ON THE AGE OF THE RZEHAKIA-BEDS AND GARÁB SCHLIER BASED ON FORAMINIFERA AND NANNOPLANKTON INVESTIGATIONS

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SUMMARY

Microflora – and fauna – studies of schlier and Rzehakian strata of Carpathian age are dealt with, carried out on the surface as well as on deep drilling profiles of the Salgótarján basin and of the area of Northern-Mátra. It has been stated that both overlying coal bed and the schlier should be placed into the NN 4 nannozone. Within the Carpathian foraminiferal fauna four associations have been separated, these being also indicators of facies. On the basis of the studies the Garáb Schlier can be well correlated with several Austrian and Slovakian sites.

1. Introduction

Some surface localities and borehole profiles of Karpatian age from the territory of the Northern-Mátra and the Salgótarján basin were examined in the last years.

The geological features and occurence of these formations are relatively wellknown, but paleontologically they are rather poorly investigated. Though a great number of authors have been dealing with the macrofauna of the Salgótarján Brown-coal Formation, of the Cardium-, Rzehakia- and Chlamys-bearing sandstones and of the Garáb Schlier (without a claim for completeness: Bartkó L., 1961–62; Csepreghyné Meznerics I., 1951, 1954, 1960; Horuschitzky F., 1939; id. Noszky J., 1930; Schréter Z., 1940, the number of the publications on the foraminiferafauna of these formations is negligible. (The comprehensive list of the foraminifera species and their references are collected in Balogh et al. 1966. pp. 52–65, and Alföldy L. et al. 1975. pp. 140–150.). The nannofloras of Karpatian age of North-Hungary were described by Báldi-Beke M. (1960) from point-like exposures. Besides those mentioned above a lot of unpublished paleontological data can be found in the documentations of the deep-drilling profiles.

Our paper will give some nannofloras and foraminiferafaunas of the Rzehakia-beds and the Garáb Schlier, and we make an attempt to emplace these formations in the Standard Neogene Nannoplankton Zonation.

2. The geology of the territory and profiles studied

2.1. The higher regressive part of the Nógrád Glauconitic Sandstone is overlain by the Zagyvapálfalva Red Beds in the Salgótarján Basin and in the surroundings of Mátraalmás. In the Recsk area the latter formation does not occur. The Gyulakeszi Rhyolith-Tuff Formation (lower rhyolith tuff) is covered by the Salgótarján Brown-Coal Formation, which is wedged out towards the basin edges. The Brown-Coal Formation is overlain by the brackish water Cardium- and Rzehakia-bearing and marin Chlamys-bearing sandstones, finally by the pelitic Garáb Schlier, which is expanded far beyond the borders of the territory dealt with. The stratigraphically higher regressive part of the Schlier is covered by the Tar Rhyolith-Tuff Formation (middle rhyolith tuff) and Mátra Andesite Formation of Badenian age.

According to the statement of the Miocene Subcommission of the Hungarian Stratigraphical Committee – proposition of G. Hámor 1977- the age of the lower rhyolith tuff, the brown-coal series and the Cardium – Rzehakia beds is Ottnangian, the age of the Chlamys-bearing sandstone and of the Schlier is Karpatian.

2.2. *The borehole profiles studied in the Mátraalmás area* (Fig. 1.)

The T – 9. borehole, which penetrated the most complete profile, terminated in the Ilonavölgy Sandstone (a part of Nógrád Sandstone) of Eggenburgian age. It is followed upwards by a thin red bed, which is lacking in the other profiles. The lower rhyolith tuff is supposed to be not deposited into water, but in the higher part of borehole T – 4. it shows some traces of water movement and yields conglomerates. The brown coal series – in contrary to its mid-basin development – has only one coal layer. The overlying stratas consist of tuff, tuffit, tuffitic sandstone with a thickness between 20 – 50 meters, which yield only few fossils. These stratas are covered by the thick sandy, clayey silt (Garáb Schlier Formation), which in its lower (transgressive) and higher (regressive) part has Arca- and Corbula-bearing middle- and fine-grained sandstone-interbeddings. (The genus were determined by Mrs. Bohn – Havas). None of the three boreholes in Mátraalmás penetrated the covering volcano-series of Badenian age.

2.3. *The profiles of the Recsk – 103, -109 and the Sirok – 1 boreholes*

The most complete profiles in the Recsk area were penetrated by the Rm – 103 borehole, but the profile of the Rm – 109 is also very similar. Both profiles are yielding the complete Oligocene series with faunas and nannofloras. The Oligocene stratas are covered by the Ilonavölgy Sandstone (Nógrád Glauconitic Sandstone) of Eggenburgian age and further by the lower rhyolith tuff. The red beds in the Recsk area are lacking. The transgressive basal stratas of the Tertiary in the borehole Sirok – 1 are laying

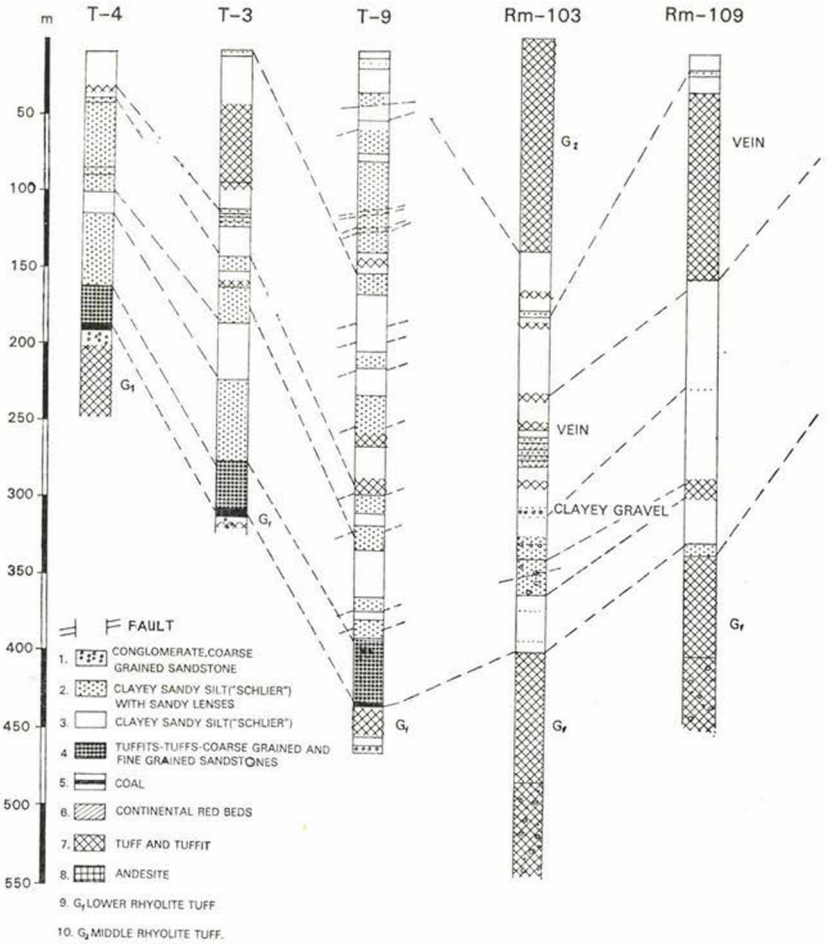


Fig. 1. Profiles of the T – 3, T – 4 and T – 9 boreholes from the Mátraalmás, Rm – 103, Rm – 109 boreholes from the Recsk area.

immediately on the diabase of the mesozoic basement and are consisting of reworked clastics of sandy rhyolith tuff.

All of the three boreholes penetrated the Garáb Schlier in different thicknesses (270 meter in the Rm – 103, 180 meter in the Rm – 109, 130 meter in the Sirok – 1 boreholes). The Schlier has some thin sandy interbeddings and is penetrated by some thin andesite-dykes too. The covering layers of middle rhyolith tuff are 70 m thick in the profile Sirok – 1 and 150 meter thick in the Rm – 103 section. The youngest formation of the area, the Mátra Andesite was observed only in the Sirok – 1 profile.

2.4. *The "Ottnangian" exposure of Kazár*

The covering formations of the Salgótarján Brown Coal Series and the Garáb Schlier crop out in a thickness of 34 m east of the gipsy's row Kazár village. The profile is described and represented in details by G. Hámor (in Papp et al. 1973, pp. 206–209.).

The deepest members of the series on the surface at this moment are a 50 centimeters thick coarse grained sandstone and over this the brown-coal bed No–1. (First nannoplankton sample.) Upwards from this point the profile is composed by the alteration of fine grained clayey silt and sandstone. An abundant Cardium- and Rzehakia-fauna was observed between 13–16 meters. (Nannoplankton samples No–2–7.) In dip direction the sandstone banks became absent and the grain structure turns to be finer. The series goes over gradually into the Garáb Schlier Formation. (Nannoplankton samples No–8–14.)

3. Nannoplankton studies

In the last decade the regional stages of the Central Paratethys became more accepted and used also in Hungary. The definitions of the stage-boundaries are based on the entrance or extinction datas of mollusc or foraminifera species and assemblages. It follows, that the zone boundaries of the Standard Nannoplankton Zonation of Martini and Worsley (1970) do not coincide with the boundaries of the regional stages. Therefore it is necessary to parallelize the regional stage stratotypes and the nannozonation precisely.

Martini et Müller (1975a, 1975b) studying the type-profiles of the Ottnangian and Karpatian stages in Austria came to the conclusion, that the Ottnangian stage corresponds to a part of the nannozones NN 3 and 4, while the Karpatian corresponds to a part of the nannozones NN 4 and 5. The absence of *Sphenolithus belemnos* Bramlette and Wilcoxon raised some difficulties, because its extinction defines the boundary between the zones NN 3 and 4. Consequently the relation between the stage Ottnangian and the nannozonation is unsolved. The *Sphenolithus heteromorphus* Bramlette and Wilcoxon existing in the zones NN 4 and 5, occurs only in some of the examined type localities of the Karpatian. Based on these results, the above mentioned authors have pointed out, that the *Sphenolithus heteromorphus* invaded the Paratethys only in the late Karpatian.

3.1. *The Mátraalmás area* (Tables I–II)

The profiles of boreholes T–3, –4, –9 were sampled at about 10 m intervals. All samples of T–9 borehole (containing the most complete profile) were examined, while a sufficient number of samples were studied from the lowest and highest parts of T–3 and –4 for to enable to place

Table I

The nannoplankton in the profile of the borehole T – 9.

	460–461 m 430–431 m 427 m 410–415 m 405–407 m	390–391 m 381–382 m 375–377 m 366–368 m 357–358 m	345–347 m 338–339 m 324–328 m 317–315 m 301–302 m	295–296 m 287–288 m 274–276 m 266–267 m 254–255 m	245–246 m 237–239 m 226–227 m 224–226 m 216–217 m	204–205 m 194–196 m 184–185 m 175–177 m 164–165 m	155–157 m 144–146 m 136–137 m 128–129 m 115–117 m	103–105 m 95– 97 m 85– 87 m 76– 78 m 64– 66 m	52– 54 m 45– 46 m 36– 37 m 27– 28 m 16– 18 m
Reticulofenestra excavata		.....							
R. minuta	... — —	.. .. —	— — ..	— — —	—	—	— — —	— —	— — —
R. pseudoumbilica	...	.... — —	.... — ..	— — —	— — —	— — —	— — —	— —	— — —
Coccolithus miopelagicus		.....		.....	.....				
C. pelagicus	— —	— — —	— —	—	—	— — —	— — —	—	— — —
C. sp.		...		...			....	....	...
Cyclococcolithus floridanus	.....	.....	— — — —	—	— —	..... — — ...	... ...		— . —
C. leptoporus		...		...					...
C. rotula					...				
Syracosphaera pulchra			...				... ...	...	
Discolithina multipora	....	... ...		....	... ...	...	.....	.....	.....
Helicopontosphaera ampliaperta	...	.. —	... ...	—	.....	.....	...		... —
H. euphratis				...	...		.....		
H. kamptneri		....	.....	— — —	— — —	— — —	— — —	— — —	— — —
H. cf. wallichi			.....	....		... .		...	... ...
Thoracosphaera sp.		...	...	— —	— —				
Rhabdosphaera pannonica					...				

Table I.

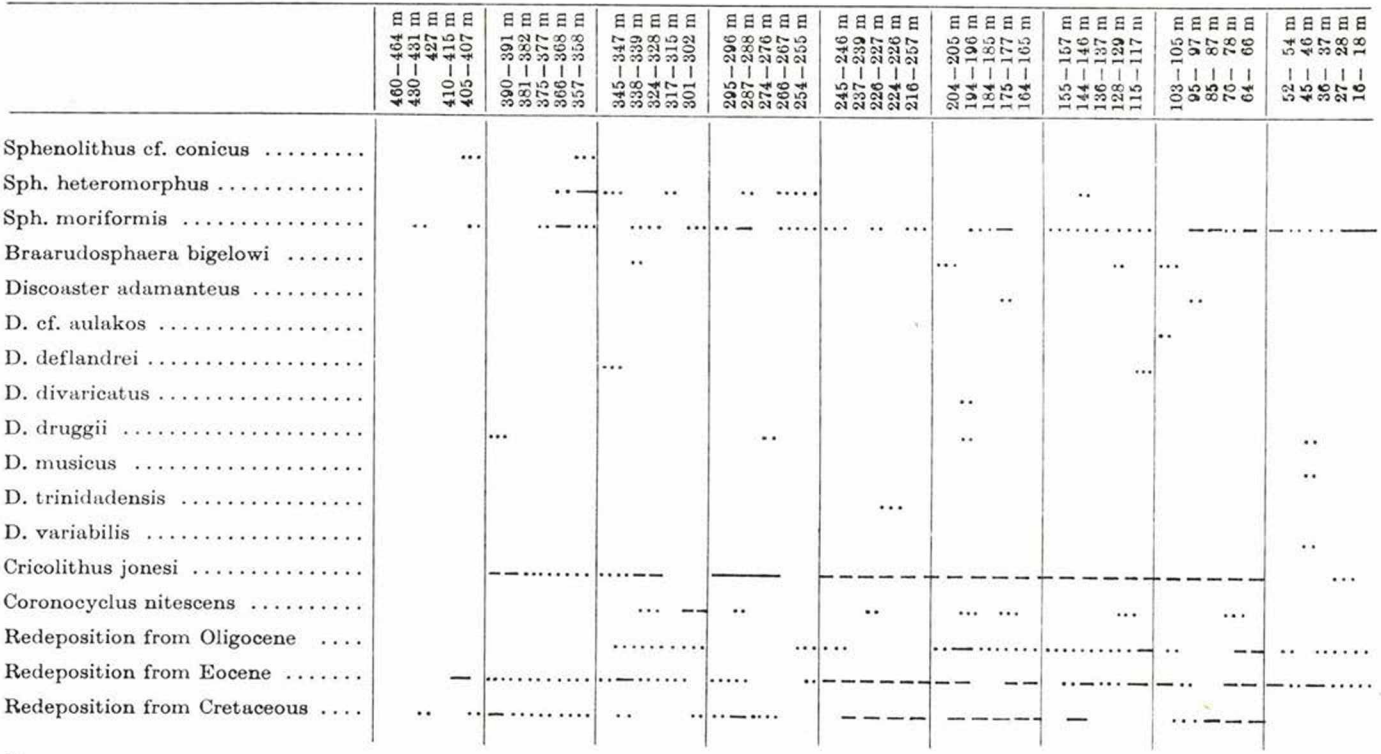

460—464 m
430—431 m
427 m
410—415 m
405—407 m
390—391 m
381—382 m
375—377 m
366—368 m
357—358 m
345—347 m
338—339 m
324—328 m
317—315 m
301—302 m
295—296 m
287—288 m
274—276 m
266—267 m
254—255 m
245—246 m
237—239 m
226—227 m
224—226 m
216—257 m
204—205 m
194—196 m
184—185 m
175—177 m
164—165 m
155—157 m
144—146 m
136—137 m
128—129 m
115—117 m
103—105 m
95— 97 m
85— 87 m
75— 78 m
64— 66 m
52— 54 m
45— 46 m
36— 37 m
27— 28 m
16— 18 m
Sphenolithus cf. conicus
Sph. heteromorphus
Sph. moriformis
Braarudosphaera bigelowi
Discoaster adamanteus
D. cf. aulakos
D. deflandrei
D. divaricatus
D. druggii
D. musicus
D. trinidadensis
D. variabilis
Cricolithus jonesi
Coronocyclus nitescens
Redeposition from Oligocene
Redeposition from Eocene
Redeposition from Cretaceous
Rare
Some
Common
Abundant

Table II.

The nannoplakton in the profiles of the boreholes T – 3. and T – 4.

	T–3.							T–4.						
	305 m	292 m	280 m	274 – 275 m	263 – 264 m	253 – 254 m	6 – 7 m	190 m	183 – 184 m	172 – 173 m	163 – 164 m	154 – 155 m	144 – 145 m	11 – 12 m
Reticulofenestra minuta			..	–	——	——			...		...	—	——	
R. pseudoumbilica				...	——	——			...		..	—	—	
Coccolithus miopelagicus					...									
C. pelagicus		.....	–	–	–	——			.....			–	–	——
C. sp.													...	
Cyclococcolithus floridanus			–	–	.....	–	–					.....		
C. leptoporus												...		
Helicopontosphaera ampliaperta				–	–	..–	...					.....	—	
H. kamptneri						...–						...	—	
H. cf. wallichi						...								
Sphenolithus cf. conicus						...								
Sph. heteromorphus														...
Sph. moriformis		.....			–	–						...–	–	–
Discoaster cf. aulakos					...									
D. divaricatus				...										
Cricolithus jonesi						...	–						...–	–
Redeposition from Oligocene		....				...				...	...			
Redeposition from Eocene		...		–	–	–					...–	–	....	
Redeposition from Cretaceous					.....	–	–					.....		

Rare .....
Some ---
Common ——
Abundant ——

these into the nannoplankton zonation correctly. The nannofloras are in general less diverse, than the nannofloras of similar facies of Badenian age, but more diverse than those of the Upper Oligocene and Lower Miocene of Hungary. The placoliths (for example *Coccolithus pelagicus*, *Reticulofenestra pseudoumbilica*, etc.) and *Helicopontosphaeras* are frequent, as well as some other forms (for example *Cricolithus jonesi*, *Sphenolithus moriformis)*. The *Sphenolithus* and *Discoaster* species, characterizing the tropical climate occur only in a restricted number, in contrary to the nannofloras of Badenian age. In our studied material three types of nannoplankton assemblages can be enumerated:

– Samples being practically free of nannofossils or containing only a single redeposited Eocene or Cretaceous species. This represents mainly the 30 meter thick coarse grained clastics covering immediately the brown coal. These sediments are probably of fresh- or brackish water origin (303 – 280 meters in the T – 3, 190 – 280 meters in the T – 4, 464 – 415 meters in the T – 9 boreholes).

– A probably slightly brackish-water nannoplankton assemblage occurs in the 10 – 20 meter thick transition between the coarse grained

clastics and the Garáb Schlier. The nannofloras are poor, but the first datum indicator species are found in these samples. (280 – 264 meters in T – 4, 164 – 155 meters in T – 9, 415 – 391 meters in T – 3 boreholes.)

– Marine nannoplanton assemblage with a high diversity and abundance. Their embedding rock is Garáb Schlier, its more pelitic parts yield more rich, its sandy interbeddings yield poorer nannofloras. (264 – 6 meters in T – 3, 155 – 11 meters in T – 4, 391 – 15 meters in T – 9 boreholes.)

All of the three borehole-profiles can be placed into the NN 4 zone whose upper boundary is defined by the extinction of *Helicopontosphaera ampliaperta*, and its lower boundary is defined by the extinction of *Sphenolithus belemnos*. In our samples there was no *S. belemnos*, so these samples are younger than zone NN 3. (We did not want to state zone boundary based on a single specimen of an uncertain *Sphenolithus sp.* conicus-belemnos group found in the 405 – 407 and 357 – 358 meter intervals of the borehole T – 9.)

The presence of *Helicopontosphaera ampliaperta*, in the highest samples in all of the three profiles makes clear, that the highest part of all sections belongs to the zone NN 4; the same is supported by the coexistence of *H. ampliaperta* and *S. heteromorphus* in some of the samples. The whole section of Garáb Schlier exposed by the borings in Mátraalmás can be placed into the nannozone NN 4. The zone boundary between NN 4 and 5 was not traceable in these profiles.

3.2. *The Recsk area*

We do not want to deal with the Karpatian nannofloras of the borings Rm – 103 and – 109 here. These are very poor not only from point of view of diversity but also of abundance. These nannoplankton assemblages do not yield datum indicator forms at all.

3.3. *Other samples* (Table III.)

The age of a sample from an exposure of the Garáb Schlier in Nagybátony – Szorospatak – Valley, also correponds to the zone NN 4.

In the Middle – Cserhát, in the section of the gravel pit in Papucs Hill – Acsa Village, the Garáb Schlier of Karpatian age covers coarse grained sandy conglomerates (oral communication of T. Báldi). Some samples taken about the boundary of the conglomerate and schlier contain the coexistence of the species *Helicopontospharea ampliaperta* and *Sphenolithus heteromorphus*. Thus, the deposition of the Garáb Schlier had to began here in the time interval of the zone NN 4.

The stratigraphical literature has been considered the age of the Kazár Rzehakia beds conventionally as Ottnangian, because of the presence of the characteristic Rzehakia assemblage. The foraminifera faunas of the so called Rzehakia-beds in North Hungary and South Slowakia are however

Table III.

The nannoplankton from other samples

rare some common abundant	Kazár								Sajóveiezd (Sv—49) 390 m	Schiller Szoros-patak	Acsa-Papucshegy	
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7—13.	No. 14.			Schlier	Conglo-merate
Reticulofenestra minuta	EMPTY	.....		EMPTY	EMPTY		EMPTY	- - -	- - -	———		
R. pseudoumbilica								.....	- - -	- - -	- - -	
Coccolithus pelagicus		- - -						- -	.....	———	- - -	———
Cyclococcolithus floridanus .		- - -										
Cyclolithella sp.		.....										
Discolithina latelliptica		.....										
D. multipora		.....										
Helicopontosphaera amplia-perta		.....						- -	- - -	- - -		- - -
H. kamptneri		.....	- - -					.....	.....	———		- - -
Sphenolithus heteromorphus			.....					.....	.....		.....	.....
Sph. moriformis						.....		- - -		- - -	.....	
Discoaster adamanteus											.....	
D. variabilis											.....	.....
Cricolithus jonesi										.....		
Redeposition from Eocene ..									- - -	———	.....	
Redeposition from Cretaceous									.....	.....	.....	.....

containing taxa, which refer rather to a Karpatian age (Kantorová, Ondrejičková, Vass in Papp et al. 1973).

The planktonic foraminifera found in the Rzehakia beds of the Salgótarján Basin (Korecz–Laky in Papp et al. 1973), furthermore the Teredos and the shark-teeth in the Kazár outcrop are indicating a not negligible connection between the brackish-water Rzehakia lagoon and the open sea with normal salinity. This connection explains the presence of stenohalyn calcareous nannofossils in the otherwise brackish-water Rzehakia beds. The concurrent occurence of *H. ampliaperta* and *S. heteromorphus* in these impoverished nannoplankton assemblages proves zone NN 4. The age of the marine Schlier, overlying the Rzehakia beds, also belongs to the zone NN 4.

In the berehole Sajóvelezd-(Sv)-42 in the Sajó–Valley (North Hungary) at a level of 390 m, the Rzehakia-bearing beds overlying the brown coal formation contain a similar nannoplankton assemblage. Its age is also NN 4, based on the coexistence of the two above mentioned species.

4. Foraminifera investigations

4.1. *The Mátraalmás area*

The most complete foraminifera faunas were found in the profile T–9. Complete faunas have been investigated, i. e. all specimens in half a kilogram of rock were selected and determined. (Denotations figured in the tables indicate the number of the specimens as follows:

○ = 1–5 specimens, × = 6–10 specimens, ⊗ = 11–20 specimens, ● = = 21–50 specimens, □ = 51–100 specimens.)

The layers covering immediatly the coal beds did not yield any foraminifera fauna, the first faunas occur only 30–50 m higher, than the coal beds. The following foraminifera fauna assemblages have been separated in the Garáb Schilier from the bottom upwards:

– *Ammonia beccarii – Florilus boueanus assemblage* (T–4 and –9 boreholes). These two species are very frequent, accompanied by some agglutinant forms *(Spiroplectammina carinata, Spirosigmoilina tenuis)*, as well as by few specimens of calcareous benthonic forms. The quantity of sponge spicules is significant, in addition few spatangides and ostracodas. The maximum thickness of the stratas yielding this kind of assemblage is 90 m in the borehole T–9. The Ammonia fauna can be correlated with the *Spirosigmoilina tenuis* assemblage in the borehole T–3, which yields *Spiroplectammina carinata, Textularia lanceolata* and *Florilus boueanus* beside the *Spirosigmoilina tenuis*.

– *Uvigerina graciliformis assemblage* is characterized by the abundant occurence of *U. graciliformis*. Also *Spiroplectammina carinata, Lenticulina inornata, Florilus boueanus* are frequent. This assemblage can be detected in the profiles T–3 and –4, the thickness of the stratas yielding such

The foraminifera-fauna in the profile of the borehole T – 9.

	16 m	27 m	36 m	45 m	64 m	76 m	85 m	95 m	103 m	115 m	128 m	136 m	144 m	155 m	164 m	175 m	184 m	194 m	204 m	216 m	226 m	237 m	245 m	254 m	266 m	274 m	287 m	295 m	301 m	314 m	327 m	338 m	346 m	357 m	366 m	375 m	381 m	390 m	405 m
Rhabdammina abyssorum							○																																
R. sp.																																							
Bathysiphon filiformis																																							
B. taurinense																																							
B. sp.																																							
Hyperammina sp.																																							
Ammodiscus miocenicus																																							
Reophax pilulifera																																							
Cribrostomoides columbiensis moravica																																							
Cyclammina karpatica																																							
C. sp.																																							
Alveolophragmium cf. crassum																																							
Reticulophragmium cf. venezuelanum																																							
R. carpaticum																																							
Ammomarginulina sp.																																							
Spiroplectammina carinata																																							
S. cf. pectinata																																							
Textularia lanceolata																																							
T. gramen abbreviata																																							
T. sp.																																							
Budashevella wilsoni																																							
Martinottiella communis																																							
Spiroloculina compressiuscula																																							
S. tenuissima																																							
S. sp.																																							
Quinqueloculina sp.																																							
Q. seminula																																							
Sigmoilopsis celata																																							
Spirosigmoilina tenuis																																							
Triloculina consobrina																																							
T. sp.																																							
Lagena clavata																																							
L. gracilicosta																																							
Lenticulina inornata																																							
Pseudonodosaria aequalis																																							
Plectofrondicularia digitalis																																							
P. racicosta																																							
P. sp.																																							
Amphimorphina hauerina																																							
Globulina gibba																																							
Guttulina problema																																							
Fissurina laevigata																																							
Bolivina antiqua																																							
B. dilatata dilatata																																							
B. fastigia																																							
B. plicatella																																							
B. plicatela mera																																							
B. pokornyi pokornyi																																							
B. cf. reticulata																																							
B. scalprata miocenica																																							
Uvigerina cf. acuminata																																							
U. bononiensis primiformis																																							
U. graciliformis																																							
U. parkeri breviformis																																							
Stilostomella approximata																																							
S. consobrina																																							
S. pyrula																																							
Bulimina affinis																																							
B. striata																																							
Praeglobobulimina ovata																																							
P. pupoides																																							
Stainforthia schreibersiana																																							
Reuselia spinulosa																																							
Trifarina angulosa																																							
Valvulineria complanata																																							
Asterigerinata planorbis																																							
Ammonia beccarii																																							
Elphidium flexuosum subtypicum																																							
Globigerina cf. angustiumbilicata																																							
G. bollii lentiana																																							
G. cf. bulloides																																							
G. cf. ciperoensis																																							
G. ciperoensis ottnangensis																																							
G. concinna																																							
G. foliata																																							
G. praebulloides occlusa																																							
G. praebulloides praebulloides																																							
G. sp. by Rögl																																							
G. sp.																																							
G. noides quadrilobatulus primordius																																							
G. noides trilobus trilobus																																							
Globorotalia obesa																																							
Globoquadrina dehiscens																																							
Cibicides pygmeus																																							
Coryphostoma cf. sinuosa																																							
Caucasina elongata																																							
C. schischkinskayae																																							
C. subulata																																							
Cassidulina laevigata																																							
Globocassidulina oblonga																																							
G. subglobosa																																							
Florilus boueanus																																							
Pullenia bulloides																																							
Alabamina cf. tangentialis																																							
Gyroidina neosoldanii																																							
Cibicidoides pseudoungerianus																																							
Hanzawaia boueana																																							
H. boueana crassiseptata																																							
Heterolepa dutemplei																																							
Melonis soldanii																																							
Echinida sheil elements																																							
Fish tooth																																							
Fin																																							
Radioalaria																																							
Ostracoda																																							
Sponge pin																																							

Number of specimens between
1 – 5 ○
6 – 10 ×
11 – 20 ⊗
21 – 50 ●
50 – 100 □

faunas is 10 – 30 m; it occurs in the T – 9 profile too, as an interbedding in the next assemblage-type described below.

– *Agglutinated assemblage* ("agglutinated level") follows upwards immediatly the *Ammonia – Florilus assemblage* in the profile T – 9, while it follows the *Uvigerina graciliformis assemblage* in the profiles T – 3 and – 4. The mainly agglutinated-fauna-bearing beds are 190 m thick in the T – 9, 180 m thick in the T – 3, 100 m thick in the T – 4 profiles. (The upper part of the latter is supposedly eroded.) The "agglutinated level" is characterized the frequency of the *Textularia lanceolata, Cyclammina karpatica, Reticoluphragmium cf. venezuelanum, Budashevella wilsoni*, etc. The composition of the fauna is not uniform within the whole profile, there is an oscillation both in diversity and abundance. This oscillation can be attributed to ecological changes, to alterations of the intensity of water movement or to the diminishing of the amount of terrigenous material. Such "oscillation" is indicated by the great quantity of plankton in the profile T – 9 between 205 – 204 m, by the great abundance of *Valvulineria complanata* between 200 – 170 m, or by the high frequency of *Heterolepa dutemplei* and *Cibicidoies pseudoungerianus* in the profile T – 3 between 110 – 80 m.

In the profiles T – 3 and – 4 the agglutinated level can be divided into sublevels, based on frequency conditions. The lower part of the agglutinated level can be characterized by a *Textularia lanceolata assemblage* (60 – 70 m thick interval), its upper part can be characterized by a *Cyclammina karpatica assemblage* (180 – 30 m thick interval).

The "agglutinated level" can be correlated with the Corbula – Arca – bearing intervals, further the Ophiuroidea sp. found in T – 3 borehole belongs to this level to.

– A *Globigerina assemblage* occurs in the profiles T – 3 and – 9, with a high frequency of planktonic forms, i. e. *Globigerina praebulloides praebulloides, Gg. ciperoensis ottnangensis. Globigerinoides sicanus* (= G. bisphaericus) however is lacking. In the T – 9 profile a rich *Uvigerina-* and *Bolivina-fauna* was observed within the Globigerina-level, with the great abundance of *Uvigerina graciliformis, U. bononiensis primiformis, Bolivina plicatella, B. plicatella mera, B. scalprata miocenica* and *B. pokornyi pokornyi*. This assemblage represents the deepest water environment.

(The arrangement of assemblages in the profiles and their related position can be seen on Fig. 2.)

4.2. *The Recsk area*

The Garáb Schlier detected in the Recsk area can be characterized by an *Ammonia beccarii – Florilus boueanus assemblage*. The agglutinated forms occur only in single intervals, mainly with frequent *Reticulophragmium* species *(R. venezuelanum, R. carpaticum)*.

The malacological investigations of T. Báldi (1970, 1971) support our statement: these foraminifera faunas do not represent a typical schlier

Table V.

The foraminifera-fauna in the profile of the borehole T – 3.

	6 m	25 m	44 m	85 m	102 m	116 m	135 m	154 m	162 m	177 m	188 m	204 m	208 m	215 m	222 m	232 m	243 m	253 m
Rhabdammina sp.						○								○				
Bathysiphon filiformis					○	○	⊗			○				○				
Ammodiscus miocenicus					○													
Reophax pilulifera							⊗											
Haplophragmoides vasiceki vasiceki															○			
Cribrostomoides columbiensis moravica		○	○															
Cyclamina karpatica	○	○	●		⊗		●		○	○	○			○	○			
C. sp.													○			○		
Alveolophragmium crassum							×								○			
Reticulophragmium carpaticum			●		×		⊗		○									
R. cf. venezuelanum	○	○	●		×			○	○	○	○			○			○	
Spiroplectammina carinata	○	○		○	×		⊗			○					⊗		○	
S. pectinata		○			○												○	
Textularia lanceolata			×		○		×	●	●	●	●	○	○	○				
T. gramen abbreviata	○				○													
Budashevella wilsoni	○				○		×											
Martinottiella communis	○				○													
Spiroloculina tenuissima	×			○	×	○	○											
Sigmoilopsis celata	⊗	×			×												●	○
Spirosigmoilina tenuis					○													
Lagena isabella					○	○												
L. striata							○											
Lenticulina cultrata	●	○				○	×		⊗		○	○						
L. inornata							○											
Marginulina glabra							○											
M. hirsuta					○		○											
Pectofrondicularia digitalis						○	○											
P. inaequalis							○											
P. sp.					○													
Amphimorphina hauerina	○																	
Globulina gibba				○			○											
G. inaequalis							○											

Table V.

	6 m	25 m	44 m	85 m	102 m	116 m	135 m	154 m	162 m	177 m	188 m	994 m	203 m	215 m	222 m	232 m	243 m	253 m
Guttulina problema							○											
Bolivina hebes	○																	
B. scalprata miocenica				○	○													
B. sp.						○												
Uvigerina cf. acuminata					○	○												
U. bononiensis primiformis	○	○		○														
U. graciliformis	○	⊗		○	×			○		⊗	○			○	□			
Stilostomella elegans					○		○											
Bulimina striata			○		○	○												
Stainforthia schreibersiana	×	⊗		○	○	○												
Valvulineria complanata							×										○	
Ammonia beccarii			○					○	○					○	○			○
Elphidium flexuosum subtypicum		○																
Globigerina bollii lentiana	⊗	⊗				○												
G. ciperoensis ottnengensis	●	●		○	○		○							○				
G. obesa	●	●			○													
G. praebulloides occlusa	⊗	×								○								
G. praebulloides praebulloides	⊗	●		○	○													
G. cf. scalena		○																
G. sp.										○		○						
Globigerinoides triobus triobus		○																
Globorotalia foliata	⊗	×																
Planulina wuellerstorfi					○													
Cibicides lobatulus ornatus						○							○					
Caucasina elongata	○	×		⊗														
C. subulata				×	○													
Cassidulina laevigata					○								○					
Globocassidulina oblonga				○														
Florilus boueanus	□	□	⊗	●	●	○	○	○	×	×	○	○	○		×	○	○	
Pullenia bulloides			○	○	○	○	×											
Gyroidina soldanii				○	×	○	○											
Cibicidoides ungerianus				○														
Cibicidoides pseudoungerianus	○	○	○	⊗	●		○											
Hanzawaia boueana				○	○			○										
H. boueana crassiseptata									○									○
Heterolepa dutemplei	●	⊗	⊗	□	□	○	⊗			○		○	○		×			
Melonis soldanii							○			○								
Spatangida	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		○	
Ostracoda	○	○					○		○	○	○	○	○	○	○		○	
Fin					○	○												
Echinida shell elements			○		○	○	○	○										
Sponge pin	○			○	○									○			○	○
Fish tooth							○											

Table VI.

The foraminifera-fauna in the profile of the borehole T — 4.

	11 m	21 m	33 m	44 m	56 m	66 m	75 m	85 m	95 m	107 m	115 m	126 m	134 m	144 m	154 m
Bathysiphon filiformis		○	○			○				○					
Hyperammina sp.		○													
Reophax pilulifera							○								
Cribrostomoides columbiensis moravica		×													○
Cyclammina karpatica	○	⊗	⊗	○	○	○		○		○	○	○			
C. div. sp.													○		
Alveolophragnium cf. crassum		×									○				
Reticulophragmium carpaticum	○	○	×												
R. cf. venezuelanum	○		○				○	○		○	○				
Ammomarginulina sp.		○													
Spiroplectammina carinata											○			○	
S. pectinata											○				
Textularia lanceolata	○	×	⊗		⊗	○	⊗	×	⊗	×		○			
Budashevella wilsoni		○	×												
Sigmoilopsis celata										○					
Spirosigmoilina tenuis													○	○	
Lenticulina inornata	○	×	○	○	○	●		○	○	○	×				
Marginulina hirsuta			○						○						
Pseudonodosaria aequalis		○													
Plectofrondicularia digitalis			○												
Bolivina scalprata miocenica		○	○												
Uvigerina graciliformis		○								⊘	□			○	
Siphogenerina sp.			○												
Stilostomella approximata		○													
S. elegans		○													○
Bulimina striata			○												
Stainforthia schreibersiana	○	○													
Ammonia beccarii							○			×		○		●	●
Globigerina ciperoensis ottnangensis					○					○					
G. sp.	○		○												
Globigerinoides trilobus trilobus												○			
Eponides umbonatus											○				
Caucasina elongata				○											
Florilus boueanus	○	⊗	○	⊗	×	×				○	⊗	○	●	⊗	
Pullenia bulloides		○	○												
Gyroidina soldanii	○	○													
Heterolepa dutemplei	○	⊗	×			○			⊗	×	⊗				○
Melonis soldanii	○		○												
Spatangida	○	○	○	○	○	○		○	○	○	○		○		○
Ostracoda			○	○	○	○	○	○	○	○	○	○	○		○
Fin	○	○	○												
Echinida shell elements	○	○	○	○		○									○
Fish tooth						○									○
Sponge pin														○	○

fauna. They indicate a relatively constant facies. No series of assemblages representing even deeper and deeper facies can be detected here, as it was observed the borehole profiles of Mátraalmás.

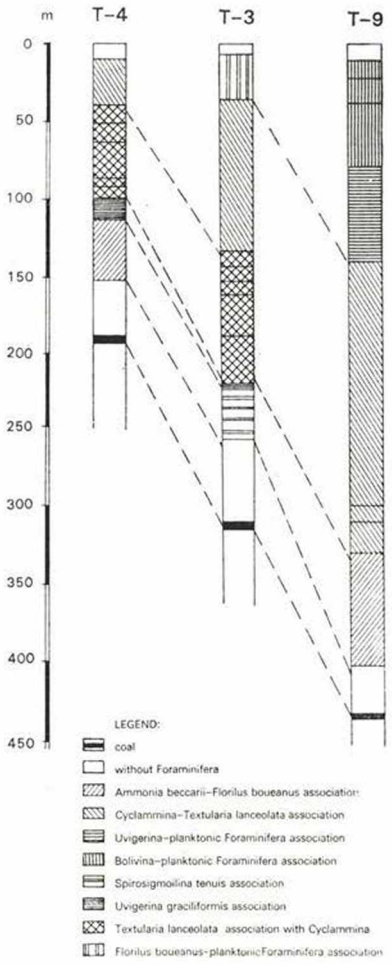


Fig. 2. The position of the foraminiferal assemblages in the Mátraalmás boreholes

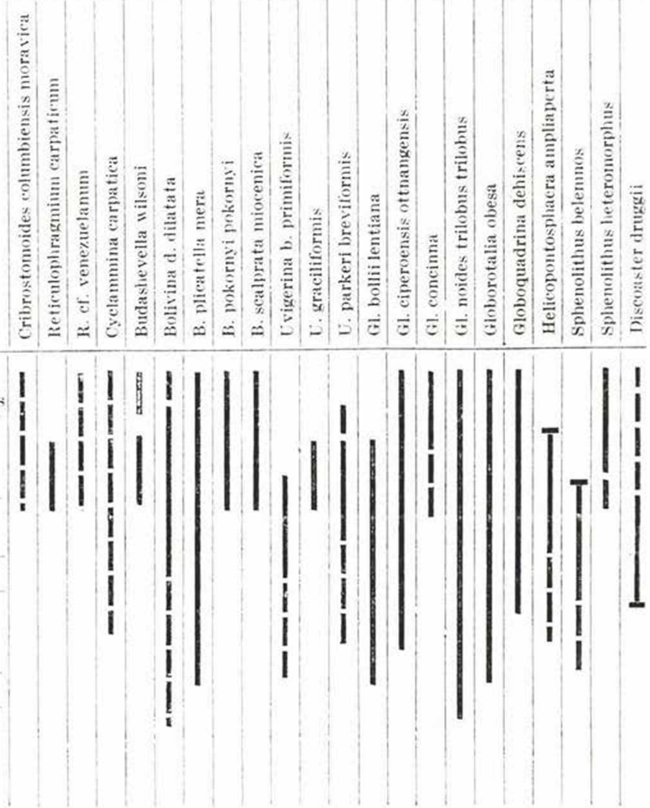
4.3. *Ecological characteristics*

The microfauna of the Garáb Schlier in the Mátraalmás area proves the gradual transgression. The shallow-water, littoral *Ammonia – Florilus fauna* turns into *Uvigerina assemblage* upwards. The optimal biotop of the recent Uvigerinas is 100 meters below the sea-level. In our case the presence

Table VII.

The regional stages of the Central Paratethys in correlation with the planktonic foraminifera zones, nannoplankton zones, showing the vertical distribution of the most important foraminifera and nannofossil datum indicatores occuring in the examined profiles

Regional stages of Miocene in the Middle Paratethys	CPN plankton zones	Denomination of the CPN plankton zones	Nannozones	Denomination of the nannozones
Badenian M_4 (Tortonian)			NN-5	Sphenolithus heteromorphus
Karpatian M_3 („Upper- Helvetian")	5	Globigerinoides bisphericus	NN-4	Helicopontosphaera ampliaperta
Ottnangian M_2 („Lower Helvetian")	4	Globigerinoides trilobus	NN-3	Sphenolithus belemnos
			NN-2	D. druggi
Eggenburgian M_1 („Burdigalian")	3	Globigerinoides quadrilobatulus primordius	NN-1	Triquetrorhabdulus carinatus
			NP-25	S. ciperoensis
Egerian OM („Aquitanian, Chatt-Aquitanian Chattian")	2	Globorotalia opima opima – Globigerinoides (ent.)	NP-24	Sphenolithus distentus



of such water depth can not be supposed owing to the monotonous character of the fauna. The *Reticulophragmiums* being frequent in agglutinated faunas indicate a sandy, soft sea bottom in shallow-sublitoral, sublitoral facies, while *Cyclammina karpatica* indicates deeper, neritic biotop. The presence of agglutinated faunas correlated with the malacological investigations proves probably a water-depth about 50 – 60 meters.

The greatest water-depth is indicated by the *Globigerina assemblage*, where *Uvigerinas* and *Bolivinas* proves a 100 m deep sea water with normal salinity.

The foraminifera assemblages of the Recsk area show the stabilized shallow-sublitoral environment. Only the faunas of the profile Sirok – 1 indicate the transgressive and regressive moments of the formation of the Garáb Schlier, though the water-depth could not surpass the 50 m even at the times of maximum transgression.

4.4. *Stratigraphic position of the foraminifera fauna*

The foraminifera faunas of both area investigated are indicating a Karpatian age. There are some species, whose time range is restricted to the Karpatian stage (e. g. *Cyclammina karpatica, Textularia lanceolata):* a lot of species appear in the Ottnangian and reach their maximum frequency in the Karpatian (e. g. *Uvigerina graciliformis):* further those species were also found, which appear in the Karpatian and became characteristic in the agglutinated assemblages of the Karpatian and Badenian *(Cyclammina karpatica, Reticulofenestra carpaticum, R. venezuelanum).*

The time range of the *Globigerina ciperoensis ottnangensis* R ö g l et al. (1975) being frequent in the plankton fauna described here, lasts from the Upper Egerian up to the Middle Karpatian. The *Globigerina praebulloides praebulloides* is one of the Tertiary taxas having the longest time range. The species *Globigerinoides sicanus* was not found in the faunas described above. This taxon appears in the Middle Karpatian and occurs in the Lower Lagenidae Zone too. Its absence can be explained by the erosion of the upper section of the Schlier, or by the biotop of Recsk area, yielding no trace of sea currents.

5. Summary

5.1. We can state, that the Rzehakia (Oncophora) beds and the greatest part of the covering Garáb Schlier belong to the nannozone NN 4.

Though we can not exclude the possibility of the occurence of *Sphenolithus belemnos* in the Central Paraterhys, this species has not been found so far. Therefore in our region it is not suitable to indicate datum level. We join to the opinion of BUKRY (1973), who proposed the redefinition of the upper limit of the *Sphenolithus belemnos zone* by the first appearence of *Sphenolithus heteromorphus*, which coincides approximately with the extinction datum of *Sphenolithus belemnos*.

Sphenolithus heteromorphus occurred in the Hungarian Miocene as early as in zone NN 4.

5.2. The study of the foraminifera fauna of the Garáb Schlier gave the first information about the presence of the "agglutinated level" in addition to the Uvigerina-faunas being known earlier already. Such Uvigerina assemblages were described from the Vienne Basin by Cicha et al. (1967) (Závod — Laksar strata, Laksarská Nova Ves — 1, — 2 boreholes). Also the same authors have mentioned Uvigerina- and Globigerina assemblages from Dolna Pribelce and Ďurkovce (South Slovakia), which area represents the northern continuation of the Hungarian Schlier-series.

5.3. Based on the recently investigated profiles and on the earlier datas of the geological literature we can state, that the brown coal covering brackish-water and marine Karpatian layers of the East (Sajó — Valley and Egercsehi) are substituted in the West (Sirok, Recsk) by a less sandy, pelitic shallow-sublitoral Schlier. The Karpatian Schlier of the borehole Rm — 103 (according to T. Báldi 1975) has deposited in a water with maximum 30 — 40 m water depth. This gives an explanation to the great frequency of the Ammonia-Florilus assemblages and to the low abundance and diversity of the nannoflora.

The Karpatian schlier of Mátraalmás could be deposited in a deeper, more pelagic part of the Karpatian sedimentary basin, than that of the Recsk area — altough it is not represented in the rock-quality, only in the fauna- and flora assemblages.

REFERENCES

Alföldi L. et al., 1975: Miskolc. Explanatory to the geological map series of 1 : 200 000, pp. 1 — 277 (in Hungarian)

Báldi T., Horváth M., 1970: Report on the study of fauna of the borehole Sirok-1. (Manuscript in Hungarian)

Báldi T., Horváth M., 1971: Preliminary summarizing report on the stratigraphic investigations Recsk. (Manuscript, in Hungarian)

Báldi T., Horváth M., 1975: Report on the macro- and microfauna of the Rm — 103. borehole. (Manuscript, in Hungarian)

Báldi T., Horváth M., Nagymarosy A., 1976: Report on the paleontological study of the boreholes Rm — 109. and Rm — 116. (Manuscript, in Hungarian)

Báldi T., Horváth M., Nagymarosy A., 1977: Report on the general biostratigraphical study of the brown coal field at Mátraalmás. (Manuscript, in Hungarian)

Báldi, Beke M., 1969: The stratigraphic importance of Hungarian Miocene Coccolithophoridas. Föld. Közl., 99., pp. 213 — 223 (in Hungarian)

Balogh K. et. al. Salgótarján. Explanatory to the geological map series of 1 : 200 000, pp. 1 — 155, (in Hungarian)

Bartkó L., 1961 — 62: Geological study of the brown coal area of Nógrád. Candidate's thesis. Manuscript (in Hungarian)

Bukry, D., 1973: Low-latitude Coccolith biostratigraphic zonation.
Repr. Edgar et Saunders: Rep. DSDP, vol. XV. Washington, pp. 685 — 703.

Cicha, I., Seneš, J., Tejkal, I., 1963: Chronstratigraphie und Neostratotypen, M_3 — Karpatien, Bratislava.

Cicha, I., Zapletalova, I., 1963: Wichtige Vertreter der Familie Lituolidae Reuss, 1861 (Foraminifera) aus dem Miozän der Westkarpathen. Sborn. Geol. ved, paleont. sv. 1. 75 — 121.

Cicha, I., Zapletalova, I., 1966: Representatives of Bolivina in the Miocene of the Western Carpathians. III-rd Sec. CMNS. pp 103 – 109.
Cicha, I., Zapletalova: I., 1966: Die Familie Textulariidae des Miozäns der Westkarpaten, III-rd. Sec. CMNS, pp. 194 – 196.
Csepreghy, Mezneries, I., 1951: Fauna of the Schlier and pectinate sandstone of the surroundings of Salgótarján. Föld. Közl., 81, pp. 303 – 319.
Csepreghy Mezneries I., 1954: The Tortonian and Helvetian fauna of the Eastern-Cserhát Ann. Hung. Geol. Inst., 41, 4, pp. 1 – 185. (In Hungarian)
Csepreghy Mezneries, I., 1960: Pectinidés du Néogene de la Hongrie et leur importance stratigraphique. Mem. Soc. Geol. France, Tom, 39, Mém. 92, pp. 1 – 56.
Horusitzky F., 1939: Upper Oligocene and Lower Miocene faunas from the Ipoly basin. Annual Report of MÁFI from 1933 – 35, 2, pp. 782 – 788 (in Hungarian).
Martini, E., Müller, C., 1975/b: Calcareous nannoplankton from the Karpatian in Austria (Middle Miocene). Proc. VI – th Congr. RCMNS, Bratislava.
Martini, E., Worsley, T., 1970: Standard Neogene Calcareous Nannoplankton Zonation. Nature, V. 225, num. 5229, pp. 285 – 290.
Martini, E., Müller, C., 1975/a: Calcareous Nannoplankton and Silicoflagellates from the type Ottnangian and equivalent strata in Austria (Lower Miocene). Proc. VI-th Cong. RCMNS, Bratislava.
Mayne, W., 1955: Reticulophragium n. gen., a new name for Alveolophragium Stschedrina, 1936. Journ. paleont., V. 29. pt. 3, pp. 557 – 558.
Noszky, J. Sen., 1930: Oligocene – Miocene strata of the northeastern part of the Hungarian Middle Mountains. II. Miocene. Ann. Hist. Nat, Mus. Nat. Hung., 27, pp. 159 – 236.
Papp, A. et. al., 1973: Ottnangien Chronostratigraphie und Neostratotypen. Bd. III. pp. 1 – 841. Bratislava.
Rögl, F., 1968: Die miozäne Foraminiferenfauna von Laa an der Thaya in der Molassenzone von Niederösterreich. Geol. Ges. 61. S. 63 – 123.
Rögl, F., 1969: Die Foraminiferenfauna aus Phosphoritsanden von Plesching bei Lins (Oberösterreich) – Ottnangien (Untermiozän). Natur. Jahrb. Stadt Sonderb.
Rögl, F., 1975: Die planktonischen Foraminiferen der Zentralen Paratethys. Proc. VI-th Congr., RCMNS, Opp. 113 – 120. Bratislava.
Rögl, F., Steininger, F., Martini, E., 1975: Current Oligocene/Miocene biostratigraphic concept of the Central Paratethys. Newsletters Stratigr., pp. 1 – 48.
Schréter, Z., 1940: Surroundings of Nagybátony, Works of the Hung. Geolegical Seciety, 2, pp. 1 – 154.