Contribution to the knowledge of meiobenthic Copepoda (Crustacea) from the Sardinian coast, Italy

N. Noli, C. Sbrocca, R. Sandulli, M. Balsamo, F. Semprucci


Abstract

Contribution to the knowledge of meiobenthic Copepoda (Crustacea) from the Sardinian coast, Italy. Data available on the Italian species of Copepoda Canuelloida Khodami, Vaun MacArthur, Blanco–Bercial and Martínez Arbizu, 2017 and Harpacticoida Sars, 1903 report overall 210 species, but their diversity and biogeography are still poorly investigated. We carried out a faunistic survey along the eastern coast of Sardinia (Ogliastra region) in order to document these taxa in the area. A total of 41 species in 36 genera and 18 families were found. Although many species were identified as putative, the current Italian checklist was updated with 12 new records of genera and 4 of species. *Longipedia coronata* Claus, 1862 (Canuelloida), *Diosaccus tenuicornis* (Claus, 1863), *Asellopsis hispida* Brady and Robertson, 1873, *Wellsopsyllus (intermediopsyllus) intermedius* (Scott and Scott, 1895) (all Harpacticoida) are reported for the first time from Sardinia coasts. The copepod community was particularly rich at Ogliastra Island, a small rocky island with natural reefs, rocky shoals and *Posidonia oceanica* meadows. Species found there were mainly related to coarse sands and macrophytal detritus.

Data published in GBIF (doi:10.15470/dxru6l)

Key words: Meiobenthic Copepoda, Meiofauna, Biogeography, Check–list, Sardinia, Italy

Resumen

Contribución al conocimiento de los copépodos (Crustacea) meiobénticos de la costa de Cerdeña, Italia. Los datos disponibles sobre especies italianas de copépodos Canuelloida Khodami, Vaun MacArthur, Blanco–Bercial y Martínez Arbizu, 2017 y Harpacticoida Sars, 1903 registran un total de 210 especies, pero la diversidad y biogeografía de las mismas siguen estando escasamente investigadas. Realizamos un estudio faunístico en la costa este de Cerdeña (región de Ogliastra) con objeto de documentar la presencia de estos taxones en dicha área. Encontramos un total de 41 especies de 36 géneros y 18 familias. Aunque muchas especies se identificaron como putativas, la lista de control italiana viente se actualizó con 12 nuevos registros de géneros y cuatro de especies. *Longipedia coronata* Claus, 1862 (Canuelloida), *Diosaccus tenuicornis* (Claus, 1863), *Asellopsis hispida* Brady y Robertson, 1873, *Wellsopsyllus (intermediopsyllus) intermedius* (Scott y Scott, 1895) (todas Harpacticoida) fueron registradas por primera vez en las costas de Cerdeña.

© [2018] Copyright belongs to the authors, who license the journal *Arxius de Miscel·lània Zoològica* to publish the paper under a Creative Commons Attribution 3.0 License, which permits its distribution, and reproduction in any medium, provided the original authors and source, the journal *Arxius de Miscel·lània Zoològica*, are cited.
La comunidad de copépodos resultó particularmente rica en la isla de Ogliastra, un islote rocoso con arrecifes naturales, bancos de rocas y praderas de *Posidonia oceanica*. Las especies encontradas en la zona estaban relacionadas principalmente con arenas gruesas y detritos macrofitos.

Datos publicados en GBIF (doi:10.15470/dxru6l)

Palabras clave: Copépodos meiobénticos, Meiofauna, Biogeografía, Lista de control, Cerdeña, Italia

**Resum**

Contribució al coneixement dels copèpodes (Crustacea) meiobèntics de la costa de Sardeña, Itàlia. Les dades disponibles sobre espècies italianes de copèpodes Canuelloida Khodami, Vaun MacArthur, Blanco–Bercial i Martínez Arbizu, 2017 i Harpacticoida Sars, 1903 registren un total de 210 espècies, però la seva diversitat i la seva biogeografia continuen estan escassament investigades. Vam portar a terme un estudi faunistic a la costa est de Sardeña (regió d’Ogliastra) a fi de documentar–hi la presència d’aquests taxons. Hi vam trobar un total de 41 espècies de 36 gèneres i 18 famílies. Tot i que moltes espècies es van identificar com a putatives, la llista de control italiana vigent va ser actualitzada amb 12 registres nous de gèneres i quatre d’espècies. *Longipedia coronata* Claus, 1862 (Canuelloida), *Diosaccus tenuicornis* (Claus, 1863), *Asellopsis hispida* Brady i Robertson, 1873, *Wellisopsyllus (intermediopsyllus) intermedius* (Scott i Scott, 1895) (totes Harpacticoida) van ser registrades per primera vegada a les costes de Sardeña. La comunitat de copèpodes va resultar particularment rica a l’illa d’Ogliastra, un illot rocallós amb esculls naturals, bancs de roques i praderies de *Posidonia oceanica*. Les espècies trobades a la zona estaven relacionades principalment amb sorres gruixudes i detritus macrofitos.

Dades publicades a GBIF (doi:10.15470/dxru6l)

Paraules clau: Copèpodes meiobèntics, Meiofauna, Biogeografia, Llista de control, Sardeña, Itàlia

Received: 02/01/2018; Conditional acceptance: 20/02/2018; Final acceptance: 22/06/2018

Nicholas Noli, Claudia Sbrocca, Maria Balsamo, Federica Semprucci, Dipartimento di Scienze Biomolecolari (DiSB), Università degli Studi di Urbino, 61029 Urbino, Italy.– Roberto Sandulli, Dipartimento di Scienze e Tecnologie (DiST), CoNISMa, Universita degli Studi di Napoli 'Parthenope’, 80143 Napoli, Italy.

Corresponding author: Federica Semprucci. E–mail: federica.semprucci@uniurb.it

**Introduction**

Copepoda Milne Edwards, 1840 is one of the largest and most diversified crustacean Subclasses. It includes over 10,000 species, 2,400 genera and 210 families (Appeltans et al., 2012). These crustaceans are found at any salinity level, from the supralittoral to the abyssal zone, and at all temperatures, from polar to tropical areas (Hicks and Coull, 1983; Giere, 2009). Copepoda are often the second most abundant meiofaunal taxon after Nematoda (Ansari et al., 2012; Sandulli et al., 2014; Semprucci et al., 2015, 2018) and even the most dominant taxon in marine algae and hard bottoms (Danovaro and Fraschetti 2002; Kotwicki, 2002). They are sensitive to pollutants, making them the best bioindicators along with Nematoda (Coull and Chandler, 1992; Frontalini et al., 2014; Semprucci et al., 2016).
Despite the importance of Copepoda and the increase in taxonomical studies, knowledge of the species of the Italian coasts is fragmentary. Most records have been reported for the Venice lagoon, the Po Delta (Adriatic Sea), the Gulf of Naples and the Genoa coast (Tyrrenian and Ligurian Sea, respectively) (Todaro and Ceccherelli, 2010), whereas little information is available on the composition of the copepod community of Sardinia (Pesce and Galassi, 1986; Ceccherelli and Mistri, 1990; Cottarelli and Bruno, 1993; Berera et al., 2001; Cottarelli et al., 2008).

The aim of this survey was to improve knowledge about Italian Copepoda Harpacticoida and Canuelloida, focusing on Sardinia, and in particular on the Ogliastra coast remained unexplored to date.

**Material and methods**

Sampling was carried out between 4 and 21 August 2015 along the coast of Ogliastra, on the eastern side of Sardinia, between Isolotto d’Ogliastra and Orrì Piscine. During the sampling, the sea was calm and water temperature was about 26 °C. The bottom was predominantly rocky, with submerged and emerging rocks interspersed with sandy deposits. *Posidonia oceanica* meadows are often common along the Ogliastra coast. Sampling depths ranged between 0–1 m and 21 m.

In detail, five sites were sampled (fig. 1):

- **Isolotto d’Ogliastra (IO)** is a small rocky island (latitude: 39.976110°N; longitude: 9.702327°E) surrounded by natural reefs and rocky shoals. Relevant *Posidonia oceanica* meadows covering the rocky bottom are present. This site is characterized by moderate human disturbance because it acts as a refuge for boats over summer only. Sediment samples were collected at a depth of 12 m from soft bottoms located offshore.

- **Cala Moresca (CM)** is a small creek near Arbatax harbour, beyond the northern limit of Porto Frailis (latitude: 39.934081°N; longitude: 9.715425°E). Human disturbance is moderate, consisting mainly of the transit of fishing boats, motorboats and ships, and also the presence of a resort. The sampling site was at a depth of 21 m.

- **Porto Frailis (PF)** is north of San Gemiliano and south of Cala Moresca (latitude: 39.924608°N; longitude: 9.706523°E). The beach is surrounded by two promontories with steep cliffs. The touristic infrastructure may be an important factor of disturbance in summer due to extensive traffic of yachts and ships in the gulf. Samples were collected at the shoreline.

- **San Gemiliano (SG)** is located between the town of Basaura and Porto Frailis (latitude: 39.919587°N; longitude: 9.700757°E). This area has a beach with numerous bathing resorts and residences. Besides the tourist impact here, there is also urban sewage flowing into the marine waters, particularly in summer. Samples were taken close to the shoreline in a sheltered area at the base of the promontory (0.10 m), far from the main beach. *P. oceanica* meadows are present near the sampling site.

- **Orrì (OR)**, located south of San Gemiliano, is a long beach with bathing resorts and tourism, making an impacting mainly in summer. The traffic of motorboats and yacht beyond 500 meters of the shore is moderate (latitude: 39.900411°N; longitude: 9.682187°E). The samples were taken in the intertidal zone.

The substratum at IO, CM and SG consisted of coarse sediments, while at PF and OR it was fine sands. All the samples contained vegetal material from seaweed and *Posidonia oceanica*.

The sediment was collected by a scuba diver from the upper two centimetres of the substratum (manual corer diameter 5 cm). At each site two samples were collected and
then treated with magnesium chloride (7% in aqueous solution) to narcotize meiofauna and then with formaldehyde (4% buffered seawater solution) to fix them (Hulings and Gray, 1976). Meiofaunal organisms were stained with Rose Bengal (0.5 g/l) before laboratory processing. In the laboratory, meiofaunal organisms were separated from sediment by washing through a set of 0.5 mm and 0.042 mm sieves. The extraction of specimens and their sorting into major taxa were performed under a stereomicroscope as reported in Semprucci et al. (2014). All the Harpacticoida and Canuelloida specimens were isolated, counted and identified to the lowest possible taxonomic level under a Nikon Optiphot–2 microscope equipped with Differential interference contrast (DIC). The identification was based on diagnoses and identification keys by Lang (1948, 1965), Huys and Boxshall (1991), Huys et al. (1992); Boxshall and Halsey (2004). The systematic position and the global geographical distribution of each taxon was discussed in accordance with the WoRMS database; Walter and Boxshall (2018) and main specific literature (Lang, 1948; Mielke, 1986; Bodin, 1997; Gee, 2006) (see table 1), while the Italian distribution was considered according to Todaro and Ceccherelli (2010). The biogeographical distribution of the marine Italian fauna was reported according to the subdivision of Italian seas reported in figure 2 (Bianchi, 2004) as follows: 1, Ligurian Sea; 2, Sardinia and Northern Tyrrenhenian Sea; 3, South Tyrrenhenian Sea and Strait of Sicily; 4, Strait of Messina; 5, South–eastern tip of Sicily, Pelagie Islands; 6, Ionian Sea; 7, Southern Adriatic Sea; 8, Central Adriatic Sea; 9, Northern Adriatic Sea.
<table>
<thead>
<tr>
<th>Taxa</th>
<th>Family</th>
<th>Subclase</th>
<th>Characteristic distribution</th>
<th>Ecological notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylindropsyllus</td>
<td>Family Cylindropsyllidae Sars, 1909</td>
<td>Copépodos</td>
<td>from the shallow water to the subtidal habitat</td>
<td>marine, sandy and muddy sediments, depth: 0.10–12 m</td>
</tr>
<tr>
<td>Enhydrosoma</td>
<td>Family Laophontidae Scott, 1904</td>
<td>Copépodos</td>
<td>from the subtidal to deep sea</td>
<td>marine, sandy and muddy sediments, depth: 10–27 m</td>
</tr>
<tr>
<td>Muller, sp. 1</td>
<td>Family Leptastacidae Lang, 1948</td>
<td>Copépodos</td>
<td>from shallow to subtidal habitat</td>
<td>marine, sandy and muddy sediments, from shallow to subtidal habitat</td>
</tr>
<tr>
<td>Rhizothrix</td>
<td>Family Paramesochridae Lang, 1944</td>
<td>Copépodos</td>
<td>from shallow to subtidal habitat</td>
<td>marine, sandy and muddy sediments, depth: 10–27 m</td>
</tr>
<tr>
<td>Haloschizopera</td>
<td>Family Parastenheliidae Lang, 1936</td>
<td>Copépodos</td>
<td>from shallow to subtidal habitat</td>
<td>marine, sandy and muddy sediments, depth: 10–27 m</td>
</tr>
<tr>
<td>Tisbe</td>
<td>Family Idyanthidae Lang, 1948</td>
<td>Copépodos</td>
<td>from shallow to subtidal habitat</td>
<td>marine, sandy and muddy sediments, depth: 10–27 m</td>
</tr>
<tr>
<td>Emertonia sp. 2</td>
<td>Family Canthocamptidae Brady, 1880</td>
<td>Copépodos</td>
<td>from shallow to subtidal habitat</td>
<td>marine, sandy and muddy sediments, depth: 10–27 m</td>
</tr>
<tr>
<td>Idyella</td>
<td></td>
<td>Copépodos</td>
<td>from shallow to subtidal habitat</td>
<td>marine, sandy and muddy sediments, depth: 10–27 m</td>
</tr>
<tr>
<td>Tisbe</td>
<td></td>
<td>Copépodos</td>
<td>from shallow to subtidal habitat</td>
<td>marine, sandy and muddy sediments, depth: 10–27 m</td>
</tr>
</tbody>
</table>

Results

A total of 225 individuals were collected and identified. Among them, we found forty–one species belonging to two orders (Canuelloida and Harpacticoida), 18 families and 36 genera (table 1; GBIF: doi:10.15470/dxru6l). Canuelloida order was represented only by one genus and species: *Longipedia coronata* Claus, 1862, while all the other taxa belonged to the Harpacticoida order.

The richest families of Harpacticoida were Miraciidae Dana, 1846 (8 species) and Paramesochridae Sars, 1903 (3), Laophontidae Scott, 1904 (3), Tetragonicipitidae Lang, 1944 (3) Cletodidae Scott, 1904 (2), Rhizotrichiidae Por, 1986 (2), Tisbidae Stebbing, 1910 (2), Ameiridae Boeck, 1865, Anconarolidae Sars, 1909, Cylindropsyllidae Sars, 1909, Harpacticidae Dana, 1846, Idynathidae Lang, 1948, Leptastacidae Lang, 1948, Orthopsyliidae Huys, 1990, and Parastenheliidae Lang, 1936 (all with one species). The families Miraciidae and Paramesochridae were also characterized by the highest number of genera: Miraciidae with 7 (Amphiascopsis Gurney, 1927, Amphiascus Sars, 1905, Bulbamphiascus Lang, 1944, Diosaccus Boeck, 1873, Haloschizopera Lang, 1944, Stenhelia Boeck, 1865, Typhlamphiascus Lang, 1944) and Paramesochridae with 3 genera (Emertonia Wilson, 1932, Paramesochra Scott, 1892, Wellsopsyllus Kunz, 1981).

The site IO was the richest (26 species), followed by OR and PF (8), CM (7) and SG (6). The following species were found only at IO: the Canuelloida *Longipedia coronata* Claus, 1863 (Longipediidae) and the Harpacticoida *Arenosetella germanica germanica* Kunz, 1937 (Ectinosomatidae), *Typhlamphiascus* spp., *Amphiascopsis* sp. 1, *Haloschizopera* sp. 1 (Miraciidae), *Emertonia* sp. 1 and 2, *Wellsopsyllus intermedius* (Scott and Scott, 1895).
Wellsopsyllus sp. 1, Paramesochra sp. 3 and 4 (Paramesochridae), Tetrarongiceps sp. 1 and 2, Phyllopodopsyllus sp. 1 (Tetragonicipitidae), Pseudolaophonte spinosa (Thompson, 1893) (Laophontidae) and Laophontodes sp. 1 (Ancorabolidae). CM showed a lower species number, but was the second richest site with several species only detected there: Stenhelia sp. 1 (Miriacciidae), Bryocamptus sp. 1 (Canthocamptidae), Enhydrosoma propinquum (Brady, 1880) (Cletodidae), Tryphoema sp. 1 (Rhizotrichidae), Laophonte cornuta Philippi, 1840 and Asellopsis hispida (Brady and Robertson, 1873) (Laophontidae).

As table 1 shows, most specimens found in this study were identified as putative species.

Discussion and conclusions

Studies on the marine meiofauna have increased considerably in number in the last decades, but few updated lists of species have been published. This is a relevant problem in advancing new hypotheses on the distribution and biogeography of a meiobenthic group. Moreover, the information present in large faunistic databases such as WoRMS may underestimate the real distribution of the species because a number of data have been published in scientific journals with only local diffusion (Semprucci, 2013; Semprucci and Balsamo, 2015). In the present study, representatives of two copepod orders, Canuelloidea and Harpacticoida, were found. Considering data currently available, 12 genera (Bradya Boeck, 1873, Bryocamptus Chappuis, 1929, Cletodes Brady, 1872, Cletocamptus Schmankevitsch, 1875, Emertonia, Haloschizopera, Idylla Sars, 1905, Laophontodes Scott, 1894, Psammastacus Apostolov and Marinov, 1988, Pseudolaophonte Scott, 1896, Rhizothrix Sars, 1909, Stenhelia, Tetrarongiceps Brady, 1880, Typhlamphiascus, Tryphoema Monard, 1926, Wellsopsyllus) and 4 species (the Canuelloidea Longipedia coronata and the Harpacticoida Diosaccus tenuicornis, Asellopsis hispida, Wellsopsyllus (intermediopsyllus) intermedius) represent new records for Sardinia and also for Italian coasts (Todaro and Ceccherelli, 2010).

Most sediments of the study area are coarse sands rich in vegetal detritus from seaweeds and P. oceanica. Copepods become typically more abundant with the increase in grain size (Losi et al., 2012; Semprucci et al., 2015) and are often associated with algal or seagrass detritus (Ceccherelli and Mistri, 1990; Mascart et al., 2013, 2015). As reported in the cited literature, the presence of macrophytal detritus may play an important role as a refuge and food source for these animals, increasing their abundance and diversity (e.g. families Laophontidae, Miraciidae and Tissidiae).

Some copepods develop peculiar adaptations to their habitat. For instance, Tissidiae are good swimmers, well-adapted to high hydrodynamic conditions, and mainly found, in fact, close to the foreshore that is more exposed to wave action (SG, PF). Tissidiae also have short reproductive cycles and they are often used as target species in laboratory experiments and as indicators of pollution (Gee et al., 1985; Hutchinson and Williams, 1989; Williams, 1992; Villano and Warwick, 1995). Miraciidae like D. tenuicornis are known to colonize subtidal habitats up to 1.16 m in depth (Sönmez et al., 2014). In the study area, D. tenuicornis was found only in the shoreline of Porto Frailis, in association with P. oceanica fragments. In this species, the presence of elongated and prehensile limbs is often regarded as adaptation to phytal habitats (Giere, 2009; Zaleha et al., 2010; Mascart et al., 2015). Instead, species with a typical mesopsammic look (e.g. Cylindropsyllus sp. 1, Psammastacus confluens and Rhizothrix sp. 1) were all found in the fine sands of Orrì. They show small, cylindrical and spindle-shaped bodies that allow them to live in the interstitial waters of the sediments (Lang, 1948).

The richness of Isolotto d’Ogliastra (IO) was notably higher (26 species) than in the other sites that all showed comparable values (i.e. from 6 to 8). The high richness at IO is likely related to the high naturalistic value of the area that is characterized by the presence of the widest seagrass system (P. oceanica) of the study area. Furthermore, an overall lower human
disturbance was present at IO than at the other sites that are subject to a higher touristic pressure. Several copepod species are, in fact, sensitive to environmental impacts and are often considered as bioindicators along with nematodes in ecological studies (Danovaro et al., 2002; Frontalini et al., 2014; Semprucci et al., 2015). Among the species unique to IO, we found samples of the genera Longipedia, Arenosetella and Wellsopsyllus that some authors highlighted as sensitive to pollution (Oviatt et al., 1982; Huys et al., 1992). In contrast, the site with the presence of sewage discharges and extensive traffic of yachts and ships (San Gemiliano) was the site with the lowest number of species reported, with genera recognized for their high survival capacities (namely Ameira, Amblyiascus Bulb amphiascus, Cletocamptus and Tisbe) (Anger and Scheibel, 1976; Gee et al., 1985; Coull and Chandler, 1992; Gee, 1999; Bejarano and Chandler, 2003; Giere, 2009).

In conclusion, the Ogliastria coast showed a good level of Copepoda richness comparable to other areas of the Mediterranean basin (e.g. Ceccherelli and Mistri, 1990; Mascart et al., 2015). Some environmental features of the study area such as the coarse grain size and the abundant macrophytal detritus concur in creating suitable life conditions for this meiobenthic group. This is underlined by the number of species documented (41) that, despite the low sampling effort in this study, covered 15 and 20% of the number of benthic meiobenthic group. This is underlined by the number of species documented (41) that, despite the low sampling effort in this study, covered 15 and 20% of the number of benthic copepod species known for the West Mediterranean Sea (283 species) and Italian coasts (210) (Todaro and Ceccherelli, 2010; Chertoprud et al., 2010). Thus, the new information collected in this survey represents a relevant update on the copepod fauna not only for Sardinia but also for the Italian and Mediterranean coasts.

References


Chertoprud, E. S., Azovsky, A. I., 2001. Harpacticoida from a seasonal field survey in the White Sea. Moscow State University, [http://dx.doi.org/10.14284/27](http://dx.doi.org/10.14284/27)


Eswari Y. N. K., Ramanibai, R., 2004. Estuarine copepod abundance and diversity in rela-


Tremblay, M. J., Anderson, J. T., 1984. Annotated Species List of Marine Planktonic Copepods Occurring on the Shelf and Upper Slope of the Northwest Atlantic (Gulf of Maine to Ungava Bay). *Canadian Special Publication of Fisheries and Aquatic Sciences*, 69.


