

Shallow water caprellids (Crustacea: Amphipoda) of Azores and Madeira

Caprélidos (Crustacea: Amphipoda) de aguas someras de Azores y Madeira

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Palabras clave: Caprélidos, hidrozoos, algas, distribución vertical, taxonomía, ecología, Azores, Madeira, aguas someras.

ABSTRACT

The species composition and vertical distribution of caprellids associated to hard bottoms (mainly hydroids and algae) were studied from 0 to 41 m deep in Azores and Madeira. The highest caprellid densities were measured between 0 and 10 m. *Caprella acanthifera* 'sensu lato' and *Caprella equilibra* Say, 1818 were the dominant species in Azores, while *Caprella penantis* Leach, 1814 and *Pseudoprotella phasma* (Montagu, 1804) were more abundant in Madeira. Lateral view figures and taxonomical remarks are provided for each species. Although Macaronesian islands seem to share most of the caprellid species, a detailed morphological and molecular study is necessary to clarify the taxonomical status of some species. Probably, the global diversity of amphipods from Macaronesia is still underestimated.

RESUMEN

Se estudió la composición de especies y la distribución vertical de los caprélidos asociados a sustrato duro (principalmente hidrozoos y algas) desde los 0 a los 41

m de profundidad en Azores y Madeira. Las mayores densidades de caprellidos se registraron en los primeros 10 m. *Caprella acanthifera* 'sensu lato' y *Caprella equilibra* Say, 1818 fueron las especies dominantes en Azores, mientras que *Caprella penantis* Leach, 1814 y *Pseudoprotella phasma* (Montagu, 1804) fueron más abundantes en Madeira. Se incluyen vistas laterales y notas taxonómicas de cada una de las especies. Aunque las islas macaronésicas parecen compartir la mayoría de las especies de caprellidos, se requiere un estudio morfológico y molecular detallado para clarificar el estatus taxonómico de algunas especies. Probablemente, la diversidad global de los anfípodos de Macaronesia está aún subestimada.

INTRODUCTION

The Macaronesian region *sensu lato* includes the Azores, Madeira, Selvagens, Canary Islands and Cape Verde. All the islands are of volcanic origin, mainly with rocky shorelines descending steeply into the sublittoral, and scarce, relatively-unstable sedimentary shores (e.g. Morton *et al.*, 1998). They are separated from the European and African continents by waters of depth exceeding 2000 m (Bamber, 2012). The benthic fauna of the sedimentary shores of these islands is generally impoverished owing to the instability of these habitats; the peracarid fauna of rocky shores is associated with algal turf habitats, and while it can be numerous it also tends to be of low diversity (see Bamber, 2012 and references therein). During the last years several studies have been published dealing with peracarid crustaceans. For example, Bamber (2012) studied the tanaids and concluded that the archipelagos of Macaronesia support low diversity of littoral tanaidacean assemblages, with lowest diversity in the Canary Islands and highest diversity in Cape Verde. Castelló & Junoy (2007) provided a checklist of the marine isopod fauna from the Macaronesian archipelagos, reporting a total of 62 species, belonging to 26 families. Regarding with amphipods, although several new species have been recently described from this region (Guerra-García, 2004; Krapp-Schickel & Takeuchi, 2005; Bellan-Santini, 2007; Rubal & Larsen, 2013; Vázquez-Luis *et al.*, 2013), there is a lack of studies, especially dealing with caprellids (e.g. Riera *et al.*, 2003).

The first studies dealing with amphipods from Azores were conducted by Guerne (1889), Stebbing (1906) and Chevreux & Fage (1925) who studied samples taken in the littoral zones of the islands to more than 3000 m deep. Mateus & Afonso (1974) and Afonso (1976, 1977) provided additional information and Lopes *et al.* (1993) listed 122 amphipod species from 29 families. Regarding with Caprellidae, to our knowledge, seven species have been reported so far from shallow waters of Azores (see Lopes *et al.*, 1993; Wirtz & Vader, 1996; Krapp-Schickel & Vader, 1998; Wirtz, 1998; Costa,

2010): *Caprella acanthifera* Leach, 1814, *C. andreae* Mayer, 1890, *C. equilibra* Say, 1818, *C. penantis* Leach, 1814, *C. stella* Krapp-Schickel & Vader, 1998, *Pseudoprotella phasma* (Montagu, 1804) and *Phtisica marina* Slabber, 1769. Costa (2010, p. 306) also included in the taxonomic list the species *Caprella linearis* (Linnaeus, 1758).

Amphipod studies in Madeira are also very scarce and most of them have focused on gammarids (e.g. Dahl, 1958; Kaim-Malka, 1970; Stock & Abreu, 1992). Fonseca *et al.* (1995) as a part of a general study of the macrozoobenthos of sediments of Porto Santo island, reported only two caprellid species, *Caprella* sp. and *Phtisica marina*. Recently, the invasive *Caprella scaura* Templeton, 1836 has also been recorded in marinas of Madeira Island (Ramalhosa & Canning-Clode, 2015). In spite of the existence of these few caprellid records, a comprehensive study dealing with caprellids from Madeira is still lacking.

The present study includes caprellids collected from shallow waters of Azores and Madeira in 1999 and 2008 (fig. 1). During August 1999, Dr. P. Wirtz and Dr. C. d'Udekem d'Acoz collected amphipods (0-41 m deep) from Azores, and caprellids were sorted, stored in ethanol and sent by Dr. T. Krapp-Schickel to the third author of the present study (JMGG). During September 2008, a sampling programme focused on hydroids from Azores and Madeira was undertaken by the second author (CM) (0-20 m deep) and caprellids were also sorted and stored. In the present study, this material is studied to include lateral view figures of all the species, together with taxonomical remarks.

MATERIAL AND METHODS

The material sampled from Azores in 1999 (fig. 1) was taken by SCUBA diving, mainly from algae of rocky shores and also from areas with the coral *Antipathes* sp. Caprellid samples were collected from different locations of Faial Island (Monte da Guia, Feteira, Ponte Do Forte) and Banco João De Castro. Depth ranged from 0 to 41 meters.

The samples of September 2008 (fig. 1) were also collected by SCUBA diving from Azores and Madeira, as a part of a more general sampling programme on hydroid assemblages. In Azores, two transects were located on rocky cliffs of São Miguel Island, one in Vila Franca do Campo (37°42'18"N, 25°26'31"W) and other one in Santa Iria (37°50'9"N, 25°29'2"W). In Madeira, two transects were also located, one in Garajau (32°38'14"N, 16°51'11"W) and other in Reis Magos (32°38'52"N, 16°49'24"W). In each transect, the following depth ranges were considered: 0-5 m, 5-10 m, 10-15 m and 15-20 m. Mainly hydroids, but also adjacent algae, were collected using a visual

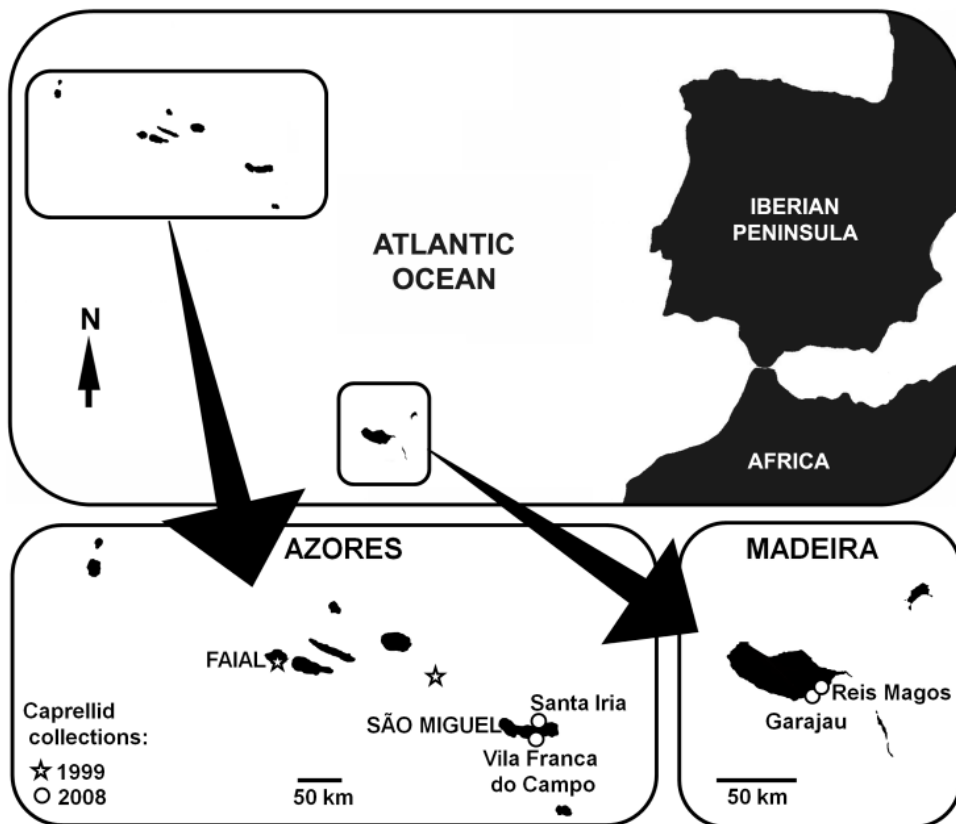


Fig. 1.—Map of the study area showing the sampling locations.

Fig. 1.—Mapa del área de estudio mostrando las localidades de muestreo.

collection technique in each depth (Boero & Fresi, 1986; Di Camillo *et al.*, 2008; Puce *et al.*, 2009; Iazza *et al.*, 2013). To homogenise the sampling effort among the two zones and depths, all samples were collected by the same diver, who moved at a constant speed along each transect collecting all hydroid colonies detected in a band 1 m wide. This visual technique probably has a lower quantitative precision than scratching off the complete surface of the sampling unit, but it allows the use of a large sampling unit which more efficiently represents the hydroid and caprellid diversity in shallow coastal habitats (Puce *et al.*, 2009; Iazza *et al.*, 2013). Each sample consisted, consequently, on a pool of substrates collected from each depth of each transect. In total, 16 samples were collected (one sample per depth, with 4 different depths in each transect and a total of 4 transects, 2 in Azores and 2 in Madeira). Caprellids from the samples were sorted in the laboratory

and identified to species level. Lateral view figures of the species, together with taxonomical remarks are also included. Voucher specimens have been deposited in the Laboratorio de Biología Marina, Universidad de Sevilla. A complete list of synonyms of the species is included in McCain & Steinberg (1970) and Guerra-García & Takeuchi (2002). Classification follows Lowry & Myers (2013).

RESULTS AND DISCUSSION

TAXONOMY

Superfamily Caprelloidea Leach, 1814

Family Caprellidae Leach, 1814

Subfamily Caprellinae Leach, 1814

Caprella acanthifera [sensu lato]

Material examined:

AZORES: 1 female (fig. 2) Faial Island, Monte Da Guia, among algae, 10m deep, coll. C. d'Udekem d'Acoz 18/8/1999; 1 male, 1 female (fig. 3) Faial Island, Monte Da Guia, 20-40 m deep, coll. P. Wirtz & C. d'Udekem d'Acoz 18/8/1999; 1 premature female Faial Island, Monte Da Guia (east part), hard bottom, with *Antipathes*, 40m deep, coll. P. Wirtz & C. d'Udekem d'Acoz 27/8/1999; 2 subadult males and 2 premature females (poor condition) Faial Island, Monte Da Guia, 41m deep, on or near *Antipathes*, coll. C. d'Udekem d'Acoz 19/8/1999; 2 males, 2 females, 1 premature female (1 male and 1 female drawn, fig. 4) Faial Island, Monte Da Guia, 41m deep, on the shell *Pteria hirundo* on *Antipathes* sp., coll. C. d'Udekem d'Acoz 18/8/1999; 1 male without head and pereonite 1 (fig. 5) Faial Island, Ponte Do Forte, rocks with algae, 6-36m deep, coll. C. d'Udekem d'Acoz 17/8/1999; 1 male, 2 females (1 male and 1 female drawn, fig. 6) Vila Franca do Campo, São Miguel, among hydroids and algae, 0-5 m., coll. C. Megina, 8/9/2008; 2 males, 4 females Vila Franca do Campo, São Miguel, among hydroids and algae, 10-20 m, coll. C. Megina, 8/9/2008; 11 males, 10 females, 4 premature females, 17 juveniles Santa Iria, São Miguel, among hydroids and algae, 0-20 m., coll. C. Megina, 8/9/2008 (large male from 5-10 m drawn, fig. 7).

MADEIRA: 1 male, 2 females Garajau, among hydroids and algae, 5-20 m., coll. C. Megina, 14/9/2008; 2 males, 3 females, 1 juvenile, Reis Magos, among hydroids and algae, 0-15 m., coll. C. Megina, 15/9/2008 (1 male and female from 5-10 m drawn, fig. 8).

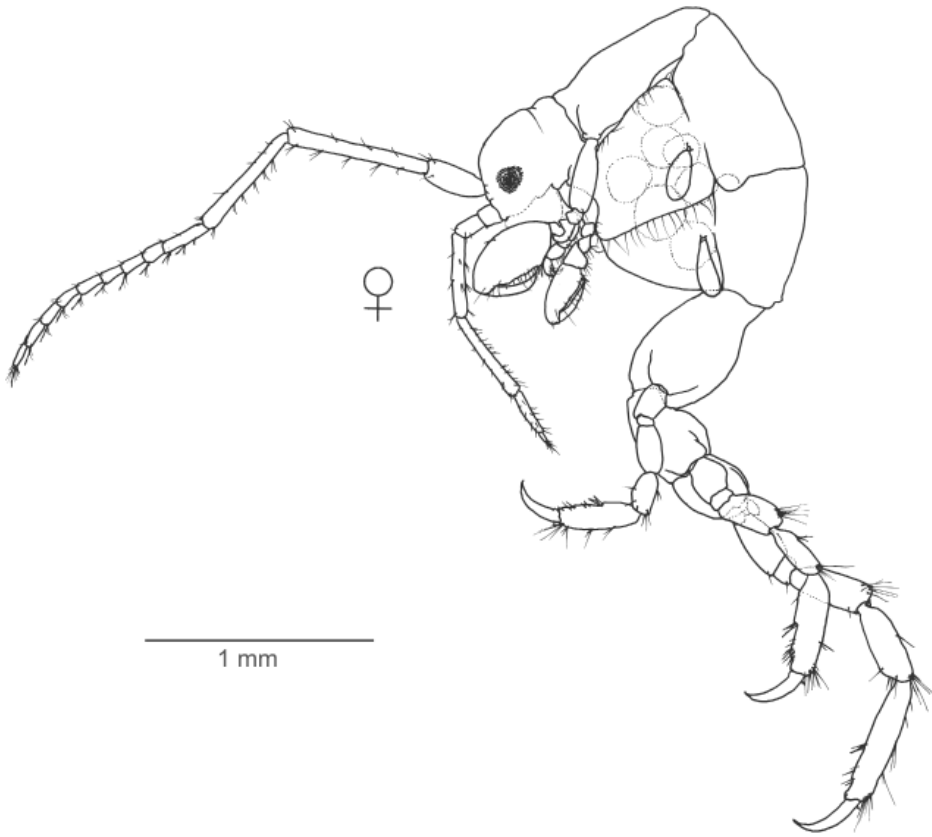


Fig. 2.—Female of *Caprella acanthifera* 'sensu lato', Faial Island, Monte Da Guia, Azores, algae, 10 m deep.

Fig. 2.—Hembra de *Caprella acanthifera* 'sensu lato', Faial Island, Monte Da Guia, Azores, algas, 10 m de profundidad.

Remarks:

Krapp-Schickel & Vader (1998) pointed out that the taxon *Caprella acanthifera*, usually considered to be on 'highly variable' species, consists of a number of closely related species. They redefined *Caprella acanthifera* Leach, 1814 'sensu stricto' and described *Caprella stella* from the aboral surface of starfishes in the Azores (15-32 m depth) and *C. cavediniae* from algae of the Mediterranean (1.5-5 m depth), all of them lacking axillary spine near the insertion of gnathopod 2 ('*C. acanthifera*-group') vs the remaining species with axillary spines ('*C. armata*-group') which are still awaiting for a revision. Guerra-García *et al.* (2001) described *C. takeuchii*, very close to

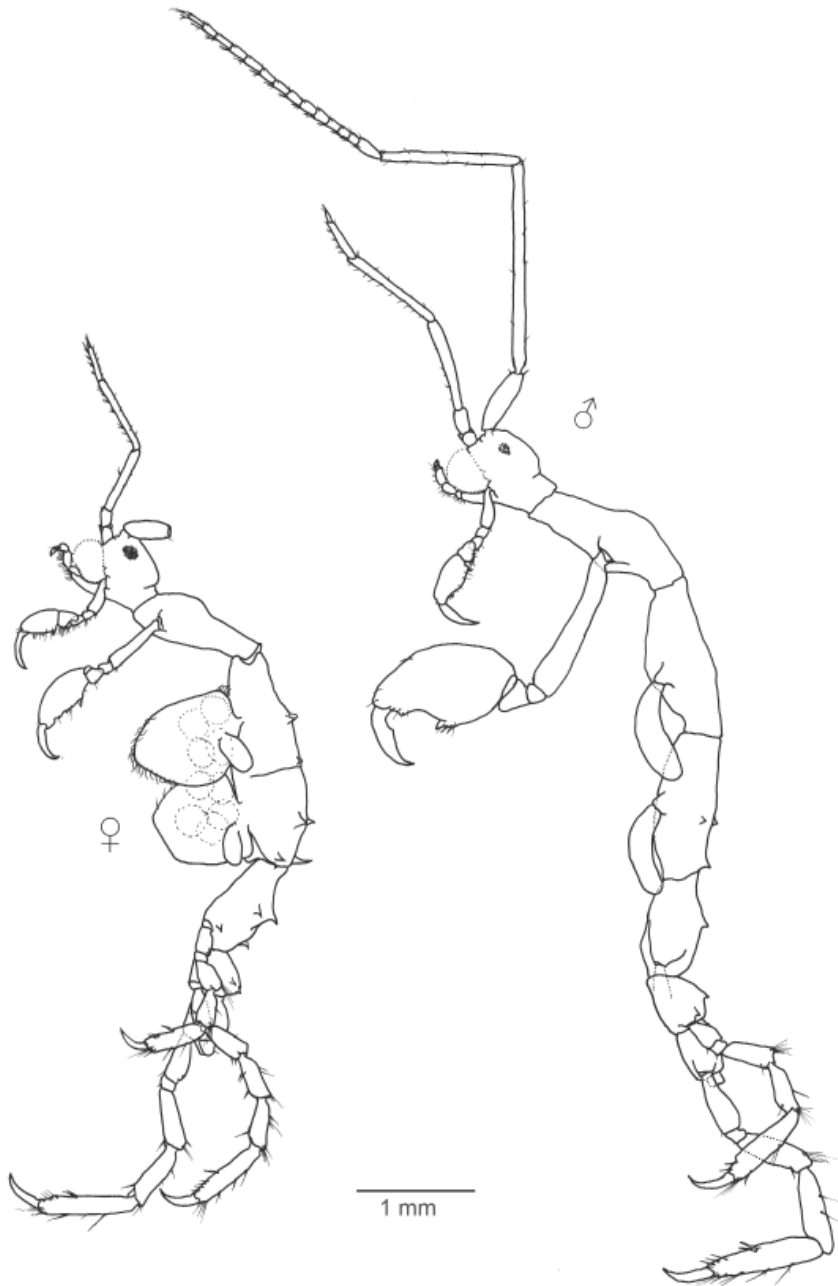


Fig. 3.—Male and female of *Caprella acanthifera* 'sensu lato', Faial Island, Monte Da Guia, Azores, 20-40 m deep.

Fig. 3.—Macho y hembra de *Caprella acanthifera* 'sensu lato', Faial Island, Monte Da Guia, Azores, 20-40 m de profundidad.

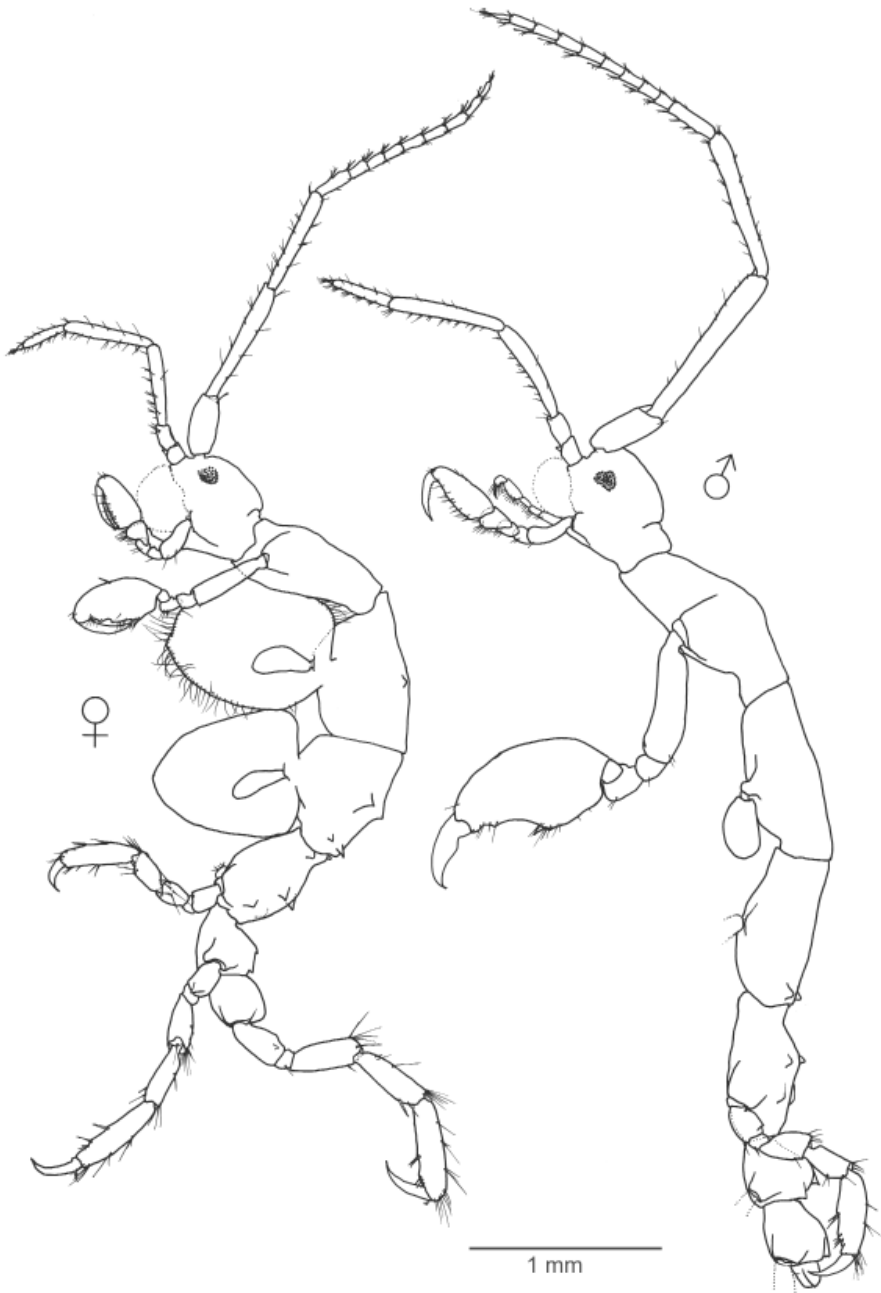


Fig. 4.—Male and female of *Caprella acanthifera* 'sensu lato', Faial Island, Monte Da Guia, Azores, shell *Pteria hirundo* on *Antipathes* sp., 41 m deep.

Fig. 4.—Macho y hembra de *Caprella acanthifera* 'sensu lato', Faial Island, Monte Da Guia, Azores, concha de *Pteria hirundo* en *Antipathes* sp., 41 m de profundidad.

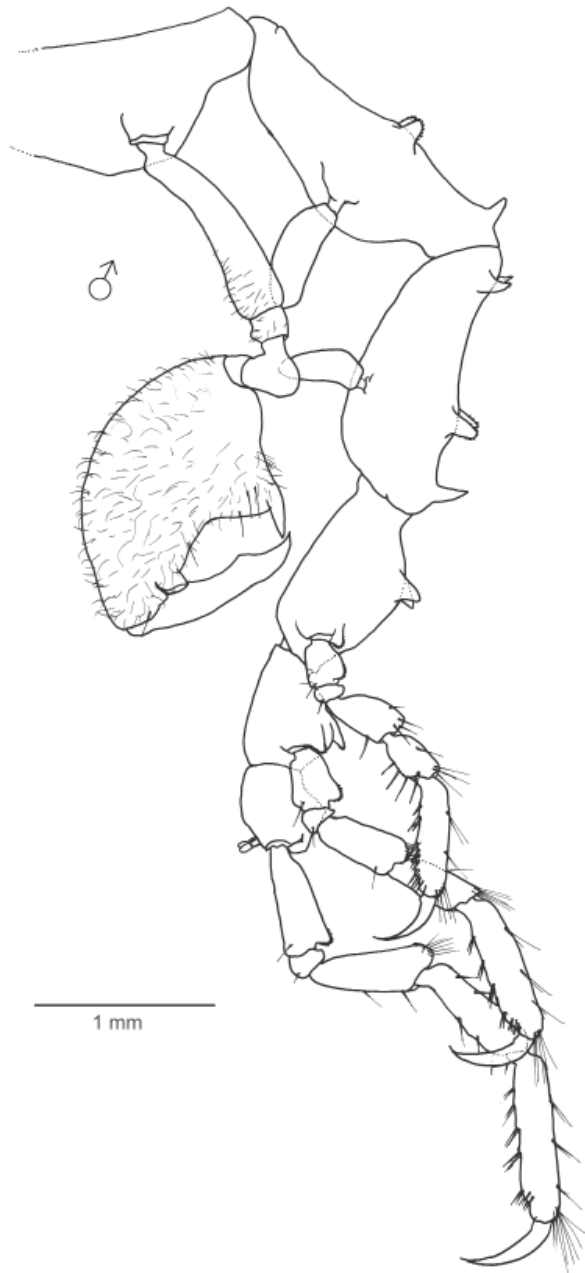


Fig. 5.—Male of *Caprella acanthifera* 'sensu lato', Faial Island, Ponte do Forte, rocks with algae, 6-36 m deep.

Fig. 5.—Macho de *Caprella acanthifera* 'sensu lato', Faial Island, Ponte do Forte, rocas con algas, 6-36 m deep.

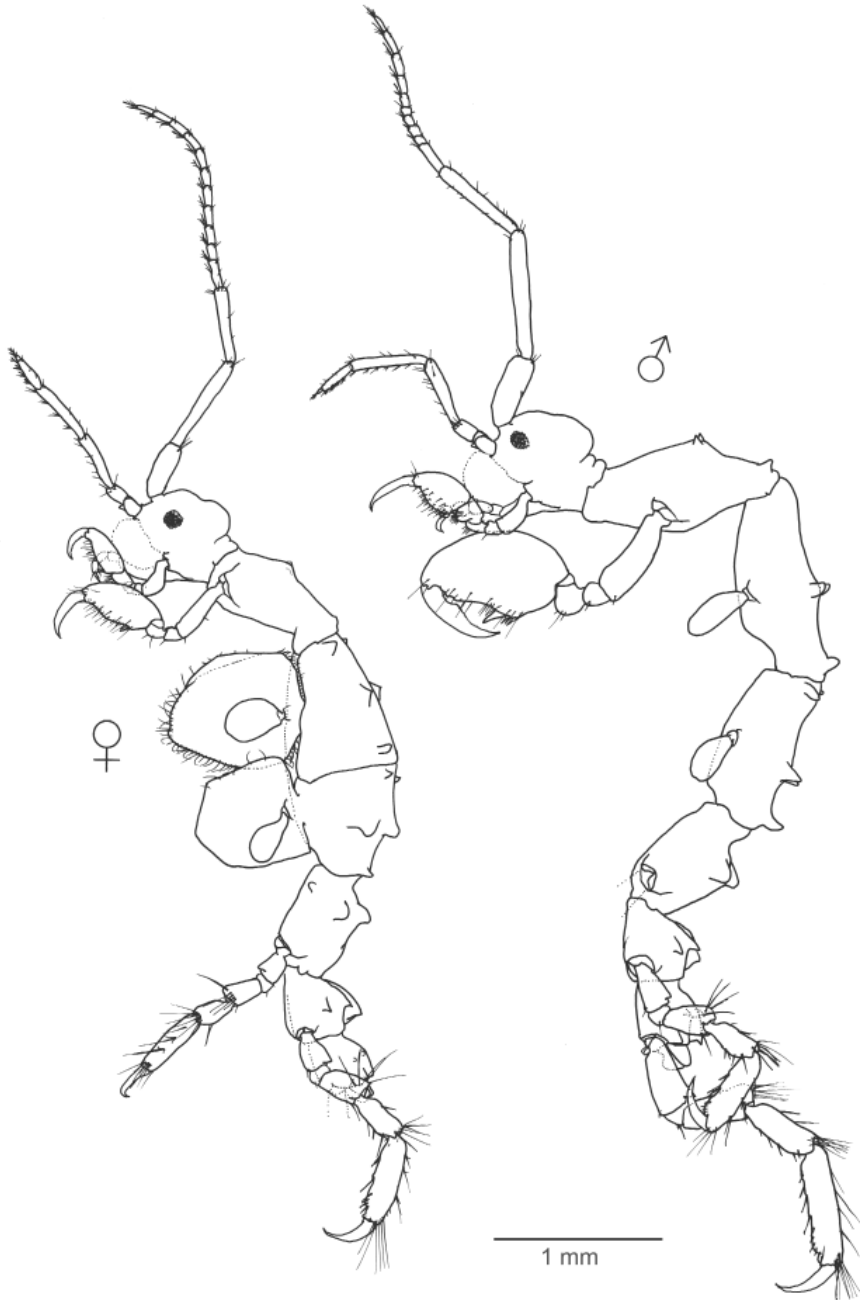


Fig. 6.—Male and female of *Caprella acanthifera* 'sensu lato', Vila Franca do Campo, São Miguel, Azores, hydroids and algae, 0-5 m deep.

Fig. 6.—Macho y hembra de *Caprella acanthifera* 'sensu lato', Vila Franca do Campo, São Miguel, Azores, hidrozooos y algas, 0-5 m de profundidad.

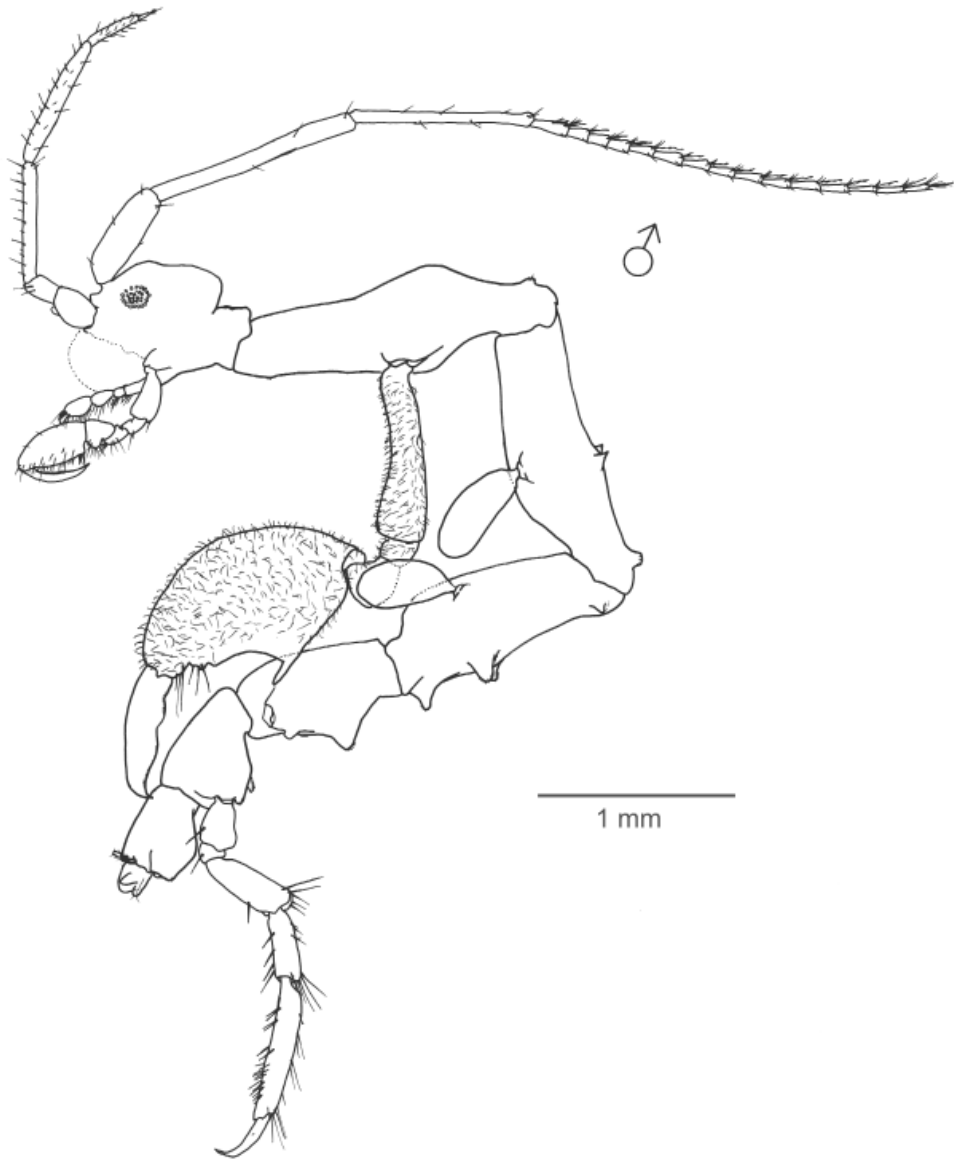


Fig. 7.—Male of *Caprella acanthifera* 'sensu lato', Santa Iria, São Miguel, Azores, hydroids and algae, 5-10 m deep.

Fig. 7.—Macho de *Caprella acanthifera* 'sensu lato', Santa Iria, São Miguel, Azores, hidrozoos y algas, 5-10 m de profundidad.

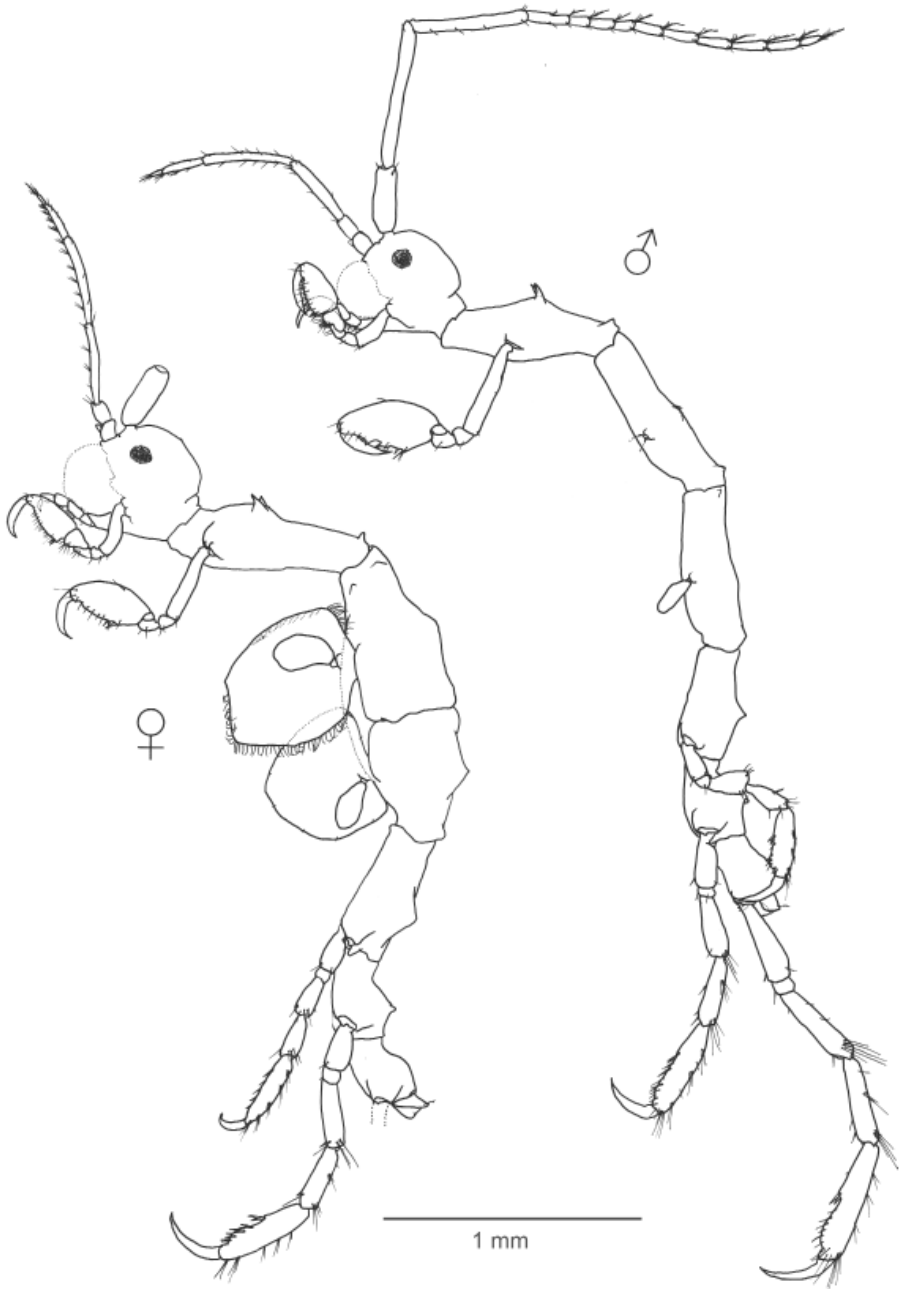


Fig. 8.—Male and female of *Caprella acanthifera* 'sensu lato', Reis Magos, Madeira, hydroids and algae, 5-10 m deep.

Fig. 8.—Macho y hembra de *Caprella acanthifera* 'sensu lato', Reis Magos, Madeira, hidrozoos y algas, 5-10 m de profundidad.

C. acanthifera 'sensu stricto', but highly setose. Presently, Cabezas *et al.* (in prep.) are using a molecular approach to explore the intra and interspecific variation within the species of the complex *Caprella acanthifera* 'sensu lato'.

The material from Azores and Madeira examined in the present study show a high degree of variation, although all the specimens collected seem to belong to the '*C. acanthifera*-group' since they lack the axillary spine near the insertion of gnathopod 2. Some specimens are very close with *C. acanthifera* 'sensu stricto', provided with tubercles and pereopods 6,7 propodus hind-margin provided with spines (fig. 6) as pointed by Krapp-Schickel & Vader (1998, page 965, table 1), but no fully developed adult males have been found during the present study so we cannot confirm the presence of *C. acanthifera* 'sensu stricto' in this region. Other specimens are provided with abundant setae and match with the species *C. takeuchii*, although setae are covering only the gnathopod 2 (figs. 5 and 7) and not the pereonites as in the original description of the species by Guerra-García *et al.* (2001). Some specimens lack spines in pereopods 6,7 propodus hind-margin (figs. 2, 3, 4 and 8). Our specimens from Azores (figs. 2-4) match fairly well with *C. stella* (see Krapp-Schickel & Vader 1998, page 965, table 1) which had been reported previously in high densities on the aboral surface of the starfish *Ophidiaster ophidianus* (Lamarck, 1816) and *Hacelia attenuata* Gray, 1840 at 15-32 m depth also from Faial Island, Azores (Wirtz & Vader, 1996) (fig. 9). However, specimens collected during the present study (figs. 2, 3, 4 and 8) show variation in size, in shape and length of gills, tubercles arrangements

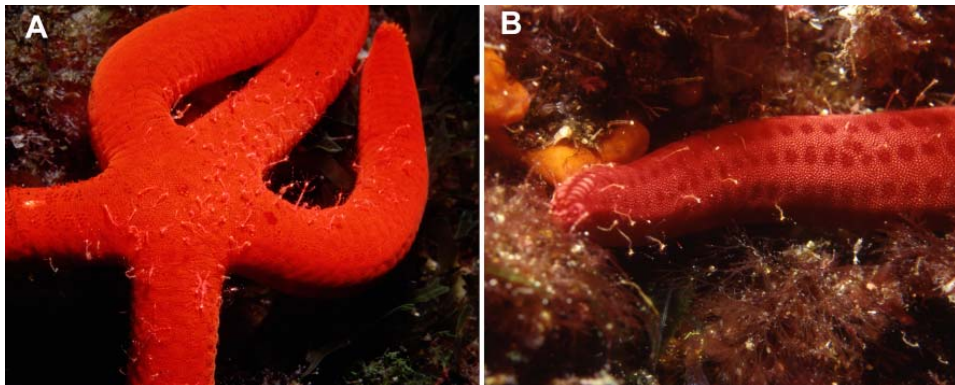


Fig. 9.—Numerous specimens of *Caprella stella* clinging to the aboral surface of the starfish *Ophidiaster ophidianus* (A) and *Hacelia attenuata* (B), Faial Island, Azores, 15-30 m deep. Author: Peter Wirtz.

Fig. 9.—Numerosos ejemplares de *Caprella stella* sobre la superficie aboral de la estrella de mar *Ophidiaster ophidianus* (A) y *Hacelia attenuata* (B), Faial Island, Azores, 15-30 m de profundidad. Autor: Peter Wirtz.

and, therefore, extensive molecular and morphological studies are necessary to clarify their taxonomical status.

***Caprella equilibra* Say, 1818**

Material examined:

AZORES: 1 male (fig. 10) Banco João De Castro, Sea Mount, 20-24m deep, coll. P. Wirtz & C. d'Udekem d'Acoz August 1999; 9 males, 10 females, 3 premature females, 9 juveniles Vila Franca do Campo, São Miguel, among hydroids and algae, 10-20 m., coll. C. Megina, 8/9/2008.

MADEIRA: 3 males, 2 females, 1 premature female, 11 juveniles Garajau, among hydroids and algae, 0-5 m., coll. C. Megina, 14/9/2008; 21 males, 20 females, 3 premature females, 21 juveniles Reis Magos, among hydroids and algae, 0-10 m., coll. C. Megina, 15/9/2008 (1 male and female from 5-10 m drawn, fig. 11).

Remarks:

All the specimens of *Caprella equilibra* examined during the present study are provided with the distinctive ventral projection between gnathopods 2, which is characteristic of this species. We found differences in robustness and size of specimens from one locality to another, since specimens from Madeira are smaller than those from Azores (see figs. 10 and 11). Recently, Guerra-García *et al.* (2015) also reported important differences in size of specimens belonging to different populations of marinas from Southern Spain. Although *C. equilibra* seems to have the ability to disperse in the water column as part of the plankton community (Takeuchi & Sawamoto, 1998), and quickly colonize artificial structures, which could explain its wide distribution, a molecular study would also help to clarify its taxonomical status and to explore the existence or not of cryptic speciation.

***Caprella penantis* [sensu lato]**

Material examined:

AZORES: 1 male (fig. 12) Faial Island, Feteira, rocky shore, among algae, coll. C. d'Udekem d'Acoz 24/8/1999; 2 juveniles Santa Iria, São Miguel, among hydroids and algae, 0-5 m, coll. C. Megina, 8/9/2008.

MADEIRA: 83 males, 157 females, 14 premature females, 80 juveniles (1 male and female drawn, fig. 13) Garajau, among hydroids and algae, 0-10 m., coll. C. Megina, 14/9/2008; 5 males, 2 females, 2 juveniles (1 male and female drawn, fig. 14) Reis Magos, among hydroids and algae, 0-5 m., coll. C. Megina, 15/9/2008; 3 males, 2 females, 1 premature female, 2 juveniles

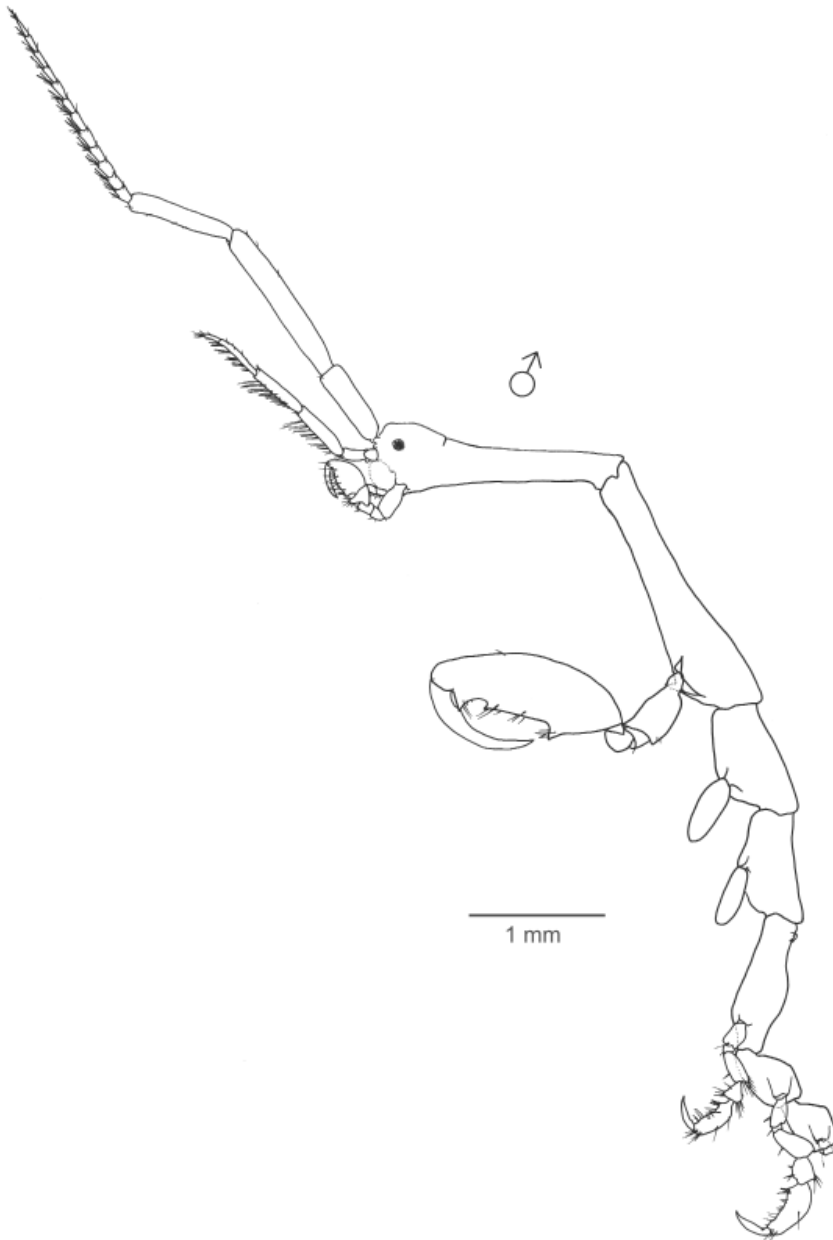


Fig. 10.—Male of *Caprella equilibra*, Banco João De Castro, Sea Mount, Azores, 20-24m deep.
Fig. 10.—Macho de *Caprella equilibra*, Banco João De Castro, Sea Mount, Azores, 20-24 m de profundidad.

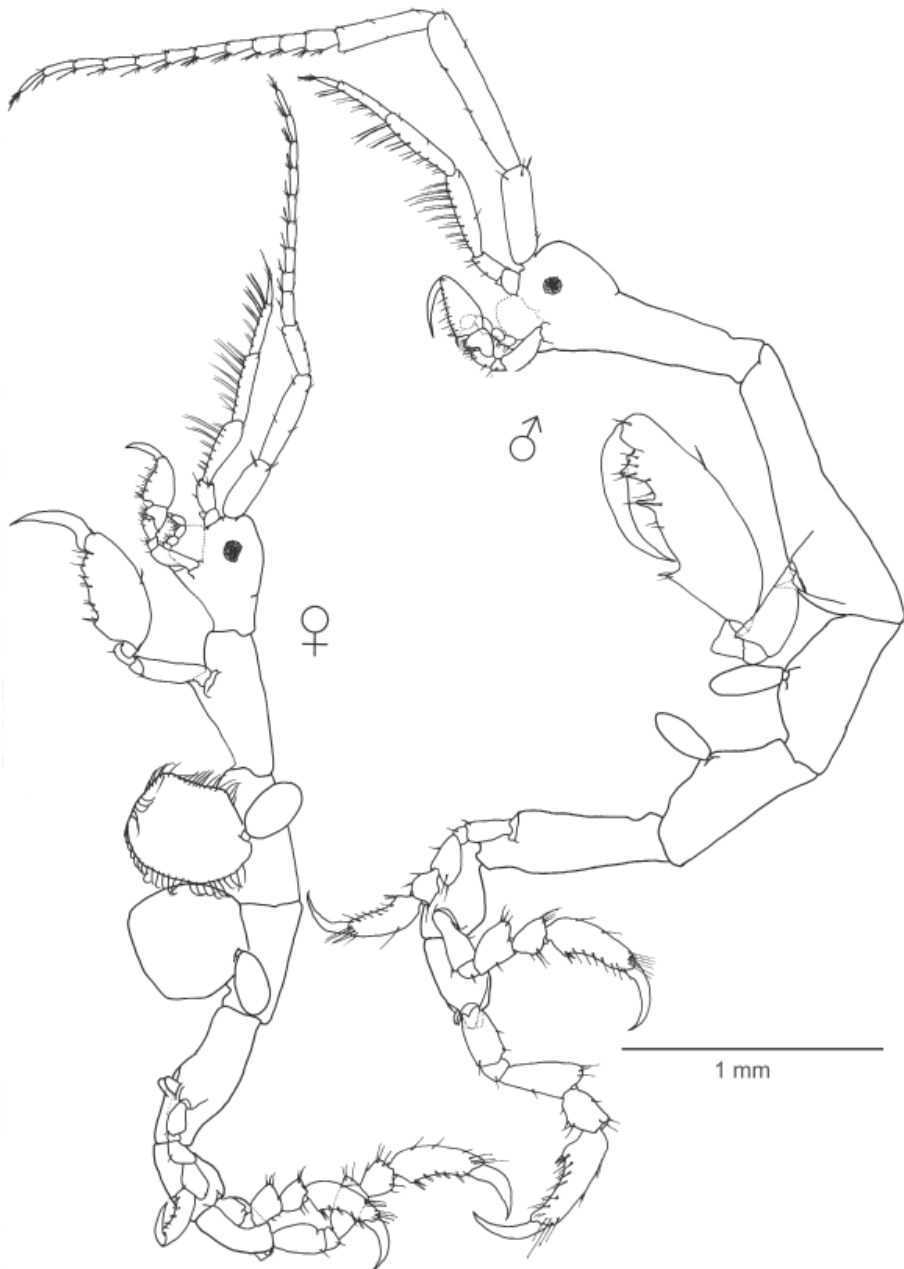


Fig. 11.—Male and female of *Caprella equilibra*, Reis Magos, Madeira, hydroids and algae, 5-10 m deep.

Fig. 11.—Macho y hembra de *Caprella equilibra*, Reis Magos, Madeira, hidrozooos y algas, 5-10 m de profundidad.

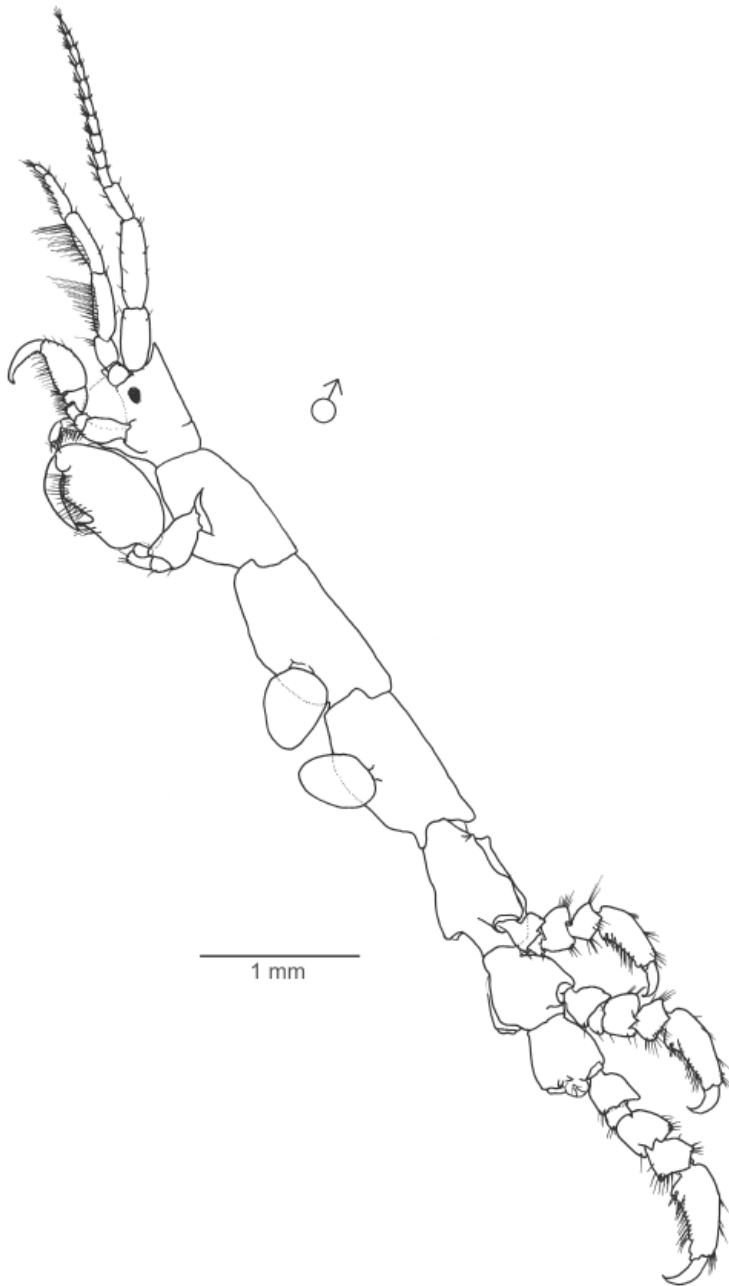


Fig. 12.—Male of *Caprella penantis* 'sensu lato', Faial Island, Feteira, Azores, rocky shore, among algae.

Fig. 12.—Macho de *Caprella penantis* 'sensu lato', Faial Island, Feteira, Azores, costa rocosa, algas.

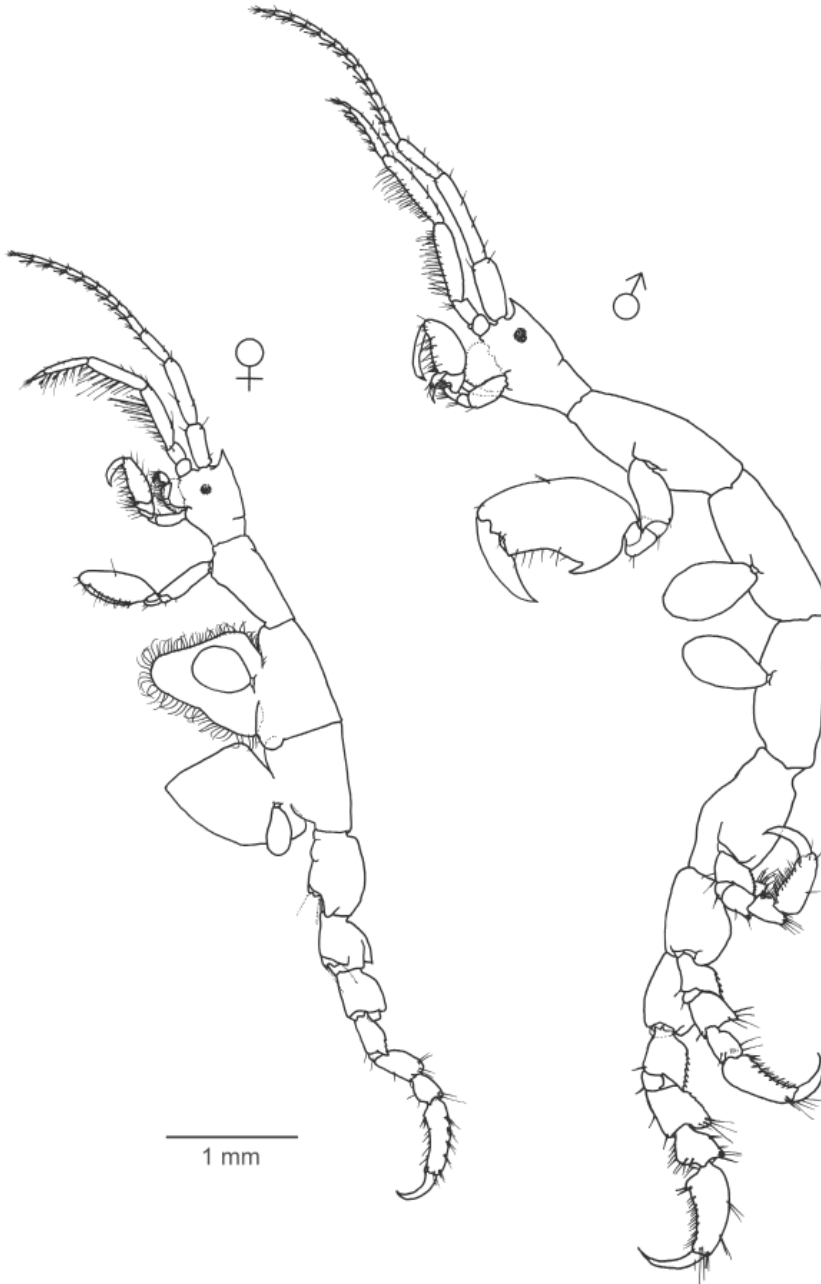


Fig. 13.—Male and female of *Caprella penantis* 'sensu lato', Garajau, Madeira, among hydroids and algae, 0-10 m.

Fig. 13.—Macho y hembra de *Caprella penantis* 'sensu lato', Garajau, Madeira, hidrozoos y algas, 0-10 m de profundidad.

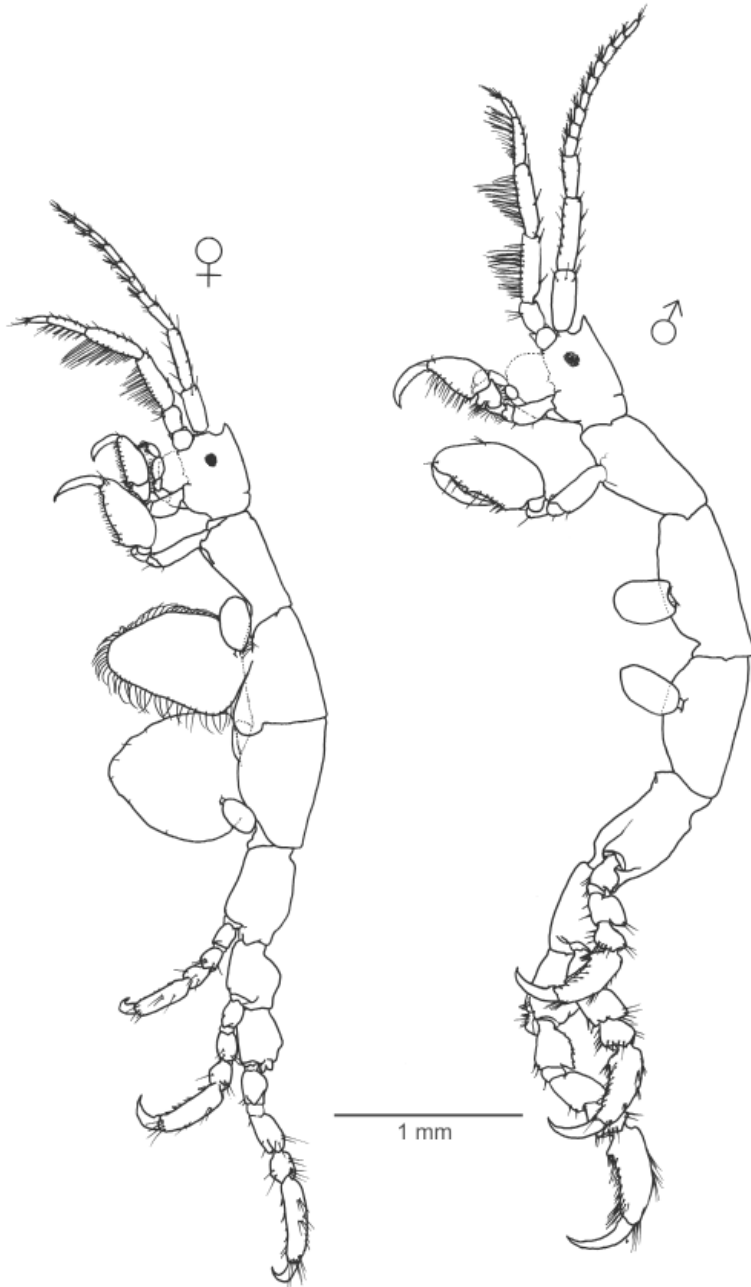


Fig. 14.—Male and female of *Caprella penantis* 'sensu lato', Reis Magos, Madeira, among hydroids and algae, 0-5 m deep.

Fig. 14.—Macho y hembra de *Caprella penantis* 'sensu lato', Reis Magos, Madeira, hidrozoos y algas, 0-5 m de profundidad.

(1 male and female drawn, fig. 15) Reis Magos, among hydroids and algae, 5-10 m., coll. C. Megina, 15/9/2008.

Remarks:

Cabezas *et al.* (2013) studied the complex of *Caprella penantis* using COI and 18S genes in combination with morphological characters, demonstrating hidden diversity and cryptic speciation and refuting cosmopolitan distribution of *Caprella penantis* Leach, 1814. The specimens from Azores and Madeira seem to belong to the form *testudo/lusitanica*, which differ from the form *simulatrix* in the presence of proximal projection on gnathopod 2. This projection is not so clear in male of fig. 14, but this specimen is smaller (ca. 4 mm) and could correspond to a subadult male. The gnathopods 2 of the adult male from Azores (fig. 12) are different to the gnathopods of adult males from Madeira (e.g. fig. 13) and basis of pereopods 5-7 lacks carina in the male from Azores (fig. 12) but carina is present in the basis of males from Madeira (figs. 13-15). Furthermore, within specimens from Madeira, there is variability on the shape of the rostrum and density of setae of antennae 2 and pereopods. Cabezas *et al.* (2013) found cryptic speciation inside *C. penantis* 'sensu lato', but, at the same time, molecular analysis evidenced that specimens with and without proximal projection on male gnathopod 2 were belonging to the same species, supporting intraspecific variation for this character. For these reasons, future molecular analysis, including these new material from Azores and Madeira would be very helpful to understand the complex and to clarify if the differences found in material from Madeira are intraspecific or interespecific.

***Pseudoprotella phasma* (Montagu, 1804)**

Material examined:

AZORES: 1 female (without gnathopods, with projections according to the formula 1-1-2-1 (Head-P1-P2 medium-P2 distal) (cf f. *typica*) Faial Island, Monte Da Guia (east part), hard bottom, with *Antipathes*, 40m deep, coll. P. Wirtz & C. d'Udekem d'Acoz 27/8/1999; 1 male, 1 female, 1 juvenile (cf f. *quadrispinis*) Vila Franca do Campo, São Miguel, among hydroids and algae, 10-15 m., coll. C. Megina, 8/9/2008.

MADEIRA: 11 males, 12 females, 2 premature females, 11 juveniles (cf. f. *quadrispinis*) (1 male and 1 female drawn, fig. 16), 1 male (cf. f. *typica*) Garajau, among hydroids and algae, 5-20 m., coll. C. Megina, 14/9/2008; 11 males, 3 females, 1 premature female, 14 juveniles (cf. f. *quadrispinis*), 13 males, 22 females, 19 premature females, 14 juveniles (cf. f. *typica*) (1 male

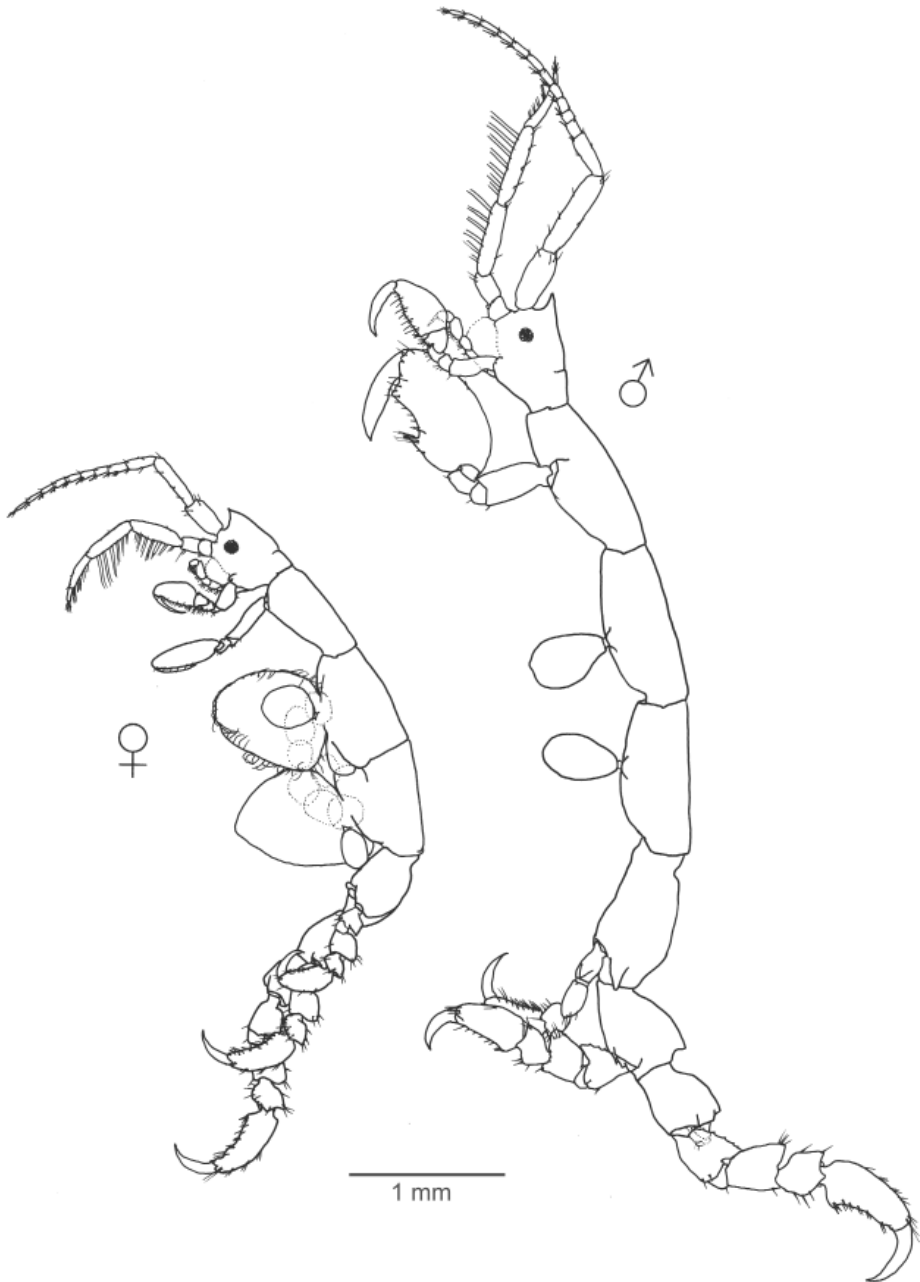


Fig. 15.—Male and female of *Caprella penantis* 'sensu lato', Reis Magos, Madeira, among hydroids and algae, 5-10 m deep.

Fig. 15.—Macho y hembra de *Caprella penantis* 'sensu lato', Reis Magos, Madeira, hidrozoos y algas, 5-10 m de profundidad.

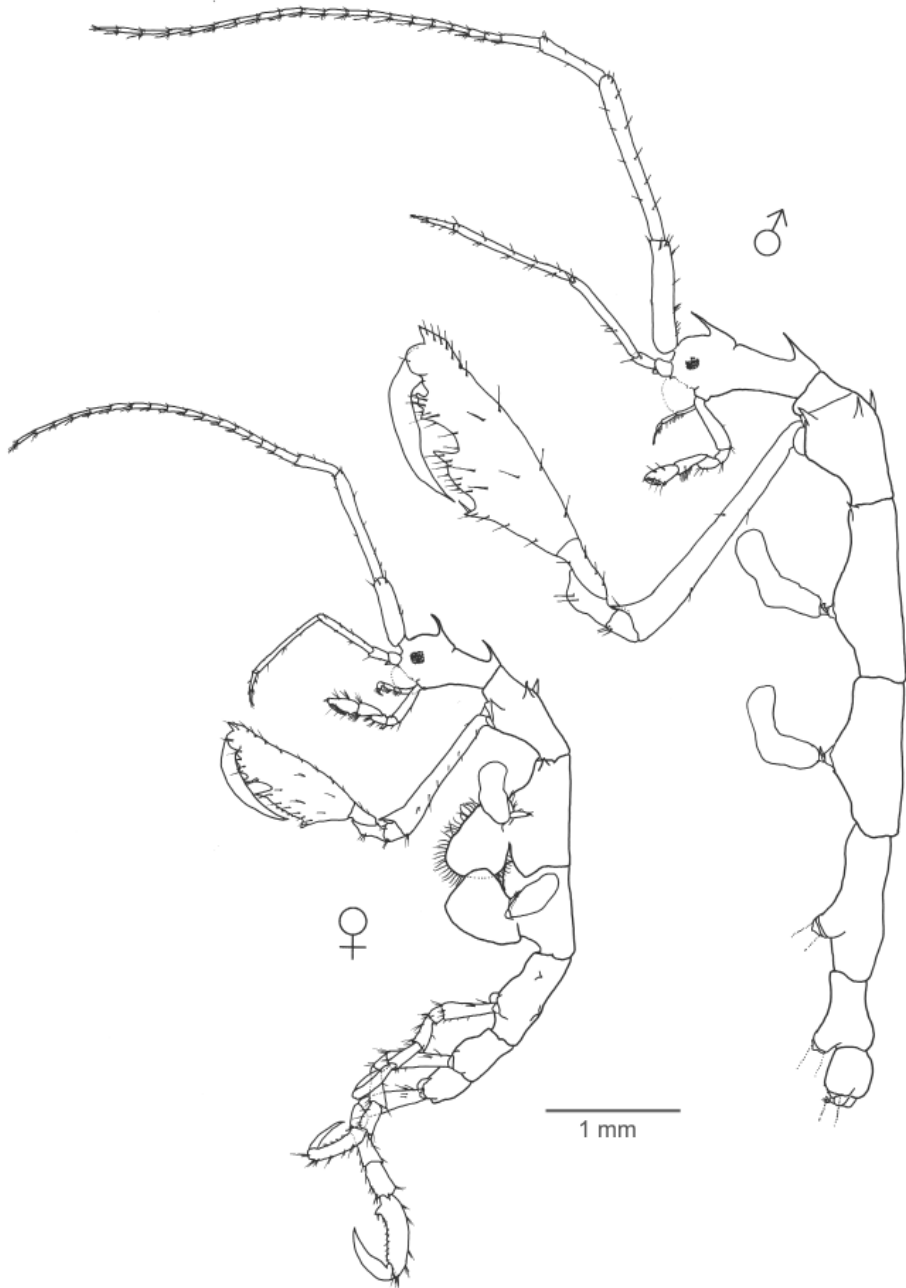


Fig. 16.—Male and female of *Pseudoprotella phasma* (cf. f. *quadrispinis*), Garajau, Madeira, among hydroids and algae, 5-20 m deep.

Fig. 16.—Macho y hembra de *Pseudoprotella phasma* (cf. f. *quadrispinis*), Garajau, Madeira, hidrozooos y algas, 5-20 m de profundidad.

and 1 female drawn, fig.17) Reis Magos, among hydroids and algae, 0-15 m., coll. C. Megina, 15/9/2008.

Remarks:

This species was initially described by Montagu (1804) as *Cancer phasma*. Mayer (1882) transferred it to the genus *Pseudoprotella* and included description and figures of the species. Mayer (1890, 1903) considered four forms (f. *typica*, f. *minor*, f. *quadrispinis* and f. *bispinis*) based on differences in the arrangement of body dorsal projections and differences in the male gnathopod 2. Chevreux & Fage (1925) and Krapp-Schickel (1993) provided a key to identify the four varieties. In Azores, the two forms reported previously (see Mayer, 1903, page 37) are f. *typica* and f. *quadrispinis*. In the present study we have also found two forms. One of the form (fig. 16) is characterised by (1) dorsal projection arrangement 1-1-2 + 0, (2) propodus of gnathopod 2 ending acutely, (3) absence of tubercles on pereonites 3 and 4 and (4) gnathopods 2 with axillary spine very well developed. All these characteristics match perfectly with the description and keys for f. *quadrispinis* provided by Chevreux & Fage (1925) and Krapp-Schickel, 1993, page 811). The second form (fig. 17) is characterised by (1) dorsal projection arrangement 1-1-2 +1, (2) axillary spine on the gnathopod 2 and (3) male propodus ending with rounded lobe. This agree with the form *typica* of the keys provided by Chevreux & Fage (1925) and Krapp-Schickel (1993) except for the end of male propodus, which has a rounded lobe in our material (as the f. *minor*) and end acutely in the f. *typica* in the keys. According to these keys, this second form of our material would be intermediate between the f. *typica* and f. *minor*. However, when Mayer (1882) described *Pseudoprotella phasma*, he figured acute ending for juveniles and rounded lobe for adult males. Therefore, probably the adult males of f. *typica* are characterised by this round projection in the gnathopod 2 males. The f. *minor* lacks the axillary spine and is distributed only in the Mediterranean, and our specimens show clearly an axillary spine, so these specimens are closer to f. *typica* than f. *minor*. In fact Mayer (1903) had reported previously the f. *quadrispinis* and f. *typica* from Azores Both forms, besides differences in body arrangements of dorsal projection and ganthopod 2, can be distinguished by the shape of gills in males, which are elongated and curved in f. *quadrispinis*. Probably, these two forms belong to valid distinct species. A detailed morphological and molecular study is necessary to clarify the differences among forms and to confirm if the different forms should be considered as valid different species, as has been shown for other species (e.g. Takeuchi & Oyamada, 2013). *Pseudoprotella phasma* is normally associated with hydroids (Guerra-García *et al.*, 2014) and specimens from Madeira have been photographed clinging on *Macrorhynchia philippina* Kirchenpauer, 1872 (fig. 18).



Fig. 17.—Male and female of *Pseudoprotella phasma* (cf. f. *typica*), Reis Magos, Madeira, among hydroids and algae, 0-15 m deep.

Fig. 17.—Macho y hembra de *Pseudoprotella phasma* (cf. f. *typica*), Reis Magos, Madeira, hidrozooos y algas, 0-15 m de profundidad.



Fig. 18.—Specimens of *Pseudoprotella phasma* clinging to the hydroid *Macrorhynchia philippina*, Madeira, 15 m deep. Author: Peter Wirtz.

Fig. 18.—Ejemplares de *Pseudoprotella phasma* sobre el hidrozoo *Macrorhynchia philippina*, Madeira, 15 m de profundidad. Autor: Peter Wirtz.

Subfamily Phtisicinae Vassilenko, 1968

Phtisica marina Slabber, 1769

Material examined:

AZORES: 2 males, 2 females, 2 premature female, 1 juvenile (1 male and 1 female drawn, fig. 19) Faial Island, Monte Da Guia, on or near *Antipathes* sp., 41 m., coll. C. d'Udekem d'Acoz 19/8/1999; 1 juvenile Faial Island, Monte Da Guia (SW), 35-40m deep, among stones, coll. P. Wirtz & C. d'Udekem d'Acoz 20/8/1999; 1 male, 1 female Vila Franca do Campo, São Miguel, among hydroids and algae, 10-15 m., coll. C. Megina, 8/9/2008.

MADEIRA: 1 male Reis Magos, among hydroids and algae, 0-10 m., coll. C. Megina, 15/9/2008.

Remarks:

All the specimens examined show a similar morphology. As pointed out by Guerra-García *et al.* (2010) the presence of developed pereopods 3 and 4 make the morphological recognition of this species easy. In many ecological studies of Mediterranean and Atlantic waters, specimens have probably been assigned to this species just on the basis of pereopod 3 and 4 fully developed

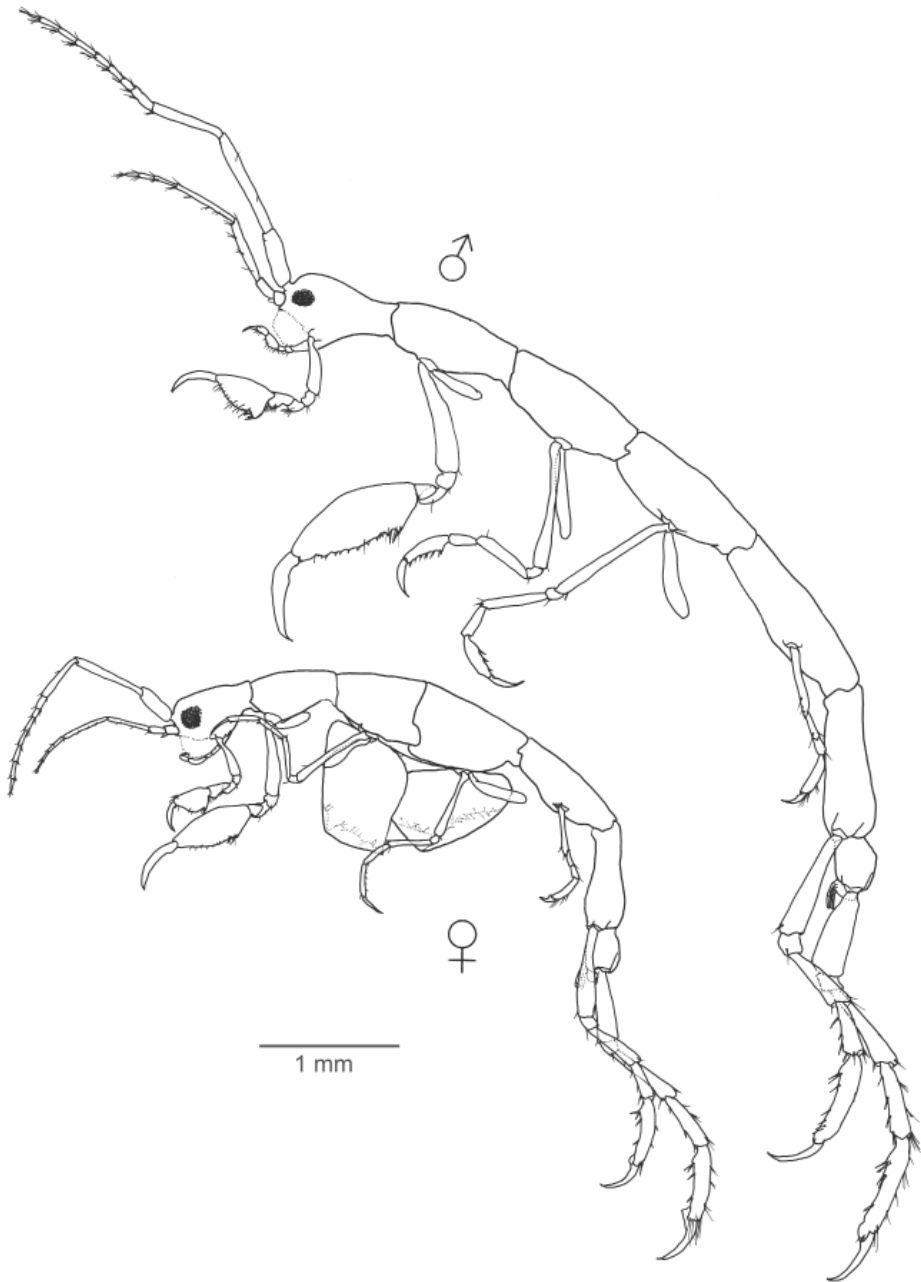


Fig. 19.—Male and female of *Phtisica marina*, Faial Island, Monte Da Guia, Azores, on or near *Antipathes* sp., 41 m deep.

Fig. 19.—Macho y hembra de *Phtisica marina*, Faial Island, Monte Da Guia, Azores, sobre o cerca de *Antipathes* sp., 41 m de profundidad.

which is a very distinctive character, without careful examination of other characters of abdomen and mouthparts. A detailed morphological study of abundant material, together with molecular studies and rearing experiments in laboratory are also necessary to assess if all the Atlantic and Mediterranean specimens belong to the same species or not.

VERTICAL DISTRIBUTION

Total caprellid abundances were higher in Madeira than in Azores, and the highest densities were measured between 0 to 10 meters (fig. 20). Although the species composition was similar in both places, the abundance pattern clearly differed. In Azores, specimens of the complex *Caprella acanthifera* 'sensu lato' were dominant, followed by *Caprella equilibra*. *Caprella penantis* 'sensu lato' and *Pseudoprotella phasma* were more abundant in Madeira, and *Phtisica marina* was occasionally collected in Azores. *C. penantis* was

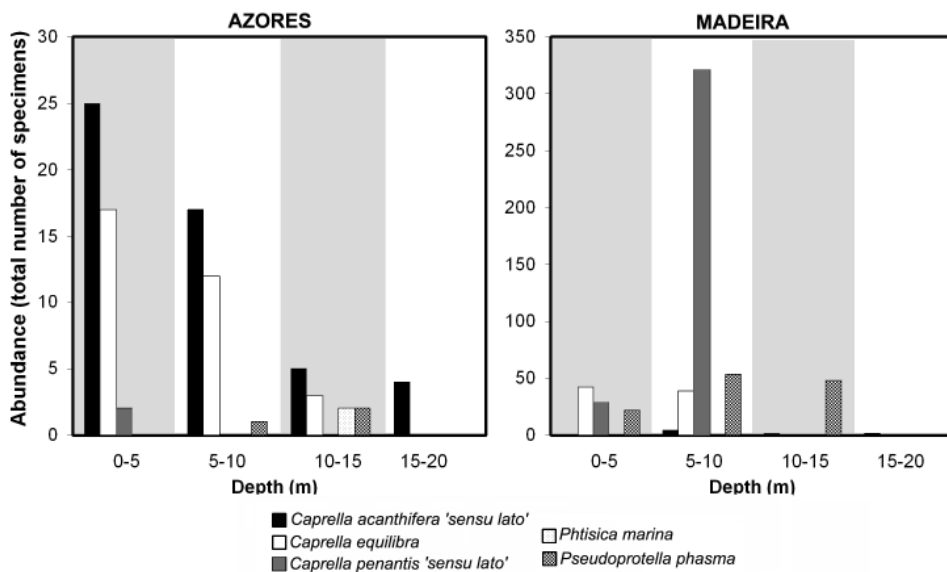


Fig. 20.—Caprellid abundances in each depth range considered, measured as the total number of specimens found in Azores and Madeira. Values represent the sum of the specimens from the two transects sampled.

Fig. 20.—Abundancia de caprélidos en cada intervalo de profundidad considerado, medido como el número total de ejemplares encontrados en Azores y Madeira. Los valores representan la suma de ejemplares encontrados en los dos transectos muestreados.

restricted to the depth range 0-10 m, with a peak of abundance in 5-10 m in Madeira. *Caprella equilibra* was collected from 0 to 15 m, but the highest densities were obtained in the first 10 meters. Recently, Guerra-García *et al.* (2014) studied the vertical distribution of caprellids associated to hydroids from the Atlantic coast of Agadir, Morocco. The sampling was conducted in a similar way so the results can be compared. The highest abundances in Agadir were also obtained in the shallowest waters up to 10 meters depth, but species composition differed. In Agadir, *Phtisica marina* was one of the most abundant species, and *Pseudoprotella inermis* was present in deeper stations. *Caprella liparotensis* was only present in Agadir and absent in Azores and Madeira, while *C. equilibra* and *C. penantis* were only collected in Azores and Madeira. Guerra-García *et al.* (2010) studied the shallow water caprellids associated to macroalgae along the Iberian Peninsula and the most abundant species in the Atlantic coast were *Caprella penantis* and *C. acanthifera*. *Caprella equilibra*, *Pseudoprotella phasma* and *Phtisica marina* were also recorded, although in lower abundances. A similar species composition was also cited by Riera *et al.* (2003) in shallow waters (10-13 m) of Canary Islands. Bamber & Costa (2009) and Bamber (2012) suggested the drift dispersal in algae as a viable mean of passive migration by tanaidaceans. Bamber (2012) described comprehensively the current circulation along the Macaronesian islands. The low to mid-latitudes of the North Atlantic are occupied by the clockwise-rotating subtropical gyre, and passive transport in drift from the northern archipelagos to those further south is feasible, as is drift from the African coast to the Cape Verde Islands (fig. 21). Passive transport of shallow water taxa to Macaronesia from the Mediterranean is not feasible but, interestingly, the transport of such taxa from Macaronesia to the Mediterranean is, on the contrary, feasible (Bamber, 2012). This probably explain in part why shallow water species common in the Mediterranean coast of the Iberian Peninsula and Strait of Gibraltar, such as *Caprella grandimana* or *C. hirsuta* (Guerra-García *et al.*, 2010) have not reached the Macaronesian islands.

Although all these islands seem to share most of the common species, a detailed morphological and molecular study is necessary to clarify the taxonomical status of some species, especially those belonging to traditional species complexes such as *Caprella acanthifera*, *C. penantis* or *Pseudoprotella phasma*. Careful examination of caprellid material from Macaronesia has recently led to the description of new taxa (e.g. Guerra-García, 2004; Krapp-Schickel & Takeuchi, 2005; Vázquez-Luis *et al.*, 2013) so, probably, the global diversity of amphipods from Macaronesian islands is still underestimated.

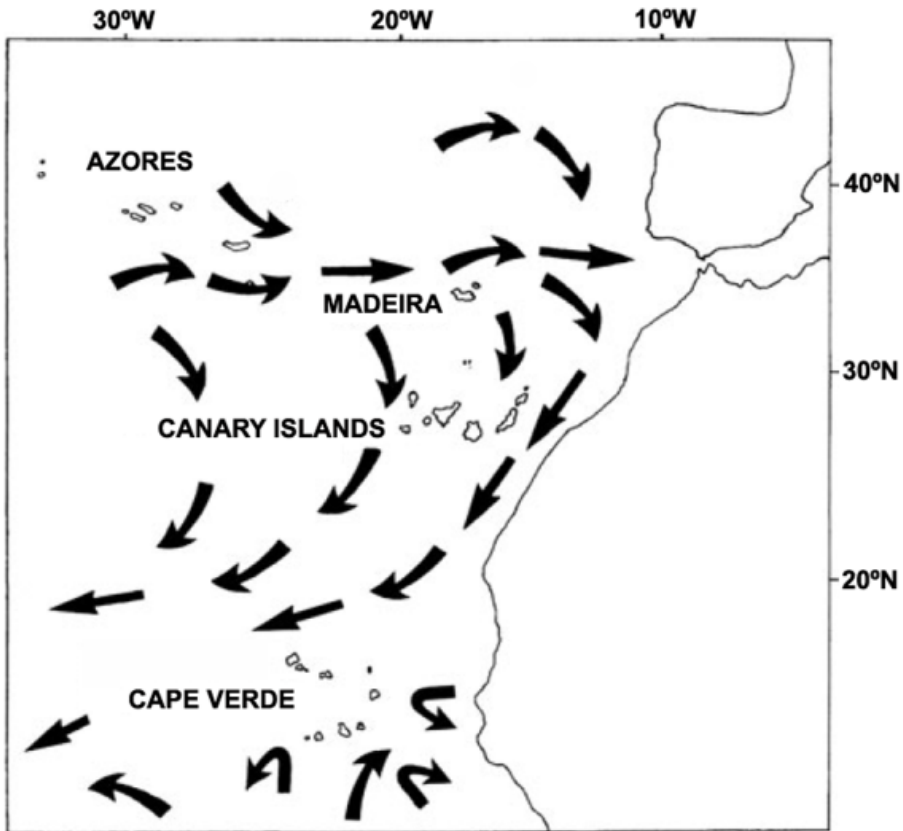


Fig. 21.—Diagrammatic map of principal current flows through Macaronesia (modified from Barton, 2001 and Bamber, 2012).

Fig. 21.—Mapa esquemático de las principales corrientes en Macaronesia (modificado de Barton, 2001 y Bamber, 2012).

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