Tertiary macrofloras of the Bohemian Massif: a review with correlations within Boreal and Central Europe

ZLATKO KVAČEK & VASILIS TEODORIDIS

Tertiary floras occurring in the Bohemian Massif based on plant macrofossils (leaves and carpological material) are reviewed. The sites are situated in various stratigraphical levels of the Cheb, Sokolov, Most, Zittau, České Budějovice and Třeboň basins, volcanic complexes of the Doupovské hory Mts and České středohoří Mts, as well as in Tertiary fluvial sedimentary relicts scattered near Plzeň, Prague and elsewhere in the western part of the Czech Republic. The overview focuses on floristic and phytostratigraphical characteristics of the defined lithostratigraphical units and their dating within the Bohemian Massif and correlation with previously defined paleofloristic units (Floristic Assemblages *i.e.*, "Florenkomplexe") of Boreal and Central Europe. New palaeoclimatical datasets obtained using the leaf physiognomy (CLAMP), co-existence (CA) and ecophysiological methodologies show vegetation and palaeoclimatic evolution during the Tertiary in the studied area. • Key words: Tertiary, macrofloras, Bohemian Massif, correlation, vegetation, palaeoclimate, Europe.

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Zlatko Kvaček, Charles University in Prague, Faculty of Sciences, Institute of Geology and Palaeontology, Albertov 6, 128 43 Prague 2, Czech Republic; kvacek@natur.cuni.cz • Vasilis Teodoridis, Charles University in Prague, Faculty of Education, Department of Biology and Environmental Education, M.D. Rettigové 4, 116 39 Prague 1, Czech Republic, vasilis.teodoridis@pedf.cuni.cz

Tertiary freshwater and volcanogenic deposists of the Bohemian Massif have been explored for a long time in respect of palaeobotanical records. Yet, the treatments of individual sites, areas or taxonomic groups are widely scattered in the literature, partly not easily accessible or even unpublished. The present account aims at reviewing all known floras connected with various geological units in Bohemia and serves as the first-hand documentation for a new treatment of brown coal of the Czech Republic.

This overview of fossil macrofloras (Tables 4, 6, 9, 11 and 12) contains a complete summary of previously known taxa recorded in the Cheb, Sokolov, Most, Zittau, České Budějovice and Třeboň basins, volcanic complexes of the Doupovské hory and České středohoří Mountains (Mts), and in fluvial sedimentary relicts scattered in various parts of the Bohemian Massif (see Fig. 1). The palaeobotanical datasets are based only on the leaf and carpological material (fruits and seeds). Indication of taxa frequency in the tables has been avoided because the frequency of macrofossils is highly misleading in comparison with the real abundance of plant taxa in the ancient vegetation, having been biased by taphonomical influences and selective collection.

The authors are attempting to contribute to the dating of the lithostratigraphical units of the Bohemian Massif on the basis of relevant plant macrofossils (see Tables 1–3, 5, 7, 8, 10). If plant assemblages of the studied sites are rich enough, a correlation to the Floristic Assemblages ("Florenkomplexe") of Boreal and Central Europe established and defined mainly by Mai (1995) and Kvaček & Walther (2001) has been attempted. Additionally, a brief summary of climate and vegetation evolution during the Tertiary of the Bohemian Massif has been given, based on datasets of three different methodologies.

Material and methods

The fossil material studied is housed mainly in the palaeobotanical collections of the National Museum, Prague, the Czech Geological Survey, Prague (also at its repository in Lužná), Charles University in Prague, Institute of Geology and Palaeontology, headquarters of the mines Bílina and Nástup-Tušimice, Staatliche Naturhistorische Sammlungen Dresden, Museum für Mineralogie und Geologie, Dresden, Hungarian Natural History Museum, Budapest

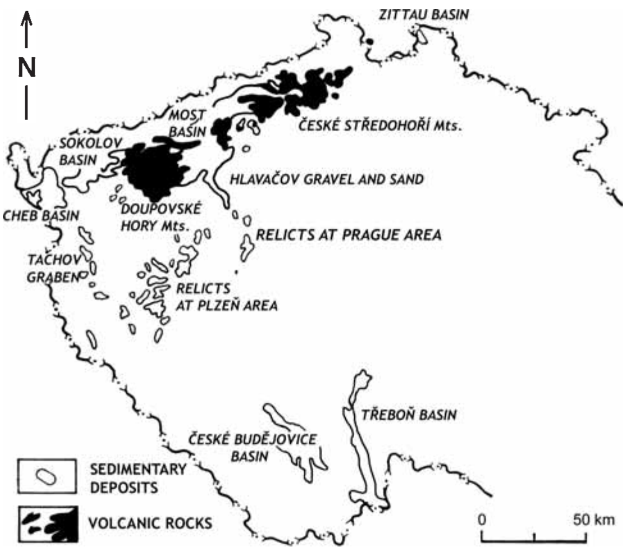

Figure 1. Distribution of the studied areas within the Bohemian Massif (adapted from Kvaček *et al.* 2006b).

and various other institutions or private collections. Detailed information about the housing of the material studied is mostly quoted in the monographs and studies that concern respective local floras.

Palaeoclimatic reconstruction has been obtained using the CLAMP (Climate Leaf Analysis Multivariate Program – methodology explained in Wolfe & Spicer 1999), the CA (Coexistence Approach – methodology explained in Mosbrugger & Utescher 1997), and the Ecophysiological method reconstructing atmospheric CO_2 concentrations in the geological past on the basis of stomatal density (*e.g.*, Burgh *et al.* 1993, Beerling 1999).

The list of abbreviations used in the text includes: MAT (Mean Annual Temperature), WMMT (Warmest Month Mean Temperature), CMMT (Coldest Month Mean Temperature) and MAP (Mean Annual Precipitation); acronyms used in the explanations of figures for repositories: NM – National Museum, Prague, ČGS – the Czech Geological Survey, Prague, PRC – Charles University in Prague, Institute of Geology and Palaeontology, DB – headquarters of the mine Bílina, MMG – Staatliche Naturhistorische Sammlungen, Museum für Mineralogie und Geologie, Dresden, PB – Hungarian Natural History Museum, Budapest.

Floristic composition, phytostratigraphical overview and correlation of the studied areas

The Cheb Basin

The Cheb Basin (Figs 1, 5; Tables 1, 4), the westernmost area of the Bohemian Tertiary, consists of several formations (or levels), partly informally defined (Ambrož 1958, Bůžek *et al.* 1982) spanning the time interval from the Eocene to Pliocene (Bůžek *et al. in* Klomínský 1994). Besides the formally defined Staré Sedlo (Late Eocene), Cypris (Early Miocene) and Vildštejn (Pliocene) formations, the remaining units, *i.e.* the Main Lignite Seam and the Lower Clayey-Sandy Formation with the Lower Lignite Seam, are informal.

The first plant macrofossils from the Cheb Basin were described in the first half of the 19th century (Haidinger 1839). More important collections were obtained later (*e.g.*, locality Mokřina, former Krottensee; Engelhardt 1879) and particularly from the drilling research during the seventies and the eighties of the 20th century (Bůžek *et al.* 1982). Unfortunately, this plant material has been only partly described in detail (Bůžek *et al.* 1985, 1996; Knobloch *et al.* 1996).

The oldest plant material was obtained from the fill of a maar lake near the village of Velký Luh (core 4359; see Bůžek *et al.* 1969, 1988; Kvaček *et al.* 1989). It contains typical Early Palaeogene elements, such as "*Nothofagus*" *stopesae*, *Hantsia pulchra*, *Manglietia hercynica*, *Rutaspermum rugosum* and *Carpolithes echinatus*. The Late Eocene Staré Sedlo Formation was documented in a small area at Nový Kostel on the western border of the Cheb Basin by the markers *Rhodomyrtophyllum reticulosum* and *Laurophyllum syncarpifolium* (Knobloch *et al.* 1996).

Figure 2. Important Late Eocene plant elements from the Sokolov Basin and the České středohoří Mts. • A – *Eotrigonobalanus furcinervis* (Rossm.) Walther & Kvaček, leaf, locality Na Pískách, NM G 6690, scale bar 10 mm. • B – *Eotrigonobalanus furcinervis* (Rossm.) Walther & Kvaček ssp. *flagellinervis* (Rossm.) Knobloch & Kvaček, leaf, locality Staré Sedlo, NM G 6692, scale bar 10 mm. • C – *Majanthemophyllum basinerve* (Rossm.) Knobloch & Kvaček, leaf, locality Jehličná, NM G 6705, scale bar 5 mm. • D – *Populus* aff. *leuce* (Rossm.) Ung., leaf, locality Staré Sedlo, NM G 6632, scale bar 5 mm. • E – *Steinhauera subglobosa* C. Presl in Sternberg, infructescence, locality Český Chloumek, NM G 6681, scale bar 3 mm. • F – *Rhodomyrtophyllum reticulosum* (Rossm.) Knobloch & Kvaček, leaf, locality Český Chloumek, NM G 6637, scale bar 10 mm. • G – *Platanus neptuni* (Ettingsh.) Bůžek, Holý & Kvaček, leaf, locality Kučlín, coll. Valíček, uncatalogued, scale bar 10 mm. • H – *Platanus neptuni* (Ettingsh.) Bůžek, Holý & Kvaček, infructescence, locality Kučlín, BP 55. 2337.1, scale bar 5 mm. • I – *Raskya venusta* (Ettingsh.) Manchester & Hably, fruit, locality Kučlín, BD KUC 16, scale bar 3 mm. • J – *Hooleya hermis* E.M. Reid & Chandler, fruit, locality Kučlín, NM G 3724a, scale bar 5 mm. • K – *Doliostrobus taxiformis* (Sternb.) Kvaček, cone scale impression with attached seed, locality Hlinná (core Úc-9), ČGS Úc 9-13, scale bar 5 mm. • L – "*Ficus*" *reussii* Ettingsh., leaf, locality Kučlín, BP 55. 2408.1, scale bar 10 mm. • M – "*Acer*" *sotzkianum* Ung., fruit, locality Kučlín, NM G 7893a, scale bar 5 mm. • N – *Doliostrobus taxiformis* (Sternb.) Kvaček, foliage shoot, locality Kučlín, NM G 3724b, scale bar 5 mm. • O – *Engelhardia macroptera* (Brongn.) Ung., fruit, locality Kučlín, DB KUC 94, scale bar 5 mm.

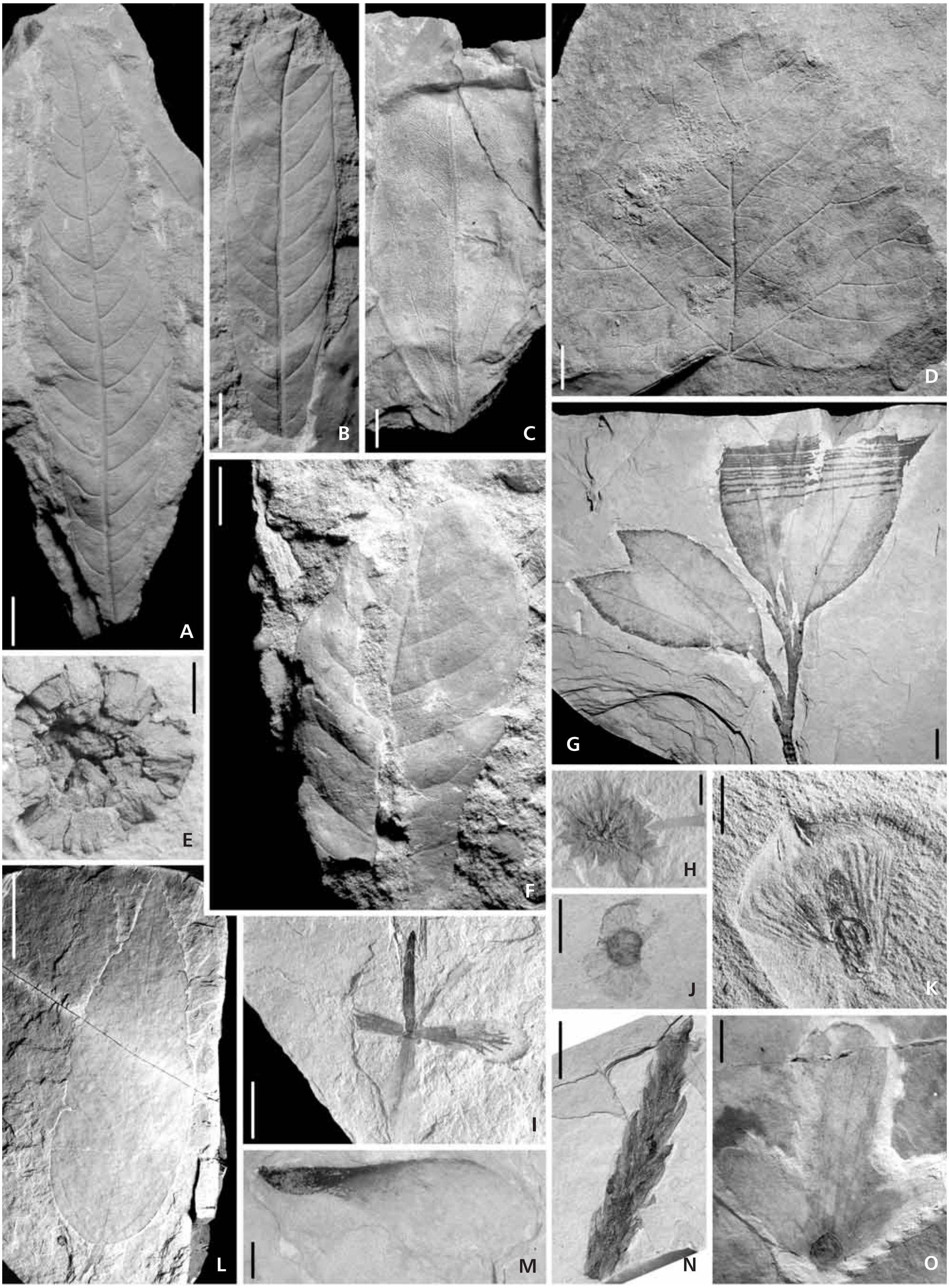
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Table 1. Correlation of selected floras of the Cheb Basin with the Boreal and Central European floristic assemblages *sensu* Mai & Walther (1991), Mai (1995) and Kvaček & Walther (2001).

Chronostr.	Lithostratigraphy		Selected macrofloras	Palaeofloristic correlation
Pliocene	Vildštejn Fm.	Nová Ves Mb.	Nová Ves	Ceyssac
		Vonšov Mb.	Hněvín	
Early Miocene	Cypris Fm.		Mokřina	Frant. Lázně-Kleinleipisch
	Coal Seam Fm.		Cheb, Františkovy Lázně	Eichelskopf-Wiesa
	"Lower Clayey-Sandy" Fm.		cores 4393, 4395 and BJ 1	Bílina-Brandis, Bitterfeld
Late Oligocene			Seussen, maar Plesná	Thierbach, Linz-Krumvíř
			Odrava	?
?Early Oligocene–Late Eocene	Staré Sedlo Fm.		Nový Kostel	Hordle-Zeitz
?Early–Middle Eocene			maar Velký Luh	Messel-Selsey, ?Belleu-Sheppey

The next higher lithostratigraphical unit, the "Lower Clayey-Sandy" Formation, has been partly dated by Oligocene elements occurring in its lowermost part (*e.g.*, *Eotrigonobalanus furcinervis* ssp. *haselbachensis* in Františkovy Lázně, core BJ 1; Bůžek *et al.* 1982). Assemblages of Oligocene/Early Miocene age were found in the deposits several tens of meters under the Main Coal Seam in the Odrava part of the basin. This flora is characterized by *Quasisequoia couttsiae*, *Pinus* subg. *Strobus* and *Pseudolarix* in an association of thermophilous elements, such as *Symplocos, Engelhardia, Cyclocarya, Meliosma, Calamus* etc. (Bůžek *et al.* 1982).

A similar assemblage is known at Seussen in Germany (Knobloch 1971) and in a maar fill at Plesná (core V 146; Bůžek *et al. in* Kvaček 1984). The flora of Seussen contains important phytostratigraphical markers, *Fagus saxonica* and *Alnus rostaniana* (*A. nostratum* in Knobloch 1971) known from the Late Oligocene and Oligocene/Miocene boundary in Germany and France (Mai & Walther 1991). The flora of Plesná is characterized by diversified coniferous elements (*Cunninghamia, Torreya, Taxus* and *Pseudolarix*) accompanied by a mass occurrence of an Oligocene marker *Laurophylum acutimontanum* and other thermophilous elements (Kvaček 1971, Bůžek *et al.* in Kvaček 1984). This level clearly corresponds to the Late Oligocene (Egerian) Floristic Assemblage of Linz-Krumvíř *sensu* Kvaček & Walther (2001) and/or Floristic Assemblage of Thierbach *sensu* Mai & Walther (1991). Sediments closely underlying the Main Coal Seam at Františkovy Lázně and Cheb (cores 4393, 4395 and BJ 1) contain assemblages that show an Early Miocene character with *Taxodium dubium, Pinus rigios, Comptonia, Liquidambar, Myrica, Laurophyllum pseudoprinceps, Platanus neptuni* etc. (Bůžek *et al.* 1982). This flora recalls in its composition that of the Holešice Member and of the lowermost part of the Libkovice Member in the Most Basin. The Lower Coal Seam has provided no evidence of plant macrofossils. A mastixioid flora of Františkovy Lázně and Cheb (Holý 1977b) comes from the deposits which are probably equivalent to the Main Coal Seam (Coal Seam Formation *sensu* Ambrož 1958) and after the recent revision it includes mainly *Mastixia*, *Eomastixia* and *Tectocarya*.

The floras from the upper clayey part of the Main Coal Seam (erroneously called the "coal facies" of the Cypris Claystone by Bůžek *et al.* 1996) contain predominantly *Pinus*, *Glyptostrobus, Myrica*, *Alnus*, *Comptonia*, *Platanus neptuni*, and *Laurophyllum rugatum* in combination with other thermophilous elements, but excluding *Taxodium* (Bůžek *et al.* 1996). The mentioned taxa suggest a direct link to the relatively thermophilous Floristic Assemblage of Františkovy Lázně-Kleinleipisch *sensu* Mai (1995). The flora of the Cypris Formation *sensu* Reuss (1852) is also thermophilous with a similar but richer floristic composition of *Mastixia, Daphnogene, Ocotea hradekensis, Laurus abchasica, Laurophyllum* sp. div., *Gordonia* and *Platanus neptuni* and newly appearing *Quercus kubinyii* (Bůžek *et al.* 1996). This flora is quite comparable with similar Early Miocene floras (Ottnagian-Karpatian) from Austria and Germany (Kovar-Eder *et al.* 2001).

Sediments of the Vildštejn Formation (Fig. 5), which were deposited after a long hiatus, include absolutely different Pliocene floras (Bůžek *et al.* 1985). The flora from the older Vonšov Member is characterized by the occurrence of *Glyptostrobus*, *Pinus leitzii, Liriodendron, Ilex, Ampelopsis ludwigii*, deciduous oaks and many herbs of Reuverian types. Similar florulas are known from fluvial relicts of the Tachov Graben attached from the south to the Cheb Basin (Bůžek *et al.* 1985), which are interpreted as relating to River "F" *sensu* Pešek & Spudil (1986). On the other hand, assemblages from the younger Nová Ves Member are distinctly cool temperate, with *Picea omoricoides*, *Chamaecyparis*, Vacciniaceae (including *Chamaedaphne*, *Oxycoccus*), *Menyanthes, Scheuchzeria* and other herbs probably suggesting the first ("Praetiglian") cooling event (Bůžek *et al.* 1985).

The Sokolov Basin

The series of brown coal basins in the piedmont of the Krušné hory Mts ("Erzgebirge") continues northeastwards into the Sokolov Basin (Figs 1, 2, 4; Tables 2, 4). The lithostratigraphy of the Sokolov Basin has recently been revised in detail and various local units and coal seams correlated within the basin (Rojík 2004). The sequence starts with the Staré Sedlo Formation, which was deposited independently from the structures of the basin. In the basin fill three partly coal-bearing formations are recognized: the Oligocene/Early Miocene Nové Sedlo Formation and the Early Miocene Sokolov and Cypris formations.

The first plant macrofossils from the Sokolov Basin were described by Sternberg (1820–1838 from the locality Putschirn, now Počerny at Karlovy Vary, belonging to the Nové Sedlo Fm.). Intense mining activities and drilling surveys in the seventies and eighties of the 20th century made it possible to collect a huge quantity of new fossil material (collected by Č. Bůžek, F. Holý, Z. Kvaček and E. Knobloch). This material has only been partially revised so far.

The flora of the Staré Sedlo Formation (Fig. 2) includes phytostratigraphical markers such as *Steinhauera subglobosa*, *Rhodomyrtophyllum reticulosum, Gordonia saxonica, Laurophyllum syncarpifolium* in the association with the predominant *Eotrigonobalanus* and *Daphnogene* (*e.g.*, localities Staré Sedlo, Jehličná, Český Chloumek, Erika Mine; see Knobloch *et al.* 1996). Such a floristic composition shows clear connections to the Late Eocene Floristic Assemblage Hordle-Zeitz *sensu* Mai (1995). No plant macrofossils have been detected in the lower part of the Nové Sedlo Formation, *i.e.* the Davidov Member. Only poor plant occurrences have been recovered in the direct roof of the Josef Coal Seam (the Josef Member). These plant datasets (mainly from the Erika and Medard mines) with *Eotrigonobalanus, Alnus, Platanus neptuni, Stratiotes neglectus* and *Taxodium* have a distinct Oligocene character (Bůžek *et al.* 1988).

The overlying sediments (the Chodov Member) have yielded enormous quantity of plant fossils. These deposits contain a partly revised mastixioid flora of Počerny-Podlesí near Karlovy Vary that is characterised by occurrences of the Late Oligocene elements, such as *Fagus saxonica*, *Alnus rostaniana* and newly reviewed *Cathaya* sp., *Mastixia venosa* and *Carya costata* (Holý 1984, Kvaček & Walther 2001). *Quercus rhenana* as an Early Miocene element was also proved in the Chodov Member. Seeds of aquatic Nymphaeaceae in the association with *Alnus rostaniana* were recovered in the area of Hroznětín (Bůžek & Kvaček 1966).

The productive Sokolov Formation includes only an unrevised mastixioid flora from the Gustav Mine near Bukovany (Habartov Member). This carpological material consists of *Mastixia, Tectocarya, Symplocos* sp. div., *Meliosma* cf. *miesleri, Meliosma wetteraviensis, Magnolia burseracea* and *Nyssa* (Holý, unpublished manuscript) that indicates an Early Miocene character and a possible correlation with the Floristic Assemblage Eichelskopf-Wiesa (Holý 1977b, Bůžek *et al.* 1988). The flora of the Cypris Formation (*e.g.*, localities Královské Poříčí, former Königswehrt, Dukla Mine at Habartov), which terminates the basin fill in the Sokolov Basin is similar in its composition and stratigraphical position to the adjacent Cheb Basin (Bůžek *et al.* 1996).

Table 2. Correlation of the selected floras of the Sokolov Basin with the floristic assemblages of Boreal and Central Europe *sensu* Mai & Walther (1991), Mai (1995) and Kvaček & Walther (2001).

Chronostr.	Lithostratigraphy		Selected macrofloras	Palaeofloristic correlation
Early Miocene	Cypris Fm.		Dukla, Medard Mines	Frant. Lázně-Kleinleipisch
	Sokolov Fm.	Antonín Mb.		?
		Anežka Mb.		
		Těšovice Mb.		
		Habartov Mb.	Gustav Mine	Eichelskopf-Wiesa
	Nové Sedlo Fm.	Chodov Mb.	Hroznětín	?Bitterfeld
Oligocene			Podlesí, Počerny	Thierbach, Linz-Krumvíř
		Josef Mb.	Erika	?Nerchau-Flörsheim
		Davidov Mb.		?
?Early Oligocene–Late Eocene	Staré Sedlo Fm.		Staré Sedlo, Jehličná	Hordle-Zeitz

The Doupovské hory Mts

The magmatic massif of the Doupovské hory Mts (Fig. 1; Tables 3, 4) is wedged between the Sokolov and Most basins. Relatively infrequent macrofossils have been known from there and have remained out of palaeobotanists' attention since the first records at Valeč (Presl *in* Sternberg 1820–1838) until now.

Knobloch *et al.* (1996) reported fragments of *Sabal lamanonis, Eotrigonobalanus* and probably *Rhodomyrtophyllum reticulosum* as very poorly preserved, but characteristic elements of the Late Eocene Staré Sedlo Formation from the sandstones underlying the volcanites at the locality Valeč. An extinct conifer *Doliostrobus*, which is an important marker related to the Eocene/Oligocene boundary and to the Floristic Assemblage of Bembridge *sensu* Mai (1995), is known from the lowermost limestone deposits belonging to the Doupov volcanic complex (Bůžek *et al.* 1968, 1987). Thin-bedded limestones and volcanoclastics from the localities Valeč, Dvérce and Vrbice belong to the higher parts of the complex. These sediments have yielded florulas of Oligocene character proved by occurrences of conifers (*Pinus ornata*, *Tetraclinis*) and the Oligocene markers of *Eotrigonobalanus* and *Alnus rostaniana* (Bů-

Table 3. Correlation of the selected floras of the Doupovské hory Mts with the floristic assemblages of Boreal and Central Europe *sensu* Mai (1995) and Kvaček & Walther (1998).

Chronostratigraphy	Lithostr.	Selected macrofloras	Palaeofloristic correlation
Early Miocene	Volcanic complex of Doupovské hory Mts		
Late Oligocene		Vrbice	Thierbach
Early Oligocene		test pits	?Nerchau-Flörsheim
		Dvérce, Hammerunter-wiesenthal	Seifhennersdorf-Kundratice
		Valeč	Haselbach
?Early Oligocene–Late Eocene	Staré Sedlo Fm.		Bembridge
			Hordle-Zeitz

žek *et al.* 1990b). Test pits and other sites on the periphery of the Doupovské hory Mts yielded thermophilous floras with predominant *Daphnogene* (Č. Bůžek, personal communication). A similar relatively thermophilous flora from Hammerunterwiesenthal in Saxony outside the Doupov complex (Walther 1998) is radiometrically dated to the Early Oligocene (Rupelian) and can be correlated with the Floristic Assemblage of Seifhennersdorf-Kundratice *sensu* Kvaček & Walther (1998).

The Most Basin

The Most Basin (Figs 1, 4; Tables 5, 6), which is better known under an informal name "the North Bohemian Browncoal Basin", was a place of interest to palaeobotanists from the beginning of the palaeobotanical research (Sternberg 1820–1838, Brongniart 1828). An intensive exploration started after the 2nd World War and continues till today (Kvaček *et al.* 2004, Teodoridis & Kvaček 2006). The lithostratigraphy has been widely discussed in the last decades (see Domácí 1977, Malkovský 1987, Hurník 2001). Three formations are generally recognized, *i.e.*, the Basal or Staré Sedlo Formation, the Oligocene Střezov Formation, and the Early Miocene Most Formation. The latter represents coal-bearing basin fill and has been divided into four units: the Duchcov, Holešice, Libkovice and Lom members *sensu* Domácí (1977). In the western part of the basin the main seam (Holešice Mb.) is split into three partial seams and two iterseam sediments called informally according to Procházka (1954), the Lower, Middle and Upper Seam and Lower and Upper Interseam Beds (for the review see Kvaček *et al.* 2004).

The floras, which should belong to the Staré Sedlo Formation are not reliably documented in the Most Basin. Quartzites located southwards of Most contain leaf fragments of *Eotrigonobalanus furcinervis*. Besides, an important Eocene marker *Steinhauera subglobosa* was found as a single impression on a quartzite boulder redeposited from the Krušné hory Mts near the locality Lom (Bůžek *et al.* 1987, Knobloch *et al.* 1996). Sediments of the Střezov Formation *sensu* Domácí (1977) contain plant macrofossil assemblages related to the volcanic complex of the České středohoří Mts mentioned below. These floras have not been worked out in detail but are briefly mentioned by Kvaček & Bůžek (1982). A floristic association of *Ostrya sensu* Kvaček & Bůžek (1982) known from the core GÚ 111 near Lochočice has an affinity with the Early Oligocene predominantly deciduous broadleaved forest vegetation of Kundratice and Bechlejovice from the České středohoří Mts (Kvaček & Walther 1998, 2004).

Figure 3. Important Oligocene plant elements from the České středohoří Mts. • A – *Ailanthus prescheri* Walther, leaflet, locality Suletice, MMG SuBe 484e, scale bar 10 mm. • B – *Engelhardia orsbergensis* (Weber) Jähnichen, Mai & Walther, leaflet, locality Suletice, MMG SuBe 3e, scale bar 10 mm. • C – *Oleinites maii* (Bůžek, Holý & Kvaček) Sachse, leaf, locality Suletice, MMG SuBe 624a, scale bar 10 mm. • D – *Calocedrus suleticensis* (Brabenec) Kvaček, foliage shoot, locality Suletice, NM G 4211, scale bar 5 mm. • E – *Carpinus mediomontana* Mai, fruit bract, locality Suletice, MMG SuBe 778:1a, scale bar 5 mm. • F – *Palaeohosiea suleticensis* Bůžek & Kvaček, fruit, locality Suletice, NM G 7045, scale bar 5 mm. • G – *Hydrangea microcalyx* Sieber, calyx, locality Suletice, NM G 5418, scale bar 5 mm. • H – *Tetraclinis salicornioides* (Ung.) Kvaček, twig with two female cones, locality Suletice, NM G 7535a, scale bar 5 mm. • I – *Sloanea artocarpites* (Ettingsh.) Kvaček & Hably, leaf, locality Suletice, NM G 7048a, scale bar 10 mm. • J – *Acer palaeosaccharinum* Stur, leaf, locality Bechlejovice, ČGS MP 42, scale bar 10 mm. • K – *Ostrya atlantidis* Ung., leaf, locality Bechlejovice, ČGS 3580, scale bar 10 mm. • L – *Ostrya atlantidis* Ung., fruit bract, locality Bechlejovice, ČGS uncatalogued, scale bar 10 mm. • M – *Cercidiphyllum crenatum* (Ung.) R. Brown, fruits, locality Bechlejovice, ČGS 9174, scale bar 5 mm. • N – *Cercidiphyllum crenatum* (Ung.) R. Brown, leaf, locality Bechlejovice, ČGS MP 33, scale bar 10 mm. • O – *Mimosites haeringianus* Ettingsh., compound leaf, locality Bechlejovice, NM G 7186, scale bar 5 mm. • P – *Ampelopsis hibschii* Bůžek, Kvaček & Walther, leaf, locality Bechlejovice, ČGS Be 1007, scale bar 20 mm. • Q – *Tilia gigantea* Ettingsh., leaf, locality Bechlejovice, NM G 7680, scale bar 50 mm. • R – *Tilia brassicoides* (Saporta) Kvaček & Walther, fruit bract, locality Bechlejovice, NM G 7172, scale bar 10 mm. • S – *Rosa saxonica* (Engelhardt) Kvaček & Walther, fruit, locality Bechlejovice, ČGS uncatalogued, scale bar 10 mm. • T – *Rosa lignitum* Heer, leaflet, locality Bechlejovice, ČGS uncatalogued, scale bar 10 mm. • U – *Torreya bilinica* Saporta & Marion, needle leaf, locality Bechlejovice, NM G 2407, scale bar 10 mm. • V – *Crataegus pirskenbergensis* (Knobloch) Kvaček & Walther, leaf, locality Bechlejovice, ČGS MP 1a, scale bar 10 mm. • W – *Dicotylophyllum deichmuelleri* Kvaček & Walther, leaf, locality Bechlejovice, ČGS MP 29, scale bar 10 mm. • X – *Cyclocarya* sp., compound leaf, locality Bechlejovice, ČGS MP 46, scale bar 10 mm. • Y – *Toxicodendron herthae* (Ung.) Kvaček & Walther, leaflet, locality Bechlejovice, ČGS MP 24, scale bar 10 mm. • Z – *Ulmus fischeri* Heer, leaf, locality Bechlejovice, ČGS 3712, scale bar 10 mm. • A* – *Cornus studeri* Heer, leaf, locality Bechlejovice, ČGS 3668, scale bar 10 mm. • B* – *Diospyros* sp., leaf, locality Bechlejovice, ČGS MP 38, scale bar 10 mm.

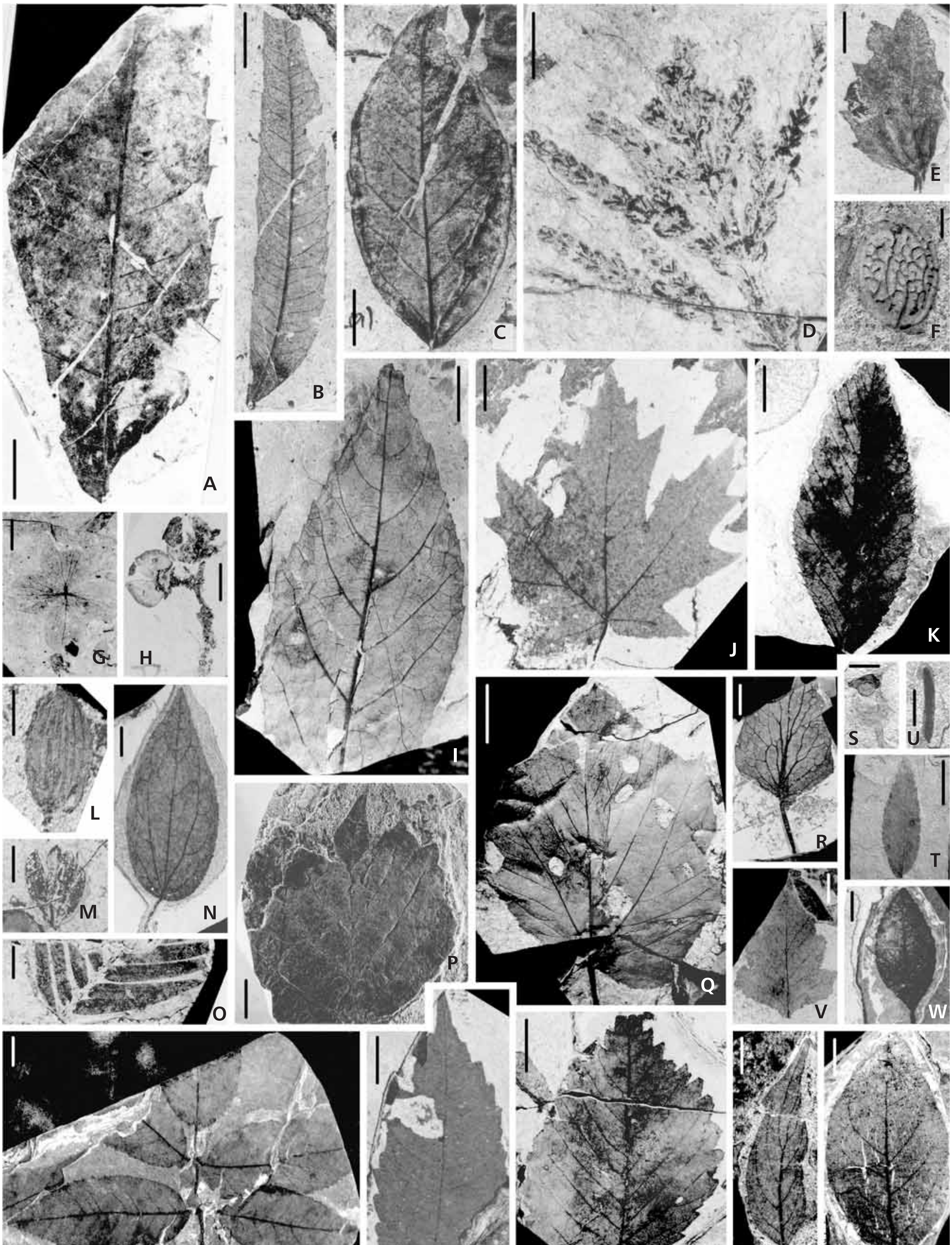
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Table 4. Summary of the floristic composition of the Cheb Basin, Sokolov Basin, the Doupovské hory Mts and of the locality Hammerunterwiesenthal (Germany). Abbreviations: C – cone, F – fruit, L – leaf, S – seed, Sp – spore, O – organs, A – Cheb Basin (ChB) & Sokolov Basin (SB), B – Vildštejn Formation (ChB), C – Cypris Formation (ChB, SB), D – Coal Seam Formation (ChH), E – "Lower Clayey-Sandy" Formation (ChH), F – Sokolov Formation (SB), G – Nové Sedlo Formation (SB), H – Staré Sedlo Formation (ChB, SB), I – Doupovské hory Mts, J – Hammerunterwiesenthal (Saxony, Germany).

Taxa	O	A							I	J
		B	C	D	E	F	G	H		
Abies sp.	C	*								
Acer angustilobum	L		*							
Acer integrilobum	L, F		*		*F					?
Acer palaeosaccharinum	L, F				*F					?
Acer tricuspidatum	L	?	*		*					?
Actinodaphne pseudogermari	L							*		
Ailanthus confucii	F		*							
Aldrovanda intermedia	S		*							
Aldrovanda sp.	S	*								
Alnus gaudinii	L		*		?					
Alnus julianiformis	L		?							
Alnus rostaniana	L, F				*F		*			?
Alnus cf. *rugosa*	L	*								
Ampelopsis ludwigi	S	*			?					
Ampelopsis cf. *rotundatoides*	S		*				?			
Andromeda polifolia	L	*								
Aracispermum compressum	S	*								
Aracispermum johnstrupii	S	*								
Betula sp.	L, F		*							
Brasenia cf. *tanaitica*	S	*								
Butomus sp.	S	*								
Buxus egeriana	L, F		*							
Calamus daemonorhops	T				?					
Caldesia sp.	F	*								
Carex nigra	F	*								
Carex cf. *rostrata*	F	*								
Carex cf. *szaferi*	F	*								
Carpinus minor	L, F				*F		?			?
Carya costata	F						*		?	
Carya rostrata	F			*			*			
Carya serrifolia	L				*					
Carya ventricosa	F			*						
Carya sp.	L		*							
Castaneophyllum venosum	L							*		
Castanea sp.	L	*								
Cathaya multiserialis	L		?							
Caulinia tenuissima	S	*								
Cedrelospermum stiriacum	F		*							
Celtis cf. *lacunosa*	F		*							
Cercidiphyllum crenatum	F, S		*		*S		*			?
Chamaecyparis cf. *pisifera*	L	*								
Cladiocarya chomutovensis	F		*							
Cladiocarya cf. *lusatica*	F		*							
Cladiocarya sp.	F						*			
Cladiocarya trebovensis	F		*							
Cladium mariscus	F	*	?							
Comptonia difformis	L		*		*					
Comptonia srodoniowae	F		*							
Corylopsis sp.	S	*								
Corylus avellana	F	*								
Craigia bronnii	F		*				*			*
Cyclocarya cf. *sibirica*	F				*					
Cyclocarya nucifera	F		*							
Cyperus sp.	F	*								
Daphnogene cinnamomifolia	L, F				*F		*	*	*	*
Daphnogene pseudopolymorpha	L							*		
Daphnogene polymorpha	L		*	*						
Decodon globosus	S	*	*							
Dicotylophyllum spiculatum	L							*		
Diplopanax limnophilus	F						*			
Distylium fergusonii	L		*							
Doliostrobus taxiformis	L, C							?	*	
Dulichium vespiforme	F	*								
Elaeocharis cf. *ovata*	F	*								
Elaeocharis sp. div.	F	*								
Elatine alsinastrum	S	*								
Engelhardia haraldii	L							*		
Engelhardia macroptera	F		*							*
Engelhardia orsbergensis	L		*		*		*			
Eomastixia saxonica	F			*						
Eotrigonobalanus andreanszkyi	F							*		
Eotrigonobalanus furcinervis	L				*		*	*	*	
Epipremnites ornatus	S				*		?			
Eurya stigmosa	S				*		?			
Fagus deucalionis	F, S				*S		*			
Fagus saxonica	L, F				*F		*			
"Ficus" jynx	L								*	
Fraxinus bilinica	L		?				*			
Glyptostrobus europaeus	C, S	*	*		*S					
Gordonia saxonica	L							*		
Gordonia knauensis	L							*		
Gordonia hradekensis	L		*							
Halesia crassa	F		*							
Hartziella cf. *rosenkjaeri*	F		*							
Hydrangea microcalyx	F									*
Hypericum coriaceum	S	*								
Hypericum septestum	S	?								
Ilex sp. div.	F	*			*					
Juncus sp.	S	*								
Juniperus cf. *communis*	S	*								
Keteleeria sp.	C						?			
Larix sp.	L	*								
Laurophyllum acutimontanum	L						*	*		?
Laurophyllum ambrozii	L							*		
Laurophyllum markvarticense	L		*	*				*		
Laurophyllum medimontanum	L		*					*		
Laurophyllum nechranicense	L		*					*		
Laurophyllum pseudoprinceps	L		*	*	*		*			?
Laurophyllum rugatum	L		*							
Laurophyllum syncarpifolium	L							*		
Laurus abchasica	L		*							
Leguminosae gen. et sp. indet.	L, F		*					*		
Leucothoë narbonensis	F	*								
Limnocarpus longipetiolatus	F		*							
Liquidambar europaea	F		*		*		*			
Liriodendron sp.	S	*								*
Ludwigia cf. *palustris*	S	*								
Lycopus cf. *europaeus*	F	*								

Taxa	O	A							I	J
		B	C	D	E	F	G	H		
Lygodium gaudinii	L, Sp		*							
Magnolia burseracea	S		*		?	*				
Magnolia kristinae	L		*							
Magnolia sp.	L, S						*			*
Mahonia sp.	L								*	
Majanthemophyllum basinerve	L							*		
Majanthemophyllum petiolatum	L							*		
Mastixia amygdaliformis	F		*	*						
Mastixia cf. *boveyana*	F							*		
Mastixia thomsonii / *venosa*	F					*	*			
Matudaea praemenzelii	L							*		
Meliosma cf. *miesleri*						*				
Meliosma pliocenica	F		*		?		?			
Melisoma wetteraviensis						*				
Menyanthes cf. *trifoliata*	S	*								
Mneme sp.	S	*								
Myrica sp.	L						*			
Myrica lignitum	L		*							
Myrica cf. *minima*	F		*							
Myrica vindobonensis	L		*							
Myriophyllum sp.	F	*								
Najas marina	S	*								
Nuphar sp.	S	*								
Nymphaea cf. *alba*	S	*								
Nymphaea szaferi	S		*							
Nymphaeaceae gen. et sp. indet.	S		*				*			
Nyssa ornithobroma	F					?	?			
Ocotea hradekensis	L		*	?						
Ocotea rhenana	F			?						
Osmunda sp.	L		*							
Ostrya atlantidis	L, F				? F		*			
Parthenocissus sp.	S		*							
Pasaniopsis trivialis	L							*		
Picea cf. *echinata*	L	*								
Phoenicites salicifolius	L							*		
Picea omoricoides	L	*								
Pinus cf. *thomasiana*	C							*		
Pinus ornata	C							*	*	
Pinus sp. div.	L, C	*	*	*	*		*	*	*	*
Pinus stroboides	C							*		
Platanus cf. *schimperi*	L							*		
Platanus neptuni	L, F		*		*		*	*	*	
Podocarpium podocarpum	L, F		*							
Polygonum sp.	F	*								
Populus aff. *leuce*	L							*		
Potamogeton sp. div.	F	*	*							
Potentilla cf. *pliocenica*	F	*								
Potentilla cf. *supina*	F	*								
Pronephrium stiriacum	L		*				*			
Proserpinaca reticulata	F	*								
Prunus sp.	L, F		*							
Pterocarya sp.	F						*			
Quasisequoia couttsiae	C			*			*	*		
Quercus cf. *drymeja*	L		*							
Quercus kubinyii	L		*							
Quercus cf. *petraea*	L	*								
Quercus rhenana	L		*				*			
Ranunculus (*Batrachium*) sp.	F	*								
Ranunculus flammula	F	*								
Rhodomyrtophyllum reticulosum	L							*		
Rhodomyrtophyllum tristanoides	L							*		
Rosaceae *(Cotoneaster / Crataegus)*	F	*								
Rubus sp.	F				*					
Rubus cf. *idaeus*	F	*								
Rumohra recentior	L								*	
Sabal lamanonis	L							*		
Sabal raphifolia	L							*		*
Salix sp. div.	L	*					*			
Salvinia cf. *natans*	Sp	*								
Salvinia reussii	L						*			
Salvinia sp.	L		*							
Sambucus pulchella	S	*								
Sambucus sp.	S				*					
"Sapindus" falcifolius	L		?		?					
Scheuchzeria palustris	S	*								
Schisandra moravica	S		*							
Schoenoplectus cf. *lacuster*	F	*		*				*		
Sequoia abietina	C						*			
Sloanea sp.	L						*			
Smilax sagittifera	L		*							
Smilax weberi	L, S				*S		?		*	
Sparganium noduliferum	F	*								
Sparganium simplex	F	*								
Spirematospermum wetzleri	S						*			
Sphenotheca incurva	F		*							
Steinhauera subglobosa	F							*		
"*Sterculia*" *labrusca*	L							*		
Stratiotes neglectus	S						*			
Stratiotes sp.	S		*							
Symplocos lignitarum	F	*	*	*			*			
Symplocos ludwigii	F		*			?				
Symplocos minutula	F		*							
Swida buglowiana	F		*							
Taxodium dubium	S, L	?			*		*	*		
Taxus sp.	L	*								
Tectocarya elliptica	F			*		*				
Ternstroemia sequoioides	S		*					*		
Ternstroemites magdae	L							*		
Ternstroemites sokolovensis	L							*		
Tetraclinis salicornioides	L		*		*		*		*	*
Teucrium tatianae	F	*								
Tilia sp.	F		*							
Toddalia maii	S		*				*			
Torreya sp.	S						?			
Trigonobalanopsis exacantha	F		*							
Trigonobalanopsis rhamnoides	L		*		*			*		?
Typha cf. *lipetskiana*	S	*								
Ulmus fischeri	L						*		*	*
Ulmus sp.	F		*		?					
Vaccinium oxycoccos	L	*								
*"Viburnum"*cf. *atlanticum*	L		*		*					
Viburnum cf. *dilatatum*	F	*								
Viola sp.	S	*								
Vitaceae gen. et sp. indet.	L		*							
Weigela szaferi	S	*								
Zanthoxylon sp.	S						*			
Zanthoxylum cf *ailanthiforme*	S		*							
Zelkova zelkovifolia	L, F		*		*F		*			
Ziziphus paradisiaca	L		*							

Table 5. Correlation of the selected floras of the Most Basin with the floristic assemblages of Boreal and Central Europe *sensu* Mai (1995). * – core Bz 372, ** – core GÚ 111

<table>
<tr><th>Chronostr.</th><th colspan="2">Lithostratigraphy</th><th>Selected macrofloras</th><th>Palaeofloristic correlation</th></tr>
<tr><td rowspan="6">Early Miocene</td><td rowspan="7">Most Fm.</td><td>Lom Mb.</td><td>Dolní Jiřetín, Lom</td><td>?</td></tr>
<tr><td rowspan="2">Libkovice Mb.</td><td>Mariánské Radčice</td><td>Eichelskopf-Wiesa</td></tr>
<tr><td>Jezeří, Přívlaky, Břešťany, Bílina Mine</td><td>Bílina-Brandis</td></tr>
<tr><td rowspan="2">Holešice Mb.</td><td>Čermíky, Holedeč</td><td rowspan="2">Bitterfeld</td></tr>
<tr><td>Pesvice, Strupčice</td></tr>
<tr><td rowspan="2">Duchcov Mb.</td><td>Tuchořice, Marianna Mine</td><td rowspan="2">Thierbach</td></tr>
<tr><td>Late Oligocene</td><td>Hlavačov</td></tr>
<tr><td rowspan="2">?Late–Early Oligocene</td><td colspan="2" rowspan="2">Střezov Fm.</td><td>Kvítkov</td><td>Nerchau-Flörsheim</td></tr>
<tr><td>Bílina*, Lochočice**</td><td>Seifhennersdorf-Kundratice</td></tr>
<tr><td>?Early Oligocene–Late Eocene</td><td colspan="2">Staré Sedlo Fm.</td><td>Lom</td><td>Hordle-Zeitz</td></tr>
</table>

A different more thermophilous vegetation including *Engelhardia, Platanus neptuni* ("maar" flora from the core Bz 372, Bílina Mine) and *Daphnogene* (trachybasaltic tuff from the Bílina Mine), and *Palaeohosiea suleticensis* in the association with *Quasisequoia couttsiae, Alnus, Ampelopsis rotundatoides, Cornus, Iodes, Parabaena europaea* and *Sambucus colwellensis* (core KV 15 near Kvítkov outside the basin see Holý 1963, Kvaček & Bůžek 1995) is correlated with Oligocene floras of the České středohoří Mts from Suletice and Holý Kluk (Kvaček & Bůžek 1995, Radoň *et al.* 2006). The lowermost part of the Most Formation, (the Duchcov Member), is palaeofloristically heterogeneous. The "limestone" flora from Tuchořice is characterised by the association of *Phoenix-Celtis lacunosa sensu* Kvaček & Bůžek (1982) and has distinct thermophilous character. Also a flora from the core JZ 44 (Jezeří) is thermophilous and includes *Laurophyllum* sp. div. associated with *Pinus* sp. and *Alnus julianiformis*.

An aquatic, halophilous association of *Cladiocarya-Limnocarpus* is known from the sediments underlying the Lower Seam Beds *sensu* Hurník & Marek (1962) in the Marianna Mine. Monotonous accumulations of leaves of *Quercus rhenana* (the association of *Quercus rhenana sensu* Kvaček & Bůžek 1982) are typical of the deepest levels of the Most Fm. in the central part of the basin (*e.g.*, core Hk 203 near Hrdlovka).

Assemblages from the same stratigraphical position in the western (Chomutov) part southward of Pětipsy (lo-

Figure 4. Important Early Miocene plant elements from the Most, Sokolov and Zittau basins. • A – *Alnus julianiformis* (Sternb.) Kvaček & Holý, leaf, locality Bílina, DB uncatalogued, scale bar 10 mm. • B – *Acer tricuspidatum* Bronn, leaf, locality Bílina, DB uncatalogued, scale bar 10 mm. • C – *Alnus gaudinii* (Heer) Knobloch & Kvaček, leaf, locality Bílina, DB uncatalogued, scale bar 10 mm. • D – *Berchemia multinervis* (A. Braun) Heer, leaf, locality Bílina, DB uncatalogued, scale bar 10 mm. • E – *Berberis berberidifolia* (Heer) Palamarev & Petkova, leaf, locality Bílina, DB uncatalogued, scale bar 10 mm. • F – *Azolla* aff. *ventricosa* P. Nikitin *sensu* Dorofeev, megaspores (arrow), locality Bílina, ČGS uncatalogued, scale bar 5 mm. • G – *Chaneya oeningensis* (Unger) Teodoridis & Kvaček, fruit, locality Břešťany, NM G 4403, scale bar 5 mm. • H – *Carya costata* (Sternb.) Brongn., fruit, locality Bílina, DB uncatalogued, scale bar 10 mm. • I – *Engelhardia macroptera* (Brongn.) Ung., fruit, locality Bílina, DB uncatalogued, scale bar 10 mm. • J – *Paliurus favonii* Ung., fruit, locality Bílina, DB uncatalogued, scale bar 10 mm. • K – *Schenkiella credneri* (Schenk) Wójcicki & Kvaček, fruit, locality Bílina, DB uncatalogued, scale bar 5 mm. • L – *Pseudolarix schmidtgenii* Kräusel, cone scale, locality Nesuchyně, PRC NN 50, scale bar 5 mm. • M – *Salvinia reussii* Ettingsh., leaf, locality Bílina, DB uncatalogued, scale bar 10 mm. • N – *Quercus rhenana* (Kräusel & Weyland) Knobloch & Kvaček, leaf, locality Bílina, DB uncatalogued, scale bar 20 mm. • O – *Paliurus tiliaefolius* (Ung.) Bůžek, leaf, locality Bílina, DB uncatalogued, scale bar 10 mm. • P – *Populus populina* (Brongn.) Knobloch, leaf, locality Bílina, DB uncatalogued, scale bar 10 mm. • Q – *Comptonia difformis* (Sternb.) Berry, leaf, locality Bílina, DB uncatalogued, scale bar 10 mm. • R – *Fagus saxonica* Kvaček & Walther, leaf, locality Přívlaky, PRC PŘ 28, scale bar 10 mm. • S – *Fraxinus bilinica* (Ung.) Kvaček & Hurník, leaf, locality Bílina, DB uncatalogued, scale bar 10 mm. • T – *Eurya stigmosa* (Ludwig) Mai, seed, locality Kundratice (core KU 127, depth 75.0–76.0 m), NM G 8507, scale bar 330 µm. • U – *Laurophyllum saxonicum* Litke, leaf, locality Břešťany, NM G 4415, scale bar 10 mm. • V – *Podocarpium podocarpum* (A. Braun) Herendeen, leaflet, locality Bílina, DB uncatalogued, scale bar 10 mm. • W – *Nyssa bilinica* (Ung.) Kvaček, leaf, locality Bílina, DB uncatalogued, scale bar 20 mm. • X – *Gordonia hradekensis* (Kvaček & Bůžek) Palamar. & Bozukov, leaf, locality Dukla Mine, Habartov, ČGS DK-38, scale bar 10 mm. • Y – *Ulmus pyramidalis* Goepp., leaf, locality Bílina, DB uncatalogued, scale bar 10 mm. • Z – "*Parrotia*" *pristina* (Ettingsh.) Stur *sensu* Bůžek, leaf, locality Bílina, DB uncatalogued, scale bar 10 mm. • A* – *Zelkova zelkovifolia* (Ung.) Bůžek & Kotlaba, leaf, locality Bílina, DB uncatalogued, scale bar 10 mm. • B* – *Myrica lignitum* (Ung.) Sap., leaf, locality Bílina, DB uncatalogued, scale bar 10 mm. • C* – *Pinus urani* (Ung.) Schimper, seed cone, locality Kundratice (core KU 114, depth 72–73 m), NM G 8513, scale bar 10 mm. • D* – *Calamus daemonorops* (Ung.) Chandler, thorn, locality Hrádek u. N. (core Hr 42, depth 111.7 m), NM G7935, scale bar 2.5 mm. • E* – *Trigonobalanopsis exacantha* (Mai) Kvaček & Walther, fruit, locality Hrádek u. N. (core Hr 44, depth 109.0 m), NM G 8057,scale bar 2.5 mm. • F* – *Meliosma wetteraviensis* (Ludwig) Mai, fruit, locality Hrádek u. N. (core Hr 42, depth 87.3 m), NM G 7977, scale bar 2.5 mm. • G* – *Mastixia lusatica* Mai, fruit, locality Kristina, Hrádek u. N., NM G 2554, scale bar 5 mm. • H* – *Tectocarya elliptica* (Unger) Holý, fruit, locality Kristina, Hrádek u. N., NM G 4240, scale bar 5 mm. • I* – *Retinomastixia schultei* Kirchheimer, fruit, locality Kristina, Hrádek u. N., NM G 4259 scale bar 5 mm. • J* – *Eomastixia saxonica* (Menzel) Holý, fruit, locality Kristina, Hrádek u. N., NM G 4175 scale bar 10 mm. • K* – *Diplopanax limnophilus* (Ung.) Czaja, fruit, locality Kristina, Hrádek u. N., NM G 4229, scale bar 5 mm.

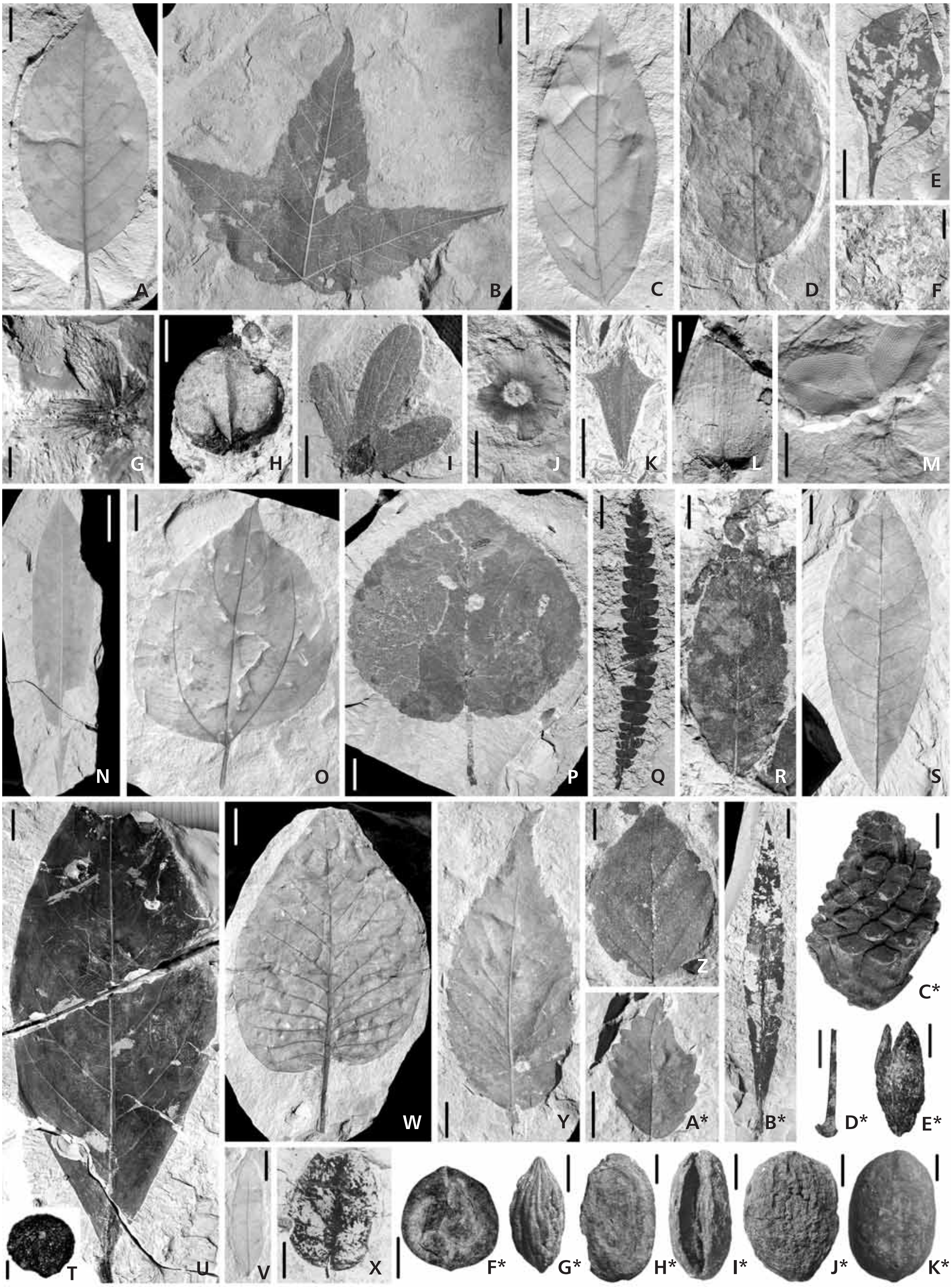
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Table 6. Summary of the floristic composition of the Most Basin and the "Hlavačov Gravel and Sand". Abbreviations: C – cone, F – fruit, L – leaf, S – seed, Sp – spore, T – thorn, O – organs, A – Most Basin, B – Most Formation, C – "Hlavačov Gravel and Sand", D – Střezov Formation, E – Duchcov Member, F – Holešice Member, G – Libkovice Member, H – Lom Member.

Taxa	O	C	A				
			D	B			
				E	F	G	H
Acer angustilobum	L	*			*	*	
Acer integerrimum	L	*			*	*	
Acer pseudomonspessulanum	L				*	*	
Acer sp. div.	F		*		*	*	
Acer tricuspidatum	L	*			*	*	
Actinidia sp.	S			*	*	*	
Ailantus confucii	F	*			*		
cf. *Alnus* sp.	L					*	*
Alnus gaudinii	L			*		*	
Alnus julianiformis	L	*		*	*	*	
Alnus kefersteinii	F	*			*	*	
Alnus lusatica	F					*	
Alnus menzelii	L				*	*	
Alnus sp.	L	*				*	
Amelopsis rotundatoides	S		*				
Ampelopsis sp.	S, L				*	*	
Asplenium sp.	L					*	
Azolla aff. *nana*	Sp				*	*	*
Azolla aff. *rossica*	Sp				*	*	*
Azolla aff. *ventricosa*	Sp				*	*	*
Berberis berberidifolia	L				*	*	
Berchemia multinervis	L				*	*	
Betula sp.	L	*		*	*	*	
Blechnum dentatum	L				*	*	
Calamus daemonorops	T			*	*	*	
Carex sp.	F			*	*	*	
Carpinus grandis	L	*	*		*	*	
Carya costata	F			*	*		
Carya cf. *serrifolia*	L	*			*	*	
Castanea atavia	L	*					
Celtis japeti	L				*		
Cercidiphyllum crenatum	L				*	*	
Cladiocarya sp.	F			*	*	*	
Cladium trilobatum	F					*	
Comptonia difformis	L	*			*	*	
Comptonia goniocarpa	F					*	
Comptonia longistyla	F					*	
Cornus sp. div.	F		*				
Craigia bronnii	F				*	*	
Crategus sp.	S				*	*	
Cyclocarya cylocarpa	F		*				
Daphnogene polymorpha	L	*	*		*	*	
Decodon gibbosus	L				*	*	*
Dicotylophyllum sp. div.	L					*	
Diospyros brachysepala	L				*	*	
Diversiphyllum aesculapi	L				*	*	
Dombeyopsis lobata	L				*	*	
Dulichium sp.	F					*	
Elephantosotis dvorakii	L					*	
Engelhardia macroptera	F					*	
Engelhardia orsbergensis	L		*			*	
Epipremnites cristatus	F			*	*		
Equisetum braunii	L					*	
Eurya stigmosa	S				*	*	
Fagus deucalionis	F	*				*	
Fagus saxonica	L	*				*	
"*Ficus*" *truncata*	L	*				*	
Fraxinus bilinica	L					*	
Fraxinus macroptera	F				*	*	
Glyptostrobus europaeus	C, S, L	*		*	*	*	*
Gordonia hradekensis	L					*	
Hemitrapa heissigii	F						*
Hydrochariphyllum buzekii	L					*	
Chaneya oehningensis	F				*	*	
Ilex sp.	F					*	
Iodes sp.	F		*				
"*Juglans*" *acuminata*	L				*	*	
"*Juglans*" *dilatata*	F			*			
Koelreuteria reticulata	F				*	*	
Laurocarpum sp.	F				*		
Laurophyllum nechranicense	L				*	*	
Laurophyllum pseudoprinceps	L			*	*	*	
Laurophyllum pseudovillense	L			*	*	*	
Laurophyllum saxonicum	L					*	
Laurophyllum sp. div.	L				*	*	
Laurus abchasica	L					*	
Leguminosites tobischii	L	*			*	*	
Lemna cestmirii	L					*	
Lemnospermum pistiforme	S					*	
Limnobiophyllum expansum	L					*	
Limnocarpus sp.	S			*			
Liquidambar europaea	L	*		*	*	*	
Lygodium gaudinii	L					*	
cf. *Magnolia* sp.	L					*	
Mahonia bilinica	L	*			*	*	
cf. *Mastixia lusatica*	F					*	
Meliosma sp.	F					*	
Meliosma wetteraviensis	F					*	
Myrica ceriferiformis	F			*		*	
Myrica integerrima	L				*	*	
Myrica lignitum	L					*	
Myrica sp.	L	*			*	*	
Myrica suppanii	F					*	
Myrica undulatissima	L						*
Nyssa bilinica	L				*	*	
Nyssa gmelinii	L						*
Nyssa ornithobroma	F				*	*	
Oleinites sp.	L					*	
Osmunda parschlugiana	L				*	*	
Ostrya atlantidis	F, L		*	?	*		
Parabaena europaea	S		*				
Palaeohosiea suleticensis	F		*				
Paliurus favonii	F				*	*	
Paliurus tiliaefolius	L				*	*	
"*Parrotia*" *pristina*	L				*	*	
Phyllites sp.	L				*	*	
Pinus engelhardtii	C				*	*	
Pinus ornata	C					*	
Pinus rigios	L				*	*	
Pinus sp.	L	*	*			*	

Taxa	O	C	A				
			D	B			
				E	F	G	H
Pinus urani	C					*	
Pistia sp.	F				*	*	
Platanus neptuni	L					*	
Poaceae vel Cyperaceae gen. et sp. indet.	L	*		*	*	*	*
Podocarpium podocarpum	L				*	*	
Populus populina	L				*	*	
Populus sp.	L				*	*	
Populus zaddachii	L	*			*		
Potamogeton wiesaensis	F				*	*	*
Potamogeton praenatans	L					*	
Pronephrium stiriacum	L					*	*
Proserpinaca reticulata	F				*		
Pseudolarix schmidtgenii	L	*					
Pterocarya cf. *limburgensis*	F					*	
Pungiphyllum cruciatum	L				*	*	
Quasisequoia couttsiae	C, L		*		*	*	*
Quercus kubinyii	L					*	
Quercus rhenana	L			*	*	*	
Rhus pyrrhae	L		*			*	
Rosa europaea	L				*	*	
Rubus merianii	F				*	*	
Sabal lamanonis	L				*	*	
Salix haidingeri	L	*			*	*	
Salix varians	L	*			*	*	*
Salvinia reussii	Sp, L	*			*	*	*
Sambucus colwellensis	Sp		*				
"*Sapindus*" *falcifolius*	L	*			*		
Selaginella sp.	S				*	*	
Schenkiella credneri	F					*	
Schisandra moravica	F				*	*	
Smilacinites ungeri	L					*	
Smilax weberi	L				*	*	
Sparganium cf. *camenzianum*	F				*	*	
Spirematospermum wetzleri	S			*	*	*	
Stratiotes kaltennordheimensis	F	*			*	*	
Stratiotes schaarschmidtii	L					*	
Symplocos sp.	F					*	
Symplocos volkeri	L					*	
Taxodium dubium	C, S, L	*		*	*	*	
Ternstroemia sp.	F			*		*	
Terstroemites sp. div.	L	*			*	*	
Tetraclinis salicornioides	L	*				*	
Thypha latissima	L				*	*	
Tilia brabenecii	L, F	*				*	
Toddalia maii	F					*	
Toxicodendron sp.	L				*	*	
Trachelospermophyllum sp.	L					*	
Trigonobalanopsis exacantha	F					*	
Trigonobalanopsis rhamnoides	L	*	*			*	
Ulmus pyramidalis	L	*		*	*	*	
Vaccinioides lusatica	L					*	
Vitis stricta	L	*				*	
Vitis teutonica	S	*		*	*		
Woodwardia muensteriana	L	*			*	*	
Zantoxylum sp.	S					*	
Zelkova zelkovifolia	L	*	*	*	*	*	
Zingiberoideophyllum liblarense	L	*			*		

cality Čermníky) contain phytostratigraphically unimportant elements, such as *Taxodium dubium*, *Ulmus pyramidalis*, *Liquidambar europaea* (Bůžek 1971) from the underlying sediments of the Lower Seam Beds. Contrary to the floras of the Duchcov Member, those of the higher Holešice Member are distinctly richer and the character of the vegetation matches the coal facies (in the Teplice and Chomutov areas) and the sandy delta facies (in the Žatec and Bílina areas). Relatively infrequent carpological occurrences are known from the localities at Pesvice, Otvice, Hošnice, Vršany, Jan Šverma Mine and Strupčice. They belong to the Lower, Middle and Upper Seam Beds *sensu* Procházka (1954) and Hurník & Marek (1962). This coal facies is floristically characterised by the predominance of the Taxodiaceae (today treated as Cupressaceae *s. l.*); *Glyptostrobus europaeus*, *Taxodium dubium*, *Quasisequoia couttsiae*, in the association with frequent occurrences of *Stratiotes kaltennordheimensis*, *Spirematospermum wetzleri*, *Myrica* sp. div., *Calamus daemonorhops*, *Salvinia* sp. and *Sparganium* sp. div. (Bůžek & Holý 1964, Bůžek *et al.* 1971).

The floras from the Lower and Upper Interseam Beds *sensu* Procházka (1954) and Hurník & Marek (1962) are represented by richer plant fossil material including leaves. The richest locality at Čermníky from the Upper Interseam Beds is interesting because of a combination of coal-forming (mainly represented by the association of *Glyptostrobus* and of *Nyssa-Taxodium sensu* Kvaček & Bůžek 1982) and riparian elements (mainly represented by the association of *Parrotia-Ulmus pyramidalis sensu* Kvaček & Bůžek 1982); Bůžek (1971) and Teodoridis (2004). Therefore, this flora can be compared well with marginal and/or extrabasinal floras in the Žatec Delta from, *e.g.*, Holedeč (Brabenec 1904, Teodoridis 2002), Záhoří near Žatec (Teodoridis 2003a), Vršovice, Dobrčice and Skyřice (Velenovský 1881, Hurník & Kvaček 1999, Kvaček & Hurník 2000). The floras of higher stratigraphical levels bound to the delta facies of the Bílina Delta system (*e.g.*, Bůžek *et al.* 1990a, Sakala 2000, Kvaček *et al.* 2004) show a similar floristic composition with a predominance of riparian elements, as listed above. However, unique aquatic endemites, *e.g.*, *Elephantosotis dvorakii*, *Hydrochariphyllum buzekii* and *Schenkiella credneri* (Kvaček 2003, Wójcicki & Kvaček 2002) in the association with new or persisting elements, *e.g.*, *Engelhardia*, *Blechnum*, *Tetraclinis*, *Sabal* and *Platanus neptuni* also occur there. An extinct aquatic(?) plant *Schenkiella credneri* is an important marker, which helps to recognize the boundary between the Floristic Assemblages of Bitterfeld *sensu* Mai & Walther (1991) and Bílina-Brandis *sensu* Mai (1995).

The lowermost part of the Libkovice Member is floristically characterized by a well diversified flora of the Břešťany Clay and carpological and leaf floras from the micaceous facies of the Krušné hory Mts (Fig. 4;

Teodoridis & Kvaček 2006). The flora of the Břešťany Clay (Ettingshausen 1866, 1868, 1869, Teodoridis & Kvaček 2006) is interesting in the mixture of basin elements (Taxodiaceae, *Cercidiphyllum*, *Nyssa*, *Craigia*, *Alnus julinaniformis*, *Quercus rhenana* and *Acer tricuspidatum*) and Mixed Mesophytic Forest elements (*Pinus*, *Myrica lignitum*, *Laurophyllum* sp. div., *Trigonobalanopsis*) bound to more acid biotopes on the basin periphery. This flora is related to the association of *Engelhardia-Taxodium sensu* Kvaček & Bůžek (1982). New elements, such as *Symplocos* sp. div., cf. *Mastixia lusatica* and *Vaccinioides lusatica*, which correspond to the association of *Comptonia-Pinus sensu* Kvaček & Bůžek (1982), are known from the floras of the micaceous facies, *e.g.*, from the localities Kundratice, Jezeří and Mariánské Radčice (Teodoridis & Kvaček 2006). A "quartzite" flora of Černovice at Chomutov probably belongs to same stratigraphical level (Bůžek 1984, Hurník 2001). Floristic datasets belonging to the Libkovice Member are known also from the Žatec Delta (localities Čermníky, Dolany, Soběsuky, Nechranice and Přívlaky; see Bůžek 1971; Teodoridis 2004, 2006). These floras contain common elements, *e.g.*, *Laurophyllum* sp. div., *Comptonia difformis*, *Quercus rhenana* and *Ulmus pyramidalis*, *Podocarpium podocarpum*, *Zelkova* and *Rosa* including re-appearing *Fagus saxonica* (Přívlaky).

The floras from the sediments closely underlying the Lom Coal Seam still within the Libkovice Member are noteworthy for a distinct increase of thermophilous elements, *e.g.*, *Laurus abchasica*, *Gordonia hradekensis*, *Cedrelospermum styriacum*, *Quercus kubinyii* and *Lygodium* and might indicate the Early Miocene Climate Optimum (Teodoridis & Kvaček 2006). The floras of the Lom Seam (lowermost part of the Lom Member) contain only aquatic herbs, such as *Salvinia*, *Azolla* sp. div., *Hemitrapa*, *Decodon*, *Potamogeton*, associated with woody elements, (*Quasisequoia*, *Glyptostrobus*, *Nyssa gmelinii*) and *Myrica undulatissima* (Teodoridis & Kvaček 2006).

The České středohoří Mts

The oldest Tertiary sediments in this area belong to the Staré Sedlo Formation (Knobloch *et al.* 1996). The magmatic complex of the České středohoří Mts (Figs 1–3; Tables 7, 8) has recently been subdivided into four formations based on magmatic differentation and radiometric dating (Cajz 2000). Plant macrofossils from the České středohoří Mts occur in many stratigraphical levels. The first plants were described by Sternberg (1820–1838) from the locality Žichov (as *Phyllites trilobatus* – today known as *Acer tricuspidatum*). In recent times this area has again been a place of intensive palaeobotanical investigations (Bůžek *et al.* 1976; Kvaček & Walther 1995, 1998, 2004; Radoň *et al.* 2006; Walther & Kvaček in press).

The flora of the Staré Sedlo Formation has been reliably proved by the marker *Steinhauera subglobosa* from the vicinity of Litoměřice at Žitenice and Skalice (Knobloch *et al.* 1996). Sediments of the lowermost part of the České středohoří Mts volcanic complex (Kučlín, Mrtvý vrch, Kostomlaty, Lbín, Hlinná) appear according to the palaeofloristic correlation to be a Late Eocene heterotopic facies of the Staré Sedlo Fm. and include important markers *Doliostrobus* and other Eocene elements, such as *Raskya*, *Hooleya* (Kvaček 2002). These sediments most probably represent an independent but not yet defined lithostratigraphical unit.

Figure 5. Important Pliocene plant elements from the Vildštejn Formation of the Cheb Basin. • A, B – *Salvinia* cf. *natans* (L.) All., megaspores, locality Nová Hospoda (core V 2, depth 11.5–11.6 m), NM uncatalogued, scale bars 115 μm. • C – *Chamaecyparis* sp., seed, locality Nová Hospoda (core V 1, depth 8.2 m), NM uncatalogued, scale bar 315 μm. • D, E – *Chamaecyparis* cf. *pisifera* Sieb. & Zucc., twig, locality Nová Ves (layer NV 9), NM uncatalogued, scale bars 1 mm. • F – *Chamaecyparis* cf. *pisifera* Sieb. & Zucc., adaxial cuticle, locality Nová Ves (layer NV 9), NM uncatalogued, scale bar 22.5 μm. • G – *Picea* cf. *echinata* Müller-Stoll, needle leaf, locality Doubrava (core HV 9, depth 38.7–38.8 m), NM uncatalogued, scale bar 5 mm. • H – *Picea* cf. *echinata* Müller-Stoll, adaxial cuticle, locality Doubrava (core HV 9, depth 38.7–38.8 m), NM uncatalogued, scale bar 22.5 μm. • I – *Picea omorikoides* C.A. Weber, needle leaf, locality Nová Ves (layer HV 9), NM uncatalogued, scale bar 5 mm. • J – *Picea omorikoides* C.A. Weber, adaxial cuticle, locality Nová Ves (layer HV 9), NM uncatalogued, scale bar 22.5 μm. • K, L – *Ranunculus flammula* L., fruits, locality Nová Ves (core HV 4, depth 23.7–23.8 m), NM uncatalogued, scale bars 230 μm. • M – *Potentila* cf. *pliocenica* E.M. Reid, fruit, locality Nová Ves (core HV 4, depth 34.3–34.4 m), NM uncatalogued, scale bar 255 μm. • N – *Potentila* cf. *supina* L., fruit, locality Starost (core HV 7 depth 33.9–34.0 m), NM uncatalogued, scale bar 255 μm. • O – *Hypericum coriaceum* Nikitin ex Dorofeev, seed, locality Nová Ves (core HV 9, depth 44.0–44.4 m), NM uncatalogued, scale bar 140 μm. • P – *Andromeda polifolia* L., leaf, locality Nová Ves (layer HV 10), NM uncatalogued, scale bar 140 μm. • Q – *Andromeda polifolia* L., adaxial cuticle, locality Nová Ves (layer HV 10), NM uncatalogued, scale bar 22.5 μm. • R – *Vaccinium oxycoccos* L., leaf, locality Nová Ves (layer HV 10), NM uncatalogued, scale bar 3 mm. • S – *Chamedaphne calyculata* (L.) Moench. leaf, locality Nová Ves (layer HV 10), NM uncatalogued, scale bar 3 mm. T – *Vaccinium oxycoccos* L., adaxial cuticle, locality Nová Ves (layer HV 10), NM uncatalogued, scale bar 22.5 μm. • U, V – *Menyanthes* cf. *trifoliata* L., seeds, locality Nová Ves, NM uncatalogued, scale bars 470 μm. • W – *Ampelopsis ludwigii* (A. Braun) Dorofeev, fragmentary seed, locality Nová Hospoda (core V1, depth 10.8 m), NM uncatalogued, scale bar 1 mm. • X – *Teucrium tatianae* Nikitin, fruit, locality Hněvín (core 55, depth 24.5–24.7 m), NM uncatalogued, scale bar 255 μm. • Y, Z – *Carex nigra* (L.) Reichard, fruits, NM uncatalogued, locality Nová Ves, scale bars 255 μm. • A*, B* – *Sparganium noduliferum* C. & E.M. Reid, endocarps, locality Hněvín (core V 55, depth 24.5–24.7 m), NM uncatalogued, scale bars 430 μm. • C*, D* – *Caulinia tenuissima* (A. Braun ex Magn.) Tzvelev, fruits, locality Hněvín (core V 55 depth 24.5–24.7 m), NM uncatalogued, scale bars. • E* – *Dulichium vespiforme* C. & E.M. Reid, fruit, locality Starost (core HV 7, depth 33.8–33.9 m), NM uncatalogued, 370 μm, • F*, G* – *Dulichium arundinaceum* (L.) Britt., fruits, locality Doubrava (vrt HV 9, depth 44–44.4 m), NM uncatalogued, scale bars 470 μm. **[The authors regret lower quality of illustrations which exceptionally arose due to the reproduction of photographs left by the late Č. Bůžek, whose original material was not available.]**

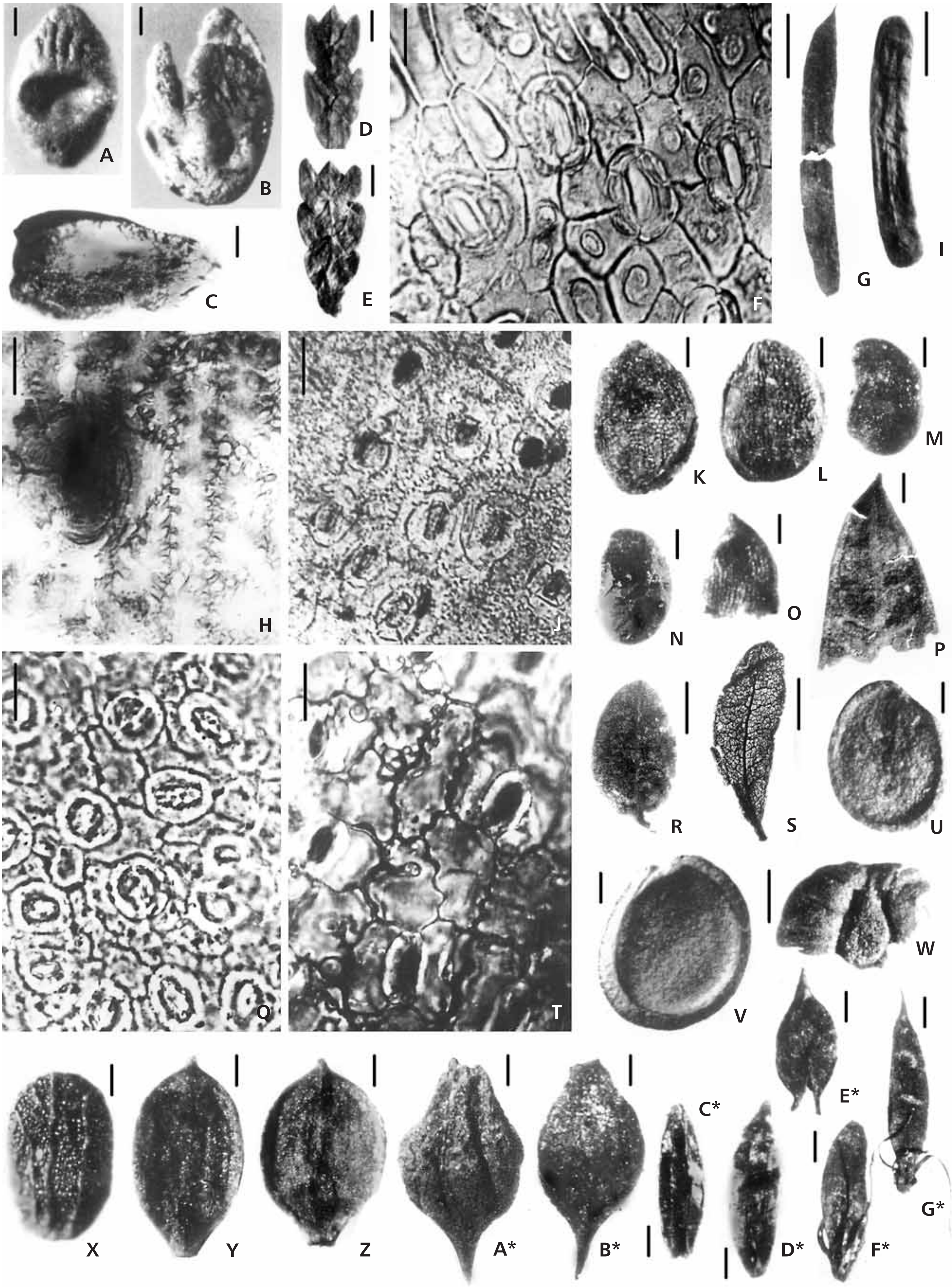
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Table 7. Correlation of the selected floras of the České středohoří Mts with the floristic assemblages of Boreal and Central Europe *sensu* Mai (1995) and Kvaček & Walther (1998).

<table>
<tr><td>Chronostr.</td><td>Lithostr.</td><td>Selected macrofloras</td><td>Palaeofloristic correlation</td></tr>
<tr><td>Early Miocene</td><td>Dobrná Fm.</td><td></td><td>?</td></tr>
<tr><td>Late Oligocene</td><td>Děčín Fm.</td><td>Žichov
Matrý
Chlum
Jedlka</td><td rowspan="2">Nerchau-Flörsheim</td></tr>
<tr><td rowspan="4">Early Oligocene</td><td rowspan="5">Ústí Fm.</td><td>Markvartice
Holý Kluk
Suletice</td></tr>
<tr><td>Hrazený
Kundratice</td><td>Seifhennersdorf-Kundratice</td></tr>
<tr><td>Bechlejovice
Větruše</td><td>Haselbach</td></tr>
<tr><td>Roudníky</td><td>?</td></tr>
<tr><td rowspan="2">Late Eocene</td><td>Lbín
Kostomlaty
Mrtvý vrch
Kučlín</td><td>Bembridge</td></tr>
<tr><td>Staré Sedlo Fm.</td><td>Žitenice
Skalice</td><td>Hordle-Zeitz</td></tr>
</table>

Most other known floras are younger and belong to the Ústí Formation (Early Oligocene). According to the invasion of deciduous Arctotertiary elements (*Ostrya*, *Carpinus, Carya*, and *Acer*) that co-occur with persisting Lauraceae and other thermophilous "Palaeosubtropical" elements (*e.g.*, *Engelhardia*, *Sloanea, Palaeohosiea*), these floras are correlated with the Floristic Assemblage of Seifhennersdorf-Kundratice *sensu* Kvaček & Walther (1998). The same authors (Kvaček & Walther 2001, 2003) tried to reconstruct the evolution of environment and ecosystems in this area from the Eocene/Oligocene boundary (localities Roudníky, Větruše and Bechlejovice) towards the Early Rupelian (localities Kundratice, Varnsdorf-Seifhennesdorf and Hrazený) and to the Late Rupelian (localities Suletice, Holý Kluk and/or Markvartice) based on a critical re-evaluation of the mentioned floras and ichthyofaunas. These floras include typical coniferous elements (*Juniperus, Torreya bilinica, Cephalotaxus parvifolia, Calocedrus suleticensis*) in the combination with thermophilous broad-leaved elements (*Platanus neptuni, "Acer" sotzkianum, Sloanea, Palaeohosiea*, *Engelhardia, Laurophyllum acutimontanum* etc.) and additional deciduous elements, *Alnus gaudinii, Acer palaeosaccharinum*, *Acer angustilobum, Cercidiphyllum, Carya*, *Betula*, *Ostrya*, *Carpinus, Craigia, Zelkova, Ulmus fischeri* (Kvaček & Walther 2001, 2003).

The floras of Žichov, Matrý, Chlum and Jedlka belong stratigraphically to the Děčín Formation and include new elements such as *Ulmus pyramidalis, Acer crenatifolium* and *Betula brongniartii*, and also *Alnus rostaniana* (only Chlum and Jedlka; Radoň 2001, Soukupová 2004). No plant macrofossils have been recovered from the Early Miocene basalts and their equivalents of the Dobrná Formation, which terminates the sequence of magmatic units in the České středohoří Mts.

The Hrádek part of the Zittau Basin

The Zittau Basin (Figs 1, 4; Tables 8, 11) extends between SE Saxony, SW Poland and N Bohemia. The lithostratigraphy is not settled across the basin (see Václ & Čadek 1962, Hirsch *et al.* 1987). There is no palaeobotanical evidence for the Staré Sedlo Formation in the Hrádek part of the Zittau Basin.

Two formations have been recognised there, the Loučeň Formation containing volcanites and the Basal Coal Seam, and the Hrádek Formation informally divided into the Lower, Middle and Upper Coal Seams. Newly revised floras of Varnsdorf in Bohemia and Seifhennersdorf in Saxony (Walther & Kvaček in press) from the periphery of the basin belong to the Floristic Assemblage Seifhennersdorf-Kundratice *sensu* Kvaček & Walther (1998) and stratigraphically correspond to the Loučeň Formation.

The flora of Seifhennersdorf and the basal seam in the Polish part of the basin are also dated by the Oligocene microfossil marker *Boehlensipollis hohlii* (Krutzsch in Mai & Walther 1978; Konzalová & Ziembińska-Tworzydło 1999, 2000). Carpological datasets obtained from the drilling survey at Hrádek n. N. and Uhelná are the only macropalaeofloristic data that characterise the Basal, Lower, Middle and Upper Coal Seams *s. l.*, including their closely underlying and overlying deposits (Teodoridis 2003b). The florula of the Basal Coal Seam contains common phytostratigraphically unimportant elements, *e.g.*, *Glyptostrobus*, *Myrica*, *Rubus* sp. and *Sparganium*. This level still belongs to the Loučeň Formation. The assemblages of the Lower and Middle Coal Seams *s. l.* are represented by numerous mainly swampy and riparian elements, *e.g.*, *Glyptostrobus*, *Cupressospermum*, *Sequoia*, *Nyssa*, *Symplocos* sp. div., *Rubus*, *Calamus daemonorhops*, *Sparganium, Magnolia, Myrica* sp., *Alnus* and *Spirematospermum* intermixed with some mesophytic elements (*Distylium* cf. *uralense*, *Pterocarya limburgensis*, *Eurya stigmosa*, *Vitis*, *Ampelopsis*, *Meliosma* and *Trigonobalanopsis exacantha*).

The flora of the Upper Coal Seam *s. l.* is characterised by a mass occurrence of thermophilous elements mainly of the family Mastixiaceae (*Mastixia lusatica*, *Tectocarya elliptica*, *Diplopanax limnophilus*). Additional thermophilous elements have been obtained from the opencast mine Kristina, *e.g.*, *Eomastixia saxonica*, *Gordonia hradekensis*, *Laurophyllum rugatum*, *Laurus abchasica, Retinomastixia schultei* and *Zanthoxylum kristinae* (Kvaček & Bůžek 1966; Holý 1974, 1977a, b, 1978; Kvaček 1971; Teodoridis 2003b). These floras are correlated to the Floristic Assemblage Eichelskopf-Wiesa *sensu* Mai (1995). The upper level of the former opencast mine Kristina (now closed and flooded) yielded a less thermophilous assemblage with additional deciduous elements including *Fagus* (Holý 1978), which might correspond to

Table 8. Correlation of the selected floras of the Hrádek part of the Zittau Basin with the floristic assemblages of Boreal and Central Europe *sensu* Mai (1995).

Chronostr.	Lithostratigraphy		Selected macrofloras	Palaeofloristic correlation
Middle Miocene	Hrádek Fm.	Upper Coal Seam *s. l.*	Kristina mine	? Frant. Lázně-Kleinleipisch, Eichelskopf-Wiesa
Early Miocene		Middle Coal Seam *s. l.*	cores	? Bílina-Brandis, Bitterfeld
		Lower Coal Seam *s. l.*	cores	
Early Oligocene	Loučeň Fm.	Basal Coal Seam *s. l.*	Varnsdorf	Seifhennersdorf-Kundratice

the Floristic Assemblage Františkovy Lázně-Kleinleipisch *sensu* Mai (1995) and Czaja (2003).

The exact correlation with other basins in the Ohře Graben remains equivocal based on the plant macrofossils available. However, floristic affinities between the floras of the Upper Coal Seam *s. l.* of the Hrádek Formation, those of the Cypris Formation and of the uppermost part of the Libkovice Member of the Most Formation are anticipated. The floristic correlation of the Lower and Middle Coal Seams *s. l.* of the Hrádek Formation is so far unclear due to poor floristic documentation. Links to the Holešice Member and the lower part of the Libkovice Member of the Most Formation, *i.e.*, to the Floristic Assemblages of Bitterfeld and Bílina-Brandis are possible.

The sedimentary relicts of the Tertiary river system from Central and Western Bohemia

Irregularly distributed relicts of the Tertiary river deposits in Central and Western Bohemia (Figs 1, 4; Tables 6, 12) are connected with a fluvial system of the River "C" including its tributaries (A_1, A_2, A_3, D_1, D_2) *sensu* Pešek & Spudil (1986).

The River "C" drained the mentioned area towards the Most Basin and was connected through the "Hlavačov Gravel and Sand" *sensu* Váně (1985) with the Žatec Delta (Teodoridis 2004). The floras of the "Hlavačov Gravel and Sand" are characterised by a predominance of riparian and swampy elements, *i.e.*, *Betula*, *Alnus julianiformis*, *Liquidambar*, *Parrotia*, *Ulmus*, *Fagus saxonica* and Taxodiaceae associated with accessory elements of the Mixed Mesophytic forests, *e.g.*, *Pseudolarix*, *Tilia*, *Acer integrilobum*, *Mahonia* (Němejc 1949, Teodoridis 2002). These floras were correlated (Teodoridis 2002) to the Late Oligocene flora of the Thierbach Formation in the Weisselster Basin (Lotsch *et al.* 1994), *i.e.*, the Floristic Assemblage Thierbach *sensu* Mai & Walther (1991). This assumption has been proved also by similar spectra of heavy minerals (Suhr 2003).

Sediments of the "Hlavačov Gravel and Sand" are comparable with the lower part of the Duchcov Member of the Most Formation (Teodoridis 2004) based on sedimentological data (Váně 1985) and palynological analysis (Konzalová 1976). Besides the main sites of the belt at Hlavačov and Nesuchyně, several isolated sedimentary relicts, such as U Sv. Antonína, Na Sulavě (Němejc 1949, Teodoridis 2001), Klínec (Kettner 1911, Procházka 1916, Němejc 1949, Teodoridis 2001) and U ručiček (Žák *et al.* 2003) contain macrofloras of the same type. These floras also belong to the River "C" and its tributaries and were originally assigned to the Klínec phase (Miocene in age) *sensu* Němejc (1949) except for the flora of the site U Sv. Antonína. The latter contains leaves of beech (*Fagus saxonica*, Teodoridis 2001), originally described as *Fagus sylvatica* L. (Němejc 1949). On the basis of this sample Němejc (1949) defined the Zdiby phase (supposedly Plio-Pleistocene in age), but this idea is incorrect in view of the above revision (Teodoridis 2001). The other mentioned floras include common elements, *e.g.*, *Salvinia*, *Taxodium*. *Glyptostrobus*, *Daphnogene*, *Ulmus*, Salicaceae and Betulaceae.

The floras from the sedimentary relicts at Plzeň recovered at the localities of Ejpovice, Kyšice, Dobříč, Horní Bříza (U tří králů) and Býkovský les were studied tentatively by Hurník & Knobloch (1966). Němejc *et al.* (2003) completely revised these floras including micropalaeobotanical analysis except for the floras of Kyšice and Ejpovice (see Kvaček *et al.* 2006c). The oldest macroflora from Dobříč can be assigned to the Oligocene because of the presence of the Oligocene marker *Laurophyllum acutimontanum* associated with *L. pseudoprinceps* and *Platanus neptuni*. There is no evidence of another important Palaeogene marker *Eotrigonobalanus*. The florulas of Zruč and Žihlice are poorly characterised (*Daphnogene, Liquidambar, Engelhardia*, *Salix*, *Nyssa*) and show an Early Miocene character. On the contrary, the rich flora from Horní Bříza includes a mixture of rare thermophilous elements (*Chamaerops*, *Laurophyllum pseudovillense, Gordonia*) and deciduous woody elements (*Ginkgo adiantoides, Platanus leucophylla, Quercus pseudocastanea* etc.), which suggests a Middle Miocene, probably Badenian age.

The České Budějovice and Třeboň Basins

A detailed geological survey of the České Budějovice and Třeboň basins (Fig. 1; Tables 10, 12) was started only after the 2nd World War (detailed in Malecha 1985, Huber 2003).

Most sedimentary rocks in these basins belong to the Klikov Formation of the Late Cretaceous (Coniacian-Santonian) on the basis of the palaeobotanical and palynological data (Němejc 1956, Malecha *et al.* 1962,

Table 9. Summary of the floristic composition from selected localities of the České středohoří Mts. Abbreviations: C – cone, F – fruit, L – leaf, S – seed, Sp – spore, O – organs, A – Selected localities from the volcanic complex of the České středohoří Mts., B – Kučlín, C – Bechlejovice, D – Kundratice, E – Suletice, Holý Kluk, F – Markvartice, G – Žichov, H – Hrazený, I – Seifhennersdorf (Saxony, Germany), J – Staré Sedlo Formation.

Taxa	O	A	H						I	J
		B	C	D	E	F	G	H		
Acer angustilobum	L		*	*	*	*	*	?	*	
Acer dasycarpoides	L			*					*	
Acer engelhardtii	L								*	
Acer integrilobum	L		*	*	*					
Acer palaeosaccharinum	L		*	*	*	*		*	*	
Acer pseudomonspessulanum	L								*	
Acer rueminianum	L			*					*	
"*Acer*" *sotzkianum*	F	*			*					
Acer tricuspidatum	L		*	?	*	*				
Acer tricuspidatum var. *crenatifolium*	L						*			
Acrostichum lanzeanum	L	*								*
Ailanthus prescheri	L		*	*	*	*		*	*	
Ailanthus sp.	F	*								
Alnus gaudinii	L		*	*		*	*	*	*	
Alnus kefersteinii	F		*	*			*	*	*	
Alnus rostaniana	L						?			
Ampelopsis hibschii	L		*	*	*				*	
Ampelopsis cf. *ludwigii*	S					*				
Ampelopsis rotundata	S		?		?				*	
Apocynophyllum neriifolium	L								*	
Apocynospermum striatum	S	*		*	*					
Arecaceae gen. et sp. indet.	L	*	*			*				*
Blechnum dentatum	L	*								
Betula brongniartii	L					*	*	*		
Betula alnoides /dryadum	L, F		*	*	?	*		*	*	
Callistemophyllum bilinicum	L	*								
Calocedrus suleticensis	L, C, S				*					
Carpinus cordataeformis	F		*					*	*	
Carpinus mediomontana	F		*		*				*	
Carpinus minor	L		*	*	*		?	*	*	
Carya costata	F			?					?	
Carya serrifolia	L		?	*	*	*	*	*	*	
Carya sp.	L		*		*	*				
Cedrelospermum leptospermos	F	*								
Cedrelospermum sp.	L	*								
Celtis bohemica	L				*				*	
Celtis pirskenbergensis	L				*			*	*	
Cephalotaxus parvifolia	L			*	?				*	
Cercidiphyllum crenatum	F, L		*	*	*	*	*	*	*	
Comptonia difformis	L		?		*			*		
Cornus studeri	L		*	*	*			*	*	
Craigia bronnii	F		*	*	*	*	*	*	*	
Crataegus pirkenbergensis	L		*	?				*	?	
Cyclocarya sp.	L		*		?			*	*	
Daphnogene cinnamomifolia	L	*		*	*	*	*	*	*	*
Dicotylophyllum deichmuelleri	L		*	*	*			*	*	
Dicotylophyllum heerii	L		*	*	*					
Dicotylophyllum ungeri	L								*	
Diospyros brachysepala	L, F		*						*	
Doliostrobus taxiformis	L, C	*								?
Dombeyopsis lobata	L		*	*	*				*	
Dryophyllum cf. *altenburgense*	L									*
Dusembaya seifhennersdorfensis	S			*	?	?			*	
Engelhardia macroptera	F	*			*	*		*	*	
Engelhardia orsbergensis	L	*		*	*	*		*	*	
Eotrigonobalanus andreanszkyii	F									
Eotrigonobalanus furcinervis	L	*								*
"*Ficus*" *reussii*	L	*								
Fraxinus sp.	F			*						
Hooleya hermis	F	*								
Hydrangea microcalyx	F	*			*				*	
Ilex castellii	L			*						
Ilex tenuiputamenta	S						*		*	
Juglandaceae gen. et sp. indet.	L			*				*		
Laurophyllum acutimontanum	L		*		?	*	?		*	
Laurophyllum markvarticense	L					*				
Laurophyllum medimontanum	L				?	*	?	*		
Laurophyllum meuselii	L								*	
Laurophyllum pseudoprinceps	L		?	*	?	*	*	?	*	
Leersia seifhennersdorfensis	L, F								*	
Leguminosae gen. et sp. indet.	L, F		*		*		*	*	*	*
Liriodendron haueri	L, F	*			*		*	*		
Magnolia burseracea	S		*		?				?	
"*Magnolia*" *longipetiolata*	L	*								
Magnolia sp. div.	L, S		?	*	*	?	?		*	
Mahonia pseudosimplex	L		*		?					
Majanthemophyllum basinerve	L									*
Matudaea menzelii	L	?	?		?	?				
Meliosma miesleri	F					*				
Mimosites haeringianus	L		*	*	*			*		
Nymphaeaceae gen. et sp. indet.	L, S	*								
Nyssa disseminata	F					?			*	
Nyssa altenburgensis	L								*	
Oleinites maii	L				*	*			*	
Osmunda lignitum	L		*		?				*	
Ostrya atlantidis	L		*	*	*	*				
Palaeohosiea bilinica	F	*								
Palaeohosiea suleticensis	F				*				*	
Parthenocissus sp.	S									
Pinus sp. div.	L						*			*
Platanus schimperi	L		*							
Platanus neptuni	L, F	*	*	*	*	*	*	*	*	
Polypodium radonii	L		*		*					
Populus zaddachii	L		*	*	*			*	*	
Potamogeton seifhennersdorfensis	L, F								*	
Potamogeton sp.	L, F					*			*	
Pungiphyllum cruciatum	L	*	*	*	*					
Pungiphyllum cf. *waltheri*	L	*								
Pronephrium stiriacum	L	*			*	*			*	
Prunus langsdorfii	F					*			*	
Pyracantha kraeuselii	L		?							
Quasisequoia couttsiae	L								?	*
Quercus bavarica	L		?							
Quercus aff. *haraldii*	L									*
Quercus lonchitis	L								*	
Raskya venusta	F	*								
Rosa lignitum	L		*	*	*	*	?	*	*	
Rosa saxonica	F		*						*	
Rosaceae (*Cotoneaster* sp./*Crataegus* sp.)	L		*			*				
Rumohra recentior	L	*	*		?					
Sabal raphifolia	L	?							*	*

Taxa	O		A						I	J
		B	C	D	E	F	G	H		
Salix sp. div.	L							*	*	
Salvinia sp.	L		*						*	
Saportaspermum dieteri									*	
Saportaspermum cf. *occidentale*	S	*	*			*	*		*	
Saxifragites crenulatus	L									*
Schefflera dorofeevii	S								*	
Sloanea artocarpites	L		?	*	*	*	*			
Sloanea nimrodi	L	*								
Sloanea sp.	F	*			*	*				
Smilax weberi	L		*	?	*		*	*	*	
Sparganium sp.	F					*				
Spirematospermum wetzleri	S								*	
Steinhauera subglobosa	F									*
"*Sterculia*"*crassinervia*	L	*	*							
"*Sterculia*" *labrusca*	L	*								*
Stratiotes sp.	S		*							
Taxodium dubium	C, L							*	*	
Taxus engelhardtii	*L*			*			?			
Tetraclinis salicornioides	L, S	*		*	*		*	*	*	
Tilia brassicoides	F		*							
Tilia gigantea	L		*	*	*		*		*	
Toddalia sp.	S					*				
Torreya bilinica	L		*	*	?	?	*		*	
Toxicodendron herthae	L		*	*				*	*	
Trigonobalanopsis rhamnoides	L								?	*
Typha latissima	L		*					*		
Ulmus fischeri	L		*	*	*			*	*	
"*Viburnum*" cf. *atlanticum*	L		*		*	*	*	*		
Vitis stricta	L			?						
Vitis teutonica	S				*		*		*	
Zanthoxylon sp.	L, F				?	?				
Zelkova zelkovifolia	L		*	*	*			*	*	
Ziziphus ziziphoides	L	*	*							

Váchová 2007). The stratigraphical position of the next unit, *i.e.* the Lipnice Formation, is unclear. Němejc (1962) and Malkovský (1995) estimated also a Late Cretaceous age for this small relict. A xylotomic flora referred to as coming probably from the Lipnice Formation (Prakash *et al.* 1974) shows the paratropical character, which rules out a correlation with the Staré Sedlo Formation originally suggested by Hurník & Knobloch (1966).

The remaining sedimentary fills of the České Budějovice and Třeboň basins belong to the Neogene. Four formations have been distinguished: Zliv, Mydlovary, Domanín, and Ledenice. The macroflora of the Zliv Formation at locality Nová Řeka consists of *Quercus rhenana*, *Dombeyopsis lobata, Acer tricuspidatum*, *Daphnogene polymorpha*, and some other elements also known from the Lower Miocene in the Cheb, Sokolov and Most basins or from the Bavarian Molasse (Knobloch & Kvaček 1996). The Mydlovary Formation, *e.g.*, localities Mydlovary, Ledenice, Hluboká and Kamenný Újezd, is characterised by a thermophilous mastixioid flora with *Mastixia amygdalaeformis, Eomastixia, Trigonobalanopsis* and *Engelhardia orsbergensis* with additional *Ziziphus paradisiaca*, *Ailanthus*, *Myrica lignitum* and *M. vindobonensis* showing

Table 10. Correlation of the selected floras of the České Budějovice and Třeboň basins with the floristic assemblage of Boreal and Central Europe *sensu* Mai (1995).

Chronostr.	Lithostratigraphy	Selected macrofloras	Palaeofloristic correlation
Pliocene	Ledenice Fm.		
Middle Miocene	Domanín Fm.		
	Vrábče "Beds".	Dobrkovská Lhotka	Wieliczka-Viehhausen
	Mydlovary Fm.	Mydlovary, Ledenice, Hluboká, Kamenný Újezd	Frant. Lázně-Kleinleipisch
Early Miocene	Zliv Fm.	Nová Řeka	Eichelskopf-Wiesa, or Bílina-Brandis
Coniacian–Santonian	Lipnice Fm.	Lipnice	
	Klikov Fm.	Klikov, Zahájí	

affinities to the flora of Františkovy Lázně (Cheb Basin; Holý 1977b) and the Cypris Formation in general. However, in addition to the mastixioids, new "younger" Badenian elements *Magnolia liblarensis*, *Smilax sagittifera* and *Illipophyllum thomsonii* appear for the first time in the Bohemian Tertiary (Knobloch & Kvaček 1996) and stress the Middle Miocene age of the Mydlovary Formation.

The next unit is the Domanín Formation, which deposited after the fall of tektites (moldavites) in the Třeboň Basin. The stratigraphical position of various moldavites-bearing sediments varies and partly remains questionable (Ševčík *et al.* 2007). Bouška (1972) estimated a Neogene to Early Quaternary age for these sediments. The oldest moldavites-bearing unit called the Vrábče Beds *sensu* Žebera (1967) can partly be interpreted as a lateral equivalent of the lowest part of the Domanín Formation (Bouška 1972). Ševčík *et al.* (2007) described a new mastixioid florula from the Vrábče Beds (locality Dobrkovská Lhotka near Trhové Sviny), which includes *Pinus hampeana*, *Carya globosa*, *Diplopanax limnophilus* and *Eomastixia saxonica*. This spectrum corresponds to the Middle Badenian flora of Wieliczka near Kraków, Poland (Łańcucka-Środoniowa & Zastawniak 1997) and to the Floristic Assemblage Kleinleipisch-Klettwitz *sensu* Mai (1995). The preservation of in situ moldavites precludes a long time span between the rain of moldavites (the Ries Event 14.5–15.0 Ma; Bouška & Konta 1987) and their re-deposition into the Vrábče Beds. This is in agreement with the age suggested by the palaeofloristic correlation. Deposits of the Domanín Formation itself and the much younger Ledenice Formation have yielded no evidence of plant macrofossils. The latter mentioned formation has been dated to the Pliocene on the basis of palynological data (Pacltová 1963) and diatoms (Řeháková 1963).

Table 11. Summary of the floristic composition of the Hrádek part of the Zittau Basin. Abbreviations: BCS – Basal Coal Seam *s. l.*, LCS – Lower Coal Seam *s. l.*, MCS – Middle Coal Seam *s. l.*, UCS – Upper Coal Seam *s. l.*, C – cone, F – fruit, L – leaf, S – seed, O – organs, A – Hrádek part of the Zittau Basin, B – Loučeň Formation, C – Hrádek Formation.

Taxa	O	A			
		B	C		
		BCS	LCS	MCS	UCS
Acer tricuspidatum	L				*
Alnus julianiformis	L				*
Alnus lusatica	F			*	
Ampelopsis ludwigii	S		*		*
Ampelopsis rotundata	S				*
Calamus daemonorhops	T		*	*	*
Cathaya multiserialis	L				*
Cinnamomum lusaticum	F				*
Cupressospermum saxonicum	C				*
Daphnogene polymorpha	L				*
Decodon gibbosus	S		*		*
Diplopanax limnophilus	F				*
Distylium uralense	S		*		*
Dulichium marginatum	F				*
Engelhardia orsbergensis	L				*
Eomastixia saxonica	F				*
Epipremnites ornatus	S				*
Eurya stigmosa	S	*	*		*
Fagus decurrens	F				*
Fagus menzelii	L				*
Fraxinus bilinica	L				*
Glyptostrobus europaeus	C	*	*	*	*
Gordonia hradekensis	L				*
Hypericum septestum	S				*
Ilex saxonica	S				*
Ilex wiesaensis	S				*
Illicium germanicum	F				*
Laurophyllum pseudoprinceps	L				*
Laurophyllum pseudovillense	L				*
Laurophyllum rugatum	L				*
Laurus abchasica	L				*
Leucothoë maii	F				*
Liquidambar europaea	F				*
Magnolia burseracea	S		*	*	*
Magnolia kristinae	L				*
Mastixia lusatica	F				*
Meliosma wetteraviensis	F		*	*	*
Microdiptera parva	S				*
Microdiptera uralensis	S			*	*
Mneme donata	S				*
Myrica ceriferiformis	F		*	*	*
Myrica ceriferiformoides	F	*	*	*	*
Myrica pseudointegerrima	L				*
Nymphaeaceae gen. et sp. indet.	S		*		*
Nyssa ornithobroma	F		*	*	*
Ocotea hradekensis	L				*
Ocotea rhenana	F				*
Potamogeton heinkei	F				*
Potamogeton nochtensis	F		*		*
Potamogeton wiesaensis	F		*		*
Pronephrium stiriacum	L				*
Proserpinaca reticulata	F		*		*
Pterocarya limburgensis	F		*		*
Quasisequoia couttsiae	C		?*	?*	*
Quercus rhenana	L				*
Retinomastixia schultei	F				*
Rubus sp. div.	F	*	*	*	*
Salix varians	L				*
Sapium germanicum	S				*
Sequia abietina	C		*	*	?*
Sparganium camenzianum	F	*	*	*	*
Spirematospermum wetzleri	S		*	*	
Symplociphyllum weylandii	L				*
Symplocos casparyi	F		*	*	*
Symplocos lignitarum	F		*		*
Symplocos minutula	F				*
Symplocos pseudogregaria	F				*
Symplocos schereri	F				*
Tectocarya elliptica	F				*
Ternstroemia chandlerae	S				*
Tetraclinis salicornioides	L				*
Tetrastigma lobata	S				*
Tilia sp.	F		*		*
Toddalia mai	S				*
Trema lusatica	F				*
Trigonobalanopsis exacantha	F			*	*
Trigonobalanopsis rhamnoides	L				*
Tsuga schneideriana	L				*
Turpinia ettingshausenii	S				*
Viscum morlotii	L				*
Vitis parasilvestris	S				*
Zanthoxylum kristinae	S				*

Palaeoclimatical signals of macrofloras in the studied areas

New palaeoclimatic methodologies, *i.e.* CLAMP, CA and Ecophysiological methods, help to estimate more objectively climatic evolution during the Tertiary (see "Material and methods" above). These aproaches are based on a refined understanding of the fossil plant assemblages. An Early Palaeogene climatic optimum from the Late Palaeocene to Early Eocene in Europe shows almost a tropical character. The MAT is expected to have attained 20–25 °C based on palaeoclimatic analysis of the London Clay (Collinson 1983) and Belleu floras (Kvaček 2006). Kaolin deposits underlying the Staré Sedlo Formation in the area of Karlovy Vary probably developed during this period. A gradual decrease of MAT towards a subtropical humid regime is typical of the Middle to Late Eocene time interval.

Table 12. Summary of the floristic composition of the selected localities in the fluvial sedimentary relicts from the vicinity of Plzeň and of the České Budějovice and Třeboň basins. Abbreviations: By – locality Býkov, C – cone, F – fruit, L – leaf, S – seed, Sp – spore, O – organs,. A – České Budějovice and Třeboň basins, B – Fluvial sedimentary relicts in the vicinity of Plzeň, C – Zliv Formation, D – Mydlovary Formation, E – Vrábče Beds, F – Dobříč, G – Zruč, H – Žichlice, I – Horní Bříza.

Taxa	O	A			B			
		C	D	E	F	G	H	I
Acer integrilobum	L		*					*
Acer tricuspidatum	L	*	*					
Ailanthus confucii	F		*					
Alnus julianiformis	L		*					
Betula sp.	L		*					
Buxus pliocaenica	L							*
Carpinus grandis	L							*
Carpinus neilreichii	F		*					*
Carya globosa	F			*				
Carya serrifolia	L		?					*
Chamaerops cf. *humilis*	L							*
Cedrelospermum sp.	L							?
Celtis purkynei	L							*
Ceratophyllum dubium	L		*					
Comptonia oeningensis	L		*					
Daphnogene cinnamomifolia	L				*			
Daphnogene polymorpha	L	?	*				*	
Decodon gibbosus	S							
Dicotylophyllum dieteri	L		*					
Diplopanax limnophilus	F			*				
Dombeyopsis lobata	L	*						
Dulichium marginatum	F							
Engelhardia orsbergensis	L		*				*	
Eomastixia saxonica	F		*	*				
Epipremnites ornatus	S							
Eurya stigmosa	S		*					
Fagus menzelii	L							*
Ginkgo adiantoides	L							*
Glyptostrobus europaeus	C, L		*			?	?	?
Gordonia hradekensis	L							*
Illipophyllum cf. *thomsonii*	L		*					
Keteleeria sp.	L		*					
Laurophyllum acutimontanum	L				*			
Laurophyllum pseudoprinceps	L		*		*			
Laurophyllum pseudovillense	L							*
Laurophyllum rugatum	L		*					
Laurus abchasica	L		*					
Leguminosae gen. et sp. indet.	L		*				*	*
Liquidambar europaea	F, L	?	*			*		
Majanthemophyllum petiolatum	L		*					
Majanthemophyllum plznense	L				*			
Magnolia kristinae	L							
Magnolia liblarensis	L		*					
Mastixia amygdalaeformis	F		*					
Myrica cestmiri	F		*					
Myrica lignitum	L		*					
Myrica vindobonensis	L		*					
Nerium sp.	L		*					
Nymphaeaceae gen. et sp. indet	S		*					
Nyssa bilinica	L	*				*		
Nyssa ornithobroma	F		*					
Ocotea hradekensis	L		*					
Osmunda parschlugiana	L		*					
"*Parrotia*" *pristina*	L							*
Pinus sp.	L		*					*
Pinus sp.	S		*					*
Pinus hampeana	C			*				
Pinus cf. *urani*	C		*			*By		
Platanus leucophylla	L							*
Platanus neptuni	L				*			
Populus cf. *balsamoides*	L		*					
Populus populina	L		*					*
Potamogeton schenkii	F		*					
Pronephrium stiriacum	L		?					
"*Punica*" *antiquorum*	F		*					
Quasisequoia couttsiae	C				*			
Quercus cf. *drymeja*	L		*					*
Quercus kubinyii	L		*					*
Quercus pseudocastanea	L							*
Quercus rhenana	L	*						
Rosa styriaca	L							?
Salix varians	L		*				*	*
Salvinia cerebrata	Sp		*					
"*Sapindus*" *falcifolius*	L							*
Smilax sagittifera	L		*					
Sparganium camenzianum	F							
Spirematospermum wetzleri	S		*					
Stratiotes kaltennordheimensis	S		*					
Symplocos (?) *erwinii*	L							*
Symplocos lignitarum	F		*					
Tectocarya elliptica	F		*					
Tilia longibracteata	F		*					*
Trigonobalanopsis rhamnoides	L		*					
Tsuga schneideriana	L		?					
Ulmus plurinervia	L							*
Woodwardia muensteriana	L		*					
Zelkova zelkovifolia	L		*					*
Ziziphus paradisiaca	L		*					

The CLAMP and CA datasets obtained from the floras of the Staré Sedlo Formation show decreasing MAT (*i.e.* 21.3 °C for CLAMP and 15.7–23.9 °C for CA – Uhl *et al.* 2007) under still humid precipitation regime. Similar palaeoclimatic proxies have been suggested for the Middle to Late Eocene floras (*e.g.*, Geiseltal in the Weisselster Basin, Germany – see in Mai 1995). The floras from the Doupovské hory Mts (locality Valeč) and from the České středohoří (localities Roudníky, Bechlejovice, Kundratice) document a distinct decreasing of MAT at the Eocene/Oligocene boundary, which corresponds to an enormous immigration of riparian deciduous broad-leaved elements from Asia to Europe.

Kvaček & Walther (2004) published palaeoclimatic proxies based on the CLAMP and CA analyses from the locality Bechlejovice, *i.e.* MAT = 16.4 ± 1.17 °C, CMMT = 8.4 ± 1.88 °C and WMMT = 25.5 ± 1.58 °C for CLAMP and MAT = 15.3–16.6 °C, CMMT = 10.0–10.2 °C, WMMT = 24.3–27.0 °C and MAP = 979–1250 mm for CA. These values correspond to the warm temperate zone. The re-appearance of the thermophilous elements (*e.g.*, palms) is connected with the warming trend, which began in the Early Oligocene continuing through Oligocene (floras of Suletice, Holý Kluk, Markvartice, Veselíčko and Vernéřice) and culminating in a subtropical climate character in the Late Oligocene (Počerny, Podlesí). Such climatic conditions were optimal for the development of coal-forming vegetation (coal seams in the Sokolov Basin and České středohoří Mts).

The beginning of the Early Miocene is characterized by a slight cooling event and the re-appearence of humid warm temperate climate. This change is proved by the CLAMP datasets from the "Hlavačov Gravel and Sand", MAT = 8.7 °C (Teodoridis 2004). This short-lasting climatic crisis was soon replaced by a gradual increase of temperature during the Early Miocene, as revealed by the CLAMP and CA datasets of Břešťany, *i.e.* MAT = 16.5 ± 1.17 °C, CMMT = 5.7 ± 1.88 °C and WMMT = 27.2 ± 1.58 °C for CLAMP, and MAT = 16.5-17.0 °C, CMMT = 9.6-11.7 °C, WMMT = 26.4-26.8 °C and MAP = 1194–1281 mm for CA (Teodoridis *et al.* 2006). Also, increase of atmospheric CO_2 concentration (Kuerschner & Kvaček 2006) during the deposition of the Libkovice Member of the Most Formation corroborates the Early Miocene optimum (*e.g.*, Teodoridis & Kvaček 2006, Sakala 2007). This time period was optimal for expansion of coal-forming vegetation in the areas of the Cheb, Sokolov and Most basins.

The Early Miocene Climate optimum reached climate parameters close to the recent subtropical climatic conditions at the end of the Early Miocene and the beginning of the Middle Miocene. The mastixioid floras are known from the whole area of Central Europe, *i.e.* from the upper part of the Sokolov and Cypris Formations, the upper part of the Libkovice Member of the Most Formation, the Upper Coal Seam *s. l.* of the Hrádek Formation and the Mydlovary Formation in the Bohemian Massif. Subsequent climate deteriorations, cooling trends expressed in changes of vegetation can be traced in various places of Central Europe at different time intervals. Hence, these changes had diachronic character (Kvaček *et al.* 2006a, Kovar-Eder *et al.* in press) gradually starting during the Middle Miocene. This event is manifested by predominance of deciduous woody elements, *e.g.*, in the flora of Horní Bříza (Němejc *et al.* 2003).

In addition, the floras of southern Moravia from the Late Miocene (Kvaček *et al.* 2006a) or the Late Neogene floras from Rhineland (Belz & Mosbrugger 1994) show similar trends. The cooling culminated in the Late Pliocene during to first "glacial" event and has been documented in the flora of the Vildštejn Formation from the Cheb Basin (Bůžek *et al.* 1985). The older flora of the Vonšov Member (Early Pliocene) still shows aspects of a temperate climate. However, the overlying flora of the Nová Ves Member bound to the "Nero" Clay indicates a cold temperate climate connected with the "Praetiglian" cooling event. The coal-forming vegetation of Nová Ves corresponds to an extant bog vegetation, as indicated by *Picea omoricoides*, *Pinus sylvestris, Vaccinium oxycoccos* and *Menyanthes* cf. *trifoliata*. It is climatically characterized by MAT = 8–12 °C (Bůžek *et al.* 1985). A similar climatic character of the Late Pliocene is also known from eastern Europe, *e.g.*, the flora of Dvorec near Dnieper (Velichkevich 1990). The areas of western and southern Europe demonstrate less severe cooling trends and a gradual transition to the Quaternary due to the influences of an oceanic climatic regime (Augusti *et al.* 2006).

The above mentioned climatic trends during the Tertiary (summarised in Mosbrugger *et al.* 2005) correspond well to the temperature changes based on geochemical analysis of oxygen stable isotopes from deep-sea profiles (Shackleton 1984) and modern analyses of the mammalian tooth enamels from terrestrial environments (Zanazzi *et al.* 2007). Causes of these oscillations are so far not well understood. Former hypotheses tried to explain these changes as consequences of global and palaeogeographical changes. Modern ideas stress the influence of greenhouse effect in the palaeoatmosphere (Pagani *et al.* 2005, Bowen 2007).

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References

AMBROŽ, V. 1958. Chebská pánev. *Časopis pro mineralogii a geologii 3*, 178–190.

AUGUSTI, J., OMS, O. & MEULENKAMP, J.E. 2006. Late Miocene to Early Pliocene environment and climate change in the Mediterranean area. *Palaeogeography, Palaeoclimatology, Palaeoecology 238*, 1–427.

BEERLING, D.J. 1999. Stomatal density and index: theory and application, 251–256. *In* JONES, T.P. & ROWE, N.P. (eds) *Fossil plants and spores: modern technique*. Geological Society of London, London.

BELZ, G. & MOSBRUGGER, V. 1994. Systematisch-paläoökologische und paläoklimatische Analyse von Blattfloren im Mio/Pliozän der

Niederrheinischen Bucht. *Palaeontographica, Abteilung B 233*, 19–156.

BOUŠKA, V. 1972. Geology of the moldavite-bearing sediments and the contributions of moldavites. *Acta Universitatis Carolinae, Geologica 1972(1)*, 1–29.

BOUŠKA, V. & KONTA, J. 1987. Moldavites. Vltavíny. *Acta Universitatis Carolinae, Geologica 1986(1)*, 1–128.

BOWEN, G.J. 2007. When the world turned cold. *Nature 445(8)*, 607–608.

BRABENEC, B. 1904. O novém nalezišti třetihorních rostlin ve spodním pásmu vrstev žateckých. *Rozpravy České Akademie císaře Františka Josefa pro vědy, slovesnost a umění v Praze 13(2),* 1–25.

BRONGNIART, A. 1828. Prodrome d'une histoire des végétaux fossiles. *Dictionaire des sciences naturelles 57*, 16–212.

BŮŽEK, Č. 1971. Tertiary flora from the northern part of the Pětipsy area (North-Bohemian basin). *Rozpravy Ústředního ústavu geologického 36*, 1–118.

BŮŽEK, Č. 1984. Návrh na ochranu lokality Hradiště u Černovic na Chomutovsku. *Památky, příroda, život, Vlastivědný čtvrtletník Chomutovska 16(2),* 40-54.

BŮŽEK, Č., ČTYROKÝ, P., FEJFAR, O. & KVAČEK, Z. 1987. Přínos paleontologie pro poznání severočeské pánve, 70–87. *In* BRUS, Z., ELZNIC, A., HURNÍK, S. & ZELENKA, O. (eds) *Geologie oblasti, XXVI. Celostátní konference ČSMG.* Most.

BŮŽEK, Č., ČTYROKÝ, P., FEJFAR, O., KONZALOVÁ, M. & KVAČEK, Z. 1988. Biostratigraphy of Tertiary coal-bearing deposits of Bohemia and Moravia (C. S. R.), 291–305. *In* PEŠEK, J. & VOZÁR, J. (eds) *Coal-bearing formations of Czechoslovakia.* Dionýz Štúr Institute of Geology, Bratislava.

BŮŽEK, Č., DVOŘÁK, Z., KVAČEK, Z. & PROKŠ, M. 1990a. Tertiary vegetation and depositional environmments of the "Bílina delta" in the North-Bohemian brown-coal Basin. *Časopis pro mineralogii a geologii 37(2)*, 117–134.

BŮŽEK, Č., FEJFAR, O., KONZALOVÁ, M. & KVAČEK, Z. 1990b. Floristic changes around Stehlin's Grande Coupure, 167–181. *In* KNOBLOCH, E. & KVAČEK, Z. (eds) *Proceedings of the Symposium Palaeofloristic and Palaeoclimatic changes in the Cretaceous and Tertiary, Prague 1989.* Geological Survey, Prague.

BŮŽEK, Č. & HOLÝ, F. 1964. Small-sized plant remains from the Coal Formation of the Chomutov-Most-Teplice Basin. *Sborník geologických věd, Paleontologie 4*, 105–138.

BŮŽEK, Č., HOLÝ, F., KONZALOVÁ, M., KVAČEK, Z. & STUCHLIK, L. 1982. Paleobotanická data k biostratigrafii a korelaci uloženin chebské pánve. *Acta montana 60*, 49–82.

BŮŽEK, Č., HOLÝ, F. & KVAČEK, Z. 1968. Die Gattung *Doliostrobus* Marion und ihr Vorkommen im nordböhmischen Tertiär. *Palaeontographica, Abteilung B 123*, 153–172.

BŮŽEK, Č., HOLÝ, F. & KVAČEK, Z. 1976. Tertiary flora from the Volcanogenic Series at Markvartice and Veselíčko near Česká Kamenice (České Středohoří Mts.). *Sborník geologických věd, Paleontologie 18*, 69–132.

BŮŽEK, Č., HOLÝ, F. & KVAČEK, Z. 1987. Evolution of main vegetation types in the Lower Miocene of NW Bohemia, 150–161. *In* POKORNÝ, V. (ed.) *Contribution of Czechoslovak Palaeontology to Evolutionary Science, 1945–1985.* Univerzita Karlova, Praha.

BŮŽEK, Č., HOLÝ, F. & KVAČEK, Z. 1996. Early Miocene flora of the Cypris Shale (western Bohemia). *Acta Musei nationalis Pragae, Series B – historia naturalis 52,* 1–72.

BŮŽEK, Č., HOLÝ, F., KVAČEK, Z. & KONZALOVÁ, M. 1969. Zpráva o nálezech rostlinných zbytků ve vrtu 4359 Velký Luh v chebské pánvi. *Zprávy o geologických výzkumech v roce 1968*, 172–173.

BŮŽEK, Č., KONZALOVÁ, M. & KVAČEK, Z. 1971. The genus *Salvinia* from the Tertiary of the North-Bohemian Basin. *Sborník geologických věd, Paleontologie P 13,* 179–222.

BŮŽEK, Č. & KVAČEK, Z. 1966. Zpráva o geologickém výzkumu v hroznětínské části sokolovské pánve. *Zprávy o geologických výzkumech v roce 1964,* 259–260.

BŮŽEK, Č., KVAČEK, Z. & HOLÝ, F. 1985. Late Pliocene palaeoenvironment and correlation of the Vildštejn floristic complex within Central Europe. *Rozpravy ČSAV, Řada matematicko-přírodních věd 95*, 1–72.

BURGH, J. VAN DER, VISSCHER, H., DILCHER, D.L. & KUERSCHERN, W. 1993. Palaeoatmospheric signatures in Neogene fossil leaves. *Science 260*, 1788–1790.

CAJZ, V. 2000. Proposal of lithostratigraphy for the České středohoří Mts volcanics. *Bulletin of the Czech Geological Survey 75*, 7–16.

COLLINSON, M. 1983. Fossil plants of the London Clay. London. *Palaeontological Association Field Guides to Fossils 1*, 1–121.

CZAJA, A. 2003. Paläokarpologische Untersuchungen von Taphozönosen des Unter- und Mittelmiozäns aus dem Braunkohlentagebau Berzdorf/Oberlausitz (Sachsen). *Palaeontographica, Abteilung B 265*, 1–148.

DOMÁCÍ, L. 1977. Litostratigrafie třetihorních sedimentů v hnědouhelné severočeské pánvi. *Acta Universitatis Carolinae, Geologica 1975(1)*, 75–80.

ENGELHARDT, H. 1879. Ueber die Cyprisschiefer Nordböhmens und ihre pflanzliche Einschlüsse. *Sitzungsberichte der naturwissenschaftlichen Geselschaft Isis 3–4*, 1–22.

ETTINGSHAUSEN, C. V. 1866. Die fossile Flora des Tertiärbeckens von Bilin I. *Denkschriften der kaiserlichen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Klasse 28*, 1–98.

ETTINGSHAUSEN, C. v. 1868. Die fossile Flora des Tertiärbeckens von Bilin II. *Denkschriften der kaiserlichen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Klasse 28*, 191–242.

ETTINGSHAUSEN, C. V. 1869. Die fossile Flora des Tertiärbeckens von Bilin III. *Denkschriften der kaiserlichen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Klasse 29*, 1–110.

HAIDINGER, W. 1839. Ueber das Vorkommen von Pflanzenreste in den Braunkohlen- und sandsteingebirge des Elbogner Kreises in Böhmen. *Abhandlungen der Böhmischen Gesellschaft der Wissenschaften, Serie V, 1*, 1–12.

HIRSCH, D., RASCHER, J. & SCHULZ, H. 1987. Geologische Einführung in das Exkursiongebiet „Die Braunkohlenlagerstätten der Oberlausitz, Tertiärbecken von Berzdorf und Zittau". Exkursion-Führer. *Veröffentlichungen der Gesellschaft der geologischen Wissenschaften 152,* 1–20.

HOLÝ, F. 1963. Zpráva o paleontologickém a stratigrafickém výzkumu v třetihorách severočeské hnědouhelné pánve. *Zprávy o geologických výzkumech v roce 1962,* 169–170.

HOLÝ, F. 1974. *Neogénní mastixioidní květena svrchního slojového pásma z lomu Kristina (Hrádek n. N.).* 131 pp. Ph.D. Thesis, National Museum, Prague.

HOLÝ, F. 1977a. On some new species from the Mastixiaceae-flora taphocenose from the Miocene near Hrádek nad Nisou (Zittau Basin, North Bohemia). *Acta Musei nationalis Pragae, Series B – historia naturalis 31(3–5)*, 109–122.

HOLÝ, F. 1977b. Representatives of the family Mastixiaceae Calestani 1905 in the Bohemian Tertiary. *Acta Musei nationalis Pragae, Series B – historia naturalis 31(3–5),* 123–147.

HOLÝ, F. 1978. The assemblage of autochthonous coal plant-remains from the Miocene near Hrádek nad Nisou (Zittau Basin, North Bohemia). *Acta Musei nationalis Pragae, Series B – historia naturalis 32(1)*, 1–13.

HOLÝ, F. 1984. *Mastixia venosa* (Presl in Sternberg 1838) comb. n. – ex strato vulcanico temporis oligocaeni de Bohemia occidentali-species noviter rehabilitata. *Acta Universitatis Carolinae, Geologica 1982(4)*, 457–470.

HUBER, K.H. 2003. Some field observations and remarks on the Gmünd Beds of the nordwestern Waldviertel Region (Lower Austria). *Jahrbuch der geologischen Bundesanstalt 143,* 543–566.

HURNÍK, S. 2001. Zavátá minulost Mostecka. *Sborník Okresního muzea v Mostě, Řada přírodní 23,* 1–139.

HURNÍK, S. & KNOBLOCH, E. 1966. Einige Ergebnisse paläontologischer und stratigraphischer Untersuchungen im Tertiär Böhmens. *Abhandlungen des Staatlichen Museums für Mineralogie und Geologie zu Dresden 11*, 17–161.

HURNÍK, S. & KVAČEK, Z. 1999. Satellite basin of Skyřice near Most and its fossil flora (Miocene). *Acta Universitatis Carolinae, Geologica 1999, 43(4),* 642–656.

HURNÍK, S. & MAREK, D. 1962. Ke stratigrafii severočeského terciéru na východ od Doupovských hor. *Časopis pro mineralogii a geologii 7*, 35–41.

KETTNER, R. 1911. O uloženinách třetihorních štěrků a jílů u Sloupu a Klínce ve středních Čechách. *Věstník Královské České společnosti nauk, Třída matematicko-přírodovědecká 1911*, 1–9.

KLOMÍNSKÝ, J. 1994. *Geologický atlas České republiky. Stratigrafie. Geological atlas of the Czech Republic. Stratigraphy*. Český geologický ústav, Praha.

KNOBLOCH, E. 1971. Die tertiäre Flora von Seussen und Pilgramsreuth (Nordbayern). *Erlangener geologische Abhandlungen 87*, 1–26.

KNOBLOCH, E., KONZALOVÁ, M. & KVAČEK, Z. 1996. Die obereozäne Flora der Staré Sedlo-Schichtenfolge in Böhmen (Mitteleuropa). *Rozpravy Českého geologického ústavu 49,* 1–260.

KNOBLOCH, E. & KVAČEK, Z. 1996. Miozäne Floren der südböhmischen Becken. *Sborník geologických věd, Paleontologie 33,* 39–77.

KONZALOVÁ, M. 1976. Micropalaebotanical (palynological) research of the Lower Miocene of Northern Bohemia. *Rozpravy Československé akademie věd, řada matematických a přírodních věd 86(12)*, 1–75.

KONZALOVÁ, M. & ZIEMBIŃSKA-TWORZYDŁO, M. 1999. Nová data pro stáří bazální sedimentace v nejvýchodnější části oherského riftu z území české a polské části žitavské pánve. *Zprávy o geologických výzkumech v roce 1998*, 102–103.

KONZALOVÁ, M. & ZIEMBIŃSKA-TWORZYDŁO, M. 2000. Mikropaleontologický výzkum nejvýchodnější části oherského riftu, české a polské části žitavské pánve. *Zprávy o geologických výzkumech v roce 1999*, 150–153.

KOVAR-EDER, J., JECHOREK, H., KVAČEK, Z. & PARASHIV, V. In press. The integrated plant record to reconstruct Neogene zonal vegetation in Europe. *Palaios, February 2008 issue.*

KOVAR-EDER, J., KVAČEK, Z. & MELLER, B. 2001. Comparing Early to Middle Miocene floras and probable vegetation types of Obendorf N Voitsberg (Austria), Bohemia (Czech Republic), and Wackersdorf (Germany). *Review of Palaeobotany and Palynology 114,* 83–125.

KUERSCHNER, W.M. & KVAČEK, Z. 2006. C4 plant and climate evolution linked to Miocene CO_2. *Abstracts, Advances in Palaeobotany, recognizing the contribution of David L. Dilcher and Jack A. Wolfe on the occasion of their 70th year, March 12–15, 2006, Gainesville*, p. 39.

KVAČEK, Z. 1971. Fossil Lauraceae in the stratigraphy on the North Bohemian Tertiary. *Sborník geologických věd, Paleontologie 13,* 47–86.

KVAČEK, Z. 1984. Tertiary taxads of NW Bohemia. *Acta Universitatis Carolinae, Geologica 1982(4),* 471–491.

KVAČEK, Z. 2002. Late Eocene landscape, ecosystems and climate in north Bohemia with particular reference to the locality Kučlín near Bílina. *Bulletin of the Czech Geological Survey 77*, 217–236.

KVAČEK, Z. 2003. Aquatic Angiosperms of the Early Miocene Most Formation of the North Bohemia (Central Europe). *Courier Forschungsinsitut Senckenberg 241*, 255–279.

KVAČEK, Z. 2006. Vegetation of the European Eocene – state of the art, 76. *In* TEODORIDIS, V., KVAČEK, Z. & KVAČEK, J. (eds) *Abstracts, 7th European palaeobotany palynology conference*, *Prague*, *September 6–12, 2006.* National Museum, Prague.

KVAČEK, Z., BÖHME, M., DVOŘÁK, Z., KONZALOVÁ, M., MACH, K. PROKOP, J. & RAJCHL, M. 2004. Early Miocene freshwater and swamp ecosystems of the Most Basin (north Bohemia) with particular reference to the Bílina Mine section. *Journal of the Czech Geological Society 49(1–2),* 1–40.

KVAČEK, Z. & BŮŽEK, Č. 1966. Einige interessante Lauraceen und Symplocaceen des nordböhmischen Tertiärs. *Věstník Ústředního ústavu geologického 41,* 291–294.

KVAČEK, Z. & BŮŽEK, Č. 1982. *Třetihorní rostlinná společenstva severočeské hnědouhelné pánve ve vztahu k litofaciálnímu vývoji.* 46 pp. Výzkumná zpráva, Ústav geologie a geotechniky ČSAV, Ústřední ústav geologický, Praha.

KVAČEK, Z. & BŮŽEK, Č. 1995. Endocarps and foliage of the flowering plant family Icacinaceae from the Tertiary of Europe. *Tertiary Research 15(3)*, 121–138.

KVAČEK, Z. & HURNÍK, S. 2000. Revision of Miocene plants preserved in baked rocks in the North Bohemian Tertiary. *Acta Musei nationalis Pragae, Series B – historia naturalis 56(1–2)*, 1–48.

KVAČEK, Z., KOVÁČ, M., KOVAR-EDER, J., DOLÁKOVÁ, N., JECHOREK, H., PARASHIV, V., KOVÁČOVÁ, M. & SLIVA, L. 2006a. Miocene evolution of landscape and vegetation in the Central Paratethys. *Geologica Carpathica 57(4)*, 295–310.

KVAČEK, Z., MACH, K., SAKALA, J. & ROJÍK, P. 2006b. Tertiary basins and volcanic complexes, 16–24. *In* FATKA, O. & KVAČEK, J. (eds) *Excursion field guide of the 7th EPPC, Prague September 6–12, 2006.* National Museum, Prague.

KVAČEK, Z., ROJÍK, P. & SAKALA, J. 2006c. Tertiary of NW Bohemia, 66–75. *In* FATKA, O. & KVAČEK, J. (eds) *Excursion field guide of the 7th EPPC, Prague September 6–12, 2006.* National Museum, Prague.

KVAČEK, Z. & WALTHER, H. 1995. The Oligocene volcanic flora of Suletice-Berand near Ústí nad Labem, North Bohemia – a review. *Acta Musei nationalis Pragae, Series B – historia naturalis 50,* 25–54.

KVAČEK, Z. & WALTHER, H. 1998. The Oligocene volcanic flora of Kundratice near Litoměřice, České středohoří Volcanic complex (Czech Republic). *Acta Musei nationalis Pragae, Series B – historia naturalis 54,* 1–43.

KVAČEK, Z. & WALTHER, H. 2001. The Oligocene of Central Europe and the development of forest vegetation in space and time based on megafossils. *Palaeontographica, Abteilung B 159,* 125–148.

KVAČEK, Z. & WALTHER, H. 2003. Reconstruction of vegetation and landscape development during the volcanic activity in the České středohoří Mountains. *Geolines, Hibsch Special Volume 15*, 60–64.

KVAČEK, Z. & Walther, H. 2004. Oligocene flora of Bechlejovice at Děčín from the neovolcanic area of the České Středohoří Mountains, Czech Republic. *Acta Musei nationalis Pragae, Serie B – historia naturalis 60*, 9–60.

KVAČEK, Z., WALTHER, H. & BŮŽEK, Č. 1989. Paleogene floras of W. Bohemia (C. S. S. R.) and the Weisselster Basin (G. D. R.) and their correlation. *Časopis pro mineralogii a geologii 34,* 385–402.

ŁAŃCUCKA-ŚRODONIOWA, M. & ZASTAWNIAK, E. 1997. The Middle Miocene flora of Wieliczka. Revision of Jan Zablocki's collection. *Acta Palaeobotanica 37*, 17–49.

LOTSCH, D., AHRENS, H., KRETZSCHMAR, W., WALTHER, H., FISCHER, O. & HEINICKE, L. 1994. Gliederungsmöglichkeiten der Thierbacher Schichten nach Ergebnissen paläobotanischer Untersuchungen. *Hallesches Jahrbuch der Geowissenschaften 16*, 1–21.

MAI, D.H. 1995. *Tertiäre Vegetationsgeschichte Europas.* G. Fischer, Jena.

MAI, D.H. & WALTHER, H. 1978. Die Floren der Haselbacher Serie im Weißelster-Becken (Bezirk Leipzig, DDR). *Abhandlungen des Staatlichen Museums für Mineralogie und Geologie zu Dresden* 28, 1–200.

MAI, D.H. & Walther, H. 1991. Die oligozänen Floren NW – Sachsens und des Bitterfelder Raumes. *Abhandlungen des Staatlichen Museums für Mineralogie und Geologie zu Dresden* 38, 1–230.

MALECHA, A. 1985. Jihočeské pánve, 51–63. *In* CHÁBERA, S. (ed.) *Jihočeská vlastivěda. Řada A Přírodní vědy: Neživá příroda.* České Budějovice.

MALECHA, A., ŠPINAR, Z., BOŘKOVÁ-GABRIELOVÁ, N., MRÁZEK, A., NĚMEJC, F., PACLTOVÁ, B., ŘEHÁKOVÁ, Z. & SLÁNSKÁ, J. 1962. Nové dělení a označení stratigrafických jednotek jihočeských pánví. *Věstník Ústředního ústavu geologického 37,* 161–170.

MALKOVSKÝ, M. 1987. Problémy stratigrafie kontinentálního terciéru Českého masívu a severočeské hnědouhelné pánve, 62–64. *In* BRUS, Z. ELZNIC, A., HURNÍK, S. & ZELENKA, O. (eds) *Geologie oblasti – XXVI. celostátní konference ČSMG, Most 1987.* Geoindustria, Praha.

MALKOVSKÝ, M. 1995. Některé problémy chronostratigrafického členění terciéru Českého masívu. *Knihovnička Zemní plyn a nafta 16,* 25–36.

MOSBRUGGER, V. & UTESCHER, T. 1997. The coexistence approach – a method for quantitative reconstructions of Tertiary terrestrial palaeoclimate data using plant fossils. *Palaeogeography, Palaeoclimatolgy, Palaeoecology 134*, 61–86.

MOSBRUGGER, V., UTESCHER, T. & DILCHER, D.L. 2005. Cenozoic continental climatic evolution of central Europe. *Proceedings of the National Academy of Sciences of the United States of America 102(42)*, 14964–14969.

NĚMEJC, F. 1949. Rostlinné otisky středočeských neogenních ostrovů. *Studia Botanica Čechoslovaca 10(1–3),* 14–103.

NĚMEJC, F. 1956. Paleobotanická studie k otázce stratigrafie uloženin jihočeské pánve. (A palaeobotanical study of the question of the stratigraphy of the deposits of the South Bohemian Basin). *Sborník Ústředního ústavu geologického, Paleontologie 22*, 335–377.

NĚMEJC, F. 1962. Paleobotanicko-stratigrafické výzkumy v jihočeských pánvích. *Zprávy o geologických výzkumech v roce 1961*, 235–236.

NĚMEJC, F., KVAČEK, Z., PACLTOVÁ, B. & KONZALOVÁ, M. 2003. Tertiary plants of the Plzeň Basin (West Bohemia). *Acta Universitatis Carolinae, Geologica 2002, 46(4),* 121–176.

PACLTOVÁ, B. 1963. Palynologická charakteristika ledenického souvrství (svrchní pliocén) v třeboňské pánvi v jižních Čechách. *Sborník geologických věd, Geologie 2*, 7–55.

PAGANI, M., ZACHOS, J.C., FREEMAN, K.H., TIPPLE, B. & BOHATY, S. 2005. Marked decline in atmospheric carbon dioxide concentrations during the Paleogene. *Science 309,* 600–603.

PEŠEK, J. & SPUDIL, J. 1986. Paleogeografie středočeského a západočeského neogénu. *Studie Československé akademie věd 14-86*, 1–79.

PRAKASH, U., BŘEZINOVÁ, D. & AWASTHI, N. 1974. Fossil woods from the Tertiary of South Bohemia. *Palaeontographica, Abteilung B 147*, 107–123.

PROCHÁZKA, J.S. 1916. *Stratiotes (Carpolithes) Websteri* (Heer) Pot. a jiné rostliny z tercierních jílů klíneckých. *Věstník Královské České společnosti nauk, Třída matematicko-přírodovědecká 1916(4)*, 1–7.

PROCHÁZKA, M. 1954. Paleontologický výzkum chomutovské a pětipeské pánve. *Zprávy o geologických výzkumech v roce 1953*, 166–174.

RADOŇ, M. 2001. *Výzkum terciérních paleontologických lokalit v Českém středohoří.* Závěrečná zpráva programového projektu Ministerstva kultury ČR, Regionální muzeum v Teplicích, přírodovědecké oddělení, Teplice.

RADOŇ, M., KVAČEK, Z. & WALTHER, H. 2006. Oligocene megafossil plant remains and environment from the newly recovered locality of the Holý Kluk hill near Proboštov (České středohoří Mountains, Czech Republic). *Acta Universitatis Carolinae, Geologica 47,* 95–124.

REUSS, A.E. 1852. Die geognostischen Verhältnisse des Egerer Bezirkes und des Ascher Gebietes in Böhmen. *Abhandlungen der kaiserlich-königlichen geologischen Reichsanstalt 1,* 1–72.

ROJÍK, P. 2004. New stratigraphic subdivision of the Tertiary in the Sokolov Basin. *Journal of the Czech Geological Society 49*, 173–185.

ŘEHÁKOVÁ, Z. 1963. Jihočeské pánevní sedimenty ve světle diatomových analýz. *Věstník Ústředního ústavu geologického 38,* 311–323.

SAKALA, J. 2000. Flora and vegetation of the roof of the main lignite seam in the Bílina Mine (Most Basin, Lower Miocene). *Acta Musei nationalis Pragae, Series B – historia naturalis 56(1–2)*, 49–84.

SAKALA, J. 2007. The potential of the fossil angiosperm wood to reconstruct the palaeoclimate in the Tertiary of Central Europe (Czech Republic, Germany). *Acta Palaeobotanica 47*, 127–133.

SHACKLETON, N.J. 1984. Oxygen isotope evidence for Cenozoic climate change, 27–33. *In* BRENCHLEY, P. (ed.) *Fossils and climate*. John Wiley & sons Ltd., London.

SOUKUPOVÁ, H. 2004. *Vegetace a paleoekologie vybraných lokalit Českého středohoří*. 105 pp. M.Sc. thesis, Charles University, Prague, Czech Republic.

STERNBERG, K. v. 1820–1838. *Versuch einer geognostisch-*

botanischen Darstellung der Flora der Vorwelt. 1 (1820) 24 pp., 2 (1821) 33 pp., 3 (1823) 39 pp., 4 (1825) 48 pp., 5–6 (1833) 1–80 pp., 7–8 (1838) 81–220 pp. Fr. Fleischer, Leipzig.

SUHR, P. 2003. The Bohemian Massif as catchment area for the NW European Tertiary Basin. *GeoLines 15*, 147–159.

ŠEVČÍK, J., KVAČEK, Z. & MAI, D.H. 2007. A new mastixioid florula from tektite-bearing deposits in South Bohemia, Czech Republic (Middle Miocene, Vrábče Member). *Bulletin of Geosciences 82(4),* xx–xx.

TEODORIDIS, V. 2001. Further revision of Tertiary floras of Central Bohemia (the localities Na Bendovce /Sv. Antonín/ near Rakovník, Klínec upon Všenory and Na Sulavě near Černošice) *Bulletin of Czech Geological Survey 76(4)*, 243–252.

TEODORIDIS, V. 2002. Tertiary flora and vegetation of the Hlavačov gravel and sand and the surroundings of Holedeč in the Most Basin (Czech Republic). *Acta Musei nationalis Pragae, Series B – historia naturalis 57(3–4)*, 103–140.

TEODORIDIS, V. 2003a. Tertiary flora and vegetation of the locality Záhoří near Žatec (Most Basin, Czech Republic). *Bulletin of Czech Geological Survey 78(3)*, 261–276.

TEODORIDIS, V. 2003b. Early Miocene carpological material from the Czech part of the Zittau Basin. *Acta Palaeobotanica 43(1),* 9–49.

TEODORIDIS, V. 2004. Floras and vegetation of Tertiary fluvial sediments of Central and Northern Bohemia and their equivalents in deposits of the Most Basin (Czech Republic). *Acta Musei nationalis Pragae, Series B – historia naturalis 60(3–4)*, 113–142.

TEODORIDIS, V. 2006. Tertiary flora and vegetation of the locality Přívlaky near Žatec (Most Basin). *Acta Universitatis Carolinae, Geologica 2003, 47(1–4)*, 165–177.

TEODORIDIS, V. & KVAČEK, Z. 2006. Palaeobotanical research of the Early Miocene deposits overlying the main coal seam (Libkovice and Lom Mbs.) in the Most Basin (Czech Republic). *Bulletin of Geosciences 81(2)*, 93–113.

TEODORIDIS, V., KVAČEK, Z. & UHL, D. 2006. CLAMP and CA proxy data from the Lower Miocene of North Bohemia. 141. *In* TEODORIDIS, V., KVAČEK, Z. & KVAČEK, J. (eds) *Abstracts, 7th EPPC, Prague September 6–12, 2006*. National Museum, Prague.

UHL, D., KLOTZ, S., TRAISER, C., THIEL, C., UTESCHER, T., KOWALSKI, E. & DILCHER, D.L. 2007. Cenozoic paleotemperatures and leaf physiognomy – A European perspective. *Palaeogeography, Palaeoclimatolgy, Palaeoecology 248(1–2)*, 24–31.

VÁCHOVÁ, Z. 2007. *Paleoklimatická analýza křídové flóry z jihočeských pánví*. 65 pp. M.Sc. Thesis, Charles University, Prague.

VÁCL, J. & ČADEK, J. 1962. Geologická stavba hrádecké části Žitavské pánve. *Sborník Ústředního ústavu geologického, Oddíl geologický 27*, 331–383.

VÁNĚ, M. 1985. Geologické poměry neogénních hlavačovských štěrkopísků mezi Rakovníkem a Holedečem. *Sborník Severočeského muzea – Přírodní vědy, Liberec, 14*, 205–218.

VELENOVSKÝ, J. 1881. Die Flora aus den ausgebrannten tertiären Letten von Vršovic bei Laun. *Abhandlungen der Königlich Böhmischen Gesellschaft der Wissenschaften 6(11)*, 3–56.

VELICHKEVICH, F.Y. 1990. The Late Pliocene floras in Belorussia, 273–276. *In* KNOBLOCH, E. & KVAČEK, Z. (eds) *Proceedings of the symposium Palaeofloristic and palaeoclimatic changes in the Cretaceous and Tertiary, 1989*. Czech Geological Survey, Prague.

WALTHER, H. 1998. Die Tertiärflora von Hammerunterwiesenthal (Freistaat Sachsen). *Abhandlungen des Museums für Mineralogie und Geologie zu Dresden 43–44*, 239–364.

WALTHER, H. & KVAČEK, Z. In press. Early Oligocene flora of Seifhennersdorf (Saxony). *Acta Musei nationalis Pragae, Series B – historia naturalis*.

WÓJCICKI, J.J. & KVAČEK, Z. 2002. *Schenkiella* genus novum, thorny disseminules of unknown affinities from the Lower Miocene of Central Europe. *Acta Palaeobotanica 42(2)*, 109–116.

WOLFE, J.A. & SPICER, R.A. 1999. Fossil Leaf Character States: Multivariate Analysis, 233–239. *In* JONES, T.P. & ROWE, N.P. (eds) *Fossil Plants and Spores: Modern Techniques*. Geological Society, London.

ZANAZZI, A., KOHN, M.J., MACFADEN, B.J. & TERRY, D.O. 2007. Large temperature drop across the Eocene–Oligocene transition in central North America. *Nature 445*, 639–642.

ŽÁK, K., TEODORIDIS, V. & SAKALA, J. 2003. Nález flóry v terciérních sedimentech u Karlštejna. *Zprávy o geologickém výzkumu v roce 2002*, 47–50.

ŽEBERA, K. 1967. Moldavite-bearing sediments between Koroseky amd Holkov in South Bohemia. *Věstník Ústředního ústavu geologického 42,* 327–337.