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PALEOECOLOGY OF MIDDLE JURASSIC BIVALVE COMMUNITIES OF STRUNGA-STRUNGULIŢA, THE WESTERN SIDE OF THE BUCEGI MOUNTAINS, ROMANIA

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Abstract: Bivalve paleocommunities are associated with depositional environments that correspond to the proximal shelf with sandy sediments, proximal shelf with fine sediments and proximal to middle shelf. Deep infaunal suspension feeders, shallow infaunal suspension feeders, epifaunal and semi-infaunal suspension feeders represent the dominant genera and morphotypes. *Pholadomya murchisoni* and *Isognomon isognomoides* occur in numerous colonies that preserved 50% of the individuals in the growth position. Occasionally, the deviations of this disposition probably reflect the natural variability of the life position. The calculation of the similarity coefficient (QS), for observing the faunal stability for three successive levels showed a value of 3.09%, which expresses a low degree of faunal stability. This situation characterises the Bajocian stage, the dependence of bivalve species with regard to a particular type of facies being demonstrated.

Key words: bivalves, Jurassic, Romania

The outcropping zones of the best studied Jurassic deposits occurring in the western side of the Bucegi Mountains are to be found at the basis of the limestone escarpment, south of Poliţe to the Ţapului Valley. South of this area, Jekelius (1938) identified the Middle Jurassic occurrence underneath the Upper Jurassic limestone sequence of the Zănoaga Mountain and of the Zănoaga Gorges. Other important outcropping areas are identified by D. Patrulius (1953): Horoaba Valley, Gura Văii-Horoaba in the southern end of the Peşterii Gorges, on both sides of the Ialomiţa Valley, in the northern end of the Tătarului Gorges, in the Zănoaga Valley, Lespezi Mountain, Rateiului Valley and in the Raciului Valley.

The richest fossiliferous and most complete succession of Jurassic deposits is the one confined by the Strunga-Strunguliţa sector, bounded by the Pasul Strunga in the north and Obârşia Văii Tătarului in the south. The richest fossiliferous points of this sector have been studied since the second half of the last century. E. Suess (1876) cited D. Stur (1860) as being the first author to demonstrate the Middle Jurassic age of these deposits. Fr. Hauer (1867), Fr. Herbich (1888) made the first faunal inventories of this zone. K. Redlich (1896) located the cephalopod bearing horizon of Pasul Strunga. V. Popovici-Hatzeg (1905) and I. Simionescu (1905) described the ammonites collected from this zone and later E. Jekelius (1916) described numerous bivalve and gastropod species. Later research accomplished by N. Oncescu (1945), D. Patrulius (1957; 1969) increased the knowledge of the stratigraphic and geological evolution of the zone, with emphasis on the Jurassic stage.

Essentially, the Middle and Upper Jurassic deposits occurring in the western side of the Bucegi Mountains are represented by the following successions, presented from base to top:

- a conglomerate, quartzite level, with centimetric elements caught in an caolinitic matrix. This level transgressively overlays the Leaota crystalline basement. The thickness of this level is 2m;
- a coal level, lens-shaped, rich in vegetal remains, passing to clays and marls (2m thick), with a rich fauna represented by *Mytilus suprajurensis*, *M. petatus*, *M. lynceus*, indicating the Lower Bajocian;
- a composite succession is the next Bajocian level, 6.5m thick, including sandstones, sandy limestone and marls with solitary corals (*Montlivaltia* sp.), brachiopods (*Epithyris* sp., *Goniorhynchia* sp.), bivalves (*Isognomon isognomoides, Pholadomya murchinsoni, Pholadomya reticulata, Unicardium cognatum* and *Quenstedtia macroides*). Within the sandstone levels, the Pholadomya species were recorded in life position with the anterior part of the shell oriented downwards in the bed. Many individuals were collected from limonitic concretions in which the shells are very well preserved, even with ornamentation elements. Also in the limonitic concretions *arthropod chelicers*, perfectly preserved;
- the following level is represented by an alternation of calcarenites and marls with a rich brachiopod fauna (*Acanthothyris spinosa, Terebratula globata, Rhynchonella spinosa, R. varians*), with solitary corals (*Montlivaltia* sp.) and frequent bivalves (*Chlamys fibrosus, Plagiostoma lesbergi, Camptonectes lens*) and numerous ostreids forming compact centimetric levels;
- the level with less abundant brachiopods, lithologically represented by sandstone, alternating with marly beds. The marls containing a rich bivalve assemblage of byssate epifaunal forms (*Limatula gibbosa, Inoperna plicata*) and infaunal forms (*Pleuromya uniformis, P. elongata, Gresslya gregaria, Ceromya plicata, Hommomya gibbosa, Goniomya proboscidea, Pholadomya murchisoni, P. ovulum*);
- the level with cephalopods is lithologically represented by a massive, compact, yellowish sandstone, passing laterally to a brown-yellowish limestone including a hard-ground towards its upper part. This hard-ground is laterally restricted (well developed in the Strunga zone) containing ammonites, entire or fragmented shells (*Hecticoceras* sp., species from *Phyloceratidae* and *Lythoceratidae* families). These ammonites are stratigraphically important, indicating the Upper Bathonian - ?Lower Callovian age;
- the Middle Callovian deposits (the Anceps Zone) and probably the Upper Callovian deposits (with rare

Peltoceratids) are lithologically represented by limestone and marls or by multicoloured jasps rich in radiolarians (within the Strunga-Vârfu Tătaru);

- the Oxfordian deposits of the Strunga-Tătaru zone are lithologically represented by limestone with red jasper interlayers. The Oxfordian deposits can be locally represented only by red jaspers;
- the limestone sequence, 30m thick, represented by massive limestone with ammonites, brachiopods and corals, indicating Kimmeridgian and Tithonian age.

The bivalve assemblage confined to the Bajocian-Lower Bathonian deposits of the Strunga-Strunguliţa sector is represented by 56 species belonging to 35 genera, the majority of the fauna being composed (presented here in frequency order) of *Pholadomyidae*, *Pleuromyidae*, *Isognomonidae*, *Mytilidae*, *Ostreidae*, *Pectinidae* families. Essentially, the bivalve species spectrum is the following:

Family MYTILIDAE Rafinesque, 1815: *Inoperna plicata* (Sow.), *Modiola sowerbyiana* (d'Orb.), *Mytilus suprajurensis*, *M. petatus*, *M. lynceus*, *Modilus* sp., *Modiolus gibbosus Sow.*, *M. imbricatus* Sow.

Family BAKEWELLIDAE King, 1850: *Gervilleia ferruginea* Beneke, G. aff. aviculoides

Family ISOGNOMONIDAE Dall, 1895: *Isognomon isognomoides* (Stahl.), I. flambarti (Golfuss)

Family PINNIDAE Leach, 1819: *Pinna* sp.

Family PECTINIDAE Rafinesque, 1815: *Chlamys fibrosus* (Sow.), C. dewalquei (Oppel), *Camptonectes lens* (Sow.), *C. annulatus* (Sow.), *Entolium* sp., *Velata* sp.

Family LIMIDAE Rafinesque, 1815: *Plagiostoma leesbergi* (Branco), *Plagiostoma* sp., *Limatula gibbosa* (Sow.), *L. globularis*, *Ctenostreon* sp., *Pseudolimea* (Radula) duplicata (Sow.)

Family OSTREIDAE Rafinesque, 1815: *Liostrea acuminata* (Sow.), *Lopha* (Arctostrea) costata (Sow.)

Family trigoniidae Lamarck, 1819: *Trigonia* ex. gr. *subpapilata* Saveliev, T. siliceum Quenstedt, T. (T.) ex. gr. cardissa Agassiz.

Family ASTARTIDAE Gray, 1840: *Astarte modiolaris* Lamarck

Family CYPRINIDAE H. et A. Adamas, 1858: *Anisocardia minima* (Sow.), A. gibbosa Munst.

Family UNICARDIIDAE Fischer, 1887: *Mactromya cognata* (Laube)

Family ISOARCIDAE Keen: *Isoarca bajociensis* d'Orb.

Family PHOLADOMYIDAE Gray, 1840: *Pholadomya murchisoni* Sow., *P. reticulata* Ag., *P. ovulum* Ag., *P. angustata* (Sow.), *Homomya gibbosa* (Sow.), Ag., G. *Goniomya proboscidea intersectans*

Family CERATOMYIDAE Arkell, 1934: *Ceratomya plicata* Ag.,

Family PLEUROMYIDAE Dall, 1900: *Pleuromya uniformis* (Sow.), *P. elongata* Munst., P. aff. *goldfussi* Rollier, *P. calceiformis*, *Gresslya gregaria* Ziethen

Family QUENSTEDTIDAE: *Quenstedtia mactroides* (Ag.)

Family PARALLELODONTIDAE: *Grammatodon* (Cosmetodon) sp., *Grammatodon jurianus* Cox.

The record and the interpretation of the bivalve distribution, being related to the sedimentary facies in which they occur, represent a rather difficult problem. Many epi- and infaunal genera can be found in a wide variety of facies. Generally, the richest faunas, from the point of view of their diversity and abundance, were recorded within siltic clays or calcarenites. The joint paleontological, sedimentological and stratigraphical information confirms the idea again that bivalves were conditioned by shallow water. The abundance and the diversity decrease with the depth. Following the litho- and biostratigraphic succession of the Bajocian deposits, I tried to emphasise the connection between the sedimentary types and the ecological bivalve groups within the main faunal assemblages. Hallam (1975) defined these ecological groups. By Hallam's adaptive scheme three successive levels can be distinguished in the study area:

1. the lower level, corresponding the a pellitic, fine facies, is represented by a bivalve association that is dominated by the infaunal species (50%). These species are the following: *Isognomon isognomoides*, *I. flambarti*. The byssate epifaunal taxa, especially the *Modiolus* and *Mytilus* species, make up only 20% of the taxa association and the deep infaunal morphotypes (*Pholadomya*, *Pleuromya*, *Cercomya*) make 30% of the association (Table 1, Fig.1);

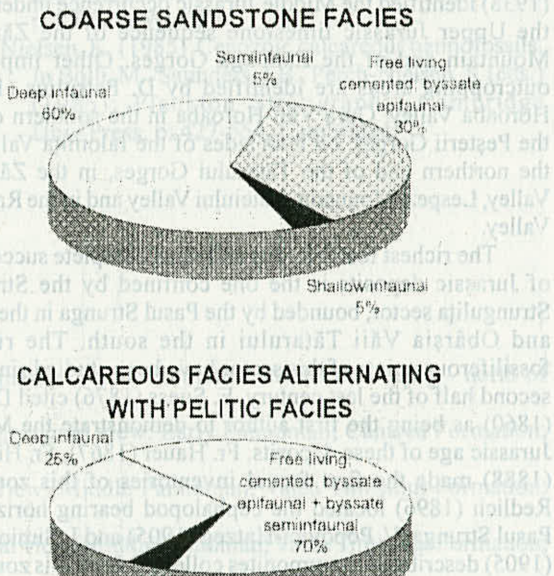
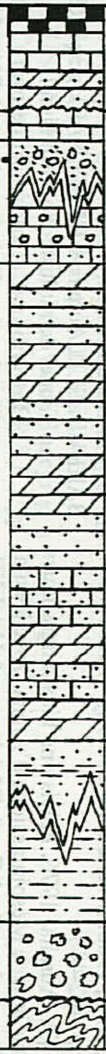


Fig. 1. Facies control on percentage distribution of bivalve ecological groups.

Table 1

Stage	Lithology	Thickness	Lithology description	 Deep infaunal suspension-feeder	 Shallow infaunal suspension-feeder	 Semiinfaunal suspension-feeder	 Byssate epifaunal suspension-feeder	 Free-living,lying epifaunal suspension-feeder	 Cemented epifaunal suspension-feeder
Oxfordian Middle Callovian Bathonian Lower Bathonian Upper Bajocian		18-25 m	Jasper Limestone bearing "hard-grounds"						
Bajocian		5-6m	Nodular sandstone with less abundant brachiopods alternating with marly levels	Pholadomya murchisoni;P.ovulum; Pleuromya uniformis;P.elongata;Gresslya gregaria;Ceromya plicata; Homomya gibbosa; Goniomya proboscidea; G. intersectans	Trigonia subpapilata; Trigonia cardissa; Myophorella sp.	Inoperna plicata; Gervilleia af. aviculoides	Limatula gibbosa; Modiola sowerbiana; Chlamys dewalchei	Entolium sp.; Ctenostreon sp.	
		5m	Calcarenites and marls rich in brachiopods and solitary corals	Pholadomya murchisoni; Pholadomya sp.	Trigonia siliceum	Isognomon isognomoides; Pinna sp.	Chlamys fibrosus Plagiostoma leesbergi;P. rarecostata;Camptonectes lens; Camptonectes annulatus		Liostrea acuminata; Lopha (Arcostrea) costata; Compact levels with ostreids
		5m	Silts alternating with pellits bearing siderite concretions	Pholadomya murchisoni; P. reticulata; Pleuromya calceiformis; Cercomya undulata		Isognomon isognomoides; I. flambarti; Grammatodon jurianus; Pinna sp.; Gervilleia feruginea	Modiola sowerbiana; Modiolus imbricatus;Mytilus suprajurensis; M. petatus; M. lynceus		
? Aalenian		2-3m	White quartzitic microconglom.						
			Leaota Crystalline						

2. the middle level, of calcarenites alternating with pellites includes an association of bivalves of all ecological types (Table 1, Fig.1). This association is dominated (70%) by byssate semi-infaunal and by byssate, cemented, lying and free-living epifaunal suspension feeders. It has to be emphasised that the cemented epifaunal species are represented only by ostreids (*Liostrea acuminata, Lopha* (*Arctostrea*) *costata*) that form compact, decimetric levels. The deep infaunal suspension feeders (*Pholadomya murchisoni*, *Pholadomya* sp.) represent 25% of the association and the shallow infaunal suspension feeders represent only 5% (*Trigonia siliceum*);

3. the upper level corresponds to a coarse sandstone sequence that contains several marly interlayers. Within this upper level, the association is dominated (60%) by deep infaunal suspension feeders, having dense populations: (*Pleuromya, Pholadomya, Gresslya, Ceromya, Homomya, Goniomya*). The shallow infaunal suspension feeders represent only 5%: (*Trigonia subpapilata, T. cardissa, Myophorella* sp.) and the semi-infaunal suspension feeders (*Inoperna plicata, Gervilleia af. aviculoides*) also reach 5%, all of them being associated to the coarse sandstone facies. The byssate, lying, free-living epifaunal forms are confined to the fine, marly interlayers, representing 30% of the upper level association.

For the three successive Bajocian levels, I calculated the similarity coefficient proposed by Kontkanen (1957) for the faunal stability evaluation.

The formula is QS=2dx(a+b+c).100, where a=the species number of the first level; b= the species number of the 2nd level; c= the species number of the 3rd level and d= the number of common species of the three levels. The low value (3.09%) of the coefficient expresses a low faunal stability, a fact that is evident if we correlate the faunal association with the facies features: in the 2nd level, rich in brachiopods, the free-living, byssate and cemented epifaunal suspensivore feeders associated to a marly-limestone facies are dominant, while in the 3rd level, the deep infaunal suspensivore feeders are dominant, associated to a coarse sandstone facies.

A series of paleoecological indications were obtained while observing the life position of the genera and species of *Pholadomya, Pleuromya* and *Isognomon*.

The deep infaunal suspensivore feeders is an ecological group represented especially by *Pholadomyidae, Pleuromyidae, Ceratomyidae*, those individuals of the species forming numerous colonies in which more than 50% of the individuals are preserved in life position, usually vertical within the sediment, with the posterior end upwards (Plate I, Fig. 1,2,3). Occasionally, the deviations of this disposition probably reflect the natural variability of life position. The life position cannot make the burrowing depth of the animals possible, due to the erosion on the one hand or to the sedimentation, and compaction of the sediment on the other hand could affect the original sediment-water interface.

The semi-infaunal suspensivores, having a hydrodynamically stable life position, are difficult to interpret with regard to their post-mortem position. Although, within the recorded levels, the Isognomon species are represented by numerous individuals, tightly wrapped in successive layers, with their umbo downwards in the bed, 90% of the shells being integral, with both valves articulated.

This shows the in situ position resulting from rapid burial (Plate I, Fig. 4).

The bivalve paleocommunities are associated to depositional environments that correspond to the proximal shelf with sandy sediments, proximal shelf with fine sediments and proximal to middle shelf. Deep infaunal suspension feeders, shallow infaunal suspension feeders, epifaunal and semi-infaunal suspension feeders represent the dominant genera and morphotypes.

The faunal association that corresponds to these depositional environments, although bivalve dominated, is also characterised by a wide variety of marine organisms, with low diversity but relatively high density: solitary corals, ammonites, belemnites, brachiopods, gastropods and crinoids. The depositional environment is characterised by shallow, warm water, generally well oxygenated, periodically storm influenced and also with slight temperature and salinity fluctuations, depending on their position relative to the shore.

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Caption of Plates

PLATE 11. I

Fig. 1. *Pholadomya murchisoni* Sow. found in life position within a pellitic facies; Dogger (Bajocian) at Strunguliţa (Romania).

Fig. 2. *Pholadomya murchisoni* Sow. found in life position within a coarse sandstone facies; Dogger (Bajocian) at Strunguliţa (Romania).

Fig. 3. *Pleuromya* sp. found in life position within a calcareous facies; Dogger (Bajocian) at Strunga (Romania)

Fig. 4. *Isognomon* sp. found in life position within a calcareous facies; Dogger (Bajocian) at Strunguliţa (Romania)