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

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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 vigente 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.

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 epecies encontradas en la zona estaban relacionadas principalmente con arenas gruesas y detritos macrófitos.

Datos publicdos 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 Sardenya, 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 faunístic a la costa est de Sardenya (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, *Wellsopsyllus (intermediopsyllus) intermedius* (Scott i Scott, 1895) (totes Harpacticoida) van ser registrades per primera vegada a les costes de Sardenya. 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 macròfits.

Dades publicades a GBIF (doi:10.15470/dxru6l)

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

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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 crustaciansare 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 (Tyrrhenian 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

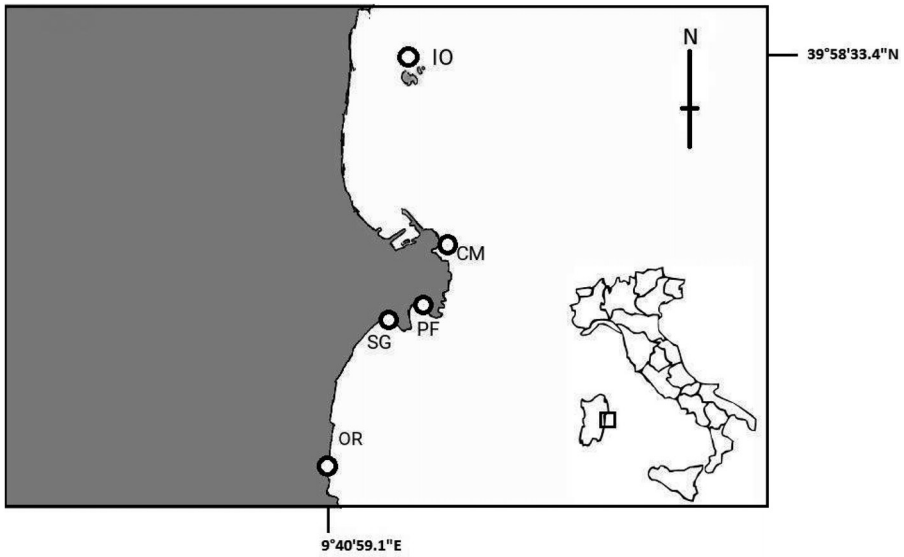

Fig. 1. Location map of the study area (Eastern Sardinia, Italy), with sampling stations: IO, Isolotto d'Ogliastra; CM, Cala Moresca; PF, Porto Frailis; SG, San Gemiliano; OR, Orrì.
Fig. 1. Mapa de situación del área de estudio (este de Cerdeña, Italia) con los puntos de muestreo: IO, islote de Ogliastra; CM, cala Moresca; PF, Porto Frailis; SG, San Gemiliano; OR, Orrì.

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 Tyrrhenian Sea; 3, South Tyrrhenian 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 1. List of Harpacticoida and Canuelloida (Subclass Copepoda) found for the Ogliastra coast (Sardinia, Tyrrhenian Sea, Italy). Ss, Sampling sites: IO, Isolotto d'Ogliastra; CM, Cala Moresca; PF, Porto Frailis; SG, San Gemiliano; and OR, Orrì. BIs, Biogeographical Italian sectors: 1, Ligurian Sea; 2, Sardinia and Northern Tyrrhenian Sea; 3, South Tyrrhenian 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. Data published through GBIF (doi:10.15470/dxru6l).

Tabla 1. Lista de Harpacticoides y Canuelloides (subclase Copépodos) hallados en la costa de Ogliastra (Cerdeña, mar Tirreno, Italia). Ss, Puntos de muestreo: IO, Islote de Ogliastra; CM, Cala Moresca; PF, Porto Frailis; SG, San Gemiliano; y OR, Orrì. BIs, sectores biogeográficos italianos: 1, Mar de Liguria; 2, Cerdeña y norte del mar Tirreno; 3, Sur del mar Tirreno y estrecho de Sicilia; 4, Estrecho de Mesina; 5, extremo sudeste de Sicilia, islas Pelagias; 6, Mar Jónico; 7, Sur del mar Adriático; 8, Mar Adriático central; 9, Norte del mar Adriático. Datos publicados en GBIF (doi:10.15470/dxru6l).

Taxa	Ss	Characteristics Ss	Global distribution	Ecological notes	BIs
Order Canuelloida Khodami, Vaun MacArthur, Blanco–Bercial and Martinez Arbizu, 2017					
Family Longipediidae Boeck, 1865					
Longipedia coronata Claus, 1862	IO	coarse sands subtidal zone, depth: 12 m	Denmark Strait (Iceland); Norwegian Sea (Norway); North Sea (Sweden, Helgoland, Scotland, England, Norway, Netherlands); Baltic Sea (Germany); Irish Sea (Scotland, England); English Channel (England); North–eastern Atlantic Ocean (Ireland); Adriatic Sea; Tyrrhenian Sea (Italy); Mediterranean Sea (Algeria, Tunisia); Indian Ocean (India) (Lang, 1948; Huys, 2001; Apostolov, 2014; Rajkumar et al., 2014 and references therein)	marine, mixed muddy and sandy sediments and on macroalgae from shallow to lower shore, depth: 1–150 m, found also at 360 m	3,9
Order Harpacticoida Sars, 1903					
Family Ectinosomatidae Sars, 1903					
Arenosetella germanica germanica Kunz, 1937	IO	coarse sands, subtidal zone, depth: 12 m	Baltic Sea (Germany); North Sea (France, Belgium, Netherlands, Denmark, Germany); British Isles (England); South Arabian Sea (India); Indian Ocean (Bay of Bengal, India, Andaman and Nicobar); Mozambique Channel (Madagascar, Mozambique); Aegean Sea and Levantine Sea (Turkey); South–eastern Pacific Ocean (Chile, Panama) (Lang, 1948; Rao and Misra, 1983; Mielke, 1986; Wells and Rao, 1987; Cattrijsse and Vincx, 2001; Huys, 2001; Muller, 2004; Sugumaran et al., 2009; Willems et al., 2009; Mantha et al., 2012; Bakir et al., 2014 and references therein)	marine, brackish and fresh, muddy and sandy, depth: 12 m sediments and on macroalgae, shallow water	2
Bradya sp. 1	OR,IO	coarse sands, intertidal and subtidal zones, depth: 0.20 and 12 m		deep sea	
Halophytophilus sp. 1	PF, OR	fine sands, shoreline and intertidal zone, depth: 0.10–0.20 m			
Family Harpacticidae Dana, 1846					
Harpacticus littoralis Sars, 1910	PF, OR, IO	fine and coarse sands, shoreline, intertidal and subtidal zones, depth: 0.10–12 m	Norwegian Sea (Norway); North Sea (Norway, Sweden, Germany, Helgoland, England, Netherlands); North–eastern Atlantic Ocean (Ireland, France); Mediterranean Sea (France, Algeria, Tunisia, Italy); Aegean Sea (Greece, Turkey); Black Sea (Romania, Ukraine); White Sea (Russia); North–western Atlantic Ocean (North America);South and North Pacific Ocean (Easter Island, Chile, California); Indian Ocean (India) (Lang, 1948, 1965; Arunachalam and Balakrishnan Nair, 1988; Herman, 1989; Goddard, 2003; Muller, 2004; Apostolov, 2008; Ustaoğlu et al., 2012; Vorobyova et al., 2016 and references therein)	marine and estuarine littoral, associated with macroalgae, shallow coastal water	2,8,9
Family Tisbidae Stebbing, 1910					
Tisbe sp. 1	SG, PF, IO	fine and coarse sands, shoreline and subtidal zone, depth: 0.10–12 m			
Tisbe sp. 2	SG	coarse sands shoreline, depth: 0.10 m			
Family Idyanthidae Lang, 1948					
Idyella sp. 1	PF	fine sands, shoreline, depth: 0.10 m			
Family Parastenheliidae Lang, 1936					
Foweya anglica (Norman and Scott, 1905)	PF	fine sands, shoreline, depth: 0.10 m	North–eastern Atlantic Ocean (Isles of Scilly in England. South-western Africa) (Boxshall and Halsey, 2004; Gee, 2006)	marine, shallow coastal water	new record in Italy
Family Miraciidae Dana, 1846					
Amphiascus sp. 1	SG, IO, CM	coarse sands, shoreline and subtidal zone, depth: 0.10–21 m			
Bulbamphiascus sp. 1	SG, PF, IO	fine and coarse sands, shoreline and subtidal zone, depth: 0.10–12 m			
Diosaccus tenuicornis (Claus, 1863)	PF	fine sands, shoreline, depth: 0.10 m	Norwegian Sea and North Sea (Norway, Sweden, Germany, England, Belgium); Baltic Sea (Sweden); Irish Sea (England); English Channel (France); North–eastern Atlantic Ocean (England, Isles of Scilly, Ireland, France, Canary Islands); Mediterranean Sea (France, Tunisia, Algeria, Italy); Aegean Sea (Turkey); Adriatic Sea and Tyrrhenian Sea (Croatia, Italy) Suez Canal (Egypt); Southwest and North–western Atlantic Ocean (South America, Canada, North America, Ungava Bay, Quebeq); North Pacific Ocean (Lang, 1948; Shih et al., 1971; Polk, 1976; Tremblay and Anderson, 1984; Hayward and Ryland, 1990; Huys, 2001; Veit–Köhler et al., 2010; Alper et al., 2015 and references therein)	marine, littoral algae or detritus, shallow water sediments and tidal pools	4,9
Typhlamphiascus sp. 1	IO	coarse sands, subtidal zone, depth: 12 m			
Typhlamphiascus sp. 2	IO	coarse sands, subtidal zone, depth: 12 m			
Haloschizopera sp. 1	IO	coarse sands, subtidal zone, depth: 12 m			
Stenhelia sp. 1	CM	coarse sands, subtidal zone, depth: 21 m			
Amphiascopsis sp. 1	IO	coarse sands, subtidal zone, depth: 12 m			
Family Ameiridae Boeck, 1865					
Ameira parvula (Claus, 1866)	SG, PF, IO	fine and coarse sands, shoreline and subtidal zone, depth: 0.10–12 m	Norwegian Sea (Norway); North Sea (Norway, Sweden, Germany, Netherlands, Scotland); Baltic Sea (Sweden, Germany); British Channel (England, France); North–eastern Atlantic Ocean (Ireland); Mediterranean Sea (France, Italy, Tunisia, Egypt); Ligurian Sea, Adriatic Sea (Italy); Aegean Sea (Greece); Black Sea (Romania, Bulgaria, Ukraine); North–western Atlantic Ocean (North America, Bermuda Island, Brazil); South Pacific Ocean (New Zealand); Yellow Sea, East China Sea, Sea of Japan (Korea); Indian Ocean (Bay of Bengal, India) (Lang, 1948; Cattrijsse and Vincx, 2001; Muller, 2004; Chang, 2007; Webber et al., 2010; Mantha et al., 2012; Sarmento and Parrera Santos, 2012 and references therein)	marine and brackish, debris and sandy bottom, shallow water sediments and tidal pools, depth: 0–30 m	1,2,3,8,9
Family Paramesochridae Lang, 1944					
Emertonia sp. 1	IO	coarse sands, subtidal zone, depth: 12 m			
Emertonia sp. 2	IO	coarse sands, subtidal zone, depth: 12 m			
Wellsopsyllus (Intermediopsyllus) intermedius (Scott and Scott, 1895)	IO	coarse sands, subtidal zone, depth: 12 m	North Sea (Helgoland, Germany, France); Irish Sea (Scotland, England); North–eastern Atlantic Ocean (England); White Sea (Russia) (Lang, 1948; Chertoprud and Azovsky, 2001; Huys, 2001; Muller, 2004; Plum and George, 2009; George, 2013 and references therein)	marine, sandy and muddy sediments, tidal zone and shallow depth	new record in Italy
Paramesochra sp. 3	IO	coarse sands, subtidal zone, depth: 12 m			
Paramesochra sp. 4	IO	coarse sands, subtidal zone, depth: 12 m			
Wellsopsyllus sp. 1	IO	coarse sands, subtidal zone, depth: 12 m			
Family Tetragonicipitidae Lang, 1944					
Tetragoniceps sp. 1	IO	coarse sands, subtidal zone, depth: 12 m			
Tetragoniceps sp. 2	IO	coarse sands, subtidal zone, depth: 12 m			
Phyllopodopsyllus sp. 1	IO	coarse sands, subtidal zone, depth: 12 m			
Family Canthocamptidae Brady, 1880					
Cletocamptus sp. 1	SG	coarse sands, shoreline, depth: 0.10 m			
Bryocamptus sp. 1	CM	coarse sands, subtidal zone, depth: 21 m			
Stenocaris minor (Scott, 1892)	OR, IO	fine and coarse sands, intertidal and subtidal zones, depth: 0.20–12 m	North Sea (Sweden, Helgoland, Germany); Irish Sea (Scotland); North–eastern Atlantic Ocean (France); North–western Atlantic Ocean (United States); Indian Ocean (Bay of Bengal and Indian estuaries) (Lang, 1948; Craeymeersh et al., 1986; Huys et al., 1992; Huys, 2001; Eswari and Ramanibai, 2004 and references therein)	marine and fresh, sandy bottom, depth: 10 m	2
Family Orthopsyllidae Huys, 1990					
Orthopsyllus sp. 1	OR, IO	fine and coarse sands, intertidal and subtidal zones, depth: 0.20–12 m			
Family Cylindropsyllidae Sars, 1909					
Cylindropsyllus sp. 1	OR	fine sands, intertidal zone, depth: 0.20 m			
Family Leptastacidae Lang, 1948					
Psammastacus confluens (Nicholls, 1935)	OR	fine sands, intertidal zone, depth: 0.20 m	Irish Sea (Scotland); Ebre Rivermouth (Spain) (Lang, 1948; Sabater, 1986; Huys, 2001 and references therein)	marine, sandy bottom, shallow subtidal zone	new record in Italy
Family Cletodidae Scott, 1904					
Enhydrosoma propinquum (Brady, 1880)	CM	coarse sands, subtidal zone, depth: 21 m	Norwegian Sea (Norway); North Sea (Norway, Sweden, Germany, Scotland, Netherlands, England, Belgium); Irish Sea (Scotland, England); North–eastern Atlantic Ocean (Scotland, Isles of Scilly, France, Ireland, Spain); Mediterranean Sea (Algeria, Tunisia, France); Adriatic Sea (Italy, Slovenia, Croatia); Black Sea; Northeast Pacific Ocean (Mexico); North–western Atlantic Ocean (Unites States) (Lang, 1948; Cattrijsse and Vinx, 2001; Por,1964; Fiers, 1996; Huys, 2001; Gomez, 2003; Muller, 2004 and references therein)	marine, sandy and muddy sediment, from shallow to subtidal habitat, depth: 0–27 m	2,9
Cletodes sp. 1	IO	coarse sands, subtidal zone, depth: 12 m			
Family Rhizotrichidae Por, 1986					
Tryphoema sp. 1	CM	coarse sands, subtidal zone, depth: 21 m			
Rhizothrix sp. 1	OR	fine sands, intertidal zone, depth: 0.20 m			
Family Laophontidae Scott, 1904					
Laophonte cornuta Philippi, 1840	CM	coarse sands, subtidal zone, depth: 21 m	Norwegian Sea (Norway); North Sea (Norway, Sweden, Scotland, Shetland Islands); Irish Sea (England); English Channel (England, France); North–eastern Atlantic Ocean (Isles of Scilly in England, Ireland, Canary Island, Gulf of Guinea); Mediterranean Sea (France, Italy, Tunisia); Ligurian Sea, Tyrrhenian Sea, Adriatic Sea (Italy, Croatia); Suez Canal and Red Sea (Egypt); Aegean Sea; South–eastern Atlantic Ocean (South Africa); North–western Atlantic Ocean (United States, Bermuda Island); South–western Atlantic Ocean (Islas Malvinas); Indian Ocean (Tasmania, New Zealand, Laccadive Island, Madagascar); Gulf of Mexico (Mexico); Pacific Ocean (Nicholls, 1944; Lang, 1948; Rao and Misra, 1983; Cattrijsse and Vincx, 2001; Huys, 2001; Muller, 2004; Gheerardyn et al., 2008; Felder and Camp, 2009; Webber et al., 2010; Yildiz and Karaytug, 2018 and references therein)	marine, on algae and associated on marine invertebrates, deep zone	1,2,3
Asellopsis hispida Brady and Robertson, 1873	CM	coarse sands, subtidal zone, depth: 21 m	North Sea (Norway, Sweden, Germany, Scotland); Irish Sea (Scotland); English Channel (England); North–eastern Atlantic Ocean (England, France); Mediterranean Sea (France); Adriatic Sea (Italy) (Lang, 1948; Herman, 1989; Huys, 2001 and references therein)	marine, from sandy to muddy sediments, depth: 10–85 m	3,9
Pseudolaophonte spinosa (Thompson, 1893)	IO	coarse sands, subtidal zone, depth: 12 m	North Sea (Norway, Sweden, Scotland, Germany, England); Irish Sea (England); Indian Ocean (Andaman and Nicobar Islands) (Lang, 1948; Wells and Rao, 1987; Herman, 1989; Huys, 2001 and references therein)	marine, coarse sand, depth: until 60 m	new record in Italy
Family Ancorabolidae Sars, 1909					
Laophontodes sp. 1	IO	marine, coarse sands, subtidal zone, depth: 12 m			

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 Lang, 1944 (6), followed by Canthocamptidae Brady, 1880 (3), Ectinosomatidae Sars, 1903 (3), Laophontidae Scott, 1904 (3), Tetragonicipitidae Lang, 1944 (3) Cletodidae Scott, 1904 (2), Rhizotrichidae Por, 1986 (2), Tisbidae Stebbing, 1910 (2), Ameiridae Boeck, 1865, Ancorabolidae Sars, 1909, Cylindropsyllidae Sars, 1909, Harpacticidae Dana, 1846, Idyanthidae Lang, 1948, Leptastacidae Lang, 1948, Orthopsyllidae 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),

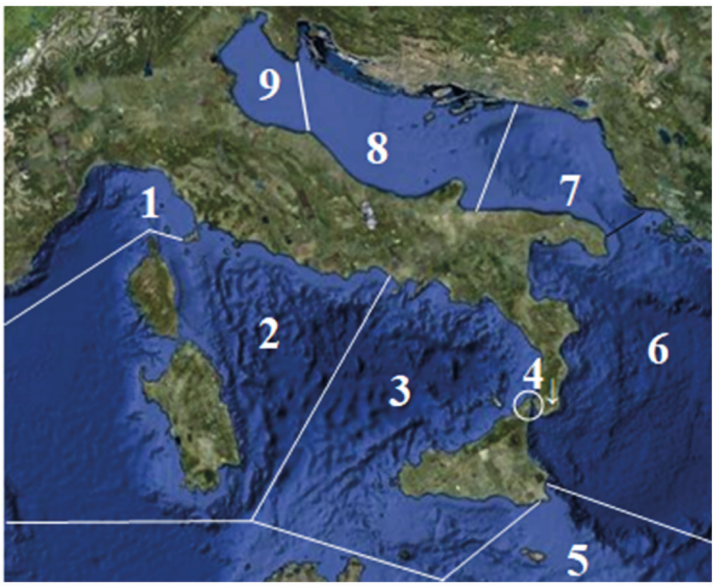

Fig. 2. Subdivision of the biogeographical Italian seas according to Bianchi (2004).

Fig. 2. Subdivisión biogeográfica de los mares italianos según Bianchi (2004).

Wellsopsyllus sp. 1, *Paramesochra* sp. 3 and 4 (Paramesochridae), *Tetragoniceps* sp. 1 and 2, *Phyllopodopsyllus* sp.1 (Tetragoniciptidae), *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 (Miraciidae), *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, Canuelloida and Harpacticoida, were found. Considering data currently available, 12 genera (*Bradya* Boeck, 1873, *Bryocamptus* Chappuis, 1929, *Cletodes* Brady, 1872, *Cletocamptus* Schmankevitsch, 1875, *Emertonia*, *Haloschizopera*, *Idyella* Sars, 1905, *Laophontodes* Scott, 1894, *Psammastacus* Apostolov and Marinov, 1988, *Pseudolaophonte* Scott, 1896, *Rhizothrix* Sars, 1909*, Stenhelia*, *Tetragoniceps* Brady, 1880, *Typhlamphiascus*, *Tryphoema* Monard, 1926*, Wellsopsyllus*) and 4 species (the Canuelloida *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 Tisbidae).

Some copepods develop peculiar adaptations to their habitat. For instance, Tisbidae 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). Tisbidae 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 l 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*, *Amphiascus Bulbamphiascus*, *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 Ogliastra 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 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.

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