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# Stenothoidae (Crustacea: Amphipoda) of hydrothermal vents and surroundings on the Mid-Atlantic Ridge, Azores Triple Junction zone

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## Abstract

Four new species of Stenothoidae were collected from the Azores Triple Junction zone during different French cruises on the Mid-Atlantic Ridge. One of the species belongs to the genus *Torometopa* (*T. saldanhae*) and is the first record of this genus in the Atlantic Ocean. The three other species belong to the genus *Stenothoe* (*S. divae*, *S. marvela*, and *S. menezgweni*). It is not possible to determine from morphological and ecological characters whether these amphipod species are endemic to hydrothermal systems or are bathyal species that may be found away from vent sites.

**Keywords:** *Amphipoda, hydrothermal vent, Mid-Atlantic Ridge, new species, Stenothoidae*

## Introduction

While we possess a lot of data on Atlantic bathyal amphipods, this is not true for amphipods that live on the Mid-Atlantic Ridge. Amphipods are not especially abundant at most locales on the Mid-Atlantic Ridge and sampling is difficult; we thus have had little material to study from each cruise. It was necessary to wait for the development of multiple programmes to obtain sufficient specimens for proper study. For example, in the samples from the FARA programme (June 1993) on Lucky Strike and Snake Pit sites, the genus *Stenothoe* was not present (Bellan-Santini and Thurston 1996).

During five Ifremer (Brest, France) diving cruises on the Mid-Atlantic Ridge, some specimens of Stenothoidae were found. Four new species were identified in this material: *Torometopa saldanhae*, *Stenothoe divae*, *S. marvela*, and *S. menezgweni*.

## Material studied

Specimens studied here were collected during several Ifremer French cruises (DIVA 1, 1994, Chief scientist, Y. Fouquet; DIVA 2, 1994, Chief scientists, A.-M. Alayse and D. Desbruyères; MARVEL, 1997, Chief scientist, D. Desbruyères; PICO, 1998, Chief

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scientist, D. Desbruyères; and ATOS, 2001, Chief scientist, P.-M. Sarradin) by the submarine Nautille or the ROV Victor 6000, on the Azores Triple Junction zone, Mid-Atlantic Ridge, on hydrothermal vents, and on the surroundings (Menez Gwen, 37°50'N, 865 m; Lucky Strike, 37°17'N, 1700 m; Rainbow, 36°13'N, 2373 m), or on MAR segments (Famous zone, 36°32'N, 2360 m, Segment 38°N, 788 m). Samples were collected by a slurp gun manipulated from the submarine among the communities living in or next to the hydrothermal fluid emissions, or sorted from washings of mytilid bivalves *Bathymodiolus azoricus* Cosel, Comtet and Krylova, 1999, or alvinocaridid shrimps, or from sediment collected by the grab of the submarine.

The holotypes are deposited in the Muséum national d'Histoire naturelle, Paris.

## Taxonomy

### *Torometopa saldanhae* n. sp.

(Figures 1, 2)

#### *Type locality*

Mid-Atlantic Ridge, Menez Gwen site, 37°50.65'N, 31°31.18'W, 839 m.

#### *Material examined*

ATOS cruise, PL115-13, 11 July 2001, slurp gun 3, MAR, site Menez Gwen, 37°50.65'N, 31°31.18'W, 839 m, three specimens: one male (holotype, MNHN-Am5869), two females with oostegites.

PICO cruise, PL1266, 2 July 1998, isotherm basket, MAR, 200 m W of the site Rainbow, 36°13.44'N, 33°54.30'W, 2273 m: one specimen; PL1267, 3 July 1998, slurp gun 3, MAR, Lucky Strike vent site, marker 21, 37°17.60'N, 32°17'W, 1648 m: four female specimens.

MARVEL cruise, PL1199, 26 August 1997, basket, MAR, Famous zone (non-hydrothermal site), 36°32.26'N, 33°27.40'W, 2364 m: five specimens, one male, two females, two juveniles.

#### *Diagnosis*

Antenna 1 lacking nasiform process on article 1, no accessory flagellum. Palp of the mandible triarticulate, palp of maxilla 1 biarticulate. Pereiopod 5 basis with a postero-distal lobe, pereiopods 6–7 basis wide. Pleon segments non-coalescent. Telson normal.

#### *Description*

*Male.* Length 4 mm.

Head slightly shorter than the first two segments of the mesosome. Body smooth. Eyes present, of normal size. Antenna 1 lacking nasiform process on article 1, shorter than half of body length, article 1 slightly shorter than article 2, article 3 equal to one-quarter of article 2, accessory flagellum absent, flagellum broken, length more than 16 articles, 19 articles in one other complete specimen. Antenna 2 as long as antenna 1, peduncle longer than flagellum, flagellum 15-articulate. Mandible with incisor process denticulate, molar

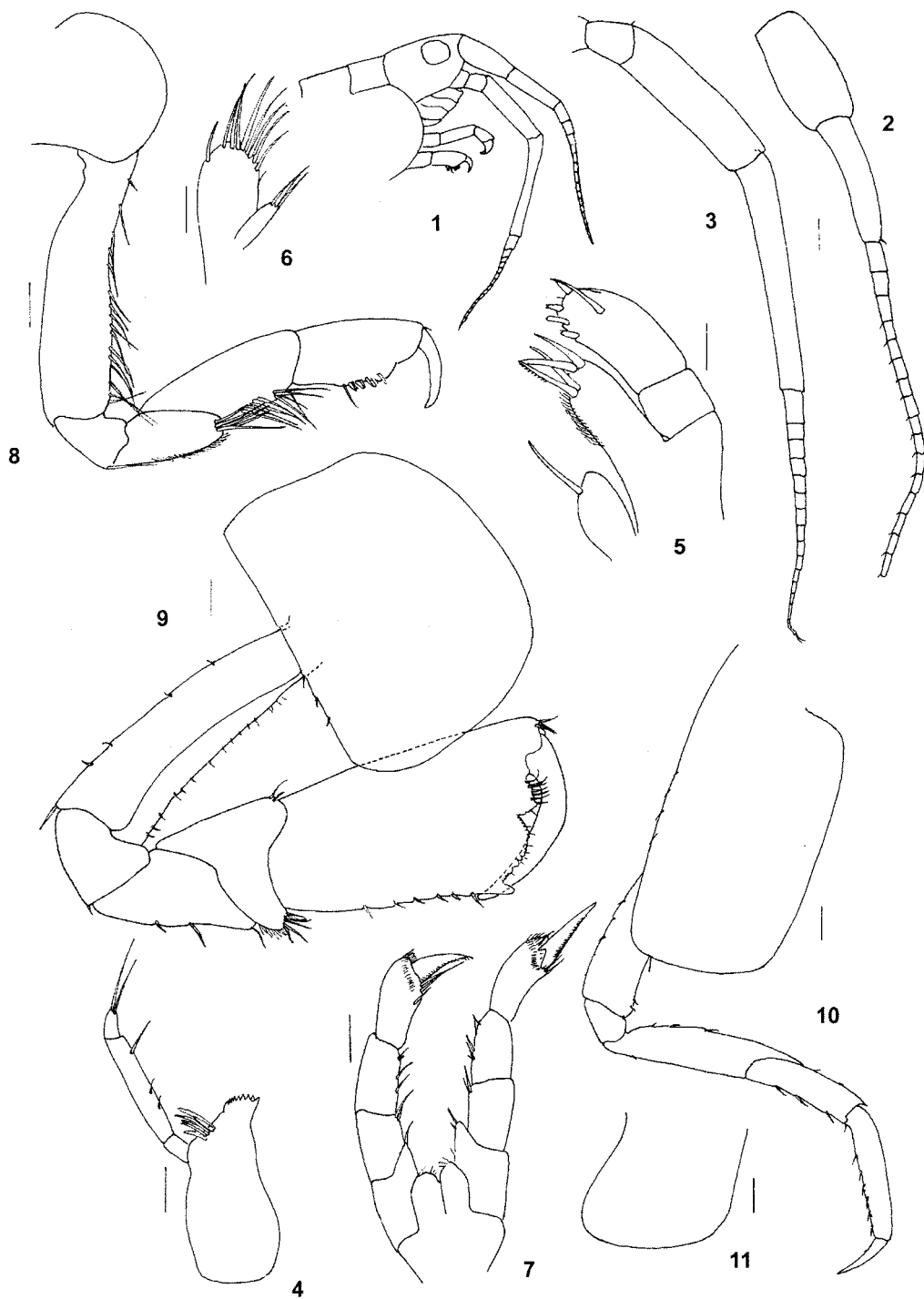


Figure 1. *Torometopa saldanhae*, ATOS, PL115-13, holotype male. (1) Head; (2) antenna 1; (3) antenna 2; (4) mandible; (5) maxilla 1; (6) maxilla 2; (7) maxilliped; (8) gnathopod 1; (9) gnathopod 2; (10) pereopod 3; (11) epimeral plate 3. Scale bars: 100  $\mu$ m.

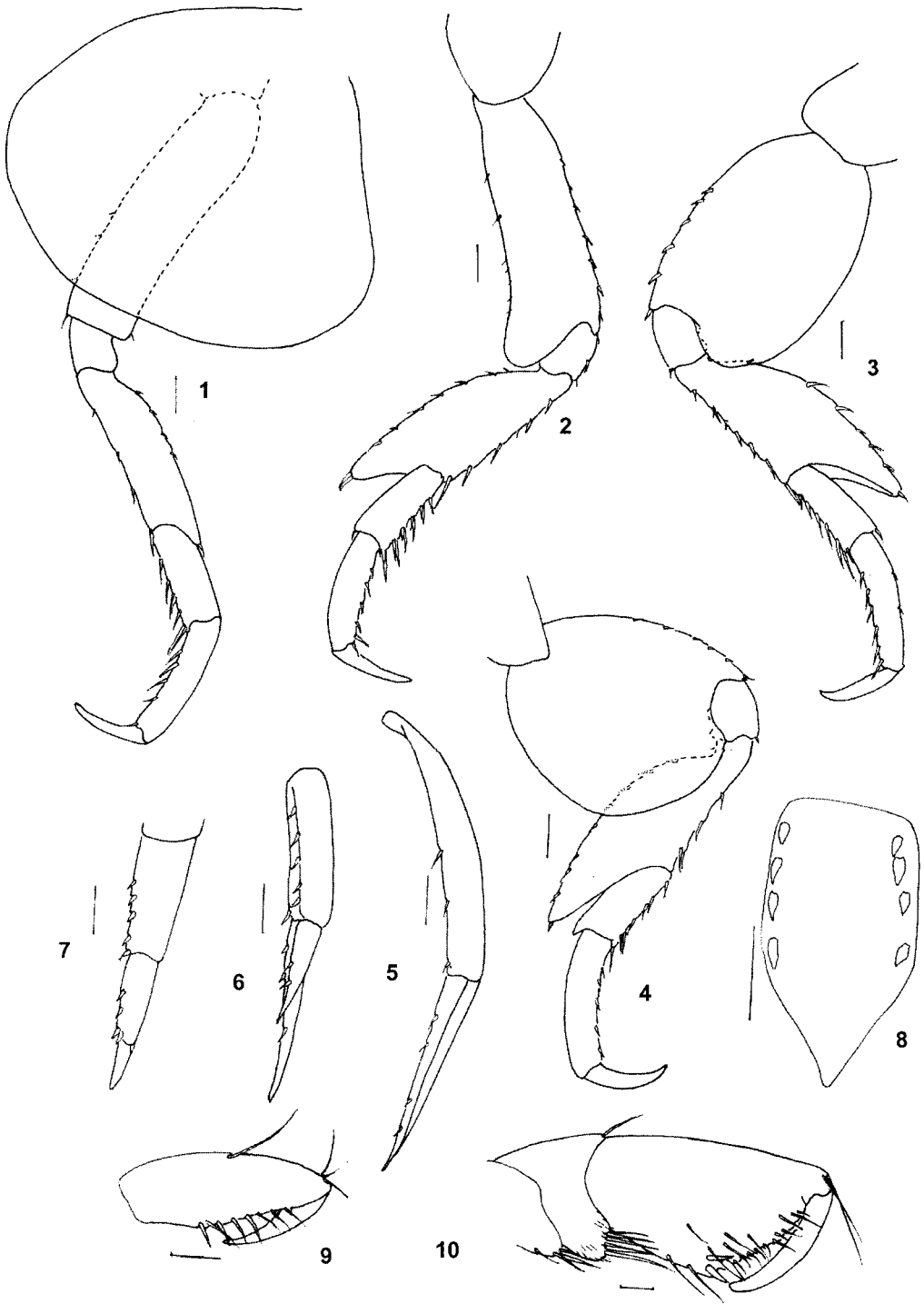


Figure 2. *Torometopa saldanhae*, ATOS, PL115-13. (1–8) Holotype male and paratype female: (1) pereiopod 4; (2) pereiopod 5; (3) pereiopod 6; (4) pereiopod 7; (5) uropod 1; (6) uropod 2; (7) uropod 3; (8) telson. (9, 10) Paratype female: (9) gnathopod 1; (10) gnathopod 2. Scale bars: 100  $\mu$ m.

evanescent, palp triarticulate. Maxilla 1, palp biarticulate, inner plate bearing a long subterminal seta, outer plate with four distal spines and a row of fine setae on the inner margin. Maxilla 2, inner plate shorter than outer, with three terminal setae. Maxilliped, inner plate well separated, outer with a prominent process at the inner distal corner, palp four-articulate, article 3 enlarged distally, surrounding the base of the unguiform article 4.

Coxa 1 small, covered by coxa 2, rounded anteriorly, coxa 3 subrectangular, coxa 4 enlarged, ovate, not posterodistally excavate. Gnathopods subchelate. Gnathopod 1 feeble, merus distally lobate, setose on the posterior side, bearing four long setae distally, carpus as long as propodus, not lobate, propodus with a short and oblique palm, defined by a spine, posterior margin with a double row of spines and a long seta. Gnathopod 2 large, merus and carpus short and lobate, propodus large, distally expanded with palm transverse, strongly indented, limited at the distal corner by a tooth, posterior margin fringed with six small spines, dactylus as long as the palm, margin smooth. Pereiopods 3–4 rectilinear. Pereiopod 5, basis not lobate in the middle of the article but a postero-distal lobe expanded to the end of ischium. Pereiopods 6–7 with expanded and lobate basis, more expanded in pereiopod 7. Merus with a large postero-distal triangular lobe. Pleonite 3 without dorsal process.

Epimeral plates 1–2 rounded, 3 rounded, with the posterior margin oblique. Uropod 1, peduncle with three spines, rami slender, shorter than peduncle. Uropod 2 shorter than uropod 1, outer ramus three-quarter of inner ramus, biarticulate. Uropod 3 with only one ramus, biarticulate. Telson entire, longer than wide, distally triangular, four spines on each side.

*Female.* Gnathopods with palm oblique, less indented than male.

### *Etymology*

This first species of the genus *Torometopa* in the Atlantic Ocean is dedicated to our friend Professeur Luiz Saldanha who was one of the promoters of the Franco-Lusitanian cooperation in oceanography, especially in the hydrothermal domain.

### *Relationship*

According to Krapp-Schickel (1996a, Table 1), *Scaphodactylus* and *Torometopa* are the only two genera of Stenothoidae with the basis of pereiopod 5 with an expanded distal lobe, and *Torometopa* is alone with zero to two articles in the accessory flagellum. With these characters our species is attributed to the genus *Torometopa*.

*Torometopa* was erected by Barnard and Karaman (1987). Presently, 22 species are described, only one of which is found in the northern hemisphere, from the Arctic Ocean, *T. medipa* Krapp-Schickel, 1996. The others are known from antarctic or subantarctic zones. Krapp-Schickel (1996b) described *T. medipa* from Greenland at 310 m depth.

*Torometopa saldanhae* differs from *T. medipa* in the presence of eyes, the shape of the gnathopods and telson.

In consideration of the characters analysed by Krapp-Schickel (1996b) for *Torometopa* species, *T. saldanhae* is characterized by the peduncle of antenna 1 with article 1 length/breadth  $<3/1$ ; the coxa 1 is oval with length/breadth  $<3/1$ ; the postero-distal lobe of the basis of pereiopod 5 is elongate and broadened; propodus of gnathopod 1 is regularly convex, palm not well defined.

### *Distribution and habitat*

Mid-Atlantic Ridge, central Atlantic Ocean between 839 to 2364 m depth. The specimens coming from the sites Menez Gwen (839 m) and Lucky Strike (1648 m) were collected at 1 or 2 m from the hydrothermal fluid emissions, among sponges (Menez Gwen) or dead mussels (Lucky Strike). The specimens of Rainbow (2273 m) and of Famous zone (2364 m) were collected among gorgonians, out of the active hydrothermal areas. Therefore, this species, occurring as well on the hydrothermal sites as in the bathyal environment, can be regarded as an opportunist among the hydrothermal communities.

### ***Stenothoe divae* n. sp.**

(Figures 3, 4)

### *Type locality*

Mid-Atlantic Ridge, south-west of Azores, Segment 38°N, 38°19.04'N, 30°40.13'W, 788 m.

### *Material examined*

DIVA 1 cruise, DV 11-5, 19 May 1994, Segment 38°N, 38°19.04'N, 30°40.13'W, 788 m: 25 specimens with two adult males, one male is the holotype, MNHN-Am5870.

### *Diagnosis*

Antenna 1 lacking nasiform process on article 1, no accessory flagellum. Mandible without palp. Gnathopod 1 with merus produced to the middle of the carpus. Gnathopod 2 with the propodus enlarged, palm oblique, excavate in the proximal part and largely indented in the distal part. Pereiopods 6–7 with expanded lobate basis. Telson entire.

### *Description*

*Male.* Length 6 mm.

Head slightly shorter than two first pereon segments. Eyes present of moderate size. Antenna 1 lacking nasiform process on article 1. Antenna 1 exceeding length of body, articles 1 and 2 subequal, accessory flagellum absent, flagellum with 23 articles. Antenna 2 shorter than antenna 1 but longer than half of body, flagellum with 14 articles. Palp of mandible absent (represented by a single seta), cutting edge strongly toothed, without molar. Palp of maxilla 1 biarticulate. Inner plates of maxillipeds well separated, palp four-articulate.

Coxa 1 small, covered by coxa 2, anteriorly rounded. Coxa 3 subrectangular, coxa 4 very large, triangular, not posteriorly excavate. Gnathopods 1–2 subchelate, strongly different from each other in size and shape. Gnathopod 1 small, merus distally produced into a setose lobe reaching the middle of the carpus, carpus as long as propodus, non-lobate, propodus with palm oblique, undefined. Gnathopod 2 greatly enlarged, merus and carpus short, lobed, propodus with palm oblique, excavate in the proximal part and strongly indented in the distal part, limited proximally by a spine. In a second specimen, the propodus is less excavate. Dactylus equal to palm, inner margin sparsely setose. Pereiopods

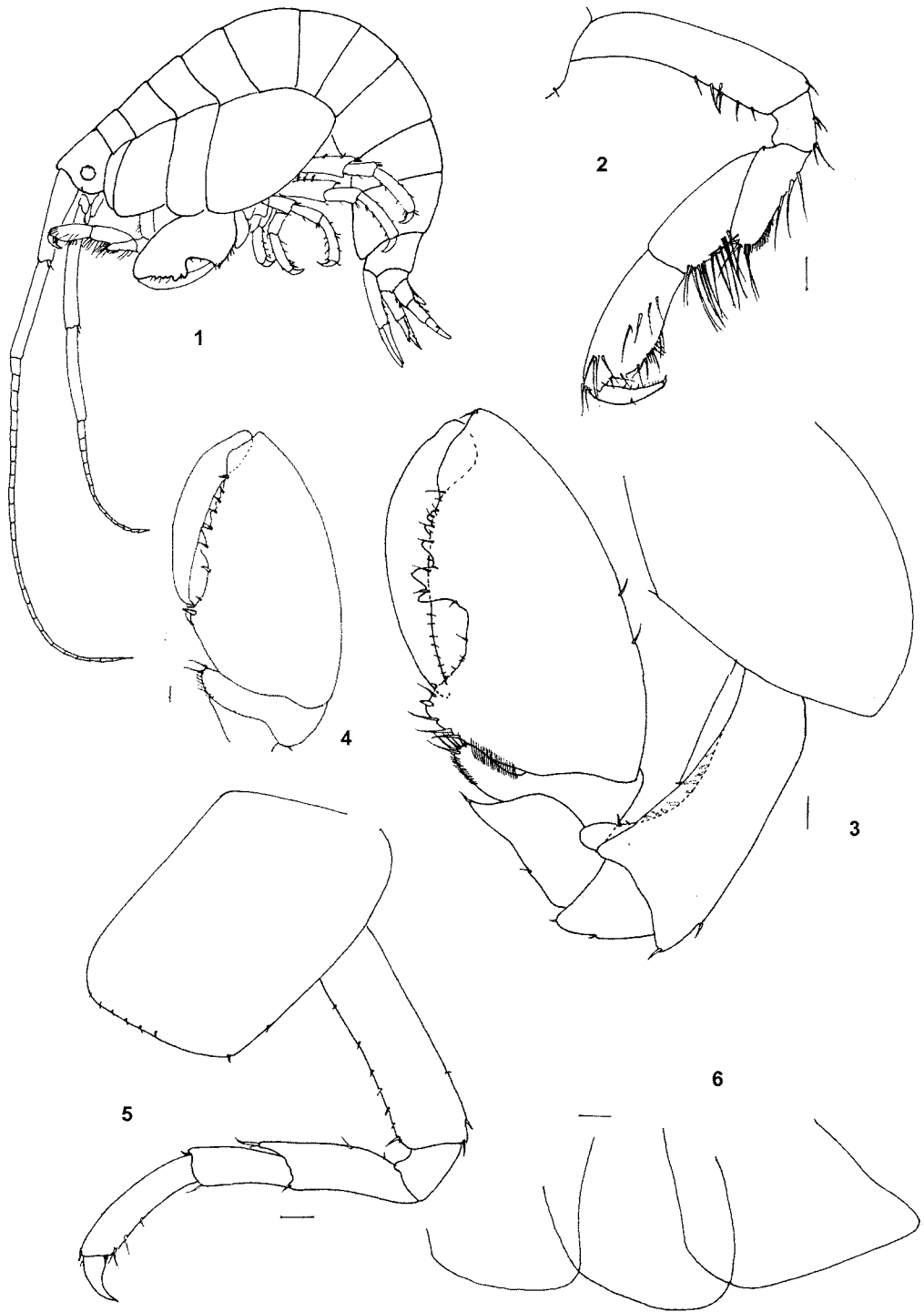


Figure 3. *Stenothoe divae*, DIVA 1, DV11-5. (1, 2, 5, 6) Holotype male and (4) paratype female: (1) habitus; (2) gnathopod 1; (5) pereiopod 3; (6) epimeral plate 3. (3) Holotype male: gnathopod 2. (4) Paratype female: gnathopod 2. Scale bars: 100  $\mu$ m.



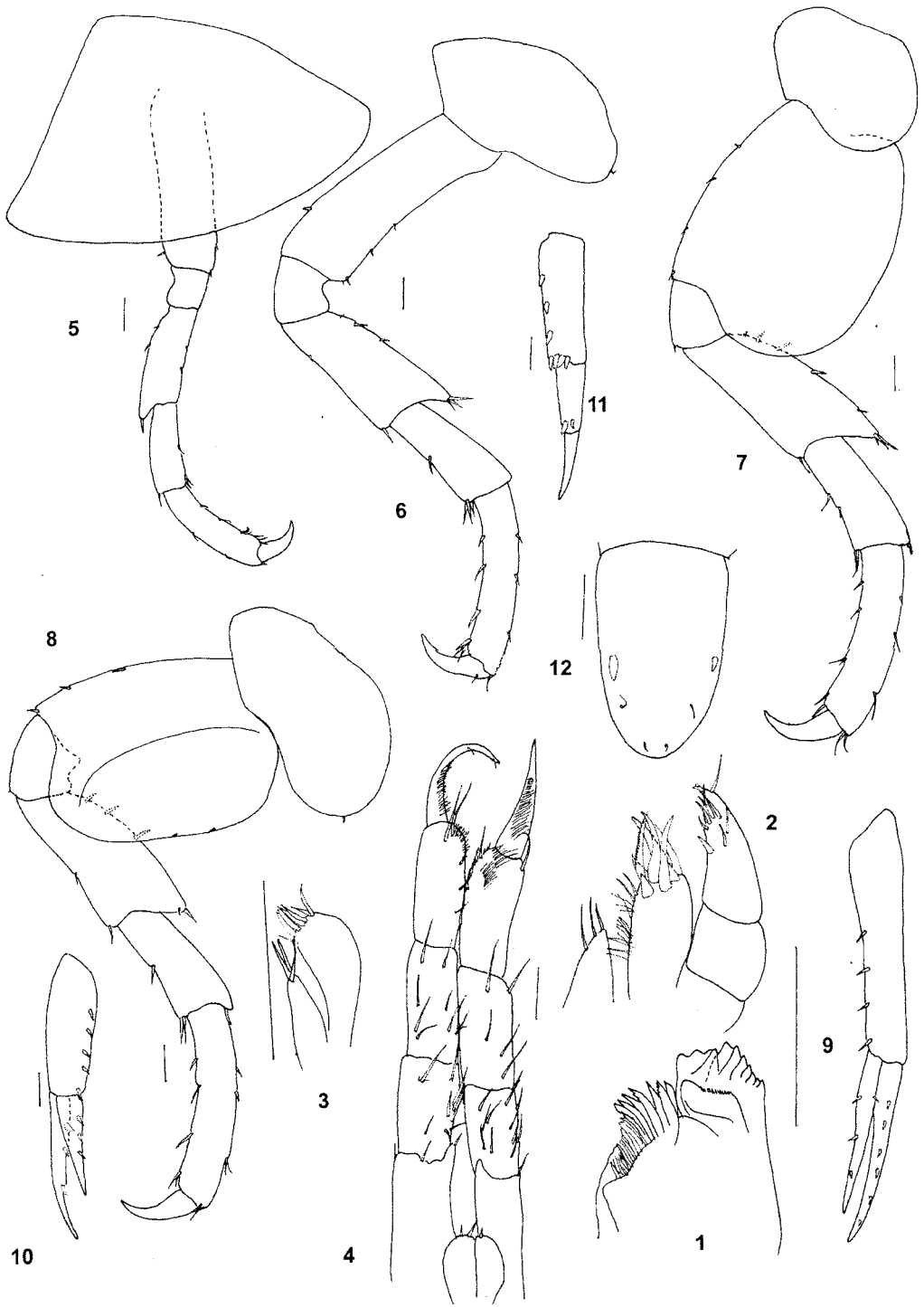


Figure 4. *Stenothoe divae*, DIVA 1, DV11-5, holotype male. (1) Mandible; (2) maxilla 1; (3) maxilla 2; (4) maxilliped; (5) pereopod 4; (6) pereopod 5; (7) pereopod 7; (8) pereopod 6; (9) uropod 1; (10) uropod 2; (11) uropod 3; (12) telson. Scale bars: 100  $\mu$ m.

3–4 slender. Pereiopod 5 with rectilinear basis. Pereiopods 6–7 with expanded and lobate basis, merus with an acute postero-distal lobe bearing terminal spines.

Epimeral plates 1 and 2 rounded, 3 rounded with the distal margin oblique. Pleonite 3 lacking dorsal process. Uropod 1 peduncle with four spines, longer than rami; uropod 2 shorter than 1, outer ramus three-quarters of the inner with, respectively, three spines. Uropod 3 with three lateral and four distal spines on the peduncle, ramus biarticulate, the proximal article with two distal spines. Telson entire, longer than broad, each lateral margin with one spine and one seta, one pair of subterminal setae.

*Female.* Female with the propodus of gnathopod 2 without excavation, but strongly indented.

#### *Etymology*

Name of the species is derived from the name of the DIVA cruise.

#### *Relationship*

This species is referable to the genus *Stenothoe*, due to no mandibular palp, and maxilla 1 with two-articulate palp. Seven species occur in the deep Atlantic: *S. aequicornis* Stephensen 1931, *S. bosporana* Sowinski, 1898, *S. coutieri* Chevreux, 1908, *S. dollfusi* Chevreux, 1887, *S. macrophthalma* Stephensen, 1931, *S. marina* Bate, 1856, and *S. richardi* Chevreux, 1895. Three species have been found in the North Sea or Norway Sea at more than 180 m deep: *S. megacheir* (Boeck, 1871), *S. microps* Sars, 1895, and *S. tenella* Sars, 1895. None of these species has a propodus of gnathopod 2 enlarged with a palm obliquely excavated in the proximal part and strongly indented in the distal part, a gnathopod 1 with merus distally produced into a setose lobe reaching to the middle of the carpus, and a telson with only one pair of spines. *Stenothoe divae* is considered a new species.

#### *Distribution and habitat*

Mid-Atlantic Ridge, south-west of Azores, Segment 38°N, 788 m depth. The specimens were collected on indurated sediment, among spongia, hydrozoans, gorgonians, and colonial tunicates.

#### ***Stenothoe marvela* n. sp.**

(Figures 5, 6)

#### *Type locality*

Mid-Atlantic Ridge, Famous zone, 36°32.26'N, 33°27.40'W, 2364 m.

#### *Material examined*

MARVEL cruise, PL 1199, 26 August 1997, Famous zone, 36°32.26'N, 33°27.40'W, 2364 m, basket 1: five specimens (one female holotype, MNHN-Am5871).

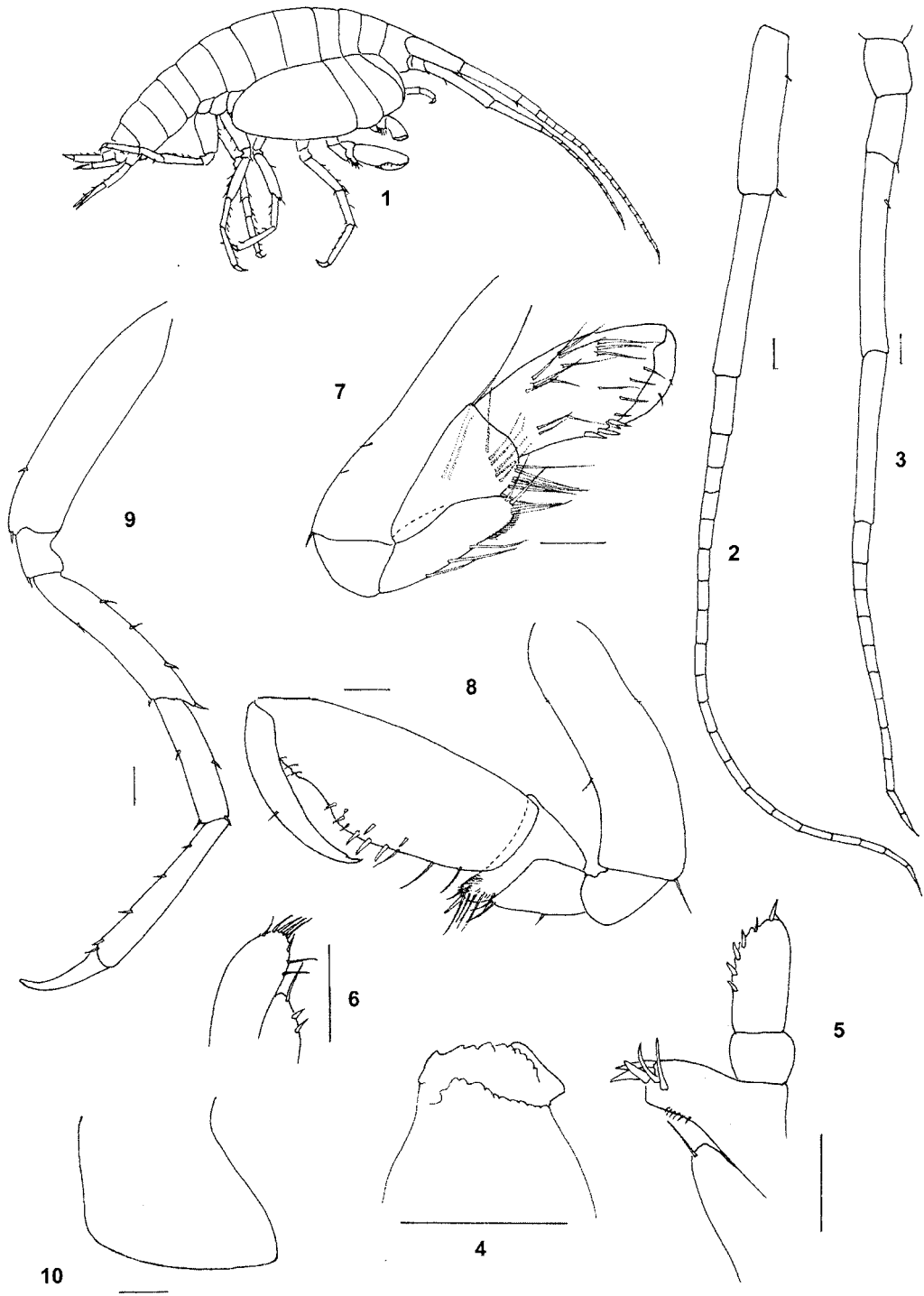


Figure 5. *Stenothoe marvela*, MARVEL, PL1199, holotype female. (1) Habitus; (2) antenna 1; (3) antenna 2; (4) mandible; (5) maxilla 1; (6) maxilla 2; (7) gnathopod 1; (8) gnathopod 2; (9) pereopod 3; (10) epimeral plate 3. Scale bars: 100  $\mu$ m.

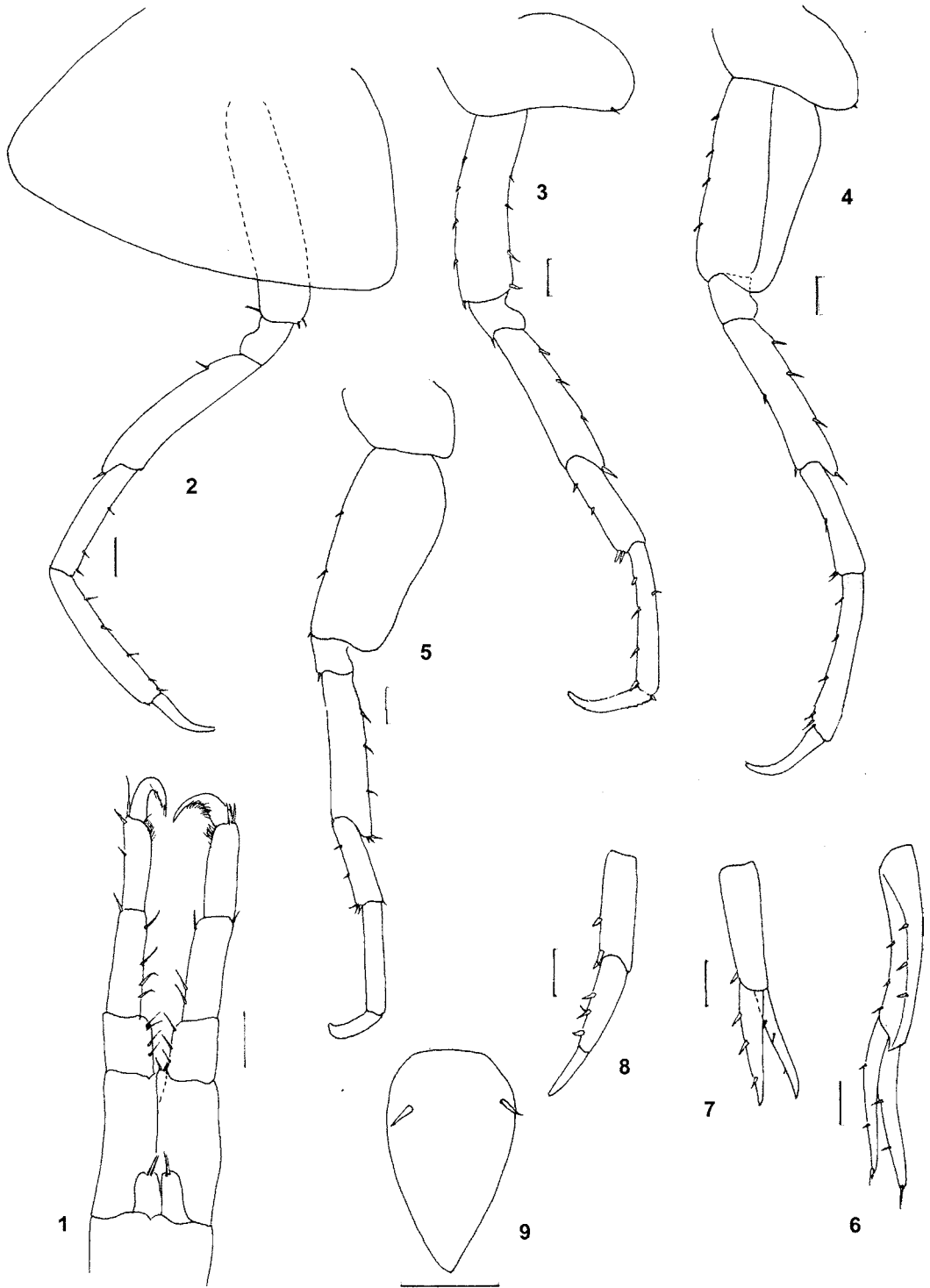


Figure 6. *Stenothoe marvela*, MARVEL, PL1199, holotype female. (1) Maxilliped; (2) pereiopod 4; (3) pereiopod 5; (4) pereiopod 6; (5) pereiopod 7; (6) uropod 1; (7) uropod 2; (8) uropod 3; (9) telson. Scale bars: 100  $\mu$ m.

### *Diagnosis*

Species blind. Antenna 1 lacking nasiform process on article 1, as long as body, no accessory flagellum. Mandible without palp. Gnathopod 1 with merus produced to the middle of the carpus. Gnathopod 2 with the propodus enlarged, palm excavate in the distal part. Pereiopods 6–7 with basis slightly lobate. Telson entire.

### *Description*

*Female.* Female with oostegites, length 4 mm.

Head slightly shorter than first segment of pereon. Eyes absent. Antenna 1 as long as body. Antenna 1 without nasiform process on article 1, articles 1 and 2 subequal, article 3 one-third of article 2, accessory flagellum absent, flagellum 19-articulate. Antenna 2 shorter than antenna 1, flagellum 11-articulate. Palp of mandible absent, incisor strongly dentate, no molar. Palp of maxilla 1 biarticulate, inner plate with a distal seta, outer plate with five teeth distally. Maxilla 2 inner plate bearing two lateral setae and one distal. Inner plate of maxilliped well separated, palp elongate four-articulate.

Coxa 1 small, covered by coxa 2, rounded anteriorly, coxa 3 subrectangular, coxa 4 large, triangular, non-excavate posteriorly. Gnathopods 1–2 subchelate, very different. Gnathopod 1 feeble, merus prolonged distally in a setose lobe reaching the middle of the carpus, carpus shorter than propodus, not lobate, propodus with an oblique palm, poorly defined by a group of spines. Gnathopod 2 large, merus and carpus short, carpus lobate, propodus with palm excavate in the distal part, palm spinose, posterior edge rectilinear, dactylus as long as half of propodus, notched distally. Pereiopod 5 with basis rectilinear. Pereiopods 6–7, basis slightly lobate.

Epimeral plates 1–2 rounded, 3 with the posterior margin oblique and the postero-distal corner rounded. Uropod 1, rami slightly unequal, shorter than peduncle. Uropod 2 shorter than uropod 1, rami subequal. Uropod 3 with peduncle shorter than biarticulate ramus, three spines on the peduncle and three on the first article of the ramus. Telson entire, triangular, longer than wide, with only one pair of proximal spines.

### *Etymology*

The name of the species is derived from the name of the MARVEL cruise.

### *Relationship*

The single blind species of Atlantic *Stenothoe* is *S. dactylipotens* Chevreux, 1908, from the Azores, considered by Krapp-Schickel (1976) as a synonym of *S. bosporana* Sowinski, 1898, but probably different (eyes, gnathopod 2, uropod 3, telson). According to Chevreux's description of the Azores specimen, *S. marvela* differs in the size of the antennae, the shape of gnathopod 2, and the telson. The shape of gnathopod 2 of *S. marvela* is near that of *S. dollfusi* Chevreux, 1887, but the two species differ in the size of the antennae, the absence of eyes in *S. marvela*, and the number of spines on the telson. *Stenothoe marvela* is a new species.

### *Distribution and habitat*

Mid-Atlantic Ridge, south-west of Azores, Segment 36°N, Famous zone, 2364 m depth. The specimen was collected among an abundant bathyal community composed of spongia, hydrozoa, gorgonians, echinoderms, and colonial tunicates.

*Stenothoe menezgweni* n. sp.

(Figures 7–9)

*Type locality*

Mid-Atlantic Ridge, south-west of Azores, Menez Gwen site, 37°50'N, 32°31'W, 865 m.

*Material examined*

DIVA 2 cruise, dive PL 922-11, 13 June 1994, 37°50.54'N, 31°31.30'W, 866 m: one specimen; dive PL 937-26, 2 July 1994, slurp gun 9 and 10, Menez Gwen site, 37°50'N, 32°31'W, 865 m: two specimens with one female with oostegites (holotype, MNHN-Am5872).

*Diagnosis*

Antenna 1 lacking nasiform process on article 1, accessory flagellum vestigial. Mandible without palp. Gnathopod 1 with merus as long as carpus; gnathopod 2 with the propodus long and narrow, palm excavate at the distal part. Pereiopods 6–7 slightly lobate. Telson entire.

*Description*

*Female.* Female, length 5 mm.

Head as long as first two pereon segments. Eyes of moderate size, brown-red in alcohol. Antenna 1 lacking nasiform process on article 1. Antenna 1 as long as body length, articles 1 and 2 subequal, article 3 short, one-quarter of the second, accessory flagellum vestigial, flagellum with 21 articles. Antenna 2 shorter than antenna 1, flagellum with 21 articles. Palp of mandible absent, cutting edge strongly toothed, without molar. Palp of maxilla 1 biarticulate, inner lobe with one small seta, outer lobe with six large teeth. Maxilla 2 with inner lobe shorter than outer, and bearing at the inner margin six setae. Inner plates of maxillipeds well separated, palp long, four-articulate.

Coxa 1 small, covered by coxa 2, coxa 2 and 3 sub-rectangular, coxa 4 very large, triangular, not posteriorly excavate. Gnathopods 1–2 subchelate strongly different from each other in size and in shape. Gnathopod 1 small, merus distally produced into a setose lobe, merus as long as carpus, not lobate, carpus shorter than propodus, palm oblique, undefined. Gnathopod 2 greatly enlarged, carpus lobate, propodus long and narrow, length  $3.5 \times$  width, palm excavate at the distal part, not indented proximally, dactyl as long as half propodus. Pereiopods 3–4 slender. Pereiopod 5 with rectilinear basis. Pereiopods 6–7 with basis slightly lobate, length  $1.8 \times$  width. Epimeral plate 3 with postero-distal corner sharp. Pleonite 3 lacking dorsal process. Uropod 1 peduncle with two rows of five and three spines, equal to rami. Uropod 2 with outer ramus shorter than inner, inner ramus with three and two spines on the sides. Uropod 3 peduncle slightly shorter than biarticulate ramus. Telson entire, each lateral margin with two or three spines and one pair of setae distally.

*Etymology*

The name of the species is derived from the name of the Menez Gwen hydrothermal site.

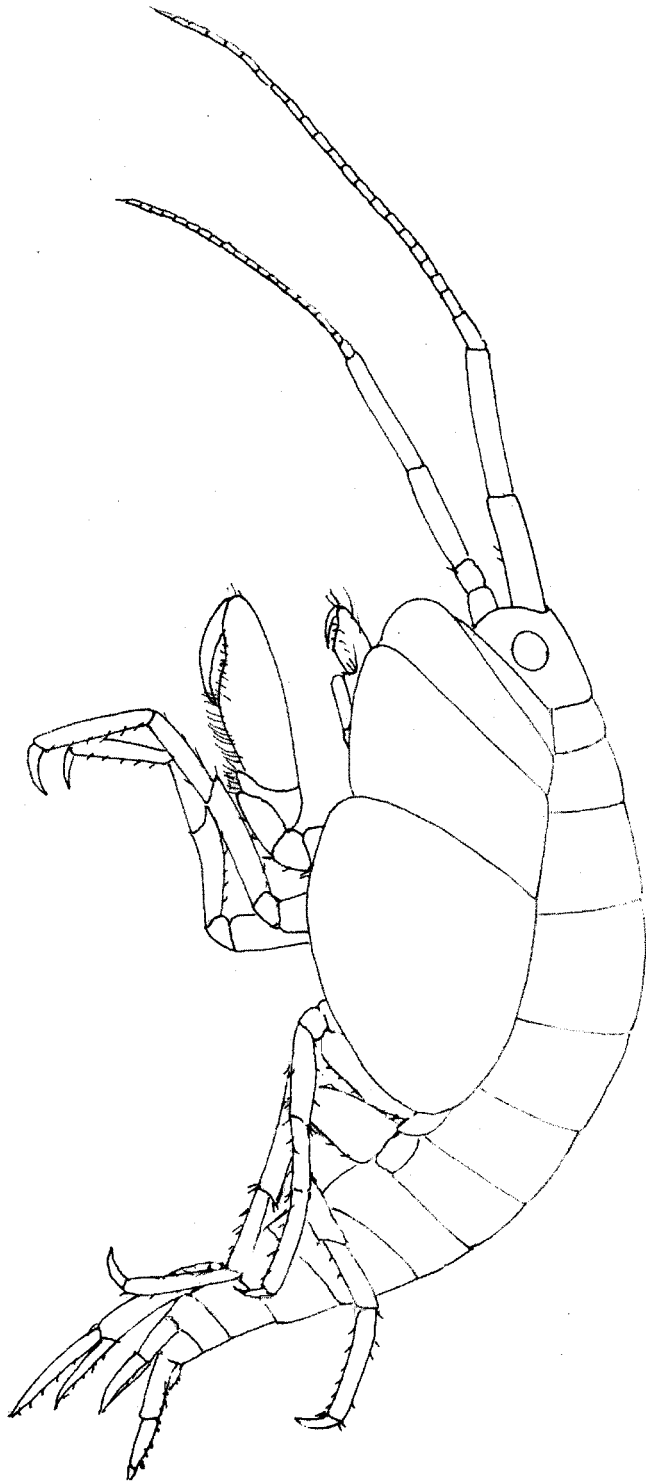


Figure 7. *Stenothoe menezgweni*, DIVA 2, PL26, holotype female. Habitus of the holotype.

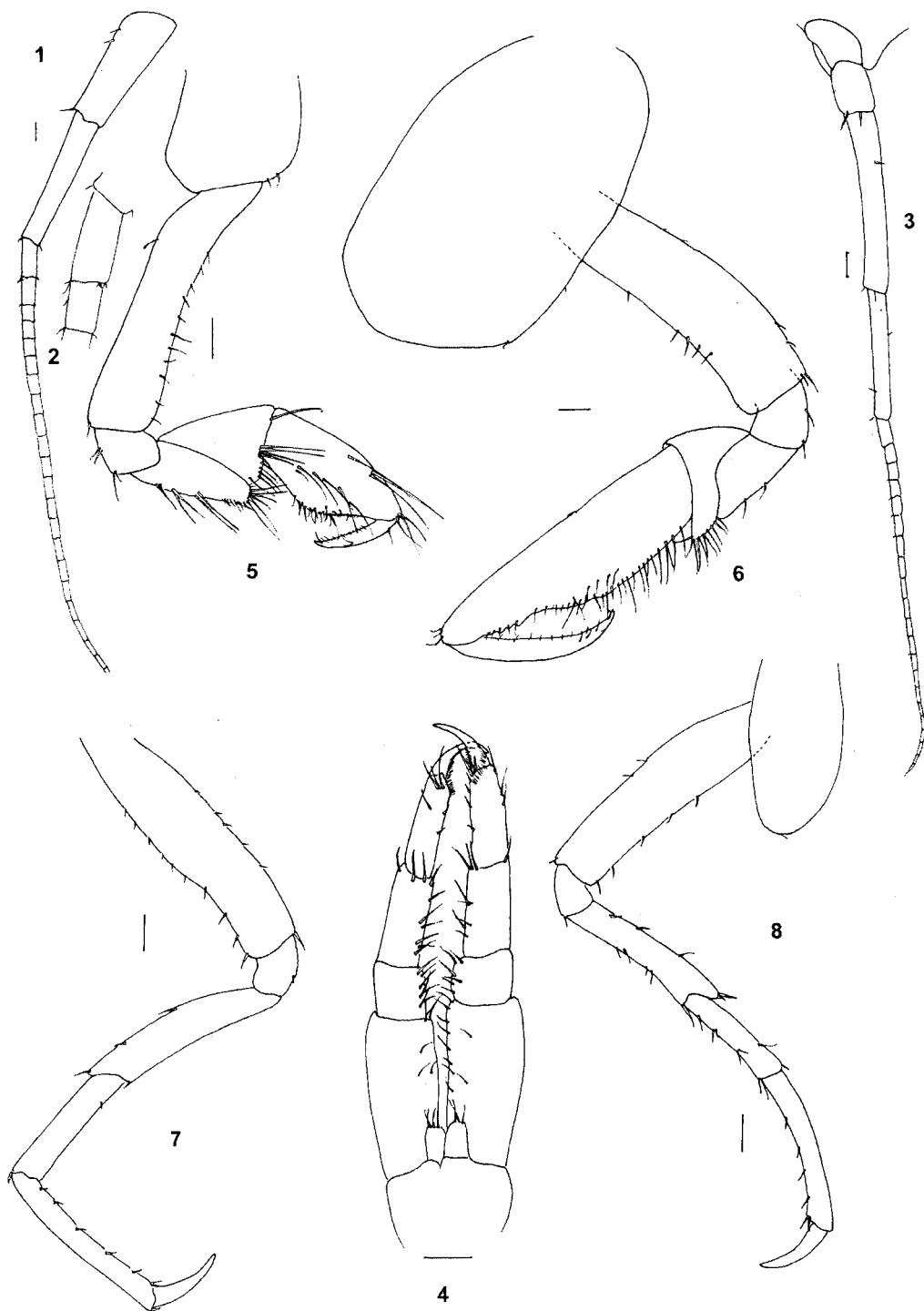


Figure 8. *Stenothoe menezgweni*, DIVA 2, PL26, holotype female. (1) Antenna 1; (2) scale as accessory flagellum; (3) antenna 2; (4) maxilliped; (5) gnathopod 1; (6) gnathopod 2; (7) pereiopod 3; (8) pereiopod 5. Scale bars: 100  $\mu$ m.



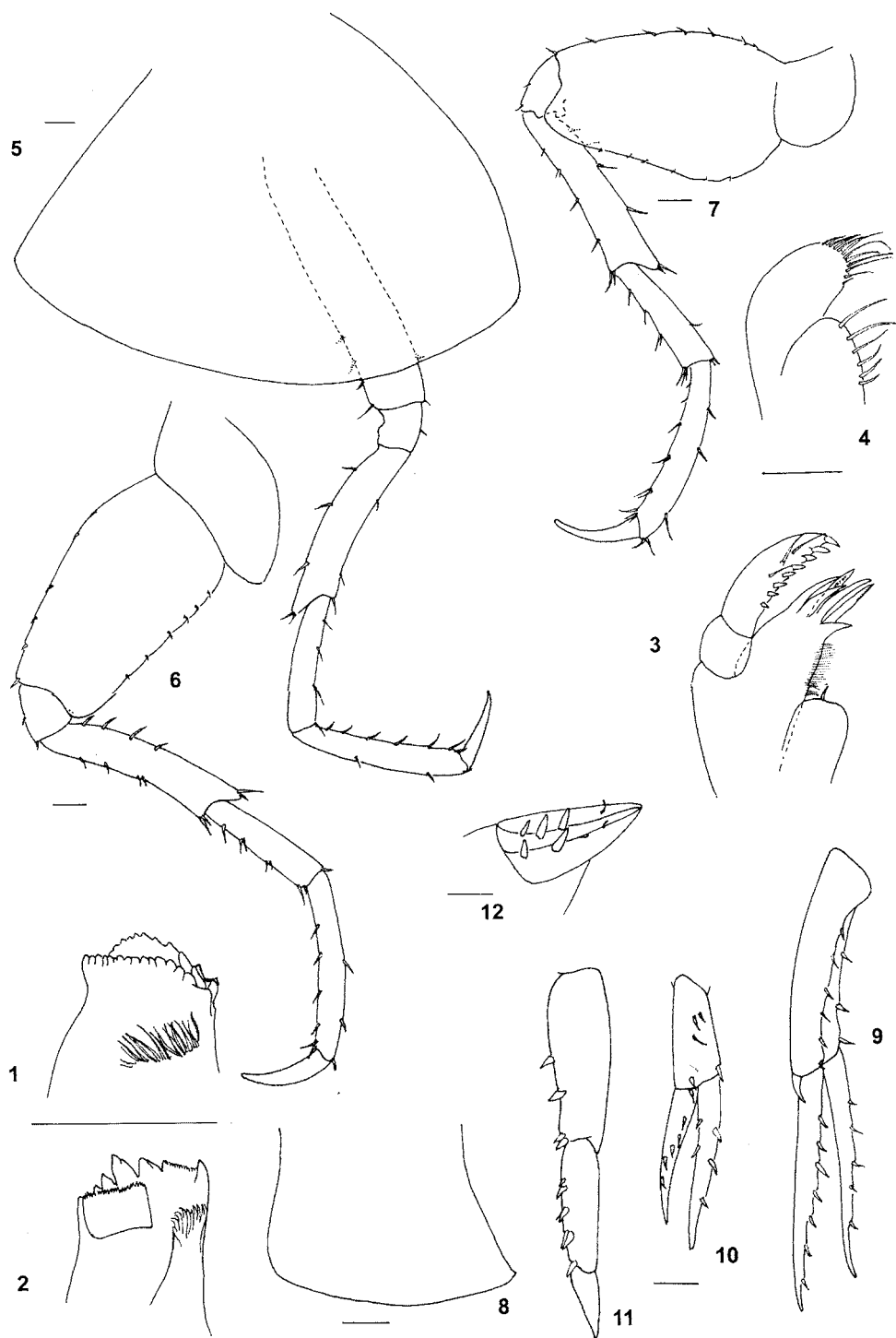


Figure 9. *Stenothoe menezgweni*, DIVA 2, PL26, holotype female. (1) Mandible right; (2) mandible left; (3) maxilla 1; (4) maxilla 2; (5) pereopod 4; (6) pereopod 6; (7) pereopod 7; (8) epimeral plate 3; (9) uropod 1; (10) uropod 2; (11) uropod 3; (12) telson. Scale bars: 100  $\mu$ m.

### *Relationship*

This species differs from other Atlantic *Stenothoe* species in the shape of the propodus of gnathopod 2, the presence of a vestigial accessory flagellum (this is not a good character because it is very difficult to distinguish). Gnathopod 2 differs little from that of *S. marvela*, but the presence of eyes, the number of spines on the telson, and the setation of the inner lobe of maxilla 2 are good characters, according to Krapp-Schickel (1996a), that distinguish this new species from *S. marvela*.

### *Distribution and habitat*

Mid-Atlantic Ridge, south-west of Azores, Menez Gwen site, 37°N, 865–866 m, on hydrothermal site.

### **Discussion**

At the Azores Triple Junction, the depth of the ridge decreases from 2400 to 850 m. The Triple Junction area is a complex zone, and at the hydrothermal vents the fauna is a mix of species endemic to vent environments and bathyal species (Desbruyères et al. 2001). Stenothoidae collected in the past in deep stations near the Azores are *Stenothoe coutieri* Chevreux, 1908, from 38°31'N, 26°50.25'W, 845 m, and *S. dactylipotens* Chevreux, 1908 (now synonymized with *S. bosporana*), from 37°40'N, 26°26'W 1919 m, from outside the influence of hydrothermal activity; they were not found again. It is not possible to say if the species described here have any relationship with hydrothermal phenomena. *Torometopa saldanhae* is present at hydrothermal sites as well as away from venting activity. *Stenothoe menesgweni* was also collected at a hydrothermal site; *S. divae* and *S. marvela* occur in non-hydrothermal sites.

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