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PALEOECOLOGY OF EARLY BATHONIAN MOLLUSCAN FAUNAS IN THE CODLEA AREA (SOUTH CARPATHIANS, ROMANIA)

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Abstract: Two stratigraphically successive molluscan assemblages in the Early Bathonian *Zigzag Zone* lying in the Codlea area are paleoecologically analysed, both qualitatively and quantitatively. The lower molluscan paleocommunity inhabiting a siltier shallow shelf, dominated by antagonistic trophic relationships between a dense *Montlivaltia* population and the bivalves, shares a marked asymmetry of epi-endobenthos ratio, the endobenthos mostly including bivalves which successfully exploited the ecospace by adopting various infaunal adaptive strategies. The higher molluscan paleocommunity inhabiting a muddier deeper shelf shares a much higher diversity and individual abundance, and also a net increase in the infaunalisation of the bivalve fauna as a result of a rise in the predation pressure from the incoming to the habitat of some highly mobile predators, mainly cephalopods.

Key words: Romania, South Carpathians, Codlea area, Early Bathonian, molluscan fauna, taxonomic composition, paleoecology

Introduction

The Middle Jurassic deposits are largely developed in the easternmost part of the South Carpathians. Aside from the regions of the Bucegi and Braşov Mountains and also of the Dâmbovicioara Zone, which have long been well-known regions for their richness in Middle Jurassic molluscan faunas, already described by HERBICH (1888), POPOVICI-HATZEG (1905), SIMIONESCU (1899, 1905), JEKELIUS (1916) and PATRULIUS (1969), there is also the Codlea area where the Middle Jurassic deposits delivered various molluscan faunas.

The Middle Jurassic deposits in the Codlea area were mapped by SĂNDULESCU (1967) whereas their molluscan faunas were partially inventoried and described by VÎLCEANU (1960) and MANOLIU-NEGREANU (1969).

Among the Middle Jurassic molluscan faunas in the Codlea area, those of the Early Bathonian show a larger development. These faunas are characterised not only by a high taxonomic diversity but also by their impressive abundance. The bivalves are particularly abundant. Besides bivalves, ammonites and gastropods are subordinately represented. Other macro-invertebrate groups are quite scarcely found or poorly diversified, e.g. brachiopods and corals.

The present paper is primarily concerned with the taxonomic composition and palaeoecological analysis, both qualitatively and quantitatively, of two stratigraphically distinct molluscan assemblages recovered by one of us (EG) from the Lower Bathonian deposits found in the Codlea area. An extensive inventory and systematic description of the Early Bathonian molluscan faunas of the Codlea area will be given in a subsequent paper.

Our paper and also STOICA's study (included in this volume) are the first approaches to the paleoecology of the Middle Jurassic molluscan faunas in the eastern part of the Getic Nappe. These will contribute to a more accurate outline of the depositional history and sequence stratigraphy of the time-interval concerned in this area of the South Carpathians.

1. Geologic and stratigraphic setting

The Codlea area, lying immediately east of the Holbav Fault, is located in the eastern extremity of the Getic Nappe, just bordering the Supra-Getic East Făgăraş Nappe.

As a consequence of their structural position, the Jurassic rock-sequences in the Codlea area are involved in an intricate tectonics. Structurally, the investigated Lower Bathonian deposits have been assigned to the Getic Holbav Unit, it being thrusted in its turn by the Măgura Codlea Slice (SĂNDULESCU, 1976).

The Lower Bathonian deposits, informally assigned by PATRULIUS (1980) to the Valea Lată Formation, scantily crop out in several rivulets which are right-hand tributaries of the Valea Lată (=Breitbach) upstream to the locality of Colonia 1 Mai. The studied molluscan faunas were recovered by digging two distinct Lower Bathonian rock-sequences found in the last rivulet near the place named "Poiana cu Ghiocei".

The first molluscan assemblage was extracted from a rock-sequence, less than 1 m in thickness, made up of blackish coloured, ferruginous weathering, micaceous argillaceous siltites and silty clays bearing bands of blackish, limonite coated, nodular silty argillaceous limestone, approximately at 50 m upstream near the junction with the Valea Lată stream. The molluscan fauna, almost exclusively represented by bivalves, is associated with a rich *Montlivaltia* population.

The second molluscan assemblage, stratigraphically higher, located approximately over 100 m upstream near the junction of the same rivulet with the Valea Lată stream, was extracted from a rock-sequence, over 2 m in thickness, made up of greyish to yellowish, ferruginous weathered clays bearing subdecimetric to decimetric, limonite coated, nodular blackish argillaceous limestone. It is the molluscan assemblage which was previously recorded by VÎLCEANU (1960) and MANOLIU-NEGREANU (1969) in the same area. The bulk of this molluscan assemblage is made up of a rich and very diversified fauna of bivalves, with which a diversified cephalopod fauna is also associated. Rare gastropods and brachiopods, and scarce, dwarf specimens of corals are also to be found.

It is noteworthy that the lower molluscan assemblage is recorded in the Codlea area for the first time. Also, in both assemblages there are several, biostratigraphically and paleobiogeographically significant genera and species of bivalves and ammonites which have been for the first time recorded in the Romanian area.

Biostratigraphically, the age of the second molluscan assemblage is precisely constrained by the ammonite species making up a homogeneous assemblage which is indicative of the *Yeovilense* Subzone in the Early Bathonian *Zigzag Zone* (Table 1). The age assignment of the first molluscan assemblage, which lacks an ammonite fauna, is rather poorly constrained. However, having in view its lower stratigraphic position and also some taxonomic similarities showed by the bivalve faunas in both assemblages, the first molluscan assemblage can be confidently biostratigraphically assigned to a lower level in the *Zigzag Zone*.

Depositionally, having in view the lithologies and the paleosynecology of the two molluscan faunas, an upward deepening tendency of the sedimentary environments during the Early Bathonian is quite evident in the Codlea area. The first molluscan assemblage, joining a dense *Montlivaltia* population, is characteristic of a shallow-water, more calcareous, siltier sedimentary environment. The second molluscan assemblage, very rich in various trophic groups of bivalves but also including a diversified cephalopod fauna providing open-sea connections, is representative for a deeper water, less calcareous, muddier sedimentary environment.

2. Taxonomic composition and ecological groups

The studied material has been recovered from a very limited area and corresponds to a short stratigraphic interval in the Early Bathonian *Zigzag* Zone. However, the two molluscan assemblages listed in Tables 2 and 3 exhibit an appropriate taxonomic diversity and abundance to allow a sound paleoecological analysis. Also, the large amount of available material, especially of bivalves, which make up the bulk in the two assemblages, is convenient for a quantitative paleoecological analysis.

As stated by ABERHAN (1994), the paleocommunities or associations, which stand for autochthonous to parautochthonous fossil assemblages, are mainly defined by the number of individuals of constituent species rather than taxonomic richness. Consequently, the quantitative analysis of fossil assemblages by calculating the relative abundance of species is very important in order to define the ecologically significant groups and to reconstruct the functional attributes of paleocommunities.

This new approach in quantitative paleoecology has been also applied to the paleoecological analysis of the two Early Bathonian molluscan assemblages in the Codlea area.

By analysing the individual morphology, the preservation pattern, the relationships of each molluscan group with the substratum, the relationships of trophic groups to each other, and by comparing our data with the available data in the relevant literature, we assigned (Tables 2 and 3) the recognised taxa in both assemblages to the main ecological groups currently established for the Jurassic molluscan paleocommunities (HALLAM, 1976; DUFF, 1978; FÜRSICH, 1980; JOHNSON, 1984; JOHNSON & LENNON, 1990; WERNER, 1986, ABERHAN, 1994, etc).

The relative percentages of ecologically significant groups at higher taxonomic levels and for the Bivalvia, which are calculated for each association, are distinctly shown in Figure 1. The relative abundance of individuals of each species in both fossil assemblages, shown in Figure 2, emphasises the trophic nucleus, i.e. the numerically most important elements that account for 80 % of the total number of individuals in both paleocommunities. The taxa forming the trophic nucleus in each association include the commonest species which give their distinctive pattern. An attempt to reconstruct the paleocommunities corresponding to the two studied Early Bathonian molluscan assemblages, inhabiting lithologically distinctive shelf habitats, is made in Figures 3 and 4.

2.a The lower molluscan paleo-community, inhabiting a siltier shallow shelf

This paleocommunity is primarily characterised by a marked asymmetry of epi-endobenthos ratio. The diversity of the epibenthos is lower as compared with that of the endobenthos which is mostly dominated by bivalves. However, the total number of bivalves in the paleocommunity is overridden by the total number of corals which are the main components of the epibenthos. The corals which seem to belong only to one single species of *Montlivaltia*, make up 60 % of the total number of the individuals in the fossil assemblage.

The preservation pattern of the faunas, not taking into account the sampling failure, is highly variable. It relates to the morphology and size of each taxon, also of their mode of life and feeding style. The corals, which are in most cases wholly preserved, although worn on the lateral sides or on the upper part, are usually not found in their life position. The corals' basis, which is very large for most specimens, is well preserved, often showing the mould of the attachment surfaces (shell or coral remains). The fixed epibenthic bivalves (*Camptonectes*) are represented by disarticulate valves with partially preserved ornamentation. The free-swimming bivalves (*Neoentolium*) show small-sized, thinly-shelled, flat-valved individuals. The endobenthic bivalves have a good to moderate preservation. The small-sized bivalves of the endobenthic group living near the water-sediment interface (*Trautscholdia*, *Pressastarte* and *Protocardia*) show varied preservation patterns. Nicaniella (*Trautscholdia*), having extremely convex shells, occurs either as articulate or disarticulate valves, frequently with well-preserved ornamentation. *Pressastarte*, with very thin and flattened valves, also having a small internal cavity, is preserved either as complete internal moulds or as shell fragments bearing the ornamentation, although for most specimens the shells were exfoliated during the sampling. A better preservation is characteristic of *Protocardia* shells which even show the very fine details of ornamentation. The higher-sized infaunal bivalves (*Pholadomya*, *Pleuromya*) are commonly preserved as internal moulds more or less deformed owing to sediment compaction. Semi-infaunal bivalves (*Inoperna*, *Pinna*) are in most cases preserved as incomplete shells, showing the anterior end which had been sunken in the substratum during their lives thus being better protected against the water movement, and consequently much better preserved, than the posterior end that remained exposed above the bottom surface. The small-sized, spear-shaped shells of infaunal bivalves (*Gervilella*) are much better preserved showing articulate valves with well-preserved ornamentation.

Inside the first marine benthic assemblages of the Jurassic epeiric seas flooding the areas previously occupied by swamps during the Early Jurassic, the first occupants had been much less sensitive organisms, which were able to colonise physically highly stressed shelf habitats. However, the ecospaces were less intensively used in such environmental conditions. It is quite well illustrated by the lower paleocommunity which shares a low taxonomic composition and also a reduced population size (Table 2 and Figure 2). The solitary corals, which were the dominant component in the epifauna, exhibit a morphological feature of a prominent paleoecological significance, i.e. a large, flattened basis as compared to the height of the polypierites. It suggests the necessity for a firm attachment to an unstable, shifting substratum in a high-energy siltier shelf habitat. The taxonomic composition of the paleocommunity was dominated by antagonistic trophic relationships between corals and bivalves, the first group being microcarnivores devouring the larvae of bivalves. In such conditions, the endobenthic bivalves successfully exploited the habitat and diversified by adopting various infaunal adaptive strategies. Some of them, more conservative, are also to be found in the next, stratigraphically higher, molluscan palae-ocommunity, together with other new incomers.

2.b The higher molluscan paleocommunity, inhabiting a muddier deeper shelf

This assemblage is characterised by an outstanding rise in diversity and relative individual abundance of some molluscan ecological groups, by the modification of the epi-endobenthos ratio and also by a net increase in numbers of individuals and population (Table 3, Figures 1 and 2).

The increase in diversity is characteristic of all taxonomic levels. Whereas the lower fossil assemblage includes 3 classes, 8 orders, 13 families and 16 species, in the higher fossil assemblage there are 5 classes, 12 orders, 28 families and 42 species. Regarding individual abundance, any other species did not realise the dominance of the corals in the lower fossil assemblage. On the contrary, in the higher fossil assemblage the corals disappeared almost completely. The most important incoming into the paleocommunity is shown by cephalopods, mainly by ammonites, which suddenly appeared in the area. Regarding the epi-endobenthos ratio, it should be stressed that a radical change of the trophic nucleus occurred. The corals were replaced by various epi- and endobenthic groups of bivalves. As a consequence, the trophic nucleus is given by a larger group of epi- and endobenthic taxa which had been in equable competition to occupy ecospaces (Figure 4). Among them, the cemented epifauna (*Catinulus*) and the shallow endofauna (*Trautscholdia*) show the highest number of individuals. Another striking feature of the fauna in the higher assemblage, which is evident in Figures 2 and 4, refers to the greater sizes of the individuals, mainly of the endobenthic bivalves (*Anisocardia, Pholadomya, Goniomya, Protocardia*) and of the semi-infaunal bivalves (*Gervilella, Pinna*). The epifaunal bivalves, although less frequent, also have large sizes, such as *Plagiostoma* which is byssally fixed in fissures, *Ctenostreon* which is lies free on the substratum, *Modiolus* and *Lycettia* which are concentrated in clusters and attached by a short byssus. The number of bivalve groups which had been independent of the substratum also show a significant increase. The group of bivalves which developed adaptations to a floating mode of life on soft bottoms, mainly in the adult life-stage (JOHNSON, 1984), includes *Entolium* and *Propeamusium*. In the same group, but planktonic, *Bositra* quite frequently occurs as compared with the above-mentioned taxa. The assignment of Bositra to either the nekto-planktonic (JEFFERIES & MINTON, 1965) or the pseudoplanktonic bivalve group, the latter being bysally attached to various floating objects (driftwood or other organic matter) only during early ontogenetic stages, seems to be not unanimously accepted (WIGNALL & SIMMS, 1990; ABERHAN, 1994).

Besides the taxa analysed above, other genera and species, which are fewer, are to be found. They are recorded in Tables 2 and 3 and are illustrated in the charts reconstructing the life habits of the molluscan paleocommunities for the two fossil assemblages (Figures 3 and 4). The very diversified cephalopod fauna, although poor in number of individuals, is however very important for the paleoecological and paleobiogeographic interpretation of the Early Bathonian molluscan assemblages occurring in the Codlea area.

The incoming of cephalopods, which were highly mobile and active predators, enhanced the competition between the trophic groups of the paleocommunity. It explains the larger occurrence in the higher molluscan assemblage of the infaunal and semi-infaunal bivalves as compared to the fixed epifaunal bivalve group, the latter being more exposed to the predation pressure of cephalopods, especially represented by ammonites and belemnites.

The relative abundance of the Oppeliids, with the two largely-occurring species of *Oxycerites*, is an ubiquitous feature in the Early Bathonian *Zigzag Zone* in both Northwest European (Boreal) and Sub-Mediterranean (Tethyan) Provinces, whilst the occurrence of several families of Phylloceratida and Lytoceratida clearly shares conspicuous Tethyan paleobiogeographic relationships (MOUTERDE et al., 1971; STURANI, 1967; TORRENS, 1971, 1987; HAHN et al., 1990). The taxonomic composition of the Early Bathonian *Zigzag Zone* ammonite assemblage recorded in the Codlea area, which combines the features mentioned above, is in good agreement with the palinspastically-restored paleogeographic position of the South Carpathian terrain, immediately lying on the northern margin of the Tethyan area.

3. Analysis of faunal diversity and stability

The two paleocommunities were quantitatively analysed taking into account the index of diversity (H) and the index of faunal stability (QS).

The index of diversity (H) was calculated for both paleocommunities by applying LLOYD & GHELARDI's formula (1964):

$H = c\,(\log N - \Sigma \log n_i / N)$ $c = 3.321928$, N is the number of individuals for all taxa in the paleocommunity, ni is the number of individuals of taxon (i).

For the lower paleocommunity (I), the diversity of the entire paleocommunity is then:

$$H_I = 3.321928\ (\log 377 - \Sigma \log n_i\ /\ 377)$$

$$\Sigma \log n_i = \log 236 + \log 12 + \log 7 + \ldots + \log 6 = 14.593829$$

$$H_I = 3.321928(\ \log 377 - 0.0387104) = \underline{8.\ 4298273}$$

The diversity calculated only for the bivalve fauna in the lower paleocommunity (I) is:

$$H_{Ibiv.} = 3.321928(\log 129 - \Sigma \log n_{ibiv.}\ /\ 129) = 6.7243121$$

$$\text{where } \Sigma \log n_{ibiv.} = 11.141736$$

For the higher paleocommunity (II), the diversity for the entire paleocommunity is then:

$$H_{II} = 3.321928(\log 270 - \Sigma \log n_i\ /\ 270)$$

$$\text{where } \Sigma \log n = 20.038308$$

$$H_{II} = 3.321928(\log 270 - 0.0742159) = \underline{7.8302754}$$

The diversity calculated only for the bivalve fauna in the higher paleocommunity (II) is:

$$H_{IIbiv.} = 3.321928\ (\log 237 - \Sigma \log n_{ibiv.}/237) = 7.6442236$$

$$\text{where } \Sigma \log n_{ibiv.} = 17.445022$$

By comparing the diversity indices of the two paleocommunities, for which

$$H_I = 8.4298273 \text{ and } H_{II} = 7.8302754$$

one can surprisingly note that H_{II} is lower than H_I, which is not in concordance with the percentage points calculated for each group of organisms in both paleocommunities. Having in view that the higher paleocommunity (II) includes both cephalopods (10.01%) and brachiopods (0.74%), whereas these groups lack in the lower paleocommunity (I), it is obvious that the higher paleocommunity (II) had a higher diversity than the lower paleocommunity (I). This may be explained by the fact that 11 cephalopod species are each represented by one single specimen, thus $\log 1 = 0$.

Therefore, when we calculate the index (*H*), so as to be significant, either the number of species represented by one single specimen should be subtracted from *H* (total number of specimens) or *H* should be calculated for each group of organisms making up the paleocommunity.

By comparing the indices of diversity of the bivalve faunas in both paleocommunities, for which $H_I\ biv. = 6.7243121$ and $H_{II}\ biv. = 7.6442236$, it may be seen that the diversity of the bivalve fauna in the higher paleocommunity (II) is higher than the diversity of the bivalve fauna in the lower paleocommunity (I). The difference is especially given by the higher abundance of epifaunal bivalves in the higher paleocommunity (II), which are also more diversified ecologically than in the lower paleocommunity (I). Moreover, as against the lower paleocommunity (I), the higher paleocommunity (II) includes 2 species of cemented epifaunal suspension feeders (49 specimens); 5 species of byssate epifaunal suspension feeders (29 specimens); 1 species of free-living suspension feeders (*Bositra buchi*, 11 specimens).

For the analysis of faunal stability of the bivalve associations in the two stratigraphically successive Early Bathonian molluscan assemblages occurring in the Codlea area, by taking into account the record of the number of species, the quotient of stability (QS), used by KONTKANEN (1957), is calculated. It is defined as:

QS = [2c / (a+b)]100 where *a* is the number of the bivalve species in the lower paleocommunity (I), *b* is the number of bivalve species in the higher paleocommunity (II), and *c* is the number of bivalve species common to the two paleocommunities I and II.

Thus calculated *QS= 0.26%*, this figure shows a low faunal stability for both paleo-communities. It is in agreement with the paleo-ecological features of the two paleocommunities as already described in the foregoing chapter.

4. Conclusions

The Early Bathonian molluscan assemblages recovered from the Codlea area, being extensively sampled, can be conveniently treated as paleocommunities or associations, thus enabling us a sound paleoecological analysis, both qualitatively and quantitatively. As no specific taphonomic observations have been made in the field, the autecological reconstruction (life positions, colonisation strategies, degree of intraspecific and interspecific competition) of the bivalve faunas is mainly based on a functional morphological analysis. The conspicuous taxonomic diversity and abundance in the higher paleocommunity as against the lower paleocommunity was the response to a striking shift in sedimentary style, from a siltier shallow shelf to a muddier deeper shelf. It was obviously related to an upward deepening of shelf habitats. The marked infaunalisation and the diversification of the bivalve fauna in the higher paleocommunity were largely controlled by the net rise in the predation pressure and the adoption of various, new adaptive strategies. Further paleoecological research of Middle Jurassic molluscan faunas in the eastern part of the Getic Nappe will improve our knowledge of depositional history and sequence stratigraphy in the area in the time-interval concerned.

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Captions of Tables and Figures

Table 1 – Correlation chart for the Bathonian in the eastern sector of the Getic Nappe in the South Carpathians showing the lithostratigraphic units and the record of the biostratigraphic zones.

Table 2 – Taxonomic composition and ecological groups of bivalve faunas and other macroinvertebrate organisms in the lower paleocommunity.

Table 3 – Taxonomic composition and ecological groups of bivalve faunas and other macroinvertebrate organisms in the higher paleocommunity.

Figure 1 – Charts and tables showing the relative abundance of the ecological groups of bivalve faunas and other macroinvertebrate groups in both paleocommunities.

Figure 2 – Charts showing the relative individual abundance and size of the bivalves and other macroinvertebrate organisms giving the trophic nucleus in both paleocommunities.
A – Trophic nucleus with *Montlivaltia* sp. and *Protocardia stricklandi* in the lower paleocommunity: 1 – *Montlivaltia* sp.; 2 – *Protocardia (P.) stricklandi;* 3 – *Grammatodon (G.) concinus*; 4 – *Neoentolium cingulatum*; 5 – *Naricopsina subcanaliculata*; 6 – *Pressastarte (P.) ungulata*; 7 – *Nicaniella (Trautscholdia) carinata*; 8 – *Inoperna sowerbyana*; 9 – *Gervilella monotis*; 10 – *Pleuromya cf.uniformis*; 11 – *Pholadomya sp.*;
B – Trophic nucleus with *Catinulus* sp.A, *Nicaniella (Trautscholdia) carinata* and *Anisocardia loweana* in the higher paleocommunity: 1 – *Catinulus sp.A*; 2 – *Nicaniella (Trautscholdia) carinata*; 3 – *Anisocardia loweana*; 4 – *Pholadomya (Bucardiomya) murchisoni*; 5 – *Bositra buchi*; 6 – *Inoperna sowerbyana*; 7 – *Modiolus imbricatus*; 8 – *Plagiostoma sp.A*; 9 – *Protocardia (P.) lycetti*; 10 – *Lycettia sp.*; 11 – *Oxycerites yeovilensis*; 12 – *Oxycerites seebachi*; 13 – *Grammatodon (Cosmetodon) keyserlingi*; 14 – *Goniomya intersectans*; 15 – *Myophorella sp.*; 16 – *Pressastarte sp.*; 17 – *Plagiostoma sp.B.*

Figure 3 – Chart reconstructing the infaunal and epifaunal life habits and showing the faunal elements giving the trophic nucleus in the lower paleocommunity. 1 – *Montlivaltia sp.*; 2 – *Protocardia (P.) stricklandi*; 3 – *Grammatodon (G.) concinus*; 4 – *Neoentolium cingulatum*; 5 – *Naricopsina subcanaliculata*; 6 – *Pressastarte (P.) ungulata*; 7 – *Nicaniella (Trautscholdia) carinata*; 8 – *Inoperna sowerbyana*; 9 – *Gervilella monotis*; 10 – *Pleuromya cf.uniformis*; 11 – *Pholadomya sp.*; 12 – *Myophorella sp.*; 13 – *Pinna sp.*; 14 – *Camptonectes (C.) auritus*;

Figure 4 – Chart reconstructing the infaunal and epifaunal life habits and showing the faunal elements giving the trophic nucleus in the higher paleocommunity. 1 – *Catinula sp.A*; 2 – *Catinula sp.B*; 3 – *Anisocardia loweana*; 4 – *Pholadomya (Bucardiomya) murchisoni*; 5 – *Myophorella sp.*; 6 – *Pinna sp.*; 7 – *Inoperna sowerbyana*; 8 – *Grammatodon (G.) concinus*; 9 – *Modiolus imbricatus*; 10 – *Lycettia sp.*; 11 – *Plagiostoma sp.A*; 12 – *Plagiostoma sp.B*; 13 – *Propeamusium pumilus*; 14 – *Protocardia (P.) lycetti*; 15 – *Nicaniella (Trautscholdia) carinata*; 16 – *Goniomya intersectans*; 17 – *Pressastarte (P.) ungulata*; 18 – *Grammatodon (Cosmetodon) keyserlingi*; 19 – *Chlamys (C.) textoria*; 20 – *Calliphylloceras disputabile*; 21 – *Bositra buchi*; 22 – *Partschiceras viator*; 23 – *Oxycerites yeovilensis*; 24 – *Oxycerites seebachi*; 25 – *Planisphinctes planilobus*; 26 – *Ebrayiceras pseudoanceps*; 27 – *Zigzagiceras plenum*; 28 – *Nannolytoceras sp.*; *Montlivaltia sp.*

Table 1

		Sub -Boreal Province NW - Europe standard		Sub -Mediteranean Province W - Tethys standard		South		Carpathians	
		zone	subzone	zone	subzone	zone	subzone	Bucegi Mts	Braşov Mts Codlea area
CALLOVIAN		*Macrocephalites (K) herveyi*		*herveyi*		*macrocephalus*			BÂRSA TAMAŞ FORMATION
BATHONIAN	Upper	*Clydoniceras (C) discus*	*discus*	*discus*				STRUNGA FORMATION condensation zone	Hiatus
			hollandi						
		Oxycerites (O) orbis		*Prohecticoceras retrocostatum (="O. aspidoides")*	*retrocostatum*	*retrocostatum*			
					blanazense				
		Procerites hodsoni		*Cadomites rectelobatus bremeri*					
	Middle	*Morrisiceras (M) morrisi*		*subcontractus*	*morrisi*			Hiatus?	
		Tulites (T) subcontractus			*subcontractus*				
		Procerites progracilis		*progracilis*		?			
	Lower	*Asphinctites (A) tenuiplicatus*		*zigzag*	*tenuiplicatus*	*zigzag*	*tenuiplicatus*	condensation zone	VALEA LATĂ FORMATION
		Zigzagiceras (Z) zigzag	*Oxycerites (O) yeovilensis*		*yeovilensis*		*yeovilensis*		
			Morphoceras macrescens		*macrescens*		*macrescens*		
			Parkinsonia (G) convergens		*convergens*				
BAJOCIAN		*Parkinsonia (P) parkinsoni*		*parkinsoni*				STRUNGULIȚA FORMATION	

Table 2.

Family	Species	Ecological group	No.ex	%
MONTLIVALTIIDAE	Montlivaltia sp.	cemented epifaunal microcarnivore	236	62.59
NATICIDAE	Naricopsina subcanaliculata (M. & L.)	infaunal carnivore	12	3.18
PARALLELODONTIDAE	Grammatodon (Grammatodon) concinus (Phillips)	infaunal non-siphonate suspension feeder	20	5.30
	Grammatodon (Cosmetodon) keyserlingi (d'Orb.)	pendant / byssate suspension feeder	7	2.59
MYTILIDAE	Inoperna sowerbyana (d'Orb.)	byssate semiinfaunal suspension feeder	8	2.96
PINNIDAE	Pinna sp.	--//--	4	1.06
ISOGNOMONIDAE	Gervilella monotis (Deslongchamps)	semiinfaunal suspension feeder	7	1.85
ENTOLIIDAE	Neoentolium cingulatum (Goldfuss)	swimmer suspension feeder	16	4.24
CHLAMIDIDAE	Camptonectes (Camptonectes) auritus (Schloth.)	byssate epifaunal suspension feeder	1	0.26
	Camptonectes (Camptochlamys) sp.	--//---	1	0.26
TRIGONIIDAE	Myophorella (Myophorella) sp.	non-siphonate infaunal suspension feeder	3	0.79
ASTARTIDAE	Nicaniella (Trautscholdia) carinata (Phillips)	non-siphonate infaunal suspension feeder	9	2.38
	Pressastarte (Pressastarte) ungulata (Lycett)		11	2.91
CARDIIDAE	Protocardia (Protocardia) stricklandi M. & L.	short siphonate infaunal suspension feeder	31	8.22
PHOLADOMYIDAE	Pholadomya sp.	long siphonate deep infaunal suspension feeder	5	1.32
PLEUROMYIDAE	Pleuromya cf. uniformis (Sowerby)	--//--	6	1.59

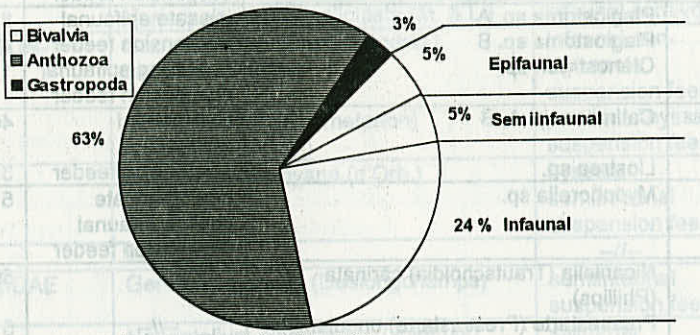
Table 3

Family	Species	Ecological groups	No. ex.	%
MONTLIVALTIIDAE	Montlivaltia sp.	cemented epifaunal microcarnivore	2	0.74
NERITOPSIDAE	Neritopsis bajociensis (M. & L.)	infaunal carnivore	1	0.37
APORRHAIDAE	Dicroloma laevigatus (M. & L.)	infaunal detritivore	1	0.37
GRAMMATODONTIDAE	Grammatodon (Grammatodon) concinus (Phillips)	non-siphonate infaunal suspension feeder	3	1.11
	Grammatodon (Cosmetodon) keyserlingi (d'Orb.)	pendant / byssate suspension feeder	6	2.22
MYTILIDAE	Inoperna sowerbyana (d'Orb.)	semiinfaunal suspension feeder	9	3.33
	Lycettia sp.	byssate epifaunal suspension feeder	7	2.59
	Modiolus imbricatus J. Sowerby	byssate epifaunal	9	3.33
PINNIDAE	Pinna sp.	byssate semiinfaunal suspension feeder	3	1.11
ISOGNOMONIDAE	Gervilella sp.	byssate	3	1.11

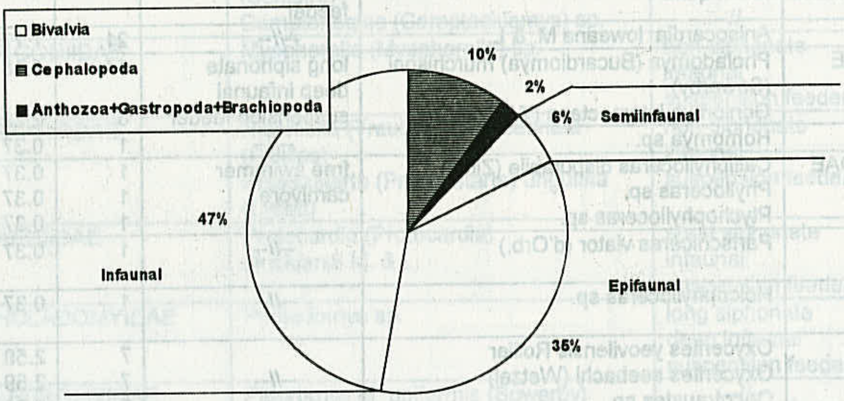
		semiinfaunal suspension feeder		
POSIDONIIDAE	Bositra buchi (Roemer)	free-swimmer	11	4.07
PROPEAMUSIIDAE	Propeamusium pumilum (Lamarck)	--//--	3	1.11
ENTOLIIDAE	Entolium sp.	--//--	1	0.37
CHLAMYDIDAE	Chlamys (Chlamys) textoria (Schoth.)	byssate epifaunal suspension feeder	1	0.37
LIMIDAE	Plagiostoma sp. A Plagiostoma sp. B Ctenostreon sp.	byssate epifaunal suspension feeder free-living epifaunal suspension feeder	8 4 1	2.96 1.48 0.37
OSTREIDAE	Catinulus sp. A, B Liostrea sp.	cemmented epifaunal suspension feeder	46 3	17.03 1.11
TRIGONIIDAE	Myophorella sp.	non-siphonate shallow infaunal suspension feeder	5	1.85
ASTARTIDAE	Nicaniella (Trautscholdia) carinata (Phillips) Pressastarte (Pressastarte) ungulata (Lycett)	 --//--	59 5	21.85 1.85
CARDIIDAE	Protocardia (Protocardia) lycetti (Rollier)	short siphonate infaunal suspension feeder	8	2.96
CIPRINIDAE	Anisocardia loweana M. & L.	--//--	21	7.77
PHOLADOMYIDAE	Pholadomya (Bucardiomya) murchisoni (Sowerby) Goniomya intersectans (W. Smith)	long siphonate deep infaunal suspension feeder	14 6	5.18 2.22
PANOPEIDAE	Homomya sp.	--//--	1	0.37
PHYLLOCERATIDAE	Calliphylloceras disputabile (Zittel) Phylloceras sp. Ptychophylloceras sp.	free swimmer carnivore	1 1 1	0.37 0.37 0.37
PHYLLOPACHY-CERATIDAE	Partschiceras viator (d'Orb.)	--//--	1	0.37
HOLCOPHYLLO-CERATIDAE	Holcophylloceras sp.	--//--	1	0.37
OPPELIIDAE	Oxycerites yeovilensis Rollier Oxycerites seebachi (Wetzel) Oecotraustes sp.	--//--	7 7 2	2.59 2.59 0.74
MORPHOCERATI-DAE	Ebrayiceras pseudoanceps (Ebray)	--//--	1	0.37
PERISPHINCTIDAE	Berbericears sekikense Roman Planisphinctes planilobus Buckman Zigzagiceras plenum Arkell	--//--	1 1 1	0.37 0.37 0.37
NANNOLYTOCERATIDAE	Nannolytoceras sp.	--//--	1	0.37
BELEMNITIDAE	Belemnopsis sp.	--//--	1	0.37
TEREBRATULIDAE	Terebratulide indet.	pedunculate epifaunal suspension feeder	2	0.74

Figure 1

Lower paleocommunity



Higher paleocommunity



Lower paleocommunity - bivalve species for each ecological group

Ecological group	No. sp.		No. ex.	%
Epifaunal suspension feeder	3 sp.	2 sp. byssate	2 ex.	0.53
		1 sp. swimmer	16 ex.	4.24
Infaunal suspension feeder	8 sp.	4 sp. non siphonate	43 ex.	11.40
		2 sp. long siphonate	11 ex.	2.91
		1 sp. short siphonate	31 ex.	8.22
		1 sp. byssate	7 ex.	1.85
Semiinfaunal suspension feeder	3 sp.	3 sp. byssate	19 ex.	5.03

Higher paleocommunity - bivalve species for each ecological group

Ecological group	No. sp.		No. ex.	%
Epifaunal suspension feeder	11 sp.	2 sp. cemented	49 ex.	18.14
		5 sp. byssate	29 ex.	10.74
		1 sp. free-living	1 ex.	0.37
		3 sp. swimmers	15 ex.	5.55
Infaunal suspension feeder	10 sp.	4 sp. non siphonate	72 ex.	26.66
		3 sp. long siphonate	21 ex.	7.77
		2 sp. short siphonate	29 ex.	10.74
		1 sp. byssate	6 ex.	2.22
Semiinfaunal suspension feeder	3 sp.	3 sp. byssate	15 ex.	5.55

Figure 2

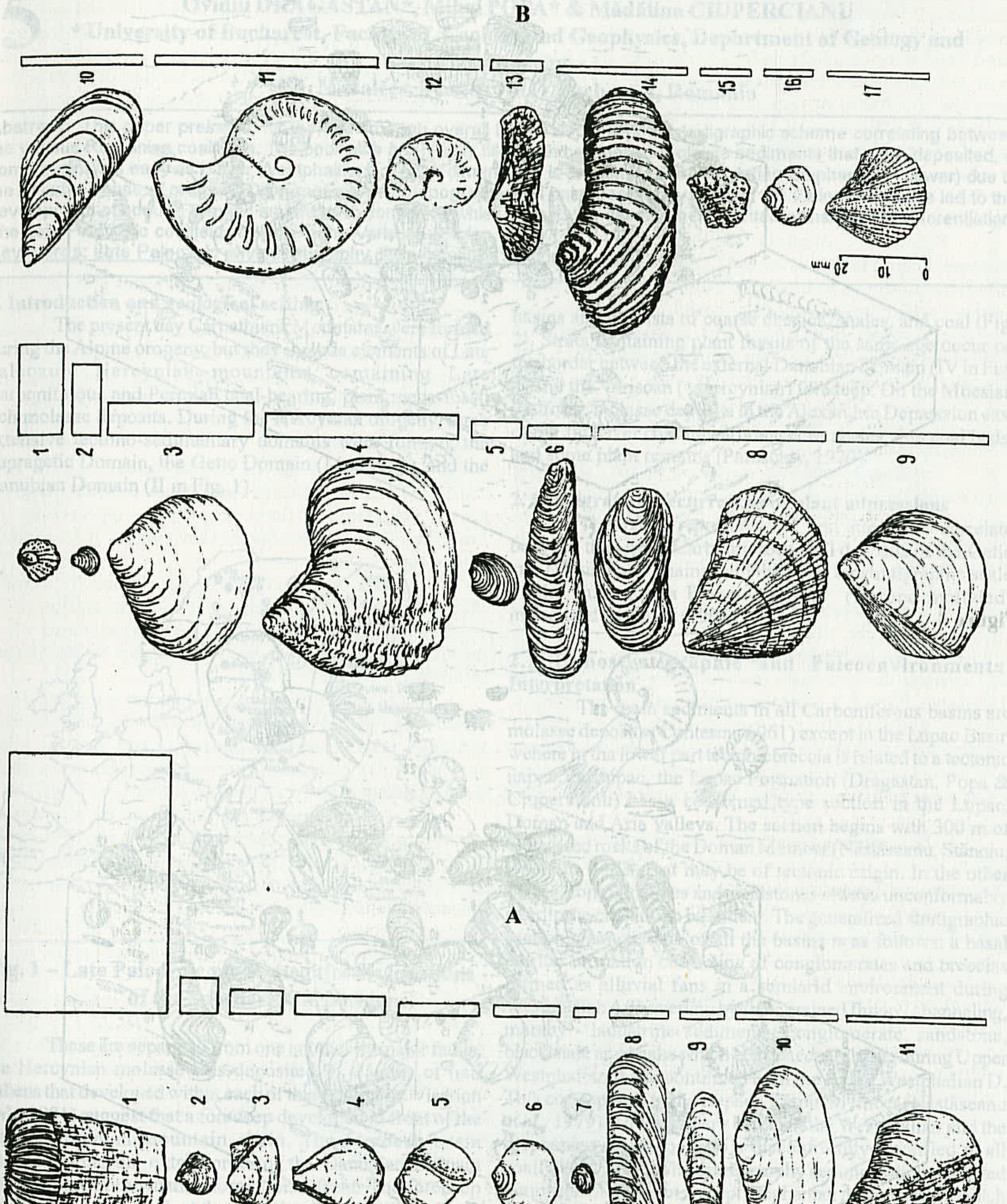

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Figure 3

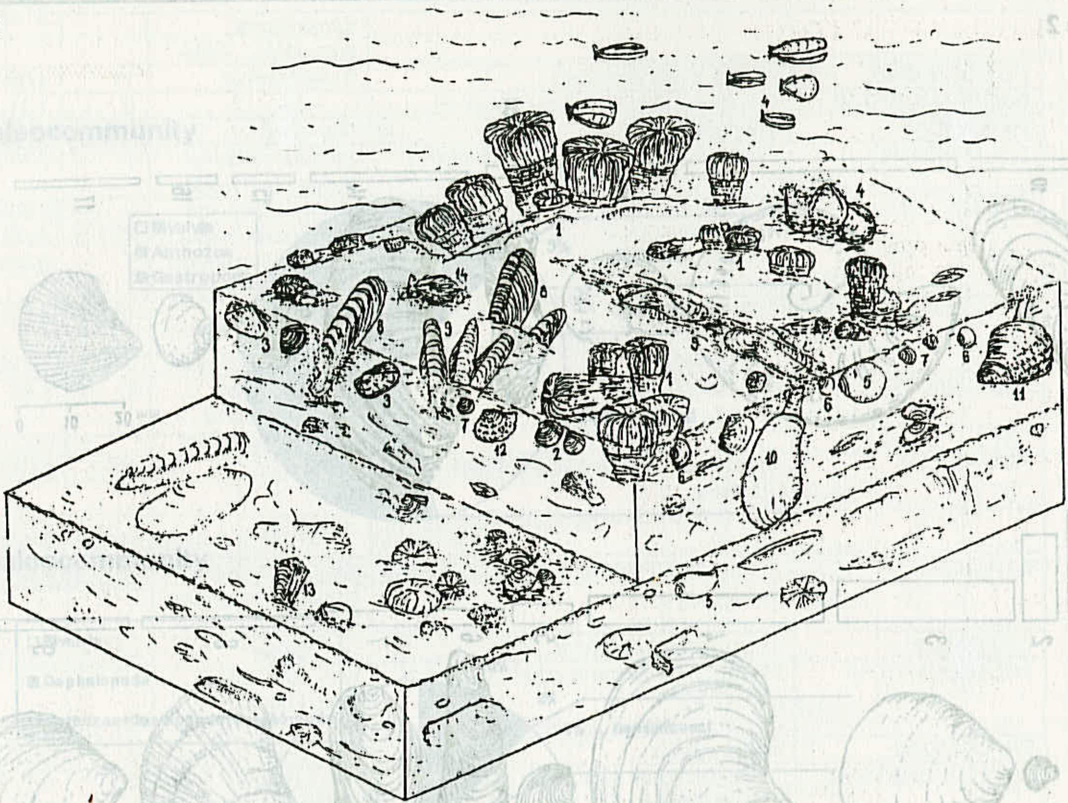

Figure 4