First record of the rare deep-water benthopelagic genus
Crassarietellus (Copepoda: Calanoida: Arietellidae) from the high
Arctic with the description of a new species Crassarietellus
septentrionalis sp.n.

Первая находка редкого глубоководного бентопелагического рода
Crassarietellus (Copepoda: Calanoida: Arietellidae) в Северном
Ледовитом океане с описанием нового вида Crassarietellus
septentrionalis sp.n.

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ABSTRACT. A new deep-water benthopelagic copepod species
Crassarietellus septentrionalis is described from the Svalbard area in the high Arctic. The
new species shares the main characters of the body structure and the morphology of oral parts and swim-
ing legs with the genus Crassarietellus Ohtsuka, Box-
shall et Roe, 1994 of the Arietellidae and differs from its congers in the smaller size, the integument, which
is not pitted, some details of the antennule and oral
parts armament and the caudal rami seta IV, which is of
peculiar swollen shape. An intact male P5 of Crassari-
etellus septentrionalis sp.n. is herein described for the
first time for the genus. The genus Crassarietellus is
for the first time recorded in the high Arctic (81°N).
This represents the northernmost finding of the genus.

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РЕЗЮМЕ. Новый глубоководный бентопелаги-
ческий вид копепод Crassarietellus septentrionalis
описан из района Шпицбергена из высоких широт
Арктики (81°N). Новый вид соответствует роду
Crassarietellus Ohtsuka, Boxshall et Roe, 1994 из се-
мейства Arietellidae по следующим признакам: стро-
ение тела, морфология ротовых органов и плава-
тельных ног и отличается от сородичей меньшими
размерами, отсутствием инкрустации хитиновых
покровов, отдельными деталями вооружения ан-
тенн и ротовых частей и своеобразной вздутой
формой щетинки IV каудальных ветвей. Впервые
для рода здесь описана неповрежденная P5 самца
посому Crassarietellus septentrionalis sp.n. Род
Crassarietellus впервые зарегистрирован в высоких
широтах Арктики (81° с. ш.) и эта находка является
самой северной, зарегистрированной для рода.

Introduction

The calanoid copepod family Arietellidae includes 52 species in 14 genera that inhabit both shallow and
deep-waters of the pelagic and benthopelagic environment
of the world oceans. Arietellids constitute a sig-
ificant component of the benthopelagic calanoid cope-
pod community and their genera are mainly near-bot-
tom dwellers [Ohtsuka et al., 2005]. Recent descrip-
tions of new benthopelagic arietellid genera and spec-
ies contributed to our knowledge of their diversity in
the vicinity of the sea bed and demonstrate, that most
of the near-bottom genera are rare and monotypic (6
genera), or comprise only 2–6 species (5 genera) [Oht-
suka, Boxshall, 2004; Soh et al., 2013; Komeda et al.,
2021]. The new species of Crassarietellus described
herein, belongs to the latter group.

Representatives of the Arietellidae demonstrate a
wide geographical distribution in the oceans of the
The genus *Crassarietellus* includes two species: *Crassarietellus huysi* Ohtsuka, Boxshall et Roe, 1994 (known from one female) and the unnamed *Crassarietellus* sp. (known from a male); both are recorded from the deep-waters of the Atlantic Ocean at about 20–21 and 38°N [Ohtsuka et al., 1994]. Individuals of the new species described herein are the northernmost reported members of *Crassarietellus*; they are found in the Arctic Ocean.

The new species shares with the genus *Crassarietellus* several important taxonomic characters. However, it differs in some features and is for now tentatively placed in the genus, as little is known about the morphology of the genus in general.

### Material and methods

Benthopelagic arietellid copepods of the genus *Crassarietellus* (5 females and 1 male) were collected with an epibenthic sledge [Brenke, 2005] during the PASCAL (Physical feedbacks of Arctic, Planetary boundary layer, Sea ice, Cloud and Aerosol) expedition on board of the RV Polarstern, cruise PS 106–1 in the Arctic Ocean adjacent to Svalbard on the Yermak Plateau slope in 2017.

Specimens were stained by adding a solution of chlorazol black E dissolved in 70% ethanol/30% water. The genital field structures were studied after processing the specimens in a solution of lactic acid/50% water 50%. Oral and swimming legs were dissected, mounted in glycerol and figured using a *lucida*. Specimens were taken from glycerol, rinsed with distilled water, dehydrated in an ascending ethanol series (SEM). The specimens were photographed with a camera lucida.

Two specimens were prepared for scanning electron microscopy (SEM). The specimens were taken from glycerol, rinsed with distilled water, dehydrated in an ascending ethanol series and then dried for 10–12 min with hexamethyldisilazane [Bock, 1987]. The preparations were photographed uncoated on a HITACHI TM-1000 scanning electron microscope.

The following abbreviations are used in the descriptions: P1–P5, legs 1–5. Free segments of the antennule are designated by Arabic numerals, ancestral segments by Roman numerals. One seta and one aesthetasc on a segment of the antennule are designated: 1s + 1ae, “1?” indicates that a setal element was broken and only the scar at the location of its attachment was counted. Terminology and definitions for the antennule segmentation and setation, antenna exopod setation, maxilla and maxilliped segmentation and setation, the antennule segmentation and setation, antenna exopod with 3 setae. The specimens were photographed uncoated on a HITACHI TM-1000 scanning electron microscope.

### Taxonomy

**Family Arietellidae** Sars, 1902

**Genus *Crassarietellus*** Ohtsuka, Boxshall et Roe, 1994

**Crassarietellus septentronialis** sp.n.

**Figs 1–8.**

**MATERIAL.** Holotype, adult female, dissected, body length 1.75 mm (SMF 37257/1–5), Arctic Ocean, 81°55.3’N 10°05.09’E, PASCAL expedition, station 24–5, 7 June 2017, above the seabed at a depth of 959 m. Paratype, adult female, dissected, body length 1.80 mm (ZIN 91160), same metadata data as for holotype. Additional material, 3 females, body length 1.70 mm (specimen 1, urosporne destroyed during SEM study); 1.70 mm (specimen 3) and 1.85 mm (specimen 2, body destroyed during SEM study) and 1 male, body length 1.50 mm (ZIN 91161).

**DESCRIPTION.** Adult female, total length 1.70–1.85 mm (holotype 1.75 mm); prosome 3.50–4.1 (holotype 4.1) times as long as urosporne. Cephalosome and pediger 1 separate, pedigers 4 and 5 fused; posterior corners of urosporne produced into rounded lobes reaching posterior end of genital double-somite (Fig. 1A–B). Urosporne of 4 somites, integument not pitted; genital double-somite wider than long (Fig. 1E); with large spermathecae directed anteriorly; gonopores paired, and paired copulatory pores are posterior to gonopores, ventral flap absent (Figs 1F–G, 8A–D); 3 integumental perforations, function unidentified, present between copulatory pore and gonopore (SB–D). Rostrum triangular, length longer than wide, with vestigial seta I, well developed setae II–VI, seta IV differs from setae II–III and V–VI in the peculiar swollen shape (holotype), seta VII originating dorsally near base of seta VI (Fig.1H).

Antennules (Figs 2A–D) reaching to the anterior border of pedigerous somite 1 (holotype and paratype), or nearly to posterior border of pedigerous somite 1 (specimen 1, broken in specimens 2 and 3); left antennule of 21 distinctly free segments (Fig. 2A–B), right antennule of 22 distinctly free segments (Fig. 2C–D); armature as follows: I–III–7s+1ae, IV–2s, V–2s+1ae, VI–2s, VII–2s+ae, VIII–XII–2s each, XIV–2s+1ae, XV–XVI–2s, XVII–XIX–2s+1ae, XX–2s, XXI–2s+ae. In left antennule segment XXII with 1s, this segment is shorter than in the right antennule (Fig. 2A–B), segment XXII with 1s and fused to segment XXIV, segments XXIV–XXVII–12s + 2ae (holotype, paratype), or with 13s + 2ae (specimen 1). In right antennule segment XXII with 1s, this segment is longer than in left antennule, segment XXIII with 1s and separated from segment XXIV (Fig. 2C–D), segments XXIV–XXVIII with 12s + 2ae. In specimen 1, segments I–V fringed with long setules along posterior margin; in the other specimens setules absent.

Antenna (Fig. 2E–F), coxa without setae, basis with 1 seta, first endopod segment nearly as long as exopod, with 1 seta and without minute spines distally, second with 3 + 5 setae and without spinules; exopod indistinctly 10-segmented, setal formula 0,0,0,1,1,1,1,0 and 2 setae.

**Mandible (Fig. 3A–C), gnathobase strong, without setules; cutting edge with 3–4 acute teeth, dorsal most bifid at tip, possessing 4 small spines nearly at its basement; basis without setae and with 2 patches of minute spines, exopod 5-segmented, with 1, 1, 1, 1, and 2 setae; endopod rudimentary 1-segmented with 2 setae of unequal length.

Maxillules (Fig. 3D), precoxal arthrite without spines, with 6 terminal spines, all lacking strong spines; coxal endite with 1 seta, coxal epipodite with 3 setae and scar in one limb of holotype or 3 setae (holotype and paratype), basis without minute enditic seta and setules, endopod rudimentary, of one segment with 2 setae of unequal lengths, exopod with 3 setae.
Fig. 1. *Crassarietellus septentrionalis* sp.n. Female, holotype: A — habitus, dorsal view; B — habitus, lateral view; C — rostrum, dorsal view; D — rostrum, lateral view; E — urosome, dorsal view; F — genital double somite, ventral view; «cp», copulatory pore, «g», gonopore; G — genital double somite, lateral view; «cp», copulatory pore, «g», gonopore; H — anal segment and caudal rami, ventral view. Scale bars: for A–B — 0.5 mm, remaining figures — 0.1 mm.

Рис. 1. *Crassarietellus septentrionalis* sp.n. Самица, голотип: А — общий вид дорсально; B — общий вид латерально; C — рострум, дорсально; D — рострум, латерально; E — уросома, дорсально; F — генитальный сомит, вентрально; «cp», копуляторная пора, «g», гонопор; G — генитальный сомит, латерально; «cp», копуляторная пора, «g», гонопор; H — анальный сегмент и каудальные ветви, вентрально. Масштаб: А—В — 0,5 мм, остальные рисунки — 0,1 мм.
Fig. 2. *Crassarietellus septentrionalis* sp.n. Female, holotype: A — left antennule; B — left antennule, segments XXII–XXVIII; C — right antennule, segments XXII–XXVIII; D — right antennule, segments XIX–XXVIII; E — antenna; F — antenna, exopod. Scale bars 0.1 mm.

Рис. 2. *Crassarietellus septentrionalis* sp.n. Самка, голотип: A — левая антенна; B — левая антенна, сегменты XXII–XXVIII; C — правая антенна, сегменты XXII–XXVIII; D — правая антенна, сегменты XIX–XXVIII; E — антенна; F — антенна, экзопод. Масштаб 0,1 мм.
Fig. 3. *Crassarietellus septentrionalis* sp.n. Female, holotype: A — mandible, palp; B, C — mandible, gnathobase, different limbs; D — maxillule; E — maxilla. Scale bars 0.1 mm.

Рис. 3. *Crassarietellus septentrionalis* sp.н. Самка, голотип: A — щупик мандибулы; B, C — гнатобазы обеих мандибул; D — максиллула; E — максилла. Масштаб 0,1 мм.
Fig. 4. Crassarietellus septentrionalis sp.n. Female, holotype: A — maxilliped; B — maxilliped, segments V–VI; «a», «b», outermost terminal setae, «c», «d», innermost terminal setae; C — P1; D — P1, exopod; E — P5 « L », left, «R», right. Scale bars 0.1 mm.

Рис. 4. Crassarietellus septentrionalis sp.n. Самика, гологипт: A — максиллипеда; B — максиллипеда, сегменты V–VI; «a», «b», наружные терминальные щетинки, «c», «d», внутренние терминальные щетинки; C — P1; D — P1, экзоподит; E — P5 «L», левая, «R», правая. Масштаб: 0,1 мм.
Maxilla (Fig. 3E), praecoxal endite with 1 seta and 1 small attenuation; coxal endite and basal endites with 2 setae each; enditic-like lobe of proximal endopodal segment with strong spine, endopod of 4 segments with 8 strong setae.

Maxilliped (Fig. 4A–B), praecoxal endites of syncoxa with 0, 0 and 1 setae (from proximal to distal); coxal endite of syncoxa with 2 setae, basis with 2 medial setae and 2 patches of spinules proximally and in the middle of the segment; endopod with 1, 4, 4, 3, 3, and 4 setae; innermost seta on endopod segments 4 and 5 relatively long; endopod segment 6 with setae “a” and b” well developed, seta “c” chitinized, bearing row of simple spinules, seta “d” long with spinules.

P1 (Fig. 4C–D), coxa with medial seta and lateral knob at the middle length covered by short spinules; basis with lateral seta and medial seta distomedially slightly curved, anterior edge with tiny denticles along the base of endopod segment 1, details of Von Vaupel Klein’s organ [Forshell, Ferrari, 2014] were not considered in this study; endopod 3-segmented; endopod segments 1 and 2 respectively with two
Fig. 6. Crassarietellus septentrionalis sp.n. Male: A — habitus, dorsal view; B — habitus, lateral view; C — posterior prosome and urosome, dorsal view; D — urosome, dorsal view; E — P5, «L», left, «R», right. Scale bars for A–B — 0.5 mm, remaining figures — 0.1 mm.

Fig. 6. Crassarietellus septentrionalis sp.n. Самец: A — общий вид дорсально; B — общий вид латерально; C — задняя часть просомы и уросома, дорсально; D — уросома, дорсально; E — P5, «L», левая, «R», правая. Масштаб: A–B — 0,5 мм, остальные рисунки — 0,1 мм.
Fig. 7. *Crassarietellus septentrionalis* sp.n. Male: A — left antennule, segments I–XV; B — left antennule, segments XVI–XXVIII; C — left antennule, segments XIX–XXVIII; D — right antennule. Scale bars 0.1 mm.

Рис. 7. *Crassarietellus septentrionalis* sp.n. Семец: A — левая антенна; сегменты I–XV; B — левая антенна, сегменты XVI–XXVIII; C — левая антенна, сегменты XIX–XXVIII; D — правая антенна. Масштаб 0,1 мм.
Fig. 8. *Crassarietellus septentrionalis* sp.n. Female: A, C — genital somite of additional specimen 1, ventral view; «cp», copulatory pore, «g», gonopore (arrowed); B, D — genital somite of additional specimen 2, lateral view; «cp», copulatory pore, «g», gonopore (arrowed). Scale bars: A, B — 50 µm, C, D — 15 µm.

P2–P3 (Fig. 5A–B), coxa with medial setae; basis without seta; endopods and exopods 3-segmented; endopod segment 1 with one lateral seta, endopod segment 2 with two lateral setae and endopod segment 3 with two lateral, two terminal and four medial setae; exopod segments 1 and 2 with one lateral and one medial seta, segment 3 with three lateral, one terminal spine and five medial setae.

P4 (Fig. 5C), coxa without medial setae; basis with seta in proximal part of the segment laterally; endopod segment 1 with one medial seta, segment 2 with two medial setae and segment 3 with two lateral, two terminal and three medial setae; exopod segments 1 and 2 with one lateral and one medial seta, segment 3 with three lateral, one terminal spine and five medial setae.

P5 (Fig. 4E), right and left coxae separate from intercoxal sclerite and basis; right basis with small lateral spine (holotype), or without spine (paratype, specimens 1 and 2), left basis with developed lateral seta (holotype, paratype and specimen 1), or without seta (specimen 2); endopod 1-segmented, present at the right leg with 1 seta (specimen 2), or two setae (holotype, paratype and specimen 1); exopod 1-segmented with one lateral spine, two lateral and one terminal spine-like attenuations and one inner spine.

Adult male, total length 1.50 mm, prosome 4.2 times as long as urosome. Cephalosome and pediger 1 separate, pedigers 4 and 5 fused; posterior corners of prosome produced
into rounded lobes, slightly asymmetrical, left reaching middle of urosome somite 3 (Fig. 6A–C). Urosome of five segments, integument not pitted (Fig. 6D). Rostrum as in female. Caudal rami symmetrical, longer than wide, without seta I, setae II–VI well developed, seta IV differs from setae II–III and V–VI in the peculiar swollen shape, seta VII originating dorsally-medially near base of seta VI (Fig. 6A).

Antennules (Fig. 7A–E), right antennule non-geniculate, reaching to the anterior border of pedigerous somite 1, of 22 free segments (Fig. 7D–E); armature as follows: I–III–6s+3ae,

IV–X–2s+ae, XI–2s, XII–2s+ae, XIII–2s, XIV–XIX–2s+1ae, XX–2s, XXI–2s+ae, XXII–XXIII–1s each, XXIV–XXVIII–11s+1ae. Left antennule geniculated, reaching the middle length of pedigerous somite 1, of 19 free segments (Fig. 7A–C); armature as follows: I–IV–6s+4ae+2?, V–XII–2s+ae, XIII–2s, XIV–XVIII–2s+ae, XIX–1 spine with denticles+2 sharpen attenuations +1ae, XX–1s+1ae, X XI–XXII fused, with 3s+2 processes+1ae, XXIV–XXVIII–10s+2ae.

Antenna, maxillula, maxilla, maxilliped (setae at segments 4 and 5 partly broken) and P1–P4 as in female, except for: mandible basis without setae and with two patches of minute spinules.

P5 (Fig. 6E), right and left coxae articulate with the intercoxal sclerite; basis articulates with the coxa, and has small setae at the right basis and well-developed plumose seta at the left basis; both legs lacking endopod; exopods 3-segmented, left and right exopod segments 1 with spine and pointed attenuation distally. Left leg exopod segment 2 oval, longer than wide and possesses lateral spine; segment 3 smaller then segment 2, tapering distally, with two short lateral setae and terminal spine. Right leg exopod segment 2 with lateral spine and medial bifid attenuation (arrowed on Fig. 6E); exopod segment 3 nearly as long as segment 2, possess two spine-like small lateral spines and terminal spine.

ETYMOLOGY. The species name “septentrionalis” means “northerly” and refers to the finding of the species in the high Arctic.

REMARKS. The new species shares with the arietellid genera Crassarietellus and Campaneria Ohtsuka, Boxshall et Roe, 1994 the possession of two lateral spines on exopod segment 3 of P1 and the possession of fewer than 8–9 setae on the maxillule epipodite [Komeda et al., 2021].

The male of the new species differs from the monotypic genus Campaneria, described from one male specimen, in the following characters: 1) the antenna exopod is indistinctly 10-segmented (vs indistinctly 8-segmented in Campaneria); 2) the innermost seta of the maxilliped endopod segment 5 is well developed (vs short in Campaneria), and 3) the outermost seta of the maxilliped endopod segment 6 is not rudimentary (vs rudimentary in Campaneria).

The species Crassarietellus septentrionalis sp.n. shares with the genus Crassarietellus the main characters of the body structure and the morphology of oral parts and swimming legs [Ohtsuka et al., 1994]. The new species, however, does not completely fit to the generic key characters of Crassarietellus [Ohtsuka et al., 1994; Komeda et al., 2021] and differs in lacking a ventral flap on the genital double-ming legs [Ohtsuka et al., 1994]. The fewer number of setae on segments XXIV–XXVIII compared to Crassarietellus sp. may be due to their breakage in the studied specimen.

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Compliance with ethical standards
Conflict of interest: The authors declare that they have no conflict of interest.
Ethical approval: No ethical issues were raised during our research.

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