

# PALYNOSTRATIGRAPHICAL CORRELATIONS AMONG SOME METAMORPHICAL GROUPS AND FORMATIONS OF THE MARAMUREŞ MOUNTAINS AND THE BISTRIŢA MOUNTAINS, EASTERN CARPATHIANS, ROMANIA

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**Abstract.** The perimeter under investigation is part of "the crystalline-mesozoic zone" of the Eastern Carpathians that represents an alpine mobile girdle ("spine") of the Median Dacides (Săndulescu, 1984) or of the Eastern Getides (according to Balintoni, 1997).

The formations and groups which outcrop in the Maramureş and Bistriţa Mountains both are: Pop Ivan metamorphical Formations and Vaser – Bretila Formation (in Maramureş Mountains) correlated with Iacobeni – Bretila Formation (in Bistriţa Mountains); Voşlobeni and Ineu Formations (in Maramureş Mountains) correlated with Izvorul Roşu, Voşlobeni and Ineu Formations (in Bistriţa Mountains), these form Rebra Group; afterwards Pinu and Pietrosul Bistriţei Formations of Negrişoara Group which existed in both crystalline massifs too; and Căboia, Holdiţa and Leşu Ursului (in Maramureş Mountains) with similar formations in Bistriţa Mountains (where outcrops the Arşiţa Rea Formations more, in the upper part of group) correlated litho and palynostratigraphic too. The sequences which outcrop of the palynomorphical analysed formations and groups in Maramureş and Bistriţa Mountains are correlated, even if outcrop incomplete, especially in Maramureş Mountains, where the geostructural aspects are complicated and even if indefinite.

However is very possible a different litho and palynostratigraphical evolution for the high metamorphical formations of the Bretila Group accumulated in other geostructural conditions side the Rebra, Negrişoara and Tulgheş Groups in which the litho and palynological overlappings are obvious.

**Keywords:** Palynological assemblages, Palynological correlations, Maramureş and Bistriţa Crystalline, Eastern Carpathians.

## GEOSTRUCTURAL FRAMING

The Crystalline of Maramureş and Bistriţa is part of the so called "crystalline-mesozoic" central zone of Eastern Carpathians that represents an alpine mobile zone of the Median Dacides (as Săndulescu called them in 1984) or Eastern Getides (as Balintoni called them in 1997).

The edge convergence of a plate, in the present case the Eurasian Plate with the Getic Microplate, seems to generate by shearing a series of nappes. In these nappes which from bottom to top are: infra-Bukovinian Nappes and Bukovinian Nappe (according to Săndulescu 1984), outcrop also the metamorphosized formations and groups of the Northern zone of the Eastern Carpathians in the Crystalline of Maramureş and Bistriţa.

## PALYNOSTRATIGRAPHICAL CORRELATIONS

The groups and formations that outcrop both in the Crystalline of Maramureş and Bistriţa are: Mezozonal Formations by Pop Ivan and Vaser – Bretila Formation that are included in Bretila Group (in the Crystalline of Maramureş) correlable both litho and palynostratigraphically with Iacobeni-Bretila Formation (of the Bistriţa Crystalline); Voşlobeni and Ineu Formations (of the Bistriţa Crystalline)

correlable with Izvorul Roşu, Voşlobeni and Ineu Formations (of the Bistriţa Crystalline) all these making up Rebra Group; then Pinu and Pietrosul Bistriţei Formations of Negrişoara Group that are also present in both Crystalline Massifs; and Căboia, Holdiţa and Leşu Ursului Formations (in the Maramureş Crystalline) with similar formations, plus Arşiţa Rea Formation (of the Bistriţa Crystalline) which make up Tulgheş Group also litho and palynostratigraphically correlable.

On what we rely on in making these considerations, firstly from a palynostratigraphical point of view because the lithostratigraphical and chronostratigraphical correlations already resulted in a more or less steady image of them (if we only remind but the syntheses: Săndulescu 1984, Kräutner 1988, Vodă and Balintoni 1994, or Balintoni 1997).

### *Bretila Group*

For the Mezometamorphical Formations of Bretila Group, both of Maramureş and Bistriţa Crystalline, the determined assemblages are not very rich due to the intensity of the metamorphism and to the advanced degree of retromorphism, but these assemblages show the ages which are included in Riphean-Vendian range. The main taxons that could be determined are shown in Tables 1 and 2, these are exclusively *Sphaeromorpha*.

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Table 1. Stratigraphical distribution of some *acritarchs* in Bretila Group of Maramureş Crystalline

LITHOSTRATIGRAPHICAL UNIT	TAXONOMICAL UNITS	STRATIGRAPHICAL DISTRIBUTION	
		UPPER PROTEROZOIC	
		RIPHEAN	VENDIAN
BRETILA GROUP (Br)	<i>Valeria sinica</i> Tim.		
	<i>Orygmato-sphaeridium distributum</i> Tim		
	<i>Leiosminuscula minuta</i> Naum.		
	<i>Spumiosa alara</i> Rud.		
	<i>Spumosata prima</i> Naum.		
	<i>Margominuscula pumila</i> Naum.		
	<i>Bavlinella faveolata</i> Shep.		
	<i>Trachysphaeridium asaphum</i> Tim.		
	<i>Trachysphaeridium attenuatum</i> Tim.		
	<i>T. laminaritum</i> Tim.		
	<i>Etmosphaeridium</i> sp.		
	<i>Leiosphaeridia</i> sp.		
	<i>Gloeocapsomorpha prisca</i> Tim.		
	<i>G. sp.</i>		
	<i>Lophominuscula rugosa</i> Naum.		
	<i>Synsphaeridium conglutinatum</i> Tim.		
	<i>S. sp.</i>		

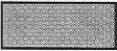


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Table 2. Stratigraphical distribution of some *acritarchs* in Bretila Group of Bistrița Crystalline

LITHOSTRATIGRAPHICAL UNIT	TAXONOMICAL UNITS	STRATIGRAPHICAL DISTRIBUTION	
		UPPER PROTEROZOIC	
		RIPHEAN	VENDIAN
BRETIȚA GROUP (Br)	<i>Leiosphaeridia hyperboreica</i> Tim.		
	<i>Lophominscula rugosa</i> Naum.		
	<i>Trachysphaeridium asaphum</i> Tim.		
	<i>Synsphaeridium conglutinatum</i> Tim.		
	<i>S. sp.</i>		
	<i>Etmosphaeridium sp.</i>		
	<i>Trachysphaeridium attenuatum</i> Tim.		
	<i>T. laminaritum</i> Tim.		
	<i>T. sp.</i>		
	<i>Bavlinella faveolata</i> Shep.		
	<i>Archaeosacculina salebrosa</i> Naum.		
	<i>A. atava</i> Pych.		
	<i>Gloeocapsomorpha prisca</i> Tim.		
	<i>G. sp.</i>		
	<i>Leiosphaeridia sp.</i>		
	<i>Orygmato-sphaeridium distributum</i> Tim.		

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**Rebra Group**

For the Mezometamorphic Formations of Rebra Group where the sequences with massive terigenic contribution are more present, like micaschists and paragneisses, there are more determinations, from a genus level (V. Iliescu, Dessila-Codarcea 1965, V. Iliescu, Mureșan 1972 and V. Iliescu, Krätner 1975) to specific level determinations (Oniceanu, Olaru 1977, Olaru 1977, Olaru,

Oniceanu 1983 and 1985, or Horaicu 2000). From the analysis of the assemblages determined for Mezometamorphical Formations of Rebra Group, their accumulation range is very likely Riphean-Lower Cambrian, because we have in abundance *Spheromorphae* as well as more advanced forms like *Diacromorphitae* or *Vendotaenidae*. A part of the determined taxons are shown in Tables 3 and 4.

Table 3. Stratigraphical distribution of some *acritarchs* in Rebra Group of Maramureş Crystalline

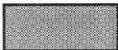
LITHOSTRATIGRAPHICAL UNIT	TAXONOMICAL UNITS	STRATIGRAPHICAL DISTRIBUTION		
		UPPER PROTEROZOIC		PALEOZOIC
		RIPHEAN	VENDIAN	LOWER CAMBRIAN
REBRA GROUP	<i>Leiosphaeridia</i> sp.			
	<i>Synsphaeridium switjasium</i> Kirj.			
	<i>S.</i> sp.			
	<i>Micrhystridium pallidum</i> Volk.			
	<i>Margominuscula pumila</i> Naum.			
	<i>Cymatiosphaera</i> sp.			
	<i>Dictyotidium birvetense</i> Pašk.			
	<i>Podoliella irregularis</i> Tim.			
	<i>Archaeosacculina salebrosa</i> Naum.			
	<i>Trachysphaeridium laminaritum</i> Tim.			
	<i>Vendotaenia antiqua</i> Gnil.			
	<i>Trematosphaeridium</i> sp.			
	<i>Stictosphaeridium</i> sp.			
	<i>Tetraedrixium elegans</i> Tim.			
	<i>Leiosphaeridia hyperboreica</i> Tim.			
	<i>Spumiosa alara</i> Rud.			



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Table 4. Stratigraphical distribution of some *acritarchs* in Rebra Group of Bistrița Crystalline

LITHOSTRATIGRAPHICAL UNIT	TAXONOMICAL UNITS	STRATIGRAPHICAL DISTRIBUTION		
		UPPER PROTEROZOIC		PALEOZOIC
		RIPHEAN	VENDIAN	LOWER CAMBRIAN
REBRA GROUP	<i>Octaedrixium sp.</i>			
	<i>Aimia jakutica Germ.</i>			
	<i>Spumiosa alara Rud.</i>			
	<i>Podoliella irregularis Tim.</i>			
	<i>Lophosphaeridium tentativum Volk.</i>			
	<i>L. sp.</i>			
	<i>Dictyotidium birvetense Pašk.</i>			
	<i>Archaeodiscina umbonulata Volk.</i>			
	<i>Retisphaeridium densum Pašk.</i>			
	<i>Trachysphaeridium laminaritum Tim.</i>			
	<i>Cymatiosphaera sp.</i>			
	<i>Trematosphaeridium sp.</i>			
	<i>Leiospheridia sp.</i>			
	<i>Vendotaenide (filamente)</i>			
	<i>Synsphaeridium switjasium Kirj.</i>			
	<i>S. sp.</i>			
	<i>Micrhystridium obscurum Volk.</i>			
	<i>M. pallidum Volk.</i>			

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### Negrișoara Group

As for Negrișoara Group Formations, mezometamorphical formations sometimes strongly retromorphosized, which initially were attached either to Rebra Group or Tulgheș Group, could be productive from a

palynostratigraphical point of view only those making Pinu Formation, lower formation of the group, predominant quartz-paragneisses with biotite. The assemblages determined in this formation are predominant Vendian with *Diacromorphitae* and *Vendotenidae*. Better preserved taxons are shown in Table 5.

Table 5. Stratigraphical distribution of some *acritarchs* in Pinu Formation (Ng1), Negrișoara Group of Maramureș and Bistrița Crystalline

LITHOSTRATIGRAPHICAL UNIT	TAXONOMICAL UNITS	STRATIGRAPHICAL DISTRIBUTION		
		UPPER PROTEROZOIC		PALEOZOIC
		RIPHEAN	VENDIAN	LOWER CAMBRIAN
PINU FORMATION (Ng1)	<i>Archaeodiscina umbonulata</i> Volk.			
	<i>Leiosphaeridia</i> sp.			
	<i>Lophosphaeridium tentativum</i> Volk.			
	<i>L.</i> sp.			
	<i>Trachysphaeridium asaphum</i> Tim.			
	<i>Stictosphaeridium</i> sp.			
	<i>Eoholynia mosquensis</i> Gnil.			
	<i>Vendotaenia</i> sp.			
	<i>Vendotaenia (filamente)</i>			
	<i>Tetraedrixium elegans</i> Tim.			
	<i>Octaedrixium</i> sp.			
	<i>Dictyotidium birvetense</i> Pašk			
	<i>Podoliella irregularis</i> Tim.			
	<i>Michhystridium dissimilare</i> Volk.			
	<i>M. pallidium</i> Volk.			

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### Tulgheș Group

The Tulgheș Group is one of the most analysed metamorphic groups from a palynostratigraphical point of view, from the first determinations made in 1965 (V. Iliescu and Dessila-Codarcea) then to 1983 (Dessila-

Codarcea 1967, V. Iliescu and Mureșan 1972, V. Iliescu and Kräutner 1975, Oniceanu, Olaru and Erhan 1977) which resulted in 1983 synthesis of the palynostratigraphy of the group accomplished by the staff led by V. Iliescu. After this synthesis palynostratigraphical analyses followed on formations outlining the palynological assemblages which characterize

each formation of this epimetamorphic group and sometimes even of the members of these formations. Palynostratigraphical correlations can be made on first three formations of Tulgheş Group that outcrop both in Maramureş and Bistriţa Crystalline and namely (from bottom to top): Căboia Formation, Holdiţa Formation and Leşu Ursului Formation. Arşiţa Rea Formation was not outlined in Maramureş Crystalline. In these formations there is a large variety of determined assemblages that to this knowledge level show the followings: for Căboia and Holdiţa Formations the assumed

age is Lower Cambrian when many taxa of *Acanthomorpha* and *Herkomorpha* were outlined; for Leşu Ursului and Arşiţa Rea Formations, the determined palynological assemblages show Middle and Upper Cambrian with plenty of *Acanthomorpha*, *Herkomorpha* and *Tasmanaceae* but without a reliable presence of *Polygonomorpha* (*Veryhachium* sort was cited in some works of V. Iliescu and co-workers but not shown as certain).

A small part of well and very well preserved ones, are shown in Tables 6, 7 and 8.

Table 6. Stratigraphical distribution of some *acritarchs* in Căboia Formation (Tg1), Tulgheş Group of Maramureş and Bistriţa Crystalline

LITHOSTRATIGRAPHICAL UNIT	TAXONOMICAL UNITS	STRATIGRAPHICAL DISTRIBUTION			
		PROTEROZOIC	PALEOZOIC		
			CAMBRIAN		
		VENDIAN	Low.	Mid.	Upp.
CĂBOAIA FORMATION (Tg1)	<i>Leiosphaeridia hyperboreica</i> Tim.				
	<i>L. sp.</i>				
	<i>Micrhystridium sp.</i>				
	<i>Leiovalia sp.</i>				
	<i>Retisphaeridium sp.</i>				
	<i>Cymatiosphaera sp.</i>				
	<i>Skiagia compressa</i> (Volk.) Dow.				
	<i>Ceratophyton vernicosum</i> Kirj.				
	<i>Synsphaeridium switjasium</i> Kirj.				
	<i>Archaeodiscina bicostata</i> Volk.				

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**CONCLUSIONS**

The sequences of the groups and formations palynostratigraphically analyzed of Maramureş and Bistriţa Crystalline are correlable, even if they outcrop completely, mainly in Maramureş Crystalline where the geostructural aspects are complicated sometimes very complicated and sometimes even of sort out.

However it is very possible and different both litho and palynostratigraphical evolution of the mezometamorphic formations belonging of Bretila Group accumulated in other geostructural conditions compared to mezometamorphical Rebra and Negrişoara Groups together with the epimetamorphic Tulgheş Group, where both lithostratigraphical and palynostratigraphical overlaps are obvious.

Table 7. Stratigraphical distribution of some *acritarchs* in Holdița Formation (Tg.2), Tulgheș Group of Maramureș and Bistrița Crystalline


LITHOSTRATIGRAPHICAL UNIT	TAXONOMICAL UNITS	STRATIGRAPHICAL DISTRIBUTION			
		PROTEROZOIC	PALEOZOIC		
			CAMBRIAN		
		VENDIAN	Low	Mid	Upp
HOLDIȚA FORMATION (Tg2)	<i>Cymatiosphaera membranacea</i> Kirj.		■		
	<i>C. nerisica</i> Jank.		■		
	<i>Lophomarginata corellata</i> N. Umn. et Vand.		■		
	<i>Ovulum saccatum</i> Jank.		■		
	<i>Baltisphaeridium primarium</i> Jank.		■		
	<i>B. spinigerum</i> Gorka		■		
	<i>Teophipolia lacerata</i> Kirj.	■	■		
	<i>Cristallinium cambriense</i> (Slav.) Vang.	■	■		
	<i>Granomarginata prima</i> Naum.		■		
	<i>G. sp.</i>		■		
	<i>Synsphaeridium switjasium</i> Kirj.		■		
	<i>Dictyotidium priscum</i> Kirj. et Volk.	■	■		
	<i>Michystridium</i> sp.	■	■		
	<i>Comasphaeridium brachyspinosum</i> Kirj.		■		
	<i>Tasmanites pirtaesis</i> Posti et Jank.		■		
	<i>T. volkovae</i> Kirj.		■		
	<i>Pterospermella solida</i> (Volk.) Volk.		■		
	<i>Pirea orbicularis</i> Volk.		■		
	<i>Cymatiosphaera</i> sp.		■		
	<i>Leiosphaeridia bicrura</i> Jank.	■	■		
	<i>L. hyperboreica</i> (Tim.)		■		
	<i>L. sp.</i>		■		
	<i>Annulum squamaceum</i> (Volk.)	■	■		
	<i>Pulvinosphaeridium antiquum</i> Pašk.		■		



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Table 8. Stratigraphical distribution of some *acritarchs* in Leşu Ursului Formation (Tg.3), Tulgheş Group of Maramureş and Bistriţa Crystalline

LITHOSTRATIGRAPHICAL UNIT	TAXONOMICAL UNITS	STRATIGRAPHICAL DISTRIBUTION			
		PROTEROZOIC	PALEOZOIC		
			CAMBRIAN		
		VENDIAN	Low.	Mid.	Upp.
LEŞU URSULUI FORMATION (Tg3)	<i>Vulcanisphaera turbata</i> Vang.				
	<i>V. sp.</i>				
	<i>Lophosphaeridium variabile</i> Volk				
	<i>L. truncatum</i> Volk.				
	<i>L. tentativum</i> Volk.				
	<i>L. bacilliferum</i> Vang.				
	<i>Ceratophyton vermicosum</i> Kirj.				
	<i>Dictyotidium hasletianum</i> Vang.				
	<i>D. priscum</i> Kirj. et Volk.				
	<i>Timofeevia pentagonalis</i> (Vang.) Vang.				
	<i>Baltisphaeridium primarium</i> .Iank				
	<i>B. spinigerum</i> Gorka				
	<i>Eliasum</i> sp.				
	<i>Archaeodiscina bicostata</i> Volk.				
	<i>Michrystridium</i> sp.				
	<i>Retisphaeridium</i> sp.				
	<i>Stictosphaeridium brayense</i> (Vang.)				
	<i>Pirea orbicularis</i> Volk.				
	<i>Granomarginata prima</i> Naum.				
	<i>Annulum squamaceum</i> (Volk.)				
<i>Cymatiosphaera membranacea</i> Kirj.					
<i>Leiosphaeridia</i> sp.					

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## BIBLIOGRAPHY

- Balintoni, I., (1997), *Geotectonica terenurilor metamorfice din România*, Edit. Carpatică, Cluj-Napoca.
- Balintoni, I., Gheucă, I., Vodă, A., (1983), *Alpine and hercynian overthrust nappes from central and southern East Carpathians crystalline-mesozoic zone*. A. Inst. Geol., 60, 1-22, București.
- Baudet, D., Aitken, J. A., Vanguetaine, M., (1985) - *Palynology of uppermost Proterozoic and lowermost Cambrian Formations, central Mackenzie Mountains*, North-Western Canada, Canadian Journal of Earth Sciences.
- Bîzova S.L. (1972), *Vestn.Mosk. Univ.Geol.*, 2, p.36-44, Moskva.
- Băncilă, I., (1958), *Geologia Carpaților Orientali*, 367p. Ed. științifică, București.
- Bercia, I., Bercia, E., Kräutner, Fl., Mureșan, M., Mureșan, G., Iliescu, V., (1971), *Monografia formațiunilor metamorfice din zona cristalino-mezozoică a Carpaților Orientali*, Arh. Inst. Geol., București.
- Bercia, I., Kräutner, H. G., Mureșan, M., (1976), *Premesozoic Metamorphites of East Carpathians*, An. Inst. Geol. Geof., 50, 37-70, București.
- Bleahu, M., (1962), *Cercetări geologice în bazinul inferior al văii Ruscova (Munții Maramureș)*, D.S. Com. geol. Inst.geol., XLV, 9397-308, București.
- Ciornei, P., (1958), *Raport geologic*, Arh., I.G.R., București.
- Codarcea-Dessila M., (1967), *Noi date asupra stratigrafiei terenurilor cristalografice din România*, Stud. cerc. geol.geof., 12, 1, 57-58, București.
- Deunef, J., Gorka, H., Rauscher, R. (1974), *Observations nouvelles et précisions sur les Acritarches à large ouverture polaire du Paléozoïque inférieur*, Geobios, 7, 5-18.
- Dimitrescu, R., (1985), *Early Caledonian event in the Pre-Alpine Metamorphic Sequences of the Romanian Carpathians*, Acta Mineralogica-Petrographica, Szeged, XXVII, 59-70.
- Dragastan, B., Petrescu, J., Olaru, L. (1981), *Palinologie*, Edit. Did. și Ped., București.
- Eisenack, A. (1968), *Über Chitinozoen des baltischen Gebietes*, Palaeontographica, 131, A, 1-6, p. 137-198, Stuttgart.
- Fensome, R.A., Williams, G.L., Bars, M.S., Freeman, J.M. and Hill J.M., (1990), *Acritarchs and Fossil Prosinorphytes: An Index to Genera, Species and Infraspecific Taxa*, ASSP Contribution Series, Number 25, 771 p.
- Folea, I., Kräutner, H.G. (1982), *Present state of research on Precambrian and Paleozoic, metamorphic rocks in the Romanian Carpathians*, 96 I.G.G.P., No. 5, Newsletter, 4, Padova-Bratislava.
- Glușco, V.V., Kruglov S.S. (1971), *Gheologhiceskoe stroenie i gornite iskopaemye Ukrainski Karpat*, Trudy Ukrngri, XXV "Nedra", Moskva.
- Hain, B., Bîzova, S.L., Rudakov, S.G., Slavin, B.I., (1968), *O pokrovnoi strukture Rahovskovo massiva (Vostocinie Karpat)*, Vestnik Maskovskovo Universiteta, Geologia 5, 5-23.
- Hedberg, H.D., (1976-1994), *International Stratigraphic Guide*, 96 p, John Wiley & Sons Inc. U.S.A.
- Horaicu, C., Olaru, L., (1985), *Palynologic considerations on crystalline rocks included in the "Argestru Series" between the Chilia Valley and the Fier Valley*, An.șt. ale Univ. "Al. I. Cuza", XXXI, s. IIb, Geografie-Geologie, 24-27, Iași.
- Horaicu, C., (1987), *The palynological assemblage of the Tulgheș Group between the Izvorul Giuralăului Valley and the Moldova Valley*, An.șt.Univ."Al.I.Cuza XXXIII", s.IIb, Geologie-Geografie, 35-39, Iași.
- Horaicu, C., (1993), *The palynostratigraphical contributions in Bretila Series, Vaser Basin, Maramureș, România*, An. șt. Univ. "Al.I. Cuza", XXXVIII-XXXIX, 511, Geologie, 237-240, Iași.
- Horaicu, C., (1995), *Palynostratigraphy of the Tulgheș Group - contribution and observation*, XV Congres C.B.G.A., vol. 4/1, Athens, Greece.
- Horaicu, C., (1998), *The presence of Stiol Subgroup (Rodna Group) in the Maramureș Massif-Romania*, C.B.G.A., XVI Congres, Abstracts, p. 212, Vienna.
- Horaicu, C., (2000), *Datări și corelări pe baza asociațiilor palinologice în formațiunile metamorfice din bazinul inferior al Văii Vaserului, Masivul Cristalin al Maramureșului și Carpații Orientali*, 168 p., Editura Sedcom Libris, Iași.
- Iliescu, V., Codarcea-Dessila, M., (1965), *Contribuții la cunoașterea conținutului microfaunistic al complexelor de șisturi cristaline din Carpații Orientali*. D.S. Com.Stat.Geol., L,1,2,13,18, București.
- Iliescu, V., Kräutner, H. (1975), *Contribution à la connaissance du contenu en microflore et de l'âge des formations métamorphiques des Monts Rodnei et des Monts Bistriței*, D.S. ale I.G.G., vol. LXI, 4 p, 11-25, București.
- Iliescu, V., Kräutner, H., Kräutner, Fl. (1976), *Precizarea vârstei seriei de Repedea s.s. din munții Rodnei, pe baza unor asociații palinologice*, D.S. Inst. geol. geofiz. 62/4, 3-10, București.
- Iliescu, V., Kräutner, H. (1978), *Contribuții la cunoașterea vârstei seriei de Rusaia*, D.S. Inst.geol.geofiz., 64/4, 7-15, București.
- Iliescu, V., Kräutner, H., Kräutner, Fl., Hann, H. (1983), *New palynological proofs on the Cambrian age of Tulgheș Group (East Carpathians)*. An. Inst. Geol.Geof., 59, 7-17, București.
- Kräutner, H. G., (1972), *Voralpidische Entwicklung und alpidischer Dekenbau in der kristallinen zone der nordlichen Ostkarpaten (Maramurescher Massiv) Rév. R.Toum. Géol., Géophys. Géogr., Géologie, 16, 2, 81-90, București.*
- Kräutner, H.G., (1980), *Lithostratigraphic Correlation of Precambrian of the Romanian Carpathians*, Ann. Inst. Geol. Geofiz., LVII, 229-296, București.
- Kräutner, H.G., Kräutner, Fl., Szasz, L., (1982), *Harta geologică a României, sc. 1:50.000, foaia Ineu*, Inst. Geol.Geofiz., București.
- Kräutner, Th., (1940), *Observations géologiques et pétrographiques dans le massif cristallin du Maramureș*, C.R. Inst., Géol., Roum, XXIII, 101-107, București.
- Kremp, G.O.W., Ames, H.T., Kovar, A.J. (1960-1961), *Catalog of Fossil Spores and Pollen*, vol.

- 2, 9, 10, 13, 14, University Park. Pennsylvania, U.S.A.
- Mânzatu, S., Lemne, M., Vâjdea, E., Tănăsescu, A., Ionică, M., Tiepac, I., (1975), *Date geomorfologice obținute pentru formațiunile cristalofiliene și masive eruptive din România*, D.S. Inst. Geol. Geofiz., LXI/5, 85-111, București.
- Menner, V.V., Aren, B., Volkova, N.A., Keller, B.M., Rozanov, A.Y., Urbanec, A., Jawarowski, (1979), *Upper Precambrian and Cambrian Paleontology of the East European Platform*, Acad.Sci.USSR, Nauka, Moskva, 210p. (in Russian).
- Miyashiro, A. (1994), *Metamorphic Petrology*, 404p., UCL Press.
- Moczdłowska, M., Vidal, G. (1986), *Early Cambrian Acritarchs from Scandinavia and Poland*, *Palynology*, 12, 1-10.
- Mutihac, V., Ionesi, L., (1974), *Geologia României*, Ed. Tehnică, București.
- Naumova, S.N. (1968), *Stratigrafia nîjnev Paleozoa izentralnoi Evropi*, Mejd.geol.Kongress XXI, Seria pro.9, Acad.Nauk. SSR Moskva.
- Olaru, L., (1991), *Stratigraphical evolution of the palynological assemblages from the crystalline formations of the Romanian East Carpathians and the correlation with other area from Europe*, *Evolution and adaptation*, 4: 77-86.
- Olaru, L., (2001), *Using Acritarch assemblages to correlate Upper Proterozoic and Lower Paleozoic metamorphic sequences in Romania*, *Proceedings of The IX International Palynological Congress*, Houston, Texas, U.S.A., 115-127 p.
- Olaru, L., Oniceanu, M., (1983), *Contribution to the sporo-protistological study of the formations with talc powder mineralization in the Drăgoiasa-Barnar (Eastern Carpathians)*, An.șt. ale Univ. „Al. I. Cuza” Iași, s. IIb, *Geologie-Geografie*, 29: 25-30.
- Olaru, L., Oniceanu, M., (1985), *Sur la présence de quelques associations d'acritarches du Protérozoïque supérieur et du Paléozoïque inférieur dans le Carpatés Orientales du Roumanie* *Sci. Géol. Bull.*, 38, I, 131-136, Strasbourg.
- Olaru, L., Gunia, T. (1987), *Palynological correlations between the Pre-Cambrian formations in the Sudetic Mountains (Poland) and the East Carpathians (Romania)*. An. Șt. ale Univ. "Al. I. Cuza", IIb, *Geol.-Geogr.*, XXXIII, 31-35, Iași.
- Olaru, L., Gunia, T. (1988), *Palynological correlations between the Cambrian formations in the Sudetic Mountains (Poland) and the East Carpathians (Romania)*. An. Șt. ale Univ. "Al. I. Cuza", IIb, *Geol.-Geogr.*, XXXIV, 23-31, Iași.
- Oniceanu, M., Olaru, L., Enciu, P., (1974), *Date noi privind vârsta unor formațiuni cristalofiliene din zona anticlinalului Brețila*. An.Șt. Univ. Iași, IIb, *Geol.*, XX, p. 23-27, Iași.
- Oniceanu, M., Olaru, L., (1977), *Contribuții la cunoașterea conținutului microfloristic al seriei de Rebra din partea de E-NE a Munților Rodnei*, An. Șt. Univ. Iași, IIb, *Geol.-Geogr.*, XXIII, 9-22, Iași.
- Paris, F., (1981), *Les Chitinozoaires dans les Paléozoïques du sud.ouest de l'Europe*, *Mém. Soc. géol. minéral. Bretagne*, 26, 412 p., Rennes.
- Paris, F., Grahn, Y., Nestor, V. and Lakova, I. (1998), *A revised chitinozoan classification*, *Journal of Paleontology*.
- Paškiviciene, L.T., (1980), *Acritarchs from beds around the boundary of the Vendian and Cambrian in the western part of the East European Platform*, *Akademii Nauk SSSR, "Nauka"*, Moskva, 75p (in Russian).
- Patruluius, D., Bombiță, Gh., Kräutner, H.G., Kräutner, Fl., (1968), *Harta geologică a R.S.R., sc. 1:200.000*, Vișeu, Inst.Geol., București.
- Pitulea, G., (1972), *Formațiunile paleozoice metamorfizate din extremitatea nord-vestică a Munților Maramureșului (bazinul văii Bistra)*, *St.Cerc.Geol., Geofiz., Geogr., Geologie*, 17, 3-12.
- Pitulea, G., Visarion, A., (1972), *Asupra prezenței unor formațiuni devoniane superioare-carbonifer-inferioare, metamorfizate, din bazinul văii Bistra (Maramureș)*. *Notă preliminară*, *St. Cerc. Geol. Geofiz., Geogr.*, 17, 43-49.
- Săndulescu, M., (1984), *Geotectonica României*, Ed. Tehnică, 336p., București.
- Săndulescu, M., Kräutner, H.G., Balintoni, Russo-Săndulescu, M., Micu, M., (1981), *The Structure of the East Carpathians (Moldavia-Maramureș Area)* *Guide Exc. Bl., Carp.Balk.Geol.Assoc.*, XXII Congr. Inst. Geol. Geof., 92 p., București.
- Săndulescu, M., Szász, L., Balintoni, I., D. Russo-Săndulescu, Bădescu, D., (1991), *Harta geologică a României, sc. 1:50.000, foaia Vișeu*, *Inst. Geol. Geof.*, București.
- Taugourdeau, P., (1979), *The Chitinozoa*, *Biologica Memoirs, Paleopalynology, Series B, vol. 4, nos. 1-2*, 1979 (1980), 48 p. Lucknow.
- Timofeev, B.V. (1966), *Mikrofitologiceskie isledovanie drevnich swit*, *Izd. Nauka, Moskva*.
- Timofeev, B.V. (1969), *Sferomorfidi proterozoa*, *Izdatelstvo "Nauka", Leningrad*.
- Timofeev, B.V. (1973), *Mikrofitofosilii dokembria Ukraini*, *Izdatestvo "Nauka", Leningrad*.
- Timofeev, B.V., Gherman T., N., Mihailova, N.S., (1976), *Mikrofitofosilii Dokembria, Kembria i Ordovica*, *Acad. Nauk., SSR Leningrad*.
- Tkaciuc, Gurjii, (1957), *Rahovskii kristalliceschii massiv. Karpat, Izd.-vo AN USSR*.
- Vanguetaine, M., (1986), *Progrès récents de la stratigraphie par Acritarches du Cambro-Ordovicien d'Ardenne, d'Islande, d'Angleterre, du Pays de Galles et de Terre-Neuve orientale*, *Ann. Soc. Géol. Nord.*, 65-76, Lille.
- Vavrdova, M., (1972), *Acritarches from Klabava Shales (Arenig)*. *Ifestustred Ust.* 47, 79-86.
- Vidal, G., (1981), *Lower Cambrian acritarch stratigraphy in Scandinavia*, *Geologiska Föreningens: FGrhandlingar, Stockholm*, 103, 183-192.
- Vodă, Al., (1993), *seria de Tulgheș*, *Raport, vol I, Arh. S.C. "Prospecțiuni", S.A., București*.
- Vodă, Al., Balintoni, L., (1994), *Corelări litostratigrafice in cristalinul Carpatilor Orientali*, *Studia Univ. "Babeș Bolyai", Geologia*, XXXIX, 1-1, 61-66, Cluj-Napoca.
- Volkova, N.A., (1968), *Acritarchs from Precambrian and Cambrian deposits in Estonia*, in *Keller, B.M.(ed). Problematics of Riphean and Cambrian of the Russian Platform, Urals and Kazakhstan*, *Academy of Sciences USSR "Nauka", Moskva*, 8-36 (in Russian).
- Volkova, N.A., (1973), *Acritarchs and correlation of Vendian and Cambrian of the western part of*

- Russian Platform, Sovieskaya Geologija*, 4, 48-62 (in Russian).
- Volkova, N.A., Kirjanov, V.V., Piskun, L.V., Paškevičienė, L.T., Jankauskas, T.V., (1979), *Plant Micrifossils*, in Keller B.M., and Rozanov A. Y, (eds). *Upper precambrian and Cambrian Paleontology of the East-European Platform*, Akad. Nauk. USSR 4-38, Moskow (in Russian).
- Zapalowiez, H., (1886), *Geologische Skizze des östlich. Teiles der POCUTISCH Marmoroscher Grenzkarpathen*. Jahrb. der, K.K. geol. R.A.Wien.
- Zincenco, D., (1971), *Stratigrafia seriei de Tulgheș in bazinele Cislă și Vaser (versantul stâng) - Maramureș*, St. Cerc. Geol., Geof., Geogr., Geologie, 16, 3 8 7-3 96.
- Zincenco, D., (1995), *Chronostratic scale of the pre-Permian Metamorphites and Granitoids from Romanian Carpathians*, Geochron. Rom., 1,3-8, Bucharest.
- Zincenco, D., Soroiu, M., Răduț, M., Văileanu, I., (1982), *Metamorphic rocks and metamorphic events in the Maramureș Mountains*, Rév. Roum. Géol., Géof, Géogr., Géophys., 26, II-2 7, Edit. Acad. R.S.R., București.