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## A new species of *Protodorvillea* (Polychaeta: Dorvilleidae) from the Western Mediterranean Sea

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### Abstract

A new species of Dorvilleidae, *Protodorvillea artemidis* sp. nov., is described from the soft bottom of the Gulf of Taranto (northern Ionian Sea) and the Straits of Messina (southern Tyrrhenian Sea), in the western Mediterranean Sea. The specimens were collected in October 2014, near the village of Rossano Calabro (Southern Italy, Ionian Sea), and in July 2016 off the village of Scilla (Southern Italy, Tyrrhenian Sea), from 6 to 38 m depth. *Protodorvillea artemidis* sp. nov. is characterised by four eyes, two short clavate antennae, dorsal and ventral cirri from the first parapodium, a long subacicular falciger reminiscent of that of *Dorvillea*, and the simultaneous occurrence of supraacicular and subacicular cultriform chaetae with serrated edges. *Protodorvillea artemidis* sp. nov. is similar to *P. kefersteini* (McIntosh, 1869) but differs from this species mainly by morphological characteristics of prostomium, mouth parts, and supraacicular and subacicular chaetae. Morphological characters important for differentiation of the new species herein described from congeneric species are discussed. The description of *P. artemidis* sp. nov. helps to improve the knowledge on the diversity of Mediterranean invertebrates, and specifically on the family Dorvilleidae, which is still poorly known and includes many opportunistic species, early indicators of pollution.

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**Keywords:** *Protodorvillea artemidis* sp. nov., *Polychaeta*, *Ionian Sea*, *Tyrrhenian Sea*, *Mediterranean Sea*

### Introduction

The Mediterranean Sea, a semi-enclosed basin, is a hotspot of biodiversity with a high rate of endemism (Bianchi & Morri 2000; Coll et al. 2010). Despite this fact, it contains many regions and habitats that remain insufficiently studied, and several taxonomic groups are still poorly known (Coll et al. 2010). Most records of new species have originated from accidental “encounters” while carrying out other research, whereas ad hoc studies on the alien and indigenous (endemic) fauna and flora have received inadequate financial support; thus, the description of new species is still common and a high priority (Lezzi 2017). Research funds as well as taxonomic expertise have great importance in the process of species monitoring, and the known distribution of different taxa may reflect the availability of taxonomic expertise within

research centres (Occhipinti-Ambrogi et al. 2011). In addition, the biodiversity of the Mediterranean is threatened, and affected by several crucial factors such as the invasion and establishment of alien species, climate change and heavy human pressures (e.g. habitat loss and degradation, pollution and eutrophication) which are giving rise to important changes in the numbers of taxonomic groups (Cerrano et al. 2000; Lejeune et al. 2010; Bianchi et al. 2012, 2014; Di Camillo & Cerrano 2015). All such disturbances will continue to change the biota and affect marine biodiversity, as they are expected to increase in frequency and severity in the future (Coll et al. 2010). The progressive “extinction” of invertebrate taxonomy specialists coupled with material not being properly identified is leading to an underestimation of invertebrate biodiversity (Boero 2001; Coll et al.

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2010), and undescribed invertebrate species may become extinct before we even become aware of their existence.

The current estimated number of polychaete species in the Mediterranean is about 1100, which contributes 10% of worldwide biodiversity, and includes 210 endemisms (Coll et al. 2010).

The family Dorvilleidae Chamberlin, 1919 has been increasingly documented in recent years in Mediterranean coastal waters, showing an underestimated diversity of this family in different parts of this basin (Martin et al. 1991; Paxton & Åkesson 2010; Núñez et al. 2013; Taboada et al. 2017). The growing occurrence of species from elsewhere has contributed further to the relatively recent expansion of this family of polychaetes in the Mediterranean (Zenetos et al. 2010; Occhipinti-Ambrogi et al. 2011; Çinar 2013; Núñez et al. 2013; Mikac 2015). Despite this, little is known about the biology of several dorvilleid species occurring in the Mediterranean Sea (Cossu et al. 2015).

To date, 10 species of the genus *Protodorvillea* are known: *P. orensanzii* Carrasco & Palma 2000, native to northern coasts of Chile; *P. atlantica* (McIntosh, 1885), originally described from the Azores (Atlantic Ocean); *P. recuperata* Banse & Nichols, 1968, native to Southern Puget Sound, Washington (Pacific Ocean); *P. gaspeensis* Pettibone, 1961, native to the Atlantic coasts of Canada; *P. biarticulata* Day, 1963, originally described from South Africa (Indian Ocean); *P. egena* (Ehlers, 1913), native to South West Africa (Indian ocean) (Day 1963, 1967); *P. kefersteini* (McIntosh, 1869), originally described from the Atlantic coasts of Europe (Scotland); *P. gracilis* (Hartman, 1938), from Central California in the Pacific Ocean (Pettibone 1961; Hartman 1963); *P. bifida* Perkins, 1979, originally described from the coasts of Florida, and known also from the Gulf of Mexico (Fauchald et al. 2009); and *P. parva* Rullier, 1974, known only from a single specimen from Cuba, and subsequently hypothesised to be a juvenile of *Pettiboneia pugettensis* (Armstrong & Jumars, 1978) by Armstrong and Jumars (1979).

Only four of the 10 known species of *Protodorvillea* are reported in the Mediterranean. *Protodorvillea biarticulata* Day, 1963 was reported in the eastern and central Mediterranean Sea (Zenetos et al. 2010; Çinar 2013); it was recorded from Greece and Egypt (Simboura et al. 1995; Abd-Elnaby & Gab-Alla 2007; Faulwetter et al. 2017). *Protodorvillea egena* (Ehlers, 1913) was reported from the Mediterranean (Zenetos et al. 2005, 2010; Coll et al. 2010; Occhipinti-Ambrogi et al. 2011; Cinar 2013) and first recorded along the Italian coasts, from Sicily (Cantone 2001), likely introduced through the Suez Canal as lessepsian migrant (Amoureux 1983). *Protodorvillea kefersteini* (McIntosh,

1869) is widely distributed from the North Atlantic to the North Sea and English Channel (Pettibone 1961; Jumars 1974; Perkins 1979; Hartmann-Schröder 1996), Mediterranean (Coll et al. 2010; Núñez et al. 2013; Çinar et al. 2015; Mikac 2015) and the Black Sea (Jakubova 1930; Kurt Sahin et al. 2017); *P. atlantica* was reported from Greece by Vamvakopoulou (1991), although Faulwetter et al. (2017) suggested that this record must be considered questionable; in the Mediterranean this species is also known from Tunisia (Zaâbi et al. 2009) and the Adriatic Sea (Mikac 2015). *Protodorvillea atlantica* was firstly described by McIntosh (1885) as *Staurocephalus atlanticus*, and reported from the Atlantic Ocean by Fauvel (1923).

We describe herein a new species of the genus *Protodorvillea* Pettibone, 1961 from coastal soft-bottom sediments off the Calabria Region (southern Italy), along both the Ionian and Tyrrhenian coasts. Following the description of the genus *Protodorvillea* provided by Pettibone (1961), Orensanz (1973) and Jumars (1974), we assign the new species to this genus.

The specimens of the new species were collected during recent surveys that we carried out on the benthic macroinvertebrate fauna of the Gulf of Taranto (Ionian Sea). This description is based also on personal unpublished research on benthic macroinvertebrates carried out in the Straits of Messina (Tyrrhenian Sea).

## Material and methods

Specimens of the new species were collected during two different monitoring surveys of benthic macroinvertebrates carried out along the coasts of the Calabria Region (Southern Italy; Figure 1), one of which was in the Gulf of Taranto (Ionian Sea), whereas the other was in the Strait of Messina (Tyrrhenian Sea). The two surveys were carried out in October 2014 and July 2016, respectively.

Specimens from the Gulf of Taranto (Ionian Sea) were collected along two bathymetric transects (T2 and T3) off the town of Rossano (Figure 1); for each transect three soft-bottom stations at different depths (i.e. 6 m, 12 m and 18 m depth) were sampled in triplicate.

Specimens of *P. artemidis* sp. nov. from the Strait of Messina were collected at a soft-bottom sampling station (SCI, a personal research station) off the village of Scilla (Figure 1). Sampling was carried out in triplicate, characterised by high sediment variability, at 38 m depth.

At each sampling station, sediment samples were collected with a van Veen grab (area: 0.1 m<sup>2</sup>) and sieved on board through a 1-mm mesh; material

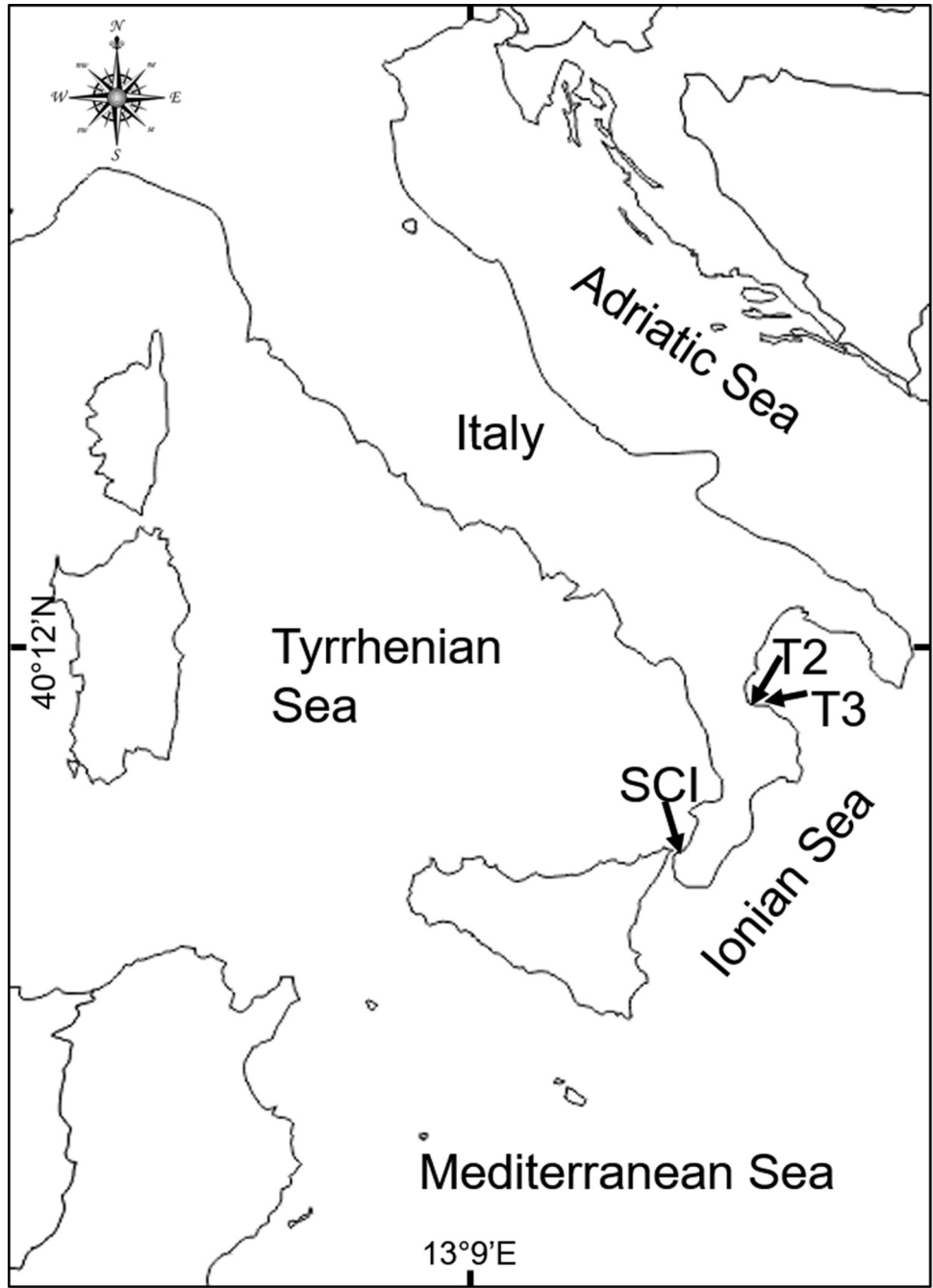


Figure 1. Map of the sampling sites: the transects of stations T2 and T3 in the Ionian Sea, and the station SCI in the Tyrrhenian Sea.

retained on the sieve was fixed in 5% buffered formaldehyde solution, and then preserved in alcohol. In the laboratory, samples were sieved through a 0.5-mm mesh and macroinvertebrates were identified to the species level.

Specimens pertaining to the genus *Protodorvillea* were examined using a stereomicroscope and a Nikon Eclipse (E200) compound microscope equipped with a digital camera to take images. Measurements of

length and width were detected by the photo analysis program Nis-Elements D (v. 2.30).

Several specimens were dehydrated and gold-coated for scanning electron microscope (SEM) study following the standard procedure described in Munari (2014).

The material examined was deposited at the Museum of Natural History of Ferrara (Mus. Civ. St. Nat. FE); further specimens are kept in the

collection of the laboratory of Marine Benthos Ecology of the University of Ferrara and available for analysis.

The terminology used to describe external morphological structures (parapodia and chaetae) and their components is derived from Pettibone (1961) and the subsequent descriptions (based on her review of the family Dorvilleidae) provided by the following authors: Banse and Nichols (1968), Hobson (1971), Orensanz (1973), Jumars (1974) and Perkins (1979). To describe the pharyngeal apparatus (i.e. mandibles and maxillae) we followed Fauchald (1970), Orensanz (1973), Jumars (1974) and Perkins (1979).

### Study area

The Gulf of Taranto (Italian coast, Ionian Sea) is subject to strong human pressures such as urban, industrial and agricultural pollution as well as aquaculture, military shipping and commercial fishing. In the Gulf there are several recreational boating stations, oil docks and the container terminal of Taranto. Moreover, in the north-eastern part of the Gulf (Mar Grande) there is a plant for the transportation of crude oil destined to feed the refinery through some submarine pipelines. The Gulf (Taranto Sea) is well known for its large number of alien species (Occhipinti-Ambrogi et al. 2011; Petrocelli et al. 2013; Corsini-Foka et al. 2017). It has been thoroughly studied with regard to marine macrophytes (see Cecere et al. 2011; Petrocelli et al. 2013), whereas, to our knowledge, the benthic invertebrates are less studied. The sampling stations are close to the important commercial fishing port of Corigliano, between urban and port sites; the coasts are characterised by the presence of *Posidonia oceanica* (L.) Delile, 1813 and organic sediments.

The Strait of Messina, located at the centre of the Mediterranean, constitutes a bridge towards the Afro-Asian countries of North Africa and the Middle East. It is unique thanks to the shape of its landscape, and its invaluable natural and historical features (thalassographic, seismic, biological). The Strait of Messina has been recognised a separate Mediterranean biogeographic microsector inhabited by rich benthic communities and some peculiar assemblages that are unknown in other Mediterranean regions (Bianchi 2007): although small, this area harbours a wealth of biogeographic peculiarities, including Pliocene Atlantic remnants and local endemisms (Fredj & Giaccone 1995; Munari 2014).

The strait is characterised by intense hydrodynamism and chemical characteristics of its waters

creating an extraordinary ecosystem, which is a unique source of biodiversity (<http://www.europeanstraits.eu/Partners/Strait-of-Messina>).

### Taxonomy

Family Dorvilleidae Chamberlin, 1919

Genus *Protodorvillea* Pettibone, 1961

Species *Protodorvillea artemidis* sp. nov.

(Figures 2–8)

#### Examined material

We analysed a total of 57 specimens from the Ionian Sea, one collected at station T2 (6 m depth, sandy gravel), 14 at Station T3 (6 m depth, sand), 41 at Station T3 (12 m, sand), one at Station T3 (18 m, sandy gravel), and two from the Strait of Messina, Station SCI (38 m, sand).

The holotype and the paratypes, i.e. the specimens most representative of the variability observed among individuals, are deposited at the Museum of Natural History of Ferrara (Mus. Civ. St. Nat. FE). Specimens analysed by SEM are catalogued and kept at the Electron Microscopy Center of the University of Ferrara.

*Holotype.* Ionian Sea (Mus.Civ.St.Nat.FE.I.AL.19.0001–1), collected at Station T3 (39° 37'44.38"N, 16°39'59.54"E, 12 m depth, sand), complete, 40 chaetigers, length 4.3 mm, width 0.46 mm including parapodia, 0.28 mm without parapodia.

*Paratypes.* Ionian Sea (Mus.Civ.St.Nat.FE.I.AL.19.0001–2) one specimen collected at Station T3 (39°37'27.69"N, 16°39'58.03"E, 6 m depth, sand), complete, 40 chaetigers, four eyes clearly visible; six complete specimens (Mus.Civ.St.Nat.FE.I.AL.19.0001–3/8, sand), collected at Station T3 (39° 37'44.38"N, 16°39'59.54"E, 12 m depth, sand), eyes slightly visible, 29–61 chaetigers; one paratype (Mus. Civ.St.Nat.FE.I.AL.19.0001–9, sand) from the Tyrrhenian Sea, collected at station SCI (38° 15'20.17"N, 15°43'1.46"E, 38 m depth, sand), complete, 57 chaetigers, four eyes slightly visible; one paratype (Mus.Civ.St.Nat.FE.I.AL.19.0001–10) from station T2, (39°37'43.55"N, 16°36'41.12"E, 6 m depth, coarse sand), 24 chaetigers, incomplete, four eyes evident.

*Topotypes.* Ionian Sea, collected at Station T3 (39° 37'44.38"N, 16°39'59.54"E, 12 m depth), 30–41 chaetigers, complete (MPPA.18.1/6).

### Etymology

The specific name of *P. artemidis* sp. nov. refers to Artemis, the ancient Greek goddess whose cult was widespread in the region where the specimens of the new species were found.

### Diagnosis

A very small and slender *Protodorvillea* species with four eyes, and non-articulate, club-shaped antennae. Slender uniramous parapodia with a prechaetal lip; a dorsal cirrus (without dorsal cirrophores) and a Y-shaped chaeta, accompanied by a long capillary with fine teeth, from the first parapodium onward. Ventrally, three kinds of compound falcigerous chaetae with bifid tips, including a long falciger somewhat reminiscent of that of *Dorvillea*. Presence of both supraacicular furcate and cultriform chaetae and of a subacicular slender cultriform chaeta in some posterior chaetigers.

### Description

The description of *P. artemidis* sp. nov. is based on the holotype and the variations occurring in paratypes for certain characters (e.g. number of chaetae

of each type at each chaetiger; number of free and fused teeth of mandible); six topotypes (i.e. among specimens catalogued and kept at the University of Ferrara) with the same morphological characteristics as the holotype and paratypes were used for SEM analysis and for photographs of some details of the maxillary apparatus. Indeed, in order to prevent damage to the holotype and paratypes, the maxillary apparatus was extruded from one topotype and photographed.

Holotype (Mus.Civ.St.Nat.FE.I.AL.19.0001-1) complete specimen (Figure 2a), 4.30 mm long and 0.46 mm wide, with 40 chaetigers. Paratypes complete specimens, with between 29 and 61 chaetigers, 2.05–6.95 mm long, and 0.42–0.5 mm wide (0.26–0.28 mm without parapodia).

Longest complete specimen (paratype Mus.Civ.St.Nat.FE.I.AL.19.0001–8, station T3, 12 m) 6.95 mm long (without anal cirri), with 61 chaetigers, and 0.5 mm wide (0.27 mm without parapodia).

Colour in alcohol: pale.

Prostomium subtriangular and rounded anteriorly, biannulated, with two short, club-shaped antennae (Figure 2a–d) and two pseudo-annulated palps (Figure 2c); with small, oval palpostyles (Figure 2a,c). Palps reaching back to chaetiger 5 (0.12 mm long in the

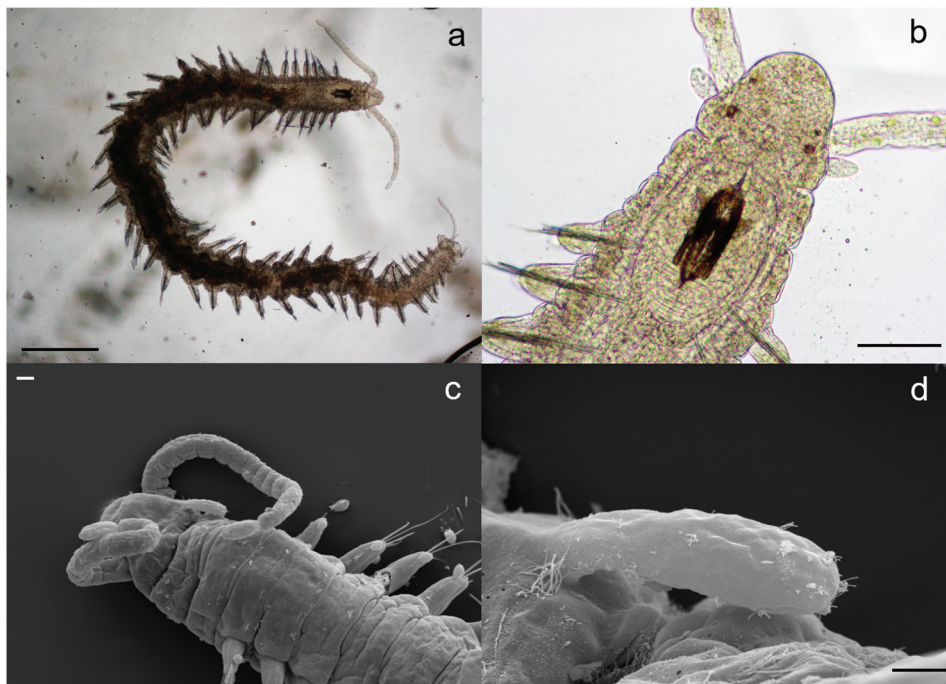


Figure 2. *Protodorvillea artemidis* sp. nov. (a) Entire worm, holotype, dorsal view; (b) anterior end, paratype (Mus.Civ.St.Nat.FE.I.AL.19.0001–2), dorsal view; (c) anterior end, topotype MPPA.18.1, palps and antennae as the holotype, dorsal view; (d) detail of the antenna (as the holotype), topotype MPPA.18.1. Scale bars: a–b = 100  $\mu$ m; c = 20  $\mu$ m; d = 10  $\mu$ m.

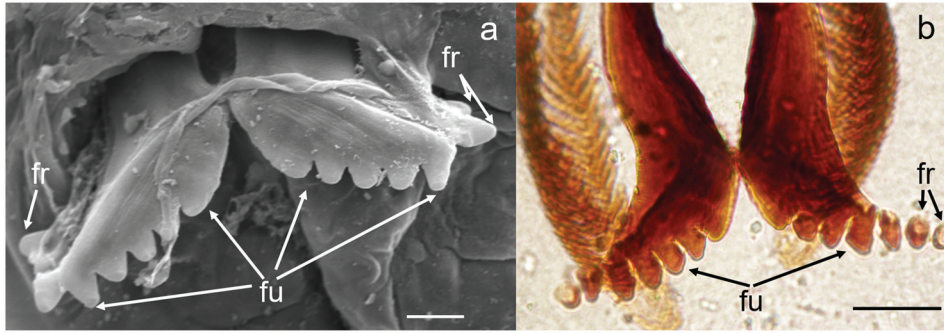


Figure 3. *Protodorvillea artemidis* sp. nov. (a) Extruded front of the mandibles, toptype MPPA.18.2 (as paratype Mus.Civ.St.Nat.FE.I.AL.19.0001–4), ventral view; (b) mandibles, holotype, with four fused and three free teeth on each side. Scale bars: a = 10 µm; b = 5 µm. Abbreviations: fu, mandible fused teeth; fr, mandible free teeth.

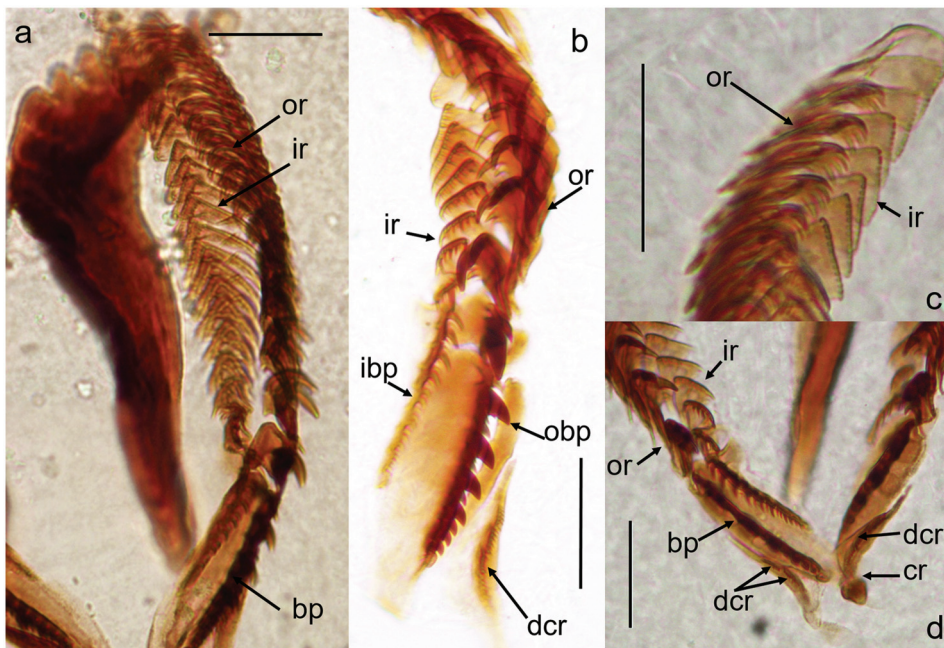


Figure 4. *Protodorvillea artemidis* sp. nov. maxillary apparatus. (a) inner and outer rows of free denticles, holotype; (b) proximal inner and outer rows of free denticles and basal plates, in detail, toptype MPPA.18.3 (as the holotype and paratypes); (c) distal inner and outer rows of free denticles in detail, paratype (Mus.Civ.St.Nat.FE.I.AL.19.0001–10); (d) proximal inner and outer rows of free denticles, basal plates and carrier, holotype. Abbreviations: bp, basal plates; or, outer row of free denticles; ir, inner row of free denticles; ibp, inner basal plate; obp, outer basal plate; cr, carrier; dcr, denticles of carrier. Scale bars: 5 µm.

holotype); antennae reaching back to the end of the first apodous ring (Figure 2d) (0.02 mm long in the holotype).

Two pairs of black eyes (Figure 2b); posterior pair largest, located medial and slightly anterior to origins of antennae; anterior pair of eyes slightly smaller, anterior and medial to origins of palps. Eyes usually not visible in preserved specimens.

Mandible anteriorly flared, with four fused and three free teeth on each side in the holotype (Figure 3a,b); teeth rounded at tip. Mandible of

paratypes with 3–5 fused and 2–4 free teeth on each side.

Maxillae (Figure 4a–d) with two pairs of basal plates (Figure 4a,b,d), two paired rows of about 24 free denticles (Figure 4a–d) continuous with basal plates, one pair of V-shaped denticulate carriers (Figure 4b,d). Inner basal plates with slender and sharp teeth. Outer basal plates with spaced teeth larger than those on the inner basal plates, and interspersed with smaller ones. Inner free denticles proximally small and with few apical teeth, gradually increasing

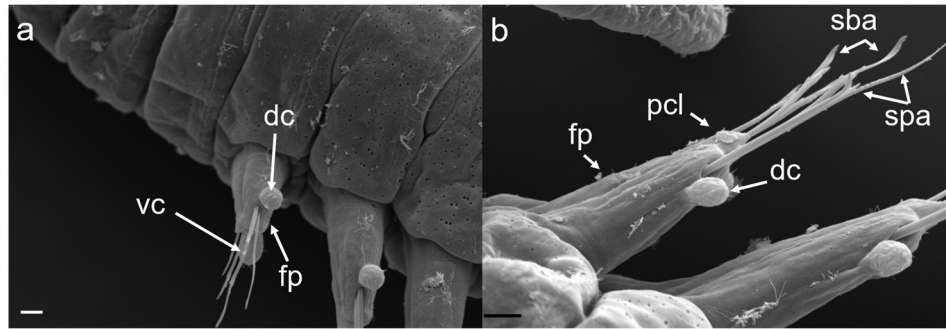


Figure 5. *Protodorvillea artemidis* sp. nov. (a) First chaetiger with uniramous parapodium and dorsal and ventral cirri (as the holotype), topotype MPPA.18.1; (b) detail of the first chaetiger with dorsal cirrus, and supraacicular and subacicular chaetae (as the holotype), topotype MPPA.18.4. Abbreviations: dc, dorsal cirrus; vc, ventral cirrus, fp, first parapodium, pcl, postchaetal lobe, spa, supraacicular chaetae; sba, subacicular chaetae. Scale bars: 10  $\mu$ m.

and changing to finely toothed (about 14 teeth) large plates distally (Figure 4b,c). Outer free denticles large proximally, with curved main fang and several smaller teeth, changing distally to denticles with four to five teeth (Figure 4c,d). Because of the difficulty in dissecting out the jaw pieces and describing them adequately, maxillae were not drawn in detail.

Two apodous peristomial rings (Figure 2b,c); subsequent segments bearing uniramous parapodia with subterminally inserted dorsal and ventral cirri (Figure 5a,b) and a retractile prechaetal lip; cirri small and clavate, dorsal cirri inserting more distal than ventral.

The chaetae are divided into two fascicles on each parapodium. Supracicular chaetae of two kinds: one (rarely, two) capillary chaetae with fine teeth and one (rarely, two) stout Y-shaped furcate chaetae, present from the first chaetiger (Figure 6a); furcate chaetae with smooth, flanged tines, asymmetrical in shape and size, and with subdistal fine and thin spinulations arranged in one row on shaft. Subacicular chaetae compound, numbering 4–5 on each parapodium: one or two upper compound falcigerous chaetae with long blades, one or two similar chaetae with blades about half as long, and one or two lowermost compound chaetae with very short blade (Figure 6b,c); shafts with serrated tips on one side and distinctly bidentate tips at the other side, blades serrated, bidentate, with secondary tooth subequal to primary tooth; upper long falcigerous chaetae with sub-terminal spines resembling hood-like structure of compounds in *Dorvillea* (Figure 6d), not always easily visible. Number of falcigerous chaetae at each chaetiger decreasing in 3–5 posteriormost chaetigers. Modified simple, cultriform chaeta (Figure 7a–d) replacing furcate chaeta in a few posterior segments, from chaetiger 35 onwards in the holotype, may be absent in larger specimens (i.e. in the paratypes Mus.Civ.St.Nat.FE.I.AL.19.0001–4, Mus.Civ.St.Nat.FE.I.AL.19.0001–7/

9) which maintain furcate chaetae in all chaetigers. Supraacicular cultriform chaeta serrated, with slightly shorter teeth near bidentate tip, and a bidentate tip. In addition, slender subacicular cultriform chaeta present in two or three posteriormost segments (Figure 7a) with serrations along edge, tapering to simple hook-shaped tip.

Pygidium rounded, with two pairs of anal cirri, and a dorsal anus (Figure 8a,b). Short pair inserted ventrally, consisting of a single joint (0.07 mm long in holotype, 0.07–0.11 mm long in paratypes). Long pair inserted dorsally, annulated, with up to five joints, up to 0.51 mm long (and 0.43 mm with four joints in holotype). Anal cirri broken in most specimens.

Last chaetiger rudimentary in most specimens (with parapodium, acicula and a reduced chaeta), absent in larger specimens (i.e. in the paratypes Mus.Civ.St.Nat.FE.I.AL.19.0001–4, Mus.Civ.St.Nat.FE.I.AL.19.0001–7, Mus.Civ.St.Nat.FE.I.AL.19.0001–9).

Holotype (Mus.Civ.St.Nat.FE. I.AL.19.0001–1) with 2–3 eggs (0.01 mm diameter) from chaetiger 19 to chaetiger 32.

Contemporary presence of both supraacicular furcate and cultriform chaetae in the posterior chaetigers of paratype Mus.Civ.St.Nat.FE.I.AL.19.0001–5 (38 chaetigers long) and a subacicular slender cultriform chaeta.

#### *Type locality*

Gulf of Taranto, northern Ionian Sea, sand, coarse sand and silty gravel (Table I), between 6 and 18 m depth (station T3): the holotype and paratypes at 12 m depth (39°37'44.38"N, 16°39'59.54"E), other paratypes at 6 m depth (39°37'27.69"N, 16°



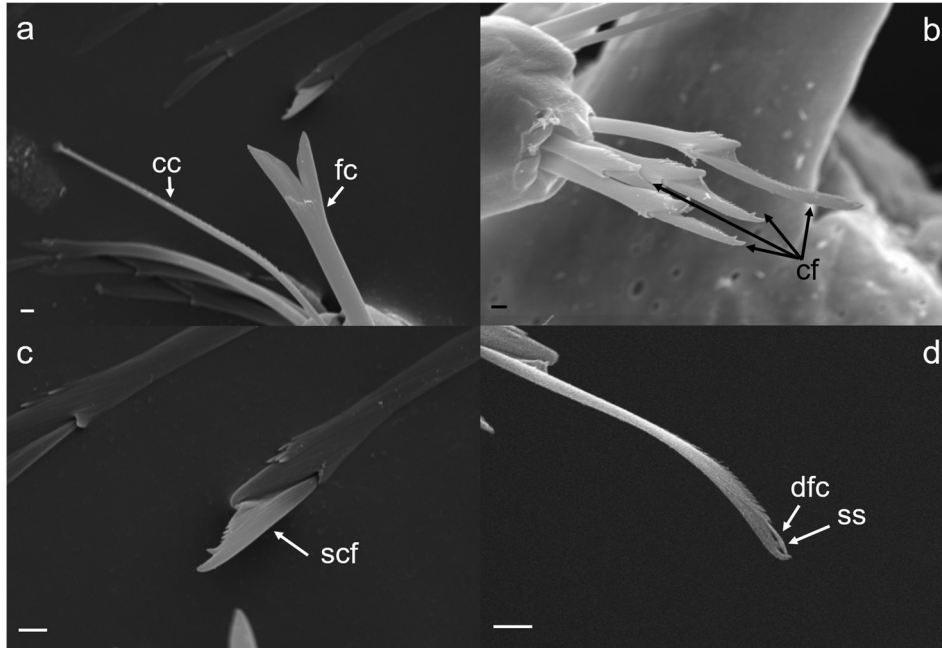


Figure 6. *Protodorvillea artemidis* sp. nov., details of supraacicular and subacicular chaetae. (a) Furcate and capillary chaeta (as the holotype), topotype MPPA.18.1; (b) the three types of falcigerous chaetae (as the holotype), topotype MPPA.18.5; (c) detail of the small compound falciger (as the holotype), topotype MPPA.18.1; (d) detail of the long falcigerous chaeta with subterminal spine resembling those of some Hesionidae (as the holotype), topotype MPPA.18.6. Abbreviations: cc, capillary chaeta; fc, furcate chaeta; cf, compound falciger; scf, small compound falciger; dfc, falcigerous chaeta like that in *Dorvillea*; ss, subterminal spine of long falciger. Scale bars: a–c = 2  $\mu$ m; d = 3  $\mu$ m.

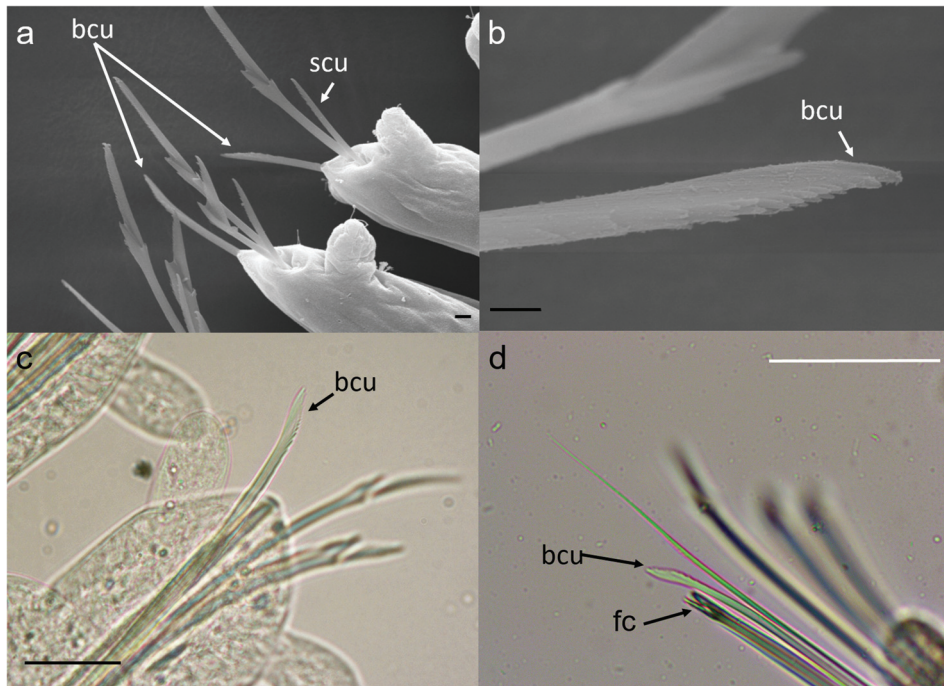


Figure 7. *Protodorvillea artemidis* sp. nov., cultriform chaetae. (a) bidentate supraacicular cultriform chaeta and slender subacicular cultriform one (as paratype Mus.Civ.St.Nat.FE.I.AL.19.0001–5), ventral view, posterior end, topotype MPPA.18.6; (b) detail by scanning electron microscope of supraacicular cultriform chaeta, topotype MPPA.18.6; (c) detail by optical microscope of supraacicular cultriform chaeta, holotype; (d) supraacicular cultriform and furcate chaetae at the same parapodium (paratype Mus.Civ.St.Nat.FE.I.AL.19.0001–5). Abbreviations: bcu, bidentate cultriform chaeta, scu, subacicular cultriform chaeta, fc, furcate chaeta. Scale bars: a = 3  $\mu$ m; b = 2  $\mu$ m; c = 5  $\mu$ m; d = 50  $\mu$ m.

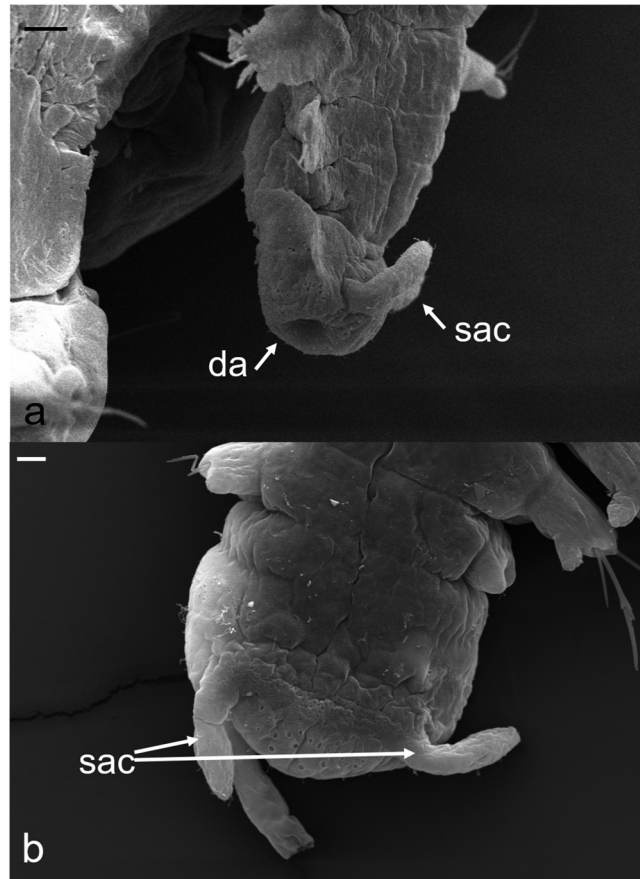


Figure 8. *Protodorvillea artemidis* sp. nov., pygidium. (a) Short anal cirri and dorsal anus (as holotype), ventral view, topotype MPPA.18.1; (b) detail of short anal cirri (as holotype), ventral view, topotype MPPA.18.6. Abbreviations: sac, short anal cirri; da, dorsal anus. Scale bars: a = 20  $\mu$ m; b = 10  $\mu$ m.

Table I. Sedimentary characteristics at the sampling stations and abundance of recorded specimens of *Protodorvillea artemidis* sp. nov.

Station	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Depth (m)	Number of specimens of <i>Protodorvillea artemidis</i> sp. nov.
T2	49.4	36.2	14.1	0.31	6	1
T3	3.35	70.6	25.2	0.91	6	14
T3	3.18	89	7.51	0.28	12	41
T3	72.4	17	10.1	0.59	18	1
SCI	0.7–20.3	98.9–77.5	0.5–2.3	0.00	38	2

39°58.03"E) and a further specimen collected at 18 m depth (39°37'59.82"N, 16°40'04.71"E).

#### Habitat and ecology

*Protodorvillea artemidis* sp. nov. was collected in soft-bottom sediments (Table I) between 6 and 38 m depth, on medium sand (with 7.5–25.2% silt), coarse sand (with 20.3–49.4% gravel) and silty gravel (with 17% sand and 10.1% silt), coastal detritic bottoms (Pèrès & Picard 1964).

In the Ionian Sea the occurrence of *P. artemidis* sp. nov. is associated with the lancelet *Branchiostoma lanceolatum* (Pallas, 1778); other abundant species were the bivalve *Corbula gibba* (Olivi, 1792) and the polychaetes *Eunice vittata* (Delle Chiaje, 1828) and *Lumbrineris latreilli* Audouin and Milne Edwards, 1834. At station T3 the new species was relatively abundant, representing 15% of the benthic community at 12 m, and 7.3% at 6 m depth.

The specimens collected from the Straits of Messina at Scilla occurred in association with the sipunculid *Aspidosiphon* (*Aspidosiphon*) *muelleri*

*muelleri* Diesing, 1851, which characterises the coastal detritic bottom biocenosis (Pérès & Picard 1964); further quite abundant species in the sampling replicates of the station were those characterising the biocenosis of sand and gravel under bottom currents such as *Branchiostoma lanceolatum* (Pallas, 1778); other abundant species were *Glycera lapidum* Quatrefages, 1866 and the amphipod *Megamphopus cornutus* Norman, 1869.

### Remarks

One paratype (Mus.Civ.St.Nat.FE.I.AL.19.0001-7) had three natatory chaetae at each parapodium originating posterior to compound falcigers. Natatory chaetae are also reported by Perkins (1979) in gravid segments of sexually mature specimens of *P. bifida*.

To our knowledge the lower (subacicular) cultriform simple chaetae observed in *P. artemidis* sp. nov. have not been reported previously for the genus *Protodorvillea*; other characteristics of this new species from the southern Italian coasts are the peculiar shape of the long compound falciger, the fine spinulations arranged in one row on the shaft of the furcate chaeta, and the simultaneous occurrence of both furcate and cultriform supraacicular and subacicular chaetae in posteriormost chaetigers.

Specimens of *P. artemidis* sp. nov. show a certain variability in the number and shape of teeth on the mandibles. Similarly, Orensanz (1973) found a wide intraspecific variability in the maxillary apparatus in specimens of *Schistomeringos rudolphi* (Delle Chiaje, 1828), and he stated that the maxilla is not a suitable diagnostic character. Variability in the mandibles has also been reported for other dorvilleid genera. For example, Martin et al. (1991) suggested that the teeth of the anterior margin of mandibles can be reduced in size due to abrasion in old specimens of *Ophryotrocha mediterranea* Martin, Abello and Cartes, 1991. Hilbig and Ruff (1990) suggested that mouthparts in the genus *Pettiboneia* should be used with caution as diagnostic specific characters as they may depend on the way the pharyngeal wall is spread on a slide. Finally, Jumars (1974) was the first to report maxillary replacement and he suggested that this phenomenon may be common to all dorvilleids. In particular, the number and shape of maxillary plates were found to depend on the age and size of specimens, leading Jumars (1974) to conclude that the role of maxillary characters for species discrimination had to be re-examined. Nonetheless, characters of the maxillary apparatus are still among the most useful for generic or species

discrimination if ontogenetic variability is considered.

Differences between the new species herein described and the other *Protodorvillea* species recorded from the Mediterranean Sea are provided in Table II.

### Discussion

Dorvilleidae occur worldwide in shallow to deep waters (Rouse & Pleijel 2001). A number of Dorvilleidae are opportunistic and occur in high numbers in organically enriched areas (Hilbig 1995). It is only during the last 25 years that the majority of Dorvilleidae have been described, and the delineation of Dorvilleidae has been and remains variable among workers (Rouse & Pleijel 2001), with a number of species still poorly known and inadequately described. Revisionary studies of the family are lacking and the more inclusive studies (Hartman 1944; Pettibone 1961; Jumars 1974) are now outdated. Further relevant knowledge is provided by regional studies from Argentina (Orensanz 1973), the Antarctic (Orensanz 1990), California (Hilbig 1995), and the US Atlantic slope (Blake & Hilbig 1990; Hilbig & Blake 1991).

At the species level, characters are not always well defined. For example, in the literature a high morphological variability among different populations of *P. kefersteini* is reported: Orensanz (1973) described the presence of clavate and non-articulated antennae, and compound chaetae with hooded and bidentate tips; Hartman (1965) recorded specimens with two black eyes and prosomial annulated antennae, whereas according to Pettibone (1961) and Hartmann-Schröder (1996) the species has only two eyes and antennae indistinctly articulated. Hartmann-Schröder (1996) also reported compound chaetae with bifid, finely toothed, stout hooked blades, while Fauvel (1923) described the antennae as very articulated and, like Hartmann-Schröder (1996), reported a bundle of compound chaetae finely bidentate. Perkins (1979) described the specimens of *P. kefersteini* from Florida as having two pairs of eyes and modified cultriform chaetae replacing forked chaetae and simple chaetae smooth, with slightly curved tips in the lower part of a few posterior parapodia. In the same way, there are considerable differences among the descriptions of *P. atlantica*: Fauvel (1923) and Hartman (1963) described specimens having a pair of large anterior eyes and a pair of rear and much smaller ones, quite long articulated antennae (with 8–12 articles), and dorsal cirri lacking at the first

Table II. Taxonomic characters for the five species of *Protodorvillea* recorded from the Mediterranean Sea.

Character	<i>P. artemidis</i> sp. nov.	<i>P. biarticulata</i>	<i>P. egena</i>	<i>P. hefersteini</i>	<i>P. atlantica</i>
Prostomial shape	Anteriorly rounded	Smoothly ovoid anteriorly	Broadly conical	Pear shaped	Elongated blunt cone
Eyes	2 pairs	1 pair	2 pairs	2 pairs, one minute	Absent
Antennae	Simple, short, reaching back to posterior peristomial ring	Biarticulate, reaching back to posterior peristomial ring	A single club-shaped joint, reaching back to the front edge of posterior peristomial ring	Indistinctly annulated, reaching back to chaetiger 1 or 2	Absent
Palps	Reaching back to chaetiger 5	Reaching back to chaetiger 10	Reaching back to chaetiger 5	Reaching back to chaetiger 4-6	Short, reaching back to chaetiger 1
Parapodial lobes	Prechaetal, retractable	Conical prechaetal and small postchaetal	Triangular prechaetal, projecting well beyond the postchaetal	Postchaetal	Neuropodia without postchaetal lobes
Dorsal cirri start	Chaetiger 1	Chaetiger 1	Chaetiger 2	Chaetiger 1	Chaetiger 2
Ventral cirri insertion	Subterminal, slightly more proximal than dorsal cirri	Subterminal, more proximal than dorsal cirri	Subterminal, at same level as dorsal cirri	Subterminal, at same level as dorsal cirri	Subterminal, more distal than dorsal cirri
Compound chaetae, shaft	Subterminally serrated, tip distinctly bidentate	Subterminally serrated, tip not described <sup>2</sup>	Subterminally serrated <sup>1</sup> , tip not described <sup>2</sup>	Subterminally serrated, tip not described <sup>2</sup>	Curved, serrated on the convex side, tip not described <sup>2</sup>
Compound chaetae, blade	3 types, longest with long, delicate subdistal tooth as in <i>Dorvillea</i>	Inferior chaetae minutely bidentate	Minutely bidentate or tridentate	Finely serrated, subdistal tooth minute	Entire, serrated, long in the upper
Simple chaetae	Capillary, finely serrated from the base of the blade	Capillary serrated at the base of the blade	Capillary, serrated at the base of the blade	Capillary, finely serrated, unidentate	Capillary, very long, curved, serrated from the upper part of the shaft
Furcate chaetae	Fine teeth in 1 row on shaft, prongs subequal	Smooth, subequal prongs	Shaft short, prongs equal	Smooth, prongs subequal	Very unequal prongs, main prong and shaft serrated
Cultriform chaetae	In far posterior segments, both supra- and subacicular, serrated, supraacicular bidentate, subacicular unidentate	Absent	Not reported	In posterior chaetigers, slender, subacicular (not observed in personal specimens: BE)	Not mentioned
Pygidium	2 short anal cirri ventrally, 2 long cirri dorsally, annulated	4 long anal cirri	4 slender anal cirri, dorsal pair annulated and long, ventral pair short	2 short anal cirri ventrally, 2 long dorsally, with about 4 indistinct articles	Not mentioned

<sup>1</sup>*Protodorvillea egena* was illustrated with terminally smooth shafts of the compound chaetae, and Banse and Hartmann-Schröder (1964) synonymised two species with *P. egena*: *P. mandapamae* Banse, 1959 and *Dorvillea graciloides* Hartmann-Schröder, 1960, which reportedly have subterminally serrated shafts.

<sup>2</sup>This character is not mentioned in the original descriptions, so it is presumed that the shaft is unidentate or, at best, slightly or indistinctly bidentate.

chaetiger, while the specimens described by McIntosh (1885) and according to Pettibone (1961) were without eyes, lacked antennae and dorsal cirri on the first chaetiger. The specimens of *P. atlantica* described by Fauvel (1923), Hartman (1963) and McIntosh (1885), despite their morphological differences, are all from deep waters, although of different habitats: the former are pelagic forms from the Azores (Atlantic Ocean); specimens described by Hartman (1963) are benthic (at about 344 m depth) and represented the first record from the eastern Pacific Ocean; and, finally, the latter are from the deep sea (between 1097 m and 1828 m depth) sediments of the Azores.

The presence of different descriptions for *P. kefersteini* as well as for *P. atlantica* could make it difficult and doubtful to allocate specimens to either of these two species. Moreover, so far this morphological intraspecific variability has not been supported by molecular analysis and is therefore doubtful.

Considering the high variability recorded in the description of *P. atlantica*, and *P. kefersteini* among different authors and different populations (as described above), we believe that all records of this genus will need to be reassessed. In particular, as originally described from deep waters off the Azores (Atlantic Ocean), records of *P. atlantica* from a lagoonal habitat and shallow waters should be considered questionable. In fact, evidence against a cosmopolitan distribution has already been presented within the Dorvilleidae family: for example, for *Schistomeringos rudolphi* (Delle Chiaje, 1828) by Jumars (1974); Hobson (1971), and later also Jumars (1974), thought it best to retain populations of *Protodorvillea* from the north-eastern Pacific Ocean (at about 116 m depth) as *P. gracilis*, and those from the Atlantic coasts of Europe and Massachusetts (intertidal to 44 m depth) as *P. kefersteini*, despite only minor morphological differences. Finally, the morphological differences observed within this family among populations of the same species (Orensanz 1973) lead us to hypothesise the presence of a higher number of species than the one so far identified. In the same way, the wide distribution of some species, and the presence of taxa showing no apparent morphological differentiation but which are separated by their differing reproductive habits (Rouse & Pleijel 2001), lead us to advance the hypothesis of the presence of cryptic species, which can be detected only by the use of molecular methodologies.

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