

## MOLLUSCAN ASSEMBLAGES IN A HIGHLY VARIABLE SETTING IN LITTORAL BOTTOMS OF THE LOWER PLEISTOCENE OF RHODES (GREECE)

Koskeridou E.<sup>1</sup>, Thivaïou D.<sup>1</sup> and Giamali Ch.<sup>1</sup>

<sup>1</sup> National and Kapodistrian University of Athens, Faculty of Geology and Geoenvironment, Department of Hist. Geology - Paleontology, [ekosker@geol.uoa.gr](mailto:ekosker@geol.uoa.gr), [dthivaïou@geol.uoa.gr](mailto:dthivaïou@geol.uoa.gr), [gchristi@geol.uoa.gr](mailto:gchristi@geol.uoa.gr)

### Abstract

*Highly diverse and well preserved marine mollusc associations from a sandy horizon of the Lower Pleistocene shallow water deposits of Rhodes island are here presented. Four significantly different molluscan assemblages characterize neighboring environments and document a variety of niches provided by the lateral change of bottom type. Molluscs of hard substrate to sandy seabed of the Infralittoral Zone were documented. A total of 55 molluscan species were identified. Gastropods dominate with 29 species. For the first time, the *Ervilia castanea* assemblage is described for the Lower Pleistocene of Greece.*

**Keywords:** Molluscs, Lower Pleistocene, Rhodes, Greece.

### Περίληψη

*Στην εργασία αυτή μελετήθηκε η πλούσια και καλά διατηρημένη πανίδα μαλακίων που περιέχεται σε αμμώδες στρώμα ρηχών θαλάσσιων αποθέσεων του Κατωτέρου Πλειστοκαίνου της νήσου Ρόδου. Πιστοποιήθηκαν 4 διαφορετικές συγκεντρώσεις μαλακίων γειτονικών περιβαλλόντων καθώς και οι οικολογικές τους φωλεές οι οποίες καθορίζονται από την πλευρική μεταβολή του τύπου του υποστρώματος. Αναγνωρίστηκαν αντιπρόσωποι μαλακίων σκληρού υποστρώματος έως και αμμώδους βυθού της παράκτιας ζώνης. Προσδιορίστηκαν 55 είδη μαλακίων εκ των οποίων 29 είδη γαστερόποδων. Πιστοποιήθηκε η παρουσία της *Ervilia castanea* και της αντιπροσωπευτικής φάσης της στο Κατώτερο Πλειστόκαινο της Ελλάδας για πρώτη φορά.*

**Λέξεις κλειδιά:** Μαλάκια, Κατώτερο Πειστόκαινο, Ρόδος, Ελλάδα.

### 1. Introduction

Rocky bottoms often neighbor soft-bottom sandy areas in the sea. These two habitat types support very different communities of plants and animals. Fossil organisms of high-energy shallow water marine environments characterized by siliciclastic sedimentation are usually uncommon because of the transportation by bottom currents, the fragmentation and dissolution of their skeletons. On the contrary, fossil shallow marine hard bottoms provide an exception as they constitute stable substrates where rich fauna is developed. A good example of this are the Gelasian drowned beachrock beds of northeastern part of Rhodes island which have been studied by Moissette et al.

(2013). These beds served as a zone of carbonate production and accumulation within a siliciclastic-dominated otherwise poor populated environment.

*The Ervilia castanea* (Montagu, 1803) facies characterizes wave exposed beaches from the Atlantic and the Mediterranean Sea has been studied and/or referred to by many authors (e.g. Morton et al. 1998, Zenetos et al. 2005). This facies is also one of the most representative siliciclastic facies in the deposits of Kritika member of Rhodes island.

In this study, highly diverse and well preserved marine mollusc associations accumulated in these deposits of the Lower Pleistocene have been recovered.

The main objectives of this paper are to compare the results obtained from the molluscs of the sandy bed from the Lower Pleistocene of Rhodes with those reported from the present-day Mediterranean and use this information to reconstruct the paleoenvironment and depositional conditions

## **2. Geology**

The island of Rhodes is located at the easternmost part of the Hellenic sedimentary fore-arc, which resulted from the Cenozoic subduction of the African Plate under the Aegean-Anatolian Block (Fig.1). The Pliocene-Pleistocene sediments encountered at the northeastern part of the island provide basinal to littoral fossiliferous deposits that are well exposed in steep palaeovalleys cutting through the Hellenic Mesozoic basement (Meulenkamp et al. 1972, Pirazzoli et al. 1989, Hanken et al. 1996). This basement is mainly carbonated calcareous and it was faulted in different directions. Thus occur the numerous steep horsts and grabens that later defined the deposits of this age as far as their nature and geographical distribution is concerned (Mutti et al. 1970). The embayments of the Lower Pleistocene (Gelacian) formed the depositional environment of the Kritika Member of Rhodes Formation (Cornée et al., 2006). This age is given according to the recent redefinition of the Pleistocene (now including the Gelasian Stage/Age as its lowermost unit, (Gibbard & Head, 2010)). It is composed of pebbles, gravels, sands and clays of estuarine to marine terrigenous origin. These beds are fossiliferous thus preserving a diverse range of taxa that correspond to fossil assemblages belonging to precise environments (paralic, nearshore).

The present study focuses on sandy beds of one outcrop of the Kritika Member (Rhodes Formation) which is composed predominantly of siliciclastic deposits intercalated with hard bottom levels formed by the drowning of former beachrock beds (Cornée et al., 2006; Moissette et al., 2013).

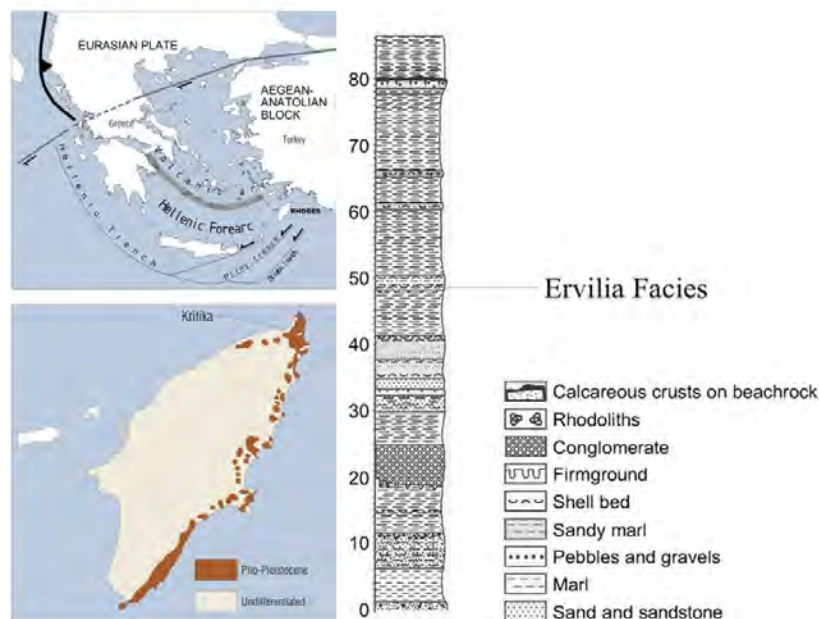
## **3. Materials and Methods**

Molluscan faunas were examined in one representative sample recovered from the studied succession (Fig. 1). The field observations included considerations of shell orientation, disarticulation, fragmentation and encrustations to distinguish whether or not the shells had been transported before final deposition. The benthic fauna was separated from the terrigenous fraction using a 0.5 mm sieve for molluscs and a 0.062 mm sieve for foraminifera. The molluscs, encountered within the >0.5 µm size fraction were classified to species level, using the descriptions based on numerous works by molluscan researchers. Then, they were semi qualitatively analyzed and an estimation of the number of specimens of each species was made.

Palaeoecological and palaeoenvironmental interpretation of species was based on a series of researches on modern analogue communities especially from the Mediterranean.

## **4. Results**

The sediments have been assigned to shallow marine sandy shell bed where the shell debris accumulated due to wave action and storm events.



**Figure 1 - Geographical location of the Island of Rhodes, location and lithological column of the Kritika Member section, Rhodes Formation.**

The bivalves are represented by 26 species. The most abundant is the burrowing bivalve *Ervilia castanea* which is highly numerical dominated and is recorded for the first time in the Lower Pleistocene of Greece. The next most dominant species is the transported *Anomia ephippium*.

The benthic gastropod assemblage of 29 species is dominated by small climbing herbivorous forms, most of them grazing on epiphytes.

Many epibyssate forms have been identified: *Talochlamys multistriata*, *Lima inflata*, *Mytilus galloprovincialis* and *Mytilaster lineatus*, *Acar clathrata*, *Barbatia barbata*, *Arca noae*, *Arca tetragona*.

Nestling species as *Cardita calyculata* and *Striarca lactea* also occur.

The infaunal elements that have been recognized are: *Tellina distorta*, *Tellina donacina*, *Callista chione*, *Lucinella divaricata*, *Dosinia exoleta*, *Dosinia lupinus*, *Diplodonta rotundata*, *Cardites antiquatus*, *Acanthocardia tuberculata*, *Donacilla cornea*, *Callista chione*, *Venus verrucosa*, *Timoclea ovata*, *Euspira catena*, *Natica* sp., *Neverita josephinia*.

The encrusting forms are: *Anomia ephippium*, *Chama gryphoides*, *Vermetus* sp., *Dedropoma* sp.

The crawling herbivores are: *Haliotis tuberculata*, *Bolma rugosa*, *Jujubinus striatus*, *Jujubinus exasperates*, *Gibbula magus*, *Gibbula ardens*, *Clelandella miliaris*, *Danilia tinei*, *Alvania cancellata*, *Alvania lineata*, *Rissoa* sp., *Tricolia pullus*, *Bittium reticulatum*, *Bittium latreillei*.

The carnivores *Naticarius stercusmuscarum*, *Nassarius* spp., *Euspira catena*, *Natica* sp., *Neverita josephinia*, *Ringicula ventricosa*, *Diodora graeca*, *Diodora gibberula*, *Buccinum corneum*, *Bolinus brandaris*, have been also recovered.

The less dominant species are *Ringicula* sp., *Nassarius* sp., *Callista chione*, *Mytilaster lineatus* and Naticidae and rare species (1 specimen/species) are *Striarca lactea*, *Acar clathrata*, *Mytilus galloprovincialis*, *Acanthocardia tuberculata*, *Lucinella divaricata*, *Lucinella divaricata*, *Talochlamys multistriata*, *Tellina distorta*, *Danilia tinei*, *Bolinus brandaris*.

Except for the vermetids, all the other gastropods are well preserved. Among the bivalves the only articulated is *Ervilia castanea* while the while the remaining species are preserved unarticulated or fragmented.

## 5. Discussion – Conclusions

Most of the taxa collected in this work, exist in the present Mediterranean Sea (e.g. Pérès & Molinier, 1957, Pérès & Picard, 1964, Pérès, 1967, Logan, 1979, Zibrowius, 1980, Riedl, 1983, Barash & Danin, 1988, 1992; Zenetos et al. 2005), which enables a comparison between the palaeofauna and recent assemblages.

The studied malacofauna is the result of heterogeneous mixing of shells with different rates of abrasion, fragmentation and disarticulation, belonging to species typical of normal marine conditions and rocky, sandy or algal substrates from the littoral marine environments. Two different types of concentrations can be defined:

Autochthonous concentrations of bivalves found articulated in sandy substrates and parautochthonous concentrations of gastropods and bivalves, including some mixed allochthonous elements represented by abraded and fragmented shells of relatively deeper sublittoral species. These concentrations can be interpreted as the result of accumulation during storm events.

Four assemblages are found living on different substrates:

1. A vermetid assemblage. The upper mediolittoral zone biota of exposed rocky substrates is represented by *Dedropoma* and *Vermetus* fragments.
2. *Ervilia castanea* assemblage. Coarse sand habitat occurs in sand-wave formations in shallow water where the infauna is characterized by the small bivalve *Ervilia castanea* (Morton et al. 1998). The dense populations of this species in the studied material indicate that it is a very successful coloniser of such energetic environment. A comparison between the fossils from the studied deposits and the present day analogue communities suggest that some of the elements belonging to the original biocoenosis are absent. Thus the other main associated species of this habitat as small opportunistic capitellid and spionid polychaetes and isopods that are adapted to living in a highly perturbed environment, have not been fossilized. *Dosinia lupinus* and *Donacilla cornea* are also present in the otherwise impoverished fauna of this environment and confirm shallow water sandy environment (Koukouras & Russo, 1991). This is the only articulated in situ preserved assemblage.
3. Hard bottom biota assemblage. It consists of a wide variety of skeletal organisms and characterizes a habitat that has been formed by the drowning of former beachrock beds (Cornée et al., 2006; Moissette et al., 2013). The most representative taxa of those living on rocky substrates are: *Cardita calyculata*, *striarca lactel*, *Bolma rugosa*, *Haliotis tuberculata*, *Diodora graeca*, *Diodora gibberula*. Among those associated with seaweeds are: rissoids, *Jujubinus exasperatus*, *J. striatus*, *Tricolia pullus*, *Alvania cancellata*, *Bittium reticulatum*, *B. latreillei*, *Euspira catena*, *Neverita josephina* and *Clelandella milliaris*. The latter may be enclaves within the following assemblage of *Posidonia oceanica* meadows. The hard rock substrates are very important since they provide both biological and geological information. They provide a stable environment for living organisms and they present a relatively high biodiversity.
4. *Posidonia oceanica* biota assemblage. The most representative species of sea grasses highlighted by this study, are: *Gibbula ardens*, *Alvania lineata*, *Tricolia pullus*, *Bittium reticulatum*, *Jujubinus striatus*, and the bivalves *Arca noae*, *Barbatia barbata*, *Lima inflata*, *Talochlamys multistriata*, *Venus verrucosa*.

Such fossilized species in hard bottom and *Posidonia oceanica* environments have been studied before in Rhodes (Moissette et al. 2007, Moissette et al. 2013), but in that case they are not in situ and they are represented with the other assemblages of the littoral bottom.

The “*Ervilia castanea*” deposits acted as a “refuge” for the parautochthonous elements of hard bottom and relatively deeper water assemblages, due to storm events and probably quick sedimentation.

The analysis of these four assemblages led to the reconstruction of the littoral palaeoenvironment represented in Figure 2.

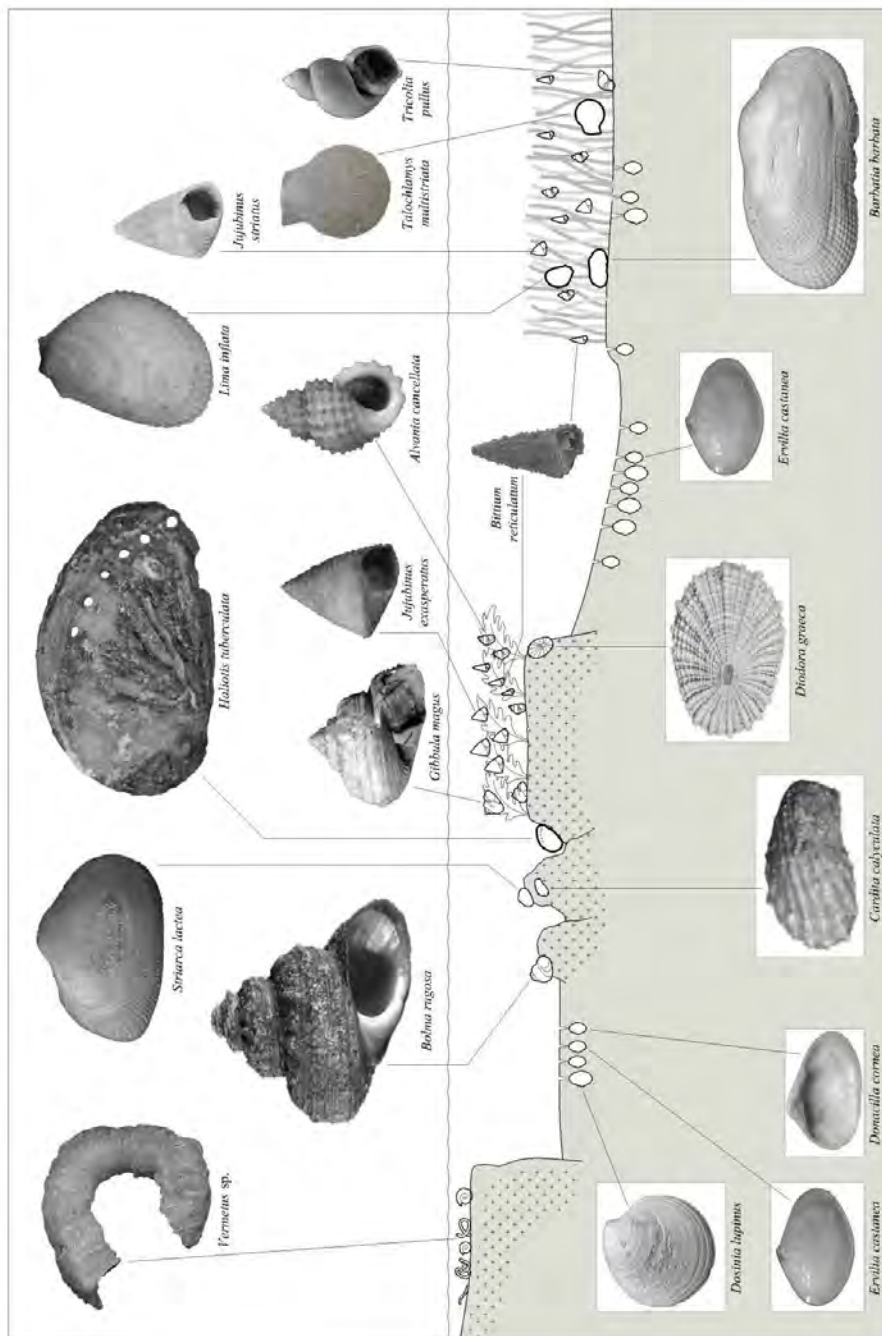


Figure 2 - Reconstruction of the sea bottom environment.

## 6. Acknowledgments

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