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FLORAS AND VEGETATION OF TERTIARY FLUVIAL SEDIMENTS OF CENTRAL AND NORTHERN BOHEMIA AND THEIR EQUIVALENTS IN DEPOSITS OF THE MOST BASIN (CZECH REPUBLIC)

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Abstract. The present paper completely revises 9 floras from fluvial and 9 floras from deltaic sediments from the area of Central and Northern Bohemia. Based on palaeobotanical data, it attempts to show a new phytostratigraphical conception of these fluvial and deltaic sediments and their possible connection with the deposits from the Most Basin including phytostratigraphical correlation within the Czech Republic (the Most Basin and fluvial sediments of Central and Northern Bohemia), and Oligo-Miocene floristic assemblages from the Boreal Province of Europe (the Weisselster Basin, the Bitterfeld Basin and elsewhere). In addition, the paper sums up the existing geological and sedimentological data and information concerning reconstruction of the Tertiary river system in the Czech Republic and Saxony (South Germany). The paper focuses also on palaeoenvironmental interpretations of the vegetation cover in fluvial, deltaic and basin biotopes using CLAMP analysis. Finally, a possible palaeoenviromental reconstruction of the Žatec Delta during Late Oligocene to Early Miocene is presented.

■ Czech Republic; Saxony; Most Basin; correlation; phytostratigraphy, palaeoecology; fossil flora; fluvial sediments; Žatec Delta; Upper Oligocene, Lower Miocene

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Introduction

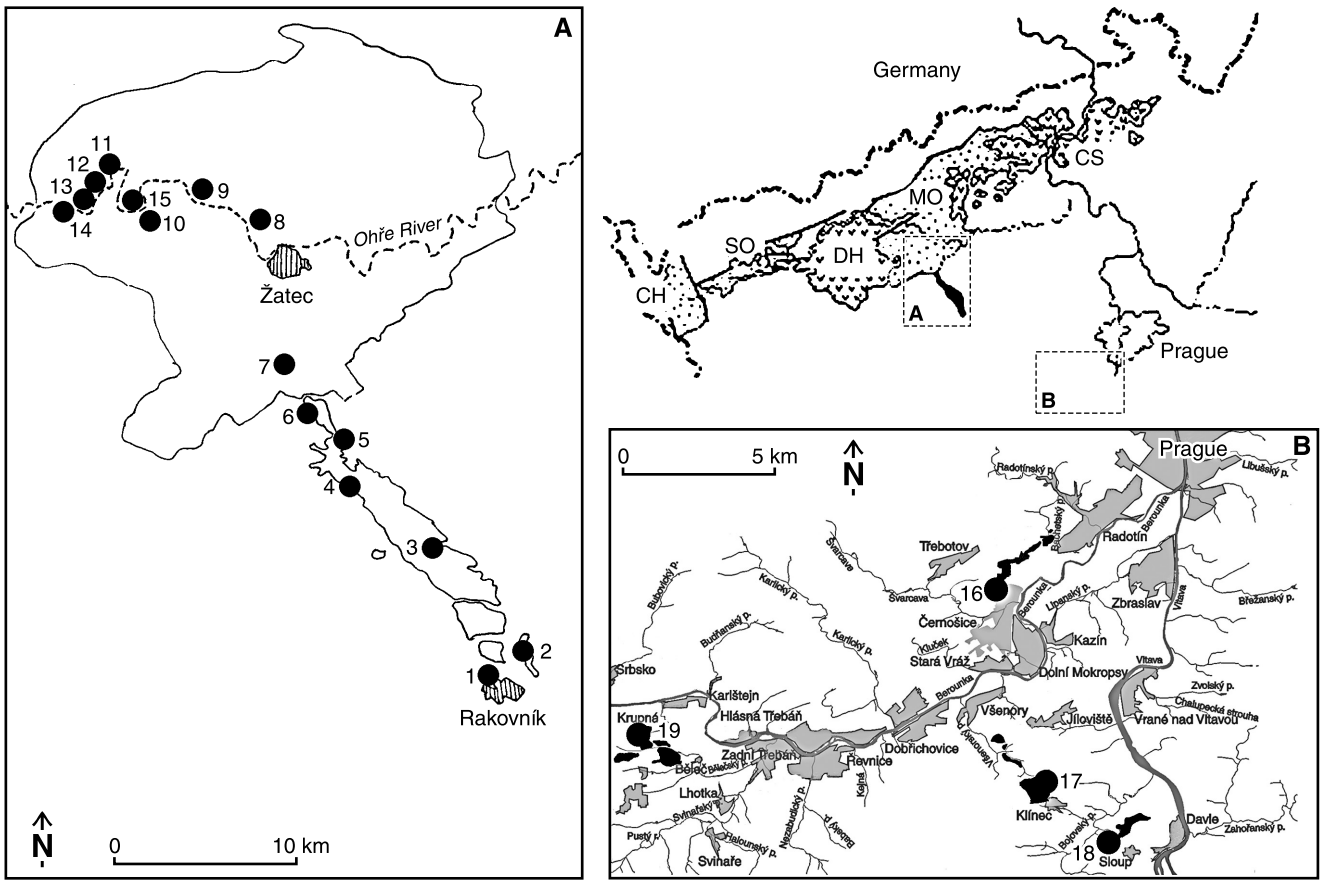
This work represents a slightly modified English version of the Ph. D. thesis of the author (Teodoridis 2003b). The paper is intended to provide a synhesis of palaeobotanical field investgations undertaken by the author from 1998 to 2003 in Central and Northern Bohemia (Teodoridis 2000, 2001, 2002, 2003a, in press, Sakala and Teodoridis 2001, Žák et al. 2003, Teodoridis and Kvaček in press). The aim of this study has been a detailed floristic revision of fluvial and deltaic floras of Central and Northern Bohemia in close cooperation with sedimentology, their correlation with deposits of the Most Basin and floristic assemblages of the Boreal Province of Europe. A new phytostratigraphical concept of the fluvial, delta and the Most Basin sediments is proposed, including a new palaeoenvironmental model of the Žatec Delta and reconstructions of vegetation cover of the fluvial, delta and basin biotopes.

Geology

The geological framework of the area presented below is based on earlier publications (e.g. Malkovský et al. 1985, Váně 1985, Brus et al. 1987, Mach 2002) as well as on own field data and consultations with M. Rajchl, K. Mach and K. Žák.

Geology of fluvial sediments from Central and Northern Bohemia

Isolated relics of Tertiary fluvial deposits occur in different parts of Central and Western Bohemia independently on the character of recent river system. The deposits consist mainly of sand, gravel and sandy intervals with irregularly distributed, variously thick lenses of clay or sandy clay, rarely containing any plant fossils. A detailed overview of the localities and the geology of fluvial relicts in Central Bohemia was given by Pešek and Spudil (1986) and Žák et al. (2001). Pešek and Spudil (1986) investigated mainly lithology of these sediments and characterized them only in the frame of the Central River (River "C") and its affluents D_1 and D_2. In addition, the preliminary report of Žák et al. (2003, fig. 2) presents a geographic overview of the fluvial relicts in Central Bohemia, and new data of the heavy minerals analysis in comparison with the older study (Čadek 1964, 1966). Žák et al. (2003) give also altitudes of these relics, which are important for their connection into fluvial system and their age. The fossiliferous relics at localities Klínec (U Slopu), Na Sulavě and the sandpit "U ručiček" are characterized below. to 4.3. Other, palaeobotanically "more or less sterile" fluvial remnants in Central and Western Bohemia were described, e.g. by Štorch in Barnet et al. (1991a, p. 16) – localities Mořina, Krupá and Běleč; Štorch in Barnet et al. (1991b, p. 17) – localities Komárov, Osek, Žebrák, Strašice and Netolice; Mašek, Straka and Havlíček in Barnet et al. (1997, p. 15) – localities Česká Bříza, Borské pole (Plzeň), Žichlice, Kyšice and Chlum (Hurník and Knobloch 1966, Němejc et al. 2003); Havlíček and Štorch in Brunnerová et al. (1992, p. 12) – localities Kobylisy and Zdiby, Mašek, Štorch and Straka in Dubec et al. (1993, p. 14) – localities Kosoř, Lochkov and Slivenec and Mašek in Drábková et al. (1998, p. 11) – localities Broumy and Březová.



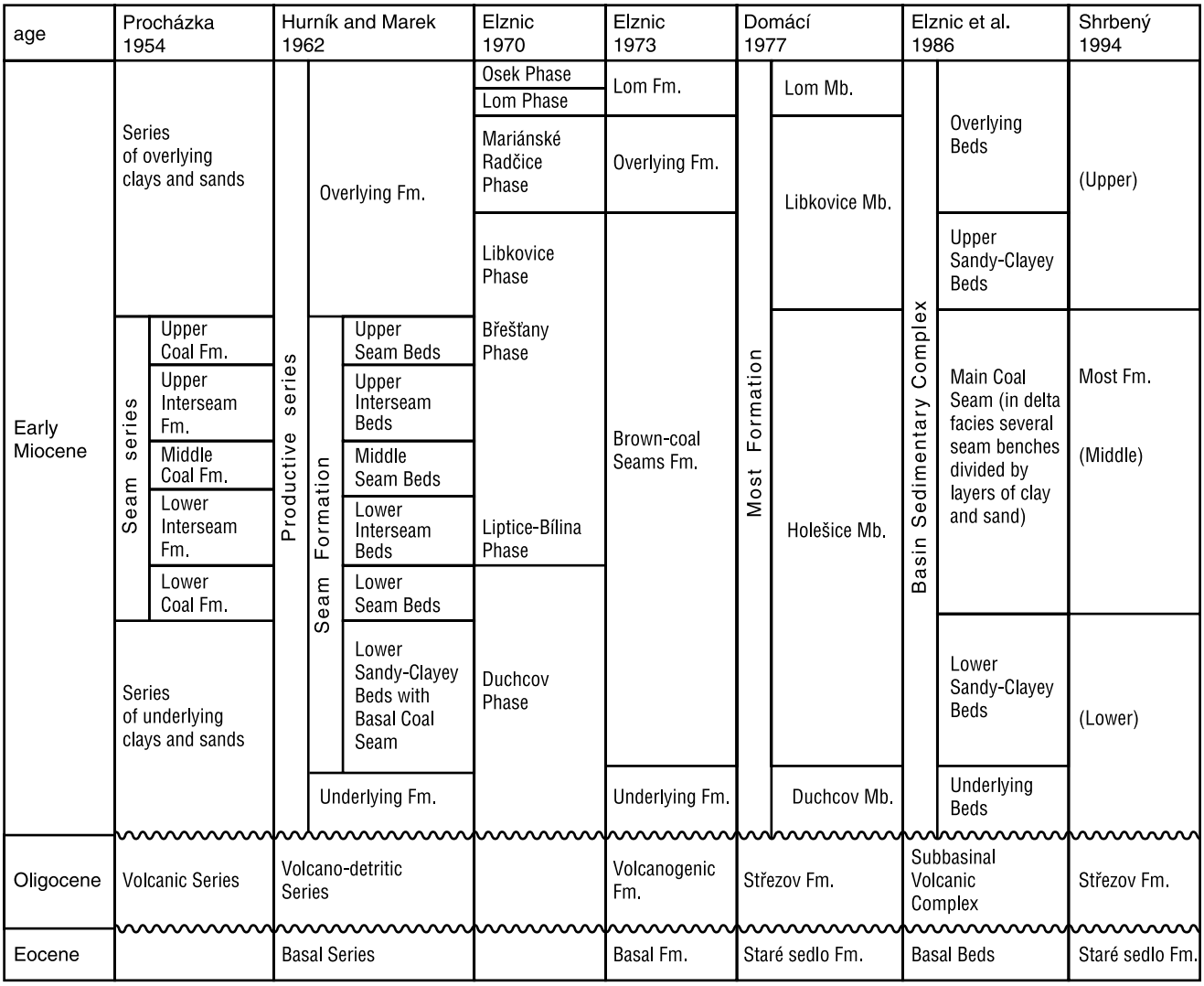
Text-fig. 1. Location of the studied localities of the "Hlavačov Gravel and Sand", the Žatec Delta and the fluvial localities in the Central Bohemia. – Symbols: 1. U Sv. Antonína, 2. Hlavačov, 3. Nesuchyně, 4. Velká Černoc, 5. Sádek, 6. Želeč, 7. Holedeč, 8. Záhoří near Žatce, 9. Přívlaky, 10. Soběsuky, 11. Čermníky, 12. Chotěnice, 13. Lomazice, 14. Dolany, 15. Nechranice, 16. Na Sulavě, 17. Klínec, 18. U Sloupu, 19. "U ručiček", CH – Cheb Basin, SO – Sokolov Basin, MO – Most Basin, DH – Doupov Mts., CS – České Středohoří Mts. (according to Mísař et al. 1982, Žák et al.2001).

A relatively continuous belt of the "Hlavačov Gravel and Sand" is situated between Rakovník and Holedeč in Northern Bohemia. The belt contains palaeobotanically important localities, i.e. Hlavačov, U sv. Antonína, Nesuchyně, Velká Černoc, Želeč and Sádek – text-fig. 1, which are characterized below. Lithologicaly, the "Hlavačov Gravel and Sand" consists of boulder and gravel mainly from white or yellowish quartzites and black lydites together with brown-yellow to orange or light grey coloured sands. An important feature is the clay content (about 3–8 %), which is generally irregularly distributed in 1 to 3 clay layers 20–50 cm in thickness, forming laterally restricted, partly fossiliferous lenses of grey or yellow colours. Čadek (1966) and Bylová (in Váně 1981) analysed the heavy mineral spectrum, which is dominated mainly by tourmaline, andalusite, sillimanite, rutile, zircone and staurolite (Čadek 1966). According to Gabriel and Valín (1968), the "Hlavačov Gravel and Sand" appears to be a typical fluvial sedimentary body with changing layers of different grain size and clay content, with a diagonal stratification and erosive boundaries inside the formation. For more information about geology and tectonics of the "Hlavačov Gravel and Sand" see Bretšnajder (1952), Váně (1985) and Teodoridis (2002, 2003b).

Geology of the Most Basin

Malkovský et al. (1985) and Brus et al. (1987) gave comprehensive information about the geological character of the Most Basin. The Most Basin is a part of the Krušné hory Graben, and it covers about 1000 km^2 between the Neovolcanic centers of the Doupov Mts. in the southwest and the České Středohoří Mts. in the northwest (e.g. Kopecký 1978, Cajz et al. 1999). For detailed information on the geology of the Most Basin see, e.g. Hurník (1960), Elznic et al. (1986), Váně (1987), Bůžek et al. (1992), Malkovský (1995), Mach (2000) and Suhr (2002).

Kopecký et al. (1960) and Váně (1960) defined the Žatec Delta as a complex of Tertiary clastic sediments occurring in the SW part of the Most Basin over an area of 500 km^2. The main accumulation period of these sediments is isochronous with the Main Coal Seam sensu Elznic et al. (1986), which was deposited in time interval from 22 to



Text-fig. 2. Summary of the stratigraphical classification of the Most Basin sediments (according to Kvaček and Hurník 2000).

20.5 MA (Shrbený 1994). Hurník (1971) and Brus (1982) focused on a detailed lithological study of the Žatec Delta. Hurník (1961, 1973) and Kvaček and Bůžek (1982) defined several plant associations based on macropalaeobotanical data from the Žatec Delta and reconstructed the vegetation cover of this area in relation to facies distribution. A new study in the area of the open mine of Libouš near Chomutov and the open-mine of Hrabák near Vršany shows that the interpretation of the Žatec Delta as a "true" delta is less probable. The clastic sediments belonging to the Duchcov and Holešice Members sensu Domácí (1977) – text-fig. 2, can be interpreted as an anastomous, river system with low gradient. The river flowed and crossed wide-ranging peat forests and prograded several times almost to the present SW basin margin (Rajchl and Uličný 2001; in press). According to Rajchl (personal communication 2003), this river system possibly represents an inland delta as today developed in the river delta of the Okavango River (McCarthy et al. 1986) or the lower reaches of the Saskatchewan River in area of the Cumberland marshes (Pérez-Arlucea ET Smith 1999). Rajchl (oral communication 2003) interpreted the clastic deposits (mainly sand and sandstone) of the basal part of the Libkovice Member sensu Domácí (1977) as a "true" deltaic sediments of the most distal part of the delta in the view of new sedimentological investigations in the locality Přívlaky and outcrops of the NW bank of the Nechranice Reservoir.

Connection of fluvial and the Most Basin sediments

The problem of relating fluvial sediments of Central and North Bohemia to the sediments of the Most Basin in the area of the Žatec Delta has not been so far satisfactorily solved. Two different models exist and they are based on the common opinion that the "Hlavačov Gravel and Sand" represents the terminal relict of the Central River sensu Pešek and Spudil (1986). The first model suggests a connection of the "Hlavačov Gravel and Sand" to nowadays denuded sediments that may have overlay the Most Formation

(Malecha 1962). The second model, on the contrary, connects these fluvial sediments with the deposits of the Most Formation, based on detailed geological study in the "key" area of Holedeč and Měcholupy (e.g. Mitášová 1962, V. Kněžek 1964, J. Kněžek 1965, Sysel 1967, Kliner and Würmová 1975, Váně 1985, pp. 212–214). A furthter problem is to find exact fluvial equivalents in the frame of the Most Formation. Pešek and Spudil (1986) correlated the "Hlavačov Gravel and Sand" with the Main Coal Seam (Elznic et al. 1986) on the basis of identical heavy mineral spectra. In addition, Bůžek and Kvaček (1989a), Walther in Lotsch et al. (1994) and Teodoridis (2002) interpreted sediments of the Duchcov Member (Domácí 1977), including the Basal Coal Seam sensu Váně (1987), as an analogue of the "Hlavačov Gravel and Sand" on basis of the comparison of the heavy minerals spectra from the "Hlavačov Gravel and Sand" and the Thierbach Beds (Lotsch et al. 1994) as well as palaeobotanical data of these fluvial sediments (Konzalová 1976, Bůžek and Kvaček 1989a, Mai and Walther 1991, Teodoridis 2002) – see below.

Reconstruction of the Tertiary river system

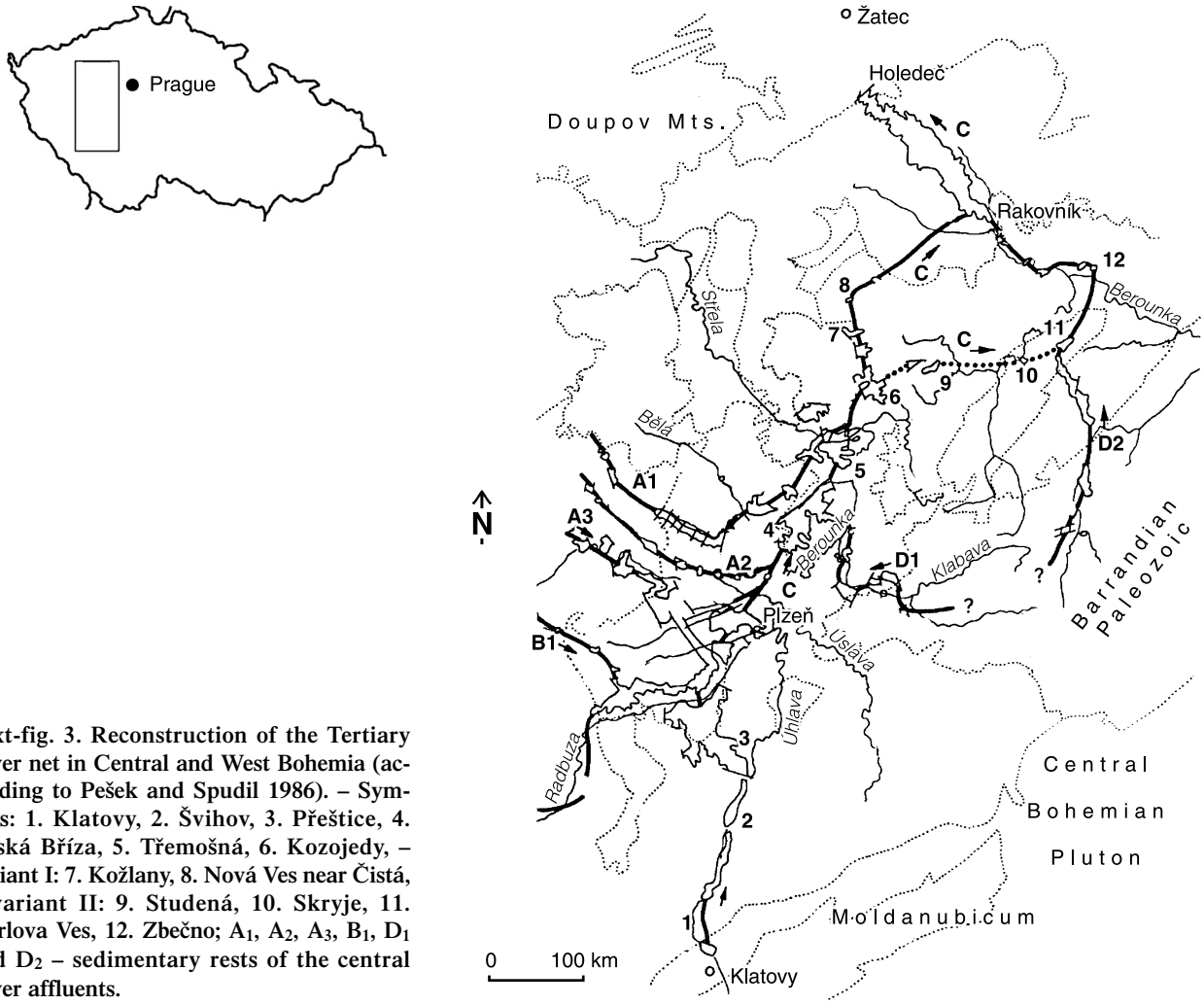
The main base for a reconstruction of the Tertiary river net is a detailed knowledge of tectonics and geomorphological development of the study area, comparative sedimentological and lithological-petrological analysis including the analysis of the heavy minerals and the exact altitude of isolated fluvial relics. The problem of the Tertiary river net and its connection to sediments of the Most Basin was solved by several authors, e.g. Malkovský (1975, 1979, 1995), Pešek (1972), Pešek and Spudil (1986), Prosová (1974), Žák et al. (2001). According to Pešek and Spudil (1986), the "Hlavačov Gravel and Sand" can be interpreted as the terminal rest of the river "C" (Central River), which is the longest Tertiary river of West and Central Bohemia (about 130–150 km). The Central River sprang probably in the watershed, which was a morphological elevation of the southwest part of the Central Bohemian Pluton in the surroundings of Klatovy. The river "C" flowed through Švihov, Přeštice, Plzeň, along the Berounka River towards Česká Bříza and Bohy to Kozojedy, where the continuation of the Central River is equivocal. The river "C" continued either from Kozojedy northwards through Kožlany to Nová Ves by Čistá and then flowed towards northeast to Rakovník (Variant I). In the second model (Variant II), it curved between Kozojedy and Kožlany eastwards through Skryje, Karlova Ves to Zbečno, where the Central River continued northwestwards to Rakovník. Important rivers of the Czech Tertiary are affluents of the river "C" (rivers A_1, A_2, A_3, D_1, D_2, E and F), relics of which are found in the West and Central Bohemian sedimentary islands (Pešek and Spudil 1986, text-fig. 3). Pešek (1972) and Pešek and Spudil (1986) mainly focused on distinguishing the Tertiary and Carboniferous clastic relics in the area of Plzeň, their mutual connection and connection to the "Hlavačov Gravel and Sand" and the sediments of the Most Basin. These authors solved marginally the area of Central Bohemia, where fluvial relics connected to the river D_2 without a direct connection to the Central River. Žák et al. (2001) applied heavy mineral analysis in the study of allochtonous clastic deposits of the Czech Karst and solved in detail the connection of these relics in Central Bohemia. Žák et al (2001, pp. 5–7) also commented on the discrepancy between the generally accepted Tertiary river net models (Malkovský, Pešek, Spudil) and the first and second chronological paradox of the Czech Karst (Petrbok 1950, Kovanda and Herzogová 1986) and some palaeontological findings near Karlštejn and Srbsko (Ložek in Kukla 1956).

Malkovský (1975, 1995) published another interpretation of the Tertiary river system suggesting two main rivers, which drained the area of SW Bohemia (corresponding the Central River sensu Pešek and Spudil 1986) and the areas of NE Bohemia (corresponding the present river Cidlina) and SE Bohemia (corresponding the present river Sázava) in the Lower Miocene (Upper Egerian-Lower Karpatian). Both rivers conflux southward from Prague and continued towards the Rakovník area, where they flowed into the Most Basin (Text-fig. 4). Malkovský (1995) showed also possible reconstructions of the river net for the Middle Miocene (upper Karpatian-lower Badian) – Malkovský (1995, fig. 3B) and Pliocene (Malkovský 1995, fig. 3C).

All the above-mentioned models of the Tertiary river net are concentrated only on the Czech Republic. Nevertheless, the model based on the identical spectrum of heavy minerals in the sediments of the "Hlavačov Gravel and Sand" and the Thierbach Beds from the Weisselster Basin (Čadek 1966, Ahrens et al. 1974) and the similarity in the floristic composition of these fluvial sediments (Walther in Lotsch et al. 1994, Teodoridis 2002; exists. Lotsch et al. (1994) presumed possible connection of the two and suggested a contemporaneous deposition of the Central River and the Thierbach Rier within one river system. cca 300 km in length with an estuary located in Saxony. On the other hand, Suhr (2003) noted another possible origin area of heavy minerals in Germany.

Methods and material

A binocular microscope was used for observations and studies of the material. Leaf morphological terminology follows Hickey (1973). Figures in text were created using Photoshop 6.0 and Corel Draw 9.0. According to Moravec et al. (2000), symbols for distinguishing vegetative storeys in environmental reconstruction are used, i.e. E1 (herbs), E2 (shrubs and lianas), E3 (trees under 25 m high) and E4 (trees over 25 m high). Principles and methods of the CLAMP (Climate Leaf Analysis Multivariate Program) are explained in, e.g. Wolfe (1990, 1993), Wolfe and Spicer (1999) or Teodoridis (2003b, p. 67). All available specimens from the localities Na Sulavě, Hlavačov, U Sv. Antonína (Na Bendovce), Nesuchyně, Velká Černoc, Holedeč and Záhoří near Žatec are housed in the collection of the National Museum, Prague; from the localities Klínec,



Text-fig. 3. Reconstruction of the Tertiary River net in Central and West Bohemia (according to Pešek and Spudil 1986). – Symbols: 1. Klatovy, 2. Švihov, 3. Přeštice, 4. Česká Bříza, 5. Třemošná, 6. Kozojedy, – variant I: 7. Kožlany, 8. Nová Ves near Čistá, – variant II: 9. Studená, 10. Skryje, 11. Karlova Ves, 12. Zbečno; A_1, A_2, A_3, B_1, D_1 and D_2 – sedimentary rests of the central River affluents.

Hlavačov, U Sv. Antonína (Na Bendovce), Nesuchyně, Velká Černoc and Přívlaky in the collection of the Institute of Geology and palaeontology, Faculty of Science, Charles University, Prague; from the localities "U ručiček" and Želeč in the collection of the Department of Biology and Environmental Education, Faculty of Education, Charles University, Prague; from the locality Přívlaky in the collection of the Regional Museum, Most and that from the localities of the Pětipsy Area of the Žatec Delta in the collection of the Czech Geological Survey, Prague.

List of abbreviations used in text and tables 4, 5, 6 follows: A_1, A_2, A_3, D_1, D_2, E, F – affluents of the the Central River (River "C") defined by Pešek and Spudil (1986); US – Series of Underlying Clay and Sand sensu Procházka 1954, (= Underlying Formation and Lower Sandy Clayey Beds with Basal Coal Seam of Seam Formation sensu Hurník and Marek 1962); UISF – Upper Inter-Seam Formation of the Seam Series sensu Procházka 1954 (= Upper Inter-Seam Beds of the Seam Formation sensu Hurník and Marek 1962); OS – Series of Overlying Clay and Sand sensu Procházka 1954 (= Overlying Formation sensu Hurník and Marek 1962); Cho 14 (Chotěnice) – dug pit described by Procházka (1956), Cho 26 (Chotěnice) – outcrop described by Procházka (1956), Lo 355 (Lomazice) – dug pit described by Procházka (1956), Do 50 (Dolany) – gravel pit described by Procházka (1955), Do 52 (Dolany) – outcrop described by Procházka (1956), So 274 (Soběsuky) – outcrops described by Procházka (1956), MAT – Mean Annual Temperature, WMMT – Warmest Month Mean Temperature, CMMT – Coldest Month Mean Temperature, MART – Mean Annual Range Temperature, 3WET – Precipitation during 3 Consecutive Wettest Months, 3DRY – Precipitation during 3 Consecutive Driest Months, MAP – Mean Annual Precipitation.

Floras of fluvial sediments of Central Bohemia and Northern Bohemia

Detail characterization of Tertiary fluvial sedimentary relics in Central Bohemia is given in the geological part of this paper. These relics are often palaeobotanically sterile. Hurník and Knobloch (1966) published a summary of the Tertiary floras from the broader vicinity of Plzeň, i.e. localities Ejpovice, Kyšice, Dobříč, Horní Bříza, U tří králů and

Býkovský les. Besides, Němejc et al. (2003) focused on the complex floristic revision including micropalaeontological analysis of the localities Býkov, Jalovčiny, Dobřič near Janov, Zruč, Žihlice, Dnešice and Horní Bříza. On the basis of the floristic analysis, these authors presume the Early Miocene age for all mentioned localities excluding the locality Horní Bříza, which stratigraphically belongs to the Middle Miocene (Upper Badenian-Lower Sarmatian) – Němejc et al. (2003). The leaf impressions have more or less fragmentary character, which indicates parautochtonous to allochtonous type of "river" fossil assemblages.

Locality Na Sulavě

Relatively large Tertiary fluvial relic called Na Sulavě is located in the northeastern area from the village Černošice (Text-fig. 1). It contains fluvial sandstone and gravel and sand, which usually alternate with irregularly distributed clay lenses. Liebus (1901) described the first fossil record of limonitic wood as *Cedroxylon hoheneggeri* FELIX. from the sandstone. According to Sakala (personal communication), it is impossible to determinate this fossil without studying the original material. However, Sakala presumes an indeterminate conifer wood, which does not contain resin ducts. Kunský (1928/29) dealt with sedimentology and palaeobotany of this locality when investigating Central Bohemian clastic fluvial relics and described 6 taxa, i.e. *Salvinia formosa* HEER, *Taxodium dubium* STERNB., *Arundo* sp., *Salix angusta* A. BR., *Salix longa* A. BR. and *Fagus feroniae* HEER. Also Němejc (1943) presented new leaf impressions from limonitic concretions at the meeting of the Czech Society for Mineralogy and Geology (9th April 1940) and he assigned this leaf material only to the generic level (i.e. *Liquidambar* sp., *Cinnamomum* sp., *Acer* sp., *Ulmus* sp., *Carpinus* sp., *Taxodium* sp. in the proceedings of the meeting). Then Němejc (1949) revised his material and the original material of Kunský and listed *Taxodium distichum miocenicum* HEER, *Salix lavateri* HEER, *Salix bilinica* NĚMEJC, *Betula subpubescens* GOEPP., *Betula prisca* ETT., *Corylus macquarii* (FORBES) HEER, *Ulmus longifolia* UNG., *Ulmus braunii* HEER, *Liquidambar europaeum* A. BR., and *Cinnamomum scheuchzeri* (HEER) FRENZEN. Unfortunately, Teodoridis (2001) had only a small fragment of the original material at his disposal for the revision (table 1).

Localities Klínec and U Sloupu

These two relatively large relics located in the broader vicinity of the villages Sloup and Klínec (Text-fig. 1) represent fluvial sandstone and gravel and sand, irregularly alternating with fossiliferous clay lenses of white or grey coloured claystone (Kettner 1911). First Feistmantel (1881, p. 291) reported on the Tertiary character of these sediments (occurrence near an old sandpit Jíloviště) based on xylotomic differences between fossil woods from this locality, which are missing, with the so-called araucarits. Kettner (1911) studied the geology and palaeobotany of these sediments and excluded their Quaternary or Cretaceous age (Kettner 1991, p. 5) and described 6 taxa, i.e. *Taxodium dubium* STERNB., *Salvinia formosa* HEER, *Fagus feroniae* HEER, *Salix macrophylla* HEER, *Quercus drymeja* UNG. and *Brasenia* sp. Later Procházka (1916) revised and supplemented palaeobotanical occurrences from Klínec (i.e. *Taxodium dubium* STERNB., *Salvinia formosa* HEER, *Fagus feroniae* HEER, cf. *Podogonium latifolium* HEER, *Quercus drymeja* UNG., *Potamogeton geniculatus* A. BR. and *Poacites aequalis* ETT.) including a very abundant record of *Stratiotes* (*Carpolithes*) *websteri* (HEER) POT. Kunský (1928/29) reassigned this leaf and seed material to *Salvinia formosa* HEER, *Taxodium dubium* STERNB., *Salix angusta* A. BR., *Fagus feroniae* HEER, *Carpinus grandis* HEER, *Acer trilobatus* A. BR., cf. *Sabal* sp. and *Stratiotes websteri* POT. Němejc (1949) revised all available material and indentified *Salvinia reussii* ETT., *Taxodium distichum miocenicum* HEER, ? *Salix bilinica* NĚMEJC, *Alnus feroniae* UNG., *Juglans acuminata* A. BR., ? *Ulmus longifolia* UNG. and *Stratiotes kaltennordheimensis* ZENKER. He defined the stratigraphical range of the Klínec phase based on palaeobotanical data (see below). The last revision of the original material including ecological reconstruction and stratigraphical re-interpretation was done by Teodoridis (2001) – table 1. This fossil association is characterized by common occurrences of *Stratiotes kaltennordheimensis* (E1) and *Salvinia reussii* (E1) from the locality Klínec (also known from the locality Holedeč, see

Table 1. Summary of the floristic composition on the localities Na Sulavě, Klínec and "U ručiček". Symbols: (♣ – present, ♣♣ – rare, ♣♣♣ – common.

Taxa	Localities		
	Na Sulavě	Klinec	"U ručiček"
Alnus julianiformis	–	♣♣	♣♣
Alnus sp.	♣	–	♣♣
Betula sp.	♣♣	–	♣♣
Betulaceae	–	–	♣♣
Carya cf. *serrifolia*	♣	–	–
Daphnogene cinnamomifolia f. cinnamomifolia	♣♣	–	♣♣
Dicotylophyllum sp. 1	–	♣	–
Dicotylophyllum sp. 2	♣	–	–
Dicotylophyllum sp. 3	–	♣	–
"Ficus" truncata	–	–	♣♣
Glyptostrobus europaeus	–	–	♣♣
Liquidambar europaea	♣♣	–	♣♣
Myrica sp.	–	–	♣
Podocarpium podocarpum	–	–	♣♣
Populus zaddachii var. *brabenecii*	–	–	♣♣
Salix haidingeri	♣	♣	♣♣
Salix varians	–	–	♣
Salvinia reussii	–	♣	♣♣
Smilax weberi	–	–	♣♣
Stratiotes kaltennordheimensis	–	♣♣♣	–
Taxodium dubium	♣♣	♣♣	♣♣
Ulmus pyramidalis	♣♣	♣♣	–

below). These elements are typical of aquatic vegetation or association of canebrakes, which can overlap towards mixed swamp forest.

Locality "U ručiček"

A relatively small relic of Tertiary clastic sediments (1 km^2) occurs in the area among Karlštejn, Liteň and Bělče. At present, only two sandpits exist, i.e. "U ručiček" (NW part of the relict) and a sandpit near Běleč (Text-fig. 1). The lithology is typical of white, gray or light rusty coloured quartzitic sand with minor occurrence of gravel and sand. The fossil leaf flora is confined to one yellowish clay lens. The flora of the locality "U ručiček" has yielded 1 fern, 2 conifers and 13 angiosperms (11 dicots, 1 monocot and 1 taxon of uncertain systematic position), i.e. *Salvinia reussii* ETT., *Taxodium dubium* (STERNB.) HEER, *Glyptostrobus europaeus* (BRONGN.) UNG., *Daphnogene cinnamomifolia* UNG. f. *cinnamomifolia*, *Liquidambar europaea* A. BR., *Betula* sp., *Alnus julianiformis* (STERNB.) Z. KVAČEK et HOLÝ, *Alnus* sp. sensu BŮŽEK, *Betulaceae* gen. et sp. div. et indet., *Myrica* sp., cf. *Salix varians* GOEPP., cf. *Salix haidingeri* ETT. emend. BŮŽEK, cf. *Populus zaddachii* HEER var. *brabenecii* TEODORIDIS, *Podocarpium podocarpum* (A. BR.) HERENDEEN, cf. "*Ficus*" *truncata* HEER sensu BŮŽEK and *Smilax weberi* WESSEL – Teodoridis in Žák et. al. (2003); table 1. An about 700 mm long permineralized woody fragment is also known from this locality (Lachmanová unpubl.) that was determined as a taxon of Taxodiaceae or Cupressaceae (Sakala in Žák et al. 2003). Very interesting phenomenon of this locality is the relatively common occurrence of *Smilax weberi*, which has been known until now only from the localities from the Most Basin (e.g. Čermníky – Bůžek 1971) and a rare occurrence of *Podocarpium podocarpum*, which is a common element of the localities Holedeč (Teodoridis 2002), Přívlaky (Teodoridis in press) and Čermníky (Bůžek 1971).

"Hlavačov Gravel and Sand"

All leaf impressions are determined only on the basis of the morphological features due to thier poor preservation, which does not allowed to apply methods of cuticular analysis. The material has fragmentary character, which can be interpreted as parautochtonous to allochtonous oryctocoenoses. The location of partial localities of the "Hlavačov Gravel and Sand" is shown in text-fig. 1. Plant impressions are more or less confined to irregularly distributed clay lenses.

Locality Hlavačov

The locality Hlavačov is situated on the eastern, forested bank of the Lišany Creek among Rakovnik, Lužná and Lišany. The first palaeobotanical reference is the record of permineralized woody fragment, which was assigned to *Qurecus* sp. (Smetana 1926). However, the validity of this determination is doubtful (Němejc 1953, Sakala personal communication). Němejc (1953) described 8 taxa of leaf fossils, i.e. *Taxodium distichum miocenicum* HEER, *Sequoia langsdorfii* HEER, *Pinus* sp., *Betula prisca* ETT., *Alnus* sp. *Ulmus longifolia* UNG., *Celtis* sp. and *Liquidambar europaeum* A. BR., which were at the disposal for this revision excluding the pine needle (Němejc 1953, pl. 2, fig. 3). This needle fragment was associated with a cone scale of *Pseudolarix schmidtgenii* KRÄUSEL (coll. Němejc, unpubl.) according to Bůžek and Kvaček (1989a). Bůžek and Kvaček (1989a) revised the original Němejc's material and identified *Taxodium dubium* (STERNB.) HEER, *Pseudolarix schmidtgenii* KRÄUSEL, *Populus heeri* SAP., *Betula* sp., *Alnus* sp., *Ulmus pyramidalis* GOEPP. and *Liquidambar europaea* A. BR. The last revision including the description of new material was done by Teodoridis (2000, 2002, unpubl.); table 2. The common occurrence of *Fagus saxonica* and *Pseudolarix schmidtgenii* is typical for this flora. This association is important for phytostratigraphical correlation of the "Hlavačov Gravel and Sand" with the floristic assemblage Thierbach and Witznitz sensu Mai and Walther (1991) from the Weisselster Basin (Saxony, Germany) – see below. Two relatively small leaves (probably juvenile) of *Populus zaddachii* var. *brabenecii* (originally *Celtis* sp. Němejc 1953, pl. 1, figs 14, 15, and *Populus heeri* SAP. Bůžek and Kvaček 1989a) may be interpreted as connecting elements with more northern floras of the Pětipsy Area and Holedeč (Bůžek 1971, Teodoridis 2000, 2002).

Locality "U Sv. Antonína" (Na Bendovce)

The locality presents the most southern occurrence of the "Hlavačov Gravel and Sand" and it is situated near Rakovník in a facies of fine-grained brown or rusty sandstone. Němejc (1949) described the first record of *Fagus sylvatica* L. (non *Fagus feroniae* UNG.) from the river and basin sediments of Central and Northern Bohemia. He excluded this locality from the Klínec phase based on the mentioned beech record and transferred it to the younger Zdiby phase. Bůžek and Kvaček (1989a) indicated a possible affinity to *Fagus attenuata* GOEPP. ssp. *seussensis* KNOBLOCH, which was confirmed by Teodoridis (2001), i.e. *Fagus saxonica* Z. KVAČEK et WALTHER, including an emendation of the stratigraphical conception of the fluvial sediments from Central Bohemia. Beside the mentioned *F. attenuata* ssp. *seussensis*, Bůžek and Kvaček (1989a) presented from the locality "U Sv. Antonína" 3 additional taxa (i.e. *Salix* cf. *varians* GOEPP., *Alnus julianiformis* (STERNB.) Z. KVAČEK et HOLÝ and *Ulmus* sp.) as revised original Němejc's material. However, these taxa were not at the disposal for the later revision (Teodoridis 2001) and Němejc (1949) has never published them.

Locality Nesuchyně

This very important and rich locality is situated approximately in the widder of the continual belt of the "Hlavačov Gravel and Sand" at the place of the old sandpit Dykasta near Nesuchyně (or Rovina near Nesuchyně). The first fossil flora was recovered by Vachtl (1935), who described

only 10 taxa: *Betula* sp., *Alnus* sp., *Carpinus* sp., *Juglans* sp., *Salix varians* GOEPP., *Salix longa* A. BR., *Ulmus longifolia* UNG., *Ulmus carpinioides* GOEPP., *Liquidambar europaeum* A. BR. and *Cinnamomum polymorphum* A. BR. Němejc (1949) revised this material and collected and described new ones, i.e. *Salix macrophylla* HEER, *Salix lavateri* HEER, *Betula subpubescens* GOEPP., *Betula prisca* ETT., *Alnus feroniae* UNG., *Alnus rotundata* GOEPP., *Carpinus grandis* UNG., *Carya bilinica* (UNG.) ETT., *Ulmus longifolia* UNG., *Zelkova ungeri* KOW., *Liquidambar europeum* A. BR. and *Cinnamomum scheuchzeri* (HEER) FRENZEN. Bůžek (1960) dealt with fragmentary plant records from the core Ně-3a (depth 24.5–25 m) and assigned them to *Carpinus grandis* UNG., cf. *Ulmus longifolia* UNG. and Poaceae gen. et. sp. indet. Later Bůžek and Kvaček (1989a) collected numerous plant material there, and preliminarily assigned it to *Woodwardia muensteriana* (C. PRESL) KRÄUSEL, *Salvinia reussii* ETT., *Taxodium dubium* (STERNB.) HEER, *Sequoia couttsiae* HEER, *Glyptostrobus europaeus* (BRONGN.) UNG., *Tetraclinis salicornioides* (UNG.) Z. KVAČEK, *Pseudolarix schmidtgenii* KRÄUSEL, *Comptonia acutiloba* BRONGN., *Myrica* sp., *Alnus* cf. *julianiformis* (STERNB.) Z. KVAČEK et HOLÝ, *Carpinus grandis* UNG., *Ulmus pyramidalis* GOEPP., *Ulmus* sp., *Acer integerrimum* (VIVIANI) MASSALONGO, *Vitis stricta* (GOEPP.) KNOBLOCH, *Tilia* sp., *Liquidambar europaea* A. BR., "*Viburnum*" *atlanticum* ETT., "*Quercus*" *bilinica* UNG., *Ailanthus confucii* UNG. and "*Musa*" *bilinica* ETT. New occurrences of leaves and bracts of *Tilia brabenecii* BŮŽEK et Z. KVAČEK and leaves of *Mahonia bilinica* (UNG.) Z. KVAČEK et BŮŽEK were separately described in Bůžek and Kvaček (1994) and Kvaček and Bůžek (1994). The last revision of all the available original material and new material from the locality Nesuchyně was done by Teodoridis (2000, 2002) and Sakala and Teodoridis (2001); table 2. Similarly as the locality Hlavačov, the Nesuchyně flora contains also a phytostratigraphically important association of *Pseudolarix schmidtgenii* and *Fagus saxonica* including cupulae of *Fagus deucalionis*. In addition most of the unique taxa occurred in Nesuchyně (e.g. *Tetraclinis salicornoides*, *Mahonia bilinica*, cf. *Trigonobalanopsis rhamnoides*, cf. *Castanea atavia*, *Salix macrophylla*, *Tilia brabenecii* and cf. *Fraxinsus* sp.). For detail information of the vegetation see Teodoridis (2002, p. 132, text-fig. 4).

Locality Velká Černoc

This locality is the biggest still working sandpit in the belt of the "Hlavačov Gravel and Sand", which is situated in the forest about 1.5 km north from the village Velká Černoc. The flora has yielded 1 fern, 2 conifers and 12 angiosperms (11 dicots and 1 monocot), i.e. *Salvinia reussii* ETT., *Pinus* sp., *Taxodium dubium* (STERNB.) HEER, *Glyptostrobus europaeus* (BRONGN.) UNG., *Fagus saxonica* Z. KVAČEK et WALTHER, *Betula* sp., *Alnus julianiformis* (STERNB.) Z. KVAČEK et HOLÝ, *Alnus* sp. sensu BŮŽEK, *Alnus kefersteinii* (GOEPP.) UNG., *Carya serrifolia* (GOEPP.) KRÄUSEL, *Salix varians* GOEPP., *Acer tricuspidatum* BRONN sensu PROCHÁZKA et BŮŽEK, *Acer* sp. and *Zingiberoideophyllum liblarense* KRÄUSEL et WEYLAND – Teodoridis (2000, 2002); table 2. Besides the very common elements known from other localities of the "Hlavačov Gravel and Sand", the flora contains several unique taxa, i.e. incomplete pine needle (*Pinus* sp.) with possible affinity to *Pinus pseudostrobus* BRONGN. (interpreted as mesophytic element of wider uplands along river system), swamp maple (*Acer tricuspidatum*), monocot *Zingiberoideophyllum liblarense* (also known from the locality Nesuchyně) and permineralised trunk of *Castanoxylon bavaricum* associated with leaf impression of cf. *Castanea atavia* from the locality Nesuchyně (Sakala and Teodoridis 2001).

Lokalita Sádek

The locality is situated in a relic occurrence of the "Hlavačov Gravel and Sand", which is presented as an isolated tectonic floe in the vicinity of a railway station Sádek (Váně 1985). Krejčí (1877, p. 899) published the first note about the existence of the palaeobotanically sterile Tertiary sediments in vicinity of Sádek. Kušta (1889, p. 223) described 10 taxa found in light grey claystone organized in relatively thin layers (3 to 4 cm), i.e. *Salvinia reussii* ETT., *Taxodium distichum miocenicum* HEER, *Poacites laevis* A. BR., *Carpinus grandis* UNG., *Quercus* sp., *Dryandroides lignitum* ETT., *Acer trilobatum* A. BR., *Eucalyptus* sp. and *Eugenia* sp. Unfortunately, this original material is missing. Smetana collected a new material from Sádek, which is now housed in the collection of the National Museum, Prague and contains only 5 fragmentary and poorly preserved leaves, i.e. *Fagus saxonica* Z. KVAČEK et WALTHER, Betulaceae gen. et sp. indet., *Alnus julianiformis* (STERNB.) Z. KVAČEK et HOLÝ and *Ulmus pyramidalis* GOEPP. – Teodoridis (unpubl.) and table 2.

Locality Želeč

The flora from the locality Želeč is bound to either greenish grey clay lenses or very thin layers of light to dark brown or black coal clay. Bůžek and Kvaček visited this locality during preparation of the excursion for the 26th Conference of ČSMG, Most 1987 and described some fossil plant material (i.e. *Taxodium dubium* (STERNB.) HEER, *Betula* sp., cf. *Fagus* sp. – Bůžek and Kvaček in Brus et al.1987; Bůžek and Kvaček 1989a). Later, both authors supplemented these sporadic records with a new material and described 18 taxa, i.e. *Salvinia reussii* ETT., *Taxodium dubium* (STERNB.) HEER, *Glyptostrobus europaeus* (BRONGN.) UNG., *Daphnogene polymorpha* (A. BR.). ETT., *Liquidambar europaea* A. BR., *Alnus julianiformis* (STERNB.) Z. KVAČEK et HOLÝ, *Alnus* sp., *Betula* sp. vel *Alnus* sp., *Ulmus pyramidalis* GOEPP., cf. *Zelkova zelkovifolia* (UNG.) BŮŽEK et KOTLABA, *Myrica* sp., *Salix* sp.

Table 2. Summary of the floristic composition on the localities of the "Hlavačov Gravel and Sand" (i.e. Hlavačov, Nesuchyně, Velká Černoc, Sádek and Želeč) and on the locality Holedeč. Symbols: ♣ – present, ♣♣ – rare, ♣♣♣ – common.

Taxa	Localities					
	Hlavačov	Nesuchyně	Velká Černoc	Sádek	Želeč	Holedeč
cf. *Acer sepultum*	–	♣♣	–	–	–	♣♣
Acer sp.	–	–	♣	–	–	–
Acer dasycarpoides	–	–	–	–	–	♣♣
Acer integerrimum	–	♣♣	–	–	♣	♣♣
Acer tricuspidatum	–	–	♣♣	♣	♣	♣♣
Acer pseudomonospessulanum	–	–	–	–	–	♣♣
Ailanthus confucii	–	♣	–	–	–	♣
Alnus kefersteinii	–	♣♣	♣♣	–	♣	♣♣
Alnus julianiformis	–	♣♣	♣♣	♣♣	♣	♣♣
Alnus sp.	♣	♣♣	♣♣	–	–	♣♣
Betula sp.	♣♣♣	♣♣♣	♣♣	–	–	♣♣
Betulaceae	–	♣♣	♣♣	♣♣	♣♣♣	♣♣
Carpinus grandis	–	♣♣	–	♣♣	–	♣♣
Carya bohemica	–	–	–	–	–	♣
Carya serrifolia	–	♣♣	♣♣	–	–	♣♣
Carya cf. *serrifolia*	–	–	–	–	–	♣♣
cf. *Castanea atavia*	–	♣	–	–	–	–
Chaneya oeningensis	–	–	–	–	–	♣
Comptonia difformis	–	♣♣	–	–	–	♣
Daphnogene cinnamomifolia	–	♣♣	–	–	♣	♣♣
Fagus deucalionis	–	♣	–	–	♣	♣♣
Fagus saxonica	–	♣♣♣	♣♣	♣♣	♣♣	♣♣
"Ficus" truncata	–	–	–	–	–	♣♣
cf. *Fraxinus* sp.	–	♣	–	–	–	–
Glyptostrobus europaeus	–	♣♣	♣♣	–	♣	♣♣
Juglans acuminata	–	♣	–	–	–	♣
Leguminosites tobischii	–	–	–	–	–	♣♣
Liquidambar europaea	♣♣♣	♣♣♣	–	–	♣	♣♣♣
Koelreuteria reticulata	–	–	–	–	–	♣♣
Mahonia bilinica	–	♣♣	–	–	–	–
Myrica sp.	–	♣♣	–	–	♣	♣
Paliurus tiliaefolius	–	–	–	–	–	♣
? *Persoonia* sp.	–	–	–	–	–	♣♣
Pinus sp.	–	–	♣	–	–	–
Podocarpium podocarpum	–	–	–	–	–	♣
Populus populina	–	–	–	–	–	♣
Populus zaddachii var. *brabenecii*	♣♣	–	–	–	–	♣♣♣
cf. *Potamogeton* sp.	–	–	–	–	♣	–
Pseudolarix schmidtgenii	♣	♣♣	–	–	–	–
Rosa europaea	–	–	–	–	–	♣♣
Rubus merianii	–	–	–	–	–	♣♣
Salix haidingeri	–	♣♣	–	–	–	♣♣♣
Salix macrophylla	–	♣	–	–	–	–
Salix varians	♣♣	♣♣♣	♣	–	–	♣♣♣
Salvinia reussii	–	♣♣	♣	♣	♣	♣♣♣
Stratiotes kaltennordheimensis	–	–	–	–	–	♣♣
Taxodium dubium	♣♣♣	♣♣♣	♣♣	♣♣	♣♣♣	♣♣♣
Tetraclinis salicornioides	–	♣	–	–	–	–
Tilia brabenecii	–	♣♣	–	–	–	–
cf. *Trigonobalanopsis rhamnoides*	–	♣	–	–	–	–
Ulmus pyramidalis	♣♣♣	♣♣♣	–	♣	♣	♣♣♣
Ulmus sp.	–	♣	–	–	–	♣
"Viburnum" atlanticum	–	♣	–	–	–	♣
Vitis stricta	–	♣♣	–	–	–	♣♣
Vitis teutonica	–	♣♣	–	–	♣	–
? *Wisteria* aff. *fallax*	–	–	–	–	–	♣♣
Woodwardia muensteriana	–	♣	–	–	–	–
Zelkova zelkovifolia	–	♣♣	–	–	♣	♣♣
Zingiberoideophyllum liblarense	–	♣	♣	–	–	–

Fagus attenuata GOEPP. ssp. *seussensis* KNOBLOCH, *Acer tricuspidatum* BRONN, *Acer integerrimum* (VIV.) MASSAL., *Vitis teutonica* A. BR., cf. *Potamogeton* sp. and Poaceae vel Cyperaceae gen. et sp. indet. (Bůžek and

Kvaček 1989b). Most of the original material was at the disposal for the revision excluding the two later mentioned taxa, whose validity was confirmed by Z. Kvaček (Kvaček personal communication 2003) – Teodoridis (2000, 2002); table 2. This locality is interesting in the occurrence of relatively complete fossil leaves confined to dark coal clay, which matches to paratochtonous oryctocenouse and low dynamic sedimentary regime of oxbow lakes. This sedimentary-ecological model is comparable to the regime on the locality Holedeč (see below).

Floras of the Žatec Delta

The below mentioned floras (localities) of the Žatec delta can be geographically devided into two areas. The first area is the southeastern part of the Žatec Delta, which contains three studied localities (floras) of Holedeč, Záhoří near Žatec and Přívlaky (Text-fig. 1). The fossil material is determined only on the basis of the morphological features due to poor preservation. The leaf material has fragmentary character and belongs to parautochtonous to allochtonous oryctocoenoses. The second area is the southwestern part of the Žatec Delta, which is known usually as the Pětipsy Area and contains many localities, which were discovered mainly by M. Procházka and Č. Bůžek. Author has chosen only 6 localities for a revision (i.e. Čermníky, Chotěnice, Lomazice, Dolany, Soběsuky and Nechranice – text-fig. 1) from which the original material was available to study. Most of the fossils are impressions, and therefore their descriptions are based on morphological features; excluding representatives of Lauraceae from the locality Čermníky, where Z. Kvaček used the methods of cuticular analysis for determination (Kvaček 1971, Bůžek and Kvaček 1974). The studied material is more complete than the material from the southeastern part of the Žatec Delta or "river" localities, which are typical for low dynamic sedimentary regime of inland deltas or lakes. The floras of the Pětipsy Area represent parautochtonous, rarely autochtonous oryctocoenoses (roots horizons recently exposed in the NW bank of the Nechranice Reservoir). The studied floras of the Pětipsy Area belong to three stratigraphical levels of the Most Basin, i.e. "US" (Series of Underlying Clay and Sand – Procházka 1954); "UISF" (Upper Inter-Seam Formation of the Seam Series – Procházka 1954); "OS" (Series of Overlying Clay and Sand – Procházka 1954) – text-fig. 2.

Locality Holedeč

The locality Holedeč belongs to the area of the Žatec Delta of the Most Basin. Brabenec (1904) described 36 taxa from grey to dark brown clay, i.e. *Salvinia reticulata* (ETT.) HEER, *Salvinia formosa* HEER, *Taxodium dubium* HEER, *Glyptostrobus europaeus* (BRONGN.) HEER, *Populus attenuata* A. BR., *Populus heeri* SAP., *Salix lavateri* HEER, *Salix denticulata* HEER, *Salix augusta* A. BR., *Salix tenera* A. BR., *Juglans acuminata* A. BR., *Carya bohemica* BRABENEC, *Carya bilinica* (UNG.) ETT., *Pterocarya denticulata* (WEB.) HEER, *Carpinus grandis* UNG., *Ulmus longifolia* UNG., *Ulmus braunii* HEER, *Planera ungeri* ETT., *Ficus truncata* HEER, *Persoonia firma* HEER, *Dryandra acutiloba* ETT., *Santalum styriacum* ETT., *Liquidambar europaeum* A. BR., *Acacia beneschi* BRABENEC, *Rhus meriani* HEER, *Rhus elegans* VELEN., *Paliurus friči* BRABENEC, *Evonymus proserpinae* ETT., *Acer trilobatum* A. BR., *Acer rüminianum* HEER, *Acer magnum* VELEN., *Acer nervatum* VELEN., *Acer decipens* A. BR., *Aesculus palaeocastanum* ETT., *Vitis teutonica* A. BR., *Porana macrantha* HEER var *punctata* BRABENEC. The original profile was drawn by J. Beneš (in Brabenec 1904, p. 2). Unfortunately, the published profile and location are insufficient for precious lithological connection to sediments of the "Hlavačov Gravel and Sand", Upper Inter-Seam Member of the Most Formation or the Overlying Formation (Hurník and Marek 1962) – see below. Later, Bůžek and Kvaček (1989a) proved leaves of *Fagus attenuata* GOEPP. ssp. *seussensis* KNOBLOCH (i.e. *Fagus saxonica* Z. KVAČEK et WALTHER) including cupules (i.e. *Fagus deucalionis* UNG.) from this locality that was the only unequivocal record of beech from the Most Basin for a long time (cf. locality Přívlaky). Some leaf material, collected by Brabenec, was revised by Bůžek (1971), i.e. *Liquidambar europaea* A. BR., *Leguminosites tobischii* ENGELH., *Populus* aff. *heeri* SAP., *Paliurus tiliaefolius* (UNG.) BŮŽEK, *Acer integerrimum* (VIVIANI) MASSALONGO and *Koelreuteria reticulata* (ETT.) EDWARDS; and by Procházka and Bůžek (1975) – i.e. *Acer integerrimum* (VIVIANI) MASSALONGO sensu PROCHÁZKA et BŮŽEK, *Acer tricuspidatum* BRONN sensu PROCHÁZKA et BŮŽEK, *Acer dasycarpoides* HEER sensu PROCHÁZKA et BŮŽEK and *Acer pseudomonspessulanum* UNG. Teodoridis (2000, 2002) worked out the complete revision of all the available material from this locality (table 2) including the detailed reconstruction of the vegetation cover (Teodoridis 2002, p. 133, text-fig. 5). A predominate occurrence of *Salvinia reussii* in association with *Stratiotes kaltennordheimensis* (also known from the locality Klínec) shows a low dynamic sedimentary regime interpreted as the regime of oxbow lakes or distal part of inland delta and ecologically mated to aquatic association or canebrakes. This sedimentary interpretation also corresponds with the obvious increase of relatively thermophilous elements, e.g. *Leguminosites tobischii*, *Podocarpium podocarpum*, *Wisteria* aff. *fallax*, *Koelreuteria reticulata*, *Acer dasycarpoides*, *Acer pseudomonospessulanum*, *Chaneya oeningensis*, *Paliurus tiliaefolius* in comparison with the deciduous, riparian elements. Teodoridis and Kvaček (in press) described a new element – *Chaneya oeningensis* (UNG.) TEODORIDIS et Z. KVAČEK, which is known also from the locality Čermníky and Břešťany.

Locality Záhoří near Žatec

The locality is situated in the wider vicinity of the town of Žatec, about 1.5 km northwest and 7 km southeast from

the dam-wall of the Nechranice Reservoir (Text-fig. 1). Plant occurrences were probably found in sedimentary outcrops that are located on the left bank of the downcutting of the Ohře River. The plant-bearing sediments are monotonous. The most common is silty claystone that is grey to whitish in colour and yellowish sandstone. Brabenec collected only this plant material in 1905 without preliminary determinations. Teodoridis (2003a, unpubl.) revised this material including a detailed reconstruction of the vegetation cover (Teodoridis 2003a, p. 266). The flora has yielded 24 taxa (3 conifers, 19 dicots and 2 taxa of uncertain stratigraphical position), i.e. *Taxodium dubium* (STERNB.) HEER, *Glyptostrobus europaeus* (BRONGN.) UNG., *Quasisequoia couttsiae* (HEER) KUNZMANN, *Laurophyllum* sp., *Daphnogene cinnamomifolia* UNG. f. *cinnamomifolia*, *Liquidambar europaea* A. BR., "*Parrotia*" *pristina* (ETT.) STUR sensu BŮŽEK, *Carya serrifolia* (GOEPP.) KRÄUSEL, *Carya* cf. *serrifolia* (GOEPP.) KRÄUSEL, *Betula* sp., *Alnus julianiformis* (STERNB.) Z. KVAČEK et HOLÝ, cf. *Alnus* sp. sensu BŮŽEK, *Comptonia difformis* (STERNB.) BERRY, cf. *Salix haidingeri* ETT. emend. BŮŽEK, *Populus populina* (BRONGN.) KNOBLOCH, *Ulmus pyramidalis* GOEPP., *Zelkova zelkovifolia* (UNG.) BŮŽEK et KOTLABA, *Podocarpium podocarpum* (A. BR.) HERENDEEN, cf. *Wisteria* aff. *fallax* (NATHORSI) TANAI et ONOE, *Paliurus tiliaefolius* (UNG.) BŮŽEK, *Acer integerrimum* (VIVIANI) MASSALONGO, *Acer dasycarpoides* HEER sensu PROCHÁZKA et BŮŽEK, "*Viburnum*" *atlanticum* ETT. and "*Ficus*" *truncata* HEER sensu BŮŽEK – table 3.

Table 3. Summary of the floristic composition on the localities Záhoří near Žatec and Přívlaky. Symbols: ♣ – present, ♣♣ – rare, ♣♣♣ – common.

Taxa	Localities	
	Záhoří near Žatec	Přívlaky
Acer dasycarpoides	♣♣	♣
Acer integerrimum	♣♣	–
Alnus julianiformis	♣♣	–
Alnus sp.	♣	♣♣♣
Betula sp.	♣♣♣	♣♣♣
Carpinus grandis	–	♣
Carya cf. *serrifolia*	♣♣	♣♣
Carya serrifolia	♣♣	–
Cercidiphyllum crenatum	–	–
Comptonia difformis	♣♣	♣♣♣
Daphnogene cinnamomifolia	♣♣	–
Diospyros brachysepala	–	♣
Fagus saxonica	–	♣♣♣
"Ficus" truncata	♣	–
Glyptostrobus europaeus	♣♣	–
Laurophyllum sp.	♣♣♣	–
Liquidambar europaea	♣♣	♣♣
Myrica sp.	–	♣
Paliurus tiliaefolius	♣	–
"Parrotia" pristina	♣	♣♣
Podocarpium podocarpum	♣	♣♣♣
Populus populina	♣♣	♣♣
Quasisequoia couttsiae	♣	–
Rosa europaea	–	♣♣
Salix haidingerii	♣♣	♣♣♣
Sapindus facifolius	–	♣♣
Taxodium dubium	♣♣	–
cf. *Toxicodendron* sp.	–	♣
Ulmus pyramidalis	♣♣	♣♣♣
"Viburnum" atlanticum	♣	–
Vitis stricta	–	♣
Wisteria aff. *falax*	♣♣	–
Zelkova zelkovifolia	♣	♣♣♣

Locality Přívlaky

Přívlaky is situated in the area of Žatec, about 4.5 km northwest of Žatec and 3.7 km southeast of the dam-wall of the Nechranice Reservoir (Text-fig. 1). Plant occurrences were found in the old sandpit (about 250 m from the chapel) and on sedimentary outcrops in the downcutting of the Ohře River (outcrops above the village of Přívlaky). Fossiliferous sediments are silty claystone to sandy siltstone that are grey and yellowish in colour. Setting of sediments can be interpreted as distal parts of delta bodies in lacustrine regime, contrary to former author's opinion (distal crevasse splays) based on Rajchl (personal communication 2001). This locality occurs in an area of obvious interaction of "true" delta and lacustrine sediments /the Libkovice Member of the Most Formation (Domácí 1977)/ – Rajchl personal communication (2003). The first palaeobotanical research was carried out by Konrádová (1959), who described 18 taxa from this locality, i.e. *Salvinia* sp., *Taxodium miocenicum* HEER, *Populus* sp., *Salix angusta* A. BR., *Myrica acutiloba* (STERNB.) SCHP., *Myrica* cf. *salicina* A. BR., *Juglans acuminata* A. BR., cf. *Betula* sp., cf. *Alnus* sp., *Quercus* sp., *Ulmus longifolia* UNG., *Zelkova ungeri* KOV., cf. *Ficus tiliaefolia* A. BR., *Liquidambar europaeum* A. BR., *Parrotia pristina* ETT., *Acer dasycarpoides* HEER f. *angustilobum* PROCHÁZKA, cf. *Diospyros brachysepala* A. BR. and Poaceae sp. Unfortunately, this material is missing. Z. Kvaček (personal communication) determined some of the leaf material from this area as *Fagus saxonica* Z. KVAČEK et WALTHER, which was collected by the former curator of the Litvínov Museum, M. Sládek in 1983. Later Z. Kvaček's team in 1998–99, collected further material which has become the main object for author's floristic study including the reconstruction of vegetation cover (Teodoridis in press). The flora from Přívlaky has yielded 23 taxa (1 coniferous and 22 dicots), i.e. *Taxodium dubium* (STERNB.) HEER, *Liquidambar europaea* A. BR., "*Parrotia*" *pristina* (ETT.) STUR sensu BŮŽEK, *Fagus saxonica* Z. KVAČEK et WALTHER, *Betula* sp., *Alnus* sp. sensu BŮŽEK, cf. *Myrica* sp., *Comptonia difformis* (STERNB.) BERRY, *Carya* cf. *serrifolia* (GOEPP.) KRÄUSEL, cf. *Diospyros brachysepala* A. BR. sensu HANTKE, *Salix haidingeri* ETT. emend. BŮŽEK, cf. *Populus populina* (BRONGN.) KNOBLOCH, *Populus* sp., *Ulmus pyramidalis* GOEPP., *Zelkova zelkovifolia* (UNG.) BŮŽEK et KOTLABA, *Rosa europaea* (ETT.) Z. KVAČEK et HURNÍK, *Podocarpium podocarpum* (A. BR) HERENDEEN, cf. *Vitis stricta* (GOEPP.) KNOBLOCH, cf.

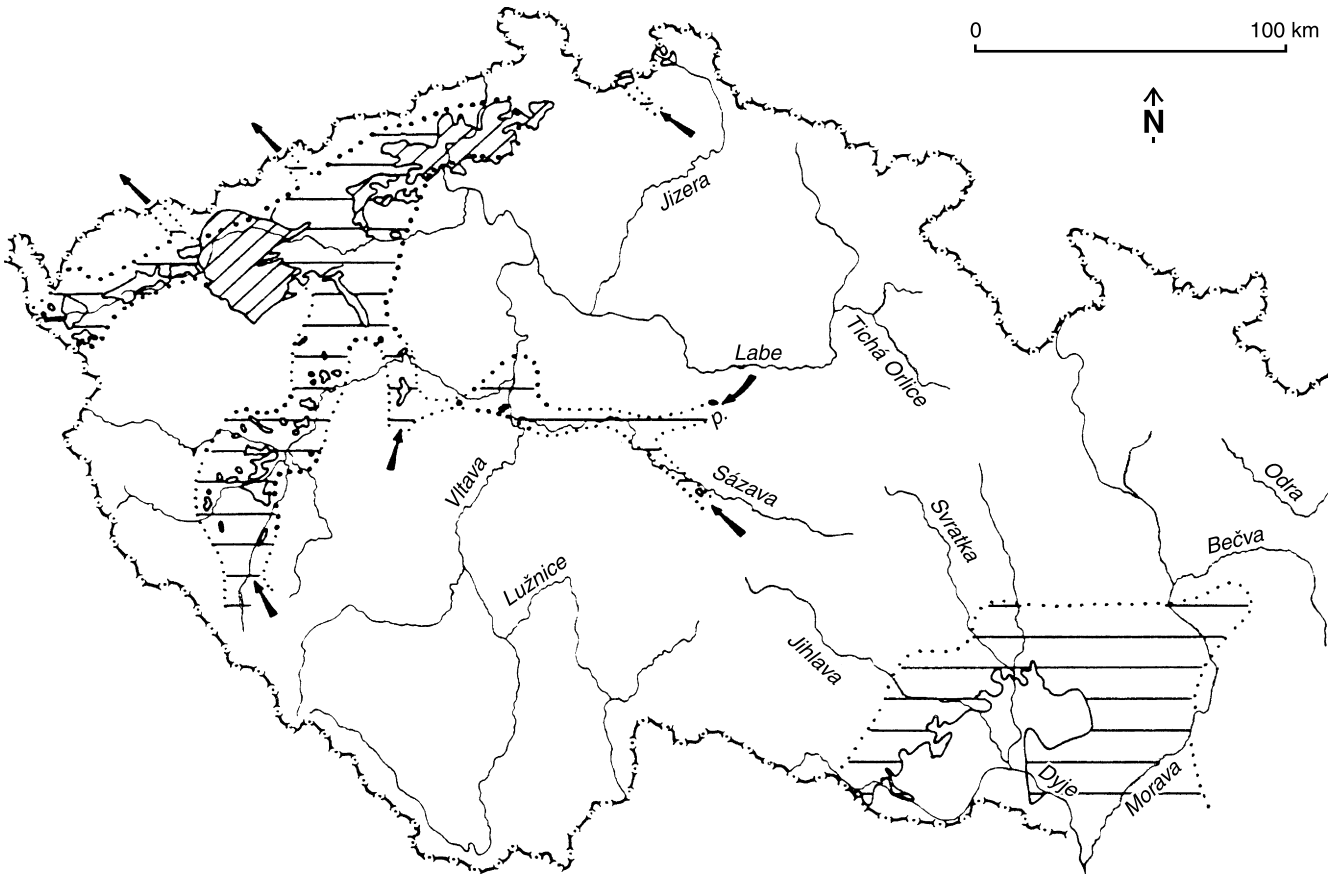
Toxicodendron sp., "*Sapindus*" *falcifolius* (A. BR.) A. BR., *Acer dasycarpoides* HEER sensu PROCHÁZKA et BŮŽEK, *Dicotylophyllum* sp. 1 and *Dicotylophyllum* sp. 2 – Teodoridis (in press); table 3.

The flora of Přívlaky is interesting in having absolute dominance of dicotyledons in contrary to conifers and ferns (so far 3 incomplete twigs of *Taxodium dubium* recovered and unsubstantiated the occurrence of *Savinia* sp. in Konrádová 1959). This fact can be explained by the absence of typical mixed swamp forest often overlapping to the association of aquatic vegetation that matches also to present sedimentary character of the locality Přívlaky.

Locality Čermníky

A collection of the fossil plants from the vicinity of the village of Čermníky (today flooded by water of the Nechranice Reservoir) is the richest locality of the Pětipsy Area. The locality consists of 25 isolated outcrops and dug pits (detailed in Bůžek 1971, pp. 19–21) which were situated on the left bank of the Ohře River eastward from the village. These floras belong to three different stratigraphical levels, i.e. "US", "UISF" and "OS". The sedimentary and stratigraphical backgrounds are characterised in detail by Procházka (1954, 1955, 1956) and Bůžek (1959, 1971). Jokély (1858) probably first noted the fossil flora from Čermníky. He described *Comptonia acutiloba* BRONGN., *Carpinus betuloides* UNG., *Ulmus minuta* GOEPP., *Populus mutabilis* A. BR. and *Ceanothus tiliaefolius* UNG.; however, the original material is missing and the laconic localisation and stratigraphical position are not precisely known. Procházka (1954, 1955, 1956) collected a great quantity of fossil plant material from Čermníky and described from "US" – *Taxodium distichum miocenicum* HEER, *Liquidambar europaeum* A. BR. and *Ulmus longifolia* Ung; from "UISF" – *Osmunda heeri* Gaudin, *Salvinia formosa* HEER, *Lastraea stiriaca* (UNG.) HEER, *Taxodium miocenicum* HEER, *Taxodium distichum miocenicum* HEER, *Glyptostrobus europaeus* HEER, *Sequoia langsdorfi* HEER, *Cercidiphyllum crenatum* (UNG.) BROWN, *Comptonia acutiloba* BRONGN., *Juglans acuminata* A. BR., cf. *Pterocarya denticulata* (WEB) HEER, *Betula prisca* ETT., *Alnus feroniae* (UNG.) CZECZOTT, *Alnus* cf. *feroniae* (UNG.) CZECZOTT, *Corylus insignis* HEER, *Fagus* sp., *Parrotia pristina* ETT., *Parrotia pseudopopulus* ETT., cf. *Parrotia pseudopopulus* ETT., *Liquidambar europaeum* A. BR., *Ulmus longifolia* UNG., *Ulmus* sp., *Zelkova ungeri* KOV., cf. *Ficus tiliaefolia* A. BR., cf. *Ficus truncata* HEER, *Laurus reussii* ETT., *Laurus agathophyllum* ETT., *Persea speciosa* HEER, cf. *Persea speciosa* HEER, *Cinnamomum* sp., *Podogonium knorri* HEER, *Leguminosae* div. sp., *Salix angusta* A. BR., *Populus heeri* SAP., *Rhamnus* sp., *Zizyphus tiliaefolius* (UNG.) HEER, cf. *Pistacia bohemica* ETT., *Acer trilobatum* (STERNB.) A. BR., *Acer dasycarpoides* HEER f. *angustiloba* PROCHÁZKA, *Acer palaeopictum* PROCHÁZKA, *Acer decipiensis* A. BR., *Smilax grandifolia* UNG. and *Smilax* sp.; and from "OS" – *Pinus rigios* UNG., *Glyptostrobus europaeus* HEER, *Comptonia acutiloba* BRONGN., *Ulmus* sp. and *Acer* sp. Later Bůžek (1959) partly supplemented the floristic composition of "UISF" and described *Taxodium miocenicum* HEER, *Sequoia langsdorfi* HEER, *Alnus feroniae* (UNG.) CZECZOTT, *Parrotia pristina* ETT., *Ulmus longifolia* UNG., *Acer palaeopictum* PROCHÁZKA, *Zelkova ungeri* KOV., *Comptonia diforme* (STERNB.) BERRY and Poaceae div. sp.

Bůžek (1971) completely revised the original material of Procházka from Čermníky including descriptions of new plant material within the framework of his Ph. D. thesis. He described the following taxa from "US" – *Taxodium dubium* (STERNB.) HEER, *Ulmus pyramidalis* GOEPP., *Liquidambar europaea* A. BR.; from "UISF" – *Osmunda parschlugiana* (UNG.) Andreánszky, *Salvinia mildeana* GOEPP., *Woodwardia muensteriana* (C. PRESL in STERNB.) KRÄUSEL, *Abacopteris stiriaca* (UNG.) Ching, *Taxodium dubium* (STERNB.) HEER, *Glyptostrobus europaeus* (BRONGN.) UNG., cf. *Mahonia* sp., *Cercidiphyllum crenatum* (UNG.) Brown, *Myrica* sp., *Comptonia acutiloba* BRONGN., *Juglans acuminata* A. BR. ex UNG., *Juglans juglandiformis* (STERNB.) Giebel, *Carya serrifolia* (GOEPP.) KRÄUSEL, *Carya* cf. *serrifolia* (GOEPP.) KRÄUSEL, *Betula* sp., *Alnus* sp., cf. *Corylus insignis* HEER, *Ostrya atlantidis* UNG., *Carpinus grandis* UNG. sensu HEER, "*Parrotia*" *pristina* (ETT.) STUR, *Liquidambar europaea* A. BR., *Ulmus pyramidalis* GOEPP., *Ulmus* sp., *Zelkova zelkovifolia* (UNG.) BŮŽEK et KOTLABA, *Celtis* sp., *Laurophyllum pseudoprinceps* WEYLAND et KILPPER, *Laurophyllum* sp. 1, *Laurophyllum* sp. 2, cf. *Laurophyllum* sp., *Daphnogene bilinica* (UNG.) KVAČEK et KNOBLOCH, *Rosa bohemica* ETT., *Crategus* sp., *Leguminosites tobischii* ENGELH., *Wisteria* aff. *fallax* (NATHORST) TANAI et ONOE, cf. *Colutea* sp., *Diospyros brachysepala* A. BR. sensu HANTKE, *Salix varians* GOEPP., *Salix haidingeri* ETT. emend. BŮŽEK, *Populus populina* (BRONGN.) KNOBLOCH, *Populus* aff. *heeri* SAP., *Dombeyopsis lobata* UNG., *Pteleaecarpum europaeum* (BRONN) BŮŽEK et KNOBLOCH, cf. *Fraxinus* sp., *Trapa* sp., cf. *Rhamnus* sp. [= *Alnus gaudinii* (HEER) KNOBLOCH et KVAČEK in Teodoridis (2003a, table 1)] – table 4., *Berchemia multinervis* (A. BR.) HEER, *Paliurus tiliaefolius* (UNG.) BŮŽEK, cf. *Ampelopsis* sp., cf. *Rhus pyrrhae* UNG., *Acer tricuspidatum* BRONN, *Acer integerrimum* (VIVIANI) MASSALONGO, *Acer dasycarpoides* HEER, *Sapindus falcifolius* (A. BR) A. BR., *Koelreuteria reticulata* (ETT.) EDWARDS, *Nyssa* sp., cf. *Abelia* sp., *Diversiphyllum aesculapi* (HEER) BŮŽEK, *Smilax weberi* WESSEL, *Spirematospermum wetzleri* (HEER) CHANDLER, Poaceae vel Cyperaceae div. gen. et sp., "*Ficus*" *truncata* HEER sensu BŮŽEK, "*Ficus*" *multinervis* HEER, "*Ficus*" *lobkowitzii* ETT. "*Persea*" *spinosa* HEER, "*Viburnum*" *atlanticum* ETT., "*Quercus*" *cruciata* A. BR., "*Musa*" sp., *Podogonium oehningense* (KOENING)



Text-fig. 4. Reconstruction of the Early Miocene River net in the Czech Massif (according to Malkovský 1995) – Late Egerian-Early Karpatian.

KIRCHH., *Phyllites nemejcii* BŮŽEK, *Phyllites kvacekii* BŮŽEK, *Dicotylophyllum* sp. 1, *Dicotylophyllum* sp. 2, *Fructus*, *Fructus* vel *semen*; and from "OS" – *Pinus* sp., *Glyptostrobus europaeus* (BRONGN.) UNG., *Myrica* sp., *Comptonia acutiloba* BRONGN., *Quercus lusatica* JÄHNICHEN, *Daphnogene bilinica* (UNG.) KVAČEK et KNOBLOCH, *Pteleaecarpum europaeum* (BRONN) BŮŽEK et KNOBLOCH, cf. *Rhus pyrrhae* UNG. Bůžek and Kvaček (1974) delt with most of the laurel elements with preserved cuticles in a separate study, where they described from "UISF" – *Laurophyllum nechranicense* BŮŽEK and Z. KVAČEK, *Laurophyllum pseudoprinceps* WEYLAND et KILPPER, *Laurophyllum nemejcii* KVAČEK, *Daphnogene bilinica* (UNG.) KVAČEK et KNOBLOCH, *Laurophyllum* sp. 1, *Laurophyllum* sp. 2, ? *Laurophyllum* sp. 3, ? *Laurophyllum* sp. 4, *Laurophyllum* sp. vel *Daphnogene* sp.; and from "OS" – *Laurophyllum nemejcii* KVAČEK, *Laurophyllum pseudoprinceps* WEYLAND et KILPPER, *Daphnogene bilinica* (UNG.) KVAČEK et KNOBLOCH. The recent taxonomical revision of the locality Čermníky was given by Teodoridis (2003a, table 1) and Teodoridis and Kvaček (in press) – table 4.

Locality Chotěnice

Floras from this locality are based on leaf impressions from two different sites (marked as Cho 14 and 26), which both stratigraphically belong to the Upper Inter-Seam Formation of the Seam Series (Procházka 1954). The first flora from the site Cho 14 was found in brownish grey-yellow sandy clay during excavations, about 500 m NNE from the village Chotěnic near a road to Čachovice. The second outcrop Cho 26 was situated on the left bank of the river Ohře between villages Chotěnice and Běšice. The leaf impressions were confined to yellow to light grey sandy clay. Procházka (1956) described only 6 taxa from both outcrops (*Taxodium miocenicum* HEER, *Glyptostrobus europaeus* HEER, *Zelkova ungeri* KOV., *Salix angusta* A. BR., *Musa* sp., Poaceae div. sp.), which were revised and assigned by Bůžek (1971) to *Taxodium dubium* (STERNB.) HEER, *Glyptostrobus europaeus* (BRONGN.) UNG., *Zelkova zelkovifolia* (UNG.) BŮŽEK et KOTLABA, *Salix haidingeri* ETT. emend. BŮŽEK, "*Musa*" sp. and Poaceae vel Cyperaceae div. gen. et sp., and by Teodoridis (2003a, unpubl) – table 4.

Table 4. Summary of the floristic composition on the localities of the Pětipsy Area in the Žatec Delta (i.e. localities Čermníky, Chotěnice, Lomazice, Dolany, Nechranice and Soběsuky). Symbols: US – the Series of the Underlying Clay and Sand sensu Procházka (1954), UISF – the Upper Inter-Seam Formation of the Seam Series sensu Procházka (1954), OS – the Series of the Overlying Clay and Sand sensu Procházka (1954); ** ♦ – locality Nechranice, ♠ – locality Soběsuky); ♣ – present, ♣♣ – rare, ♣♣♣ – common.

Taxa	Stratigraphical position/Localities						
	US	UISF				OS	
	Čermníky	Čermníky	Chotěnice	Lomazice	Dolany	Čermníky	Dolany**
Acer dasycarpoides	–	♣♣♣	–	–	–	–	–
Acer integerrimum	–	♣♣♣	–	–	–	–	–
Acer tricuspidatum	–	♣♣♣	–	–	♣♣	–	–
cf. *Alnus gaudinii*	–	♣♣♣	–	♣	–	–	–
Alnus sp.	–	♣♣♣	–	–	–	–	♣
cf. *Ampelopsis* sp.	–	♣	–	–	–	–	–
Berchemia multinervis	–	♣♣	–	–	–	–	–
Betula sp.	–	♣♣	–	–	–	–	–
Carpinus grandis	–	♣♣	–	–	–	–	–
Carya cf. *serrifolia*	–	♣♣♣	–	–	–	–	–
Carya serrifolia	–	♣	–	–	–	–	–
Celtis sp.	–	♣♣	–	–	–	–	–
Cercidiphyllum crenatum	–	♣♣	–	–	♣♣	–	–
Comptonia difformis	–	♣♣♣	–	–	–	♣♣	♦♣
Craigia bronnii	–	♣♣	–	–	–	♣	–
Crategus sp.	–	♣	–	–	–	–	–
Daphnogene polymorpha	–	♣♣♣	–	–	–	♣	–
Decodon gibbosus	–	♣	–	–	–	–	–
Dicotylophyllum sp. 1	–	♣♣	–	–	–	–	–
Dicotylophyllum sp. 2	–	♣♣	–	–	–	–	–
Diospyros brachysepala	–	♣♣	–	–	–	–	–
Diversiphyllum aesculapi	–	♣♣	–	–	–	–	–
Dombeyopsis lobata	–	♣♣♣	–	–	♣♣♣	–	–
"Ficus" lobkowitzii	–	♣♣	–	–	–	–	–
"Ficus" truncata	–	♣♣♣	–	–	–	–	–
Fraxinus bilinica	–	♣♣	–	–	♣♣	–	–
cf. *Fraxinus* sp.	–	♣	–	–	–	–	–
Glyptostrobus europaeus	–	♣♣♣	♣♣	♣♣	♣♣	♣♣	♦♦
Chaneya oeningensis	–	♣	–	–	–	–	–
Juglans acuminata	–	♣♣♣	–	–	♣♣	–	–
Koelreuteria reticulata	–	♣	–	–	–	–	–
Laurophyllum nechranicense	–	♣	–	–	–	–	–
Laurophyllum pseudoprinceps	–	♣♣	–	–	–	♣♣	–
Laurophyllum saxonicum	–	♣	–	–	–	♣	–
Leguminosites tobischii	–	♣♣	–	–	–	–	–
Liquidambar europaea	♣	♣♣♣	–	–	–	–	–
Mahonia bilinica	–	♣	–	–	–	–	–
Myrica sp.	–	♣	–	–	–	♣	–
Nyssa haidingeri	–	♣♣	–	–	♣♣♣	–	–
Nyssa ornithobroma	–	♣	–	–	–	–	–
Osmunda parschlugiana	–	♣♣♣	–	–	–	–	–
Ostrya atlantidis	–	♣	–	–	–	–	–
Paliurus tiliaefolius	–	♣♣♣	–	–	–	–	–
"Parrotia" pristina	–	♣♣♣	–	–	–	–	–
Phyllites kvacekii	–	♣♣	–	–	–	–	–
Phyllites nemejcii	–	♣♣	–	–	–	–	–
Pinus sp.	–	–	–	–	–	♣	–
Poaceae vel Cyperaceae div. gen. et sp.	–	♣♣♣	♣♣	–	–	–	–
Podocarpium podocarpum	–	♣♣♣	–	–	–	–	–
Populus populina	–	♣♣	–	–	–	–	–
Populus zaddachii var. *brabenecii*	–	♣♣	–	–	–	–	–
Pronephrium stiricum	–	♣♣	–	–	♣♣	–	–
Pungiphyllum cruciatum	–	♣♣	–	–	–	–	–
Quercus rhenana	–	–	–	–	–	♣♣	–
cf. *Rhus pyrrhae*	–	♣	–	–	–	♣	–
Rosa europaea	–	♣♣	–	–	–	–	–
Rubus vrsovicensis	–	♣	–	–	–	–	–
Salix haidingeri	–	♣♣♣	♣♣	♣♣	–	–	–

Table 4. Continued

Taxa	Stratigraphical position/Localities						
	US	UISF			OS		
	Čermníky	Čermníky	Chotěnice	Lomazice	Dolany	Čermníky	Dolany**
Salix macrophylla	–	–	–	♣	–	–	–
Salix varians	–	♣♣♣	–	–	–	–	–
Salvinia reussii	–	♣♣	–	–	–	–	–
Sapindus falcifolius	–	♣♣	–	–	–	–	–
Smilax weberi	–	♣♣	–	–	–	–	–
Spirematospermum wetzleri	–	♣	–	–	–	–	–
Taxodium dubium	♣♣	♣♣	♣♣	–	♣♣	–	–
?? *Trapa* sp.	–	♣	–	–	–	–	–
Ulmus pyramidalis	♣♣	♣♣♣	–	–	♣♣	–	♣♠♠
Ulmus sp.	–	♣♣	–	–	–	–	–
"Viburnum" atlanticum	–	♣♣	–	–	–	–	–
Wisteria aff. *fallax*	–	♣♣♣	–	–	–	–	–
Woodwardia muensteriana	–	♣♣♣	–	–	♣♣♣	–	–
Zelkova zelkovifolia	–	♣♣♣	♣♣	–	–	–	–
Zingiberoideophyllum liblarense	–	–	♣	–	–	–	–

Locality Lomazice

The locality was a dug pit marked as Lo 355 that was situated near the church in Lomazice along the road to the village Poláky. The flora stratigraphically belongs to the Upper Inter-Seam Formation of the Seam Series (Procházka 1954) and was confined to grey sandy clay. Procházka (1956) described 4 taxa from there, i.e. *Glyptostrobus europaeus* HEER, *Salix angusta* A. BR., *Salix macrophylla* HEER, cf. *Rhamnus heeri* ETT., which were revised by Bůžek (1971) – *Glyptostrobus europaeus* (BRONGN.) UNG., *Salix haidingeri* ETT. emend. BŮŽEK, *Salix macrophylla* HEER, cf. *Rhamnus* sp. [= *Alnus gaudinii* (HEER) KNOBLOCH et KVAČEK in Teodoridis (2003a, table 1)] – Teodoridis (2003a, unpubl.); table 4.

Locality Dolany

Fossil material was obtained from two different places in broader vicinity of the village Dolany (marked as Do 50 and 52). The locality Do 50 was a small gravel-pit westward of the village, where the leaf impressions were confined to red sandy clays and stratigraphically belong to the Upper Inter-Seam Formation of the Seam Series (Procházka 1954). The second locality (Do 52) was also confined to red claystone, belonging to the Series of the Overlying Sand and Clay (Procházka 1954). Procházka (1955, 1956) and Bůžek (1959) described from there *Pteris bilinica* ETT., *Woodwardia roessneriana* (UNG.) HEER, *Taxodium miocenicum* HEER, *Glyptostrobus europaeus* HEER, cf. *Sequoia langsdorfi* HEER, *Cercidiphyllum crenatum* (UNG.) BROWN, cf. *Juglans acuminata* A. BR., cf. *Carya bilinica* (UNG.) ETT., *Alnus gaudinii* (HEER) KNOBLOCH et KVAČEK, cf. *Ficus tiliaefolia* A. BR., *Persea speciosa* HEER, *Acer trilobatum* (STERNB.) A. BR. and *Comptonia diforme* (STERNB.) BERRY (Bůžek 1959) from the locality Do 50 and *Comptonia acutiloba* BRONGN., *Alnus feroniae* (UNG.) CZECZOTT and *Ulmus longifolia* UNG. from the locality Do 52. Later, Bůžek (1971) revised all the available material from Dolany and determined *Woodwardia muensteriana* (C. PRESL in STERNB.) KRÄUSEL, *Abacopteris stiriaca* (UNG.) Ching, *Taxodium dubium* (STERNB.) HEER, *Glyptostrobus europaeus* (BRONGN.) UNG., *Cercidiphyllum crenatum* (UNG.) Brown, *Juglans acuminata* A. BR. ex UNG., *Juglans juglandiformis* (STERNB.) Giebel, *Ulmus pyramidalis* GOEPP., *Dombeyopsis lobata* UNG., *Acer tricuspidatum* BRONN "*Persea*" *spinosa* HEER and *Comptonia acutiloba* BRONGN. from "UISF" and *Comptonia acutiloba* BRONGN., *Alnus* sp. and *Ulmus pyramidalis* GOEPP. from "OS". The recent revision was done by Teodoridis (2003a, unpubl.); table 4.

Locality Soběsuky

The outcrop marked as So 274 is situated on the left bank of the Ohře River, about 900 m NNE from the village of Soběsuky. A leaf impression originally described as *Ulmus longifolia* UNG. (*Ulmus pyramidalis* GOEPP. in Bůžek 1971; Teodoridis 2003a) was collected by Procházka (1956) from a yellow-brown pelosiderite concretion from yellow clay of the Series of the Overlying Clay and Sand (Procházka 1954).

Locality Nechranice

Č. Bůžek collected leaf impressions from this locality in the excavation during the construction of the dam of the Nechranice Reservoir. The material is confined to grey clay, which stratigraphically belongs to the Upper Inter-Seam Member of the Seam Series (Procházka 1954). Bůžek (1971) described 2 taxa from there, i.e. *Glyptostrobus europaeus* (BRONGN.) UNG. and *Comptonia acutiloba* BRONGN. [= *Comptonia difformis* (STERNB.) BERRY in Teodoridis (2003a, table 1)] – table 4.

Phytostratigraphical correlations

Phytostratigraphical correlations of the fluvial sediments

On the basis of general floristic analysis of the floras of the "Hlavačov Gravel and Sand" (table 2), it is possible to correlate the floras of the localities Nesuchyně and Hlavačov with the Late Oligocene floristic assemblage of Thierbach (Mai and Walther 1991). This correlation is based on the occurrence of *Pseudolarix schmidtgenii* and *Fagus saxonica* in association with other elements, e.g. *Trigonobalanopsis rhamnoides*, Taxodiaceae, Betulaceae (cf. table 2 and Mai and Walther 1991, pp. 147–161 and 153, 161–166; Kvaček and Walther 2001, tables 6 and 7). The association of *Pseudolarix schmidtgenii* and *Fagus saxonica* does not occur in other floras of the "Hlavačov Gravel and Sand", where *Pseudolarix schmidtgenii* was missing. Nevertheless, the only presence of *Fagus saxonica* as an important Late Oligocene element is not enough significant in view of new stratigraphical data from the locality Přívlaky (see below). This is in contrary to the former author's - opinion (Teodoridis 2002, 2003a, in press). Insufficient investigation and incomplete fossil collections can explain better the absence of *Pseudolarix schmidtgenii* in the localities (i.e. Velká Černoc, Sádek and Želeč) rather than some speculation about different character and composition of these floras, which would be probably caused by specific abiotic factors of the biotopes, or eventually different (probably younger) character of this flora. Isochronous character of the floras of the "Hlavačov Gravel and Sand" can be proved by continual sedimentation of this belt and similarity in the floristic composition of these floras (table 2). Very interesting fact supporting this floristic correlation is the similarity in spectra of heavy minerals of the "Hlavačov Gravel and Sand" (Čadek 1966) and the Thierbach Beds (Ahrens et al. 1974), which was at first published by Lotsch et al. (1994). The team of German authors supposed a possibility of the mutual association and genesis of both river systems and interpreted the Central River (Pešek and Spudil 1986) to be connected over central part of the Most Basin and Krušné hory Mts. with sediments of the Thierbach River in a single great river system. This concept was proved by new sedimentological investigations in the Žatec Delta connecting the deposits of the "Hlavačov Gravel and Sand" with the basal delta sediments (Váně 1985, pp. 212–214) and occurrence of clastic deposits (gravel, sand) in the underlying of the Seam Formation (Hurník and Marek 1962); Mach, Rajchl (personal communication 2002). These clastic underlying sediments can be interpreted either in a direct context to the above mentioned great river system or as northeast sedimentary equivalent of the "Hlavačov Gravel and Sand" river system when accepting the objections published in Suhr (2003). He noticed an incompatibility of the "Hlavačov Gravel and Sand" and Thierbach Beds based on other possible sources of some heavy minerals in Germany and a new sedimentary model of the Inland Delta for the fluvial system acting during the set of sediments of the Basal Coal Seam (Váně 1987). It is possible to correlate all floras of the "Hlavačov Gravel and Sand" with the flora of the locality Borna-Ost, i.e. the type locality of the Thierbach floristic assemblage (Mai and Walther 1991) and the locality Witznitz, which corresponds to the floristic assemblage of Witznitz (Mai and Walther 1991). The macropalaeontological data from the Underlying Formation and Lower Sandy Clayey Beds with Basal Coal Seam (Hurník and Marek 1962) are absolutely insufficient for phytostratigrafical correlation (Bůžek 1971; table 4). However, the palynological data from these sediments of the lower part of the Most Formation sensu Shrbený (1994) show, besides relative common Miocene elements, also maximal abundance of *Fagus* pollen that occurred less frequently also in the middle and upper parts of the Most Formation (Shrbený 1994); Konzalová (1976). On the basis of this *Fagus* pollen maximum and the above-mentioned facts of the sedimentary connection of the "Hlavačov Gravel and Sand", it is possible to correlate these deposits stratigraphically to the Basal Coal Seam (Váně 1987) and its clastic equivalents that belong to the sediments of the Duchcov Member and the lower part of the Holešice Member (Domácí 1977) – text-fig. 2. Generally, the belt of the "Hlavačov Gravel and Sand" can be interpreted as an erosionally exposed lowermost part of the fluvial system that brought the clastic material into the area of the Most Basin during depositon of the Underlying Formation and the Lower Sandy Clayey Beds with the Basal Coal Seam (Hurník and Marek 1962) that belong to the Duchcov Member and the Lower part of the Holešice Member (Domací 1977).

The classification of fluvial sediments from the area of Central Bohemia comes out from a concept that distinguished two different stratigraphical phases, i.e. the Klínec Phase (the Miocene age palaeobotanically fixed – e.g. Kettner 1911, Němejc 1943) and the Zdiby Phase (the Pliocene age without palaeobotanical proofs – Kodym and Matějka 1920). According to Žebera (1972) and Žák et al. (2001) the occurrence of tektites (impact before 15 MA – Balestrieri et al. 1998) in sediments of the Zdiby phase in Prague-Kobylisy revalues the age of these sediments to the Middle Miocene or ? younger). This classical concept was generally accepted due to absence of palaeobotanical data in most of the Tertiary sedimentary relics in Central Bohemia. According to the floristic analysis of all available palaeobotanical material and newly-collected material, Němejc (1949) corroborated the classification of the fluvial Tertiary relics in Central Bohemia and re-defined the stratigraphical ranges of the Klínec and Zdiby Phases and its equivalents (in Klínec Phase) in the Most Basin, i.e. the Klínec Phase, Lower Miocene, Overlying Formation (Hurník and Marek 1962) of the Most Basin, the Zdiby phase, Upper Pliocene to Lower Pleistocene. Němejc (1949) assigned only the locality of U Sv. Antonína into the Zdiby phase based on the occurrence of leaf impressions that he determined as *Fagus sylvatica* L. (Teodoridis 2001). Later, Nemějc (1964) re-defined stratigrafically the Klínec Phase and correlated it with the Mydlovary Formation (Lower Badenian). Holý and

Bůžek (1966) critically evaluated the Němejc opinion and defined the Klínec Phase using detailed palaeobotanical study of the Žatec Facies (presence of *Stratiotes kaltennordheimensis*) and correlated it to the sediments of the Lower part of the Seam Series (Procházka 1954). Teodoridis (2001) and Žák et al. (2003) noticed the similarity in the floristic composition of fluvial relics in Central Bohemia, i.e. Klínec, Na Sulavě and "U ručiček" with the floras of the "Hlavačov Gravel and Sand" (cf. tables 1 and 2; table 5) and therefore these floras could be correlated with the floristic assemblages of Thierbach and Witznitz (Mai and Walther 1991) or Linz-Krumvíř sensu Kvaček and Walther (2001). On the other hand, it is unequivocal that the floras described from fluvial islands contain very common elements of Early Miocene that are known from the localities belonging stratigraphically to the Seam Series (Procházka 1954), i.e. the Main Coal Seam (Elznic et al. 1986) – text-fig. 2, or the Overlying Formation (Hurník and Marek 1962), e.g. the localities Čermníky (Bůžek 1971), Želénky (Kvaček and Hurník 2000), Bílina (Kvaček 1998, Sakala 2000) etc. Therefore the suggested phytostratigraphical correlation of the Tertiary fluvial sediments from Central Bohemia with the floristic assemblages of Boreal Europe and deposits of the Most Basin has speculative character.

Phytostratigraphical correlations of the Žatec Delta

The locality Holedeč belongs to the area of the Žatec Delta (the Most Basin); however, Váně (1985) considered this locality to be a common tectonically isolated component of the "Hlavačov Gravel and Sand". The flora of Holedeč is confined to clay lenses that are lithologically similar to the material from the nearby locality Záhoří near Žatec. However, the lithological similarities cannot be used for correlation of the Holedeč flora. The interpretation of *Fagus saxonica* from Holedeč as a connecting element with the floras of the "Hlavačov Gravel and Sand" is equivocal due to new sedimentological interpretation of the Přívlaky flora (see below, cf. Teodoridis in press). The floristic composition of the Holedeč flora shows considerable differences from those of the "Hlavačov Gravel and Sand" in having new species e.g. *Populus populina*, *Rosa europaea*, *Rubus merianii*, *Leguminosites tobischii*, *Podocarpium podocarpum*, *Wisteria* aff. *fallax*, *Koelreuteria reticulata*, *Acer dasycarpoides*, *Acer pseudomonospessulanum*, *Chaneya oeningensis*, *Paliurus tiliaefolius*, "*Ficus*" *truncata* and ? *Persoonia* sp. These taxa are common in the partial flora of Čermníky from the Upper Inter-Seam Member of the Most Formation, which belongs to the Upper part of the Holešice Member (Domací 1977) [cf. table 5] and can be interpreted as connecting elements of both floras important for correlation. Similarly as Holedeč, the flora of Záhoří near Žatec can be correlated with the flora of Čermníky belonging to the Upper part of the Holešice Member (Domací 1977). The correlation is based on floristic analysis of both floras (cf. tables 3 and 5) and on identical lithostratigraphical position (Text-fig. 5).

The flora of the locality Přívlaky contains several elements (cf. tables 3 and 5) that occur as common elements in floras of the Pětipsy Area and floras of the "Hlavačov Gravel and Sand" (table 5). However, based on detailed study of the drilling documentation (Kliner and Würmová 1975) and profiles (Collective of authors 1980) from this area, it is possible to correlate the locality of Přívlaky to the lowermost part of the Overlying Formation (Hurník and Marek 1962), i.e. basal part of the Libkovice Member of the Most Formation (Domácí 1977) without doubt (Text-fig. 5). A possible floristic equivalent with sediments of the Most Basin is the flora from the cores of MR 59, MR 58, LoM 16 and Os 9 that stratigraphically belongs to deposits closely underlying the Lom Seam within the Libkovice Member of the Most Formation (Bůžek et al. 1993). These floras have subtropical character and are usually correlated with the floristic assemblage of Eichelskopf-Wiesa sensu Mai (1995), floristic zone VI sensu Mai (1967) /Eggenburgian-Ottnangian/. Alternatively and more probably, equivalents are the potential floras from lower part of the Overlying Formation (Hurník and Marek 1962), i.e. floras of the lowermost part of the Libkovice Member from NW bank of the Nechranice Reservoir. These floras contain common basin elements, e.g. *Nyssa haidingeri*, *Taxodium dubium*, *Glyptostrobus europaeus*, *Alnus julianiformis* and *Ulmus pyramidalis* Teodoridis (unpubl.). This correlation is proved both by similarity of palaeofloristic composition and the identical stratigraphical position of Přívlaky (i.e. closely overlying the Seam Series – Procházka 1954).

Floras of the Pětipsy Area (Žatec Delta) belong to the three stratigraphically different positions in sedimentary filling of the Most Basin, i.e. the Series of the Underlying Clay and Sand (Procházka 1954) – locality Čermníky; the Upper Inter-Seam Coal Formation of the Seam Series (Procházka 1954) – localities Čermníky, Chotěnice, Lomazice and Dolany; and the Series of the Overlying Clay and Sand (Procházka 1954) – Čermníky, Dolany, Soběsuky and Nechranice (table 4, for next stratigraphical equivalents see text-fig. 2).

On the basis of analogy of the floristic composition, it is possible to correlate the floras of the Upper Inter-Seam Coal Formation of the Seam Series (Procházka 1954) with the floristic assemblages of Bílina-Brandis (Mai 1995) and/or Bitterfeld (Mai and Walther 1991). The occurrence of the index fossil *Schenkiella credneri* in the floristic assemblage of Bílina-Brandis and its absence in floras of the floristic assemblage Bitterfeld defines unequivocally the borderline between both assemblages. Wójcicki and Kvaček (2002) completely revised all Bohemian occurrences of *Schenkiella credneri* and exactly defined the basal borderline of the floristic assemblage Bílina-Brandis within the framework of the Most Basin deposits. This taxon is known from fossiliferous horizons Nos. 21 and 24 sensu Bůžek et al. (1992) and from the close overlying sediments of the Main Coal Seam (Elznic et al. 1986) [= the Seam Series sensu Procházka (1954) in the Maxim Gorkij Mine (Wójcicki and Kvaček 2002)]. Based on this fact, it is possible to safely correlate

Table 5. Summary of the floristic composition on the localities of the studied area. Symbols: US – the Series of the Underlying Clay and Sand sensu Procházka (1954), UISF – the Upper Inter-Seam Formation of the Seam Series sensu Procházka (1954), OS – the Series of the Overlying Clay and Sand sensu Procházka (1954); ** (localities Klínec, Na Sulavě, and "U ručiček); ♣ – present, ♣♣ – rare, ♣♣♣ – common.

Taxa	Localities							
	Záhoří near Žatec	Pětipesy Area			Přívlaky	Holedeč	"Hlavačov Gravel and Sand"	Fluvial sediments of Central Bohemia **
		US	UISF	OS				
Acer dasycarpoides	♣	–	♣	–	♣	♣	–	–
Acer integerrimum	♣	–	♣	–	–	♣	♣	–
Acer pseudomonospessulanum	–	–	–	–	–	♣	–	–
Acer tricuspidatum	–	–	♣	–	–	♣	♣	–
Ailanthus confucii	–	–	–	–	–	♣	♣	–
cf. *Alnus gaudinii*	–	–	♣	–	–	–	–	–
Alnus julianiformis	♣	–	–	–	–	♣	♣	♣
Alnus kefersteini	–	–	♣	–	–	♣	♣	–
Alnus sp.	♣	–	♣	♣	♣	♣	♣	♣
cf. *Ampelopsis* sp.	–	–	♣	–	–	–	–	–
Berchemia multinervis	–	–	♣	–	–	–	–	–
Betula sp.	♣	–	♣	♣	♣	♣	♣	♣
Carpinus grandis	–	–	♣	–	♣	♣	♣	–
Carya cf. *serrifolia*	♣	–	♣	–	♣	♣	–	♣
Carya serrifolia	♣	–	♣	–	–	♣	♣	–
cf. *Castanea atavia*	–	–	–	–	–	–	♣	–
Celtis sp.	–	–	♣	–	–	–	–	–
Cercidiphyllum crenatum	–	–	♣	♣	–	–	–	–
Comptonia difformis	♣	–	♣	♣	♣	♣	♣	–
Craigia bronnii	–	–	♣	–	–	–	–	–
Crategus sp.	–	–	♣	–	–	–	–	–
Daphnogene cinnamomifolia	♣	–	♣	♣	–	♣	♣	♣
Decodon gibbosus	–	–	♣	–	–	–	–	–
Diospyros brachysepala	–	–	♣	–	♣	–	–	–
Diversiphyllum aesculapi	–	–	♣	–	–	–	–	–
Dombeyopsis lobata	–	–	♣	–	–	–	–	–
Fagus deucalionis	–	–	–	–	–	♣	♣	–
Fagus saxonica	–	–	–	–	♣	♣	♣	–
"Ficus" lobkowitzii	–	–	♣	–	–	–	–	–
"Ficus" truncata	♣	–	♣	–	–	♣	–	♣
Fraxinus bilinica	–	–	♣	–	–	–	–	–
cf. *Fraxinus* sp.	–	–	♣	–	–	–	♣–	–
Glyptostrobus europaeus	♣	–	♣	♣	–	♣	♣	♣
Chaneya oeningensis	–	–	♣	–	–	♣	–	–
Juglans acuminata	–	–	♣	–	–	♣	♣	–
Koelreuteria reticulata	–	–	♣	–	–	♣	–	–
Laurophyllum nechranicense	–	♣	–	–	–	–	–	
Laurophyllum pseudoprinceps	?♣	–	♣	–	–	–	–	–
Laurophyllum saxonicum	?♣	–	♣	–	–	–	–	–
Leguminosites tobischii	–	–	♣	–	–	♣	–	–
Liquidambar europaea	♣	♣	♣	–	♣	♣	♣	♣
Mahonia bilinica	–	–	?♣	–	–	–	♣	–
Myrica sp.	–	–	♣	♣	♣	–	♣	♣
Nyssa haidingeri	–	–	♣	–	–	–	–	–
Nyssa ornithobroma	–	–	♣	–	–	–	–	–
Osmunda parschlugiana	–	–	♣	–	–	–	–	–
Ostrya atlantidis	–	–	♣	–	–	–	–	–
Paliurus tiliaefolius	♣	–	♣	–	–	♣	–	–
"Parrotia" pristina	♣	–	♣	–	♣	–	–	–
? *Persoonia* sp.	–	–	–	–	–	♣	–	–
Phyllites kvacekii	–	–	♣	–	–	–	–	–
Phyllites nemejcii	–	–	♣	–	–	–	–	–
Pinus sp.	–	–	–	♣	–	–	♣	–
Poaceae vel *Cyperaceae*	–	–	♣	–		♣	♣	–
Podocarpium podocarpum	♣	–	♣	–	♣	♣	–	♣
Populus populina	♣	–	♣	–	♣	♣	–	–
Populus zaddachii var. *brabenecii*	–	–	♣	–	–	♣	♣	♣
Pronephrium stiricum	–	–	♣	–	–	–	–	–
Pseudolarix schmidtgenii	–	–	–	–	–	–	♣	–

Table 5. Continued.

Taxa	Localities							
	Záhoří near Žatec	Pětipesy Area			Přívlaky	Holedeč	"Hlavačov Gravel and Sand"	Fluvial sediments of Central Bohemia **
		US	UISF	OS				
Pungiphyllum cruciatum	–	–	–	♣	–	–	–	–
Quasisequoia couttsiae	♣	–	–	–	–	–	–	–
Quercus rhenana	–	–	♣	–	–	–	–	–
cf. *Rhus pyrrhae*	–	–	♣	–	–	–	–	–
Rosa europaea	–	–	♣	–	♣	♣	–	–
Rubus meriani	–	–	–	–		♣	–	–
Rubus vrsovicensis	–	–	♣	–	–	–	–	–
Salix haidingerii	♣	–	♣	–	♣	♣	♣	♣
Salix macrophylla	–	–	♣	–	–	–	♣	–
Salix varians	–	–	♣	–	–	♣	♣	♣
Salvinia reussii	–	–	♣	–	–	♣	♣	♣
Sapindus facifolius	–	–	♣	–	♣	♣	♣	–
Smilax weberi	–	–	♣	–	–	–	–	♣
Spirematospermum wetzleri	–	–	–	–	–	–	–	–
Stratiotes kaltennordheimensis	–	–	–	–	–	♣	–	♣
Taxodium dubium	♣	♣	♣	–	–	♣	♣	♣
Tetraclinis salicornioides	–	–	–	–	–	–	♣	–
Tilia brabenecii	–	–	–	–	–	–	♣	–
cf. *Toxicodendron* sp.	–	–	♣	–	♣	–	–	–
? *Trapa* sp.	–	–	♣	–	–	–	–	–
cf. *Trigonobalanopsis rhamnoides*	–	–	–	–	–	–	♣	–
Ulmus pyramidalis	♣	♣	♣	♣	♣	♣	♣	♣
Ulmus sp.	–	–	♣	–	–	–	–	–
"Viburnum" atlanticum	♣	–	♣	–	–	♣	♣	–
Vitis stricta	–	–	–	–	♣	♣	♣	–
Wisteria aff. *fallax*	♣	–	♣	–	–	♣	–	–
Woodwardia muensteriana	–	–	♣	–	–	–	♣	–
Zelkova zelkovifolia	♣	–	♣	–	♣	♣	♣	–
Zingiberoideophyllum liblarense	–	–	?♣	–	–	–	♣	–

floras of the Přívlaky (Text-fig. 5) and the floras of the Pětipsy Area, which belong to the Overlying Formation (Hurník and Marek 1962), to the floristic assemblage of Bílina-Brandis (Mai and Walther 1991), floristic zone IV (Mai 1967). More problematic phytostratigraphical correlations are these of sedimentological equivalents of the Upper Inter-Seam Formation of the Seam Series (Procházka 1954). These floras show considerable similarity with floras of the floristic assemblage Bílina-Brandis, but differ in occurrences of *Schenkiella credneri*, or *Vaccinioides lusatica*, *Engelhardia macroptera, E. orsbergensis, Pinus engelhardtii, P. rigios* and *Trigonobalanopsis rhamnoides*. Most of these taxa (except for *Schenkiella credneri*) are typical paraclimax to climax elements of the *Engelhardia-Taxodium* association sensu Kvaček and Bůžek (1982). A possible interpretation of absence of these elements in the floras of the Upper Inter-Seam Coal Formation of the Seam Series (Procházka 1954), due to specific environmental factors of the mentioned inland delta regime, is highly speculative and equivocal. Therefore, the most probable correlation of these floras is that with the floristic assemblage of Bitterfeld (Mai and Walther 1991), floristic zone III (Mai 1967). This floristic assemblage is based on the flora of Bitterfeld, which contains dominantly represented arctotertiary elements and shows relatively temperate character compared to the floras of the Bílina-Brandis floristic assemblage, probably due to the riparian type of vegetation. Floras of the Bitterfeld floristic assemblage, e.g. Glopa, Röse-Sausedlitz, Holzweissig, Delitzsch and Muldenstein, stratigraphically belong to the Main Bitterfeld Coal Seam including its close underlying and overlying sediments ("Bitterfelder Liegendton und Deckton"), and are mainly based on carpological material (Mai and Walther 1991, pp. 161–176). Nevertheless, these floras from the Bitterfeld Basin are comparable to floras of the Upper Inter-Seam Formation of the Seam Series (Procházka 1954) based on their taxonomical composition.

Mai (1995) correlated with doubt the so-called Žatec Delta (Čermníky) and sediments between Žatec and Rakovník (Hlavačov, Holedeč and Nesuchyně) to the floristic assemblage of Münzenberg-Bitterfeld. The flora of Münzenberg is dated by faunal zone MN 1 that does not correspond to the dating of the basal part of the Main Coal Seam (Elznic et al. 1986) – MN3a to MN3b (Fejfar 1989, Fejfar and Kvaček 1993). Therefore, it can not be correlated to the floras of the Žatec Delta, the "Hlavačov Gravel and Sand" and Holedeč to the flora of Münzenberg. However, the correlation to the undated locality Bitterfeld is very probable, except for the floras of the Underlying Formation and the Lower Sandy Clayey Beds with the Basal Coal Seam (Hurník and Marek 1962) of the Most Basin and floras of the "Hlavačov Gravel and Sand" (see above).

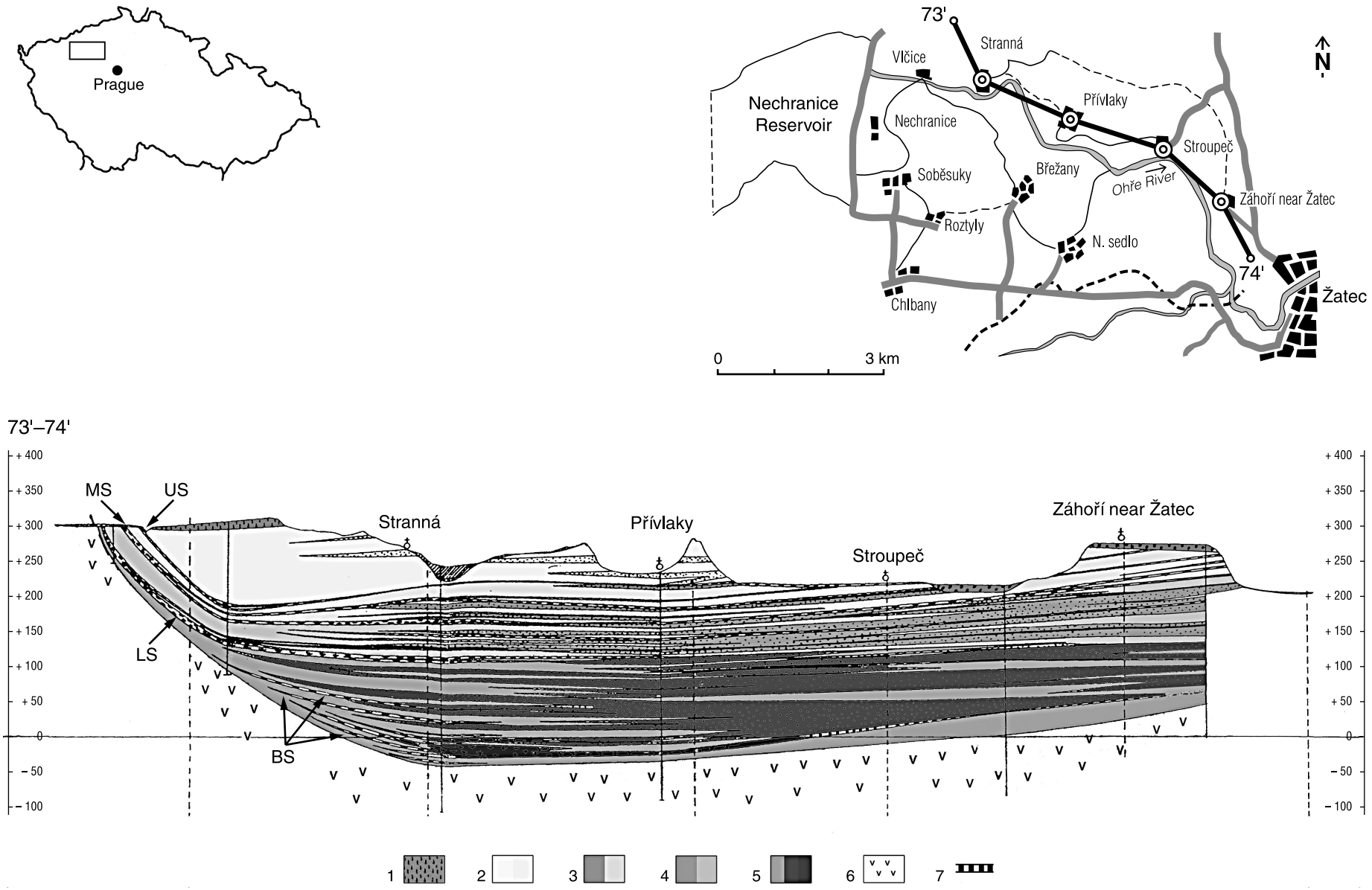
A completely speculative character of phytostratigraphical correlations can be presumed for the lower part of the Main Coal Seam of the Most Formation in the area of the Žatec Delta due to almost absence of macropalaeobotanical data. On the basis of the superposition of the Lower Coal Seam Beds, the Lower Inter-Seam Beds and the Middle Coal Seam Beds (Hurník and Marek 1962) to the Underlying Formation and the Lower Sandy Clayey Beds with the Basal Coal Seam (Hurník and Marek 1962) [correlated with the floristic assemblage of Thierbach and Witznitz (Mai and Walther 1991) – see above] and their underlying position to the Overlying Formation (Hurník and Marek 1962), the Upper Inter-Seam Beds and the Upper Seam Coal Beds (Hurník and Marek 1962), these sediments can be probably correlated with the floristic assemblage Bitterfeld (Mai and Walther 1991).

Phytostratigraphical correlation of the studied floras to the floras of the Weisselster and Bitterfeld Basins

According to the analysis of heavy mineral spectra, macropalaeobotanical and palynological data in the studied area and the Weisselster and Bitterfeld Basins, it is possible to correlate the fluvial sediments of the "Hlavačov Gravel and Sand" (Váně 1985) to the deposits of the underlying complex of the Most Formation (Domácí 1977), i.e. Duchcov Member and lower part of the Holešice Member, in the Czech Republic and to the sediments of the Thierbach Beds in the Weisselster Basin. According to Standke (2002), the Thierbach Beds are interpreted as broadly erosive sediments that arose in a fluvial-estuary system from Late Oligocene to Early Miocene. The Thierbach Beds contain either floras assigned to the mentioned floristic assemblage of Thierbach or the flora of the floristic assemblage of Witznitz (Mai and Walther 1991). The floristic assemblage Thierbach is defined in undated localities Bockwitz near Borna and Borna-Ost from the Weisselster Basin. These floras are confined to clay lenses or sandstone situated above the Coal Seam No 4 and corresponding to the floristic zone I (Mai 1967). This floristic assemblage corresponds to obvious climatic deterioration (Mai 1995, Gastaldo et al. 1998) that shows distinct decrease of palaeotropical elements (only *Eotrigonobalanus*, *Trigonobalanopsis* occurred) at the expense of predominate deciduous elements, i.e. *Alnus*, *Ulmus*, *Cyclocarya cyclocarpa*, *Populus* and *Fagus saxonica* in association of *Nyssa* and *Taxodium*. Besides, the two mentioned localities, Mai and Walther (1991) presented other localities that belonged to the Thierbach floristic assemblage including the taxonomical list of leaf and carpological material, i.e. Thierbach, Kitscher, Otterwisch, Breitenfeld near Leipzig and Delitzsch (floras from cores in "Glimmersand-Komplex") – Mai and Walther (1991, pp. 154–161). The floristic assemblage of Thierbach is often published in association with the flora from the locality Rott or as a redefined floristic assemblage of Rott-Thierbach (e.g. Mai 1995, Kvaček and Walther 2001). The flora from Rott (Siebengebirge, Germany) is dated by mammal zone MP 29 and MP 30 (Schmidt-Kittler 1987) and is characterized by the domination of deciduous elements (e.g. Weyland 1937, Kvaček and Walther 2001, table 6). However, when the author compared the floral list of Rott and Thierbach floristic assemblage (Borna-Ost and Bockwitz), only six species were present, i.e. *Daphnogene cinnamomifolia*, *Fagus deucalionis*, *Glyptostrobus europaeus*, *Magnolia* sp., *Majanthemophyllum petiolatum* and *Symplocos salzhausensis*. Therefore the classification of both localities in one floristic assemblage is not objective at least. The next flora of Witznitz from the Thierbach Beds is assigned to the floristic assemblage of Witznitz (Mai and Walther 1991) and is confined to a coal layer. The flora shows more thermophilous character than the floras from Bockwitz or Borna-Ost due to predominate occurrences of mesophytic elements (e.g. Magnoliaceae, Lauraceae). This floristic contrast between these localities confined to different lithological facies of one sedimentary cycle can be explained as two isochronous and different but mutually overlapping vegetation types. Floras of the Thierbach floristic assemblage are possible to interpret as a paraautochtonous assemblage of the riparian forest that laterally integrated with the zonal mesophytic forest represented by probably allochtonous elements of flora from Witznitz. The flora of Witznitz is mainly based on carpological data (Mai and Walther 1991, pp. 161–162, Kvaček and Walther 2001, table 7); however it is possible to parallel most of the taxa on specific levels to the floras of Thierbach floristic assemblage – cf. Kvaček and Walther (2001, tables 6 and 7), Mai and Walther (1991, pp 147–161 and 153, 161–166). According to the floristic similarity, it is possible to unite both floristic assemblages of the Thierbach Beds comprising two different lithological facies and vegetation types.

Table 6. Results of the CLAMP analysis from the localities Čermníky, Holedeč and Nesuchyně. – Symbols: MAT (Mean Annual Temperature), WMMT (Warmest Month Mean Temperature), CMMT (Coldest Month Mean Temperature), 3WET (Precipitation during 3 Consecutive Wettest Months) and 3DRY (Precipitation during 3 Consecutive Driest Months).

Climatic parameters	Localities			DEV Residuals
	Čermníky	Holedeč	Nesuchyně	
MAT (°C)	10.57	9.62	8.70	1.17
WMMT (°C)	22.28	22.01	22.1	1.58
CMMT (°C)	-0.1	-1.77	-3.65	1.88
3WET (mm)	63.2	58.06	61.27	14.02
3DRY (mm)	37.37	38.26	46.21	9.3



Text-fig. 5. Geological profile 73'–74' from the locality Stranná to the locality Záhoří near Žatec (according to Collective of authors 1980), vertically exaggeration 1:5. Symbols: 1 – Quaternary sediments, 2 – Overlying Formation, 3 – Upper Interseam Beds, 4 – Lower Interseam Beds, 5 – Lower Sand-Clayey Beds with Basal Coal Seam, 6 – Volcano-detritic Series, 7 – Coal Seam; US – Upper Seam Beds, MS – Middle Seam Beds, LS – Lower Seam Beds and Underlying Formation, BS – Basal Coal Seam (all in sense of Hurník and Marek 1962).

Additonaly, sediments of the Main Coal Seam (Elznic et al. 1986) including its clastic equivalents in the area of the Žatec Delta can be correlated with the Main Bitterfeld Coal Seam inclusive of its close underlying and overlying sediments (? whole "Deckton complex"), i.e. 4th Lusatia Seam Complex. Finally, the underlying sediments of the Main Coal Seam including its analogous in the Žatec Delta may be correlated with the sediments of the Main Brandis Coal Seam, which corresponds to basal part of the 3rd Lusatia Seam Complex (Standke 2002). According to Bůžek et al. (1993), the floras occurring in close underlying sediments of the Lom Coal Seam (within the Libkovice Member – Domácí 1977) can be correlated with the floristic assemblage of Eichelskopf-Wiesa (Mai 1995). This floristic assemblage corresponds to the floristic zone VI (Mai 1967), i.e. Eggenburgian-Ottnangian age, and to sediments of the 2nd Lusatia Coal Seam Complex in the Bitterfeld Basin.

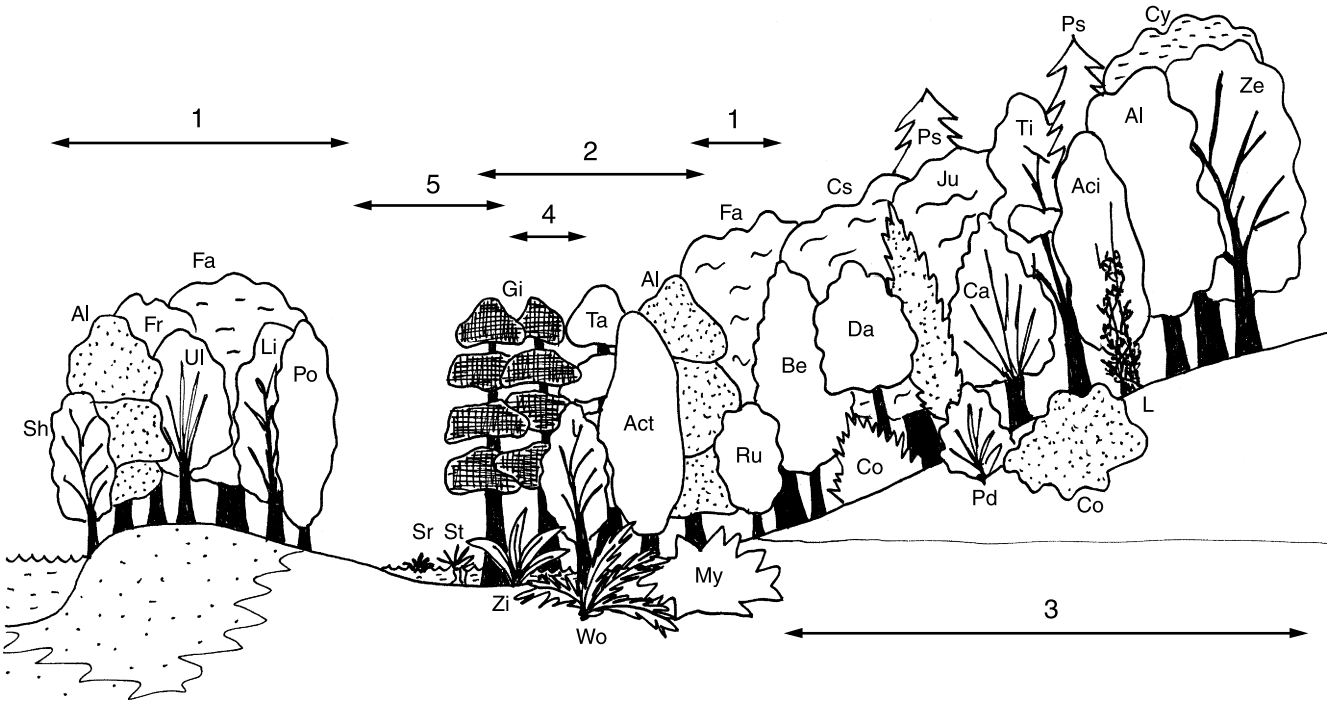
Palaeoenvironmental signals

Vegetation of the fluvial environment

The suggested ecological interpretation is based on vegetation analysis of individual plant assemblages of the fluvial facies from Central and Northern Bohemia. Generally, the basic vegetation type may be interpreted as a relatively temperate riparian forest with predominance of deciduous elements, e.g. *Taxodium dubium*, *Fagus saxonica* and representatives of Betulaceae and Salicaceae. It has been possible to distinguish five different types of vegetation that are defined by specific ecological conditions and mutual integration on their ecotons. The first and predominating association is the riparian forest that is typically composed of elements preferring waterlogged substrates with a relatively high water table. It includes *Ulmus pyramidalis* (E3), *Alnus julianiformis* (E3), *Alnus* sp. (E3), *Fagus saxonica* (E3), *Liquidambar europaea* (E3), *Rosa europaea* (E2), *Populus populina* (E3), *Populus zaddachii* var. *brabenecii* (E3), *Salix haidingeri* (E2) *Salix macrophyla* (E2) and *Fraxinus* sp. (E3). The second association is the mixed swamp forest that is typical of environments with relatively low dynamic and has often occupied swamp facies or oxbow lakes in the river system. This association consists of plants preferring stagnant water or periodical, relatively long-lasting floods, i.e. *Salvinia reussii* (E1), *Woodwardia muensteriana* (E2), *Taxodium dubium* (E4), *Glyptostrobus europaeus* (E4), *Alnus julianiformis* (E3) *Salix varians* (E2), *Myrica* sp. (E2), *Rubus merianii* (E2), *Acer tricuspidatum* (E3), *Stratiotes kaltennordheimensis* (E1) and *Zingiberoideophyllum liblarense* (E1). The association of the mesophytic forest is characterized by zonal mesophytic elements (more or less allochtonous), fixed on relatively dry biotopes with the lower water table in wider river vicinity or uplands, i.e. *Pseudolarix schmidtgenii* (E4), *Tetraclinis salicornioides* (E3), *Daphnogene cinnamomifolia* UNG. f. *cinnamomifolia* (E3), *Mahonia bilinica* (E2), *Comptonia difformis* (E2), *Castanea atavia* (E4), *Trigonobalanopsis rhamnoides* (E4), *Carya serrifolia* (E4), *Carya* cf. *serrifolia* (E4), *Juglans acuminata* (E4), *Betula* sp. (E3), *Carpinus grandis* (E3), *Koelreuteria reticulata* (E3), *Ailanthus confucii* (E4), *Zelkova zelkovifolia* (E4), *Tilia brabenecii* (E4), *Acer integerrimum* (E3), *Acer dasycarpoides* (E3), "*Ficus*" *truncata* (E3), "*Viburnum*" *atlanticum* (E3), *Wisteria* aff. *fallax* (E2), *Leguminosites tobischii* (E3), *Podocarpium podocarpum* (E2) and *Smilax weberi* (E2). Similarly, it is possible to note several elements that can be included also into an association of the riparian forest, e.g. *Betula* sp., *Alnus* sp., *Populus zaddachii* var. *brabenecii*, *Rosa europaea*, *Paliurus tiliaefolius* (E2), *Vitis stricta* (E2), *Vitis teutonica* (E2), eventually *Carya* cf. *serrifolia* and *Carya serrifolia*. The third association corresponds to canebrakes, typical of aquatic rooted elements that bordered riparian or mixed swamp forest and included Poaceae vel Cyperaceae (E1), *Stratiotes kaltennordheimensis* (E1), *Potamogeton* sp. (E1) or eventually monotypic growths of *Salix haidingeri* (E2) – Kvaček (1998). The last association is free-floating aquatic vegetation that occupied biotopes with very low dynamics and corresponded to the sedimentary system of basins or oxbow lakes. It includes mainly two elements: *Salvinia reussii* (E1) and *Stratiotes kaltennordheimensis* (E1). The latter mentioned component can be interpreted also as an ecotonal element between this association and canebrakes or mixed swamp forest – text-fig. 6.

Vegetation of the delta and basin environments

Bůžek (1971) defined three different lithofacies including their special types of vegetation within the Pětipsy Area. First lithofacies represent coal clay and coal beds mainly containing *Glyptostrobus europaeus*, *Taxodium dubium*, *Alnus* sp., *Salix varians*, *Acer tricuspidatum*, *Nyssa haidingerii*, *Craigia bronnii*, *Dombeyopsis lobata* and *Woodwardia muensteriana*. This association can be compared to swamp forests. The next vegetation from the clay lithofacies is characterized by domination of swampy and aquatic elements, i.e. *Salvinia reussii*, *Taxodium dubium*, *Glyptostrobus europaeus*, *Comptonia difformis*, *Alnus* sp., *Acer tricuspidatum* and Poaceae vel Cyperaceae. These elements are often associated with less humid elements, e.g. *Ulmus pyramidalis*, *Salix haidingeri*, "*Parrotia*" *pristina*, *Paliurus tiliaefolius*, *Fraxinus bilinica* and *Craigia bronnii*. The last lithofacies is sandy claystone or sandstone that has a little different character and vegetation cover. The vegetation grows on less humid biotopes than the former and is represented by e.g. *Osmunda parschlugiana*, *Zelkova zelkovifolia*, "*Parrotia*" *pristina*, *Liquidambar europaea*, *Salix haidingeri*, *Acer integerrimum*, *Acer dasycarpoides*, *Juglans acuminata*, *Carya* cf. *serrifolia*, *Ulmus pyramidalis*, *Paliurus tiliaefolius*, *Berchemia multinervis*, *Populus zaddachii* var *brabenecii*, *Daphnogene bilinica*, *Diospyros brachysepala*, *Rosa europaea*, cf. *Alnus gaudinii*, *Sapindus falcifolius*, *Podocarpium podocarpum*, *Smilax weberi* and rarely *Koelreuteria reticulata*, *Populus populina*, *Carpinus grandis*, *Ostrya atlantidis*, *Crategus* sp., cf. *Ampelopsis* sp.



Text-fig. 6. Reconstruction of vegetation cover in the river environment. – Symbols: 1. riparian forest, 2. mixed swamp forest, 3. mesophytic forest, 4. canebrakes, 5. aquatic vegetation; Aci – *Acer integerrimum*, Act – *Acer tricuspidatum*, Ai – *Ailanthus confucii*, Al – *Alnus julianiformis*, Be – *Betula* sp., Co – *Comptonia difformis*, Cy – *Carya* sp., Da – *Daphnogene cinnamomifolia*, Fa – *Fagus saxonica*, Fr – *Fraxinus* sp., Gl – *Glyptostrobus europaeus*, Ju – *Juglans acuminata*, L – *Smilax weberi*, *Wisteria* aff. *fallax*, *Vitis* sp., Li – *Liquidambar europaea*, Ma – *Mahonia bilinica*, My – *Myrica* sp., Pd – *Podocarpium podocarpum*, Po – *Populus* sp., Ps – *Pseudolarix schmidtgenii*, Ru – *Rubus merianii*, Sh – *Salix haidingeri*, Sr – *Salvinia reussii*, St – *Stratiotes kaltennordheimensis*, Sv – *Salix varians*, Ta – *Taxodium dubium*, Te – *Tetraclinis salicornioides*, Ti – *Tilia brabencii*, Ul – *Ulmus pyramidalis*, Wo – *Woodwardia muensteriana*, Ze – *Zelkova zelkovifolia*, Zi – *Zingiberoideophyllum liblarense*.

and *Celtis* sp. On the other hand, Bůžek (1971) also noted the occurrence of swampy elements, i.e. *Salvinia reussii*, *Glyptostrobus europaeus*, *Acer tricuspidatum*, *Dombeyopsis lobata* in allochtonous assemblages of this lithofacies.

Similarly as in the case of the mentioned structure of the "river" vegetation, it is possible to distinguish some partial associations of delta and basin vegetation based on the floristic analysis of the relevant localities. The associations are defined by specific ecological factors. They integrated mutually on their ecotons (Text-fig. 7). The first typical basin association is the coniferous swamp forest that is identical to the association of *Glyptostrobus* sensu Kvaček and Bůžek (1982). A relatively high water table and relatively long-lasting floods, changing to permanent floods in the distal part of the basin characterize this association. The dominant elements are representatives of the family Taxodiaceae, i.e. *Glyptostrobus europaeus* (E4) and *Quasisequoia couttsiae* (E4). The latter mentioned element is an important taxon known from several localities from the coal lithofacies of the Most Basin and the Břešťany Clay. However, it is only proved from the Žatec Delta sediments in the locality Záhoří near Žatec (Teodoridis 2003a). The next association overlapping with the coniferous swamp forest towards waterside is an association of the mixed swamp forest that is comparable to the *Nyssa – Taxodium* association sensu Kvaček and Bůžek (1982) or the Most-Bílina palaeofloristic area sensu Hurník (1961). Besides the mentioned elements of Taxodiaceae, this association includes also *Taxodium dubium* (E4), *Alnus julianiformis* (E3), *Ulmus pyramidalis* (E3), *Nyssa haidingeri* (E2), *Acer tricuspidatum* (E3), *Craigia bronnii* (E3), *Dombeyopsis lobata* (E3), *Cercidiphyllum crenatum* (E3), *Fraxinus bilinica* (E3), *Salix varians* (E2), *Myrica* sp. (E2), *Quercus rhenana* (E3) and *Woodwardia muensteriana* (E2) and is also confined to the coal lithofacies. It is possible to define a partial sub-association containing monotonous stands of *Quercus rhenana* that is usually interpreted as early succession or final phase of swamp supported by the occurrence of this taxon in dark-grey clay in close underlying and overlying the coal seam (Kvaček and Bůžek 1982). Riparian forest is mainly confined to sandy clay or sand of the Žatec Delta. These sediments can be easily interpreted as clastic relics of the complicated anastomosing river system of the inland delta. The association of the riparian forest corresponds to the *Parrotia – Ulmus pyramidalis* association sensu Kvaček and Bůžek (1982) or association of the levée riparian mixed deciduous broad-leaved forest sensu Boulter et al. (1993) and includes, i.e. "*Parrotia*" *pristina* (E2), *Salix haidingeri* (E2),

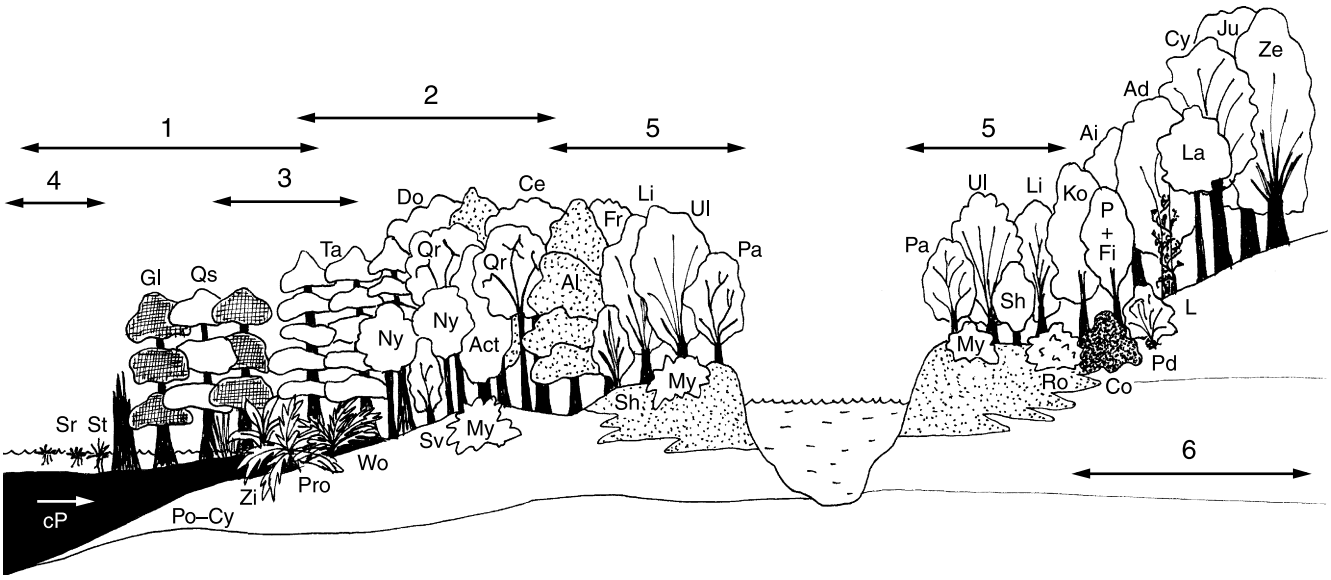
Ulmus pyramidalis (E3), *Liquidambar europaea* (E3), eventually *Alnus julianiformis* (E3), *Alnus* sp. sensu Bůžek (E3), *Rosa europaea* (E2) and *Comptonia difformis* (E2). Kvaček and Bůžek (1982) supposed that several mesophytic elements, such as *Acer dasycarpoides* (E3), *A. integerrimum* (E3), *Zelkova zelkovifolia* (E4), *Daphnogene polymorpha* (E3), *Koelreuteria reticulata* (E3), *Paliurus tiliaefolius* (E2), *Podocarpium podocarpum* (E2), "*Ficus*" *truncata* (E3), "*Viburnum*" *atlanticum* (E3), *Smilax weberi* (E2), *Wisteria* aff. *fallax* (E2), *Berchemia multinervis* (E2) can be alternatively associated with the riparian forest. This opinion is possible. However, these mesophytic elements including also *Carya* cf. *serrifolia* (E4), *Carya serrifolia* (E4), *Juglans acuminata* (E4), *Leguminosites tobischii* (E3), *Mahonia bilinica (*E2) are interpreted as possibly as allochtonous accessory plants growing on wider uplands bordering basins and along rivers than more or less parautochtonous or autochtonous elements from mesophytic biotopes within the mentioned inland delta system. Free-floating aquatic vegetation was well developed and studied in detail from the locality Bílina (Kvaček 1998). In the area of the Žatec Delta (excluding Holedeč), this association is characterized only by *Salvinia reussii* (E1) and corresponds to the association of *Salvinia reussii* sensu Kvaček and Bůžek (1982, p. 20). The aquatic vegetation often overlaps distally with the coniferous swamp forest, mixed swamp forest or the last defined association of canebrakes. This association is comparable to the *Decodon* – Poaceae vel Cyperaceae association sensu Kvaček and Bůžek (1982), or to horizons of aquatic vegetation sensu Hurník (1961, 1973) and is typical of aquatic rooted elements that bordered riparian or mixed swamp forests. The association of canebrakes includes Poaceae vel Cyperaceae (E1), *Zingiberoideophyllum liblarense* (E1), *Pronephrium stiriacum* (E2), *Decodon gibbosus* (E2), eventually *Calamus daemonorhops* (E2), *Sabal* sp. (E2), *Sparganium* sp. (E1), *Potamogeton* sp. (E1), *Proserpinaca reticulata* (E1) and *Stratiotes kaltennordheimensis* (E1) – e.g. Bůžek and Holý (1964), Holý and Bůžek (1966).

According to Kvaček (1998), the accumulation of *Salix haidingerii* known from clastic sedimentary bodies (e.g. Bílina, Hrabák) is probably best interpreted as periodically flooded, pioneer, monotonous growths that occurred in association with aquatic vegetation (Bílina, horizon No 47), i.e. *Salvinia* reussii, *Azolla* sp., *Lemna* sp., *Limnobiophyllum expansum* (HEER) KVAČEK, *Hydrochariphyllum buzekii* KVAČEK and *Elephantosotis dvorakii* KVAČEK.

The ecological interpretation is based on the floristic analysis of the Pětipsy Area and the Žatec Delta (see above). The vegetation of the mixed swamp forest, riparian forest, canebrakes, aquatic plants and probably allochtonous mesophytic forest has also been recognized in these types of environment – text-fig. 7. The association of the coniferous swamp forest is typical of relatively high water table and long-lasting flooding that may change to permanent flooding areas in the distal part of the basin. The coniferous swamp forest represents only monotonous stands of *Glyptostrobus europaeus* and *Quasisequoia couttsiae*. These above-mentioned associations match the new sedimentary model of the Žatec Delta, which is interpreted as a complicated anastomosing river system with low gradient, resembling recent inland deltas, e.g. the lower reaches of the Saskatchewan River in the area of the Cumberland marshes (Pérez-Arlucea and Smith 1999, Rajchl oral consultation 2003, – text-fig. 8). The vegetation model of the Žatec and Pětipsy area in stratification of the above-metioned associations can be described as mutual integrations of the riparian forest (levée zone), mixed swamp forest (occasional flooding zone) and coniferous swamp forest (permanent flooding zone) within the main river channel and open water table. These three associations integrated with canebrakes and aquatic vegetation – text-fig. 8. This vegetation model corresponds to the assemblages of the Pětipsy and Žatec areas that are stratigraphically comparable with the sediments of the Main Coal Seam of the Most Basin (Elznic et al. 1986). Deposits (mainly sand and sandstone) and plant assemblages of the Overlying complex, e.g. the basal part of the Libkovice Member (Domácí 1977), can be interpreted as connected to a "true" delta, i.e. the distal part of the delta sedimentary system (locality Přívlaky, Nechranice, Soběsuky, partly Čermníky a Dolany) – Rajchl (oral communication 2003). In this case, the new environmental model must be modified to fit the condition in a delta. The vegetation assemblages are identical, but their mosaic distribution changed from the linear type (distribution and stratification of vegetation along the river into open water table) to the fingered shaped type of delta (distribution and stratification of vegetation assemblages perpendicularly to the river).

Palaeoclimatic signals

The palaeoclimatic reconstructions have come out from the CLAMP analysis, done on three localities, i. e., Čermníky, Holedeč and Nesuchyně – table 6. The CLAMP analysis results from Čermníky are similar to an assumption of climate on this locality published by Knobloch and Kvaček (1976). These authors correlated the vegetation of Čermníky to the Mixed Mesophytic Forest from southeastern Asia on the basis of the ratio of the entire and toothed leaves (i.e. 37:63 %). According to Wolfe (1979), the temperature character of the extant Mixed Mesophytic Forest is defined: MAT = 10–13 °C, CMMT = 1–(-2) °C and MART = 20–29 °C. The ratio of the entire and toothed leaves from Holedeč was specified on 33.3:66.6 %, which also matches the Mixed Mesophytic Forest from SE Asia. The lower value of MAT based on CLAMP (9.62 °C) fits still the climate conditions of several localities from Japan, e.g. Hakoneyama (936 m alt.), Tsukubasan (869 m alt.), Asosan (1143 m alt.), Funatsu (860 m alt.) and Ashio (647 m alt.), where the Mixed Mesophytic Forest grows (Wolfe 1979). Similar climatic conditions can be assumed also in case of other localities that stratigraphically belong to the deposits of the



Text-fig. 7. Reconstruction of vegetation cover in the delta and basin environments. – Symbols: 1. coniferous swamp forest, 2. mixed swamp forest including sub-association of *Quercus rhenana*, 3. canebrakes, 4. aquatic vegetation, 5. riparian forest, 6. mesophytic forest (often overlapping with association No. 5), Act – *Acer tricuspidatum*, Ad – *Acer dasycarpoides*, Ai – *Acer integerrimum*, Al – *Alnus julianiformis*, Ce – *Cercidiphyllum crenatum*, Co – *Comptonia difformis*, Cy – *Carya* sp., Do – *Dombeyopsis lobata*, Fr – *Fraxinus bilinica*, Gl – *Glyptostrobus europaeus*, Ju – *Juglans acuminata*, Ko – *Koelreuteria reticulata*, L – *Smilax weberi*, *Wisteria* aff. *fallax*, *Berchemia multinervis*, La – Lauraceae (*Daphnogene polymorpha*), Li – *Liquidambar europaea*, My – *Myrica* sp., Ny – *Nyssa haidingeri*, P + Fi – *Paliurus tiliaefolius*, "*Ficus*" *truncata*, Pa – "*Parrotia*" *pristina*, Pd – *Podocarpium podocarpum*, Po-Cy – Poaceae vel Cyperaceae, Pro – *Pronephrium stiriacum*, Qr – *Quercus rhenana*, Qs – *Quasisequoia couttsiae*, Ro – *Rosa europaea*, Sh – *Salix haidingeri*, St – *Stratiotes kaltennordheimensis*, Sv – *Salix varians*, Sr – *Salvinia reussii*, Ta – *Taxodium dubium*, Ul – *Ulmus pyramidalis*, Wo – *Woodwardia muensteriana*, Ze – *Zelkova zelkovifolia*, Zi – *Zingiberoideophyllum liblarense*, cP – direction of peat compaction.

Main Coal Seam of the Most Formation including their clastic equivalents in the Žatec Delta (Záhoří near Žatce, Chotěnice, Lomazice and Dolany).

The CLAMP analysis results of the "Hlavačov Gravel and Sand" show distinctly lower values of MAT and CMMT in comparison to the climatic data of the localities Čermníky and Holedeč. The ratio of the entire and toothed leaves is 22.2:77.8 % there, which corresponds to the recent vegetation of the Mixed Northern Hardwood Forest from the area of SE Asia (MAT = 3–10 °C and MART = 23–45 °C – Wolfe (1997). The decline of CMMT and MAT on the localities of the "Hlavačov Gravel and Sand" (table 6) is probably induced by a majority of toothed deciduous elements that are typical of dominated vegetation of riparian forest on these localities. The above-mentioned domination of these azonal elements at the expense of more or less entire-margined mesophytic elements (cf. the ratio of toothed and entire leaves) distinctly distorts the whole palaeoclimatic character of "riparian floras of Hlavačov Gravel and Sand". Similar environmental conditions are also supposed at the stratigraphically comparable locality of Thierbach, where Mai and Walther (1983) and Mai (1995) defined MAT = 8–10 °C, CMMT = 0–(-4) °C, WMMT = 23°C and MAP = 1500 mm.

The climate character of the localities that stratigraphically belong to the Overlying Formation (Hurník and Marek 1962), i.e. Přívlaky, Čermníky, Dolany, Soběsuky and Nechranice, and are correlated with the floristic assemblage of Bílina-Brandis can be compared with environmental aspects of the localities Bílina and Brandis. According to Mai and Walther (1983, 1991) and Kvaček (1998), the climate regime of these localities is optimally humid and warm-temperate (i.e. MAT = 10–15 °C, CMMT = 0 °C, WMMT = 24–26 °C and MAP = 1800 mm) and corresponds to the vegetation of the Mixed Mesophytic forest from SE Asia.

Generally, the climate conditions of the investigated area were stable with gradual warming trends, culminating when sediments of the Overlying Formation (Hurník and Marek 1962) of the Most Basin deposited. The climate disproportion between vegetation of fluvial sediments in Central Bohemia and that of the Most Basin, supported by the CLAMP proxies (Čermníky versus Nesuchyně), are induced by dominance of deciduous, riparian elements that imitate the colder character of the "Hlavačov Gravel and Sand" vegetation.

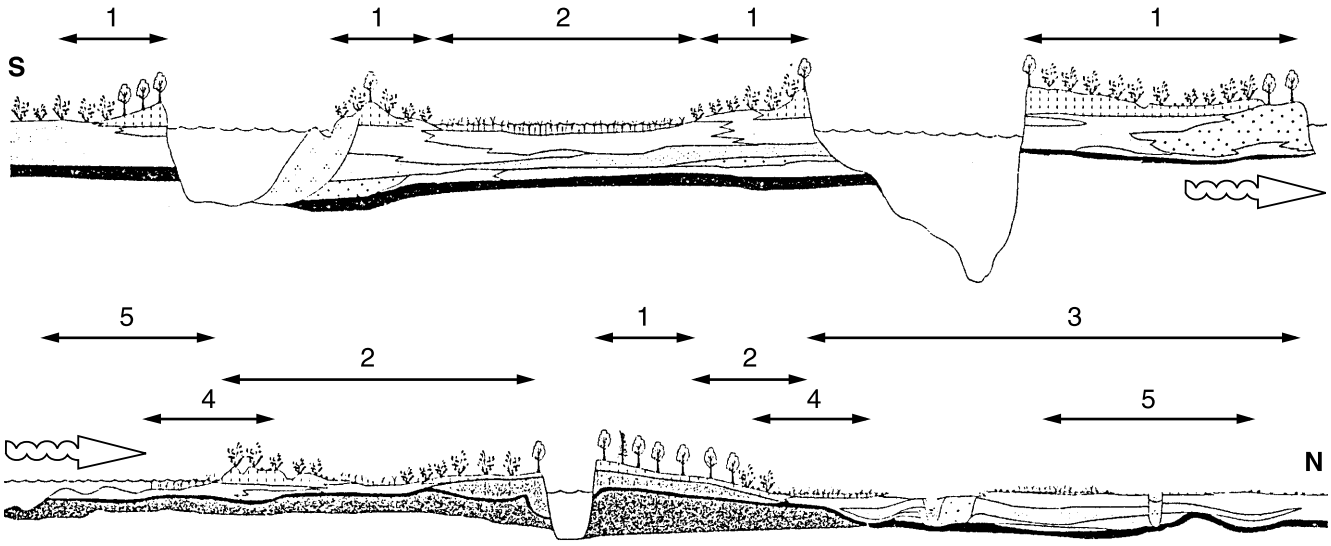
Conclusions

The Tertiary fluvial sediments of Central Bohemia have been located southwest of Prague and in broader surround-

ing of Plzeň (Němějc et al. 2003). Unfortunately, the Tertiary fluvial sediments of Central Bohemia are not fossiliferous in most cases. The plant material was obtained from the classical localities Klínec, U Sloupu (Kettner 1911) and Na Sulavě (Kunský 1928/29). Recently, Žák et al. (2003) discovered and described a flora from the sandpit "U ručiček". Generally, 22 taxa (1 fern, 2 conifers and 19 angiosperms) were described with dominance of Betaulaceae, Salicaceae and Taxodiaceae from the three above-mentioned localities (Teodoridis 2001, Žák et al. 2003). Classification of fluvial sediments in the area of Central Bohemia comes out from the original conception that defines "the Klínec Phase" (Miocene – Kettner 1911, Němejc 1943) and "Zdiby Phase" (Pliocene – Kodym and Matějka 1920). Most described taxa from fluvial sediments of Central Bohemia are common elements of Early Miocene floras stratigraphically assigned to the deposits of the Most Formation. Therefore, a possible precise correlation of these floras with floristic assemblages of Boreal Europe or sediments of the Most Basin is of a speculative character.

The tertiary fluvial sediments of Northern Bohemia are represented by a sedimentary belt of the "Hlavačov Gravel and Sand" that is located between Rakovník and Žatec (Teodoridis 2002). Generally, 42 taxa are known (2 ferns, 5 conifers and 35 angiosperms) from six localities, i.e. St. Antonín, Hlavačov, Nesuchyně, Velká Černoc, Sádek and Želeč. The locality Hlavačov and Nesuchyně are typical of association of *Fagus saxonica* and *Pseudolarix schmidtgenii*. The occurrence of *Populus zaddachii* var. *brabenecii* from the locality Nesuchyně can be interpreted as a connecting member with the floras of the Žatec Delta (localities Čermníky and Holedeč) and "river" floras from Central Bohemia (locality "U ručiček"). The floras of "Hlavačov Gravel and Sand" can be correlated with the Series of the Underlying Clay and Sand (Procházka 1954) and with the floristic assemblage of Thierbach (Mai and Walther 1991) and floristic assemblage of Witznitz (Mai and Walther 1991) on the basis of their floristic similarities. The continuous sedimentary belt of the "Hlavačov Gravel and Sand" represents an erosionally uncovered, lowermost part of fluvial system that had brought clastic material in the Most Basin while the deposits of the Series of the Underlying Clay and Sand (Procházka 1954) including the Basal Coal Seam (Váně 1987) were deposited [i.e. sediments of the Duchcov Member and lowermost part of the Holešice Member of the Most Formation (Domácí 1977)].

Floras of the Žatec Delta are divided into floras of the Pětipsy Area (see below) and floras of south-eastern part of the Žatec Delta. The second group contains floras from the localities Holedeč, Záhoří near Žatec and Přívlaky. The flora of Holedeč contains 44 taxa (1 fern, 2 conifers and 41 angiosperms) with a predominant occurrence of Taxodiaceae, Fagaceae and Betulaceae in combination of new mesophytic elements (Teodoridis 2002). This flora is comparable with the flora from the locality Čermníky that is stratigraphically assigned to the Upper Inter-Seam Formation of the Seam Series (Procházka 1954) and with the floristic assemblage Bitterfeld (Mai and Walther 1991). The flora of Záhoří near Žatec has yielded 24 taxa (3 conifers and 21 angiosperms) – Teodoridis (2003). The occurrences of one female cone of *Quasisequoia couttsiae* and relatively frequent elements of Lauraceae are interesting. This flora belongs to the uppermost part of the Upper Inter-Seam Formation of the Seam Series (Procházka 1954), i.e. upper part of the Holešice Member (Domácí 1977) on the basis of the study of the geological profiles and drilling documentation of this area. The flora of Záhoří near Žatec is comparable with the floristic assemblage Bitterfeld (Mai and Walther 1991). The flora of Přívlaky consists of 23 taxa (1 conifer, 22 angiosperms) – Teodoridis (in press). The absolute dominance of angiosperms in this locality is interesting. Based on the study of the geological profiles and drilling documentation in surroundings of Přívlaky, it is possible to correlate this flora more accurately with the basal part of the Series of the Overlying Clay and Sand (Procházka 1954), i.e. the basal part of the Libkovice Member of the Most Formation (Domácí 1977) and with the floristic assemblage of Bílina-Brandis (Mai 1995). The floras of the Pětipsy Area are assigned to three different stratigraphical levels of the Most Formation, i.e. the Series of the Underlying Clay and Sand (Procházka 1954) – locality Čermníky; the Upper Inter-Seam Formation of the Seam Series (Procházka 1954) – localities Čermníky, Chotěnice, Lomazice and Dolany, and the Series of the Overlying Clay and Sand (Procházka 1954) – localities Čermníky, Dolany, Nechranice and Soběsuky (Procházka 1954, 1955, 1956; Bůžek 1971). Generally, 76 taxa (3 ferns, 4 conifers and 69 angiosperms) have been known with predominant occurrence of Taxodiaceae, Betulaceae, Juglandaceae, Aceraceae, Salicaceae and Lauraceae (Bůžek 1971). The floras assigned to the Series of the Overlying Clay and Sand (Procházka 1954) are correlated with the floristic assemblage of Bílina-Brandis (Mai 1995) on the basis of their floristic context and occurrence of the index fossil *Schenkiella credneri* (Wójcicki and Kvaček 2002) in the floristic assemblage of Bílina-Brandis (Mai 1995) and its absence in the floristic assemblage of Bitterfeld (Mai and Walther 1991). The floras assigned to the Upper Inter-Seam Formation of the Seam Series (Procházka 1954) correspond to the floristic assemblage of Bitterfeld (Mai and Walther 1991) in spite of their affinity to the flora of Bílina. Any possible phytostratigraphical correlation of the Lower Coal Seam Formation (Procházka 1954), the Lower Inter-Seam Formation (Procházka 1954) and the Middle Coal Seam Formation (Procházka 1954) in the area of the Žatec Delta are absolutely speculative due to the absence of macropalaeobotanical data. On the other hand, it is possible to compare these sediments with the floristic assemblage of Bitterfeld (Mai and Walther 1991) on the basis of the superposition of these deposits on the Series of the Underlying Sand and Clay (Procházka 1954) in the Most Basin (correlation with the floristic assemblage of Thierbach and



Text-fig. 8. Palaeoenvironmental model of the Žatec Delta (modified according to Pérez-Arlucea and Smith 1999). – Symbols: 1. riparian forest, 2. mixed swamp forest, 3. coniferous swamp forest, 4. canebrakes, 5. aquatic vegetation.

Witznitz (Mai and Walther 1991 – see above) and their underlying position to the sediments of the Series of the Overlying Clay and Sand (Procházka 1954) in the Most Basin [including the Upper Inter-Seam Formation and Upper Seam Formation (Procházka 1954)].

The ecological interpretation of the fluvial environment is based on the separate vegetative analysis of the "river" floras from Central and Northern Bohemia. Generally, the vegetation of fluvial regime can be interpreted as a relatively temperate riparian forest with predominance of deciduous elements, e.g. *Taxodium dubium*, *Fagus saxonica* and representatives of Betulaceae and Salicaceae. It is possible to distinguish five vegetative associations, i.e. riparian forest, mixed swamp forest, mesophytic forest, canebrakes and aquatic vegetation. Similarly, the ecological interpretation of delta and basin environments is based on floristic analysis of the Žatec Delta. Besides the five "river" vegetative associations, the coniferous swamp forest association is also defined there. These above-mentioned associations are simply integrated into a new sedimentary model of the Žatec Delta interpreted as a complicated anastomousing river system with low gradient, resembling recent inland deltas. The vegetative model of the Žatec Delta in stratification of the above defined vegetative associations can be described as mutual overlapping riparian forests (levée zone), mixed swamp forest (occasional flooding zone) and coniferous swamp forest (permanent flooding zone) from the main river channel towards open water. These three associations freely intermixed with canebrakes and aquatic vegetation. This vegetative model corresponds to the floras of the Žatec Delta that are stratigraphically comparable with the sediments of the Main Coal Seam (Elznic et al. 1986) of the Most Basin. Deposits (mainly sand and sandstone) and floras of the Series of the Overlying Clay and Sand (Procházka 1954), i.e. basal part of the Libkovice Member (Domácí 1977), can be interpreted as a "true" delta – Rajchl (oral communication 2003). In this case, the mentioned new environmental model can be modified a little to mosaic distribution of the identical mentioned vegetative association in the fingered shaped delta type. The paleaoclimatic reconstruction came out from the CLAMP analysis (i.e. Čermníky: MAT = 10.57 °C, WMMT = 22.28 °C, CMMT = -0.1 °C, 3WET = 63.2 mm, 3DRY = 37.37 mm; Holedeč: MAT = 9.62 °C, WMMT = 22.01 °C, CMMT = -1.77 °C, 3WET = 58.6 mm, 3DRY = 38.26 mm and Nesuchyně: MAT = 8.7 °C, WMMT = 22.1 °C, CMMT = -3.65 °C, 3WET = 61.27 mm, 3DRY = 46.21 mm). The CLAMP signals from the localities Čermníky and Holedeč and ratio of entire-mergined and dentate leaves correspond to a recent vegetation of the Mixed Mesophytic Forest type from southeastern Asia, where MAT = 10–13 °C, CMMT = 1–(-2) °C and MART = 20–29 °C (Wolfe 1979).

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