Substrate Controls in the Development of Molluscan Communities of the Nicosia Formation (Pliocene) of Central Cyprus

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INTRODUCTION

The Nicosia Formation of central Cyprus was deposited in the Pliocene. It directly overlies evaporites formed during the Messinian Salinity Crisis. Eight mollusk-dominated communities within the Nicosia Formation were sampled. The most common taxa in these communities are oysters and pectinid bivalves.

Despite the uniformity of sediment texture, significant differences in community structure were noted. The goal of this research is to investigate the role of substrate in the establishment and distribution of molluscan communities in the Nicosia Formation.

METHODS

Eight localities within the Nicosia Formation were sampled in the field:

"Ellen" site: N35^0 5.609; E33^0 7.191
"Mark" site: N35^0 5.439; E33^{0}7.106
Epsilos-Giant: N35^0 5.686; E33^0 8.916
Epsilos-Turritella: N35^0 5.717; E33^0 8.925
Epsilos-Shark: N35^0 5.767; E33^0 8.568
Pelican-Brach: N35^0 5.693; E33^{0}6.778
Epsilos-Oyster: N35^0 5.686;E33^{0}8.916
Coral Reef: N35^{0}5.767; E33^{0}8.925

Mollusks and other fossils were collected at each of the above sites. In the field, mollusks were identified and divided into one of three groups: non-heterodont bivalves (including *Ostrea* sp. and pectinids); heterodont bivalves; and gastropods. At each sampled site, mollusks were counted by taxa. Identifications to the species level were made after returning from the field. The identification of the mollusks was done in order to develop a complete list of represented genera and species. A literature review was conducted to determine the life habits of the identified mollusks. Estimation of water depths was made using planktic ratios of foraminiferans (see E. Avery abstract, this volume).

THE OYSTERS

Ostrea sp. (Fig. 1) were found in all sampled localities. The systematics are summarized below:

Kingdom: Animalia
Phylum: Mollusca
Class: Bivalvia (Linne, 1758)
Order: Dysodonta (Neumayr, 1883)
Family: Ostreidae (Rafinesque, 1815)
Genus: *Ostrea* (Linne, 1758)
Species: *Ostrea* sp.

Ostrea sp. inhabits warm, shallow, brackish to normal marine waters (Moore et al., 1987). They are epifaunal filter-feeders that recline on mud (Stanley, 1970). During the larval stage of development, the earliest form of the shell, the prodissoconch appears (Moore et al., 1987). The prodissoconchs settle to the bottom and colonize the soft mud (Moore et al., 1987). Within the Nicosia Formation, *Ostrea* sp. were collected from fine-grained sediments that provided the muddy substrate. The distribution of *Ostrea* in the Nicosia Formation is summarized in Table 1.

Table 1.
Ostrea and pectinid bivalves from the Nicosia Formation expressed in percentages of individuals in each community.

SPECIES	ELLEN	MARK	EP-G	EP-T	EP-S	PEL/BR	EP-O	CORAL REEF
Ostrea sp.	43.60	37.68	17.97	4.19	29.30	4.60	64.85	3.28
Amusium cristatum			3.91			10.73		
Pecten jacobaeus	8.14		12.50		1.91	1.53		
Pecten zenonis	1.74		8.25		0.84			
Pecten bicknelli		13.04		0.74				
Pecten zenonis horridula					2.55		0.61	
Pectenid sp.		1.45						
Peplum sp.	2.33					6.13		1.48
Spondylus sp.					0.64		0.61	11.28

THE PECTINID BIVALVES

Nine pectinid bivalves were identified within the Nicosia Formation. Their distribution of pectinids in the Nicosia Formation are summarized in Table 1. The pectinids are subdivided into two groups on the basis of their mode of attachment. The first group (systematics summarized below) attached to firm substrate:

Kingdom: Animalia
Phylum: Mollusca
Class: Bivalvia (Linne, 1758)
Order: Dysodonta (Neumayr, 1883)
Family: Pectinidae (Rafinesque, 1815)
Genus: *Pecten* (Muller, 1776)
Species: *Pecten jacobaeus*

Genus: *Pecten* (Muller, 1776)
Species: *Pecten zenonis*

Genus: *Pecten* (Muller, 1776)
Species: *Pecten zenonis* var. *horridula*

Genus: *Pecten* (Muller, 1776)
Species: *Pecten bicknelli*

Order: Isodonta (Dall, 1895)
Family: Spondylidae (Gray, 1826)
Genus: *Spondylus* (Linne, 1758)
Species: *Spondylus* sp.

These pectinids (*Pecten jacobaeus* shown in Fig.1) are epifaunal suspension feeders (Stanley, 1970) and typically inhabit shallow water environments (Aguirre et al., 1996). They become attached to firm substrates through the byssus, a thread-like material that anchors the shell to hard surfaces (Aguirre et al., 1996; Moore et al.,1987)).

The systematics of the pectinid bivalves colonizing soft substrate are summarized below:

Family: Pectinidae (Rafinesque, 1815)
Genus: *Chlamys* (Leach, 1815)
Species: *Chlamys* sp. 1

Genus: *Peplum* (Bucquoy et al., 1889)
Species: *Peplum* sp.

Genus: *Chlamys* (Leach, 1815)
Species: *Chlamys* sp. 2

Genus: *Amusium* (Roding, 1798)
Species: *Amusium cristatum*

These pectinids are epifaunal suspension feeders (Stanley, 1970) and typically inhabit deeper water environments. They recline on soft sediment and have the ability to swim in order to escape predation (Stanley, 1970). The deeper water pectinids have thinner shells compared to the shallow water species (Aguirre et al., 1996).
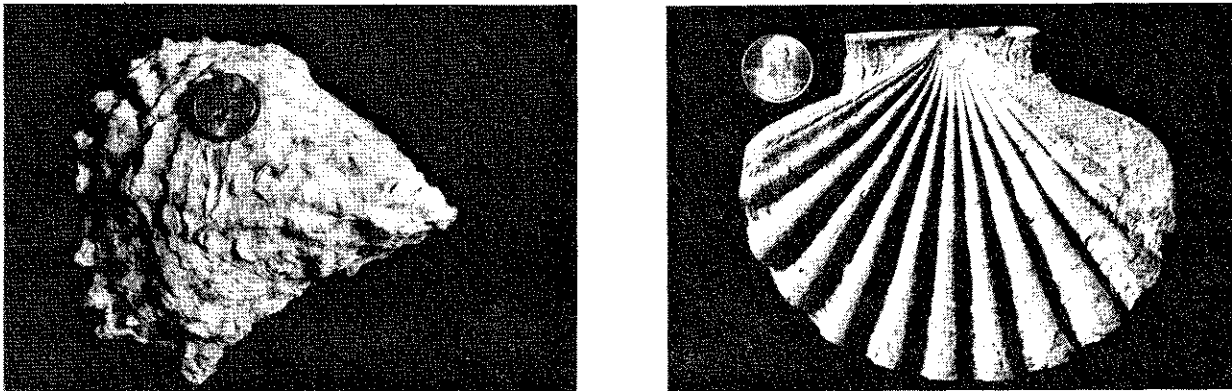

Figure 1.
Photographs of *Ostrea* sp. (left) and *Pecten jacobaeus* (right) collected from the Nicosia Formation in central Cyprus.

DISCUSSION

There appear to be two distinct depth-related assemblages represented within the Nicosia Formation. The first is characterized by high faunal diversity, including oysters, pectinid bivalves, heterodont bivalves, gastropods, and corals. Estimates of water depth (see E. Avery, this volume) range from 40 to 50 meters. A principal control on faunal distribution within this shallow-water assemblage appears to be substrate type. Oysters likely were the first to colonize the soft muds of the Nicosia Formation. Their shells contributed to the developing hard substrate which later became the surface of attachment for the non-heterodont bivalves and corals. The Coral Reef community is a spectacular example of a diverse hard substrate fauna which could develop only after the initial settlement on the mud by oysters and pectinids. The Coral Reef community contained a higher diversity of taxa in comparison to the other communities in a depth range of 40-50 m. The shells of the *Ostrea* sp. and pectinid bivalves provided the firm substrate that enabled other epifaunal organisms, particularly *Cladocora* (coral) which made up the Coral Reef community. Although *Ostrea* and pectinid bivalves are not well represented in the Coral Reef community, they were

critical to its development by providing the base upon which the reef was built.

The Pelican/Brach site contained a lower diversity community dominated by gastropods and non-heterodont bivalves. Water depth at this site is estimated to be approximately 1000 m.

The somewhat patchy distribution of oysters may be related to larval ingestion by the gastropod *Turritella*. This hypothesis is being explored by E. Avery (see abstract, this volume). It appears that the distribution of the molluscan communities also was controlled by water depth. This hypothesis is also being tested by E. Avery (see abstract, this volume). S. Dornbos is investigating the life habits of heterodont bivalves in an effort to understand pre- and post-Messinian paleoenvironments.

CONCLUSIONS

1. Eight mollusk-dominated communities within the Nicosia Formation in central Cyprus were sampled. The most common taxa in these communities are oysters and pectinid bivalves.

2. There are two distinct depth-related assemblages within the Nicosia Formation. The first assemblage is characterized by high faunal diversity including oysters, pectinid bivalves, heterodont bivalves, gastropods, and corals. Estimates of water depth are 40 to 50 m. The second assemblage is characterized by low diversity and is dominated by gastropods and non-heterodont bivalves. Water depth is estimated at approximately 1000 m.

3. The principle control on faunal distribution within the shallow water assemblage appears to be substrate type. Oysters and pectinids were the first to colonize the soft muds of the Nicosia Formation and provided the hard substrate which enabled heterodont bivalves and coral reef to become established. The coral reef is an especially good example of a community that could become established only after a firm substrate was provided.

REFERENCES CITED

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