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Description of a new species of *Microcanuella* Mielke, 1994 (Copepoda: Polyarthra: Canuellidae) from the Great Meteor Seamount plateau (subtropical NE Atlantic Ocean), with remarks on the geographical distribution of the genus

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Abstract

The species *Microcanuella secunda* sp. n. (Copepoda, Polyarthra, Canuellidae) is described from the plateau of the Great Meteor Seamount. It can be clearly identified as *Microcanuella* Mielke, due to the following generic autapomorphies: (1) Body size < 700 µm; (2) Reduced armature of P4 exp3 and enp3 with only 2 setae; (3) P1 enp3 with at most 4 elements and (4) P1 exp3 with at most 5 elements. As this is the second described species of *Microcanuella*, an extended generic diagnosis is provided. Furthermore, *M. secunda* sp. n. can be separated from *M. bisetosa* Mielke on the basis of the following apomorphic characters: (A) A1: 3rd segment with 3 long, rat-tailed setae; (B) A2 enp1 with 1 seta; (C) Mx1 basis without endites and with 6 setae.

M. bisetosa was found in the Pacific (Punta Morales, Costa Rica), *M. secunda* sp. n. and two closely related but undescribed species in the Atlantic Ocean (Great Meteor Seamount, Seine Seamount, Sedlo Seamount). All species are known from only one locality each, hence each one of them might be endemic. However, as the genus is widely distributed and present on different seamounts, it can be supposed that seamounts act as stepping stones within this genus.

Key words: Meiofauna; seamounts; taxonomy; biogeography

1. Introduction

Meiobenthic organisms are smaller than 1000 μm , stick to the sediment and neither have any planktonic life stages, nor a restricted reproduction and dispersal (Giere, 2009). However, the same meiobenthic species can be found world-wide (Gheerardyn and Veit-Köhler, 2009; Koller and George, 2011; Menzel, 2011; Menzel et al., 2011; Plum and George, 2009; Pointner et al., 2013). Many possible distribution mechanisms have already been discussed, like emergence (Armonies, 1988; Giere, 2009; Palmer, 1988; Thistle, 2003; Thistle and Sedlacek, 2004), erosion (Giere, 2009; Hicks, 1992; Palmer, 1988; Palmer and Gust, 1985) or rafting (Faust and Gullede, 1996; Giere, 2009; Hicks, 1988; Houle, 1999), as well as geological processes (Giere, 2009; Sterrer, 1973) and structures (Ax and Armonies, 1990; Menzel et al., 2011). However, this problem is still unresolved and has therefore been named the “Meiofauna Paradox” by Giere (2009).

Hubbs (1959) elaborated the hypothesis that seamounts could play a role in species distribution as stepping stone or as a trapping stone, capturing specimens. George and Schminke (2002) referred this hypothesis to meiobenthic organisms. Until now, the harpacticoid copepods have only been studied on a small number of seamounts (George, 2013), among which the Great Meteor Seamount (GMS) is one of the best-studied (George, 2004a, 2004b, 2006; George and Schminke, 2002; Koller and George, 2011; Plum and George, 2009). It can be seen as a trapping stone for Harpacticoida, as most of the species presumably are endemic (George and Schminke, 2002). Up to now, the new species *Microcanuella secunda* sp. n. has only been found on the GMS (March 2010, expedition P397 GroMet, German RV “Poseidon”; George, 2010), where it is very abundant. This supports the hypothesis of George and Schminke (2002) of a perhaps high

number of endemic species on the GMS plateau. Nevertheless, two closely related species have been identified on the Seine and the Sedlo Seamount (Büntzow, 2011). The geographical distribution of the taxon *Microcanuella* Mielke, 1994 is discussed in this paper.

Microcanuella secunda sp. n. belongs to the up to now monotypic taxon *Microcanuella*, which was established by Mielke (1994) based on the reduced setal armature of P1, P4 and P5. As two additional species have been identified, *Microcanuella* is no longer monotypic and the generic diagnosis is therefore extended on basis of the described species. This taxon is part of the Canuellidae Lang, 1944, which comprises 17 different genera¹ (Wells, 2007). Lang (1944) placed this family (together with Longipediidae Boeck, 1865) into the suborder Polyarthra Lang, 1944, which together with the Oligoarthra Lang, 1944, belongs to the Harpacticoida Sars, 1903. Recent studies (Dahms, 2004; Seifried and Schminke, 2003; Tiemann, 1984) give valid reasons for the exclusion of the Polyarthra from the Harpacticoida; hence the terms Harpacticoida and Oligoarthra can be seen as synonyms (Seifried and Schminke, 2003) and the Polyarthra might be a very basal group of the Copepoda (Por, 1984).

2. Materials and Methods

The type material was collected at the plateau of the GMS during the expedition P397 (GroMet; German RV “*Poseidon*” in 2010; George, 2010). The GMS is located at 30°00.0 N, 28°30.0 W, about 550 sea miles to the west of the Canary Islands (Fischer, 2005) and raises from a depth from 4,800 m up to 270 m below the sea surface (George and Schminke, 2002). Twenty-one stations, equally distributed over the plateau (Fig. 1), were sampled repeatedly and quantitatively with a uniform device, the Van Veen grab (0.1 m² surface).

¹ According to the World Register of Marine Species (WoRMS) the number is 18 genera (Walter, 2014), as the taxon *Indicanuella* is included as valid genus. However, as already noted by Bodin (1997), that genus was established by Becker (1972) in his doctoral thesis, that cannot be regarded as a publication ((ICZN Art. 9, § 11). Thus, *Indicanuella* is not valid and has therefore been retained as *species incertae sedis* in *Canuella* T. and A. Scott, 1893 by Wells (2007). I agree with that argumentation and therefore adopt Wells’ (2007) assignment.

Sample treatment is described in Pointner et al. (2013), but instead of 5 % buffered formalin as fixation 96% undenatured ethanol was used. The samples were determined to major level with a Leica MZ 12.5 stereomicroscope. Copepoda were separated from the samples, counted, mounted on slides with a glycerin-water solution (1:1) and identified on family-level. All other animals remained in the samples.

All identified Canuellidae were determined to species level based on Huys et al. (1996), Wells (2007) and original species descriptions, with a Leica DMR microscope. The general terminology follows Huys et al. (1996).

In total, 361 specimens of *Microcanuella secunda* sp. n. have been collected from the plateau of the GMS (Tab.1). Eight of these were used as type specimens. One female and one male were mounted in glycerin on slides and drawn from the dorsal and lateral view (400 x magnifications) and a detailed drawing of the male P6 (2000 x magnification) was made. Six specimens (four females and two males) of these were dissected in order to illustrate the A1, mouthparts, swimming legs, female genital complex and caudal rami (2000 x magnification). All drawings were made with the aid of a Leica DM 2500 microscope. All specimens are stored in the collection of the Senckenberg Forschungsinstitut und Naturmuseum Frankfurt am Main (SMF), Germany. Besides these eight specimens, ten more specimens were chosen randomly for body length measurements. The body length of *Microcanuella secunda* sp. n. was measured laterally from the tip of the rostrum to the end of the caudal rami.

The map of the plateau of the GMS was created after a Hydrosweep survey (George and Schminke, 2002), the distribution map with the software PanMap version 0.9.6 (Diepenbroeck et al., 2000; NGDC/NOAA, 1993; IOC et al., 1994). The drawings were digitalized with the help of the graphic tablet Wacom Bamboo 3rd generation and the software Adobe Photoshop CS6.

Abbreviations used in this text: A1: antennule, A2: antenna, aes: aesthetasc, cphth: cephalothorax, CR: caudal rami, enp: endopod, exp: exopod, GMS: Great Meteor Seamount, md: mandible, mx: maxilla, mxl: maxillule, mxp: maxilliped, P1–P6: pereopods 1–6.

3. Results

Polyarthra Lang, 1944

Canuellidae Lang, 1944

Microcanuella Mielke, 1994

Type species: *Microcanuella bisetosa* Mielke, 1994

Other species: *Microcanuella secunda* sp. n.

Generic diagnosis: Body vermiform, comparatively small, at most 700 µm, whole body covered with small, round depressions. Rostrum well developed, as long as half of the length of the cphth and not fused to cphth. P1 bearing somite fused to cephalosome to form a cphth. Second and third female urosomites fused to form genital double somite with clear lateral cuticular ridge. Distal margin of genital somite and of following 2 urosomites with row of long setules. Anal operculum small, with fine setules. CR of conical shape, 3–4 times longer than wide, maximum of 7 setae present. Female A1 5-segmented, 6-segmented in male, only weakly modified, haplocer. Third segment of both female and male A1 with 2 aes. Exp of A2 arising from basal socle, 6- or 7-segmented. Each segment of exp with 1 seta except last one that bears 3 apical setae. Enp of A2 3-segmented, 7 setae at distal segment. Md with strong gnathobase, enp of mandibular palp 2-segmented, exp 2- or 3-segmented. Coxal arthrite of mxl with 9 elements, coxal endite with 3 elements, exp 1-segmented with up to 8 setae, enp 2-segmented with a maximum of 11 setae. Mx with 1 long and slender seta arising from the basis close to the enp. All

rami of P1–P4 3-segmented, seta and spine armor reduced: P1 enp3 with at most 4 elements, P1 exp3 with at most 5 elements and P4 bearing only 2 setae on distal segments of exp and enp. P5 small, consists of 3 setae. Male P6 single triangular plate with 1 seta and 2 slightly crossing, short elements on inner corner. Sexual dimorphism in A1, P5 and P6.

3.1. *Microcanuella secunda* sp. n.

Type locality: Plateau of the Great Meteor Seamount, subtropical north-eastern Atlantic Ocean (30°00.0 N, 28°30.0 W), sediment type: biogenic carbonate sediment, water depth: 284–339 m below sea surface.

Type material: Samples from several stations collected with the Van Veen grab during RV “*Poseidon*” cruise P397 (GroMet expedition, March 2010). For detailed information see figure 1 and table 1. All examined specimens are registered and deposited in the collection of Senckenberg Forschungsinstitut und Naturmuseum Frankfurt, Germany.

Holotype: female from station #104-5 (29°52.977 N, 28°27.960 W, depth 300 m), not dissected, 1 slide, coll. no. SMF 37069/1. Allotype: male from station #91-7 (30°04.987 N, 28°37.983 W, depth 311 m) not dissected, 1 slide, coll. no. SMF 37070/1. Paratype 1: female from station #92-5 (30°05.062 N, 28°33.994 W, depth 301 m), dissected, mounted on 8 slides, coll. nos. SMF 37071/1–8. Paratype 2: female from station #105-2 (29°52.985 N, 28°23.999 W, depth 315 m), dissected, mounted on 5 slides, coll. nos. SMF 37072/1–5. Paratype 3: male from station #92-6 (30°05.067 N, 28°33.991 W, depth 301 m), dissected, mounted on 2 slides, coll. nos. SMF 37073/1–2. Paratype 4: male from station #92-6 (30°05.067 N, 28°33.991 W, depth 301 m), dissected, mounted on 1 slide, coll. no. SMF 37074/1. Paratype 5: female from station #95-2 (30°01.051 N, 28°31.952 W, depth 301 m), dissected, mounted on 4 slides, coll. nos. SMF

37075/1–4. Paratype 6: female from station #92-6 (30°05.067 N, 28°33.991 W, depth 301 m), dissected, mounted on 7 slides, coll. nos. SMF 37076/1–7.

Furthermore, 353 specimens, collected from different stations (Tab. 1) on the plateau of GMS, were not included into the type material.

Etymology: The species described here is called *Microcanuella secunda* sp. n., as it is the second described species of the taxon *Microcanuella*.

3.1.1. Description of the female holotype

Habitus (Figs. 2A, B). Cylindrical and vermiform, completely covered with small round depressions, exemplarily shown in frame (Fig. 2A); body length 365–445 μm (average: 391 μm , 10 individuals measured from tip of rostrum to end of CR); rostrum (Fig. 2B) not fused to cphth, well developed, tongue-like elongated, reaching beyond third segment of A1 (Fig. 3A) and 35–45 μm long (average: 40 μm , 10 individuals measured). P1 bearing segment fused to form a cephalothorax, row of minute spinules at posterior margin of the cephalothorax. Pores and sensilla present in low numbers on whole body. Genital double somite fused but with clear lateral cuticular ridge. Caudal margin of genital somite and of the following 2 urosomites with row of long setules. Telson very short, with row of spinules at the insertion points of the CR. Anal operculum rounded (Fig. 2A) with row of minute spinules.

CR (Fig. 2B) of conical shape, 3 times longer than maximum width, measured laterally; several setules along inner margin (Fig. 2A), difficult to detect. Setation as in male, description see male part.

A1 (Figs. 3A, B) five-segmented. First segment bare, 2nd segment the smallest, 3rd segment with 2 aesthetascs and 18 setae, 3 of which long and rat-tailed, and 4 of which long and

multipinnate, 4th segment with 3 bare setae, 5th segment with 16 setae, 1 of which long and multipinnate on posterior side. Setal formula: I-0; II-3; III-18 + 2 aes; IV-3; V-16.

A2 (Fig. 4). Basis with short row of small spinules. Enp 3-segmented (Fig. 4A). First segment with plumose seta at distal third of the segment. Second segment with 4 plumose setae, 3 of which posterior, 2 long, 1 short, and 1 apical, long and plumose. Third segment with 7 apical setae, 5 plumose and slender, 2 bare and short, and 2 rows of spinules, 1 minute at apical, posterior margin and 1 row of stout and long spinules at outer margin. Exp (Figs. 4B, C) 7-segmented, arising from a socle (arrow in Fig. 4B). First segment with 1 plumose seta, segments 2–6 with one long, slender and bare seta each, segment 7 with 3 apical, long, slender and bare setae.

Md (Fig. 5D) Gnathobase with 6 teeth, 1 with barbed hook, and 1 with three peaks, *lacinia mobilis* stout. Three spinules at dorsal corner. Three minute spinules on the margin to the basis. Basis with 2 plumose setae at inner margin. Enp 2-segmented, proximal segment with 2 slender and plumose setae and 1 row of spinules, distal segment with 6 long setae, 2 of which plumose, 4 bare. Exp 2-segmented, but distal segment indistinctly divided. Proximal segment with 1 long and slender seta at inner margin, proximal part of distal segment with 2 long, slender and plumose setae, distal part of same segment with 3 long, slender and plumose setae, outer one broken in figure 5D.

Mxl (Fig. 5A) Precoxa and coxa fused; proximal arthrite with 1 row of spinules and 9 marginal elements and 1 fine seta on the inner margin. Coxal endite with 3 marginal elements. Basis with 1 row of setules on posterior side and 6 setae on inner margin, 2 of which long and slender (1 of which bare and 1 plumose) and 4 shorter setae (2 bare and 2 plumose). Enp 2-segmented, proximal segment with 3 setae, all long and slender (1 of which plumose); distal segment with 5 long and slender setae (1 of which plumose and the seta at the outer corner stout,

plumose). Exp 1-segmented with a row of setules on anterior side and a hook at the outer margin; with 7 setae, 2 bare, 4 plumose and 1 unfortunately broken in figure 5A.

Mx (Fig. 5B). Praecoxa with 2 endites; proximal endite with 1 plumose and 4 bare setae, 1 of which minute and 2 longer; distal endite with 2 plumose setae. Row of spinules on outer margin of praecoxa and minute spinules on inner proximal margin. Coxa with 2 endites; proximal endite with 2 plumose and 1 bare setae, distal endite with 2 setae, 1 of which short and plumose, 1 longer and spiny pinnate. Basis with 1 pinnate claw and 3 setae, 2 bare and 1 pinnate with 2 long pinnules; additionally with 1 long bare seta, arising from the basis close to the enp. Enp probably divided, border not clearly visible, with altogether 9 setae, 7 of which distally arising (3 long and plumose, 4 long and bare, 1 short and bare; 1 long and bare seta inserting proximally).

Mxp (Fig. 5C). Syncoxa and basis fused, bearing altogether 9 setae, all spiny plumose; surface with 4 rows of spinules: 1 at proximal end, 1 at inner margin and 2 at outer margin. Enp 1-segmented, with 8 spiny plumose setae.

P1–P4 (Figs. 6A, B; 7A, B) Each ramus 3-segmented. Setal formula (Tab. 2) given according to Sewell (1949).

P1 (Fig. 6A) Coxa with inner plumose spine. Row of long spinules at outer margin, another row of smaller spinules at distal margin of the coxa. Ridge on anterior side. Basis with 1 short, outer seta and 1 longer, robust seta at the inner margin. Slender setules at inner margin. Exp projecting beyond enp2. Exp1 with 1 outer, plumose spine and row of spinules at outer margin. Exp2 with 1 outer plumose spine and 1 inner, bare seta, row of setules on outer and 3 setules at inner margin. Exp3 with 3 lateral spines, 2 plumose and 1 bare, 1 distal, uniplumose seta and 1 inner, plumose seta, 3 setules at inner margin. Enp1–2 with long, flexible and plumose seta at inner margin and row of setules at outer and inner margin. Enp3 with 2 outer bare spines, 1 distal

uniplumose seta and 1 inner plumose seta. Two setules on outer, 3 on inner margin. Intercoxal sclerite attached to coxa: distal end on anterior side of coxa, proximal end on posterior side.

P2–P4 (Figs. 6B; 7A, B) Coxa P2–P4 with surface structure on anterior side. Coxa P2 and P3 with 1 row of setules at outer margin, 1 row of smaller setules on distal margin of anterior side and 1 row of longer setules, getting smaller to lateral margins, on the distal margin of posterior side. Coxa P3 with 1 additional row of spinules on outer margin on posterior side. Coxa P4 with 2 rows of stout spinules, 1 row of smaller and very fine spinules and 2 setules on anterior side, 1 row of setules on posterior side on distal margin. Basis P2–P4 with 1 outer seta, slender and bare. Posterior side of basis P2–P4 distally thorn-like prolonged. Basis P4 with 1 row of very small setules on distal margin. Exp P2–P3 with outer, plumose spine on exp1 and exp2 and outer distal corner prolonged distally. Exp3 with 2 outer spines, both bare in P2, outer one bare and inner one uniplumose in P3, 1 distal seta, uniplumose in P2 and biplumose in P3, and 1 inner, smaller and bare seta. Exp1–3 P2–3 with row of setules on outer margin, exp1 with additional row on distal margin, exp2–3 with row of setules on inner margin. Exp2–3 P3 with pore in apical part of the segments. Enp P2–P3 with inner, plumose seta at enp1 and enp2 and outer margin prolonged distally up to the distal margin of the next segment. Enp3 with 2 outer spines, 1 distal seta and 1 inner seta. All these setae plumose in enp3 P3, outer and inner setae of enp3 P2 bare, rest plumose. Distal margin of exp3 and enp3 of P2–P3 with thorn-like process, stronger developed in enps, as long as one third of the distal seta.

Exp P4 with outer, plumose spine on exp1 and exp2. Exp3 with 2 distal plumose setae. Exp1 with 2 spinules on proximal part, 1 row of setules at outer margin, smaller setules around outer seta and 1 row of tiny spinules on distal edge of inner margin. Exp2–3 with setules around outer setae and 3 setules on inner margin. Exp3 with pore on posterior side. Enp1 P4 with inner plumose seta, enp2 without inner seta, enp3 with 2 distal, plumose setae, outer one shorter. Small

row of spinules on inner, anterior margin of enp1–3, on enp3 also on distal, posterior side. Outer margin of exp2 and enp2 with thorn-like process. Distal margin of exp3 and enp3 with thorn-like process, not as strong developed as in enp3 P2–P3.

Tip of longest apical seta (both of exp P3) of each ramus P1–P4 resemble barbed hook. Intercoxal sclerite of P2–P4 exemplarily shown in figure 7B.

P5 (Fig. 2C) Consisting of 3 setae, outer one the longest, outer 2 setae plumose, inner one bare. Between left and right P5 row of long and slender setules.

P6 and genital complex (Fig. 2C) P6 represented by 1 small seta. Between the 2 genital pores row of spinules.

3.1.2. *Description of the male allotype*

Habitus (Figs. 8A, B) and most of the features as in female. Sexual dimorphism observed in the body length, antennule, P5, P6.

Body length 326–448 μm (average: 371 μm , 10 individuals measured from tip of rostrum to end of CR).

CR (Fig. 9C) of conical shape, proximal end twice as wide as distal end, 3 times longer than maximum width, measured laterally. Distal margin with tube-pore and thorn-like, pinnate process (Fig. 9C, arrow). Some hyaline setules (Fig. 9C) on inner margin of CR. Setation of CR as in female; CR with 7 setae: setae I and II close together at the middle of inner margin, I small and bare, II longer than seta I and plumose; setae III–VII inserting distally, III long and bare, IV shorter than seta III, plumose and distal part rat-tailed, seta V long, bare and flexible, seta VI long, slender, bare, seta VII very short, plumose.

A1 (Fig. 9A, B) six-segmented. First segment bare, 2nd segment smallest with 2 setae, 3rd segment with 2 aesthetascs and 17 setae, 2 of which long and bare, 2 multipinnate, 4th segment

with 3 setae, 5th segment with 1 plumose seta and 1 spine, 6th segment with deep indentation and 6 setae. Setal formula: I-0; II-2; III-17 + 2 aes; IV-3; V-1; VI-6.

P5 (Fig. 8C) as in female, but setae not plumose.

P6 (Fig. 8D). One single triangular plate with 1 apical seta, long, slender and plumose. In inner corner 2 slightly crossing, short elements. Anterior surface of P6 with 2 rows of spinules, on apical margin 1 row of long spinules.

3.2. Remarks on species of *Microcanuella* and their geographical distribution

During the study of the Seine and Sedlo Seamounts (Atlantic Ocean), Büntzow (2011) identified two more species of *Microcanuella* (Fig. 10); unfortunately they are still undescribed. Up to now, the species *Microcanuella* sp.1 has only been reported from the plateau of the highest pinnacle of the Sedlo Seamount (consisting of 3 pinnacles and rising from 2800 m depth up to 750 m below sea surface). One specimen was collected at station 705 (40°19.0 N, 26°40.0 W; depth: 773 m; sampling gear: multicorer; Büntzow, 2011). *Microcanuella* sp.2 has only been collected from the Seine Seamount (of conical shape and raising from 4000 m up to 170 m below sea surface; Büntzow, 2011). Five specimens were collected on the plateau of this seamount (two specimens detected at station 755; 33°48.0 N, 14°22.0 W; depth: 235 m; sampling gear: multicorer; one specimen at station 759; 33°46.0 N, 14°21.9 W; depth: 178 m; sampling gear: giant box corer; two specimens at station 760; 33°46.2 N, 14°22.9 W; depth: 180 m; sampling gear: giant box corer; Büntzow, 2011). *M. bisetosa* has been recorded only in the littoral of the island Punta Morales, Gulf of Nicoya, Costa Rica (Mielke, 1992; Mielke, 1994; Morales-Ramírez, 2001) and *M. secunda* sp. n. only from the plateau of the GMS (Fig. 1, Fig. 10).

M. sp.1 and *M. sp.2* are very similar to *M. bisetosa* and *M. secunda* sp. n. (Pointner pers. obs.), so the differences between these four species are listed here. They differ in their body size.

M. sp.1 measures 657 μm (only one specimen available), *M. bisetosa* 580 μm (data based on the original description), *M. sp.2* 566 μm (average; five female specimens measured) and *M. secunda* sp. n. 391 μm (average; ten female specimens measured). *M. sp.1* as well as *M. bisetosa* bear 3 setae at the distal segment of enp P2 and P3, whereas *M. sp.2* and *M. secunda* sp. n. bear 4 setae. Furthermore, differences between *M. sp.2* and *M. secunda* sp. n. can be detected in the md and the mx. In *M. sp.2*, the basis of the md is without any seta (*M. secunda* sp. n. bears 2 setae) and the exp is 3-segmented, which is not clearly visible in *M. secunda* sp. n.. The proximal endite of the mx of *M. sp.2* bears 2 setae, the distal one 3 setae. In *M. secunda* sp. n., however, the proximal endite bears 3 setae and the distal one 2. The exp of A2 of these four species arises from a basal socle, but in *M. sp.1*, *M. sp.2* and *M. secunda* sp. n. the exp is 7-segmented, whereas in *M. bisetosa* it is 6-segmented.

4. Discussion

4.1. Systematics

The taxon Polyarthra Lang, 1944 can be considered as a monophylum, supported by many apomorphic characters (Dahms, 2004; Seifried, 2003). Nevertheless, the placement of the Polyarthra within the Harpacticoida is still being discussed; arguments supporting a monophyletic status of the Harpacticoida have been presented (Huys and Boxshall, 1991; Willen, 2000) as well as reasons for declining this hypothesis (Dahms, 2004; Seifried and Schminke, 2003; Tiemann, 1984). The present contribution follows the argumentation of Dahms (2004).

The apomorphic characters listed in the following part are based on the principle of oligomerization (Huys and Boxshall, 1991). Although most of these characters refer to a setal reduction, these are important apomorphies (Seifried and Schminke, 2003). Furthermore, the

plesiomorphic conditions are based on the groundpattern of Polyarthra (Seifried, 2003) and of Copepoda (Huys and Boxshall, 1991).

4.1.1. Placement of *Microcanuella* within the Canuellidae

Including the new species *Microcanuella secunda* sp. n., the Canuellidae contains 59 species, classified into 17 genera (Wells, 2007). The phylogeny within the Canuellidae is far from being clear, but the taxon *Microcanuella* can clearly be characterized as monophylum based on the following features [plesiomorphic characters in square brackets]:

Character 1: Body size < 700 μm [body size \geq 700 μm]

Character 2: Reduced armature of P4 exp3 with only 2 setae [exp P4 with at least 3 setae]

Character 3: Reduced armature of P4 enp3 with only 2 setae [enp P4 with at least 3 setae]

During the comparison of *Microcanuella* with all other taxa of the Canuellidae, two more autapomorphies were detected:

Character 4: P1 enp3 with at most 4 elements [at least 5 elements]

Character 5: P1 exp3 with at most 5 elements [at least 6 elements]

Character 1: Mielke (1994) characterized the taxon *Microcanuella* by the size of < 1000 μm . Such small species can also be found within other taxa of the Canuellidae (e.g. the male of *Brianola hamondi* Wells and Rao, 1987: 637 μm ; *Galapacanuella beckeri* Mielke, 1979: 720 μm ; *Nathaniella reichi* (Por, 1964): 970 μm), while species larger than 1000 μm are also present (e.g. *Sunaristes inaequalis* Humes and Ho, 1969: 2160 μm). Representatives of *Microcanuella*

are minute compared to these latter species and body size is an important character of this taxon. Hence, the upper size limit is set to $< 700 \mu\text{m}$, and therefore it is considered as an autapomorphy for *Microcanuella*. The male of *B. hamondi* ($637 \mu\text{m}$) is the only other Canuellidae smaller than $700 \mu\text{m}$. As all autapomorphies of *Microcanuella* do not fit to the taxon *Brianola*, the reduction of the body size may have evolved convergently.

Characters 2 + 3: In *M. bisetosa*, *M. secunda* sp. n., *M. sp.1* and *M. sp.2*, the P4 is armed with 2 setae at the exp3 and enp3. *M. secunda* sp. n., *M. sp.1* and *M. sp.2*, bear an additional triangular cuticular extension distally. These characters have not been observed in any other taxon of the Canuellidae so far. The most similar setal ornamentation bears *Ellucana* Sewell, 1940 (P4 exp3 and enp2 with 3 distal setae each, but enp 2-segmented), whereas taxa like e.g. *Galapacanuella* Mielke, 1979 and *Canuellina* Gurney, 1927 (both taxa: P4 exp3 with 4 distal setae, enp3 with 3 distal setae) bear a more plesiomorphic state of P4. Thus, apomorphies 2 and 3 are the most derived in Canuellidae and therefore considered as autapomorphies for *Microcanuella*.

Character 4: All species of *Microcanuella* have at most 4 elements on P1 enp3, whereas the plesiomorphic condition can be found in nearly all other taxa of Canuellidae. *Galapacanuella beckeri*, *Brianola stebleri* (Monard, 1926) and *Scottolana bulbosa* (Por, 1964) also bear 4 elements at P1 enp3, but these species do not match with the other autapomorphies of *Microcanuella* and each species is characterized by its corresponding generic autapomorphies (*Brianola*: e.g. 9 setae at the 1-segmented enp of the mxp; *Scottolana*: e.g. mx1 coxa with at most 2 setae; *Galapacanuella*: e.g. mx enp1 bare). This reduction is also detectable in other, congeneric species but not in the groundpattern of the corresponding genera and therefore it is regarded as an autapomorphy for *Microcanuella*.

Character 5: The setation of P1 exp3 is reduced from 9 to 5 elements in all species of *Microcanuella*. This reduction also occurs in certain species of *Brianola* and in *Ifanella chacei* Vervoort, 1964. *I. chacei* is characterized e.g. by the apomorphic absence of the proximal praecoxal endite of the mx. Due to the corresponding apomorphies, these taxa cannot be merged into one group. Hence, character 5 is considered as an autapomorphy for *Microcanuella*.

4.1.2. Placement of *Microcanuella secunda* sp. n. within the taxon *Microcanuella* and differentiation of *M. bisetosa*

Because of characters 1–5 *Microcanuella secunda* sp. n. can easily be classified within *Microcanuella*, which until now only included the type species *M. bisetosa*. *M. secunda* sp. n. is supported by the following autapomorphies [plesiomorphic conditions in square brackets]:

Character 6: Female A1: 3rd segment with 3 long, rat-tailed setae [3rd segment without rat-tailed setae]

Character 7: A2 enp1 with 1 seta [A2 enp1 with 2 setae]

Character 8: A2 enp2 with 4 seta [A2 enp2 with 5 setae]

Character 9: Gnathobase with 6 teeth [gnathobase with 9 teeth]

Character 10: Gnathobase without seta [gnathobase with 1 seta]

Character 11: Md enp1 with 2 setae [md enp1 with 3 setae]

Character 12: Md enp2 with 6 setae [md enp2 with 8 setae]

Character 13: Mx1 arthrite elements “tooth”-like [mx1 arthrite elements spines]

Character 14: Mx1 coxa epipodite bare [mx1 coxa epipodite with 3 setae]

Character 15: Mx1 basis without endites [mx1 basis with 2 endites]

Character 16: Mx1 basis with 6 setae [mx1 basis with 8 setae]

Character 17: Mx: distal endite of coxa with 2 setae [distal endite of coxa with 3 setae]

Character 18: Tip of longest apical seta of each rami of P1–P4 like barbed hook [tip pointed]

Character 6: The 3rd segment of the female A1 of *M. secunda* sp. n. bears 3 long, rat-tailed setae, whereas in *M. bisetosa*, only long and slender setae are present (some bare and some plumose). This derived feature (Willen, 1996) has not been observed or described in any other species of the Canuellidae so far.

Character 7: A2 enp1 of *M. secunda* sp. n. bears only 1 distal (plumose) seta. In *M. bisetosa*, this segment is armed with 2 setae, one of which on the surface and the other one in the middle of the anterior edge. This reduction is regarded as an apomorphy of *M. secunda* sp. n., but as this character is also present in certain other species of Canuellidae, it must have evolved convergently.

Character 8: A2 enp2 of *M. secunda* sp. n. bears 4 apical setae; while in *M. bisetosa* it bears 5 setae. In the groundpattern of the Polyarthra the 2nd segment bears 5 setae and this reduction is interpreted as an apomorphy of *M. secunda* sp. n.

Characters 9 + 10: The gnathobase of *M. secunda* sp. n. bears 6 teeth and no seta, whereas in *M. bisetosa* it is armed with 8 teeth and 1 seta on the outer edge. In the plesiomorphic groundpattern of the ancestral copepod the outer edge of the gnathobase bears 2 setae. Hence, in *M. secunda* sp. n. these characters are the most reduced ones and are interpreted as apomorphies.

Characters 11 + 12: The md enp1 of *M. secunda* sp. n. is armed with 2 plumose setae, while *M. bisetosa* bears 3 setae (1 long, slender and plumose, and the other 2 long, thin and bare). The enp2 of *M. secunda* sp. n. bears 6 setae (2 plumose and 4 bare setae). *M. bisetosa*, there are 8 setae (all are of different size, plumose). Compared to all other species of the Canuellidae with

the same segmentation of the md enp, the setation of *M. secunda* sp. n. is one of the most reduced ones. Many other species of Canuellidae show a more plesiomorphic setation than *M. secunda* sp. n. (e.g. *Scottolana dissimilis* Fiers, 1982 (md enp1 with 3, enp2 with 9 setae)), while *Echinosunaristes bathyalis* Huys, 1995 bears 1 seta at enp1 and 4 setae at enp2. The same setation as in *M. secunda* sp. n. can only be observed in *Ifanella chacei*, which is clearly distinct from the taxon *Microcanuella* (because in *I. chacei* all elements of P2 enp2 are reduced, whereas in *Microcanuella* one inner element is still present). The reduction at the md enp is an apomorphy of *M. secunda* sp. n., but has evolved several times within Canuellidae.

Character 13: The elements of the mx1 arthrite seem to be “tooth”-like (small with rounded tip) in *M. secunda* sp. n, and more like spines in *M. bisetosa*. It is more probable that the spine-like elements became thicker and the tip rounder than that the spine-like elements got reduced and replaced by tooth-like elements. Therefore, this character is interpreted as an apomorphy for *M. secunda* sp. n.. This feature has not been observed in any other species of Canuellidae, but might have been overlooked as it is difficult to discern.

Character 14: The mx1 coxa does not have an epipodite in *M. secunda* sp. n., while it is present in *M. bisetosa* bearing 3 plumose setae. The groundpattern of the Polyarthra supposes 5 setae at the epipodite, so this feature is reduced in *M. bisetosa*, and even more reduced in *M. secunda* sp. n.. While in the Canuellidae there are also other species without epipodite (e.g. *Ifanella chacei*), the comparatively plesiomorphic characteristic of 3 setae on the epipodite is present in most species of the Canuellidae.

Character 15 + 16: In *M. bisetosa*, the mx1 basis bears 2 endites, each with 4 setae; hence 8 setae in total are present. These are the plesiomorphic conditions, as they are also indicated in the groundpattern of the Polyarthra. In *M. secunda* sp. n., these characters are more reduced. The endites are merged with the basis, and also 1 seta of each former endite is lost, so the basis is

armed with only 6 setae. However, the fusion of the basal endites with the basis seems to have evolved convergently, as several species of different genera within Canuellidae bear the same reduction of the endites (e.g. *Brianola vangoethemi* Fiers, 1982 and *Scottolana antillensis* Fiers, 1984). Nevertheless, the mxI basis of *M. secunda* sp. n. is the most reduced one in the Canuellidae known so far, as no other species shows the fusion of the endites with the basis and the additional reduction of setae. Thus, these two characters are apomorphies of *M. secunda* sp. n..

Character 17: The distal endite of the mx coxa is armed with 2 setae in *M. secunda* sp. n., whereas *M. bisetosa* bears 3 setae, as in the groundpattern of the Polyarthra. The reduction to two setae must have occurred several times, as also other species of Canuellidae show this reduction (e.g. *Brianola vangoethemi*) as well as the taxon *Canuellina*. However, this group can be separated from *Microcanuella* because of the CR, where setae I and II are placed more distally than in *Microcanuella* and the male A1 (chirocer in *Canuellina* and haplocer in *Microcanuella*). Furthermore, all mentioned autapomorphies of *Microcanuella* do not fit to *Canuellina*. Thus, the setal reduction of the distal endite of the mx coxa is an apomorphy for *M. secunda* sp. n., and this feature must have evolved convergently within Canuellidae.

Character 18: The tip of several setae of each exp3 and enp3 P1–P4 of *M. secunda* sp. n. resembles a barbed hook (Figs. 6, 7). The tips of the homologous setae in *M. bisetosa* are of normal pointed shape, as in all remaining Canuellidae. As this character has been reported for the first time within this species, it seems to be an autapomorphy of *M. secunda* sp. n.. However, first comparisons with *M. sp.1* and *M. sp.2* reveal, that the “barbed-hook” tips are also present in these species. This character cannot be dedicated as an autapomorphy, as it might have been overlooked within other species of Canuellidae. But it can support the determination of *M. secunda* sp. n. and *M. bisetosa*.

M. bisetosa is also characterized by certain apomorphic characters [plesiomorphic conditions in square brackets]:

Character 19: P3 enp3 with 3 elements [P3 enp3 with 4 elements]

Character 20: A2 exp 6-segmented [A2 exp 7-segmented]

Character 19: The P3 enp3 of *M. bisetosa* bears 3 elements, while in *M. secunda* sp. n., however, it bears 4 elements. In the groundpattern of the Polyarthra 6 setae are present at this segment. Therefore, the setation of *M. secunda* sp. n. is already reduced, while in *M. bisetosa* it is the most derived one presenting an autapomorphic character of *M. bisetosa*.

Character 20: The A2 exp is 6-segmented in *M. bisetosa*, whereas the one of *M. secunda* sp. n. is 7-segmented. The groundpattern of the Polyarthra shows an 8-segmented exp A2. Compared to this pattern, the segmentation of the A2 exp of *M. bisetosa* is the most reduced one. Thus, this character is an autapomorphy of *M. bisetosa*.

4.1.3. Remarks on the A2 exp, P5 and male P6

Mielke (1979) realized that the A2 exp arises from a basal protrusion (named “socle” by Mielke (1979) and “pedestal” by Mu and Huys (2004)), but also mentioned that this feature can be easily overlooked or misinterpreted. With an increasing number of described species of Canuellidae, it becomes obvious that this character is present in most species, either mentioned in the description or shown in the drawings. The groundpattern of all copepods (Huys and Boxshall, 1991) reveals a 10-segmented exp, with 1 seta at each segment except the distal one, which is armed with 3 setae. As the basal socle in most species bears 1 seta, it might be reasonable to assume that the socle in fact represents the first segment of the exp fused with the basis. *Scottolana geei* Mu and

Huys, 2004 bears a 9-segmented exp with an additional socle. This is the least derived exp within the Polyarthra and constitutes the groundpattern of that taxon (instead of an 8-segmented A2 exp as postulated by Seifried (2003)). The exp consists of less segments in other species, e.g. *Echinosunaristes bathyalis* with an 8-segmented exp with socle, *M. secunda* sp. n. with a 7-segmented exp with socle, 6-segmented exp with socle are also present (e.g. *Microcanuella bisetosa*, *Scottolana oleosa* Wells and Rao, 1987). Not only the basal socle is an indicator for the fusion of segments but also the setation of A2 exp points to a fusion of exopodal segments. In the Canuellidae, there are species with 4 distal setae (e.g. *Echinosunaristes bathyalis*, *Galapacanuella beckeri*; possibly due to fusion of last 2 segments), or even 5 distal setae (*Ellucana longicauda* (Sewell, 1940); possibly due to fusion of more than last 2 segments). The same fact appears within the basal socle, e.g. *Scottolana longipes* (Thompson and A. Scott, 1903) and *S. oleosa* bear 2 setae at the socle, suggesting a fusion of the first 2 segments. The segmentation and setation of the exp A2 is, however, very variable within the Canuellidae. Hence, during a revision of the Canuellidae special focus should be set on this structure, as it might help to clarify the phylogeny of the Canuellidae.

Mielke (1994) stated that the reduced P5 with 3 setae is also present in *Sunaristes inaequalis*, *Canuella indica* Krishnaswamy, 1957 and *Galapacanuella beckeri*. The P5 of *G. beckeri* and *M. bisetosa* is identical, whereas the P5 of *S. inaequalis* is highly variable within the species (left P5 of 1 specimen with 3 setae and with 5 setae on the right leg). The P5 of *C. indica* is described as “represented by 3 short setae” without any drawing, so unfortunately it is not possible to make any further comparisons. However, in *Microcanuella*, *M. bisetosa* and *M. secunda* sp. n. have the same P5 without any variation: 3 setae, outer one longest, with a row of setules between the legs. As this P5 can also be found in *G. beckeri*, this character is not

considered as autapomorphic for *Microcanuella*, but as a valuable and important feature for identification.

The male P6 of *M. secunda* sp. n. bears on the inner corner of each plate 2 slightly crossing, short elements, named petasma by Por (1984). Unfortunately, the male of *M. bisetosa* is not known, hence no comparisons within *Microcanuella* are possible. Other taxa like e.g. *Scottolana*, *Brianola* and *Canuella* or *Galapacanuella* all bear a petasma of different shape, so this structure might help clarifying relationships within the Canuellidae (Por, 1984).

4.1.4. Related taxa of *Microcanuella*

Although *Microcanuella* can be easily identified on the basis of certain apomorphies (characters 1–5), there are some attributes that are also present in other taxa. As Mielke (1994) already mentioned, *Galapacanuella* is very similar to *Microcanuella*, but they do not share any synapomorphies. Although characters 4 and 5 have convergently evolved in *Galapacanuella* (for discussion of characters 4 and 5 see 4.1.1), the apomorphies of *Galapacanuella* (e.g. A2 enp2 with 2 setae; mx enp1 bare) do not fit to *Microcanuella*, and therefore these species cannot be merged into one group. Nevertheless, they are very similar in the following attributes: small body size, identical P5 (consisting of 3 setae), similar male A1 (haplocer), P1 enp3 (4 elements). Further, also the taxa *Brianola* and *Canuellina* share attributes with *Microcanuella*: P4 exp2 (with only 1 outer element), P3 exp3 (with 4 elements). However, there are also characters which are plesiomorphic in *Microcanuella* and *Galapacanuella* compared to *Brianola* and *Canuellina* (mx enp and basis bear together at most 12 setae in *Microcanuella* and *Galapacanuella* and at most 11 setae in *Brianola* and *Canuellina*). Furthermore, there are also attributes, which are plesiomorphic in *Galapacanuella* (e.g. 2-segmented mx enp and 11 setae at the mxl exp) and apomorphic in *Microcanuella*, *Brianola* and *Canuellina* (e.g. mx enp 1-segmented) or in

Microcanuella and *Brianola* (e.g. mx1 exp with at most 8 setae). Obviously, it is very difficult to identify the most closely related taxa within the Canuellidae. Due to the above mentioned attributes, *Galapacanuella*, *Brianola* and *Canuellina* seem to be closely related to *Microcanuella*.

Nevertheless, a complete revision of the Canuellidae, not only based on morphological but also on genetic data, is necessary in order to clarify the phylogenetic relationships between all 17 genera.

4.2. Geographical distribution of *Microcanuella*

Microcanuella secunda sp. n. has been collected from all over the plateau of the GMS. In the north (locations #1–#6) 140 specimens were detected, in the middle (locations #7–#14) 99 and in the south (locations #15–#21) 122 specimens (Tab.1; only at location #7 (Fig. 1) no specimens of *M. secunda* sp. n. have been detected so far, but only 1 sample has been analyzed so far). Hence, the species is very abundant on the plateau of the GMS. *M. secunda* sp. n. is not the only species, which is widely spread across the whole plateau. *Zosime annea* Koller and George, 2011, for example, is distributed all over the plateau as well (Koller and George, 2011). Koller and George (2011) defined this species as eurybathic, as it is also known from the slope and rise of the GMS. *M. secunda* sp. n. has only been identified on the plateau of the GMS, in depths ranging from 287 m (station 100-7) to 339 m (station 105-1). The related species *M. bisetosa* and *M. sp.2* are known from shallow areas (*M. bisetosa*: beach, *M. sp.2*: 178 – 235 m), whereas the species *M. sp.1* is only known from the bathyal (*M. sp.1*: 773 m). Therefore, the taxon *Microcanuella* seems to be eurybathic. The fact that most of the species of *Microcanuella* have not been collected from deeper areas yet, does not indicate that their habitat is only restricted to shallow waters.

Until today, the taxon *Microcanuella* is only known from coarse and biogenic carbonate sediment (Büntzow, 2011; Hesemann, 2013; Mielke, 1992; Plum and George, 2009); supporting

the assumption that the species of these taxa favor this type of sediment. But species of *Brianola* have already been detected in the deep sea (muddy sediment; Büntzow, 2011). Hence, different taxa of Canuellidae prefer different types of sediment. More samples have to be analyzed to gain more knowledge about the habitat of *Microcanuella*.

Each *Microcanuella* species has been reported from single localities only (*M. secunda* sp. n.: GMS; *M. bisetosa*: Punta Morales, Costa Rica; *M. sp.1*: Sedlo Seamount; *M. sp.2*: Seine Seamount), which might point towards a restrictive distribution of these species (or even to local endemism). This somewhat speculative assumption may, however, be supported by the fact that other harpacticoid species (e.g. some Paramesochridae Lang, 1944) actually do occur on different seamounts and islands including the GMS (e.g. *Apodopsyllus aberrans* Mielke, 1984 identified on the GMS, Seine Seamount and Madeira; Packmor et al., 2015). In contrast, it must be stated that at least at species level, there is no indication yet for seamounts acting as stepping stones for the investigated species of Canuellidae. Nevertheless, at the generic level such conclusion can clearly be made. The monophylum *Microcanuella* has a wide distribution range from the Pacific coast to the subtropical north-eastern Atlantic Ocean (Fig. 10), and three of the four findings are reported from Atlantic seamounts. Thus, seamounts play an important role for the distribution of the monophylum *Microcanuella*.

Further investigations on Canuellidae of additional seamounts, coastal habitats and the surrounding deep sea might clarify if this role extends even to the species level and if it may apply also to other canuellid taxa.

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References

- Armonies, W., 1988. Active emergence of meiofauna from intertidal sediment. *Marine Ecology Progress Series*, 43, 151–159. <http://dx.doi.org/10.3354/meps043151>
- Ax, P., Armonies W., 1990. Brackish water Plathelminthes from Alaska as evidence for the existence of a boreal brackish water community with circumpolar distribution. *Microfauna Marina*, 6, 7–110.
- Becker, K. H., 1972. Eidonomie und Taxonomie abyssaler Harpacticoidea (Crustacea, Copepoda). Doctoral thesis, Christian-Albrechts-Universität, Kiel, Germany.
- Bodin, P., 1997. Catalogue of the new marine Harpacticoid Copepods. *Documents de travail de l'Institut royal des Sciences naturelles de Belgique* 89, 1–304.
- Boeck, A., 1865. Oversigt over de ved Norges Hyster iagttagne Copepoder henhørende til Calanidernes, Cyclopidernes og Harpacticidernes Familier. *Forhandlinger i Videnskabselskabet i Kristiania*, 1864, 1–57.
- Büntzow, M., 2011. Vergleichende gemeinschaftsanalytische und taxonomische Untersuchungen der Harpacticoidenfauna der Seeberge „Sedlo“ und „Seine“ (nördlicher Mittelatlantik). Doctoral thesis, Carl-von-Ossietzky-Universität, Oldenburg, Germany.
- Dahms, H.U., 2004. Exclusion of the Polyarthra from the Harpacticoida and its reallocation as an underived branch of the Copepoda (Arthropoda, Crustacea). *Invertebrate Zoology*, 1 (1), 29–51.

Diepenbroek, M., Grobe, H., Sieger, R., 2000. PanMap. Available from:

<http://www.pangaea.de/Software/PanMap> (accessed 15.09.2014)

Faust, M.A., Gullledge, R.A., 1996. Associations of microalgae and meiofauna in floating detritus at a mangrove island, Twin Cays, Belize. *Journal of Experimental Marine Biology and Ecology*, 197, 159–175. [http://dx.doi.org/10.1016/0022-0981\(95\)00159-x](http://dx.doi.org/10.1016/0022-0981(95)00159-x)

Fiers, F., 1982. New Canuellidae from the northern coast of Papua New Guinea (Copepoda: Harpacticoida). *Bulletin del'Institut Royal des Sciences Naturelles de Belgique: Biologie*, 54, 1–32.

Fiers, F., 1984. Harpacticoid copepods from the West Indian Islands: Canuellidae and Longipediidae (Copepoda, Harpacticoida). *Bijdragen tot de Dierkunde*, 54, 197–210.

Fischer, L., 2005. Der Einfluss der Großen Meteorbank auf die Ernährungsbiologie und Verteilung dominanter Calanoida (Crustacea, Copepoda). *Berichte zur Polarforschung und Meeresforschung*, 499.

George, K.H., 2004a. Description of two new species of *Bodinia*, a new genus incertae sedis in Argestidae Por, 1986 (Copepoda, Harpacticoida), with reflections on argestid colonization of the Great Meteor Seamount plateau. *Organisms, Diversity & Evolution*, 4, 241–264. <http://dx.doi.org/10.1016/j.ode.2004.02.003>

George, K.H., 2004b. *Meteorina magnifica* gen. et sp. nov., a new Idyanthidae (Copepoda, Harpacticoida) from the plateau of the Great Meteor Seamount (Eastern North Atlantic). *Meiofauna Marina*, 13, 95–112.

George, K.H., 2006. New Ancorabolidae Sars, 1909 (Copepoda, Harpacticoida, Ancorabolidae) of the Atlantic Ocean. Description of *Pseudechinopsyllus sindemarkae* gen. et sp. nov. and *Dorsiceratus ursulae* sp. nov. from the Great Meteor Seamount, and

redescription of *D. octocornis* Drzycimski, 1967, and *D. triaticulatus* Coull, 1973.

Meiofauna Marina, 15, 123–156.

George, K.H., 2010. Abschlussbericht. Available from:

[http://www.geomar.de/zentrum/einrichtungen/wasser/f-s-poseidon/fahrtberichte-
poseidon-reisen-2010/#c7858](http://www.geomar.de/zentrum/einrichtungen/wasser/f-s-poseidon/fahrtberichte-poseidon-reisen-2010/#c7858) (accessed 20.11.2014)

George K.H., 2013. Faunistic research on metazoan meiofauna from seamounts – a review.

Meiofauna Marina, 20, 1–32.

George, K.H., Schminke, H.K., 2002. Harpacticoida (Crustacea, Copepoda) of the Great Meteor

Seamount, with first conclusions as to the origin of the plateau fauna. *Marine Biology*,
144, 887–895. <http://dx.doi.org/10.1007/s00227-002-0878-6>

Gheerardyn, H., Veit-Köhler, G., 2009. Diversity and large-scale biogeography of

Paramesochridae (Copepoda, Harpacticoida) in South Atlantic abyssal plains and the deep
Southern Ocean. *Deep-Sea Research I*, 56, 1804–1815.
<http://dx.doi.org/10.1016/j.dsr.2009.05.002>

Giere, O., 2009. *Meiobenthology: The microscopic motile fauna of aquatic sediments*. 2nd ed.

Springer, Berlin. <http://dx.doi.org/10.5860/choice.46-5018>

Gurney, R., 1927. *Zoological Results of the Cambridge Expedition to the Suez Canal, 1924*.

XXXIII. Report on the Crustacea:– Copepoda (littoral and semi–parasitic). *Transactions
of the Zoological Society of London*, 22, 451–577.

<http://dx.doi.org/10.1111/j.1096-3642.1927.tb00207.x>

Hesemann, F., 2013. *Genese der bioklastischen Sedimente der Großen Meteorbank*

(Atlantik). Bachelor thesis, University of Bremen, 1–49.

Hicks, G.R.F., 1988. Sediment rafting: a novel mechanism for the small-scale dispersal of

intertidal estuarine meiofauna. *Marine Ecology Progress Series*, 48, 69–80.

<http://dx.doi.org/10.3354/meps048069>

Hicks, G.R.F., 1992. Tidal and diel fluctuations in abundance of meiobenthic copepods on an intertidal estuarine sandbank. *Marine Ecology Progress Series*, 87, 15–21.

<http://dx.doi.org/10.3354/meps087015>

Houle, A., 1999. The origin of platyrrhines: an evaluation of the Antarctic scenario and the floating island model. *American Journal of Physical Anthropology*, 109, 541–559.

[http://dx.doi.org/10.1002/\(sici\)1096-8644\(199908\)109:4<541::aid-ajpa9>3.0.co;2-n](http://dx.doi.org/10.1002/(sici)1096-8644(199908)109:4<541::aid-ajpa9>3.0.co;2-n)

Hubbs, C.L., 1959. Initial discoveries of fish faunas on seamounts and offshore banks in the eastern Pacific. *Pacific Science*, 13, 311–316.

Humes, A.G., Ho, J.S., 1969. The genus *Sunaristes* (Copepoda, Harpacticoida) associated with hermit crabs in the western Indian Ocean. *Crustaceana*, 17, 1–18.

<http://dx.doi.org/10.1163/156854069x00015>

Huys, R., 1995. A new genus of Canuellidae (Copepoda, Harpacticoida) associated with Atlantic bathyal sea-urchins. *Zoologica Scripta*, 24, 225–243.

<http://dx.doi.org/10.1111/j.1463-6409.1995.tb00401.x>

Huys, R., Boxshall, G. A., 1991. *Copepod Evolution*. The Ray Society, London.

<http://dx.doi.org/10.1163/193724092x00193>

Huys, R., Gee, J. M., Moore, C. G., Hamond, R., 1996. Marine and brackish water harpacticoid copepods. Part 1. *Synopses of the British Fauna (New Series)*, 51, 1–352.

IOC, IHO, BODC, 1994. *GEBCO Digital Atlas*, published on behalf of the Intergovernmental Oceanographic Commission (of UNESCO) and the International Hydrographic Organization as part of the General Bathymetric Chart of the Oceans (GEBCO); British Oceanographic Data Center, Birkenhead.

- Koller, S., George, K.H., 2011. Description of a new species of *Zosime* Boeck, 1872 (Copepoda, Harpacticoida, Zosimeidae) from the Great Meteor Seamount, representing one of the few eurybathic Harpacticoida among the distinct plateau and deep-sea assemblages. *Meiofauna Marina*, 19, 109–126.
- Krishnaswamy, S., 1957. Studies on the Copepoda of Madras. University of Madras.
- Lang, K., 1944. Monographie der Harpacticiden (vorläufige Mitteilungen). Almqvist and Wiksells boktryckeri AB, Uppsala, Sweden.
- Menzel, L., 2011. First descriptions of copepodid stages, sexual dimorphism and intraspecific variability of *Mesocletodes* Sars, 1909 (Copepoda, Harpacticoida, Argestidae), including the description of a new species with broad abyssal distribution. *ZooKeys*, 96, 39–80. <http://dx.doi.org/10.3897/zookeys.96.1496>
- Menzel, L., George, K.H., Martínez Arbizu, P., 2011. Submarine ridges do not prevent large-scale dispersal of abyssal fauna: A case study of *Mesocletodes* (Crustacea, Copepoda, Harpacticoida). *Deep-Sea Research I*, 58 (8), 839–864. <http://dx.doi.org/10.1016/j.dsr.2011.05.008>
- Mielke, W., 1979. Interstitielle Fauna von Galapagos. XXV. Longipediidae, Canuellidae, Ectinosomatidae (Harpacticoida). *Mikrofauna des Meeresbodens*, 77, 1–106.
- Mielke, W., 1984. Einige Paramesochridae (Copepoda) von Panama. *Spixiana*, 7 (3), 217–243.
- Mielke, W., 1992. Six representatives of the Tetragonicipitidae (Copepoda) from Costa Rica. *Microfauna Marina*, 7, 101–146.
- Mielke, W., 1994. *Microcanuella bisetosa* gen. n., sp. n., a new taxon of Canuellidae (Crustacea, Copepoda) from the Costa Rican Pacific coast, with remarks on *Galapacanuella beckeri*. *Bijdragen tot de Dierkunde*, 64 (1), 55–64.

- Monard, A., 1926. Note sur la faune des harpactoides marins de Cette. *Archives de Zoologie Expérimentale et Générale*, 65, 39–54.
- Morales-Ramírez, A., 2001. Biodiversidad marina de Costa Rica, los microcrustáceos: Subclase Copepoda (Crustacea: Maxillopoda). *Revista de Biología Tropical*, 49 (2), 115–133.
- Mu, F.H., Huys, R., 2004. Canuellidae (Coepoda, Harpacticoida) from the Bohai Sea, China. *Journal of Natural History*, 38, 1–36. <http://dx.doi.org/10.1080/00222930210138935>
- NGDC/NOAA, 1993. Global Relief Data on CD-ROM, World Data Center for Marine Geology & Geophysics, Boulder, courtesy Defense Mapping Agency. Available from: <http://www.ngdc.noaa.gov/mgg/fliers/93mgg01.html> (accessed date 24.11.2014)
- Packmor, J., Müller, F., George, K.H., 2015. Oceanic islands and seamounts as staging posts for Copepoda Haracticoida (Crustacea) – Shallow-water Paramesochridae Lang, 1944 from the North-East Atlantic Ocean, including the (re-) description of three species and one subspecies from the Maderidan Archipelago. *Progress in Oceanography*, 131, 59–81. <http://dx.doi.org/10.1016/j.pocean.2014.11.012>
- Palmer, M.A., 1988. Dispersal of marine meiofauna: a review and conceptual model explaining passive transport and active emergence with implications for recruitment. *Marine Ecology Progress Series*, 48 (1), 81–91. <http://dx.doi.org/10.3354/meps048081>
- Palmer, M.A., Gust, G., 1985. Dispersal of meiofauna in a turbulent tidal creek. *Journal of Marine Research*, 43 (1), 179–210. <http://dx.doi.org/10.1357/002224085788437280>
- Plum, C., George K.H., 2009. The paramesochrid fauna of the Great Meteor Seamount (Northeast Atlantic) including the description of a new species of *Scottopsyllus* (*Intermedopsyllus*) Kunz (Copepoda, Harpacticoida, Paramesochridae). *Marine Biodiversity*, 39 (4), 265–289. <http://dx.doi.org/10.1007/s12526-009-0022-7>

- Pointner, K., Kihara, T.C., Glatzel, T., Veit-Köhler, G., 2013. Two new closely related deep-sea species of Paramesochridae (Copepoda, Harpacticoida) with extremely differing geographical range sizes. *Marine Biodiversity*, 43 (4), 293–319.
<http://dx.doi.org/10.1007/s12526-013-0158-3>
- Por, F.D., 1964. The genus *Nitocra* Boeck (Copepoda Harpacticoida) in the Jordan Rift Valley. *Israel Journal of Zoology*, 13, 78–88.
- Por, F.D., 1984. Canuellidae Lang (Harpacticoida, Polyarthra) and the ancestry of the Copepoda, in: Vervoort, W. (ed.), *Studies on Copepoda II. Proceedings of the First International Conference on Copepoda, Amsterdam, The Netherlands, 24-28 August 1981. Crustaceana, Supplement 7*, 1–24.
- Sars, G.O., 1903. An account of the Crustacea of Norway. *Copepoda Harpacticoida* 5, (Pt I–III), 1–28.
- Scott, T., Scott, A., 1893. Notes on Copepoda from the Firth of Forth: *Longipedia coronata*, Claus; and a preliminary description of an apparently new genus and species. *Annals of Scottish natural History*, 1893, 89–94.
- Seifried, S., 2003. *Phylogeny of Harpacticoida (Copepoda): Revision of „Maxillipedasphalea“ and Exanechentera*. Cuvillier Verlag Göttingen, Germany.
- Seifried, S., Schminke, H.K., 2003. Phylogenetic relationships at the base of Oligoarthra (Copepoda, Harpacticoida) with a new species as the cornerstone. *Organisms Diversity & Evolution*, 3 (1), 13–37. <http://dx.doi.org/10.1078/1439-6092-00056>
- Sewell, R.B.S., 1940. *Copepoda Harpacticoida*. *Scientific Reports of the John Murray Expedition*, 7, 117–382.
- Sewell, R.B.S., 1949. The littoral and semi-parasitic Cyclopoida, the Monstrilloida and Notodelphyoida. *Scientific Reports of the John Murray Expedition*, 9 (2), 17–199.

- Sterrer, W., 1973. Plate tectonics as a mechanism for dispersal and speciation in interstitial sand fauna. *Netherlands Journal of Sea Research*, 7, 200–220.
[http://dx.doi.org/10.1016/0077-7579\(73\)90045-8](http://dx.doi.org/10.1016/0077-7579(73)90045-8)
- Thistle, D., 2003. Harpacticoid copepod emergence at a shelf site in summer and winter: implications for hydrodynamic and mating hypotheses. *Marine Ecology Progress Series*, 248, 177–185. <http://dx.doi.org/10.3354/meps248177>
- Thistle, D., Sedlacek L., 2004. Emergent and non-emergent species of harpacticoid copepods can be recognized morphologically. *Marine Ecology Progress Series*, 266, 195–200.
<http://dx.doi.org/10.3354/meps266195>
- Thompson, I.C., Scott, A., 1903. Report on the Copepoda collected by Professor Herdman at Ceylon, in 1902. Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar, Supplementary Report, 7, 227–307.
<http://dx.doi.org/10.5962/bhl.title.23477>
- Tiemann, H., 1984. Studies on Copepoda II. Is the taxon Harpacticoida a monophyletic one? *Crustaceana Supplement*, 7, 47–59.
- Vervoort, W., 1964. Free-living Copepoda from Ifaluk Atoll in the Caroline Islands with notes on related species. *Bulletin of the United States National Museum*, 236, 1–431.
<http://dx.doi.org/10.5479/si.03629236.236.1>
- Walter, T.C., 2014. *Indicanuella* Por, 1984. In: Walter, T.C., Boxshall, G., 2014. World of Copepods database. Available from: World Register of Marine Species at <http://www.marinespecies.org/aphia.php?p=taxdetails&id=347297> (accessed 20.11.2014)
- Wells, J.B.J., 2007. An annotated checklist and keys to the species of Copepoda Harpacticoida (Crustacea). *Zootaxa*, 1568, 1–872.

Wells, J.B.J., Rao, G.C., 1987. Littoral Harpacticoida (Crustacea: Copepoda) from Andaman and Nicobar Islands. *Memoirs of the Zoological Survey of India*, 16 (4), 1–385.

Willen, E., 1996. *Pseudomesochra* T. Scott, 1902 as a member of the Paranannopidae Por, 1986 (Copepoda, Harpacticoida) with a description of three new species. *Senckenbergiana maritima*, 28, 81–109. <http://dx.doi.org/10.1007/bf03042824>

Willen, E., 2000. Phylogeny of the Thalestridimorpha Lang, 1944 (Crustacea, Copepoda). Cuvillier Verlag, Göttingen, Germany.

Figure captions:

Fig. 1. Sampling locations (#1–#21) on the plateau of the GMS during the expedition P397 GroMet with the research vessel RV “Poseidon” in 2010. Dots indicate all sampling stations, black: *Microcanuella secunda* sp. n. was detected, white: *Microcanuella secunda* sp. n. was not detected until now.

Fig. 2. *Microcanuella secunda* sp. n., female. (A) Habitus dorsal view, frame shows exemplarily surface structure (holotype). (B) Habitus lateral view (holotype). (C) P5, P6 and genital complex (paratype 2). Scales: A, B: 100 µm, C: 50 µm.

Fig. 3. *Microcanuella secunda* sp. n., female A1 (paratype 1). (A) General shape and rostrum. (B) Setation of segments 3–5. Scale: 50 µm.

Fig. 4. *Microcanuella secunda* sp. n., A2. (A) General shape, enp in detail (paratype 4, male). (B) Exp of A2, general shape (paratype 5, female), arrow indicates socle. (C) Exp of A2, setation of single segments (paratype 5, female). Scale: 25 µm.

Fig. 5. *Microcanuella secunda* sp. n.. (A) Mx1 (paratype 1, female). (B) Mx (paratype 6, female). (C) Mxp (paratype 2, female). (D) Md (paratype 1, female). Scale: 25 µm.

Fig. 6. *Microcanuella secunda* sp. n., swimming legs (paratype 1, female). (A) P1 with intercoxal sclerite. (B) P2. Scale: 25 μ m.

Fig. 7. *Microcanuella secunda* sp. n., swimming legs (paratype 1, female). (A) P3. (B) P4 with intercoxal sclerite. Scale: 25 μ m.

Fig. 8. *Microcanuella secunda* sp. n., male. (A) Habitus: dorsal view, frame shows exemplarily surface structure (allotype). (B) Habitus: lateral view (allotype). (C) P5 (paratype 3). (D) P6 and genital pore (allotype). Scales: A, B: 100 μ m, C, D: 50 μ m.

Fig. 9. *Microcanuella secunda* sp. n., male. (A) A1: setation of segment 3 (paratype 4). (B) A1: general shape and rostrum (paratype 4). (C) CR: ventral view (paratype 3), I–VII number of setae, arrow indicates pinnate process. Scales: A, B: 20 μ m, C: 50 μ m.

Fig. 10. Distribution of the so far known species of *Microcanuella* in the world oceans. (Map-Source: Pangea, PanMap).

Table 1. List of sampled stations of the expedition P397 GroMet with RV “Poseidon” on the plateau of the Great Meteor Seamount in 2010, where specimens of *Microcanuella secunda* sp. n. were found so far. Location, station, depth (meter), sampling date, geographical locality and number of individuals (σ : male, ♀ : female, Σ : sum of male and female) are given. Locations additionally shown in figure 1.

Location	Station	Depth (m)	Sampling Date	Geographic locality	Number of individuals
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					♂	♀	Σ
#1	91-5	310.0	15.03.2010	30° 05.000 N, 28° 37.979 W	11	2	13
#1	91-7	311.0	15.03.2010	30° 04.987 N, 28° 37.983 W	11	5	16
#1	91-8	310.0	15.03.2010	30° 05.006 N, 28° 37.971 W	1	3	4
#2	92-5	301.0	15.03.2010	30° 05.062 N, 28° 33.994 W	18	7	25
#2	92-6	301.0	15.03.2010	30° 05.067 N, 28° 33.991 W	5	9	14
#3	98-6	309.0	17.03.2010	30° 05.030 N, 28° 30.038 W	11	8	19
#4	99-1	302.0	17.03.2010	30° 01.007 N, 28° 27.999 W	4	5	9
#4	99-3	303.0	17.03.2010	30° 01.042 N, 28° 27.985 W	0	2	2
#5	95-1	287.0	16.03.2010	30° 01.019 N, 28° 31.960 W	2	3	5
#5	95-2	284.0	16.03.2010	30° 01.051 N, 28° 31.952 W	10	11	21
#6	97-1	290.0	17.03.2010	30° 01.009 N, 28° 36.020 W	7	2	9
#6	97-3	292.0	17.03.2010	30° 00.995 N, 28° 36.067 W	3	0	3
#8	102-4	288.0	19.03.2010	29° 57.218 N, 28° 34.003 W	4	0	4
#9	100-7	287.0	18.03.2010	29° 57.010 N, 28° 29.999 W	2	2	4
#10	101-2	307.0	18.03.2010	29° 57.043 N, 28° 26.032 W	2	1	3
#10	101-3	306.0	18.03.2010	29° 57.060 N, 28° 26.100 W	0	1	1
#11	105-1	339.0	19.03.2010	29° 52.982 N, 28° 23.992 W	5	2	7
#11	105-2	315.0	19.03.2010	29° 52.985 N, 28° 23.999 W	10	10	20
#12	104-4	299.0	19.03.2010	29° 52.977 N, 28° 27.954 W	5	3	8
#12	104-5	300.0	19.03.2010	29° 52.977 N, 28° 27.960 W	8	9	17
#12	104-6	299.0	19.03.2010	29° 52.978 N, 28° 27.957 W	2	1	3
#13	103-1	288.0	19.03.2010	29° 53.021 N, 28° 31.991 W	3	3	6

#13	103-2	289.0	19.03.2010	29° 52.997 N, 28° 31.981 W	3	3	6
#13	103-3	290.0	19.03.2010	29° 53.004 N, 28° 31.999 W	0	1	1
#14	90-5	296.0	14.03.2010	29° 53.094 N, 28° 35.989 W	7	2	9
#14	90-6	296.0	14.03.2010	29° 53.080 N, 28° 35.997 W	4	6	10
#15	109-1	307.0	20.03.2010	29° 48.986 N, 28° 34.008 W	4	7	11
#15	109-2	309.0	20.03.2010	29° 48.991 N, 28° 33.987 W	5	7	12
#16	112-3	297.0	21.03.2010	29° 49.000 N, 28° 29.957 W	1	0	1
#17	106-4	299.0	19.03.2010	29° 48.963 N, 28° 25.959 W	1	2	3
#17	106-6	299.0	19.03.2010	29° 48.974 N, 28° 25.941 W	3	3	6
#18	113-4	293.0	21.03.2010	29° 44.997 N, 28° 24.048 W	15	13	28
#18	113-5	292.0	21.03.2010	29° 44.918 N, 28° 24.034 W	5	6	11
#19	111-4	292.0	21.03.2010	29° 44.979 N, 28° 27.936 W	12	8	20
#19	111-5	293.0	21.03.2010	29° 44.964 N, 28° 27.933 W	10	12	22
#19	111-6	293.0	21.03.2010	29° 45.003 N, 28° 27.932 W	2	3	5
#20	89-3	316.0	14.03.2010	29° 44.990 N, 28° 32.002 W	1	0	1
#21	114-1	289.0	21.03.2010	29° 40.962 N, 28° 26.051 W	0	1	1
#21	114-2	288.0	21.03.2010	29° 40.944 N, 28° 26.078 W	0	1	1
					199	162	361

Table 2. Seta and spine formula of *Microcanuella secunda* sp. n. Roman numbers indicate spines, Arabic numbers setae. Outer margin mentioned first and separated from the inner margin by a hyphen. Setation of distal segment separated by a comma: “outer, distal, inner” margins (Sewell, 1949).

	coxa	basis	exopod segment			endopod segment		
			1	2	3	1	2	3
P1	0-1	1-1	I-0	I-1	III, 1, 1	0-1	0-1	II, 1, 1
P2	0-0	1-0	I-0	I-0	II, 1, 1	0-1	0-1	II, 1, 1
P3	0-0	1-0	I-0	I-0	II, 1, 1	0-1	0-1	II, 1, 1
P4	0-0	1-0	I-0	I-0	0, 2, 0	0-1	0-0	0, 2, 0

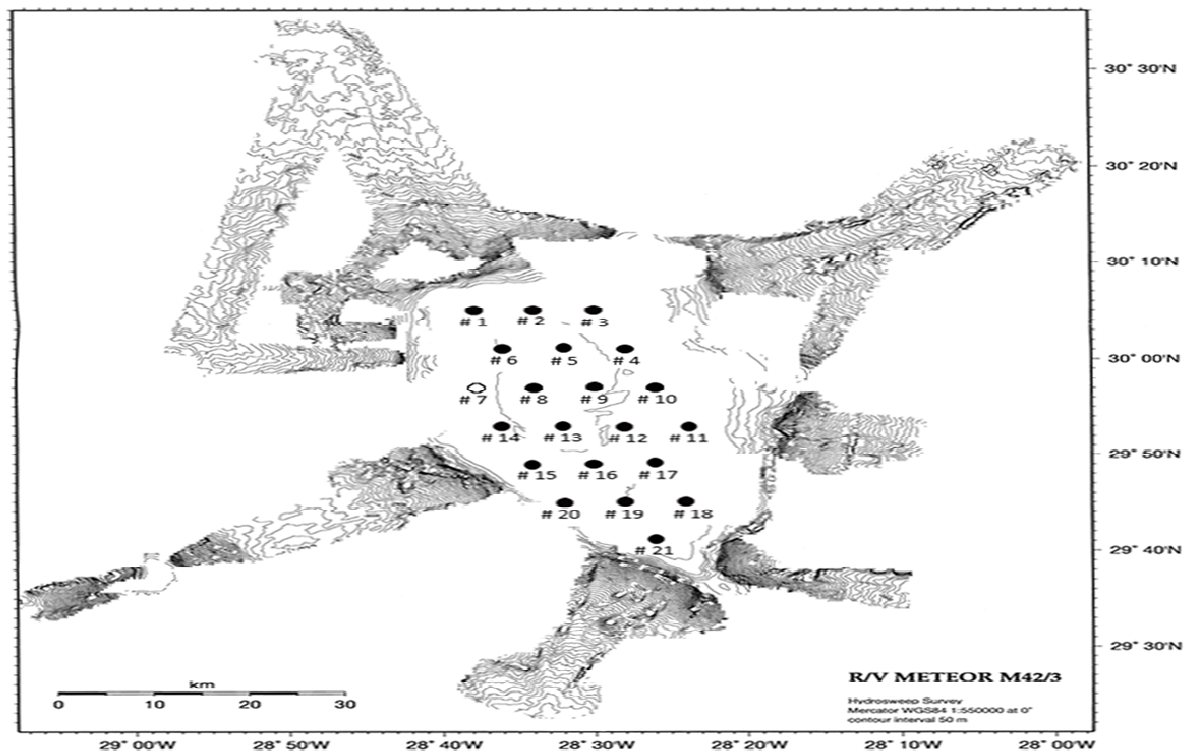


FIG1 .

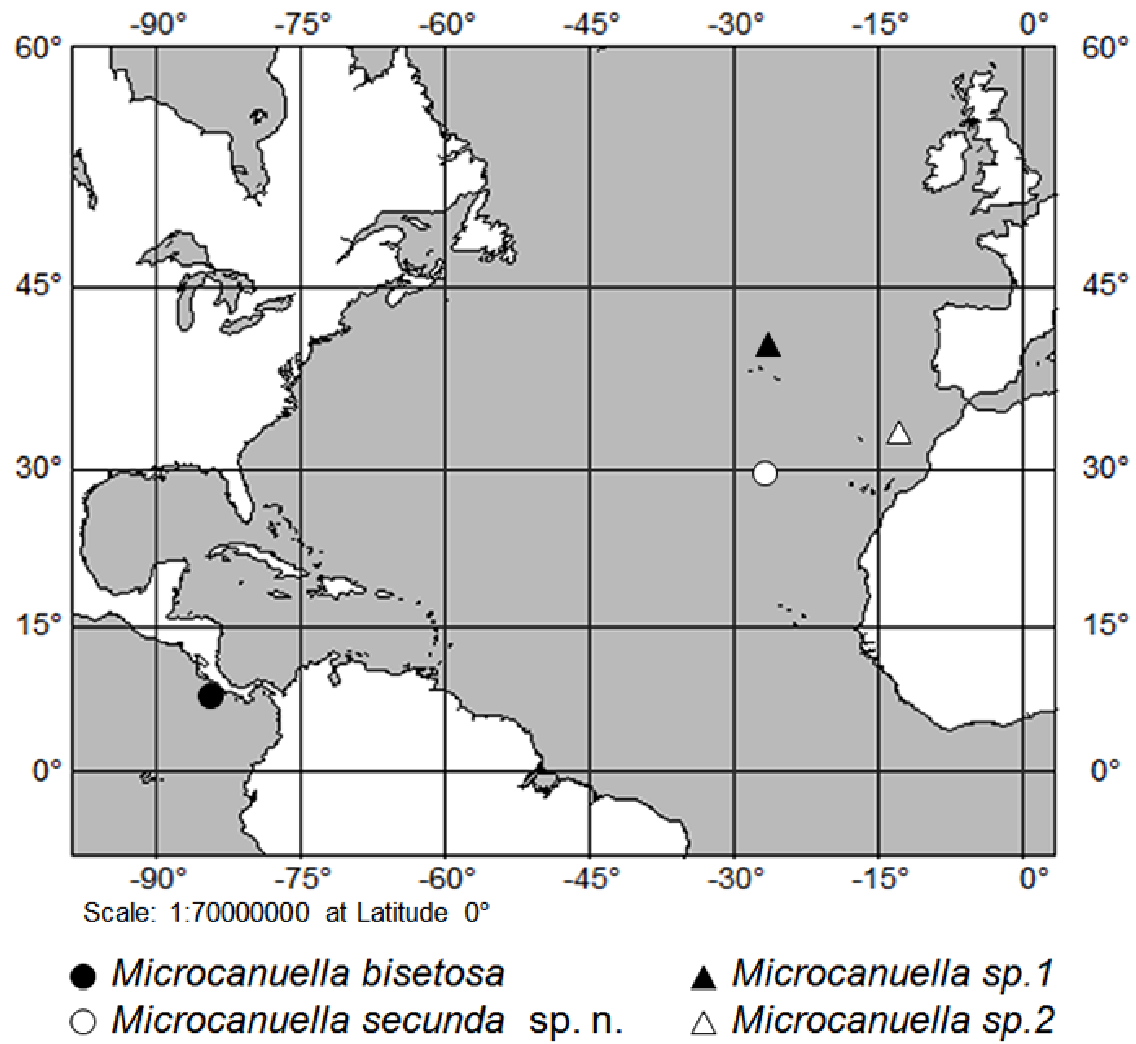


FIG10 .

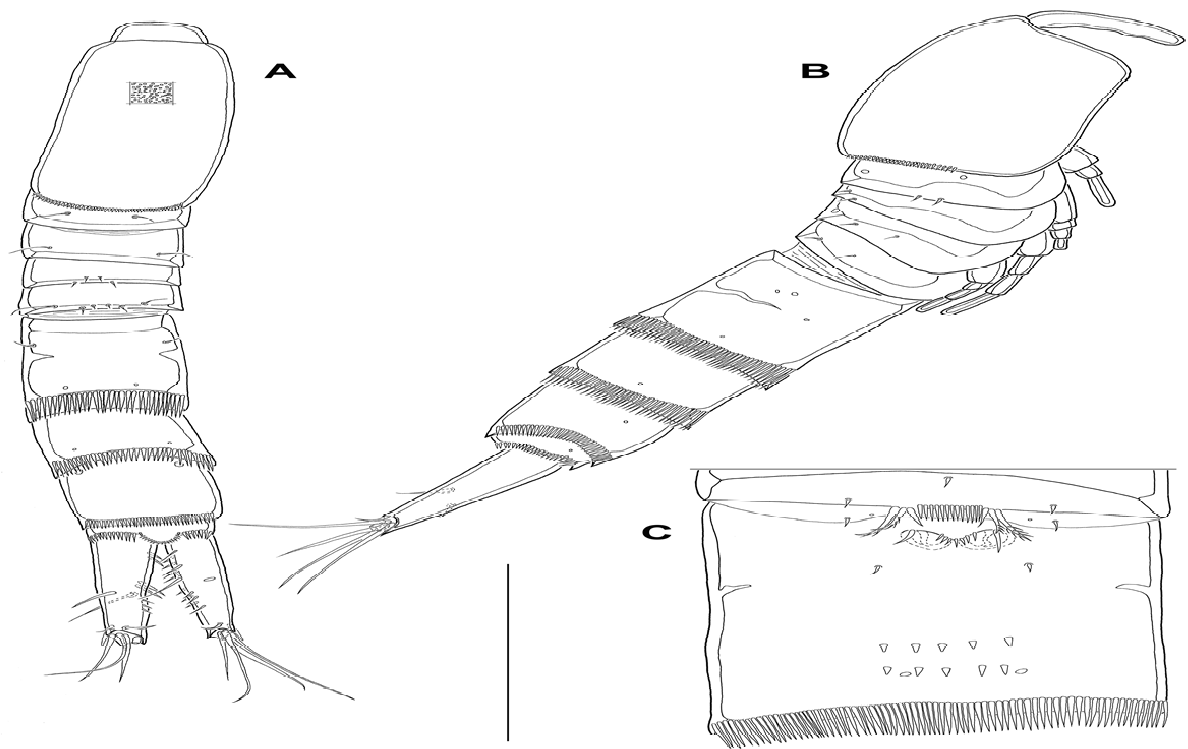


FIG2 .

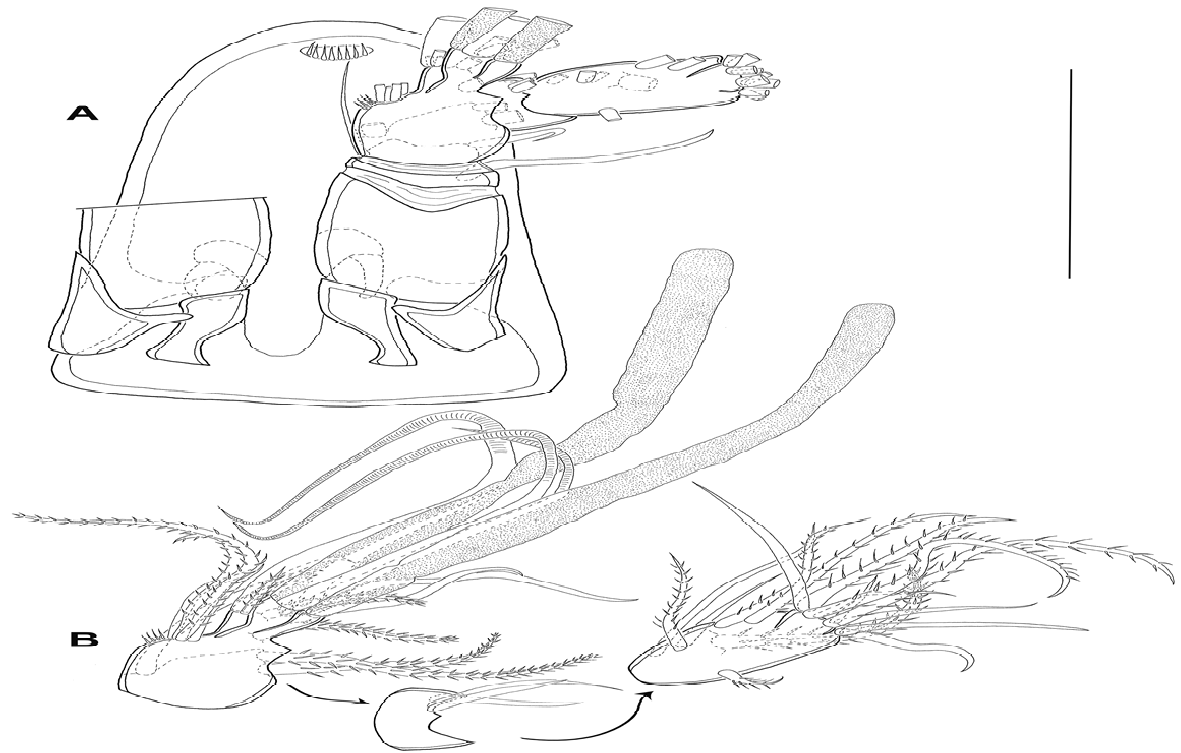


FIG3 .

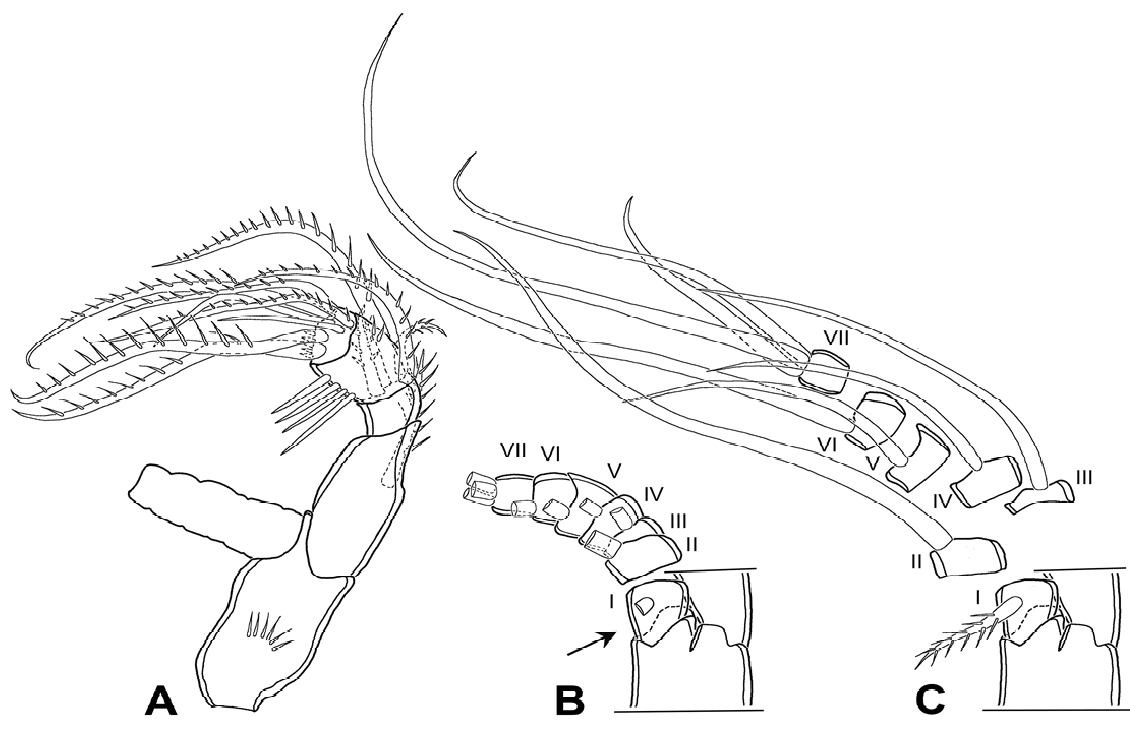


FIG4, horizontal format, half page .

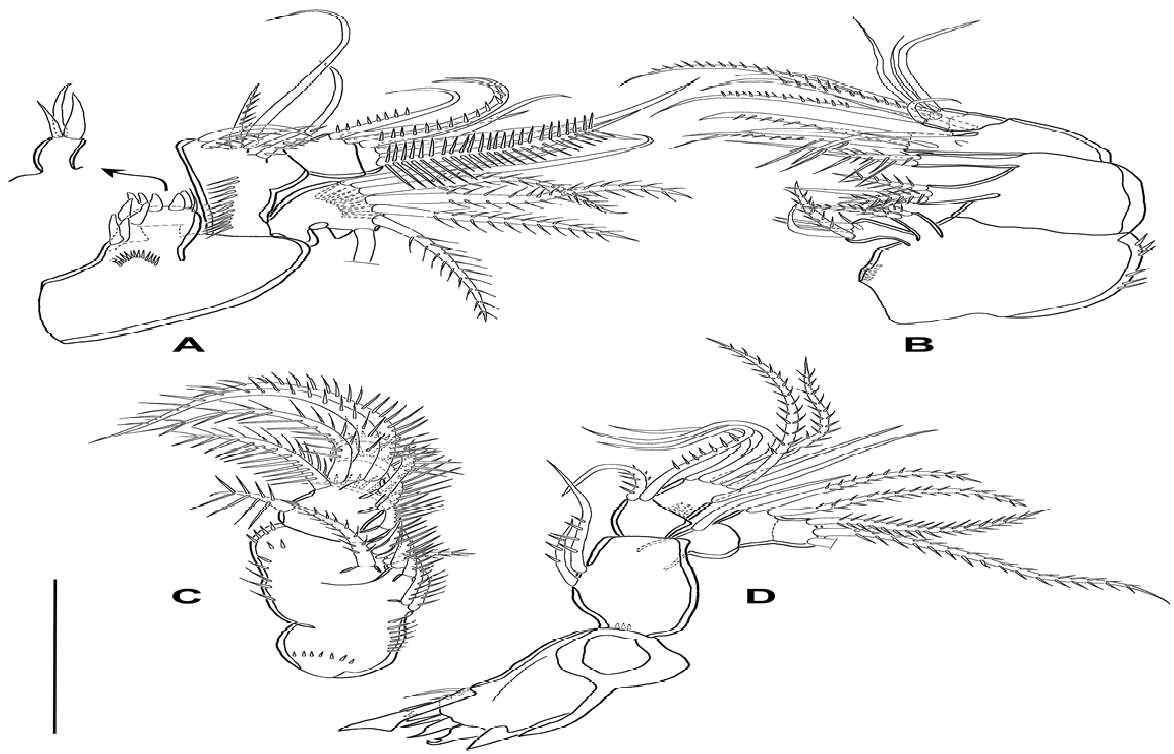


FIG5 .

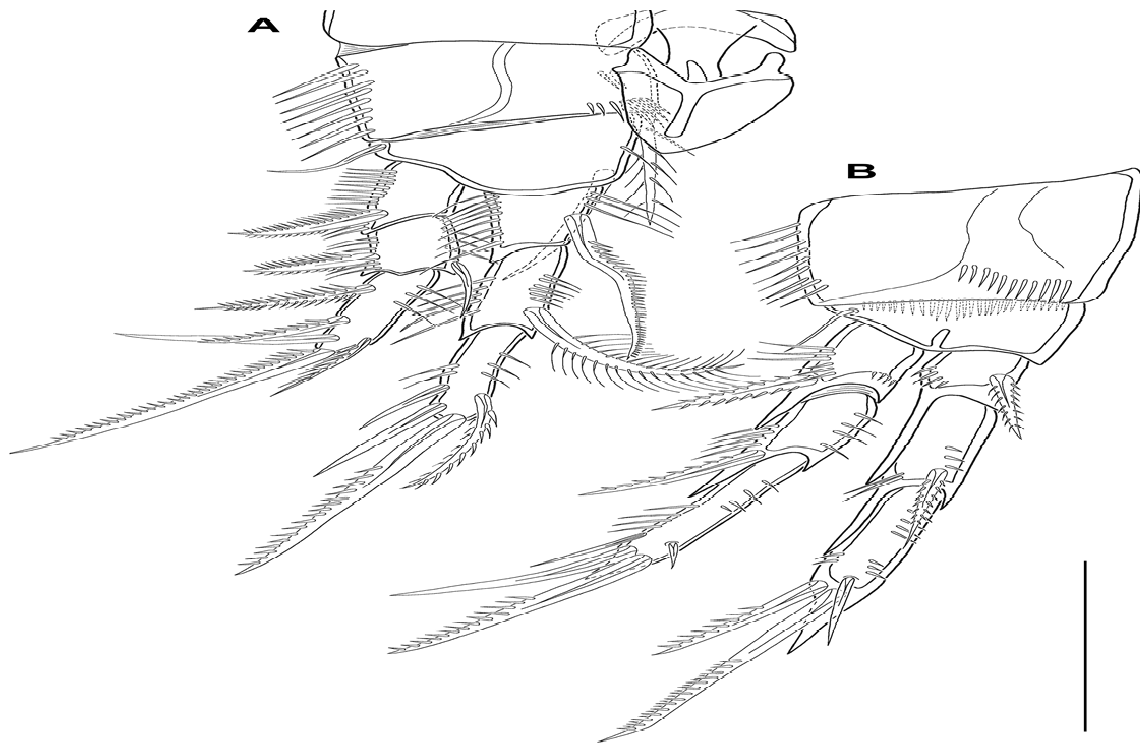


FIG6 .

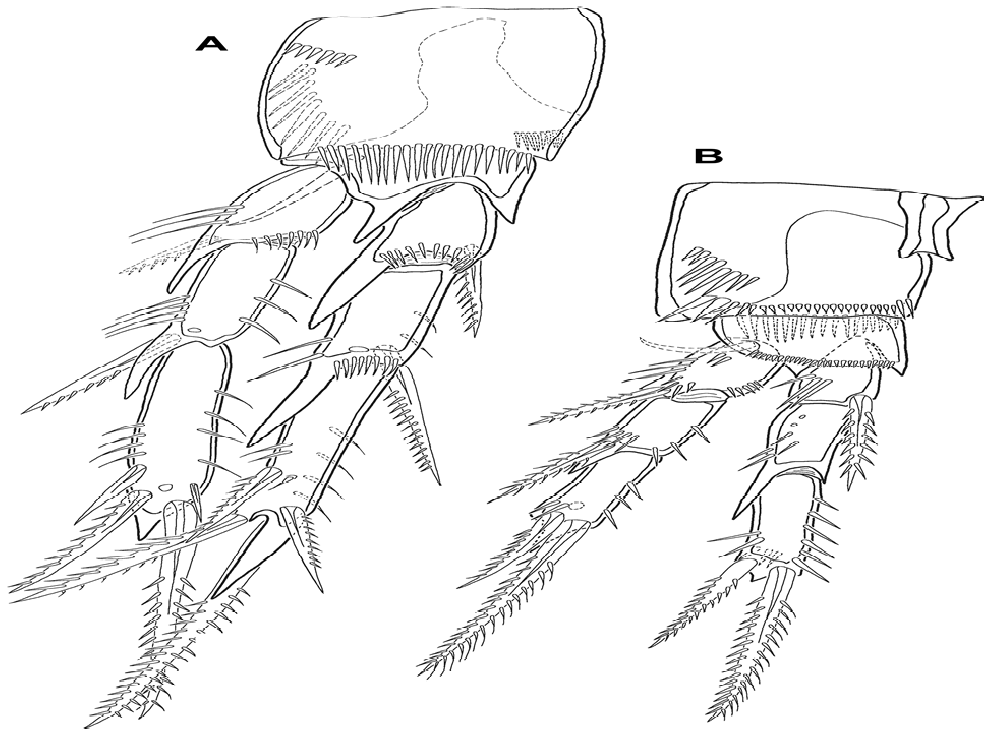


FIG7 .

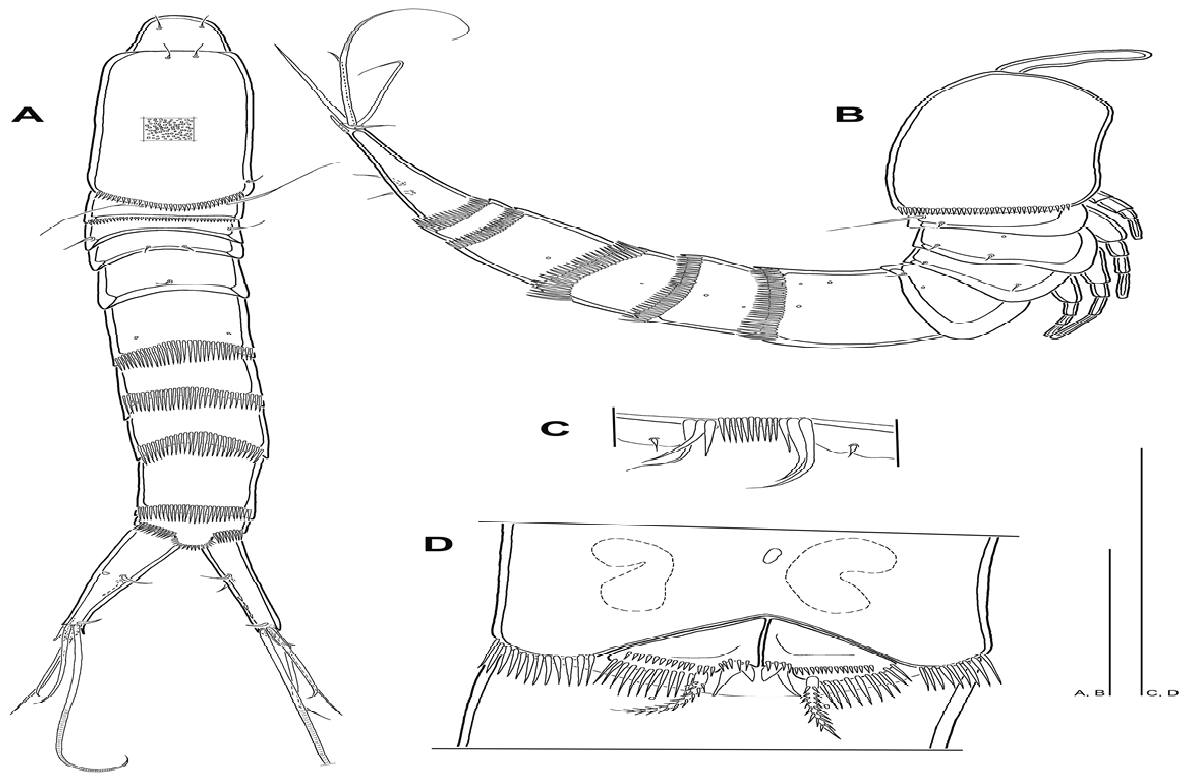


FIG8 .

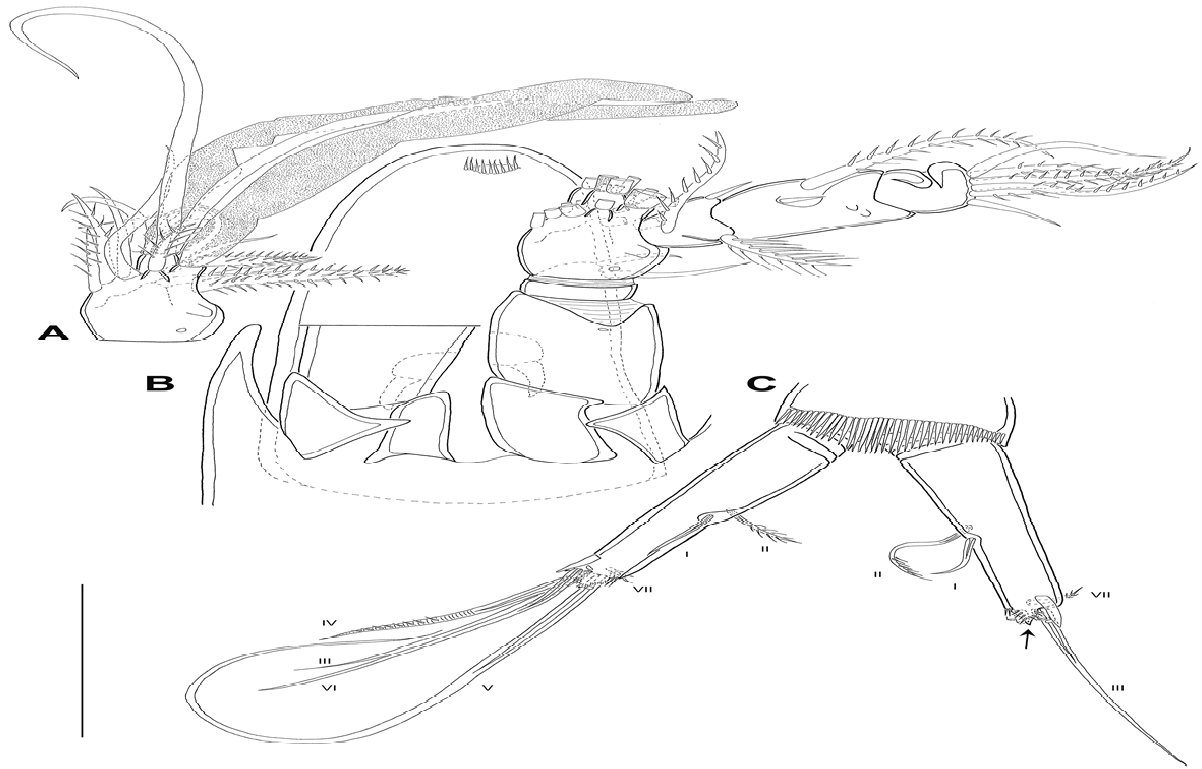


FIG9 .