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Research Article

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OXFORD

Description of a new species of *Stenula* Barnard, 1962 (Amphipoda: Stenothoidae) from British Columbia, Canada associated with *Bouillonia* sp. (Cnidaria: Hydrozoa: Tubulariidae), with a key to the world species of *Stenula*

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ABSTRACT

A new species of the amphipod family Stenothoidae found living in association with tubulariid hydroids in British Columbia, Canada is described. *Stenula traudlae* **sp. nov.**, which has a rounded naked telson, a rounded posterodistal tooth on Ep3, and a heavily spinose P5, is described morphologically. We also include an updated key to world species of *Stenula* s.l. Associations of amphipods with tubulariids and other small hosts are discussed.

KEY WORDS: Crustacea, Peracarida, symbiotic amphipods

INTRODUCTION

Amphipods living in association with other taxa are often hard to document. Unless the association is of the amphipod living inside another animal such as, for example *Metopa glacialis* (Krøyer, 1842) within the mollusk *Musculus discors* (Linnaeus, 1767) (Tandberg *et al.*, 2010b) or is truly ectoparasitic such as species of Cyamidae on whales, the association is usually disrupted during sampling. Amphipods associated with benthic Hydrozoa have been little known until recently, when scuba diving and remotely operated vehicles (ROVs) have been used to both discover, observe, and sample these cohabitations (Marin & Sinelnikov, 2017; Tandberg & Vader, 2023). In all documented association of amphipods with tubulariid hydroids, the amphipods are members of Stenothoidae, and all observations are of a single pair of adults, sometimes with several juveniles sitting on the aboral tentacles (Marin & Sinelnikov, 2017; Tandberg & Vader, 2023; AHST, unpublished data).

During scuba-diving fieldwork in British Columbia in 2012, several tubulariid hydroids were sampled, including their associated amphipods. *Metopa insolita* Tandberg & Vader, 2023 was found in association with *Zyzzyzus rubusidaeus* Brinckmann-Voss & Calder, 2013. A polyp of a different and unidentified tubulariid also proved to have an undescribed amphipod associate belonging to Stenothoidae, which is described herein.

MATERIAL AND METHODS

The material was collected during scuba diving in the Kuldekduma Sound, near the northern tip of Vancouver Island, British Columbia, Canada, by Neil McDaniel. The amphipods were sitting in the crown of a polyp of a tubulariid hydroid at 18 m depth (Fig. 1). The hydroid was attached to a rock in a habitat dominated by sponges and barnacles. After photography, the amphipods were collected together with the hydroid in a fine-meshed sampling-bag and sorted to family level on land. The collected amphipod material (two specimens of the species being described herein, together with several other amphipods) was initially preserved in formaldehyde before being transferred to ethanol and sent to the authors for identification.

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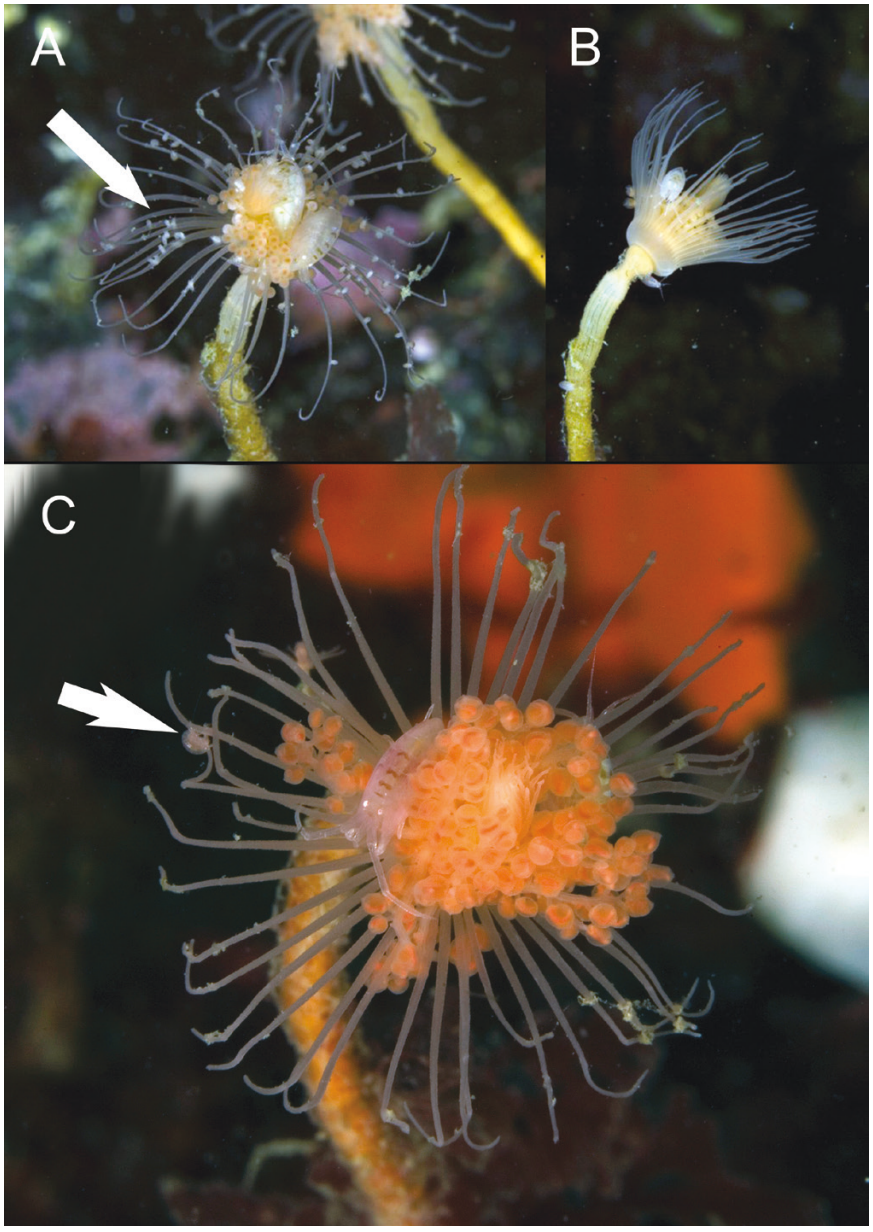

Figure 1. *In situ* photos of tubulariid hydroids with associated *Stenula traudlae* **sp. nov.** Two adults in crown and several juveniles sitting on aboral tentacles (arrow) (**A**), one adult sitting among gonophores of the hydroid (**B**), one adult among gonophores with older juvenile on aboral tentacle (arrow) (**C**). Photos by Neil McDaniel.

The habitus photo (Fig. 2) was produced using a Leica M205C (Leica Biosystems, Wetzlar, Germany) equipped with the stacking photography suite (Leica LAS V4.13). Stack-photos were collated using Zerene Stacker vers. 1.04 (Zerene Systems, Richland, WA, USA). One specimen (the holotype) was prepared for microscope slides using a Leica M125 dissecting microscope and mounted using Faure medium. Drawings were made using a Leitz Dialux20 fitted with a camera lucida. Pencil drawings were inked using Adobe CC Illustrator (Adobe, San Jose, CA, USA), following the methods described by Coleman (2003, 2009).

Type material is kept in the Universitetsmuseet i Bergen (University Museum of Bergen) Zoological Collections, Bergen, Norway (ZMBN).

TAXONOMY

Order Amphipoda Latreille, 1816

Infraorder Amphilochida Boeck, 1871

Parvorder Amphilochidira Boeck, 1871

Family Stenothoidae Boeck, 1871

Genus *Stenula* Barnard, 1962

Stenula traudlae sp. nov.

(Figs. 1–5)

Type material: Holotype: ZMBN 104467 (dissected, microscopy slide), male, 4 mm. Sitting on *Bouillonia* sp. polyp collected at Kuldekduma Point, British Columbia, Canada:

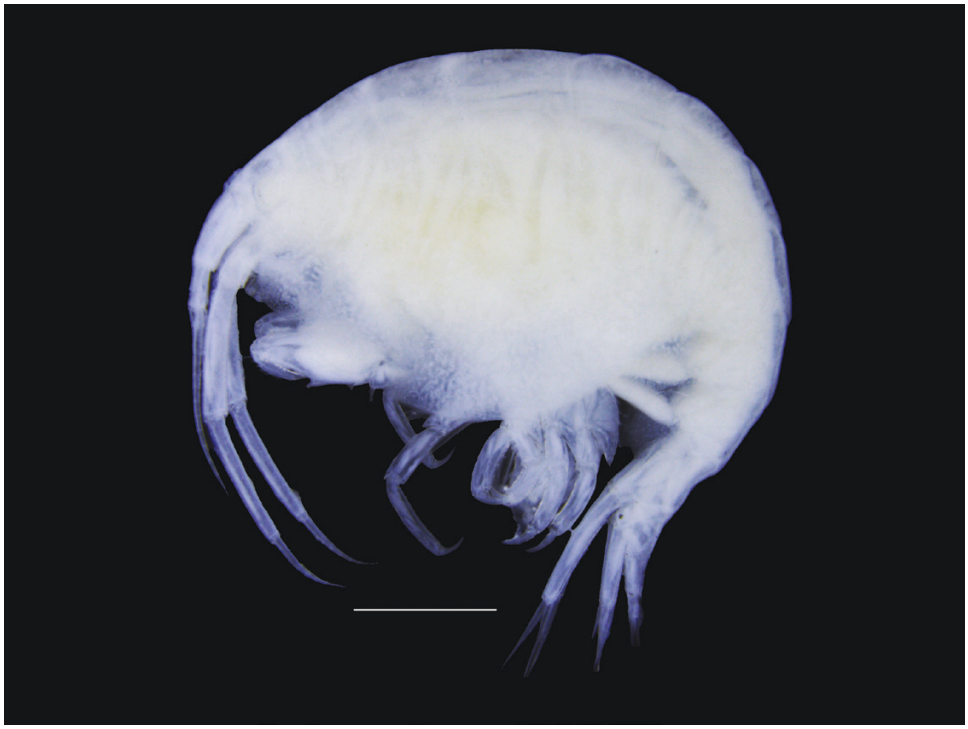

Figure 2. *Stenula traudlae* **sp. nov.** holotype male (ZMBN 104467). Scale bar = 1 mm.

50°35.299′N, 126°50.046′W, depth 18 m, 30 March 2012, coll. Neil McDaniel. Paratype: ZMBN 104468 (ethanol sample), male, 4 mm. Same information as holotype.

Etymology: The name *traudlae* is in honour of Dr. Traudl Krapp-Schickel, world specialist on Stenothoidae and a great friend and mentor.

Description: Head: antenna 1 (Fig. 3A) shorter than peduncle of antenna 2. Article 1 slightly longer than articles 2 + 3; flagellum with 13 articles; no accessory flagellum.

Antenna 2 (Fig. 3B) with articles 4, 5 subequal in length; flagellum with 7 articles, article 1 of flagellum almost as long as the rest of the flagellum articles combined.

Eyes (Fig. 2) round, quite large, clearly more than half head length.

Mandible (Fig. 3D, E) with molar absent; 6 thick, denticulate raker spines on each mandible; lacinia mobilis and incisor coarsely serrate; palp 1 articulate, long, relatively thin, as long as the distance from palp to incisor edge, 4 long marginal setae.

Maxilla 1 (Fig. 3F, G) with inner plate short and round with single seta; outer plate reaching half-length of palp, 6 robust setae in 2 rows, several short simple setae; palp uniarticulate, attached halfway along outer plate, 6 short marginal, robust setae, 3 short simple setae.

Maxilla 2 (Fig. 3H) with plates in tandem position, with 7 simple setae on each plate.

Maxilliped (Fig. 3I) slender; inner plate deeply cleft; outer plate fully reduced; palp 4-articulate, dactylus with comb-like setae on inner margin.

Pereon smooth.

Pereopod 1 (Fig. 4A) clearly subchelate; coxa small, distal margin rounded; basis long (as long as the rest of the leg), with long, marginal simple setae; merus distally free and produced, with patch of short simple setae directly proximal of the apical partly plumose setae; carpus triangular, with long simple setae along posterior margin, at disto-anterior corner; propodus as long as carpus, palm oblique, serrate, as long as dactylus and posterior margin; dactylus smooth, except for few serrations near tip at inner margin.

Pereopod 2 (Fig. 4B) clearly subchelate; coxa tongue-shaped, with few short, simple marginal setae; basis long (as long as rest of leg); ischium, merus, carpus short, with groups of marginal simple setae; propodus broad, oval, palm oblique, palmar corner with pronounced tooth, palm irregularly crenulate with short setae; dactylus smooth, slightly shorter than palm.

Pereopod 3 (Fig. 4C) coxa narrow, distally rounded, posteriorly with few short setae; basis slender, shorter than rest of leg; rest of leg slender; dactylus short, curved.

Pereopod 4 (Fig. 4D) coxa subtriangular, with ventral margin smoothly rounded; leg like that of pereopod 3, but slightly broader.

Pereopod 5 (Fig. 5A) coxa short, rounded without posterior lobe; basis rectolinear; merus distally widened, meral lobe approximately half length of carpus; rest of leg slender but stronger than that of pereopods 3, 4.

Pereopod 6 (Fig. 5B) coxa short with rounded posterior lobe; basis broadly rounded, convex posterior margin; merus expanded distally, meral lobe almost reaching end of carpus; rest of leg as for pereopod 5.

Pereopod 7 (Fig. 5C) stronger and longer than pereopod 6; coxa short, rounded; basis strongly widened, posterior margin convex, evenly rounded posterior lobe covering ischium; merus

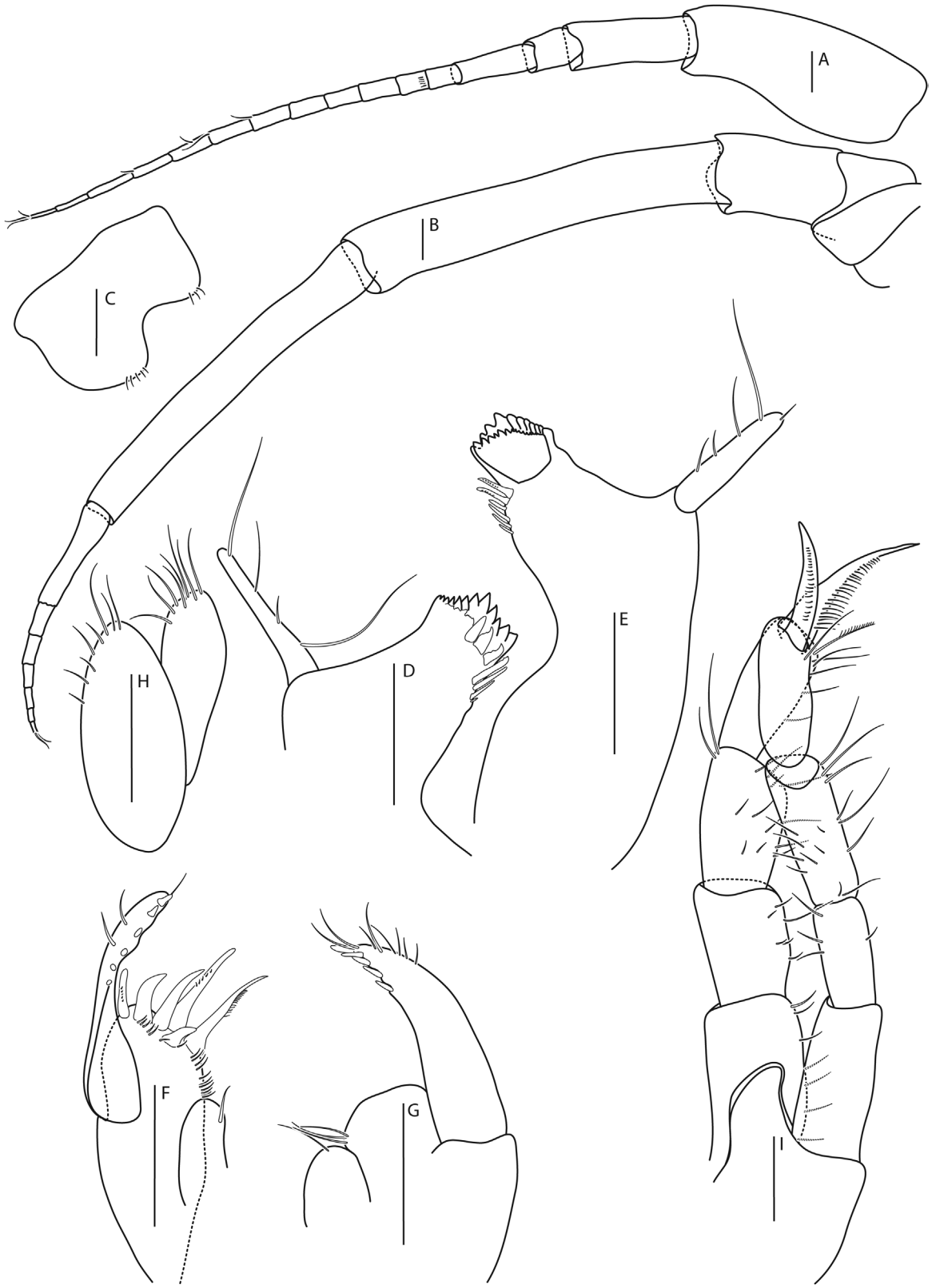

Figure 3. *Stenula traudlae* **sp. nov.** holotype male (ZMBN 104467). Antenna 1 (**A**), antenna 2 (**B**), labrum (**C**), right mandible (**D**), left mandible (**E**), right maxilla 1 (**F**), left maxilla 1 (**G**), maxilla 2 (**H**), maxilliped (**I**). Scale bars = 0.1 mm.

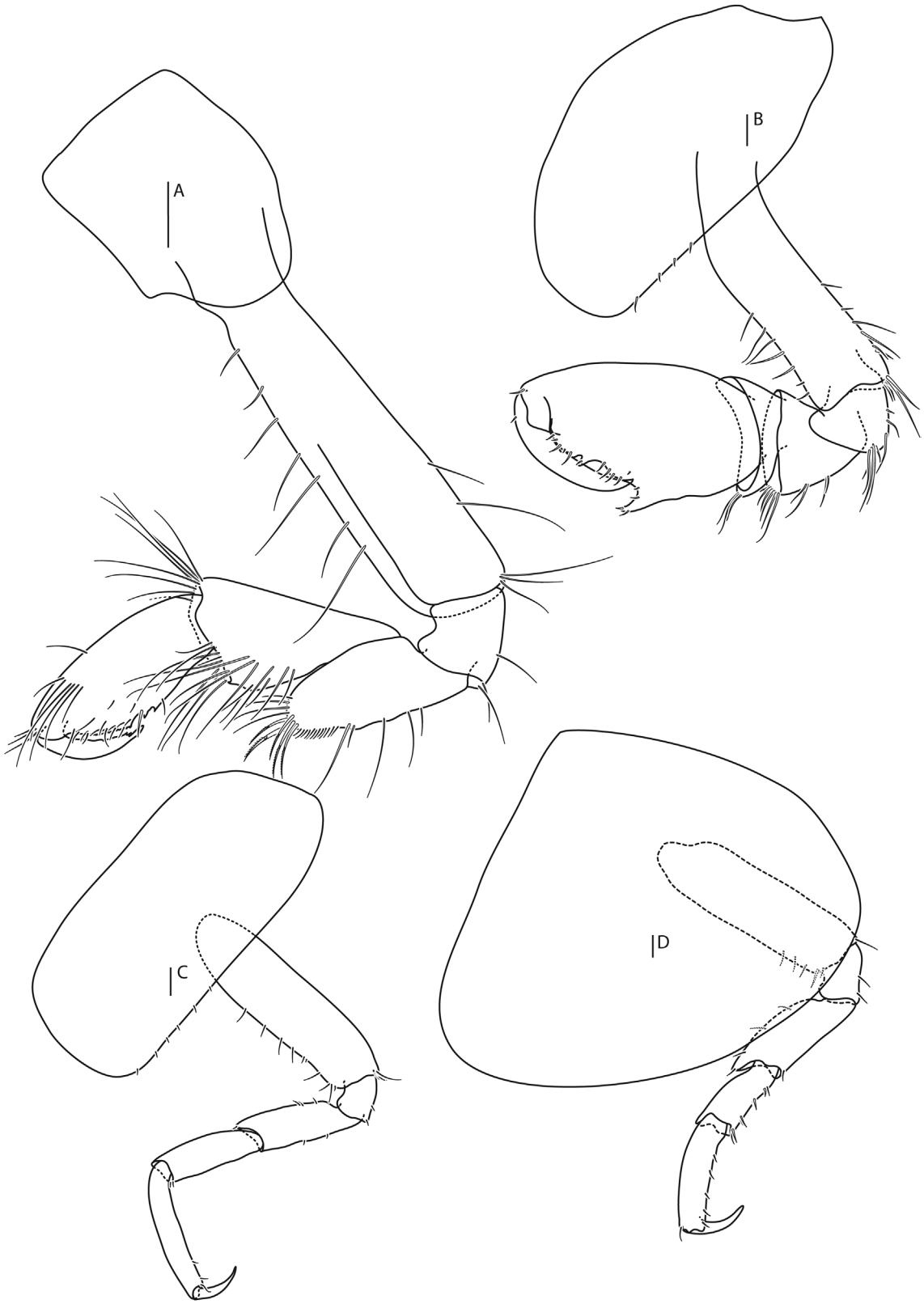

Figure 4. *Stenula traudlae* **sp. nov.** holotype male (ZMBN 104467). Pereopod 1 (gnathopod 1) (**A**), pereopod 2 (gnathopod 2) (**B**), pereopod 3 (**C**), pereopod 4 (**D**). Scale bars = 0.1 mm.

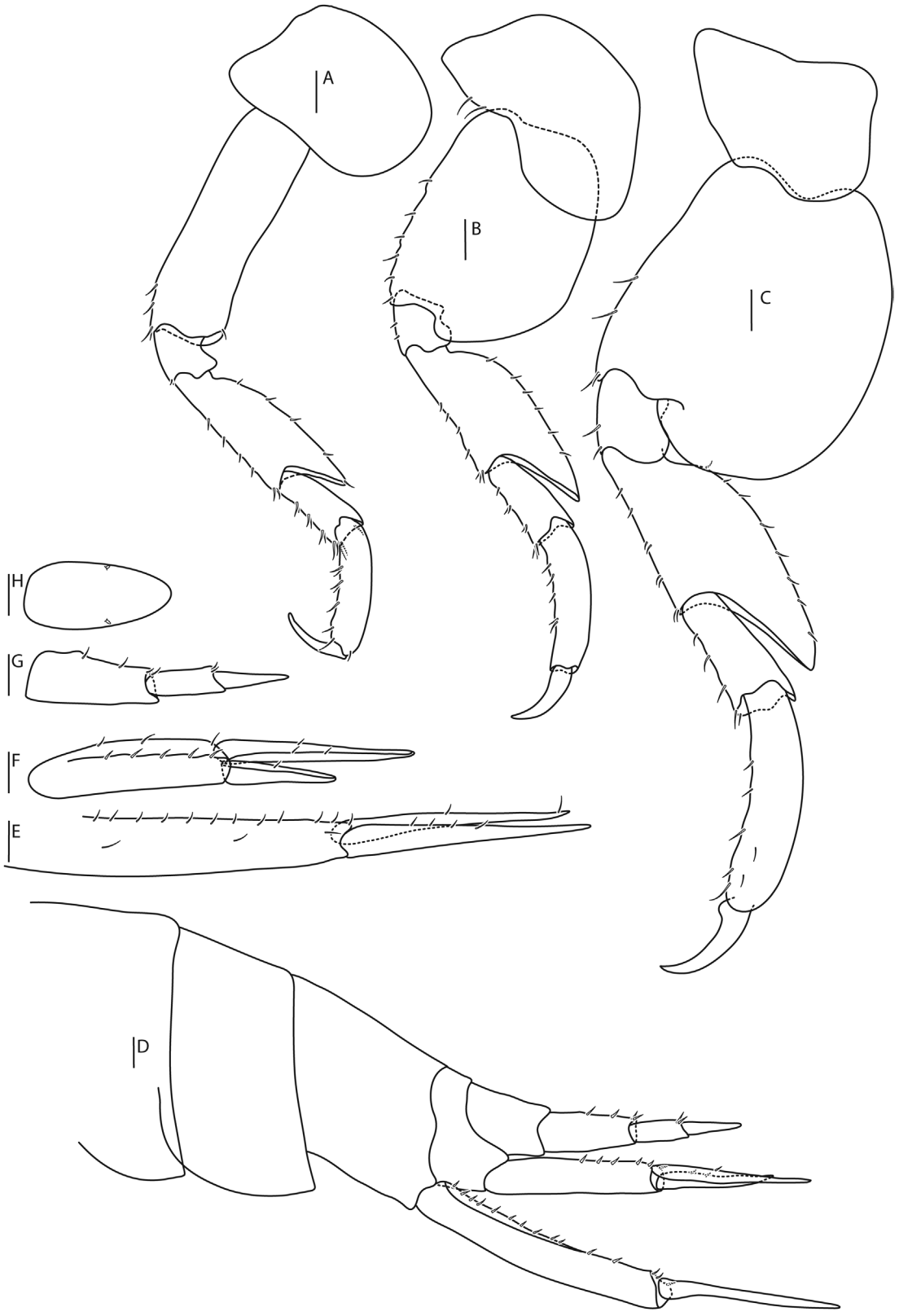

Figure 5. *Stenula traudlae* **sp. nov.** holotype male (ZMBN 104467). Pereopod 5 (**A**), pereopod 6 (**B**), pereopod 7 (**C**), urosome (**D**), uropod 1 (**E**), uropod 2 (**F**), uropod 3 (**G**), telson (**H**). Scale bars = 0.1 mm.

Table 1. Differences between *Stenula peltata* (and its synonym *S. ratmanovi*), *S. incola*, and *S. traudlae* **sp. nov.** A1, A2, antenna 1, 2; Art, article; Ep3, epimeral plate 3; Md, mandible; P1–P7, pereopods 1 –7; T, telson.

Species	Md palp	A1 length	A2 length (articles 4, 5)	Gn 1 shape palm:posterior margin	Coxa 4	P5 meral lobe	P5 basis setation	P7 meral lobe	Ep3 shape	Telson shape
Stenula peltata (Smith, 1874 in Smith & Harger, 1874) (= *S. /ratmanovi* Gurjanova, 1948)	short, thick	A1 art. 1 (length 1.5B)	A2 art. 4, 5 less than 4 times as long as broad	poorly defined palm, no clear palmar corner	rounded	0.5 of carpus	both margins heavily spinose	covers 0.75 of carpus	posterodistal (rounded) tooth	rounded, bare
Stenula incola Barnard, 1969	short, thin	A1 art. 1 (length 1.5B)	A2 art. 4, 5 less than 4 times as long as broad	poorly defined palm, palmar corner consists of proximal broadening of propodus	sinous	0.3 of carpus	few setae at distal corners	reaches all of carpus	not known	subacute, 2 setules
Stenula traudlae **sp. nov.**	long, thin	A1 art1. (length 2B)	A2 art. 4, 5 more than 6 times as long as broad	defined palm palm, clear palmar corner	rounded	0.5 of carpus	few setae at distal corners	reaches all of carpus	rectangular	rounded, 2 setules

distally greatly expanded, meral lobe as long as carpus; rest of leg smooth, same shape as pereopods 5, 6.

Pleon (Fig. 5D) smooth.

Epimeral plates 2, 3 (Fig. 5D) posterior corner rectangular.

Urosome with uropod 1 longer than uropod 2 longer than uropod 3. Uropod 1 (Fig. 5E) rami subequal, shorter than peduncle. Uropod 2 (Fig. 5F) outer ramus almost half length of inner ramus; inner ramus subequal to peduncle. Uropod 3 (Fig. 5G) uniramous, ramus 2-articulate, subequal length of peduncle.

Telson (Fig. 5H) elongated, rounded, with single pair of small, robust marginal setae.

Live colour (Fig. 1): semitransparent whitish, with light brown transverse dorsal patches, eyes white.

Ecology: Found on polyps of *Bouillonia* sp. at shallow depths (18 m), with adults located centrally, presumably guarding a large number of hatched young sitting on the hydroid's tentacles (Figs. 1A, C).

DISCUSSION

The genus *Stenula* has a complicated taxonomic history, which was discussed in detail by Krapp-Schickel & Vader (2015). As in the case of *Metopa* Spence Bate, 1857, *Stenula,* as presently understood, is probably not a monophyletic group, and a further revision seems necessary (Tandberg, 2011; Krapp-Schickel & Vader, 2015). The new species appears to be a 'typical' species of *Stenula* in most aspects, and in the key in Krapp-Schickel & Vader (2015) it keys out to the California species *Stenula incola* Barnard, 1962. There are, however, clear differences (Table 1). The poorly known *Stenula peltata* (Smith, 1874) [Smith & Harger, 1874] and its purported synonym, *S. ratmanovi* Gurjanova, 1948 (Krapp-Schickel & Vader, 2015), are included in Table 1 to demonstrate that the new species is not identical to these previously described taxa. We amend and update the key of Krapp-Schickel & Vader (2015), including *Stenula traudlae* **sp. nov.**

Most *Stenula* species seem to live in association with other marine invertebrates, often with coelenterates. For an overview of the current knowledge of associations between stenothoids and host species, see table 1 in Krapp-Schickel & Vader (2015). *Stenula traudlae* **sp. nov.** was found not only exclusively sitting on its tubulariid host, but as a single adult or a pair of adults sitting among the gonopores, with several juveniles on the aboral tentacles (Figs 1A, C).

Several species of amphipods have been shown to have extended parental care, adults guarding their hatched offspring for a period, and even providing offspring with food and/or grooming (Thiel, 1999a). Good examples are the calliopiid *Calliopiella michaelseni* Schellenberg, 1925 sheltering under the gastropod *Patella* Linnaeus, 1758 (Branch, 1975; Vader & Tandberg, 2013), species of *Liljeborgia* Claus 1866 found on the top whorls of gastropod shells occupied by hermit crabs (Vader, 1995), and the burrow-inhabiting melitid *Casco bigelowi* Blake, 1929 (Thiel 1999a, b). Parental care in the strict sense in most of these cases is only inferred and deduced from the strong territorial behaviour. Such is also the case in the stenothoids *Metopa alderi* (Tandberg, Schander & Pleijel 2010) [Tandberg *et al.*, 2010a] and *M. glacialis* (Vader & Beehler, 1983) (Tandberg *et al.*, 2010b), that live inside small bivalves.

In all these cases, the amphipods live in a confined space, where room and probably food are highly restricted. Usually, only a single adult pair, and one or more generations of broods, are present in a single host. This seems also to be the case in the present species (Figs 1A, 1C), where food more than space seems to be at a premium.

KEY TO WORLD *STENULA* BARNARD, 1962 (AND ONE SPECIES OF *METOPA* BOECK, 1871) MODIFIED FROM KRAPP-SCHICKEL & VADER (2015: 27)

1a. Coxa 4 distal margin clearly sinuous; N. Norway, 4 mm … *Metopa sinuata* Sars, 1892
1b. Coxa 4 distal margin regularly convex or almost straight … 2

2a. Gn1 propodus and carpus very long and slender, dactylus broad and heavily setose; Gn2 rectipalmate … 3
2b. Gnathopods with propodus and carpus not very long and slender, dactylus normal for the genus (slim, weakly curved, not setose) … 4
3a. Gn1 propodus < carpus, palm concave, dactylus length to width = 2; northern Norway, 5 mm … *Metopa palmata* Sars, 1892
3b. Gn1 propodus > carpus, palm convex, dactylus length to width = 3:2; Laptev Sea, northern Russia, 3.8 mm … *S. alexanderi* Tzvetkova & Golikov, 1990
4a. P6, 7 basis and merus posteriorly serrated, hind margin of basis proximally with acute tooth; Kurile Islands, northeastern Pacific, 7 mm … *S. serripes* (Gurjanova, 1955)
4b. P6, 7 basis not serrated nor with tooth … 5
5a. Gn2 propodus in male with deep U-shaped excavation … 6
5b. Gn2 propodus in male not with deep U-shaped excavation …7
6a. Gn2 propodus palm in male semicircularly excavated near distal corner, rest of palm much longer than width of excavation; Japan Sea, 4 mm … *S. ussuriensis* (Gurjanova, 1948)
6b. Gn2 propodus palm in male deeply and irregularly excavated, rest of palm shorter than width of excavation; Japan Sea, 5 mm … *S. bassarginensis* (Gurjanova, 1948)
7a. Gn2 propodus male palm clearly irregular, defined by strong tooth … 8
7b. Gn2 propodus in male palm smooth or slightly crenulate, convex or straight … 10
8a. Telson with 3 pairs of spines; Kamchatka, northeastern Pacific, 3.5 mm … *S. beringiensis* (Gurjanova, 1948)
8b. Telson naked or with small setules … 9
9a. U2 rami subequal, telson subacute; California, 2 mm … *S. incola* Barnard, 1969
9b. U2 outer ramus almost half length of inner ramus, telson rounded; Vancouver Island, 4 mm … *S. traudlae* **sp. nov.**
10a. Gn2 propodus palmar corner prominent, shaped like a finger-tip; Chukchi Sea, 3 mm …. *S. pugilla* Krapp-Schickel & Vader, 2015
10b. Gn2 propodus palmar corner blunt or with acute tooth …11
11a. Gn1 carpus unusually long, up to three times longer than wide; eyes very large …12
11b. Gn1 carpus clearly not as long, eyes normal … 13
12a. Gn1 dactylus not reaching half-length of propodus; A1 clearly shorter than A2; P6, 7 basis with rounded hind margin; western Greenland, 5 mm … *S. nordmanni* (Stephensen, 1931)
12b. Gn1 dactylus reaching half-length of propodus; A1 and A2 subequal; P6, 7 basis with straight hind margin; California, 2 mm … *S. modosa* Barnard, 1962
13a. Telson with two pairs of spines; Bering Sea, 4 mm … *S. derjugini* (Gurjanova, 1948)
13b. Telson naked … 14
14a. Gn1 carpus clearly shorter than propodus … 15
14b. Gn1 carpus subequal to propodus … 16
15a. P7 basis very broad, posterior margin convex; mandible palp long but 1-articulated; Ungava Bay, Arctic Canada, 3–4 mm … *Metopa hearni* (Dunbar, 1954)
15b. P7 basis slender, posterior margin rather straight; mandible palp short; Point Barrow (Arctic) Alaska, 3 mm… *S. angusta* (Shoemaker, 1955)
16a. P6, 7 posterior lobe of merus reaches halfway or less along carpus … 17
16b. P6, 7 posterior lobe of merus reaches clearly further than halfway along carpus …18
17a. Gn2 propodus length:width = 3; P7 basis broad, length = 2× width; northern Norway, 4 mm … *S. invalida* (Sars, 1892)
17b. Gn2 propodus length:width = 2; P7 basis less wide, length < 2× width; northern Norway, 7 mm … *S. solsbergi* (Schneider, 1884)
18a. P7 coxa bilobed, Arctic (Kamchatka Peninsula, Russia to St. Lawrence Bay, Canada), 3 mm … *S. latipes* (Chevreux & Fage, 1925)
18b. P7 coxa rounded, English Channel, 5 mm … *S. peltata* (Smith, 1874 in Smith & Harger, 1874)

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