

A new species of *Caprella* (Crustacea: Amphipoda) from the Mediterranean Sea

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Abstract A new caprellid amphipod, *Caprella tavolarensis* n. sp., is described based on specimens collected from a *Posidonia oceanica* seagrass meadow at the Tavolara-Punta Coda Cavallo Marine Protected Area (Sardinia, Mediterranean Sea). The species is close to *Caprella liparotensis*, but can be clearly distinguished by smaller size, presence of a short rostrum, body elongate and dorsally smooth, absence of serrate carina on the basis of gnathopod 2 and pereopods, mouthparts scarcely setose, absence of fine setae on peduncle of antenna 1 and absence of swimming setae on antenna 2. The number of caprellid species reported from the Mediterranean Sea has increased from 23 (1993) to 41 (2010), consequently, further taxonomical studies should be addressed to properly estimate the total amphipod diversity in the Mediterranean Sea.

Keywords Amphipoda · Caprellidae · New species · Marine protected area · *Posidonia oceanica* · Mediterranean Sea

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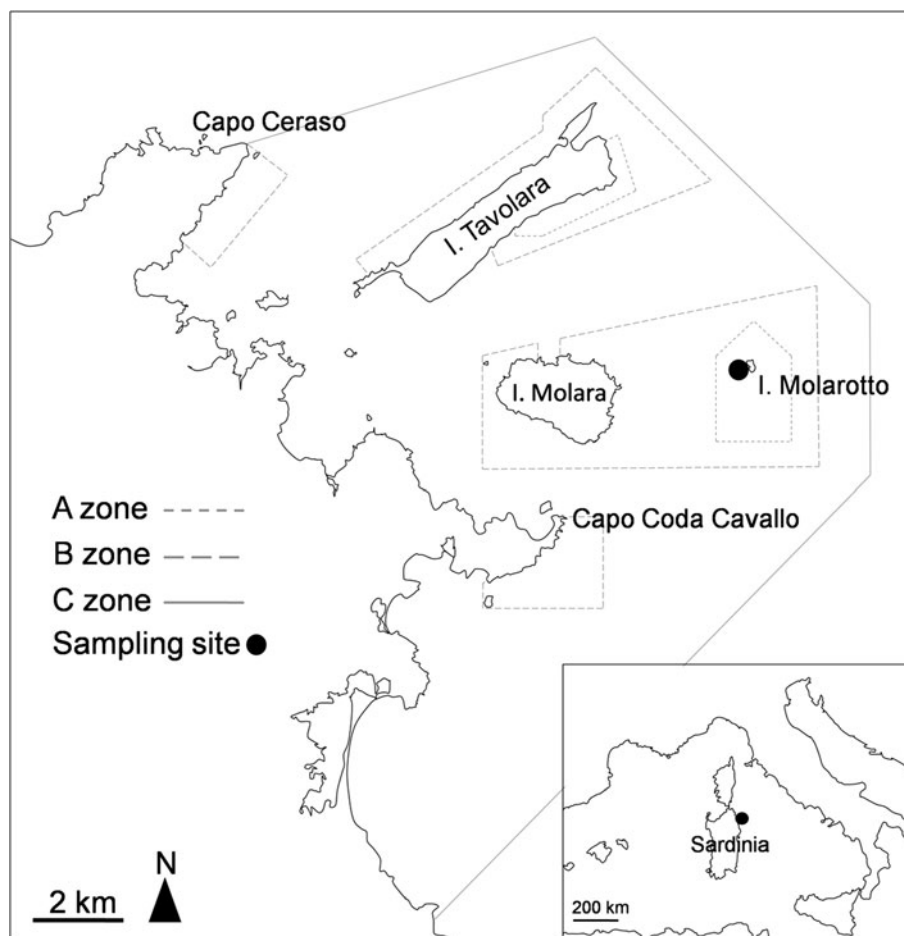
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Introduction

Seagrasses are distributed worldwide (600.000 km² of the marine bottoms are covered by these spermatophytes) and play an important role in the general coastal dynamics and biology (Larkum et al. 1989; Templado 2004; González et al. 2008). When compared with neighbouring areas, the meadows reveal higher abundances and species richness (Edgar et al. 1994). The main factors contributing to this improvement in biodiversity are availability of microhabitat, protection from predators, trophic resources, sediment settling, hydrodynamic force reduction (see Pranovi et al. 2000). Seagrass beds of the temperate zone support large numbers of invertebrate species and individuals, thereby providing abundant food for fishes, compared to adjacent unvegetated areas (Nakamura and Sano 2005). Along the coasts of the Mediterranean Sea, five species occur: *Posidonia oceanica* (Linnaeus) Delile, *Zostera marina* Linnaeus, *Zostera noltii* Hornemann, *Cymodocea nodosa* (Ucria) Ascherson and a lessepsian species *Halophila stipulacea* (Forsskål) Ascherson (Buia et al. 2000). In spite of the abundance of these seagrass meadows in the Mediterranean, caprellid communities associated to these plants have been scarcely studied, and the only records of caprellids from these habitats come from general faunistic or ecological studies (see González et al. 2008).

As a part of a general project assessing the effects of protection status (totally, partially and non protected areas) on amphipod communities associated to *Posidonia oceanica* beds along the Sardinian coast (Italy), several specimens of the genus *Caprella* were collected. Detailed examination revealed that these specimens belonged to a new species close to *Caprella liparotensis*, here described as *Caprella tavolarensis* n. sp.

Fig. 1 Study area showing the sampling site in the Tavolara-Punta Coda Cavallo Marine Protected Area (Sardinia, Mediterranean Sea). Zone A (integral reserve), zone B (general reserve) and zone C (partial reserve) are shown



Materials and methods

The sampling was conducted at Molarotto island, an integral reserve area located at the Tavolara-Punta Coda Cavallo Marine Protected Area, NE Sardinia, Italy (Fig. 1). Samples were collected from *Posidonia oceanica* bed (10–15 m) by SCUBA diving using an airlift sampler and light traps (about methods see Michel et al. 2010). The samples were sieved through a 0.5-mm mesh and fixed in formalin 4%, then transferred to 70% ethanol. Selected specimens were dissected under a Leica dissecting microscope. Appendages of selected specimens were mounted in polyvinyl-lactophenol and camera lucida drawings were made using a Leica compound microscope.

Although the phylogeny and higher classification of the caprellids are still under debate (see Laubitz 1993; Takeuchi 1993; Ito et al. 2008), Myers and Lowry (2003) have recently proposed a new phylogeny and classification for the suborder Corophiidea Leach, 1814. Based on the hypothesis of the evolution of different feeding strategies, the Corophiidea are divided into two infraorders, the Corophiida and the Caprellida. In their new classification, the

superfamily Caprelloidea contains five families: Caprellidae, Caprogammaridae, Cyamidae, Dulichiidae and Podoceridae. The Caprellidae are subdivided into three subfamilies: Caprellinae, Paracercopinae and Phtisicinae. In the present paper, we have adopted the classification of Myers and Lowry (2003) considering the family Caprellidae, and the subfamily Caprellinae.

The symbols used in the present work are: A1, 2 = Antenna 1, 2; UL = Upper lip; LL = Lower lip; LMd = Left mandible; RMD = Right mandible; Mx 1, 2 = Maxilla 1, 2; Mxp = Maxilliped; Gn 1, 2 = Gnathopod 1, 2; P5–7 = Pereopod 5–7; Ab = Abdomen. All the type material is deposited in the Museo di Storia Naturale di Verona, Italy (MVR).

Results

Family Caprellidae Leach, 1814

Subfamily Caprellinae Leach, 1814

Caprella tavolarensis n. sp. (Figs. 2, 3, 4, 5, 6, 7, 8, 9)

Type material Holotype male (used for drawings) (MVRCr 500.0). Paratype female (used for drawings)

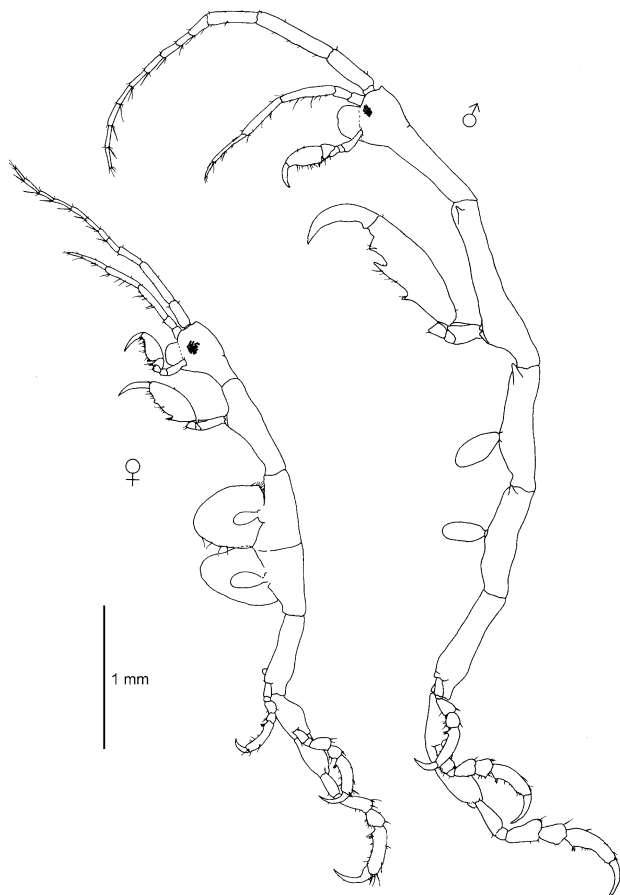


Fig. 2 *Caprella tavolarensis* n. sp. Lateral view of holotype male (MVRCr 500.0) and paratype female (MVRCr 500.1)

(MVRCr 500.1). Paratypes dissected (used for drawing the mouthparts) (3 males and 3 females, MVRCr 500.2–500.7). Other paratypes (10 males, 8 females, 2 juveniles, MVRCr 500.8). All the material was collected from the type locality (July–August 2008).

Additional material examined 17 males, 13 females, 2 juveniles, collected from the type locality (July–August 2007)

Type locality All the material has been collected from a *Posidonia oceanica* meadow between 10 and 15 m depth at the Tavolara-Punta Coda Cavallo Marine Protected Area, A zone of Molarotto island (40°52'25"N, 9°46'35"E), NE Sardinia, Italy (Fig. 1).

Etymology The specific name refers to the area where the species was found.

Diagnosis Head with very short rostrum. Pereonites 2, 3 and 4 with anterolateral projections. Body dorsally smooth. Peduncular articles of antenna 1 not setose. Antenna 2 without swimming setae. Basis of gnathopod 2 without serrated carina but with inner projection.

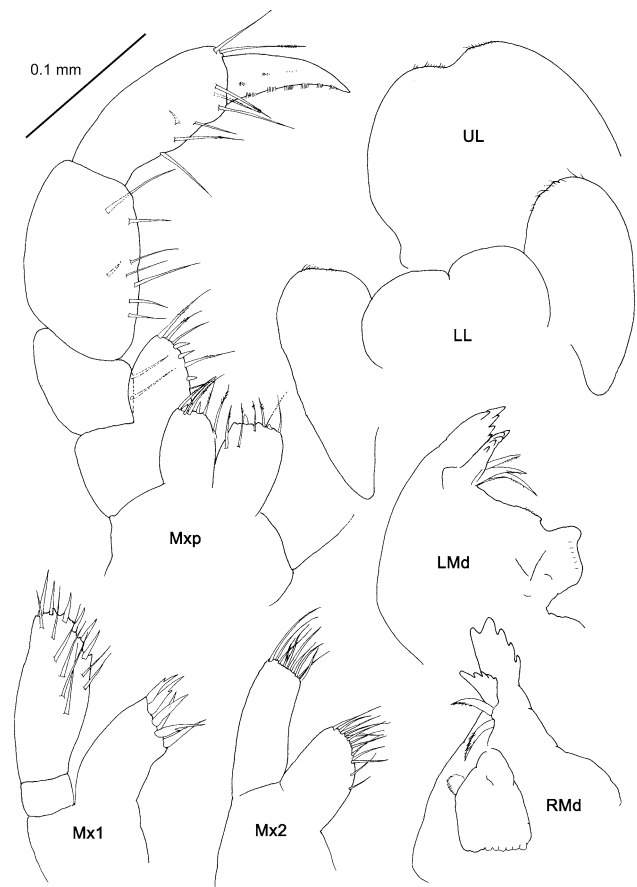


Fig. 3 *Caprella tavolarensis* n. sp. Mouthparts of paratype male (paratype 1, MVRCr 500.2)

Description

Holotype male (MVRCr 500.0)

Body length 5.8 mm.

Lateral view (Fig. 2). Head with a short rostrum (almost absent in subadult males), suture between head and pereonite 1 present. Body dorsally smooth, without tubercles. A pair of anterolateral projections on pereonites 2, 3 and 4.

Gills (Fig. 2). Present on pereonites 3–4, elongate, length about twice width.

Mouthparts (Fig. 3, figured from paratype 1). Upper lip symmetrically bilobed, small setulae apically. Mandibular molars process strong; incisor and lacinia mobilis 5-toothed; left mandible with three pectinated setae, right mandible with only two; small molar flake present on right mandible. Lower lip with inner lobes poorly demarcated and outer lobes scarcely setose. Maxilla 1 outer lobe with six robust and stout setae; distal article of palp with

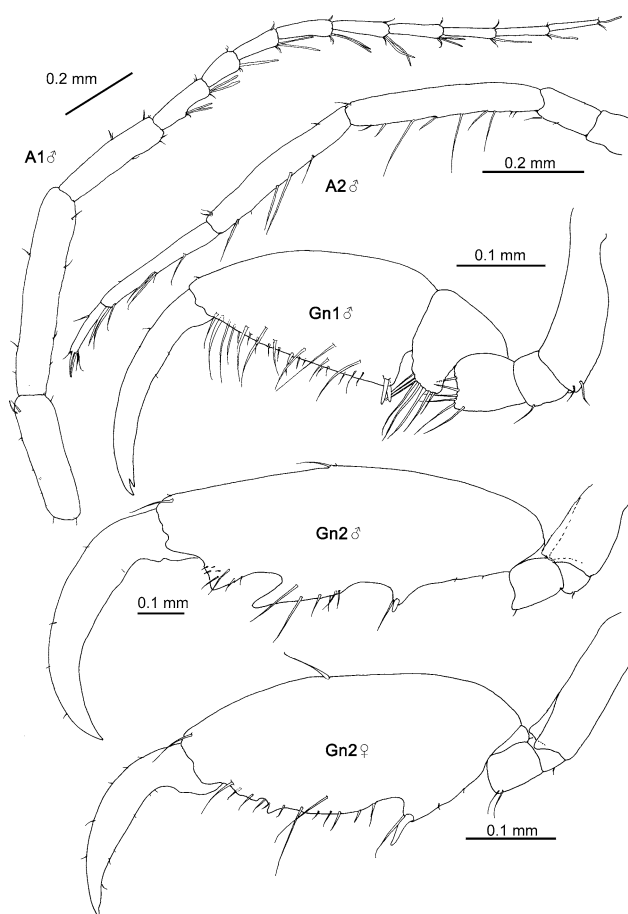


Fig. 4 *Caprella tavolarenis* n. sp. Male holotype (MVRCr 500.0) antenna 1, antenna 2 and gnathopods 1 and 2. Female paratype (MVRCr 500.1) gnathopod 2

six setae distally and eight lateral setae. Maxilla 2 inner lobe oval and outer lobe rectangular, about 1.5 times as long as the inner lobe. Maxilliped inner plate with three robust and short setae (similar to “teeth”) and five plumose setae; outer plate with long, plumose setae and three robust setae (like “teeth”); palp four-articulate, with long plumose setae, article 4 with rows of setulae on its grasping margin.

Antennae (Fig. 4). Antenna 1 about half of the body length; peduncle scarcely setose; flagellum 9-articulate. Antenna 2 flagellum two-articulate, with scarce setae; swimming setae absent.

Gnathopods (Fig. 4). Gnathopod 1 basis as long as ischium, merus and carpus combined; propodus palm with two proximal grasping spines, grasping margin smooth; dactylus elongate. Gnathopod 2 inserted near distal end of pereonite 2; basis short, about one-sixth of pereonite 2 in length, provided with a ventral projection and lacking serrate carina; propodus elongate, length about 3 times width; palm concave with one proximal projection provided with grasping spine; another projec-

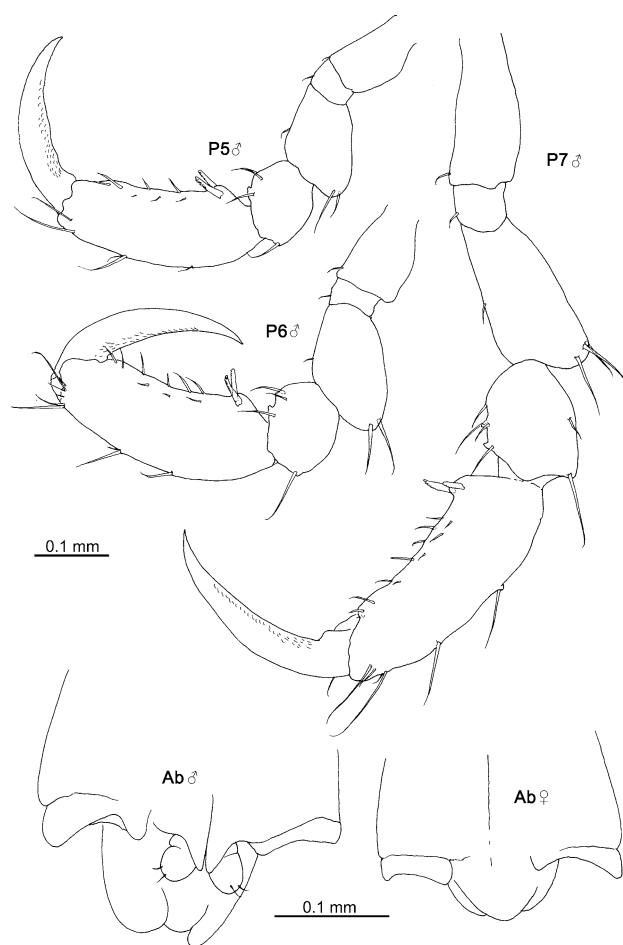


Fig. 5 *Caprella tavolarenis* n. sp. Pereopods 5–7 and abdomen of male paratype (paratype 1, MVRCr 500.2). Abdomen of female paratype (paratype 4, MVRCr 500.5)

tion one-quarter length from distal end, followed by “U” notch distally.

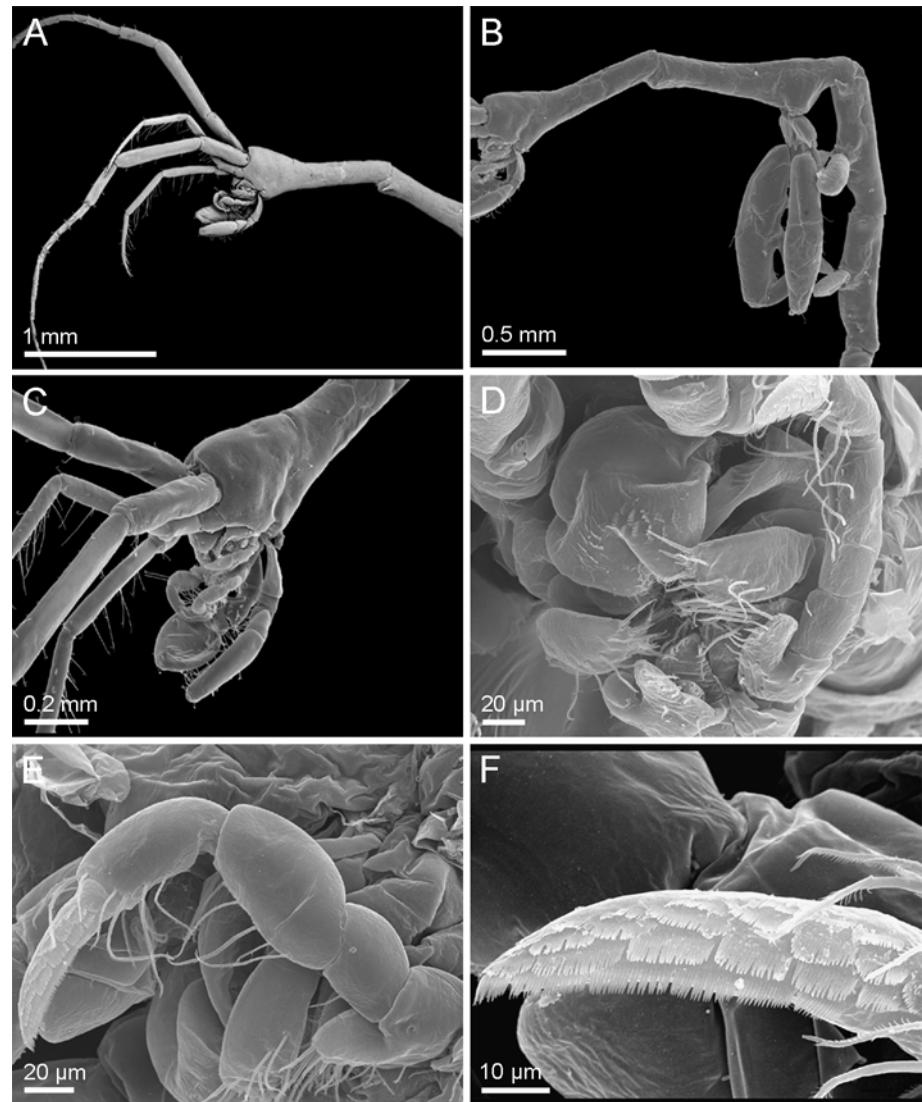
Pereopods (Fig. 5, figured from paratype 1). Pereopods 3 and 4 absent. Pereopod 5, 6 and 7 increasing in length; basis without serrate carina; carpus of pereopod 5 and 6 with an inner tooth, and pereopod 7 with two teeth; propodus provided with a pair of grasping spines proximally.

Penes (Fig. 5). Short, length about 1.2 times the width. Abdomen with a pair of two-articulate appendages, a pair of lateral lobes and a single dorsal lobe.

Paratype female (MVRCr 500.1)

Body length 3.5 mm. Similar to male, except for the following characters: flagellum of antenna 1 eight-articulate (Fig. 2); oostegites present (Fig. 2), being slightly setose on pereonite 3; gnathopod 2 (Fig. 4) inserted on the anterior half of pereonite 2, basis about one-fourth of pereonite 2 in length, length of propodus about 2 times width, U-notch

Fig. 6 Scanning electron microscopy (SEM) pictures of *Caprella tavolarensis* n. sp. male adults. **a** Head region with antennae, mouthparts and gnathopods 1, lateral view. **b** Head and pereonites 1–4 with gnathopods 1, 2 and gills, lateral view; large male length: 6.1 mm. **c** Head region with mouthparts and insertion of gnathopods 1, lateral view. **d** Mouthparts with maxilliped, ventral view. **e** Maxilliped, lateral view. **f** Maxilliped dactylus outer margin



lacking; abdomen without appendages, only the lateral lobes and dorsal lobe present.

Intraspecific variation

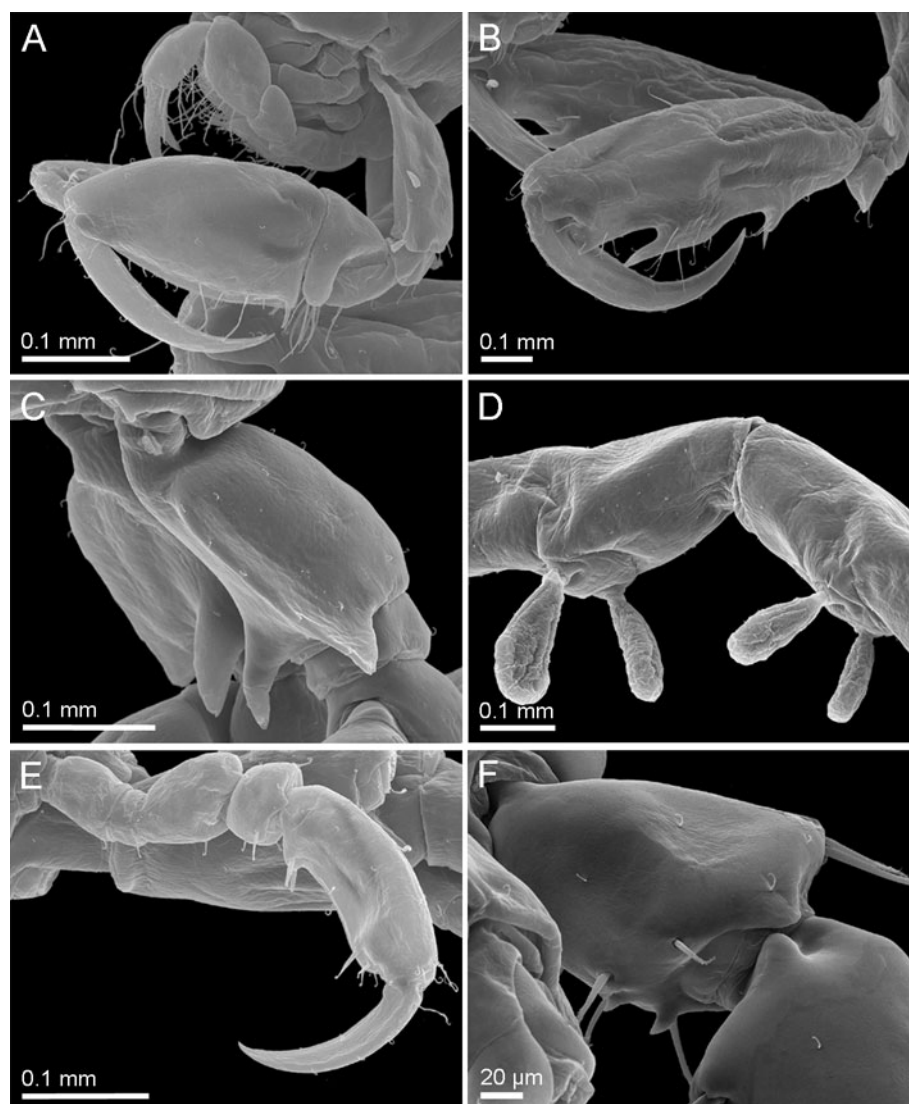
Length varied from 2.8 to 6.3 mm (males) and 2.0–4.3 mm (females). Most of the morphological characters studied in the present paper were rather constant. All the specimens examined had the body smooth dorsally, lacking tubercles. The rostrum was very short in both males and females, being extremely reduced (almost absent) in subadult specimens. Insertion of gnathopod 2 was near distal end of pereonite 2, although the insertion could vary from half to distal end of pereonite 2, depending on the maturation stage of the specimen. Length of pereonite 1 and 2 vary also according to the stage of development (Figs. 6b, 8d). All the specimens were lacking serrate carina on the basis of gnathopod 2 and basis of pereopods. Carpus of pereopods 5–7 was

provided by tiny teeth (Figs. 7f, 9e), although the number of these internal teeth could vary between 1 and 3. Six paratype specimens (3 males and 3 females) were dissected for examination of mouthparts. The structure of mouthparts is very constant, except for the following: (a) the number of strong setae (similar to “teeth”) in the outer lobe of the maxilliped could vary between 1 and 3; (b) the number of lateral setae of distal article of the palp of maxillae varied also from 4 to 8.

Ecological remarks

The specimens of *Caprella tavolarensis* n. sp. were collected from a well-preserved *Posidonia oceanica* bed between 10 and 15 m depth, located in a totally protected area. The meadow under investigation occurs on sandy bottoms and granitic rocks, and extends to a lower limit of about 27–30 m in depth. At sampling depth, mean meadow

Fig. 7 SEM pictures of *Caprella tavolarenis* n. sp. male adults, lateral views.
a Gnathopod 1 and maxilliped.
b Gnathopods 2. **c** Basis of gnathopods 2 with projections.
d Pereonites 3–4 with gills.
e Pereopod 5. **f** Pereopod 6 carpus with acute teeth



density reached 259 ± 98 shoots m^{-2} (mean \pm standard deviation of 16 measurements).

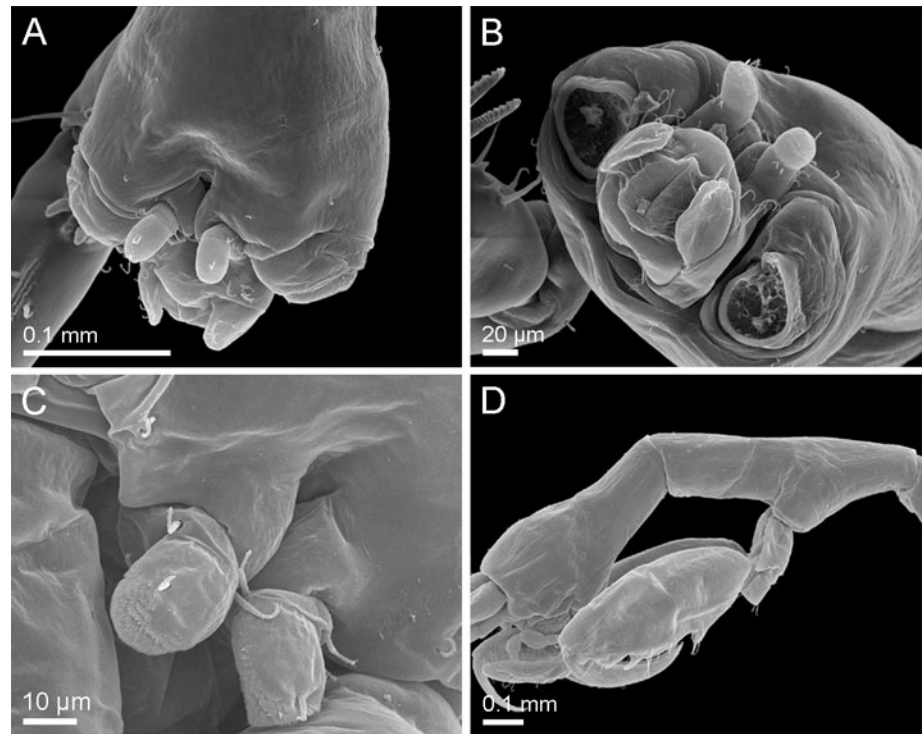
The amphipod fauna of this meadow is dominated by the species *Caprella tavolarenis* n. sp. (37.2%), *Apherusa chireghinii* Giordani-Soika (17.4%), *Aora spinicornis* Afonso (12.1%) and *Phtisica marina* Slabber (11.3%). *Caprella tavolarenis* mean density was 64 ± 75 individuals m^{-2} (mean \pm standard deviation of 16 samples) and reached maximum density of 271 individuals m^{-2} . The examination of horizontal spatial variability patterns, using a hierarchical nested design with spatial scales ranging from metres to hundred of metres, revealed that *C. tavolarenis* density exhibited the larger variation at the small spatial scale (~ 1 m). Although the existence of small-scale patchiness in density within *P. oceanica* meadows has long been recognised (Panayotidis et al. 1981), no correlation has been found between *C. tavolarenis* abundance and meadow density. Previous studies revealed that there is no correlation

between parameters of the vagile fauna such as number of individuals and features of the *P. oceanica* meadow such as density (Scipione et al. 1996). In the same area, several experiments dealing with fish predation have been conducted. This species is little predated in comparison with other accompanying species such as *Caprella acanthifera*. Probably, the small size could let the specimens camouflaged among *Posidonia* leaves and escape from predators. Three caprellid species were found living in *P. oceanica* bed together with *Caprella tavolarenis*: *Caprella acanthifera*, *Phtisica marina* and *Pseudoprotella phasma*.

Discussion

The new species *Caprella tavolarenis* n. sp. is close to *Caprella liparotensis* Haller, 1879, and *Caprella wirtzi* Krapp-Schickel and Takeuchi 2005. *Caprella liparotensis*

Fig. 8 SEM pictures of *Caprella tavolarensis* n. sp. male adults. **a** Abdomen, ventral view. **b** Abdomen, ventroposterior view. **c** Detail of penes and abdominal appendages, ventral view. **d** Head and pereonites 1–2 with gnathopods 1, 2, lateral view; young male length: 3.6 mm



was described based on specimens collected from Lipari, Italy and has since been reported from Portugal to the whole Mediterranean, including the Adriatic and Black Seas (Krapp-Schickel and Takeuchi 2005). Additional descriptions of this species have been provided by Chevreux and Fage (1925), Krapp-Schickel (1993) and Guerra-García and Takeuchi (2002). Krapp-Schickel and Takeuchi (2005) described *Caprella wirtzi* from Cape Verde Islands (Atlantic), close to *C. liparotensis*, but showing differences on antenna 2, gnathopod 2 and pereonites.

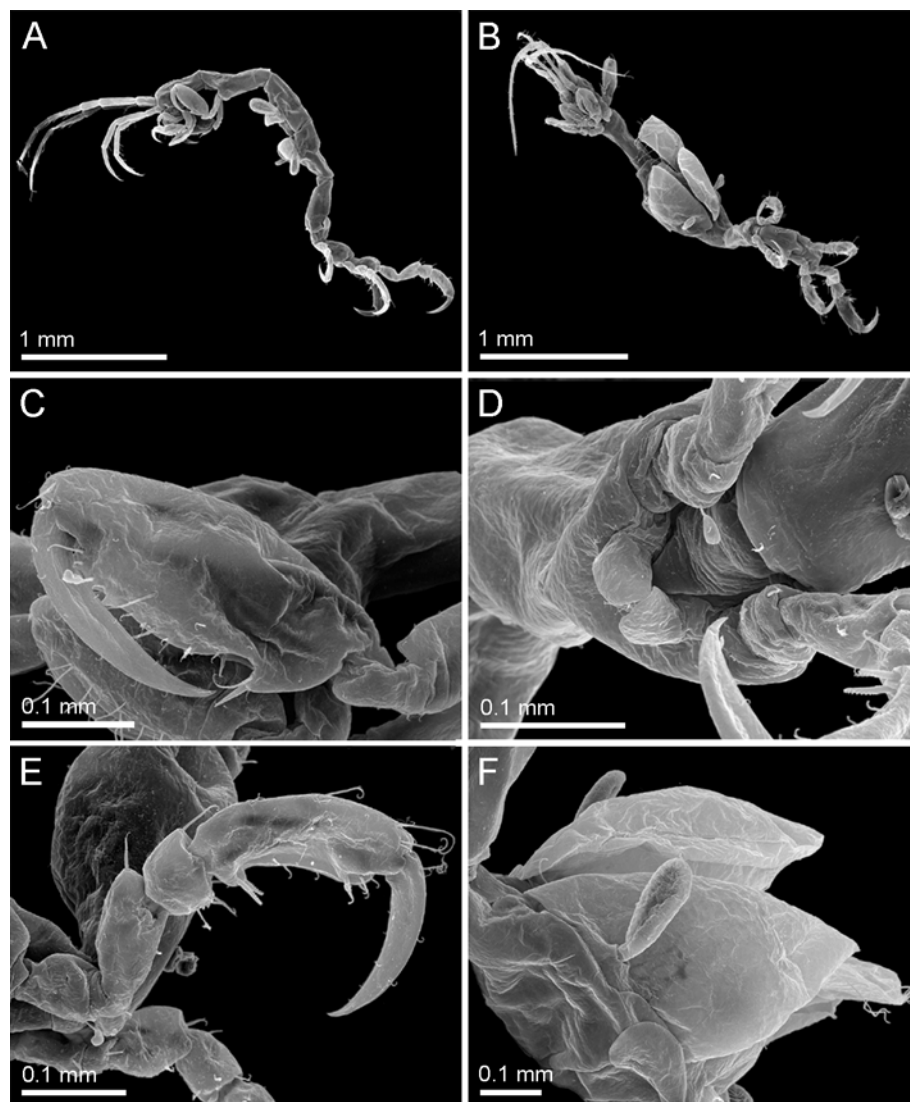
The new species *Caprella tavolarensis* clearly differs from *C. liparotensis* and *C. wirtzi* on the following characters: (1) smaller size in *C. tavolarensis* (males 3–6 mm, females 2–4 mm) than in *C. liparotensis* (males 7–12 mm, females 4–7 mm) and *C. wirtzi* (males 8–12 mm, females 4–6 mm); (2) body more elongate and dorsally smooth in *C. tavolarensis*, while dorsal tubercles or acute projections are present on pereonites 5–7 on the other two species; (3) very short rostrum in *C. tavolarensis*, while well developed in *C. liparotensis* and *C. wirtzi*; (4) maxilliped less setose in *C. tavolarensis*; (5) peduncle articles 2 and 3 of antenna 1 lacking dense setae in *C. tavolarensis*; (6) antenna 2 lacking swimming setae in *C. tavolarensis*; (7) basis of gnathopod 2 and pereopods lacking serrate carina in *C. tavolarensis* and *C. wirtzi*, while a developed serration is present in *C. liparotensis*.

The elongate shape of the body together with the scarcely setose antennae and very short rostrum make *C. tavolarensis* to resemble the species *Caprella mitis* and

C. paramitis. However, the gnathopod 2 is totally different in these species.

Based on the considerable degree of intraspecific morphological variation in *C. liparotensis*, Krapp-Schickel and Takeuchi (2005) already doubted about the wide distribution of *C. liparotensis* within the Mediterranean and north-east Atlantic and pointed out that careful checking of rich series taken from many different localities should shed more light on what is variable and what are small but constant differences. Probably, the new species described in the present paper may have been misidentified as *C. liparotensis* in the past. So far, *C. liparotensis* had been recorded from different species of algae and hydroids (Krapp-Schickel 1993; Guerra-García 2001; Guerra-García and Takeuchi 2002), and also from *P. oceanica* seagrass beds (Scipione and Fresi 1984; Zakhama-Sraieb et al. 2006). The most common caprellid species recorded from seagrasses at Mediterranean sites are *Caprella acanthifera* Leach, 1814, *Caprella rapax* Mayer, 1890, *Phtisica marina* Slabber, 1769, *Pseudoprotella phasma* Montagu, 1804 and *Pariambus typicus* Krøyer, 1844 (Scipione 1998; Sánchez-Jerez et al. 1999; Luque et al. 2004; González et al. 2008). However, these caprellid species are not exclusive of these habitats since they have been collected from many different substrates (Guerra-García 2001). During the present study, the new species *Caprella tavolarensis* was found together with *Caprella acanthifera*, *Pseudoprotella phasma* and *Phtisica marina*. Probably, further studies on *Posidonia oceanica* beds of other Mediterranean areas could reveal

Fig. 9 SEM pictures of *Caprella tavolarensis* n. sp. female adults. **a** Entire animal, lateral view. **b** Entire animal, ventral view. **c** Gnathopod 2, lateral view. **d** Pereonites 5–6 showing genital papillae on pereonite 5, ventral view. **e** Pereopod 5, lateral view. **f** Oostegites and gills, lateral view



the presence of *C. tavolarensis*, although we cannot exclude that the species could be an endemism of the area, and this would explain that the species has not been reported so far in the Mediterranean. Monitoring of the amphipod fauna in other comparable partially protected localities (B and C zones) of the Tavolara-Punta Coda Cavallo Marine Protected Area (Fig. 1) showed that specimens of *Caprella tavolarensis* have been found in only very rare cases, while it is the dominant species in the A zone with 37.2% of the total amphipod fauna. We cannot exclude a possible role of the protection status of this locality, highlighting the importance of totally protected areas in species conservation.

So far, 41 caprellid species have been recorded at the Mediterranean Sea (Table 1). Krapp-Schickel (1993) included 23 species in her revision. After these, several taxa were described, especially from the Strait of Gibraltar area, doubling the number of species included in the monographs

edited by the late Sandro Ruffo. *Caprella scaura* Templeton, 1836 has also been recorded recently from the Mediterranean as invader species (Krapp et al. 2006). Most species (51%) have been collected only in Mediterranean waters and can be considered Mediterranean endemic so far (Table 1), with many species restricted to the Strait of Gibraltar area. Bellan-Santini and Ruffo (1998) reported 37% of amphipod species endemic to the Mediterranean Sea. Consequently, more caprellid studies are needed since, probably, further researches along the Atlantic Coast of North Africa and the Iberian Peninsula would likely reduce the number of caprellids that are considered endemic to the Mediterranean. It is the case, for example, of *Caprella rapax* and *Parvipalpus major*, which have been collected recently on the Atlantic Iberian coast (see Guerra-García and Takeuchi 2002). Although *Caprella grandimana* and *C. hirsuta* have also been reported from nearby areas of the Atlantic side of the Strait of Gibraltar (Bellan-Santini and

Table 1 Caprellids cited in Mediterranean waters

Name of species	Distribution
<i>Caprella acanthifera</i> Leach, 1814	M, A
<i>Caprella andreae</i> Mayer, 1890	M, A, P
<i>Caprella caulerpensis</i> Guerra-García, Sánchez-Moyano and García-Gomez, 2002	E*
<i>Caprella cavediniae</i> Krapp-Shickel and Vader, 1998	E
<i>Caprella ceutae</i> Guerra-García and Takeuchi, 2002	E*
<i>Caprella danilevskii</i> Czerniavski, 1868	M, A, P, I
<i>Caprella dilatata</i> Krøyer, 1843	M, A
<i>Caprella equilibra</i> Say, 1818	M, A, P, I
<i>Caprella erethizon</i> Mayer, 1901	M, A
<i>Caprella fretensis</i> Stebbing, 1878	M, A
<i>Caprella grandimana</i> Mayer, 1882	E
<i>Caprella hirsuta</i> Mayer, 1890	E
<i>Caprella lilliput</i> Krapp-Shickel and Ruffo, 1987	E
<i>Caprella linearis</i> Linnaeus, 1767	M, A
<i>Caprella liparotensis</i> Haller, 1879	M, A
<i>Caprella mitis</i> Mayer, 1890	E
<i>Caprella monai</i> Guerra-García, Sánchez-Moyano and García-Gómez, 2001	E*
<i>Caprella paramitis</i> Guerra-García, Sánchez-Moyano and García-Gómez, 2001	E*
<i>Caprella penantis</i> Leach, 1840	M, A, P, I
<i>Caprella pseudorapax</i> Guerra-García, Sánchez-Moyano and García-Gómez, 2001	E*
<i>Caprella rapax</i> Mayer, 1890	M, A
<i>Caprella sabulensis</i> Guerra-García, Sánchez-Moyano and García-Gómez, 2001	E*
<i>Caprella santosrosai</i> Sánchez-Moyano, Jiménez-Martín and García-Gómez, 1995	E*
<i>Caprella scaura</i> Templeton, 1836	M, A, P, I
<i>Caprella takeuchii</i> Guerra-García, Sánchez-Moyano and García-Gómez, 2001	E*
<i>Caprella tavolarenis</i> n.sp.	E
<i>Caprella telarpax</i> Mayer, 1890	E
<i>Caprella tuberculata</i> Bate and Westwood, 1868	M, A
<i>Caprella</i> sp (armata-group) (see Krapp-Shickel and Vader, 1998)	M, A
<i>Deutella schieckei</i> Cavedini, 1982	E
<i>Liropus elongatus</i> Mayer, 1890	E
<i>Liropus minimus</i> Mayer, 1890	E
<i>Pariambus typicus</i> Krøyer, 1844	M, A
<i>Parvipalpus linea</i> Mayer, 1890	M, A
<i>Parvipalpus major</i> A. Carausu, 1941	M, A
<i>Pedocolina bacescui</i> A. Carausu, 1940	E
<i>Pedocolina garciagomezi</i> Sánchez-Moyano, Carballo and Estacio, 1995	E*
<i>Phtisica marina</i> Slabber, 1769	M, A, P
<i>Pseudolirius kroyerii</i> Haller, 1879	E
<i>Pseudoprotella inermis</i> Chevreux, 1927	M, A
<i>Pseudoprotella phasma</i> Montagu, 1804	M, A

Modified from Guerra-García and Takeuchi (2002)

E Mediterranean endemic;
M Mediterranean Sea;
A Atlantic Ocean; P Pacific
Ocean; I Indian Ocean

* Indicates that the species has a restricted distribution area to the Strait of Gibraltar

Ruffó 1998), we have considered these species as truly Mediterranean endemics since a recent study of Guerra-García et al. (2010) showed that the distribution of these two species is clearly restricted to Mediterranean waters. Only a few species (i.e. *Caprella andreae*, *C. danilevskii*, *C. equilibra*, *C. penantis* and *Phtisica marina*) show a wide distribution area. On the other hand, species such as

Caprella erethizon, *C. fretensis* or *Caprella tuberculata*, typically distributed along the North Atlantic, have been recently collected at the Mediterranean side of the Strait of Gibraltar.

Summarising, in spite of the amphipod fauna from the Mediterranean can be considered as very well studied, still new species are being described. Further sampling, especially

from sediments, maerl bottoms and corraligène (below 40–50 m) should be conducted to complete our knowledge about Mediterranean caprellids.

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