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CORRELATION OF PALEOECOLOGICAL CONDITIONS IN THE TIME OF THE UPPER EGGENBURGIAN—KARPATIAN ON THE BASIS OF MICROFLORISTIC STUDIES

(Figs. 4, Pls. 2)

Abstract: In the paper solution of biostratigraphical and paleoclimatic problems in the time of the Ottnangian from the Paratethys region and of correlation of Eggenburgian—Karpatian microfloras with microflora of the coal and *Cypris* Formations in the Cheb Basin is concerned.

We were focused on solution of contradictions in the character of microflora from the stratotype locality Ottnang-Schanze (Hochuli, 1978) and facies stratotype locality Pôtor-Slatinka in southern Slovakia (Planderová, 1983, 1988 in refer.) and correlation of microflora from the Cheb Basin.

We have established that the microflora from the coal sediments underlying the *Cypris* Formation corresponds in its composition nannoflora correlable with the NN-3/4 Zone, even also the micro- to the microflora of the Pôtor beds from southern Slovakia. The microflora from the locality Ottnang-Schanze (Hochuli, 1978) corresponds to the microflora from the overlying clays (Plachtince beds) in southern Slovakia, which contain a microfauna and nannoflora correlable with the NN-3/4 Zone even also the microflora from the basal part of the *Cypris* Formation.

Резюме: В работе представлены результаты корреляции микрофлоры Западного Паратетиса с Центральным, а также микрофлоры *Цыприсовых* слоев Хебской впадины.

Разноречивые данные о охлаждении климата в отнанге Западного Паратетиса (Hochuli, 1978) по сравнению с Центральным Паратетисом дали основания для нового возрастного зачленения угольных отложений в области южной Словакии и северной Венгрии в верхний егенбург. Другой возможностью решения разноречивых данных об охлаждении климата в отнанге является предположение, что отложения стратотипового местонахождения Отнанг-Сханзе (Hochuli, 1978) относятся к верхнему отнангу (коррелируются с зоной NN—3/4), чему отвечает микрофлористический состав нижней части отложений *Циприсовых* слоев в Хебской впадине.

In this article we are focused on climatic changes at the end of the Lower Miocene, which are a subject of discussions at present. This concerns mainly controversial opinions of cooling of the climate in the Ottnangian. As in the Central Paratethys region this period was investigated particularly in detail from the micro- and macrofloristic viewpoint we have obtained further information on the climate in the Ottnangian and Karpatian of the Cheb Basin, we want to deal with question in detail.

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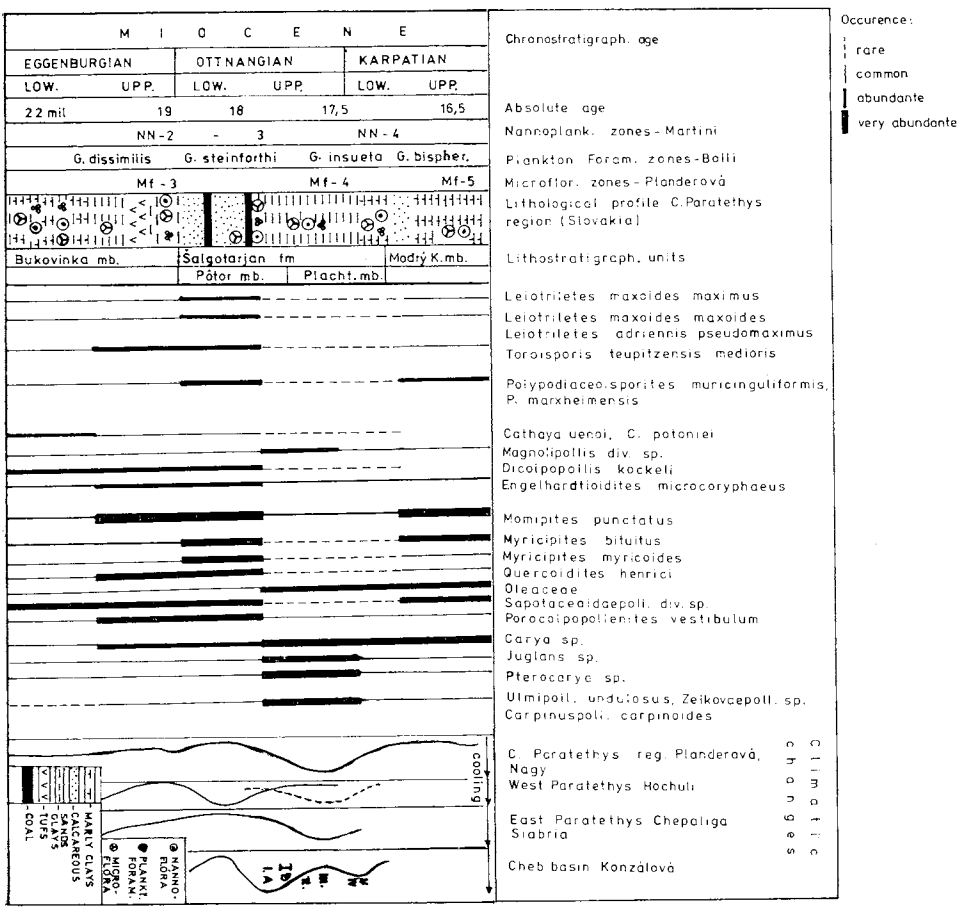
Rögl—Steininger (1984) on the basis of finds of thermophile macrofauna mention warming up in the Eggenburgian, which was replaced by rapid cooling in the Ottnangian caused by the influence of polar climate resulting in cooling all over the world in that time. This knowledge on cooling in the Ottnangian was supported by the find of psychrophilous flora also by Hochuli (1978).

We may discuss about climatic conditions through out the Lower Miocene only when we correlate the sequences dated by equal microfauna, nannoflora or absolute dating.

In correlation of absolute age there are certain discrepancies between dating by Van Couvering (1972), older dating by Vass (1975) and later by Vass—Repčok et al. (1985). In the last time, however, quite uni-

Plate 1

Tentative range of the selected taxa from Central Paratethys region (Slovakia) (correlation of climate changes)



formly 18 mil. y. are mentioned for the Ottnangian. Therefore we used in correlation only the data of 18 mil. y. for the Ottnangian.

Correlations on the basis of microfauna have also certain lacks, the Upper Eggenburgian and Ottnangian in the Western Paratethys (R ö g l, 1975) is characterized by other foraminifer species than in the Central Paratethys region. The index species for the Ottnangian in the Western Paratethys in *Globigerina stainforthi* and *G. insueta*, in the Central Paratethys it is *Globigerina angulisuturalis, G.* ex *gr. bulloides*. The palynological results from the whole Central Paratethys region indicate a warm climatic phase with rich representation of subtropical flora (Pl. 1). There are from the continuous profiles from the Eggenburgian to Badenian, from sediments in which a foraminifer fauna and nannoflora were found. I have established that cooling set in the Upper Ottnangian. In the Karpatian to Lower Badenian the climate was warming up again. The warm subtropical-tropical climate, manifested in composition of the Lower Ottnangian flora by the occurrence of large leiotrilete spores, which belong to the family *Schizeaceae (Lygodium),* by a richer occurrence of pollen if the families *Sapotaceae, Symplocaceae, Cyrillaceae, Engelhardtia, Platycarya, Dicolpopollis cockeli* and retreat of arctotertiary flora of the type *Ulmus, Fagus, Carpinus, Betula, Carya.* An intense cooling of the climate in the Upper Ottnangian (Plachtince beds of the Salgotarian sequence) caused that large trilete spores of the genus *Lygodium* were not found at all in sporomorph associations and also other above mentioned pollen of tropical plant species decreased in per cent.

Our results from the Paratethys region of Slovakia (P l a n d e r o v á, 1988) and Hungary (N a g y, 1985) correspond to the results from the Eastern Paratethys region (C h e p a l i g a, 1985; S i a b r i a y — S h c h e k i n a, 1983).

Ottnangian microfloras in the Bohemian Massif

The Ottnangian and Ottnangian—Karpatian sedimentary sequence in the Bohemian Massif is known from the Cheb Basin in the western part of Bohemia, from the sedimentary sequence overlying the main brown coal seam, the so-called *Cypris* Formation. This sequence represents continental lake deposits from where the vertebrate fauna is known. The stratigraphic position is based mainly on small mammalian fauna evaluated by F e j f a r (C i c h a — F a h l s b u c h — F e j f a r, 1974) in analogy with the Miocene faunal rests in the Paratethys area. The Ottnangian associations were encountered at the locality Dolnice near Cheb (Fig. 2). The fauna from the vicinity of Františkovy Lázně is most probably of Karpatian age. The rich preserved ichthyofauna enabled a subdivision of the *Cypris* Formation into six biozones (O b r h e l o v á — O b r h e l, 1983), significant for the short distant correlation.

Three lithological facies, reflecting the palaeoenvironmental history of the *Cypris* lake, are distinguished within the *Cypris* Formation: the facies of coal clay the variegated facies and the widespread facies of *Cypris* claystones. The layer of coal clay facies is of large extent in the central and western parts of the Cheb Basin and can be considered as key horizon, overlying the main coal seam and underlyin the claystones with mammals at Dolnice. Its micro-

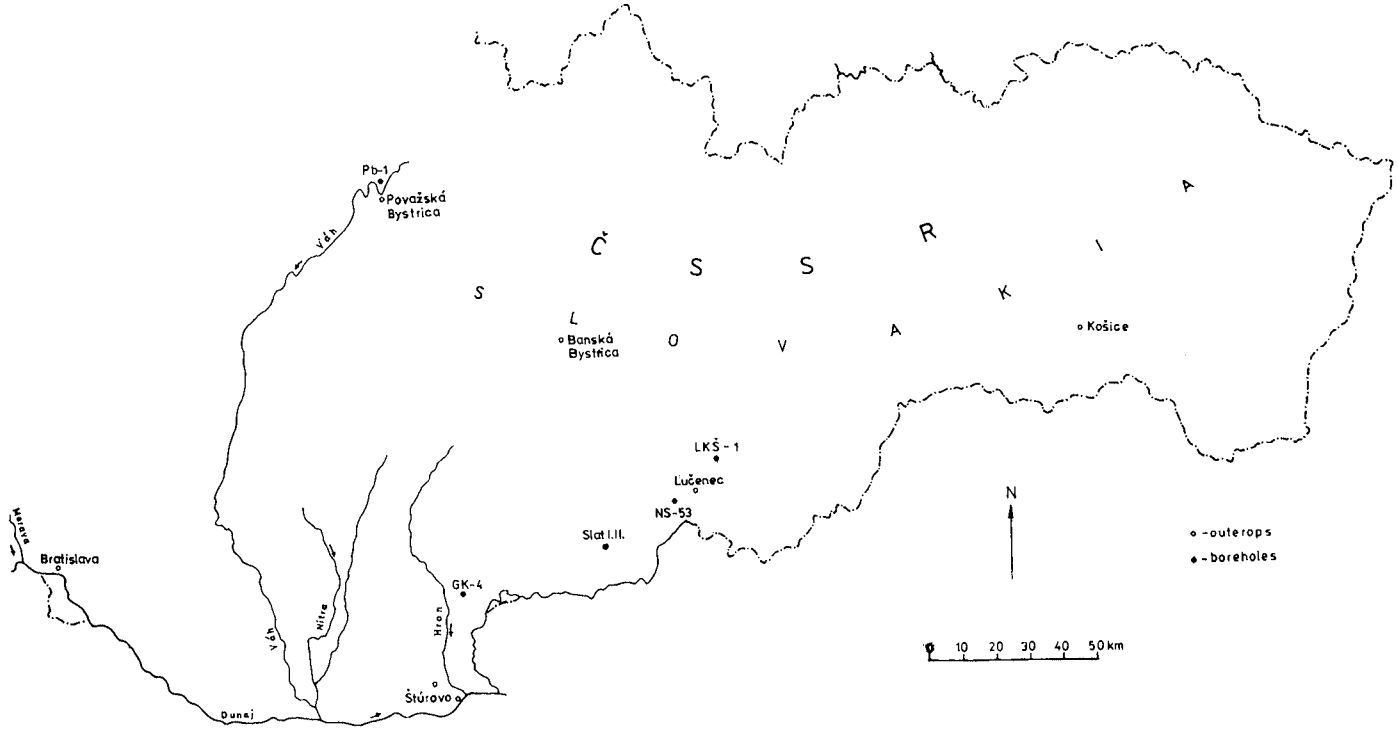


Fig. 1. The orientation map of the boreholes and outcrops in the Central Paratethys (Slovakia).

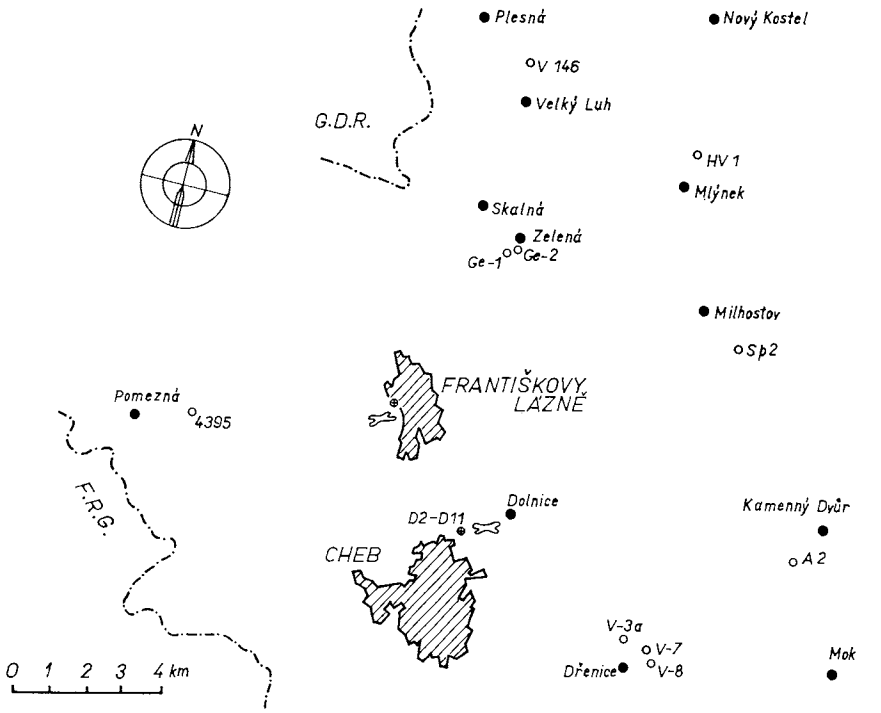


Fig. 2. The orientation map of the boreholes, ditches and outcrops in the Cheb Basin, West Bohemia.

floristic content was thoroughly taxonomically and roughly numerically evaluated (Konzálová—Stuchlík, 1983) and compared with the rich documented spectra in the Paratethydian area (Nagy, 1969; Planderová, 1963, 1973). This comparison has shown common features in the composition of the conifer forest and the presence of probable riparian lowland forest in both areas in the time interval denoted by Nagy as "Late Helvetian" and "Early Tortonian". Despite this broad comparison the attempt is made to correlate the Bohemian sediments with the Ottnangian sediments in Bavaria and Austria beside those of south Slovakia and northern part of Hungary (Shalgotarjan Basin) in the present paper.

The Ottnangian sediments were thoroughly evaluated taxonomically and in relative frequencies by Hochuli (1978). The collections of samples comprise also the schlier of the holostratotype locality Ottnang-Schanze in Upper Austria. (It represents the zone NN3-NN4 of calcareous nannoplankton.) It is of special interest for the close comparison with the spectra from western Bohemia. Almost all the taxa evaluated from the Ottnangian schlier are common in Miocene sediments, and all the species are present in the *Cypris* Formation (see e.g. Ganguli, 1966; Deb, 1973; Pacltová, 1982; Konzálová—Stuchlík in Bužek et al., 1982; Konzálová

Cypris Formation, West Bohemia

	Bore Sp 2			V3a 72 m	V7 81.5 m	Mokřina	Mlýnek HV—1 108.6 m
	112.0—112.45	172.0—173.0	183.0—184.0				
Thermophylic	17	34	18	21	17	15	14
Intermediate	29	10	18	38	5	39	25
Arcto-Tertiary	16	6	28	9	7	6	19
Facies element	38	17	29	23	43	39	42

	Central Paratethys (after Hochuli, 1978)	Wackersdorf- (after Thiele—Pfeiffer, 1979)
Thermophylic	23	37
Intermediate	11	15
Arcto-Tertiary	24	26
Facies element	21	17

	Wackersdorf (after Thiele—Peiffer, 1979)		
	Oder I/II	Oder I	Oder I
Thermophylic	28	29	33
Intermediate	14	15	13
Arcto-Tertiary	21	18	21

Fig. 3. The relation of three main groups of floristic elements in the Ottnangian pollen assemblages in the West Paratethys (Hochuli, 1978) and Wackersdorf (Thiele—Pfeiffer, 1980).

—Stuchlík, 1983). For the detail comparison the selected samples from the borehole Sp 2 at Milhostov and from the Mokřina (Grottensee) outcrop — at the depth 5 m were revised and the frequencies of the bore samples V 3a at the depth 72 m, V 7 at the depth 80.5 m and 81.5 m and HV 1 at the depth 108.6 m were numerically evaluated for the comparison. The frequencies of three main taxa are characteristic for the Ottnangian sediments at the locality

Ottnang-Schanze—Upper Austria (Ottnangian schlier): *Momipites punctatus* 15.1, *Caryapollenites simplex* 31.4 *Polyporopollenites undulosus* 11.6 (see common plant elements in the compared areas in Fig. 3).

More significant are the rare occurring species of pollen taxa or the taxa designated by H o c h u l i as characteristic for the Ottnangian sediments. He designated *Graminidites soellichauensis* and the absence or the rare occurrence of *Tsuga* (spinulosus type) as characteristic. *Graminidites soellichauensis* W. KR. occurs in the bore V 3a at the depth 70 m in the facies of *Abietinae*, numerous *Taxodiaceae* — *Cupressaceae*, *Carya* and *Ulmaceae*, but the spectrum is also more taxonomically differentiated (see the list of

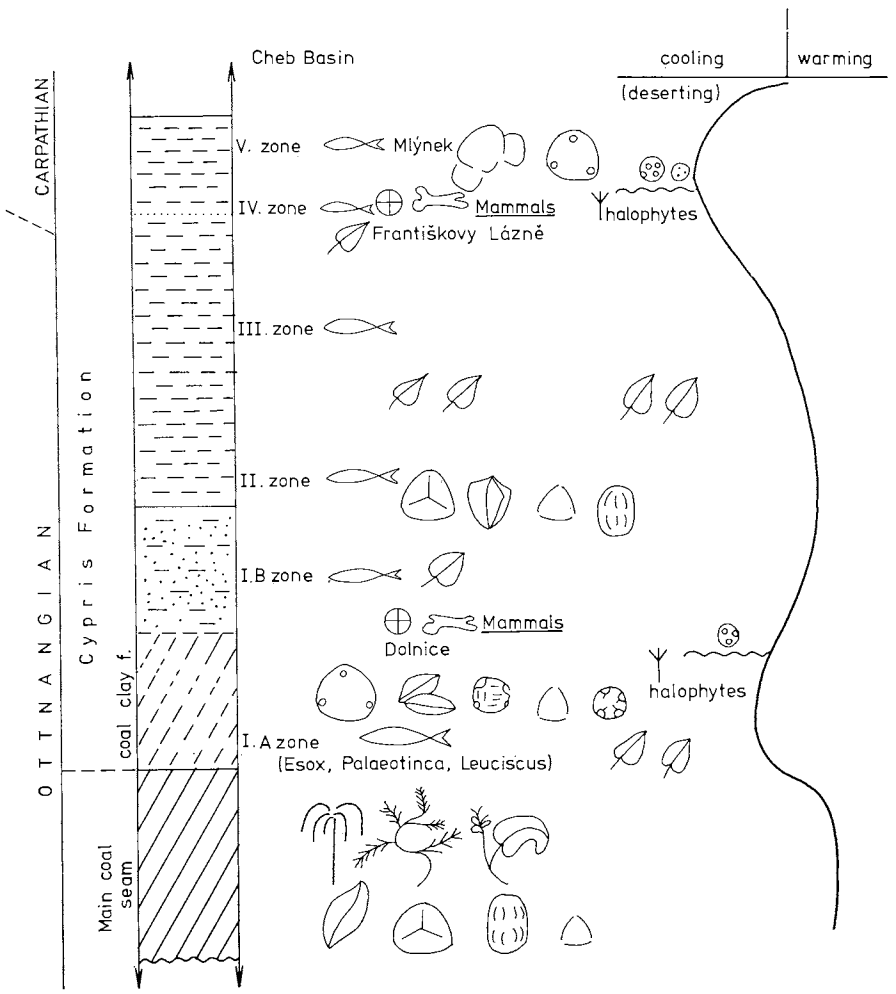


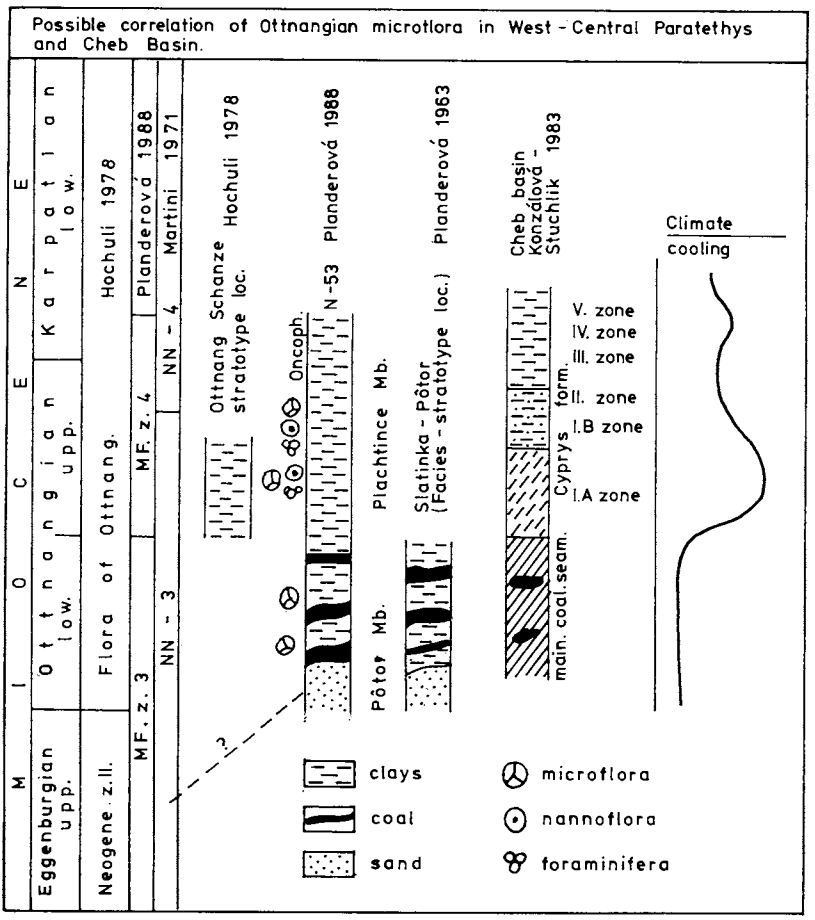
Fig. 4. Schematic picture of the sedimentary sequence of the Ottnangian and Ottnangian/Karpatian in the Cheb Basin with the designation of paleoontological finds and ichthyozones.

various elements and Fig. 4). Common features are to be seen in the occurrence of *Graminae, Cyperaceae.*

The basal part of the *Cypris* Formation, represented by the distinct horizon of coaly clay facies directly underlying the Dolnice fauna closely comparable with the spectra of Ottnangian zone (sensu H o c h u l i) from Upper Austria and Bavaria and Plachtince formation, in the C. Paratethys area S. Slovakia. The slight climatic oscillation may be presumed at the basal part of the *Cypris* Formation and during the deposition of claystones corresponding probably to the ichthyofauna zone V (see Fig. 4).

In the relation to the Austrian and Bavarian Ottnangian spectra the Bohemian assemblages are more differentiated taxonomically, but are compa-

Plate 2
Possible correlation of Ottnangian layers from Central-West Paratethys and lower part od Cheb Basin



rable in main features (see Figs. 3, 4). They display also the higher proportions of warm-like elements in the average spectra, but coincide well with those Ottnangian sections at the localities, where the relative proportions are similar (L a n g a u — H o c h u l i, 1978).

General correlation of microflora of Central-West Paratethys and Cheb Basin

H o c h u l i (1978) established a tropical-subtropical microflora in the Upper Eggenburgian and a more psychrophylous in the Lower Ottnangian. The correlation of microfloras from the Cheb Basin at the base of the *Cypris* Formation, which is discussed in detail by of the authoresses (M. K o n z á l o v á), is fully valid for the Plachtince beds (i.e. Upper Ottnangian of the Central Paratethys region). The different results, to which H o c h u l i (1978) came with cooling in the Ottnangian, we may explain by several factors.

We set out from the fact that H o c h u l i (1978) evaluated the microflora from the stratotype locality of the Ottnangian Schanze. We compared our microflora from the Pôtor beds (Fig. 1) (locality Pôtor, boreholes Be-1, LKS-1, NS-53) which are the facies-stratotype locality for the Ottnangian (sediments from the locality Pôtor), with microflora presented by H o c h u l i (1978) as an Ottnang flora. The author found out rich representation of Arctotertiary and intermediate flora there (of a composition presented in the previous chapter). We established this type of microflora (Figs. 3—4) in the Upper Ottnangian of southern Slovakia (Central Paratethys region) and in the lower part of the *Cypris* Formation (Cheb Basin). This time of sedimentation was also evaluated on the basis of nannoflora and planktonic foraminifers from the region of southern Slovakia (V a s s et al., 1987). The fauna and flora obtained from overlying marls was correlated with the NN-3/4 Zone, it is the time of the Upper Ottnangian and Karpatian base.

Provided that we shall consider the results of H o c h u l i (1978) as the basis for microfloristic characterization of the Ottnangian (although there is an evaluation of only a small number of samples, what is little for recording of the statistical character of the palynological method, and samples were not from a continuous profile), then we suppose the following possibilities, which could cause dispersion in the data on microflora composition:

1. Ottnangian sediments were correlated with a fauna of different facies at the type locality (Ottnang-Schanze), in the Central Paratethys region of Slovakia as we mentioned above.

2. We also may suppose that the Lower Ottnangian (of the Central Paratethys region) is actually a freshwater development of the Upper Eggenburgian. This is also indicated by the agreement of the Upper Eggenburgian microflora from northwestern Slovakia (borehole Pb-1) with the Lower Ottnangian microflora from southern Slovakia. When we, however, consider correlation with a microfauna and nannoflora from a continuous profile (N-53) in southern Slovakia where the Pôtor beds (Lower Ottnangian with thermophilous-tropical-subtropical flora) and Plachtince beds with psychrophilous flora, which correspond to the Upper Ottnangian to Lower Karpatian (NN-3/4 Zone), are represented, then in the Central Paratethys region of Slovakia the sedimentary content of the Ottnangian would consist of the overlying clays, which terminate with the *Oncophora* beds.

Comparing our microflora of the "tropical-subtropical" Lower Ottnangian,

"cold" Upper Ottnangian with the microflora from the Cheb Basin, which is correlated with the results from the Central Paratethys, we come to further knowledge. The microflora of the coal sequence below the *Cypris* Formation is of the same character as the Pôtor beds from the Central Paratethys (subtropical-tropical phase of the Lower Miocene). At the base of the *Cypris* Formation (I. A Zone) the microflora was correlable with the Ottnangian flora (from the locality Ottnang-Schanze) according to Hochuli (1978) and with the microflora from the Plachtince beds where sudden cooling of the climate was established. After this time warming up of the climate in Cheb Basin (Zone I. B. II—III) again and cooling at the base of the Karpatian or at the Ottnangian—Karpatian boundary (Zone IV—V) were established. With correlation of the Ottnangian microflora from the Salgotarjan formation (Pôtor beds) with microflora from the coal formation in the Cheb Basin (below the *Cypris* Formation) we have found out an agreement in the pretension to the climate in both areas. When comparing with the microfloristic data from the Western Paratethys (Hochuli, 1978), however, the microflora investigated by us is in accordance with the Upper Eggenburgian microflora from the localities Eggenburg and Maiersch (Freischling).

If we admit the possibility to correlate the Lower Ottnangian microfloristic associations with the Upper Eggenburgian in the Western Paratethys (Hochuli, 1978), then the Ottnangian in the Central Paratethys begins with the overlying clays of the Plachtince formation, in which a thermophilous microflora has been established. The sediments of the Plachtince formation contain a nannoflora and microfauna correlable with the NN-3/4 Zone (end of the Ottnangian - beginning of the Karpatian). Then in our Ottnangian—Lower Karpatian conditions there is no analogy to cooling from the end of the time of the *Cypris* Formation (Zone IV—V).

Conclusion

The pollen spectra from the Ottnangian sediments of the Paratethydian area, in the West Carpathians in Slovakia, western part of Central Paratethys in Upper Austria and from the Wackersdorf area were compared to gather more data and more detail recognition of their palynological spectra. From the close comparison based on both the taxonomy and numerical analysis of taxons, the following resemblance or differences in pollen assemblages between the compared areas may be stated.

With correlation of several microfloristic associations from the regions of the Central Paratethys, Eastern, Western Paratethys and Cheb Basin (Pl. 1) we have found out:

a) The differences in the data about composition of the microflora (thermophilous—psychrophylous, in the same period of sedimentation) could be caused by correlation with a fauna of different facies and so also a stratigraphical shift could take place with correlation of microfloras.

b) The thermophilous flora established in the Lower Ottnangian is correlable with the Lower Ottnangian microflora in Hungary (Nagy, 1985) and from the coal beds below the *Cypris* Formation in the Cheb Basin (Konzálová—Stuchlík, 1983) and with the data from the Eastern Paratethys region (Chepaliga, 1985; Siabriay—Shchekina, 1983) as well as

with the sediments underlying the Ottnangian beds from the localities Eggenburg and Maiersch (Freischling) (H o c h u l i, 1978).

c) If we accept the data about composition of the microflora from Ottnang--Schanze as sufficient (H o c h u l i, 1978), on the basis of correlation with them we may consider the Pôtor beds (southern Slovakia, facies-stratotype locality of the Ottnangian Pôtor-Slatinka) as Upper Eggenburgian (freshwater development of the Eggenburgian) and the Plachtince beds (NN 3/4 Zone) as Ottnangian (Pl. 2).

d) A further possibility is in agreement with the results of the above mentioned authors to admit the Lower Ottnangian sediments as valid from southern Slovakia and to correlate the Upper Ottnangian sediments from southern Slovakia (Plachtince beds proved by fauna and flora) with the Ottnangian from the locality Ottnang-Schanze (H o c h u l i, 1978). In this case the lower coal formation below the *Cypris* Formation would belong to the warm phase of the Lower Ottnangian and the colder phase at the base of the *Cypris* Formation would have analogy with the Upper Ottnangian in Paratethys region on the basis of correlation.

It is evident from the mentioned considerations, that even when we came to certain knowledge by correlation of microfloristic associations, further microfloristic investigations of the underlying and overlying sediments of the stratotype locality of the Ottnangian will be necessary with the possibility of wider interregional correlation in connection with sediments dated faunistically. So far, until these questions are cleared up on the basis of investigation of a greater amount of samples from the Western Paratethys region (mainly from stratotype localities), so that statistical reliability of microfloristic data should be recorded, we leave the question of microflora correlation open and shall consider the facies stratotype sediments, i.e. the Pôtor beds (Central Paratethys, locality Pôtor-Slatinka) as the Lower Ottnangian with a warm subtropical climate.

In the present time it is most probable that there are no great differences between the microflora from Upper Eggenburgian and Lower Ottnangian.

The greatest correlation possibility is to correlate the microflora from Upper (cold) Ottnangian from Central Paratethys region (Slovakia) with microflora from stratotype locality Ottnang-Schanze (sensu H o c h u l i, 1978) because of correlation of both regions with nannoplanktonic zones NN-3/4. The age of both layers would be Upper Ottnangian.

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