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PALAEOENVIRONMENTAL SIGNIFICANCES OF THE OYSTER UPPER BADENIAN COMMUNITIES IN SOUTH DOBROGEA

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Abstract: The Upper Badenian of South Dobrogea is represented by shallow marine environment. The depositional system has been interpreted as a homoclinal carbonate ramp. Some sedimentary episodes in the inner carbonate ramp have been analysed. The most important is the floor layer in which the oysters are the dominant bivalves. In addition to epifaunal organisms (which present a moderate diversity) there are boring specimens. The valves of oysters are riddled by sponges, bored by bivalves and encrusted by bryozoan, tube secreting worms, corals or forams. The trophic and habitus analysis has been made. The new data help us to reconstruct the palaeoenvironmental settings of the Semeni Formation during Upper Badenian time. On the basis of the identified fauna the climatic conditions, basin depth and salinity of water have been estimated.

Key words: Upper Badenian, South Dobrogea, Oyster communities, Boring species, Palaeoenvironment.

INTRODUCTION

The marine Upper Badenian sequence of the South Dobrogea is well known for its rich benthic fauna. The paper of Munteanu & Munteanu (1999) offers detailed information on distribution patterns of communities of oysters from the Badenian of South Dobrogea. The depositional system has been interpreted as a homoclinal carbonate ramp.

The purpose of mentioned paper is to summarize the information given by the environmental interpretation of the recognized benthic communities of oysters identified on the inner ramp, in Cernavoda area.

The analysis of this benthic fauna has been based on comparisons with ecological data on Recent fauna (Heckel, 1974, fide Boucot, 1981) and on information concerning the conditions of life of the Miocene fauna given in descriptions of various papers (Chiriac, 1970; Kojumdgieva, 1976; Jakubowsky & Musial, 1979; Boucot, 1981; Szczechura, 1982).

GEOLOGICAL SETTING

Palaeoenvironmental data have been obtained by a bed by bed analysis of five sections from Dunarea, Seimenii Mari and Silistea Valley where the deposits of Seimeni Formation are outcropping and the oysters are the abundantly bivalves (Munteanu & Munteanu, 1996).

The representative profile is at Seimenii Mari (right bank of the Danube; Figure 1) and it is composed of the following layers (from the floor upwards):

a - Biocalcarenites, not very dense, containing a considerable admixture of the terrigenic material;

b - A bed of very compact, fine-grained, light-gray in color calcareous sandstones, with a calcitic cement and dense structure;

c - Compact biocalcarenites (micritic organogenic limestones) composed of twisted serpulid worms besides bivalve fauna;

d - Silts and silty clays yellow-greenish in color.

The fauna occurs unequally and irregularly. It is most abundant in the limestone occurring in the floor layer a, being represented dominantly by oysters. A fauna almost exclusively in the form of molds (excepting the *Chlamys* genus) have been observed in the layer c. The last layer d (Figure 1), of the Upper Badenian series, is characterized by the presence of the *Velapertina* species.

PRESENTATION OF THE EXAMINED COMMUNITIES OF OYSTERS

Our study is based on oyster fauna and on the epifauna attached to more than 300 shells of oysters collected from Seimeni Formation of northwestern South Dobrogea.

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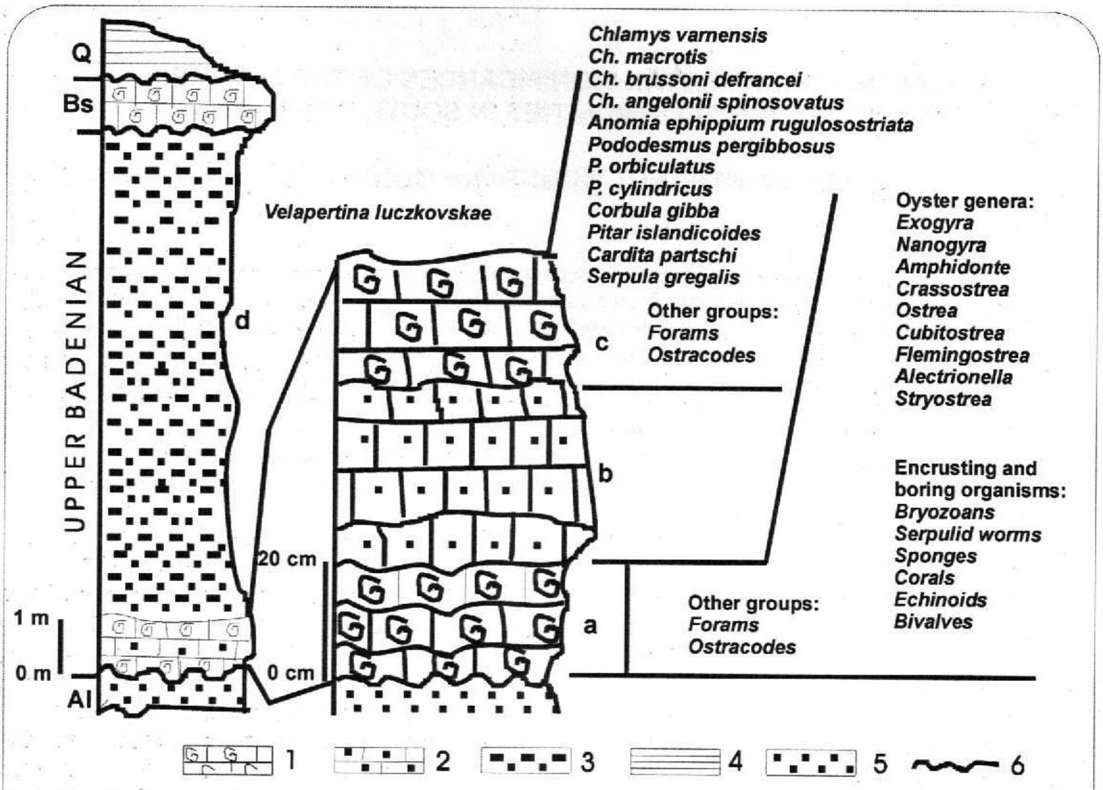

Fig. 1 Cretaceous (Albian), Neogene (Upper Badenian, Basarabian) and Quaternary deposits of the exposure located near Seimenii Mari village and their fauna

Legend: 1, biocalcarenite; 2, sandstone; 3, silty clay; 4, red clay; 5, glauconitic sand; 6, unconformity.

The macrofauna in the floor layer deposits under study is relatively poor, in regard to the number of species. Of 40 identified species of molluscs (Munteanu & Munteanu, 1999) abundantly occur only three species of oysters: *Crassostrea gryphoides* (SCHLOTHEIM), 1813, *Ostrea (Ostrea) lamellosa* BROCCHI, 1814 and *Cubitostrea digitalina* (DUBOIS), 1831. There are also very rare specimens of *Nanogyra, Exogyra, Amphidonte, Saccostrea, Flemingostrea, Alectrionella, Ostrea (Turkostrea), Stryostrea* genera.

The valves of oysters which occur in laminae, are distributed concordantly to bedding. They were undoubtedly transported, but not for a long distance. Indicative for that is the fact that they are undamaged and incrusted on their surface,
and that the numbers of right and left valves of the appropriate size are similar.

The presence of encrusters and borers points out that shells remained exposed on the sea bottom for a long time. The shell surface is partially encrusted by few bivalve, worm, coral and bryozoan epizoans (Plate I, Figures 1 - 8).

Young oysters, pertaining to the *Crassostrea, Ostrea, Cubitostrea* genera and to the species of *Pododesmus* genus have been identified among epizoan bivalves (Plate I, Figures 1 - 7). They are more common around margins of the oyster hosts. (Plate I, Figures 2 - 4, 6, 7). Sometimes, epizoan worms cover the entire surface of valve (Plate III, Figure 7).

Two of the *Flemingostrea* valves bear corals belonging to the *Balanophyllia calyculus* WOOD, 1844 (Plate I, Figures 8, 8a).

Among polychaetes have been identified the following specimens: *Serpula gregalis* EICHWALD, 1830, *Serpula reussi* ROVERETO, 1904, *S. fastigiata* EICHWALD, 1830, *Serpula sp., Potamoceros triqueter bicanaliculatus* (MÜNSTER) in GOLDFUSS, 1834, *Spirorbis spirorbis* (LINNÉ), 1788 (Plate II, Figures 1 - 10).

It is impossible to establish if the encrusted fauna grew on a live or dead oyster hosts. The encrusting of the inner parts of the shells indicates that they were encrusted after the death of the mollusc.

In addition to epifaunal organisms there are boring specimens of varied types. Sponges riddled oyster valves (Plate III, Figures 1-4, 8; Plate IV, Figure 1). The network tunnels ca 1 mm in diameters due to *Clyona* sp. is very frequent (Plate III, Figures 1,2; Plate IV, Figures 1, 2). Noted the varying degrees of shell destruction.

The thick valves of *Cubitostrea fimbriata crassa* (SCHAFFER), 1910, are bored by chemical borers such as *Lithophaga lithophaga* (LINNÉ), 1758 (Plate III, Figures 1, 2; Plate IV, Figures 1, 1b, 3, 3a). In the investigated community there are other boring bivalves such as *Corbula* and *Cardita*. Note preference of *Lithophaga* and *Clyona* borings for protected areas, under shell, and especially around beaks.

Worms made a lot of burrows: sinuous tube (Plate III, Fig. 5; Plate IV., Figures 2, 2b) are present on the valves pertaining to all the oyster genera.

The bryozoans are represented by: *Schizoporella geminipora* (REUSS), 1848, *Umbonulla macrocheila* (REUSS), 1848, *Crysia sp.* (Plate IV, Figures 4, 5).

The spines and an echinoid fragment (Plate IV, Figure 6) have been observed in our material.

Note the presence, in the layers a and c (Figure 1), of benthic forams (*Ammonia, Glandulina, Elphidium, Triloculina, Nonion, Nonionella, Lagena, Cycloforina* etc.) studied by Ionesi & Chintăuan (1976) and Munteanu & Munteanu (1996), as well as ostracods (*Cytherella, Cytheridea, Eocytheropteron, Loxoconcha* etc.) inventoried by Ionesi & Chintăuan (1976).

PALAEOENVIRONMENTAL CONSIDERATIONS

A study of the oyster fauna supplies evidence for a tentative restoration of the conditions under which the Seimeni Formation have been formed in this northwestern part of Southern Dobrogea.

The identified fauna pertains to the following trophical ecological groups: cemented epifaunal suspension feeders (Ostreidae, Serpulidae, Bryozoa), epibyssate suspension feeders (*Chlamys, Pododesmus, Anomia*), semi-infaunal suspension feeders (*Corbula*), epifaunal herbivore and/or detritus feeders and borers (Bivalves *(Lithophaga)*, Sponges, Echinoids, *Polychaete* worms).

The analyzed communities are composed of variable percentages of mentioned groups and exhibits high faunal densities represented by oysters genera with their epizoans, in layer a, and by *Chlamys*, *Corbula* and *Serpula* in layer c.

In the time of the Upper Badenian transgression have arrived vast numbers of pelagic oyster larvae transported by ocean currents. The favorable conditions on the inner ramp have produced a maximum population in a single generation in the layer a. The high rate of multiplication and territorial expansion were followed by a rapid decline in numbers (oysters are very rarely in layers b and c) since the competition for space or food was too severe for survival. The fluctuations of key predators in time and space might have a great effect upon vertical zonation. In our community boring sponge damage to oysters. Warburton (1958, fide Boucot, 1981) discusses a probable high mortality rate of oysters due to boring-sponges among spat.

A significantly lower number of benthic organisms in the studied area are indicative for the intertidal region. The intertidal biota has a restricted number of species limited by the severity of the environment (Boucot, 1981).

Both the presence and morphology of this widely distributed species are controlled by environmental conditions, mostly salinity, turbulence, bathymetry, light, temperature, nutrients, oxygen, suspended sediment etc.

Crassostrea is very numerous in the analyzed community because among various oyster genera this genus is capable of growing fastest. *Crassostrea* seems to be the most polyhaline oyster genus. *Ostrea* is polyhaline to euhaline and less polyhaline than *Crassostrea*. In most situations *Ostrea* prefers brackish water of higher salinity than *Crassostrea*. *Saccostrea* is restricted to tropical and subtropical climates and to waters of normal salinity. Other taxa are strictly euhaline (*Exogyrinae*) or polyhaline to nearly euhaline (*Flemingostrea*). The warm temperate and cold temperate climatic belts have only two shallow-water oyster genera, namely Crassostrea and Ostrea (Stenzel, 1971).

The left valves of oysters, in the investigated community, are more prominent ornamented (Plate I, Figures 1, 3; Plate IV, Figures 1, 3) and the right valves are more convex (Plate III, Figures 3 - 5) because they seems to be exposed on the sunlight.

The turbulence of water was not very strong as indicated by the fact that it did wash out the burrowing species and that the valves of oysters are well preserved. The abundance of suspension feeders should correlate with clear waters (Boucot, 1981) but the water energy must have been sufficient enough to keep the nutrients in suspension. Note the changes in the character of sedimentation, caused probably by the withdrawal of the coastline, determining the inflow of the terrigenic material in layer a (Figure 1).

Referring to the other groups of organisms in the analyzed fauna, it observed that the bryozoans and sponges are an index of relatively quiet and stable water sedimentation.

Heckel (1974, fide Boucot, 1981) has summarized the environmental tolerances of serpulid and oyster fauna in the Recent occurrence. The salinity is between 15 ‰ and 25 ‰ for oyster bank and smaller than 15 ‰ for serpulid worms reefs and the depth less than 30 m.

Most of the identified forams in layers a and c (Figure 1) are polyhaline (*Ammonia, Elphidium*) and a few of them euhaline (*Triloculina, Lagena*). Species of ostracodes (*Cytheridea, Eocytheropteron, Loxoconcha*) suggested salinity between 16,5‰ - 33‰ (Keen, 1977).The distribution of the benthonic foraminifera indicates that the lower part of the studied profile represents the deposits of shallower water, not more than 50 m deep, while the upper part of the profile represented by layer d corresponds to an overdeeping of the basin to at least 100 to 120 m. Szczechura (1982) has arrived to the similar conclusion referring to the depth of the Upper Badenian basin in SE Poland (Roztocze area).

From the presented data the conclusion may be drawn that the depth of aquatic biotope in this sector of the inner ramp, dominated by the oyster, *Chlamys, Corbula* and *Serpula* species (Cernavoda area) did not exceed 30 m. The salinity was normal at the beginning that's why the euhaline oysters survived. In consequence of the inflow of fresh-water from the continent has registered a decrease of salinity that favored the extraordinary development of the polyhaline oyster species. It's probable that the oyster Upper Badenian community has developed in the cool Temperate Zone. In fact, ramps are possibly more common in temperate climatic zones than in warmer regions (Einsele, 1992).

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REFERENCES

Boucot, A. 1981, with Contributions on Bioturbation, Biodeposition, and Nutrients by Carney R., Principles of Benthic Marine Paleoecology. Academic Press, 463 p., London.

Brocchi, G. B. 1814, Conchiologia fossile subapennina con osservationi geologiche sugli apennini e sul suolo adiacente. G. Silvestri, Stamperia Reale, v. 2, p. 241 – 712, Milano.

Chiriac, M. 1970, Răspîndirea şi faciesurile Tortonianului în Dobrogea de Sud. Inst. Geol. Geofiz., *Dări de seamă ale şedinţelor,* 56/4, p. 89-112, Bucureşti.

Dubois, de M. 1831, Conchiologie fossile et apercu geognostique des formations du plateau Volhyni – Podolien. Simon Schropp, 76 p., Berlin.

Eichwald, E. 1830, Naturhistische Skizze von Lituanien, Volhynien und Podolien. Wilna, 256 p.

Einsele, G. 1992, Sedimentary Basins-Evolution, Facies, and Sediment Budget. 628 p., Springer – Verlag Berlin Heidelberg.

Goldfuss, G.A. 1826 – 1844, Abbildungen und Beschreibungen der Petrefacten Deutschlands und der angranzenden Lander unter Mitwirrkung des Herrn Grafen Georg zu Munster: pt. 1 (1826 – 1833), X + 252 p.; pt. 2 (1834 – 1840) [1833 – 1841], III + 312 p.; pt. 3 (1841 – 1844) [1841, 1844], IV + 128 p., Arnz. & Co., Dusseldorf.

Ionesi, B., Chintăuan, I. 1976, Contribuţii la studiul faunei badeniene de la Seimenii Mari (Dobrogea de Sud). *Analele ştiinţifice ale Universităţii "Al. I. Cuza"* (ser. nouă), secţ. II/b, Geol., XVII, p. 79 – 90, Iaşi.

Jakubowski, G., Musial, T. 1979, Lithology and fauna of the Middle Miocene deposits of Trzesiny (Roztocze Tomaszowskie Region, South – eastern Poland). *Prace Muzeum Ziemi*, 32, p. 37 – 100, 6 pl., Warszawa.

Keen, M.C. 1977, Ostracod assemblages and the depositional environments of the Headon, Osborne and Bembridge Beds (Upper Eocene) of the Hampshire Basin. *Palaeontology,* 20, p. 405-446.

Kojumdgieva, E. 1876, Paléoécologie des communautés des Mollusques du Miocène en Bulgarie du Nord-Ouest. II. Communautés des Mollusques du Badénien (Miocène moyen) en Bulgarie du Nord-Ouest. *Geologica Balcanica,* 6. 2, Mai 1976, p. 63 - 94, Sofia.

Linné, C 1758, Sysyema Naturae, vol. 1, 10 th. ed., Holmiae (Stockholm).

Munteanu E., Munteanu M. - T. 1996, Biostratigraphical Considerations on the Neogene Deposits of Cernavoda Area. *Anuarul Institutului Geologic al României*, vol. 69, Suppl.1, Abstr., p. 140 – 142, 6 pl., Bucureşti.

Munteanu, E., Munteanu, M. - T. 1999, Upper Badenian Bivalves in Cernavoda Area. *Acta Palaeontologica Romaniae* V. 2, Second Romanian Symposium on Palaeontology 1 – 3 October 1999, p. 275 - 286, Babeş – Bolyai Univ., Cluj – Napoca.

Reuss, A. E. 1848, Die fossilen Polyparien des Wiener tertiar-beckens. Ein monographischer versuch. *Naturwissenschaftliche Abhandlungen,* vol. II, nr. 1, 109 p., 11 pl., Wien.

Schlotheim, E.F. von 1813, Beitrage zur Naturgeschichte der Versteinerungen in geognostischer Hinsicht. Taschenbuch Gesammite Mineralogie, etc., C.C. Leonhard (ed.), v. 7, Abh., p. 3 – 134.

Schaffer, F.X. 1910, Das Miocan von Eggenburg. *Abhandlungen der kaiserlich – koniglichen Geologischen Reichanstalt,* BAND XXII, Heft 1, 126 p., Wien.

Stenzel, H.B. 1971, Oysters. Treatyse on invertebrate Paleontology. Part N., Mollusca 6, Bivalvia, 3, p. 953 – 1224. The Geological Society of America, Inc. and The University of Kansas, Lawrence.

Szczechura, J. 1982, Middle Miocene foraminiferal Biochronology and Ecology of SE Poland. *Acta Palaeontologica Polonica,* vol. 27, nr. 1-4, p. 3-44, 17 pl., Warszawa.

Wood, S.V. 1844 – 844, A monograph of the crag mollusca. *Palaeontographical Society Monograph,* vol. 1 – 4, suppl. 1 – 3., London.

PLATES

Plate I

Figure 1 *Pododesmus* sp. (1 a) and *Cubitostrea* sp. (1 b) attached to *Cubitostrea seimeniensis* MUNTEANU & MUNTEANU (X 0,9)

Figures 2 - 7 Young epizoan *Ostrea, Crassostrea* and *Cubitostrea* attached to *Cubitostrea* sp. (Fig. 2 X 1), *Cubitostrea adriatica* (LAMARCK) (Fig. 3 X 1) *Ostrea (Ostrea) lamellosa* BROCCHI (Fig. 4 X 1), *Crassostrea crassissima* (LAMARCK) (Fig. 5 X 1,3), *Exogyra* sp. (Fig. 6 X 1) and *Allectrionella plicatula* (GMELIN)

Figures 8, 8a *Flemingostrea hemiglobosa* (ROMANOVSKIY) (Fig. 8 X 0,9) encrusted by a coral, *Balanophyllia calyculus* WOOD (Fig. 8 a X 3)

Plate II

Figures 1 - 3 *Serpula gregalis* EICHWALD (Fig. 1 X 3,5; FIG. 2 X 2; FIG. 3 X 2,5)

Figure 4 *Serpula reussi* ROVERETO (X 3,5)

Figure 5 *Serpula fastigiata* EICHWALD (X 5)

Figure 6 *Serpula sp.* (X 3,5)

Figures 7-9 *Potamoceros triqueter bicanaliculatus* (MÜNSTER) (Fig. 7 X4; Fig. 8 X 3; Fig. 9 X 4,5)

Figure 10 *Spirorbis spirorbis* (LINNÉ), (X 4)

Plate III

Figures 1, 2 *Ostrea (Ostrea) lamellosa* BROCCHI (left valves, Fig. 1 X 0,8; Fig. 2 X 1) with erosion and crumbling by *Cliona* sp. and *Lythophaga lithophaga* LINNÉ borings

Figures 3, 4 *Flemingostrea hemiglobosa* (ROMANOVSKIY) (right valve, Fig. 3 X 1; Fig. 4 X 0,8) boring by *Cliona* sp.

Figure 5 *Ostrea (Turkostrea)* sp. boring by serpulid worms (right valve, X 0,7)

Figure 6 *Potamoceros triqueter bicanaliculatus* (MÜNSTER) attached tubes to *Cubitostrea cf. granensis* FONTANNES (left valve, X 0,9)

Figure 7 *Serpula fastigiata* EICHWALD attached tubes to *Cubitostrea frondosa* (DE SERRES) (left valve, X 0,8)

Figure 8 *Crassostrea crassissima* (LAMARCK) (left valve, X 0,7) - beginning of penetration by *Cliona* sp.

Plate IV

Figures 1, 1 a, 1 b *Ostrea (Ostrea) boblayei* DESHAYES, (left valve, X 0,4) boring by *Cliona* sp. (1a) and by *Lithophaga lithophaga* LINNÉ (1b) (X 2,5)

Figures 2, 2 b *Flemingostrea hemiglobosa* (ROMANOVSKIY) (right valve, X 1), boring by *Cliona* sp. (2a, X 1,5) and by worms (2 b - tunnels on the internal side of valve, X 1,2)

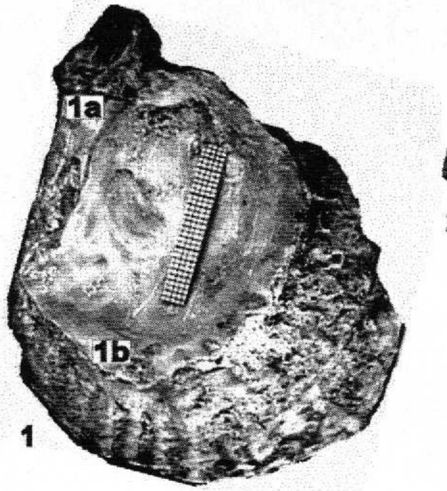
Figures 3, 3 a *Cubitostrea fimbriata crassa* (SCHAFFER) (left valve, dorsal vue, X 0,6) Fig. 3 a - lateral vue (X 0,7) - boring by *Lythophaga lithophaga* LINNÉ -finger sized borings

Figure 4 *Crassostrea crassissima* (LAMARCK) encrusted by *Umbonulla macrocheila* (REUSS) (X 5)

Figure 5 *Ostrea (Ostrea) lamellosa* BROCCHI encrusted by *Schizoporella geminipora* (REUSS) (X 6)

Figure 6 Echinoid fragment (X 5)

All specimens : Upper Badenian, Cernavoda area



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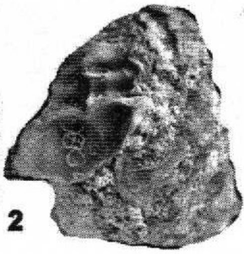

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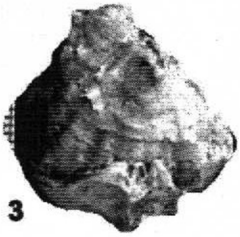

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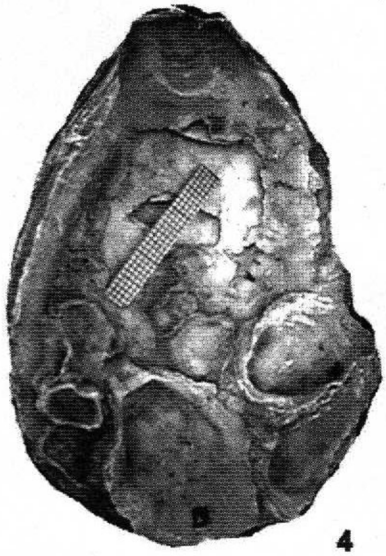

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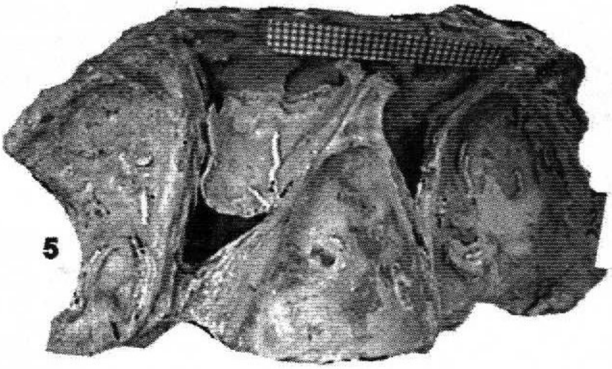

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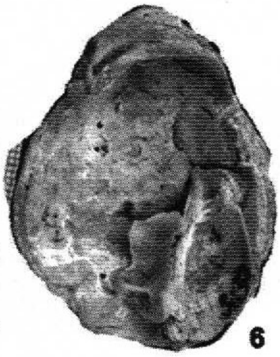

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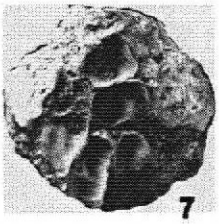

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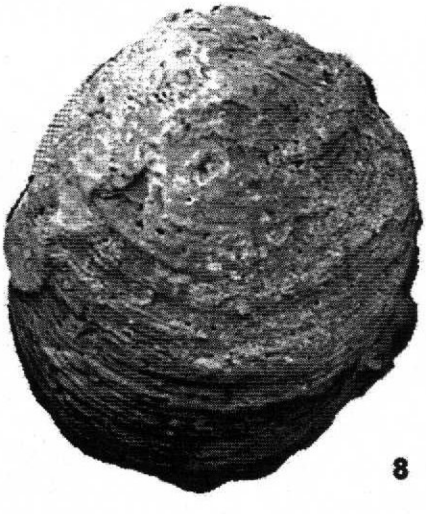

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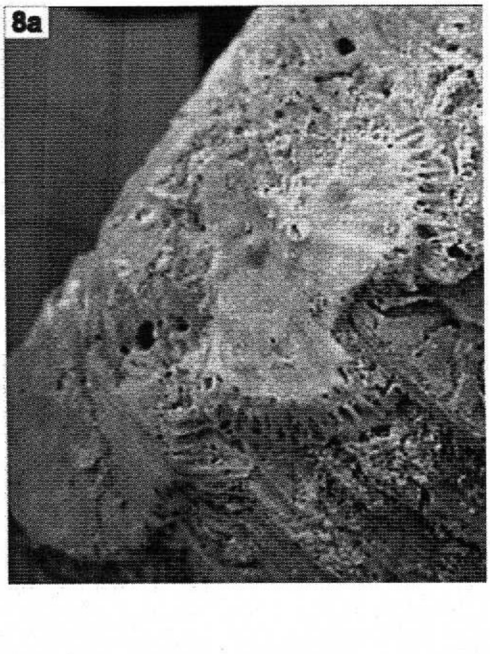

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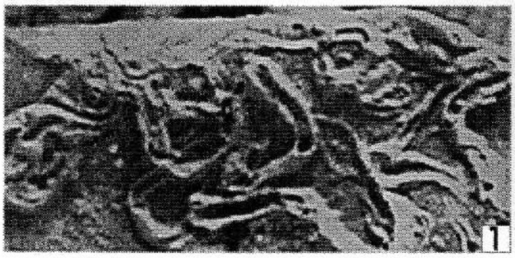
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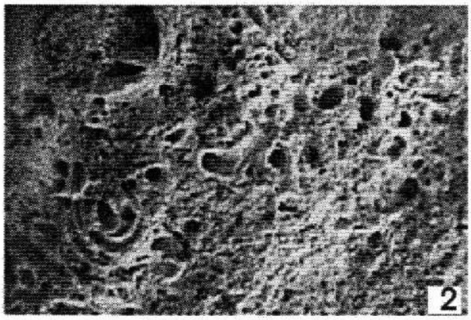
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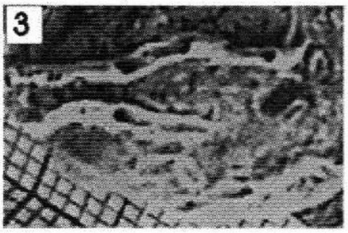
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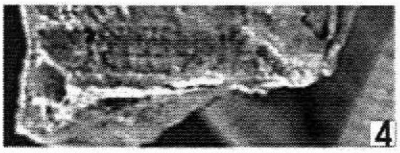
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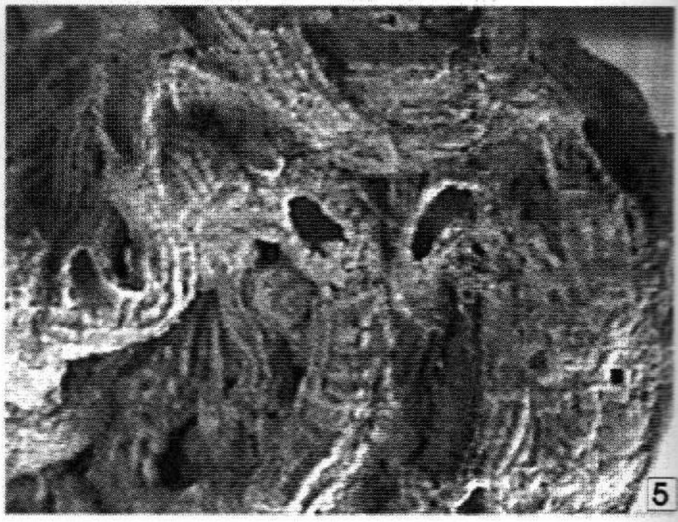
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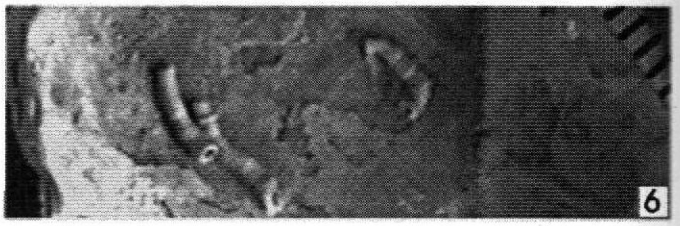
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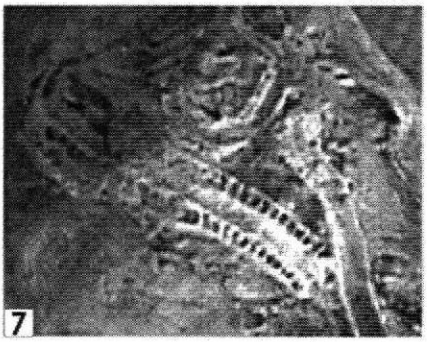
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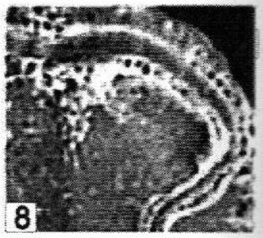
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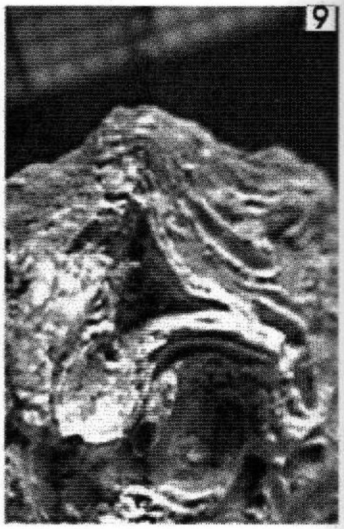
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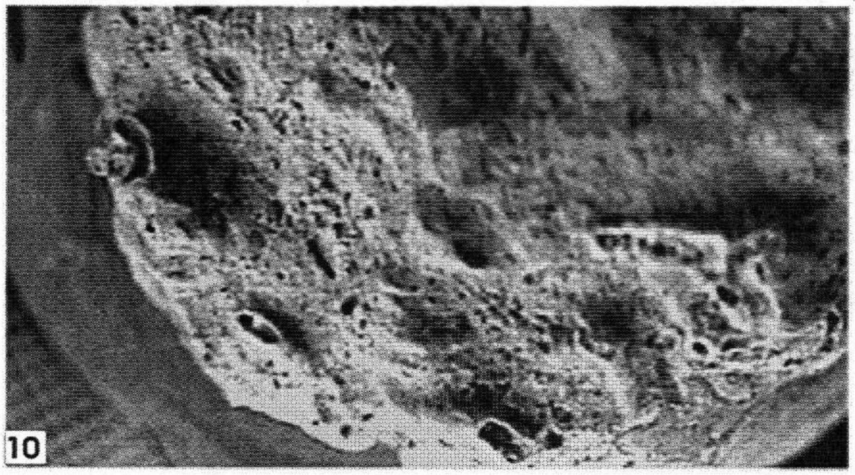
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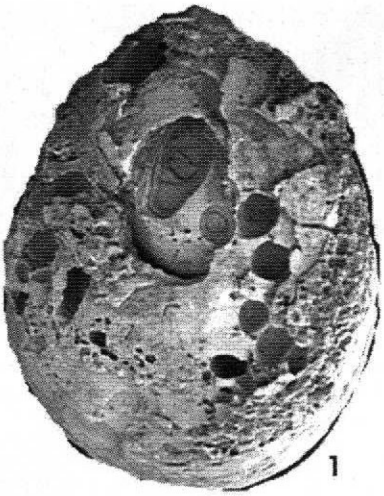
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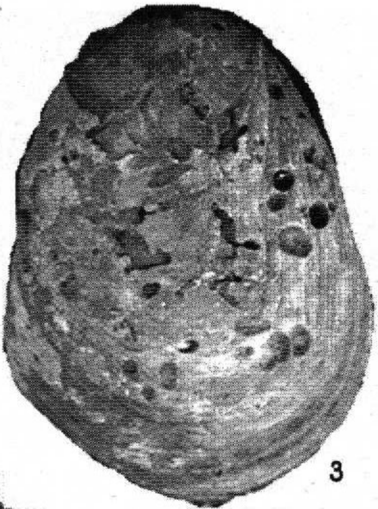
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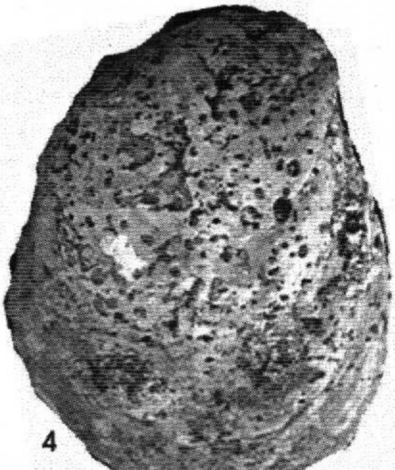
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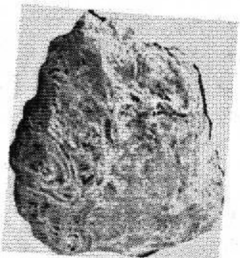
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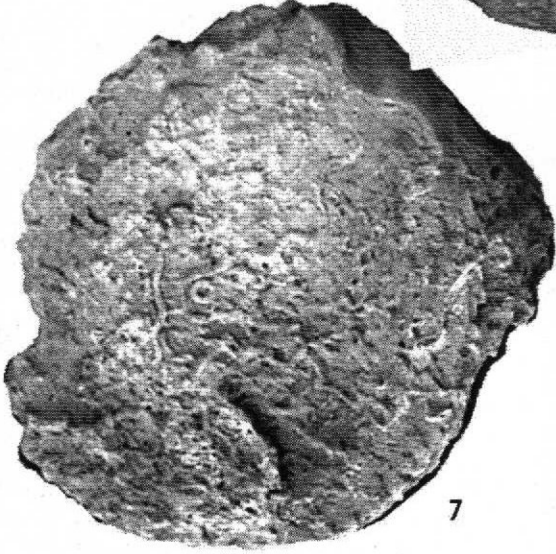
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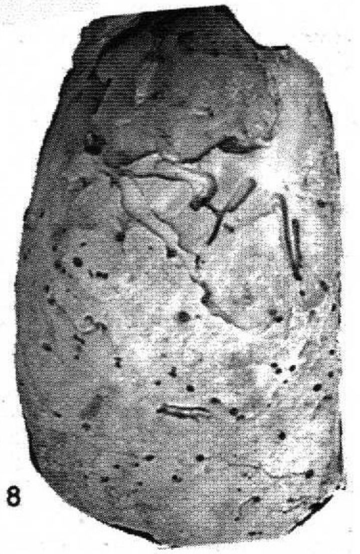
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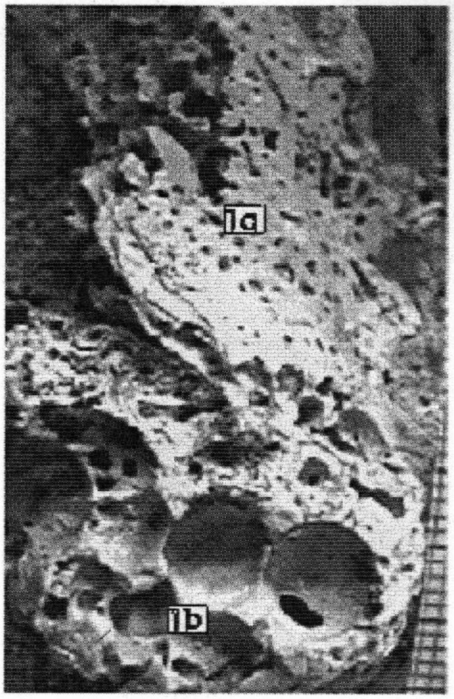

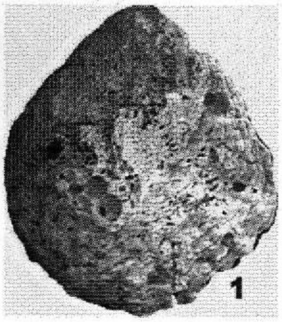
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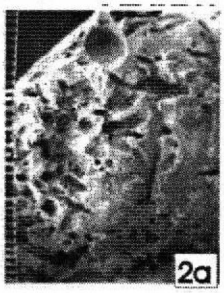
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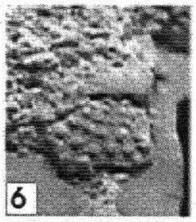
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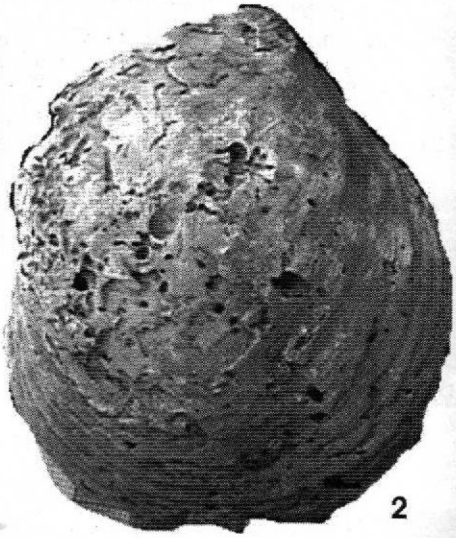
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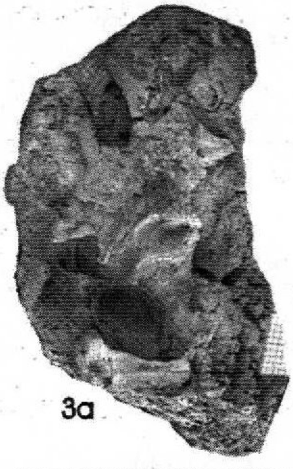
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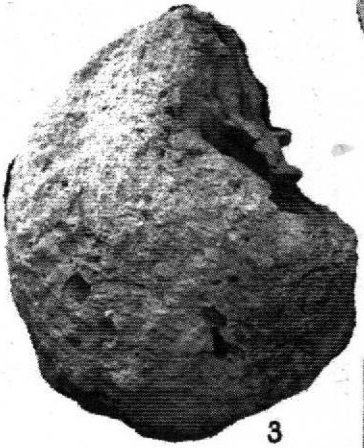
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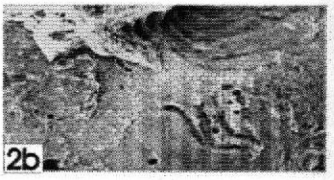
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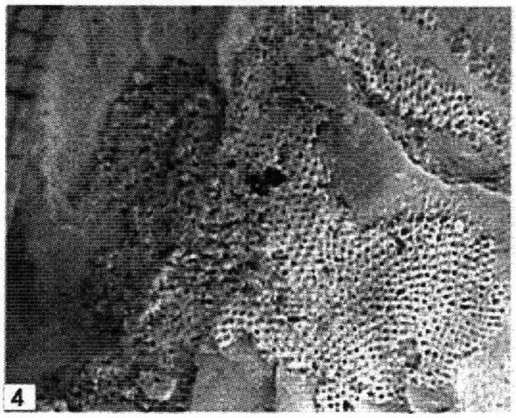
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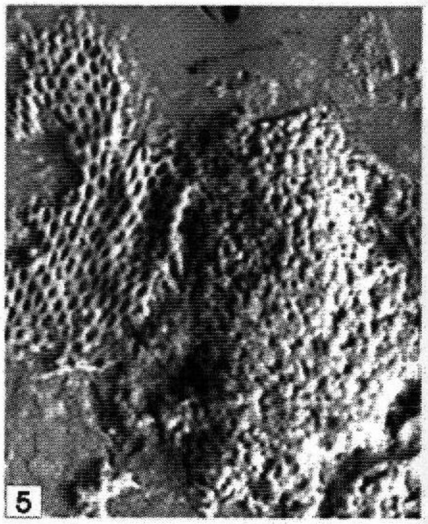
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