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Ancorabolus chironi sp. nov., the first record of a member of the *Ancorabolus*-group (Copepoda: Harpacticoida: Ancorabolidae) from the Mediterranean

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Abstract Multicorer sampling at Anaximenes Seamount (eastern Mediterranean) during RV METEOR cruise M 71/1 in December 2006 yielded several specimens of a new species of Ancorabolidae Sars, 1909. The new species belongs to the taxon *Ancorabolus* Norman, due to the following apomorphies: (1) process bearing cephalothoracic sensillar group I more produced and spinous; (2) cephalothoracic sensillar group II: sensilla b–c and posterior tube-pore arising from individual thorn-like processes; anterior tube-pore raised; (3) cephalothoracic sensillar group IV: constriction and allometric growth resulting in distad displacement of sensilla a and d; (4) P3 enp-2 inner seta absent; (5) P4 female enp-2 inner seta absent; (6) P4 enp-2 outer element sexually dimorphic (setiform in female, spiniform in male). It differs, however, from the remaining species in overall shape, ornamentation of natatory legs and presence of anterior processes on cephalic shield. This justifies the erection of a new species, *Ancorabolus chironi* sp. nov. The record constitutes the first finding for members of the *Ancorabolus* group in the Mediterranean. A diagnostic key to the *Ancorabolus* species is provided.

Keywords Meiobenthos · Anaximenes Seamount · Taxonomy · Mud volcanoes · Deep sea

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Introduction

The bizarre morphology and general structure of their body processes easily identify most members of Ancorabolinae Sars, 1909. Despite their relatively low occurrence in marine samples, early discovery led to the first description by Norman (1903), marking an early start for research on this group. Sars (1909) established the family Ancorabolidae Sars, 1909, which was later on subdivided by Lang (1944, 1948) into Ancorabolinae and Laophontodinae Lang, 1944. Revived interest in this family as well as advancements in meiofauna sampling techniques led to various papers and descriptions in the past two decades (e.g. Arroyo et al. 2003; Conroy-Dalton 2001, 2003a, b, 2004; Conroy-Dalton and Huys 2000; Fiers 1988; George 1998a, b, 2001, 2006a, b, c; George and Plum 2009; George and Schminke 1998; George and Tiltack 2010; Gheerardyn and George 2010; Gómez and Conroy-Dalton 2002; Kornev and Chertoprud 2008; Schizas and Shirley 1994; Wandeness et al. 2009).

Extensive research on seamounts in the past years revealed several new ancorabolid species [Great Meteor Seamount, Atlantic: George (2006b); Sedlo and Seine Seamounts, Atlantic Ocean: George and Plum (2009)]. The Anaximander Mountains in the eastern Mediterranean are known mostly by geologists for their interesting tectonic and volcanic activity (cf. ten Veen et al. 2004). The Anaximander Mountains are constituted by three big seamounts, namely Anaximander, Anaxagoras, and Anaximenes Seamounts, and several smaller elevations. Their evolution has been controversially discussed (cf. ten Veen et al. 2004).

Anaximenes Seamount is an elongate, west-eastern curved seamount, steeply sloped at its northern flank, but gently sloped at its south-eastern flank. The Amsterdam mud volcano is situated at its south eastern edge (ten Veen

et al. 2004). Recently, marine biologists gained interest and are now researching the specific fauna associated with such volcanically active areas (Fisher et al. 2007; Lösekann et al. 2007). The present publication not only marks the first description of an *Ancorabolus* member from the Mediterranean Sea, but also contributes to the knowledge on seamount and mud volcano meiofauna.

Material and methods

The material was collected during expedition M71/1 of RV "Meteor" in December 2006 in the eastern Mediterranean Sea (Christiansen et al. 2010). Multicorer samples taken on December 14th, 2006 at station no. 891 were located on a mud volcano on the south-eastern flank of Anaximenes Seamount at 1,259 m depth (Fig. 1). Twelve cores with an inner diameter of 9.4 cm (sampling surface of 69.4 cm^2) were taken. The upper 5 cm of sediment were extracted, stored, and fixed with a 5% formalin-seawater solution. Samples were later sorted at the Deutsches Zentrum für Marine Biodiversität (DZMB), Senckenberg am Meer in Wilhelmshaven, Germany using a Leica MZ 12-5 stereo microscope. Single specimens were transferred to glycerol. The type material was deposited in the collection of the Senckenberg Forschungsinstitut und Naturmuseum Frankfurt, Germany. Drawings were made under a Leica DMR compound microscope equipped with a drawing tube and interference contrast at 1,000× magnification.

Terminology is adopted from Lang (1948) and Huys and Boxshall (1991), phylogenetic terms follow Hennig (1982) and Ax (1984). The term "telson" is used according to Schminke (1976).

Abbreviations used in the text: *A1* antennule, *A2* antenna, *aes* aesthetasc, *Benp* baseoendopod, *Cphth* cephalothorax, *enp* endopod, *exp* exopod, *enp-1–3* endopodal segments 1–3, *exp-1–3* exopodal segments 1–3, *FR* furcal ramus/rami, *GDS* genital double somite, *GF* genital field, *Md* mandibula, *Mx* Maxilla, *Mx1* maxillula, *Mxp* maxilliped, *P1–P6* swimming legs 1–6, *PT* paratype.

Results

The extracted upper 5 cm of very muddy sediment layer from all cores combined yielded 21 specimens, 14 females and seven males of the present new species.

Type locality Station no. 891 (Fig. 1), Anaximenes Seamount, 35°28.61′N/30°15.14′E, 1,259 m depth.

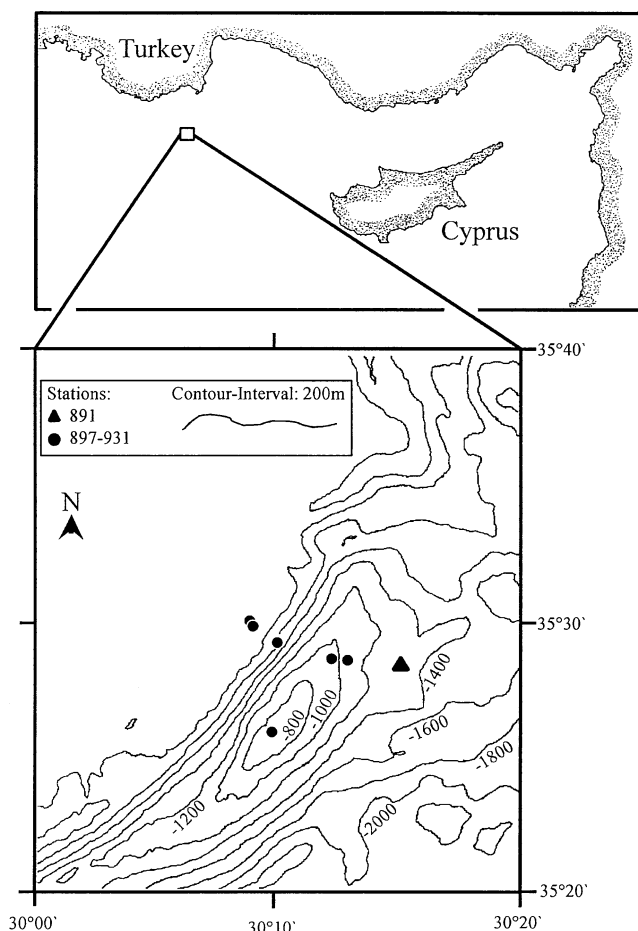*Type material* Female holotype on one slide, collection number SNG 36163/1. Additionally, 20 paratypes (PT)

Fig. 1 Location of Anaximenes Seamount in the eastern Mediterranean (*small square*) and the stations sampled with the multicorer. *Triangle*: MUC station where *Ancorabolus chironi* sp. nov. was collected. Map showing sampled stations modified after F. Peine (Rostock, Germany)

complete the type series: PT 1: female, dissected, mounted on four slides, coll. no. SNG 36164/1–4; PT 2: female, dissected, mounted on seven slides, coll. no. SNG 36165/1–7; PT 3 ("allotype"): male on one slide, coll. no. SNG 36166/1; PT 4: male dissected, mounted on eight slides, coll. no. SNG 36167/1–8; PT 5: male, dissected, mounted on ten slides, coll. no. SNG 36168/1–10; PT 6: female on one slide, coll. no. SNG 36169/1; PT 7: female partly dissected, mounted on two slides, coll. no. SNG 36170/1–2; PT 8: male on one slide, coll. no. SNG 36171/1; PT 9: female on one slide, coll. no. SNG 36172/1; PT 10: male on one slide, coll. no. SNG 36173/1; PT 11: female on one slide, coll. no. SNG 36174/1; PT 12: male, put on one slide, coll. no. SNG 36175/1; PT 13: female on one slide, coll. no. SNG 36176/1; PT 14: female on one slide, coll. no. SNG 36177/1; PT 15: female on one slide, coll. no. SNG 36178/1; PT 16: female on one slide, coll. no. SNG 36179/1; PT 17: female on one slide, coll. no. SNG 36180/1; PT 18: male on one slide, coll. no. SNG 36181/1; PT 19:

female on one slide, coll. no. SNG 36182/1; PT 20: ovigerous female on one slide, coll. no. SNG 36183/1.

Etymology The specific name *chironi* refers to Chiron of the Greek mythology, who stands out amongst the centaurs with his wisdom and kindness and his sacrifice for human beings.

Ancorabolidae Sars, 1909
Ancorabolinae Sars, 1909
Ancorabolus Norman, 1903

Type species A. mirabilis Norman, 1903. Additional species: *A. confusus* Conroy-Dalton and Huys, 2000, *A. hendrickxi* Gómez and Conroy-Dalton, 2002, *A. inermis* Conroy-Dalton and Huys, 2000. *Species inquirenda*: *A. ilvae* George, 2001.

Generic diagnosis as provided by Conroy-Dalton and Huys (2000) and amended by Gómez and Conroy-Dalton (2002).

Ancorabolus chironi sp. nov. (Figs. 2, 3, 4, 5, 6, 7, 8)

Description of female

Habitus (Fig. 2a). Total body length 530 μm, measured from anterior tip of rostrum to posterior end of furca. Body profile more or less round, slightly tapering towards posterior end. No distinction between prosome and urosome. Somites strongly chitinized and highly ornate. Somatic hyaline frills narrow. Posterior margin of cphth and somites with fine setules.

Cphth (Fig. 3a) with paired, branched and simple processes at proximal outer corners and along lateral margins of cephalic shield. Processes with sensilla and tube-pores in five distinct groups [defined by Conroy-Dalton and Huys (2000)] as follows:

Sensillar group I located at anterolateral corner of cephalic shield. A bulb-shaped process covered with spinules bears a bifid sensillum at its tip, consisting of spiniform main branch and lateral flagellum.

Sensillar group II located laterally and posterior to group I, consisting of three sensilla and two tube-pores. Arising from a common projection, one simple sensillum is located anteriorly. Two thorn-like projections covered with spinules bear bifid sensilla and arise from the dorsoanterior and ventroposterior corners of common base. A thorn-like projection in the dorsoposterior corner bears 1 tube-pore at its tip, and is likewise covered with spinules. A ventroanteriorly located and naked bottle-like projection is extruded into a long tube-pore.

Sensillar group III located laterally but more ventrally than previous projections, consisting of three sensilla located on a common projection. One dorsal and one ventral bifid sensillum located on long backwardly pointed projections covered with spinules. One simple sensillum is located on anterior side.

Sensillar group IV located on the ventrolateral corner of the cephalic shield, consisting of three backwardly pointed projections bearing bifid sensilla at their tips, spinules on margins and two simple sensilla located on anterior side between previous projections. Base elongated.

Sensillar group V located in dorsolateral corner of cephalic shield. A large thorn-like projection covered with spinules arises on posterior side and bears one tube-pore at its tip. Two smaller projections with bifid sensilla and spinule rings are located on proximal side of thorn with one emerging directly from its base. Two simple sensilla emerge on anterior side of base and posterolateral side of thorn.

In addition to sensillar groups the cephalothorax bears four paired sensilla on dorsal surface: one pair of tube-pores emerging near the base of A1 dorsally; with fine setules laterally and on elevated peak (Fig. 8) on anterior third of cephalothorax, which become longer near rostrum. Rostrum (Figs. 2a, 3a) triangular, with bifid tip; covered with long setules, and with two lateral sensilla and short tube-pore dorsally. Body somites bearing P2–P5 (Fig. 2a) showing one paired dorsal process, one paired dorsolateral process, which is accompanied by smaller process at its base (the latter absent in P5-bearing somite), and with one paired large lateral process. All processes furnished with spinules and with bifid sensilla at their tips. Genital and abdominal halves of GDS and second abdominal somite each with one large lateral and one dorsolateral pair of processes. Abdominal half of GDS and following somite ventrally with additional tube-pore emerging from a depression of cuticle near base of large lateral process (Figs. 2b, c).

GDS (Figs. 2a, b) with dorsal surface ridge, dorsolateral projections and tubercles on both halves indicating original segmentation; completely fused ventrally.

Telson (Figs. 2a, c) with short spinules around hind margins; ventrally with two tube-pores posteriorly; with long, fine spinules dorsally and along posterior margin of anal operculum.

FR (Fig. 2c) cylindrical, about 5.5-times as long as broad, with seven setae (I–VII); lateral margin, ventral side and insertion sites of setae (I–III, V) with short spinules; tube-pores on lateral margin of anterior end, and on ventral side of posterior end in left FR. Setae I and II half along outer margin, seta I dorsal to, and about half the length of seta II; seta III located on outer margin near posterior end of ramus, as long as seta II; seta IV fused basally to seta V, slightly shorter than setae II and III; seta V well developed, bipinnate and as long as entire body; seta VI inserting at posterior inner corner of ramus, as long as seta I; seta VII triarticulate, arising from dorsoposterior pedestal.

A1 (Figs. 4a, a') three-segmented, first segment with ten setae (two distal setae broken). Distally with small thorn-
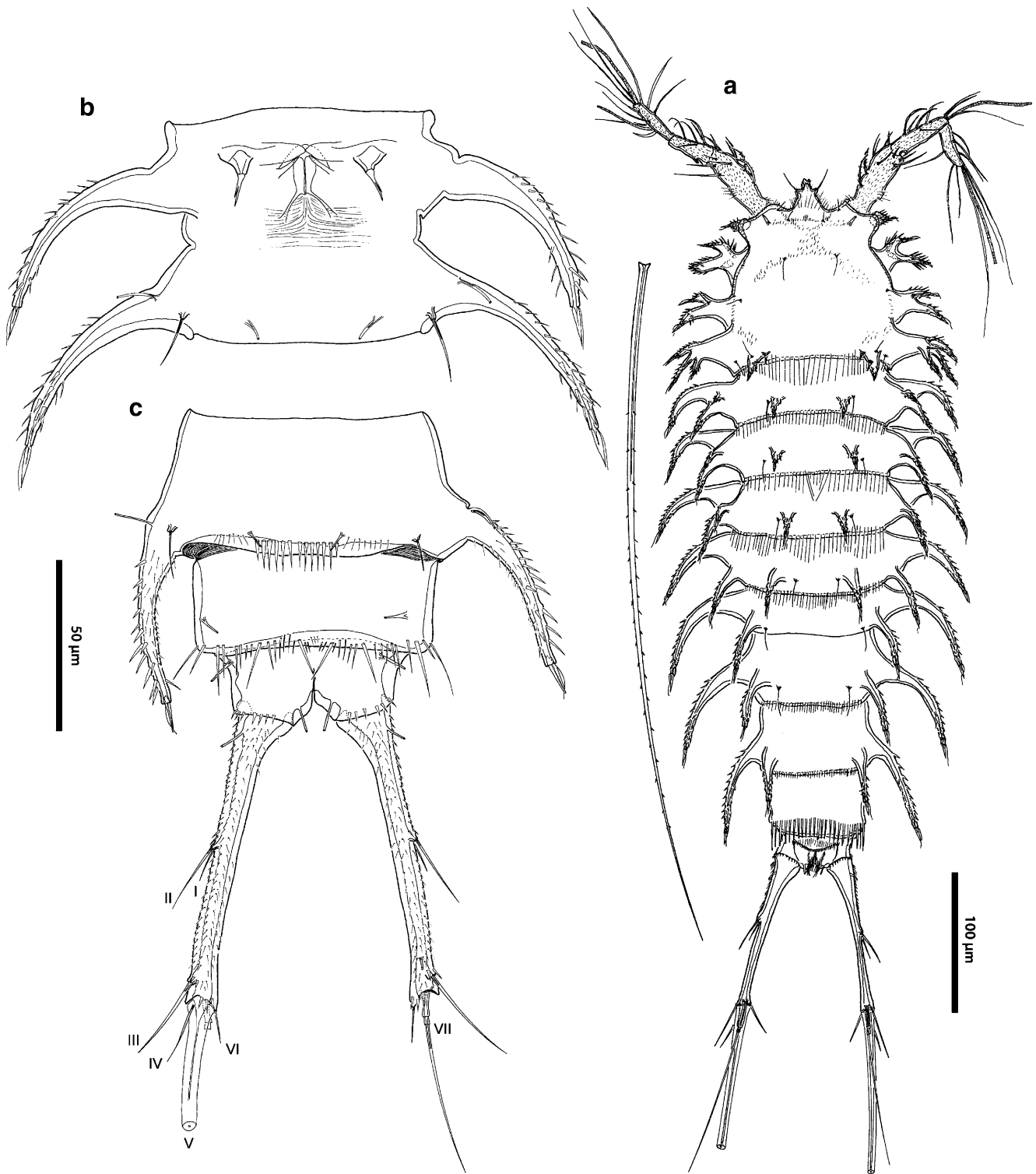
Fig. 2a–c *Ancorabolus chironi* sp. nov., female. **a** Habitus dorsal. **b** Genital double-somite with genital field and P6, ventral. **c** Last abdominal somites and telson with FR, ventral

like projection bearing one seta (broken, *arrowed with asterisk* in Fig. 4a). Second segment with eight setae, one of which fused basally with one long aesthetasc; posterior margin with hook-like process (*arrowed* in Fig. 4a). Third

segment shortest, bearing nine setae (two broken) and one aesthetasc forming apical acrothek together with two additional setae. All segments covered with weak setules (Fig. 4a').
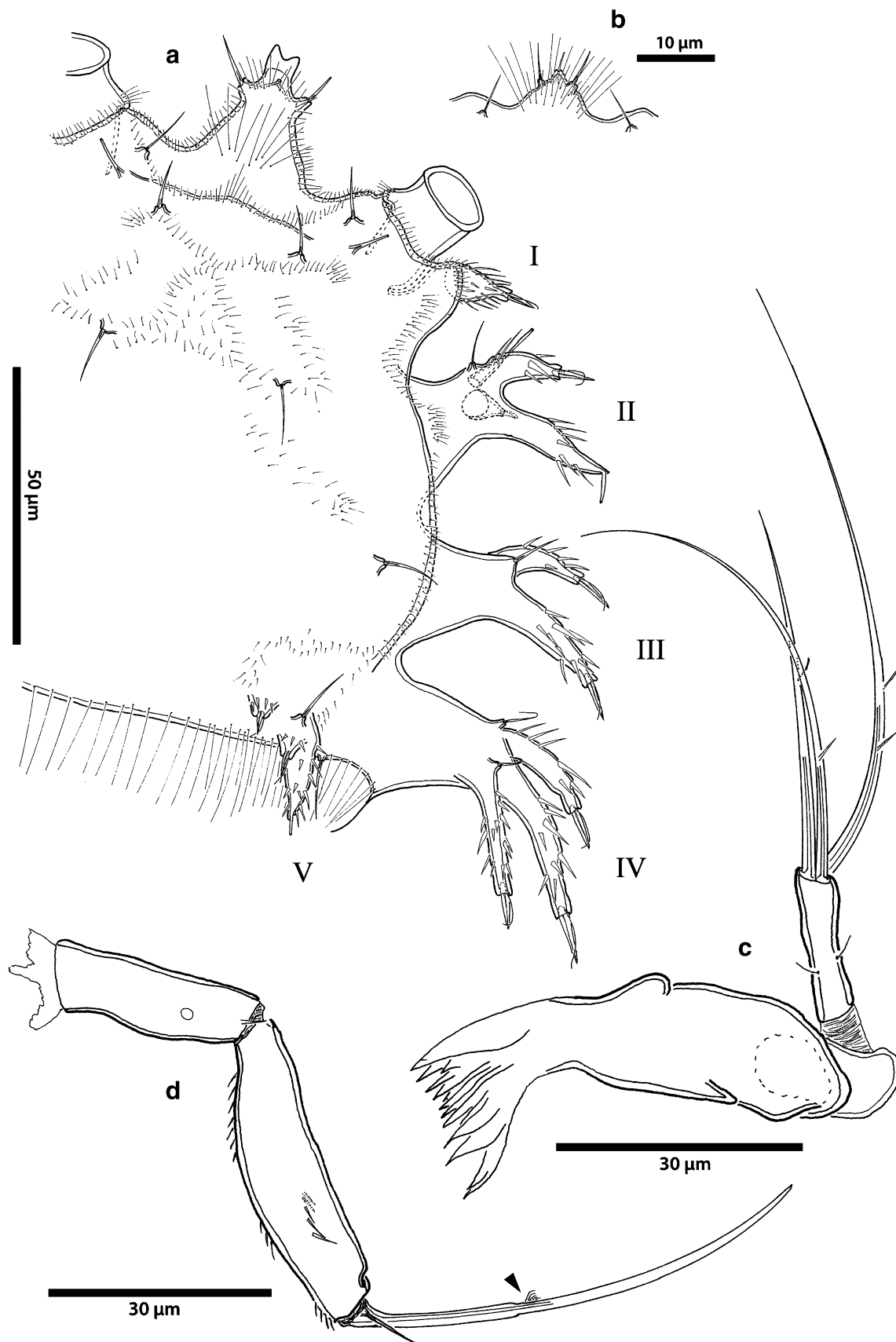
Fig. 3a–d *Ancorabolus chironi* sp. nov. a Female cephalothorax with rostrum and sensillar groups I–V, dorsal. b male rostrum, dorsal. c Md. d Mxp
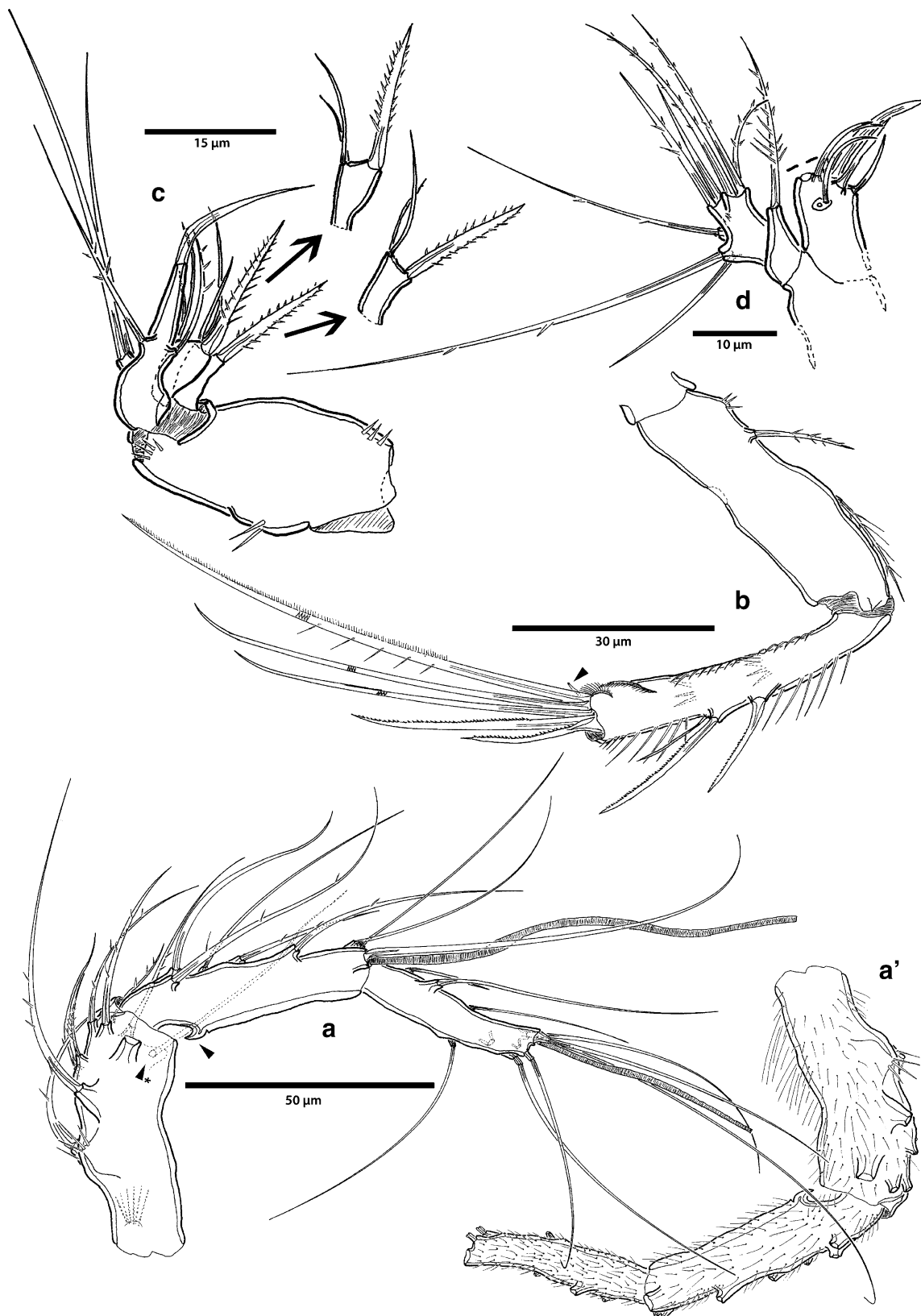
Fig. 4a–d *Ancorabolus chironi* sp. nov., female. **a** A1, setation (curved process on second segment *arrowed*; thorn-like projection with broken seta *arrowed with one asterisk*). **a'** A1 ornamentation without setae, **b**. A2 (small tube pore *arrowed*). **c** Mx. **d** Mxl
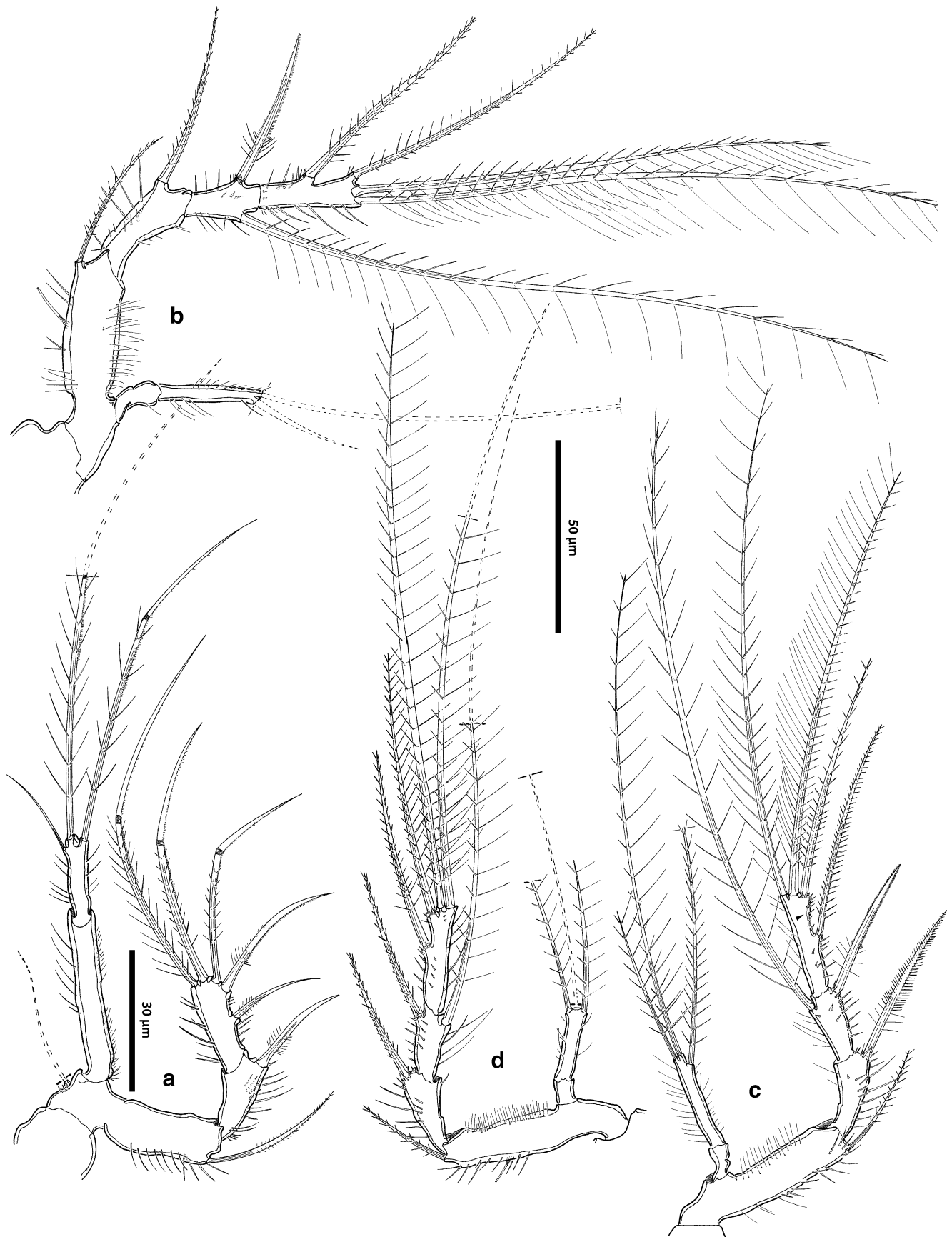
Fig. 5a–d *Ancorabolus chironi* sp. nov., female. **a** P1. **b** P2. **c** P3 (tube-pore *arrowed*). **d** P4. The *50-μm scale bar* applies to Figs. 5b–d

Fig. 6a–c *Ancorabolus chironi* sp. nov. **a** Female P5. **a'** Benp of P5 counterpart (place where a missing inner seta should be situated *arrowed*). **b** Male P5. **c** Male P3 enp (tube-pore *arrowed*, pore of apophysis *arrowed with one asterisk*)

Setal formula: $1 - 10$; $2 - 8 +$ aes; $3 - 11 +$ aes.

A2 (Fig. 4b). Allobasis with two bipinnate setae on abexopodal margin. Exp absent, membranous gap on inner margin marking its original position. Enp with three outer elements (two unipinnate spines, one naked fine seta) and five distal setae (two unipinnate, non-geniculate, and three geniculate; longest seta bipinnate, carrying one small tube-pore (*arrowed*); additional, basally fused vestigial seta not discernible (if present). Inner margin with long spinules; outer margin with two comb-like and inwardly curved
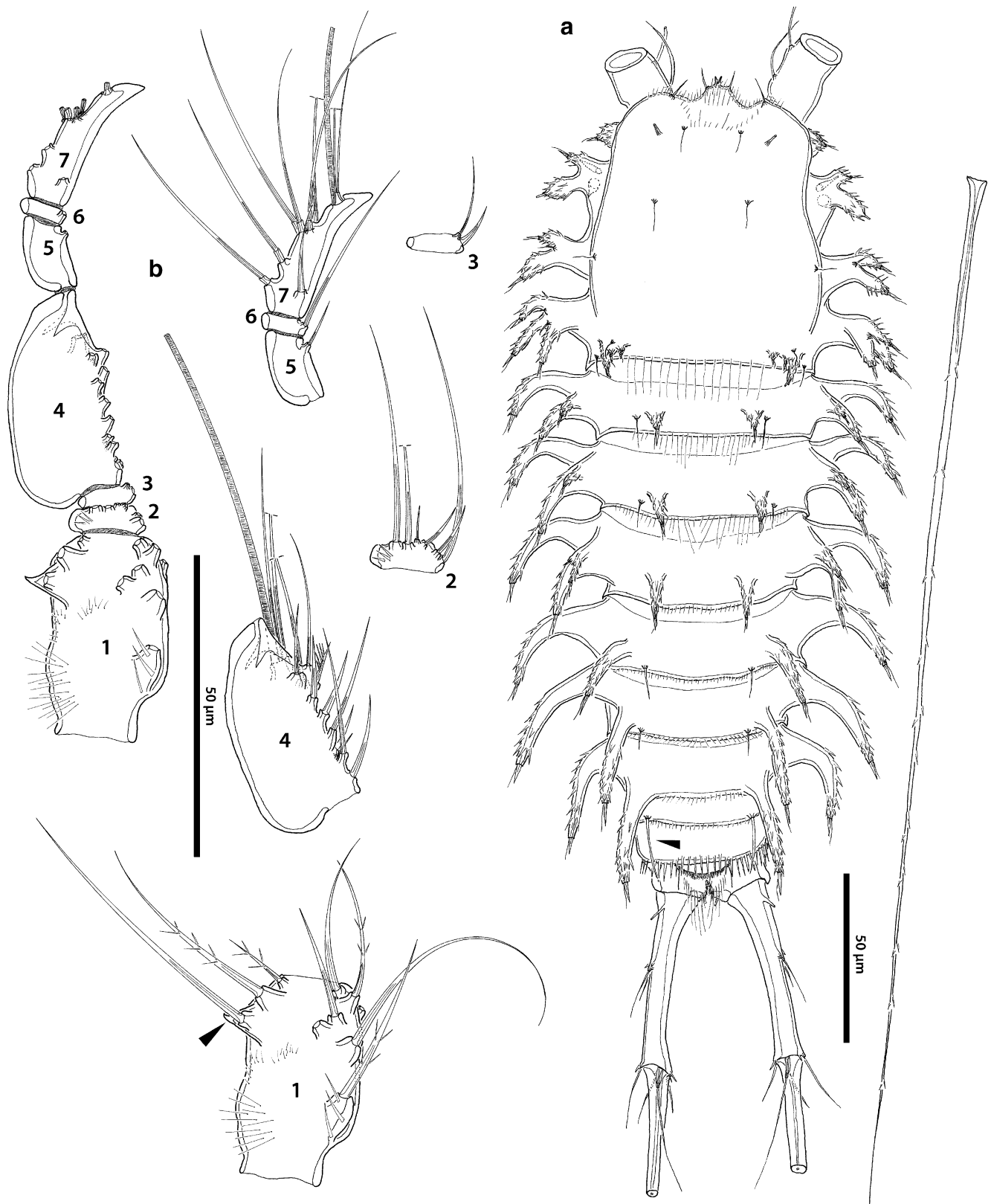
Fig. 7a, b *Ancorabolus chironi* sp. nov., male. **a** Habitus dorsal, small and narrow dorsal processes on second abdominal somite *arrowed*. **b** A1, shape without setae, and segments with corresponding setation (thorn-like projection on first segment *arrowed*)
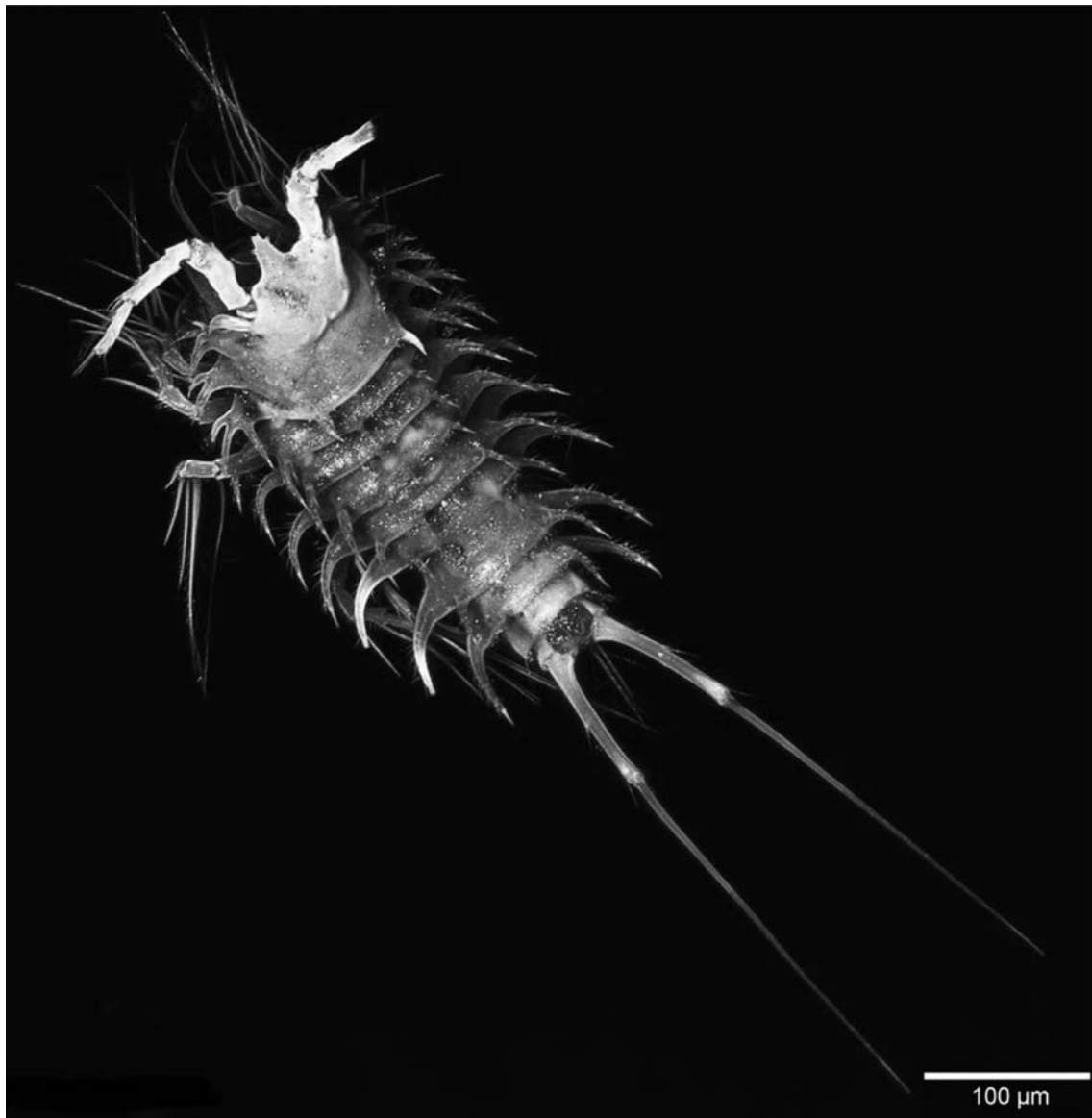
Fig. 8 *Ancorabolus chironi* sp. nov., female. Photo taken with a Leica TCS SP5 CLSM, illustrating the three-dimensional shape of the organism. Photo taken by J. Michels (Kiel) and MS

spinule rows; distally with two surface frills bearing very fine spinules.

Md (Fig. 3c). Slender coxa with two small lumps, distally widening into gnathobase bearing incised blades; ventrally and dorsally with stronger chitinized blade. Palp 1-segmented; well developed, with three apical unipinnate setae and very fine setules laterally.

Mxl (Fig. 4d). Praecoxal arthrite rectangular, with six terminal spines (one broken) and two surface setae (one broken). Coxal endite with one bipinnate seta. Basis with two endites; proximal endite with three, distal endite with two setae; with small spinules between endites. Enp represented by two unipinnate setae, exp represented by one naked seta.

Mx (Fig. 4c). Syncoxa with two patches of spinules and one longer spinule row; with two endites arising from membranous area, with one strong pinnate spine and two naked setae each. Allobasis drawn into spine, with two pinnate setae at base of spine. Enp minute, bearing two naked setae.

Mxp (Fig. 3d) elongate. Syncoxa with one distal spinule and lateral circular depression. Basis with outer longitudinal row of spinules proximally. Enp drawn into long curved claw with small tapering halfway in which a short row of very fine setular extensions originate (*arrowed*); with one accessory seta at base.

P1 (Fig. 5a) basis transversely elongate, with naked inner and bipinnate outer seta; insertion sites of setae ornamented with spinules; with anterior spinule row, and fine hair-like spinules on posterior margin. Exp 2-segmented; exp-1 with one finely serrate outer spine. Exp-2 with three geniculatre bipinnate apical setae and two outer

spines, the latter with setules at their bases. Enp 2-segmented, enp-1 elongate (approx. as long as basis), with fine setules along inner and outer margins: enp-two terminally with two geniculate, pinnate apical setae and one inner naked seta; with fine setules proximally.

P2–P3 (Figs. 5b, c). Basis transversely elongate, anterior margin with patch of fine setules and with rows of long spinules. P2 with one tube-pore halfway on anterior margin; posterior margin with fine hair-like setules; with outer bipinnate seta. Exp 3-segmented, with elongate bipinnate outer spines; exp-2 with outer spine finely serrate, and with very long inner bipinnate seta; exp-3 with two apical setae and two outer spines. P3 exp-3 with small tube-pore between outer spines (arrowed in Fig. 5c). Enp 2-segmented, and as long as exps 1 and 2 combined; enp-1 small, at most with few very fine setules as well as notches halfway at inner margin; P2 enp-2 elongate, with fine setules along margins and with two terminal pinnate setae (broken in Fig. 5b), P3 enp-2 with two apical and one outer seta.

P4 (Fig. 5d) as in P2–P3 except for unmodified distal spine on P4 exp-2. Enp-1 small; enp-2 with two apical and one outer seta.

Setation of P1–P4 is summarized in Table 1.

P5 (Figs. 6a, a') biramous; basis and enp fused, forming benp; outer seta of basis arising from very long setophore; with tube-pore close to setophore; with patch of fine setules between exp and baseoendopodal lobe. The latter well developed, with fine outer setules; with three (Fig. 6a', arrow) or four (Fig. 6a) pinnate setae in different individuals and even in single specimens. Exp 2.5-times as long as enp, with two pinnate outer setae, two pinnate apical setae and one modified plumose inner spine; with long tube-pore between apical setae.

GF (Fig. 2b). P6 with short bifid element. Proximal projections of sixth leg forming genital operculum. Wing-like structures forming long midventral slit with depression leading to large copulatory pore.

Description of male

The male differs from the female in the habitus, rostrum, A1, P3 enp, P4 enp, and P5.

Table 1 Setation of swimming legs P1–P4 (f female, m male; outer elements given in Roman numerals)

	exp-1	exp-2	exp-3	enp-1	enp-2
P1	I, 0	II, 3, 0	–	0, 0	0, 2, 1
P2	I, 0	I, 1	II, 2, 0	0, 0	0, 2, 0
P3	I, 0	I, 1	II, 2, 0	0, 0	I, 2, 0 (f)
					0, 2, 0 + apophysis (m)
P4	I, 0	I, 1	II, 2, 0	0, 0	I, 2, 0

Habitus (Fig. 7a) stubbier and shorter than the female. Body length 320 μm measured from tip of rostrum to posterior margin of furcal rami. Rostrum (Fig. 3b) reduced and very short. Frontal peak not discernible. P5-bearing somite without dorsal processes, second abdominal somite with dorsal processes being long, narrow, and bare (arrowed).

A1 (Fig. 7b) prehensile, subchirocer, seven-segmented. First segment with ten setae (two broken) with small seta-bearing thorn (arrowed) and fine setule patch; second segment short, with six setae and few setules; third segment minute, with two inner setae; fourth segment swollen, with ten bare, and one unipinnate seta; one long aesthetasc and two associated setae forming apical acrothek; with geniculation between segments 4 and 5. Fifth and sixth segment with one inner seta each; last segment with nine setae and one aesthetasc (six setae biarticulate, acrothek (two setae+aes) on elevated basal structure distally, and one dorsal seta.

Setal formula: $1 - 10;\ 2 - 6;\ 3 - 2;\ 4 - 11 + (2 + \text{aes})$; $5 - 1;\ 6 - 1;\ 7 - 7 + (2 + \text{aes})$.

P3 exp as in female, enp (Fig. 6c) two-segmented; enp-1 small, without ornamentation; enp-2 elongate, with two apical bipinnate setae and tube-pore (arrowed in Fig. 6c); with curved apophysis showing small subapical pore (arrowed with asterisk).

P4 enp-2 (not drawn) with outer element modified, being stronger than in female and serrate.

P5 (Fig. 6b) biramous; rami shorter than in female. Benp with one bipinnate and one very plumose terminal seta, subterminally with long tube-pore.

Diagnostic key to the known species of Ancorabolus (except species inquirenda A. ilvae):

1. Cphth anteriorly with pair of dorsal processes, dorsal thoracic processes long...2
   - Cphth anteriorly without pair of dorsal processes, dorsal thoracic processes small...4
2. Second segment of A1 with curved process, inner seta on P1 enp2 at least half as long as terminal setae... Ancorabolus mirabilis Norman, 1903
   - Second segment of A1 without curved process, inner seta on P1 enp2 much smaller than terminal setae, not reaching half of their length...3
3. Last segment of A1 not covered with small spinules, mandibular palp with three setae, maxillular coxa with one seta...A. confusus Conroy-Dalton and Huys, 2000
   - Last segment of A1 covered with small spinules, mandibular palp with five setae, maxillular coxa without setae...A. hendrickxi Gómez and Conroy-Dalton, 2002
4. Cphth and first two antennular segments lacking coverage with small spinules, female rostrum strongly elongate, inner apical seta on male P3 enp2 as long as apophysis...A. inermis Conroy-Dalton and Huys, 2000
   - Cphth and all antennular segments covered with small

setules, female rostrum small, triangular in shape, inner apical seta on male P3 enp2 remarkably smaller than apophysis...*A. chironi* sp. nov.

Discussion

Systematics

Revising *Ancorabolus* Norman, 1903 has caused some confusion in the past years. While the type material of *A. mirabilis* is lost (cf. George 2001), preventing a redescription of the type species, the material deposited in the Natural History Museum (London) turned out to represent a distinct taxon, *Juxtaramia polaris* Conroy-Dalton and Huys, 2000. Moreover, the material held in the Langian (Stockholm) and Sarsian (Oslo) collections proved to be a mixture of two species, *A. confusus* and *A. inermis*, instead of the supposed *Ancorabolus mirabilis* (Conroy-Dalton and Huys 2000). With *A. hendrickxi* and *A. ilvae* (sp. *inquirenda*), the total number of *Ancorabolus* species increased to six (including the here described *A. chironi* sp. nov.), with the type species *A. mirabilis* being identifiable by Norman's (1911) plate 29 (Figs. 1, 2, 3, 4, 5, 6, 7, 8, 9), only.

According to Gómez and Conroy-Dalton (2002, p. 127), the monophyly of *Ancorabolus* is confirmed by the following apomorphies (plesiomorphies *in square brackets*):

1. Males without lateral wing-like processes on second abdominal somite [processes still present];

2. Cephalothoracic sensillar group V: displacement of sensilla a–c (with associated process) onto spinous projection [all sensilla still on posterior margin, separated from associated process];

3. Modification of male P5 inner element into spiniform and serrate spine [inner element bipinnate seta];

4. All sensilla arising from produced cuticular processes modified [sensilla of normal shape].

As *A. chironi* sp. nov. fits apomorphies 1–4, its allocation into *Ancorabolus* is doubtless. Inside that taxon, however, the relationships remain unclear. According to the cladistic analysis provided by Gómez and Conroy-Dalton (2002), *A. inermis* appears to be the most primitive *Ancorabolus* species, while the remaining *A. mirabilis*, *A. confusus*, *A. hendrickxi* and *A. ilvae* form a monophyletic group that might be justified by:

5. The presence of a pair of dorsal processes anteriorly on cephalothorax [anterior dorsal processes absent];

6. P2–P4 exopodal outer elements elongate and setiform [exopodal outer elements spiniform] (Gómez and Conroy-Dalton [2002, p. 120, armature table] provide a wrong number of outer elements on P2 and P3 exp-3; instead of I, 2, 0 it should be II, 2, 0).

As *A. chironi* sp. nov. lacks the anterior dorsal processes on cphth (character 5), it cannot be assigned to the supposed monophylum *A. confusus*—*A. hendrickxi*—*A. ilvae*—*A. mirabilis* and resembles the rather primitive *A. inermis*. Character 6 must be ignored here, because Conroy-
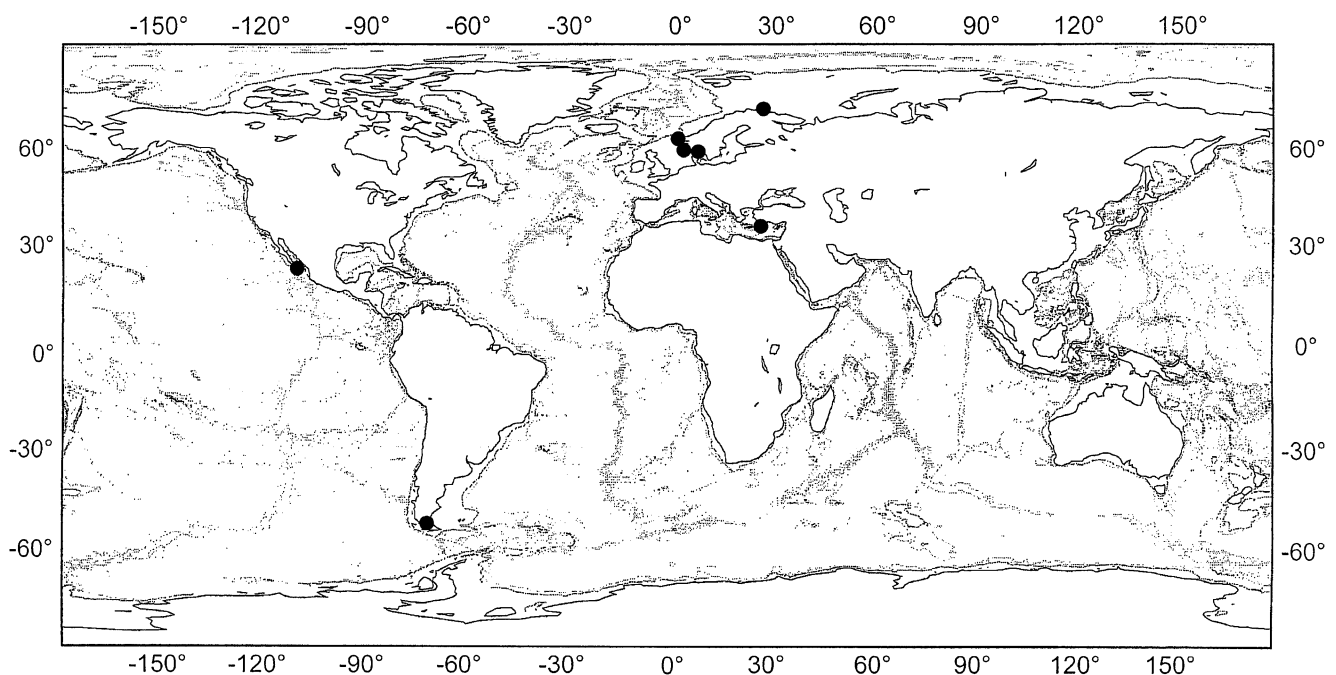

Fig. 9 Global distribution pattern of the genus *Ancorabolus* Norman, 1903

Dalton and Huys ([2000](#)) did not provide descriptions of P2–P4 exopods of *A. confusus* nor of *A. inermis*, while *A. chironi* sp. nov. presents both types of elements (spiniform as well as elongate and setiform, cf. Figs. [5b–d](#)). Re-examination of the type material of *A. ilvae* confirms the rather elongate and setiform outer elements on P2–P4 exp in that species, not reaching, however, the length as in *A. hendrickxi*. This character should be neglected for systematic analysis, as it seems to be quite weak.

In addition to character 5 that might be interpreted as an evident and well-founded apomorphy, another character of similar high phylogenetic quality produces a remarkable incongruence:

7. Second segment of female A1 with "curved process" (Norman [1911](#); "re-curved" in Gómez and Conroy-Dalton [2002](#)) [curved process absent].

That apomorphy is present in *A. inermis* (cf. Conroy-Dalton and Huys [2000](#), Fig. [3a](#)) and *A. chironi* sp. nov. (cf. Fig. [4a](#)), but also in *A. mirabilis* (cf. Norman [1911](#), Plate 29, Fig. [2](#)) and (less strong developed) in *A. ilvae* (cf. George [2001](#), Fig. [2b](#)). Therefore, basing on character 7, a monophylum *A. chironi sp. nov.—A. inermis—A. ilvae—A. mirabilis* might be justified. Such a monophylum would stand opposite to the formerly named taxon *A. confusus—A. hendrickxi—A. ilvae—A. mirabilis*. The incongruence is due to the presence of both derived stages of characters 5 and 7 in *A. mirabilis* and *A. ilvae*. Contrary to Gómez and Conroy-Dalton ([2002](#)) we do not believe that a peculiar feature like character 7—peculiar because of its characteristic shape, its position on the antennular segment and the fact, that no other ancorabolid taxon possesses an even similar projection—has developed more than once independently, in particular in such closely related species, and it is quite obvious that it represents a synapomorphy of all species bearing it. Its development might be a derived condition; since it is absent in other members of the *Ancorabolus*-group. Therefore, *A. confusus* and *A. hendrickxi*, which lack that curved process (1) present the rather primitive condition, or (2) have reduced that process secondarily. Since the very closely related *Juxtaramia polaris* lacks such curved process as well (Conroy-Dalton and Huys [2000](#)), this process may represent a derived condition that has to be interpreted as a synapomorphy of all corresponding species. That assumption is much more plausible than the alternative, which would be the development of such curved process in *Ancorabolus* (compared with *Juxtaramia*), its retention in *A. chironi* sp. nov., *A. ilvae*, *A. inermis*, and *A. mirabilis*, but lost again in *A. confusus* and *A. hendrickxi*.

However, at this time it is impossible to prove the phylogenetic value of both the curved process (character 7) and the dorsal anterior processes on cphth (character 5), applying for the latter the same argumentation as for the curved process: *Juxtaramia polaris* lacks such dorsal processes, so their absence in *A. chironi* sp. nov. and *A. inermis* may represent the primitive condition rather than a secondary loss. The combination of the cephalic anterior dorsal processes and the presence of the curved antennular process cause a conflict. Both features are of high quality, as they are complex, characteristic and restricted to limited numbers of closely related species only. However, whereas *A. confusus* and *A. hendrickxi* share character 5 but lack character 7; and while *A. inermis* and *A. chironi* sp. nov. share character 7 but lack character 5, *A. mirabilis* shows both derived stages. The same applies to *A. ilvae*, whose CV presents cephalic anterior dorsal processes and a curved antennular process also clearly indicated (George [2001](#)). Perhaps *A. ilvae* may play a crucial role when analysing this problem. Since *A. ilvae* is known by copepodid stages only, the record of adult stages might reveal if the curved antennular process, only weakly developed in CV, becomes stronger or lost in the adult, the latter pointing to its phylogenetical secondary loss in *A. confusus* and *A. hendrickxi*.

In their cladogram, Gómez and Conroy-Dalton ([2002](#): Fig. [9](#), p. 126) made reference to one additional character, the fusion of the former first and second antennular segments, resulting in a three-segmented female A1 (character 12). This character is omitted here, because (1) apart from *Juxtaramia polaris*, all remaining taxa of the *Ancorabolus*-group, including the most basal taxon *Arthropsyllus*, show a three-segmented female A1; thus, the distribution of that character over the taxa is highly incongruent [according to Gómez and Conroy-Dalton ([2002](#)), the fusion of former first two segments in A1 must have occurred four times independently]; (2) as demonstrated by George ([2001](#)) for *A. ilvae*, none of the copepodid stages (not proved for CIII) shows more than three antennular segments. This might not only be true for *Ancorabolus* but for all taxa inside the *Ancorabolus*-group. It seems unlikely that just *Juxtaramia polaris*, being a derived member of the *Ancorabolus*-group, should have retained partly separated first and second A1 segments. Inspection of ontogenetic stages of *J. polaris* will have to be examined to shed more light on this issue.

Besides the above mentioned two derived characters 5 and 7, almost all apomorphies listed by Gómez and Conroy-Dalton ([2002](#), pp. 125–127) for *Ancorabolus* species show similar incongruent features. Just *A. confusus* and *A. hendrickxi* are characterized as monophylum, sharing the synapomorphic elongate spinous extension on cephalothoracic sensillar group V. Furthermore, *A. hendrickxi* can be characterized by the loss of all setae on maxillular coxal endite. Regarding *A. chironi* sp. nov., comparison with remaining *Ancorabolus* species reveals three apomorphies (plesiomorphies *in square brackets*):

8. Cphth with patterns of fine setules (cf. Fig. 3a) [setules absent];
9. Mxp claw with conjunction and fine setule row (cf. Fig. 4f) [claw bare, no conjunction];
10. Male P3 enp2: inner terminal seta small (shorter than apophysis; cf. Fig. 6c) [seta long (longer than apophysis)].

Based on these apomorphies, we consider the erection of a new species, *Ancorabolus chironi* sp. nov., as sufficiently justified. No other *Ancorabolus* species shares these features. Comparison with (re)-descriptions provided by Conroy-Dalton and Huys (2000) and Gómez and Conroy-Dalton (2002) reveals that none of the species (re-)described therein shows patterns of setules on cphth (character 8), nor the derived maxillipedal claw (character 9) or the size-reduced inner terminal seta on male P3 enp2 (character 10). All remaining species are characterized by apomorphic but convergent characters that are partly present even in other genera (cf. Gómez and Conroy-Dalton 2002). Future findings of *Ancorabolus* species shall enable the elucidation of the phylogenetic relationships within that genus and the whole *Ancorabolus*-group.

Distribution patterns of the genus *Ancorabolus*

Conroy-Dalton and Huys (2000, p. 345) provide a detailed list of the distribution records of all so far known members of the *Ancorabolus*-group. At that time, three *Ancorabolus* species were known to science: *A. mirabilis*, *A. inermis*, and *A. confusus*. All three species were reported from England, Norway, Scotland, and Sweden. Conroy-Dalton and Huys (2000) additionally list a fourth, undetermined species "*Ancorabolus* sp. indet.", whose distribution seems to be also restricted to the above mentioned region. Later on, George (2001) reported *Ancorabolus ilvae* from the Magellan Region (South America). Since *A. ilvae* was described from a CV stage, it was relegated to *species inquirenda* (Gómez and Conroy-Dalton 2002). Gómez and Conroy-Dalton (2002) reported *A. hendrickxi* from north-western Mexico. With *A. chironi* sp. nov. the distribution of *Ancorabolus* extends to the Mediterranean Sea. The genus shows a widespread but quite disjunctive distribution (Fig. 9), which has recently been observed in several ancorabolin genera, like e.g. *Ancorabolina* George, 2006 (George 2006c; George and Tiltack 2010; Gheerardyn and George 2010), *Ceratonotus* Sars, 1909 (Conroy-Dalton 2003a, George 2006a), *Dendropsyllus* Conroy-Dalton, 2003 (Conroy-Dalton 2003a, George 2006a, George and Schminke 1998), *Dorsiceratus* Drzycimski, 1967 (Coull 1973; Drzycimski 1967; George 2006b), and *Echinopsyllus* Sars, 1909 (Conroy-Dalton 2003b, Wandeness et al. 2009). Moreover, *Ancorabolus* seems to be a eurybathic taxon,

whose vertical distribution ranges from 29 m (Sars 1909) down to 1,985 m depth (Gómez and Conroy-Dalton 2002), and enclosing sediment types from mud and silt up to sand and even gravel (cf. Conroy-Dalton and Huys 2000). As already noted by George and Tiltack (2010), *Ancorabolina*, *Ceratonotus*, *Echinopsyllus*, and also *Ancorabolus* are an indication against the formerly assumed preference of Ancorabolidae for deep-sea habitats (Hicks and Coull 1983; Huys and Boxshall 1991; Lang 1948). At least the taxon Ancorabolinae is characterized by eurybathic taxa, which suggests that sediment and other biotic/abiotic variables rather than depth are important for the bathymetric distribution of (at least) certain meiobenthic groups.

The Anaximenes Seamount was sampled at six stations across its surface, but *A. chironi* sp. nov. was only found in samples gathered from a mud volcano located on a flank of the Anaximenes Seamount (Fig. 1) (cf. Charlou et al. 2003). Depending on the rate at which these features expel gas, fluids and solids, typical faunal communities aggregate in surrounding areas. Rapid flux systems show a lack in macrofauna and are characterized by mud-prone features and smaller fauna such as bacterial mats and meiofauna, while moderate to slow flux systems are characterized by mineral-prone features, tube worm communities and mussel beds (Fisher et al. 2007). This suggests that the present new species might be associated with rapid flux systems and possibly could be found in nearby and similar habitats. However, the remainder of the MUC cores gathered on the Anaximenes Seamount showed that *Ancorabolus chironi* sp. nov. is restricted to the mud volcano site, although similar muddy sediments were observed elsewhere.

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