Middle Cretaceous palaeophytogeography of the Central Tethys and geodynamic implications

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Abstract: Palynological studies of Middle Cretaceous deposits of the Central Tethys allow the distinction of three palaeophytogeographic provinces: 1. Land vegetation of the archipelagos of the intra-oceanic carbonate platform, 2. Land vegetation on the newly formed island chains in the Central Tethys, 3. Land vegetation on island chains along the northern margin of the Central Tethys.

Detailed investigations of Albian-Cenomanian deposits in the Czech Republic, northern Hungary, the Carpatho-Balkanides and the Moesian platform indicate that nearby localities contain vegetation remnants of different palaeophytogeographic provinces. On the other hand, continental pollen and spore associations of far distant localities in northern Hungary-western Serbia, western Serbia-Moesian platform, etc., belong to the same palaeophytogeographic province. To understand the geodynamic evolution of SE-Europe since the Middle Cretaceous, it is important to know that the vegetation of the Inner Dinarides (western Serbia, northern Hungary) and the Moesian platform was part of the same palaeophytogeographic province. Spectra of the Middle Cretaceous Tethyan palaeophytogeographic realm, which was originally situated further to the north, have been recorded in sediments of the Carpatho-Balkanides, which are wedged between the Dinarides and the Moesian platform.

Keywords: Palaeophytogeography, Central Tethys, Sporomorphs, Middle Cretaceous, Geodynamics

1. INTRODUCTION

In the last few decades, palynological investigations have contributed an important share to the overall recognition and distribution of the Middle Cretaceous palaeophytogeographic provinces (Brenner 1976, Hochuli & Kelts 1980, Hochuli 1981, Herngreen & Chlonova 1981, 1983, Pantić et al. 1983, Pantić & Isler 1988, Voronova 1993, Voronova & Voronova 1997, Herngreen et al. 1996).

From the north southward, Brenner (1976) distinguished four Middle Cretaceous palaeophytogeographic provinces:

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1. *"Northern Laurasian Province"*. Temperate, humid climate. Bisaccate pollen grains of Pinaceae and Podocarpaceae dominate. Other gymnosperms, such as *Classopollis* and *Cycadopites*, are very rare. Pteridophyte spores show low diversity.
2. *"Southern Laurasian Province"*. Warm temperate to sub-tropical, humid climate. Spores of the pteridophyta, particularly of the Schizaeaceae and Gleicheniaceae families dominate. Bisaccate conifer grains, with Pinaceae and Podocarpaceae as predominate families, frequently occur. *Classopollis, Ephedripites* and other gymnosperms, such as *Araucariacidites, Cycadopites, Callialasporites* etc. are scarcely present.
3. *"Northern Gondwana Province"*. Tropical, semi-arid climate. Gleicheniaceae have been found sporadically, as well as bisaccate conifer grains. A significant feature of this province vegetation is the dominance of *Classopollis, Inaperturopollenites* (*Araucariacites*), *Ephedripites* and *Callialasporites* genera. The basic characteristic of this vegetation is the appearance of typical "African" floral elements (*Elaterosporites, Elaterocolpites, Galeacornea, Sofrepites* etc.), which frequently have been found in Middle Cretaceous deposits from Peru in South America, to central and northern Africa.
4. *"Southern Gondwana Province"*. Warm temperate to sub-tropical humid climate. This vegetation has been found in Middle Cretaceous deposits from southern Latin America, southern Africa, Australia, New Zealand and India. A high content of pteridophyte spores and bisaccate conifer grains has been observed in this province.

In a study of Cretaceous palaeophytogeography, HERNGREEN & CHLONOVA (1981, 1983) separated the following provinces in the Middle Cretaceous:
1. Boreal palynofloristic province, encountered in Europe (excluding Italy), northern America and the major part of Asia.
2. African-South American palynofloristic province (ASA).
3. Gondwana province (Argentina, southern Africa, Madagascar, Australia).

HERNGREEN et al. (1996) updated and reviewed the Cretaceous palaeophytogeographic provinces:
1. Palynofloristic provinces of the Northern Hemisphere, which can be divided into:
- *The Early Cretaceous Cerebropollenites province*, in which pteridophyte spore and bisaccate conifer grains predominate.
- *The mid-Cenomanian-Maastrichtian Normapolles province* (mainly Europe and south-eastern North America).
- *The Turonian – Maastrichtian Aquilapollenites province* (occupies mainland Asia and a major part of North America).
- *The Senonian Continental Margin province* (parts of westernmost America and ?Mexico).
- *The Aptian – Senonian Schizaeoisporites province* (south-eastern Asia).
2. **Equatorial belt** with:
- *The Neocomian – Aptian Dicheiropollis etruscus/Afropollis province, the Albian-Cenomanian Elaterate*, and the *Senonian Palmae Provinces.*
3. **Austral region** with:
- *The Early Cretaceous – Cenomanian Microcachrydites province* (which is characterised by trisaccate pollen).
- *The Turonian – Senonian Proteacidites/Nothofagidites province.*

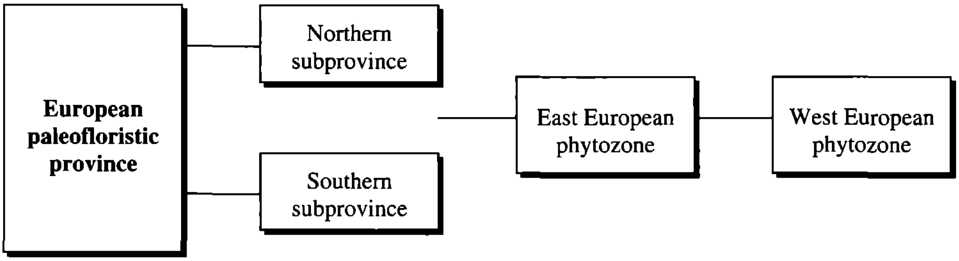

Fig. 1: Palaeophytogeography of the European palaeofloristic province (VORONOVA, 1992–1993).

Within the European palaeofloristic province, VORONOVA (1993) distinguished a **Northern sub-province** and a **Southern sub-province**. Within the latter, two phytozones can be recognised – *Eastern European phytozone* and *Western European phytozone* (Fig. 1).

In numerous articles (TREVISAN, 1971, 1980; HOCHULI & KELTS, 1980; HOCHULI, 1981; PANTIĆ et al., 1983; PANTIĆ & ISLER, 1988), palaeophytogeographic considerations included the specific development of the vegetation on the Tethyan islands and archipelagos. Beside the palaeophytogeographic provinces, a 'Transit zone' (HOCHULI & KELTS, 1980; HOCHULI, 1981), or a 'Tethyan palaeophytogeographic realm' (PANTIĆ et al., 1983; PANTIĆ & ISLER, 1988) was identified, spread over the wide continental area.

2. MIDDLE CRETACEOUS PALAEOPHYTOGEOGRAPHYOF THE CENTRAL TETHYS

The palynologic investigation of the Middle Cretaceous deposits in the Central Tethys area, enabled us to reconstruct the island vegetation developed in the Tethyan regions, and to separate three palaeophytogeographic provinces (DULIĆ, 1999; Fig. 2):

1. **Land vegetation on the archipelagos of the intra-oceanic carbonate platform** – tropical, arid to semi-arid climate.
2. **Land vegetation on the newly formed island chains in the Central Tethys (? near the African plate)** – sub-tropical to tropical climatic belt, with periodic aridity (Transdanubia in Hungary, Inner Dinarides, Moesian platform – or only some blocks in these area)
3. **Land vegetation on island chains along the northern margin of the Central Tethys** – sub-tropical to sub-tropical-temperate and humid climate (Carpatho-Balkanides)

2.1. Province of land vegetation on the archipelagos of the intraoceanic carbonate platform

The most distinctive characteristics of the vegetation, spread over the intra-oceanic carbonate platform islands, are the temporary presence of "African" floral elements, such as *Dicheiropollis etruscus, Afropollis jardinus, Elateroplicites africaensis, Elaterosporites, Galeacornea* etc. and the frequent occurrence and diversity of the genera *Classopollis, Inaperturopollenites (Araucariacites), Ephedripites, Callialasporites* etc.

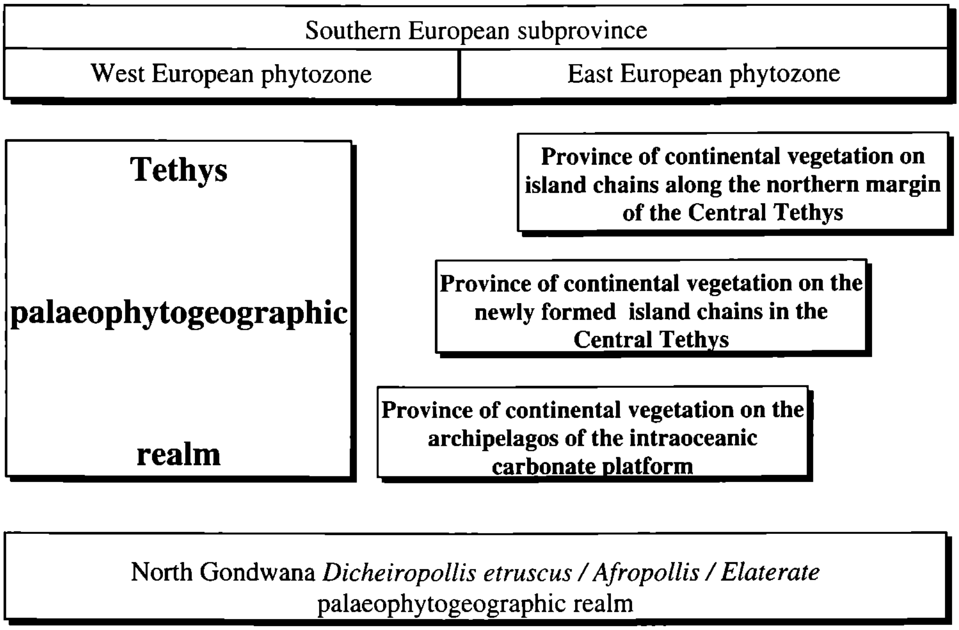

Fig. 2: Middle Cretaceous palaeophytogeography of the Central Tethys.

Within this vegetation, bisaccate conifers and ferns from the Gleicheniaceae are uncommon. This type of vegetation is well documented in Middle Cretaceous deposits of the Southern Calcareous Alps – southern Switzerland and northern Italy (Hochuli, 1981), Southern Tuscany (Trevisan, 1971, 1980), Montenegro (Fig. 3; Dulić, unpublished data) and in wells from the northern Atlantic (DSD project wells No. 417 and 418; Hochuli & Kelts, 1980).

2.2. Province of land vegetation on the new island chains in the Central Tethys

Palynomorphs from Middle Cretaceous deposits of the Inner Dinarides (western Serbia and eastern Bosnia and Herzegovina; Dulić, in press) and the Moesian platform (well cores from the easternmost Serbian localities; Dulić, in press) indicate that the character of the island vegetation is closely related to the synchronous vegetation recorded in Transdanubian northern Hungary (Deák, 1965; Juhász, 1972, 1977a, 1977b, 1979a, 1979b, 1983a, 1983b; Juhász & Góczán, 1976; Góczán & Juhász, 1985; Juhász & Smirnova, 1985). These similarities are obvious from the following facts:

- The tricolpate and tricolporate dicotyledon angiosperm pollen *(Tricolpites minutus, T. sagax, T. albiensis, T. virgeus, Retitricolpites baconicus, R. soleaformis, R. spurcus, R. splendidus, Tricolporoidites lascivus, T. bohemicus, T. modestus, T. elegans, T. obesus)* are very similar.
- The frequent occurrence of the monosulcate, acolumellate angiosperms from the

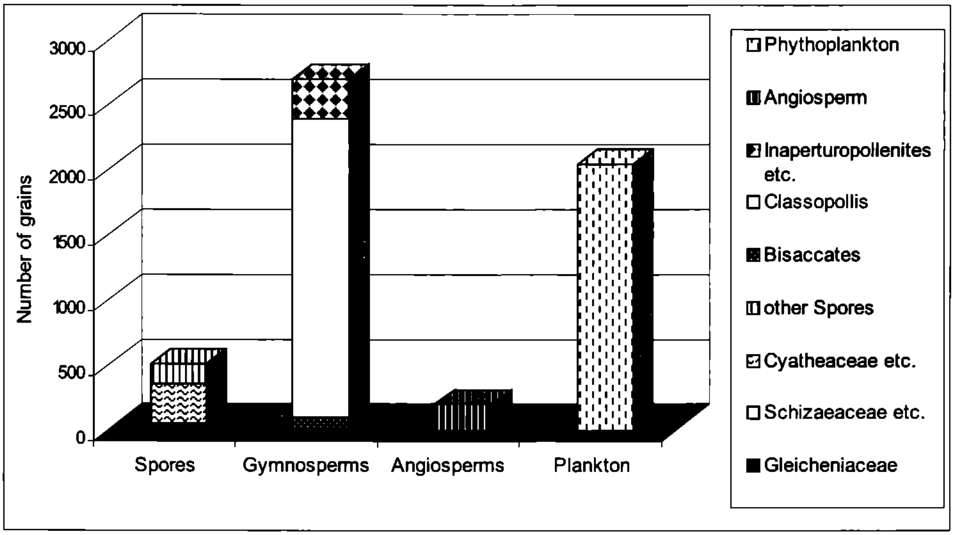

Fig. 3: Latitudinal distribution of sporomorphs in the Albian of southern Montenegro (Outer Dinarides).

Retimonocolpites reticulatus – peroreticulatus group, and the genus *Clavatipollenites* (*C. hughesi, C. tenellis, C. rotundus*).

- Monosulcate tectate, perforate angiosperms, known exclusively from Middle Cretaceous localities of Hungary and Serbia, are of special importance for the correlation. It is essential to emphasise that these grains are not found in Middle Cretaceous deposits of Austria, the Czech Republic, Slovakia, Romania, Italy, France, Spain and Portugal. Frequent occurrences of the genera *Transitoripollis* (*T. amnulisulcatus, T. similis, T. praesimilis* etc.), *Crassipollis* (*C. ovalis, C. minimus, C. urcutensis, C. tesensis, C. deake* etc.), *Similipollis* (*S. varireticulatus* etc.), as well as a unique occurrence of *Oroszlanyipollis* in the Upper Albian sediments in the Belgrade area, undoubtedly point to a great vegetation similarity, of which remnants were retained in Hungary, western Serbia and the Moesian plate.
- Extremely diversified and specific bryophyte and pteridophyte spore assemblages. It is noteworthy to emphasise the similar bryophyte and lycopsid spore assemblages (*Couperisporites clavatoides, Phaeocerosporites purus, Sestrosporites* etc.), amongst which identical genera assemblages *Vadaszisporites* (*V. urkuticus, V. pseudofoveolatus, V. uniformis, V. gregussi, V. minutireticulatus, V. sacali*), *Camarozonosporites* (*C. cerniidites, C. insignis, C. concinnus, C. hammenii*), *Retitriletes* etc. have been detected. A very great similarity has been noted within the fern spore assemblages, especially within the Lygodiaceae (genera: *Concavissimisporites, Impardecispora, Bicolisporites, Triletes, Acritosporites*), Mohriaceae (*Nodoszisporites* etc.), Anemiaceae (*Plicatella, Appendicisporites* and *Costatoperforosporites*), Schizaeaceae (*Corniculatisporites* and *Microfoveolatisporis*) and Matoniaceae (*Matonisporites major, M. simplex, M. minor, Phlebopterisporites hungaricus, Trilobosporites góczáni*

etc). Species such as *Duplexisporites generalis* and *Vinculisporites flexus*, first described from Hungarian localities, significantly contributed to the successful correlation.

These observations indicate the faults in explanations of the similarities by the direct contact of the Middle Cretaceous vegetation of northern Hungary with synchronous vegetation assemblages of Austria, the Czech Republic, Slovakia, and further east, despite the fact that these localities are spatially close nowadays. Remnants of a Middle Cretaceous vegetation from Transdanubia, in Hungary, belong to a unique, tropical-subtropical island type vegetation, numerous specimens of which were detected in Middle Cretaceous deposits from the Inner Dinarides and the Moesian plate (fig. 4). The palynomorph assemblage from the Moesic platform mentioned by BALTES (1967) does not support our speculation. The absence of *Classopollis* and *Applanopsis* (noted by N. BALTES), extremely frequent pollen grains of pinaceous and podocarpaceous affinity, as well as a pteridophyte spore association (among others genera *Pilosisporites, Rouseisporites, Acanthotriletes* etc.), point to a relation of these assemblages with the temperate climatic belt.

The specific evolution of the angiosperms (*Transitoripollis, Crassipollis, Similipollis, Oroszlanypollis*, the extremely diversified monosulcate grain association of the *Retimonocolpites reticulatus – peroreticulatus* – group, abundance of dicotyledonous angiosperms etc.) and the extremely diversified pteridophyte spore association suggest

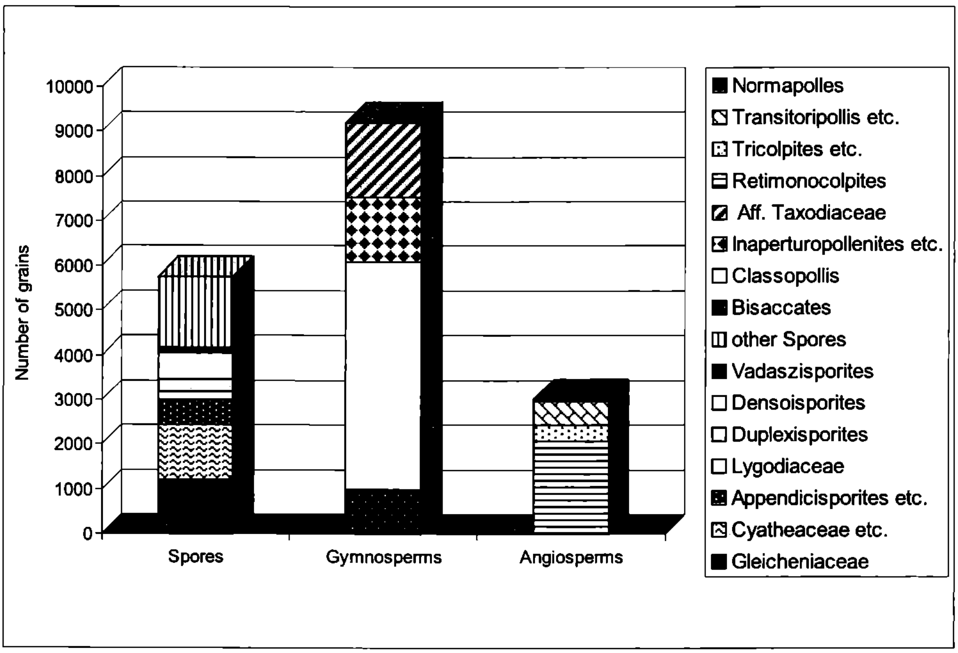

Fig. 4: Latitudinal distribution of sporomorphs elements in the early Cenomanian of western Serbia (inner Dinarides).

that the terestrial sporomorphs from the Middle Cretaceous Transdanubian, Inner Dinarides and Moesian platform, belong to one more or less isolated tropical-subtropical land vegetation which developed on the newly formed island chains in the central Tethys. Based on the character of this vegetation, it can be assumed that these island chains were distributed from the southern to the central belt of the Tethyan palaeophytogeographic realm.

2.3. Province of land vegetation on island chains along the northern margin of the Central Tethys

The sporomorphs from the Albian and Cenomanian formations of the Carpatho-Balkanides show that the island vegetation that developed was closely related to the Eurasian palaeophytogeographic realm. This conclusion is supported by the following observations related to angiosperm evolution:

- Triporate grains assigned to *Normapolles* – this group, based on the latest observations, appear at the beginning of the Cenomanian. Within the Lower Cenomanian deposits there is a prominent number of *Complexiopollis* species and genera, like *Tenerina, Monstruosipollis, Plicapollis* (*P. serta*) etc. It is significant that *Complexiopollis* occurs extremely rarely within the Lower Cenomanian deposits of the Inner Dinarides (until now, the *Normapolles* group has not been detected in the Lower Cenomanian Transdanubian deposits).
- Very frequently tricolpate and tricolporate dicotyledonous angiosperm grains can be found. They are completely dominant in the Upper Albian and Lower Cenomanian. The most frequent species, especially in the Albian, are those with a smooth exine, while in the Cenomanian types appear with more developed tricolpate and tricolporate apertures than those found in the Cenomanian of Inner Dinarides.
- In addition to tricolpate types, bicolpate angiospermous pollen grains also developed during the Cenomanian. A spread of bicolpate angiosperms has been noted in the Cenomanian – Turonian deposits of Khazahstan (TARASEVICH & ZHILIN, 1998).
- The genus *Clavatipollenites*, together with representatives of the *Retimonocolpites reticulatus – peroreticulatus* group is solely encountered in a small number of samples, and *Transitoripollis* and *Crassipollis* are even more sparsely found.

  Furthermore, the composition of the pteridophytic spore and coniferous pollen assemblages are of great importance. Among the lycopsida, the representatives of the Lycopodiaceae family are dominant, especially the genera *Retitriletes* and *Neoraistrickia*. The genus *Vadaszisporites* is particularly common after the Early Cenomanian, while *Bicolisporites* and *Triletes* have not been detected before the Turonian.
- Within the fern spore assemblage, *Distaltriangulisporites* (*D. perplexus, D.* cf. *costatus, D.* cf. *irregularis*) and *Murosporoides* have been found frequently, while *Kuylisporites* (*K. lunaris*), *Asbeckiasporites* and *Pilosisporites* are rare. These genera are, according to recent investigations, not present in the Middle Cretaceous deposits of the Inner Dinarides.
- The conifer assemblage is characterised by bisaccate pollen grains of Pinaceae and Podocarpaceae. *Classopollis, Inaperturopollenites, Callialasporites* etc. are of lesser importance.

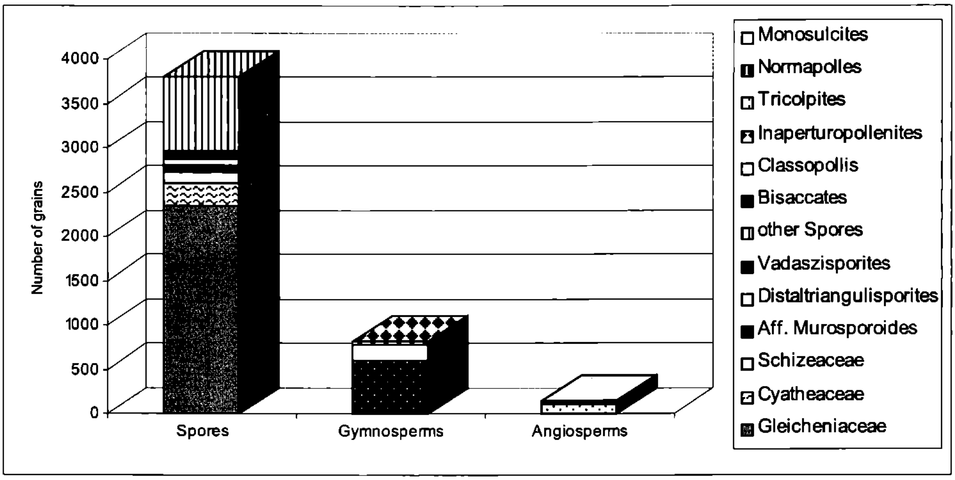

Fig. 5: Latitudinal distribution of sporomorphs in the early Cenomanian of eastern Serbia (Carpatho-Balkanides).

In particular the evolution of the angiosperms, pteridophyte spore assemblages etc. shows that the terestrial sporomorphs from the Albian and Cenomanian deposits of the Carpatho-Balkanides, belong to an isolated, subtropical to subtropical-temperate island vegetation (Fig. 5). The spores (aff. *Murosporoides, Asbeckiasporites, Distaltriangulisporites* etc.) and angiosperms (*Gothanipollis, Plicapollis serta, Bicolpites,* aff. *Proteacidites,* association of tricolpate and tricolporate grains etc.) indicate that the evolution of these island vegetations can be compared with continental vegetations, developed in the eastern part of the Euro-Asian palaeophytogeographic realm (Ukraine and further east – VORONOVA, 1984, 1990, 1993; VORONOVA & VORONOVA, 1997; TARASEVIČ & ZHILIN, 1998, etc.).

3. PALAEOPHYTOGEOGRAPHY AND GEODYNAMICS IMPLICATIONS

Plant evolution and the distribution of palaeophytogeographic provinces are closely related to global geodynamic events and palaeoclimatic development.

As a result of the spreading of the Meso-Tethys, two land areas with different vegetation types formed, due to different climatic belts and area isolation. Separate directions of development is indicated by the distribution of palaeophytogeographic provinces during the Jurassic (Liassic), and consequently two palaeophytogeographic provinces can be separated within Tethys (PANTIĆ, 1981; PANTIĆ & DULIĆ, 1990):

1. Euro-Asian province – Tethyan northern margin.
2. Gondwana province, with Tethyan palaeophytogeographic province on its northern margin – vegetation at the islands of intra-oceanic carbonate platform. The flora of the Tethyan area is successfully studied at Sardinia (DEL RIO M., 1984), northern Italy

(ERVE VAN, 1977), Switzerland (PANTĆ & FELBER, 1983), Outer Dinarides (PANTIĆ, 1952, 1981; PANTIĆ, DULIĆ & GAKOVIĆ, 1989).

It is noteworthy that until Early Cenomanian (? Turonian) times, the archipelagos of the intra-oceanic carbonate platform, were located close to the African continent. In Barremian deposits of the Southern Calcareous Alps, African gymnosperms, such as *Dicheiropollis etruscus* and frequent *Classopollis* and *Ephedripites* have been detected. In the Aptian, *Classopollis* and *Ephedripites* predominate, while *Afropollis jardinus* is also present. Albian and Cenomanian deposits contain of "African" floral elements such

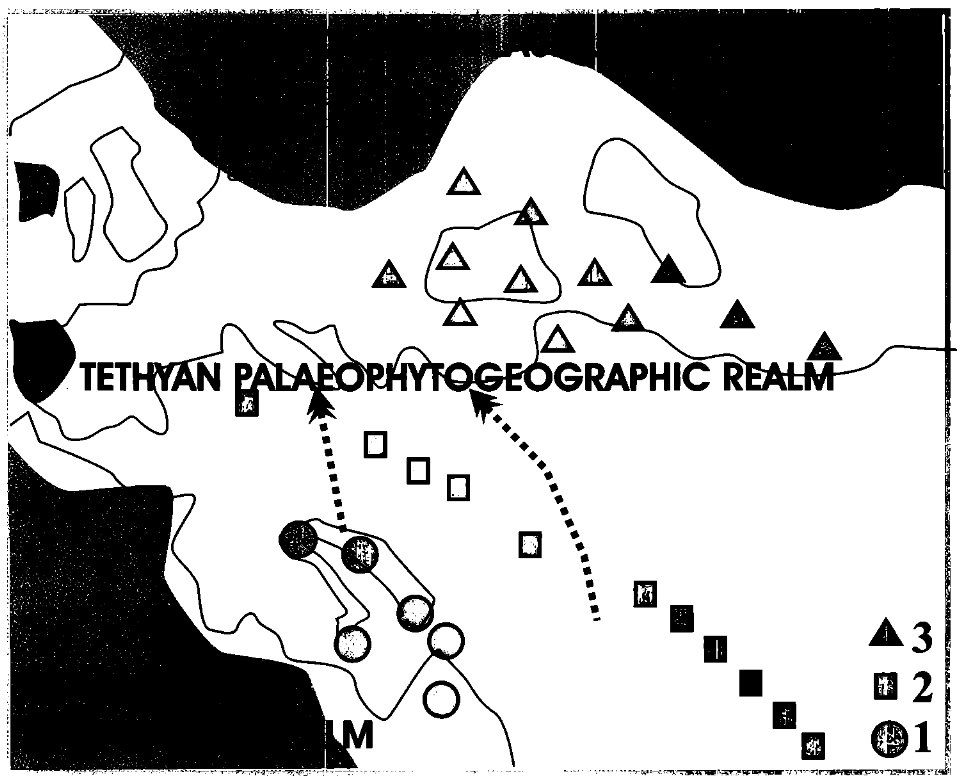

Fig. 6: Reconstruction of Middle Cretaceous palaeophytogeographic provinces in the Central Tethys.

1. Province of land vegetation on the archipelagos of the intra-oceanic carbonate platform – tropical, arid to semi-arid climate.
2. Province of land vegetation on the newly formed island chains in the Central Tethys (? near the African plate) – sub-tropical to tropical climatic belt with periodic aridity (Transdanubia in Hungary, Inner Dinarides, Moesian platform – or only some blocks in these area).
3. Province of land vegetation on island chains along the northern margin of the Central Tethys – sub-tropical to sub-tropical-temperate and humid climate (Carpatho-Balkanides).

as *Reyrea polymorphus, Elateroplicites africaensis, Elaterosporites klaszi, Galaeacornea causea*, with extremely frequent *Ephedripites, Steevesipollenites* and *Classopollis* (HOCHULI, 1981).

The development of continental vegetations and the distribution of palaeophytogeographic provinces in Middle Cretaceous times were caused by global events, such as closing of the Tethys ocean, intensive volcanic activity, increased oscillations in palaeoclimatic development and intensification of extratelluric events (PANTIĆ, SLADIĆ-TRIFUNOVIĆ & DULIĆ, 1993).

Fig. 7: Present spatial disposition of deposits containing remnants of Middle Cretaceous vegetations from different palaeophytogeographic provinces of the Central Tethys.

1. Province of land vegetation on the archipelagos of the intraoceanic carbonate platform – tropical, arid to semi-arid climate.
2. Province of land vegetation on the newly formed island chains in the Central Tethys (? near the African plate) – sub-tropical to tropical climatic belt with periodic aridity (Transdanubia in Hungary, Inner Dinarides, Moesian platform – or only some blocks in these area).
3. Province of land vegetation on island chains along the northern margin of the Central Tethys – subtropic to subtropic-temperate and humid climate (Carpatho-Balkanides).

As a result of the closing of the Tethys, deep flysch troughs, submarine mountains and island chains were formed. On the newly formed islands (archipelagos), specific development of the continental vegetation took place, which was dependent of palaeogeographic position, palaeoclimatic conditions and more or less influenced by African or Euro-Asian land floras. Due to frequent periods of colder climate, predominantly during Late Albian and Early Cenomanian times, the Tethyan tropical and subtropical belts narrowed, while the temperate climatic belt widened, which significantly influenced outgrowth of vegetation in the Tethyan region.

Palynological investigations of Middle Cretaceous deposits allow a reconstruction of the different land vegetations which developed in the Tethys area. Several types can be recognised: vegetation on intra-oceanic carbonate platform archipelagos, vegetation on the newly formed island chains in the central Tethys and vegetation spread along island chains on the Tethyan northern margin (Fig. 6).

The spatial distribution of the sporomorph assemblages from Middle Cretaceous deposits of Central and Southern Europe (Czech Republic – Peruc Korycany Fm.; Hungary – Middle Cretaceous of Transdanubia; Yugoslavia – Moesian platform, Carpatho-Balkanides, Inner Dinarides, Outher Dinarides; northern Italy – Southern Calcareous Alps, Toscana etc.), suggest that blocks nowadays located close together in northern Hungary and south-eastern part of the Czech Republic contain remnants of Albian–Cenomanian vegetation from two widely distributed palaeophytogeographic provinces. The same is true for eastern Serbia (Carpatho-Balkanides) and western Serbia (Inner Dinarides), as well as for localities spread over the Moesian platform. In contrast, localities in widely distributed Middle Cretaceous deposits from northern Hungary and western Serbia, contain similar spore and pollen assemblages – belonging to the same palaeophytogeographic province (Fig. 6, 7).

The palaeophytogeographic reconstructions of the Tethyan island vegetation shows that during the Middle Cretaceous the Moesian platform was located south-eastward from its present position. This fact indicates that, like the Apulian plate and Dinarides, after the closure of the Tethys ocean and the rotation of the African plate, Moesia also (or parts of it) moved in a general SE-NW direction. For the purpose of a better understanding the essentials of the geodynamic evolution in this area, it is important to note that palaeophytogeographic reconstructions show that remnants of Middle Cretaceous vegetation, from the Inner Dinaride deposits (western Serbia, northern Hungary) and Moesian platform, belong to the same palaeophytogeographic province. Namely, between the Dinarides and Moesia are wedged deposits with remnants of vegetation belonging to the Middle Cretaceous province, located more northward in the Tethyan palaeophytogeographic area (Fig. 6, 7).

Palaeophytogeographic studies are, therefore, an important tool for reconstructing the position of blocks which were tectonically displaced thousands of kilometres from Middle Cretaceous to Late Neogene times.

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References

BALTES, N., 1967: The microflora of the Albian "Green sands" in the Moesia platform (Romania). – Rev. Palaeobot. Palynol. **5**: 183–197, Amsterdam.

BRENNER, G. J., 1976: Middle Cretaceous floral provinces and early migration of Angiosperms. – In: C. B. BECK (Ed.): Origin and Early Evolution of Angiosperms. – 23–47, New York (Columbia University Press).

DEÁK, M. H., 1965: Recherches palynologiques des dépôts aptiens de la Montagne centrale Transdanubie. – Geol. Hung. ser. Palaeont., fasc. 29–32: 1–105, Budapest.

DEL RIO, M., 1984: Palynology of Middle Jurassic black organic shale of "Tacco di Laconi", Central Sardinia, Italy. – Boll. Soc. Paleont. Ital., **23**: 325–342.

DULIĆ, I., 1999: Middle Cretaceous Palynomorphs of Serbia and Palaeophytogeography of Central Tethys. – Bulletin T. CXIX de l' Académie serbe des arts –1999, N° 39, 151–161, Beograd.

ERVE VAN, A. W., 1977: Palynological investigation in the Lower Jurassic of the Vicentinian Alps (Northern Italy). – Rev. Palaeobot. Palynol., **23**: 1–177.

GÓCZÁN, F. & JUHÁSZ, M., 1985: Monosulcate pollen grains of angiosperms from Hungarian Albian sediments, II. – Acta Biol., **31**: 69–88, Szeged.

HERNGREEN, G. F. W. & CHLONOVA, A. F., 1981: Cretaceous microfloral provinces. – Pollen et Spores **23**, 441–555.

HERNGREEN, G. F. W. & CHLONOVA, A. F., 1983: Melovie palinoflorističeskie provincii mira. – Akad. Nauk SSSR, Trudi Inst. geol. i geof., V. **556**, Izdatelstvo "Nauka", 1–134, Novosibirsk.

HERNGREEN, G. F. W., KEDVES M., ROVNINA V. L. & SMIRNOVA B. S., 1996: Cretaceous Palynofloral Provinces: A Review. – Vegetational history, Chapter 29, 3, 1157–1188, AASP Foundation.

HOCHULI, P., 1981: North Gondwanan floral elements in Lower to Middle Cretaceous sediments of the Southern Alps (southern Switzerland, northern Italy). – Rev. Palaeobot. Palynol. **35**: 337–358.

HOCHULI, P. & KELTS, K., 1980: Palynology of Middle Cretaceous black clay facies from Deep Sea Drilling Project sites 417 and 418 of the Western North Atlantic. – In: DONNELY T. et al.: Int. Pap. DSDP **51**, **52**, **53**, 897–935, Washington.

JUHÁSZ, M., 1972: Study of the *Trilites* formgenus in Lower Cretaceous deposits. – Acta Biol., **23**: 3–17, Szeged.

JUHÁSZ, M., 1977a: Gleicheniaceae spores from Lower Cretaceous deposits of Hungary. – Acta Biol., **18**: 43–53, Szeged.

JUHÁSZ, M., 1977b: Monolete spores of Schizaeaceae from Hungarian Albian deposits. – Acta Biol. **23**: 19–38, Szeged.

JUHÁSZ, M., 1979a: Palynology of Hungarian Lower and Middle Cretaceous. – Diss. Cand. Sci., Szeged.

JUHÁSZ, M., 1979b: Dispersed Matoniaceae spores from the Hungarian Lower and Middle Cretaceous sediments. – Acta Biol. **25**: 33–47, Szeged.

JUHÁSZ, M., 1983a: Palynostratigraphic zonation of the Transdanubian Middle Cretaceous. – Acta Geol. Hung. **26**: 41–68.

JUHÁSZ, M., 1983b: Spores of Hungarian Middle Cretaceous and its botanical relationship. – Acta Biol. **29**: 89–99, Szeged.

JUHÁSZ, M. & GÓCZÁN, F., 1976: Early angiosperm pollen grains from Hungarian Lower Cretaceous. – Botanikai Közlem. **63**: 37–41, Budapest.

JUHÁSZ, M. & SMIRNOVA, B. S.,1985: *Gregussiporites*, a new spore genus from Albian sediments. – Acta Biol. **31**: 217–219, Szeged.

PANTIĆ, N., 1952: Liassic flora from Budos mountain – Montenegro. – Glasnik Prir. muzeja Srp. zem., A, I, **5**, 293–308, Beograd.

PANTIĆ, N., 1981: Macroflora and palynomorphs from Lower Jurassic of Budoš mountain, Montenegro. – Geol. an. Balk. pol., **XLX**: 157–171, Beograd.

PANTIĆ, N. & DULIĆ, I., 1990: Palaeophytogeography of Jurassic land flores in Tethyan regions and its margins. – Geol. an. Balk. pol., **LIII**: 237–247, Beograd.

PANTIĆ, N., DULIĆ, I. & GAKOVIĆ, M., 1989: Palynomorphs of the upper Pleinsbachian (Domerian) from Herzegovina. – Geol. an. Balk. pol., **LIII**: 237–261, Beograd.

PANTIĆ, N., GRUBIĆ, A. & SLADIĆ-TRIFUNOVIĆ, M., 1983: The importance of Mesozoic floras and faunas from intraoceanic carbonate platforms for the interpretation of paleogeographic and geodynamic events in the Tethys. – Boll. Soc. Pal. Italiana **22**: 5–14.

PANTIĆ, N. & FELBER, P., 1983: Palynomorphen aus den *Zoophycos*-Schichten (*Subfurcatum*-zone, obers Bajocian) der Zentralschweizer Klippen-Decke. – Eclogae geol. Helv. **76**: 333–353.

PANTIĆ, N. & ISLER, A., 1988: Palynologische Untersuchungen an Bohrproben des Albian und Cenomanian des Molassenuntergrund von Oberösterreich. – Geol. an. Balk. pol., **LII**: 209–230, Beograd.

PANTIĆ, N., SLADIĆ-TRIFUNOVIĆ, M. & DULIĆ, I., 1993: Development of Natural Systems on the Earth and Mid – Cretaceous Impacts. -Geol. an. Balk. pol., **LVII**: 1–23, Beograd.

TARASEVIĆ, F. V. & ZHILIN, G. S., 1998: On monosulcate and bisulcate pollen grains from the Albian-Turonian in Kazakhstan. – Proceedings the Fifth European Paleobotanical-Palynological Conference, June 26–30,Cracow.

TREVISAN, L., 1971: *Dicheiropolis* a pollen type from Lower Cretaceous sediments of southern Tuscany (Italy). – Pollen et Spores **13**: 561–596.

TREVISAN, L., 1980: Ultrastructural notes and consideration on *Ephedripites*, *Eucommidites* and *Monosulcites* pollen grains from Lower Cretaceous sediments of southern Tuscany (Italy) – Pollen et Spores **22**: 85–132.

VORONOVA, M. A., 1984: Miospori ranego mela Ukraini. – Nauk. Dumka, 1–117p., Kiev.

VORONOVA, M. A., 1990: Floristic and paleoclimatic changes in the southern part of the east European platform in Early Cretaceous times. – Proc. Symp. "Paleofloristic and Paleoclimatic changes in the Cretaceous and Tertiary", Prague, August 28 – September 1., 1989., Geol. Surv. Publ., 39–45, Prague.

VORONOVA, M. A., 1993: Evolution of some Cretaceous ferns in European paleofloristic province. – Proceedings of the international symposium: Paleofloristic and Paleoclimatic changes in the Cretaceous and Tertiary, September 14–20, 1992, Bratislava. Geologicky Ustav Dionyza Štura,11–16, Bratislava.

VORONOVA, M. A. & VORONOVA, N. N., 1997: The Middle Cretaceous Flora of the European Paleofloristic Province. – Proceedings 4th EPPC, Mededelingen Nederlands Institutu voor Toegepaste Geowetenschappen TNO, 58, 157–161.