



Description of *Euchone anceps* sp. nov. (Annelida: Sabellidae) from the Mediterranean Sea and Northeast Atlantic, with remarks on the difficulty of generic definition

A. Giangrande, B. Wasson, M. Lezzi & M. Licciano

To cite this article: A. Giangrande, B. Wasson, M. Lezzi & M. Licciano (2017) Description of *Euchone anceps* sp. nov. (Annelida: Sabellidae) from the Mediterranean Sea and Northeast Atlantic, with remarks on the difficulty of generic definition, *The European Zoological Journal*, 84:1, 193-207

To link to this article: <http://dx.doi.org/10.1080/24750263.2017.1297499>



© 2017 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.



Published online: 23 Mar 2017.



Submit your article to this journal [↗](#)



View related articles [↗](#)



View Crossmark data [↗](#)



Description of *Euchone anceps* sp. nov. (Annelida: Sabellidae) from the Mediterranean Sea and Northeast Atlantic, with remarks on the difficulty of generic definition

A. GIANGRANDE^{1*}, B. WASSON², M. LEZZI¹, & M. LICCIANO¹

¹Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali (Di.S.Te.B.A.), Università del Salento, Lecce, Italy, and

²Marine Ecological Surveys Ltd, Bath, UK

(Received 17 November 2016; accepted 10 February 2017)

ABSTRACT

The problem of the generic placement of some peculiar Mediterranean and Atlantic sabellids, showing a mixture of features found in the genera *Euchone* and *Paradialychone*, is addressed. Due to the high similarity to *E. pseudolimnicola*, this peculiar taxon had previously been informally named *Euchone* cfr. *pseudolimnicola*. However, while the presence of a simple pre-pygidial depression without lateral wings or a distinct ridge in the uppermost margin is similar to *Dialychone* and *Paradialychone*, the dentition of thoracic and abdominal uncini resembles that found in *Paradialychone*. In this study, the morphological features of Mediterranean and British material were re-examined and compared to *E. pseudolimnicola* specimens, and a cladistics analysis was performed. The genus *Euchone* appears not well defined; *E.* cfr. *pseudolimnicola* and *E. pseudolimnicola* are located close to each other and also located in the area of the phylogenetic tree containing the other examined *Euchone* species. We suggest to maintain both these taxa within the genus *Euchone* until a revision based on the examination of type material of all the *Euchone* species is performed. The new species *Euchone anceps* sp. nov. has been described, and the large morphological variability existing in some Mediterranean material is also addressed. An updated taxonomic key for the species of the considered genera present in Northeast Atlantic and Mediterranean Sea is also provided.

Keywords: Sabellidae, *Euchone anceps* sp. nov., cladistics

Introduction

Cochrane (2003) introduced the term “*Chonea*” for a group including the highly speciose sabellid genera *Chone* Krøyer, 1856, and *Euchone* Malmgren, 1866. The genera within this group have a very similar external morphology and their taxonomy has been problematic since the first phylogenetic analysis was performed by Fitzhugh (1989), and another later by Nogueira et al. (2010). The cladistics analysis by Cochrane (2003) showed *Euchone* to be paraphyletic due to the disposition of pinnules on radioles in the branchial crown, and the number of chaetigers forming the pre-pygidial depression. Phylogenetic relationships were assessed within

Chone by Tovar-Hernández (2008), whose analysis revealed the existence of three monophyletic genera previously assigned to *Chone*: *Dialychone* Claparède, 1870, *Paradialychone* Tovar-Hernández, 2008 and *Chone* sensu stricto. This last genus is characterised by squared abdominal uncini with similar morphology in all the abdominal segments, and the absence of a pre-pygidial depression. The other genera have anterior abdominal uncini differing in shape from the posterior ones, and a pre-pygidial depression is present.

Among the diagnostic characters normally utilised in defining all of these genera, the shape of the abdominal uncini is a problematic feature, tak-

*Correspondence: Adriana Giangrande, Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali (Di.S.Te.B.A.), Università del Salento, Via Provinciale Lecce-Monteroni, 73100 Lecce, Italy. Tel: +39 0832 298659. Fax: +39 0832 298626. Email: adriana.giangrande@unisalento.it

ing into consideration the great variability within a given region of the abdomen or even within the same fascicle (Banse 1972; Fitzhugh 1989; Bick & Randel 2005). With regard to the pre-pygidial depression, in *Dialychone* and *Paradialychone*, it appears only as a terminal flattened portion (simple depression), and only *Euchone* has a distinctive depression that appears hollowed. In addition, in most of the *Euchone* species the pre-pygidial depression is characterised by the presence of lateral wings. However, this feature cannot be considered an apomorphy for the genus *Euchone* since they are lacking in *Euchone pseudolimnicola* Giangrande & Licciano, 2006, and *Euchone limnicola* Reish, 1959, but are present also in the genus *Euchoneira* Licciano, Giangrande & Gambi, 2009 (Licciano et al. 2009). As for the internal structure of the crown, the definitions of the “*Chonea*” genera show that the presence/absence of dorsal radiolar appendages has been considered important. The assessment of these features, however, has produced varied interpretations. Although Cochrane (2003) considered *Euchone* to lack these structures, according to Fitzhugh (2003) the genus is characterised by dorsal lips with radiolar appendages supported only by blood vessels, even though histological analysis by Bick and Randel (2005) showed the presence of a radiolar skeleton in *Euchone analis* (Krøyer 1856). Tovar-Hernández (2008) considered radiolar appendages to be present in *Euchone* and absent in *Chone*, *Dialychone* and *Paradialychone*. Finally, Capa et al. (2011) confirmed the presence of radiolar appendages in *Euchone*, and in *Dialychone australiensis* (Hartmann-Schröder 1979), stating that they are likely present in both *Dialychone* and *Paradialychone*.

Understanding the divisions among these taxa is important because the “*Chonea*” sabellids are widespread in soft-bottom habitats and are useful in monitoring studies. However, many problems and doubts arise when people try to identify specimens. Indeed, some species can confidently be assigned to one of the currently defined genera, while there are other species that share diagnostic features from two or more genera. As an example, some species have been described and easily placed within *Dialychone* or *Paradialychone* (Nishi et al. 2009; Tovar-Hernández & Dean 2010; Selim et al. 2012), whereas for others, it was difficult to determine the taxonomic status due to the presence of several diagnostic features typically attributed to *Chone*, *Dialychone* and *Paradialychone* (Capa & Murray 2015).

This was also the case for the fairly common and interesting specimens collected from soft-sediment

benthic surveys conducted in the Gulf of Salerno (Mediterranean Sea) and along British coasts (Shetland Isles and off the south-western coast of England), where individuals exhibited a mix of features found in *Euchone*, *Dialychone* and *Paradialychone*. Due to a similarity with the Mediterranean taxon *E. pseudolimnicola*, specimens were recorded as *Euchone* cfr. *pseudolimnicola*, whilst the British material was initially identified as *Chone* cfr. *collaris*. This was mainly due to the presence of a crenulated collar, but later, this material was also informally named *Euchone* cfr. *pseudolimnicola*. A more careful examination, however, showed this taxon to be different from *E. pseudolimnicola*. To further complicate matters, more recently, similar specimens, also identified as *Euchone* cfr. *pseudolimnicola* but showing a high morphological variability, have been collected in the northern Mediterranean area (Gulf of Lion).

The aim of the present work is to understand the generic placement, and to provide a detailed description, of this particular taxon. For this purpose a phylogenetic analysis was performed using related taxa for which detailed descriptions were available. Furthermore, the features of *E. pseudolimnicola* have been re-examined, using the type material, specimens from the Mediterranean and other localities, and specimens identified as *Euchone* cfr. *pseudolimnicola*.

Materials and methods

The examined material of *Euchone* cfr. *pseudolimnicola* came from ecological studies conducted along the Italian coast (Lorenti et al. 2011), and British (SGS M-Scan, Ltd. 2012, 2014) and French coasts (material provided by Dr Celine Labrune), while *E. pseudolimnicola* was collected only along the Italian coast (Giangrande & Licciano 2006). Material of *E. limnicola* collected from shallow subtidal areas of Tees Estuary on the east coast of England (April 2013) was examined during the NE Atlantic Marine Biological Analytical Quality Control Scheme (NMBAQC) course, held in Newcastle, 2014.

Holotypes are housed at the Museum Nacional de Ciencias Naturales de Madrid, Spain (MCNM). Paratypes and additional material are located at the Polychaete Collection of the Laboratory of Zoology of the University of Salento (Lecce), Italy (PCZL).

Drawings were made with the aid of a camera lucida attached to stereo and compound microscopes; photographs were taken using a stereomicroscope equipped with a Nikon Coolpix 990 camera. Staining patterns were obtained using methyl green

stain, while the internal structure of the crown and ventral sacs were evidenced utilising a textile fibre identification stain (Shirlastain A).

Phylogenetic analysis was carried out on a matrix of 21 taxa for 27 characters (Table I). Representative taxa were selected from among the most plesiomorphic sabellid genera (Fitzhugh 1989; Cochrane 2003; Nogueira et al. 2010), already considered in a previous analysis by Licciano et al. (2009), and using *Sabella spallanzanii* (Gmelin 1791) as outgroup. Descriptions of character states are given in Table II. The analysis included species for which detailed descriptions were available, and specimens that were readily available for examination (e.g. Mediterranean material). When possible, the type species for each genus was included. The character state matrix was computed based on the analysis by Tovar-Hernández (2008), and the data matrix and tree diagrams were created using MacClade version 3.08 (Maddison & Maddison 2005). Analysis was carried out using PAUP version 4.0b8 (Swofford 2002). A heuristic search for the most parsimonious trees was carried out by using the default settings of PAUP (tree-bisection-reconnection (TBR) branch-swapping, MULTREES and COLLAPSE options in effect). A random stepwise addition sequence of 100 replicates was used, and a strict consensus tree using the accelerated transformation principle (ACCTRAN) was compiled for all minimum length trees retained.

Results

Cladistic analysis

The analysis produced 60 trees, from which the strict consensus tree is reported (96 steps, CI: 0.67, RI: 0.78; Figure 1), where CI is the consistency index, and RI the retention index.

The analysis did not solve the relationships among genera. Only *Jasmineira* Langerhans, 1880 and *Claviramus* Fitzhugh, 2002 appeared well separated, branching off at the base of the tree. Among the “*Chonea*” taxa, the region of the tree containing *Chone*, *Dialychone* and *Paradialychone* appears better defined than that containing *Euchone* and *Euchoneira*, which represents the most unresolved area of the tree. *Chone*, which is the only genus without a pre-pygidial depression, also lacks dorsal radiolar appendages. *Chone* does have pinnular appendages, squared abdominal uncini with similar morphology in all the abdominal segments, and paleate chaetae in the thorax. Paleate chaetae are also characteristic of *Paradialychone* and *Dialychone*. According to the analysis of Tovar-Hernández (2008), pinnular appendages are present in *Chone*, *Euchone* and *Paradialychone*, but are lost in *Dialychone*. Furthermore, while thoracic uncini have teeth of similar size over the main fang in *Chone*, they are decreasing in size in *Dialychone*, and have a secondary tooth over the main fang in *Paradialychone*.

Among all the considered *Euchone* species, which are scattered along a branch of the tree, *E. limnicola*, which, according to the absence of lateral wings

Table I. Character state distribution for 21 taxa and 27 characters used in the present analysis.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
<i>Sabella spallanzanii</i>	1	1	0	1	2	1	0	1	0	0	0	1	2	0	0	0	1	1	1	0	1	1	0	3	1	0	1
<i>Amphicorina armandi</i>	0	0	1	0	0	0	0	1	2	0	1	0	0	0	0	3	0	0	0	4	0	0	0	0	0	0	0
<i>Jasmineira caudata</i>	2	0	1	1	0	1	0	0	0	1	1	0	2	0	1	3	0	0	0	0	2	0	0	3	1	0	0
<i>Claviramus grubei</i>	1	0	?	?	0	1	1	0	0	1	0	1	1	0	1	1	0	0	0	0	2	0	0	2	1	0	0
<i>Euchoneira knoxi</i>	0	1	1	0	0	1	0	4	2	0	1	0	1	0	1	1	1	0	1	0	3	0	0	3	1	2	0
<i>Chone infundibuliformis</i>	0	1	1	0	0	1	0	4	2	0	2	0	0	0	0	1	0	0	1	3	4	0	0	1	1	0	0
<i>Chone fauweli</i>	0	1	1	0	0	1	0	4	2	0	2	0	0	0	0	1	0	0	1	3	4	0	0	1	1	0	0
<i>Dialychone acustica</i>	2	0	0	0	0	1	0	2	1	0	2	0	0	0	0	2	0	0	1	1	4	0	1	1	1	1	0
<i>Dialychone collaris</i>	2	0	0	0	0	1	0	3	2	0	1	0	0	1	0	2	0	0	1	1	4	0	1	1	1	1	0
<i>Paradialychone americana</i>	2	1	1	0	0	1	0	3	1	0	1	0	0	0	0	1	0	0	1	2	4	0	1	1	2	1	0
<i>Paradialychone diazi</i>	2	1	1	0	0	1	0	4	2	0	1	0	0	0	0	1	0	0	1	2	4	0	1	1	2	1	0
<i>Euchone analis</i>	1	1	1	1	0	1	0	3	2	0	2	1	1	0	1	1	1	0	1	0	2	0	1	1	1	2	0
<i>Euchone pallida</i>	1	1	1	1	0	1	0	4	2	0	2	1	1	0	0	1	1	0	1	0	3	0	0	1	1	2	0
<i>Euchone limnicola</i>	1	?	?	1	0	1	0	4	1	0	1	0	0	0	0	3	1	0	1	0	2	0	?	1	1	3	0
<i>Euchone pseudolimnicola</i>	1	1	1	1	1	1	0	3	1	0	2	1	2	2	0	1	0	0	1	2	2	0	1	1	2	3	0
<i>Euchone</i> cfr. <i>pseudolimnicola</i>	1	1	1	1	2	1	0	3	1	0	2	0	2	2	0	1	0	0	1	2	2	0	1	1	2	3	0
<i>Euchone pararosea</i>	1	0	1	?	0	1	0	4	0	0	1	0	2	1	0	1	1	0	1	0	2	0	1	1	1	2	0
<i>Euchone rosea</i>	1	?	1	?	0	1	0	4	2	0	1	0	1	0	0	1	1	0	1	0	3	0	1	1	1	2	0
<i>Euchone rubrocincta</i>	1	0	1	?	0	1	0	3	1	0	1	0	1	0	1	1	1	0	1	0	2	0	1	1	1	2	0
<i>Euchone danieloi</i>	1	0	1	1	0	1	0	3	1	0	0	0	1	0	0	1	0	0	1	0	3	0	0	1	1	2	0
<i>Euchone glemnoi</i>	1	0	1	1	0	1	0	1	1	0	0	0	1	0	0	1	0	0	1	0	3	0	0	1	1	2	0

Table II. List of characters and character states.

 Characters of the branchial crown

1. Shape of dorsal lips

0 broadly rounded; 1 elongate, distally tapered with branchial skeleton extensions; 2 elongate without branchial skeleton extensions

2. Dorsal pinnular appendages

0 absent; 1 present

3. Ventral radiolar appendages

0 absent; 1 present

4. Parallele lamellae

0 absent; 1 present

5. Ventral sacs

0 absent; 1 present, poorly developed; 2 present, highly developed

6. Pinnules

0 unpaired alternating; 1 paired

7. Shape of radiolar tips

0 filiform; 1 expanded foliaceous

8. Palmate membrane

0 absent; 1 less than one-quarter of the branchial crown length; 2 one-quarter to one-third; 3 half; 4 two-thirds to three-quarters

9. Flanges

0 absent; 1 narrow; 2 broad

10. Abcission zone

0 absent; 1 present

Character of the peristomium**11. Anterior peristomium**

0 fully exposed; 1 partially exposed; 2 covered

12. Mid-dorsal collar gap

0 narrow; 1 wide

13. Ventral incision of the anterior collar margin

0 absent; 1 short; 2 long

14. Anterior margin of collar

0 smooth; 1 crenulated all around; 2 crenulated ventrally

15. Vascular loops in the peristomium

0 absent; 1 present

Characters of the thorax**16. Glandular ridge on chaetigers 2**

0 absent; 1 narrow; 2 broad; 3 vestigial

17. Ventral thoracic shields

0 undifferentiated; 1 differentiated

18. Thoracic uncini

0 acicular; 1 avicular

19. Biannulate thoracic segments

0 absent; 1 present

20. Dentition above main fang of thoracic uncini

0 a series of teeth of nearly uniform size above the main fang; 1 teeth gradually decreasing in size away from main fang; 2 a large tooth offset from midline, followed by a series of smaller teeth; 3 a large tooth above the main fang in midline, followed by a series of smaller teeth; 4 one or two large teeth above the main fang in midline, followed by a series of smaller teeth

21. Inferior thoracic notochaetae posterior row(s)

0 absent; 1 spine like; 2 broadly hooded (subspatulate type A); 3 narrowly hooded (type B); 4 paleate

22. Companion chaetae in the thorax

0 absent; 1 present

Characters of the abdomen**23. Abdominal uncini**

0 similar shape along entire abdominal segments; 1 uncini from posterior abdomen modified from those in anterior abdominal segments

24. Breast of abdominal uncini

0 hooked; 1 squared; 2 narrow swelling; 3 avicular

25. Dentition of abdominal uncini

0 rasp-shaped plates without distinct main fang; 1 a series of teeth of near-uniform size above the main fang; 2 a large tooth above the main fang in midline, followed by a series of smaller teeth

26. Pre-pygidial depression

0 absent; 1 simple flattened; 2 defined by lateral wings; 3 simple hollowed with or without anterior margin

27. Arrangement of abdominal chaetae0 linear; 1 in tuft

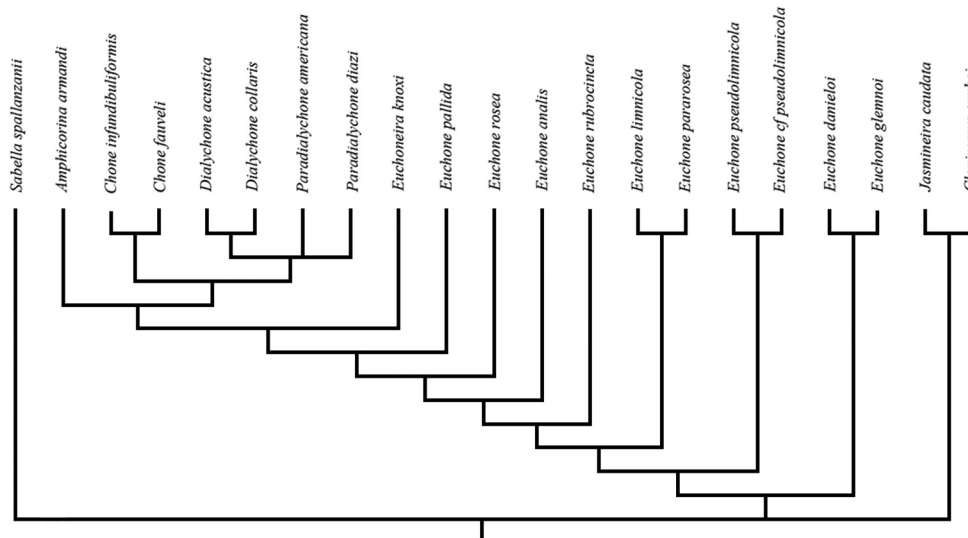


Figure 1. Strict consensus tree of the retained trees.

appeared to be very similar to *E. pseudolimnicola*, clustered instead with *Euchone pararosea* Giangrande & Licciano, 2006. The recently described species *Euchone danieloi* Capa & Murray, 2015 and *Euchone glemnoi* Capa & Murray, 2015 are close to each other, and *E. pseudolimnicola* and *E. cfr. pseudolimnicola* are closely related.

The genus *Euchone* should be defined by the presence of dorsal lips with radiolar appendages, and the absence of paleate chaetae in the thorax. Most of the *Euchone* species have thoracic uncini with teeth of similar size over the main fang, well-defined ventral shields, variation of abdominal uncinal shape between segments, a well-defined and hollowed pre-pygidial depression with lateral wings, and a ventral incision in the anterior collar margin, a feature also present in *Jasmineira* and *Euchoneira*. However, several exceptions to this pattern can be highlighted. *Euchone limnicola* has an entire ventral collar margin and a pre-pygidial depression without wings, a feature also present in *E. pseudolimnicola* and *E. cfr. pseudolimnicola*, which, however, have the ventral collar deeply incised ventrally. These latter two species also differ from the other *Euchone* in having no defined ventral shields and thoracic and abdominal uncini with a secondary tooth over the main fang, a state that according to the present analysis appears homoplastic, being present also in the genus *Paradialychone*. The pre-pygidial depression without wings of *E. pseudolimnicola* and *E. cfr. pseudolimnicola*, however, is hollowed and thus more defined in comparison to the flattened type present in *Diallychone* and *Paradialychone* species, from which they also differ by the presence of radiolar appendages and in the shape of the inferior thoracic notochaetae.

Lastly, *E. pseudolimnicola* and *E. cfr. pseudolimnicola* are characterised not only by the presence of a very long incision on the anterior collar margin but also by the presence of parallel lamellae. These structures were never described before for any representative of the “*Chonea*” group. Recently, however, they were reported for *E. danieloi* and *E. glemnoi* (Capa & Murray 2015). Parallel lamellae are connected to the ventral lips, and in *E. pseudolimnicola* and *E. cfr. pseudolimnicola*, they form a fold under the collar, right behind the peristomial tip. This fold, especially in *E. cfr. pseudolimnicola*, appears as a bilobed structure (Figure 2a, e) which are here interpreted as ventral sacs. The different development of these structures is the main feature separating *E. pseudolimnicola* from *E. cfr. pseudolimnicola*.

Notwithstanding the above underlined problems within the genus *Euchone*, the present analysis does not suggest the erection of a new genus for *E. pseudolimnicola* and *E. cfr. pseudolimnicola*.

Taxonomic accounts

Genus *Euchone*

Euchone pseudolimnicola Giangrande & Licciano, 2006: pp. 1307–1308 (Figure 3)

Material examined

PCZL: Mediterranean material from the original description, seven specimens from South Coast of

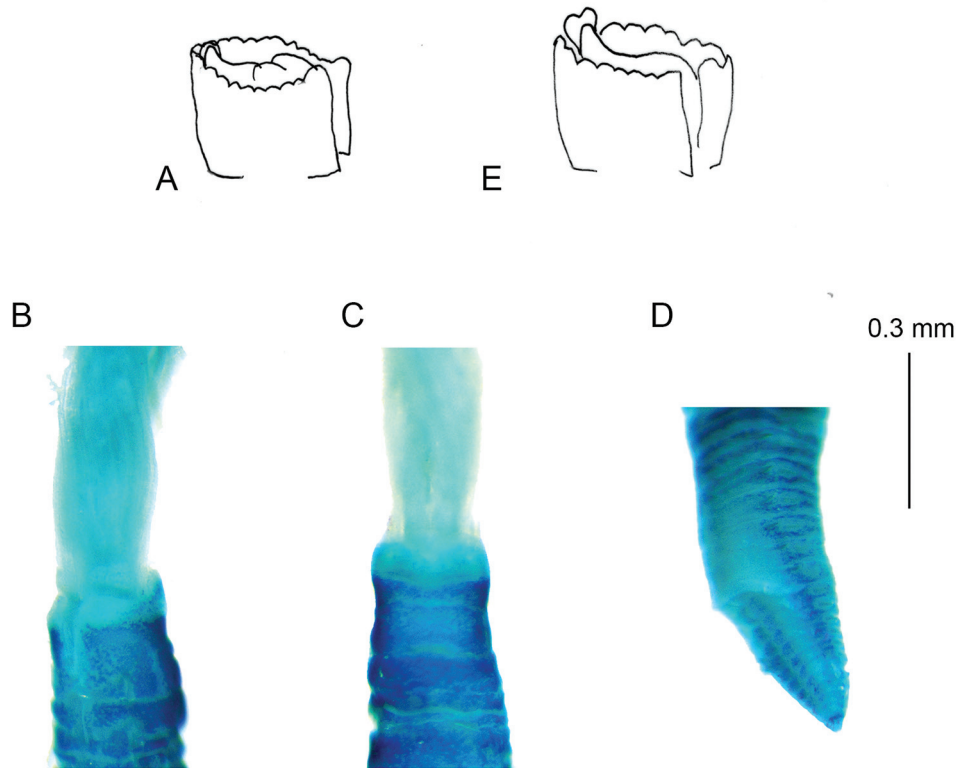


Figure 2. *Euchone pseudolimnicola*. (A) Scheme of the peristomial lobe; (B) staining pattern of the collar dorsal view; (C) staining pattern of the collar ventral view; (D) staining pattern of the pre-pygidial depression; (E) scheme of the peristomial lobe from *Euchone anceps* sp. nov.

Ustica Island, 50 m depth, 38°42'00"N, 13° 11'00"E. Sediment mainly composed of medium sand, biogenic and volcanic particles together with a significant amount of red calcareous algae.

Description

The description of the species is available in Giangrande and Licciano (2006).

Addition to the original description

Ventral peristomial lobe triangular not exposed. Parallel lamellae forming small rounded structure interpreted as ventral sacs that appear covered by ventral lappets of the collar (Figure 2a). After methyl green staining the collar showed the apical part less coloured than the basal part (Figures 2b, c and 6a). Pre-pygidial depression highly developed and formed of nine chaetigers without wings but generally with a distinct ridge in the uppermost part (Figure 2d). Uncini of the pre-pygidial depression not highly modified, but with more teeth of similar size over the main fang compared to teeth of the pre-pygidial depression.

***Euchone anceps* sp. nov.**
(Figures 2e, 3–5, and 6b–f)

Euchone cfr. *pseudolimnicola*. – Giangrande et al. 2015, comments, p. 36.

Chone cfr. *collaris*. – SGS M-Scan Ltd. 2012; 2014, appendix 8b, p. 365 (non Langerhans, 1881).

Type material

Holotype 16.01/17716 MNCN: Gulf of Salerno, 15 m depth, February 2007, 40°39'N, 14°46'E

Paratypes PCZLS.EU. 9.1: Gulf of Salerno, 15 m depth, February 2007, 40°39'N, 14°46'E, seven specimens.

Additional material

PCZLS.EU.: Shetlands Little Roe, 51 m depth, June 2012, 60°30'N, 1°17' W; Shetlands, Orka Voe, 20 m depth, June 2012, 60°28'N, 1°15'W (three specimens); Shetlands, Jetty Grid, 26 m depth, June 2012 60°27'N, 1°18'W (one specimen); Western English Channel 88 m depth, July 2011, 49°33'N, 4°36'W (one specimen); Western English

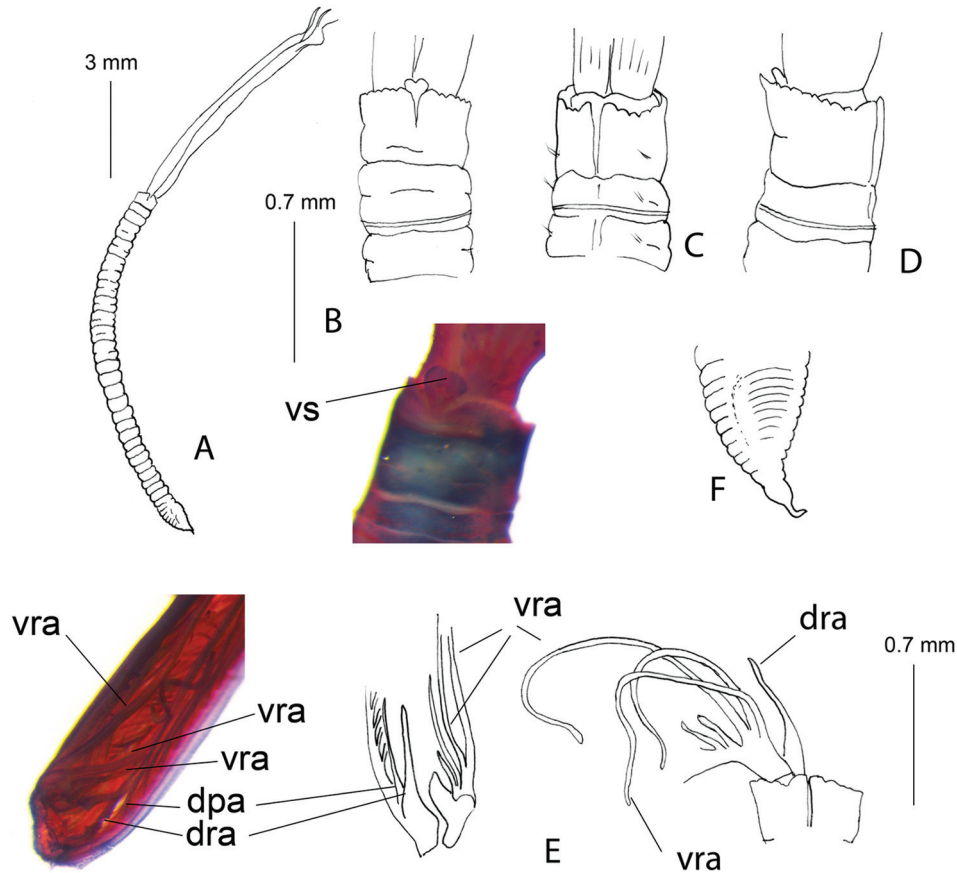


Figure 3. *Euchone anceps* sp. nov. holotype. (A) Entire worm; (B) collar ventral view (drawn and photographed); (C) collar dorsal view; (D) collar lateral view; (E) internal structures of the crown (stained with SHIRLASTAIN); (F) pre-pygidal depression. dpa: dorsal pinnular appendage; dra: dorsal radiolar appendage; vs: ventral sacs; vra: ventral radiolar appendage.

Channel, 88 m depth, July 2011, 49°33'N, 4°36'W (one specimen); Shetlands, Calbeck Ness, 53 m depth, June 2014, 60°29'N, 1°17'W (one specimen); Shetlands, Orka Voe, 17 m depth, June 2014, 60°28'N, 1°15'W (one specimen); Shetlands, Jetty Grid, 28 m depth, June 2014, 60°27'N, 1°18'W (two paratypes); Shetlands, Jetty Grid, 19 m, June 2014, 60°27'N, 1°16'W (one specimen); Shetlands, Jetty Grid, 28 m depth, June 2014, 60°27'N 1°18'W (one specimen); Leucate: 20 m depth, December 2012, 42°51'N, 3°03'E (one specimen). Grau du Roi: 9.5 m depth, December 2012, 43°31'N, 4°05'E (one specimen). Porquerolles: 48 m depth, December 2012, 43°01'N, 6°16'E (one specimen). Beauduc: 15 m depth, December 2012, 43°23'N, 4°34'E (three specimens). Faraman: 11 m depth, December 2012, 43°20'N, 4°47'E (two specimens). Levant: 35 m depth, December 2012, 43°00'N, 6°43'E (two specimens). Ile Maire: 44 m depth, December 2012, 43°20'N, 5°34'E (two specimens).

Description

Holotype complete with eight thoracic and 30 abdominal chaetigers (Figure 3a). Branchial crown length 7 mm; total thorax-abdomen length 10 mm; maximum width 0.3 mm. Branchial lobes each with seven fully developed radioles with palmate membrane for about half of their length; radiolar flanges present distal to palmate membrane; radioles terminating as extra-long filaments (Figures 3a and 4c). Dorsal pinnular appendages present but poorly developed, dorsal lips pointed with dorsal radiolar appendages (Figure 3e). Ventral lips triangular, parallel lamellae present, three pairs of ventral radiolar appendages of variable length, some of them about three-quarters the length of the radioles (Figure 3e). Collar high, slightly higher ventrally, regularly crenulated except dorsally, where it shows a cleft continuing in a lobe united with each side of the faecal groove (Figure 3c). Ventral margin of collar with a deep incision. Ventral peristomial lobe triangular; not exposed because it is covered by a bilobed

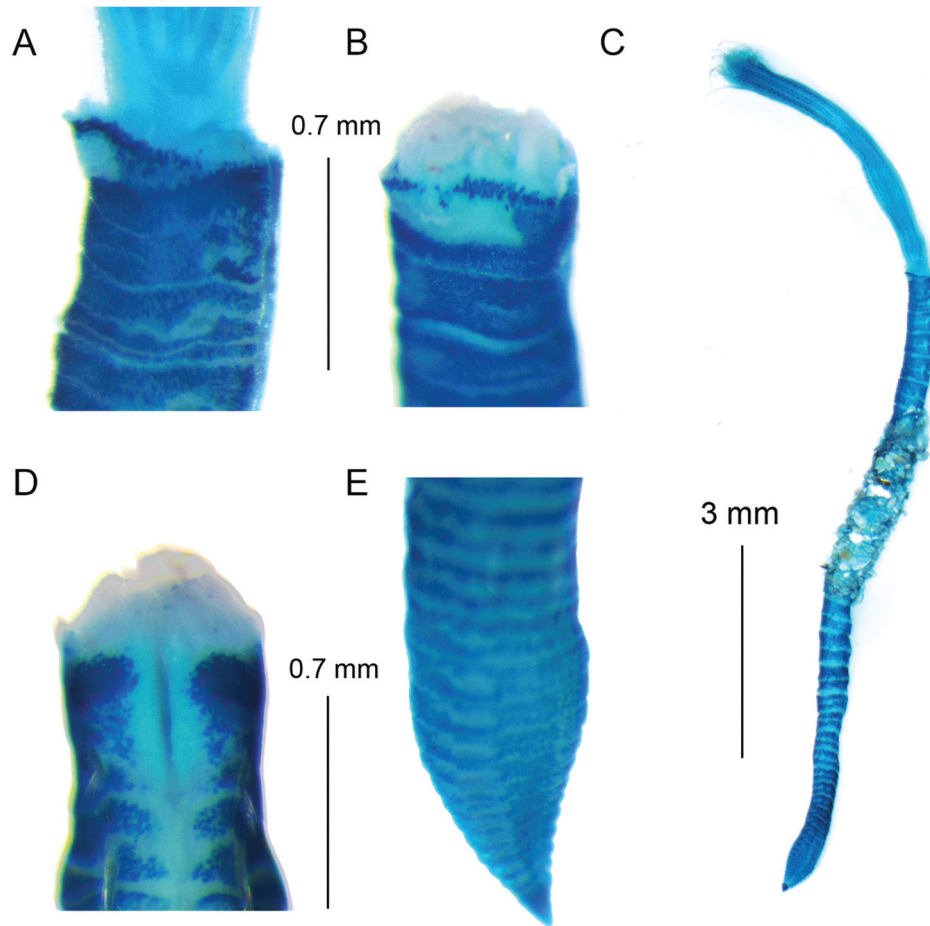


Figure 4. *Euchone anceps* sp. nov. British material. (A) collar staining pattern (Methyl green stain) lateral view; (B) collar staining pattern ventral view; (C) entire worm; (D) collar staining pattern dorsal view; (E) pre-pygidial depression.

structure interpreted as ventral sacs. The ventral sacs are centrally located, not covered by the collar, and appear as folds under the collar (Figures 2e and 3b). Lobe of anterior peristomial ring dorsally not covered by collar margin (Figure 3d). After staining, ventral collar markedly stained close to the edge (Figures 4a, b, d and 6b, c). Ventral shields visible only after methyl green staining. Apart from the peculiar methyl pattern in the ventral collar, colouration remains quite uniform along the body. Notopodia in chaetiger 1 with six narrowly hooded chaetae. Glandular ridge present on chaetiger 2, narrow all around. Notopodial fascicle from chaetigers 2–8 with superior group of five elongated broadly hooded chaetae (Figure 5a), and inferior group with five subspatulate chaetae posteriorly and two bayonet-type anteriorly. Subspatulate chaetae narrow, with long tip (Figure 5b). Thorax with 10 neuropodial uncini per torus, with a large tooth over

the main fang and additional teeth of different sizes (Figure 5c). Abdominal neuropodial fascicles with modified, elongated narrowly hooded chaetae (Figure 5d). Abdominal notopodia with 9–10 avicular uncini, with main fang surmounted by three or four rows of teeth of different sizes, the first larger over the main fang, as in the thoracic uncini (Figure 5e). Intratorus variation absent.

Pre-pygidial depression not highly developed, formed by nine chaetigers without wings or distinct ridge, but hollowed and sometimes laterally swollen (Figures 3a, f and 4e). Uncini of the pre-pygidial depression not highly modified, but with more teeth of similar size over the main fang compared to that of abdominal segments anterior to the pre-pygidial depression (Figure 5e, f). Pygidium rounded, showing in most of the specimens a filiform appendix (Figure 3f). Tube incrustated with detritus and sand (Figure 4c).

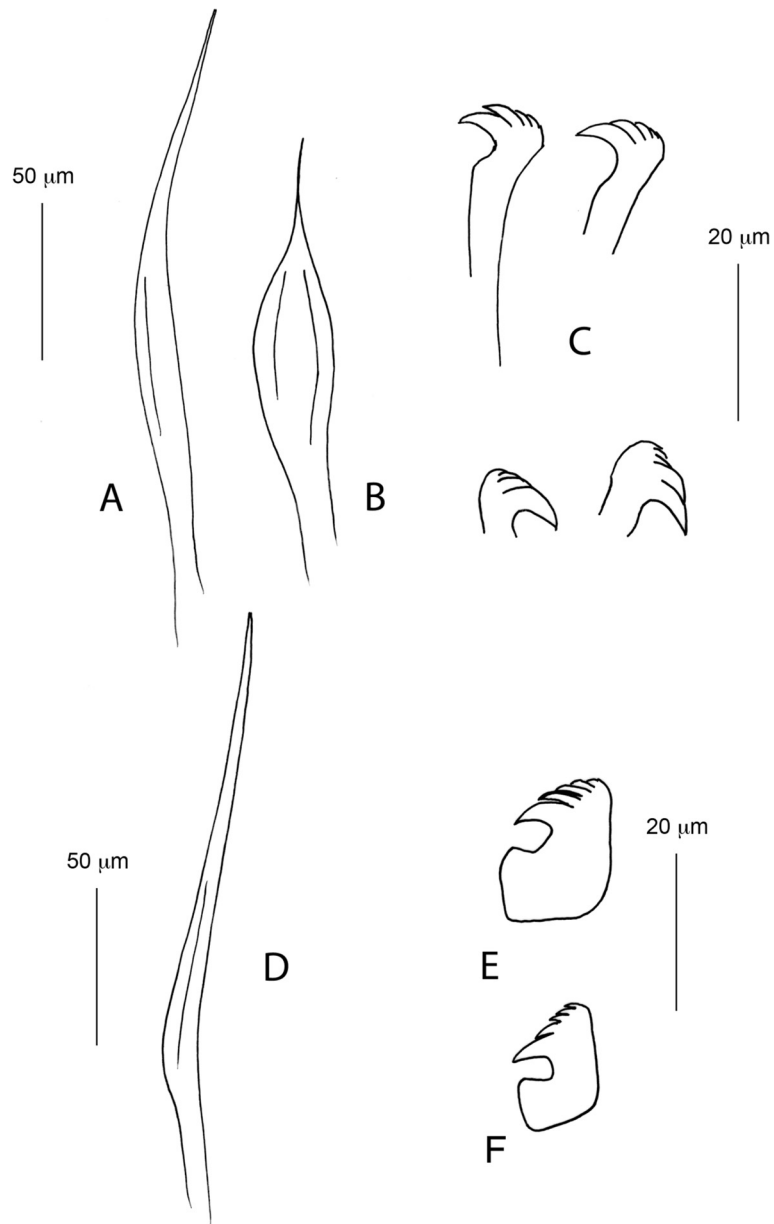


Figure 5. *Euchone anceps* sp. nov. holotype. (A) Superior thoracic chaeta; (B) inferior thoracic chaeta; (C) thoracic uncini; (D) abdominal chaeta; (E) abdominal uncinus from first abdominal chaetiger; (F) abdominal uncinus from pre-pygidial depression.

Variation

All the type material and specimens collected in the British waters had a consistent staining pattern for the collar, and they had a poorly developed pre-pygidial depression (without a distinct ridge in the anterior edge). However, the specimens collected from the Gulf of Lion had highly variable staining pattern. These specimens can have a darker staining pattern of the collar coupled with a pre-pygidial depression similar to that of British material (Figure 6d–f), or a staining pattern similar to that of British specimens, but with a more developed pre-pygidial depression (Figure 6g–i).

Ecology and distribution

This species was collected from 10 to 80 m depth in coarse muddy sand bottoms. It is distributed in Mediterranean and British waters.

Etymology

The specific name ‘anceps’ is from Latin and refers both to the presence of some differences in generic definition from other *Euchone* species, and to the presence of high variability within some features.

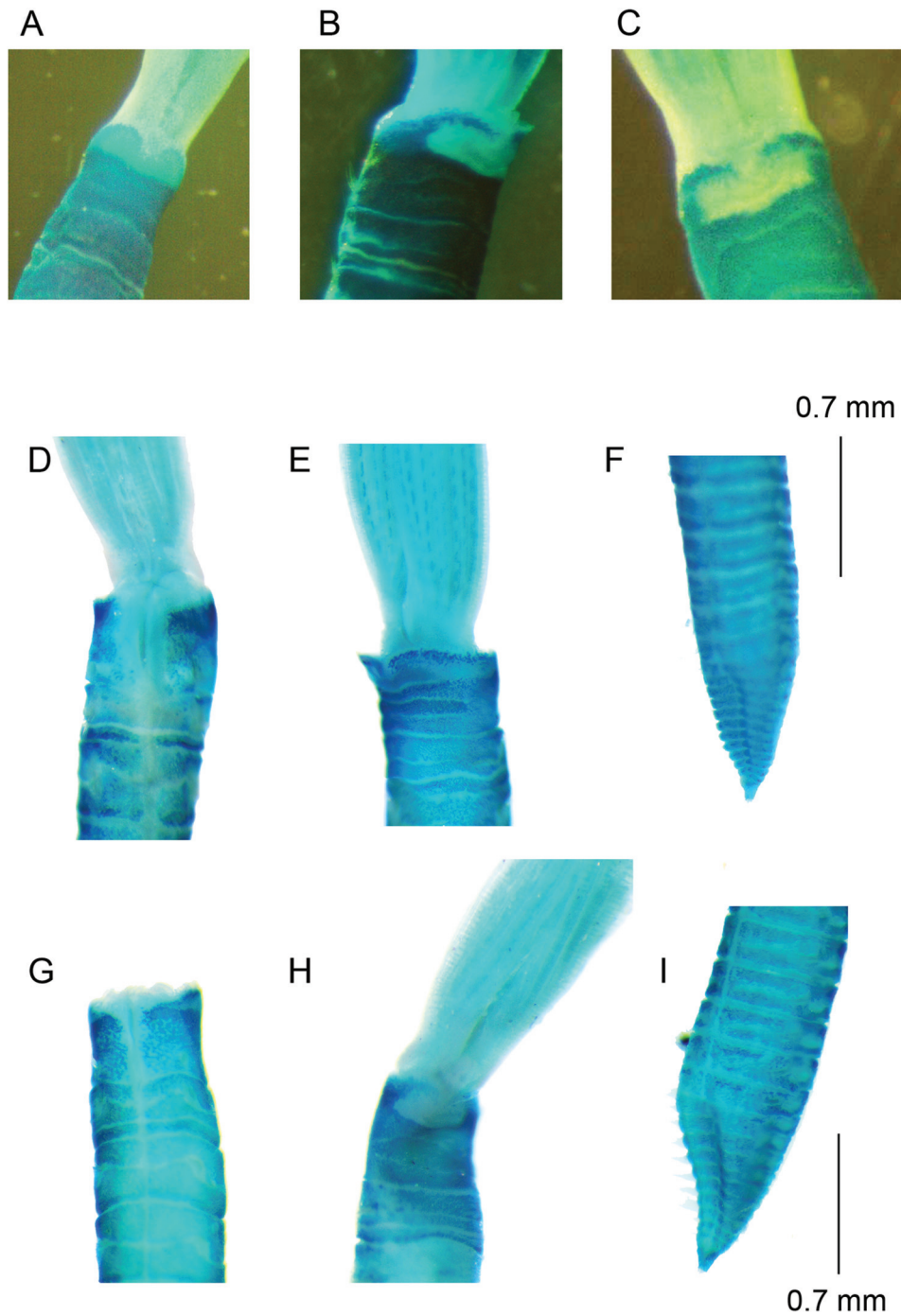


Figure 6. Comparison of collar staining pattern from *E. pseudolimnicola* (A) and *E. anceps* sp. nov. Holotype (B–C); variability of collar staining pattern (Methyl green) and development of pre-pygidial depression in two different specimens of *E. anceps* sp. nov. from the Gulf of Lion: (D–F) (Beauduc) and (G–I) (Levant).

Remarks

Due to the presence of a crenulated collar, at first the British material of *P. anceps* sp. nov. was reported by different authors as *Chone* cfr. *collaris* (SGS M-Scan Ltd 2012, 2014), and only after comparison to the Mediterranean material named *E.* cfr.

pseudolimnicola. Indeed, it differs in several features from the true *Chone collaris*, now *Dialyhone collaris* (Langerhans, 1881) (Tovar-Hernández 2008), including the shape of the collar with a discontinuous crenulation, the longer radiolar tips, the absence of peristomial eyes, the absence of paleate chaetae, and the presence of a pre-pygidial depression more

developed and hollowed than in *D. collaris*. Mediterranean material from the Gulf of Salerno (Tyrrhenian Sea) was considered strongly similar to *E. pseudolimnicola* and at first named *E. cfr. pseudolimnicola*. The two taxa have a similar number of chaetigers, a similar number and morphology of radioles, and a filiform appearance of the body, an irregularly crenulated collar with a ventral cleft and a hollowed pre-pygidial depression without wings. However, numerous characters make this taxon different from *E. pseudolimnicola*. *Euchone anceps* sp. nov. is a larger species with a longer crown, and with more developed bilobed structures here interpreted as ventral sacs (Figure 2a, e). Moreover, the collar in *E. pseudolimnicola* is higher ventrally, with more developed lappets, and has a different staining pattern (Figure 6a–c). In addition, the presently described species has narrower subspatulate chaetae in the inferior group. Finally, the two species show a different development of pre-pygidial depression. However, due to the high variability existing within the taxon, the best features separating it from *E. pseudolimnicola* are the development of ventral sacs and the staining pattern of the collar.

Key to the “Chonea” group of genera and species from Northeast Atlantic and Mediterranean area

- 1 a. Pre-pygidial depression present, posterior abdominal uncini modified from those in anterior abdomen 2
- b. Pre-pygidial depression absent, posterior abdominal uncini similar to those in anterior abdomen 20 (*Chone*)
- 2(1) a. Pre-pygidial depression simple flattened, always without lateral wings 3
- b. Pre-pygidial depression hollowed, often with lateral wings.....10 (*Euchone*)
- 3(2) a. Uncini from anterior abdomen with a series of nearly uniform-sized teeth 4 (*Dialychone*)
- b. Uncini from anterior abdomen with a large tooth above main fang, followed by a series of smaller teeth. Narrow flanges reaching the tip of the radioles. Inferior thoracic chaetae paleate. A second glandular girdle on first abdominal chaetiger.....*Paradialychone gambiae*
Mediterranean
- 4(3) a. Only a glandular girdle on the second chaetiger 5
- b. An additional glandular girdle on chaetiger 13 ...
..... *Dialychone egyptica*
Mediterranean

- 5(4) a. Collar with a crenulate margin
..... *Dialychone collaris*
Mediterranean
- b. Collar with a smooth margin 6
- 6(5) a. Collar high, dorsally covering the junction between peristomium and the base of the branchiae 7
- b. Collar oblique, dorsally not covering the base of branchial crown 8
- 7(6) a. Palmate membrane very low, maximum one-quarter of the radiolar length, difficult to detect. Collar very high, anterior peristomial lobe triangular, not exposed. Large species
..... *Dialychone acustica*
Mediterranean and Northeast Atlantic
- b. Palmate membrane highly developed covering three-quarters of the radiolar length, and with flanges reaching the tip of the radioles. Peristomial lobe exposed and bilobed. Small species with superior thoracic chaetae long and narrowly hooded
..... *Dialychone longiseta*
Mediterranean
- 8(6) a. Radioles with short free tips and several black spots along radioles. Peristomial lobe exposed triangular *Dialychone arenicola*
Mediterranean
- b. Radioles with long free tips and without black spots 9
- 9(8) a. Anterior peristomial lobe not exposed and triangular *Dialychone usticensis*
Mediterranean
- b. Peristomial lobe exposed bilobed
..... *Dialychone dumerificta**
- Mediterranean and Northeast Atlantic
- 10(2) a. Margin of the collar crenulated 11
- b. Margin of the collar smooth 13
- 11(10) a. Pre-pygidial depression without lateral wings. Ventral sacs present 12
- b. Pre-pygidial depression with well developed lateral wings *Euchone pararosea*
Mediterranean
- 12(11) a. Ventral sacs highly developed, appearing as a fold under the collar *Euchone anceps* sp. nov.
Mediterranean and Northeast Atlantic
- b. Ventral sacs smaller, covered by the collar
..... *Euchone pseudolimnicola*
Mediterranean
- 13(10) a. Fewer than 10 abdominal chaetigers before the pre-pygidial depression, often small-sized species 14
- b. More than 10 abdominal chaetigers before the pre-pygidial depression, often large-sized species 17

- 14(13) a. Pre-pygidial depression without lateral wings and formed by 9–12 chaetigers. Collar entire ventrally *Euchone limnicola*
Northeast Atlantic
- b. Pre-pygidial depression with lateral wings formed by fewer than nine chaetigers. Collar with a small ventral cleft 15
- 15(14) a. Pre-pygidial depression formed by only three chaetigers. A second glandular girdle present in abdominal chaetigers. *Euchone incolor*
Northeast Atlantic and Mediterranean **
- b. Pre-pygidial depression formed by 4–5 chaetigers 16
- 16(15) a. Two types of uncini in anterior abdominal chaetigers. *Euchone arenae*
Northeast Atlantic
- b. Only one type of uncini in anterior abdominal chaetigers *Euchone southerni*
Northeast Atlantic
- 17(13) a. Pre-pygidial depression formed by 8–12 chaetigers, large-sized species 18
- b. Pre-pygidial depression formed by 5–7 chaetigers, small-sized species *E. rosea*
Mediterranean and Northeast Atlantic
- 18(17) a. Abdominal chaetigers before the pre-pygidial depression numbering 11–15, and 10–12 chaetigers in the pre-pygidial depression .. *E. rubrocincta*
Mediterranean and Northeast Atlantic
- b. Abdominal chaetigers before the pre-pygidial depression numbering 16–22, and 8–12 chaetigers in the pre-pygidial depression 19
- 19(18) a. Abdominal chaetigers before the pre-pygidial depression numbering 21, and 8–10 chaetigers in the pre-pygidial depression. Inferior thoracic chaetae broadly hooded..... *Euchone papillosa*
Northeast Atlantic
- b. Abdominal chaetigers before the pre-pygidial depression numbering 16–22, and 9–12 chaetigers in the pre-pygidial depression. Inferior thoracic chaetae narrowly hooded *Euchone analis*
Northeast Atlantic
- 20(1) a. Collar high covering the base of the branchiae 21
- b. Collar oblique dorsally not covering the base of the branchiae *Chone duneri*
Northeast Atlantic
- 21(20) a. Tip of the radioles long, with very developed flanges. Peristomial lobe exposed and bilobed *Chone filicaudata**
Northeast Atlantic
- b. Tip of the radioles short and flanged. Peristomial lobe not exposed, and triangular 22
- 22(21) a. Collar with narrow gap dorsally. 23

- b. Collar with broad gap dorsally. Methyl green pattern with clearer areas dorsally along the body and ventrally in the collar *Chone kroyeri*
Northeast Atlantic
- 23(22) a. Methyl green pattern darker in the anterior part of the collar *Chone infundibuliformis*
Northeast Atlantic
- b. Collar very high with methyl green pattern lacking on the superior margin *Chone fauveli*
Northeast Atlantic

*Wasson et al. 2017.

**Adriana Giangrande, personal observation.

Discussion

Several problems arise when examining characters within the sabellid genera *Euchone*, *Chone*, *Dialychone* and *Paradialychone*. This is particularly true considering:

- the internal structures of the crown, which need histological examination;
- the uncinal shape variation, which remains a problematic feature in the definition of all these genera due to the difficulty in ascertaining the uncinal state (modified or not) (Giangrande et al. 2015) and the large variability within and/or between fascicles showed by several species (Banse 1972; Fitzhugh 1989; Bick & Randel 2005);
- the presence of a pre-pygidial depression which in several *Euchone*, *Dialychone* and *Paradialychone* species often appears to be not clearly defined.

The presently described taxon *E. anceps* sp. nov., together with *E. pseudolimnicola*, shares with the genus *Euchone* the dorsal lips with radiolar appendages, a ventral cleft in the collar and the presence of a well-defined and hollowed pre-pygidial depression. However, the two species differs from the other *Euchone* species in the undefined ventral shields, and especially in a different dentition of both thoracic and abdominal uncini. This last feature appears very peculiar, with the presence of a second highly developed and asymmetric tooth over the main fang similar to that described for *Paradialychone*. Moreover, the poorly defined pre-pygidial depression lacking wings could suggest that *E. anceps* sp. nov. and *E. pseudolimnicola* are closely related to the genera *Dialychone* or *Paradialychone*, thus leading to a narrowing of the boundaries between genera of the “*Chonea*” group, and suggesting that generic definitions in this group need to be reexamined.

Due to the above considerations, specimens abundantly collected along the British coast have for a long time been identified as *Chone* cfr. *collaris*, and more recently as *Euchone* cfr. *pseudolimnicola*. A similar ambiguity in generic placement due to the mixed combination of morphological traits was also pointed out by Capa and Murray (2015), who recently described a new taxon from Australian coasts as *Dialychone ambigua* Capa & Murray, 2015.

The cladistic analysis, performed to underline the relationships of the new taxon to the most plesiomorphic sabellid genera, revealed the genus *Euchone* to be not well defined. However, *E. pseudolimnicola* and *E. cfr. pseudolimnicola* (now *E. anceps* sp. nov.) appear more closely related to the other considered *Euchone* species than to *Dialychone* and *Paradialychone*. Therefore, we suggest maintaining both these taxa within the genus *Euchone* until a revision based on the examination of type material of all the *Euchone* species can be performed.

The pre-pygidial depression present in *E. pseudolimnicola* and *E. anceps* sp. nov. is simple but hollowed, while the pre-pygidial depression of *Dialychone* and *Paradialychone* appears only as a terminal flattened portion of the abdomen (simple depression). True lateral wings are lacking also in *E. limnicola*, a locally abundant species colonising marine to estuarine habitats along British and French coasts of the North Sea (Giangrande et al. 2015; Guyonnet & Borg 2015). This species, native to California on the Pacific Coast of North America, but introduced worldwide (South-Eastern Australia, New Zealand) (Wilson & McArthur 2008), still needs to be well defined with the examination of more material from different areas. The *E. limnicola* specimens here examined, indeed, show an entire ventral margin of the collar, whilst all the *Euchone* species up to now described have a more or less pronounced ventral cleft. This feature, however, is not unique to the *Euchone* genus, being present also in *Jasmineira* and *Euchoneira*, and in one species of *Dialychone*: *D. arabica* Tovar-Hernández & Dean, 2010.

Finally, peculiar to the new taxon and to *E. pseudolimnicola* is the presence of ‘ventral sacs’ which are highly developed, especially in *E. anceps* sp. nov. These structures have never been described within the plesiomorphic sabellid genera. Fitzhugh (1989) described the parallel lamellae as an extension of the ventral lips along the anterior midline, which terminates near or between the mid-ventral cleft of the collar, or in two ventral vesicles (ventral sacs). Parallel lamellae usually characterise the most apomorphic sabellid genera and, according to the Fitzhugh analysis (1989), in the most apomorphic

area are present only in the genera *Jasmineira* and *Panousea* Rullier & Amoureux, 1970, arising between *Myxicola* Renier, 1804 and *Potamethus* Chamberlin, 1919. Therefore, the parallel lamellae were never described for any species of *Chone* or *Euchone*. Recently, however, Capa and Murray (2015) report the presence of parallel lamellae in the two *Euchone* species they described, *E. danieloi* and *E. glemnoi*. We re-examined all the *Euchone* material available in our collection, finding that, although these structures are very difficult to check, probably most *Euchone* have parallel lamellae, and probably the presence of these structures is linked to the presence of a ventral cleft in the collar.

In *E. pseudolimnicola* and *E. anceps* sp. nov. not only parallel lamellae are present, but also the ventral sacs, though to different degrees of development. The presence of ventral sacs, which were not reported in the original description of *E. pseudolimnicola*, could be of high importance in sabellid phylogeny, even if in the present analysis their presence was not enough to separate these two taxa from the other *Euchone* species. Aside from differing development of the ventral sacs, these two species differ from each other in several features. *Euchone anceps* sp. nov. is a larger species with a longer crown, and has more broadly hooded chaetae in the superior thoracic fascicle, and narrow subspatulate chaetae in the inferior group. Also, it shows a different methyl green pattern in the collar and a less-developed pre-pygidial depression without a distinct ridge in the anterior edge.

These last two features are, however, highly variable in Mediterranean material from the Gulf of Lion, where specimens collected at 35–40 m depth are morphologically similar to the type material from Tyrrhenian Sea collected at 15 m depth; here the shallowest specimens present a darker staining pattern and a different development of the pre-pygidial depression. By contrast, the specimens from the British area, collected from 20 to 80 m depth, are morphologically indistinguishable from the type material. These populations could thus represent either a highly variable taxon or a complex of species. In conclusion, their status remains uncertain until additional morphological and molecular evidence is presented.

Finally, from the provided key for the genera included in the “*Chonea*” group, it is evident that the Northeast Atlantic region contains a higher number of species (16, of which 10 are exclusive to the area) compared to the Mediterranean region (14, of which nine are exclusive to the area). This is particularly interesting because usually the Mediterranean area is considered a biodiversity

hotspot. Moreover, a low similarity between the two areas is observed (25%), with *Chone* present only in the Northeast Atlantic area, *Paradialychone* only in the Mediterranean, and *Dialychone* and *Euchone* more speciose in the Mediterranean and in the Northeast Atlantic area, respectively. As suggested by Giangrande and Licciano (2004), this last point is probably linked to a taxonomic impediment, particularly for the genus *Euchone*, which is often neglected within Mediterranean works.

Acknowledgements

The specimens used in this paper were available from monitoring surveys. For the Tyrrhenian Sea type material we would like to thank M. Cristina Gambi (Zoological Station of Naples), who sent us the specimens from soft-bottom macrofaunal assemblages in the Gulf of Salerno. For the Shetland specimens we would like to thank Meriem Kayoueche-Reeve and the Sullom Voe Association Ltd, the funders of the Shetland Oil Terminal Environmental Advisory Group's environmental monitoring programme for marine chemistry and macrobenthos. Thanks also go to Paul McIlwaine of the Centre for Environment Fisheries and Aquaculture Science (CEFAS) for the south-west England specimens, and to Celine Labrune Observatoire Océanologique de Banyuls/mer for the Mediterranean specimens from the Gulf of Lion. We wish to thank also Rhian Pugh from EMU Ltd who furnished us with specimens of *Euchone limnicola* from the Tees Estuary. The study was carried out using the facilities of the Experimental Research Centre of Biodiversity Organization and Ecosystem Functioning (BIOforIU) of the University of Salento.

References

- Banse K. 1972. Redescription of some species of *Chone* Krøyer and *Euchone* Malmgren, and three new species (Sabellidae, Polychaeta). Fishery Bulletin 70:459–495.
- Bick A, Randel N. 2005. Ontogenetic variations in characters of *Euchone analis* (Krøyer, 1856) (Polychaeta, Sabellidae, Sabellinae) from Spitsbergen, and new assignments of *Oriopsis ingelora* Plate, 1995 and *O. liefdefjordensis* Plate, 1995. Acta Zoologica 86:145–157. DOI:10.1111/j.1463-6395.2005.00196.x.
- Capa M, Murray A. 2015. A taxonomic guide to the fan worms (Sabellidae, Annelida) of Lizard Island, Great Barrier Reef, Australia, including new species and new records. Zootaxa 4019:98–167. DOI:10.11646/zootaxa.4019.1.8.
- Capa M, Nogueira JMM, Silva Rossi MC. 2011. Comparative internal structure of dorsal lips and radiolar appendages in Sabellidae (Polychaeta) and phylogenetic implications. Journal of Morphology 272:302–319. DOI:10.1002/jmor.10914.
- Chamberlin RV. 1919. The Annelida Polychaeta (Albatross Expeditions). Vol. 48. Memoirs of the Museum of Comparative Zoology at Harvard College, Cambridge. pp. 1–514.
- Claparède E. 1870. Les Annélides Chétopodes du Golfe de Naples. Seconde partie. Annélides sédentaires. Mémoires de la Société de physique et d'histoire naturelle de Genève 20:1–225. Available: <http://www.archive.org/details/lesannlidesch02clap>. Accessed Oct 2016 10.
- Cochrane SJ. 2003. Snowflakes and feather-dusters some challenges for soft-bottom fanworm systematics. Hydrobiologia 496:49–62. DOI:10.1023/a:1026168025573.
- Fitzhugh K. 1989. A systematic revision of the Sabellidae-Caobangiidae-Sabellongidae complex (Annelida: Polychaeta). Bulletin of the American Museum of Natural History 192:1–104.
- Fitzhugh K. 2002. Fan worm polychaetes (Sabellidae: Sabellinae) collected during the Thai-Danish BIOSHELF project. Phuket Marine Biological Center Special Publication 24:353–424.
- Fitzhugh K. 2003. A new species of *Megalomma* Johansson, 1927 (Polychaeta: Sabellidae: Sabellinae) from Taiwan, with comments on sabellid dorsal lip classification. Zoological Studies 42:106–134.
- Giangrande A, Licciano M. 2004. Factors influencing latitudinal pattern of biodiversity: An example using Sabellidae (Annelida, Polychaeta). Biodiversity & Conservation 13:1633–1646. DOI:10.1023/B:BIOC.0000029327.63397.6b.
- Giangrande A, Licciano M. 2006. The genus *Euchone* (Polychaeta, Sabellidae) in the Mediterranean Sea, addition of two new species and discussion on some closely related taxa. Journal of Natural History 40:1301–1330. DOI:10.1080/00222930600901458.
- Giangrande A, Licciano M, Wasson B. 2015. Guide to identification of Sabellidae and Fabriciidae (Polychaeta) in north east Atlantic and Mediterranean waters. NMBAQC 2014 taxonomic workshop: Dove Marine Laboratory. Available: <http://www.nmbaqs.org/scheme-components/invertebrates/literature-and-taxonomic-keys/sabellid-guide/>. Accessed Sep 2015 24.
- Gmelin JF. 1791. Vermes. In: Gmelin JF, editor. Caroli a Linnaei Systema Naturae per Regna Tria Naturae, Editio Decima Tertia, Aucta Reformata. Tome 1, Pars 6 (Vermes). Lipsiae: GE Beer. pp. 3021–3910.
- Guyonnet B, Borg D. 2015. Premier signalement de l'espèce introduite *Euchone limnicola* Reish, 1959 (Polychaeta: Sabellidae) sur les côtes françaises de la Mer du Nord (Grand Port Maritime de Dunkerque). Les Cahiers Naturalistes de l'Observatoire Marin 4:15–23.
- Hartmann-Schröder G. 1979. Die Polychaeten der "Atlantischen Kuppenfahrt" von FS "Meteor" (Fahrt 9 c, 1967). 1. Proben aus Schleppgeräten. Meteor Forschungs-Ergebnisse, Reihe D 31:63–90.
- Krøyer H. 1856. Meddelelser af en Afhandling Ormeslaegten Sabella Linn., isaer med Hensyn til dens nordiske Arter. Oversigt over det Kongelige Danske videnskabernes selskabs forhandling 1856:1–36.
- Langerhans P. 1880. Die wurmfauuna Madeiras. II. Zeitschrift für wissenschaftliche Zoologie 33:271–316.
- Langerhans P. 1881. Die Wurmfauna von Madeira. III. Zeitschrift für wissenschaftliche Zoologie 34:87–143.
- Licciano M, Giangrande A, Gambi MC. 2009. A new genus of Sabellidae (Annelida, Polychaeta) from Antarctica, with discussion of relationships among plesiomorphic genera within Sabellinae. Zootaxa 2226:28–42. DOI:10.11646/zootaxa.2226.1.1.

- Lorenti M, Gambi MC, Guglielmo R, Patti FP, Scipione MB, Zupo V, Buia MC. 2011. Soft bottom macrofaunal assemblages in the Gulf of Salerno, Tyrrhenian Sea, Italy, affected by the invasive seaweed *Caulerpa racemosa* var. *cylindracea*. *Marine Ecology* 3:320–334. DOI:10.1111/j.1439-0485.2011.00472.x.
- Maddison DR, Maddison WP. 2005. MacClade 4: Analysis of phylogeny and character evolution. Version 4.08a. Available: <http://macclade.org>. Accessed Oct 2015 20.
- Malmgren AJ. 1866. Nordiska Hafs-Annulater. Öfversigt af Königlich Vetenskapsakademiens förhandlingar, Stockholm 22:355–410.
- Nishi E, Tanaka K, Tovar-Hernández M, Giangrande A. 2009. *Dialychone*, *Jasmineira* and *Paradialychone* (Annelida: Polychaeta: Sabellidae) from Japan and adjacent waters, including four new species descriptions. *Zootaxa* 2167:1–24. DOI:10.11646/zootaxa.2167.1.1.
- Nogueira JMM, Fitzhugh K, Rossi S, Cappellani M. 2010. A new genus and new species of fan worms (Polychaeta: Sabellidae) from Atlantic and Pacific Oceans—the formal treatment of taxon names as explanatory hypotheses. *Zootaxa* 2603:1–52. DOI:10.11646/zootaxa.2603.1.1.
- Reish DJ. 1959. A new species of Sabellidae (Annelida, Polychaeta) from southern California. *Annals and Magazine of Natural History (Series 13)* 2:717–719. DOI:10.1080/00222935908655757.
- Renier SA. 1804. Prospetto della Classe dei Vermi nominati e ordinati secondo il sistema di Bosc. *Zoologische Jahrbucher. Abteilung Für Systematik* Jena 64:41–110.
- Rullier F, Amoureux L. 1970. Nouvelle contribution a l'étude de la faune des Annélides Polychètes du Maroc. *Bulletin de la Société des Sciences Naturelles et Physiques du Maroc* 49:109–142.
- Selim SA, Rzhavsky AV, Britayev TA. 2012. *Dialychone* and *Paradialychone* (Polychaeta: Sabellidae) from the Mediterranean Coast of Egypt with description of *Dialychone egyptica* sp.n. *Invertebrate Zoology* 9:105–114.
- SGS M-Scan Ltd. 2012. Chemical and macrobenthic monitoring in Sullom Voe Sediments- 2012. Report to SOTEAG from SGS M-Scan Ltd, 1211/23366. Available: <http://www.soteag.org.uk>. Accessed Jan 2016 12.
- SGS M-Scan Ltd. 2014. Chemical and macrobenthic monitoring in Sullom Voe Sediments- 2014. Report to SOTEAG from SGS M-Scan Ltd, 141/24728. Available: http://www.soteag.org.uk/files/2015/05/SGS-M-Scan-2014-Chemical-and-macro-benthic-monitoring-in-Sullom-Voe-sediments_final.pdf. Accessed Jan 2016 12.
- Swofford DL. 2002. PAUP*. Phylogenetic analysis using parsimony (* and other methods) v.4. Sunderland, MA: Sinauer Associates.
- Tovar-Hernández MA. 2008. Phylogeny of *Chone* Kröyer, 1856 (Polychaeta: Sabellidae) and related genera. *Journal of Natural History* 42:2193–2226. DOI:10.1080/00222930802254714.
- Tovar-Hernández MA, Dean H. 2010. Four new species of fan worms (Polychaeta: Sabellidae) from Worldwide Localities. *Scientia Marina* 74:815–826. DOI:10.1080/00222930802254714.
- Wasson B, Giangrande A, Tovar-Hernández MA. 2017. Re-establishment of *Chone filicaudata* Southern, 1914 from material collected from British coasts, and the first British record of the Mediterranean species *Dialychone dumerificta* (Tovar Hernández et al. 2007). *Cahiers de Biologie Marine*.
- Wilson R, McArthur M. 2008. Fan worm *Euchone limnicola*. Australia: Pest and Diseases Image Library. Available: <http://www.padil.gov.au>. Accessed Jul 2016 14.