






# *Bathypsirus sonnei* sp. nov. – A new species of the rare deep-sea isopod genus (Crustacea, Isopoda, Asellota) from the Aleutian Trench, north-eastern Pacific with notes on the Bathypsurinae<sup>☆</sup>

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## ABSTRACT

A new species of the genus *Bathypsirus* Nordenstam, 1955 (Munnopsidae, Bathypsurinae) is described from the Aleutian Trench in the North-east Pacific collected during the RV Sonne expedition AleutBio (Aleutian Trench Biodiversity Studies) (SO293) from depths between 4224–5170 m from both the northern sub-Arctic slope as well as the southern North Pacific slope of the Aleutian Trench. *Bathypsirus sonnei* sp. nov. differs from the other species of the genus in several characters related to the mouthparts and pleopod 2 of the female.

*Bathypsirus sonnei* sp. nov. is 65 mm long, making it the largest munnopsid isopod ever sampled. The genus *Bathypsirus* is considered rare, with only a few specimens sampled to date, and only limited genetic data available prior to this study. In this study, we present the first mitochondrial DNA data for the genus, specifically COI and 16S sequences. Our results indicate that, despite being collected from opposite sides of the trench, the specimens belong to the same species.

## 1. Introduction

Exploration of the deep sea has unearthed a plethora of previously unknown species, underscoring the importance of species discovery in these uncharted regions. This not only advances our understanding and knowledge of the Earth's biological landscape, but also provides valuable insights into the structure and functioning of different ecosystems. In this context, the process of discovering deep-sea species shapes our understanding of evolutionary adaptations and ecological relationships, and underpins the importance of stewardship of these fragile and complex ecosystems.

Deep-sea regions encompass a wide array of habitats and ecosystems, ranging from the shelf break to the extensive abyssal plains and the Earth's deepest points, the hadal trenches. The unique challenges posed by these environments have led to distinctive adaptations in the deep-sea crustaceans that inhabit them. Among these, numerous species exhibit brood care or have lecithotrophic larvae (Pearse et al., 2009 and

references therein). Many crustaceans in the deep sea are scavengers. The phenomenon of deep-sea gigantism, where some species attain unusually large body sizes, contrasts with the prevalent trend of smaller-sized species dominating these ecosystems (McClain et al., 2006). In the food-deprived deep sea, smaller body sizes would appear to be more advantageous metabolically (van der Grient & Rogers, 2015). However, numerous deep-sea species do not consistently exhibit reduced sizes if compared to their shallow-water counterparts. This is exemplified by asellote isopods, where Wolff (1962) found deep-sea genera to be modestly larger than their shallow-water representatives.

The isopod family Munnopsidae Lilljeborg, 1864 exhibit a wide-spread distribution across various depths within the world oceans (Malyutina & Brandt, 2020) and can range from a few millimetres in size up to several centimetres (Kussakin, 2003). Within the munnopsid subfamily Bathypsurinae Wolff, 1962, the only two genera *Bathypsirus* Nordenstam, 1955 and *Paropsirus* Wolff, 1962, are remarkably large, with specimens recorded so far reaching 60 mm in size (Wilson

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and Ah Yong, 2015). Each genus comprises of two species. This study focuses on a newly identified species of *Bathyopsurus*, collected from the abyssal waters of the Aleutian Trench. Specimens within this species stand as the largest munnopsid isopod found to date.

The genus *Bathyopsurus* consists of the type species *B. nybelini* described from the Puerto Rico Trench between 5500–7900 m depth and *B. abyssicolus* (Beddard, 1885) from the abyss off the Azores. Both species are differentiated by articles of the antenna and the mandibular *pars incisiva*. In *B. nybelini* Nordenstam, 1955 the article 2 of antenna is longer anteriorly than posteriorly and the five teeth in the left *pars incisiva* are arranged at an angle of about 90°. In *B. abyssicolus* (Beddard, 1885) the second article of the antenna is of about equal length anteriorly and posteriorly and, moreover, the five teeth of the mandibular *pars incisiva* are arranged in a semi-circle.

The newly discovered species, collected during the recent AleutBio expedition (Brandt, 2022), represents the northernmost recorded distribution of the Bathyopsurinae (Fig. 1). It is distinguished from the previously described species, *B. abyssicola* (Beddard, 1885) and *B. nybelini* Nordenstam, 1955, by notable morphometric differences in the mouthparts and pleopods. This study provides a comprehensive description of the species and its diagnostic features.

## 2. Methods

### 2.1. Sample collection

Specimens of the new species were collected from the Aleutian Trench using an epibenthic sledge (Brandt and Barthel, 1995; Brenke, 2005) during the RV *Sonne* expedition (SO 293) as part of the AleutBio (Aleutian Trench Biodiversity Studies) project. Samples were collected from a minimum depth of 4224 m on the northern slope at station 4–9 (51°43'N 170°29'E) to a maximum depth of 5170 m at station 10–9 (51°41'N 166°28'E) on the southern slope of the Aleutian Trench.

Upon retrieval of the sample, the cod end was sorted in a cool room (2 degrees), fixed in pre-cooled 96% undenaturated ethanol. In the laboratory, the material was investigated and identified using a Wild M5 dissecting microscope and illustrated using a Leica M60 microscope,

equipped with a camera lucida. Photographs have been taken on board by Anne-Helene Tandberg and at Senckenberg in Frankfurt am Main (Germany) by Sven Tränkner and Andreas Kelch.

The terminology and measurements follow Wolff (1962) and Wilson (1989). The total body length was measured medially from the tip of the rostrum to the posterior tip of the pleotelson. We used the dorsal view for measuring width, while the length of the body segments is measured in lateral view.

### 2.2. Extraction, amplification and sequencing

For extraction, tissue samples were taken from each specimen. Residual ethanol was eliminated by pipetting and then allowing the tissue to air dry at room temperature. The extraction process adhered to the protocol described by Gilbert et al. (2007). A fragment of the Cytochrome Oxidase subunit I (COI) gene was amplified using universal primers LCO1490/HCO2198 Folmer et al. (1994) and degenerate primers LCO1490-JJ/HCO2198-JJ (Astrin & Stüben, 2008), in combination with repliQa HiFi ToughMix (Quantabio, USA). The PCR conditions followed those described by Riehl et al. (2014) for LCO1490/HCO2198 and Hou et al. (2007) for LCO1490-JJ/HCO2198-JJ, with the exception that the denaturation temperature was adjusted to 98 °C to account for the specific properties of the master mix. The amplification of fragments of the 16S rRNA gene was carried out using the SF/SR primer pair (Tsang et al., 2009). The PCR protocol included an initial denaturation at 98 °C for 1 min, followed by 36 cycles of 10 s of denaturation at 98 °C, 10 s of annealing at 45 °C, and 10 s of extension at 68 °C. These were followed by a final extension at 68 °C for 1 min. Sanger sequencing was carried out at the Senckenberg BIK-F Laboratory using the same primers employed in the PCR process.

### 2.3. Editing and Aligning

COI and 16S sequences of the four specimens were edited using Geneious 9.1.8 (<https://www.geneious.com>). The sequences were compared to sequences of selected isopods available from GenBank

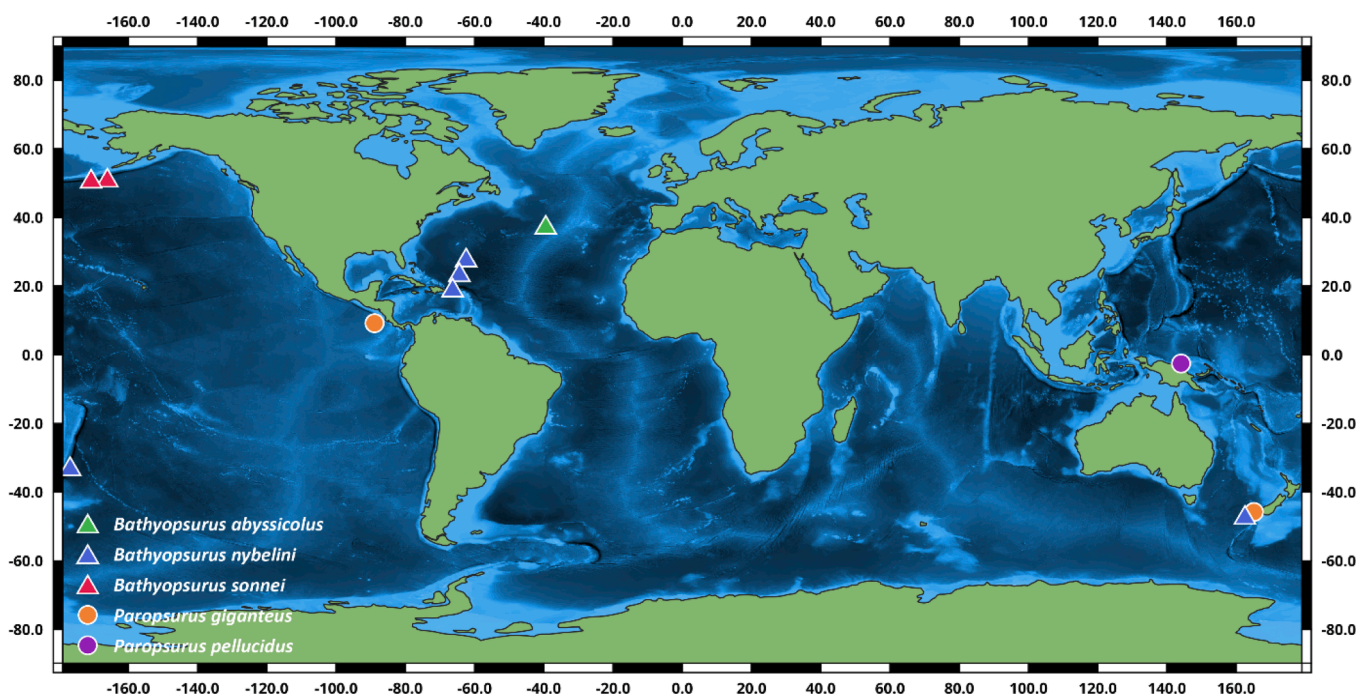


Fig. 1. Global distribution map of all known species of the Bathyopsurinae (Munnopsidae). Distributional data for all bathyopsurid species except *Bathyopsurus sonnei* sp. nov. were inferred from the respective literature (Beddard, 1885; Nordenstam, 1955; Wolff, 1962).

(Table 2). The phylogenetic analyses were using maximum likelihood (ML) using the COI/16S sequences alignment with IQ-TREE 1.6.12 (<http://www.iqtree.org/>). Ultrafast bootstrap analyses were used to assess for node support performed under standard parameters. The phylogenetic tree was visualized using ITOL-Webtool (<https://www.itol.embl.de>).

#### 2.4. Environmental variables

Environmental data recorded at the maximum depth (benthic layers) were downloaded from the “global environmental datasets for marine species distribution modelling” Bio-ORACLE (<http://www.bio-oracle.org/>; Tyberghein et al., 2012; Assis et al., 2017). Data were assembled by a combination of satellite and in situ observations, for a period of 14 years (2000–2014; Assis et al., 2017).

### 3. Results

#### 3.1. Taxonomy

Munnopsidae Lilljeborg, 1864.

Bathyopsurinae Wolff, 1962.

Bathyopsurus Nordenstam, 1955.

Synonymy: *Bathyopsurus* Nordenstam, 1955: 205; Kussakin, 2003: 335; Brandt et al. 2004: 276.

**Diagnosis** (changed after Nordenstam, 1955): Front part of the head, anteriorly from the incisions for the antennulae and the antennae short, trapezoidal and separated from the large posterior part of the head by a furrow.

Four anterior pereonites of about equal length, the first one reaching no further down laterally than the others, not embracing head. Antennulae and antennae situated dorsally on the head. Antennula article 1 anteriolaterally expanded into a broadly rounded lobe. Article 2 of antennula almost quadratic in shape. Mandibles devoid of molar process and palp. Maxilliped with short epipod, shorter than basis, distally broadly oval. Article 4 of palp of maxilliped elongated, with parallel

margins and much narrower than articles 1–3. Basis of the first pereopods about three times the basis of the second, third and fourth pereopods. Basis of pereopods VII less than half of the basis of pereopods V and VI length and width. Pleopods 3 and 4 are split up into several net-like pieces. Female operculum very broad, length almost twice the width and with distal margin almost straight. First pair of male pleopods distally obtusely pointed. Second pair of male pleopods with broad sympod and short rami, situated near each other.

**Remarks:** *Bathyopsurus* can easily be distinguished from *Paropsurus* by the head, which is clearly separated from pereonite 1 and not surrounded by pereonite 1 as in *Paropsurus*. Moreover, pereonite 1 is about subequal in length to pereonites 2–4, in *Paropsurus* is it much shorter. Basis of pereopods VII of *Paropsurus* is almost as long and broad as bases of pereopods V–VI, while it is much smaller in *Bathyopsurus*.

**Type species:** *Bathyopsurus nybelini* Nordenstam, 1955.

**Distribution:** *B. nybelini* is known from three localities in and north of the Puerto Rico Trench at 7625–7900 m, 5500–5987 m, and 5850–5860 m depths (Nordenstam, 1955) as well as from the Kermadec Trench (32°10'S 175°54'W) at 5850–5900 m (Wolff, 1962) and the Tasman Sea (45°51'S 164°32'E) at 4400 m (Wolff, 1962); *B. abyssicolus* is known from one locality off the Azores (38°03'N 39°19'W), 3886 m (Beddard, 1885).

***Bathyopsurus sonnei* sp. nov.** (Figs. 2–9) Brandt & Kelch.

**Material examined.** – **Holotype:** preparatory female (SMF-62376) of 65 mm length, RV *Sonne*, SO293, Station 4–9, epibenthic sledge, 2. August 2022, 51°43'N–170°29'E, 4224 m. **Paratypes:** 2 males of 18 and 41 mm lengths, adult male (SMF-62377) of 41 mm length, same station as holotype; manca (SMF-62378), in developing stage to premature male, of 18 mm length, same station as holotype.

**Additional material.** – 1 female (SMF-62379) of 34 mm length, RV *Sonne*, SO293, Station 10–9, epibenthic sledge, 20. August 2022, 51°42'N–166°28'E, 5170 m.

Environmental parameters of the stations are summarized in Table 1.

**Type locality.** Northern Slope of Aleutian Trench.

**Distribution.** Northern Slope of Aleutian Trench and southern slope of Aleutian Trench on East Pacific plate.



**Fig. 2.** *Bathyopsurus sonnei* sp. nov. Holotype female SMF-62376: In ventral view directly after sampling including P7 and additional appendages broken off. Scale bar = 1 cm © Anne-Helene Tandberg.



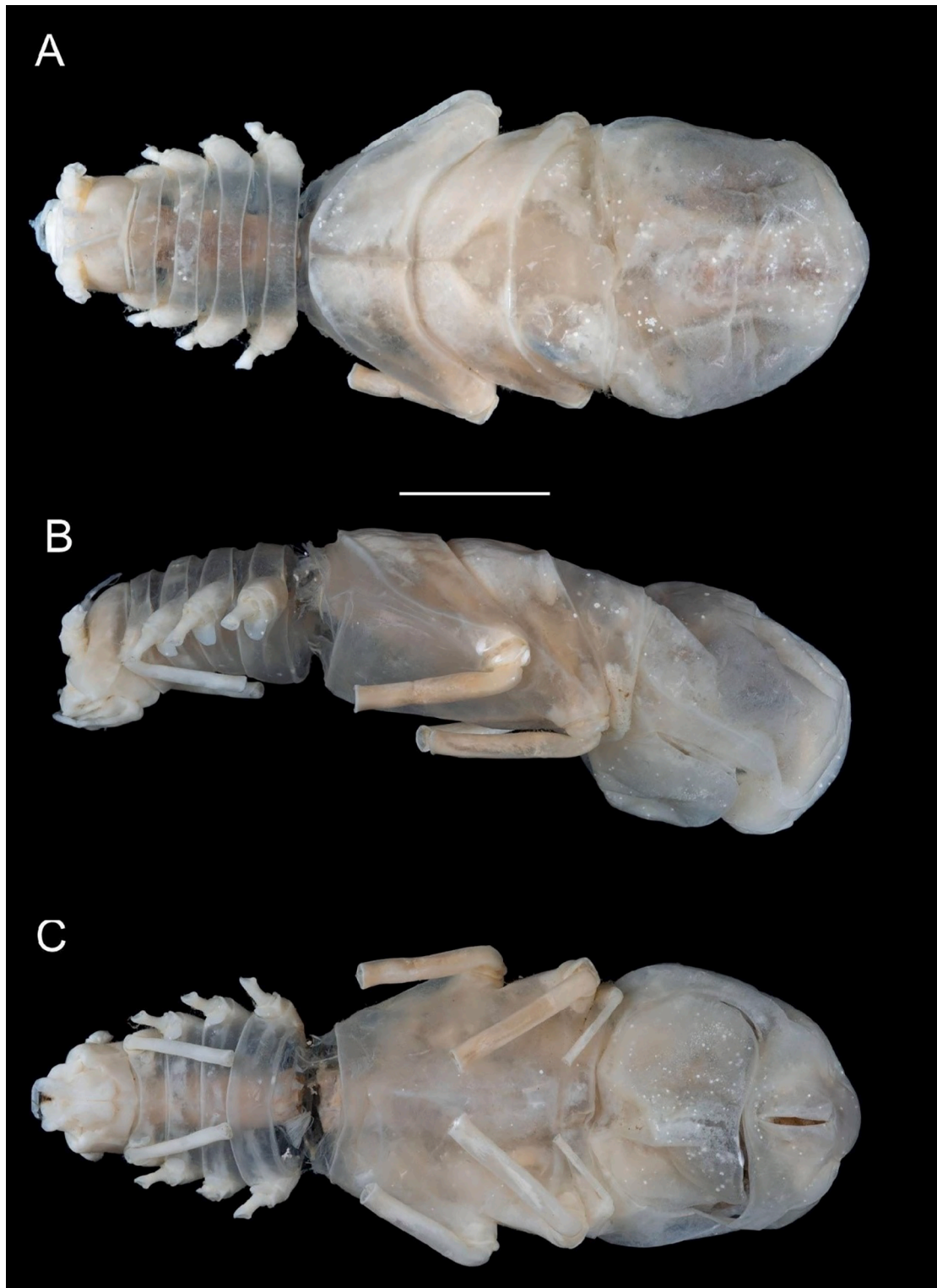


Fig. 3. *Bathypsirus sonnei* sp. nov. Holotype female, SMF-62376: A Dorsal, B lateral and C ventral views. Scale bar = 1 cm © Sven Tränkner.

**Etymology:** The species name “*sonnei*” is derived from the latinized genitive form, honoring the research vessel *Sonne* and its master, officers and crew, whose skill and dedication enable the success of deep-sea research. The RV *Sonne* serves as an exceptional platform for the collection of invaluable samples, providing crucial insights into the biodiversity of the deep sea.

**Diagnosis:** Integument opaque. Head only slightly surrounded by pereonite 1, which is laterally not completely embracing head.

Mandibles slender, 3.3 times longer than wide; inner endite of the maxillula blunt and rounded; length of maxilliped palp article 31.4 times length of palp article 2, palp article 4 1.2–1.3 times length of article 3; epipod 0.8–0.9 times length of basal part of endite. Female pleopod 2 (operculum) width 1.4 times length, distal margin concave and ventrally covered with setules. Natasoma without carina, medial incision visible on pereonite 5; insertion of pereopod 5 mediolateral. Branchial cavity 0.6 times length of pleotelson. Four anterior pereonites of about



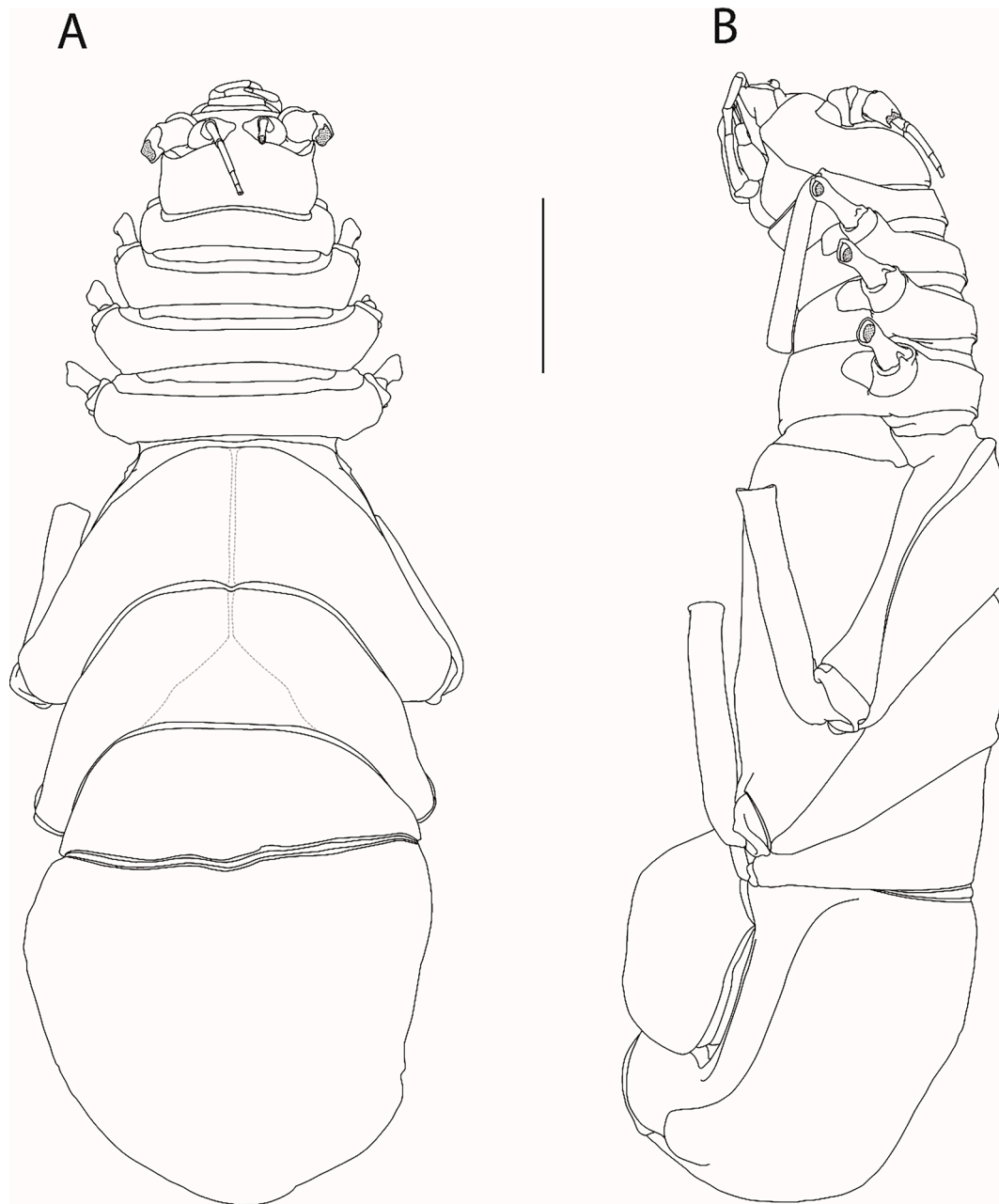


Fig. 4. *Bathypsirus sonnei* sp. nov. Holotype female, SMF-62376: Habitus drawing in A dorsal, B lateral. Scale bar = 1 cm.

subequal length, the first one reaching no further ventrolaterally than the others, not embracing head. Article 2 of antennula peduncle almost quadratic.

### 3.2. Description of holotype female (mouthparts described from paratype male)

Body (Figs. 2–4) with soft, parchment-like integument, fragile.

Head (Figs. 3, 4) squarish in front and with sharp-edged posterior corners. Frontal margin almost straight; no distinct rostrum between antennulae. The foremost upper part of head raised over epistome and labrum.

Pereonites 1–4 (Figs. 3, 4) subequal in length, increasing in width from 1 to 4, pereonite 1 surrounding posterolateral margin of cephalon. Pereonite 2 laterally bent anteriorly, surrounding pereonite 1, pereonites 3 and 4 less anterolaterally bent.

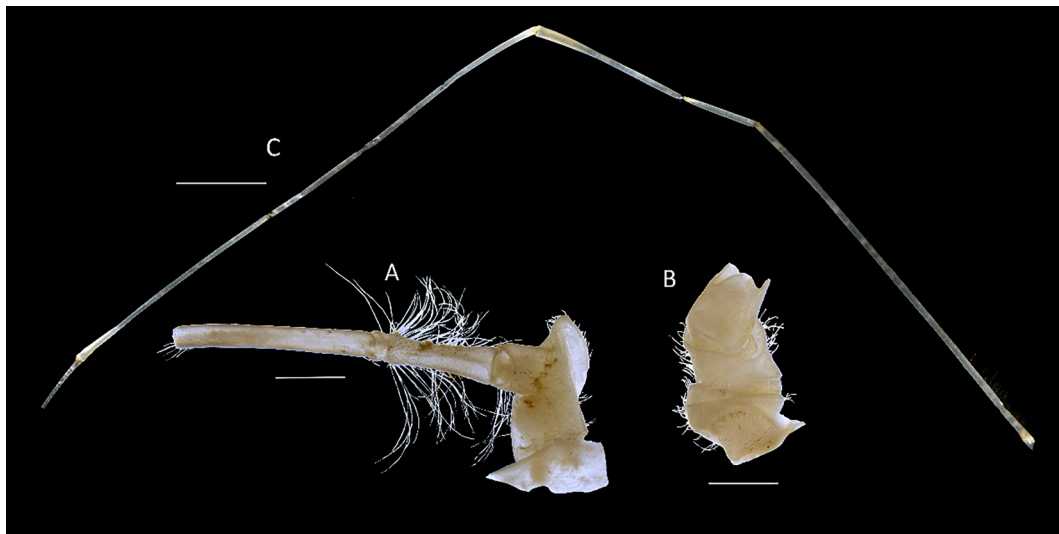
Natasoma. Anterior and posterior margins of pereonites 5 and 6

rounded, posterolaterally bent, pereonite 5 surrounding pereonite 6 and pereonite 6 surrounding pereonite 7; pereonite 7 about as long as both pereonites 5 and 6 each, posterior margin straight (see lateral view in Figs. 3, 4).

Pereonites 5–7 dorsomedially free, with clearly visible segment lines; pereonite 5 incised, no dorsal keel visible; pereonite 6 dorsomedially incised at half-length from anterior margin, then slightly vaulted to posterior margin, forming an almost triangular shallow depression from dorsal view (Figs. 2, 3).

Pereonites 5 and 6 fused ventrally, no separation between the segments visible, however, separation between pereonite 6 and 7 visible ventrally. Nevertheless, all segments can be distinguished from both dorsal and lateral sides (Figs. 3, 4). Anterior margin of pereonite 5 stabilized by a very fine chitinous seam extending laterally over coxal plate.

Pleon consists of one very short, ring-shaped pleonite with 10–11 setae on mediolateral borders (only visible from dorsal, but not from ventral side) followed by the huge, bulbous, almost rounded pleotelson,



**Fig. 5.** *Bathyopsirus sonnei* sp. nov. Paratype male, SMF-62377: A Antennula and B antenna; holotype female, SMF-62376: C Last two segments of antenna. Scale bar A, B = 1 mm; C = 1 cm.

0.9 times as long as broad (Figs. 2, 3); posterior end with the anal face drawn considerably downwards, situated ventrally (Figs. 2, 3) and branchial cavity 0.6 length of pleotelson.

Antennula (Fig. 5 A) article 1 twice as broad as long, with scattered, short setae, especially on the outer, distal part; article 2 length 0.8 times article 1 length, distal margin with densely setose area of long simple setae; article 3 length 1.8 times article 1 length, with long simple setae around distal margin; flagellar article 1 short, ring-like, length 0.2 times peduncular article 1 length, with two distal feather-like setae; flagellar article 2 broken off, length 14.3 times flagellar article 1 length, images captured immediately post-haul reveal that the multijointed flagellum originally extends beyond the anterior margin of pereonite 5.

Antenna (Fig. 5 B, C) (measurements taken from lateral view). Article 1 maximal width 3.6 of maximal length, with lateral simple setae; article 2 length 0.8 times article 1 length, with lateral simple setae; article 3 length 4 times article 1 length, dorsally and ventrally with simple long setae, lateral spine-like rudimentary flagellum with distal tuft of simple setae; article 4 length 1.1 times article 1 length; article 5 length 17 times length of preceding articles together, with simple setae along; article 6 length 0.9 times article 5 length, with simple setae along; distal part of flagellum broke off, first article length 7.2 times length of the following articles.

All mouthparts are illustrated from paratype male.

Labrum (Fig. 6 A) 3.3 times broader than long, with a median small convexity on frontal margin and a dense row of short setae. Left mandible 3.8 mm long, *pars incisiva* with six teeth arranged concavely (Fig. 6 C, Fig. 7); third tooth longest and broadest. First and second teeth connected with a sharp keel. *Lacinia mobilis*, almost of a concave molar shape with sharp toothed edges dorsally and ventrally, medially concave, three dorsal and one ventral teeth and ventrally sawed margin, ventral edge equally long as dorsal; small lateral tooth at half-length of *lacinia mobilis*; spine row short, as short as *lacinia mobilis*, consisting of many simple setae. *Pars molaris* below spine row reduced. Right mandible 3.4 mm long, *pars incisiva* with five teeth arranged concavely (Fig. 6 C); second tooth longest and broadest, all teeth acute and connected with keels. *Lacinia mobilis* reduced; spine row of many simple setae. *Pars molaris* reduced. Labium (hypopharynx) (Fig. 6 A) with a large, rounded mediobasal corner on the outer lobes – which are strongly setiferous including medial margins. Inner lobes small, cushion-shaped of almost quadrangular shape, distally with short setae, and separated by a deep furrow. Maxillula (Fig. 6 E) 2.9 mm long, with eleven spines in three rows on outer larger endite, two or three quite small; spines on outer endite slender, acute, dorsal ones longest; outer

endite with long simple setae on both margins in distal third; inner endite reaching shortest inner teeth of outer endite, rounded distally, with distal densely setose tip and many distal and fewer medial long simple setae. Maxilla (Fig. 6 D) with two endites plus lateral endopod, inner one broadest, twice the width of the outer endites, outer one longest, slightly longer than medial; four rather long, distally setulated strong spine-like setae, more than 20 strongly setulated setae on the medial endite; all endites with long simple setae on both margins. Maxilliped 6.7 mm long (Fig. 6 F) with rectangular basis and fringe of ventral long simple setae; epipod 1.3 as long as wide, rounded and surrounded with short simple setae; epipod length 0.6 of endite length; epipod distally triangular, 4.8 times longer than wide, with distal tuft of strong simple setae; endite curved considerably inwards, basally widest. A small ridge, curved in frontal view, continues from the row of 24 coupling hooks. Palp article 1 shortest, ring-like, article 2 widening distodorsally, width 1.3 times article 1 width, length 6 times article 1 length, width article 3 0.9 times article 2 width, article 3 broadest medially, 1.6 times longer than wide and length 1.4 times article 2 length, article 4 longest, slender, 4.3 times longer than wide, 1.3 times longer than wide article 3, article 5 narrowest, length 3 times article 1 length, length 0.26 times article 4 length; rows of closely inserted setae along the margins, longer on mesial margin; article 5 with four setulated strong setae and many long simple setae around, most apically.

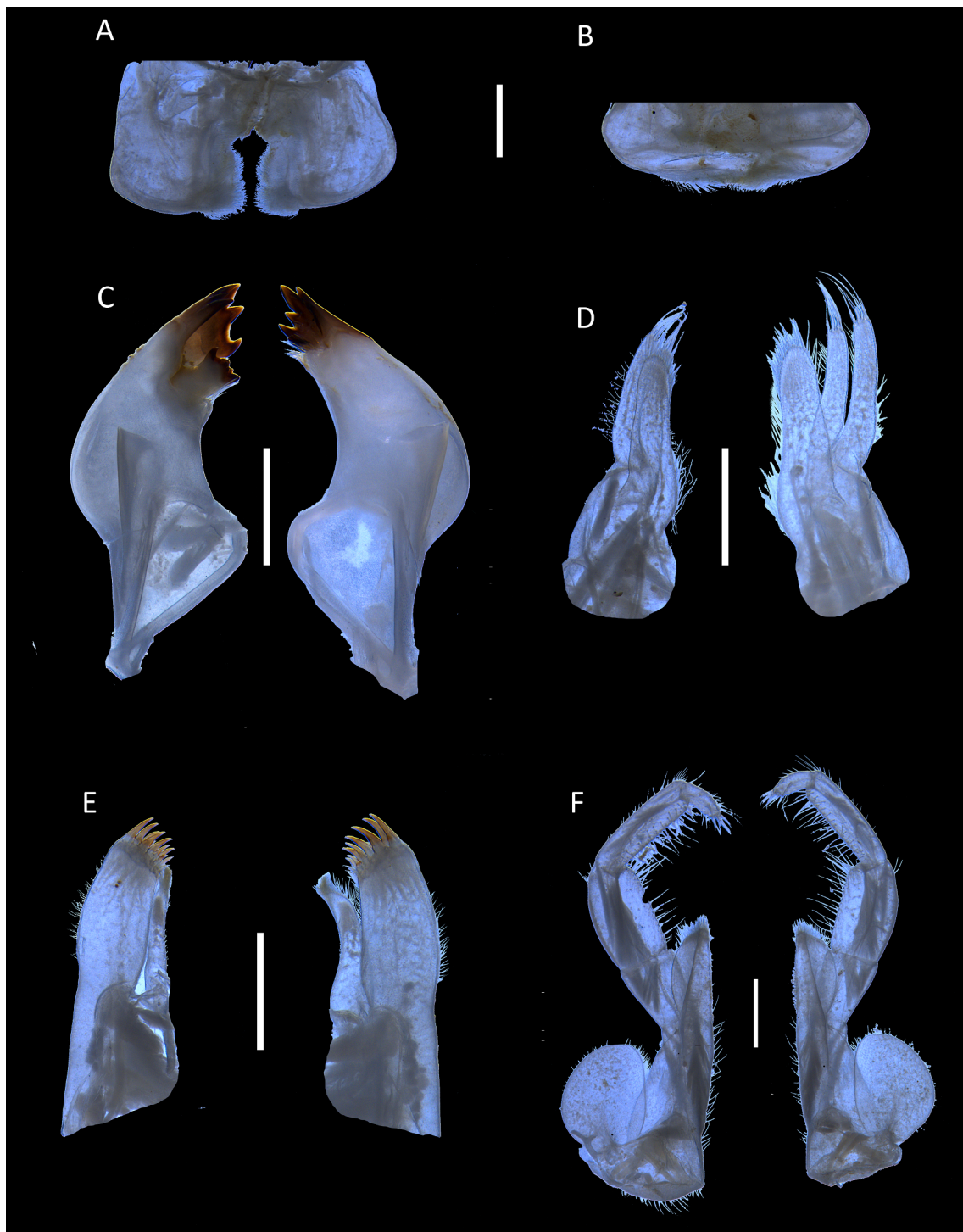
Pereopods I–VII have only the bases or coxae left at the specimens. (Figs. 1–3). Bases of pereopod I held posteroventrally and reaching frontoventral margin of fourth pereonite. Coxal extensions of pereopods 2–4 0.27 length of basis of pereopod 1. Bases of pereopods 5 and 6 length 1.6 basis of pereopod 1 length, basis of pereopod 7 small, slender, length 0.8 basis of pereopod 1 length.

Pereopod I (Fig. 8 A) narrow throughout, basis the longest article, carpus 1.1 times longer than ischium. Most articles have setae of varying length situated along the inner margin and distally, few laterally; dactylus with lateral simple setae and distal bunch-like simple short setae, unguis missing.

Pereopod II (Fig. 8 B) narrow throughout, carpus is the longest article, length 6.4 times ischium length. Articles have setae of varying length situated along the whole article; on dactylus unguis missing with simple short setae on the inner margin.

Pereopod III (Fig. 8 C) narrow throughout, propodus is the longest article, length 12.1 times ischium length. Articles have setae of varying length situated along the whole article; dactylus unguis missing with simple short setae on the inner margin.

Pereopod IV (Fig. 8. D) probably longest, broken off during sampling,



**Fig. 6.** *Bathypsirus sonnei* sp. nov. Paratype male, SMF-62377: A Hypopharynx, B labrum, C left and right mandibles, D left and right maxillae, E left and right maxillulae, F left and right maxillipeds. Scale bars = 1 mm.

only carpus and part propodus are preserved. Carpus 1.3 times longer than carpus of pereopod IV.

Pereopods V and Pereopod VI similar (Fig. 8 C, D), length meri 0.53 times carpi length; 1.75 times longer as wide; length propodi 0.95 times carpi length and 1.7 times longer than wide; dactyli absent. Carpi and meri surrounded by short setulated setae.

Pereopod VII (Fig. 2) broken off.

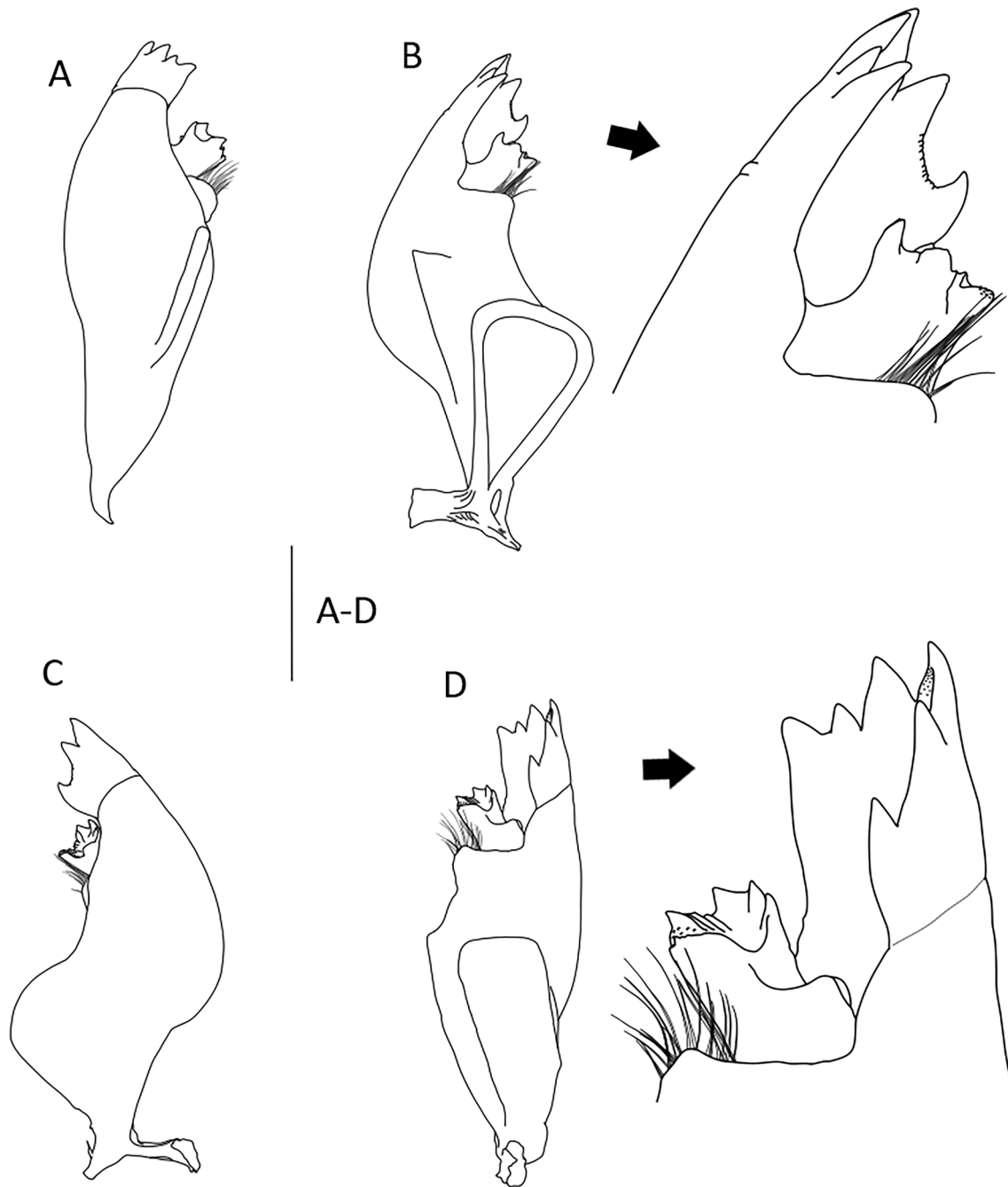
Operculum (Figs. 2, 3) 1.4 as wide as long, almost flat, only slightly vaulted. Ventrally covered with very small setules.

Uropods broken off in all specimens.

Paratype male pleopod 1 (Fig. 8 G) triangular, 7.8 mm long, proximally 10.3 times as broad as distally; distal corners outstanding, diverging and obtusely pointed; dorsal side furnished with simple setae; posteroventral side of the pleopodal plate slightly excavated, possessing anterior oblong elevations, which slightly diverge from each other towards the distal ends; posteromedially of these elevations two very short keels or crests on dorsal surface; fused rami posteriorly excavated into a groove.

Paratype male pleopod 2 (Fig. 8 H) rounded, 7.1 mm long, as long as wide; stylet short and small, length 0.2 times length of pleopod 2,





**Fig. 7.** *Bathyposurus sonnei* sp. nov. Paratype male, SMF-62377: A-D Left mandible and *lacinia mobilis*. Scale bar A-B = 1 mm.

exopod a short protrusion.

### 3.3. Molecular-genetic characterization

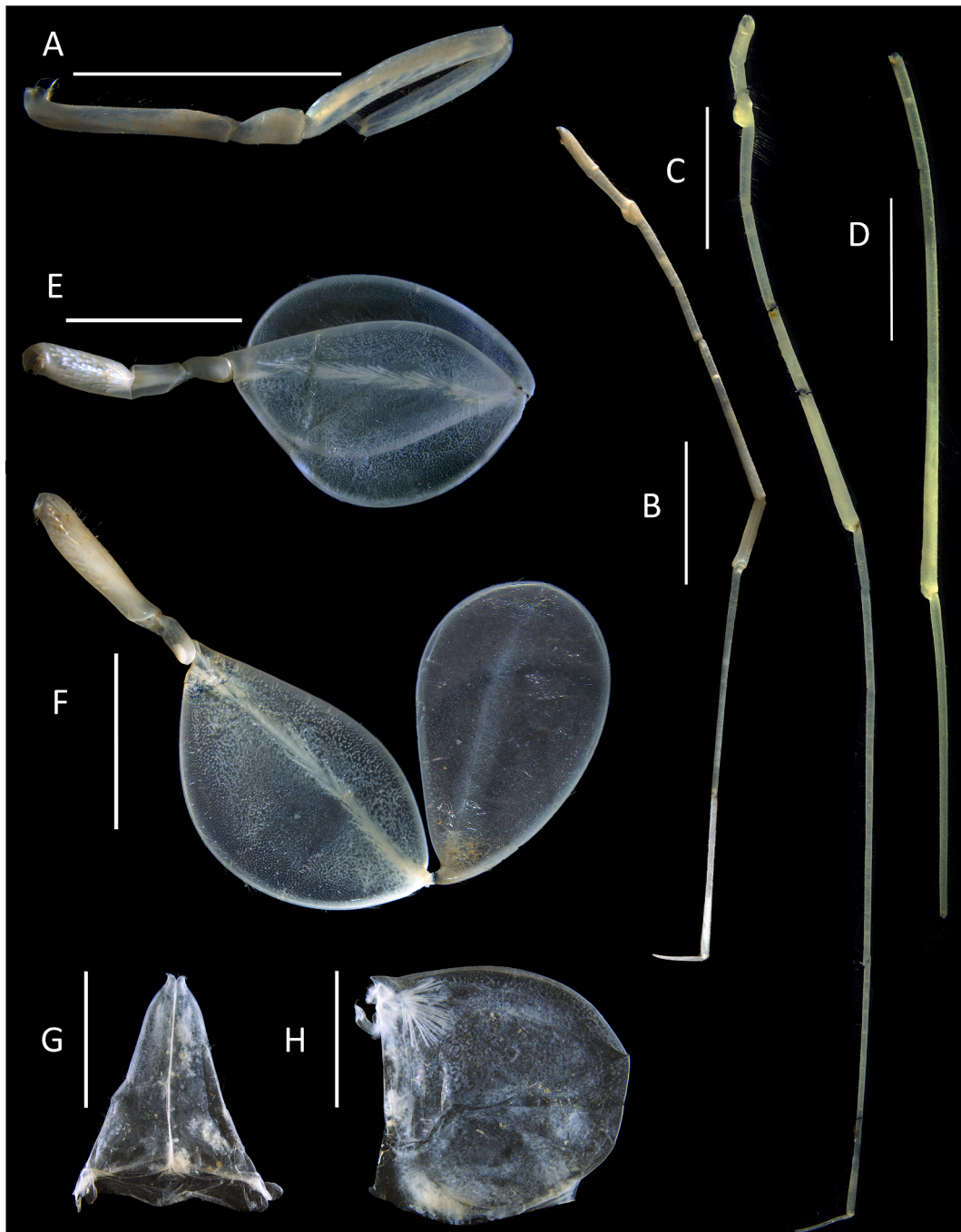
Complete sequencing of both COI and 16S rRNA genes was not achieved for all *Bathyposurus sonnei* sp. nov. specimens. COI sequences (Table 2) were successfully retrieved from a subset of specimens (AB2903, AB690), while 16S sequences were obtained from another subset (AB691, AB690, AB689). We initially tested two different primer pairs for COI amplification; however, successful amplification was only achieved using the degenerate primers LCO1490-JJ/HCO2198-JJ (Astrin & Stüben, 2008). Maximum likelihood analyses of the COI and 16S phylogenetic trees indicate strong genetic similarity among the available sequences, with bootstrap support values of 97 % and 99.3 %, respectively (Figs. 10, 11). Due to the absence of comparative

*Bathyposurus* sequences in GenBank, this analysis primarily confirms the genetic concordance among the analysed individuals. These phylogenetic results corroborate the classification of all *Bathyposurus* specimens as conspecific, with occurrences documented on both sides of the Aleutian Trench.

## 4. Discussion

### 4.1. Comparative morphology

*Bathyposurus sonnei* sp. nov. can be clearly distinguished from the other two species of the genus. The new species differs from the hadal species *B. nybelini* Nordenstam, 1955 in several characters related to the mouthparts and pleopod 2 of the female. The mandibles of *B. sonnei* sp. nov. are more slender than those of *B. nybelini*, with a length-to-width



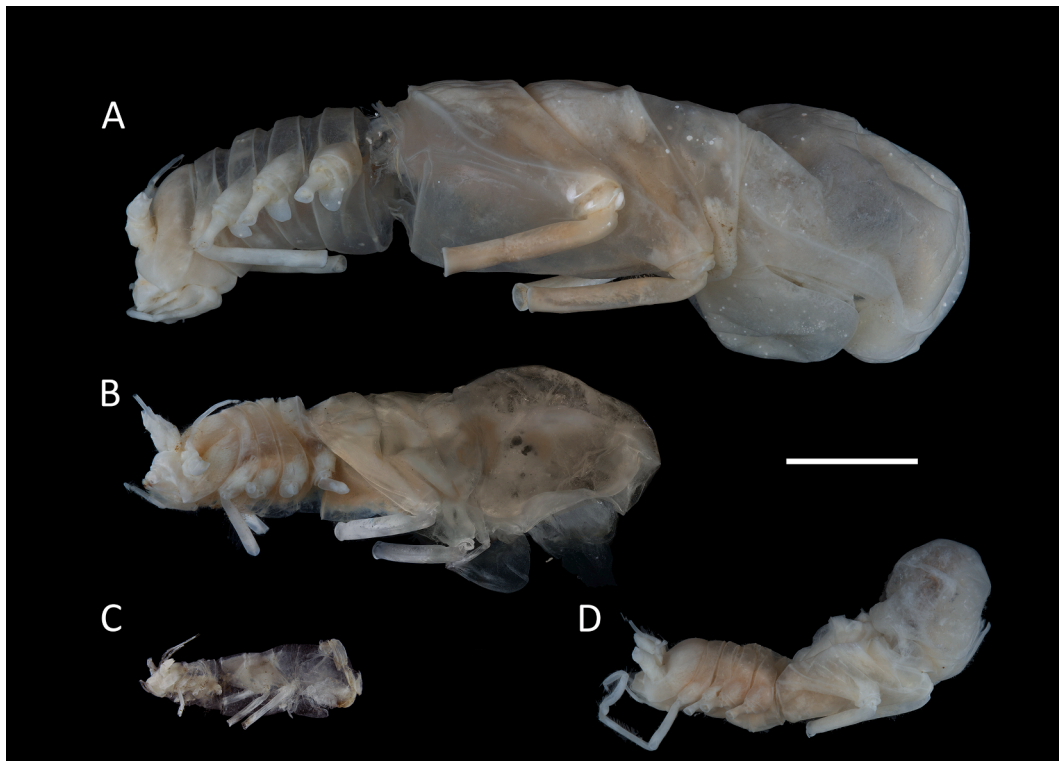
**Fig. 8.** *Bathypsirus sonnei* sp. nov. Holotype female SMF-62376: A Pereopod I, B pereopod II, C pereopod III, D pereopod IV, E pereopod V, F pereopod VI; paratype male, SMF-62377: G pleopod I and H pleopod 2. Scale bar A-F = 5 mm, G-H = 1 mm.

ratio of 3.3 compared to 2.1 in *B. nybelini*. The inner ramus of the maxillula of *B. sonnei* sp. nov. is less acute, blunter and more rounded than in *B. nybelini*. In the maxilliped of *B. sonnei* sp. nov. the length of palp articles 2 and 3 are 1.4, in *B. nybelini* the ratios of the palp articles are 0.9; palp article 4 is 1.2–1.3 times the length of article 3 in *B. sonnei* sp. nov., in *B. nybelini* article 4 is 1.7 times longer than article 3; epipod of *B. sonnei* sp. nov. is 0.8–0.9 times the length of basal part of endite, in *B. nybelini*, it is 0.65 times length of basal part of endite. Moreover, the female pleopod 2 (operculum) of *B. sonnei* sp. nov. is 1.4 wider than long, caudomedially slightly concavely indented and ventrally covered with very small setules all over the operculum, in *B. nybelini*, on the contrary, the operculum is 1.8. wider than long, ventrally almost straight, and possesses setules only mediolaterally. [Beddard \(1885\)](#)

describes the integument of *B. abyssicolus* as extremely delicate and transparent; in *B. sonnei* sp. nov. this is not the case, the integument is not transparent ([Fig. 9](#)). In addition, [Beddard \(1885\)](#) stated that the first four pereonites of *B. abyssicolus* are short and increase progressively in length, in *B. sonnei* sp. nov., on the contrary, pereonites 1–4 are subequal in length.

#### 4.2. Ecological and biogeographical considerations

[Wolff \(1962\)](#), in his seminal analysis of isopod crustaceans from the Galathea expedition, provided one of the few detailed accounts by examining the gut contents of eight species of Munnopsidae, including *Bathypsirus* and *Paropsirus* (Tables 17–19, p. 240). He identified 21



**Fig. 9.** *Bathypsirus sonnei* sp. nov. Lateral view of the four life stages: A Preparatory female, holotype, SMF-62376; B adult male, paratype male, SMF-62377; C developing stage to premature male, paratype manca, SMF-62378; D adult female, SMF-62379. Scale bar = 1 cm. A and D © Sven Tränkner.

**Table 1**

Environmental parameters of stations, where *Bathypsirus sonnei* sp. nov. has been found. Environmental layers were retrieved from Bio-ORACLE (<http://www.bio-oracle.org/>; Tyberghein et al., 2012, Assis et al., 2018). For details of sampling and environment see Brandt (2022).

Station	4–9	10–9
Depth [m]	4224	5170
Chlorophyll [mg/m <sup>3</sup> ]	0.0044	0.0044
Velocity [m/s]	0.0254	0.059
Oxygen [mol/m <sup>3</sup> ]	153.8082	154.562
Iron [μmol/m <sup>3</sup> ]	0.0006	0.0006
Nitrate [mol/m <sup>3</sup> ]	37.4377	37.4234
Phosphate [mol/m <sup>3</sup> ]	2.5954	2.5992
Salinity [PSS]	34.686	34.689
Silicate [mol/m <sup>3</sup> ]	169.8797	173.1016
Temperature [°C]	1.11	1.11
Surface phytoplankton [μmol/m <sup>3</sup> ]	2.8318	2.0225
Surface Prim. Productivity [g/m <sup>3</sup> /day]	0.0087	0.0058

instances of potential predation on various taxa, such as polychaetes and crustaceans. In contrast, *B. nybelini* has been documented feeding on *Sargassum*, displaying functional adaptations in its pereopods and mouthparts to exploit macroalgae (Peoples et al., 2024).

**Table 2**

GenBank Accession number and source of isopod specimen used for the phylogenetic analyses.

Species	Sample ID	Collection no.	GenBank ass. no. (16S)	GenBank ass. no. (COI)	Source
<i>Chelator aequabilis</i>	D2D051	–	KJ578663	KJ578690	Brix et al., 2014
<i>Acanthocope cf. galathea</i>	DSB_1479	–	MN550402	MW072740	Brix et al. 2020
<i>Munneurycope</i> sp.	DSB_1648	–	MN550428	MW072755	Brix et al. 2020
<i>Disconectes</i> sp. 3	DSB_1663	–	MN550469	MW072781	Brix et al. 2020
<i>Paropsirus giganteus</i>	LACM-CR 2002–047.1	–	–	EF682287	Osborn 2009
<i>Bathypsirus sonnei</i> sp. nov.	AB689	SMF-62376	PQ456793	–	
<i>Bathypsirus sonnei</i> sp. nov.	AB690	SMF-62377	PQ456794	PQ461849	
<i>Bathypsirus sonnei</i> sp. nov.	AB691	SMF-62378	PQ456795	–	
<i>Bathypsirus sonnei</i> sp. nov.	AB2903	SMF-62379	–	PQ461850	

From a biogeographical perspective, our current records of the new species are confined to the Aleutian region. Its presumed strong swimming capabilities may explain its ability to traverse the Aleutian Trench, as confirmed by our genetic data. Other species within the genus exhibit similarly broad ranges, such as *B. nybelini*, which has been reported from the Puerto Rico Trench (but also sampled from the Tasman Sea) and *B. abyssicolus* from the North Atlantic, near the Azores. Given these patterns, it seems plausible that *Bathypsirus sonnei* sp. nov. also possesses a more expansive distribution than current sampling suggests.

The global scarcity of specimens from this genus, despite their relatively large size, is likely due to sampling challenges in the deep sea, such as the use of suboptimal gear, limited sampling efforts, and potentially low population densities. Additionally, these specimens may possess a high escape potential, further complicating collection. While *B. nybelini* has been documented feeding on *Sargassum* (Peoples et al., 2024), similar behavior was observed in munnopsid isopods during a recent deep-sea expedition in the central Atlantic (authors AB, HK, SK, personal observation), potentially including *Bathypsirus* species, which provides insight into possible dietary habits of the genus. However, the feeding ecology of *B. sonnei* sp. nov. remains unknown. The lack of phylogenetic data compounds the uncertainty regarding the evolutionary relationships within *Bathypsirus*. This study provides the first



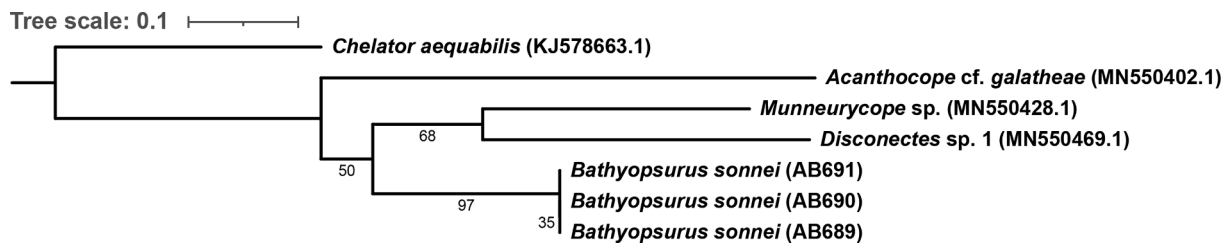


Fig. 10. Phylogenetic tree based on 16S sequences of six specimens of munnopsid isopods and one specimen of desmosomatid isopod as outgroup. Node support values are expressed as bootstrap support (%).

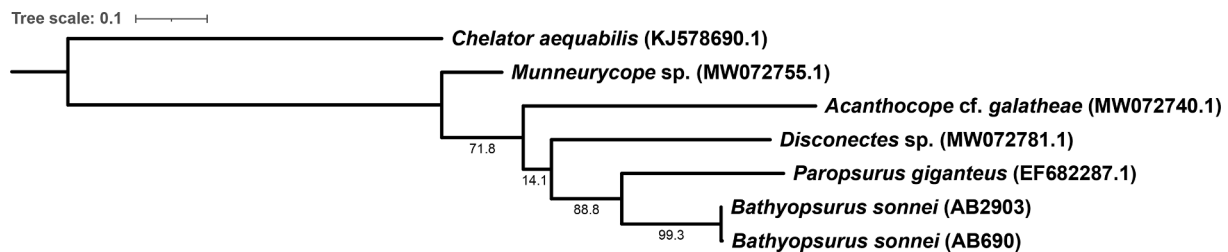


Fig. 11. Phylogenetic tree based on COI sequences of seven specimens of munnopsid isopods and one specimen of desmosomatid isopod as outgroup. Node support values are expressed as bootstrap support (%).

COI barcodes for the genus, establishing a foundation for future phylogeographic research. A more comprehensive understanding of the ecology, biogeography, and evolutionary history of *Bathypsirus* will require targeted sampling and expanded molecular datasets, which are essential for resolving taxonomic uncertainties and clarifying the ecological roles of this genus in deep-sea environments.

#### CRedit authorship contribution statement

**Angelika Brandt:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Davide Di Franco:** Writing – original draft, Data curation. **Henry Knauber:** Writing – original draft, Methodology, Investigation. **Stefanie Kaiser:** Writing – original draft, Visualization, Methodology, Investigation, Formal analysis. **Andreas Kelch:** Writing – original draft, Visualization, Methodology, Investigation, Formal analysis.

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#### Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: [Angelika Brandt reports financial support was provided by Senckenberg Research Institute and Natural History Museum Frankfurt. Angelika Brandt reports a relationship with Senckenberg Research Institute and Natural History Museum Frankfurt that includes: employment. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper].

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This is AleutBio publication # 12.

#### Data availability

No additional data were used than those published in the article.

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