PALEOECOLOGY OF PLIOCENE MOLLUSCS FROM MORENI – OCNIȚA ZONE, NORTHERN FRAME OF THE DACIAN BASIN / ROMANIA

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Abstract. The study approaches the morphology and biometry of mollusc shells (unionoids and viviparids) for a better correlation of Pliocene coal seams from Ocnița – Moreni area. In the same time, this study contributes to the better understanding of these molluscs by combining the biometrical and morphological data with geochemical features.

Key words: Environmental changes, Animal interactions, Geochemical spectra, Coal seams.

PALEONTOLOGICAL AND PALEOGEOGRAPHICAL SETTING OF PLIOCENE DEPOSITS OF OCNIȚA-MORENI AREA

During and after geological surveying activities I could find in Bana-Moreni working area a series of gastropods resembling those reported by Botez (1914). Northern of that area, along the Sângeriș Valley (just north of Moreni Hill) I could collect a fauna of strongly ornamented unionids reported by Nicolaescu et al. (1980, Figures 1, 2). A part of this fauna, collected from the same outcrop as Botez did, was illustrated in the papers of Nicolaescu et al. (1980) and Lubenescu & Nicolaescu (1987). This fauna indicates Middle Romanian (Figure 3).

The paleofauna of Bana Hill cited by Botez (1914), “Levantinian” in age, occurring north of Moreni and along the Cervenia Valley, was identified as being Middle Romanian (Papaianopol et al., 1985; Nicolaescu et al., 1976; Lubenescu et al., 1976, Lubenescu & Nicolaescu, 1987; Papaianopol, 1992). The paleofauna of Cervenia Valley was cited lately by Mrazec & Atanasiu (1927), and by Ghenea & Ghenea (1970), when they approached the geology of the diapiric anticline of Moreni. Species of this fauna were identified in areas belonging to the Siliștea Dealului anticline, having the following occurrences: Trestiea Valley, Nisipoasa Valley and westwards, in Dan’s Valley (Ocnița Valley tributary) and in Ialomitza Valley, over the third coal seam (Papaianopol et al., 1985, Damian, 1999). During prospecting work, the Lower Romanian age was confirmed for deposits occurring in the following areas: east of Ocnița, Moreni (Schela Mare), Filipești de Pădure mine (Cervenia, Palanga, Roșioara, Gura Ocniței – Moreni anticline).

The Lower Romanian age is indicated by the Viviparus bifarcinatus bifarcinatus zone, represented by unionoids, melanopsids, bullimids, sometimes with lumachelles containing a single species. This zone is represented by Pristinunio pristinus (Bielz), Psilunio atavus (Partsch), Ps. biplicatus (Bielz), Viviparus bifarcinatus bifarcinatus (Bielz), V. stricturatrus (Sabella), Melanopsis (Melanopsis) sandbergeri rumana Tourn., M. (M.) bergeroni Sabha (Nicolaescu et al., 1976; Damian, 1999).

Along Dan’s Valley was identified a Middle Romanian fauna, almost the same with that of Moreni. The fauna was collected from yellow sands that are fine to slightly coarse, bearing mica, and it is represented by entire shells of Psilunio moreniorum (Botez), Ps. (Cyclopotomida) excelentis Papaian., Ps. (C.) munieri (Sabella), Ps. (Psilunio) stoliczkae (Neumayr), Ps. (Ps.) solinus Papaian., Rytia motuensis (Jonescu-Argetoaia), Pristinunio davilai (Porumbaru), Pr. pristinus (Bielz), Pr. mutabilis (Papaian.), Lub., Cuneopsis beyricki (Neumayr) Papaian., Rugunio mojsxari (Penecke) Papaian. (a detailed report was given by Papaianopol et al., 1985).

In Valea Dulce – Plaiul Văii Dulci area occur spotted clays and gravels with white, rounded quartz elements, 0.5-1.5 m thick that can be interpreted as reworked Romanian deposits during Middle-Upper Pleistocene, after the “Cândești gravels” were deposited in thick deposits north of Moreni. But as no stratigraphic data can sustain this idea no map indicating it can be drawn.

North of Cârăbuș Peak, in Ruda syncline, occur gravels (“Cândești beds”) overlaying the Romanian deposits which still outcrop upstream in valleys

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Fig. 1. Location of the outcrops with coal in the Moreni Hill - Sângeriş Valley sector
1, 2 = outcrops with thin coal levels
13 A.R. = outcrops 13 location (Astra-Română), with coal level at 20 m deep, under outcrop with fossils described by Gh. Botez (1914)
3 = escarpment with yellow sand (? with fauna described by Gh. Botez)

Fig. 2. Outcrop with coal levels in the right slope of the upper Sângeriş Valley

Fig. 3. Unionide fauna - Middle Romanian
1. *Rugunia condai* (Porumb.)
a - left valve x 1; b - right valve x 1.5
c - dorsal view; d - internal view of right valve

2. *Rugunia cf. condai* (Porumb.)
a - left valve x 1; b - right valve x 1

3. *Rugunia mojsvari* Penecke
a - left valve - external view x 1
b - left valve - internal view x 1

4. *Rytilia cf. pauli* (Neumayr) x 1

5. *Cuneopsidea beyrichi* (Neumayr)
a - left valve - external view x 1
b - left valve - internal view x 1.5
such as Corboia, Ursoaia, Seaca and along slopes of Ruda Valley. The deposits belonging to the Ruda syncline were identified as Upper Romanian – Lower Pleistocene. This age identification was possible when considering the gastropod fauna, the geometric relationships between the beds and the actual position of the “Cândești beds”. It is worthwhile to note that Enciu and Andreescu (1990) considered that the Cândești Formation was deposited since the Middle Romanian.

EVOLUTION OF THE MOLLUSC PALEOBIOCENOSCES

The criteria used for paleoenvironmental reconstruction are presented in Figures 4 and 5. The Dacian Basin began its development after the Late Pontian, as a great gulf of the Euxinic Basin, initially having an outline stretched between the Subcarpethians and Prebalkans. During the Late Neogene, within the Dacian Basin thick deposits were accumulated in molasse features. The deposition of these deposits was controlled by the general tectonics and, for some areas, by the salt tectonics. In the central-northern sector, the upper molasse is characterized by brackish and freshwater facies.

The importance of coals, the number, distribution and thickness of coal seams is an effect of local environmental conditions, triggered by the paleogeographic evolution of wider areas.

The process of salinity decrease and the basin sediment infilling led to changes in biodiversity, as shown by large populations. The unionids and viviparids indicate a generic diversity decrease and adaptation to the local depth and substrate morphology conditions.

Since the Late Pontian the salinity decreased. During the Dacian times, a large coastal swamp developed, reflected by the alternation of clays and sands, coal beds and plants. The viviparids and unionids increased their frequency. The unionids preferred the shallow waters, living in sandy environments with ornamentation indicating little disturbance. Some unioninds can be found with both valves still connected. Among them can be cited Pristinunio davilai (Porumbaru), Pr. pristinus (Bielz), Pr. mutabilis (Bielz) (Figures 1-5, Plate I). In viviparids can be noted the thickening of the shells and size modifications. The Pontian viviparids have thin shells (V. rumanus Tourn.) and they gained ridges and smaller sizes during the Late Dacian (V. bifarcinatus Bielz), while during the Middle Romanian (V. dasmanianus Brus.) they were more ornamented.

The causes of diversity and population decrease are hard to identify. The data gathered from outcrops and drills show drastic changes of environmental conditions. During the Middle Romanian a drastic diversity and population decrease occurred when the region was uplifted and fluvial and glacial deposits were formed on the slopes of the Subcarpathians. That was the moment of “Cândești gravels” deposition, those deposits yielding very rare faunal remains, such as freshwater gastropods Tachaeocampylaea (Mastodontopsis) dodeleini Brus., identified upstream on Corboia, Ulioa and Seaca Valleys.

The substrate played a more important role than the temperature, depth or salinity in the development and extension of molluscs.

Symmetric shapes of shells and the alternating ribs show an alternative settle of individuals. The infaunal organisms (with elongated shapes) show ornamentation over the burial line. A slow movement of individuals can be expressed by the high frequency of circular shells. Rugunio mojivari (Penecke) is interpreted as dwelling alternatively on each valve, the characteristic ribs indicating coarser substrate (Figure 3.3); Rytiia sp. indicates a position on umbo, among rocks.

The salinity decreased suddenly and rapidly and this process influenced morphological and biometrical characters of the shells.

In Figure 6 are shown two distribution fields of some viviparids, defined by the ratio H/L and H/h. It can be observed the grouping of species in two fields. The A field includes V. turgidus and V. argesiensis. The other species are grouped in a separate, B field. The distribution field of V. bifarcinatius is rectangular and crosses the other’s three species fields. The dispersion line sits symmetrically, at equal distances.

The dispersion line of distribution for each species is parallel with the symmetry line of the ration H/L and H/h. V. turgidus and V. argesiensis cover together a common field and this may indicate actually that the collected material represents a single species. The graph suggests that the ornamentation is an adaptation to the environment.

DIAGENESIS AND POST-DIAGENESIS SIGNIFICATIONS. SCARS AND PARASITIC SIGNATURES ON SHELLS

Many of the studied species represented food for other species. Borings, cracks, abnormal thickenings are considered effects of animal interactions and they occur in areas around umbos, apertures or on growth ribs (Plates I-III). Some marks were done immediately after death, most of them being generated by larvar worms. Some circular borings were inflicted by naticids (Figure 7a, Plate I).
Figure 4. Analysis of the molluscan palaeofauna from the Ocnița – Moreni area

**Shell Morphology**

Bivalves: ○ ± circular outline; □ oblong outline; rarely internal casts (bivalve)

**Dimensions** (can be considered for broken shells too)
- great generic & specific variability
- species variability, different stages of growth in the same habitat

**Internal Features** (Bivalvia)
- medium and high degree of preservation (in some cases even of ligament area)
- cardinal teeth (sometimes eroded/abraded)
- lateral (lamellar) teeth - eroded (with good preservation in ○ shells)
- dental (teeth) socket - with good preservation
- palial line and muscle scars clearly marked (in shells - posterior erased);

**External Features** (Bivalvia & Gastropoda)
- equilateral shells (valves) have good preservation; thick shells usually led to good preservation
- inequilateral, elongated valves are posteriorly broken
- circular peristom complete
- other shapes usually broken
- gastropods shells are more complete, a few apical parts are broken
  
  diversified ornamentation (ribs, growth lines, commarginal lines, tubercules, divaricate)

**Preservation**
- autochtonous
- allochtonous (transported) → articulated or not dismembered outline broken

**Shells**
- ○ thicker
- □ best preserved
- ○ most are tuberculated

**Shells**
- ○ good preservation
- □ usually posterior (thinner) part broken

"Prints"
- attack
- parasitism/comensality/symbiosis

**Filling mode**
- most are empty
  - fine siliclastic material
  - secondary fill with siliclastic material
  - bioclastic fragments or organisms with smaller dimensions
- Neoforation process: especially pyritizations, rarely calcifications, deposition

Are easily removed through washing

Chemical deposition:
- thin manganese films
- granular pyrite

Locally or regionally - two sedimentary episodes:
- subsident – anoxic (Mn and pyrite)
- emergent – oxidant
Figure 5. Criteria of palaeoenvironmental reconstruction

**Biotic Factors**
- (trophic structure)
- (other relations)

**Abiotic Factors**
- Basinal Configuration
  - depth
  - substrate consistency
  - turbulence
  - luminosity

**Physical and Chemical Factors**
- temperature
- salinity
- chemical conditions
- bottom water oxygenation

**Population Dynamics (Changes)**
- Development of the ecological niches

**Fossils Assemblages**

**Criteria for recognizing**

**Stratigraphical Traits**

**Sedimentological Traits**
- lithological and chemical features

**Palaeontological Traits**
- body fossils
- trace fossils

**Fluid-dynamic Action**
- Differential preservation
- Spatial distribution pattern in relation with the sedimentary process

**Palaeobiological Reconstruction**

**Palaeoenvironmental Reconstruction**

- type of basin
  - substrate consistency, depth and temperature
- selective transport, wave action, water flow
  - "water energy"
- large specific diversity
  - generations with changes in shell morphology

**Ecological niche**
- fragmentation
- raining articulation

**Shell condition**
- Complete or incomplete shells

**Granofacies**
- sand
- silt
- mud
- Lower hydrodynamic energy

**Sedimentological features**
Some marks may be done by algae or fungi, during life, such as those along the aperture, along the sutures and in the umbo zone, where these organisms were stick (Figure 1b, 2-7, Plate III).

**Interpreting the geochemical features of the mollusc shells**

During spectral analysis, the values of the following minor elements were studied: Ti, Mn, Cr, Ni, Co, V, Mo, Cu, Pb, Zn, Sn, Ag, As, Ga, Zr, Ba, Sr and, for some samples, B (the tables show only elements of that sample).

Among the recorded elements, Co, V, Cr, Zn, Cu, Pb occur in the ash of extant trees (V occurs in vascular cryptogams, Zn in Viola calaminaria, Cu is 6500 ppm in Viscria alpina and in conifers it can reach 133 ppm). Elements such as Pb, Ni and As are toxic for living organisms.

From an outcrop occurring on the Sângereș Valley (Moreni) were analyzed four spectral samples, of ash and clay (Table 1).

**Table 1. Spectral values (in ppm) – Sângereș Valley (Moreni) outcrop**

| Sample no. | Distribution Lim. Lithology | Ti  | Mo  | Cr  | Ni  | Co  | V  | Mo  | Cu  | Pb  | Zn  | Sn  | As  | Ba  | Sr  | B  |
|------------|-----------------------------|-----|-----|-----|-----|-----|----|-----|-----|-----|-----|-----|-----|-----|----|
| 520        | clay                        | 300 | 300 | 0   | 3   | 10  | 10 | 3   | 10  | 3   | 0   | 0   | 0   | 0   | 0   |
| 521        | clay                        | 2500| 150 | 0   | 5   | 10  | 30 | 0   | 10  | 10  | 0   | 3   | 0   | 0   | 0   |
| 522        | coal                        | 300 | 3000| 0   | 3   | 0   | 10 | 3   | 10  | 10  | 0   | 3   | 0   | 0   | 0   |
| 523        | clay                        | 300 | 300 | 10  | 5   | 10  | 10 | 3   | 20  | 20  | 0   | 0   | 0   | 0   | 0   |
Table 2. Spectral values (in ppm) on molluscs shells

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<th>Sample no.</th>
<th>Fossil</th>
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<th>30 T</th>
<th>30 Mn</th>
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<th>3 Ni</th>
<th>3 Co</th>
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<th>3 Mo</th>
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<th>3 Pb</th>
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<th>300 As</th>
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- traces, under the distribution boundary
* geochemical values shown in graphs for syngenetic, diagenetic and biogenetic elements.

It can be seen that the same geochemical spectra characterize the species Rugunio mojsvani from two separate areas of occurrence, at 12 km distance in between. The occurrence of B is in the same concentration, as this element is a marine salinity marker. But the differences with regard to Rugunio lenticularis are reflected mainly by the increase of Ba and Sr contents. In Pristinunio pristinus occur Ni, Co, Mo, Zn with lower values, Sn and As being close to the detection limit (in other shells these elements do not occur). Sr has higher values than in many samples as it is related to Ba that has high, proportional values too.

In Figures 7 and 8 there are shown histograms of trace elements in the mollusk shells collected from Dan's Valley and respectively from Sângereș Valley.

The minor elements can be included in the following categories: biogenetic elements – Co+Ti+Mn; syngenetic elements – Mo+Cr+Zn and diagenetic elements – Pb+Ni+V. For some shells, the graph for trace elements is shown in Figure 9.

Figure 7. Histograms of geochemical spectra on shells from Dan's Valley
Dendrites characters on mollusks shells

The dendrites have pellicular aspect and occur along fissures and pores of mollusks shells (especially bivalves) as on growth ridges at unionids and apertural ridges at viviparids.

The conditions for that are given by the existence of manganese and iron sources and by possibility of transport of these elements. The dendrites represent a peculiar case and they occur as alteration coatings under rapid, pressured transport. On carbonate rocks and on carbonate shells, the chemical content of the dendrites is given by oxides of Fe and Mn. The X-ray analysis of dendrite powders indicates amorphous and crystalline phases (Damian, 1999, Ph.D. thesis). The crystalline phase is represented by very small sized crystals of psilomellane, piroluzite, goethite.

The genesis of dendrites is due to the process of under pressured flow of the fluids within the shell’s pores and fissures, through reaching a critical level between the superficial tension and the moving speed, accompanied by the release of latent evaporation and precipitation heat (crystallization), when the spread of the liquid front on divergent branches takes place. The dendrite’s morphology on shells of P. pristinus (Figures 1-3, Plate I) shows the following shapes: radial-lateral (Figure 3, Plate II); radial-symmetrical (Figure 4, Plate II) or radial-dichotomous, especially with alternating arrangement of branches (Figure 1, Plate II).

On some areas of shells occur pore fillings. These manganese fillings can penetrate deeply the shell (Figure 3a, Plate II).

Although the dendrites occur on the inner surfaces of the shells or along the gastropods’ apertures, a corresponding report of the “dendritic picture” could not be identified at the shell surface (during the fluid circulation under pressure on the “conduct-pores”).

On some valves occur manganese covers, developed from the umbo (Figure 2, Plate II). Usually, the viviparid shells have manganese fillings within the umbilicus or, rarely, along growth ridges (Figure 3 and 4, Plate III). Some depressions made by predators are filled with newly formed Mn powder (Figure 1, Plate III).

Figure 8. Histograms of geochemical spectra on shells from Sångeriş Valley

Figure 9. Ratios of syngenetic/diagenetic and biogenetic elements
CONCLUSIONS

1. In this paper there were approached morphological aspects of viviparids and unionids. Their morphology is correlated with their paleoenvironment and with diagenetic processes. The interpretations presented here contribute to the general paleoecological image of the Dacian Basin, within the Ocnita- Moreni sector.

2. The distribution of trace elements found in the shells is triggered by the large water exchange within the basin and not only by local causes. The geochemical markers can be used for correlating the coal seams.

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PLATES

PLATE I
Figures 1-3. *Pristinunio pristinus* (Bielz) x 1, Rm; Dan's Valley; (2, 3 with internal structures of hinge preserved - ecological niche from Valea lui Dan – Dan’s Valley – Ocnita)
Figures 4, 5. *Pristinunio davilai* (Porumb.) x 1, Rm; Dan's Valley – Ocnita
Figures 6. *Pristinunio mutabilis* (Bielz) x 1, Rm; Dan’s Valley – Ocnita
Figures 7. *Rumanunio rumanus* Tourn. x 1, Dc; Ialomița Valley (On the right valve there are circular borings by naticids.)

PLATE II
Figures 1-4. *Pristinunio pristinus* (Bielz), Rm; Dan’s Valley – Ocnita (digital photos: Fig. 1a x 1.2; Fig. 1b > 9 x Fig. 1a; Fig. 2 x 1.9; Fig. 3a x 3; Fig. 3b > 5.3 x Fig. 3a; Fig. 4a x 3.2; Fig. 4b > 4.2 x Fig. 4a)
The Mn dendrite’s morphology on shells of *P. pristinus* shows the following shapes:
- radial-dichotomous, with alternating arrangement of branches – Fig. 1;
- manganese curtains – Fig. 2;
- manganese fillings penetrate deeply the shell – Fig. 3a; radial-lateral shape Fig. 3b;
- radial-symmetrical shape – Fig. 4a.

PLATE III
Figures 1-8. *Viviparus* div. sp. show marks of animal interactions represented by borings and cracks. Some depressions are made by predators are filled with Mn powder.
Figures 1c, 2-5, 8 shows depressions which are filled with Mn powder along growth ridges and suture zones. Figures 1b (detailed in Fig. 6) and Fig. 7 show marks done by algae or fungi in the umbo zone.