Bollettino della Società Paleontologica Italiana, 55 (3), 2016, 205-217. Modena

Ostracods associated with cold-water corals in the Pleistocene of Scoppo (Messina, Sicily) and description of two new species

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KEY WORDS - Marine ostracods, Deep-water corals, New species, Early Pleistocene, Sicily.

ABSTRACT - Ostracod assemblages associated with deep-water corals from the Pleistocene (early Calabrian - MNN19b and 19c biozones) sedimentary succession cropping out along the Scoppo hill (Messina, Sicily) have been studied. Thirty-five taxa were recognized in the samples examined. The association mainly consisted of Pseudocythere caudata *Sars, 1866, followed by* Macrocyprina succinea *(Müller, 1894),* Bythocypris obtusata *(Sars, 1866),* B. bosquetiana *(Brady, 1866),* Paradoxostoma simile *Müller, 1894 and* Sclerochilus contortus *(Norman, 1862). It has been attributed to a palaeoenvironment located within the deeper horizons of the Circalittoral Zone and higher horizons of the Bathyal Zone. The presence and abundance of shallow water phytal taxa of the genera* Paradoxostoma, Paracytherois *and* Sclerochilus *has been explained by the capability of these organisms to extend towards deep environments in the presence of food resources availability. In the Scoppo palaeoenvironment food was presumably provided by organic matter produced by deep coral colonies, as observed for comparable communities in North Atlantic, the Caribbean Sea and off Santa Maria di Leuca in the Mediterranean. Some particularly significant species are illustrated, and two species, i.e.,* Bythocythere agostinae *n.sp. and* Microxestoleberis scillae *n. sp. are described.*

RIASSUNTO - [Ostracodi associati a coralli profondi del Pleistocene di Scoppo (Messina, Sicilia) e descrizione di due nuove specie] *- Sono state studiate le associazioni ad ostracodi associati a coralli profondi, provenienti dalla successione sedimentaria pleistocenica (Calabriano inferiore - biozone MNN19b e MNN19c) affiorante lungo il fianco della collina di Scoppo (ME, Sicily). Nei campioni esaminati sono stati riconosciuti 35 taxa. L'associazione prevalente è costituita da* Pseudocythere caudata *Sars, 1866, seguita da* Macrocyprina succinea *(Müller, 1894),* Bythocypris obtusata *(Sars, 1866),* B. bosquetiana *(Brady, 1866),* Paradoxostoma simile *Müller, 1894 e* Sclerochilus contortus *(Norman, 1862) ed è stata riferita ad un paleoambiente collocato tra i livelli più profondi del Piano Circalitorale ed i livelli più elevati del Piano Batiale. La presenza e abbondanza di taxa fitali tipici di acque basse appartenenti ai generi* Paradoxostoma, Paracytherois *e* Sclerochilus *in questi ambienti è stata spiegata con la capacità di questi organismi di spostarsi verso aree in cui è possibile reperire maggiori risorse trofiche al fondo. Nel paleoambiente documentato a Scoppo l'incremento in nutrimento era presumibilmente legato alla materia organica prodotta nell'associazione a coralli profondi, analogamente a quanto osservato per associazioni attuali in Nord Atlantico, nel Mar dei Caraibi e al largo di Santa Maria di Leuca, in Mediterraneo. Nel presente lavoro, inoltre, alcune specie particolarmente significative dal punto di vista ecologico e/o sistematico sono state illustrate e commentate. Due specie,* Bythocythere agostinae *n. sp. e* Microxestoleberis scillae *n. sp., sono descritte come nuove.*

INTRODUCTION AND GEOLOGICAL SETTING

Plio-Pleistocene deep water sediments are exposed in several localities of Sicily, mostly along the coastline. Their ostracod associations have been studied from southern areas such as Monte St. Nicola (Aiello et al., 2000) and Capo Rossello (Aiello & Barra, 2001), as well as from eastern areas, such as Centuripe (Sciuto et al., 2003) and Serra San Biagio (Sciuto, 2015), and the north-eastern sector of the island at Capo Milazzo (Sciuto, 2014a) and Furnari (Sciuto & Rosso, 2008).

One of the most interesting areas to study these sediments is the Straits of Messina, where a complex series of lenses and wedge-shaped Plio-Pleistocene sedimentary bodies crop out on both Sicily and Calabria sides. In particular, along the Sicily side, near Messina, Plio-Pleistocene discontinuous deposits unconformably lay on a strongly faulted substrate, which locally consists of Middle-Upper Miocene siliciclastic successions, a brecciated Messinian "Calcare di base", or by metamorphic rocks of the Calabride Complex (Vertino, 2003; Vertino et al., 2013).

The basal part of the Plio-Pleistocene succession consists of the Lower Pliocene "Trubi" Formation, represented by whitish foraminiferal marls and marly limestones. These Plio-Pleistocene discontinuous deposits, as well as the basement, are both unconformably overlain by bathyal facies and circalittoral to infralittoral deposits (Barrier et al., 1987; Vertino, 2003; Vertino et al., 2013). Sediments interpreted as deposited in bathyal environments include: Carbonate-dominated Facies (CF) and Siliciclastic dominated Facies (SF). The CF facies mainly consisted of cold-water coral rudstones, formed almost exclusively of skeletal fragments of frame-building deep-water scleractinians. Coral rudstones interfinger with calcarenites and carbonate sands containing scattered isidiid octocorals and only rare scleractinians. Locally, these facies are truncated by erosional surfaces and overlain by debris flow deposits containing polygenic boulders (up to two metres in size) floating in a coral rubble matrix. The SF facies is represented by marly clays and silty clays containing scattered soft-bottom species among which the corals *Caryophyllia communis* (Seguenza, 1863) and *Flabellum* sp., and embedding large coral rudstone boulders whose surface is typically colonised by bathyal hard-bottom species belonging to corals, bivalves, serpulids and bryozoans (Vertino, 2003). In exceptionally well preserved outcrops, these silty to clayey sediments

ISSN 0375-7633 doi:10.4435/BSPI.2016.18

Fig. 1- Geographical location of Scoppo section (image from Google Earth).

crop out adjacent to sindepositional palaeofault planes, which produced steep cliffs in the palaeodepositional basin and whose surfaces are partially preserved and still covered by encrusting faunas (Barrier, 1984; Di Geronimo et al., 2005). Circa to infralittoral sediments of Middle Pleistocene age forming the "Upper Gravels and Sands" of Barrier (1984) follows, in turn overlain by the Messina formation, i.e. clinostratified gravels and sands deposited in a wide Gilbert-delta depositional system.

Knowledge on Cenozoic ostracod fauna of this area essentially relay on papers dating back to the last 19th century (Seguenza, 1883a, 1883b - 1885) and to critical reviews of them (Müller, 1912; Ruggieri, 1989) without access to further samples.

The present paper is part of a wide program of systematic, stratigraphic and palaeoecological revision on the Pleistocene of the Messina side of the Straits (Vertino et al., 2010, 2013). It focuses on a 2.5 metres thick richly fossiliferous sedimentary succession cropping out along the Scoppo hill, west of Messina (Fig. 1) (IGM 1:25000 scale map "Messina", Sheet 254 IV SO; 38.20129° N; 15.54462° E) and aims to update ostracod knowledge from Pleistocene sediments of the Strait area.

MATERIALS AND METHODS

The sedimentary succession of Scoppo starts from the bottom with brecciate evaporitic limestones referred to the Messinian, unconformably covered by a sedimentary sequence (Figs 2-3) consisting predominantly of white coral rudstones with *Madrepora oculata* (Linnaeus, 1758), *Desmophyllum pertusum* (Linnaeus, 1758), and *D. dianthus* (Esper, 1794), passing laterally and upwards to poorly cemented white marls which contain sparse corals and, locally, cirriped remains (see Vertino et al., 2013). These sediments were deposited during the MNN19b and 19c biozones of *Globigerina cariacoensis* Rogl & Bolli, 1937 and *Globorotalia inflata* (d'Orbigny, 1839) (Baldanza pers. com.; Vertino et al., 2010, 2013), corresponding to the Santernian.

For the present study, a total of seven samples were collected from the Quaternary succession (Figs 2-3); 300 cm^3 of sediment per sample were routinely washed and ostracod picked up from the > 63 µm fraction. The specimens were examined and measured under a stereomicroscope and photographed using a LMU Tescan Vega II Scanning Electron Microscope.

The presence of carapaces and valves, as well as of juveniles, is indicated in Tab. 1. The palaeoecological interpretation and the distinction between autochthonous and allochthonous species was done based on autoecological data available for living species, and especially on the syntheses by Guernet & Lethiers (1989), Montenegro et al. (1996), and Smith & Horne (2002). For extinct species inferences were made on the basis of comparable characters present on allied taxa. Therefore ostracods have been grouped into associations based on their current distribution in different areas of the benthic domain as defined by Pérès & Picard (1964) and successfully applied to fossil community interpretation (Sciuto et al., 2003; Sciuto, 2015; Sciuto & Rosso, 2015, inter alias). Ostracod associations were grouped as: species typical of shallow water, species typical of the Circalittoral Zone, and species typical of the Circalittoral-Bathyal Zone. A group including species with no particular meaning and/or misrepresented and/or reworked species was also added.

The analyzed material is housed in the palaeontological section of the Museo di Scienze della Terra of the University of Catania. The repository number of the holotypes and the paratypes is given in the systematic descriptions.

RESULTS

Thirty-five taxa of ostracods were identified from the sedimentary succession of Scoppo, most of them determined at species level and only some at genus level (Tab. 1). The section (Figs 2-3), consists of a lower part of predominantly white coral rudstones with subordinate marly layers (from where samples 1-4 were collected), and by an upper part predominantly formed by loose sediments (marls and silty-marls), from where the samples 5-7 originate.

Fig. 2 - The sedimentary succession cropping out at Scoppo with position of the studied samples.

Ostracods from the lower part show low taxa richness (17) and poor specimen abundances (84). The most abundant and common species is *Pseudocythere caudata* Sars, 1866, followed by *Bythocypris obtusata* (Sars, 1866), all the other found species are rare and/or poorly represented (Tab. 1); among them *B. bosquetiana* (Brady, 1866) is the most significant. In contrast, ostracod associations are more diversified (30 taxa) and more abundant (327 specimens) in the upper layers. The most abundant and common species is again *P. caudata,* followed by *Macrocyprina succinea* (Müller, 1894), *Paradoxostoma simile* Müller, 1894 and *Sclerochilus contortus* (Norman, 1862). In general, the specimens abundance increases more than the specific diversity in the upper part of the stratigraphic sequence (Fig. 4).

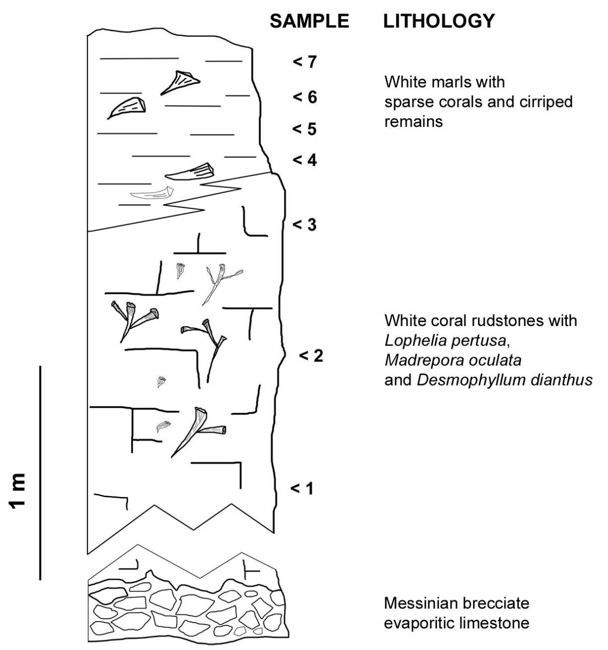


Fig. 3 - Stratigraphic log of Scoppo (from Vertino et al., 2010 mod.).

Most ostracod species (26 out of 35 species) are known to thrive in deep marine environments (Fig. 5) and were thus considered as constituents of the in situ original assemblages. The remaining species, always rare and poorly represented, include shallow water species of the genera *Aurila*, *Loxoconcha, Carinocythereis,* and *Eucythere*, and have been considered seemingly displaced and constituted the allochthonous component of the fauna (Tab. 1).

Among the ostracod taxa found along the succession of Scoppo, three species showed characters that cannot be ascribed to any of the already known species, two of them, are described as new species while the third one is left in open nomenclature owing to the paucity of material. Furthemore, some species significantly abundant and ecologically interesting or poorly reported from Sicily are listed and commented.

Bythocypris bosquetiana (Brady, 1866)

This species has been found prevalently in the upper part of the studied sequence. Living specimens of this species occurs in the Atlantic-Mediterranean region from the deeper horizons of the Circalittoral Zone to the Bathyal and Abyssal zones (Puri & Dickau, 1969; van Harten & Drost, 1988).

As fossil, it has been found in sediments referable to deep water environments (Colalongo & Pasini, 1980, 1988; Sciuto, 2003, 2005; Sciuto & Rosso, 2008, inter alias).

Bythocypris obtusata (Sars, 1866)

This species presently lives between 600 and 2669 m depth in the Atlantic and the Mediterranean Sea

TAXA	SCOPPO SAMPLES													
	1	%	2	%	3	%	4	%	5	%	6	%	7	%
Argilloecia acuminata Müller, 1894									2	1.61	2	1.53		
Aurila spp.*			7	23.33	5	18.52	8	29.63						
Bairdoppilata conformis (Terquem, 1878)									3	2.42	3	2.29	2	2.78
Bythocypris bosquetiana (Brady, 1866)					1	3.70	4	14.81	10	8.06	12	9.16	7	9.72
Bythocypris obtusata (Sars, 1866)					10	37.04	3	11.11	12	9.68	7	5.34	4	5.56
Bythocythere turgida Sars, 1866									1	0.81				
Bythocythere agostinae n. sp.									7	5.65				
Carinocythereis whitei (Baird, 1850)*							1	3.70						
Cytherella vulgatella Aiello, Barra, Bonaduce & Russo, 1996											1	0.76		
Cytheropteron cf. *C. alatum* Sars, 1866									6	4.84	11	8.40		
Cytheropteron adriaticum Bonaduce, Ciampo & Masoli, 1975														
Eucythere curta Ruggieri, 1975*			1	3.33									1	1.39
Kangarina abissicola (Müller, 1894)			1	3.33										
Krithe sp.									1	0.81				
Loxoconcha rhomboidea (Fischer, 1855)*			1	3.33			2	7.41						
Macrocyprina succinea (Müller, 1894)*					1	3.70	1	3.70	12	9.68	8	6.11	13	18.06
Macrosarisa bensoni Maddocks, 1990									3	2.42	2	1.53		
Microxestoleberis scillae n. sp.									6	4.84				
Microxestoleberis sp.1									1	0.81				
Microxestoleberis xenomys (Barbeito-Gonzalez, 1971)									2	1.61				
Neonesidea corpulenta Müller, 1894*					1	3.70			2	1.61	1	0.76	2	2.78
Neonesidea formosa (Brady, 1868)*					1	3.70					2	1.53	2	2.78
Neonesidea mediterranea (Müller, 1894)*					3	11.11	1	3.70			3	2.29	5	6.94
Neonesidea spp. juv.*					2	7.41					3	2.29		
Paracytherois acuminata Müller, 1894													1	1.39
Paracytherois flexuosa (Brady, 1867)					1	3.70					8	6.11	2	2.78
Paradoxostoma acuminatum Müller, 1894											8	6.11	1	1.39
Paradoxostoma simile Müller, 1894			3	10.00			1	3.70	4	3.23	12	9.16	3	4.17
Pontocypris acuminata (Müller, 1894)			2	6.67					7	5.65	6	4.58	7	9.72
Pseudocythere caudata Sars, 1866			12	40.00	2	7.41	2	7.41	30	24.19	26	19.85	18	25.00
Pseudocytherura calcarata (Seguenza, 1880)*									1	0.81				
Sclerochilus gr. *contortus* (Norman, 1862)			3	10.00			4	14.81	7	5.65	9	6.87	3	4.17
Xestoleberis communis Müller, 1894									4	3.23	3	2.29		
Xestoleberis dispar Müller, 1894											4	3.05		
Xestoleberis plana Müller, 1894									3	2.42			1	1.39
Number of specimens (Taxa)	0		30	100	27	100	27	100	124	100	131	100	72	100
Number of taxa	0		8		10		10		22		20		16	
Number of specimens (Species)	0		20		20		15		110		108		69	
Number of species	0		6		8		8		18		17		16	

Tab. 1 - Distribution of ostracods in the Scoppo samples (* = allochthonous).

(Bonaduce et al., 1983). At 300 m depth in the Gulf of Naples (Bonaduce & Pugliese, 1979), between 145-165 m water depth from Norwegian and British coasts (Sars, 1928) and between 150-2905 m in the Mediterranean Sea (Puri et al., 1969).

Plio-Pleistocene records of *B. obtusata* are all from sediments interpreted as deposited in bathyal environments (Tyrrhenian Sea: Colalongo & Pasini, 1988; Colalongo et al., 1990; Le Castella section: Colalongo, 1965; Capo Milazzo: Sciuto, 2003, 2005; Furnari: Sciuto & Rosso, 2008; Vrica section: Colalongo & Pasini, 1980). The stratigraphic range of this species goes back to the Miocene (Sissingh, 1972; Bonaduce & Russo, 1985).

Macrocyprina succinea (Müller, 1894) (Pl. 1, fig. 3)

At Scoppo, this species dominates in the upper part of the section. *M. succinea* in presently living in the Mediterranean Sea where it is widely reported, mostly

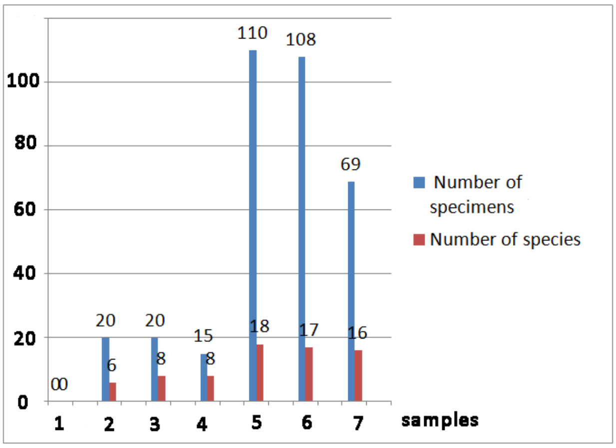


Fig. 4 - Ostracods distribution (specimens and species) along the section of Scoppo.

from shelf environments (Bonaduce & Pugliese, 1979; Rome Dom, 1964 inter alias) associated with *Posidonia* and algae (Puri et al., 1964). Fossil is reported since the Pliocene (Aranki, 1987).

Macrosarisa bensoni Maddocks, 1990 (Pl. 1, fig. 4)

M. bensoni has been never reported from the present-day Mediterranean Sea, whereas, it has been found in North Brazil (Brady, 1880) and South Atlantic at 834-939 m water depth (Maddocks, 1990), and from the Gulf of Mexico at 1079 m water depth (Maddocks et al., 2009). Fossil specimens have been reported by Sissingh (1972) from bathyal sediments of the Calabrian stage of Rodi and from the Pleistocene of Serra San Biagio (Sciuto, 2015). On the basis of the few available data it is likely that in the Quaternary Mediterranean area the species is exclusively bathyal.

Pseudocytherura calcarata (Seguenza, 1880) (Pl. 1, fig. 7)

This species is represented by a single valve from sample 4 in the Scoppo section. Like other Seguenza's species, *P. calcarata* has a rather confused taxonomic history difficult to be disentangled due to the loss of the type material, and the poor quality of original figures and description. First established within *Cytheropteron* (Seguenza, 1880) based on Pleistocene specimens from near Reggio Calabria, it was later reported with different names by Seguenza himself. Ruggieri (1989) fixed the characters of the species establishing a neotype from Pleistocene sediments of Carrubbare (Reggio Calabria).

Ruggieri (1989) considered P. *calcarata* as relatively rare in the Mediterranean Basin, from where there is actually no record of living specimens, and only isolated valves have been found prevalently in shallow water environments (Masoli, 1968; Uffenorde, 1972). The report of *P. calcarata* from 2669 m water depth in the Western Mediterranean by Bonaduce et al. (1983) likely refers to a dead, possibly reworked specimen.

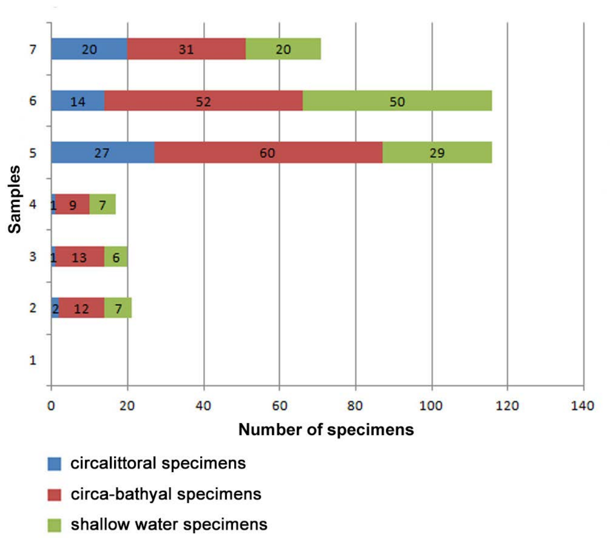


Fig. 5 - Relationships among the different recognised ecological groups in the studied samples.

Microxestoleberis xenomys (Barbeito-Gonzalez, 1971) (Pl. 1, fig. 12; Pl. 2, figs 1-2)

The species is known from the late Calabrian to the Recent. Like all other species of the genus, *M. xenomys* is reported prevalently from shelf environments of the present-day Mediterranean (Müller, 1894; Bonaduce et al., 1983, 1988).

Bythocythere turgida Sars, 1866 (Pl. 2, fig. 4)

Living specimens of *B. turgida* have been reported from 20-140m water depth in the Atlantic coast of Norway and in the Arctic Sea (Sars, 1866; Elofson, 1941; Athersuch et al., 1983; Faranda & Gliozzi, 2011). The species is known from sediments deposited during Pleistocene cold periods from the Mediterranean area (Ruggieri, 1976; Faranda & Gliozzi, 2011; Sciuto, 2015). In contrast, there is no record of living specimens from the Mediterranean Sea. Only few empty valves have been reported from the Adriatic Sea (Breman, 1976, inter alias), together with other ostracods that could document an association, which lived during a cold phase of the Younger Dryas, approximately between 11,800 and 10,000 y BP (sensu Hoek, 2008). Therefore, according to Faranda & Gliozzi (2011) this species can be considered a real "Northern Guest".

Pseudocythere caudata Sars, 1866

This is a common species, which seems to have a very wide ecological distribution from the mid continental shelf to the bathyal and abyssal environments in the Recent Mediterranean. In the Santa Maria di Leuca area, valves of *P. caudata* were found mostly in the Framework Corals facies at depth of 515-747 m (Sciuto & Rosso, 2015). Fossil specimens are known from the Pliocene-Pleistocene sediments presumably deposited in deep water environments, such as Monte S. Nicola (Aiello et al., 2000), Le Castella (Colalongo, 1965), Vrica (Colalongo & Pasini, 1980), ODP Leg 107, site 654 (Colalongo et al., 1990).

SYSTEMATICS

Class Ostracoda Latreille, 1806
Order Podocopida Sars, 1866
Family Xestoleberididae Sars, 1928

Genus *Microxestoleberis* Müller, 1894
Type species *Microxestoleberis nana* Müller, 1894

Microxestoleberis scillae n. sp.
(Pl. 1, figs 8-11)

Derivatio nominis - The species is named after Agostino Scilla (1629-1700), naturalist, philosopher and painter in Messina.

Holotype - The right valve (L = 460 µm; H = 190 µm; l max = 130 µm) from sample 5, figured in Pl. 1, fig. 8 (PMC.O15H.18.12.2014).

Paratypes - One valve figured in Pl. 1, figs 9-11 (PMC. O58-62P. 12.02.2014) and further two not figured valves, all from sample 5.

Type locality - South side of the Scoppo hill, west of the town of Messina (Tav. Messina, F. 254, IV, SO. Lat. 38.20173° N; Long 15.54460° E), in poorly cemented marls which contain sparse corals (Figs 2-3).

Diagnosis - *Microxestoleberis scillae* n. sp. is characterized by an elongated, flattened and laterally inflated carapace with polygonal outline in dorsal view.

Description - Carapace elongated, dorsal-ventrally compressed but laterally inflated, with a typical projection in the posteroventral corner. Outline sub trapezoidal and flattened in lateral view, and ovoid-to-elongated hexagonal in dorsal view. Dorsal margin short, anterior margin acutely rounded below. Ventral margin slightly arcuate, posterior margin concave with short caudal processes at the end. Outer surface ornamented by a weak labyrinthic curvilinear sculpture. A prominent ridge runs along the ventral margin slightly uphill to the anterior margin close to which bifurcates.

Few normal simple pore-canals. Eye spots not detectable. Inner lamella narrow anteriorly, nearly absent posteriorly (Pl. 1, fig. 11), marginal pore-canals not visible.

Hinge adont consists of a simple straight groove and a bar without teeth (Pl. 1, fig. 11).

Remarks - This species is allocated in the genus *Microxestoleberis* Müller, 1894, rather than *Xestoleberis* Sars, 1866, for the absence of teeth in the hinge. *Microxestoleberis scillae* n. sp. differs from all the Recent and Pleistocene species of this genus owing to the ornamentation of the external surface.

Geographic and stratigraphic distribution - The genus *Microxestoleberis* seems to be represented only by three species in the Mediterranean Sea, namely *M. xenomys* (Barbeito-Gonzalez, 1971), reported from Tunisian shallow waters (45-115 m) by Bonaduce et al. (1988); *M. kykladica* (Barbeito-Gonzalez, 1971) known from the Aegean Sea, and *M. nana* Müller, 1894 from the Gulf of Naples and shallow waters near Malta (Bonaduce & Masoli, 1970).

Outside the Mediterranean Sea, other living species are *M. depressa* (Brady & Norman, 1889) from the North Atlantic; *M. hamelini* Howe & Mckenzie, 1989 from Western Australia, *M. rostrata* Klie, 1936 from the North Sea (Helgoland), and *M. triangulata* Swanson, 1980 from New Zealand.

All the reports of *Microxestoleberis* are related to depth from a few meters to a maximum of 100 m water depth.

The genus is known as far back as the Tortonian -Messinian with *M. pustulosa* Ciampo, 1986, whereas oldest species previously assigned to this genus were subsequently moved to other genera.

Fossil records are rare yet again: in the Mediterranean area *M. kykladica* is reported from the Pleistocene of Cinisi (Ruggieri, 1976).

Age - The specimens of Scoppo are referred to the Santernian.

EXPLANATION OF PLATE 1

Ostracods of Pleistocene of Scoppo.

Fig. 1 - *Bairdia formosa* Brady, 1868. Left valve, (external lateral view). Scale bar corresponds to 200 µm.

Fig. 2 - *Neonesidea mediterranea* (Müller, 1894), complete carapace (external right lateral view). Scale bar corresponds to to 200 µm.

Fig. 3 - *Macrocyprina succinea* (Müller, 1894), right valve (external lateral view). Scale bar corresponds to 200 µm.

Fig. 4 - *Macrosarisa bensoni* Maddocks, 1990, complete carapace (external left lateral view). Scale bar corresponds to 200 µm.

Fig. 5 - *Cytheropteron adriaticum* Bonaduce, Ciampo & Masoli, 1976, right valve (external lateral view). Scale bar corresponds to 100 µm.

Fig. 6 - *Kangarina abyssicola* (Müller, 1894), left valve (external lateral view). Scale bar corresponds to 100 µm.

Fig. 7 - *Pseudocytherura calcarata* (Seguenza, 1880), right valve (external lateral view). Scale bar corresponds to 200 µm.

Figs 8-11 - *Microxestoleberis scillae* n. sp.

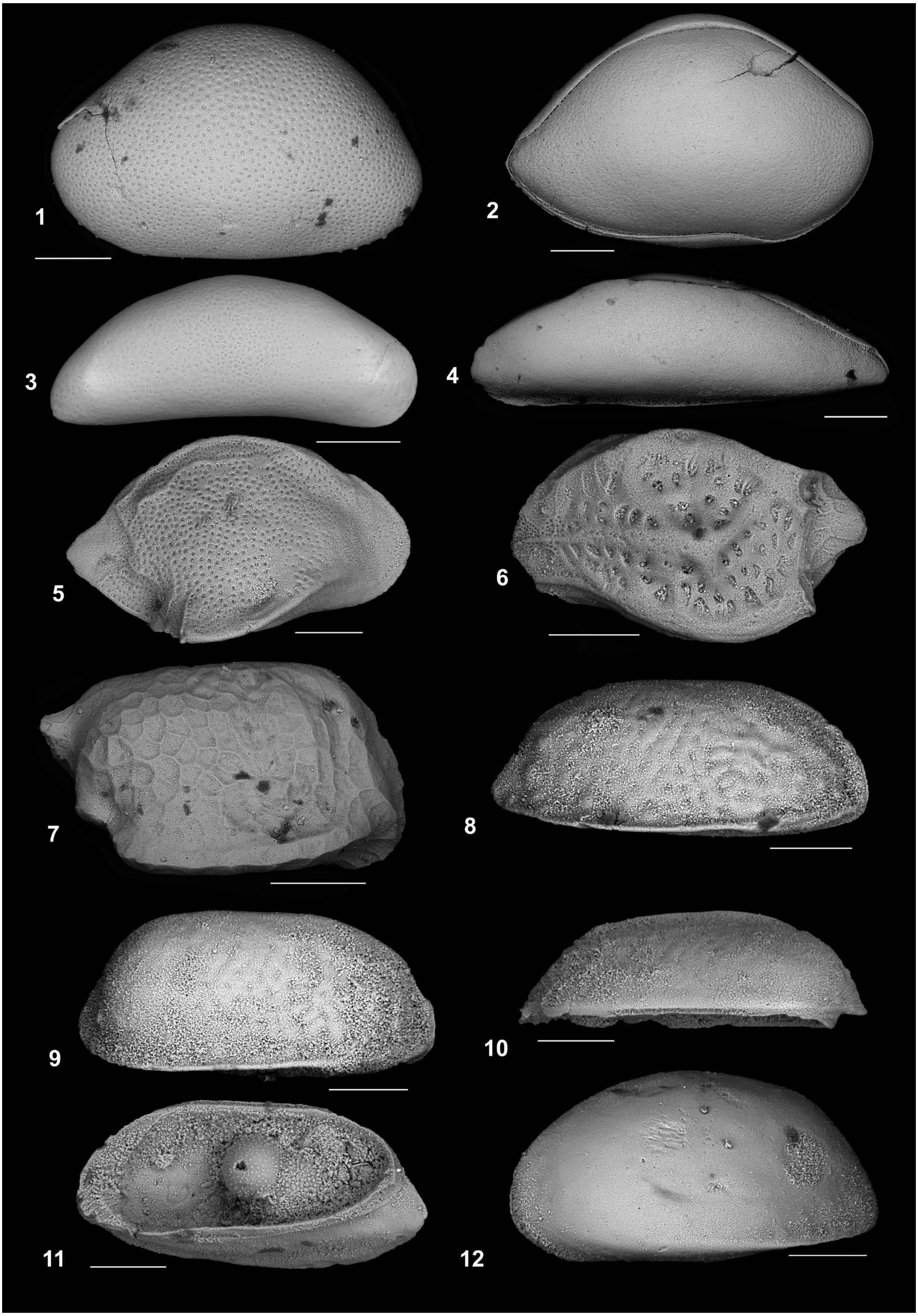
8 - Holotype PMC.O15H.18.12.2014, right valve (external lateral view). Scale bar corresponds to 100 µm.

9 - Paratype PMC.O58P. 12.02.2014, right valve (external lateral view). Scale bar corresponds to 100 µm.

10 - Paratype PMC.O59P. 12.02.2014, left valve (dorsal view). Scale bar corresponds to 100 µm.

11 - Paratype PMC.O60P. 12.02.2014, right valve (internal lateral view). Scale bar corresponds to 100 µm.

Fig. 12 - *Microxestoleberis xenomys* (Barbeito-Gonzalez, 1971), left valve (external lateral view). Scale bar corresponds to 100 µm.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Microxestoleberis sp. 1
(Pl. 2, fig. 3)

Material - Only one valve was found from sample 5.

Remarks - This valve has distinctive characters in relation to those of the previous species including the general outline and the ornamentation. It is similar to *M. xenomys* (Barbeito-Gonzalez, 1971), but differs by the presence of few shorts squat tubercles irregularly scattered on the carapace. Normal pores canals are present at the top of the tubercles.

Family Bythocytheridae Sars, 1866

Genus *Bythocythere* Sars, 1866
Type species *Bythocythere turgida* Sars, 1866

Bythocythere agostinae n. sp.
(Pl. 2, figs 5-11)

Derivatio nominis - The species is named after the palaeontologist and coral specialist Agostina Vertino, for her scientific contribution to Neogene invertebrates.

Holotype - The left valve (L = 540 µm; H = 280 µm; l max = 200 µm) from sample 5, figured in Pl. 2, fig. 5 (PMC.O14H.18.12.2014).

Paratypes - Four left valve and two right valves, figured in Pl. 2, figs 6-11, from the same sample (PMC. O52-57P. 12.02.2014).

Type locality - South side of the Scoppo hill, west of the town of Messina (Tav. Messina, F. 254, IV, SO. Lat. 38.20173° N; Long 15.54460° E), in poorly cemented marls, which contain sparse corals and, locally, obvious cirriped remains interbedded with massive to thickly-bedded coral rudstones.

Diagnosis - *Bythocythere agostinae* n. sp. is characterized by subrectangular valves, laterally inflated, and with a slight acute swelling in the postero-ventral area.

Description - Carapace medium-sized, subrectangular in lateral view (Pl. 2, figs 5-7), inflated, often with slight acute expansion in postero-ventral area. Anterior margin regularly arched. Dorsal margin long, straight and parallel to the ventral margin. Caudal process small, slightly obtuse and well marked in subdorsal position. Ventral margin straight, with a slight oral convexity centrally, and regularly and steeply bending posteriorly, towards the caudal process. Central area of valves inflated, with acute swelling in the postero-ventral area (Pl. 2, figs 5, 7).

Carapace subtriangular in frontal and dorsal views; acute dorsally and progressively wider toward the ventral margin (Pl. 2, fig. 11).

Outer surface ornamented by a weak polygonal reticulum formed by intersecting muri and fossae, barely visible through stereomicroscope, with longitudinal elements more marked in the anterior and ventral area.

Normal pore-canals simple, numerous and regularly distributed on the carapace along oblique directions (Pl. 2, figs 5-7).

Eye tubercles absent. Inner lamella narrow present anteriorly and postero-ventrally (Pl. 2, figs 8-9), marginal pore-canals not visible.

Hinge lophodont: a straight groove parallel to the dorsal margin with two little simple tooth at the anterior and posterior extremities, in the right valve; left valve complementary (Pl. 2, figs 8-9).

Muscle scars not visible. Sexual dimorphism pronounced, females (?) show acute swelling in centro-ventral area that seems to simulate an alar process.

Remarks - This species shares morphological features of the shell lateral view with both Bythocytheridae and Semicytheruridae. Although central muscle scars are not visible on the available material, the species is assigned with a good approximation to the genus *Bythocythere*

EXPLANATION OF PLATE 2

Ostracods of Pleistocene of Scoppo.

Figs 1-2 - *Microxestoleberis xenomys* (Barbeito-Gonzalez, 1971).
1 - Complete carapace (dorsal view).
2 - Broken right valve (internal lateral view).

Fig. 3 - *Microxestoleberis* sp. 1, left valve (external lateral view).

Fig. 4 - *Bythocythere turgida* Sars, 1866, left valve valve (external lateral view).

Figs 5-11 - *Bythocythere agostinae* n. sp.
5 - Holotype PMC.O14H.18.12.2014, female right valve (external lateral view).
6 - Paratype PMC.O52P. 12.02.2014, female left valve (external lateral view).
7 - Paratype PMC.O53P. 12.02.2014, male left valve (external lateral view).
8 - Paratype PMC.O54P. 12.02.2014, left valve (internal lateral view).
9 - Paratype PMC.O55P. 12.02.2014, right valve (internal lateral view).
10 - Paratype PMC.O56P. 12.02.2014, female right valve (dorsal view).
11 - Paratype PMC.O57P. 12.02.2014, female left valve (anterior view).

All scale bars correspond to 100 µm.


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based on the lophodont hinge type, and the narrow marginal areas and the small caudal processes, that are typical features of the this genus.

Bythocythere agostinae n. sp. is distinguishable from all the other Plio-Pleistocene species of this genus (see Athersuch et al., 1983) for the presence of its slight acute expansion in the postero-ventral area, in dorsal view, and for the ventral and dorsal margins that are parallel each other in lateral view. Only *B. constricta* Sars, 1866 shares with the present species parallel dorsal and ventral margins in external lateral view, but the dorsal outlines are totally different, sub-triangular in the new species but sub-ovoidal with a median sulcus in *B. constricta*.

Geographic and stratigraphic distribution - The genus *Bythocythere* Sars has a wide distribution in present day and Cenozoic seas.

In the Boreal hemisphere, recent or living species have been reported mostly from the Arctic and northern seas including localities from the British Isles (Athersuch et al., 1983, 1989), Norway (Sars, 1926), Greenland (Whatley et al., 1996), Ireland (Whatley & Wall, 1969), Novaya Zemlya (Neale & Howe, 1975), Laptev Sea, Siberia (Stepanova et al., 2003). Some species extend southward as far as North Carolina (Hazel, 1975) and the Tsushima Strait, Japan (Tanaka, 2008).

In the Recent Mediterranean Sea the presence of the genus *Bythocythere* is not certain, because Aiello & Barra (2010) listed species but did not indicate if collected specimes were living or dead. According to Faranda & Gliozzi (2011), findings of *B. minima* Bonaduce, Ciampo & Masoli, 1975 and *B. turgida* Sars, 1866 from Circalittoral and Bathyal Zone of the Mediterranean by Bonaduce et al. (1975, 1983) and by Arbulla et al. (2004) possibly relate to dead specimens.

Fossil species included in this genus are known from the Lower Miocene of the Avignon basin, SE France (Jacobzone & Carbonnel, 1971), the Pleistocene of England and Norway (Athersuch et al., 1983), the Northern Atlantic (Cronin et al., 1999) and the Greenland (Jones et al., 1999). Further records are from Pleistocene submarine cores in Southern Atlantic (Majoran & Dingle, 2001), off Marion Island (Dingle, 2002) and from Holocene marine sediments of the Mississippi delta (Howe & van den Bold, 1975).

The genus is reported also in the Plio-Pleistocene of the Mediterranean area (Benson & Sylvester Bradley, 1971; Ciampo, 1976; Colalongo & Pasini, 1980; Ciampo, 1992; Amore et al., 2000; Faranda & Gliozzi, 2011).

Age - The specimens of Scoppo are referred to the Santernian.

DISCUSSION AND CONCLUSION

The seven samples analyzed from the Pleistocene section of Scoppo show some peculiar characteristics: the ostracod allochthonous component is very scarce, both in terms of abundance and species richness (Tab. 1), while the ostracods considered indigenous are clearly dominated by the deep water ostracod group (including species of the Circalittoral and the Bathyal Zones) (Fig. 5). This group consists of *P. caudata*, *B. bosquetiana* and *B. obtusata* present in almost all samples with relevant percentages, and of the rarer species *A. acuminata*, *B.conformis*, and *M. bensoni*. Taxa with exclusively bathyal distributions are missing, with the exception of *M. bensoni,* found in a few samples with a few specimens.

Therefore the data available on the autoecology of most abundant species found in the Scoppo section allow to delineate a palaeoenvironment located, on the slope between the deeper level of the Circalittoral Zone and the highest levels of the Bathyal Zone, at a depth comprised between 150 and 300 meters water depth. This datum agrees with the bathymetric distribution of the scleractinaires *M. oculata*, *L. pertusa*, *D. dianthus* during the Pleistocene and the Recent in the Mediterranean Sea (Corselli, 2010).

Furthermore, while the Messina Straits area, in the Recent and in the Pleistocene as well, is strongly characterized by phenomena of sediment mass displacement (gravity flows), as well as displacement of single skeletal remains and even of living specimens (Montenat et al., 1987; Ridente et al., 2014; Sciuto, 2014b). because of the steepness of the slopes and the extremely reduced shelf (Montenat et al., 1987; Sciuto, 2014b), the presence of authocthonous coral colonies in the Scoppo area, whose growth would be hindered by gravity flows, and the significant abundance of specimens and species which often can be considered in equilibrium with the environment, testify that the palaeoenvironment of Scoppo was located outside the sedimentary flow area certainly perched on a high lateral ridge that borders the canyon.

Another peculiar feature of the Scoppo succession is the occurrence of shallow water phytal ostracod taxa such as *Sclerochilus*, *Paradoxostoma* and *Paracytherois* that are mainly reported from shelf environments sometimes rich in plants and/or biodetritus.

In this respect it should be recalled that the scleractinian community produces large amounts of organic matter detritus which remains in suspension for long time available for local organisms (Di Geronimo et al., 2005; Monaco et al., 2014) that may explain the presence in the deep of these taxa.

A similar close relationship was observed by Coles et al. (1996) from the Porcupine Basin in bathyal coral bioconstructions at 750 m water depth in Caribbean Sea by Maddocks & Steineck (1987) and recently in the Santa Maria di Leuca Cold Water Coral province where the abundance of these shallow water taxa rises to a maximum in the Framework corals facies and progressively lowers moving away from areas colonized by corals, possibly in relation to a decrease of available resources (Sciuto & Rosso, 2015).

ACKNOWLEDGEMENTS

The author is grateful to the referees for the suggestions on the manuscript. Special thanks are due to the editor Marco Balini for the detailed critical review of the manuscript and Alfio Viola (University of Catania) for SEM assistance. Palaeoecological Research Group contribution n. 414.

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Manuscript received 30 January 2015
Manuscript revised accepted 23 December 2016
Zoobank registration number *urn:lsid:zoobank.org:pub:A6D29755-9919-4E20-838D-3FF1EECF6D45*
Zoobank registration date 28 December 2016
Published online 30 December 2016
Editor Marco Balini