Volcanosedimentary Complex of the České Středohoří and Doupovské Hory Mts. in Palynological Record

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ABSTRACT. A summary of important palynodata is presented, based on the investigation of sedimentary interbeds of volcaniclastic rocks. The recorded plant microfossils comprise remains of algae, fungi and phanerogams. The pattern of taxa and their frequency are shown in broader context of climatic changes and radiation of new plant invaders. As an example, six different localites from the České středohoří Volcanic Complex and the Doupovské hory Mts. composite volcano were selected, including the sites with vertebrate fauna. These are confined to the Paleogene Zones MP 21-MP 22, to the post-Grand-Coupure time, as most of the localites under discussion.

KEY WORDS: plant microfossils, interbeds in volcanic rocks, Tertiary volcanic complex, Bohemia.

Introduction

Sedimentary interbeds of clays, mudstones and diatomites within volcaniclastic rocks were studied systematically from borehole sections and occasional outcrops (Konzalová, l.c.). Some of them contained significant microfossils derived from higher plants often associated with fungal and algal bodies. Besides organic remains, frustules of diatoms and Silicispongia were also recorded. Several localities were selected as an example of floral pattern and its changes. Of the 18 sites studied, the present survey deals with the localities of Kučlín, Kundratice, Roudníky near Modlany, Pařidla in the České Středohoří Mts., Dvérce (partly Dětaň) and Valeč in the Doupovské hory Mts. Some of them belong to the significant mammalian sites and provided poor or no paleontological record yet.

České středohoří Mts.

The studied localities are situated in the area between the towns of Most, Teplice, Ústí nad Labem and Lovosice (Fig. 1).

Kučlín (former Kutschlin) near Bílina, NE of Most

Significant pollen grain assemblage observed in the sediments underlying the diatomites contained paleotropical/subtropical floral elements, which pointed to the late Eocene – early Oligocene age (Konzalová 1977, 1981).

The overlying diatomites belong to one of the earliest known and also exploited raw material. This fact contributed essentially to the early paleontological knowledge of the locality. The most frequent and common component of diatomites is *Melosira granulata,* now *Aulacoseira granulata* (Ehr.) Simonsen, well known since the time of Ehrenberg's investigations. The frustules of centric and pennate diatoms are locally excellently preserved (Fig. 2) and serve as calibration objects for the optical equipment. The diatomites are rather poor on organically preserved particles, however Pinaceae – *Pityosporites* sp. div. and Juglandaceae, *Engelhardia – Engelhardtioidites microcoryphaeus* (R.Pot.) R. Pot. can be mentioned. Perfectly preserved are the fish remains (e.g. Salmonoidei, *Thaumaturus* Reuss, Obrhelová 1975) and some significant plant imprints, including the ancient conifer *Doliostrobus* Marion and angiosperm leaves of Lauraceae or individual fruits of *Hooleya* Reid et Chandler (Bůžek et al. 1990). Radiometric dating of the basalt at the top of the sedimentary complex (Trupelník Hill – Trippelberg in Hibsch's maps) points to 38.3 Ma (Bellon et al. 1998), the age of the tephrite to 33.5 Ma (Ulrych et al. 2002). The Kučlín locality may be linked with the sites of Hlinná and Lbín, which display exotic elements in microfloral assemblages, such as *Dalbergia*- or *Barringtonia-Planchonia* types (Konzalová 1980), and with some core-levels at the localities lacking Arctotertiary components in the gross palynospectra. The sites of Kučlín, Hlinná and Lbín have been considered the localities of the earliest known flora, connected with volcanic activity in the České středohoří Mts.

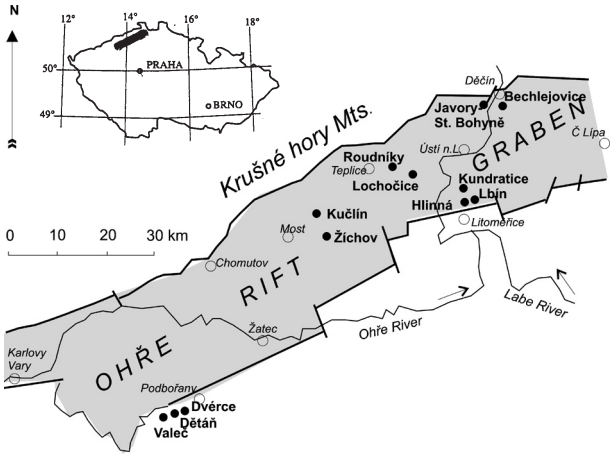

Fig. 1. Position of the studied localities (with the exception of the Pařidla locality) in the area of the Ohře Rift graben.

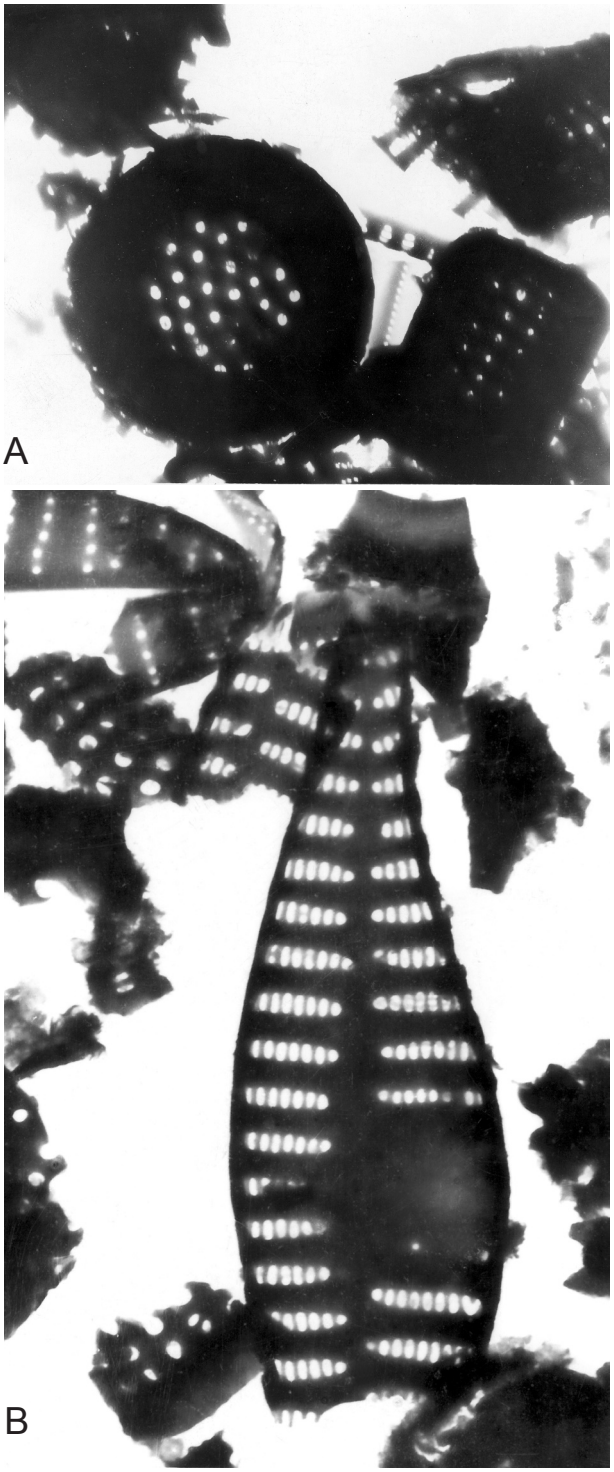

Fig. 2. An example of the centric (a) and pinnate (b) frustules of diatoms within diatomites, SEM micrographs x 10,000, Kučlín locality. (Research Institute of Ceramics, Brno).

Kundratice (former Kundratitz) near Litoměřice (Leitmeritz in the Hibsch's map) NE of Most

The classic locality Jesuitengraben of the distinguished paleobotanist Engelhardt comprises palynomorphs and leaf imprints in the diatomaceous bituminous clays and slates. Their bituminous content is derived from algal necrocoenosis formed predominantly by oil-forming algal detritus (Konzalová 1996), compacting also fungous spores and pollen exines. Pollen are derived mostly from the anemophilous land plants. Notable is the pollen content recorded at two superposed levels of diatomaceous deposits from the core section (Ku 1). The decomposed plant detritus ("microlitters") is closely comparable at the two levels, the composition of the pollen spectra differs. The lower level differs in very low deciduous tree components, occurring rather as accessories, in contrast to the upper level formerly accessible on the outcrop where Arctotertiary components are characteristic. *Ulmus, Fagus, Alnus,* Tiliaceae, *Betula, Engelhardia,* cf. *Magnolia, Carya, Salix,* Vitaceae – *Ampelopsis -Parthenocissus* – type (Fig. 3) and other taxa can be mentioned. The lower-level assemblage displays pollen of Hamamelidaceae, Fagaceae – *Fususpollenites fusus* (R. Pot.) Kds., *Tricolporopollenites cingulum* (R. Pot.) Th. et Pf., *Juglandaceae – Subtriporopollenites anulatus* Th. et Pf.,

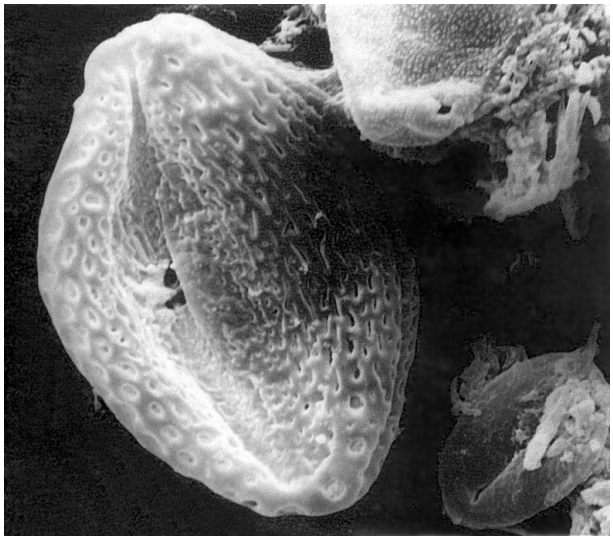

Fig. 3. Pollen of *Ampelopsis – Parthenocissus,* family Vitaceae, SEM micrographs, x 5000. A characteristic liana of the volcanogenic succession of the Ohře Rift.

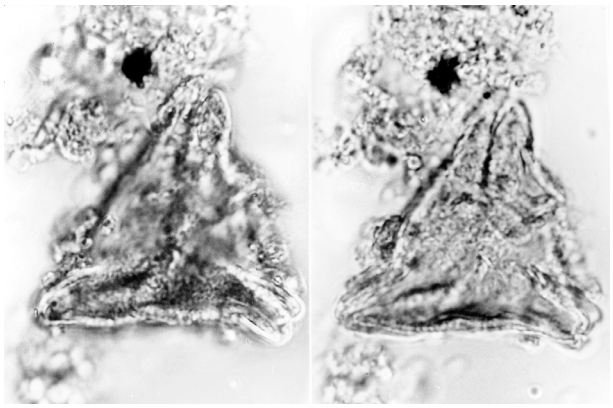

Fig. 4. *Boehlensipollis hohli* W.Kr., the marker of the Rupeslian to Eochattian microfloras. LM, photo in the phase-contrast at two focus levels x 1,300, České středohoří Mts., diatomites, Žíchov locality.

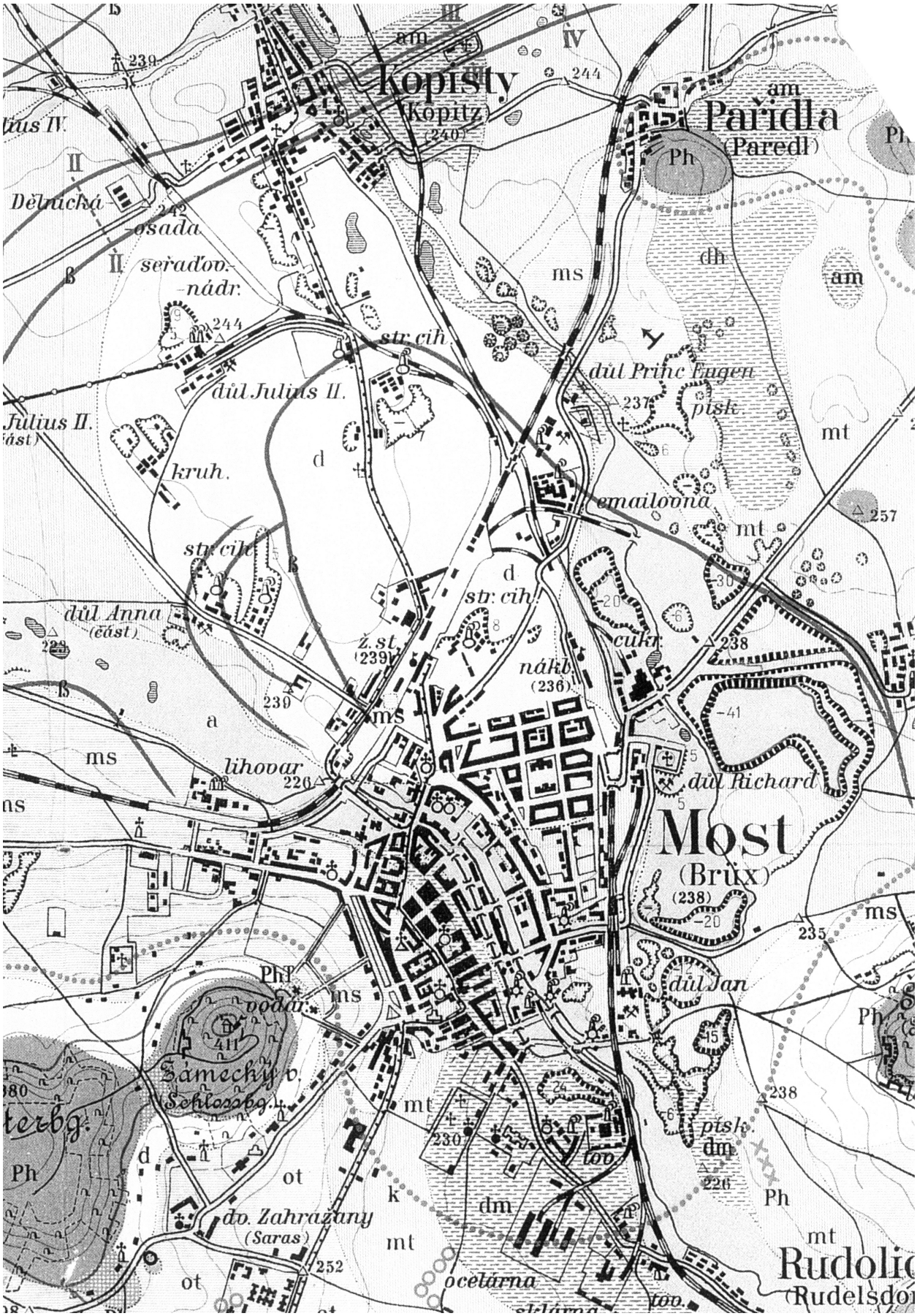

Fig. 5. Pařidla (Paredl) locality, map of Hibsch (1929).

Fig. 6. Recent rim community dominated by sedges (Cyperaceae), grasses (Gramineae), cat-tails (Typhaceae) and trees of *Alnus* and *Pinus*. It is close to the rim vegetation reflected by the pollen spectra at the localities of Dvérce and Valeč. Photo by J. Marek.

Symplocos – *Porocolpopollenites vestibulum* (R. Pot.) Th. et Pf., Cornaceae-Mastixiaceae – *Tricolporopollenites satzveyensis* Pf. in Th. et Pf., Cyrillaceae – *Tricolporopollenites megaexactus* (R.Pot.) Th. et Pf., Rutaceae – *Toddaliapollenites typicus* Th.-Pfeif., Sapotaceae – *Tetracolporopollenites sapotoides* Pf. et Th. in Th. et Pf., Calamoideae – *Dicolpopollis kockeli* Pfl., Arecaceae (Palmae) – *Arecipites* cf. *pseudoconvexus* W. Kr., which are referred to the thermophilous components of the surrounding mixed mesophytic forest vegetation. The presence of water plants, the macro-hydrophytes, is documented by the occurrence of the family Nymphaeaceae – *Nymphaeapollenites neogenicus* Th.- Pfeif., determined for the first time in the CS Volcanic Complex, except for the small macroremain in the Kučlín diatomites (Bůžek et al.1990).

Both mentioned levels are separated by effusive volcaniclastic rocks. The differences in pollen composition may be not only environmentally controlled but point also to the change in topography reflected in the surrounding forest composition. The characteristic Oligocene plant microfossil *Boehlensipollis hohli* W. Kr. (Fig. 4) was ascertained in the pollen spectra of

both levels (Konzalová 1981 and l.c. above). Radiometric age for the basaltic sheet (Bellon ex Kvaček and Walther 1998) overlying these deposits is 32 Ma.

Roudníky (former Raudnig) near Teplice (Teplitz in the Hibsch's map)

The locality (the name is alternative with the close locality Modlany) lies near the southern border of the Most Basin (formerly North Bohemian Brown Coal Basin). Its assemblages (core section Ru-43) display a high proportion of pollen from the families Taxodiaceae and Cupressaceae (70–80 % of the total summ), which is an exception among the localities studied. These inaperturates reflect early existence of a swamp cypressus forest among volcanic occurrences near the edge of the basin. Saccate pollen (Pinaceae) at the same level are represented only by 2%. *Pityosporites microalatus* (R. Pot.) Th. et Pf., *P. labdacus* (R. Pot.) Th. et Pf., *P. minutus* (Zakl.) W. Kr., *Piceapollis* sp. and *Tsuga* are involved among these conifers. The angiosperm components point to mesophytic forest composed of *Carpinus, Ostrya, Carya,* Tiliaceae (two pollen species present – *Intratriporopoll. insculptus* Mai, *I. microreticulatus* Mai), *Celtis, Platycarya, Engelhardia* and lianas of Vitaceae, among others (Konzalová and Bouška 1988). Pollen of *Carpinus/Ostrya* show the highest frequencies, comparable only with the spectra of the nearest studied locality Lochočice – Rovný (core Lch-30, Konzalová 1974, 1981, close to the Stadice paleobotanical locality). The occurrence of *Carpinus* is comparable within the České středohoří Mts. Even though the pollen may be over-represented, their abundance is evidenced also by the macroremains in the leaves and catkins at the near locality of Suletice. Both occurrences are in good agreement with the frequent finds (H. Walther, personal communication, 1990). The deposits are overlain by tuffaceous rocks and two basalt sheets whose high radiometric age (35.4 ± 0.9 Ma.), in discrepancy to the macro- and microfloral records**,** has been discussed by Kvaček in Bellon et al. (1998).

Pařidla (former Paredl, Fig. 5) NNE of Most (Brüx in the Hibsch's map; for the situation of the locality see the map of Hibsch 1929)

This locality no more exists due to the progressive coal mining in the Most Basin, but provided pollen spectra from clay deposited between two sheets of tephrite – phonolite underlying the lower clays (of the Most Formation) in the Braňany – Most area. The assemblage contained ferns of Polypodiaceae – *Laevigatosporites haardti* (R. Pot. et Ven.) Th.et Pf., of *Pteris* (pro parte) – *Polypodiaceoisporites* sp.div., conifers of Taxodiaceae – Cupressaceae – *Inaperturopollenites* sp. div., and further pollen of Fagaceae including *Castanea, Castanopsis – Tricolporopollenites cingulum pusillus* (R. Pot.) Th. et Pf., *Tricolporopollenites cingulum oviformis* (R. Pot.) Th. et Pf., *Tricolpopollenites liblarensis fallax* (R. Pot.) Th. et Pf. and *Carya – Subtriporopollenites simplex* (R. Pot. et Ven.) Th. et Pf. as the frequent components. The presence of Arctotertiary representatives *Betula*, *Alnus, Ulmus – Polyporopollenites undulosus* (Wolff) Th. et Pf., *Sciadopitys – Monocolpopollenites serratus* (R. Pot. et Ven.)Th. et Pf., *Pityosporites cedroides* Thoms., stressed by the occurrence of *Corrusporis* W.Kr., is characteristic. *Engelhardia, Sterculiaceae – Reevesiapollis* W. Kr., *Symplocos-Porocolpopolenites vestibulum* (R. Pot.) Th. et Pf., aff. *Acer*- and *Gramineae*- pollen link this assemblage with mixed mesophytic forest but also indicate riparian and rim vegetation. Noteworthy is the record of Loranthaceae – *Gothanipollis* W.Kr. in a close core section (Konobrž). The whole assemblage reflects mild, temperate climatic phase (Konzalová 1976), hardly comparable with the above mentioned localities.

Doupovské hory Mts.

The localities are situated on the SE margin of the Doupov composite volcano and belong to the mammalian faunal sites (Fig. 1).

Dvérce (former Wärzen)

The localities of Dvérce, Dětaň and Valeč (see below) are outstanding sites of fossil vertebrate finds (Fejfar 1987, 1989) with the only safely dated MP 21 Zone in central Europe (Fejfar in Bůžek et al. 1990). Because the plant macroremains are rare, all the microfloral finds are obviously important. Their first record from Dvérce is given in Table 3 (Konzalová 1981) and comprises, among others, also a type of small-sized *Aglaoreidia,* the significant monoporate pollen distributed in the European Oligocene Floras (Krutzsch and others 1992). The gross spectrum of the locality is characterized by the ferns of Gleicheniaceae – *Gleicheniidites* sp., Polypodiaceae – *Verrucatisporites* sp. div., grasses *(Gramineae)* and sedges (Cyperaceae), cat-tails – Typhaceae and Sparganiaceae-Potamogetonaceae. Except for the ferns, this rim and water vegetation recorded in pollen is close to the analogous Recent communities (Fig. 6). Tertiary features are represented by the presence of the Japanese tree *Cercidiphyllum* (widespread in the pollen spectra of the České středohoří Mts.), American *Carya* and Caucasian *Pterocarya* (for further finds see Konzalová in Bůžek et. al. 1990). The microflora (including also Ericaceae, *Erica* sp., Fig. 7) reflects a time section with open vegetation convenient for invasion of new types of fauna, evidenced by small mammals from the East (Fejfar 1989). The former continuous forests were replaced by more open habitats convenient not only for small vertebrates but also for colonizing by new herbaceous plants. This is evidenced by the first finds of *Artemisia* pollen – *Artemisiaepollenites sellularis* Nagy at this locality and in the volcanic complex in general. *Artemisia* is a characteristic open-place herb of dry soils and Eastern steppes, and its record matches well with the vertebrate radiation.

Dvérce and the close locality Dětaň are referred to the Paleogene mammalian Zones MP 21 and MP 22 (Fejfar 1989). Significant are the mammalian remains of *Elomeryx crispus* Gervais found at Dvérce, known from the Oligocene deposits of Greece and Lower Oligocene strata of Great Britain, and *Entolodon antiquum* Repelin, the high-resolution mammalian fossil, at the locality of Dětaň. [Because of a poor paleobotanical finds at the latter locality, the record of numerous frustules

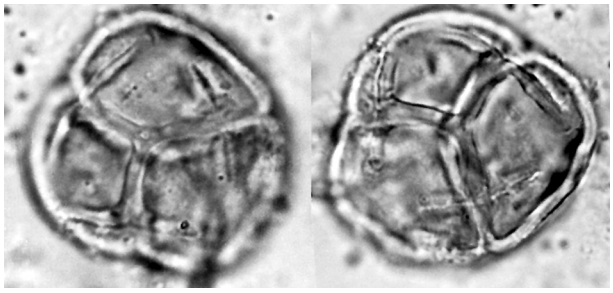

Fig. 7. Tetrade pollen of Ericaceae, *Erica* sp., light microscope (LM) x 1,000, Doupovské hory Mts., Dvérce locality.

of centric *Melosira (Aulacoseira)* diatoms identified during the present palynological investigation is worth mentioning. They are embedded in a siliceous bed stuffed with "microlitters" of more resistant plant bodies and tissues, with well discernible cellular structures. These types of diatoms are widely distributed in the České středohoří Mts.] The locality of Dvérce also contains gastropods and has been compared with the Flörsheim locality in the Mainzer Becken in Germany. Floral studies of micro- and macroflora (Pross et al. 1998) have been carried out recently. Compared to the Flörsheim locality and the borehole section in Bodenheim, the pollen assemblage from Dvérce displays many features in common. However, slight differences can be also recognized in the occurrence of less temperate elements in the microflora of Dvérce.

Valeč (former Waltsch)

Valeč belongs among very significant mammalian sites of the Paleogene Zone MP 21 with perissodactyl representative *Ronzotherium* (Fejfar 1987, 1989 and in Bůžek et al. 1990) and the rodent skeleton of *Bransotoglis* cf. *micio* Misonne (Fejfar et Storch 1994). All the palynological finds confined to tuffites were obtained recently and are new for the locality. Pollen of *Carpinus, Alnus, Ulmus, Carya, Cercidiphyllum*, *Platanus* were identified as rather frequent elements, along with Pinaceae, Cupressaceae – *Cupressacites insulipapillatus* (Trevisan) W. Kr. and a single occurrence of *Cunninghamia – Cunninghamiaepollenites janinae* Stuchlik et Konzalová. Characteristic is also aquatic algal microflora. Among rarely occurring angiosperms, *Reevesiapollis* W. Kr. and Leguminosae, Mimosaceae – *Polyadopollenites* sp. were identified, new pollen records for the volcanogenic successions of the Ohře Rift region. They are referred to subtropical elements and pose components of the mesophytic forest vegetation (Mai 1995). Pollen of Mimosaceae match well with plant macrofossil *Mimosites haeringianus* Ett. which occurs in the České středohoří Mts. (for example Suletice – Berand locality, Kvaček and Walther 1995; Bechlejovice, Knobloch 1994 and others). Nevertheless, the whole assemblage shows features of vegetation (Fig. 8) growing under slightly warm moderate climatic conditions. As a stratigraphic marker, only one specimen of the aff. *Boehlensipollis hohli* W. Kr. type was encountered.

The locality has been dated to mammalian MP 21 Zone for the earlier level with bedded limestone and to MP 22 Zone for the overlying tuff and tuffites. The co-occurrence of mammals and pollen in tuffites is environmentally and biostratigrafically important. All the sites with vertebrate record exclude the pre-Grande-Coupure age. Their floral content, though not rich, is remarkable and the pollen spectra indicate a temperature drop comparable with that at the beginning or the end of the Oligocene.

Remarks on individual taxa of the volcanogenic successions of the Ohře Rift region

One of the key pollen taxa of the volcanic assemblages is *Boehlensipollis hohli* W. Kr., the fossil of unambiguous botanical affinity (Lythraceae, ?Rubiaceae, Sapindaceae) but significant in range, confined to the Oligocene (Rupelian to Eochattian) after Krutzsch 1993. Finds of the exotic family *Barringtoniaceae,* endemic for India and SE Asia, are significant for the earlier volcanic microfloras. The pollen spectra of most of the České středohoří Mts. localities point to the Rupelian microfloras, for which the temperatures of 15.7–17.1 °C are given as the average annual temperature (Pross et al. 1998). After the occurrence and coexistence interval of Cyrillaceae, *Ampelopsis-Parthenocissus,* Cornaceae-Mastixiaceae, Araliaceae, *Castanea-Castanopsis,* Sapotaceae, *Symplocos, Ilex, Alnus, Carpinus, Carya,* and other taxa, comparable data can be preliminarily derived. For the localities on the southern slope of the Doupovské hory Mts., lower temperatures – but not reaching the freezing point (palm occurrence) – must be considered.

The lower coexistence interval for *Castanea-Castanopsis, Carya, Cedrus, Picea, Betula* and Loranthaceae may be realistic in temperature data consideration for the locality near the

Plant elements in pollen record				
	Localities	Palaeo-tropical/ Subtropical	Inter-mediate	Deci-duous
1 České středohoří Mts.	Javory-Stará Bohyně	38.5	19.2	42.3
2	Žichov	26.3	31.6	42.1
3	Bechlejovice	33.3	27.3	39.4
4	Lochočice	36.8	31.6	31.6
5	Lbín	46.7	30.0	23.3
6	Kučlín	61.3	22.6	16.1
7 Doupovské hory Mts.	Dvérce	10.0	16.6	73.3
8	Valeč	2.7		97.3

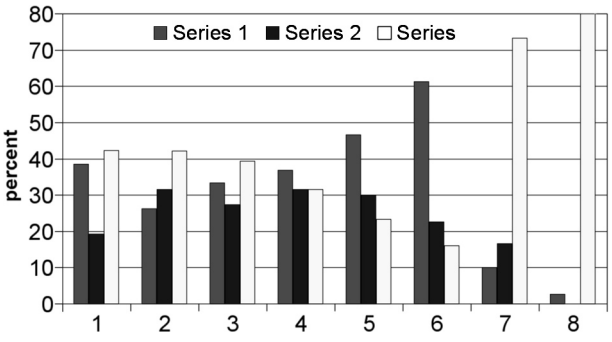

Fig. 8. Proportions of the thermophilic (Section 1), intermediate (Section 2) and deciduous plants (Section 3) in the pollen record at the discussed localities.

margin of the Most Basin (between the trachyte – phonolite sheets near Most).

The range of the significant plant elements encountered in the assemblages of the studied localities is given in Fig. 8.

Results

1. The microfloras of the volcanogenic successions of the Ohře Rift provide good evidence of climatic and environmental changes from the beginning of the volcanic activity in the Doupovské hory Mts. to the start of sedimentation in the Most Basin.
2. The data obtained by the proportions of paleotropical/subtropical and deciduous components in the vegetation pattern differ from one another at the individual localities but generally point to the oscillation of temperature and humidity with general trend to the dropping temperature toward the basal Miocene deposits.
3. The identification of new exotic, highly thermophilous elements pointed to the climatic demands of the earlier flora of the volcanics with *Dalbergia* and *Barringtonia* types.
4. The well dated mammalian fauna sites and the post-Grande-Coupure interval in fauna migration have been complemented by pollen plant records and new plant immigrant elements.
5. Besides azonal communities, components of mixed mesophytic forest were identified at the localities with fossil fauna.
6. Local existence of swamp cypressus forest has been recognized as early as in the time of volcanic activity in the Ohře Rift region, at favourable habitats near the edge of the Most Basin.
7. The composition of microfloral content between two sheets of trachyte – phonolite displayed features more related to the Miocene basinal assemblages.
8. The highest proportion of deciduous tree components was recorded at the localites of the Doupovské hory Mts.
9. New floral elements were recognized for the volcanogenic succession of the Ohře Rift region.

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