Rivista Italiana di Paleontologia e Stratigrafia | volume 103 | numero 3 | tavole 1-10 | pagine 389-426 | Dicembre 1997

PLEISTOCENE BATHYAL MOLLUSCAN ASSEMBLAGES FROM SOUTHERN ITALY

ITALO DI GERONIMO & RAFAEL LA PERNA

Key-Words: Bathyal benthos, Molluscs, Pleistocene, Mediterranean, Southern Italy, Systematics, Paleoecology.

Riassunto. Sono state studiate quattro faune a molluschi batiali provenienti da depositi pleistocenici dell'Italia meridionale (Calabria e Messina). Vengono segnalate 136 specie, 24 sono trattate nella parte sistematica e 35 sono illustrate.

Le seguenti nuove combinazioni vengono proposte: *Solariella marginulata* (Philippi, 1844), *Iphitus tenuisculptus* (Seguenza, 1876), *Benthomangelia tenuicostata* (Seguenza, 1879), *Chrysallida microscalaria* (Seguenza, 1876), *Ennucula corbuloides* (Seguenza, 1877), *Ennucula rotundata* (Seguenza, 1877), *Thestyleda cuspidata* (Philippi, 1844), *Katadesmia confusa* (Seguenza, 1877), *Austrotindaria pusio* (Philippi, 1844), *Austrotindaria salicensis* (Seguenza, 1877). I generi *Fissurisepta* Seguenza, 1862, *Solariella* Wood, 1842, *Ennucula* Iredale, 1931, *Thestyleda* Iredale, 1929, *Ledella* Verrill & Bush, 1897, *Yoldiella* Verrill & Bush, 1897, *Bathyspinula* Filatova, 1958, *Katadesmia* Dall, 1908, *Austrotindaria* Fleming, 1948 e *Cadulus* Philippi, 1844 sono tassonomicamente commentati.

I caratteri composizionali delle faune studiate, ed in particolare la ricchezza in nuculoidi, corrispondono a quelli tipici delle associazioni malacofaunistiche profonde. Una profondità di sedimentazione di 500-600 m è indicata per due delle faune ed una maggiore, probabilmente entro i 1.000 m, è suggerita per le altre due.

Notevoli sono le affinità tassonomiche con le malacofaune profonde del nord-est atlantico ed oceaniche in generale. L'evoluzione del benthos profondo mediterraneo durante il Plio-Quaternario viene discussa.

Abstract. Four Pleistocene bathyal molluscan assemblages from southern Italy (Calabria and Messina area) were studied. One hundred and thirty-six species were recorded. Twenty-four were classified and described in detail and thirty-five were illustrated.

The following new combinations are proposed: *Solariella marginulata* (Philippi, 1844), *Iphitus tenuisculptus* (Seguenza, 1876), *Benthomangelia tenuicostata* (Seguenza, 1879), *Chrysallida microscalaria* (Seguenza, 1876), *Ennucula corbuloides* (Seguenza, 1877), *Ennucula rotundata* (Seguenza, 1877), *Thestyleda cuspidata* (Philippi, 1844), *Katadesmia confusa* (Seguenza, 1877), *Austrotindaria pusio* (Philippi, 1844), *Austrotindaria salicensis* (Seguenza, 1877). Comments concerning the taxonomy of *Fissurisepta* Seguenza, 1862, *Solariella* Wood, 1842, *Ennucula* Iredale, 1931, *Thestyleda* Iredale, 1929, *Ledella* Verrill & Bush, 1897, *Yoldiella* Verrill & Bush, 1897, *Bathyspinula* Filatova, 1958, *Katadesmia* Dall, 1908, *Austrotindaria* Fleming, 1948 and *Cadulus* Philippi, 1844 are included.

The assemblages are dominated by nuculoids and fit the general compositional pattern of the deep-sea molluscan communities. A paleodepth of 500-600 m is inferred for two assemblages, whereas a greater depth, probably not exceeding 1,000 m, is suggested for the other two.

Taxonomic affinities with northeast Atlantic and more generally with World Ocean deep-sea molluscan faunas are remarkable. The Plio-Quaternary evolution of the deep Mediterranean benthos is discussed.

Introduction.

Although Plio-Pleistocene Mediterranean molluscs have been investigated since the last century, the deep-sea forms have been disregarded for a long time. Difficulties in finding deep-sea deposits, located mainly in areas affected by strong Plio-Quaternary tectonics, low density of deep-sea macrofaunas, and taxonomic complexities, have all probably restrained paleontological investigation. Pioneer contributions were made in the late 19th century by Giuseppe Seguenza, who investigated extensively the Plio-Pleistocene deposits of southern Calabria and Messina, describing many deep-sea species and correctly interpreting their paleoecological meaning (Di Geronimo, 1991, pp. 137-143). Many of the fossil species described by Philippi (1836, 1844) from the same area have been shown to come from deep-sea deposits as well. Seguenza referred most species to the "Astian", a middle-late Pliocene stage now in disuse. On the basis of modern stratigraphic knowledge, the Astian deposits of Seguenza are known to be middle-late Pliocene to early-middle Pleistocene in age.

More recently, several papers (some by amateur malacologists) have been devoted to deep-sea Pliocene and Pleistocene molluscan faunas of Italy, mainly dealing with their composition and paleoecology (Di Geronimo, 1979; Robba, 1981; Rindone & Vazzana, 1989; Micali & Villari, 1989, 1991; Tabanelli, 1993, 1997; D'Alessandro & De Marco, 1993; Palazzi & Villari, 1994, 1996; Vazzana, 1996; Barrier et al., 1996, etc.).

Other works dealing with several benthic invertebrates, have helped to outline the Plio-Quaternary evo-

---

- Istituto Policattedra di Oceanologia e Paleoecologia, Università di Catania, Corso Italia 55, I-95129 Catania.

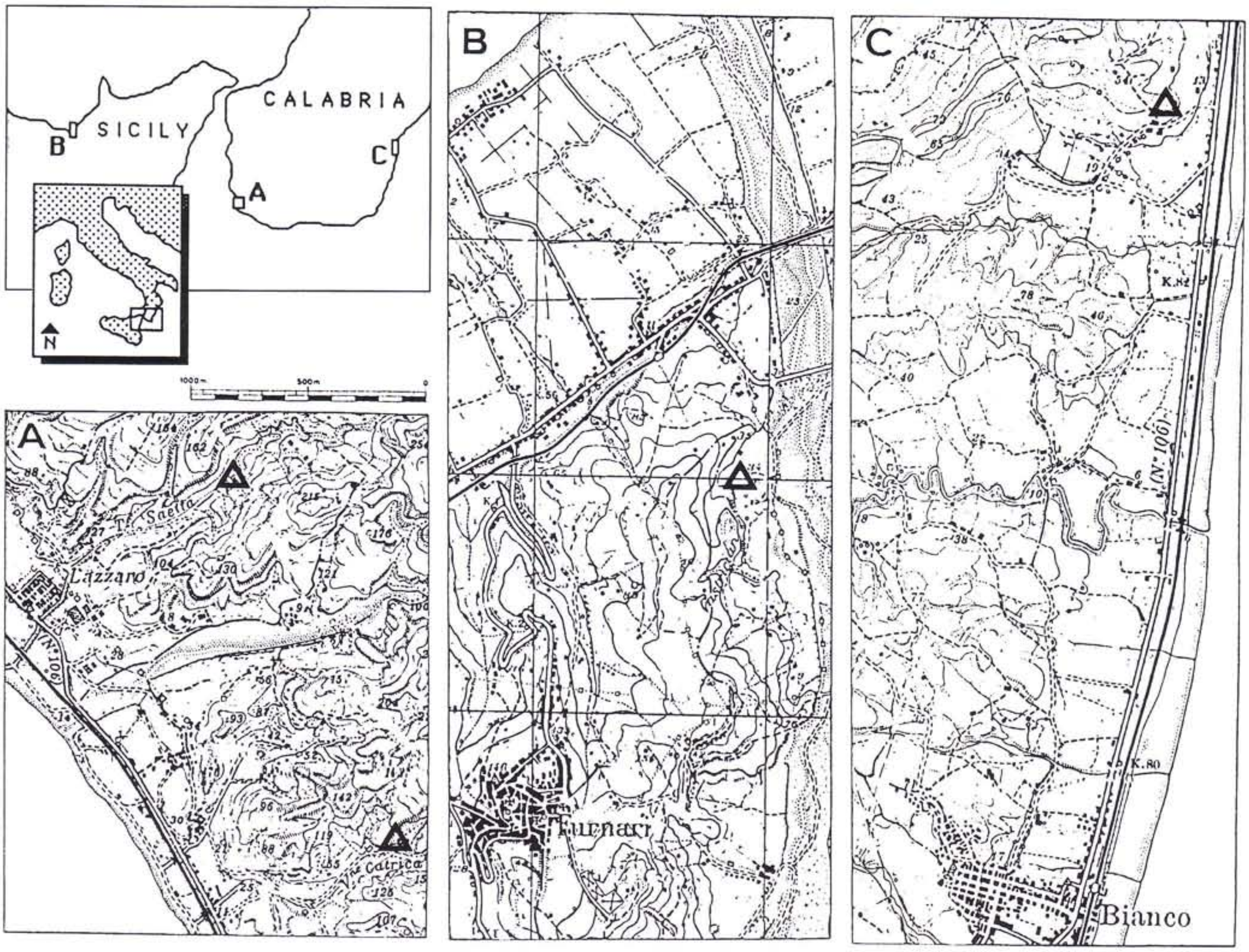


Fig. 1 - Location of the sampled sites (triangles): A. Lazzàro and Vallone Catrica; B. Furnari, C. Bianco (I.G.M. maps, modified).

lution of the deep Mediterranean benthos (Benson, 1972; Gaetani & Saccà, 1984; Zibrowius, 1987, 1991a,b; Roux et al., 1988; Barrier et al., 1989; La Perna, 1994; Moissette & Spjeldnaes, 1995; Di Geronimo et al., 1996; Di Geronimo & La Perna, 1996, 1997; Rosso & Di Geronimo, in press). All of these papers support an "oceanic" model of the Plio-Pleistocene deep-sea benthos, markedly different from the Recent one. Climatic changes and geodynamic events at Gibraltar have been increasingly interpreted as the main factors contributing to the faunistic and oceanographic evolution of the deep Mediterranean.

Taxonomic studies of Plio-Pleistocene deep-sea molluscs have, however, only occasionally been attempted. Many species have never been revised, and most knowledge is based solely on living species.

The present work deals with four Pleistocene bathyal molluscan assemblages from a classical area, i.e. the southern Calabria and Messina regions. Systematic, ecological and biogeographical aspects of several species are reported and discussed in the context of an evolutionary model of the deep Mediterranean benthos.

Materials and methods.

The faunas studied come from four Pleistocene pelitic outcrops (Fig. 1). One site is located ca. 2 km northeast of Furnari (Messina). Two other sites are located in southern Calabria (Messina Strait area), near Lazzàro and at Vallone Catrica (ca. 2 km southeast of Lazzàro). A fourth site is ca. 4 km north of Bianco (Jonian coast).

Faunas were collected *via* sediment bulk samples and manual picking at outcrops. About 10 dm^3 of sediment were sampled at Furnari, Vallone Catrica and Lazzàro, whereas ca. 40 dm^3 were sampled at Bianco, due to the low density of macrofauna.

Bulk sampling is highly recommended in paleoecological studies (Di Geronimo & Robba, 1976; Robba, 1978), as it allows quantitative data related to the original paleocommunities (relative abundances, size-class distributions, etc.) to be obtained. Bulk sampling is also comparable with sampling Recent shelled assemblages using a grab or boxcorer. On the other hand, large and rare species are more easily collected by hand.

Bulk samples were disaggregated in water and washed through a 250 μm mesh. Molluscs were sorted from the whole dried fraction coarser than 500 μm, whereas only small amounts of the fine fractions were examined.

Fossils were generally well preserved and did not show signs of *post-mortem* wear. Some particularly thin and fragile shells were largely fragmented, such as *Seguenzia monocingulata, Delectopecten vitreus* and *Abra longicallus*, as well as the long-shelled scaphopods *Graptacme agilis* and *Entalina tetragona*. Shell repairs, and evidence of drilling and boring by endobionts, were also observed, mainly in large species.

Concerning the species addressed in our systematic study, the material examined is generally abundant (up to several hundred specimens), except for a few rare species. Material from other localities in southern Italy and from some North Atlantic stations (Muséum National d'Histoire Naturelle, Paris; MNHN) was also used for comparisons. The material studied is housed in the Museo di Paleontologia dell'Università, Catania.

Geological setting.

The Plio-Quaternary sedimentation in the Messina Strait area was strongly affected by tectonics, which split the substrate into several fault-controlled compartments (Barrier, 1987; Ott d'Estevou et al., 1987). Stratigraphic sequences show sharp lithological and bathymetric changes, as well as signs of synsedimentary tectonis, such as gravity flows, olistoliths, fault escarpments and neptunian dikes (Vachard et al., 1987; Barrier et al., 1987; Barrier et al., 1996). Extensional movements led to a rapid sinking of compartments and to deep-sea sedimentation. Subsequent uplifting raised the bathyal deposits as much as 400-500 m above the present sea-level (Barrier, 1987; Montenat & Barrier, 1987).

More distal Tyrrhenian and Jonian sectors of southern Calabria seem to have been affected by less intense Plio-Quaternary tectonics, as demonstrated by weaker synsedimentary deformations. Strong vertical displacements are recognizable in these areas as well, related to an increasing uplift of the Peloritani Mounts during the Pleistocene (Fabbri et al., 1980).

The geology of the Furnari area was studied by Kezirian (1992) who recognised the "Furnari block", a compartment a few km wide, controlled by two fault systems (N30°E and N140°E). Shelf calcarenites and silts overlay the Miocene substrate, whereas two N-S faults affect the northern margin of the block, defining a graben ca. 200x500 m in size. The graben is filled with grey bathyal marls, while on the fault escarpments remains of deep-sea sessile faunas are preserved. Foraminiferal assemblages indicate an early Pleistocene age.

The geology of Vallone Catrica was described by Barrier (1987). A fault escarpment, involving the Miocene substrate, is encrusted by deep-sea sessile faunas. The escarpment is draped by early Pleistocene grey marls containing bathyal faunas. Faulting caused a progressive deepening of the basin, as suggested by the early colonization of the escarpment by deep-shelf faunas ("yellow corals") and the subsequent settlement of bathyal faunas ("white corals").

Barrier (1987) also studied the sequence of Lazzàro, where some shallow water units, followed by bathyal marls (ca. 13 m thick) and deltaic conglomerates are distinguished from the base to the top. Boulders fell from the faulted basement during the deep-sea sedimentation, becoming "rocky islands" on the muddy bottom (Barrier et al., 1996). Bathyal marls are early-middle Pleistocene in age, as shown by foraminiferal (Violanti, 1988) and magnetostratigraphic data (Aifa et al., 1987).

The Plio-Quaternary sequence along the Jonian coast of southern Calabria ("Jonian Basin post-orogenic Complex" of Ogniben, 1973), where the Bianco outcrop is located, may be summarized as follows: early Pliocene whitish marls ("Trubi"), middle-late Pliocene bluish marls, Pleistocene greyish marls, yellowish silts and calcarenites. The Plio-Pleistocene marls and silts are deep-sea deposits. The sample studied comes from the upper part of the greyish marls.

Composition and paleoecology.

Overall, 136 species were recovered from the four sites (Tab. 1), most of them from bulk samples. The richest faunas are those from Furnari (96 species, 1,847 specimens) and from Bianco (74 species, 1,109 specimens), whereas the faunas from Vallone Catrica (55 species, 605 specimens) and Lazzàro (56 species, 305 specimens) are less abundant. Several small-sized species were detected from the fine fractions, such as some gastropods informally listed as "skeneimorph" (*sensu* Warén, 1992). About 13% of the species occur in all of the bulk sample assemblages, although with different degrees of dominance. The trochid *Solariella marginulata*, the nuculoids *Ennucula corbuloides*, *Austrotindaria pusio*, *Bathyspinula excisa*, *Katadesmia confusa*, *Ledella messanensis* and the scaphopods *Graptacme agilis*, *Cadulus ovulum* and *Entalina tetragona* are among the most frequent species.

The dominance of nuculoids (40% to 47%) and scaphopods (6% to 23%), the scarcity of heterodonts, consisting almost exclusively of the micromorphic *Kelliella abyssicola*, and the occurrence of several taxa, such as *Fissurisepta*, *Cantrainea*, *Solariella*, *Seguenzia*, *Benthomangelia*, *Ledella*, *Yoldiella*, *Bathyspinula*, *Katadesmia*, *Bathyarca*, *Limopsis*, *Delectopecten*, *Cyclopecten*, *Cadulus*, resulted in a compositional pattern closely fitting the "taxonomic structure" of the soft-bottom deep-sea molluscan communities (Clarke, 1962; Knudsen, 1979; Hickman, 1984; Rex, 1981).

Nuculoids account for one of the dominant trophic groups, i.e. the infaunal detritus-feeders. Epifaunal detritus-feeders are also well represented by trochids and rissoids. Scaphopods are microcarnivorous, preying on benthic foraminifers (Bilyard, 1974; Poon, 1987). Filter-feeders are scarce and consist mainly of epifaunal (arcids, anomiids, pectinaceans) or seminfaunal (*Limopsis*) species, whereas *Kelliella abyssicola* is the only abundant heterodont. Carnivorous taxa are typically represented by neogastropods. Some parasitic eulimid and pyramidellid species are also present.

A strong bathyal mud-dwelling stock, accounting for 77-90% of the bulk sample assemblages, can be reco-

	B	F	L	C
Gastropoda				
cocculinomorph sp.	0.3			
Notocrater sp.	0.8			
Fissurisepta papillosa Seguenza, 1862			1.6	0.6
Fissurisepta rostrata Seguenza, 1862			+	0.2
Puncturella noachina (Linnè, 1771)			0.3	0.5
Puncturella granulata (Seguenza, 1862)			0.3	
Solariella marginulata (Philippi, 1844)	0.6	6.1	3.8	5.7
Danilia otaviana (Cantraine, 1835)				+
Putzeysia wiseri (Calcara, 1842)			0.3	0.2
Callumbonella suturale (Philippi, 1836)	0.9	1.1	+	+
Cantrainea peloritana (Catraine, 1835)		+	+	+
Homalopoma emulum (Seguenza, 1876)			0.3	0.2
Parviturbo sp.	0.3	0.1		
Akritogyra conspicua (Monterosato, 1880)	*			*
Lissotesta minima (Seguenza, 1876)	0.2			
Lissotesta gittembergeri (Van Aartsen & Bogi, 1988)	*			
Lissotesta turrita (Gaglini, 1987)	*	*	*	
Lissotesta sp. A	*	*		
Lissotesta sp. B	*			
Trochaclis versiliensis Warén, Carrozza & Rocchini, 1992	*			
Orbitestella sarsi (Bush, 1897)	*			*
Rugulina monterosatoi (Van Aartsen & Bogi, 1986)		*		
Cirsonella romettensis (Granata-Grillo, 1877)		0.7	0.3	
Moelleriopsis messanensis (Seguenza, 1876)		+	0.3	0.6
skeneimorph sp. A	*	0.2	*	*
skeneimorph sp. B	*			
skeneimorph sp. C	*	0.1		
Brookula (?) sp.			*	*
Seguenzia monocingulata Seguenza, 1876	6.7	0.3		
Haloceras carinata (Jeffreys, 1883)		0.1		
Alvania cimicoides (Forbes, 1844)	*	8.4	0.7	
Alvania subsoluta (Aradas, 1847)	4.3	4.1	2.0	
Alvania zetlandica (Montagu, 1815)		+		
Pseudosetia turgida (Jeffreys, 1870)		0.3		
Obtusella sp.	1.5	1.2	0.3	
Aporrhais serresianus (Michaud, 1828)	0.5	0.1		
Torellia delicata (Philippi, 1844)			+	+
Capulus ungaricus (Linnè, 1758)		0.1		
Polinices fusca (Blainville, 1825)	0.4	0.2		+
Strobiligera brychia (Bouchet & Guillemot, 1978)		+	+	
Eumetula aliceae (Dautzenberg & Fischer, 1896)	0.4	0.1		
Aclis attenuans Jeffreys, 1883	0.4		0.3	0.2
Aclis bicincta Seguenza, 1879		0.1		
Graphis gracilis (Monterosato, 1874)	0.2	1.0	0.7	0.3
Melanella spiridioni (Dautzenberg & Fischer, 1896)		0.2		
Granulina sp.		0.4		
Claviscala richardi (Dautzenberg & de Boury, 1897)		+		
Opaliopsis atlantis (Clench & Turner, 1952)		+		
Iphitus tenuisculptus (Seguenza, 1876)		0.1		
Pagodula echinata (Kiener, 1840)	1.6	1.9		+
Trophonopsis muricata (Montagu, 1803)		0.1		
Coralliophila richardi (Fischer, 1882)		+		
Coralliophila squamosa (Bivona, 1838)		+		
Fusinus rostratus (Olivi, 1792)	+	0.2		

	B	F	L	C
Nassarius lima (Dillwin, 1817)		2.4		
Nassarius edwardsi (Fischer, 1882)		0.1		
Nassarius cabrierensis (Fischer & Tournouer, 1873)	0.1			+
Profundinassa spinulosa (Philippi, 1844)		0.1		
Amphissa acutecostata (Philippi, 1844)	0.7	4.4	0.3	+
"Babylonella" profunda (Tabanelli, 1985)	0.3	0.1		
Benthomangelia tenuicostata (Seguenza, 1879)	1.7	2.5	0.3	
Turriclavus harpula (Brocchi, 1814)		0.1		
Drilliola emendata (Monterosato, 1872)	0.2	0.5		
Taranis moerchi (Malm, 1863)		0.1		
Taranis cf. *borealis* Bouchet & Waren, 1980	1.3		+	
Gymnobela torquata (Philippi, 1844)		0.2		
Spirotropis confusa (Seguenza, 1879)		0.3		
Mitrolumna smithi (Dautzenberg & Fischer, 1896)		0.3	+	
Teretia teres (Reeve, 1844)		0.2		
Pleurotomella packardi Verrill, 1872	0.1	0.1		0.2
Pleurotomella eurybrocha (Dautzenberg & Fischer, 1896)	0.2	0.1		
Heliacus alleryi (Seguenza, 1876)		0.2		
Heliacus zancleus (Seguenza, 1876)		+		
Ammonicera rota (Forbes & Hanley, 1850)	*			*
Ammonicera fischeriana (Monterosato, 1869)	*			
Chrysallida brattstroemi Warén, 1991	0.6	0.6	0.7	
Chrysallida stefanisi (Jeffreys, 1869)		*		
Chrysallida microscalaria (Seguenza, 1876)		0.2		
Chrysallida sp.	0.1			
Eulimella scillae (Scacchi, 1835)	0.9	0.2		
Eulimella ventricosa (Forbes, 1844)	0.1	0.1		
Odostomia acuta Jeffreys, 1848	1.9	1.1		
Odostomia sp.	0.4			
Ondina sp.	0,2			
Tjaernoeia exquisita (Jeffreys, 1883)	*			*
Japonacteon pusillus (McGillivray, 1843)	0.1			
Acteonidae sp.	0.2			
Pyrunculus obesiusculus (Brugnone, 1877)	0.8	1.1	0.7	0.2
Ringicula leptocheila Brugnone, 1873	0.1	0.1		
Cylichna alba (Brown, 1827)		0.1		
Bivalvia				
Nucula sulcata (Bronn, 1831)	0.1	2.4	3.0	3.2
Ennucula corbuloides (Seguenza, 1877)	0.1	0.5	7.2	2.6
Ennucula rotundata (Seguenza, 1877)		0.1	3.0	1.2
Ennucula decipiens (Philippi, 1844)			+	
Ennucula tenuis (Montagu, 1808)		0.4	1.3	
"Yoldia" minima (Seguenza, 1877)		0.1	1.6	0.6
Phaseolus ovatus Seguenza, 1877		0.4		0.2
Microgloma tumidula (Monterosato, 1880)	*	*	*	
Microgloma pusilla (Jeffreys, 1879)		0.2		0.3
Microgloma sp.			2.0	
Austrotindaria pusio (Philippi, 1844)	8.5	2.1	3.3	6.6
Thestyleda cuspidata (Philippi, 1844)	0.6	0.8	1.6	6.9
Bathyspinula excisa (Philippi, 1844)	28.9	30.0	15.6	1.4
Katadesmia confusa (Seguenza, 1877)	2.1	1.9	1.6	1.2
Ledella messanensis (Jeffreys, 1870)	1.9	1.7	5.2	13.7
Yoldiella micrometrica (Seguenza, 1877)		0.2		
Yoldiella philippiana (Nyst, 1845)			0.7	+

	B	F	L	C
Yoldiella seguenzae Bonfitto & Sabelli, 1995	1.4	0.3	1.6	3.7
Asperarca nodulosa (Müller, 1776)		0.6	2.3	0.8
Bathyarca grenophia (Risso, 1826)	0.1	0.1	3.0	6.9
Limopsis pygmaea (Philippi, 1836)	1.9	2.4	0.3	
Limopsis minuta (Philippi, 1836)	+	0.2		+
Limopsis aurita (Brocchi, 1814)	+			
Limopsis sp.	+			
Cyclopecten hoskynsi (Forbes, 1844)		0.2		0.9
Delectopecten vitreus (Gmelin, 1791)		1.8	12.1	5.1
Karnekampia bruei (Payraudeau, 1826)		+	0.3	0.2
Spondylus gussonii Costa O.G., 1829		+	0.3	+
Pododesmus aculeatus (Mueller O.F., 1776)	0.4	0.2	8.2	22.6
Acesta excavata (Fabricius, 1779)		0.2		
Notolimea crassa (Forbes, 1844)	0.1	0.1		0.2
Leptaxinus ferruginosus (Forbes, 1844)				0.3
Digitaria digitaria (Linnè, 1758)	0.1			
Plagiocardium papillosum (Poli, 1795)	0.1			
Abra longicallus (Scacchi, 1834)	0.5	1.0	0.3	
Kelliella abyssicola (Forbes, 1844)	1.4	0.6	4.8	1.4
Timoclea ovata (Pennant, 1777)				0.2
Poromya granulata (Nyst & Westendorp, 1839)		0.5		
Spinosipella acuticostata (Philippi, 1844)		0.2		+
Cuspidaria rostrata (Spengler, 1793)		1.2	0.3	0.2
Cardiomya philippi (Seguenza, 1876)			+	0.2
Scaphopoda				
Graptacme agilis (Sars M. in Sars G.O., 1872)	5.2	1.2	3.3	5.2
Cadulus ovulum (Philippi, 1844)	2.3	0.6	1.6	1.7
Cadulus diploconus Seguenza, 1876	0.3			
Gadila jeffreysi (Monterosato, 1875)	0.5	1.5	1.0	2.0
Entalina tetragona (Brocchi, 1814)	15.0	2.4	1.6	2.0
Total of specimens	1,109	1,847	305	650

Tab. 1 - Systematic list of the studied faunas, relative abundance of species and total amount of specimens from bulk-samples (B = Bianco, F = Furnari, L = Lazzàro, C = Vallone Catrica). Unscored species are from the fine fraction (<500 μm) (stars) and from manual picking (crosses).

gnised. Most nuculoids and scaphopods, together with many other bivalves and gastropods, can be referred to this stock. The remaining portion consists mainly of mud-dwelling species ranging from the outer-shelf to the bathyal zone, such as *Alvania cimicoides*, *Nucula sulcata*, *Kelliella abyssicola* and *"Gadila" jeffreysi*. A minor stock of sessile bivalves (*Asperarca nodulosa*, *Bathyarca grenophia*, *Spondylus gussonii*, *Pododesmus aculeatus*, *Acesta excavata*) can be distinguished within the dominant free-living epifaunal and infaunal species. Sessile bivalves are more frequent at Furnari, Lazzàro and Vallone Catrica, due to the nearby hard-bottoms (fault-escarpments and boulders) or to coarse skeletal remains on the bottom. A few shelf coarse-bottom species, i.e. *Digitaria digitaria*, *Plagiocardium papillosum* and *Timoclea ovata*, occur as rare juvenile valves in two samples.

As noted by Moissettte & Spjeldnaes (1995) and by Di Geronimo et al. (in press), paleodepth inferences from deep-sea fossil faunas are difficult. In the present case, this is due mainly to the wide bathymetric range of most of the extant species. Furthemore, the abundant occurrence of extinct species, such as *Solariella marginulata*, *Bathyspinula excisa*, *Thestyleda cuspidata*, *Austrotindaria pusio*, *Katadesmia confusa* and *Cadulus ovulum*, makes paleobathymetric comparisons with the Recent assemblages even more difficult. Nevertheless, a depth not shallower than 500 m is clearly suggested by the taxonomic composition and ecological structure. This value is also indicated by the occurrence in all samples of *Ennucula corbuloides* and *Yoldiella seguenzae*, whose present depth range begins at about 500 m (see below). Di Geronimo & La Perna (1996) regarded the increasing dominance of *Bathyspinula excisa* in Pleistocene beds as related to depth. On this basis, the molluscan faunas from Bianco and Furnari should be regarded as the deepest. The occurrence of *Seguenzia monocingulata* in both sites, and of *Haloceras carinata* at Furnari, also suggests a greater depth, probably within 1,000 m. On the other hand, it is worth noting the scarce occurrence at Lazzàro and Vallone Catrica of *Yoldiella philippiana*, a species which "replaces" the allied *Y. seguenzae* at depths shallower than 500-600 m. A paleodepth greater than 1,000 m for the Furnari and Bianco assemblages cannot be excluded, although no data presently exist to support this conclusion.

Systematic description

Class **Gastropoda** Cuvier, 1797
Subclass **Prosobranchia** Milne Edwards, 1848
Family *Fissurellidae* Fleming, 1822

Fissurisepta papillosa Seguenza, 1862

Pl. 1, fig. 1, 2, 3

1862 *Fissurisepta papillosa* Seguenza, p. 10, fig. 2, 2a, 2b.
1974 *Fissurisepta papillosa* - Taviani, p. 40, fig. 1a, 1b, 1c.
1980 *Fissurisepta papillosa* - Warén, p. 14, pl. 2, fig. 19, 20.
1983 *Fissurisepta papillosa* - Ghisotti & Giannini, fig. 5.

Description. Small, low-conical, laterally compressed shell, with apical hole and internal septum. Ovate base. Early coiled stage lost. Apical hole roughly triangular to polygonal. Septum consisting of a thin lamina, slightly curving when inserting on shell sides. Sculpture of small tubercles loosely arranged in radial rows to randomly scattered. Short ill-defined radial ridges extending downward from tubercles. Rugose comarginal microsculpture. Height up to 1.9 mm, base 2.8x2.0 mm.

Taxonomy. This is the type-species of *Fissurisepta* Seguenza, 1862. Regarded previously as a subgenus of *Puncturella* Lowe, 1827, *Fissurisepta* was ranked definitively to full genus status by Cowan (1969) (see also Warén, 1972 and Corselli & Bernocchi, 1993).

Remarks. Jeffreys (1883a) described *F. granulosa* from the Norwegian coast, correcting a previous identification as *papillosa* Seguenza. In the same paper, he reported *F. papillosa* from the Portugal coast as well. Warén (1980) noted that this last *papillosa* is different from the one described by Seguenza, and is probably an undescribed species.

F. papillosa and *F. granulosa* are closely related, the latter differing mainly in having smaller tubercles, regularly aligned in radial rows (see Taviani, 1974). A rugose microsculpture also occurs in *F. granulosa*.

Comparing the shell shape of several *Fissurisepta* species, Ghisotti & Giannini (1983) distinguished two morphological groups: low-conical forms (characterised by generally smaller species, lower than 3 mm), and high-conical forms, consisting of larger species. In the first (most typical) group, shells are generally thicker and more heavily sculptured, as in *F. papillosa* and *F. granulosa*, as well as other Atlantic species (*tenuicola* Dall, 1927, *trifolium* Dall, 1881, *agulhasae* Clarke, 1961) and the Pacific *F. undulata* Okutani, 1964. The Atlantic *acuminata* Watson, 1883, the Pacific *festiva* Crozier, 1966 and the southern *onychoides* Herbert & Kilburn, 1986 all belong to the second group, together with *F. rostrata* Seguenza, 1862 (see below). These species share thin, glossy and finely granulous shells. Such a morphological grouping could be useful for a subgeneric arrangement of *Fissurisepta*.

Distribution. The only "Recent" Mediterranean record is that by Taviani (1974), who reported both *F. papillosa* and *F. granulosa* as subfossil shells from a 900 m deep Tyrrhenian station. Nordsieck (1968) also reported both species from the Northeast Atlantic, but his drawing of *F. papillosa* is not very reliable.

Seguenza (1862) originally reported *F. papillosa* as a Miocene fossil from Rometta (Messina), whereas he referred it to the deep-sea "Astian" faunas in a later work (Seguenza, 1879).

F. papillosa is common in Pleistocene bathyal deposits from southern Italy (La Perna, 1994), being frequent where a coarse biogenic fraction occurs on pelitic substrates (Barrier et al., 1996).

Fissurisepta rostrata Seguenza, 1862

Pl. 1, fig. 4, 5

1862 *Fissurisepta rostrata* Seguenza, p. 10, fig. 3, 3a, 3b, 3c.
1896 *Fissurisepta crossei* Dautzenberg & Fischer, p. 492, pl. 22, fig. 15.

Description. Small, high-conical, laterally compressed shell with apical hole and internal septum. Ovate base. Early coiled stage lost. Posterior apex. Ovate apical hole. Anterior slope convex, posterior slope concave. Septum consisting of a thin straight lamina, inserting on shell sides and extending well below midway of shell height. Sculpture of fine granules, roundish to ovate, aligned in irregular radial rows, becoming crowded and randomly scattered towards the base. Smooth apical portion. Faint sulcus, internally corresponding to septum insertion, extending on both sides from apex. Height up to 5.8 mm, base 4.0x2.8 mm.

Remarks. *F. rostrata* is similar to the North Atlantic *F. acuminata* (Watson, 1883), which differs in being shorter and less curved. It is also very similar to *F. onychoides* Herbert & Kilburn, 1986 (South Africa, 250-430 m), which differs in being more curved and with a shorter septum.

Two specimens from the Biscay Bay (THALASSA Exp., St. 413, 48°03N/08°29E, 805 m, MNHN), containing the soft body , were examined. They closely resemble both *F. crossei* Dautzenberg & Fischer, 1869 (from Azores in 1,022-1,385 m) and the fossil Mediterranean specimens. Therefore, *F. crossei* should be regarded as a synonym of *F. rostrata*.

Distribution. The Recent distribution of *F. rostrata* ranges from Biscay Bay south to the Azores, excluding the Mediterranean. Jeffreys (1883a) reported *F. rostrata* from 740-1,095 fms. off Portugal. He also reported the "Travailleur" (Biscay Bay, 1,093 fms.) and the "Challenger" (Bermudas, 1,375 m) findings. The latter proved to be based on *F. acuminata* by Pérez Farfante (1947).

In deep-sea Pleistocene deposits *F. rostrata* frequently occurs together with *F. papillosa*.

Family *Trochidae* Rafinesque, 1815

Solariella marginulata (Philippi, 1844) comb. nov.

Pl. 1, fig. 6, 7

1844 *Trochus marginulatus* Philippi, p. 227, pl. 28, fig. 4.
1846 *Solarium nitidum* Aradas, p. 172, pl. 1, fig. 9a,b.
1986 *Lischkeia marginulata* - Micali & Villari, fig. 2.
1994 *Calliotropis marginulata* - Palazzi & Villari, fig. 22, 31.
1996 *Lisckeia marginulata* - Vazzana, pl. 1, fig. 2a,b.

Description. Medium-sized, trochoid, solid shell. Protoconch ca. 1.5 whorls, finely pitted, 350 µm large. Flat teleoconch whorls, numbering up to 5. Suture deep. First 3 whorls with axial faintly prosocline riblets, intersected by 3-4 spiral cords. Following whorl with a subsutural series of sharp tubercles, a fainter suprasutural one, and axial riblets. Last whorl with a subsutural series of sharp tubercles, two peripheral keels (the uppermost sometimes granulated) and basal granulated cords bounding a wide funnel-shaped umbilicus. Parietal lip thickened by a strong granulated funiculus. Peripheral and basal part frequently displaying faint spiral striae. Roundish aperture. Height up to 7 mm. Height to breadth ratio ca. 1.0 in adult specimens.

Taxonomy. This species may appear somewhat different in morphology from the low-spired and strongly keeled type-species of *Solariella* S.V. Wood, 1842 (*S. maculata* S.V. Wood, 1842), showing instead a certain resemblance to *Calliotropis* L. Seguenza, 1903. Actually, *Solariella* is still used in a rather broad sense (see discussion in Warén, 1993) and *S. marginulata* is even more similar to the type-species, when compared with other smooth-shelled species referred to *Solariella*. In *Calliotropis*, however, many spiral rows of sharp tubercles occur on the last whorl. In the type-species *C. ottoi* (Philippi, 1844), the protoconch is slightly protruding and inrolled (Colman & Tyler, 1988; Warén, 1991), as seen in the New Zealand species (Marshall, 1979). In *S. marginulata*, the protoconch is rather flat and regularly coiled, as in other *Solariella* species (Herbert, 1987; Warén, 1993). *Calliotropis* and *Solariella* were allocated in distinct subfamilies by Hickman & McLean (1990), mainly on the basis of soft body features.

Remarks. The only Atlantic species showing a certain resemblance in shape and sculpture to *S. marginulata* is *S. amabilis* (Jeffreys, 1865), recently treated by Warén (1993). Another seemingly closely related species was reported by Dautzenberg & Fischer (1896, p. 178, pl. 20, figs. 15-17) from the Azores as *S. cincta* (Philippi, 1836). It is, however, quite distinct from Philippi's species (see holotype in Warén, 1993) and it might be an undescribed species, if not a peculiar form of *S. amabilis*. This species, together with *S. marginulata* and *S. amabilis*, seem to represent a group of allied eastern Atlantic deep-sea species. As suggested by Warén (pers. comm.), the western deep-sea species *Solariella* (*Suavotrochus*) *lubrica* (Dall, 1881) (holotype in Quinn, 1979), also shows a certain resemblance to *S. marginulata*, but is distinguishable by its markedly convex and smoother whorls.

S. cincta was also described from the Plio-Pleistocene of southern Italy. The east Atlantic *Gibbula inoptanda* Locard, 1897 was recently considered a synonym (Warén, 1993).

Trochus marginulatus was originally reported from "prope Messina". The original drawing, description and origin of *Solarium nitidum* Aradas, 1846 from Gravitelli (Messina) leaves no doubt about its synonymy with *T. marginulatus*.

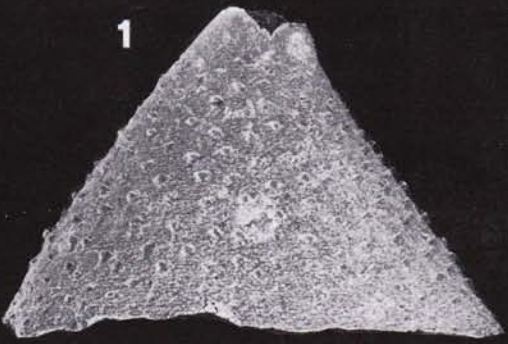
Distribution. *S. marginulata* is known only from deep-sea Pleistocene deposits of southern Italy, where it is one of the most frequent species.

As "*Calliotropis marginulatus*", it has been regarded (Di Geronimo et al., 1996; Di Geronimo & La Perna, 1997) as a cold stenothermic species, extinct in the Mediterranean. The present revision supports this paleoecological interpretation.

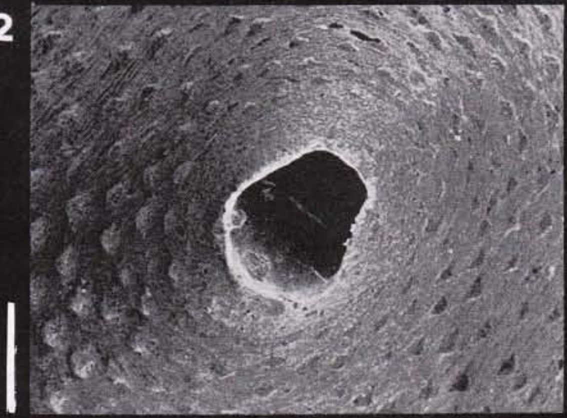
PLATE 1

Fig. 1, 2, 3 - *Fissurisepta papillosa* Seguenza, 1862. Lazzàro. 1. Lateral view, 1.5 mm. 2. Apical view, scale bar = 250 µm. 3. Sculpture detail, scale bar = 100 µm.
Fig. 4, 5 - *Fissurisepta rostrata* Seguenza, 1862. Lazzàro. 4. Lateral view, 4.5 mm. 5. Sculpture detail, scale bar = 50 µm.
Fig. 6, 7 - *Solariella marginulata* (Philippi, 1844). Furnari. 6. 6.1 mm. 7. Protoconch, scale bar = 200 µm.

1

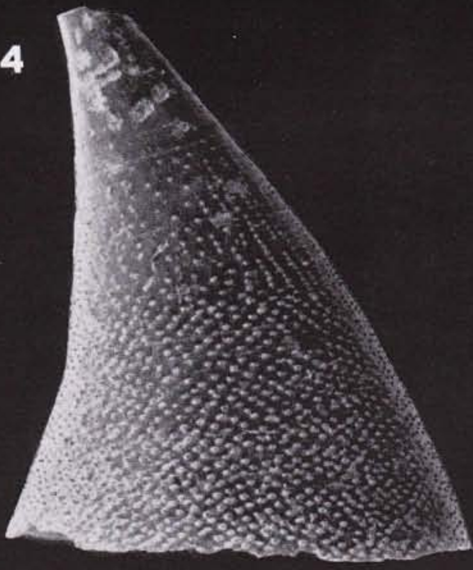


2



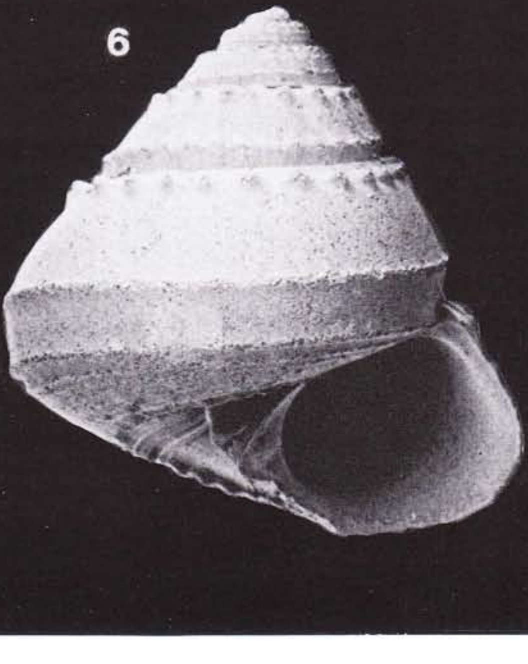
3

4

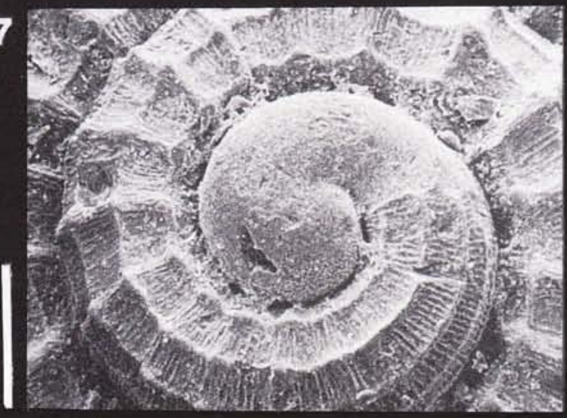


5

6



7



Family Seguenziidae Verrill, 1884

Seguenzia monocingulata Seguenza, 1876

Pl. 2, fig. 5-8

1876a *Seguenzia monocingulata* Seguenza, p. 188.
1994 *Seguenzia monocingulata* - Palazzi & Villari, fig. 7.

Description. Small, conical-globose, thin, fragile shell. Prominent protoconch, ca. one whorl, finely granulated, 270-300 µm large. Teleoconch of 5 whorls in fully grown specimens. Spire whorls with a sharp slightly supramedian keel (shoulder keel), beginning soon after protoconch and a faint subsutural and suprasutural cord. Last whorl with a shoulder and a peripheral keel, and 5 basal cords. Axial sculpture of faint, sigmoidal riblets, evenly spaced, not crossing spiral cords, numbering 12-13 per mm on last whorl. Whorl profile concave between spirals. Suture mostly hidden by sutural cords. Convex base, becoming flatter to slightly concave around the umbilicus. Umbilicus closed in adults, narrow in juveniles. Concave and tooth-bearing columellar lip. Outer lip broken in all specimens examined. Height up to ca. 4.0 mm; height to breadth ratio 1.3 in fully grown specimens; last whorl to shell height ratio 0.6.

Remarks. An important unresolved puzzle involves the genus *Seguenzia*, as Seguenza (1876a) and Jeffreys (1876) proposed it almost simultaneously. The priority of *Seguenzia* Jeffreys on *Seguenzia* Seguenza was proven by Marshall (1983) on the basis of ICZN rules, but according to Warén (pers. comm.), priority is still pending.

Beginning with Jeffreys (1877, 1885), *S. monocingulata* Seguenza, 1876 and *S. formosa* Jeffreys, 1876, have been regarded as synonyms. However, in spite of a gross resemblance (see illustration of *S. formosa* in Jeffreys, 1876), the two species are quite distinct. In *formosa*, "ten thread-like riblets on the base" occur, whereas *monocingulata* is characterized by five cords (as also noted by Seguenza). In the former, the sigmoidal axial striae are crossed by "fine close-set spiral lines, producing a reticulate appearance", whereas only sharp cords or keels occur in *monocingulata*. On the basis of present knowledge of shell morphology and sculpture in *Seguenzia* and Seguenziidae (Quinn, 1983; Marshall, 1983, 1991), these differences cannot be disregarded.

As usual, Seguenza described some "varieties", namely *elegans* (with well-defined axial striae), and *elata* (higher than the typical form).

Another Seguenziidae, *Ancistrobasis reticulata* (Philippi, 1844), was described as a fossil from southern Italy. It is presently known from the Atlantic (Warén, 1991).

Distribution. "*S. monocingulata*" was reported from the Atlantic by some authors (Watson, 1886, Dautzenberg, 1927, etc.), but the actual value of these records can be evaluated only by examining the material. Quinn (1983) listed *S. monocingulata* without comment on synonymy or its present distribution.

S. monocingulata is rather common in deep-sea deposits from southern Italy. Di Geronimo & La Perna (1996) reported it as *S. formosa*.

Family Haloceratidae Warén & Bouchet, 1991

Haloceras carinata (Jeffreys, 1883)

Pl. 4, fig. 2, 9

1883b *Cithna carinata* Jeffreys, p. 111, pl. 20, fig. 9.
1991 *Haloceras carinata* - Warén & Bouchet, 137, fig. 33, 36, 58-61, 105-108.
1993 *Haloceras carinata* - Bouchet & Warén, p. 722, fig. 1708, 1709, 1719, 1723.

Remarks. One fully grown but partly broken and one post-larval specimen were found in the sample from Furnari.

The deep-sea family Haloceratidae was recently described extensively by Warén & Bouchet (1991). About twenty species are presently known from the Atlantic, Indian and Pacific Oceans, five of them occurring in the northeast Atlantic.

Distribution. *H. carinata* was reported originally from Portugal in 994 fms. (Jeffreys, 1883b). It is an amphiatlantic species, ranging from 27-42°N in 700-2,075 m (Warén & Bouchet, 1991; Bouchet & Warén, 1993).

The specimens from Furnari are the first record of Haloceratidae from the Mediterranean area.

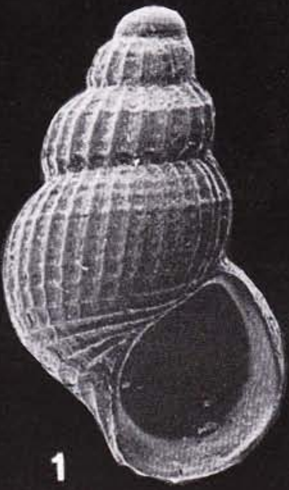
Family Epitoniidae Berry, 1910

Iphitus tenuisculptus (Seguenza, 1876) comb. nov.

Pl. 4, fig. 4

PLATE 2

Fig. 1 - *Alvania subsoluta* (Aradas, 1847). Lazzàro, 2.1 mm.
Fig. 2 - *Alvania zetlandica* (Montagu, 1815). Furnari, 3.0 mm.
Fig. 3 - *Pyrunculus obesiusculus* (Brugnone, 1877). Vallone Catrica, 3.5 mm.
Fig. 4 - *Graphis gracilis* (Monterosato, 1874 ex Jeffreys ms.). Furnari, 2.1 mm.
Fig. 5-8 - *Seguenzia monocingulata* Seguenza, 1876. Bianco. 5. Aboral view of a partly broken juvenile, 1.6 mm. 6. Detail of fig. 5. 7. Apical view, scale bar = 200 µm. 8. Protoconch detail, scale bar = 25 µm.

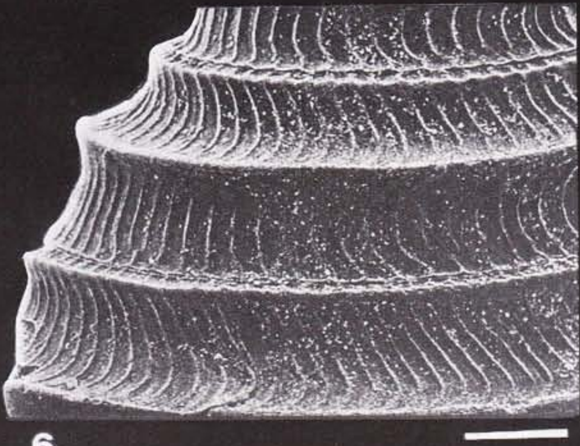

1


2

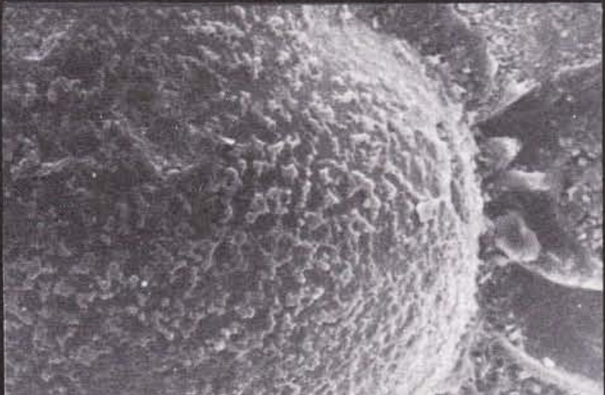

3


4


5


6


7


8

1876b *Stylotrochus tenuisculptus* Seguenza, p. 186.
1925 *Cithna marshalli* Sykes, p. 190, pl. 9, fig. 4, 4a.
1986 *Iphitus marshalli* - Bouchet & Warén, p. 492, fig. 1137, 1158, 1159.
1994 *Stylotrochus tenuisculptus* - Bertolaso & Palazzi, unnumb. fig.

Remarks. Bertolaso & Palazzi (1994) first recognised the synonymy between *Stylotrochus tenuisculptus* Seguenza, 1876 and *Cithna marshalli* Sykes, 1925. They regarded *Iphitus* Jeffreys, 1883 as a synonym of *Stylotrochus* Seguenza, 1876, which is preoccupied by *Stylotrochus* Haeckel, 1862.

Two other *Iphitus* species are known from deep-sea Pleistocene deposits, i.e. *I. asperatus* (Seguenza, 1876) [= *I. tuberatus* (Jeffreys, 1883)] and *I. papillosocinctus* (Seguenza, 1876) (see Bertolaso & Palazzi, 1994; Palazzi & Villari, 1996). The former is also known from Mediterranean Late Glacial submerged beds (Taviani & Sabelli, 1982). The latter is closely related to *I. cancellatus* Dautzenberg & Fischer, 1896 from the Azores.

Distribution. *I. tenuisculptus* is known presently from Portugal and the Gibraltar Strait, its depth range being probably not shallower than 500 m (Bouchet & Warén, 1986).

Family *Cancellariidae* Gray, 1853

"Babylonella" profunda Tabanelli, 1985

Pl. 3, fig. 8

1985 *Babylonella nassiformis profunda* Tabanelli, p. 21, fig. 1-3.
1993 *Admete dregeri profundus* - Tabanelli, fig. 4.

Remarks. This species was originally described (Tabanelli, 1985) as a bathyal Late Pliocene subspecies of *Babylonella nassiformis* (Seguenza, 1879). Later, the same author (Tabanelli, 1993) reported it as *?Admete dregeri profundus*, following the remarks by Petit (1986) and Verhecken (1986), about the preoccupied status of *Cancellaria nassiformis* Seguenza. The latter author proposed *?Admete* (s.l.) *dregeri* (Hoernes & Auinger, 1890) as the valid name for this species. However, there are several reasons to rank *"Babylonella" profunda* to full species status. It has a prevailing axial sculpture, in contrast to the markedly cancellate sculpture in *"Babylonella" dregeri*. The protoconch shows many spiral threads in *profunda*, and a few (3-4) in *dregeri*. *"B." profunda* had a bathyal distribution, whereas *dregeri* was a shelf species. Furthermore, the stratigraphic distributions are different (see below).

Actually, *Babylonella* Conrad, 1865 does not represent a good systematic position for either of these species. As stressed by Verhecken (1986), the type-species of *Babylonella* has two well-defined columellar folds and apertural lirations, whereas both the columella and the inner lip are smooth in *dregeri* and in *profunda*. Considerable shape differences also occur. On the other hand, *Admete* Kröyer in Möller, 1842 is markedly bucciniphorm in shape (e.g. see the northeast Atlantic species in Bouchet & Warén, 1985). A better systematic position for *dregeri*, *profunda* and several related Miocene and Pliocene species (see Pavia, 1976; Davoli, 1995) should be traced among the present-day Indo-Pacific deep-sea cancellariids (e.g. see Verhecken, 1997).

Distribution. *"B." profunda* is found rarely in Pleistocene bathyal deposits. It ranges from (Middle)-Late Pliocene to Pleistocene, whereas *"B." dregeri* ranges from Late Miocene to Early Pliocene.

Family *Turridae* Swainson, 1840 *s.l.*

Mitrolumna smithi (Dautzenberg & Fischer, 1896)

Pl. 3, fig. 1; Pl. 4, fig. 7

1896 *Mitromorpha smithi* Dautzenberg & Fischer, p. 432, pl. 15, fig. 19.
1980 *Mitrolumna smithi* - Bouchet & Warén, p. 78, fig. 161.

Remarks. Although in the typical form the last whorl is axially smooth, a faint axial sculpture occurs rarely among the specimens examined. The protoconch of *M. smithi* has 2.5 whorls, as in the common shallow-water *M. olivoidea* (Cantraine, 1835), but it is larger in the former (680 µm) than in the latter (500 µm).

Distribution. *M. smithi* is known presently from the Azores, in 400-800 m (Bouchet & Warén, 1980). This is the first record from the Mediterranean area.

Benthomangelia tenuicostata

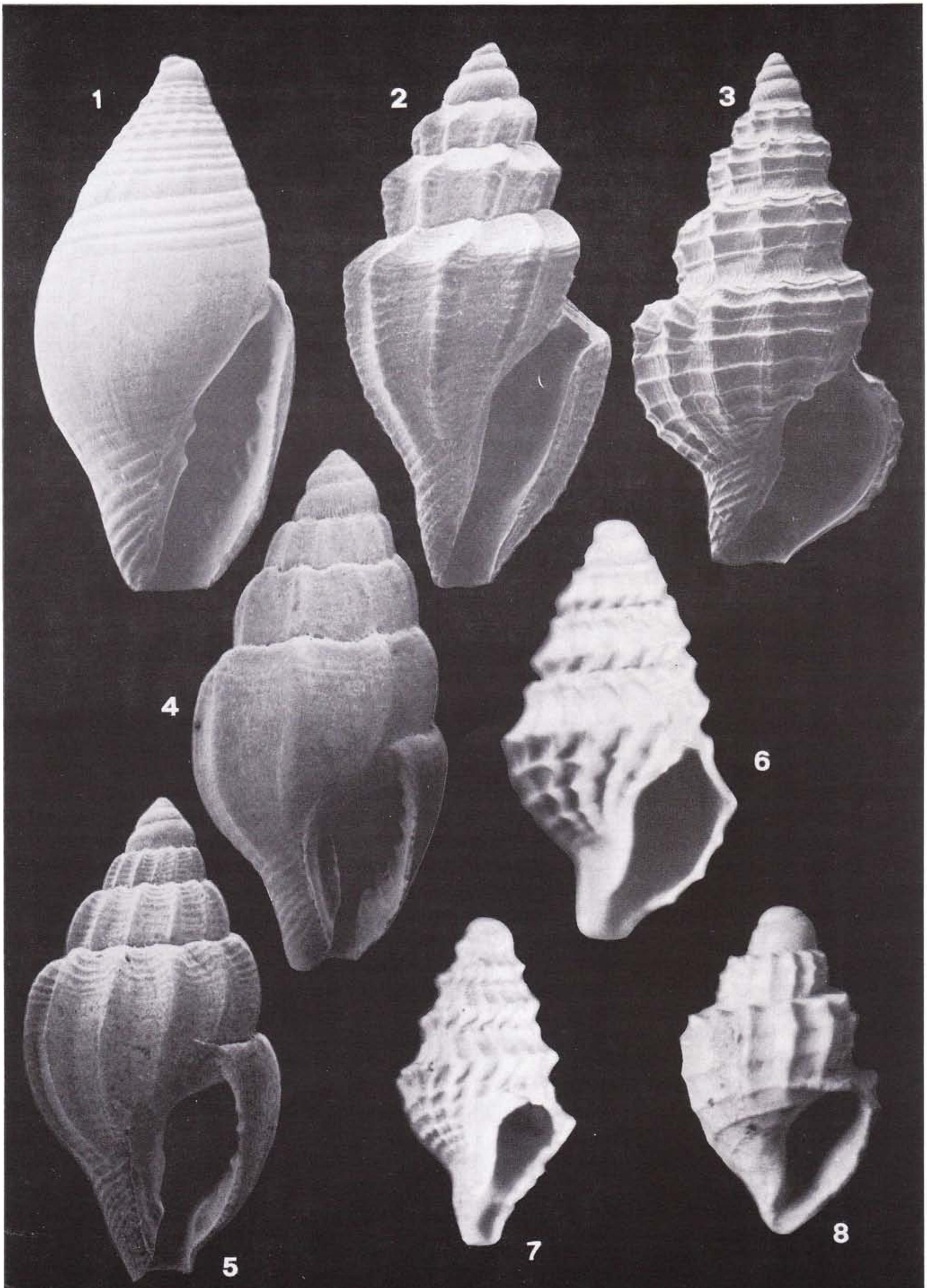
(Seguenza, 1879) comb. nov.

Pl. 3, fig. 2; Pl. 4, fig. 1

1879 *Mangelia tenuicostata* Seguenza, p. 258.
1994 *Mangelia tenuicostata* - Palazzi & Villari, fig. 17, 18, 29.

PLATE 3

Fig. 1 - *Mitrolumna smithi* (Dautzenberg & Fischer, 1896). Furnari, 6.1 mm.
Fig. 2 - *Benthomangelia tenuicostata* (Seguenza, 1879). Furnari, 4.7 mm.
Fig. 3 - *Pleurotomella eurybrocha* (Dautzenberg & Fischer, 1896). Furnari, 4.8 mm.
Fig. 4, 5 - *Amphissa acutecostata* (Philippi, 1844). Bianco. 4. 6.1 mm. 5. 5.8 mm.
Fig. 6, 7 - *Taranis* cf. *borealis* Bouchet & Warén, 1980. Bianco. 6. 4.2 mm. 7. 3.2 mm.
Fig. 8 - *"Babylonella" profunda* Tabanelli, 1985. Bianco, subadult, 3.3 mm.


1
2
3
4
6
5
7
8

Description. Medium-sized, roughly biconical, rather solid shell. Protoconch of 3.5 convex whorls, 760-960 µm large, with opisthocline riblets on ending portion. Teleoconch of 3-4 whorls in fully grown specimens, with a shoulder one third from the adapical suture. Axial sculpture of strong, faintly opisthocline ribs (ca. 10 per whorl), flexuose and almost lamellar on ramp. Spiral striae, arranged as alternating stronger and fainter ribs, crenulating axial ribs and lacking on ramp. Well-incised, sinuose suture. Narrow, elongate aperture, with a terminal rib. Deep subsutural sinus. Height up to 6.5 mm. Height to breadth ratio 1.9. Last whorl to shell height ratio 1.5 in adults.

Taxonomy. Warén (pers. comm.) suggested *Benthomangelia* Thiele, 1925 as the suitable systematic position for the present species. *Benthomangelia* is rather similar to *Mangelia* Risso, 1826, the former differing from the latter by having a thinner and markedly shouldered (biconical) shell, fainter and more flexuose axial ribs, becoming almost lamellar on the ramp, a well-developed spiral sculpture and a deeper subsutural sinus. Furthermore, *Mangelia* typically has a shallow-water distribution, whereas *Benthomangelia* is a bathyal to abyssal genus.

B. macra (Watson, 1881), a northeast Atlantic to Mediterranean deep-sea species (Bouchet & Warén, 1980), is rather close to *B. tenuicostata*. It differs in being more slender, high-spired, and less sculptured than the present species. *B. tenuicostata* also shows the typical protoconchal sculpture of the planktotrophically developing *Benthomangelia* species (see Bouchet & Warén, 1980, fig. 212, 213).

Remarks. A "*Mangelia tenuicostata* (Brugnone, 1862)" is reported in the Mediterranean Mollusca checklist (Sabelli et al., 1990). This probably originates from Nordsieck's (1977) report of "*Mangelia tenuicostata* Brugnone, 1868", clearly based on *Pleurotoma attenuata* var. *tenuicosta* Brugnone, 1862.

Distribution. *B. tenuicostata* is known only from Pleistocene bathyal deposits of Messina and Calabria.

Taranis cf. borealis (Bouchet & Warén, 1980)

Pl. 3, fig. 6, 7

cf. 1980 *Taranis borealis* Bouchet & Warén, p. 78, fig. 162, 270.
1989 *Taranis borealis* - Rindone & Vazzana, fig. 10.

Remarks. The scant Pleistocene material examined so far differs from the North Atlantic specimen reported by Bouchet & Warén (1980), mainly in having the peripheral keel in a lower position. Some (Pl. 3, Fig. 7) are as slender as the Atlantic specimen, whereas others are larger and more squat (Pl. 3, Fig. 7; see also Rindone & Vazzana, 1989, fig. 10). A clear-cut distinction between these forms (both occurring in the same assemblages) is not apparent, and these differences might be intraspecific (e.g. see the variability of *Taranis moerchi* noted by Bouchet & Warén, 1980). Whether the Pleistocene material really belongs to *T. borealis* is not fully understood.

Distribution. *T. borealis* is known presently from the Swedish and Norwegian coast (150-1,980 m) and from the western Atlantic (Bouchet & Warén, 1980).

Subclass Heterobranchia Gray J.E., 1840

Family *Pyramidellidae* Gray J.E., 1840

Chrysallida microscalaria (Seguenza, 1876) comb. nov.

Pl. 4, fig. 8

1876a *Turbonilla (Pyrgulina) microscalaria* Seguenza, p. 92.

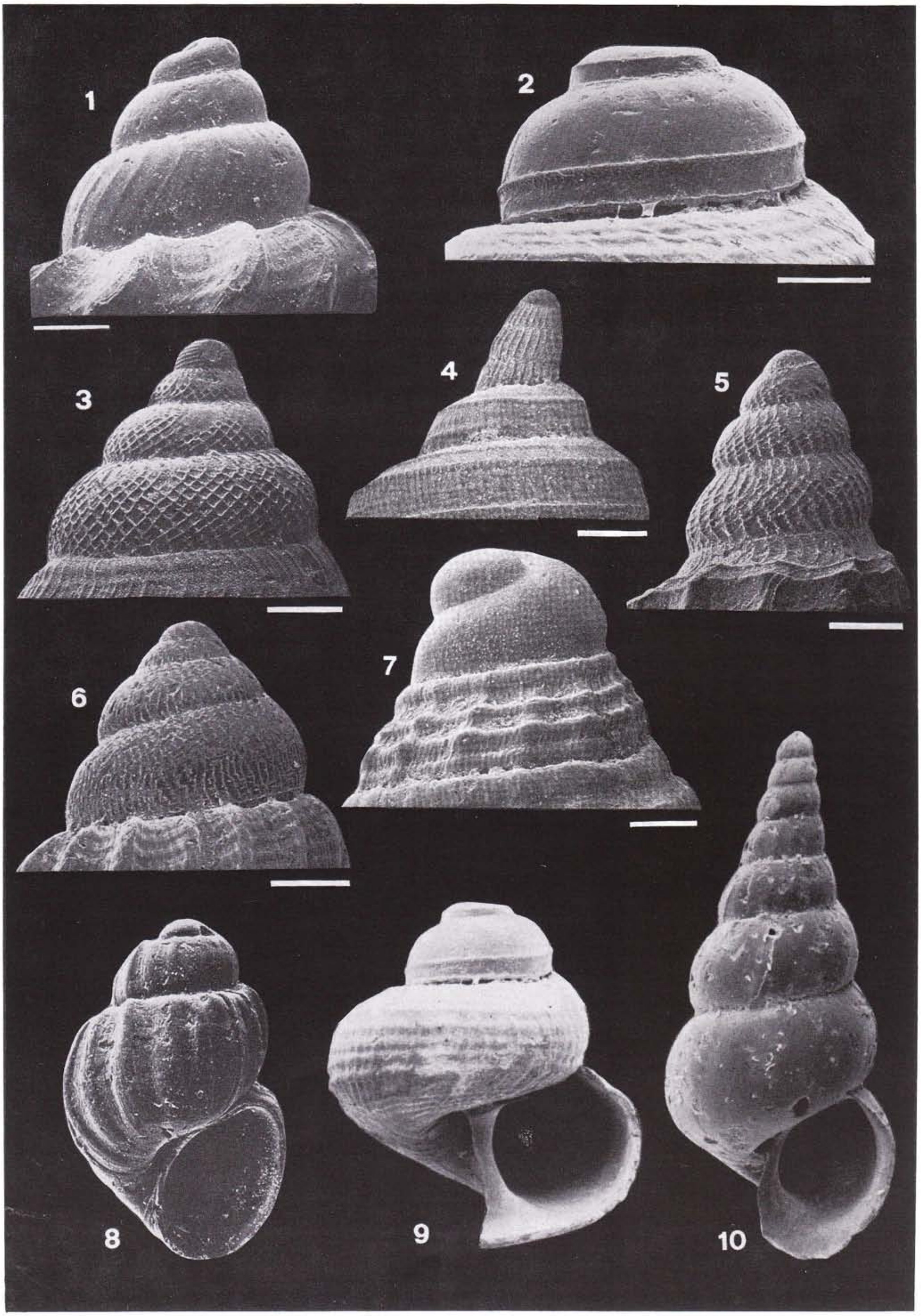
Description. Very small shell, markedly thick for the genus. Shape somewhat scalariform. Smooth protoconch, strongly intorted and protruding, consisting of slightly more than one visible whorl. Two convex teleoconch whorls with ill-defined spiral striae and strong orthocline ribs (14-15 in last whorl), weakening toward the base and entering the umbilicus. Deep, almost channelled suture. Ovate aperture. Absent columellar fold. Height up to 1.25 mm. Last whorl to shell height ratio 0.8.

Remarks. In the brief original description, Seguenza stressed a resemblance to "*Pyrgulina pygmaea*", his species differing in having a shorter shell, more crowded ribs and a well-defined umbilicus. He marked it with an "s", to indicate a deep-sea species. The species regarded as *pygmaea* is most likely *Chrysallida stefanisi* (Jeffreys,

---

PLATE 4

Fig. 1 - *Benthomangelia tenuicostata* (Seguenza, 1879). Furnari, protoconch, scale bar = 200 µm.
Fig. 2 - *Haloceras carinata* (Jeffreys, 1883). Furnari, protoconch, scale bar = 200 µm.
Fig. 3 - *Gymnobela torquata* (Philippi, 1844) [= *G. abyssorum* (Locard, 1897)]. Furnari, protoconch, scale bar = 200 µm.
Fig. 4 - *Iphitus tenuisculptus* (Seguenza, 1876). Furnari, protoconch, scale bar = 250 µm.
Fig. 5 - *Pleurotomella eurybrocha* (Dautzenberg & Fischer, 1896). Furnari, protoconch, scale bar = 200 µm.
Fig. 6 - *Amphissa acutecostata* (Philipphi, 1844). Bianco, protoconch, scale bar = 250 µm.
Fig. 7 - *Mitrolumna smithi* (Dautzenberg & Fischer, 1896). Furnari, protoconch, scale bar = 200 µm.
Fig. 8 - *Chrysallida microscalaria* (Seguenza, 1876). Furnari, 1.1 mm.
Fig. 9 - *Haloceras carinata* (Jeffreys, 1883). Furnari, 2.9 mm.
Fig. 10 - *Aclis attenuans* Jeffreys, 1883. Lazzàro, 4.9 mm.


1
2
3
4
5
6
7
8
9
10

1869), for a long time misidentified as *C. pygmaea* (Grateloup, 1838) (see Linden & Eikenboom, 1992), and also occurring in deep-sea Pleistocene deposits. *C. pygmaea* is a Miocene species, recently renamed *C. interita* by Linden & Eikenboom (1992).

C. microscalaria can be easily distinguished from *C. stefanisi*, being shorter, thicker, roughly ribbed, and in lacking spiral ribs.

Distribution. *C. microscalaria* is known only from Pleistocene deep-sea deposits of southern Italy, where it is rather common.

Chrysallida brattstroemi Warén, 1991

1991 *Chrysallida brattstroemi* Warén, p. 100, fig. 32a-c, 33d.
1994 *Chrysallida brattstroemi* - Palazzi & Villari, fig. 11, 12.

Distribution. This is the most frequent *Chrysallida* in bathyal Pleistocene deposits (Palazzi & Villari, 1994; Di Geronimo et al., in press).

It is known presently from western Norway (found living in 200-270 m; Warén, 1991). Empty shells are known from deep Mediterranean waters (Warén, 1991; Bonfitto et al., 1994), probably originating from Late Glacial beds.

Subclass Opistobranchia Milne-Edwards, 1848
Family *Retusidae* Thiele, 1931

Pyrunculus obesiusculus (Brugnone, 1877)

Pl. 2, fig. 3

1877 *Cylichna obesiuscula* Brugnone, p. 39, pl. 1, fig. 7
1994 *Pyrunculus* sp. - Bonfitto et al., p. 148, fig. 25.
1996 *Cylichna obesiuscula* - Palazzi & Villari, p. 262, fig. 95.

Remarks. As recently noted by Palazzi & Villari (1996), the *Pyrunculus* species occurring in deep-sea Pleistocene beds is different from *P. ovatus* (Jeffreys, 1870), and should be referred to as *P. obesiusculus* (Brugnone, 1877). This attribution was confirmed by Jeffreys himself, to whom Brugnone sent his material (Brugnone, 1877).

Bouchet (1975) reported the presence of a specimen of "*Cylichna obesiuscula* Monterosato", labelled so by Monterosato himself, in Locard's collection (*Travailleur* and *Talisman* exp., MNHN). It was said to be "un peu plus ventrue" than *P. ovatus*. The name was never used by Monterosato in published works, but was introduced by Brugnone (1877) for the fossil species from Ficarazzi (Palermo), listed by Monterosato (1877) as "*Cylichna ovata* Jeffreys".

P. ovatus (Warén, 1980, pl. 6, fig. 14; Bouchet, 1975, pl. 2, fig. d) differs from *P. obesiusculus*, being more slender and less pyriform in shape. The aperture is also narrower in its upper part than in *P. ovatus*.

The species reported as *Cylichna ovata* Jeffreys by Watson (1886, p. 664, pl. 49, fig. 9) from some Atlantic stations seemingly fits the description of *P. obesiusculus*.

Bonfitto et al. (1994) illustrated a markedly ovate *Pyrunculus* from a Late Glacial Mediterranean assemblage, dubiously regarding it as *P. obesiusculus*. The specimen actually falls within the variability range of *P. obesiusculus*.

Distribution. *P. obesiusculus* is common in Pleistocene bathyal assemblages. Its "Recent" Mediterranean findings are probably based on Late Glacial shells.

Class Bivalvia Linnè, 1758
Subclass Protobranchia Pelseneer, 1889
Family *Nuculidae* Gray, 1824

Ennucula corbuloides (Seguenza, 1877) comb. nov.

Pl. 5, fig. 1-7, 15, 16

1877a *Nucula corbuloides* Seguenza, p. 92.
1877b *Nucula corbuloides* - Seguenza, p. 9, pl. 1, fig. 3, 3a, 3b.
1986 *Leionucula corbuloides* - Di Geronimo & Bellagamba, pl. 3, fig. 8, 9.
1992 *Nuculoidea bushae* (partim ?) - Rhind & Allen, p. 73, fig. 9-10.
1996 *Nuculoma corbuloides* - Palazzi & Villari, fig. 140.

Description. Small, thin, somewhat inflated, ovate-elongate, inequilateral shell. Umbo orthogyrate, large, rising well above the dorsal margin. Ill-defined lunule and escutcheon. Moderately truncate posterior margin. Surface with faint concentric ridges. Chevron-shaped teeth, numbering 4-5 anteriorly and 5-6 posteriorly in 3 mm long valves. Ovate, weakly impressed muscle scars. Smooth inner margin. Well-developed condrophore, ver-

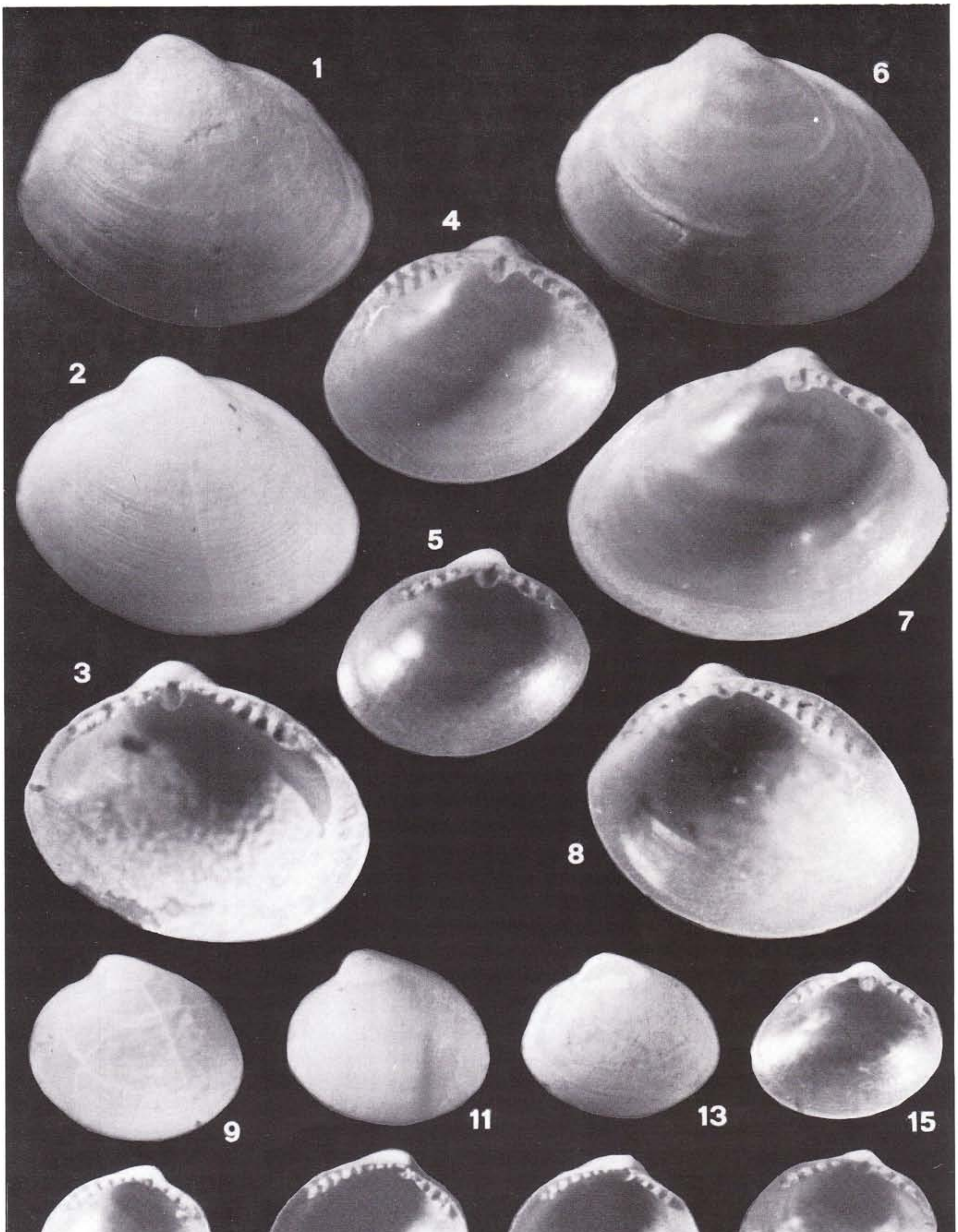
---

PLATE 5

Fig. 1-7, 15, 16-*Ennucula corbuloides* (Seguenza, 1877). 1. Lazzàro, 3.5 mm. 2. Lazzàro, 3.4 mm. 3. Lazzàro, 3.4 mm. 4. Ibero-Maroccan Gulf (BALGIM Exp., St. DW61, 35°31N 7°26W, 1,222 m, MNHN), 2.9 mm. 5. Lazzàro, 2.5 mm. 6, 7. Tyrrhenian Sea (St. BS 78-14, NE Sardinia, 1,707-1,293 m), 3.7 mm. 15. Tyrrhenian Sea (EOCUMM95, St. 16, Eolian Archipelago, 1,340 m), 2.0 mm. 16. Lazzàro, 2.1 mm.

Fig. 9-14 - *Ennucula rotundata* (Seguenza, 1877). 9. Vallone Catrica, 2.2 mm. 10. Lazzàro, 1.8 mm. 11, 12. Lazzàro, 1.9 mm. 13, 14. Lazzàro, 1.9 mm.

Fig. 8 - *Ennucula aegeenis* (Forbes, 1844). Tyrrhenian Sea (EOCUMM95, St. 37, Eolian Archipelago, 248 m), 3.2 mm.


1
6
4
2
5
7
3
8
9
11
13
15
10
12
14
16

tically projecting from the hinge-plate. Maximum antero-posterior length ca. 4 mm. Roundish prodissoconch, 270-310 µm in length.

Taxonomy. Three genera, namely *Nuculoma* Cossmann, 1907, *Leionucula*, Quenstedt, 1930 and *Ennucula* Iredale, 1931, were used for the Recent ovate, smooth-margined nuculids. Allen & Hannah (1986) regarded *Nuculoma* as the only valid genus, Maxwell (1988) treated *Ennucula* as the suitable genus (see also Schenck, 1934, 1939), whereas Bergmans (1991) regarded *Ennucula* as a senior synonym of *Leionucula*. Rhind & Allen (1992) referred some deep-sea smooth-margined nuculids with orthogyrate umbo and a vertical resilifer to *Nuculoidea* William & Breger, 1916, and used *Nuculoma* for opisthogyral species with an oblique resilifer. We agree with Maxwell (1988) in considering the type-species of *Nuculoma* (Jurassic) too different from the modern smooth-margined nuculids. The type-species of *Nuculoidea* (Late Paleozoic) is also quite different, whereas the type-species of *Leionucula* (Cretaceus) appear rather close to the modern species. Since protobranchs, and nuculids in particular, are markedly conservative (Allen, 1978), strong evolutionary restraints in shell morphology are to be expected. The lack of a radial structure in the outer shell layer, accounting for the smooth-margin (Van De Poel, 1955), probably evolved several times (e.g. polyphyletically through paedomorphosis; see Gofas & Salas, 1996). On these grounds, *Ennucula* is much more suitable for the Cenozoic species, than a Mesozoic or older genus.

Remarks. Among the Atlantic deep-sea nuculids, *E. corbuloides* was recently reported by Rhind & Allen (1992) as *Nuculoidea bushae* (Dollfuss, 1898) [= *Nucula subovata* Verill & Bush, 1898 = *Nucula bushi* nom. nov. Dollfuss, 1898 = *Nucula bushae* emend. Schenck, 1939]. *E. bushae*, however, is most probably different from *E. corbuloides*. The drawings of *Nucula subovata* by Verill & Bush (1898, p. 852, pl. 81, fig. 8, pl. 83, fig. 5) show a nuculid with a thicker and longer hinge, and a markedly lower umbo, compared with *E. corbuloides*. Whether all the material examined by Rhind & Allen (1992) from many eastern and western North Atlantic stations belongs to Verrill & Bush's or Seguenza's species is unknown. Anyway, *E. corbuloides* does occurs in the North Atlantic, and it is probably widespread throughout the European basin, as reported by Jeffreys (1879). We examined some Atlantic specimens (Ibero-Moroccan Gulf, BALGIM exp., MNHN; Pl. 5, Fig. 4), finding them closely resembling their Pleistocene and Recent Mediterranean counterparts.

Young specimens of *E. aegeensis* (Forbes, 1844) (Pl. 5, fig. 8), a common species in outer-shelf and upper-slope Mediterranean stations, may be misidentified as *E. corbuloides*. In individuals of the same size, the valves of *E. aegeensis* are less inflated, thicker and more oblique than in *E. corbuloides*. Furthermore, the resilifer in *E. aegeensis* is smaller and oblique, becoming almost vertical only in large valves (up to 7-8 mm). Young specimens of *E. corbuloides* are somewhat rounded in shape and might be mistaken for *Ennucula rotundata* (Seguenza, 1877) (see below).

Distribution. *E. corbuloides* is one of the most frequent deep-sea nuculids in Pleistocene deposits (La Perna, 1994; Di Geronimo et al., in press). It is known from Mediterranean stations deeper than 500 m (Di Geronimo et al., 1995; La Perna, unpubl. data).

The BALGIM stations in the Ibero-Moroccan Gulf, where *E. corbuloides* occurs, range from 540 to 2,000 m.

Ennucula rotundata (Seguenza, 1877) comb. nov.

Pl. 5, fig. 9-14

1877b *Nucula corbuloides* var. *rotundata* Seguenza, p. 9, pl. 1, fig. 3c, 3d, 3e.

Description. Small, thin, somewhat inflated, ovate-triangular, inequilateral shell. Opisthogyrate umbo, rising moderately above the dorsal margin. Ill-defined lunule and escutcheon. Moderately truncate posterior margin. Surface with faint concentric ridges. Roughly chevron-shaped teeth, numbering 7-8 anteriorly and 5 posteriorly in 2 mm long valves. Roundish-ovate, impressed muscle scars. Inner margin smooth. Short condrophore, faintly projecting from the hinge-plate. Maximum antero-posterior length ca. 2.2 mm. Roundish prodissoconch, ca. 160 µm in length.

Remarks. *E. rotundata* was described by Seguenza as a "shorter and more rounded" variety of *Nucula corbuloides*. It was also well illustrated.

It is not understood whether *E. granulosa* (Verrill, 1884) (see Rhind & Allen, 1992 as *Nuculoma granulosa*) is a synonym of *E. rotundata*, although some differences may point to two distinct species. Judging from the drawings and description by Rhind & Allen (1992), the North Atlantic *E. granulosa* differs from *E. rotundata* in

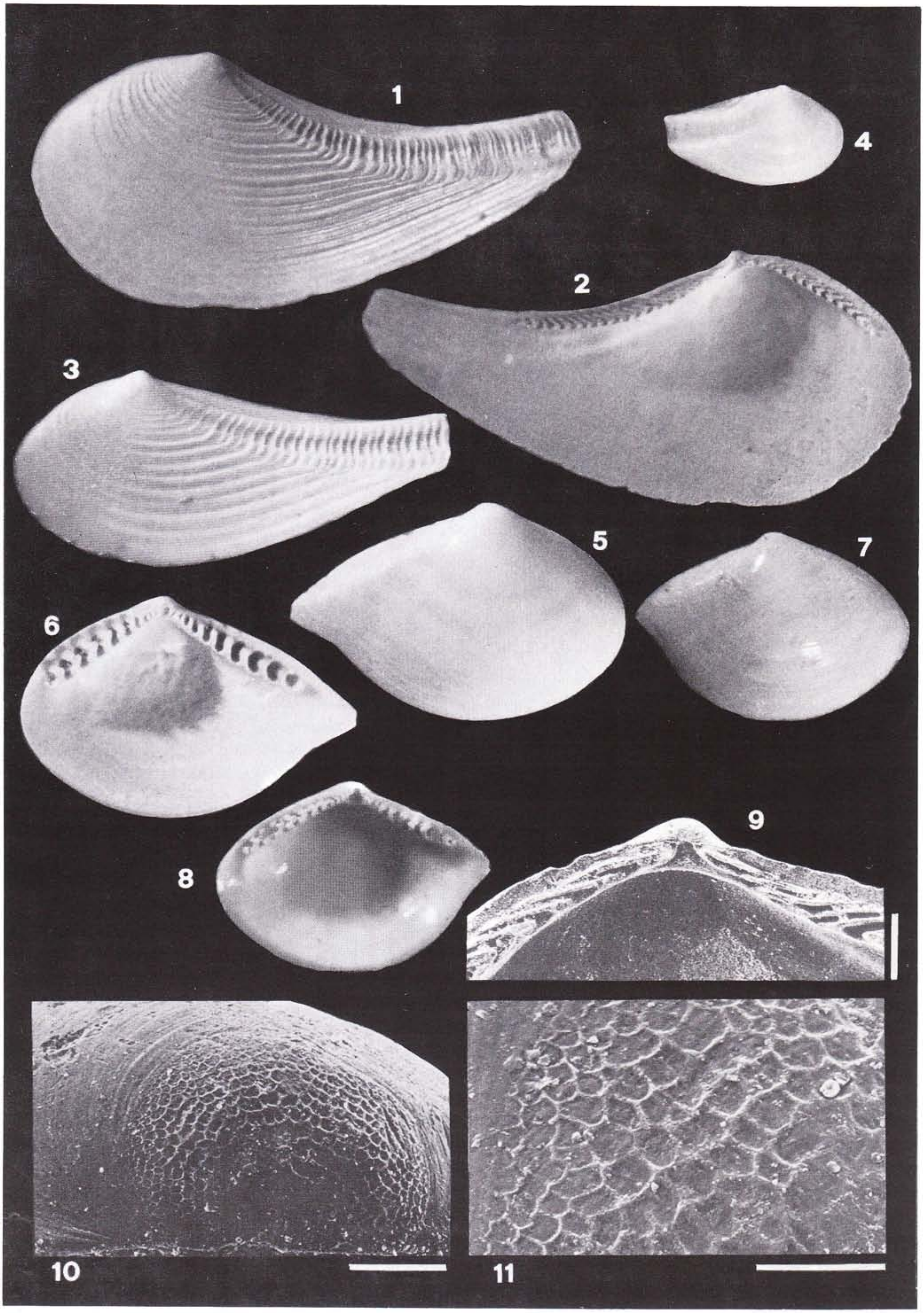
---

PLATE 6

Fig. 1-4, 9-11-*Thestyleda cuspidata* (Philippi, 1844). 1, 2. Lazzàro, 8.1 mm. 3. Lazzàro, 5.1 mm. 4. Lazzàro, 3.2 mm. 9. Furnari, hinge detail from a juvenile (3.5 mm), scale bar=200 µm. 10. Prodissoconch, scale bar = 50 µm. 11. Prodissoconch detail, scale bar=20 µm.

Fig. 5, 6 - *Ledella messanensis* (Jeffreys, 1879). Vallone Catrica, 4.4 mm.

Fig. 7, 8 - *Ledella nicotrae* (Seguenza, 1877). Grammichele (SE Sicily, early Pleistocene), 3.7 mm.


1
4
2
3
5
7
6
9
8
10
11

having a rounded to subquadrate outline, whereas *E. rotundata* is ovate-triangular, as well as a little more equilateral than *E. granulosa*. Anterior teeth are more numerous (up to 8) and more close-set in *E. rotundata* than in *E. granulosa* (up to 6).

Both *E. granulosa* and *E. rotundata* resemble *E. corticata* (Møller, 1842) from Greenland (see Schiøtte & Warén, 1992).

E. rotundata can be easily distinguished from juvenile stages of *E. corbuloides*, being markedly opisthogyral and sub-triangular in shape. Anterior teeth are smaller and more closely set in *E. rotundata*.

The fossil "*Nucula tenuis* var. *subrotunda*" of Brugnone (1877, pl. 1, fig. 3; as var. *rotundata* in the text, p. 20) is most probably *E. aegeensis*, whereas "*Lionucula corbuloides rotundata* (Seguenza)" of Nordsieck (1971, fig. 7) is *E. corbuloides.*

Distribution. *E. rotundata* is known only from southern Italy deep-sea Pleistocene deposits. It often occurs together with *E. corbuloides*, as reported also by Seguenza (1877b).

Family *Nuculanidae* H. & A. Adams, 1858

Thestyleda cuspidata (Philippi, 1844) comb. nov.

Pl. 6, fig. 1-4, 9-11

1844 *Nucula cuspidata* Philippi, p. 47, pl. 15, fig. 8.

1994 *Nuculana cuspidata* - Palazzi & Villari, fig. 48, 49.

1996 *Nuculana (Costelloleda) cuspidata* - Palazzi & Villari, fig. 134, 135, 141.

Description. Moderately large, convex, elongate, anteriorly ovate shell, posteriorly extending in a long, bent and blunt rostrum. Ventral margin regularly convex to slightly concave towards the rostrum tip. Concave postero-dorsal margin. Small, barely rising, opisthogyrate umbo. Sculpture made of widely spaced concentric ridges, anteroventrally obsolete, and two keel-like rostral ridges, long and flat postero-dorsal area. Concentric ridges turn at right angles to the rostrum, becoming slightly sinuous, stronger and doubled in number. Space between rostral ridges barely concave. Internal mid-rostrum ridge from umbonal area to posterior tip. Taxodont, moderately thick hinge, with 13 anterior and 21 posterior teeth in 9 mm long valves. Chevron-shaped, close-set teeth, becoming somewhat lamellar and overlapping in the proximal area. Deep, triangular, slightly oblique resilifer. Unequal adductor scars, the posterior much smaller and elongate, both close to the hinge ends. Indistinct pallial scar. Ovate, net-like sculptured prodissoconch, ca. 230 m in length,. maximum shell length 10 mm.

Taxonomy. The type species of *Thestyleda* Iredale, 1929 is *Leda ramsayi* Smith, 1885, a deep-sea species from New South Wales. *Thestyleda* was regarded as a subgenus (e.g. Clarke, 1961; Okutani, 1962) or as a synonym (Allen & Hannah, 1986) of *Nuculana* Link, 1807, but it is worth keeping these long-shelled nuculanids with a slender and bent rostrum, distinct from *Nuculana*. The partly lamellar and overlapping teeth (Pl. 6, Fig. 9) are also distinctive of *Thestyleda*, and are completely chevron-shaped in *Nuculana*. However, the shape of *Thestyleda* juveniles closely resembles *Nuculana* (Pl. 6, Fig. 4) and the net-like prodissoconch sculpture is similar in the two species (Pl. 6, Fig. 10, 11; see *N. minuta* in Ockelmann & Warén, in press, and comments by La Perna, in press).

Thestyleda shows a world-wide deep-sea distribution, whereas *Nuculana* has a mainly boreal shelf distribution. Several deep-sea species may be referred to *Thestyleda*, such as *Leda cordyla* Dall, 1908, *L. longicaudata* Thiele, 1912, *Nuculana scalata* Prashad, 1932, *N. louiseae* Clarke, 1961, *N. subscalata* Okutani, 1962. A marked cold-water adaptation of *Thestyleda* is obvious in the Antartic *T. longicaudata* (see Dell, 1990 as *Propeleda longicaudata*).

Propeleda Iredale, 1924 was used also for these long-shelled nuculanids. However, both *Propeleda* and the related *Poroleda* Hutton, 1893 (see Maxwell, 1988) differ markedly from *Thestyleda* in having smoother, flatter and almost unkeeled shells. In addition, the rostrum is more squat and less bent than in *Thestyleda*. The Mio-Pliocene "*Leda*" *clavata* (Calcara, 1841) and the Plio-Pleistocene "*Leda*" *hoernesi* Bellardi, 1875, seem instead to pertain to *Propeleda*.

Distribution. Originally reported from the Lamato River valley (Calabria), *T. cuspidata* was reported by Seguenza (1877b) from many southern Italy "Astian" localities. It is really one of the most common nuculoids in Pleistocene bathyal deposits (La Perna, 1994; Palazzi & Villari, 1994, 1996; Di Geronimo et al., in press).

Ledella messanensis (Jeffreys, 1870)

Pl. 6, fig. 5, 6

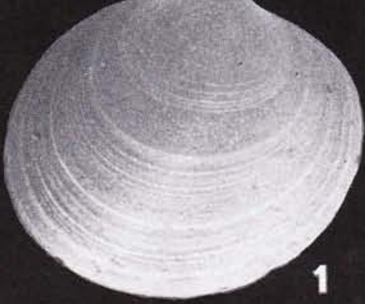
PLATE 7

Fig. 1, 2, 10-12-"*Yoldia*" *minima* (Seguenza, 1877). 1. Lazzàro, 1.4 mm. 2. Lazzàro, 1.6 mm. 10. Lazzàro. Hinge detail, scale bar = 200 µm. 11. Lazzàro. Prodissoconch, scale bar = 50 µm. 12. Lazzàro. Prodissoconch detail, scale bar = 10 µm.

Fig. 3, 4 - *Microgloma tumidula* (Monterosato, 1880). 3. Bianco, 0.8 mm. 4. Bianco, 0.7 mm.

Fig. 5, 6 - *Yoldiella seguenzae* Bonfitto & Sabelli, 1995. Lazzàro, 3.9 mm.

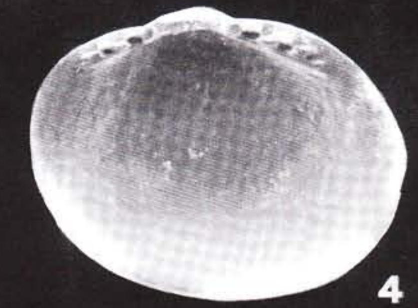
Fig. 7-9 - *Bathyspinula excisa* (Philippi, 1844). 7, 8. Lazzàro, 7.3 mm. 9. Furnari, hinge detail from a fully grown valve, scale bar = 500 µm.

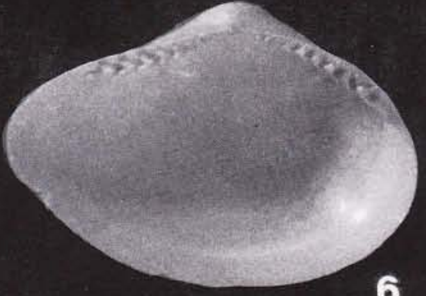

1


3


5

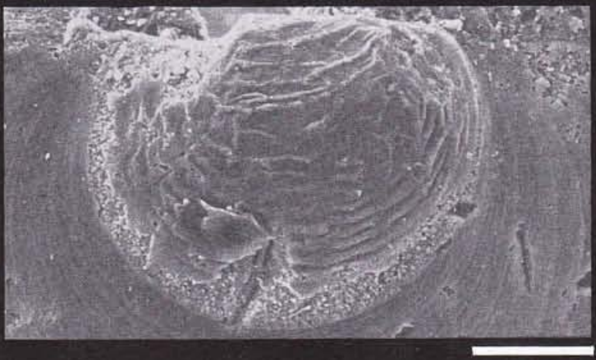

2


4

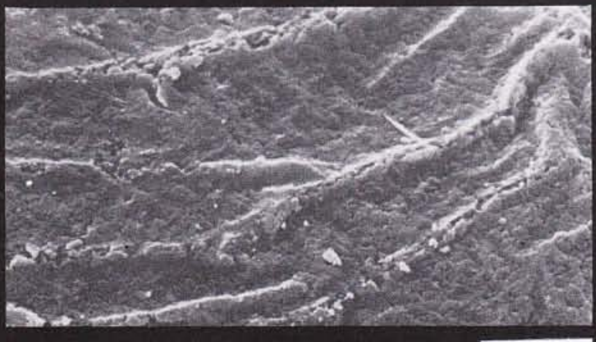

6

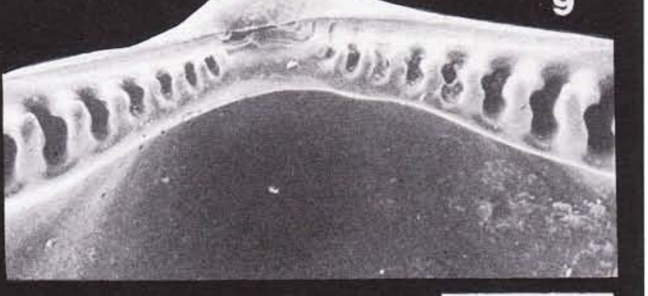

10


7


11


8


12


9

1870 *Leda acuminata* Jeffreys, p. 69.
1877b *Leda (Junonia) acuminata* - Seguenza, p. 15, pl. 3, fig. 15, 15a-c.
1879 *Leda messanensis* Jeffreys, p. 576 (nom. nov.).
1978 *Yoldiella acuminata* - Warén, p. 215, fig. 10, 11.
1978 *Yoldiella messanensis* - Warén, p. 218, fig. 20, 21.
1981 *Ledella messanensis* - Di Geronimo & Li Gioi, pl. 2, fig. 5,6.
1986 *Nuculana (Ledella) pusio* - Laghi, pl. 3, fig. 1-7 (not fig. 5); pl. 4, fig. 1-5.
1989 *Yoldiella messanensis* - Warén, p. 329, fig. 3e, 11a,b.
1989 *Ledella acuminata* - Allen & Hannah, p. 153, fig. 57-60.
1994 *Nuculana messanensis* - Palazzi & Villari, fig. 54, 56.

Taxonomy. *Ledella bushae* Warén, 1978 was proposed by Warén (1981) as type-species of *Ledella* Verrill & Bush, 1897. Later, Allen & Hannan (1989) regarded *L. bushae* as a synonym of *L. ultima* (Smith, 1885).

Among the species treated by Warén (1978, 1989) under the genus *Yoldiella*, "*Yoldiella*" *messanensis* stands out as a notable exception, as it has a moderately thick shell, a sharp rostrum and a well-defined subrostral sinus. Although this species may appear somewhat different from the thick, short and bluntly rostrate *Ledella bushae* or *L. ultima*, it is also quite different from *Yoldiella lucida* (Lovén, 1846), the type-species of *Yoldiella* Verrill & Bush, 1897. The rostrum and subrostral sinus are good taxonomic features to distinguish *Ledella* from *Yoldiella*, as also noted by Verrill & Bush (1898). In *Ledella*, the rostrum may be more or less sharp, elongate or weakly keeled, and always enhanced or outlined by a sinus. The rostrum tip is typically turned down in *Ledella* and slightly upturned or straight in *Yoldiella*. Furthermore, *Yoldiella* has thinner, flatter and smoother valves, with a shorter and more delicate hinge. Allen & Hannah (1989), Kilburn (1994) and Allen et al. (1995) recently followed the same taxonomic approach for *Ledella* and *Yoldiella*.

Remarks. Jeffreys (1879) replaced *Leda acuminata* with Seguenza's m.s. *messanensis* (Jeffreys, 1870), believing that *Nucula acuminata* Von Buch, 1833 and *N. acuminata* Eichwald, 1853 were to be placed in *Leda*.

Warén (1978) kept the Recent *acuminata* distinct from the fossil *messanensis*, but later (Warén, 1989) referred both the fossil and Recent material to *messanensis*. Actually, *L. messanensis* is markedly variable in outline, thickness and sculpture, as reported by Warén (1978, 1989). The Pleistocene specimens parallel Recent examples in shell variability. Nevertheless, the Pleistocene upper-slope specimens differ notably from those found deeper, being shorter, thinner, more convex and less rostrate (Pl. 6, Fig. 7, 8) than the typical *L. messanensis*. Additional material is currently under study to more precisely define the taxonomic status of this form, which corresponds to *L. nicotrae* (Seguenza, 1877).

The origin of the European *Ledella* lineage dates back to the late Miocene, with *L. peraffinis* (Seguenza, 1877) and *L. glabra* (Laghi & Palazzi, 1991). *L. seminulum* (Seguenza, 1877) is a Pliocene bathyal species (reported by Robba, 1981, pl. 11, fig. 2, 3 as *Nuculana messanensis*). In Pleistocene bathyal deposits another species, *L. rectidorsata* (Seguenza, 1877) (Di Geronimo et al., in press) occurs, of which the northeast Atlantic *L. folini* (Warén, 1978) may be a synonym.

Distribution. The Recent distribution of *L. messanensis* ranges from Norway south to the Azores and the Mediterranean, at depths ranging between 200-2,000 m (Warén, 1989; Allen & Hannah, 1989). It is one of the most common nuculoids in Mediterranean Pleistocene to Recent bathyal faunas.

Yoldiella seguenzae Bonfitto & Sabelli, 1995

Pl. 7, fig. 5, 6

1877b *Yoldia abyssicola* - Seguenza, p. 20, pl. 5, fig. 28.
1994 *Yoldiella producta* - Palazzi & Villari, p. 99, fig. 58, 59, 66.
1995 *Yoldiella seguenzae* Bonfitto & Sabelli, p. 24, fig. 5, 6, 7, 9, 10, 11.

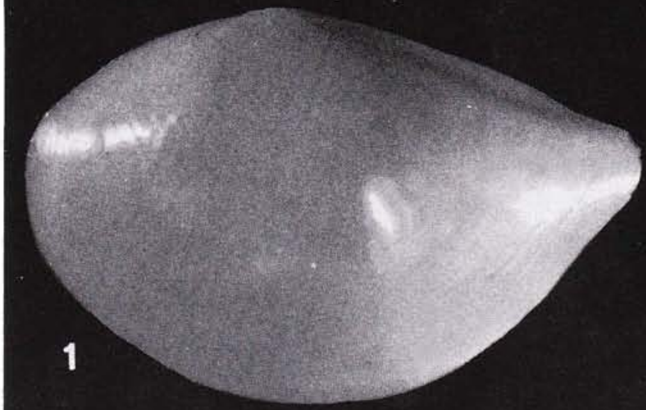
Taxonomy. *Yoldiella seguenzae*, as well as the shallower *Y. philippiana* (Nyst, 1845), the Atlantic *Y. lenticula* (Möller, 1842), *Y. propinqua* (Leche, 1878), the Arctic *Y. tamara* (Gorbunov, 1946) (all treated by Warén, 1989), and the Tertiary fossil *Y. pygmaea* (Münster, 1837) (see Janssen, 1979) belong to a homogeneous group which differs from the *Yoldiella* type-species and allied species in having thicker and more convex valves with a blunt and "low" rostrum. The hinge is also longer and relatively thicker. Allen et al. (1995) treated this group in part as *Portlandia* Mörch, 1857, but the type-species *P. arctica* (Gray, 1824) is quite distinct from these species.

Remarks. Seguenza (1877b) reported this species as *Yoldia abyssicola* Torell, listing "*Leda producta* Monterosato" and "*Yoldia striolata* Brugnone" as synonyms. *L. producta*, first published as a synonym (Monterosato, 1875), was never used as an available name and the combination proposed by Palazzi & Villari (1994), i.e. "*Yoldiella producta* (Seguenza, 1877)", is unjustified.

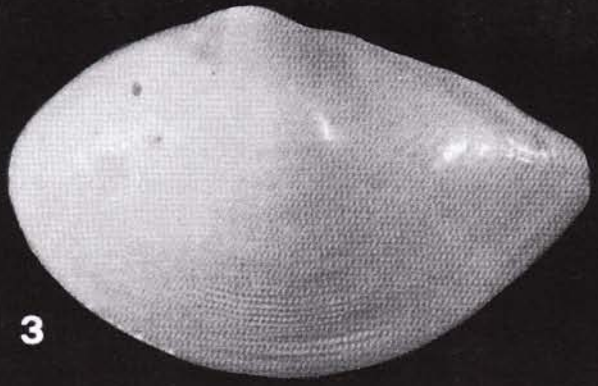
Distribution. *Y. seguenzae* is known from the Mediterranean and northeast Atlantic in 500-2,000 m (Bonfitto & Sabelli, 1995; La Perna, unpubl. data). It is also one of the most abundant bathyal nuculoids in Pleistocene deposits (Di Geronimo et al., in press).

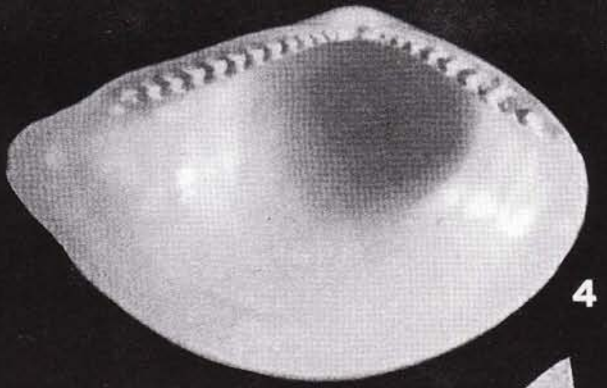
PLATE 8

Fig. 1-10 - *Katadesmia confusa* (Seguenza, 1877). 1, 2. Archi, 5.4 mm. 3, 4. 5.1 mm. 5. Furnari, 5.1 mm (postero-dorsal margin partly broken = *Yoldia confusa* var. *major* Seguenza, 1877). 6. Furnari, 4.6 mm. 7. Lazzàro, 5,2 mm. 8, 9. Archi, juvenile, 2.5 mm (=*Neilo phaseolinus* Seguenza, 1877). 10. Lazzàro, hinge detail from a fully grown valve, scale bar = 500 μm.


1


2


3


4


5


8


9


7


6


10

Bathyspinula excisa (Philippi, 1844)

Pl. 7, fig. 7, 8, 9

1844 *Nucula excisa* Philippi, p. 46, pl. 15, fig. 4.
1989 *Spinula excisa* - Warén, fig. 12d, e.
1993 *Spinula excisa* - Tabanelli, fig. 5.
1994 *Spinula excisa* - Palazzi & Villari, fig. 57, 68.
1996 *Bathyspinula excisa* - Di Geronimo & La Perna, p. 108, pl. 1, fig. 1-10; pl. 2, fig. 1-3.

Taxonomy. Because of the preoccupied status of *Spinula* Dall, 1908, Filatova & Schileyko (1984) replaced it with *Bathyspinula* Filatova, 1958, originally proposed as a subgenus of *Spinula*. They also proposed *Acutispinula* as a replacement name for the subgeneric rank of *Bathyspinula calcar* Dall, 1908, i.e. the type-species of *Spinula*. The present species belongs to the subgenus *Bathyspinula,* like all the Recent Atlantic species, although *Bathyspinula* and *Acutispinula* probably deserve a full generic status.

In the systematic framework by Allen and co-workers, *Bathyspinula* is referred to the subfamily Spinulinae Allen & Sanders, 1982 (now Acutispinulinae), within the family Nuculanidae. Maxwell (1988) maintained this allocation. Filatova & Schileyko (1984) raised Ledellinae Allen & Sanders, 1982 to a family rank, referring *Bathyspinula* to it. According to a recent classification scheme of nuculoids by Ockelmann & Warén (in press), *Bathyspinula* is allocated within an undivided Nuculanidae family.

The ligament features of *Bathyspinula* are similar to those of the malletiids. A mainly external ligament occurs in mature specimens, whereas juveniles show a well-developed inner pit (Di Geronimo & La Perna, 1996: pl. 1). Both in *Bathyspinula* (Pl. 6, Fig. 9) and in malletiids (Pl. 7, Fig. 10) adult specimens show a central hinge area resembling a well-developed resilifer. Actually, it consists of an edentulous gap, in which the ligament holds only a small portion close to the beak.

Remarks. Historical review, description and distribution of *B. excisa* were reported and discussed by Di Geronimo & La Perna (1996).

"Yoldia" minima (Seguenza, 1877)

Pl. 7, fig. 1, 2, 10-12

1877a *Yoldia minima* Seguenza, 96.
1877b *Yoldia minima* - Seguenza, p. 18, pl. 5, fig. 27, 27 a,b.
1981 *Yoldia minima* - Di Geronimo & Li Gioi, pl. 2, fig. 1,2.

Description. Small, rounded-ovate, rather convex, moderately thin shell. Neither carination, nor rostration. Weakly prominent, orthogyrate, anterior to midline umbo. Surface with faint concentric striae and lowly stepped growth increments. Moderately thin, taxodont hinge, with short, weakly chevron-shaped teeth, numbering 8 anteriorly and 11 posteriorly in 2 mm valves. Triangular, deep ligament pit, located beneath the beak. Roundish adductor scars, equal in size. Indistinct pallial scar. Ovate, wrinkled prodissoconch, ca. 150 µm large. Maximum shell length 2.5 mm.

Taxonomy. A conservative allocation in "*Yoldia*" is maintained, as it is still difficult to find a suitable systematic position for this species, both at the genus and family level. "*Y.*" *minima* shows a weak shell-shape resemblance to *Sarepta* A. Adams, 1860 and to *Psuedoglomus* Dall, 1898, whose type-species were recently illustrated by Ockelamnn & Warén (in press). *Sarepta* resembles *Yoldiella* morphologically (Warén, pers. comm.), whereas the hinge of *Pseudoglomus* shows affinities to malletids, tindariids and neilonellids.

An unusual wrinkled prodissoconch sculpture occurs in this species.

Distribution. "*Y.*" *minima* is common in Pleistocene bathyal deposits (La Perna, 1994; Di Geronimo et al., in press). It is also found as old shells from Mediterrranean deep-sea stations (Di Geronimo & Li Gioi, 1981; La Perna, unpubl. data). According to Jeffreys (1879), it also occurs in the Atlantic.

Family *Malletiidae* H. & A. Adams, 1858

Katadesmia confusa (Seguenza, 1877) comb. nov.

Pl. 8, fig. 1-10

1877a *Yoldia confusa* Seguenza, p. 96.
1877a *Neilo phaseolinus* Seguenza, p. 96.
1877b *Yoldia pellucida* - Seguenza, p. 19, pl. 4, fig. 25, 25a.
1877b *Yoldia confusa* - Seguenza, p. 20, pl. 4, fig. 24, 24a, 24b, 24c.
1877b *Neilo phaseolinus* - Seguenza, p. 23, pl. 5, fig. 31, 31a, 31b.

Description. Elongate-oval, inequilateral, inflated, moderately thin shell. Posterior margin extending in a blunt rostrum. Orthogyrate umbo. Faint dorsal keel, running from umbo to rostrum tip. Glossy valve surface, with faint growth lines and concentric ridges close to the ventral margin. Narrow hinge-plate. Chevron-sha-

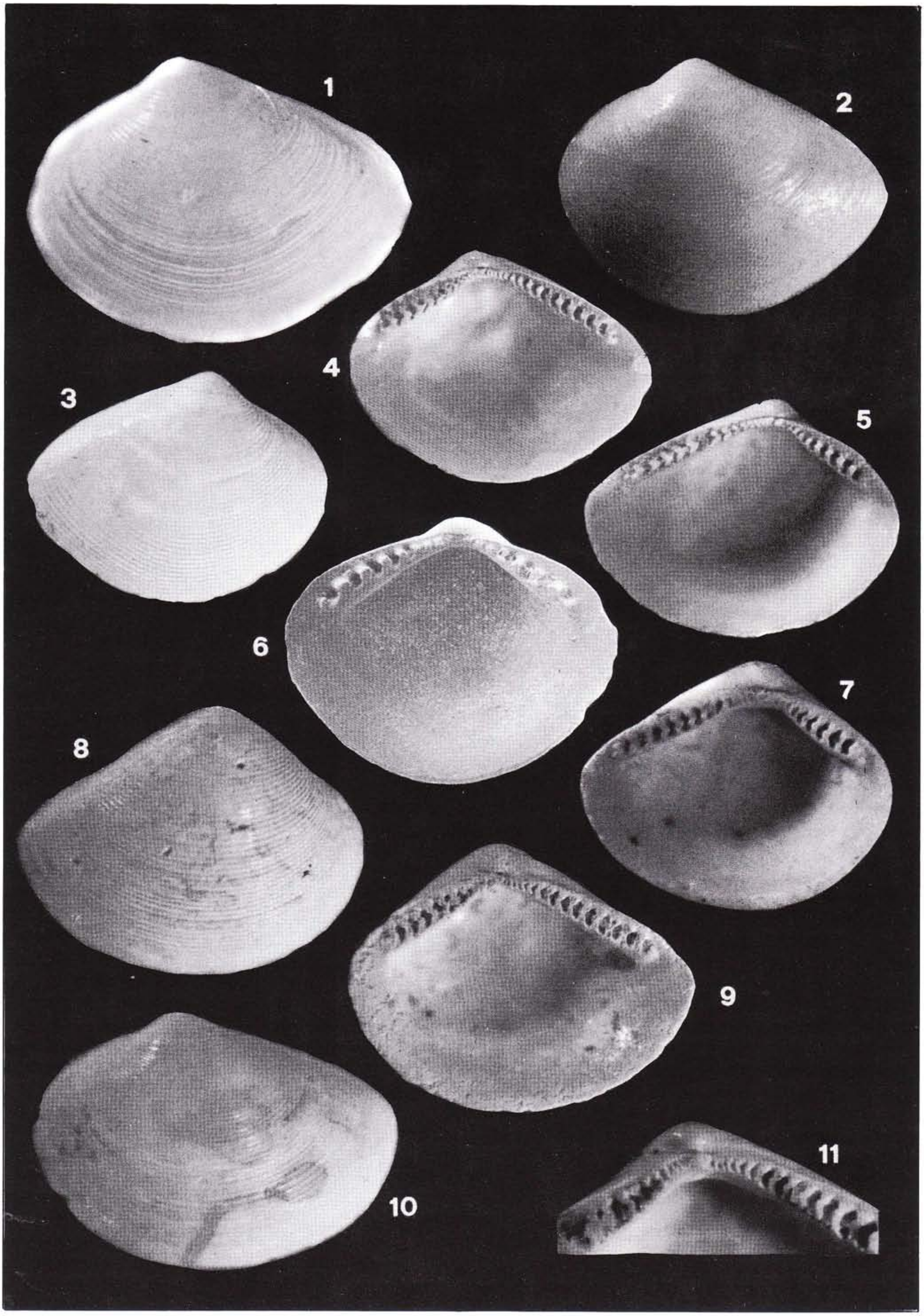
---

PLATE 9

Fig. 1-6, 11 - *Austrotindaria pusio* (Philippi, 1877). 1. Bianco, 5.1 mm. 2. Furnari, 4.3 mm. 3, 4. Bianco, 3.9 mm. 5. Furnari, 4.1 mm. 6. Bianco, juvenile, 1.3 mm. 11. Bianco, hinge detail from a fully grown valve.

Fig. 7-9 - *Austrotindaria salicensis* (Seguenza, 1877). 7. Salice (Messina, early Pleistocene), 4.1 mm. 8, 9. Rometta (Messina, middle Pliocene), 4.5 mm.

Fig. 10 - *Austrotindaria latior* (Jeffreys, 1876). Tyrrhenian Sea (St. BS 78-14, NE Sardinia, 1,707-1,293 m), 4.8 mm.


1
2
4
3
5
6
7
8
9
11
10

ped teeth, 9-10 anterior and 14-15 posterior in 5 mm long valves. Outer anterior and posterior ligament furrows, the former short and ill-defined, the latter well-defined, as long as tooth series. Shallow and elongate ligament pit beneath the beak. Oval muscle scars, the anterior one a little larger. Deep pallial sinus. Antero-dorsal U-shaped scar. Posterior region marked internally by an abrupt decrease in convexity. Ovate, weakly rostrate juveniles. Maximum antero-posterior length 6.5 mm. Bean-shaped prodissoconch, 240-260 µm in length.

Taxonomy. Bouchet & Warén (1979) and Warén (1989) distinguished three malletiid genera, i.e. *Malletia* Desmoulins, 1832, *Pseudomalletia* Fischer, 1886 and *Katadesmia* Dall, 1908, whereas Sanders & Allen (1985) treated the latter two as synonyms of *Malletia*. In *Katadesmia* the shell is elongate and posteriorly pointed, whereas it is ovate and more equilateral in the southern and shallower *Malletia*, and subrectangular in *Pseudomalletia*. *Katadesmia* typically comprises bathyal and abyssal species.

The U-shaped anterior scar is a peculiar and disregarded malletiid feature, as noted by Knudsen (1970) in "*Nuculana*" *pallida* (Smith) (=*K. pallida*). This shell feature appears to be related to soft-body anatomy, as the hind-gut, making an anterior loop, does not penetrate the mantle (Sanders & Allen, 1985).

Marked growth-related shape changes, like those observed in *K. confusa*, were reported by Sanders & Allen (1985) for several malletiids.

Remarks. Briefly introduced by Seguenza (1877a), it was soon after reported as *Yoldia pellucida* (Philippi) and *Yoldia confusa* (Seguenza 1877b). Philippi's drawing (1844) of *Nucula pellucida* shows an ovate nuculoid, anteriorly and posteriorly rounded (it is probably synonym of "*Yoldia*" *longa* Bellardi, 1875). Surprisingly, Seguenza stressed a close resemblance between his specimens and Philippi's species. Seguenza illustrated both *Y. pellucida* and *Y. confusa* as very similar to each other, the latter showing a small ligament pit. Subsequently, Seguenza (1879) resolved the puzzle, reporting his species as "*Y. confusa* Seguenza = *L. pellucida* Seguenza (non *Nucula* Phil.), *Y. lucida* Seguenza (non Lovén)". The last species, however, was only in part misidentified, as it was illustrated correctly (Seguenza, 1877b, pl. 5, fig. 26).

The form reported by Seguenza as *Y. confusa* var. *major*, showing a slightly upturned rostrum, was apparently based on a large valve with the postero-dorsal margin partly broken (Pl. 8, Fig. 5). Seguenza also described *Neilo phaseolinus*, a small nuculoid which proved to be a juvenile stage of *K. confusa* (Pl. 8, Fig. 8, 9).

Laghi (1986, pl. 3, fig. 5) illustrated a USNM specimen of *K. confusa* from "Pliocene, Messina" as *Nuculana (Ledella) pusio* (Philippi, 1844) (=*Ledella messanensis*, see below), among other true *messanensis*. Palazzi & Villari (1994, fig. 53) also reported a valve of *K. confusa* as "*Nuculana messanensis*" from the Pleistocene of Messina. They also illustrated "*Neilo phaseolinus*".

Three Atlantic species (see Sanders & Allen, 1985) are markedly close to *K. confusa*, i.e. *K. pallida* (Smith, 1885), *K. polita* (Verrill & Bush, 1898) and *K. malita* (Sanders & Allen, 1985). The cosmopolitan *K. cuneata* (Jeffreys, 1876) is the only *Katadesmia* presently occurring in the Mediterranean. It more closely resembles the type-species *K. vincula* (Dall, 1908) than the *confusa*-group.

Features useful in distinguishing *K. confusa* from the frequently co-occurring *Ledella messanensis*, include the shell outline (no subrostral sinus in *Katadesmia*), the slightly upturned rostrum tip and the markedly inflated shell.

Distribution. Seguenza (1877a,b, 1879) reported this species from several "Astian" deep-sea sites near Messina and southern Calabria. It is one of the most frequent nuculoids among the Pleistocene bathyal faunas. It was recently reported from the Archi section (southern Calabria) (Di Geronimo et al., in press), where some of the specimens illustrated here were collected.

Family *Neilonellidae* Shileyko, 1989

Austrotindaria pusio (Philippi, 1844) comb. nov.

Pl. 9, fig. 1-6, 11

1844 *Nucula pusio* Philippi, p. 47, pl. 15, fig 5.
1986 *Psudoneilonella salicensis* - Laghi, p. 191, pl. 5, fig. 1a, b, 3a,b, 4, 5a,b, 6a,b,c, 7a,b,c.
1989 *Neilonella pusio* - Warén, p. 252, fig. 16e, f.
1993 *Neilonella pusio pusio* - Tabanelli, fig. 10.
1994 *Neilonella pusio* - Palazzi & Villari, fig. 60, 61, 63, 67.

Description. Triangular-ovate, inequilateral, rather thick shell. Rounded anterior side, posterior side obtu-

---

PLATE 10

Fig. 1-6, 10 - *Cadulus ovulum* (Philippi, 1844). 1. Bianco, 3.2 mm, lateral view. 2, 3. Furnari, 3.0 mm, lateral (2) and dorsal (3) view. 4. Salìce, 3.0 mm, lateral view (this form may correspond to *C. salicensis* Seguenza, 1879). 5. Lazzàro, 3.3 mm, lateral view. 6. Vallone Catrica, 3.0 mm, lateral view. 10. Furnari, apical detail.

Fig. 7-9, 11 - *Cadulus attenuatus* Monterosato, 1875. 7, 8. Bovalino, 3.3 mm, lateral (7) and dorsal (8) view. 9. Grammichele, 2.9 mm, lateral view. 11. Bovalino, apical detail.

Fig. 12-14 - "*Gadila*" *jeffreysi* (Monterosato, 1875). 12, 13. Lazzàro, 4.1 mm lateral (12) and dorsal (13) view. 14. Furnari, 4.5 mm, lateral view.

Fig. 15, 16 - *Cadulus diploconus* Seguenza, 1876. Bianco, 3.0 mm, lateral (15) and dorsal (16) view.


1


2


3


4


5


6


7


8


9


10


11


12


13


14


15


16

sely angulate. Regularly convex ventral margin, posterior margin slightly convex. Orthogyrate umbo, anterior of midline. Sculpture of fine concentric ridges, often becoming obsolete postero-dorsally. Weakly defined lunule, escutcheon absent. Roughly ovate muscle scars, the anterior scar a little larger. Pallial sinus well-incised aligned with posterior angulation. Moderately large hinge-plate. Chevron-shaped teeth, numbering 10-11 anteriorly, 12-13 posteriorly in 4 mm long valves. Ligament pit well-defined in juveniles, ill-defined to absent in adults. Short ligament furrow, extending from beak as far as fifth-sixth posterior tooth. Maximum shell length ca. 5 mm. Bean-shaped prodissoconch, 170-210 µm in length.

Taxonomy. In gross shell morphology, this species resembles *Neilonella corpulenta* (Dall, 1881), type-species of *Neilonella* Dall, 1881, from the Caribbean area. Both have ovate and concentrically ridged shells, with a mainly external ligament, which is amphidetic in *corpulenta* and opisthodetic in *pusio*. This feature was well described by Dall (1881, 1886) and is also obvious from the holotype illustrated by Laghi (1986). Noting this difference, Laghi (1986) proposed that *Pseudoneilonella* should replace the preoccupied *Saturnia* Seguenza, 1877. However, *Pseudoneilonella* Laghi, 1986 appears as a junior synonym of *Austrotindaria* Fleming, 1948. The same difference also led Maxwell (1988) to question the synonymy between *Austrotindaria* and *Neilonella* reported in the literature (e.g. Allen & Hannah, 1986).

The type-species of *Austrotindaria* is *A. wrighti* Fleming, 1948 (Recent, New Zealand). Notable differences, in addition to ligament characteristics, occur between *Neilonella* and *Austrotindaria,* as stressed by Fleming (1948). *Neilonella* has a slightly concave, postero-dorsal side, resulting in a slightly upturned "rostrum", which is slightly downturned in *Austrotindaria*, due to the convex postero-dorsal side. The hinge is more equilateral in *Neilonella* than in *Austrotindaria*. "No defined lunule or escutcheon" are present in *Austrotindaria*, whereas both are well-defined in *N. corpulenta*.

Since neilonellids and tindariids show strong similarities in shell morphology, one may suspect that *Austrotindaria* is a tindariid. Tindariids differ mainly from neilonellids by lacking siphons (and a pallial sinus) (Sanders & Allen, 1977; Warén, 1989). No mention of a pallial sinus was given when Fleming (1948) described *Austrotindaria*. However, judging from the drawings and description ("Hinge-plate strong, wide at either end, interrupted below the beaks by a gap occupied by the narrow base of the ligament"), the hinge of *A. wrighti* is very similar to that of *A. pusio*. A gap or a shallow pit in the hinge is actually characteristic of neilonellids; the tindariid hinge is uninterrupted beneath the umbo (Sanders & Allen, 1977; see also Warén, 1989 and the *Tindaria* and "*Neilonella*" species reported by Knudsen (1979). In *A. pusio*, the ligament pit is well-developed in juveniles (Pl. 8, Fig. 6), becoming more and more reduced in adults (Pl. 9, Fig. 4, 5) to the point of being quite overgrown by teeth (Pl. 8, Fig. 11).

Remarks. Philippi (1844) described *Nucula pusio* from Bianco, virtually the "same locality" of the present work.

According to Laghi (1986), a wrong interpretation of *N. pusio* Philippi originated from Seguenza (1877b), who misidentified *Leda (Saturnia) pusio* when describing "*var. salicensis*". Laghi therefore regarded *N. pusio* as corresponding to the species commonly known as *Ledella* or *Yoldiella messanesis* (see above), and ranked "var. *salicensis*" as *Pseudoneilonella salicensis*. However, Philippi described in detail its species, which do not show any definite resemblance to *Ledella messanensis* (see also Warén, 1989).

Var. *salicensis* has had a notable success since its description. Jeffreys (1879) referred to it as *Leda pusio* var. *latior*. Locard (1889) reported both *Leda pusio* [= *Yoldiella semistriata* (Jeffreys, 1879)] and *Leda salicensis* [= *Austrotindaria latior* (Jeffreys, 1876) = *A. striolata* (Brugnone, 1876) *sensu* Warén, 1989] from the Atlantic. Laghi (1986) treated it as *Pseudoneilonella salicensis*, whereas Warén (1989) put *salicensis* in synonymy with *Leda striolata* Brugnone, 1876 and with *Leda pusio* var. *latior* Jeffreys, 1876. Before attempting to give any value to var. *salicensis*, it should be stated that the Pleistocene material of *A. pusio* examined closely resembles the typical form illustrated by Philippi, except for some shallower (upper-slope) populations, which may be *Leda striolata* Brugnone, 1876 (see below). Var. *salicensis* was said to be thicker, narrower, more convex and with more gibbous umbos, than the typical form. We examined a few specimens closely resembling var. *salicensis*, from Salìce (type-locality, early Pleistocene) (Pl. 8, fig. 7) and Rometta (middle Pliocene) (Pl. 8, fig. 8, 9). It should be noted that typical valves of *A. pusio* also occur at Salìce. The early Pliocene valves illustrated by Robba (1981) also seem to agree with *salicensis*. These observations support the hypothesis that two distinct species exist, one Pliocene, ranging up to the early Pleistocene (*A. salicensis*), and one Pleistocene (*A. pusio*). However, more Pliocene material still needs to be examined.

Pleistocene material seemingly referable to *Leda striolata* Brugnone, 1876 (described from Pleistocene deposits near Palermo) is currently under study. Shells are narrower, less triangular and more regularly ridged than *A. pusio*. They are markedly different from *A. salicensis*, and also different in outline from *A. latior* (Jeffreys, 1876). For these reasons *A. latior* is considered distinct from *L. striolata* Brugnone.

Three species similar to *A. pusio* are known from the east Atlantic. One of them is *A. latior* (Jeffreys). It is known from the North Atlantic in the 200-3,100 m depth range, and is also found rarely in Late Glacial Mediterranean assemblages (Pl. 8, Fig. 10). As noted by Warén (1989), *Pseudoneilonella montanaroe* Laghi, 1986 is a synonym of *A. "striolata"*, i.e. of *A. latior*, but the small fossil valves from Sicily (Laghi, 1986, pl. 9, fig. 5a, b, 8a, b) belong to *A. pusio*. Another species is known as *Neilonella guineensis* (Thiele, 1931) from the east Atlantic (4° N) to Southeast Asia, in 2,278-4,018 m (see Knudsen, 1970). The third species was described by Métivier (1982) as *Nuculana foresti* from the Azores in 3,360 m.

The original shallow-water records (58 and 22 fms.) of *A. wrighti* are striking when compared with the general distribution of *Austrotindaria* and the neilonellids.

Distribution. *A. pusio* is abundant in Pleistocene deep-sea deposits.

The late Miocene report of *Neilonella pusio* by Sacco (1898) *"fide Doderleini"* was based on *Ledella glabra* (Laghi & Palazzi, 1991) (see Laghi, 1986; Laghi & Palazzi, 1991).

Class Scaphopoda Bronn, 1862
Family *Gadilidae* Stoliczka, 1868

Cadulus ovulum (Philippi, 1844)

Pl. 10, fig. 1-6, 10

1844 *Dentalium ovulum* Philippi, p. 208, pl. 27, fig. 21.
1979 *Cadulus ovulum* - Caprotti, p. 244, pl. 14, fig. 5-8.
1991 *Cadulus ovulum* - Pavia, pl. 9, fig. 6, 9, 10.
1994 *Cadulus ovulum* - Palazzi & Villari, fig. 41.

Description. Globose, swollen, smooth, shiny shell. Slightly anterior maximum diameter. Roundish section. Ventral side much more prominent than the dorsal side in lateral view, rapidly sloping to the apex and gently curving to the oral opening. Slightly ovate, coronate apical opening, with inner callus. Oblique, shortly constricted oral opening, larger than the apical opening. Length up to 3.5 mm; length to maximum diameter ratio 1.6-1.9.

Taxonomy. This is the type-species of *Cadulus* Philippi, 1844. Two *Cadulus* groups can be distinguished: a typical group, with globose shells and a crown-like apical opening, and a spindle-shaped group, with a simple apex. A third group consists of slender, more ore less bent, centrally swelling and thin-walled species, lacking the apical callus (e.g. *jeffreysi* Monterosato, *subfusiformis* Sars, *sauridens* Watson, *simillimus* Watson). This group, including both shelf and deep-sea species, is treated either as *Gadila* or *Cadulus* by different authors. Actually, this group resembles neither *Gadila s.s.* nor *Cadulus s.s.*, although it is probably closer to *Gadila* than *Cadulus*.

According to the most recent classification of Scaphopoda (Steiner, 1992; Scarabino, 1995), *Cadulus* is allocated to the order Gadilida Starobogatov, 1974, family Gadilidae Stoliczka, 1868, subfamily Gadilinae Stoliczka, 1868.

Remarks. A certain variability has been observed among the material examined from Pleistocene deep-sea deposits (several hundred shells). Most of them are strongly swollen (length/diameter = 1.6-1.7) and with the apical markedly narrower than the oral opening (Pl. 10, fig. 1-4). They closely resemble the type specimen from Crotone (south Calabria), as originally illustrated. Some specimens are more slender (length/diameter = 1.7-1.9), with the apical and oral diameters more similar, or with the "neck" weakly defined (Pl. 10, fig. 5, 6). The occurrence of intergrading specimens in the same samples strongly suggests a single species.

A distinct species, so far misidentified as *C. ovulum*, occurs in shallower (upper-slope) Pleistocene deposits from southern Italy (Pl. 10, fig. 7-9). It resembles the slender form of *C. ovulum*, except for a markedly barrel shape (length/diameter up to 1.9) and an apical and oral opening that are roughly equivalent. It is also generally smaller than *C. ovulum*, with more oblique apical and oral openings and a more central swelling. The apical crown is often well-preserved, whereas it is frequently worn out in *C. ovulum*, probably because the lobes are more deeply incised than in *C. ovulum* (Pl. 10, fig. 10, 11). The shells illustrated by Di Geronimo (1979, pl. 7, fig. 2a-c) and Pavia (1991, pl. 9, fig. 6, 10) as *C. ovulum* belong to this species. Pavia also reported a scatter-plot (fig. 6) suggesting two distinct species. The name *Cadulus attenuatus* Monterosato, 1875 should be used for this species. *C. ovulum* var. *attenuata* was reported as a *nomen nudum* by Monterosato (1872) from the Pleistocene beds of Ficarazzi (Palermo). Subsequently, he reported it as a synonym of *C. cyathus* (De Cristofori & Jan, 1832) (see below) and briefly described it ["più piccolo del precedente (*C. ovulum*), nè così gibboso nel mezzo della sua parte dorsale", Monterosato, 1875]. The Ficarazzi beds contain deep-shelf to upper-slope faunas, among which truly bathyal species are scarce, compared with the faunas studied in the present work (La Perna, in press). Similar faunas occur in the deposits where the specimens illustrated here were collected (La Perna, 1996). It is also worth noting that Seguenza (1879) reported "*C. cyathus* = *C. ovulum* var. *attenuata* Monterosato" from several southern Italy localities, keeping it distinct from *C. ovulum*.

C. gibbus Jeffreys, 1883 from Biscay Bay ("allied to *C. ovulum* of Philippi, but much smaller and not so oval, and the ends are equal in size"), appears to resemble *C. attenuatus*. The Miocene *C. taurovolum saccoi* Pavia, 1991, is markedly barrel-shaped and less swollen than *C. attenuatus*.

Although accurately described ["Creseis testa minima, cyathiformi-inflata (alt. 2 mm, lat. 1 mm"], *C. cyathus* is still an enigmatic species. Pinna (1971) illustrated the original material, consisting of a badly broken shell from an unknown locality. It is probably not a Pleistocene fossil, like all the species in De Cristofori & Jan's collection. It might be the same as *C. ovulum*, as supported by Caprotti (1979); however, since the Miocene and Pliocene deep-sea *Cadulus* are still very poorly known, it is not advisable to regard the well-described and now well-known *C. ovulum* as a junior synonym of *C. cyathus*, involving also the type-species of *Cadulus* itself.

Distribution. Although *C. ovulum* is listed among the Mediterranean Mollusca checklist (Sabelli et al., 1990), it should be regarded as absent from the Mediterranean, if not extinct. The Atlantic "finding" by Fischer, quoted by Jeffreys (1883a) and Locard (1898) may be based on a particularly inflated specimen of *C. gibbus*. The Mediterranean report by Acton (off Naples, see Jeffreys, 1883a) and those by Caprotti (1979) and Gaglini (1986), are likely based on reworked shells (or dredged from old sediments). The specimens examined by Gaglini (1986) were said to be fossils or subfossil-looking and some to come from "a few metres". Bonfitto et al. (1994) recently listed *C. ovulum* from a deep-sea Tyrrhenian assemblage in which several Pleistocene species were also found.

According to Pavia (1991), Sacco's report (1897) of *C. ovulum* from the northern Italy late Miocene may be based on *C. taurovolum*, although this material was lost.

C. ovulum was also reported from Pliocene deposits (Bernasconi, 1996), although no reliable Pliocene shell has been illustrated so far.

Cadulus diploconus Seguenza, 1876

Pl. 10, fig. 15, 16

1876c *Cadulus diploconus* Seguenza, p. 266.
1994 *Cadulus diploconus* - Palazzi & Villari, fig. 42, 43.

Description. Spindle-shaped, slightly bent, smooth, shiny shell. Maximum diameter at mid-height of shell, where an obscure angulation occurs. Roundish section. Ventral side regularly convex in lateral view, gradually sloping to apical and oral openings; dorsal side centrally swelling. Slightly ovate apex, with inner callus. Roundish, oblique oral opening, larger than the apical opening. Length up to 3.0 mm; length to maximum diameter ratio ca. 1.8.

Taxonomy. This species belongs to the spindle-shaped, non-coronate *Cadulus* group.

Remarks. Palazzi & Villari (1994) recently reported this species, tentatively regarding *C. tumidosus* Jeffreys, 1883 as a synonym. Judging from the original drawing, *C.* (?) *tumidosus* is quite distinct from the present species. On the contrary, two Indo-Pacific deep-sea species described by Scarabino (1995) closely resemble *C. diploconus*, i.e. *C. sofiae* and *C. labeyriei*. *C. rossoi* described by Nicklès (1979) from Senegal in 150-250 m is also roughly similar to *C. diploconus*, but it lacks the inner apical callus, and thus probably belongs to the third "*Cadulus*" group previously mentioned.

Distribution. *C. diploconus* is known only from Pleistocene bathyal deposits of Calabria and the Messina area, where it is found rarely.

Discussion.

Two noteworthy faunal groups occur among the faunas studied. The first group consists of North Atlantic species, i.e. *Fissurisepta rostrata, Puncturella noachina, P. granulata, Callumbonella suturale, Haloceras carinata, Pseudosetia turgida, Torellia delicata, Eumetula aliceae, Melanella spiridioni, Claviscala richardi, Opaliopsis atlantis, Iphitus tenuisculptus, Taranis* cf. *borealis, Mitrolumna smithi, Pleurotomella eurybrocha*, and *Pleurotomella packardi*. *Seguenzia monocingulata, Pyrunculus obesiusculus, Chrysallida brattstroemi, Ennucula rotundata* and "*Yoldia*" *minima* may also be added. Except for other species mentioned in the present work, other Atlantic species from Pleistocene bathyal deposits (La Perna, 1994) deserve to be mentioned, such as *Micropilina minuta* Warén, 1989, "*Diodora*" *tenuiclathrata* (Seguenza, 1862) (= *Glyphis edwardsi* Dautzenberg & Fischer, 1896), *Calliostoma maurolici* (Seguenza, 1876) (= *Gibbula obesula* Locard, 1898), "*Trochus*" *luciae* (Seguenza, 1876) (= *Gibbula hannonis* Locard, 1898), and *Calliotropis ottoi* (Philippi, 1844). This list is not exhaustive, as several fossil species still need to be revised and compared with their Atlantic counterparts.

With a few exceptions, such as *Puncturella noachina*, living at shelf depths in northern latitudes, most of these Atlantic species have a deep-sea distribution throughout their latitudinal ranges. Several Atlantic species have been reported also from deep thanatocoenoses and referred to the Late Glacial age (Di Geronimo & Li Gioi, 1981; Di Geronimo & Bellagamba, 1986; Bouchet & Taviani, 1989, Corselli & Bernocchi, 1990; Bonfitto et al., 1994, etc.).

Whether Atlantic deep-sea species presently enter the Mediterranean is a matter of discussion (see below). Larval ecology is undoubtedly an important factor (Bouchet & Taviani, 1989, 1992, 1993). Apart from the deep oceanographic conditions, some biotic factors may also bias the Mediterranean distribution of "Atlantic" species. This is the case of *Acesta excavata*, *Iphitus asperatus* and *Coralliophila richardi* (see Ghisotti, 1979; Taviani & Sabelli, 1982; Taviani & Taviani, 1986), all associated with deep-sea scleractinian communities, presently declining in the Mediterranean. According to Corselli & Bernocchi (1993), the disappearance of *Puncturella granulata* was due to the loss of its trophic supply, i.e. the deep-sea porifer communities. On the other hand, some species regarded previously as Atlantic, such as *Ennucula corbuloides*, *Yoldiella micrometrica*, *Katadesmia cuneata*, prove instead to be common components of eastern and western Mediterranean bathyal assemblages (Janssen, 1989; Di Geronimo et al., 1995, La Perna, unpubl. data), although currently found only as empty shells.

The other faunistic group was recognised more recently (La Perna, 1994). It consists of extinct species which are closely related to Atlantic species or to Oceanic taxa in general. As shown for *Homalopoma emulum* (Di Geronimo & La Perna, 1997) and for *Bathyspinula excisa* (Di Geronimo & La Perna, 1996), these species have no Recent counterparts among the deep Mediterranean benthos. Other species should be referred to this group, such as *Fissurisepta papillosa*, *Solariella marginulata*, *Profundinassa spinulosa*, *Benthomangelia tenuicostata*, *Austrotindaria pusio*, *Thestyleda cuspidata*, *Katadesmia confusa*, *Cadulus ovulum* and *Cadulus diploconus*. It is also worth reporting other species, such as the trochaceans *Calliostoma sayanum* (Seguenza, 1876), *Calliostoma formosissimum* (Seguenza, 1876) and *Microgaza solarioides* (Seguenza, 1876), all showing close relationships with North Atlantic deep-sea species. The pseudococculinids *Notocrater* sp. and *Coccullinella* sp., also deserve to be noted. Close phyletic relationships between living and fossil species are obvious, although any lineage reconstruction is difficult or merely theoretical due to the lack of data concerning Atlantic fossil deep-sea faunas. The presence of archaeogastropods, nuculoids and scaphopods among this oceanic stock is clearly related to the non-planktotrophic larval development shared by these groups.

These species have been regarded as cold-stenothermic due to their oceanic affinities (Di Geronimo et al., 1996; Di Geronimo & La Perna, 1996, 1997). A range of roughly 10-8 to 4°C can be inferred for them, according to the thermal range accounted for the psycrosphere (e.g. Benson, 1972, 1975).

Other deep-sea species, such as *Chrysallida microscalaria* and "*Babylonella*" *profunda* seem to have evolved from shallower ancestors, as outlined for the *Pagodula vaginata-echinata* lineage by La Perna (1996). A similar trend probably involved *Cadulus*. *C. ovulum* appears to represent the cold deep-sea term of a lineage ranging from the Miocene *taurovolum* to the Pleistocene *attenuatus*.

An Atlantic affinity of the deep Mediterranean Plio-Peistocene benthos has been reported for several faunistic groups, such as ostracods, scleractinians, brachiopods, stalked crinoids and bryozoans (see references in Introduction). Benson's report (1972) deserves special mention, being the first modern work to stress the paleooceanographic meaning of psychrospheric Plio-Pleistocene taxa from the Mediterranean.

On these grounds, a model of the Plio-Quaternary evolution of the deep Mediterranean benthos has been outlined (La Perna, 1994; Di Geronimo et al., 1996; Di Geronimo & La Perna, 1996). According to this model, many deep-sea cold species appeared and successfully spread in the Mediterranean since the middle-late Pliocene. This phenomenon should be seen within a generalised development of the deep oceanic benthos following the Northern Hemisphere cooling trend (Berggren, 1972; Shackleton & Opdyke, 1977, Thunnel & Williams, 1983). The "absence" of a sill at Gibraltar during the Plio-Pleistocene, supported by geological data (Bousquet & Philip, 1976; Dillon et al., 1980), allowed the Mediterranean basin to have full hydrological and faunistic exchanges with the Ocean (or much wider than those present today). At that time, the North Atlantic-Mediterranean benthos had lost most of the Mesogean deep-sea taxa (see Barrier et al., 1991; La Perna, in press).

Dramatic changes occurred in the Late Pleistocene, when the oceanic-like communities disappeared. Colalongo & Pasini (1988) dated the end of psychrospheric conditions in the Mediterranean to the upper part of early Pleistocene. In any case, rich oceanic bathyal communities are known from Pleistocene deposits in Calabria ranging from 1.1 M.y. to 600-700 k.y. (MNN 19e-MNN 19f Biozones of Rio et al., 1990) (Di Geronimo et al., in press). A compression phase at Gibraltar since 1 Ma (Bousquet & Philip, 1976; Dillon et al., 1980) seems to have played a strong role in isolating the Mediterranean from the Atlantic Ocean, and in determining its present-day oceanographic features. A main role in the fate of bathyal communities has been ascribed (Di Geronimo & La Perna, 1997) to warm homothermic conditions which developed during Late Quaternary interglacial phases. A model of increasing homothermy, however, seems to fit better the increasing threshold-basin conditions, related to the sill uplift. As known from the literature (e.g. Allouc, 1987, Delibrias & Taviani, 1985) the deep Mediterranean benthos flourished again in part during the Late Pleistocene glacial phase (Würmian), when the oceanic Plio-Pleistocene species had already been lost.

What kind of deep-sea benthos was selected by such processes? A scarcity of endemisms, a lack of cold-stenothermic species, low diversity, low density and biomass, and a high degree of eurybathy, have been stressed often as characteristic of the deep Mediterranean benthos (Perès & Picard, 1964; Menzies, 1973; Fredj & Laubier, 1985; Bouchet & Taviani, 1992, 1993; Harmelin & d'Hondt, 1993), although a slightly different model was outlined by Bellan-Santini et al. (1992).

Bouchet & Taviani (1992, 1993) proposed a model depicting the deep Mediterranean benthos as mainly represented by "pseudopopulations" of Atlantic species. In other words, the deep Mediterranean benthos is supplied with a meroplanktonic inflow from the Atlantic *via* the Gibraltar threshold. Planktotrophic larvae of deep-sea species can bypass the sill thanks to vertical ontogenetic migrations (Bouchet, 1976; Bouchet & Fontes, 1981), but the deep hydrological conditions prevent full benthic development or reproduction. This model was applied originally to turrids, a molluscan group in which planktotrophy is widespread. It is difficult, however, to use this theory to explain the occurrence of non-planktotrophically developing species in the Mediterranean, whose depth-range begins well beyond the sill-depth e.g. *Ennucula corbuloides* and *Yoldiella seguenzae* (>500 m), *Yoldiella micrometrica* (>600-700 m) and *Katadesmia cuneata* (>800-1,000 m). In these cases, persistence since the Plio-Pleistocene seems more likely than a present-day introduction. A larval inflow of many planktotrophically developing species from the adjacent Atlantic Ocean is a reasonable hypothesis, but the presence of an autochtonous, although scarce, deep Mediterranean benthos cannot be rejected. It consists of species which endured better than others oceanographic changes during the Late Quaternary.

Acknowledgements.

We wish to express our thanks to Serge Gofas and Philippe Bouchet (Muséum National d'Histoire Naturelle, Paris), who made available the material from the BALGIM and THALASSA Expeditions and kindly assisted one of us at MNHN. We also thank Anders Warén (Naturhistoriska Riksmuseet, Stockholm), for suggestions concerning taxonomy and help with the bibliography. Orazio Torrisi (C.N.R., Catania) assisted in SEM photography. Earlier versions of the manuscript were reviewed by Anders Warén (Naturhistoriska Riksmuseet, Stockholm) and Elio Robba (Milan University).

Financial support was provided by M.U.R.S.T. Grants to Prof. Italo Di Geronimo (40%, 60%).

REFERENCES

Aifa T., Barrier P., Feinberg H. & Pozzi J.-P (1987) - Paléomagnetisme des terrains sédimentaires plio-quaternaires du Détroit de Messine. *Doc. et Trav. IGAL*, v. 11, pp. 83-90, Paris.

Allen J.A. (1978) - Evolution of the deep sea protobranch bivalves. *Phil. Trans. R. Soc. London*, B, v. 284, pp. 387-401, London.

Allen J.A. & Hannah F.J. (1986) - A reclassification of the Recent genera of the subclass Protobranchia (Mollusca: Bivalvia). *J. Conch.*, v. 32, pp. 225-249, London.

Allen J.A. & Hannah F.J. (1989) - Studies on the deep-sea Protobranchia: the subfamily Ledellinae (Nuculanidae). *Bull. Br. Mus. nat. Hist. (Zool.)*, v. 55, pp. 123-171, London.

Allen J.A., Sanders H.L. & Hannah F.J. (1995) - Studies on the deep-sea Protobranchia (Bivalvia); the subfamily Yoldiellinae. *Bull. Br. Mus. nat. Hist. (Zool.)*, v. 61, pp. 11-90, London.

Allouc J. (1987) - Les paléocommunautés profondes sur fond rocheux du Pléistocène Méditerranée. Description et essai d'interprétation paléoecologique. *Geobios*, v. 20, pp. 241-263, Lyon.

Aradas A. (1846) - Descrizione di varie specie nuove di conchiglie viventi e fossili della Sicilia. *Atti Acc. Gioenia Sc. Nat.*, s. 2, v. 3, pp. 159-184, Catania.

Barrier P. (1987) - Stratigraphie des dépôts pliocènes et quaternaires du Détroit de Messine. *Doc. et Trav. IGAL*, v. 11, pp. 59-81, Paris.

Barrier P., Montenat C. & Ott d'Estevou P. (1987) - Exemples de relation entre tectonique et sédimentation dans le Plio-Pleistocène du Détroit de Messine: troncatures sous-marines et dépôt-centres. *Doc. et Trav. IGAL*, v. 11, pp. 143-151, Paris.

Barrier P., Di Geronimo I., Montenat C., Roux M. & Zibrowius H. (1989) - Présence de faunes bathyales atlantiques dans le Pliocène et le Pléistocène de Méditerranée (Détroit de Messine, Italie). *Bull. Soc. Géol. France*, s. 8, v. 5, pp. 787-796, Paris.

Barrier P., Zibrowius H., Lozouet P., Montenat C., Ott d'Estevou P., Serrano F. & Soudet H.-J. (1991) - Une faune de fond dur du bathyal supérieur dans le Miocène terminal des Cordillères Bétiques (Carboneras, SE Espagne). *Mésogée*, v. 51, pp. 3-13, Marseille.

Barrier P., Di Geronimo I., La Perna R., Rosso A., Sanfilippo R. & Zibrowius H. (1996) - Taphonomy of deep-sea hard and soft bottom communities: the Pleistocene of Lazzàro (Southern Italy). In Meléndez Hevia G. et al. (Eds.) - II Reunión de Tafonomía y fosilización (Zaragoza, 1996), Institución "Fernando el Catolico", pp. 39-46, Zaragoza.

Bellan-Santini D., Fredj G. & Bellan G. (1992) - Mise au point sur le connaissance concernant le benthos profond Méditerranéen. *Oebalia*, suppl. 17, pp. 21-36, Taranto.

Benson R.H. (1972) - Ostracods as indicators of threshold depth in the Mediterranean during the Pliocene. In

Stanley D.J. (Ed.) - The Mediterranean Sea: a Natural Sedimentation Laboratory, pp. 63-73, Dowden, Hutchinson & Ross, Stroudsburg.

Benson R.H. (1975) - The origin of the psychrosphere as recorded in changes of deep-sea ostracode assemblages. *Lethaia*, v. 8, pp. 69-83, Oslo.

Bergmans W. (1991) - Mollusca Bivalvia: archibenthal Nuculidae off New Caledonia. In Crosnier A. & Bouchet P. (Eds.) - Résultats des Campagnes MUSORSTOM, 7, *Mém. Mus. Natn. Hist. Nat., Zool.*, v. 150, pp. 29-40, Paris.

Berggren W.A. (1972) - Late Pliocene-Pleistocene glaciation. In Laughton A. S., Berggren W. A. et al. (Eds.) - *Initial Rep. DSDP*, v. 12, pp. 953-963, Washington.

Bernasconi M.P. (1996) - Scaphopod significance in the Pliocene molluscan paleocommunities. In Cherchi A. (Ed.) - Autoecology of selected fossil organisms: Achievements and problems. *Boll. Soc. Paleont. Ital.*, Spec. Vol. 3, pp. 19-30, Modena.

Bertolaso L. & Palazzi S. (1994) - *Iphitus* Jeffreys, 1883, un sinonimo di *Stylotrochus* G. Seguenza, 1876. *Boll. Malacologico*, v. 29, pp. 286-290, Milano.

Bilyard G. R. (1974) - The feeding habits and ecology of *Dentalium entale stimpsoni* Henderson. *The Veliger*, v. 17, pp. 126-138, Berkeley.

Bonfitto A., Oliverio M., Sabelli B. & Taviani M. (1994) - A Quaternary deep-sea marine molluscan assemblage from East Sardinia (Western Tyrrhenian Sea). *Boll. Malacologico*, v. 30, pp. 141-157, Milano.

Bonfitto A. & Sabelli B. (1995) - *Yoldiella seguenzae*, a new species of Nuculanidae (Bivalvia; Nuculoida) from the Mediterranean Sea. *J. Moll. Stud.*, v. 61, pp. 21-27, London.

Bouchet P. (1975) - Opistobranches de profondeur de l'Océan Atlantique: I. Cephalaspidea. *Cah. Biol. Mar.*, v. 16, pp. 317-365, Roskoff.

Bouchet P. (1976) - Mise en évidence d'une migration de larves véligères entre l'étage abyssal et la surface. *Comp.-rend. hebd. séances Acad. Sc., Paris*, v. 283, pp. 821-824, Paris.

Bouchet P. & Fontes J.-C. (1981) - Migrations verticales des larves de Gastéropodes abyssaux: arguments nouveaux dûs à l'analyse isotopique de la coquille larvaire et postlarvaire. *Comp. -rend. hebd. séances Acad. Sc., Paris*, v. 292, pp. 1005-1008, Paris.

Bouchet P. & Taviani M. (1989) - Atlantic deep sea gastropods in the Mediterranean: new findings. *Boll. Malacologico*, v. 25, pp. 137-148, Milano.

Bouchet P. & Taviani M. (1992) - The Mediterranean deep-sea fauna: pseudopopulations of Atlantic species? *Deep-Sea Res.*, v. 39, pp. 169-184, Stratford-upon-Avon.

Bouchet P. & Taviani M. (1993) - La colonizzazione dei bacini a soglia. Il caso del Mar Mediterraneo. *Lavori S.I.M.*, v. 24, pp. 31-35, Parma.

Bouchet P. & Warén A. (1979) - The abyssal molluscan fauna of the Norwegian Sea and its relation to other faunas. *Sarsia*, v. 64, pp. 211-243, Bergen.

Bouchet P. & Warén A. (1980) - Revision of the North-East Atlantic bathyal and abyssal Turridae (Mollusca, Gastropoda). *J. Moll. Stud.*, Suppl. 8, 1-119, London.

Bouchet P. & Warén A. (1985) - Revision of the Northeast Atlantic bathyal and abyssal Neogastropoda, excluding Turridae. *Boll. Malacologico*, Suppl. 1, pp. 121-296, Milano.

Bouchet P. & Warén A. (1986) - Revision of the Northeast Atlantic bathyal and abyssal Aclididae, Eulimidae, Epitoniidae (Mollusca, Gastropoda). *Boll. Malacologico*, Suppl. 2, pp. 298-576, Milano.

Bouchet P. & Warén A. (1993) - Revision of the Northeast Atlantic bathyal and abyssal Mesogastropoda. *Boll. Malacologico*, Suppl. 3, pp. 579-840, Milano.

Bousquet J.C. & Philip M. (1976) - Observations microtectoniques sur la compression nord-sud quaternaire des Cordillères Bétique orientales (Espagne méridionale, Arc de Gibraltar). *Bull. Soc. Géol. France*, v. 28, pp. 711-724, Paris.

Brugnone G. (1877) - Osservazioni critiche fatte dall'Ab. Giuseppe Brugnone sul Catalogo delle Conchiglie fossili di Monte Pellegrino e Ficarazzi del Marchese di Monterosato. *Bull. Soc. Malac. Ital.*, v. 3, 17-46, Pisa.

Caprotti E. (1979) - Scafopodi neogenici e recenti del bacino mediterraneo. *Boll. Malacologico*, v. 15, pp. 213-288, Milano.

Clarke A.H. (1961) - Abyssal mollusks from the South Atlantic Ocean. *Bull. Mus. Comp. Zool.*, v. 125, pp. 345-386, Harvard.

Clarke A.H. (1962) - On the composition, zoogeography, origin and age of the deep-sea mollusk fauna. *Deep-Sea Res.*, v. 9, pp. 291-306, Stratford-upon-Avon.

Colalongo M.L. & Pasini G. (1988) - Ostracofauna plio-pleistocenica batiale rinvenuta nel Pozzo 645A dell'ODP Leg 107 (Mare Tirreno occidentale). *Boll. Soc. Paleont. Ital.*, v. 27, pp. 277-289, Modena.

Colman J.G. & Tyler P.A. (1988) - Observations on the reproductive biology of the deep-sea trochid *Calliotropis ottoi* (Philippi). *J. Moll. Stud.*, v. 54, pp. 239-242, London.

Corselli C. & Bernocchi A. (1990) - Paleocommunities of the last glacial from the Sardinia continental slope: a paleoceanography problem. In Robba E. (Ed.) - Atti IV Simp. Ecol. Paleoecol. Com. Bent., *Boll. Mus. Reg. Sc. Nat. Torino*, pp. 576-595, Torino.

Corselli C. & Bernocchi A. (1993) - On the presence of *Puncturella (Cranopsis) granulata* (Seguenza, 1862) in the Pliocene of Northern Italy. *Lavori S.I.M.*, v. 24, pp. 107-118, Parma.

Cowan I. McT. (1969) - A new species of Gastropod (Fissurellidae, *Fissurisepta*) from the Eastern North Pacific Ocean. *The Veliger*, v. 12, pp. 24-26, Berkeley.

D'Alessandro A. & De Marco A. (1993) - Bionomic analysis of two Upper Pliocene communities from southern Italy. *Beringeria*, v. 8, pp. 109-137, Würzburg.

Dall W.H. (1881) - Reports on the results of dredging, under the supervision of A. Agassiz, in the Gulf of Mexico and in the Caribbean Sea, 1877-79, by the U.S. Coast Survey Steamer «Blake» ... Preliminary Report on the Mollusca. *Bull. Mus. Comp. Zool.*, v. 9, pp. 33-144, Harvard.

Dall W.H. (1886) - Reports on the results of dredging, under the supervision of A. Agassiz, in the Gulf of Mexico, 1877-78, and in the Caribbean Sea, 1879-80, by the U.S. Coast Survey Steamer «Blake» ... Part I. Brachipoda and Plecypoda. *Bull. Mus. Comp. Zool.*, v. 12, pp. 171-318, Harvard.

Dautzenberg P. (1927) - Mollusques provenant des campagnes scientifiques du Prince Albert Ier de Monaco dans l'Ocean Atlantique et dans le Golfe de Gascogne. *Rés. Camp. Scient. Prince Albert Ier*, v. 72, pp. 1-400, Monaco.

Dautzenberg P. & Fischer P. (1896) - Dragages effectués par l'Hirondelle et par la Princesse Alice, 1888-1895. *Mém. Soc. Zool. France*, v. 9, pp. 395-498, Paris.

Davoli F. (1995) - I molluschi del Messiniano di Borelli (Torino). 3. Cancellariidae. *Boll. Mus. Reg. Sc. Nat. Torino*, v. 13, pp. 221-264, Torino.

Delibrias G. & Taviani M. (1985) - Dating the death of Mediterranean deep-sea Scleractinian Corals. *Mar. Geol.*, v. 62, pp. 175-180, Amsterdam.

Dell R. K. (1990) - Antartic Mollusca with special reference to the fauna of the Ross Sea. *Roy. Soc. New Zeland, Bull*, v. 27, pp. 1-311, Wellington.

Di Geronimo I. (1979) - Il Pleistocene in facies batiale di Valle Palione (Grammichele, Catania). *Boll. Malacologico*, v. 15, pp. 85-156, Milano.

Di Geronimo I. (1991) - Mollusca: specie nuove plio-quaternarie di G. Seguenza (1858-1881). *Atti Acc. Pelorit. Pericolanti (Sc. Fis. Mat. Nat.)*, v. 67, Suppl. 1, pp. 137-254, Messina.

Di Geronimo I. & Bellagamba M. (1986) - Malacofaune dei dragaggi BS 71-1 e BS 77-2 (Sardegna Nord Orientale). *Boll. Soc. Paleont. Ital.*, v. 24, pp. 111-129, Modena.

Di Geronimo I. & La Perna R. (1996) - *Bathyspinula excisa* (Philippi, 1844) (Bivalvia, Protobranchia): a witness of the Plio-Quaternary history of the deep Mediterranean benthos. *Riv. Ital. Paleont. Strat.*, v. 102, pp. 105-118, Milano.

Di Geronimo I. & La Perna R. (1997) - *Homalopoma emulum* (Seguenza, 1876), a bathyal cold-stenothermic gastropod in the Mediterranean Pleistocene. *Geobios*, v. 30, pp. 215-223, Lyon.

Di Geronimo I., La Perna R. & Rosso A. (1996) - The Plio-Quaternary evolution of the Mediterranean deep-sea benthos: an outline. In La Méditerranée: variabilités climatiques, environnement et biodiversité, Actes du Colloque Scientifique Internacional (Montpellier, 6-7 Avril 1995), pp. 286-291, Montpellier.

Di Geronimo I., La Perna R., Rosso A. & Sanfilippo R. (1995) - Primi dati sulle tanatocenosi bentoniche dei bacini di Cefalù e Gioia (Tirreno Sud Orientale). In Faranda F.M. (Ed.) - Caratterizzazione ambientale marina del sistema Eolie e dei bacini limitrofi di Cefalù e Gioia (EOCUMM94), Data rep., pp. 289-302, Napoli.

Di Geronimo I., D'Atri A., La Perna R., Rosso A., Sanfilippo R. & Violanti D., in press - The Pleistocene bathyal section of Archi. *Atti 13° Congr. Soc. Paleont. Ital.*, Parma, 1996.

Di Geronimo I. & Li Gioi R. (1981) - La malacofauna würmiana della staz. BS 77/4 al largo di Capo Coda Cavallo (Sardegna nord-orientale). *Ann. Univ. Ferrara (n.s.), sez. IX - Sc. Geol. Paleont.*, v. 6, suppl., pp. 123-151, Ferrara.

Di Geronimo I. & Robba E. (1976) - Metodologie qualitative e quantitative per lo studio delle biocenosi e paleocomunità marine bentoniche. *C.N.R. Gruppo Paleobenthos, Rapp. Lav. 1*, pp. 1-35, Modena.

Dillon W.P., Robb J.M., Green H.G. & Lucena J.C. (1980) - Evolution of the continental margin of southern Spain and the Alboran Sea. *Mar. Geol.*, v. 36, pp. 205-226, Amsterdam.

Fabbri A., Ghisetti F. & Vezzani L. (1980) - The Peloritani-Calabria range and the Gioia Basin in the Calabrian Arc (Southern Italy): relationships between land and marine data. *Geol. Romana*, v. 19, pp. 131-150, Roma.

Filatova Z.A. & Schileyko A.A. (1984) - Size, structure and distribution of the deep-sea Bivalvia of the family Ledellidae (Protobranchia). *Trudy Okeanol. Inst.*, v. 119, pp. 106-139, Moscow (in Russian).

Fleming C.A. (1948) - New species and genera of marine Mollusca from the Southland Fiords. *Trans. R. Soc. New Zeal.*, v. 77, pp. 72-92, Wellington.

Fredj G. & Laubier L. (1985) - The deep Mediterranean benthos. In Moraitou-Apostolopoulou M. & Kiortis V. (Eds.) - Mediterranean marine ecosystems, Plenum Press, pp. 109-145, New York.

Gaetani M. & Saccà D. (1984) - Brachiopodi batiali nel Pliocene e Pleistocene di Sicilia e Calabria. *Riv. Ital. Paleont. Strat.*, v. 90, pp. 407-458, Milano.

Gaglini A. (1986) - La classe Scaphopoda nel Mediterraneo. *Notiz. CISMA*, v. 7/8, pp. 2-14, Roma.

Ghisotti F. (1979) - Ritrovamento di *Acesta (Acesta) excavata* (Fabricius, 1779) vivente in Mediterraneo (Bivalvia, Limidae). *Boll. Malacologico*, v. 15, pp. 57-66, Milano.

Ghisotti F. & Giannini F. (1983) - Considerazioni sul genere *Fissurisepta*. *Boll. Malacologico*, v. 19, pp. 25-36, Milano.

Gofas S. & Salas C. (1996) - Small Nuculidae (Bivalvia) with functional primary hinge in the adults. *J. Conch.*, v. 35, pp. 427-435, London.

Harmelin J.-C. & d'Hondt J.-L. (1993) - Transfers of bryozoan species between the Atlantic Ocean and the Mediterraneanea via the Strait of Gibraltar. *Ocean. Acta*, v. 16, pp. 63-72, Paris.

Herbert D.G. (1987) - Revision of the Solariellinae (Mollusca: Prosobranchia: Trochidae) in South Africa. *Ann. Natal Mus.*, v. 28, pp. 283-382, Pietermarizburg.

Hickman C.S. (1984) - Composition, structure, ecology and evolution of six Cenozoic deep-water mollusk communities. *J. Paleont.*, v. 58, pp. 1215-1234, Lawerence.

Hickman C.S. & McLean J.H. (1990) - Systematic revision and suprageneric classification of Trochacean Gastropods. *Nat. Hist. Mus. Los Angeles County, Science Series*, v. 35, pp. 1-169, Los Angeles.

Janssen R. (1979) - Revision der Bivalvia des Oberoligozäns (Chattium, Kasseler Meeressand). *Geol. Abh. Hessen*, v. 78, pp. 1-181, Wiesbaden.

Janssen R. (1989) - Benthos-Mollusken aus dem Tiefwasser des östlichen Mittelmeres, gesammelt während der "METEOR"-Fahrt 5 (1987). *Senckenbergiana marit.*, v. 20, pp. 265-276, Frankfurt am Main.

Jeffreys J.G. (1870) - Mediterranean Mollusca. *Ann. Mag. Nat. Hist.*, s. 4, v. 6, pp. 65-86, London.

Jeffreys J.G. (1876) - Preliminary report on the biological results of a cruise in H.M.S. *Valorous* to Davis Strait in 1875. *Proc. R. Soc. London*, v. 25, pp. 177-230, London.

Jeffreys J.G. (1877) - New and peculiar Mollusca of the Eulimidae and other families of Gastropoda as well as of the Pteropoda procured during the *Valorous* expedition. *Ann. Mag. Nat. Hist.*, v. 4, pp. 317-339, London.

Jeffreys J.G. (1879) - On the Mollusca procured during the *Lightining* and *Porcupine* Expeditions. Part 2. *Proc. Zool. Soc. London* (1878), pp. 553-588, London.

Jeffreys J.G. (1883a) - On the mollusca procured during the *Lightning* and *Porcupine* Expeditions. Part 5. *Proc. Zool. Soc. London*, (1882), pp. 656-687, London.

Jeffreys J.G. (1883b) - On the mollusca procured during the *Lightning* and *Porcupine* Expeditions. Part 6. *Proc. Zool. Soc. London*, (1883), pp. 88-115, London.

Jeffreys J.G. (1885) - On the mollusca procured during the *Lightning* and *Porcupine* Expeditions. Part 9. *Proc. Zool. Soc. London*, (1885), pp. 27-63, London.

Kezirian F. (1992) - Evolution tectono-sedimentaire post-nappes des Monts Peloritains (Sicile Nord-Orientale, Italie). *Mém. de Géologie de l'IGAL*, v. 49, 260 pp. (unpublished) Paris.

Kilburn R.N. (1994) - The protobranch genera *Jupiteria*, *Ledella*, *Yoldiella* and *Neilo* in South Africa, with the description of a new genus (Mollusca: Bivalvia: Nuculanoidea). *Ann. Natal Mus.*, v. 35, pp. 157-175, Pietermarizburg.

Knudsen J. (1970) - The systematics and biology of abyssal and hadal bivalvia. *Galathea Rep.*, v. 11, pp. 1-241, Copenhagen.

Knudsen J. (1979) - Deep-sea bivalves. In Van der Spoel S., Van Bruggen A. C. & Lever J. (Eds.) - Pathways in Malacology, pp. 195-224, Scheltema & Holkema, Utrecht.

Laghi G.F. (1986) - *Nucula pusio* Philippi, 1844 (Paleotaxodonta, Bivalvia): strudio critico e proposte. *Attti Mem. Acc. Naz. Sc. Lett. Arti Modena*, s. 7, v. 1 (1983-84), pp. 155-195, Modena.

Laghi G. F. & Palazzi S. (1991) - Neotipo di *Nuculana* (*Ledella*) *peraffinis* (Seguenza, 1877) (=*Leda peraffinis* Seg.) e descrizione di *Nuculana* (*L.*) *peraffinis glabra* n. subsp. (Bivalvia, Paleotaxodonta). *Atti Acc. Pelor. Peric. (Sc. Fis. Mat. Nat.)*, v. 67, Suppl. 1, Messina.

La Perna R. (1994) - Malacofaune batiali del Quaternario del Mediterraneo: aspetti paleoecologici e paleobiogeografici. Doctorate Thesis - University of Messina. V. of 120 pp. (unpublished), Messina.

La Perna R. (1996) - Phyletic relationships and ecological implications between *Pagodula vaginata* (De Cristofori & Jan, 1832) and *Pagodula echinata* (Kiener, 1840) (Gastropoda, Muricidae). *Boll. Soc. Paleont. Ital.*, v. 35, 81-92, Modena.

La Perna R. (in press) - Revision of *Leda erctensis* Brugnone, 1876, *Leda striatella* Ponzi, 1876, *Leda trigona* Seguenza, 1877, *Leda gibba* Seguenza, 1877, with taxonomic and biogeographic comments on *Jupiteria* Bellardi, 1875 (Bivalvia, Protobranchia). *Boll. Acc. Gioenia Sc. Nat.*, Catania.

Linden (Van Der) J. & Eikenboom J.C.A. (1992) - On the taxonomy of the Recent species of the genus *Chrysallida* Carpenter from Europe, the Canary Islands and the Azores (Gastropoda, Pyramidellidae). *Basteria*, v. 56, pp. 3-63, Leiden.

Locard A. (1889) - Expedition scientifiques du Travailleur et du Talisman. II. V. of 516 pp., Masson, Paris.

Marshall B.A. (1979) - The Trochidae and Turbinidae of the Kermadec Ridge (Mollusca: Gastropoda). *New Zeal. J. Zool.*, v. 6, pp. 521-552, Wellington.

Marshall B.A. (1983) - Recent and Tertiary Seguenziidae (Mollusca: Gastropoda) from the New Zeland region. *New Zeal. J. Zool.*, v. 10, pp. 235-262, Wellington.

Marshall B.A. (1991) - Mollusca Gastropoda: Seguenziidae from the New Caledonia and the Loyalty Islands. In Crosnier A. & Bouchet P. (Eds.) - Résultats des Campagnes MUSORSTOM, 7, *Mém. Mus. Nat. Hist. Nat., Zool.*, v. 150, pp. 41-109, Paris.

Maxwell P.A. (1988) - Comments on "A reclassification of the Recent genera of the subclass Protobranchia (Mollusca: Bivalvia)" by J.A. Allen and F.J. Hannah (1986). *J. Conch.*, v. 33, pp. 85-96, London.

Menzies R.J. (1973) - Biological history of the Mediterranean Sea with reference to the abyssal benthos. *Rapp. Comm. int. Mer. Médit.*, v. 21, pp. 717-723, Monaco.

Métivier B. (1982) - Description d'espèce abyssales de Nuculacea des Açores. *J. Conch.*, v. 31, pp. 39-44, London.

Micali P. & Villari A. (1986) - Riscoperta di *Calliostoma sayanus* (G. Seguenza, 1873) e considerazioni sul Pleistocene di Archi (RC). *Boll. Malacologico*, v. 22, pp. 267-272, Milano.

Micali P. & Villari A. (1989) - Il deposito fossilifero di Salìce (Messina) con particolare riferimento alle specie istituite da Giuseppe Seguenza. (Contributo I). *Boll. Malacologico*, v. 25, pp. 77-84, Milano.

Micali P. & Villari A. (1991) - Le specie malacologiche di Salìce (Messina) istituite da Giuseppe Seguenza. *Atti Acc. Peloritana Pericolanti, Sc. Fis. Mat. Nat.*, 67, Suppl. 1, pp. 345-363, Messina.

Moissette P. & Spjeldnaess N. (1995) - Plio-Pleistocene deep-water bryozoans from Rhodes, Greece. *Palaeontology*, v. 38, pp. 771-799, Cambridge.

Montenat C. & Barrier P. (1987) - Approche quantitative des mouvements verticaux quaternaires dans le détroit de Messine. *Doc. et Trav. IGAL*, v. 11, pp. 185-190, Paris.

Monterosato M.T.A. (1872) - Notizie intorno alle conchiglie fossili di Monte Pellegrino e Ficarazzi. V. of 44 pp., Uff. Tipografico M. Amenta, Palermo.

Monterosato M.T.A. (1875) - Nuova rivista delle conchiglie mediterranee. *Atti Acc. Palermo Sc. Lett. Arti*, sez. 2, v. 5, pp. 1-50, Palermo.

Monterosato M.T.A. (1877) - Catalogo delle Conchiglie fossili di Monte Pellegrino e Ficarazzi presso Palermo. *Boll. R. Com. Geol. Ital.*, 1-2, pp. 28-42, Roma.

Nicklès M. (1979) - Scaphopodes de l'Ouest-Africain (Mollusca, Scaphopoda). *Bull. Mus. natn. Hist. nat., Paris*, 4e sér., v. 1 A, pp. 41-77, Paris.

Nordsieck F. (1968) - Die Europäischen Meeres-Gehäuseschnecken (Prosobranchia) von Eismeer bis Kapverden und Mittelmer. V. of 273 pp., Fischer, Stuttgart.

Nordsieck F. (1971) - Kontinentale und abyssische Meeresmollusken des Jonischen Meeres. *Arch. Moll.*, v. 101, pp. 187-190, Frankfurt am Main.

Nordsieck F. (1977) - The Turridae of the European Seas. V. of 129 pp., La Conchiglia, Roma.

Ockelmann K. & Warén A., (in press) - Taxonomy and biological notes on the bivalve genus *Microgloma*, and comments on Protobranch nomenclature. *Ophelia*, Helsingør.

Ogniben L. (1973) - Schema geologico della Calabria in base ai dati odierni. *Geol. Romana*, v. 12, pp. 243-585, Roma.

Okutani T. (1962) - Report on the Archibenthal and Abyssal Lamellibranchiate Mollusca mainly collected from Sagami Bay and adjacent waters by the R.V. Soyo-Maru during the years 1955-1960. *Bull. Tokai Reg. Fish. Res. Lab.*, v. 32, pp. 1-40, Tokai.

Ott d'Estevou P., Barrier P., Bousquet J.-C., Chabellard J.-G., Coppier G., Jarrige J.-J., Lanzafame G. & Laniece C. (1987) - Évolution structural pliocène et quaternaire du Détroit de Messine. *Doc et Trav. IGAL*, 11: 105-114, Paris.

Palazzi S. & Villari A. (1994) - Malacofaune batiali plio-pleistoceniche del Messinese. 1. Venetico Marina. *Naturalista sicil.*, s. 4, v. 18, pp. 73-106, Palermo.

Palazzi S. & Villari A. (1996) - Malacofaune batiali plio-pleistoceniche del Messinese. 2. Capo Milazzo. *Natutralista sicil.*, s. 4, v. 20, pp. 237-279, Palermo.

Pavia G. (1976) - I molluschi del Pliocene inferiore di Monteu Roero (Alba, Italia NW). *Boll. Soc. Paleont. Ital.*, v. 14, pp. 99-175, Modena.

Pavia G. (1991) - I molluschi del Messiniano di Borelli (Torino). 2. Scaphopoda. *Boll. Mus. Reg. Sci. Nat. Torino*, v. 9, pp. 105-172, Torino.

Pérès J.M. & Picard J. (1964) - Nouveau manuel de Bionomie bentique de la mer Méditerranée. *Rec. Trav. St. Mar. Endoume*, v. 31, pp. 1-137, Marseille.

Pérez Farfante I. (1947) - The genera *Zeidora*, *Nesta*, *Emarginula*, *Rimula* and *Puncturella* in the Western Atlantic. *Johnsonia*, v. 2, pp. 93-148, Cambridge.

Petit R.E. (1986) - The status of *Cancellaria nassiformis* Seguenza, 1880. *Boll. Malacologico*, v. 22, pp. 79-80, Milano.

Philippi R.A. (1836) - Enumeratio molluscorum Siciliae. V. of 270 pp., Sumptibus Simonis Schropi et Sociorum, Berolini.

Philippi R.A. (1844) - Enumeratio molluscorum Siciliae. V. of 304 pp., Sumptibus Eduardi Anton, Halis Saxonum.

Pinna G. (1971) - I tipi delle specie di Gasteropodi terziari istituite da Giuseppe De Cristofori e Giorgio Jan nel 1832 conservati nelle collezioni del Museo Civico di Storia Naturale di Milano. *Atti Soc. It. Sc. Nat. Museo Civ. St. Nat. Milano*, v. 112, pp. 421-440, Milano.

Poon P.A. (1987) - The diet and the feeding behavior of *Cadulus tolmei* Dall, 1897 (Scaphopoda: Siphonodentalioida). *The Nautilus*, v. 101, pp. 88-92.

Quinn J.F. (1979) - Biological results of the University of Miami deep-sea expeditions. 130. The systematics and zoogeography of the gastropod family Trochidae collected in the Straits of Florida and its approaches. *Malacologia*, v. 19, pp. 1-62, Ann Arbour.

Quinn J.F. (1983) - A revision of the Seguenziacea Verrill, 1884 (Gastropoda, Prosobranchia). I. Summary and evaluation of the superfamily. *Proc. Biol. Soc. Washington*, v. 96, pp. 725-757, Washington.

Rex M.A (1981) - Community structure in the deep-sea benthos. *Ann. Rev. Ecol. Syst.*, v. 12, pp. 331-353, Palo Alto.

Rhind P.M. & Allen J.A. (1992) - Studies on the deep-sea Protobranchia (Bivalvia): the family Nuculidae. *Bull. Br. Mus. nat. Hist. (Zool.)*, v. 58, pp. 61-93, London.

Rindone V. & Vazzana A. (1989) - Alcune specie di molluschi delle argille batiali del Piano Siciliano (Pleistocene inf.) della cava di Archi (Reggio Calabria). *Boll. Malacologico*, v. 25, pp. 233-240, Milano.

Rio D., Raffi I. & Villa G. (1990) - Pliocene-Pleistocene calcareous nannofossil distribution patterns in the Western Mediterranean. *Proc. ODP Sc. Res.*, v. 107, pp. 513-533, Washington.

Robba E. (1978) - Studi paleoecologici sul Pliocene ligure. 3. Osservazioni sul metodo di campionamento nelle argille. *Riv. Ital. Paleont. Strat.*, v. 84, pp. 491-522, Milano.

Robba E. (1981) - Studi paleoecologici sul Pliocene ligure. IV. Malacofaune batiali della Liguria occidentale. *Riv. Ital. Paleont. Strat.*, v. 87, pp. 93-164, Milano.

Rosso A. & Di Geronimo I. (in press) - Bathyal Pleistocene Bryozoans. *Geobios*, Lyon.

Roux M., Barrier P., Di Geronimo I. & Montenat C. (1988) - Découvert de Crinoïdes pédonculés bathyaux d'origine atlantique dans le Pliocène supérieur et le Pléistocene moyen méditerranéen: conséquences biogéographiques. *C. R. Acad. Sci. Paris*, v. 307, n. III, pp. 259-264, Paris.

Sabelli B., Giannuzzi-Savelli R. & Bedulli D. (1990) - Annotated check list of Mediterranean marine mollusks. I. Libreria Naturalistica Bolognese. V. of 348 pp., Bologna.

Sacco F. (1897) - I Molluschi dei terreni terziari del Piemonte e della Liguria. Part XXII. V. of 148 pp., Clausen, Torino.

Sacco F. (1898) - I Molluschi dei terreni terziari del Piemonte e della Liguria. Part XXVI. V. of 70 pp., Clausen, Torino.

Sanders H.L. & Allen J.A. (1977) - Studies on the deep sea Protobranchia (Bivalvia); the family Tindariidae and the genus *Pseudotindaria*. *Bull. Mus. Comp. Zool.*, v. 148, pp. 23-59, Harvard.

Sanders H.L. & Allen J.A. (1985) - Studies on deep-sea Protobranchia (Bivalvia); the family Malletiidae. *Bull. Br. Mus. Nat. Hist. (Zool.)*, v. 49, pp. 195-238, London.

Seguenza G. (1862) - Paleontologia malacologica dei terreni terziari del distretto di Messina. Famiglia Fissurellidi. *Ann. Acc. Aspiranti Naturalisti*, s. 3, v. 2, pp. 1-21, Napoli.

Seguenza G. (1876a) - Studi stratigrafici sulla formazione pliocenica dell'Italia meridionale. *Boll. R. Com. Geol. Ital.*, v. 3-4, pp. 92-103, Roma.

Seguenza G. (1876b) - Studi stratigrafici sulla formazione pliocenica dell'Italia meridionale. *Boll. R. Com. Geol. Ital.*, v. 5-6, pp. 180-189, Roma.

Seguenza G. (1876c) - Studi stratigrafici sulla formazione pliocenica dell'Italia meridionale. *Boll. R. Com. Geol. Ital.*, v. 7-8, pp. 260-271, Roma.

Seguenza G. (1877a) - Studi stratigrafici sulla formazione pliocenica dell'Italia meridionale. *Boll. R. Com. Geol. Ital.*, v. 3-4, pp. 92-99.

Seguenza G. (1877b) - Nuculidi terziarie rinvenute nelle province meridionali d'Italia. *Mem. R. Acc. Lincei, Cl. Sc. Fis. Mat. Nat.*, s. 3, v. I (A. 274, 1876-77), pp. 1163-1200, Roma.

Seguenza G. (1879) - Le formazioni terziarie della Provincia di Reggio (Calabria). *Mem. R. Acc. Lincei, Cl. Sc. Fis. Mat. e Nat.*, s. 3, v. 6, 1-446 pp, Roma.

Scarabino V. (1995) - Scaphopoda of the tropical Pacific and Indian Oceans, with description of 3 new genera and 42 new species. In P. Bouchet (ed.), Résultats des Campagnes MUSORSTOM, 14. *Mém. Mus. natn. Hist. nat.*, v. 167, pp. 189-379, Paris.

Schenck H.G. (1934) - Classification of nuculid pelecypods. *Bull. Inst. R. Sc. Nat. Belg.*, v. 10, pp. 1-78, Bruxelles.

Schenck H.G. (1939) - Revised nomenclature for some nuculid pelecypods. *J. Paleont.*, v. 13, pp. 21-41, Lawrence.

Schiøtte T. & Warén A. (1992) - An annotated and illustrated list of the types of Mollusca described by H.P.C. Møller from West Greenland. *Meddelelser om Grønland - Bioscience*, v. 35, pp. 1-34, Odense.

Shackleton N.J. & Opdyke N.D. (1977) - Oxygen isotope and paleomagnatic evidence for early Northern Hemisphere glaciation. *Nature*, v. 270, pp. 216-219, London.

Sykes E.R. (1925) - On the Mollusca procured during the Porcupine expeditions, 1869-70. Supplemental notes. Part 5. *Proc. Malacol. Soc. London*, v. 16, pp. 181-193, London.

Steiner G. (1992) - Phylogeny and classification of Scaphopoda. *J. Moll. Stud.*, v. 58, pp. 385-400, London.

Tabanelli C. (1985) - Un cancellaride batifilo per il Pliocene italiano. *Boll. Malacologico*, v. 21, pp. 21-24, Milano.

Tabanelli C. (1993) - Osservazioni ed ipotesi sulle malacofaune plioceniche della Romagna. *Quad. Studi Nat. Romagna*, v. 2, pp. 1-20, Cesena.

Tabanelli C. (1997) - III Contributo alla conoscenza della malacofauna batiale del Pliocene di Romagna: *Aclis bartolomeae* n. sp. (Mollusca, Gastropoda, Aclididae). *Quad. Studi Nat. Romagna*, v. 7, pp. 7-15, Cesena.

Taviani M. (1974) - Nota sul ritrovamento di cinque specie di molluschi Gastropoda, Prosobranchia poco conosciuti o nuovi per le acque del Mediterraneo. *Quad. Civ. St. Idrob. Milano*, v. 5, pp. 39-49, Milano.

Taviani M. & Sabelli B. (1982) - *Iphitus*, a deep-water genus new to the Mediterranean sea. *Lavori S.I.M.*, v. 18, pp. 129-131, Napoli.

Taviani M. & Taviani N. (1986) - Remarks on *Coralliophila richardi* (P. Fischer, 1882) (Gastropoda, Prosobranchia). *Boll. Malacologico,* v. 22, pp. 65-72, Milano.

Thunell R.C. & Williams D.F. (1983) - The stepwise development of Pliocene-Pleistocene paleoclimatic and paleoceanographic conditions in the Mediterranean: Oxygen isotopic studies of DSDP Sites 125 and 132. *Utrecht Micropal. Bull.*, v. 30, pp. 111-127, Utrecht.

Vachard D., Barrier P., Montenat C. & Ott d'Estevou P. (1987) - Dykes neptuniens, brèches internes et éboulis cimentés des escarpements de faille du détroit de Messine au Plio-Quaternaire. *Doc. et Trav. IGAL*, v. 11, pp. 127-141, Paris.

Van De Poel L. (1955) - Structure du test et classification des nucules. *Bull. Inst. R. Sc. Nat. Belg.*, v. 11, pp. 1-68, Bruxelles.

Verhecken A. (1986) - *Admete dregeri* valid name for *Babylonella nassiformis*; with notes on *Babylonella* (Neogastropoda: Cancellariidae). *Boll. Malacologico*, v. 22, pp. 245-250, Milano.

Verhecken A. (1997) - Mollusca Gastropoda: Arafura Sea Cancellariidae collected durign the KARUBAR Cruise. In Crosnier A. & Bouchet P. (Eds.) - Résultats des Campagnes MUSORSTOM, 16. *Mém. Mus. natn. Hist. nat.*, v. 172, pp. 295-323, Paris.

Verrill A.E. & Bush K.J. (1898) - Revision of the deep water Mollusca of the Atlantic coast of North America with descriptions of new genera and species. Part I. Bivalvia. *Proc. U.S. Nat. Mus.*, v. 20, pp. 775-901, Washington.

Vazzana A. (1996) - Malacofauna batiale del Pleistocene inferiore del Vallone Catrica (Reggio Calabria, Italia). *Boll. Malacologico*, v. 31, pp. 143-162, Milano.

Violanti D. (1988) - Benthic foraminifera from Lazzaro section (Southern Italy): an attempt of quantitative paleoenvironmental analysis. *Rev. Paléobiol.*, vol. spec. 2, pp. 909-919, Géneve.

Warén A. (1972) - On the systematic position of *Fissurisepta granulata* Jeffreys, 1882 and *Patella laterocompressa* De Rayneval & Ponzi, 1854 (Gastropoda, Prosobranchia). *Sarsia*, v. 51, pp. 17-24, Bergen.

Warén A. (1978) The taxonomy of some North Atlantic species referred to *Ledella* and *Yoldiella* (Bivalvia). *Sarsia*, v. 63, pp. 213- 219, Bergen.

Warén A. (1980) - Marine Mollusca described by John Gwyn Jeffreys, with the location of the type material. *Conch. Soc. Great Britain and Ireland, Spec. Publ.*, 1, pp. 1-60, London.

Warén A. (1981) - *Ledella* Verrill & Bush, 1897 (Mollusca, Bivalvia) proposed designation of type species. *Bull. zool. Nom.*, v. 38, pp. 134-137, London.

Warén A. (1989) - Taxonomic comments on some Protobranch Bivalves from the Northeastern Atlantic. *Sarsia*, v. 74, pp. 223-259, Bergen.

Warén A. (1991) - New and little known Mollusca from Iceland and Scandinavia. *Sarsia*, v. 76, pp. 53-124, Bergen.

Warén A. (1992) - New ad little known "skeneimorph" gastropods from the Mediterranean Sea and the adjacent Atlantic Ocean. *Boll. Malacologico*, v. 27, pp. 149-247, Milano.

Warén A. (1993) - New and little known Mollusca from Iceland and Scandinavia. Part 2. *Sarsia*, v. 78, pp. 159-201, Bergen.

Warén A. & Bouchet P. (1991) - Mollusca Gastropoda: Systematic position and revision of *Haloceras* Dall, 1889 (Caenogastropoda, Haloceratidae fam. nov.). In Crosnier A. & Bouchet P. (Eds.) - Résultats des Campagnes MUSORSTOM, 7, *Mém. Mus. Natn. Hist. Nat., Zool.*, v. 150, pp. 111-161, Paris.

Watson R.B. (1886) - Report on the Scaphopoda and Gastropoda collected by H.M.S. Challenger during the years

1873-76. *Rep. Scient. Res. Voyage H.M.S Challenger, 1873-1876, Zoology*, v. 15, pp. 1-680, London.

Zibrowius H. (1987) - Scléractiniaires et Polichètes Serpulidae des faunes bathyales actuelle et plio-pléistocene de Méditerranée. *Doc. et Trav. IGAL*, v. 11, pp. 255-257, Paris.

Zibrowius H. (1991a) - A propos des Gorgonaires Isididae du Plio-Pléistocene de Méditerranée (Cnidaria: Anthozoa). *Atti Acc. Pelor. Pericolanti (Cl. Sc. Fis. Mat. Nat.)*, v. 67 (1989), Suppl. 1, pp. 159-179, Messina.

Zibrowius H. (1991b) - Gorgonaires Primnoidae bathyaux à croûtes calcaires massives dans le Plio-Pléistocene de la Méditerranée (Cnidaria: Octocorallia). *Atti Acc. Pelor. Pericolanti (Cl. Sc. Fis. Mat. Nat.)*, 67 (1989), Suppl. 1, pp. 473-481, Messina.

Received May 23, 1997; accepted July 23, 1997