

Antonio Bonfitto* Marco Oliverio** Bruno Sabelli*
and Marco Taviani***

A QUATERNARY DEEP-SEA MARINE MOLLUSCAN ASSEMBLAGE
FROM EAST SARDINIA (WESTERN TYRRHENIAN SEA)****

KEY WORDS: Mediterranean, Quaternary, deep-sea molluscs, new records.

Abstract:

Deep-sea dredging off the eastern margin of Sardinia (Tyrrhenian Sea), carried out within the frame of the project *De Profundis*, has yielded important new data on late Quaternary (glacial Pleistocene to Present) deep-sea benthic molluscan fauna of the Mediterranean basin. Here we report on the molluscs from the assemblage recovered at station DP91-4 (ca. 40°43'N-009°54'E, 571-347 m water depth). Overall, the mollusc component comprises 127 taxa mostly represented by empty shells. In fact, only a minor fraction of the total macrobenthos of stn. DP91-4 was found alive, a further confirmation of the poorness of the postglacial Mediterranean deep-sea fauna. We hypothesize that a significant part of the dredged material belongs to pre-Modern assemblages, probably of late Pleistocene (last glacial) age. This assumption is also supported by the occurrence of *Pseudamussium septemradiatum*. Some taxa appears new to the Mediterranean waters. For instance, *Pilus conicus* (Verrill, 1884) and *Dacrydium ockelmanni* Mattson & Warén, 1977, were previously known only for a limited area of the NE Atlantic ocean. They are probably last glacial fossils to be added to the list of 'boreal guests' of the Mediterranean Quaternary. Finally, the assemblage contains a few allochthonous elements clearly of upper shelf provenance (*Bittium reticulatum*, *Cerithidium submamillatum*, *Nassarius reticulatus*).

Riassunto

La recente campagna di dragaggi effettuata dalla N/O *Bannock* sul margine orientale sardo nell'ambito del progetto *De Profundis*, ha comportato l'acquisizione di nuovi dati sulla fauna profonda del Mediterraneo. In questa sede vengono discussi i molluschi provenienti dalla stazione DP91-4 (ca. 40°43'N-009°54'E, profondità m 571-347). In totale sono state raccolte 127 specie, in massima parte conchiglie prive delle parti molli. La frazione vivente del macrobenthos è risultata minima, a ulteriore conferma della scarsità del benthos profondo nel Mediterraneo attuale. Sono stati invece individuati alcuni taxa nuovi per le acque mediterranee. Fra questi *Pilus conicus* (Verrill, 1884) e *Dacrydium ockelmanni* Mattson & Warén, 1977, erano precedentemente noti solo per un limitato settore dell'Atlantico nordorientale. Si ipotizza che appartengano ad associazioni dell'ultima epoca glaciale e che quindi siano da annoverare nella lista degli «ospiti nordici» del Quaternario del Mediterraneo. La presenza di una componente pleistocenica nella stazione DP91-4 è anche suffragata da valve di *Pseudamussium septemradiatum*. Infine è degna di menzione la presenza di specie di bassa profondità che testimoniano l'importanza di fenomeni di trasporto gravitativi nell'area in esame.

* Museo di Zoologia dell'Università di Bologna. Via S. Giacomo 9, I-40126 Bologna, Italy.

** Dipartimento di Biologia Animale e dell'Uomo, Università «La Sapienza». V.le dell'Università 32, I-00185 Roma, Italy.

*** Istituto per la Geologia Marina, Area di Ricerca, C.N.R. Via Gobetti 101, I-40129 Bologna, Italy.

**** Lavoro accettato il 20 giugno 1994.

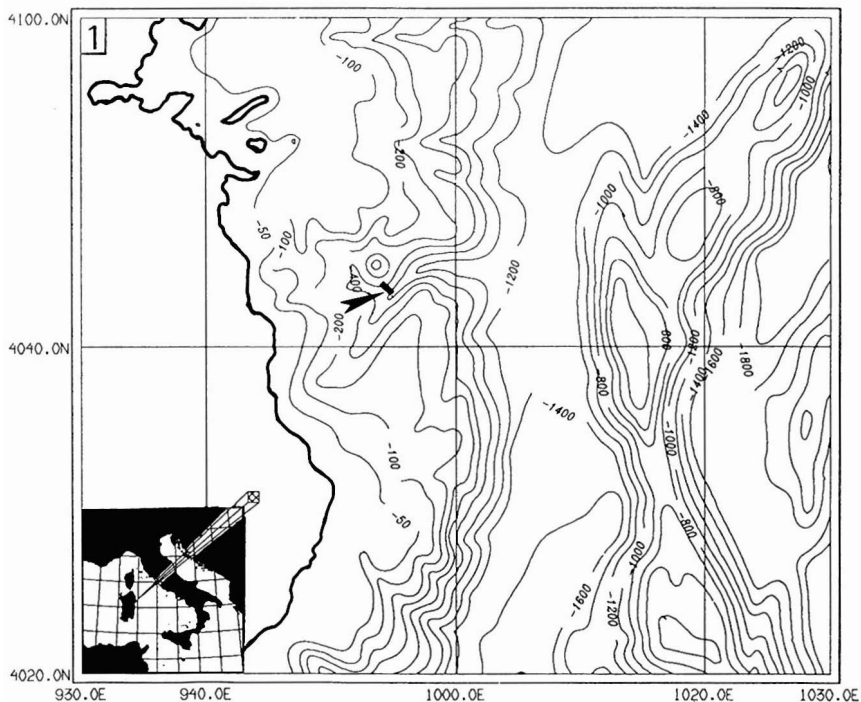


Figure 1 - Location map of station DP91-4. The black bar indicated by the arrow is the dredging path.

Introduction

In the frame of the project *De Profundis* aimed at the understanding of the Pleistocene to Recent evolution of the deep-sea Mediterranean biota, the eastern margin of Sardinia has been selected as a first sampling area. During Cruise DP 91 of *R/V Bannock* extensive dredging has been carried out on the continental slope and bathyal plain East of Sardinia, also including some seamounts (BONFITTO *et al.*, 1994).

Previous information about the molluscan deep-sea fauna of this sector of the western Tyrrhenian Sea is scanty and mostly limited to the description of last glacial assemblages (COLANTONI *et al.*, 1970; DI GERONIMO & LI GIOI, 1980; DI GERONIMO & BELLAGAMBA, 1984). Findings of deep-sea molluscs from the eastern side of Sardinia are reported in numerous short notes (e.g., CECALUPO, 1984, 1985, 1986; BOGI & CANTAGALLI, 1986; BOGI & NOFRONI, 1986).

In this paper, we report on the benthic molluscs found dredging offshore Punta D'Ottiolu, at station DP 91-4 [40° 43.54' Lat. N - 009° 54.58' Long. E-571 m (beginning) / 40° 43.77' - 09° 54.27'-374 m (end), see fig. 1]. Dredging was done by means of a modified epibenthic dredge.

The material is preserved in the malacological collection of the Zoological Museum (University of Bologna, ZMB). Voucher lots have been deposited in the Museum National d'Histoire Naturelle (MNHN, Paris).

Table 1. Molluscs from the tanathocoenosis at strn. DP91-4.

POLYPLACOPHORA

Lepidopleurus sp.
Connexochiton platynomenus Kaas, 1979

GASTROPODA

Addisonia excentrica (Tiberi, 1857)
Pilus conicus (Verrill, 1884)
Emarginula tuberculosa Libassi, 1859
Emarginula multistriata Jeffreys, 1882
Anatoma crispata Fleming, 1828
Anatoma cfr. *umbilicata* (Jeffreys, 1883)
Fissurisepta granulosa Jeffreys, 1883
Orbitestella dariae (Liuuzzi & Stolfa-Zucchi, 1979)
Putzeysia wiseri (Calcara, 1842)
Daniella otaviana (Cantraine, 1835)
Trochidae indet.
Granigyra granulifera Warén, 1992
Bentonella tenella (Jeffreys, 1869)
Alvania cimicoides (Forbes, 1844)
Alvania subsoluta (Aradas, 1847)
Alvania elegantissima (Monterosato, 1875)
Alvania testae (Aradas & Maggiore, 1844)
Pseudosetia cfr. *turgida* (Jeffreys, 1870)
Pusillina sp. A
Pusillina sp. B
Euspira nitida (Donovan, 1804)
Aporrhais serresianus (Michaud, 1828)
Cerithiella metula (Lovén, 1846)
Opalia abbotti (Clench & Turner, 1952)
Melanella sp.1
Melanella sp.2
Haliella stenostoma Jeffreys, 1858
Acis attenuans Jeffreys, 1883
Acis sp.
Bittium sp.
Cerithidium submammatum (De Rayneval, Van den Hecke & Ponzi, 1854)
Amphissa acutecostata (Philippi, 1844)
Fusinus rostratus (Olivi, 1792)
Nassarius lima (Dillwin, 1817)
Nassarius torulosus (Risso, 1826)
Nassarius aff. *cabrierensis italicus* (Mayer, 1876)
Nassarius reticulatus
Tropon echinatus (Kiener, 1840)
Tropon muricatus (Montagu, 1803)
Microdrilia loprestiana (Calcara, 1841)
Taranis moerchi (Malm, 1863)
Pleurotomella packardi Verrill, 1872
Raphitoma pseudohystrix Sykes, 1906
Teretia teres (Reeve, 1844)
Odostomia suboblonga Jeffreys, 1884
Odostomia silesui Nofroni, 1988
Chrysalida brattstroemi Warén, 1990
Chrysalida fenestrata (Jeffreys, 1848)
Chrysalida dollfusi (Kobelt, 1903)
Turbonilla attenuata (Jeffreys, 1884)
Pyramidella minuscula Monterosato, 1880
Eulimella acicula (Philippi, 1836)
Eulimella praelonga (Jeffreys, 1884)
Eulimella superflua (Monterosato, 1875)
Eulimella sp. A
Eulimella sp. B
Eulimella sp. C
Anisocycla sp.
Graphis sp.
Ringicula blanchardi Dautzenberg & Fischer, 1896
Ringicula sp.
Crenilabium exile (Jeffreys, 1870)

Lissacteon sp.

Cylichna cylindracea (Pernant, 1777)
Cylichna sp.
Philine cfr. *scabra* (Mueller, 1784)
Laona sp.
Cylichna nitidula (Loven, 1846)
Roxania cfr. *monterosatoi* Dautzenberg & Fischer 1896
Roxania cfr. *abyssicola* (Dall, 1889)

SCAPHOPODA

Dentalium agile Sars M. in Sars G.O., 1872
Entalina tetragona (Brocchi, 1814)
Cadulus ovulum (Philippi, 1844)
Cadulus jeffreysi (Monterosato, 1875)
Cadulus subfusiformis (Sars M., 1865)
"Scaphopoda" indet.

BIVALVIA

Nucula nitidosa Winckworth, 1930
Nucula sulcata Bronn, 1831
Nuculoma corbuloides Seguenza G., 1877
Nuculoma aegeensis (Forbes, 1844)
Nuculana commutata (Philippi, 1844)
Phaseolus pusillus (Jeffreys, 1879)
Malletia obtusa Sars G.O., 1872 ex Sars M. ms
Yoldia micrometrica Seguenza G., 1877
Yoldiella frigida (Torell, 1859)
Yoldiella lucida (Loven, 1846)
Yoldiella messanensis (Jeffreys, 1870 ex Seguenza G. ms)
Yoldiella sp.
Neilonella striolata (Brugnone, 1877)
Barbatia scabra (Poli, 1795)
Batharca grenophia (Risso, 1826)
Batharca philippiana (Nyst, 1848)
Limopsis cfr. *aurita* (Brocchi, 1814)
Musculus costulatus (Risso, 1826)
Dacrydium hyalinum Monterosato, 1875
Dacrydium ockelmanni Mattson & Warén, 1977
Modiolula phaseolina (Philippi, 1844)
Aequipecten opercularis (Linné, 1758)
Cyclopecten hoskynsi (Forbes, 1844)
Propeamussium fenestratum (Forbes, 1844)
Pseudamussium septemradiatum (Mueller O.F., 1776)
Spondylus gussoni Costa O.G., 1829
Pododesmus cfr. *squamula* (Linné, 1758)
Acesta excavata (Fabricius J.C., 1779)
Limatula subauriculata (Montagu, 1808)
Linea crassa (Forbes, 1844)
Lucinoma boreale (Linné, 1767)
Thyasira alieni Carozza, 1961
Thyasira flexuosa (Montagui, 1809)
Axinulus croulinensis (Jeffreys, 1847)
Leptaxinus ferruginosus (Forbes, 1844)
Tellimya ferruginosa (Montagui, 1808)
Neolepton sulcatulum (Jeffreys, 1859)
Astarte sulcata (Da Costa, 1778)
Parvicardium minimum (Philippi, 1836)
Parvicardium ovale (Sowerby G.B.II, 1840)
Tellina donacina Linné, 1758
Abra nitida (Mueller O.F., 1776)
Abra longicallus (Scacchi, 1834)
Kellicella abyssicola (Forbes, 1844)
Hiatella arctica (Linné, 1767)
Saxicavella jeffreysi Winckworth, 1930
Pholadomya loveni Jeffreys, 1882
Cuspidaria rostrata (Spengler, 1793)
Cochlodesma cfr. *tenerum* (Fischer P., 1882)
Cardiomya costellata (Deshayes, 1835)

Results

The dredge recovered about 0.1 m³ of muddy sediment together with numerous slabs of porous limestone (see Allouc, 1990 for a comprehensive view about the origin of such crusts). Biogenic content is very high and includes numerous shells of benthic and pelagic molluscs (thecosomata pteropods and heteropods), scleractinian corals and brachiopods. Some slabs are heavily encrusted by epibenthic forms (corals, serpulids and bivalves) and are often patined and blackened by Mn-Fe oxides. Only a few organisms were found alive (see below). Occasionally, shells of vagrant benthic molluscs are encased within the CaCO₃ cemented muddy matrix.

The quasi-totality of our molluscan material is represented by empty tests in various state of preservation ranging from very fresh to worn, broken, encrusted and patined shells. Although the fauna (Table 1) is by large constituted by deep-sea organisms, we have observed the presence of some allochthonous shells recycled from the shelf, namely *Cerithidium submamillatum*, *Bittium* sp. and *Nassarius reticulatus*.

Living organisms represent only a minor fraction of the total recovery and belong to Annelida (Polychaeta), Sipuncula, Crustacea (FROGLIA & BONFITTO in prep.), Cnidaria (Hydrozoa), Echinodermata (Asteroidea and Echinoidea) and Mollusca (Caudofoveata, Gastropoda and Bivalvia). The molluscs found either alive or dead but with the soft parts are:

Falcidens sp.

Putzeysia wiseri (Calcara, 1842)

Alvania elegantissima (Monterosato, 1875)

Alvania subsoluta (Aradas, 1847)

Opalia abbotti Clench & Turner, 1952

Dentalium agile Sars M. in Sars G.O., 1872

Bathyarca grenophia (Risso, 1826)

Barbatia scabra (Poli, 1795)

Musculus costulatus (Risso, 1826)

Dacrydium hyalinum Monterosato, 1875

Spondylus gussonii Costa O.G., 1829

Cochlodesma tenerum (Fischer P., 1882)

As expected the fauna as a whole is typical of deep-sea soft muddy bottoms but the presence of the firm substratum of the calcareous crusts allows for such organisms as *S. gussonii*. *O. abbotti* was found crawling on one of the slabs, but its obligatory association to hard substrata is not certain. For a few noteworthy species we report some remarks below.

Connexochiton platynomenus Kaas, 1979

Material: some intermediate plates

Remarks: KAAS & VAN BELLE (1990) discussed the synonymy of *B. biondii* Dell'Angelo & Palazzi, 1988 with *C. platynomenus* Kaas (and the correlated synonymy of the families Bathychitonidae and Leptochitonidae). Recently, DELL'ANGELO & PALAZZI (1994) accepted conservatively such synonymy, but remarked the doubts still standing.

***Addisonia excentrica* (Tiberi, 1857)**

(Figs. 2, 3)

Material: 1 shell (juvenile)

Remarks: juvenile shells of this species are frequently recovered in sediments from the Tuscan Archipelago, and present some difficulties of identification. The protoconch is always lacking as in other Lepetelloid archaeogastropods. A revision of the Mediterranean species of *Cocculiniformia*, with notes on their anatomy and a key of the Mediterranean species is presently carried out by HASZPRUNAR *et al.* (in prep.) and we refer to that work and to LUQUE & DANTART (in press, with details on nomenclature) for further details on this species.

***Pilus conicus* (Verril, 1884)**

(Figs. 4-6)

Material: 1 shell

Remarks: *Cocculina conica* Verril 1884 has been recently redescribed (the type material is destroyed) by WARÉN (1991) who proposed a new monotypic genus for this small *Capulus*-shaped species [we assume that *Pilus* is intended as masculine]. The protoconch of about half a whorl has a diameter of 0.21 mm and an expansion immediately before the aperture. The sculpture of the larval shell consists of small pits arranged to give a somewhat reticulate pattern. They remain only in a partially protected area of the protoconch of our specimen, and in our opinion are not caused by corrosion. Dimension, length 0.92 mm width 0.72 mm and we agree with Warén that such specimens are very unlikely to be juveniles. External morphology, radula and anatomy are still unknown thus a definitive familial attribution is at present difficult. We are anyway confident of a relationship with (if not a classification in) the Pseudococculinidae basing on protoconch features. More recently, WARÉN (1993) indicated a possible relationship with the Bathysciadiidae on the basis of similar pattern observed in the protoconchs (hitherto unknown) of *Xenodonta* and *Bathysciadium*. The species was originally described from Northeastern United States, and Warén added Southwestern Iceland in Atlantic; the present record of *Pilus* is thus the first one for the Mediterranean Sea. Our single shell is very well preserved but is probably a Pleistocene (glacial) fossil. Depth range is from 300-500 m to 900-1500 m basing on Warén's and our own data.

***Orbitestella dariae* (Liuzzi & Stolfa-Zucchi, 1979)**

(Figs. 7-11)

Material: 1 shell

Remarks: since its original publication, this minute species has been only seldom reported in the literature. A possible relationship with Orbitestellidae has been suggested by PONDER (1990). General shell features (Figs. 7, 8) agree in part with such an interpretation, addressing to

Orbitestella-like species. Anyway, similarities can be scored also with the archaeogastropod *Cyclostremiscus/Pachystremiscus* groups. Protoconch features (Figs. 9-11) confirm Ponder's suggestion. The protoconch is paucispiral but clearly heterostrophic (Fig. 11). We use the genus *Orbitestella* in a wide sense, until anatomical data on this group will not be available. A certain degree of variation in the dimensions (diameters and number of whorls) of the protoconch has been observed in the material available (comp. figs. 9-11); it should be studied perhaps morphometrically, to define whether there is intraspecific variation or cryptic species are involved. A single specimen with the soft parts partly decayed and dried have been sorted out off the Latium coasts, at -200/400 m depth, together with several shells (OLIVERIO & VILLA, 1982). Regrettably, the specimen was destroyed during unsuccessful search for the radula. This record witnesses for the belonging of *O. dariae* to the Recent fauna of the Mediterranean Sea. *O. dariae* is a deep water species, always found below 80-100 m down to many hundreds meters of depth all over its range. The original record by Liuzzi and Stolfa Zucchi from a very shallow depth of the upper Adriatic sea is suspect and has never been confirmed again. We consider very likely a contamination of their Adriatic samples with deep-sea material.

***Melanella* sp. 1**

(Fig. 12)

Material: 2 shells + fragments

Remarks: our specimens do not fit perfectly any NE Atlantic (see BOUCHET & WARÉN, 1986). The sole known taxon to which we can compare our shells is *Eulima halorhaphae* Dautzenberg & Fischer, 1896. The original figure and that by DAUTZENBERG (1927; see also BOUCHET & WARÉN, 1986: 356 fig. 840) represent the holotype, which is said to be lost. It closely resembles our material except for the aperture that is smaller and the curvature of the shell that is more pronounced in our specimens. Another species (*Melanella* sp. 2: Figs. 13, 14) similar to the present one still wants a correct identification.

***Aclis* sp.**

(Figs. 15, 16)

Material: 1 shell

Description: shell solid, tall, conical and perforated consisting of 1.5 whorls of protoconch and 2.75 whorls of teleoconch. Protoconch smooth, dome-shaped, of 1.5 whorls. Teleoconch with strong spiral cords, whose number increases with age (from two on the first whorl to five on the body whorl). A microsculpture of very fine spiral striae is present. Suture impressed. Outer lip broken but according to incremental scars appears to be slightly opisthoclyne. Umbilical chink evident. Colour ivory white.

Remarks: our only shell, probably subfossil, belongs to a slightly immature specimen. Protoconch morphology addresses clearly to a non-plaktotrophic larval development. Teleoconch ornamentation strongly recalls the sculpture of other NE Atlantic species, i.e., *A. minor* (Brown, 1827)

and *A. ascaris* (Turton, 1819) which, however, develop a by planktrophic larva, and *A. verduini* Aartsen, Menkhorst & Gittermberger, 1984 which is more cylindrical and smaller in size. This species is known from Western Mediterranean from slightly shallower environment (continental shelf sediments) and from the Western African coasts. Investigations on its taxonomic position are in progress (OLIVERIO & NOFRONI, in prep.).

***Nassarius* aff. *cabrierensis italicus* (Mayer, 1876)**

(Fig. 17)

Material: 1 shell

Remarks: our only shell, not fully adult, shows a reticulate sculpture on its teleoconch which is similar to that of the early whorls of *N. macrodon recidivus* (von Martens, 1876). The available iconography of the Recent species of the *N. semistriatus*-complex (see e.g. NOFRONI, 1986; POPPE & GOTO, 1990) does not include any form similar to our shell. A similar teleoconch pattern, however, is shared with a common deep-sea European Neogene taxon, namely *N. cabrierensis italicus* (Mayer, 1876). This taxon, abundant in the Mediterranean Pliocene, is usually considered to be extinct since the Lower Pleistocene. ADAM & GLIBERT (1974) regard it as a chronological subspecies linked to the Miocene-Recent *N. cabrierensis* (Fischer & Tournouer, 1873) lineage. Other Authors maintain its distinct specific status (e.g. CAVALLO & REPETTO, 1992). In the present state of the art, lacking a comprehensive revision of the *N. semistriatus*-complex, we prefer to adhere to the Adam & Glibert's interpretation. Our specimen recalls some of the forms with stronger sculpture (see e.g. ADAM & GLIBERT, 1974: pl. 3, fig. 7).

N. c. italicus is considered extinct in the Sicilian, and its record at stn. DP91-4 raises a chronological problem. We do not believe our sampling has recovered material older than 75.000-10.000 years B.P. Therefore, we consider likely that the present shell belongs to a last glacial community. If our identification is correct, this taxon (*italicus*) results having a wider stratigraphical distribution, that previously supposed.

***Nassarius torulosus* (Risso, 1826)**

(Fig. 18)

Material: 4 shells + some fragments

Remarks: the present species belongs to the complex of *Nassarius semistriatus* (Brocchi, 1814) whose phylogeny and taxonomy still wait to be satisfactorily worked out. Late Pleistocene to Recent Mediterranean shells with spiral lines over the entire body whorl, are generally referred to as *N. cabrierensis ovoideus* (Locard, 1896) (NOFRONI, 1986; SABELLI *et al.*, 1990-92). Nearly all such materials (including our shells) reveal a protoconch witnessing a non-planktrophic development, differently from their Neogene-early Pleistocene relatives generally ascribed to *N. cabrierensis* s.s. The poor knowledge of the entire group suggests caution before taking as definitive the above classification of our shells.

***Chrysalida brattstroemi* Warén, 1990**

Material: 1 shell

Remarks: this species, described after material from Norway and also known from the Mediterranean, has a wide stratigraphical range, having been recorded from the Italian Pleistocene (MICALI *et al.*, 1993).

***Ringicula* sp.**

(Fig. 19)

Material: 1 shell

Description: shell ovate-globular with the surface sculptured by spiral lines, finely and regularly impressed, nearly equidistant in the middle of the body whorl. In the superior fifth of the body whorl they seem to be more spaced, and at the base the interspaces appear more irregular. The spire is conical and short. The 4.5 whorls are convex, and grow very rapidly. The last whorl is globose and large, more than twice the spire. The aperture is large, with the peristome regularly rounded, and with a weak sinus posteriorly. The outer lip is moderately tickened. The columellar calus is thin and does not extend over the body whorl. Two strong, nearly equal, columellar ridges are present.

Remarks: it differs from *R. leptocheila* Brugnone 1873 being less elongated, more globose, and bearing an evident posterior sinus. Such sinus breaks the regular curvature of the lip that appears nearly straight at the middle of its height and bends, gradually but evidently, towards the columella.

***Pirunculus* sp.**

(Fig. 25)

Material: many shells

Remarks: our shells have some similarities to *Pirunculus obesusculus* (Brugnone, 1877) described as fossil from the 'Pliocene' (most probably Pleistocene) of Messina and as Recent from the Atlantic.

***Roxania* cfr. *monterosatoi* Dautzenberg & Fischer, 1896**

(Figs. 23, 24)

Material: 1 shell

Remarks: we are very uncertain about the exact taxonomic position of this shell. It is characterised by the rounded shape and the weak spiral sculpture. However, both characters are possibly a consequence of the poor preservation state of the shell which is very worn and decorticated. A good clue for its identification is the lack of an umbilical chink. Another Cephalaspidea, more commonly encountered also at stn. DP91-4 (Figs. 26, 27) may prove to belong to *Roxania abyssicola* (Dall, 1889), according to the figure given by BOUCHET (1975). Our specimens have a clear spiral pitted sculpture and an evident umbilical chink.

***Bathyarca grenophia* (Risso, 1826)**

(Fig. 36)

Material: 10 left and 6 right valves

Remarks: compared with the typical morphology of *B. grenophia*, some of the specimens recovered have the anterior limb teeth parallel to the margin and larger in size, whilst the posterior ones are not parallel to the margin; in *B. grenophia* both series of teeth are equal in size and disposition (not parallel). Moreover, these specimens are slightly elongated along their ventral margin. Such characters are usually found in *B. frielei* Jeffreys in Friele, 1879, a species that has been long considered as a synonym of *B. grenophia* (= *pectunculooides* Scacchi, 1834). BOUCHET & WARÉN (1979) regard them as different species. The two species are characterised by a different morphology of the anterior teeth: typically crenulated in *grenophia*, smooth in *frielei*. The teeth parallel to the margin, typical in adult *frielei*, are a juvenile feature in *grenophia* (WARÉN, pers. comm.). The presence of sibling (cryptic) species in the *grenophia* group is still to be verified, as well as the presence of *frielei* in the Mediterranean Sea, presently based on the record of PANETTA (1971) from the gulf of Taranto.

***Dacrydium ockelmanni* Mattson & Warén, 1977**

(Figs. 31, 32)

Material: 1 left valve and two fragments with limb

Remarks: this species has never been recorded before for the Mediterranean Sea. We are unable (and not very prone) to assign this species to the living fauna of the Mediterranean. The Recent distribution seems to be restricted to the northernmost latitudes of the NE Atlantic (MATTSON & WARÉN, 1977; WARÉN, 1991).

***Thyasira alleni* Carrozza, 1981**

(Fig. 37)

Material: 1 left valve

Remarks: this species is also known from the NE Atlantic outside the Mediterranean. From the Mediterranean it was known only from the type locality (CARROZZA, 1981), close to stn. DP 91/4.

***Laevicordia* sp.**

(Figs. 33, 35)

Material: 1 valve

Remarks: our single valve belonged to a young specimen, and is very similar to that figured by DI GERONIMO & BELLAGAMBA (1984: as *L. gemma*). We would stress here that young forms of Verticordiidae offer serious identification problems, and several nomenclatorial problems follow this. Especially, the high degree of morphological variation has been remarked by BOUCHET & WARÉN (1979a) while suspecting that *L. gemma* is a young

stage of *Polycordia cordata* Verrill & Bush, 1988 and somehow related to *P. jeffreysi* (Friele, 1879). Young stages of the latter as figured in BOUCHET & WARÉN (1979a), display a remarkable degree of similarity to our specimen. It anyway bears some differences: the radial riblets are lesser in number (8-9), and there are wider spaces between them; the ventral margin is symmetrically angled with respect to the umbo (we stress here the variability with the age in *P. jeffreysi*). The ribs develop on two thirds of the valve, whilst the proximal part shows a close net of pores of 0.7 to 1 μm in diameter. The latter feature is not reported for any of the other species.

***Cochlodesma tenerum* (Fischer P., 1882)**

(Fig. 38)

Material: 1 specimen

description: shell fragile, globose, inaequilateral, inaequivalve, with the umbo slightly posterior. Anterior margin curved, the posterior rostrated and trunked; the ventral margin, curved anteriorly and tapering posteriorly, develops maximally before the umbo. The periostracum is tawny, more evident on the posterior margin area. Sinupalleated, with the sinum curved and entirely comprised in the part of the shell posterior to the umbo. Ligament internal, with a well developed, spatuliform, quadrangular and hollow condrophore. The sculpture consists of concentric growth lines, more evident along the ventral edge and on the posterior margin, where they appear to be more raised.

Dimensions, 13 mm length.

Remarks: *C. tenerum* and *C. praetenua* (Pulteney, 1799) have been reported several times for the Mediterranean Sea, but never with documented material (either shells or live specimens). This is therefore, the first documented record of this genus as living in the Mediterranean.

Concluding remarks

Since the beginning, a couple of decades ago, of an indepth systematic screening of the Mediterranean deep-sea fauna we have assisted to a steady increment of the number of molluscs to be added to the Quaternary (late Pleistocene to Recent) fauna of this basin (BOUCHET & TAVIANI, 1989; 1992 with references therein). Records are mostly represented by empty shells of East Atlantic taxa. The mollusc fauna described in this paper is no exception in being mostly represented by a dead mollusc assemblage which also contains fossil shells of probable last glacial age, namely *Pseudamussium septemradiatum* and *Acesta excavata* (e.g., COLANTONI *et al.*, 1970; TAVIANI & COLANTONI, 1979). In particular, judging from their present-day distribution, two species may be, to the best of our knowledge, considered as likely extinct in the Mediterranean, i.e., *Dacrydium ockelmanni* and *Pilus conicus*. These species can thus be added to the list of «boreal guests» which settled the Mediterranean deep waters at the time when global colder conditions favoured the southwards shift of many north-atlantic taxa (e.g. RAFFI, 1986; TAVIANI *et al.*, 1992).

From the study of the mollusc assemblage dredged at stn. DP 91/4 the following conclusions can be drawn:

- 1) a conspicuous fraction of the recovered fauna is represented by dead material, part of which is certainly attributable to a (last) glacial assemblage: living molluscs represent a quantitatively and qualitatively minor component of the entire catch. Among them, *Cochlodesma tenerum* is here recorded for the first time as living in the Mediterranean;
- 2) two species (empty shells) are reported for the first time for the Mediterranean basin, i.e., *Pilus conicus* and *Dacrydium ocklemanni*; their prevalent boreal present distribution in the Atlantic ocean supports the hypothesis that these species are (last) glacial fossils and their extinction within the Mediterranean is likely.

Once more, the deep relationship of the Mediterranean deep-sea molluscan assemblages with the Atlantic fauna, is confirmed, for both the fossil (richer) and the Recent (scanty) components.

Acknowledgements

We thank Captain, Officers and Crew aboard *R/V Bannock* during cruise DP 91. S. Gofas, I. Fellegara and N. Taviani are gratefully acknowledged for scientific and technical cooperation. The epibenthic dredge has been modified by M. Bigazzi. G. Bortoluzzi and D. Penitenti prepared the location map. A. Warén is gratefully acknowledged for critical suggestions on some taxa. Work partly supported by MURST (40%) funds. This is IGM scientific contribution n. 974.

REFERENCES

- ADAM W. & M. GLIBERT, 1974 - Contribution a la connaissance de *Nassarius semistriatus* (Brocchi, 1814) (Mollusca: Gastropoda). *Bull. Inst. r. Sci. nat. Belg., Biologie*, **50** (3): 1-78.
- ALLOUC J., 1990 - Quaternary crusts on slopes of the Mediterranean Sea: A tentative explanation for their genesis. *Marine Geology*, **94** (1990): 205-238.
- BELLAGAMBA M., 1986 - La malacofauna del dragaggio BS 77-8 (Bacino della Sardegna - Area nord-occidentale). *Lavori Società Italiana di Malacologia*, **22**: 209-226.
- BOGI C. & G. CANTAGALLI, 1986 - First record of *Poromya neaeroides* Seguenza, 1877 in the Mediterranean. *La Conchiglia*, **202/203**: 18-19.
- BOGI C. & I. NOFRONI, 1986 - Su alcuni micromolluschi mediterranei rari o poco noti. *Bollettino Malacologico*, **22** (5-8): 153-160.
- BONFITTO A., M. BIGAZZI, I. FELLEGARA, S. GOFAS, R. IMPICCINI, M. OLIVERIO, M. TAVIANI & N. TAVIANI, 1994 - Crociera DP91 sul margine orientale sardo: Rapporto tecnico-scientifico. *Bollettino Malacologico*, **30** (5-9): 129-140.
- BOUCHET P., 1975 - Opisthobranches de profondeur de l'Océan Atlantique: 1 - Cephalaspidea. *Cahiers de Biologie Marine*, **16**: 317-365.
- BOUCHET P. & M. TAVIANI, 1989 - Atlantic deep-sea gastropods in the Mediterranean: new findings. *Bollettino Malacologico*, **25** (5-8): 137-148.
- BOUCHET P. & M. TAVIANI, 1992 - The Mediterranean deep-sea fauna: pseudopopulations of Atlantic species? *Deep-Sea Research*, **39** (2): 169-184.

- BOUCHET P. & A. WARÉN, 1979 - The abyssal molluscan fauna of the Norwegian Sea and its relation to other faunas. *Sarsia*, **64** (3): 211-243.
- BOUCHET P. & A. WARÉN, 1986 - Revision of the northeast Atlantic bathyal and abyssal Aclidiidae, Eulimidae, Epitoniidae. *Bollettino Malacologico*, suppl. 2: 297-576.
- CARPINE C., 1970 - Ecologie de l'étage bathyal dans la Méditerranée occidentale. *Mémoires Institut Océanographique Monaco*, **2**: 1-146.
- CARROZZA F., 1981 - *Thyasira alleni* n. sp. *Bollettino Malacologico*, **17**: 223-228.
- CAVALLO O. & G. REPETTO, 1992. Conchiglie fossili del Roero. Atlante iconografico. Ass. Natur. Piemontese. Memorie Vol. 2, Amici del Museo «Federico Eusebio», 251 pp.
- CECALUPO A., 1984 - Rinvenimento di specie rare al largo della Sardegna sud-orientale (contributo I). *Bollettino Malacologico*, **20**: 109-112.
- CECALUPO A., 1985 - Rinvenimento di specie rare al largo della Sardegna sud-orientale (contributo II). *Bollettino Malacologico*, **21**: 37-40.
- CECALUPO A., 1986 - Rinvenimento di specie rare al largo della Sardegna sud-orientale (contributo III). *Bollettino Malacologico*, **22**: 261-266.
- COLANTONI P., A. PADOVANI & R. TAMPIERI, 1970 - XI. Molluschi. *Giornale di Geologia*, (2) **37** (1): 163-188.
- DAUTZENBERG P., 1927. Mollusques provenant des campagnes scientifiques du Prince Albert 1er de Monaco dans l'Océan Atlantique et dans le golfe de Gascogne. *Résultats des campagnes scientifiques ... Albert 1er*, **72**: 1-401.
- DELL'ANGELO B. & S. PALAZZI, 1994. Prima segnalazione di *Connexochiton platynomenus* Kaas, 1979 nel Pleistocene calabro. *Bollettino Malacologico*, **29**: 233-236.
- DI GERONIMO I. & M. BELLAGAMBA, 1984 - Malacofauna dei dragaggi BS 77-1 e BS 77-2 (Sardegna nord-orientale). *Bollettino Società Paleontologica Italiana*, **24** (2-3): 111-129.
- DI GERONIMO I. & R. LI GIOI, 1980 - La malacofauna wurmiana della stz. BS 77/4 al largo di Capo Coda Cavallo (Sardegna nord-orientale). *Annali Università Ferrara*, (N.S.), Sez. 9 (Sc. geol. paleont.), suppl. **6**: 123-162.
- MATTSON S. & A. WARÉN, 1977. *Dacrydium ockelmanni* sp. n. (Bivalvia, Mytilidae) from western Norway. *Sarsia*, **63**: 1-6.
- MICALI P., I. NOFRONI & J.J. AARTSEN VAN, 1993 - Addition to the knowledge of the European *Chrysalidia* species, with notes on a recent work by Van der Linden & Eikenboom (Gastropoda, Opisthobranchia). *Basteria*, **57**: 147-154.
- NOFRONI I. & M. SILESU, 1986 - Molluschi rari della Sardegna meridionale. *La Conchiglia*, **202/203**: 6-7.
- NOFRONI I. & M. SCIUBBA, 1985 - Prima segnalazione di *Adeuomphalus ammoniformis* Seguenza, 1876, in Mar Mediterraneo. *La Conchiglia*, **190/191**: 22-23.
- NOFRONI I., 1986. Synoptic tables of Mediterranean and European conchology, fam. Nassariidae. Part. I. *La Conchiglia*, **208-209**: 20-21.
- OLIVERIO M. & R. VILLA, 1982 - Contributo alla conoscenza dei molluschi conchiferi dei fondali sublittorali del Lazio. 1) Reperti dei pescherecci di Fiumicino. *Notiziario CISMIA*, Roma **III** (1-2): 33-44.
- PANETTA P., 1971. Molluschi interessanti e nuovi del Golfo di Taranto raccolti durante la crociera della motobarca «Albatross». *Atti Società Italiana Scienze Naturali - Museo Civico St. Naturale. Milano*, **112** (3): 409-412.
- PONDER W.F., 1990. The anatomy and relationships of the Orbitestellidae (Gastropoda: Heterobranchia). *Journal of Molluscan Studies*, **56**: 515-532.
- POPPE T.G. & Y. GOTO, 1991. European Seashells. Vol. 1, Verlag Christa Hemmen, Wiesbaden, 352 pp.
- RAFFI S., 1986 - The significance of marine boreal mollusks in the early Pleistocene faunas of the Mediterranean area. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **52**: 267-289.

- SABELLI B., R. GIANNUZZI-SAVELLI & D. BEDULLI, 1990-1992. *Annotated Check-list of Mediterranean marine mollusks*. Vols. 1-3. Libreria Naturalistica Bolognese, Bologna.
- TAVIANI M., P. BOUCHET, B. METIVIER, M. FONTUGNE & G. DELIBRIAS, 1991. Intermediate steps of southward faunal shifts testified by last glacial submerged thanatocoenoses in the Atlantic Ocean. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **86**: 331-338.
- TAVIANI M. & P. COLANTONI, 1979 - Thanatocoenoses wurmiennes associées aux Coraux blancs. *Rapp. Comm. int. Mer Médit.*, **25/26** (4): 141-142.
- TAVIANI M. & P. COLANTONI, 1984 - Paleobiocoenoses profondes à Scléractiniaires sur l'escarpement de Malte-Siracuse (Mer Méditerranée): leur structure, leur age et leur signification. *Rev. Inst. Fr. Pétrole*, **39** (5): 547-559.
- WARÉN A., 1980 - Marine Mollusca described by John Gwyn Jeffreys, with the location of type material. *Conchological Society of Great Britain and Ireland. Special Publication* 1; 1-60.
- WARÉN A., 1991 - New and little known mollusca from Iceland and Scandinavia. *Sarsia* **76**: 53-124.
- WARÉN A., 1993 - New and little known mollusca from Iceland and Scandinavia. Part. 2. *Sarsia* **78**: 159-201.
-

Figure Captions

Figure 1 - Location map of station DP91-4. The black bar indicated by the arrow is the dredging path.

Figures 2-11 - 2, 3. *Addisonia excentrica* juv. (3. Particular of the apical area). 4-6. *Pilus conicus* (5, 6. Protoconch). 7-11. *Orbitestella dariae* (7-9. DP91-4; 10, 11. Latium -500 m depth). Scale bars: 1 mm (2), 500 μ m (3, 4, 7, 8), 100 μ m (9-11).

Figures 12-22 - 12. *Melanella* sp. 1. 13, 14. *Melanella* sp. 2 15, 16. *Aclis* sp. (16. Protoconch). 17. *Nassarius* aff. *cabrierensis italicus*. 18. *N. torulosus*. 19. *Ringicula* sp. 20. *Odostomia silesui*. 21. *O. sp.* 22. *O. suboblonga*. Scale bars: 4 mm (17, 18), 1 mm (12-15, 19-22), 500 μ m (16).

Figures 23-30. 23, 24. *Roxania* cfr. *monterosatoi*. 25. *Pirunculus* sp. 26, 27. *Roxania* cfr. *abyssicola*. 28. *Philine scabra*. 29-30. *Laona finmarchica*. Scale bars: 2 mm (23, 24, 26-30), 1 mm (25).

Figures 31-38. 31, 32. *Dacrydium ockelmanni* (32. Particular of the hinge area). 33-35. *Laevicordia* sp. (34, 35. Particulars of the sculpture). 36. *Bathyarca grenophia*. 37. *Thyasira alleni*. 38. *Cochlodesma tenerum*. Scale bars: 500 μ m (31, 32, 33), 200 μ m (36, 17), 100 μ m (34, 35).

