

BIOSTRATIGRAPHIC AGE INDICATORS IN THE LOWER PALAEOZOIC SUCCESSIONS OF THE MOESIAN PLATFORM OF ROMANIA

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(Manuscript received August 22, 1991; accepted in revised form December 12, 1991)

Abstract: Diverse Lower Palaeozoic sequence on the Moesian Platform show different faunal records because of differential subsidence. The faunas show affinities with Avalonian, Bohemian, Baltican and Podolian Basins. Local disappearances of graptolite species can only be distinguished from general extinctions by examination of species ranges over a much wider area than the Moesian Platform.

Key words: Lower Palaeozoic, Moesian Platform, graptolites, trilobites, tentaculites, brachiopods, bivalves.

Introduction

The Moesian Platform is the structural geological unit situated within the arc formed by the Carpathians to the north and the Balkans to the south. On the Romanian territory it covers the Romanian Plain as well as Central and Southern Dobrogea.

A complex fault system delimits numerous sunken and uplifted compartments; the Moesian Platform is bounded by major crustal faults such as the Peceneaga-Camena Fault to the north - east, the Peri-Carpathian Fault to the north - west and the Pre-Balkan Fault to the south, while the Calarasi-Fierbinti Fault is an intra-Moesian Fault (Fig. 1). The sequences on this platform are known from numerous boreholes which have penetrated basement rocks in places and the sedimentary cover - consisting by quasihorizontal deposits belonging to the Paleozoic, Mesozoic and Tertiary systems.

The basement consists of amphibolite-epidote schists in the western part of the platform and of a greenschists formation in the east. This last formation has been compared with the Marisian sequence of the Carpathians and the Brioverian of the Bohemian Massif (Kräutner 1987).

The sedimentary cover of the Moesian Platform is composed of flat lying to weakly folded (quasihorizontal) unmetamorphosed rocks, 8 - 10 000 m thick, which are sunken to the north being continued under the folded formations of the Carpathian foredeep along the Pericarpethian line (Iordan 1981).

The following lithostratigraphic units were separated in the Paleozoic cover's rocks (Iordan 1988):

- 1 - the Corbu-Mangalia gritty-quartzites (Cambro - Ordovician);
- 2 - the Mitrofani-Habesti argillites (Middle Cambrian, Mutiu 1988);
- 3 - the Tandarei-Calarasi graptolite shales (Ordovician - Pridolian);
- 4 - the Mangalia-Oprisor argillites (Gedinian - Emsian);
- 5 - the Smirna gritty-quartzites (? Emsian - Eifelian);
- 6 - the Calarasi Formation (limestone, Givetian - Lower Viséan);
- 7 - the Viroaga limestones (Famennian);
- 8 - the Dobromiru Formation (carbonate + detritic, Middle - Upper Viséan);
- 9 - the Vlasin Formation (paralic, Namur - Westphal, Paraschiv 1982);
- 10 - the Cetate-Dobromiru conglomeratic-breccia (Stephanian - Permian).

Based on the faunal assemblages (graptolites, trilobites, tentaculites, brachiopods, bivalves) and on the assemblages of palynomorphs the Cambrian, Ordovician and Silurian Series of the Lower Paleozoic were identified, as well as their detailed zonation (Iordan 1981, 1984, 1990; Iordan & Spassov 1989) (Fig. 2).

Cambrian

In the south - west of the platform, boreholes at Mitrofani and Habesti have recently provided the following trilobites yielded in black argillites (clayey shales): *Paradoxides paradoxissimus* (Wahl.), *P. sjögreni* (Linn.), *Eccaparadoxides aff. oelandicus* (Sjögreni), *Peronopsis fallax* (Linn.). These species indicate a Middle Cambrian age for "the Mitrofani-Habesti ar-

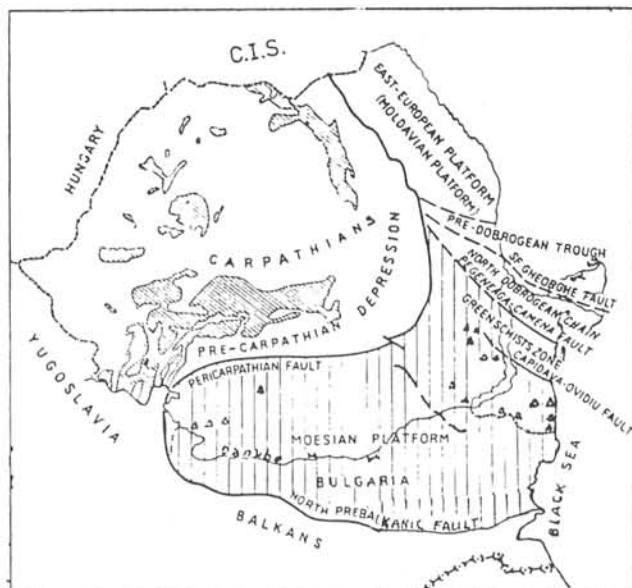


Fig. 1. Geotectonic sketch map of the Moesian Platform.

		GRAPTOLITES ZONES	TENTACULITES ZONES	TRILOBITES ZONES	BRACHIOPODS	BIVALVES	DIVERSE FAUNA	PALYNO ZONES	LITHOSTRATIGRAPHIC UNITS												
S I L U R I A N	PRIDOLIAN	transgrediens?	Tentaculites tenuis	Acaste daylana	Eospirifer schmidtii	Cardiolita bohémica	Scyphocrinites	G ₂	TANDAREI -	P											
		ultimus-formosus				Cardiolita tartis	Favosites gothlandicus														
	LUDLOVIAN	upp.			inexpectatus	Fardenia wieniukovi	Howellella bragensis					„Cardiola“ insolita	Orthoceratids	G ₂	SHALLY FAUNA FACIES	L					
					bohemicus												Lunulacardiids				
		low.																DUALINA	DUALINA	Triplasma formosum	
																					incipiens
																					scaenicus
		niissani																			
	WENLOCKIAN	upp.			lundgreni	Leptaena rhomboidalis	Isorthys clavosid				Morinorhynchus orbigny	Cardiola interrupta	Orthoceratids	G ₁	CORBU-MANGALIA GRAPTOLITE SHALES	W					
					radians																
		mid.																			
					firmus																
		low.			murchisoni																
					insectus-centrifugus																
LLANDOVERIAN																					
ORDOVICIAN	ASHGILL							O ₃	CORBU-MANGALIA GRITTY QUARTZITES	LL											
	CARADOC																				
	LLANDEIL																				
	LLANVIRN																				
	ARENIG	hirundo									Lingulella davisii	O ₂									
	TREMADOCIAN	extensus									Acrotretids	O ₁									
CAMBRIAN	Upper		Paradoxides	Paradoxissimus					MITROFANI - HABESTI ARGILLITES	K											
	Middle										Peronopsis fallax										
	Lower																				

Fig. 2. Litho- and biostratigraphic zonation of the Lower Palaeozoic in the Moesian Platform.

gillites" (Mutiu 1988). In the other boreholes "the Corbu-Mangalia gritty-quartzites" contain Cambrian and Cambro - Ordovician assemblages of palynomorphs (Beju 1972, 1973).

Ordovician

On the north - east margin of the Moesian Platform, in the Bordei Verde borehole, black argillites and grey-greenish glauconitic siltites are present with an Arenig fauna consisting of *Didymograptus hirundo* (Salt.), *D. cf. extensus* (Hall) and the inarticulate brachiopod *Lingulella aff. davisii* M'Coy (Murgeanu & Spassov 1968). Other Ordovician fauna are very poor: in the Tandarei borehole in the east, black argillites contain scarce minute acrotretid brachiopods, *Lingulella* fragments, a ?*Didymograptus* fragment, which, together with palynological data, suggest Tremadoc and Caradoc/Ashgill ages (Jordan 1981; Beju 1972; Jordan & Spassov 1989). These Ordovician deposits are included in the "Tandarei-Calarasi graptolite shales" (Ordovician - Pridolian) and are characterized by "hirundo Zone" (graptolite zone) and by "O₁ and O₃ zones" (palynomorphs zones) (Fig. 2).

Silurian

On the Moesian Platform the Silurian strata lies transgressively over the greenschists, the crystalline schists or over the Ordovician deposits and support the Devonian sediments either conformably or unconformably with sedimentary gap or it is overlain even by Mesozoic rocks in places. The lithologic facies is represented by the "graptolite shales" - classical in the lower part and mixed type in the upper part of the Silurian; in the south - western part of the platform the "shelly-fauna" facies has

been discovered too (Jordan et al. 1985).

There are no sediments of proven Llandovery age on the base of faunal assemblages, though some boreholes show Wenlock graptolitic shales resting on older rocks (Jordan 1981). The Lower Wenlock has been recognised by the presence of the *insectus-centrifugus*, *murchisoni* and *firmus* Zones; the Upper Wenlock by the radians and *lundgreni* Zones.

In the Tandarei and Bordei Verde boreholes the black argillites contain a Lower Wenlock graptolite assemblage (Jordan 1981, 1990): *Retiolites geinitzianus* Berr., *Barrandeograptus pulchellus* (Tullb.), *Monograptus priodon* (Bronn), *M. firmus* (Bouč.), *M. pseudocultellus* Bouč., *M. kolihai* Bouč., *Monoclimacis vomerina vomerina* Nich., *M. vomerina basilica* (Lapw.), *M. linnarssoni* (Tullb.), *Pristiograptus praedubius* (Bouč.), *P. cf. dubius* (Suess), *Cyrtograptus murchisoni* Carr., C. sp. 1.

In the Ianca-Berlescu and Bordei Verde boreholes the dark grey and black argillites contain an Upper Wenlock graptolite assemblage and some characteristic bivalves and orthoconic nautiloids (Jordan 1981, 1990): *Plectograptus praemacilentus* Bouč. et Münch, *Monograptus flemingii* (Salter), *Monoclimacis flumendosae* (Gort.), *Pristiograptus dubius* (Suess), *P. pseudodubius* (Bouč.), *Cyrtograptus trilleri* Eisel, *C. lundgreni* Tullb. (graptolites); *Butovicella migrans* (Barr.), *Cardiola* sp. cf. *C. interrupta* Sow. (bivalves); "Orthoceras" sp. ex gr. *primaevum* (Forbes), *Geisonoceras* sp., *Michelinoceras* sp. (cephalopods).

The borehole record shows a much more widespread distribution of Ludlow rocks. Early Ludlow classical graptolite shales are recorded widely (Grigoras 1956; Jordan 1981, 1990; Paraschiv & Mutiu 1975), and mixed type of the graptolite shales facies are present in the late Ludlow and the Pridoli (Jordan 1981, 1990). In the Tuzla-Costinesti, Mangalia, Calarasi, Tandarei, Biruinta, Fauresti, Capu Dealului, Usurei boreholes the

Lower Ludlow zones present are the nilssoni-scanicus and incipiens. In the black, partly carbonatic, shales, with interbeds of marly grey-blackish shales and black argillites these graptolite zones are attested by the follow assemblage: *Holoretiolites (Balticograptus) balticus* Eis., *Plectograptus macilentus* (Törnq.), *Monograptus uncinatus* Tullb., *M. incipiens* (Barr.), *Monoclimacis micropoma* (Jaeck.), *Pristiograptus dubius* (Suess), *Saetograptus colonus* (Barr.), *S. chimaera* (Tullb.), *Bohemograptus bohemicus* (Barr.), *Lobograptus scanicus* Tullb., *Neodiversograptus nilssoni* (Barr.).

In the Calarasi, Zavoia, Tandarei and Biruinta boreholes the Upper Ludlow incorporates the *bohemicus* and *inexpectatus* Zones (Jordan 1981, 1990). The black argillites or the light grey argillites with interbeds of fine grey-whitish limy sandstones contain a mixed fauna with predominant small bivalves, flattened orthoconic cephalopods, tiny brachiopods and crinoid ossicles, and scarce graptolites: *Dualina* sp. aff. *D. fidelis* (Barr.), *Lunulacardium* cf. *evolvens* Barr., *Cardiolita* ex gr. *C. bohemia* Barr. (bivalves); "*Orthoceras*" cf. *primaevum* (Forbes), *Parakionoceras* sp., *Geisonoceras* sp., *Michelinoceras* sp. (cephalopods); *Bohemograptus bohemicus* (Barr.), *Pristiograptus grigorasii* Jordan, *Linograptus posthumus* (Richter), *Neodiversograptus* sp. ex gr. *N. nilsoni* (Barr.) (graptolites).

The Pridolian strata have been identified in the mixed type of the "graptolite shales" facies too. In the Calarasi, Zavoia and Tandarei boreholes the black argillites contain scarce graptolites of the *ultimus-formosus* Zone (*Monograptus* ex gr. *formosus* Bouček, M. sp. A, M. sp. 1, *Saetograptus rarus* (Teller), *Pristiograptus grigorasii* Jordan, *Linograptus posthumus* (Richter), L. sp. 1). The faunal assemblages contain predominantly bivalves of families *Cardiolidae*, *Lunulacardiidae* and *Antipleuridae* (*Cardiolita* cf. *bohemia* (Barr.), *C. cf. fortis* (Barr.), "*Cardiola*" *insolita* Barr., *Lunulacardium undulatum* Barr., *Dualina* sp.); flattened orthoconic cephalopods ("*Orthoceras*" *vertebratum* (Barr.), *Geisonoceras rivale* (Barr.)); tiny brachiopods (*Orbiculoidae* sp., *Leptostrophia* sp., *Plectodonta* sp., *Howellella* sp.), crinoids ossicles (*Crotalocrinus* sp., *Scyphocrinites* sp.).

All these mentioned deposits with respective faunal assemblages are included in the "Tandarei-Calarasi graptolite shales" lithological units (Jordan 1988) (Fig. 2).

In the south - western part of the Moesian Platform at the Girla Mare and Oprisor boreholes a Silurian shelly-fauna have been discovered (Jordan 1984; Jordan et al. 1985). In black argillites with sandstone interbeds and in green siltstones have been recorded Wenlockian shelly-fauna: (*Lisostrophia* (L.) cf. *cooperi* Ams., *Mesopholidostrophia* sp., *Morinorhynchus* cf. *orbigny* (Dav.), *Isorthis* aff. *clivosa* Walms., *Leptaena rhomboidalis* (Wahl.), *Atrypa* aff. *reticularis* Linn.); Ludlovian one (*Fardenis* cf. *wieniukovi* (Kozl.), *Howellella* cf. *bragensis* (Wenj.), *Strophodonta* sp., *Triplasma formosum* (Prantl), *Zalophyllum* aff. *conicus* Bulv., *Phaulactis* sp., *Pentagonocyclus* sp., *Anthinocrinus* sp., *Pisocrinus* sp., and *Calymene* sp. at Capu Dealului borehole); and Pridolian one with *tenuis* and *dayiana* Zones (*Tentaculites tenuis* Sow., *Tentaculites* cf. *ornatus* Sow., *Uniconus* sp., *Acaste dayiana* Richter, *Mesodouvillina subinterstitialis* Kozl., *Eospirifer* cf. *schmidti* Lindstr., *Leptostrophia* sp., *Spondilostrophia* sp., *Shaleria* sp., *Strophochonetes* sp., *Favosites gothlandicus* Lamk., *Acrophyllum* sp., *Pentagonocyclus acanthaclus* Yelt.).

Conclusions

The borehole evidence from the Moesian Platform indicates the presence of marine environments from the Middle Cambrian onwards. The Cambrian and Ordovician sediments are only developed locally but the Lower Ludlow sediments are the most widespread.

The Lower Paleozoic sequence is dominated by clastics (argillites, shales, siltstones, sandstones, quartzites).

As far as the sedimentation conditions are concerned, we should emphasize the reducing environment characteristic of an euxinic basin for the "graptolite shales" facies and a neritic realm in the shallow water basin for the shelly-fauna facies.

In the Lower Paleozoic strata of the Romanian Moesian Platform the age indicators fossils are represented by graptolites, trilobites, tentaculites, brachiopods and bivalves.

The species and zones of graptolites are very similar to those in England, Bohemia, Thuringia and Poland. When a particular graptolite disappears from a section, it is not possible to be sure it has become extinct. Local disappearances can only be distinguished from general extinctions by examination of species ranges over a much wider area than the Moesian Platform.

The trilobites and shelly fauna have affinities with those in the Avalonian, Bohemian, Baltican and Podolian Basins (e.g. all Cambrian trilobites, *Lingulella davisii*, *Eospirifer schmidti*, *Butovicella migrans*, *Cardiolita bohemia*, *C. fortis*, "*Cardiola*" *insolita*, *Fardenia wieniukovi*, *Howellella bragensis*, etc.).

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