ANALELE ŞTIINŢIFICE ALE UNIVERSITĂŢII "AL. I. CUZA" IAŞI
Geologie. Tomul LII, 2006

CONTRIBUTIONS TO THE PALYNOLOGICAL STUDY OF BÂRNOVA - MUNTELE FORMATION (MOLDAVIAN PLATFORM)

DANIEL ŢABĂRĂ

KEY WORDS: Palynology, Sarmatian deposits, Bârnova – Muntele Formation, Moldavian Platform.

The region studied is situated in the central part of the Moldavian Platform, at approximately 10 km south from Iaşi municipality, close to Bârnova rail station.

From the stratigraphic point of view, the "Bârnova sands" are surrounded by Atanasiu (1945), Jeanrenaud (1963, 1971), Ionesi and Cochior (1995) at the Upper Basarabian. From the lithological point of view, we notice the predominance of fine sands of white colour with clay intercalations , the sands also comprising a weakly brackish fauna (*Congeria, Melanopsis, Neritina)* and fresh water characteristics (*Planorbis*) (Jeanrenaud, 1971; Ionesi, Cochior, 1995).

For the whole succession of deposits with weakly brackish fauna extended on the whole area of Moldavian Platform, Ionesi et. al (2005) proposes the name of **Bârnova - Muntele Formation** (the name of Bârnova comes from the right side of Prut and the denomination of Muntele comes form the left side of Prut) belonging to the weakly brackish Biofacies of the Basarabian. From the lithostratigraphic point of view, the authors distinguish two members in the Bârnova - Muntele Formation: an inferior one, with the greatest width (170-180 m) named by *Vlădiceni* (encountered under the name of Vlădiceni Clays and Sands in Brânzilă , 1999) and for the superior one he proposes the denomination of *Pârâul Pietrei*.

Grasu et al. (2002) makes several observations about the interpretation of depositional field of "Bârnova sands" from the studied outcrop , identifying several facieses grouped in four associations:

1. The association of A facieses – fine and very fine grey sands in which we notice the stratification intersected at a small and plane angle – parallel.
2. The association of B facieses - white sands dominated by the stratification intersected at a very small angle, and, at a small scale, locally , the intersected lamination

3. The association of C facieses – mudstone with plants summing up widths that vary from 0,5-1,5 m where we can notice intercalations rich in foliar and a fauna with big unionidae.
4. The association of D facieses – laminated mudstone , with a length of 0,4 m and situated in the bottom part of the column.

Palynological study

The clay samples analyzed palynologicaly were prevailed from a stratigraphic width of approximately 100 m, between 250-350 m altitude (Figure 1). Within this width we can establish the two members of Bârnova - Muntele Formation in the subsequent manner (Figure 1) : the Vlădiceni Member (250-317 m alt.) and the Pârâul Pietrei Member (317-350 m altitude).

The quantitative-qualitative analysis of the microflora of the 8 samples has emphasized the following frequencies of the systematic groups: Gimnosperms – 22 %; Angiosperms -59 %; Ferns – 5 % and Phytoplancton – 14 %.

• The Phytoplancton is represented in reduced proportions in the P1, P2 and P3 samples (Figure 1), reaching in P6- 19% and in P8 - 45 %. Among the species identified we can mention *Pleurozonaria stellulata* , *Botryococcus braunii, Deflandrea* sp. (Table 1) , but the highest percentage value belongs to the *Ovoidites* sp., that exceed 40 % in P8. This taxon is absent in the inferior side of the analyzed column. Its presence is specific to the weakly brackish deposits of Bârnova - Muntele Formation, being a plankton organism associated to the deposits settled down in the fresh water (Nagy, 1969).

• The ferns are relatively diversified and have a reduced frequency. The maximum value is reached in P6 - 13 %. The most frequent spores are the *Polypodiaceae* represented by *Laevigatosporites haardti haardti, L. gracilis, Polypodiidites secundus*. Among the *Schizaeceae* we can mention *Leiotriletes microsinuosoides, L. wolffi*, les frequently *Extrapunctatosporis seydaensis, Neogenisporis* sp., *Echinatisporis cycloides* and *Bryophytae* (*Stereisporites zonales*) (Table 1). The most numerous species belong to P4.

• The coniferous trees are regularly represented by the families:

- *Taxodiaceae* : 4%
- *Pinaceae* : 17,1 %

The *Pinus* type predominates in the palynological spectra of this order being represented by *Pityosporites insignis, P. alatus, P. labdacus, P. minutus, P. microalatus, Pinuspollenites miocaenicus* etc. Within the Pinaceae family we also notice the presence of the *Tsuga* type only at the level of Pârâul Pietrei Member (*Zonalapollenites igniculus, Z. rueterbergensis, Z. spinulosus* etc.), *Picea* (*Piceapollis tobolicus, P. planoides*), *Cedrus* and *Abies.*

The *Taxodiaceae* are represented especially by *Inaperturopollenites hiatus, I. concedipites, I. radiatus,* and *Cupressacites bockwitzensis,* while *Sciadopityspollenites* and *Sequoiapollenites* appear rather seldom.

The Ginkgoale and Cycadale family has few representatives (approximately 1 %), only a few samples belonging to *Ginkgoretectina neogenica* and *Cycadopites miocaenica* being identified.

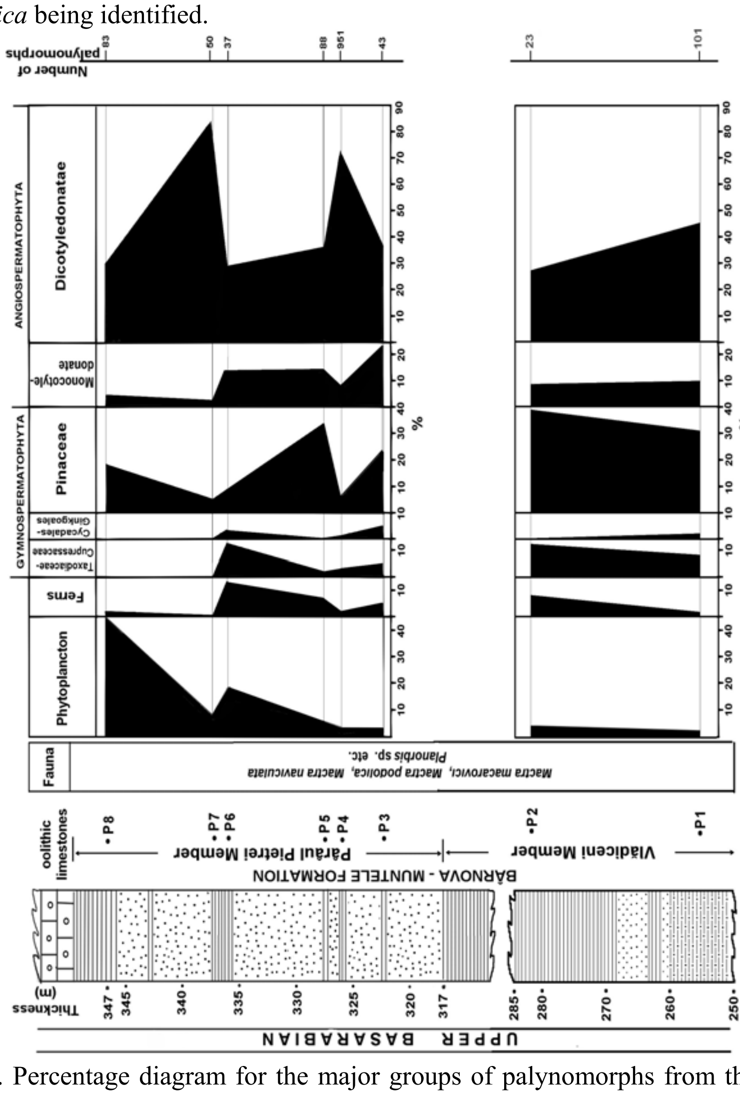

Figure 1. Percentage diagram for the major groups of palynomorphs from the Bârnova outcrop.

Table 1. List of the palynomorphs taxa from the Bârnova outcrop.

TAXA	**Frequence**							
	P 1	**P 2**	**P 3**	**P 4**	**P 5**	**P 6**	**P 7**	**P 8**
PHYTOPLANCTON								
Pleurozonaria stellulata (Cook. et Man.1960)		x	x		x			
Botryococcus braunii Kützing				+	x	x		
Hystrichosphaera sp.				x				
Tytthodiscus sp.	x					+		
Ovoidites sp.				••	x	x	+	••
Deflandrea sp.	x			x				
PTERIDOPHYTA								
Laevigatosporites gracilis Wilson-Webster 1946				x	x			
Laevigatosporites haardti haardti Kr. 1967				x				
Laevigatosporites pseudodiscordatus Kr. 1959				x				
Laevigatosporites sp.				+				
Polypodiaceoisporites saxonicus Kr. 1967				x				
Polypodiidites secundus (Pot. 1934) Kr. 1963				x				
Extrapunctatosporis seydaensis Kr. 1967				x	x	x		
Extrapunctatosporis minimus Kr. 1967			x		x			
Extrapunctatosporis miocaenicus Kr. 1967		x						
Leiotriletes asp. *microsinuosoides* Kr. 1962				x				
Leiotriletes wolffi Kr. 1962	x							
Echinatisporis cycloides Kr. 1963				x				
Neogenisporis sp.					x	x		
Toripunctisporis sp.				x				
Stereisporites (*Distzonosporis*) *zonales* Kr. 1963				x				
Hydrosporis azollaënsis Kr. 1962				x		x		
Retitriletes sp.				x				
GYMNOSPERMATOPHYTA								
Pityosporites sp.	•	+	+	••	•		x	•
Pityosporites microalatus (Pot. 1931) Th.-Pf. 1953	x	x		x	+			
Pityosporites alatus (Pot. 1931) Th.-Pf. 1953		x		x	x			
Pityosporites labdacus (Pot. 1931) Th.-Pf. 1953	x			+	+			x
Pityosporites scopulipites (Wodeh. 1933) Kr. 1971			x	x				
Pityosporites insignis (Naum. ex Bolch. 1953) Kr. 1971	x			x				
Pityosporites microinsignis Kr. 1971				x				
Pityosporites macroinsignis Kr. 1971				x				
Pityosporites minutus (Zakl. 1957) Kr. 1971		x		x				
Pinuspollenites miocaenicus Nagy 1985			x	x	x			x
Abiespollenites absolutus Thiergart 1937				x				
Abiespollenites sp.	x			8				
Piceapollis planoides Kr. 1971				x				
Piceapollis tobolicus (Panova 1966) Kr. 1971	x			x				
Cedripites miocaenicus Kr. 1971			x		x			
Cedripites sp.	x			+				

Podocarpidites sp.	x							
Zonalapollenites igniculus (Pot. 1931) Th.-Pf. 1953			+					
Zonalapollenites rueterbergensis Kr. 1971				x	x			
Zonalapollenites spinulosus Kr. 1971				x				
Zonalapollenites minimus Kr. 1971					x			
Zonalapollenites verrucatus Kr. 1971								x
Sciadopityspollenites varius Kr. 1971				x				
Sciadopityspollenites sp.	x	x	x	+	x			
Inaperturopollenites hiatus (Pot. 1931)Th.-Pf. 1953	x	x	x	●				
Inaperturopollenites concedipites (Wodeh. 1933) Kr. 1971	x			+				
Inaperturopollenites radiatus Kr. 1971	x			x				
Inaperturopollenites sp.	+	x		+	x	x		
Cupressacites bockwitzensis Kr. 1971	x			+				
Cycadopites miocaenica Nagy 1969	x			x				
Cycadopites sp.	x			+				
Ginkgoretectina neogenica Nagy 1969			x	+		x		
Sequoiapollenites largus (Kremp 1949) Man. 1962						x		
Ephedripites sp.				+				
ANGIOSPERMATOPHYTA. MONOCOTYLEDONATAE								
Monocolpopollenites tranquillus (Pot. 1934) Th.-Pf. 1953	x			+		x		
Monocolpopollenites sp.	x		x	●	x	x	x	x
Arecipites sp.	x		x	+				
Dicolpopollis kockeli Pflanzl 1956				+				
Graminidites media (Cookson 1947) Pot. 1960	x			+				
Graminidites sp.	+	x	+	+	x	+		
Sparganiaceaepollenites polygonalis Thg. 1937				●●	+			x
Typha angustifolia Leschik 1956				+				
ANGIOSPERMATOPHYTA. DICOTYLEDONATAE								
Magnolipollis neogenicus Kr. 1970	x			x				
Nymphaeaepollenites minor Nagy 1985	x		+	+	+	x	●●	●●
Tricolpopollenites librarensis (Th. 1950) Th.-Pf. 1953 ssp. *librarensis*	+	x		+	x	x		
Tricolpopollenites librarensis (Th. 1950) Th.-Pf. 1953 ssp. *fallax* (Pot. 1934) Th.-Pf. 1953	+	x		x	x			
Tricolporopollenites microhenrici (Pot. 1930) Kr. 1960	x		x	+	x	x		
Tricolporopollenites henrici (Pot. 1930) Kr. 1960	x			●	x			
Tricolporopollenites cingulum oviformis (Pot. 1931) Th.-Pf. 1953		x	x	x	x	x		
Tricolporopollenites cingulum (Pot. 1931) Th. et Pf. 1953 subsp. *pusillus* (Pot. 1934) Th. et Pf. 1953	x	x		x				
Tricolporopollenites pseudocingulum (Pot. 1931) Th.-Pf. 1953				+				
Tricolporopollenites marcodurensis Pf.-Th. 1953	x			x				
Tricolporopollenites sp.	+		x	x	x			
Quercopollenites robur Nagy 1969				+				

Quercopollenites granulatus Nagy 1969				+				
Quercopollenites petrea Nagy 1969				+				
Quercopollenites sp.	x			••	x	x	x	
Faguspollenites crassus Nagy 1969			x	+				
Faguspollenites minor Nagy 1969	x		x	+				
Faguspollenites sp.			x	+	x			
Engelhardtioidites microcoryphaeus (Pot. 1931) Th.-Thg. 1950 ex Pot. 1960	+		x	+	+	x		
Triatriopollenites rurensis Th.-Pf. 1953	+			x	x			
Myricipites myricoides (Kremp 1950) Nagy 1969				x				
Myricipites bituitus (Pot. 1931) Nagy 1969				+	x			
Myricipites sp.				+				
Momipites punctatus (Pot. 1931) Nagy 1969	x							
Momipites quietus (Pot. 1931) Nichols 1973					x			
Chenopodipollis multiplex (Weyl.-Pf. 1957) Kr. 1960		x		••		x		
Ulmipollenites undulosus Wolff 1934	+		x	••	x			
Zelkovaepollenites thiergarti Nagy 1969			x	+				
Zelkovaepollenites potoniéi Nagy 1969				x				
Salixipollenites densibaculatus Nagy 1969				•	x			
Salixipollenites helveticus Nagy 1969					x			
Aceripollenites rotundus Nagy 1969				•	x			
Alnipollenites verus (Pot. 1931) Pot. 1934				+	x		x	
Caryapollenites simplex (Pot. 1931) Kr. 1960	x			+	x	x		
Carpinipites carpinoides (Pf. 1953) Nagy 1985				+				
Juglanspollenites maculosus Pot. 1931	x			+				
Pterocaryapollenites stellatus (Pot. 1931) Thg. 1937				+				
Platycaryapollenites miocaenicus Nagy 1969	x			+	x			
Eucommiapollis eucommi (Planderova 1990) Petr. 1999				+	x			
Cyrillaceaepollenites megaexactus (Pot. 1931) Pot.1960			x					
Cyrillaceaepollenites exactus (Pot. 1931) Pot. 1960	x			x				
Araliaceoipollenites edmundi (Pot. 1931) Pot. 1951				+				
Ericipites callidus (Pot. 1931) Kr. 1970				x				
Intratriporopollenites instructus (Pot. 1931)Th.-Pf.1953	x					x	x	
Sapotaceoidaepollenites sp.				x				
Caprifoliipites gracilis Nagy 1969				x				
Plantaginacearumpollis soói Nagy 1963				x				
Umbelliferoipollenites sp.				x				
Spinuliferoidaepollenites sp.				x				
Frequency: x – very scarce (1–2 grains); + - scarce (3-9 grains); • – frequent (10-20 grains); •• - very frequent (> 21 grains).								

• The monocotyledonous angiosperms reach a medium frequency of approximately 11 % and they were especially identified in the 255-336 meters altitude interval (Figure 1). They present little diversification and they belong to the monocolpate and dycolpate palm pollen (*Monocolpopollenites tranquillus, Dicolpopollis kockeli*) and monoporeus pollen (*Sparganiaceaepollenites polygonalis, Graminidites media, Typha angustifolia)*. We remark the higher number of samples of *Palmae* and *Sparganium* in P4.

• The dicotyledonous angiosperms (with a maximum value in P7) present a great diversity (almost 40 morphological types). The most numerous ones belong to the *Fagaceae* families (*Tricolporopollenites microhenrici, T. henrici, Quercopollenites petrea, Q. robur, Faguspollenites minor, Tricolporopollenites cingulum oviformis* etc.), *Nympheaceae (Nymphaeaepollenites minor,* with a percent of 78 % in P7 and 30 % in P8), *Juglandaceae* (*Engelhardtioidites microcoryphaeus, Caryapollenites simplex, Pterocaryapollenites stellatus, Juglanspollenites maculosus*), *Ulmaceae* (*Ulmipollenites undulosus, Zelkovaepollenites thiergarti , Z. potoniéi*). Also, the following types were identified: *Salix, Acer, Eucommia, Magnolia, Myrica, Cyrilla, Alnus, Aralia* etc. The *Chenopodipollis multiplex* pollen reaches a maximum percent of 48 % in P4, in the other samples being almost absent.

The reconstitution of the paleoenvironment can be accomplished taking into account the information that result from investigating the fauna, the macroflora and the microflora that exist in the moment of sedimentation.

According to the current information (Grasu et al., 2002; Ionesi L et al., 2005) the fresh water fauna (*Planorbis, Unio, Anodonta*) identified in the Bârnova - Muntele Formation (the Pârâul Pietrei Member) developed in a lagoon area, isolated from the brackish sea through a seaside belt. It was supposed that the water alluvium from the continent was sufficient to diminish the salinity of lagoon waters until total sweetening.

This weakly brackish characteristic, sometimes sweetened, is also illustrated by the phytoplancton identified in the analyzed samples. Thus, we notice a predominance of the forms belonging to *Ovoidites* and *Botryococcus* in the superior part samples of Bârnova profile. Another category of hydrophilic vegetation identified is that of the deltaic field (*Nymphaea*) and eutrophic marsh and lake (*Typha angustifolia*, *Sparganium*). The *Nymphaea* type becomes dominant in the superior part of the profile (P7, P8). The *Azolla* fern (*Hydrosporis azollaënsis*) belongs to the same category of aquatic vegetation.

The presence of fern spores, most of them belonging to the *Polypodiaceae*, together with the coniferous (*Taxodium* and *Glyptostrobus*) and angiosperms (*Myrica , Cyrilla, Nyssa*) prove the existence of a swamp area near the sedimentation basin.

The mesophyle forest formation (of low and medium altitude) was represented by *Juglandaceae* (*Engelhardtia, Carya, Pterocarya*)*, Fagaceae* (*Fagus, Quercus, Castanea*)*, Ulmaceae* (*Ulmus, Zelkova*)*, Tilia, Sapotaceae* etc. The herbaceous xerophytic paleocommunities from the interior of the continent, represented by the presence of the *Chenopodiaceae*, *Ephedra* and *Graminidites*, denote the existence of some open areas. The predominance of *Chenopodiaceae* was noticed by Planderova

(1990) at the level of microfloristic zone MF-9 (Upper Sarmatian – Lower Pannonian) from Slovakia and Ivanov et al. (2002) also remarks an abundance of this type of pollen at the end of Basarabian and in the northern Bulgaria Chersonian.

The high altitude areas present some representatives of *Pinaceae* family like *Pinus, Abies, Tsuga, Picea.*

Paleoclimatical considerations

From the paleoclimatic point of view, the identified palynological specter reveals the existence of some tropical -subtropical elements, until the temperate ones. Among the macrothermal species we identify the *Polypodiaceae* spores, the palms (*Monocolpopollenites, Arecipites*) and especially the *Dicotyledonous* (*Elgelhardtioidites microcoryphaeus, Triatriopollenites rurensis, Cyrillaceaepollenites exactus, Araliaceoipollenites edmundi* etc.).

The mezothermal pollen presents a rather high frequency, among these forms mentioning the following: *Zelkovaepollenites, Tricolporopollenites cingulum, Caryapollenites, Pterocaryapollenites, Cedripites* etc.

The microthermal pollen is best represented at the level of *Pinaceae* (*Pinus, Abies, Tsuga, Sciadopitys*), and among the temperate angiosperms we can mention: *Quercus, Fagus, Ulmus, Salix, Carpinus* etc.

Statistically speaking, the correlation between the paleoclimatic types of the terrestrial vegetation present the following values (Figure 2).

Samples	temperate %	subtropical %	tropical %	mediterranean %
P8	88,6	6,8	4,6	-
P7	97,7	-	2,3	-
P6	56	36	8	-
P5	62,8	30	7,1	-
P4	82,6	10,4	6,3	0,7
P3	61,1	22,2	13,9	2,7
P2	55	45	-	-
P1	51,8	28,2	17,6	2,4

We notice a parity of subtropical - tropical elements with the temperate ones, in the inferior part of the column, after which the temperate ones become the majority (P7, P8).

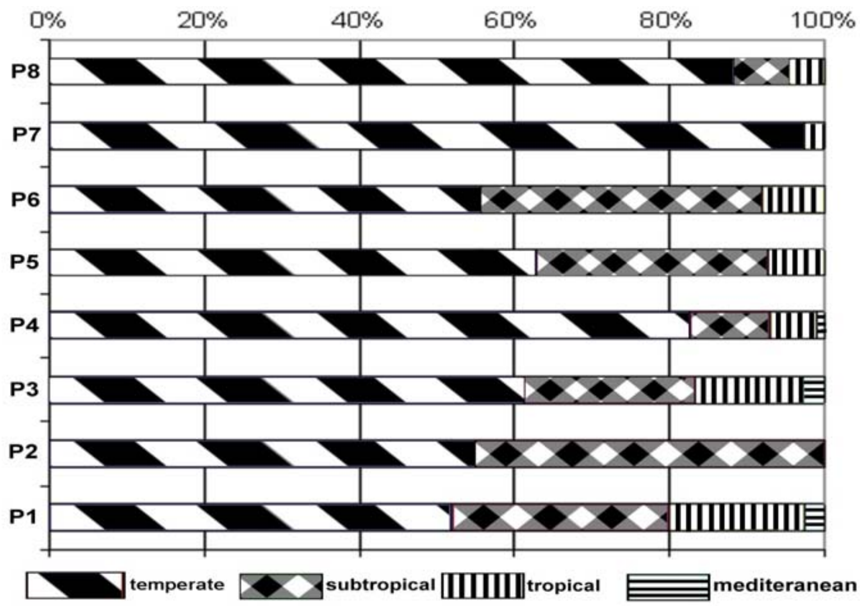

Figure 2. Paleoclimatical diagram ascertain on the Upper Basarabian microflora (Bârnova – Muntele Formation) from the Bârnova outcrop.

In conclusion, the contoured vegetation at the level of Bârnova - Muntele Formation (Bârnova profile) reveals the existence of a fresh water phytoplancton (*Ovoidites)* and of a hydrophilic vegetation (*Nymphaea, Sparganium Typha, Azolla*) in the samples from the superior part of the profile. The existence of some dry areas situated somewhere towards the interior of the continent, is proven by the abundance of *Chenopodiaceae* (in sample P4) , in association with *Ephedra* and *Graminidites.*

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EXPLANATION OF PLATES

Plate I

1 – 11. *Ovoidites* sp.
12. *Pleurozonaria stellulata* (Cook. et Man. 1960) Mädler 1968
13. *Extrapunctatosporis seydaensis* KRUTZSCH 1967
14. *Stereisporites* (*Distzonosporis*) *zonales* Kr. 1963
15. *Laevigatosporites haardti* (Pot. et Ven. 1934) Th et Pf., 1953 subsp. *haardti* Kr. 1967
16. *Polypodiidites secundus* (Pot. 1934) Kr. 1963
17. *Laevigatosporites pseudodiscordatus* Kr. 1959
18. *Leiotriletes* asp. *microsinuosoides* Kr. 1962
19. *Hydrosporis azollaënsis* Kr. 1962
20. *Polypodiaceoisporites saxonicus* Kr. 1967
21. *Botryococcus braunii* Kützing

Plate II

1. *Piceapollis tobolicus* (Panova 1966) Kr. 1971
2. *Pityosporites insignis* (Naum. ex Bolch. 1953) Kr. 1971
3. *Pityosporites alatus* (Pot. 1931) Th. et Pf. 1953
4. *Pinuspollenites miocaenicus* Nagy 1985
5. *Pityosporites labdacus* (Pot. 1931) Th. et Pf. 1953
6. *Pityosporites labdacus pseudocristatus* (Dokt. et Hrebn. 1960) Kr. 1971
7. *Pityosporites macroinsignis* Kr. 1971
8. *Pityosporites minutus* (Zakl. 1957) Kr. 1971
9. *Inaperturopollenites concedipites* (Wodeh. 1933) Kr. 1971
10. *Inaperturopollenites hiatus* (Pot. 1931) Th. et Pf. 1953
11. *Zonalapollenites igniculus* (Pot. 1931) Th. et Pf. 1953
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14. *Inaperturopollenites radiatus* Kr. 1971
15. *Zonalapollenites verrucatus* Kr. 1971
16. *Zonalapollenites minimus* Kr. 1971
17. *Sciadopityspollenites varius* Kr. 1971
18. *Cycadopites* sp.
19. *Ginkgoretectita neogenica* Nagy 1969

Plate III

1. *Graminidites media* (Cook. 1947) Pot. 1960
2. *Monocolpopollenites tranquillus* (Pot. 1934) Th. et Pf. 1953
3. *Dicolpopollis kockeli* Pflanzl 1956
4. *Sparganiaceaepollenites polygonalis* Thierg. 1937
5. *Typha angustifolia* Leschik 1956
6. *Magnolipollis neogenicus* Kr. 1970
7. *Tricolpopollenites liblarensis* (Th. 1950) Th. et Pf. 1953 subsp. *fallax* (Pot. 1934) Th. et Pf. 1953
8. *Tricolpopollenites liblarensis* (Th. 1950) Th. et Pf. 1953 subsp. *liblarensis*
9. *Platycaryapollenites miocaenicus* Nagy 1969
10. *Intratriporopollenites instructus* (Pot. 1931) Th. et Pf. 1953
11. *Tricolporopollenites microhenrici* (Pot. 1930) Kr. 1960
12. *Tricolporopollenites pseudocingulum* (Pot. 1931) Th. et Pf. 1953
13. *Quercopollenites petrea* Nagy 1969
14. *Quercopollenites robur* Nagy 1969
15. *Quercopollenites granulatus* Nagy 1969
16. *Triatriopollenites rurensis* Pf. et Th. 1953
17. *Tricolporopollenites cingulum* (Pot. 1931) Th. et Pf. 1953 subsp. *pusillus* (Pot. 1934) Th. et Pf. 1953
18. *Faguspollenites crassus* Nagy 1969
19. *Faguspollenites minor* Nagy 1969
20. *Carpinipites carpinoides* (Pf. 1953) Nagy 1985
21. *Spinuliferoidaepollenites* sp.
22. *Myricipites bituitus* (Pot 1931) Nagy 1969
23. *Eucommiapollis eucommi* (Planderova 1990) Petr. 1999
24. *Pterocaryapollenites stellatus* (Pot. 1931) Thierg 1937
25. *Ulmipollenites undulosus* Wolff 1934
26. *Zelkovaepollenites potoniéi* Nagy 1969
27. *Zelkovaepollenites thiergarti* Nagy 1969
28. *Caryapollenites simplex* (Pot. 1931) Kr. 1960
29. *Aceripollenites rotundus* Nagy 1969

30 – 31. *Chenopodipollis multiplex* (Weyl. et Pf. 1957) Kr. 1966

32. *Salixipollenites densibaculatus* Nagy 1969

33 – 34. *Nymphaeaepollenites minor* Nagy 1985