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Palaeoecological Investigations of Buried Peat Profiles from the Zbudovská blata Marshes, Southern Bohemia

Abstracts

The authors present the results of basic stratigraphic investigation, pollen analyses and macroscopic analyses of plant remains concerning two buried peat profiles and their mineral covers in the Zbudovská blata marshes near České Budějovice (southern Bohemia, Czechoslovakia). Both profiles (JC-9-A and JC-9-B) are characterized by two phases of sedimentation — earlier organogenic (Dryas III, Pre-boreal, Boreal periods) and later minerogenic (Sub-atlantic period). A stratigraphic hiatus appears between these two phases. The palaeoecological investigation supports the existing information about the rare occurrence of *Corylus* in some areas of Czechoslovakia during the Boreal period, brings proofs of fir forests in the area of the České Budějovice Basin in the early Sub-atlantic period, and yields new data on the palaeophytogeography of some aquatic, swamp and mire plants. The paper also attempts to reconstruct the succession of local peat-forming communities. A comparison of the development of vegetation in the České Budějovice Basin and in the neighbouring Třeboň Basin is appended.

INTRODUCTION

The phytocenological and ecological investigations of meadows in the České Budějovice and Třeboň Basins, carried out by the Geobotanical Division of the Botanical Institute, Czechoslovak Academy of Sciences (BLAŽKOVÁ 1973), led to the discovery of two buried peat profiles in the České Budějovice Basin at the SE. edge of the Zbudovská blata marshes. While the occurrence of peat and lake sediments in the neighbouring Třeboň Basin is abundant and the sediments have been discussed in many palaeoecological studies (RUDOLPH 1917, ŠTĚPÁNOVÁ 1930, PUCHMAJEROVÁ 1947, JANKOVSKÁ 1967), data on the occurrence of organic layers in the České Budějovice Basin are very rare and palaeoecological data are still more sporadic. The two buried peat profiles recently found widen our present palaeoecological knowledge of the area and give the first, though incomplete, view of the vegetational development of the České Budějovice Basin. Because of the incomplete sequence of layers found in the profiles, one of the primary intentions, i.e. the establishment of the origin of the recent meadow complexes in the Zbudovská blata marshes, could not be fully realized;

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however, the other data obtained (on primaeval vegetation, and on the succession of aquatic and mire plant communities) are of importance and, as the authors believe, merit publication.

The three authors contributed to this as follows: E. Rybníčková analyzed half of the pollen spectra, and evaluated and interpreted the results of the pollen analyses; K. Rybníček performed the macroscopic analyses of plant remains, evaluated the succession of local peat-forming communities, summarized the stratigraphic results and collaborated in interpreting the pollen diagrams; V. Jankovská analyzed the other half of the pollen spectra and supplied data for comparison with the situation in the Třeboň Basin.

DESCRIPTION OF THE AREA

Zbudovská blata denotes a vast complex of formerly waterlogged or mesic, mostly alluvial meadows. They are situated in the area of the so-called "Blaťácké obce" (marshland villages) of Pašice, Plástovice, Pištín, Zliv and Zbudov in the České Budějovice Basin, southern Bohemia. The area lies about 10 to 15 km NNW. of České Budějovice and 5 to 10 km W. of Hluboká nad Vltavou. The altitude of the Zbudovská blata marshes varies about 380 m ASL. (Fig. 1).

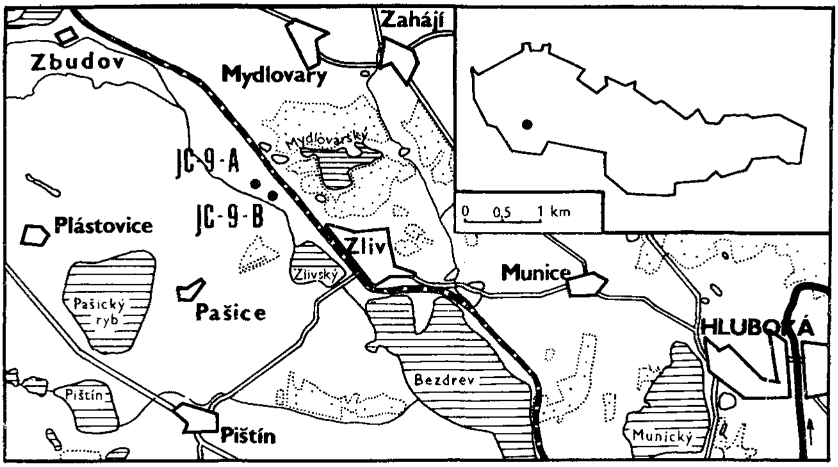

Fig. 1. The localisation of the profiles JC-9-A and JC-9-B in the Zbudovská blata marshes. (Situation before 1970.)

The geological substrate is formed by relatively rich upper Cretaceous lake sediments and Tertiary clays, mostly covered by Quaternary sediments. The latter consist chiefly of clays and sands, while gravels are deposited only in the alluvia of larger streams and in the valley of the Vltava river. Organic sediments appear only exceptionally and their area is insignificant.

Climatically, the České Budějovice Basin belongs to the mild temperate region and is a moderately humid district with mild winters. The annual mean temperature is 7.8 °C; the January average varies between −2 to −3 °C; and the July average, between 17 to 18 °C (Vesecký et al. 1958). The annual mean precipitation (Vodňany station) reaches 570 mm, slightly increasing eastward and southward (Hluboká nad Vltavou — 600 mm). In comparison with the Třeboň Basin, in which the precipitation is much higher (Chlum u Třeboně station — 681 mm), the higher continentality of rainfall distribution in the České Budějovice Basin becomes conspicuous. This can perhaps also explain certain differences in the vegetation of the two regions (see page 175).

In comparison with the Třeboň Basin, the České Budějovice Basin is characterized by an almost complete absence of forests, which is due to secondary causes. Fishponds with their typical vegetation are common to both regions. Until recently, vast meadow complexes were found in both areas, but in the České Budějovice Basin, they have been ploughed and converted into fields. A similar change has taken place in the Zbudovská blata marshes. Field geobotanical reconstruction suggests the following types of primaeval communities in the České Budějovice Basin: forest stands belonging to the alliances *Alnion glutinosae* (MALCUIT) MEIJER-DREES 1936, the *Alno-Padion* KNAPP 1942 em. MEDW. apud MATUSZKIEWICZ et BOROWIK 1957, and the *Ulmion* OBERD. 1953 on the river alluvium; acidophilous oak-forests (the *Quercion robori-petraeae* BR.-BL. 1932) on the dry-land habitats; and smaller islands of beech stands (the *Eu-Fagion* OBERD. 1957 em. TX. 1960) along the border of the basin above an altitudes of 500 m ASL.

METHODS

The profiles were excavated after preliminary soundings in autumn 1964. The description of layers is based on the classification of sediments used by FIRBAS (1949). Samples for pollen and macroscopic analyses were taken from open faces at approximately 5 cm intervals, taking into account the visible borders of the layers.

Common pollenanalytical methods (ERDTMANN 1943, KNOX 1942) were employed; where mineral material was abundant, HF treatment was used first. Minimum AP count was 400. Absolute numbers of all determined sporomorphs are given in Tabs. 3 and 4. Pollen diagrams (Figs. 2 and 3 Appendix 2) are constructed as total diagrams (AP + NAP excl. Sporophyta et Hydrophyta = = 100 %).

The same samples of the standard volume of 100 ccm were used for macroscopic analyses of plant remains. The results are summarized in Tabs. 1 and 2. The data on countable plant remains (seeds, fruits, etc.) are given in the tables in absolute values per 100 ccm, while the data on plant tissues are presented in estimated volume percentage per 100 ccm. In order to simplify the print of tables, some mineral layers containing few or no macroscopic finds were combined together.

DESCRIPTION AND STRATIGRAPHY OF THE PROFILES

The profiles under study (JC-9-A and JC-9-B) are situated about 0.5 km N W. of the village of Zliv between the former stream of the Zlivský potok and the railway track. The distance between the two profiles is about 200 m and no connection between them has been ascertained.

At both sites sedimentation followed a similar course, and may be divided into two phases. The lower organogenic sedimentation began in Dryas III (JC-9-B) and continued during the Pre-boreal and Boreal periods. The organic layers are followed by clay deposited throughout the Sub-atlantic period. The borderline between the two types of sediment is very conspicuous in the case of the JC-9-B profile, while an indistinct transitional zone can be found in the JC-9-A profile. Similarly, the pollen and macroscopic analyses show striking vegetational discontinuity. As both deposits under study are limited in extent and do not seem to be connected, they are presumed to have originated by the infilling of small water basins or abandoned channels of the present Zlivský potok brook. The infilling reached its highest rate in the Boreal period and then either ceased in the Boreal and throughout the Atlantic and Sub-boreal periods, or, if sedimentation continued then the upper layers must have been destroyed by surface erosion from time to time. At the beginning of, or during the early Sub-atlantic period ("älterer Teil des Subatlantikums" of FIRBAS 1949), a shallow water basin of unascertained size probably developed (perhaps by a natural damming of the run-off). In this reservoir the sedimentation of clayey and sandy particles, which covered the lower organic layers, took place. In the JC-9-B profile, a distinct diatom layer was found on the borderline of the two sedimentation types, and this fact supports the above explanation. Minerogenic sedimentation continued in the late Sub-atlantic period ("jüngerer Teil des Subatlantikums" of FIRBAS 1949).

This discussion of the stratigraphic discontinuity is based on the stratigraphic situation and on the results of palaeobotanical analyses only. The conclusions should be revised when a suitable complete reference profile from this region is found and absolute C^{14} dating of the critical layers is available.

JC-9-A: the sequence of layers

0—48 cm	Stratum confusum. Loamy gley occasionally ploughed
48—72 cm	Dark grey, tough, distinctly layered clay
72—82 cm	Brownish grey, tough clay
82—128 cm	Grey-black compact heavy clay with a small admixture of Phragmites-peat
128—141 cm	Dark brown semi-decomposed Carex-Phragmites-peat with an admixture of grey layered clay
141—147 cm	Grey, tough, very compact clay with a small admixture of Phragmites-peat

Table 1. Survey of plant records and sequence of past plant assemblages in the profile

Depth from / to cm		205 210	200 205	195 200	193 195	187 193	183 187	180 183	170 180
Period (FIRBAS 1949)		IV							
Carex cf. *lasiocarpa* EHRH.	s	10	7	.	7	.	.	.	.
Menyanthes trifoliata L.	t	10	5	3	.	1	3	3	.
Menyanthes trifoliata L.	s, p	2	1	.	1	(+)	.	.	.
Carex rostrata STOKES	s	49	19	7	12	2	.	.	.
Comarum palustre L.	s, p	.	(2)	(+)	.	(+)	.	.	.
Carex cf. *gracilis* CURT.	s	.	.	.	.	.	.	.	.
Ranunculus sp.	s	.	.	.	.	.	.	.	.
Carex pseudocyperus L.	s	.	.	.	.	.	.	.	.
Viola palustris L.	s	.	.	.	.	.	.	.	.
Lycopus europaeus L.	s	.	.	.	.	.	.	.	.
Carex cf. *canescens* L.	s	.	.	.	.	.	.	.	.
Poaceae	s, p	.	.	.	.	.	1	.	.
Ranunculus cf. *lingua* L.	s	.	.	.	.	.	.	.	.
Alisma plantago-aquatica L.	s, p	.	(+)	.	.	.	.	.	.
Filipendula cf. *ulmaria* (L.) MAXIM.	p	.	.	.	.	.	.	.	.
Sphagnum L.	p	.	.						
Salix sp.	t	1	1	.	.	5	5	.	.
Betula sp.	s	.	2	.	.	.	7	2	.
Carex L. (*Cyperaceae*)	p, t	(+)	(2)	(2)	(2)	(5)	(3)	(2)	(5)
Phragmites communis TRIN.	t	.	.	1	10	15	3	10	15

In addition, there occur: *Myriophyllum spicatum* L. 1p (200—205); *Carex* cf. *aquatilis* WAHLENB. 1s (205—210); *Carex* cf. *limosa* L. 2s (205—210); *Epilobium* L. 1p (115—130); *Lysimachia vulgaris* L. 1p (135—145); *Parnassia palustris* L. 1p (187—193); *Asteraceae?* 1s (183—187), 1s (157—160); *Potamogeton* L. 3p (79—115). *Drepanocladus exannulatus* (BR. EUR.) WARNST. 1m (205—210); *Cenococcum geophilum* FR. 2scl (157—160).

Explanation for Tabs. 3 and 4:
p — pollen or spores

147 – 157 cm	Dark semi-decomposed Carex-Phragmites-peat with an admixture of grey clay
157 – 190 cm	A little decomposed dark brown, non-cohesive, slightly layered Carex-peat
190 – 200 cm	Light brown gyttja with an admixture of Carex-peat
> 200 cm	Grey sand and subjacent gravel

JC-9-B: the sequence of layers

0 – 20 cm	Stratum confusum. Loamy gley, occasionally ploughed
20 – 107 cm	Grey, in some places dark grey, tough, compact clay with a negligible admixture of *Phragmites* remains; a thin sandy intercalation within 48 – 50 cm
107 – 110 cm	Grey-brown sandy clay, whitish after drying, with a small admixture of Carex-peat; a considerable amount of diatom frustules
110 – 161 cm	Reddish-brown, semi-decomposed Carex-peat
161 – 164 cm	Greyish-brown Carex-peat with an admixture of fine clay

Zbudovská blata, JC-9-A.

167 170	165 167	163 165	160 163	157 160	153 157	147 153	145 147	135 145	130 135	115 130	79 115	77 79	50 77	0 50
V									IX				X	
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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.	2	2	.	.	.	.	.	.	.	.	.	.	.	.
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.	1	.	.	1	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	1	1	.	.	.	.	.	.	.	.
.	.	.	.	.	1	2	.	.	.	.	.	.	.	.
(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	.	(+)	(+)	(2)	(+)	.
.	.	.	.	.	.	.	.	.	.	.	.	6	.	.
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.	.	.	.	(+)	(+)	(+)	(+)	[+]	(+)	(+)	(+)	.	.	.
.	.	.	(+)	.	.	.	.	.	.	(+)	(+)	.	.	(+)
3	3	.	10	.	1	5	3	1	.	1	1	1	1	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
(5)	(5)	(5)	(+)	.	.	.	.	.	.	.	1	1	1	.
5	5	10	5	10	5	5	3	10	1	1	1	1	.	.

s — seed, fruit (absolute number per 100 ccm)
scl — sclerotium (absolute number per 100 ccm)
t — plant tissue (in vol. %)
m — moss plants and their parts (in vol %)
(+) — important occurrence of pollen et spores
[+] — maximum accumulation of pollen or spores
(1) — seed or tissue (absolute number or %) and occurrence of pollen or spores
[1] — seed or tissue (absolute number or %) and maximum accumulation of pollen or spores

164 – 220 cm	Reddish-brown, semi-decomposed Carex-peat
220 – 234 cm	Redish-brown, semi-decomposed Carex-peat with an admixture of grey fine clay
234 – 244 cm	Gyttja with a small admixture of Carex-peat and clay
>244 cm	Greyish-brown sand and subjacent gravel

SUCCESSION OF LOCAL VEGETATION

Although it is possible to find common features in the development of local peat-forming communities on both sites (the main part of the past vegetation consists of communities similar to the present *Magnocaricion* W. Koch 1926 or *Caricion lasiocarpae* Van den Berghen 1949), the two successions differ so much in detail that they will be described separately.

JC-9-A: (Tab. 1) The development of peat-forming plant communities was comparatively simple and the small number of species indicates the presence of very primitive plant communities. The formation of organic sediment begins in the Preboreal period with *Carex rostrata* stands; in addition to the dominant, *Carex* cf. *lasiocarpa*, *Menyanthes trifoliata* and *Comarum palustre* were found. The oldest communities, forming the lowest layers, are, among others, characterized by *Myriophyllum spicatum*, *Carex* cf. *limosa* and *Carex* cf. *aquatilis*. Of the mosses, only several leaves of *Drepanocladus exannulatus* were found. All these plants indicate that the site was permanently flooded — perhaps it was a small pool. This conclusion is also supported by the admixture of gyttja in the Carex-peat. In the Boreal period aquatic species such as *Myriophyllum*, *Menyanthes*, etc. gradually disappeared as the pool become filled in. *Carex rostrata* seems to have remained as the dominant, while the presence of other plants (*Carex* cf. *gracilis*, *Carex pseudocyperus*, *Viola palustris*) is determined on the basis of a few seeds only.

The stands with *Carex rostrata* obviously close the series of the peat-forming communities. They are followed by badly definable communities of minerogenic lacustrine sediments. The number of macroscopic plant remains in the sediment abruptly decreases. *Lycopus europaeus* and *Carex canescens* have been proved at the end of the Boreal period, and the maximum of *Filipendula* (*ulmaria*) pollen falls within the same period of time. Some caryopses of undetermined *Poaceae*, achenes of *Ranunculus* cf. *lingua*, seeds of *Alisma plantago-aquatica* and pollen of *Polygonum* cf. *persicaria* are dated to the end of the late Sub-atlantic period.

During the whole period of sedimentation some willow species occurred on the site or in the close neighbourhood. Its wood is scattered in almost all analysed layers of the JC-9-A profile. The occurrence of willow shrubs with *Polypodiaceae* in the close vicinity of the site during the Boreal period is highly probable. In the upper stages of development, the existence of *Phragmites communis* is certain; its rhizomes and sheaths formed a regular admixture with the minerogenic sediment of the Sub-atlantic. The finds of *Phragmites* rhizomes in older organogenic layers should be considered as secondary.

This reconstructed succession is reflected completely in the changing curves of the pollen diagram (Fig. 2 Appendix 2): high values of *Cyperaceae* in the oldest periods, the highly regular course of the *Salix* curve, increase of *Poaceae* in the upper spectra of the profile, etc.

JC-9-B: (Tab. 2) Unlike the preceding profile, the basal samples of JC-9-B are older (the Dryas III period) and indicate a well developed water community similar to the present stands of the *Eu-Potamion* Koch 1926. The following species were identified: *Potamogeton filiformis*, *P.* cf. *obtusifolius*, *P.* cf. *perfoliatus*, *P.* cf. *polygonifolius*, *Myriophyllum spicatum*, *Hippuris vulgaris*, *Zannichellia palustris* and *Batrachium* sp. In addition, plants now generally found growing in the shore and swamp communities of tall sedges (the *Magnocaricion elatae* W. Koch 1926 and the *Caricion lasiocarpae* Vanden Berghen 1949) were found. These are: *Carex* cf. *aquatilis*, *Galium* sp. (polen), *Sparganium* cf. *minimum*, *Carex rostrata*, *C.* cf. *lasiocarpa* and *Menyanthes trifoliata*. Both types of plant community obviously invaded each other during the infilling of the basin. The character of the corresponding sediment — gyttja with Carex-peat — also corresponds to the vegetational conditions outlined above. Willow shrubs probably occurred along the edge of the water body.

After the disappearance of the free water through infilling, sedge stands persisted, dominated at first by *Carex rostrata*. *Carex lasiocarpa* declined but *Carex* cf. *gracilis* increased and seems to have become the dominant. Later on, *Carex pseudocyperus* and some grasses joined the assemblage.

At the beginning of the Pre-boreal period, the assemblage probably underwent some quantitative changes in the representation of species. The abundance of *Carex* cf. *gracilis* seems to have decreased, or the plant may have persisted with reduced vitality (cf. the low number of diaspores found). On the other hand, the representation of *Carex pseudocyperus* probably increased and the presence of *Poaceae* and *Comarum palustre* became stabilized. At the same time the following species invaded the assemblage: *Lycopus europaeus*, *Cicuta virosa*, *Eleocharis palustris* agg., *Carex vesicaria*, *Parnassia palustris* (pollen). *Equisetum* was apparently abundant, as suggested by the high values of spores in the corresponding spectra.

The series of identifiable peat-forming communities is closed by a new type of plant assemblage; this appears abruptly in the profile and most probably corresponds to the final stages of the infilling of the pool. The plant assemblage seems to be close to some present waterlogged meadow communities of the *Caricion canescentis-fuscae* Nordh. 1936: it was formed by *Carex fusca*, *C. diandra* and *C. canescens*, *Cirsum* sp., *Filipendula ulmaria*, some undetermined *Poaceae* and *Equisetum*. This type of plant community can be considered as a kind of a virgin meadow, which — together with swamp vegetation and in different combinations — may have covered the alluvial parts of the locality during the Boreal period. Due to the supposed invasion of arboral plants in the later periods (proved for the Sub-boreal period — see pollen diagram, Fig. 3 Appendix 2) this vegetational type of virgin meadow was, in general, doomed to disappear.

The following 100 cm of mineral sediments are sterile and contain almost no macroscopic plant remains. Only pollen grains of *Polygonum* t. *persicaria*, *P.* t. *lapathifolium* and *Montia* cf. *fontana*, willow twigs and sedge roots, scattered in the layers, and the rhizomes and sheaths of *Phragmites communis*, which occur continuously, were found. All of them are very probably of local origin. In the only layer pollenanalytically dated to the end of the early Sub-atlantic period, nutlets of *Carex rostrata* and *C.* cf. *gracilis* have been preserved. The subrecent layers, when minerogenic sedimentation probably became slower and the free water periodically disappeared, contain — besides *Phragmites communis* — the fruits and seeds of *Bolboschoenus maritimus* ssp.

Table 2. Survey of plant records and sequence of past plant assemblages in the profile

Depth from cm		245	240	237	235	230	220	215	205	195	190	185	180
to		250	245	240	237	235	230	220	215	205	195	190	185
Period (FIRBAS 1949)		III											
Myriophyllum spicatum L.	s,p	(7)	(6)	(6)	(5)	(+)	.	.	.	.	.	.	.
Potamogeton L.	p	.	(+)	.	.	.	(+)	.	.	.	.	.	.
Potamogeton filiformis PERS.	s	7	8	8	1	2	.	.	.	.	.	.	.
Potamogeton cf. *polygonifolius* RCHB.	s	4	2	2	1	1	.	.	.	.	.	.	.
Potamogeton cf. *obtusifolius* M. et K.	s	2	3	8	.	.	.	.	.	.	.	.	.
Potamogeton cf. *perfoliatus* L.	s	2	2	.	.	.	.	.	.	.	.	.	.
Carex cf. *aquatilis* WAHLENB.	s	11	2	1	1	.	.	.	.	.	.	.	.
Galium L.	p	.	(+)	(+)	(+)	(+)	(+)	.	.	.	.	.	.
Hippuris vulgaris L.	s	1	1	.	1	.	.	.	.	.	.	.	.
Sparganium cf. *minimum* WALLR.	s	1	.	1	1	.	.	.	.	.	.	.	.
Zannichellia palustris L.	s	.	3	.	.	1	.	.	.	.	.	.	.
Batrachium sp.	s	.	3	3	2	4	.	.	(+)	.	.	.	.
Carex rostrata STOKES	s	26	81	82	.	9	8	.	3	2	9	23	.
Carex cf. *lasiocarpa* EHRH.	s	51	18	9	19	2	5	.	.	.	.	2	.
Menyanthes trifoliata L.	t	3	.	.	.	10	3	.	3	5	.	.	.
Menyanthes trifoliata L.	s,p	2	(8)	4	.	2	(1)	.	.	.	.	.	.
Comarum palustre L.	s,p	.	.	.	.	2	.	.	(1)	.	(+)	.	.
Carex cf. *gracilis* CURT.	s	.	.	.	3	33	4	12	37	4	10	1	2
Carex pseudocyperus L.	s	.	.	.	.	.	.	2	.	2	8	25	49
Poaceae	s,p	.	.	.	.	.	.	.	(1)	(1)	(+)	(+)	(+)
Lycopus europaeus L.	s	.	.	.	.	.	.	.	.	.	.	4	3
Cicuta virosa L.	s	.	.	.	.	.	.	.	.	.	.	3	13
Equisetum L.	p,t	.	.	.	.	.	.	.	.	.	.	(+)	[+]
Eleocharis palustris (L.) R. et SCH.	s	.	.	.	.	.	.	.	.	.	.	.	3
Carex diandra SCHRANK	s	.	.	1	.	.	.	.	.	.	.	.	.
Carex fusca ALL.	s	.	.	.	1	.	.	.	.	.	.	.	.
Filipendula ulmaria (L.) MAXIM.	s,p	.	.	.	.	.	.	.	.	.	.	.	.
Carex canescens L.	s	.	.	.	.	.	.	.	.	.	.	.	.
Cirsium sp.	s	.	.	.	.	.	.	.	.	.	.	.	.
Bolboschoenus maritimus (L.) PALLA ssp. *eumaritimus* HEJNÝ	s	.	.	.	.	.	.	.	.	.	.	.	.
Alisma plantago-aquatica L.	s,p	.	(+)	.	.	.	.	.	.	.	.	.	.
Lythrum L.	p	.	.	.	.	.	.	.	.	.	.	.	.
Sagittaria sagittifolia L.	s	.	.	.	.	.	.	.	.	.	.	.	.
Pedicularis cf. *palustris* L.	p	.	.	.	.	.	.	.	.	.	.	.	.
Sphagnum L.	p	.	.	.	.	.	.	.	.	.	.	.	.
Betula sp.	s	.	.	1	.	.	.	.	.	.	.	.	1
Salix sp.	t	5	10	.	.	.	.	.	.	.	.	.	.
Rubus sp.	s	.	.	.	.	.	.	.	.	.	.	1	1
Carex sp. (*Cyperaceae*)	t,p	(5)	(5)	(5)	(5)	(10)	(+)	(10)	(5)	(5)	(3)	(+)	(5)
Phragmites communis TRIN.	t	.	.	.	.	5	.	3	5	5	1	.	10

In addition there occur: *Pinus silvestris* L. 1s (130—135); *Carex vesicaria* L. 1s (180—185); *Carex echinata* MURR. 4s (35—45); *Carex* sp. 1s (135—145); *Urtica*

For explanation see Tab. 3.

Zbudovská blata, JC-9-B.

175	170	165	162	160	155	150	145	135	130	125	115	100	50	47	40	35	25	20	0
180	175	170	165	162	160	155	150	145	135	130	125	115	100	50	47	40	35	25	20
IV						V							IX	X					
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14	10	4	4	17	17	.	.	.	.	.	.	.	.	9	.	.	.	.	.
25	5	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
3	.	.	.	.	3	.	.	.	.	.	1	.	.	.	.	.	.	.	.
.	1	1	4	.	3	5	4	4	.	.	.	.	(+)	.	.	.	.	.	.
4	8	7	14	.	7	10	15	(3)	.	.	.	.	(+)	.	.	.	.	.	.
.	.	.	3	.	3	.	.	.	.	.	.	.	.	33	.	1	.	.	.
2	2	1	.	10	1	2	4	2	.	.	.	.	.	.	.	.	.	.	.
(2)	(+)	(2)	(2)	(2)	(2)	(1)	(1)	(+)	1	1	.	.	.	.	.	.	.	.	.
1	1	4	24	.	.	.	2	3	.	.	.	.	.	.	.	.	.	.	.
14	1	.	1	1	4	1	8	1	.	.	.	.	.	.	.	.	.	.	.
[+]	[+]	[+]	[+]	[+]	(+)	(+)	(+)	(+)	1	1	.	.	.	.	.	.	.	.	.
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.	.	.	.	.	.	(+)	.	.	.	.	.	.	(+)	(+)	(+)	(+)	.	.	.
3	3	.	2	.	3	2	1	.	.	1	.	.	.	1	.	.	.	.	.
.	.	.	.	.	.	.	10	.	.	.	.	5	1	1	1	.	.	.	.
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.	.	.	.	5	.	.	5	5	3	.	10	.	.	.	.	.	1	1	.
5	.	.	.	.	.	.	.	5	10	1	5	1	1	1	1	1	1	1	.

dioica L. 2s (240—245); *Isolepis setacea* (L). R. Br. 1s (165—170); *Parnassia palustris* L. 1p (160—162); *Ranunculus* cf. *lingua* L. 1s (237—240); *Amblystegiaceae* Roth 1t (162—165); *Cenococcum geophilum* Fr. 1s (130—135).

Table 3. Absolute numbers of pollen and spores, Zbudovská blata, JC-9-A

	0	50	60	70	80	90	95	103	113	123	125	130	135	140	145	150	155	160	170	180	190	200
AP																						
Abies	1	10	3	15	48	48	133	101	188	81	56	35	8	.	.	.	.	.	.	.	.	.
Alnus	31	137	175	75	82	36	264	50	106	308	297	347	57	.	11	.	5	2	2	3	3	1
Betula	39	56	38	81	55	45	59	42	45	61	41	5	16	59	14	22	38	82	28	41	73	53
Corylus	8	4	2	5	4	3	15	8	5	13	12	14	19	1	.	1	.	4	.	.	1	3
Fagus	1	4	4	7	2	4	7	18	9	11	2	.	3	.	.	.	.	.	.	.	.	.
Picea	25	18	11	23	30	40	66	25	63	79	37	94	11	4	3	.	2	2	1	1	1	1
Pinus	255	93	93	141	221	97	132	97	150	186	119	151	401	419	467	447	413	397	419	481	561	363
Quercus	20	2	4	1	1	2	15	14	3	5	2	.	1	.	.	.	.	.	.	.	.	.
Salix	10	10	2	8	3	2	11	11	.	7	4	.	2	.	9	.	5	2	.	1	2	11
Tilia	.	2	2	4	.	1	2	1	2	6	1	3	.	.	.	.	.	.	.	.	.	.
Ulmus	2	.	.	1	.	1	.	.	.	.	1	.	3	2	2	.	3	2	.	1	1	.
Σ AP	404	336	338	363	446	279	704	367	571	757	572	649	521	485	507	470	466	491	450	530	642	435
NAP																						
Artemisia	5	1	1	8	.	1	.	1	1	.	.	.	2	.	3	.	1	3	3	.	4	4
Asteraceae Liguliflorae	6	6	2	6	.	1	.	1	4	.	.	1	.	1	1	.	1	.	.	.	.	.
Asteraceae Tubuliflorae	30	4	3	7	2	.	.	.	1	1	.	.	.	.	.	.	.	1	.	.	.	2
Brassicaceae t. *Cardamine*	1	1	.	2	1	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	1	2
Cerealia t. *Secale*	21	5	1	29	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chenopodiaceae	5	9	5	4	.	1	.	.	.	2	.	.	.	.	.	.	1	.	.	.	2	.
Cyperaceae	45	86	59	97	52	97	44	121	69	100	14	8	33	56	124	28	72	29	52	208	272	279
Daucaceae	5	4	6	6	.	1	1	1	1	.	1	.	3	1	2	1	1	.	.	1	.	1
Filipendula	95	6	14	13	18	11	141	33	65	46	63	3	7	197	28	14	17	4	7	3	1	2
Galium t.	2	1	.	1	.	.	2	.	.	1	1	1	1	.	1	.	.	1	.	.	4	5
Plantago lanceolata	14	.	1	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poaceae	827	120	92	547	37	160	114	240	206	151	51	23	160	150	137	54	168	62	30	5	32	44
Ranunculaceae t. *Ranunculus*	12	.	.	2	.	1	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.
Rumex t. *acetosa*	15	5	.	3	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.
Silenaceae t. *Silene*	2	4	2	7	1	2	1	.	.	.	.	1	.	.	.	.	1	1	.	.	1	.
Sparganium—Typha angustifolia t.	2	.	.	1	.	.	.	.	.	.	.	.	.	4	2	1	.	.	.	.	.	.

Typha latifolia	1	.	.	.	1	.	.	.	.	.	1	1	.	2	7	3	1	.	.	1	.	1
Varia	6	31	14	21	10	6	16	11	11	15	11	5	3	2	2	1	1	1	1	1	4	7
Σ NAP	1196	296	214	783	124	282	321	408	359	319	142	45	210	420	310	103	266	102	93	220	325	352
AP + NAP	1600	632	552	1146	570	561	1025	775	930	1076	714	694	731	905	817	573	732	593	543	750	967	787
Σ Hydrophyta (see below)	.	.	.	.	1	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	1
Pteridophyta																						
Equisetum	4	1	1	.	.	1	.	1	.	1	1	11	10	12	2	4	1	11	5	2	1	7
Polypodiaceae	11	127	143	44	80	27	68	11	32	157	86	213	90	160	318	363	51	319	81	4	5	5
Σ *Pteridophyta*	15	128	144	44	80	28	68	12	32	158	87	224	100	172	320	367	52	331	86	6	6	12
Bryophyta																						
Sphagnum	1	.	1	.	.	.	.	.	1	1	1	.	.	.	.	.	.	1	.	1	.	.
Σ *Bryophyta*	1	1	2	.	.	.	.	.	1	1	1	.	.	.	.	.	.	1	.	1	.	.

In addition there occur:

AP: *Ephedra distachya* 145 cm (1); *Frangula* 0 cm (1); *Fraxinus* 0 cm (6); *Juniperus* 60 cm (3), 200 cm (2); *Larix* 0 cm (2), 180 cm (2), 200 cm (1); *Populus* 60 cm (1), 70 cm (2); *Sorbus* 0 cm (3).

NAP: *Alisma* 200 cm (1); *Asteraceae* t. *Cirsium* 0 cm (4); *Brassicaceae* t. *Barbarea* 0 cm (5); *Centaurea cyanus* 50 cm (6), 60 cm (5), 70 cm (1); Cerealia indet. 60 cm (7), 70 cm (21), 80 cm (2); Cerealia t. *Triticum* 0 cm·(4): *Epilobium* t. 90 cm (1); *Galeopsis* t. 0 cm (1);*Lamiaceae* 0 cm (2), 123 cm (1); *Lycopus* 0 cm (2); *Lysimachia vulgaris* 0 cm (1); 140 cm (2), 145 cm (1); *Menyanthes trifoliata* 190 cm (1), 200 cm (2); *Parnassia palustris* 190 cm (1); *Plantago* t. *major-media* 0 cm (1), 50 cm (1); *Polygonum aviculare* 0 cm (2), 60 cm (1), 200 cm (1); *Polygonum* t. *bistorta* 180 cm (1); *Polygonum* t. *persicaria* 70 cm (3); *Potentilla—Comarum* t. 0 cm (1), 190 cm (2), 200 cm (1); *Ranunculaceae* t. *Caltha* 123 cm (1); *Sanguisorba officinalis* 0 cm (53), 145 cm (1); *Silenaceae* t. *Scleranthus* 50 cm (2), 70 cm (1); *Silenaceae* t.*Sagina* 0 cm (2); *Thalictrum* 0 cm (1), 140 cm (4); *Trifolium* t. *pratense* 0 cm (4); *Trifolium* t. *repens* 0 cm (11); *Urtica* 0 cm (3), 135 cm (1), 145 cm (1): *Vacciniaceae* 50 cm (4), 95 cm (1); *Valeriana* t. *dioica* 0 cm (1); *Valeriana* cf. *officinalis* 60 cm (1), 70 m (1); *Vicia* t. 0 cm (3), 155 cm (1); *Viola* t. *canina* 0 cm (1).

Hydrophyta: *Myriophyllum spicatum* 123 cm (1); 200 (1); *Potamogeton* t. 80 cm (1), 95 cm (1), 103 cm (1).
Pteridophyta: *Lycopodium clavatum* 160 cm (1).

Bryophyta: *Anthoceros* 50 cm (1); *Riccia* 60 cm (1).

eumaritimus, *Alisma plantago-aquatica* (including pollen), *Sagittaria sagittifolia*, and the pollen grains of *Lythrum*, *Pedicularis* cf. *palustris*, *Comarum palustre*, *Parnassia palustris* and *Polygonum* t. *persicaria*. In addition, the following pollen types have an uniterrupted curve in the uppermost layers: *Typha latifolia*, *Sparganium-Typha angustifolia* t. and *Asteraceae*. The plant community has an analogue in the community found today in the České Budějovice Basin on periodically denuded shores or the bottoms of fishponds. It is possible that the introduction of this plant assemblage was actually brought about by the construction of the Bezdrev fishpond in 1490; the area of this water body was much larger before 1868, when the water level was artificially reduced to the present state.

In the JC-9-B profile (see Fig. 3 Appendix 2) the course of pollen curves also corresponds to the reconstructed series of local plant communities (cf. the curves of *Cyperaceae*, *Poaceae*, *Salix*, etc.).

Notes on the determination of some seeds and fruits

Carex cf. *lasiocarpa* and *C.* cf. *limosa:* The material included only trigonous nutlets without utricles; most of them (JC-9-B), according to reference material, corresponded most probably to *Carex lasiocarpa*. The distinctly spindle-formed nutlets (JC-9-A, 205 cm, see Plate 10:21) are considered as belonging to *Carex limosa*. As both types of subfossil nutlet converge in some forms, the species determination presented here, especially the quantitative relation of both types, should be regarded as approximate.

Carices sect. *acutae:* (*Carex gracilis*, *C. caespitosa*, *C. fusca*, *C. aquatilis* and others). The sediments analyzed were very rich in nutlets of *Carices* sect. *acutae*. These species are characterized by considerable variability in form and size of utricule and nutlet. Their determination, especially in subfossil form, is very difficult. In the profiles studied, only *Carex fusca* (Plate 10:16, 17) could be determined with a high degree of certainty. The determination of *Carex gracilis* (Plate 10 : 13), represented almost exclusively by nutlets without utricles, can be considered, after comparison with reference material, to be very probable, although the set of subfossil nutlets shows considerable variability. The determination of *Carex aquatilis* (Plate 10:20) especially as far as its quantitative representation is concerned, is uncertain, because it was not always possible to prove the presence of scattered elongated purple cells, which are characteristically found on the utricles of this species (Wasylikowa 1964).

Poaceae: In the analyzed material, 3 to 4 types of subfossil grass caryopses were found, but they were corroded to such a degree that their specific determination was impossible. They probably belonged to some hydro- or hygrophilous grasses with caryopses of medium size (3.0—3.5 mm); for examples see Plate 9:10 and 10:24.

DESCRIPTION AND INTERPRETATION OF POLLEN DIAGRAMS

The pollen analyses (Figs. 2 and 3 Appendix 2, Tabs. 3 and 4) record general changes of dry-land vegetation in the midwestern part of the České Budějovice Basin from the Dryas III (only in JC-9-B) through the Pre-boreal to Boreal periods. The layers corresponding to the Atlantic and Sub-boreal periods are absent (see p. 159) and the vegetation can again be reconstructed only from the beginning of the Sub-atlantic period. The zonation used follows Firbas (1949).

Dryas III: The delimitation of the period is based on the identity of basal pollen spectra with those described from this period in other parts of Central Europe. Apparently, forest vegetation did not develop in the area. Arboreal plants reach only about 40 % T Σ in the AP: NAP ratio and are represented by *Pinus*, *Betula*, *Juniperus* and *Salix* only. Isolated grains of *Corylus*, *Ulmus*, *Quercus*, *Alnus* and *Picea* do not mean that these trees occurred in the area; the grains probably come from long-distance transport. The predominance of non-forest vegetation is indicated onthe one hand, by the strictly heliophilous woody plants in the spectra (*Juniperus*, *Picea*, *Betula*, *Salix*) and, on the other hand, by continuous representation of heliophilous herb elements, such as *Artemisia*, *Helianthemum*, *Brassicaceae*, *Galium*, *Chenopodiaceae*, *Daucaceae*, *Silenaceae*, etc.

Pre-boreal: This period is characterized by a gradual increase of the woody plant component of the pollen spectra. The abrupt increase of the *Pinus* curve is typical, while the values of *Betula* (in comparison to *Pinus*) increase only slightly. Simultaneously, the pollen values of *Juniperus* and *Salix* (with only the local hydrophilous willows probably persisting) as well as the heliophilous herbs (*Artemisia*, *Helianthemum*, *Brassicaceae*, *Chenopodiaceae*) decrease in the spectra. It is interesting that only the Pre-boreal spectra contain late Weichselian (Glacial) species, such as *Ephedra distachya* and *Hippophaë*; however, the finds of isolated grains of these species cannot be considered as a proof of the existence of the plant in the area. The finds of arboreal pollen typical of the climatic optimum (*Corylus*, *Alnus*, *Ulmus*) are as insignificant as in the preceding period.

Boreal: The delimitation of the Boreal in the profiles is to a certain degree problematic, because of the supposed interruption of sedimentation in the middle Flandrian (Holocene) period. The spectra, which are denoted as coming from the Boreal can also be regarded as belonging to the late Pre-boreal, for the vegetational differentiation and the drawing of the borderline are indistinct. However, in accordance with present knowledge of the character of Boreal vegetation, marked by the absence of hazel in the southern and western part of Czechoslovakia (KRIPPEL 1965, JANKOVSKÁ 1967, RYBNÍČEK et RYBNÍČKOVÁ 1968, RYBNÍČKOVÁ et RYBNÍČEK 1972, RYBNÍČKOVÁ 1974), it is possible to consider the spectra formed mostly by pine, in which *Pinus* reaches its highest values, as belonging to the Boreal. The maximum of hazel pollen, typical of the Boreal spectra of western and NW. Europe and for the northern and western part of Central Europe does not appear in the České Budějovice Basin at all; perhaps *Corylus* did not reach this area. Isolated grains apparently come from long-distance transport. The representation of heliophilous late Weichselian elements in the area almost disappeared during this period, thus suggesting the existence of relatively dense pine forests with an admixture of birch. Unlike other areas with a similar type of Boreal vegetation (op. cit.) in Czechoslovakia, the *QM* elements, which usually begin to appear in the Boreal period, seem to be almost totally absent here. Further research is needed, beginning with a discovery of another suitable profile in the České Budějovice Basin, which would record the whole Flandrian period and thus complete or correct the conclusions presented in this paper.

Spectra which are considered as belonging to the Boreal come to a very abrupt end and it is posible that the whole of the period is not represented in the profiles. On the basis of vegetational and sedimentational discontinuity, a long hiatus in the sedimentation sequence, lasting perhaps more than 5000 years, is presumed to

Table 4. Absolute numbers of pollen and spores, Zbudovská blata, JC-9-B

Depth cm	0	20	30	40	50	60	70	75	80	85	90	95
AP												
Abies	.	38	49	26	11	103	117	108	149	38	111	76
Alnus	25	64	96	76	16	66	115	122	45	88	170	260
Betula	23	36	26	40	5	12	22	45	31	61	14	66
Carpinus	1	1	1	1	.	.	.	1	.	2	.	.
Corylus	.	6	29	15	7	17	10	9	7	5	23	11
Fagus	1	7	9	18	.	27	11	17	27	5	30	13
Fraxinus	.	1	1	.	.	.	.	1	.	2	1	.
Juniperus	.	8	6	6	.	.	.	.	.	.	.	.
Picea	17	25	72	40	6	42	77	72	59	39	54	49
Pinus	128	153	200	207	45	177	82	151	123	81	49	163
Quercus	5	5	4	21	2	2	5	5	9	14	6	10
Salix	8	12	10	9	4	.	4	1	1	4	7	5
Tilia	1	2	3	2	1	3	5	1	2	.	2	2
Ulmus	.	1	1	3	6	2	.	4	.	2	3	1
Σ AP	210	359	507	464	103	451	448	537	453	341	471	656
NAP												
Alisma	.	7	7	3	.	.	.	.	.	1	1	.
Artemisia	6	5	2	2	1	1	2	.	.	1	3	1
Asteraceae Liguliflorae	2	3	12	10	2	3	.	.	.	1	3	.
Asteraceae Tubuliflorae	10	5	17	14	.	1	.	2	.	1	2	.
Brassicaceae t. *Barbarea*	.	.	1	2	.	.	1	.	.	.	1	.
Brassicaceae t. *Cardamine*	6	.	1	3	2	.	.	.	.	.	.	.
Cerealia t. *Secale*	11	11	17	17	11	5	.	.	.	.	1	.
Cerealia t. *Triticum*	18	21	10	11	.	.	.	.	.	.	.	.
Chenopodiaceae	8	3	2	1	1	.	.	.	.	.	.	.
Cyperaceae	14	80	136	217	21	111	305	264	275	113	110	30
Daucaceae	1	1	5	13	2	.	3	3	.	.	1	2
Filipendula	3	7	8	27	1	10	222	161	34	122	223	83
Galium t.	2	3	2	2	1	1	1	2	1	2	1	2
Plantago lanceolata	8	5	4	2	.	.	.	.	1	.	.	.
Plantago t. *major-media*	3	5	.	3	.	.	.	.	.	.	.	.
Poaceae	467	160	193	260	28	193	89	240	227	180	172	70
Polygonum aviculare	.	2	5	6	.	.	.	.	.	.	2	.
Potentilla-Comarum t.	.	1	1	.	.	.	.	.	.	.	1	.
Ranunculaceae t. *Ranunculus*	32	5	11	8	.	.	3	.	.	3	10	.
Rosaceae	.	1	.	.	.	.	.	.	.	.	.	.
Rumex t. *acetosa*	2	9	15	8	.	.	.	.	.	1	.	.
Sanguisorba officinalis	47	.	.	1	.	.	.	.	.	.	.	.
Scrophulariaceae	.	2	.	.	.	.	.	.	.	.	.	.
Silenaceae	1	.	3	5	.	2	3	.	.	1	1	1
Sparganium-Typha angustifolia t.	2	19	4	1	.	.	.	.	.	.	.	1
Thalictrum	.	1	5	3	.	.	1	.	.	.	5	.
Typha latifolis	1	19	25	9	.	3	.	.	1	.	1	.
Urtica	6	4	5	3	.	.	11	.	.	1	3	.
Valeriana	.	.	1	.	.	.	.	.	.	2	3	.
Varia	10	18	17	11	2	5	13	18	5	12	19	11

100	105	110	115	120	130	140	150	160	170	180	190	200	210	220	230	240
35	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
624	22	1	8	.	.	3	.	2	1	5	1	1	1	.	.	2
64	19	53	16	7	6	19	30	119	56	65	61	21	119	28	54	39
1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
19	5	13	.	.	2	.	.	6	3	1	4	3	12	.	.	1
12	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	2	3	2	.	7	10	22	5	24	11
41	11	8	.	.	1	6	1	.	5	.	.	6	1	1	.	.
165	655	630	482	505	489	532	348	651	412	547	396	320	372	294	270	251
11	1	1	.	.	.	.	.	.	.	.	1	.	.	.	.	1
.	1	17	3	3	2	4	.	4	.	1	10	2	10	6	7	19
4	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.
1	.	4	.	.	.	.	.	4	.	.	.	2	.	1	1	.
977	716	728	509	515	500	564	381	792	480	621	482	366	537	335	356	324
.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
.	.	1	1	.	1	.	.	3	1	.	11	.	44	6	15	11
.	.	.	.	.	.	.	.	1	1	.	1	.	1	.	.	2
.	.	1	.	.	.	1	.	.	.	.	2	.	1	2	.	2
1	.	1	.	.	.	.	.	1	.	.	.	1	.	.	.	1
.	.	.	.	.	.	.	.	.	.	.	2	.	7	3	2	2
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	3	.	7	1	2	.
19	70	449	87	133	154	55	65	129	89	25	409	66	841	237	294	338
.	.	7	3	1	.	.	.	12	1	3	3	2	5	3	1	5
14	25	62	16	11	17	1	2	27	6	3	8	4	14	.	2	4
2	.	1	1	1	1	3	1	4	1	1	.	1	5	1	13	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.
58	81	108	36	81	55	42	116	444	97	125	179	266	201	46	64	93
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	2	.	.	.	.	14	.	17	.	.	.
.	.	.	.	.	.	.	.	4	1	2	3	1	4	3	2	2
13	.	.	.	.	.	.	5	.	.	.	2	.	2	.	.	3
7	.	2	.	.	.	.	1	1	.	.	.	.	.	1	2	1
.	1	2	.	.	.	.	.	1	1	1	1	.	5	.	.	.
3	.	.	.	.	.	.	.	.	.	.	.	2	.	1	.	.
.	.	.	.	.	.	.	.	1	.	1	8	.	5	1	1	1
.	.	.	.	.	.	.	.	.	1	.	.	1	7	1	.	1
.	1	1	.	.	1	1	1	2	5	3	3	1	2	1	3	1
.	2	3	.	.	.	.	2	7	4	.	2	7	1	1	2	6
7	.	1	.	.	.	.	4	6	.	.	.	3	.	.	.	4
1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
10	4	1	.	4	2	2	5	3	1	6	5	6	28	9	5	6

Tabelle 4. (Continuation)

Depth cm	0	20	30	40	50	60	70	75	80	85	90	95
Σ NAP	677	413	524	651	74	337	654	692	544	443	564	202
Σ AP + NAP	887	772	1031	1115	177	788	1102	1229	997	784	1035	858
Hydrophyta												
Myriophyllum spicatum	.	.	1	.	.	.	.	.	.	.	.	.
Potamogeton t.	.	1	4	.	2	.	.	.	.	.	.	.
Σ Hydrophyta	.	1	5	.	2	.	.	.	.	.	.	.
Pteridophyta	.	6	10	3	2	2	2	.	.	.	2	1
Equisetum												
Polypodiaceae	4	57	68	25	4	15	7	22	9	19	53	50
Σ *Pteridophyta*	4	64	78	30	6	18	29	22	9	19	55	51
Bryophyta												
Sphagnum	.	.	3	1	1	.	1	1	.	.	.	.

In addition there occur:

AP: *Acer* 90 cm (1); *Ephedra* t. *distachya* 190 cm (1); *Hippophaë* 160 cm (2); *Juglans* 0 cm (1); *Malus* 180 cm (1); *Populus* 170 cm (1); 180 cm (1), 200 cm (1).

NAP: *Asteraceae* t. *Cirsium* 30 cm (1), 240 cm (1); *Bupleurum* 160 cm (1); *Calluna* 20 cm (1), 30 cm (1), 100 cm (1); *Campanulaceae* 115 cm (1), 200 cm (3), 210 cm (2); *Centaurea cyanus* 20 cm (3), 30 cm (1), 40 cm (1); *Centaurea jacea* 85 cm (1); Cerealia indet. 0 cm (4); *Chamaenerium* 210 cm (1); *Chrysosplenium* 20 cm (1), 100 cm (4); *Echium* t. 0 cm (1); *Geranium* 20 cm (1); *Helianthemum* 210 cm (19), 220 cm (1), 230 cm (1); *Humulus-Cannabis* t. 20 cm (1); *Lamiaceae* 20 cm (3), 85 cm (1); *Lotus* t. 30 cm (9); *Lysimachia vulgaris* t.

occur in the profile. This means that the Boreal spectra are directly followed in the diagrams by those of the upper Flandrian.

Early Sub-atlantic ("älterer Teil des Subatlantikums"): This period falls immediately before the continuous settlement of the České Budějovice Basin, the composition of its pollen spectra thus having considerable significance for understanding the virgin vegetation uninfluenced by human activity. The upper Flandrian spectra differ radically from those of the lower Flandrian. They are characterized, on the one hand, by low representation of pine and, on the other hand, by the predominance of pollen from trees, demanding well developed soils and a suboceanic climate. Our spectra show that the climax vegetation of the basin was most probably formed by fir forests with spruce and a small admixture of beech (up to 5 % of T sum) instead of the acid oak forests expected by geobotanists (Mikyška et al. 1968). The occurrence of *Corylus, Ulmus, Tilia, Quercus, Fraxinus* and *Acer* could not be very great. The quantity of their pollen is relatively low in the spectra, even if small pollen production and poor spreading of many of these species are taken into consi-

100	105	110	115	120	130	140	150	160	170	180	190	200	210	220	230	240
140	184	644	145	231	232	107	202	653	209	170	656	364	1225	318	410	490
1117	900	1372	654	746	732	671	583	1445	689	791	1138	730	1762	653	766	814
.	.	.	.	.	.	.	.	.	1	.	3	2	6	2	9	269
.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	2
.	.	.	.	.	.	.	.	.	1	.	3	2	7	4	9	271
.	1	3	1	.	3	116	84	581	363	563	25	4	35	6	5	9
130	286	8	17	12	30	72	23	27	9	10	3	2	1	.	.	1
130	287	11	18	13	33	188	107	608	372	573	28	6	36	6	5	11
1	.	3	.	.	.	.	1	.	.	.	.	.	.	.	.	.

75 cm (1), 130 cm (1); *Lythrum* 40 cm (2); *Melampyrum* 40 cm (1), 160 cm (1); *Mentha* t. 40 cm (1); *Menyanthes* 90 cm (1), 220 cm (1), 240 cm (1); *Montia* 50 cm (1); *Parnassia palustris* 40 cm (1), 160 cm (1); *Pedicularis* 30 cm (1); *Polygonum* t. *bistorta* 160 cm (1), 210 cm (1); *Polygonum* cf. *lapathifolium* 40 cm (1); *Polygonum* t. *persicaria* 20 cm (2), 75 cm (1); 95 cm (1); *Ranunculaceae* t. *Anemone* 210 cm (1); *Trifolium* t. *pratense* 0 cm (4), 30 cm (2), 60 cm (1); *Trifolium* t. *repens* 40 cm (1), 50 cm (1), 60 cm (1); *Trollius* t. 240 cm (1); *Vaccinium* t. 110 cm (4), 160 cm (1); *Viciaceae* 0 cm (8), 20 cm (4), 40 cm (1).

Hydrophyta: *Batrachium* t. 210 cm (1).

Pteridophyta: *Botrychium* 240 cm (1); *Lycopodium* cf. *complanatum* 20 cm (1), 40 cm (1); *Ophioglossum* 120 cm (1); *Petridium aquilinum* 40 cm (1), 60 cm (1).

deration. The insignificant representation of *Carpinus* pollen in the spectra, however, confirms the conclusions of the geobotanical mapping concerning the absence of hornbeam itself and of oak-hornbeam forests (*Carpinion betuli* OBERD. 1953) in southern Bohemia. Alder spread considerably in this period and perhaps formed a dominant in azonal communities of waterlogged areas. However, it could not occur on unconsolidated upper Flandrian mineral sediments which are supposed to exist in the closest vicinity of our profiles. It seems that alder was replaced by willow in such places (see the absence of alder wood and the presence of *Salix* wood in our sediments). It is possible that the abrupt decrease of alder curves in the diagrams (JC-9-A 110 cm, and JC-9-B 90 cm) accompanied by the first grains of cereals and synanthropic plants in about the same layers of the second profile could be caused by the first colonists clearing the alder trees.

Late Sub-atlantic ("jüngerer Teil des Subatlantikums"): the lower borderline of the period is clearly marked by an abrupt decrease in the pollen curves of the climax trees, especially of *Abies*, less so of *Fagus* and *Picea*. Simultaneously, an increase in the curves of cereals (especially *Secale*) and in the curves of synanthropic and weed species can be observed. The general clearance of the virgin forests and the reduction of former fir stands ("black forests") are also indicated by a re-occurrence of heliophilous *Betula*, *Pinus*, *Salix* and *Juniperus* in the spectra. The present character of the landscape, however, is fully reflected only in the surface samples, showing the ratio AP: NAP as low as 1 : 3, i.e. about 75 % NAP.

SETTLEMENT OF THE AREA AND VEGETATIONAL CHANGES

According to archaeological finds, the area under study was practically unsettled in primaeval times (i.e. throughout Neolithic and the Bronze Age). The first very scattered archaeological finds date back to the late Hallstatt, but the first relatively dense land occupation did not occur until the La Tène period. La Tène settlements and finds have been excavated in the neighbouring villages of Munice, Plástovice, Zbudov, Zliv, Mydlovary, Pištín and Zálužice (Beneš 1974).

If we correlate the first agricultural pollen spectra in our diagrams with this culture we can say that the La Tène settlements did not substantially influence the neighbouring climax fir forest. They seem to have been concentrated in the wide valleys scattered inside alluvial alder stands. This is indicated firstly by the abrupt decrease in the alder curves and then by the subsequent increase in *Filipendula* and perhaps also *Poaceae* curves. The first pollen grains of synanthropic plants and scattered pollen of cereals accompany this situation.

In spite of the fact that the La Tène culture is supposed to have had a relatively high agricultural technique (Filip 1969, 2 ; 670) it seems to be concentrated rather on animal breeding (meadows) than on arable farming in this area. All these data support the statement of Böhm (1963 : 71) that dispersed type od settlement, i.e. a system of individual farm-houses was typical of southern Bohemia in this period.

The next continuous land occupation is much younger, dating to the late Slavonic era (700 A. D.). The break in land occupation was probably the cause of a partial regeneration of alder stands, as it is depicted in the pollen diagrams by increasing values of alder pollen. Slavonic settlements were found near the village of Zbudov and also near Zliv on the shore of the present Bezdrev fishpond. The more abundant finds of charcoals in the sediments (about 50 cm in JC-9-B) just before the decrease in the curves of climax AP (fir, beech, spruce) correspond to the deforestation of the country and to the extensive arable agriculture of the Slavonic population. This Slavonic settlement, which undoubtedly developed into general colonization of the area (first historical data on the neighbouring villages come from the 13th century), denotes the origin of systematic agricultural activity (cf. the continuous curves of cereals, weeds and synanthropic plants). Extensive cultivation of *Secale* seems to be characteristic of Slavonic agriculture in general (cf. Lange 1971).

The period of intensification of agricultural production, dating to the 17th and 18th centuries and commonly observed in Czechoslovak pollen diagrams, is not recorded in the present diagrams. The corresponding upper layers of the sediments were not analyzed as they were obviously disturbed.

THE COMPARISON OF VEGETATIONAL DEVELOPMENT IN THE ČESKÉ BUDĚJOVICE AND THE TŘEBOŇ BASINS

Close proximity and geological and geomorphological resemblance on the one hand, some climatic and vegetational differences between the two basins on the other hand call for a comparison of the two regions from the point of view of vegetational development. The comparison, attempted here, uses results from the present paper and recent studies on the Třeboň Basin (JANKOVSKÁ 1967).

Up to the end of the Boreal period, the dry-land vegetation in the two basins developed along the same lines: from the late Weichselian open landscape with scattered patches of woodland to the closed pine forests without hazel in the Boreal period. A comparison of the middle Flandrian conditions is impossible so far, as no data from the České Budějovice Basin are available at the moment.

In the Třeboň Basin, *Alnus* and *Picea* (and *Ulmus* and *Quercus* among the *QM* species) began to expand,, while *Pinus* was receding in the early Atlantic period. In the late Atlantic, *Alnus* and *Picea* seem to have become dominant trees, reaching their Flandrian maximum at that time. To a certain degree this also applies to the *QM* woody plants and to *Corylus*, but in comparison with other similarly situated areas in Central Europe these species were little represented in the forest cover. In the Sub-boreal period, *Abies* and *Fagus* began to expand in the Třeboň Basin, while the values of *Alnus*, *Picea* and *QM* woody plants decrease a little.

Because of the hiatus described in our profiles, it is impossible to ascertain whether or not the vegetational difference between the two basins appeared as early as the middle Flandrian period. Some differences, however, can be found in the early Subatlantic period. While the climax forests in the Třeboň Basin were fir stands with an unequal but regular admixture of beech and spruce and with a small admixture of *QM* trees, in the České Budějovice Basin the climax forests seem to have been formed by fir stands with spruce, while beech was very rare and its presence is expected rather along the border of the area (cf. p. 172). In both regions, pollen analyses put in doubt the existence of virgin acidophilous oak forests as they were reconstructed by geobotanical mapping (cf. MIKYŠKA et al. 1968). At present, perhaps, acidophilous oak forests should be regarded as a potential vegetation type ("potentielle Vegetation" sensu TÜXEN 1956) rather than as virgin climax forest ("ursprüngliche Vegetation").

The land occupation in the České Budějovice Basin was earlier than in the Třeboň Basin and seems to have taken place during a shorter period. The features of deforestation appear very abruptly in the pollen diagrams, while in those of the Třeboň Basin the decrease in the curves of climax trees is more gradual and not so marked. Surface spectra from the Třeboň Basin have also preserved their forest character reflecting the appearance of the country, while the spectra from the České Budějovice Basin have the typical character of an overcultivated, deforested region.

Clear-cut differences can be found in the development of azonal mire and water vegetation. In the Třeboň Basin during the Atlantic period, the aquatic and fen stages of the mire succession gave way to the transitional and raised-bog peat-forming communities, which still exist there. In the České Budějovice Basin, on the other hand, the development of the peat-forming communities ended with fen communities of low or tall sedges (the *Caricion canescentis-fuscae* NORDH. 1936, *Magnocaricion*

W. Koch 1926 and *Caricion lasiocarpae* Vanden Berghen 1949 alliances) as early as the Boreal period. Elements of transitional and raised-bog mire communities have not been ascertained in the České Budějovice region at all, i.e. neither in the subfossil nor in the present vegetation. At present (or in the not too distant past) mires and swamps occupy nearly 6 % of the total area of the Třeboň Basin, while no living mire is known in the České Budějovice Basin and buried or dead mire areas are quite insignificant. The causes of quantitative and qualitative differences in mire development can be seen, first of all, in the different amounts of precipitation in the two regions. From this point of view, the Třeboň Basin has much more advantageous conditions, for the annual mean precipitation is almost 100 mm higher than that of the České Budějovice Basin (see p. 158). This value certainly has some influence on the total hydrological relations of the two basins.

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SUMMARY

The present paper sums up the results of stratigraphic and palaeoecological investigation of two buried peat profiles (JC-9-A, JC-9-B) from the Zbudovská blata marshes in the České Budějovice Basin, southern Bohemia, Czechoslovakia. The two profiles studied were formed by two separate sedimentation processes: by organogenic sedimentation (Dryas III, Pre-boreal and Boreal periods), and by late minerogenic sedimentation which covered the lower organogenic layers during the late Flandrian (the Sub-atlantic period). No middle Flandrian layers were found in either of the profiles.

Because of this stratigraphic discontinuity some problems (such as the explanation of the causes of stratigraphic anomalies, final delimitation of the borders of climatic-vegetational pollen zones, chiefly between Pre-boreal and Boreal, and the final solution of the origin and development of the nearby meadow vegetation of today) remain unsolved. Nevertheless, the communication of the results is considered to be of value, because no palaeoecological data from the České Budějovice Basin have been published before. It is suggested that the existence of aquatic and peat-forming plant communities was restricted to relatively small areas (pools, abandoned channels). Plant communities similar to the present stands of the *Potamion* W. Koch 1926 and the *Magnocaricion elatae* W. Koch 1926 and *Caricion lasiocarpae* Vanden Berghen 1949 were responsible for the infilling of these pools. Unlike the neighbouring Třeboň Basin, where peat-formation took place over large areas, the succesion did not proceed to transition and raised-bog communities but, instead, remained at the swamp or fen stages mentioned above. The role of mosses in the peat-forming process was very small in the profiles studied.

Carpological analyses of the sediments brought some palaeophytogeographical information, such as, for example, the finds of *Zannichellia palustris*, *Potamogeton filiformis*, *P.* cf. *polygonifolius*, *Hippuris vulgaris*, *Myriophyllum spicatum* in the Dryas III layers, *Cicuta virosa*, *Carex pseudocyperus* in the Pre-boreal and Boreal layers, etc.

Pollen analyses did not record the usual expansion of *Corylus* in the early Flandrian especially in the Boreal, they show that hazel was probably totally absent from the area. This supports again the existing observations on the absence or low occurrence of *Corylus* in the southern regions of Czechoslovakia. Fir forests with an admixture of spruce and with very rare beech were pollenanalytically proved as climax vegetation for the late Sub-atlantic period in the České Budějovice Basin. This conclusion does not correspond to the results of the geobotanical mapping, which suggested acidophilous oak-forests as the virgin vegetation before the human occupation of the region. The present paper suggests that it would be better to consider the acidophilous oak-forests as a potential vegetation type.

A comparison of vegetational development in the České Budějovice and Třeboň Basins suggests that the development was identical at least up to the end of the early Flandrian period. In the late Flandrian, the quantitative representation of the leading climax trees is more diverse: fir forests with spruce and very rare beech in the České Budějovice region, fir forests with beech and spruce admixture in the Třeboň region. The pollen diagrams show that the present differences in the landscape character of the basins, especially in their forest cover and the degree of their agricultural exploitation, have existed for about 1000 years. The more intensive exploitation of the České Budějovice Basin is due, among other things, to higher continentality of the region. This prevents the waterlogging of soils and peat-forming processes, which are so frequent in the Třeboň region, from taking place.

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Explanation to plates 9 and 10

Plate 9: 1. *Hippophaë rhamnoides*, pollen grain, JC-9-B 160 cm; 2. *Rosaceae* (*Geum* t.), pollen grain, JC-9-B 210 cm; 3. *Myriophyllum spicatum*, pollen grain, JC-9-B 210 cm; 4. *Alisma plantago-aquatica*, pollen grain, JC-9-B 30 cm; 5. *Asteraceae Tubuliflorae* (*Achillea* t.), pollen grain, JC-9-B, 220 cm; 6. *Juniperus*, pollen grain, JC-9-B 210 cm; 7. *Bupleurum* t., pollen grain, JC-9-B 160 cm. 8. *Myriophyllum spicatum*, nutlet, JC-9-B 240—245 cm; 9. *Batrachium* sp., achene, JC-9-B 240—245 cm; 10. *Poaceae* (indet.), caryopsis, JC-9-B 162—165. Figs. 1—7 1000×, figs. 8—10 15×.

Plate 10: 11. *Potamogeton* cf. *perfoliatus*, fruitstone, JC-9-B 245—250 cm; 12. *Potamogeton filiformis*, fruitstone, JC-9-B 237—240 cm; 13. *Carex* cf. *gracilis*, utricle with nutlet, JC-9-B 205—215 cm 14. *Zannichellia palustris*, achene, JC-9-B 240—245 cm; 15. *Hippuris vulgaris*, fruit, JC-9-B 245—250 cm; 16. *Carex fusca*, utricle with nutlet, JC-9-B 130—135; 17. *Carex fusca*, nutlet, JC-9-B 125—130; 18. *Potamogeton* cf. *polygonifolius*, fruitstone, JC-9-B 245—250 cm; 19. *Cicuta virosa*, fruit, JC-9-B 180—185 cm; 20. *Carex* cf. *aquatilis*, utricle with nutlet, JC-9-B 245—250 cm; 21. *Carex* cf. *limosa*, nutlet, JC-9-A 205—210 cm; 22. *Sagittaria sagittifolia*, achene, JC-9-B 35—40 cm; 23. *Alisma plantago-aquatica*, achene, JC-9-B 35—40; 24. *Poaceae* (indet.), caryopsis, JC-9-A 183—187; 25. *Bolboschoenus maritimus* ssp. *eumaritimus*, nutlet, JC-9-B 35—40 cm; 26. *Sparganium* cf. *minimum*, fruit, JC-9-B 237—240 cm. All figs. 15×.

Appendix 2, Plates 9—10.

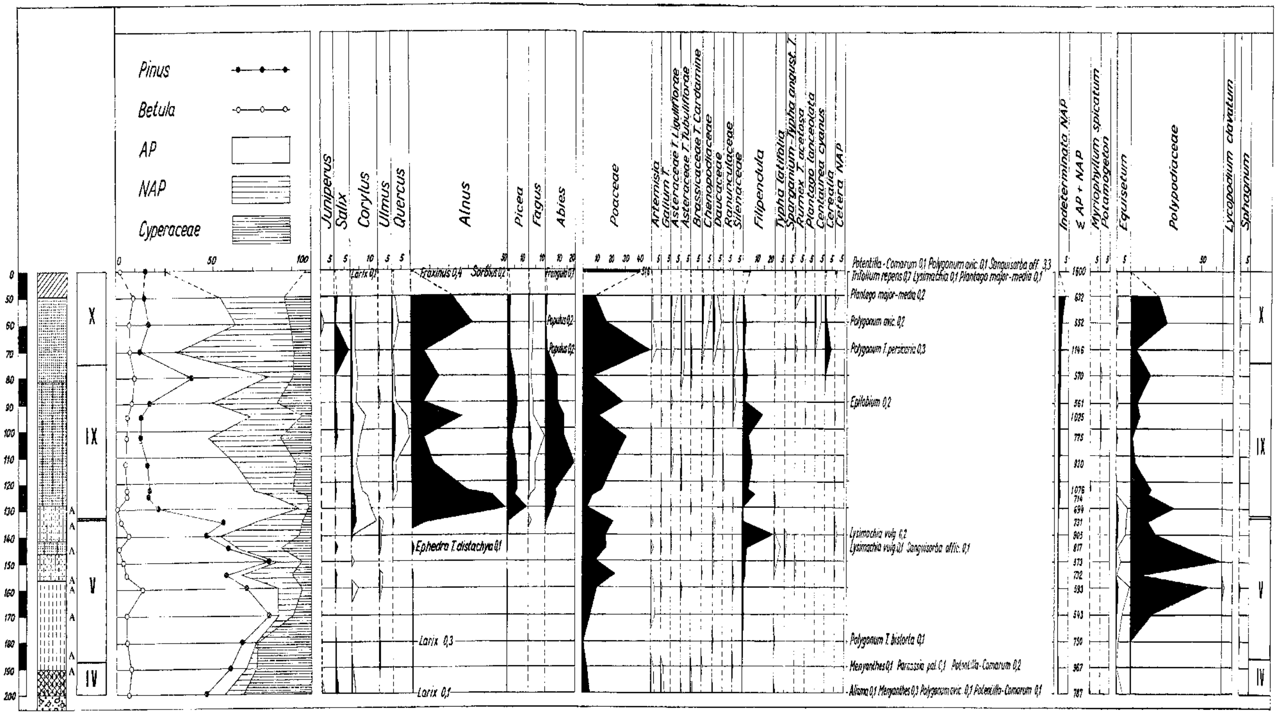
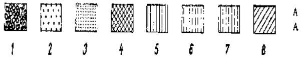


Fig. 2. Pollen diagram from the Zbudovská blata marshes – (JC-9-A)

Explanation to Figs. 2 and 3: 1. gravel, 2. sand, 3. clay, 4. gyttja, 5. Phragmites-peat, 6. Carex-peat, 7. Carex-Phragmites-peat, 8. stratum confusum, A charcoals.



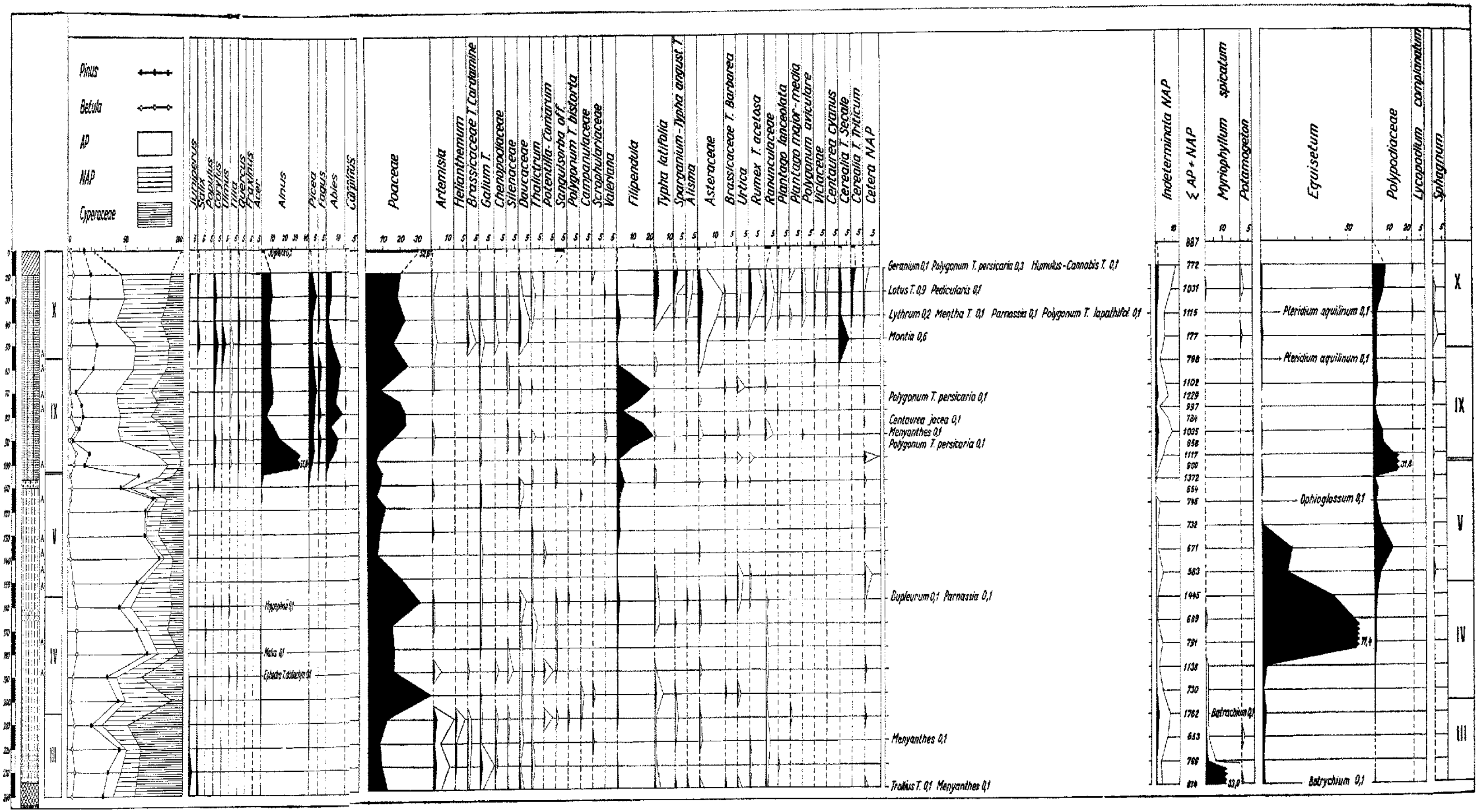
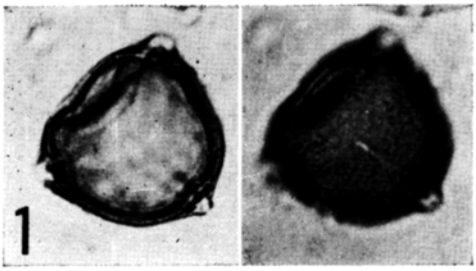


Fig. 3. Pollen diagram from the Zbudovská blata marshes (JC-9-B)

For explanations see Fig. 2.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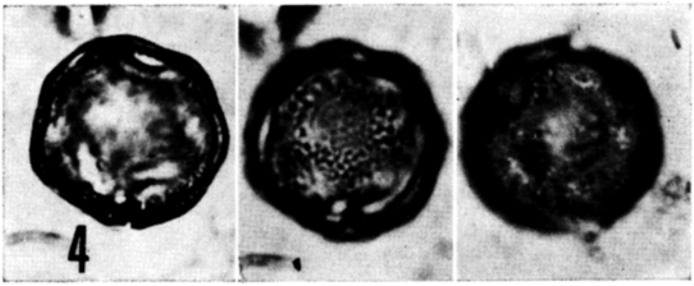
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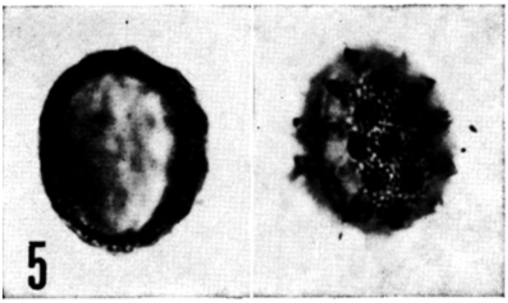
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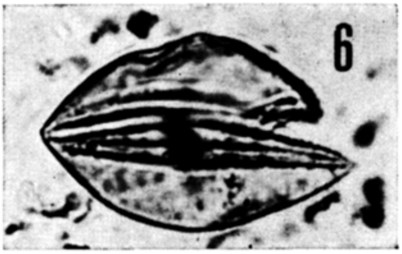
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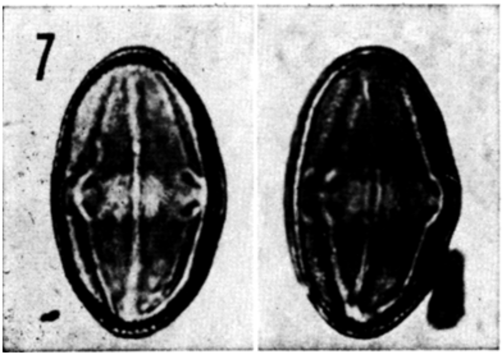
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Pollen grains and macroscopic remains from the Zbudovská blata profiles


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Macroscopic remains from the Zbudovská blata profiles