	1,2,3
3	0-1	1-0	I-1	I-1	III,I,4	0–1	0–2	1–2-3
4	0-1	1-0	I-1	I-1	III,I,4	0–1	0–2	1,2,2

basis, and two-segmented exopod. Integument of segments adorned with heterogeneous array of spinules and denticles. Coxa reduced, unarmed. Basis with single outer seta located posterodistally on pedestal. Proximal exopod segment unarmed, with outer distal margin produced into sharp, pointed process. Distal exopod segment elongate, about 3.6 times as long as wide, with armature comprising short and stout pinnate spine flanked with one seta at each side; relative lengths of spine and setae as figured. Outer distal angle of segment produced into pointed process. Ordinary pore opening subdistally on anterior surface of segment.

Adult male. Unknown.

Etymology. This species is dedicated to Prof. Dr. H. K. Schminke. We want to acknowledge in this way his enthusiastic dedication in promoting taxonomic and systematic research in Germany during the last decades.

Variability. The left antennule of the single specimen available is only 18-segmented due to an incomplete fusion of second and third segments. The mandibular exopod displays an armature arrangement which merits a

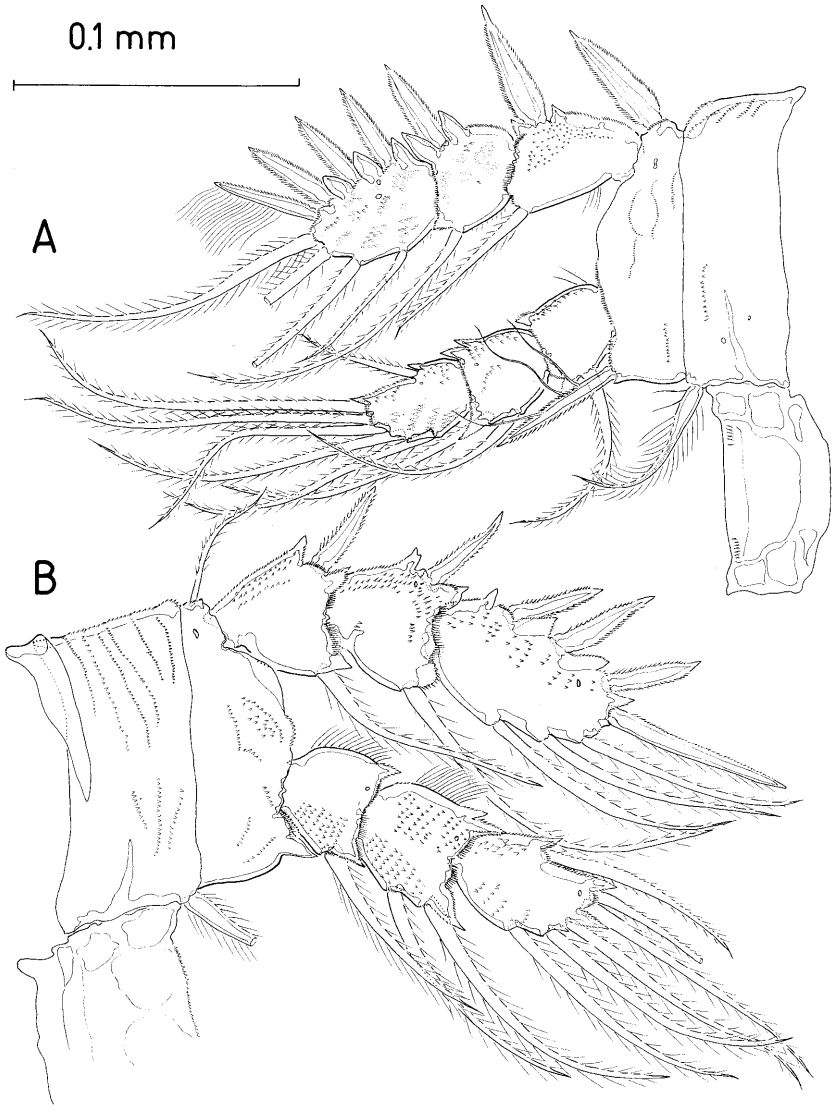

Fig. 13 *Misophriella schminkei* sp. nov., adult female. **A** First leg; **B** second leg

comment here. Whereas this branch is indistinctly four-segmented in both mandibles, the setal formula for the right mandible is 0, 1, 2, 2, but 0, 1, 3, 2 for the left one (see Fig. 11B). The former condition is compatible with Huys and Boxshall's (1991) proposal of a five-segmented condition with setal formula 1, 1, 1, 1, 2 for the ancestral copepod: it could result from the failure to express both the seta corresponding to the first ancestral segment and the articulation between ancestral segments III and IV. However, the presence of three setae on segment 3 of the left mandibular exopod is incompatible with Huys and Boxshall's (1991) proposal. This 0, 1, 3, 2 condition could be interpreted as a teratology, but, curiously, the same setal arrangement seems to be expressed in the single specimen of *M. tetraspina* Boxshall (see Boxshall 1983: Fig. 7a). This could be an indication that a six-segmented condition with setal formula 0, 1, 1, 1, 1, 2 could have been the ancestral condition for the exopod of the mandibular palp of the Copepoda (see Martínez Arbizu and Seifried 1996; Jaume and Boxshall 1997). The 0, 1, 3, 2 condition of *Misophriella* could have resulted from the failure to express the articulation between segments III and IV, and between IV and V of the ancestral copepod groundpattern.

Remarks. The monotypic genus *Misophriella* was erected for a single female misophriid collected 23 to 56 m off the bottom at about 3000-m depth in the North Atlantic (Boxshall 1983). The new taxon from the Antarctic can be included in this genus because of the retention of a 19-segmented antennule with compound segments 2 (II–VI), 5 (IX–XII), and 19 (XXVI–XXVIII) (a plesiomorphic character displayed otherwise only by *Arcticomisophria* and *Fosshageniella*), and because of the segmentation and armature of the fifth legs. The new species and *Misophriella tetraspina* Boxshall, 1983 are the only species of Misophriidae with no trace of the endopod on the fifth legs. Another important synapomorphic character of these species is the absence of setae on the mandibular basis. Both species are, together with *Misophriopsis*, the only ones that have no outer seta on the first exopodal segment of leg 5. *Misophriopsis* differs from them in lacking the articulation between the coxa and basis of this leg. Other di-

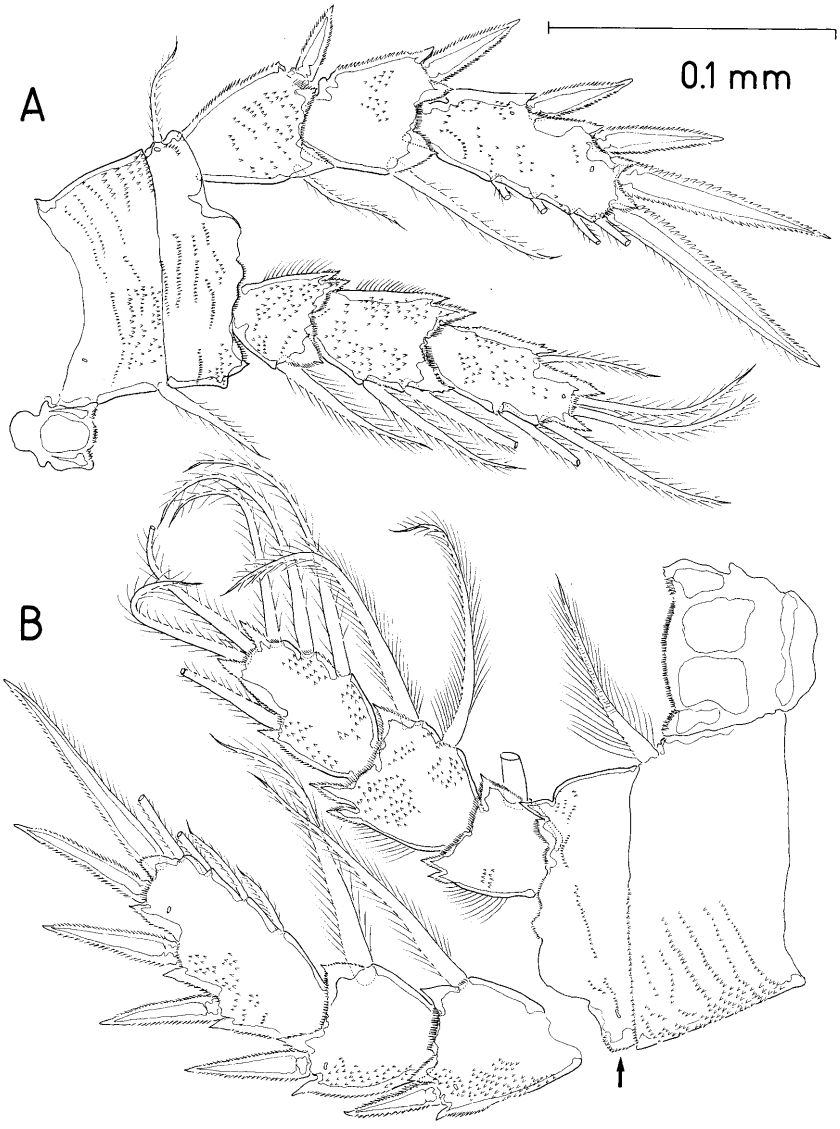

Fig. 14 *Misophriella schminkei* sp. nov., adult female. **A** Fourth leg; **B** third leg with disarticulated exopod (*arrow* pointing to insertion of accidentally lost outer basal seta)

agnostic derived characters of *Misophriella* are the presence of only one seta on both the antennary basis and the first endopodal segment, and the miniaturisation of the inner setae on the second antennary endopodal segment.

Misophriella tetraspina differs from *M. schminkei* sp. nov. in the spiniform condition of some setae on the first and second antennulary segments (to which the species name alludes), the homologous armature elements being normal setae in the Antarctic species. The distal exopodal segment of the fifth legs is considerably longer in the new species (three times longer than wide, compared with only 1.7 times longer than wide in *M. tetraspina*). The apical spine of this segment in *M. tetraspina* is smooth and slender, whereas in *M. schminkei* sp. nov. it is rather oblong and barbed. The inner seta in *M. tetraspina* is much longer than the apical spine, whereas in *M. schminkei* sp. nov. it is shorter. In contrast, in this species the outer seta is considerably longer than the apical spine (about 4 times longer), whereas it is less than twice as long as the apical spine in *M. tetraspina*.

The antennary exopod of *Misophriella schminkei* sp. nov. shows some suture lines on the first, second and apical segments. These suture lines indicate that the first segment is a triple segment, while the second and apical ones are double segments. The antennary exopod could therefore be derived from an ancestral ten-segmented exopod (which represents the groundpattern in Copepoda) displaying the following fusion pattern: (I–III), (IV–V), VI, VII, VIII, (IX–X).

In the single specimen of *M. schminkei* sp. nov., the gut contents consisted of parts of copepod limbs. In particular, a fifth leg belonging to a cyclopinid copepod (very common in the sample) was identified. This indicates that the species is carnivorous; it may be a predator or a scavenger.

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