First record of *Cocculinella* (Mollusca, Gastropoda, Cocculiniformia) from the Lower Pleistocene of Southern Italy with the description of two new species

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ABSTRACT
Cocculinella freti n. sp., from Archi and Valanidi (Reggio Calabria) and *Cocculinella bertolasoi* n. sp., from Valanidi (Reggio Calabria) and Capo Milazzo (Messina, Sicily), are described from three southern Italian Lower Pleistocene outcrops (bathyal assemblages). No species of the genus *Cocculinella* Thiele, 1909 is known from the Atlantic and the Mediterranean, whereas three living species are known from the Indo-Pacific. Very little, mostly questionable information is known on fossil species of the genus. The present report is the first unequivocal fossil record of *Cocculinella*, allowing the stratigraphic and biogeographic range of the genus to be extended to the Lower Pleistocene of the Mediterranean.

KEY WORDS
Mollusca,
Gastropoda,
Cocculiniformia,
Cocculinellidae,
Pleistocene,
Mediteranean basin,
Italy,
new species.

RÉSUMÉ
Première occurence de Cocculinella *(Mollusca, Gastropoda, Cocculiniformia) du Pléistocène inférieur du sud de l'Italie, avec la description de deux nouvelles espèces.*
Cocculinella freti n. sp. et *Cocculinella bertolasoi* n. sp. sont décrites de trois affleurements du Pléistocène inférieur (biocénoses bathyale) du sud de l'Italie.

MOTS CLÉS
Mollusca,
Gastropoda,
Cocculiniformia,
Cocculinellidae,
Pléistocene,
bassin Méditerranéen,
Italie,
espèces nouvelles.

La première espèce a été trouvée dans des échantillons d'Archi et Valanidi (province de Reggio Calabria), la deuxième dans des échantillons de Valanidi et de Capo Milazzo (province de Messina, Sicile). Le genre *Cocculinella* Thiele, 1909 n'est pas connu dans les faunes modernes de la mer Méditerranée et de l'océan Atlantique, alors que trois espèces vivantes sont signalées dans les océans Indien et Pacifique. Dans le même temps, les informations sur les espèces fossiles sont rares et incertaines. Les deux espèces nouvelles représentent donc la première occurrence de ce genre dans les faunes fossiles et nous permettent d'étendre sa présence au Pléistocène inférieur du sud de l'Italie.

INTRODUCTION

The Cocculinellidae Moskalev, 1971 are a family of symmetrical limpets, with a narrowly elliptical aperture and subcentral apex (Haszprunar 1998). The radula is highly modified and highly diagnostic (Moskalev 1976; Marshall 1983, 1985).

A single genus, *Cocculinella* Thiele, 1909, is known for the family, including three species: *Cocculinella coercita* Hedley, 1907, from Australia, *C. osteophila* Marshall, 1983, from New Zealand and *C. minutissima* (Smith, 1904), type species of the genus, from the Andaman Islands (Indian Ocean) (Marshall 1983, 1985; Haszprunar 1988, 1998). Another species, *C. kopua* Marshall, 1983, described from a single dead shell from New Zealand, was re-considered, by Marshall (1985), as a possible synonym of *C. osteophila*. Two other Australian species, *C. tasmanica* (May, 1919) and *C. mayi* Finlay, 1926 are recorded in some web-databases, such as "A Guide to the Marine Molluscs of Tasmania" (http://www.molluscsoftasmania.net [2010]) or OBIS (Ocean Biogeographic Information System); these species are not considered belonging to *Cocculinella* by Haszprunar (1998), and are refered to *Tectisumen* Finlay, 1926, a genus attributed to family Lepetellidae Dall, 1882 by other authors (e.g., Keen 1960; Moskalev 1978).

All cocculinellid species live and feed on fish bones.

This paper focuses on the finding of four fossil shells of *Cocculinella* in three Lower Pleistocene outcrops in southern Italy, attributed to two different species, described as new. No living species of this genus are known in the Mediterranean Sea and in the Atlantic Ocean, and there is very little information on fossil species, and so the description of the these new species is particularly important for the knowledge of the stratigraphic and biogeographic distribution of the genus.

MATERIAL AND METHODS

The shells were found by Stefano Palazzi in two Lower Pleistocene outcrops in Southern Italy, Archi (Reggio Calabria, 1 shell) and Valanidi (Reggio Calabria, 2 specimens), and by Luca Bertolaso at Capo Milazzo, Sicily (Fig. 1).

Archi is a clay quarry, locally known as "Fornace Aloi", situated in the northern suburbs of Reggio Calabria, with a rich lower Pleistocene fauna, that can be attributed to a bathyal paleoenvironment, 500 to 1000 m deep (Guadagno *et al.* 1979; Di Geronimo *et al.* 1997). The molluscs have been listed by Micali & Villari (1986), Rindone & Vazzana (1989) and Di Geronimo *et al.* (1997).

Valanidi is a clay quarry, near Bovetto (Reggio Calabria), with a rich lower Pleistocene fauna, that can be attributed to a bathyal biocoenoses. This outcrop has scarcely been reported in the literature (Seguenza 1879; Barrier 1987), and there is no published list of the molluscs occuring there, apart from isolated reports of some rare species (e.g., Vazzana 1996).

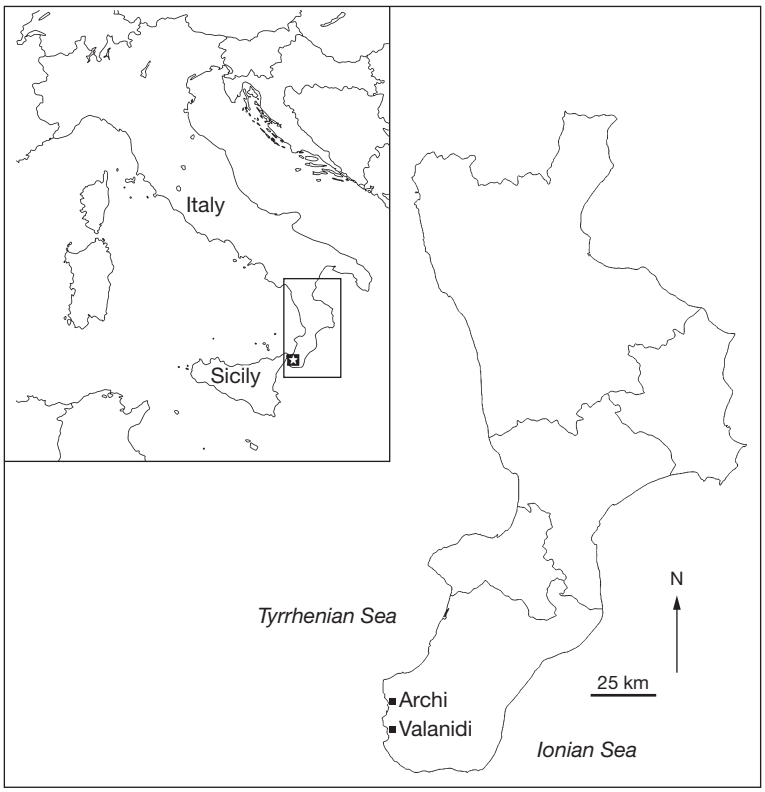

FIG. 1. – Location of the outcrops in Southern Italy, where *Cocculinella* Thiele, 1909 species were found.

The Neogene sedimentary sequence at Capo Milazzo (Messina, NE Sicily) is well known (Ruggieri & Greco 1965; Fois 1990). The *Cocculinella* shell was found in bathyal deposits of Lower Pleistocene age outcropping at Punta Lazzi, which can be attributed to a bathyal biocoenoses (Palazzi & Villari 1996). There have been several papers on Capo Milazzo molluscs (Gignoux 1913; Mars 1956), and the Plio-Pleistocene bathyal molluscan assemblages are well documented (Palazzi & Villari 1996).

SEM micrographs were taken using a JEOL model JSM-5200.

ABBREVIATIONS

AL anterior length (distance from the posterior extremity of protoconch to the anterior end of teleoconch parallel to apertural plain);
H shell height;
L shell length;
W shell width.

Repository

BD Bruno Dell'Angelo collection, Genova, Italy;
MZB Museo di Zoologia dell'Università di Bologna, Italy.

SYSTEMATICS

Superorder COCCULINIFORMIA
Superfamily LEPETELLOIDEA
Family COCCULINELLIDAE Moskalev, 1971

Genus *Cocculinella* Thiele, 1909

TYPE SPECIES. — *Acmaea minutissima* Smith, 1904; Recent, Andaman Islands, Indian Ocean, 238-457 m.

TABLE 1. — Measurements (in mm) of *Cocculinella freti* n. sp. shells.

***Cocculinella freti* n. sp.**	**L**	**W**	**H**	**AL**	**L/W**	**L/H**	**L/AL**	**W/H**
Holotype (Archi)	3.03	1.04	1.38	1.77	2.91	2.20	1.71	0.75
Paratype (Valanidi)	5.21	1.39	2.41	2.68	3.75	2.16	1.94	0.58

TABLE 2. — Measurements (in mm) of *Cocculinella bertolasoi* n. sp. shells.

***Cocculinella bertolasoi* n. sp.**	**L**	**W**	**H**	**AL**	**L/W**	**L/H**	**L/AL**	**W/H**
Holotype (Valanidi)	3.87	1.62	1.92	1.95	2.39	2.02	1.98	0.84
Paratype (Capo Milazzo)	2.03	1	1.19	1.22	2.03	1.71	1.66	0.84

Cocculinella freti n. sp.
(Fig. 2A-F)

TYPE MATERIAL. — Holotype: MZB 45691, shell from Archi (Fig. 2A, B, D-F). Paratype: BD, shell from Valanidi (Fig. 2C).

ETYMOLOGY. — From the latin world "*fretum*", "strait" (of Messina), alluding to the occurrence at two outcrops near the Calabrian coast of the Messina Strait.

TYPE LOCALITY AND HORIZON. — Archi, Reggio Calabria Province, Southern Italy, Lower Pleistocene.

MEASUREMENTS. — see Table 1.

DESCRIPTION
Shell patelliform, up to 5.21 mm long (3.03 mm the holotype), thin and fragile. Aperture narrowly elliptical, ends evenly rounded, sides subparallel and very shallowly rounded, slightly convex from side to side so that only the center contacts a flat surface. Spire depressed-conical, apex slightly behind the centre, anterior slope profile slightly convex, posterior slope profile shallowly concave, anterior and posterior slope areas regularly connected with lateral areas, posterior outline subangular. Protoconch clearly demarcated, 285 µm long and 188 µm wide in the holotype, of about one whorl, tip of apical fold perfectly fused behind the apertural rim. Teleoconch with only fine collabral growth lines.

REMARKS
The paratype from Valanidi has the same narrow and elongate general shape as the holotype. The protoconch is partially eroded, so it was possible only to measure the length, 310 µm, which is closely accordant with that of the holotype (285 µm).

DISTRIBUTION
Cocculinella freti n. sp. is only known from the lower Pleistocene of Archi and Valanidi, Reggio Calabria Province, Southern Italy.

Cocculinella bertolasoi n. sp.
(Fig. 2G-L)

TYPE MATERIAL. — Holotype: MZB 45692, shell from Valanidi (Figs 2G, H, J-L). Paratype: BD, shell from Capo Milazzo (Fig. 2I).

ETYMOLOGY. — The specific name honours our friend Luca Bertolaso (Reggio Emilia), who collected part of the material here presented and made it available to the authors.

TYPE LOCALITY. — Valanidi, Reggio Calabria Province, Southern Italy.

TYPE STAGE. — Lower Pleistocene.

MEASUREMENTS. — see Table 2.

DESCRIPTION
Shell patelliform, up to 3.87 mm long (the holotype), thin and fragile. Aperture narrowly elliptical, ends evenly rounded, sides subparallel and very shallowly rounded, slightly convex from side to side so that only the center contacts a flat surface. Spire depressed-conical, apex slightly behind the

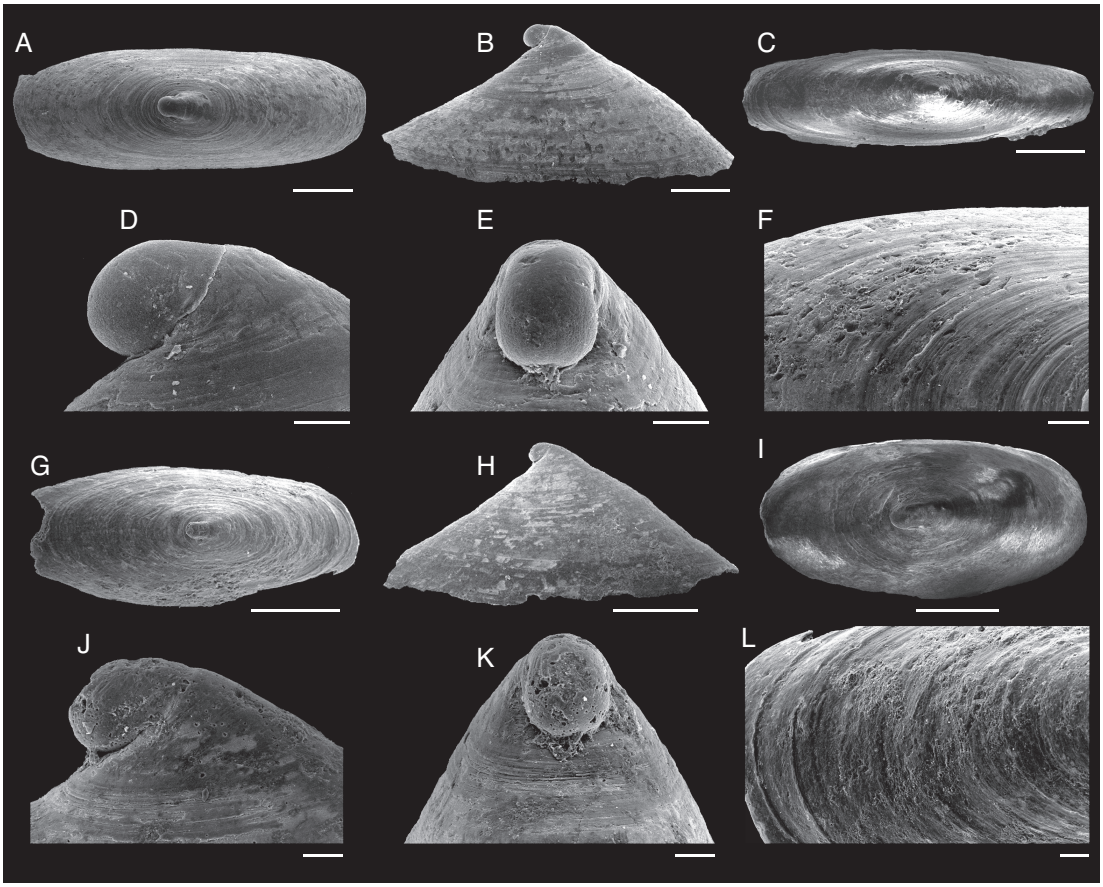

Fig. 2. — Lower Pleistocene *Cocculinella* Thiele, 1909 species: **A**-**F**, *Cocculinella freti* n. sp.; **A**, **B**, **D**-**F**, holotype (MZB 45691) from Archi (Reggio Calabria Province) in dorsal (**A**) and lateral (**B**) views; **D**, **E**, protoconch; **F**, teleoconch; **C**, paratype from Valanidi (Reggio Calabria Province), dorsal view, not coated; **G**-**L**, *Cocculinella bertolasoi* n. sp.; **G**, **H**, **J**-**L**, holotype (MZB 45692), from Valanidi (Reggio Calabria Province) in dorsal (**G**) and lateral (**H**) views; **J**, **K**, protoconch; **L**, teleoconch; **I**, paratype from Capo Milazzo (Messina Province, Sicily), not coated. Scale bars: A, B, I, 500 µm; C, G, H, 1 mm; D-F, J-L, 100 µm.

centre, anterior slope profile slightly convex, posterior slope profile practically straight or shallowly concave, anterior and posterior slope areas regularly connected with lateral areas, posterior outline regularly rounded. Protoconch clearly demarcated, 335 µm long and 220 µm wide in the holotype, of about one whorl, tip of apical fold perfectly fused behind the apertural rim. Teleoconch with only fine collabral growth lines.

Remarks

The paratype from Capo Milazzo has the same general shape as the holotype. *Cocculinella bertolasoi* n. sp. differs from *C. freti* n. sp. in general shape, more narrow and elongate in *C. freti* n. sp. (L/W 2.91-3.75 in *C. freti* n. sp. vs 2.03-2.39 in *C. bertolasoi* n. sp.; W/H 0.58-0.75 in *C. freti* n. sp. vs 0.84 in *C. bertolasoi* n. sp.) and in having a more globose and larger protoconch (285 × 188 µm in *C. freti* n. sp. vs 335 × 220 µm in *C. bertolasoi* n. sp.).

Distribution

Cocculinella bertolasoi n. sp. is only known from the lower Pleistocene of Valanidi (Reggio Calabria Province, Calabria) and Capo Milazzo (Messina Province, Sicily), Southern Italy.

TABLE 3. — *Cocculinella* Thiele, 1909 species, published data.

	shells	Protoconch size (µm)	L (mm)	L/W	L/H	L/AL	W/H
C. minutissima (Smith, 1904)	1	–	3.5	2.63	3.5	–	1.33
C. osteophila Marshall, 1983	6	233 × 150	1.13-2.30	1.82-2.33	3.12-4.83	1.41-1.64	1.41-1.72
C. coercita Hedley, 1907	6	–	2.60-6.60	2.20-4.12	2.60-3.77	1.57-1.94	0.80-1.24
C. freti n. sp.	2	285 × 188	3.03-5.21	2.91-3.75	2.16-2.20	1.71-1.94	0.58-0.75
C. bertolasoi n. sp.	2	335 × 220	2.03-3.87	2.03-2.39	1.71-2.02	1.66-1.98	0.84

DISCUSSION

There are few taxonomically useful shell characters that can be used to separate the species of the family Cocculinellidae. All the known species (1.13-6.6 mm long) have a narrowly elliptical aperture and subcentral apex, and exhibit a weak, concentric sculpture. The protoconch has a fused tip and has no significant sculpture. The radula is greatly modified and highly diagnostic (Haszprunar 1998). The present species are attributed to the genus *Cocculinella* on the basis of the close similarity of the shell to those of the known Recent *Cocculinella* species, *C. minutissima* from the Indian Ocean, and *C. coercita* and *C. osteophila* from the south-western Pacicific Ocean. Very few data are available on the variability of these species. All available morphometric data is tabulated here (Table 3).

Two *Cocculinella* species were reported by Vera-Peláez *et al*. (1995) from the Pliocene of Estepona: *C.* cf. *minutissima* (Smith, 1904) and *C. compressiuscula* (Karsten, 1849), described from the Miocene of the North Sea basin. These were simply names in a list of molluscs, with no other data or figures, and were not reported by Landau *et al.* (2003) in their paper on Estepona Vetigastropoda. *Patella compressiuscula* Karsten, 1849 is probably referable to *Lepetella.* B. Landau (pers. com.) has informed us that no species referable to *Cocculinella* has been found in the Estepona Pliocene, so it is better to ignore these reports.

Cocculinella salisburyensis Ludbrook, 1956 was described from the Pliocene of South Australia, but the only available specimen (holotype) has a much more strongly posterior apex that any Recent *Cocculinella* and is very doubtfully referable to this genus (Marshall 1983: 142).

The present report is thus the first fossil record of *Cocculinella*, allowing the stratigraphic and biogeographic range of the genus to be extended to the Lower Pleistocene of the Mediterranean.

An Indo-Pacific affinity for some molluscan taxa from the Plio-Pleistocene bathyal deposits of the Mediterranean basin is fairly well known (e.g., La Perna *et al*. [2004] for the nuculanid genus *Jupiteria* Bellardi, 1875 and *Zealeda* Marwick, 1924; La Perna [2007] for the nuculanid genus *Deminucula* Iredale, 1931). This affinity can be explained by the faunal continuity between the two areas, as part of the Tethys Realm, until the Early Miocene (Popov 1993; Harzhauser *et al*. 2002, 2007), when the formation of a landbridge between the Eurasia and Arabian plates, in the late Burdigalian (approximately 19 Ma), separated western (Proto Mediterranean Atlantic Region) and eastern (Proto Indo-West-Pacific Region) parts (Rögl 1998, 1999; Harzhauser *et al*. 2007). However, as regard to the genus *Cocculinella*, the hypothesis of a fragmentation of the area of origin can only be considered assuming that the taxon is much older and with a wider distribution than the one appearing in the fossil record.

Other members of the superorder Cocculiniformia have a fossil distribution not so erratic as suggested by the occurrence of *Cocculinella*; in the genus *Cocculina* Dall, 1882 (family Cocculinidae, superfamily Cocculinoidea), *Cocculina miocaenica* Boettger, 1901 is known from the Paratethys (Romania, Poland) and North Sea basin (The Netherlands) Miocene, *Cocculina adunca* (Jeffreys, 1883) from the Spanish and Italian Early Pliocene, *Cocculina dittmeri* (Anderson, 1964) from German Miocene and *Cocculina unica* Bałuk, 2006 from the Paratethys (Poland) Miocene (Anderson 1964; Janssen 1984; Landau *et al*. 2003; Bałuk 2006).

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