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Vegetation of the Holsteinian interglacial in Stonava-Horní Suchá (Ostrava region)

Vegetace holsteinského interglaciálu ve Stonavě-Horní Suché (Ostravsko)

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Abstract: The paper brings the results of palynological analyses of four newly exposed sections in the peat sediments at Stonava and their correlation with the previous palaeobotanical studies. The main goal was to elucidate the stratigraphic position and paleogeographic development of Stonava fossil lake and its environs.

The locality presents a typical transition type of a peat bog. Stratigraphically, it belongs to the Holsteinian interglacial and its plant succession falls into four phases:

I. (A)-A_1 - cool pine-birch forests, A_2 - cool birch-pine forests

II. (B) - temperate to warm early stage of the warm phase in typical interglacial, spruce phase, first mixed groves

III. (C) - interglacial climatic optimum, fir-hornbeam phase, climax stadium of mixed thermophilous groves, expansion of alder clumps

IV. (D) - cooling, reappearance of pine-birch forests, D_1 - fading of mixed groves, reduction of alder clumps, marked cooling, D_2 - expansion of spruce forests, scarce alder clumps, slow improvement of climate (warming).

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Lens-like wedging out layers of organic sediments which are geologically considered as pertaining to fossil Stonava Lake, were discovered between the villages Horní Suchá and Stonava (Karviná district) in the Ostrava region. Samples of the sediments underwent a pollen analysis.

Results of the palynological study of these sediments were compared with analyses performed here some thirty years ago by V. Kneblová-Vodičková (Kneblová 1957, 1958a,c, Kneblová-Vodičková 1961b, Kneblová-Vodičková, Macoun et al. 1965).

Field works at the Stonava locality were carried out during the years 1983-1984.

Profile No. I and I/OV was sampled with an interval of 0.1 m, profile No. II in a combined way - as individual samples, the lower and upper part after 0.05 m, and one metre was taken in form of monoliths into canisters sizing 0.5 x 0.1 x 0.1 m (100 samples per 0.01 m).

During the laboratory processing a modified method of the acetolysis described by G. Erdtman (1943, 1954) was applied. To clear of the mineral constituents (clay, sand), the samples were dissolved in cold hydrofluoric acid. Glycerol was used as a medium for microscopic biological preparations.

The data obtained from the microscopic analysis were evaluated in a way allowing construction of pollen diagrams. The sum of the found pollen grains of wood (AP) and herb (NAP) taxa was considered to make up 100 per cent. Spores and remains of other represented groups were not included into the total sum, just referred to it. The actual numbers of pollen grains and spores in the individual samples were presented in tables (Břízová 1986, 1988b). The pollen diagrams (1-4) show the development and character of the vegetation in the individual periods. Where the curve was inexpressive, the values were 10x overestimated.

The pollen spectra were stratigraphically interpreted on the basis of their composition. Classification of the individual developmental stages (phases) of the vegetation during the interglacial followed that by J. Dyakowska (1952) and partly by V. Vodičková (Kneblová 1957, 1958a, 1958c, Kneblová-Vodičková 1961b, Macoun et al. 1965).

The palynological evaluation included 157 samples (297 preparations). Altogether 3 profiles were sampled and the fourth one was evaluated for comparison being previously analysed also by V. Vodičková (Stonava-Kateřina). The construction of the pollen diagrams counted with more than 500 pollen grains of AP in one sample.

The development of the vegetation generally corresponds to what has so far been known as the Holsteinian (Mindel-Riss) interglacial.

The taxonomic nomenclature follows the List of vascular plants of the Czechoslovak flora (Dostál 1982).

Geology of the locality and its wider environs

Fossil Stonava Lake was located in the SE part of the Ostrava glacigene Basin, in the today's Orlová plateau. Its relief bears a character of a flat upland which is a result of sedimentation and erosion phases of glacial and interglacial cycles on the one hand and sedimentary and denudation processes after a final retreat of the continental ice sheet on the other. Solifluction and eolian sedimentation by the end of the Middle and in the Upper Pleistocene were the main modellation factors during the younger phases.

In the NW the Ostrava Basin abutes on the Opavská upland, in the SW on the Moravian Gate, and in the S on the Podbeskydská upland (fig. 1).

Hydrographically the area belongs to the Odra river basin. The surroundings of the locality is being dewatered by the Lučina into the Ostravice and the Stonávka

1. Synoptic map of the Stonava locality wider surroundings. 1 – significant phytopaleontological localities, 2 – state border, 3 – boundary of the presumed extent of the Elsterian glaciation, 4 – boundary of the presumed extent of the Saalian glaciation, 5 – boundaries of orographic units, 6 – Nízký Jeseník Mts., 7 – Opavská upland, 8 – Ostrava glacigene Basin, 9 – Moravian Gate – Odra part, 10 – Podbeskydská upland, 11 – Moravskoslezské Beskydy Mts.

into the Olše which are the right-handed tributaries of the Odra river.

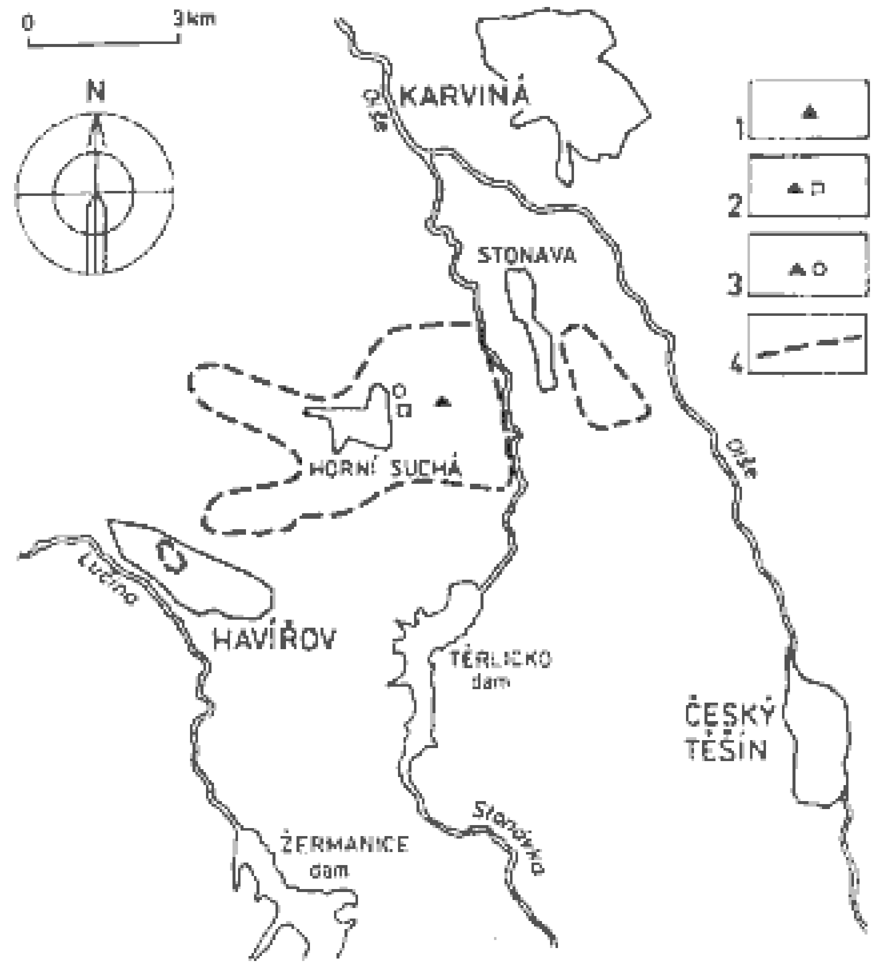
The locality and its wider environs have moderate and humid climate with annual precipitation rate around 750 mm and the mean annual temperature 8 °C (comp. Atlas of the Climate of the CSR 1958).

From the viewpoint of the geological structure, the locality and its wider environs are situated in the Carpathian Foredeep separating the Bohemain Massif from the Western Carpathians. The Upper Carboniferous basement exhibits a rugged relief (Menčík et al. 1983).

The Carboniferous relief was buried by the Miocene deposits of which the most significant are lower Badenian sediments (the Moravian). The formation is built of basal clastic rocks and calcareous claystones with sandy intercalations. Somewhen between the Karpatian and Badenian, along with the sea regression, flysch nappes of the upper Styrian phase began to thrust over the s. margin of the Ostrava Basin. Consequently, the continental sedimentary and denudation cycle started here. In the Pliocene and Lower Pleistocene, after a definitive regression of the sea, a drainage in certain parts identical with the course of the present streams was formed (Macoun 1980a). This is documented by the occurrence of fluvio-limnic and fluvial sediments haphazardly scattered over the pre-Quaternary bedrock. Stratigraphically, they fall in with the transitional Pliocene-Pleistocene period. Usually they bear a collective designation preglacial sediments because their origin precedes the oldest continental glaciation period.

The main sedimentary cycle immediately related to the sediments of fossil Stonava Lake started in the Middle Pleistocene when during the Elsterian glacial the Scandinavian continental glacier shifted far to the S and reached as far as the Ostrava Basin. Within the Elsterian glacial two transgressions of the glacier stratigraphically interpreted (Macoun 1980b) as separate glaciations (glacials) took place here. By the end of the interstadial, separating the Lower and the Upper Elsterian and in the anaglacial phase of the Upper Elsterian, fluvial gravels of the main terrace, namely its lower and locally also its middle part, were being laid down in the valleys of the streams. The fluvial complex of this terrace is the stratigraphic index horizon terminating the sedimentation of the Lower Elsterian glacial cycle. Its sediments are overlain by the limnic formation deposited during the cataglacial phase of the Upper Elsterian glaciation with continuation to the anaglacial phase of the next, i.e. the Saalian glacial (s.l.). In places this limnic horizon is overlapped also by the fluvial gravel of the upper accumulation of the main terrace.

This limnic horizon is the second marker in the Ostrava glacigene Basin. In the places free of glacial sediments the fluvial sediments of the main terrace have a special stratigraphic significance. The sediments of interglacial Stonava Lake refer also to the limnic sedimentary complex.



2. Sketch map of the Suchá-Stonava region with the sedimentary basin and palynologically evaluated sediments. 1 - Stonava-Kateřina profile, 2 - profiles evaluated by V. Kneblová-Vodičková, 3 - profiles evaluated by the author, 4 - Stonava Lake sediments (according to M. Růžička and J. Tyráček)

Fossil Stonava Lake was situated among today's Havířov, Dolní and Horní Suchá, Albrechtice and Stonava (fig. 2). Its shape was irregular with many embayments in the hilly belt of the moraine relief. Maximum detected thickness of its sediments makes here around 15 m. The formation base lies at the altitude of 260-265 m and the surface does not exceed 275 m (Tyráček et al. 1983).

The limnic complex and/or the upper accumulation of the main terrace is overlain by a formation of sediments of the Saalian glacial falling into two glaciations - the lower and the upper Saalian and contingently into their oscillation stages. Total maximum thickness of the glacial sediments in the Ostrava region is about 100 m.

After the recession of the last ice sheet from our territory mainly fluvial, deluvial and eolian sedimentation gradually remodelling the glacial relief followed.

During the interstadials and interglacials the fluviolimnic, limnic, organic and organogenic sedimentation prevailed.

The dominating sediment of the present relief as to the areal extent is an extensive loess cover of the last glacial. Glacial sediments crop out as a rule just on steeper, W-oriented valley slopes.

Vegetational development in the wider surroundings of the locality

Deposits with plant remains and fossil organic sediments suitable for a pollen analysis are very widespread and ubiquitous in the Ostrava region, however, hey do not always show a complete vegetational development in the area. The geological record of the localities suitable for a floristic study is incomplete and so far we have failed to find the deposits of all Quaternary stages (e.g. Eemsian interglacial, Weichselian interstadials and the last Weichselian stadial).

The oldest palynologically evaluated sediments come from the Lower Pleistocene of the Kobeřice locality (Vodičková 1981) and from the base of the clay pit of the Hlučín brickyard (Vodičková in Macoun 1980a).

The bog deposits at Skřečoň (Kneblová-Vodičková 1961a,b, in Macoun et al. 1965), in Ostrava-Muglinov (Opravil 1964, 1965), at Kateřinky near Opava (Kneblová-Vodičková in Macoun et al. 1965, Opravil 1960a, 1961a) are dated to the younger stage of the Elsterian.

The Holsteinian interglacial was palynologically proved in the sediments of fossil Stonava Lake (Břízová 1986, 1988a,b, Kneblová 1957, 1958a,c, Kneblová-Vodičková 1961b, in Macoun et al. 1965).

Some more precisely undated phase of a cool oscillation from the Saalian glaciation period is reflected in the flora at the locality Řepiště near Paskov (Ambrož - Kneblová 1959).

Vegetation of the Saalian-Warthian interstadial has been preserved in bog and nekron mud layers in the sediments of the Saalian glaciation near Stará Bělá s. of Ostrava (Kneblová 1957, Kneblová-Vodičková in Macoun et al. 1965).

The Weichselian ice sheet did not reach the Ostrava region, however it markedly influenced the local vegetation. Vegetation of the cool stadials was recognized at Brušperk (Kneblová 1958b, Kneblová-Vodičková in Macoun et al. 1965) and Zábřeh (Kneblová-Vodičková 1961a, in Macoun et al. 1965). A slight climatic change in the vegetation of this glacial was reflected in the Český Těšín sediments (Kneblová-Vodičková 1962, 1963).

The oldest Quaternary palynologically proved sediments from Kobeřice (Vodičková 1981) might have originated in some Lower Pleistocene period, probably at the turn of the Pliocene and Lower Quaternary. The stratigraphic position and the overall paleogeographical development of the area indicate that the warm period best corresponds to the oldest interglacial - the Tiglian (Macoun 1980a), because the proportion of Tertiary types - g. *Tsuga, Pterocarya,* scarcely even *Carya, Liquidambar* etc. in the composition of the plant assemblage is higher. The origin of the organic sediment relics from the base of the clay pit of the Hlučín brickyard is of the same date (Vodičková in Macoun 1980a). Here the representation of the genera *Carya, Pterocarya, Engelhardtia, Liquidambar, Tsuga, Taxodium, Osmunda* is also quite strong. The vegetation of this interglacial developed also from climatically undemanding assemblages to climatic and vegetation optimum with mixed forests in which deciduous woods prevailed.

The decaying Elsterian ice sheet retreating from the Ostrava region left behind its deposits and an almost vegetationless landscape. In this time the peat bog deposits found at Skřečoň (Kneblová-Vodičková 1961a,b, in Macoun et al. 1965), in Ostrava-Muglinov (Opravil l.c.), at Kateřinky near Opava (Kneblová-Vodičková in Macoun et al. 1965, Opravil 1960a, 1961a) were sedimenting. After the glacier recession the climate improved and the vegetation was represented by semiclosed deciduous forests. Later on, vegetation with some elements of Tertiary flora (genera *Carya* and *Juglans*) spread out quite rapidly. The forests were mostly coniferous, composed of g. *Pinus* with a slight admixture of some deciduous trees like *Quercus*, *Corylus* etc. They were alternating with steppe assemblages with g. *Geranium, Helianthemum, Scabiosa, Artemisia, Centaurea, Campanula, Epilobium, Pleurospermum*, etc. Along the rivers and oxbow lakes field forests spread out.

This warm period is separated from the next one by a prominent cool oscillation. This is indicated by a layer of a compressed moss (of a typically arctic species) *Paludella squarrosa* overlying the Muglinow peat bogs (Opravil 1964). The vegetation corresponds to Arctic to Subarctic climate when herbal formations dominated in the Ostrava region. The arboreal taxa are represented by g. *Pinus* with a slight admixture of g. *Betula, Picea, Alnus, Salix* and *Larix*.

During the climatic and vegetation optimum of the Holsteinian interglacial (Mindel-Riss) larger parts of the Ostrava region were covered by swamps, peat bogs and large lakes. The largest one was in the Suchá-Stonava area with more shallow bays and a coastal marginal belt overgrown with swamp vegetation (Břízová l.c., Kneblová l.c., Kneblová-Vodičková 196lb, in Macoun et al. 1965). The development of the vegetation in this period started with thin pine-birch forests, during the climatic and vegetation optimum changing into mixed forests, and again faced the colder climate reflecting the readvance of the glacier toward the S. During the optimum of the Holsteinian interglacial the Ostrava region was covered with extensive, rich mixed forests. Deciduous, more climatically demanding woods were represented by the assemblage *Quercetum mixtum*. Margins of lakes were still overgrowing with alder (*Alnus*).

During the next glacial the Ostrava region was covered with the Saalian glacier again. Gradual cooling of the climate impeded the vegetation development. Its reconstruction is difficult at the present because Řepiště near Paskov (Ambrož - Kneblová 1959) with supposingly cool glacial vegetation from some period of this glaciation is the only locality studied.

From this more detailed review, ensue certain regularities in the development of vegetation and in preservation of some elements of Pleistocene flora (e.g. *Pterocarya, Carya, Ilex, Buxus, Osmunda* etc.) already from the Tertiary, and subsequent gradual reduction of these types during the Holocene up to the present.

The development of the Holocene vegetation on this area was studied and analysed by V. Vodičková (Kneblová 1955b, 1956b) and E. Opravil (1960b,c, 1961b, 1962, 1963). Holocene sediments with plant material were discovered at Ostrava-Heřmanice, Ostrava-Svinov, Ostrava-Radvanice (Kneblová 1955b), Mexiko s. of Klimkovice and in the Odra River valley (Kneblová 1956b). The Atlantic, Subboreal and Subatlantic stages are recorded in the NHKG section (Kneblová 1955b).

Peat bogs and development of forests in the Holocene in the Beskydy Mts. were investigated by M. Puchmajerová (1945), H. Salaschek (1935), V. Kneblová-Vodičková (1966). The development of the Jeseníky forest vegetation was described in a comprehensive work by J. Nožička (1956).

The Ostrava region was of a great importance for the development of the Central European vegetation. The repeated advances and retreats of the Scandinavian ice sheet allowed the plants to migrate to the S and back to the N (Podpěra 1921, Szafer 1927). In J. Dostál's (1960) concept the Slezská lowland and the Ostrava region belong to the Silesian foothill and lowland belt (Subcarpaticum silesiacum). Here, mesophyte and xerophyte elements permeate with a slight admixture of Carpathian flora. In Silesia termophilous vegetation spreads mainly along the marginal highlands of the Ostrava Basin. Xerotherm associations were thoroughly described by J. Vicherek (1959). SW of Ostrava a cultivated land prevails.

The Ostrava region vegetation of today is of a rather humid character (Balátová-Tuláčková 1952, 1954, 1955, Šmarda 1953). However, more climatically demanding assemblages can be found here too (Kneblová 1955a, 1956a, Podpěra 1921), some of them occurring secondarily on dumps and along railway banks (Hejný et al. 1973). Forests have been strongly changed by man's impact, deciduous and mixed grooves were changed into monocultural forests of spruce (Picea). The natural character of the vegetation has been disturbed particularly by black coal mining and associated industry.

Pollen analysis

Locality Stonava-Horní Suchá

Samples of profiles Nos. I, I/0V and II come from exposures of lenslike thinning out peat remains of fossil Stonava Lake NE of the community Horní Suchá (see fig. 2).

Profile No. I

On November 1st, 1983 the samples were taken directly from the face of the lens of organic sediments (per 0.10 m from the base upwards, the last sample per 0.05 m) and numbered 1-14.

Characteristics of the sediment

0–0.25 m – dark brown peat with clay and scarcely with wood remains

0.25–0.80 m – dark brown peat with scarce wood fragments and seeds

0.80–0.95 m – black-brown peat with a strongly concentrated organic substance, at the base of the layer wood fragments

0.95–1.25 m – rusty brown, strongly compressed peat with a plenty of seeds

1.25–1.35 m – faintly dark brown, strongly grained, sandy and micaceous clayey silt, still strongly humic with scarce plant remains

1.40 m – the bedrock

The samples were analysed according to the already mentioned method. Pollen diagram No. 1 (Fig. 3) illustrates most completely the development of vegetation in Stonava Lake and environs.

Profile No. I/OV

Except for the profile No. I described above, 6 informative samples taken from a sequence of rather anorganic sediments of Stonava Lake not far from the mentioned exposures, were palynologically evaluated. Their stratigraphic position was interpreted with help of complete profile No. I.

Characteristics of the sediment

1 – grey brown, grey and light or brown micaceous loess loam with a humic horizon, at the surface about 0.05–0.10 m thick, at the base an intensively rusty dotted, some 0.10 m thick layer, Fe-coloured (sample 1)

2 – grey, brownish (humic) and bluish laminated clayey silt, a lens of light grey medium-grained sand, abruptly wedging out toward the S and then dark brown clay with a strong admixture of organic remains continues. At the base there is a ca. 0.02–0.05 m layer passing into light grey, yellowish and rusty medium-grained sand (sample 2)

3 – bluish grey silty clays, in upper 0.10 m lenses of a strongly humic interrupted layer (sample 3). 3b – brown, in places violet- and rusty-shaded and grey marly silt

4 – violetish, medium-grained sand with darker clayey layers

5 – dark brown clayey peat, in lower 0.10 m with interlayers of grey and brown-grey sands (samples 4C, 4B, 4A).

Samples 1, 2, 3 were taken informativement with respect to the sediment type, samples 4C, 4B, 4A from a peat lens (interval 0.10 m) while the distance between the two sections was approximately 0.70 m. Pollen diagram No. 2 (fig. 4) illustrates the development of the vegetation cover.

Profile No. II

On April 5th, 1984, another samples were taken from the lens of organic sediments (in a similar way as in the previous exposures): 1–10 and 1/4–4/4 per 0.05 m, 1/2–50/2 and 1/3–50/3 per 0.01 m. Altogether 114 samples were analysed with the uppermost one being negative.

Characteristics of the sediment

About 0.30 m – waste dump

0–0.05 m – clay

0.05–0.20 m – sandy clay with a peat admixture

0.20–0.70 m – grey or yellow-grey sandy clay with a peat admixture (0.20–0.30 m grey-yellow, 0.50–0.70 m rather yellow)

0.70–0.80 m – sandy clay with a negligible organic admixture

0.80–1.20 m – grey-blue peat with an anorganic admixture

1.20–1.75 m – dark fen peat

1.75 m – bedrock

Pollen diagram No. 3 (fig. 5) presents the onset and the whole climatic and vegetation optimum of this interglacial (Mindel-Riss).

Locality Stonava-Kateřina

Profile No. III

The sampling and paleobotanical analysis of the profile was already performed by V. Vodičková (Kneblová 1958c). The samples come from a borehole situated on the e. margin of the fossil deposit, SE of the village Kateřina (Nový Svět). Therefore the organic sediments have already been markedly mixed with an anorganic material and intercalated by sandy layers.

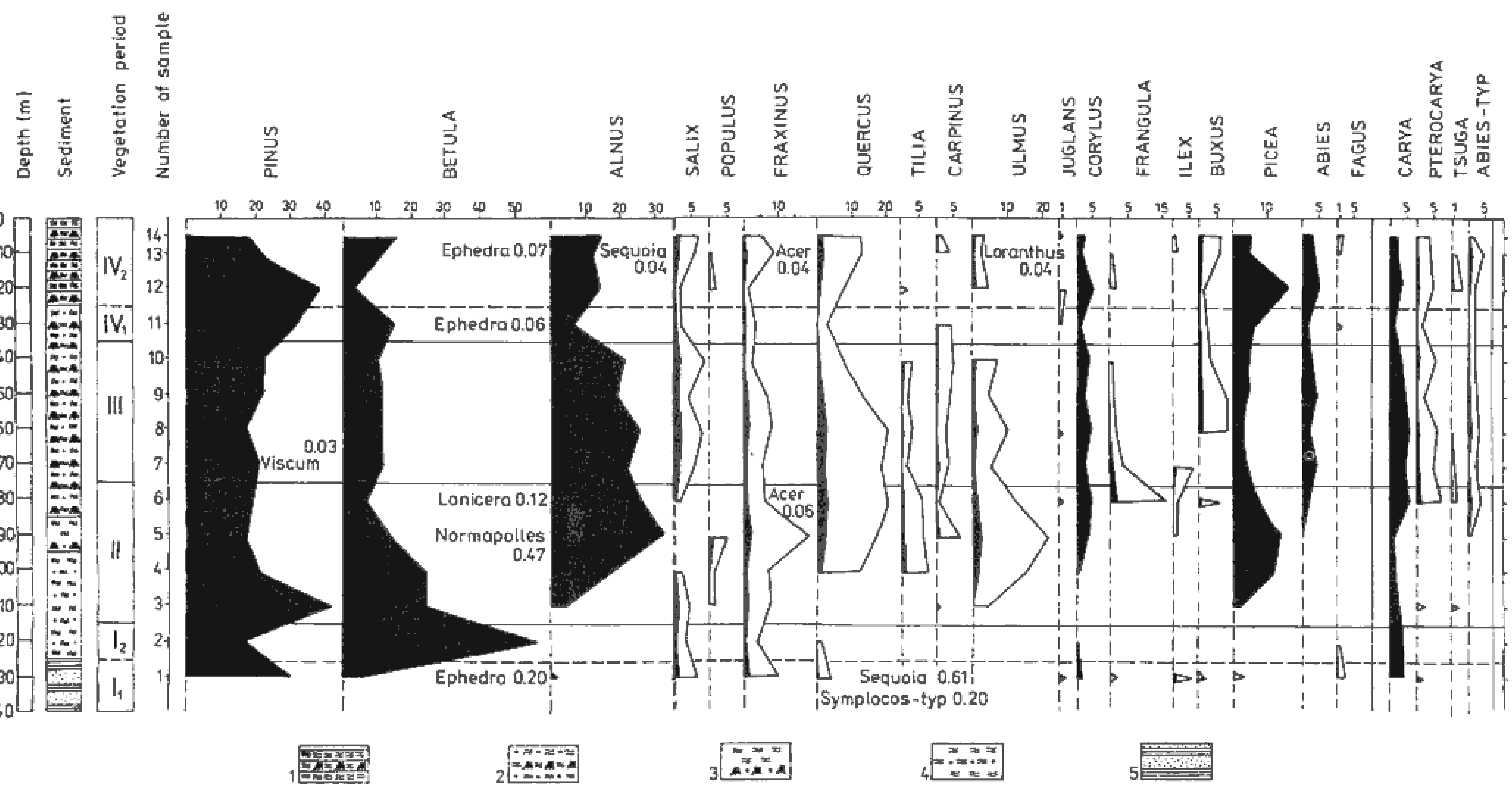
Even here the pollen analysis was carried out for the author's own comparison. However, most samples appeared to be sterile and just Nos. 6, 15–20 and 22 were positive.

The stratigraphic position was inferred from the results of V. Vodičková and plotted into the pollen diagram No. 4 (fig. 6).

Characteristics of the individual vegetation phases

Based on the geological position and development of vegetation identified by the pollen analysis, the organic sediments of fossil Stonava Lake are being referred to the Mindel-Riss (Holsteinian) interglacial, what accords also with the conclusions of V. Vodičková (Kneblová 1957, 1958a,c, Kneblová-Vodičková 1961b, in Macoun et al. 1965).

The course of representation of the individual main



3. Pollen diagram No. 1: Stonava-Horní Suchá 1986 (SHS). 1 - peat with clay and wood remains, 2 - peat with wood fragments and seeds, 3 - peat with wood fragments at the base, 4 - peat with seeds, 5 - silt, 6 - *Pinus*, 7 - *Betula*, 8 - *Cyperaceae*, 9 - *Poaceae*, 10 - AP/NAP, 11 - AP, 12 - NAP

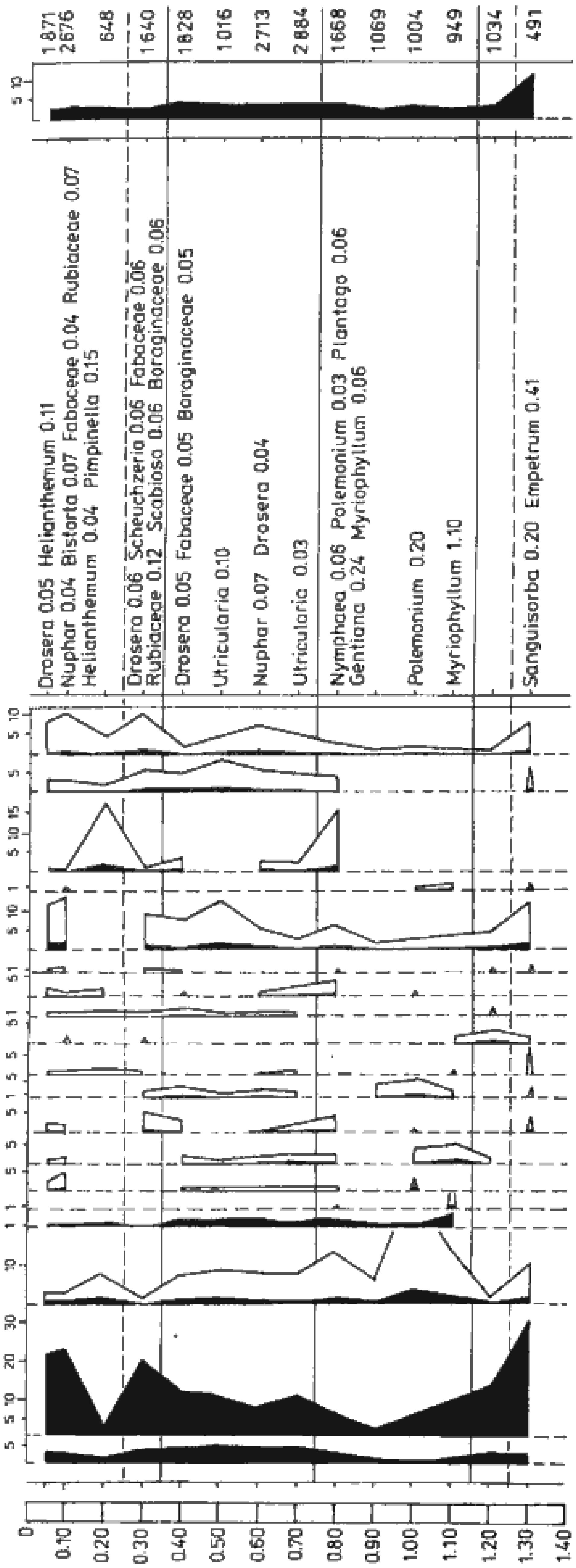


Fig. 3 – continuation

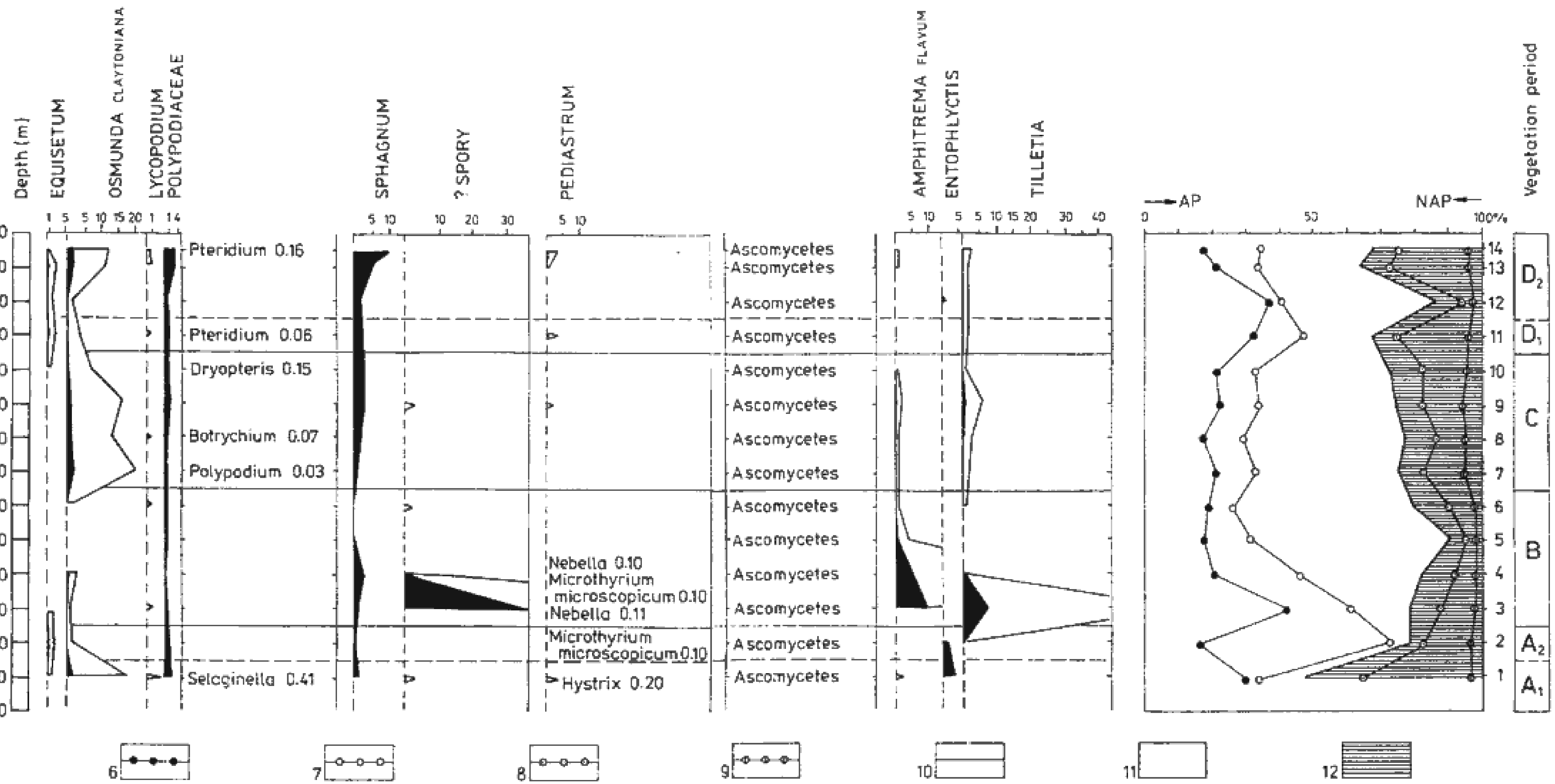


Fig. 3 - continuation

wood species in my pollen diagrams more or less corresponds with the above author's results. In the course of the whole period climatically less demanding woods as *Pinus* and *Betula* prevailed even in the spans generally characterized as periods of mixed and deciduous groves (IInd and IIIrd phase).

The most important wood species for the evaluation of their succession were, except for the mentioned genera, also *Picea, Alnus, Carpinus*, and *Abies*. Other deciduous woods of the group *Quercetum mixtum*, were less important. The vegetation characteristics of this interglacial was completed with climatically demanding plants sometimes designated "exotic" because they do not grow on our territory any more: *Ilex* cf. *aquifolium, Buxus* cf. *sempervirens*, g. *Pterocarya, Juglans, Osmunda claytoniana.*

In my pollen diagrams pollen grains of woods typical of the Tertiary and older periods also appeared, e.g. g. *Carya, Sequoia, Symplocos*, a grain from the group *Normapolles*. The grains may have originated from a small number of specimens surviving on this area from even warmer periods or an advance growth from not very remote refuges, or the grains may have been redeposited from older sediments.

Problematic was also a find of pollen grains of the genus *Abies* diferring from a normal type. For the present they are indicated as *Abies-Typ*. Whether it was *Abies fraseri* Poiret, distinguished in some profiles of this age on the Polish territory (but on the basis of macroscopic analysis only), is uncertain.

Using the compiled pollen diagrams the author observed the vegetation development and made comparison particularly with the earlier published diagrams from the same locality (Kneblová-Vodičková in Macoun et al. 1965) and with Polish profiles (see Stratigraphic evaluations, mainly Nowiny Żukowskie (Dyakowska 1952).

Based also on results of palynological studies at other localities, the Holsteinian interglacial succession (Mindel-Riss) in Stonava Lake is classified in this paper into four stages:

I. (A) - is divided into the older phase $I_1(A_1)$ and the younger phase $I_2(A_2)$.

A_1 - in the wider surroundings of Stonava Lake Subarctic pine-birch forests just with a slight admixture of *Picea, Abies* and some deciduous woods were widespread. In more distant regions probably more climatically demanding deciduous woods could survive, namely g. *Pterocarya, Ilex* cf. *aquifolium, Buxus* cf. *sempervirens*, of ferns *Osmunda claytoniana*. Cooler climate is documented by the occurrence of the genera *Ephedra, Juniperus, Selaginella, Equisetum, Lycopodium, Centaurea*, and *Artemisia*.

Wetter ecotypes around the lake were still sporadically inhabited by *Alnus* and *Salix*. The basin margins were overgrown mainly with *Carex* of the family *Cyperaceae* and grasses of the f. *Poaceae*. G. *Sparganium, Typha latifolia, Menyanthes trifoliata* were present too.

A free water level was indicated by the genera *Potamogeton, Nymphaea*, sometimes *Nuphar, Trapa, Myriophyllum*.

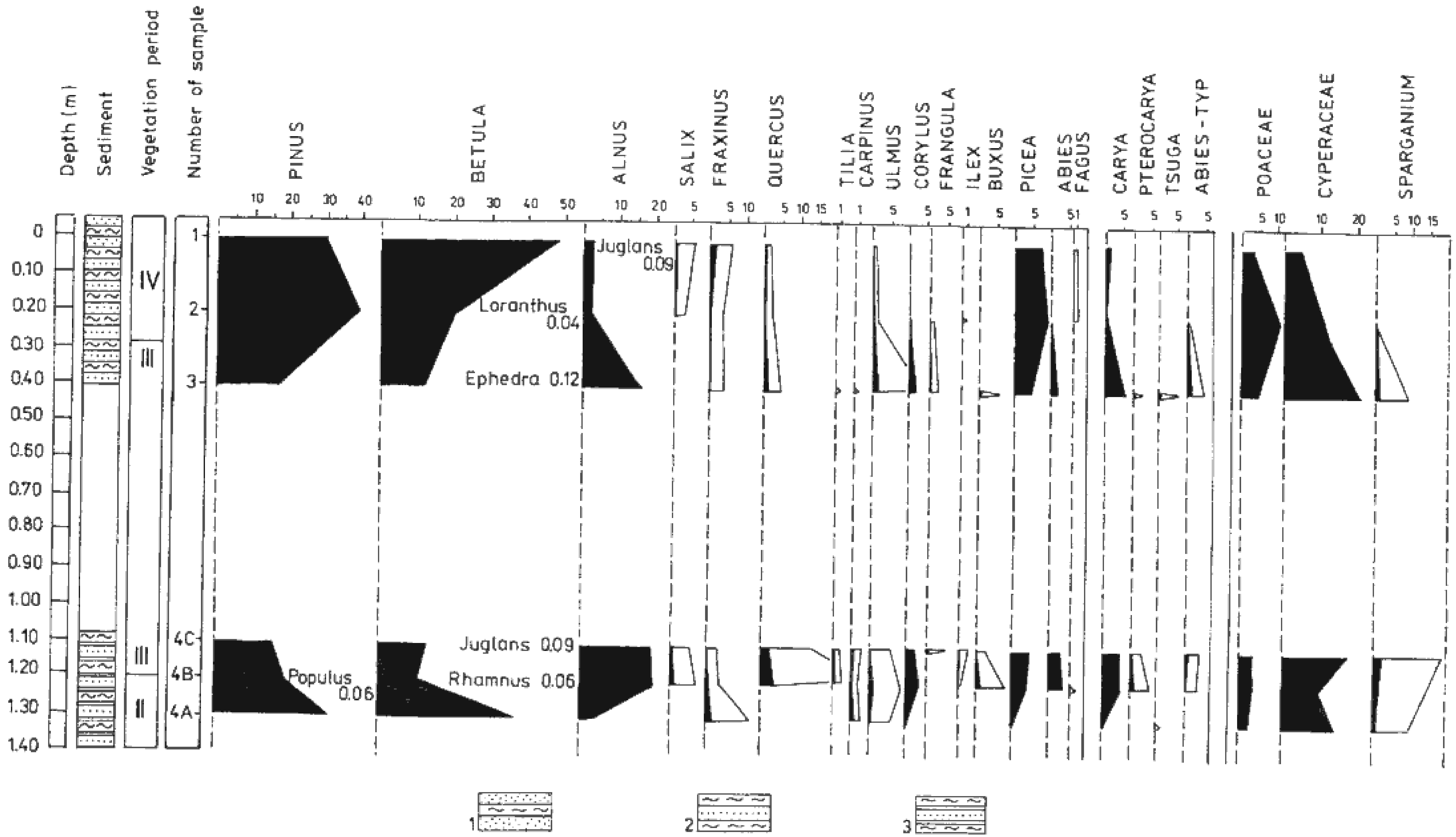
A_2 - the younger phase was characterized by Subarctic birch-pine forests. Admixture of other wood species was very slight: g. *Quercus, Fraxinus, Tilia, Carpinus, Ulmus, Picea*. In the undergrowth *Corylus, Buxus* cf. *sempervirens*, and *Hedera* occurred. Clumps of alders around the lake were still inextensive. Accompanying herbs were mainly the representatives of the f. *Cyperaceae* and *Poaceae*, swamp and water vegetation. The species composition of other assemblages was variegated too. In the undergrowth ferns mostly of the f. *Polypodiaceae* and g. *Equisetum* were present, climatically more demanding *Osmunda claytoniana* was sporadic.

Accompanying organism groups ascertained in both the phases were g. *Hystrix, Pediastrum, Entophlyctis lobata*, group *Ascomycetes, Tilletia sphagni, Microthyrium microscopicum*, tests of *Amphitrema flavum*. The proportion of the herbal and wood components was equal during the whole stage, sometimes the amount of pollen grains even slightly overtopped that of the woods.

II. (B) - in my opinion, this stage represents the start of the climatic and vegetation optimum of this interglacial. In the beginning , the cooler climate is still fading out and g. *Pinus* and *Betula* dominate in the forest assemblage. However gradually they start to be substituted by climatically more demanding woods, and later on mixed and deciduous graves (g. *Quercus, Fraxinus, Tilia, Carpinus, Ulmus, Acer*, lesser *Fagus*) prevail. This stage is being designated also as the spruce one because in this time *Picea* gets more widespread. Other conifer penetrating into the growths was *Abies*. Of shrubs, g. *Corylus, Frangula alnus, Buxus* cf. *sempervirens, Ilex* cf. *aquifolium, Lonicera, Juniperus, Hedera* were frequent. An important wood indicating this interglacial was *Pterocarya*. By the end of this period the basin margins were densely overgrown with clumps of alders. This indicates a considerably humid climate.

Herbs were represented mainly by the types of the families *Cyperaceae* and *Poaceae*. Water margins were rimmed by an association with g. *Sparganium, Typha latifolia*, and the water surface was overgrowing with *Potamogeton, Myriophyllum* and *Nymphaea*. Peat-bog and swamp vegetation was represented by *Utricularia, Comarum, Polygonum, Bistorta, Iris*, and *Menyanthes trifoliata*. Moss of the g. *Sphagnum* also continuously coated the peat-bogs. Herbs of other assemblages were variegated - g. *Rumex, Artemisia*, species of f. *Rosaceae* are worth mentioning. Plant assemblages were enriched with ferns of f. *Polypodiaceae*, g. *Equisetum, Lycopodium*, lesser *Osmunda claytoniana*. Other organism groups were also frequent (see the pollen diagrams).

In this stage particularly climatically more demanding vegetation appeared and developed - climate got feelingly better (warmer and humid). The forest formation



4. Pollen diagram No. 2: Stonava-Horní Suchá 1986 (SHS/OV). 1 - loess loam with a humous horizon, 2 - silt clays with a humous lens, 3 - clayey peat with sand layers, 4 - *Pinus*, 5 - *Betula*, 6 - *Cyperaceae*, 7 - *Poaceae*, 8 - AP/NAP, 9 - AP, 10 - NAP

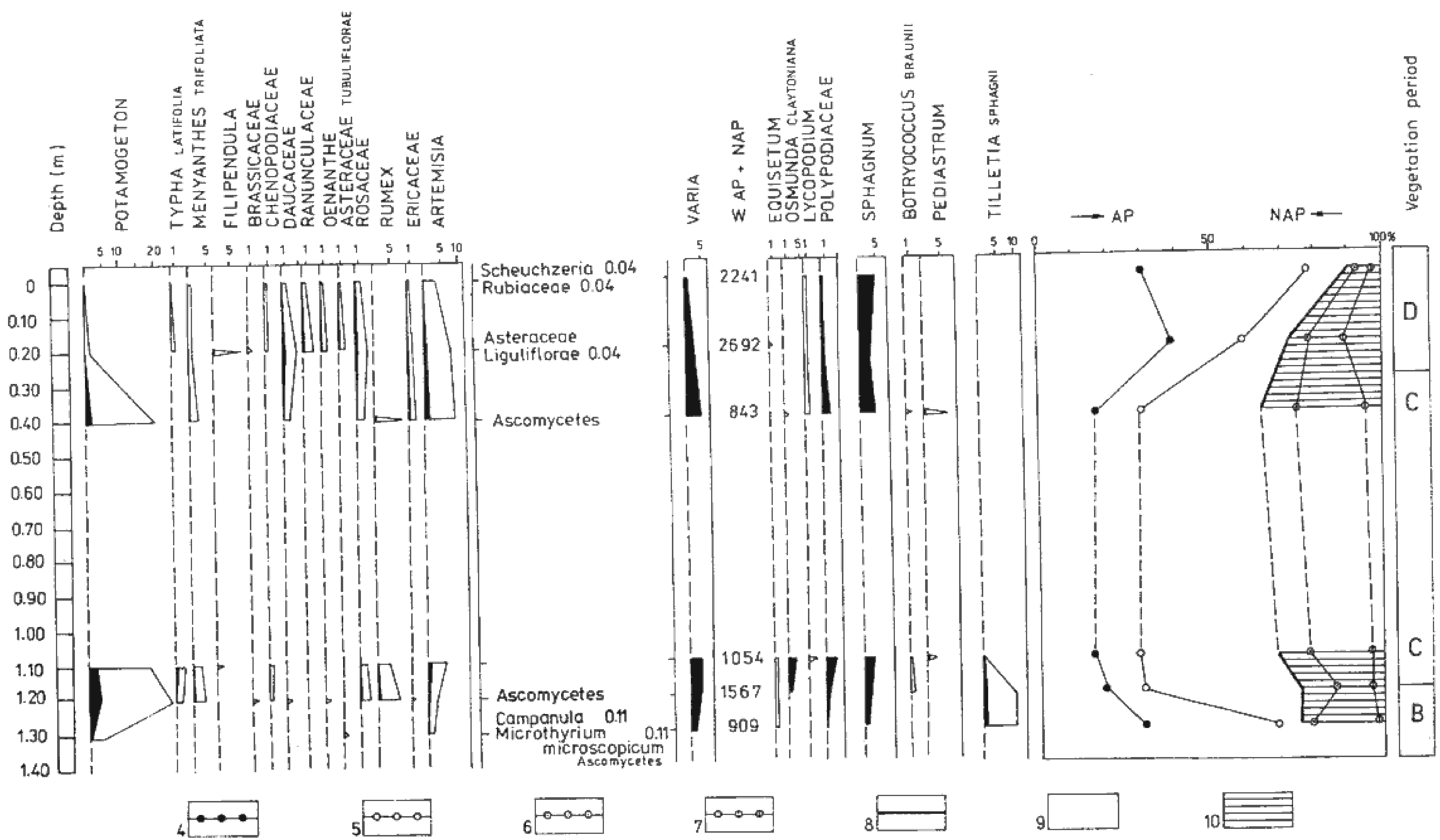
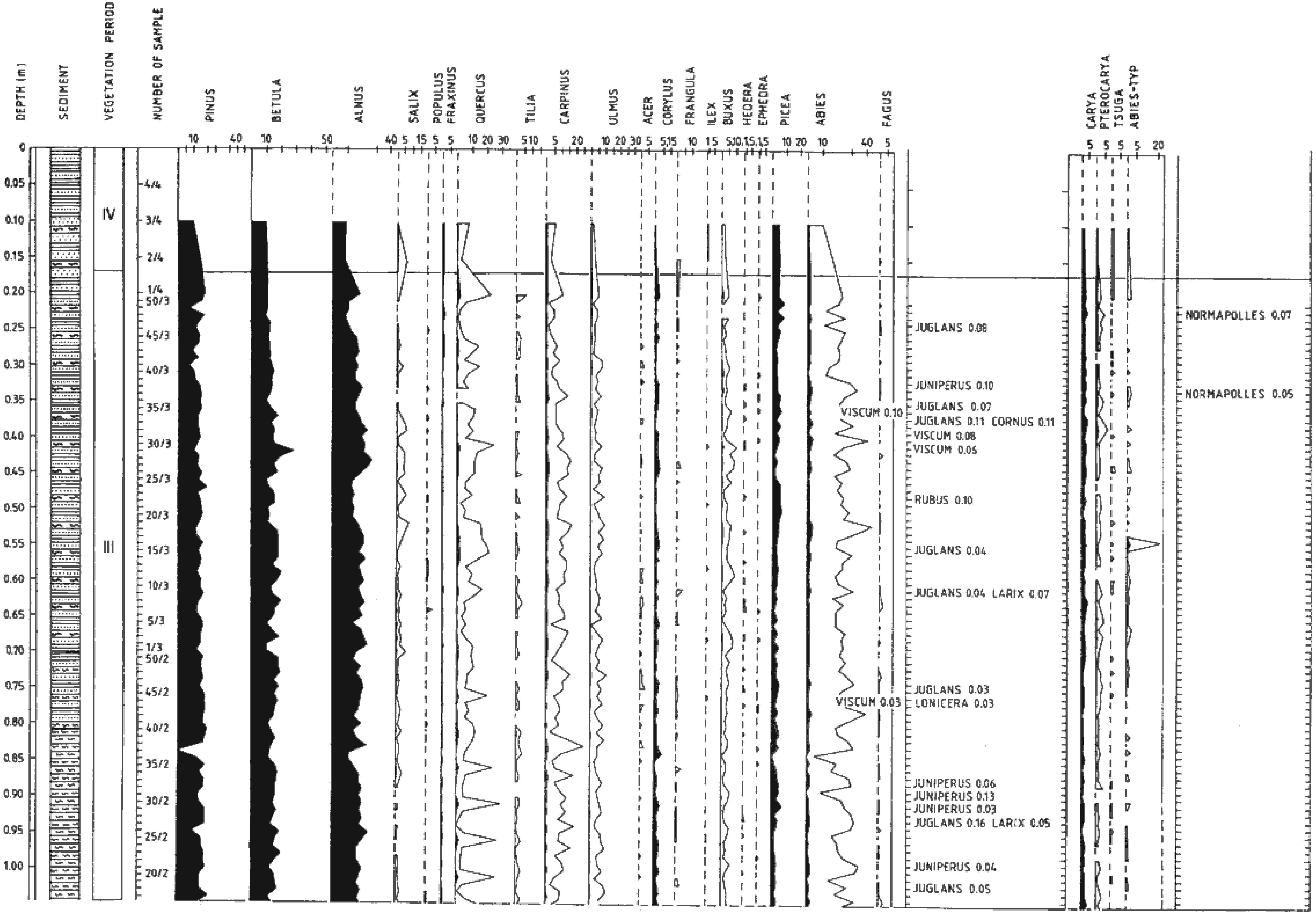


Fig. 4 - continuation



5. Pollen diagram No. 3: Stonava-Horní Suchá 1986 (SS). 1 - clay, 2 - sandy clays with a peat admixture, 3 - grey to grey-yellow sandy clays with peat, 4 - sandy clays with an organic admixture, 5 - peat with an anorganic admixture, 6 - fen peat, 7 - *Pinus*, 8 - *Betula*, 9 - *Cyperaceae*, 10 - *Poaceae*, 11 - AP/NAP, 12 - AP, 13 - NAP

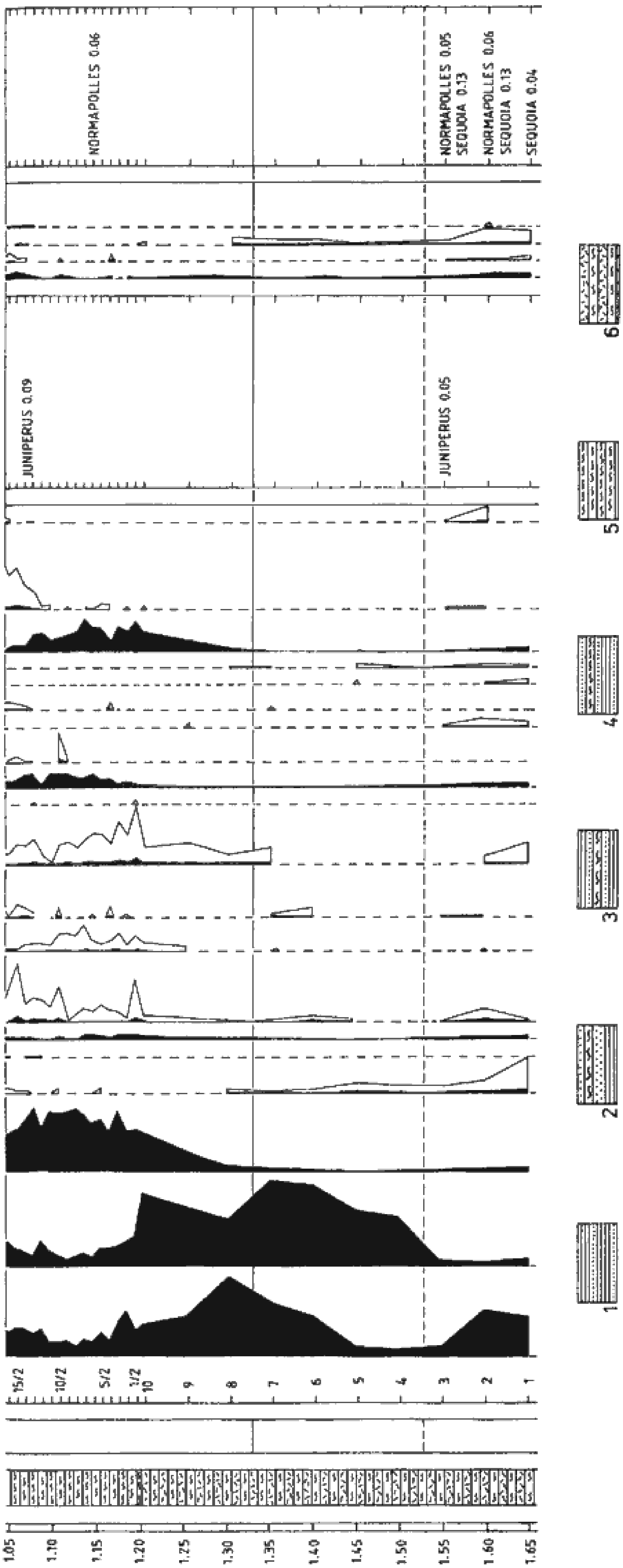


Fig. 5 – continuation

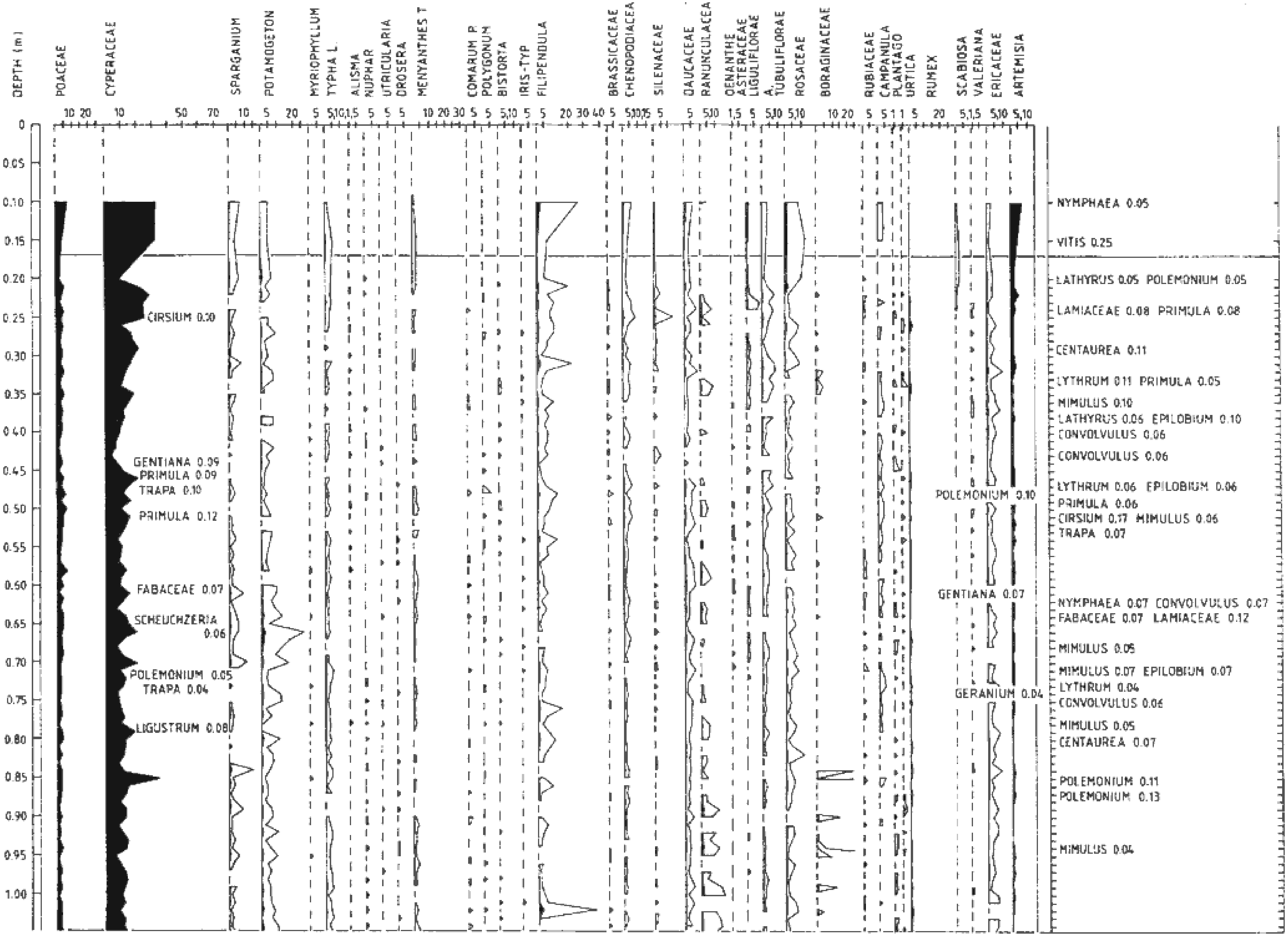


Fig. 5 - continuation

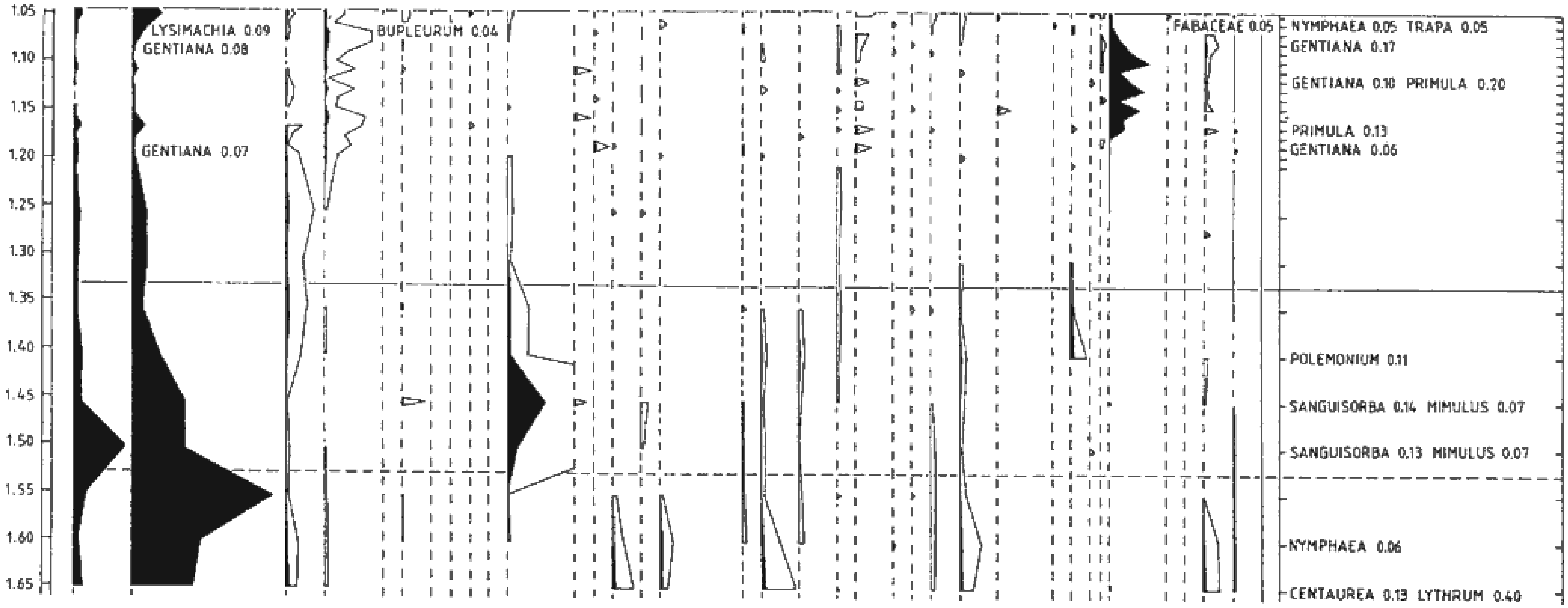


Fig. 5 - continuation

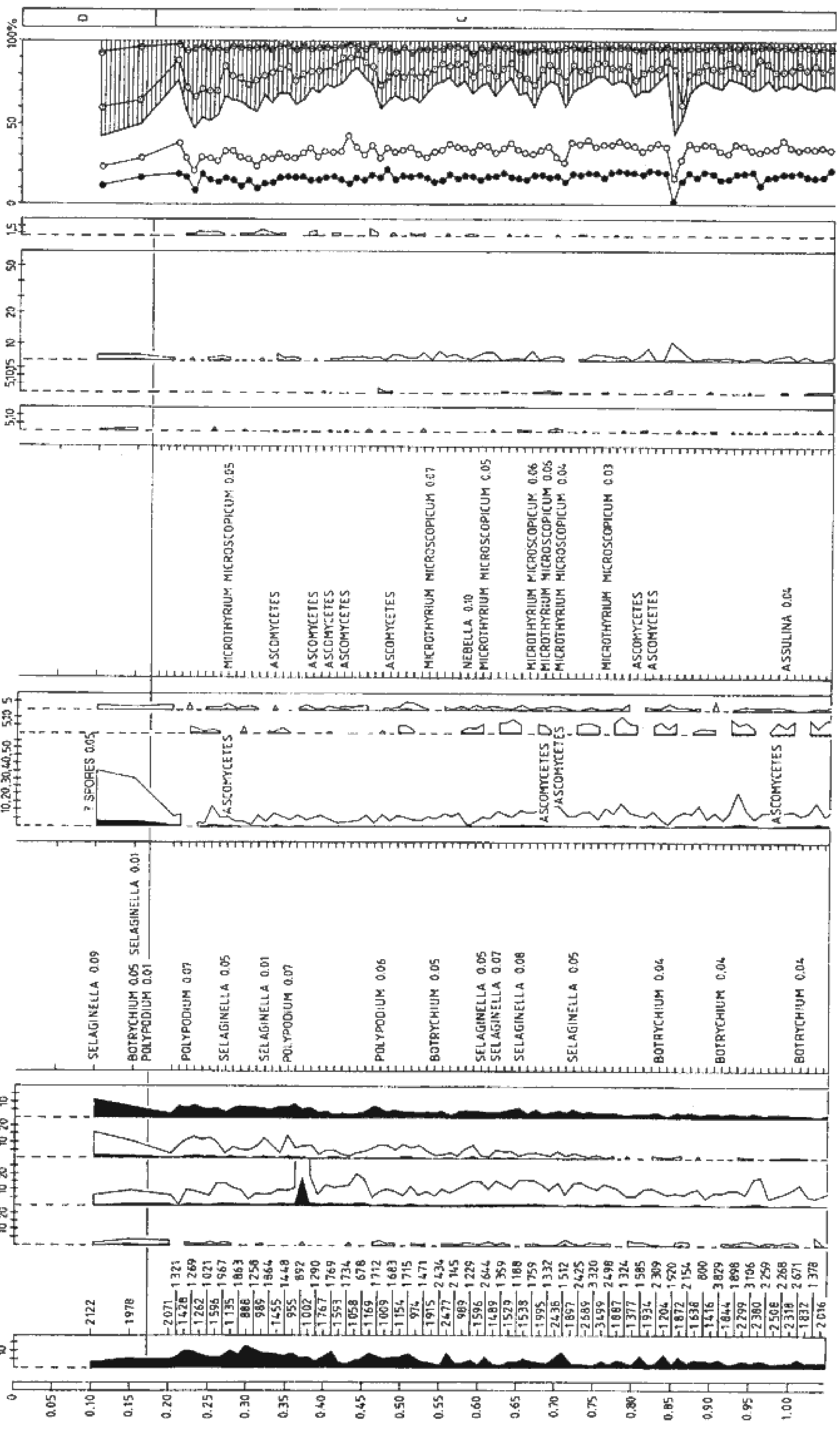


Fig. 5 – continuation

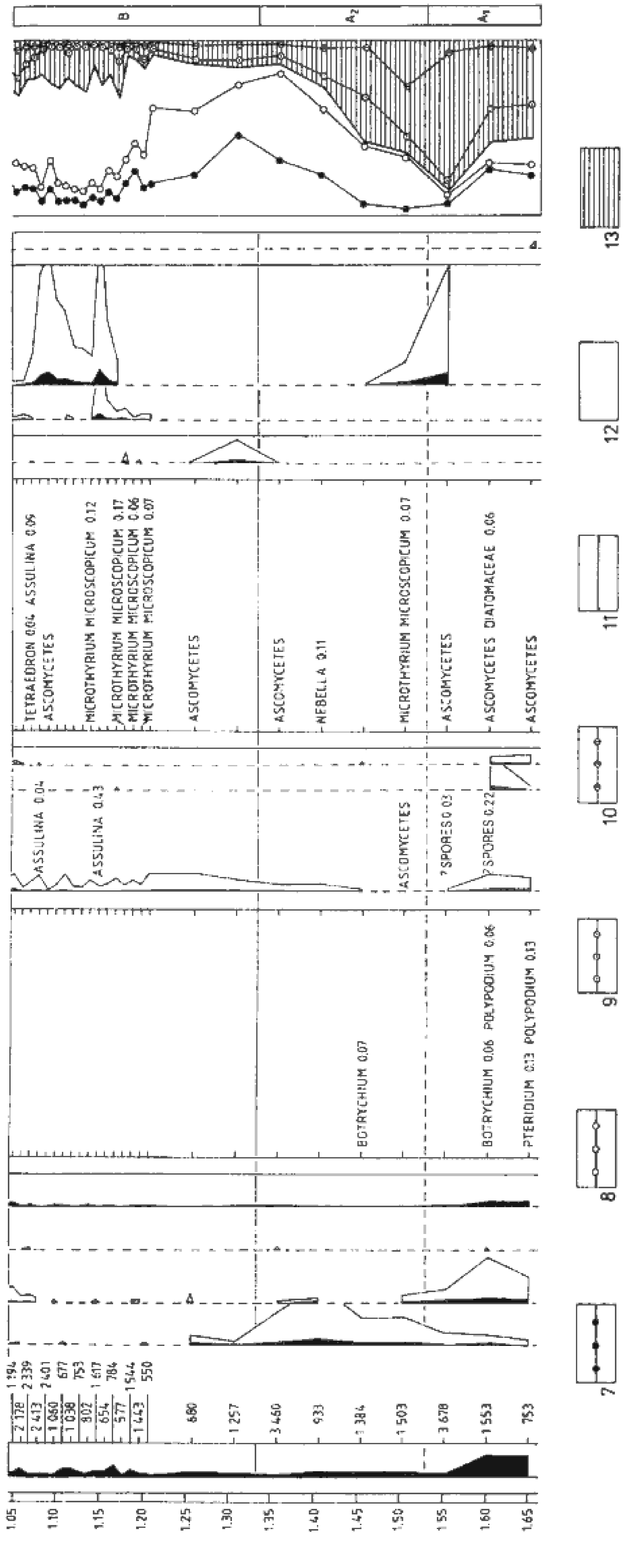


Fig. 5 - continuation

started to preponderate. For the present, the question of the pollen grains of "exotic" woods of g. *Carya, Tsuga, Abies-Typ*, etc. found in the pollen spectrum remains open.

III. (C) - involves the vegetation and climatic optimum of the Holsteinian interglacial. Climatically more demanding assemblages became stabilized.

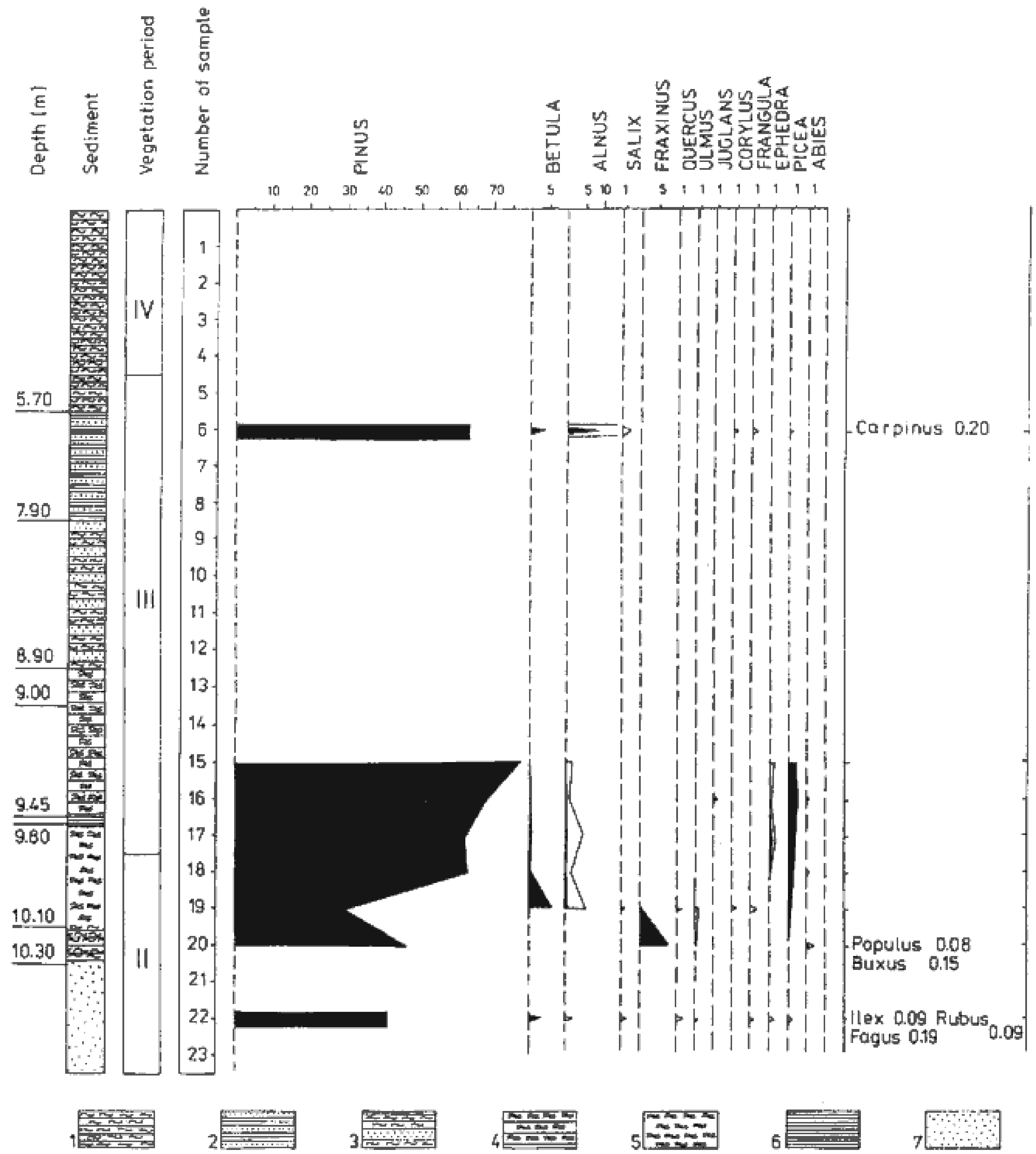
The studied area was covered with rich mixed forests. More demanding deciduous woods were represented by g. *Quercus, Tilia, Carpinus, Ulmus, Fraxinus, Acer, Fagus, Juglans, Pterocarya*, with an admixture of *Pinus, Betula, Picea, Abies* and *Larix*. Rich undergrowth was formed mainly by g. *Corylus, Lonicera, Cornus, Buxus* cf. *sempervirens, Ilex* cf. *aquifolium, Rubus, Frangula alnus, Juniperus, Hedera.*

This stage is also called as fir-hornbeam. In my pollen diagrams the pollen grains of both woods formed a continuous curve with culmination peaks. In diagram No. 1 we can observe firstly two culminations of *Abies* succeeded by a sole maximum of *Carpinus*, in diagram No. 3 the maximum of *Carpinus* precedes that of *Abies.*

The species of the herbal undergrowth varied, percentage of the individual taxa was lower, and increased slightly by the end of this period.

The mentioned assemblages were completed with frequent, climatically demanding fern *Osmunda claytoniana* whose spore curve has two prominent peaks. Other types as f. *Polypodiaceae*, g. *Sphagnum* were less frequent.

Water margins were densely overgrowing with alder clumps and swamp vegetation.



6. Pollen diagram No. 4: Stonava-Kateřina 1986 (SK). 1 - clay and peat mixture, 2 - sandy clay, 3 - peat with clay and sand streaks, 4 - peat with clay and sand layers, 5 - peat, 6 - clay, 7 - quicksand, 8 - *Pinus*, 9 - *Betula*, 10 - *Cyperaceae*, 11 - *Poaceae*, 12 - AP/NAP, 13 - AP, 14 - NAP

Again, the problem with the occurrence of pollen grains of "exotic" plants (*Tsuga, Carya, Abies-Typ*) remains unsolved.

IV. (D) - this stage is divided into an older $IV_1(D_1)$ and a younger $IV_2(D_2)$ phase.

D_1 - this period brought gentle cooling manifested by reextension of the genera *Pinus* and *Betula*. Rich mixed forests and alder clumps suddenly recessed. Some climatically more demanding woods were still present: *Quercus, Corylus, Carpinus, Buxus* cf. *sempervirens*. Spruce growths were more common again.

On dry, deforested areas flora of cool forest-steppes and steppes proliferated (g. *Ephedra, Scabiosa, Artemisia*). In this period the decrease of the wood species composition was considerable, however I am of the opinion that we cannot speak about total deforestation in the sense of V. Vodičková (Kneblová 1957, 1958c). This was probably the period of the Scandinavian glacier oscillation and its advance to the S.

D_2 - unlike the preceding period, this was warmer again but still cooler than the IInd phase of the interglacial. Vegetation was characterized by pine forests with an admixture of *Betula, Picea,* and *Abies*. Still comparatively cool climate was indicated by g. *Ephedra*. In coniferous forests also climatically more demanding deciduous woods and shrubs with *Corylus* and *Buxus* cf. *sempervirens* started to appear. The amount of herbal types increased, however their variance did not exceed that in the IInd and IIIrd phase. Of ferns, *Osmunda claytoniana* and of mosses, g. *Sphagnum* were dominant.

Pinus and *Betula* attained maximum on a pollen curve in cool weather sections and recessed with the onset of climatically more demanding mixed and deciduous spe-

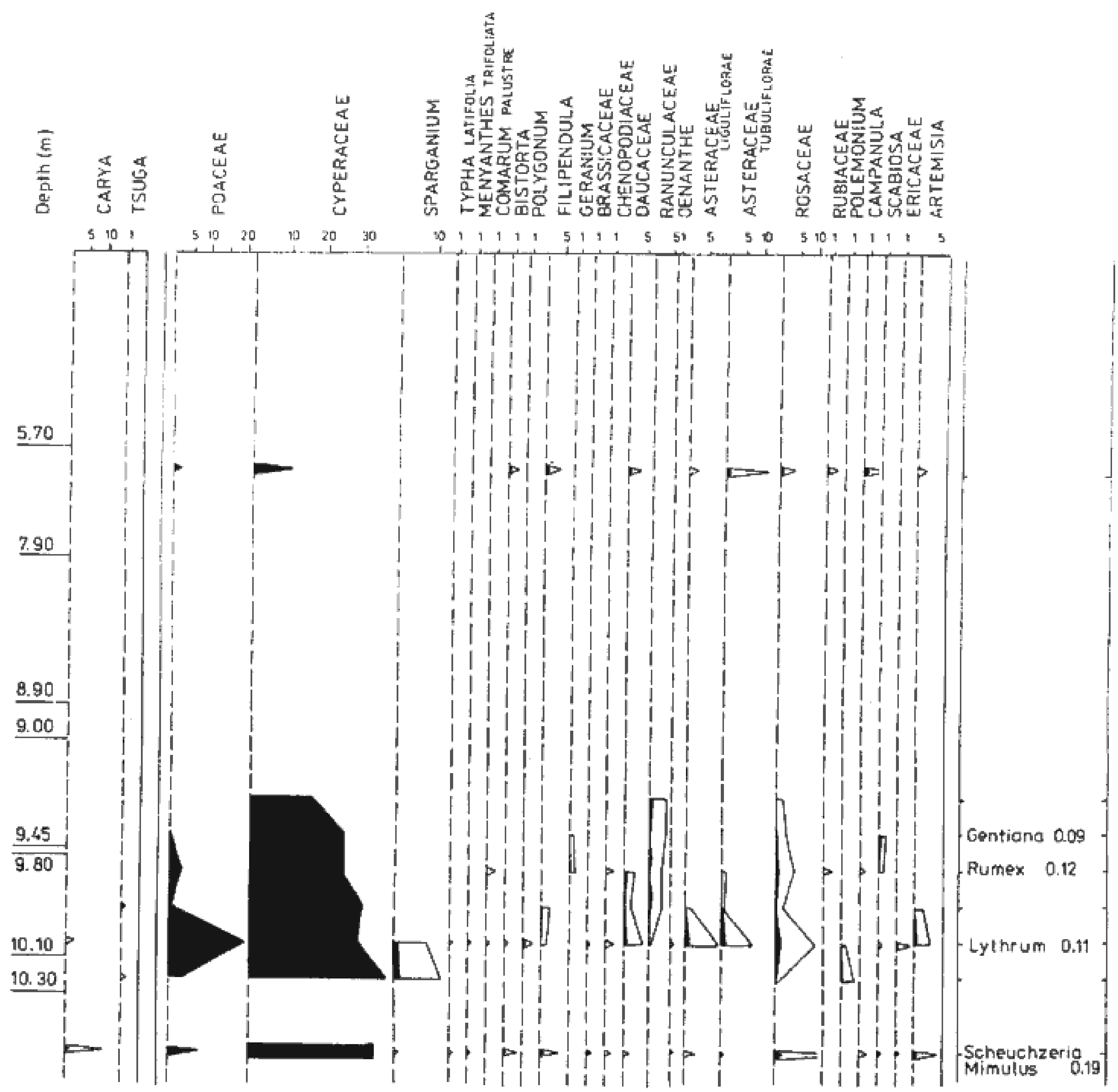


Fig. 6 - continuation

cies. G. *Pinus* was represented by the species *P. sylvestris* and *P. cembra*.

The pollen curve of g. *Alnus* culminated after the apex of the two preceding woods. It flourished mainly in sections with wet and warm climate. An extraordinary development in the Stonava profiles was probably caused by specific climatic and ecological conditions of the Ostrava Basin (Kneblová-Vodičková 1961b).

The pollen curve of g. *Corylus* does not exhibit any marked apex - its course is even throughout the profile.

The curves of the genera *Abies* and *Carpinus* culminate in the climaoptimum, after the maximum occurrence of g. *Picea*.

Pollen grains of g. *Fagus* appeared sporadically in the Stonava profile. This evidences its absence or just limited distribution typical of the Holsteinian interglacial.

The occurrence of climatically demanding species of g. *Pterocarya, Juglans, Vitis, Ilex* cf. *aquifolium, Buxus* cf. *sempervirens, Osmunda claytoniana* in this interglacial period is typical. They no longer grow on our territory today.

G. Carya, Sequoia, Tsuga, Symplocos, Abies-Typ, group *Normapolles* a.o. the pollen grains of which have been found in my sediments will be subject to further studies.

Other interesting plants are being dealt with in the paper by V. Vodičková (Kneblová-Vodičková 1961b).

Stratigraphic evaluation

Palynological analyses confirmed the stratigraphic classification of the sediments. The investigated sediments

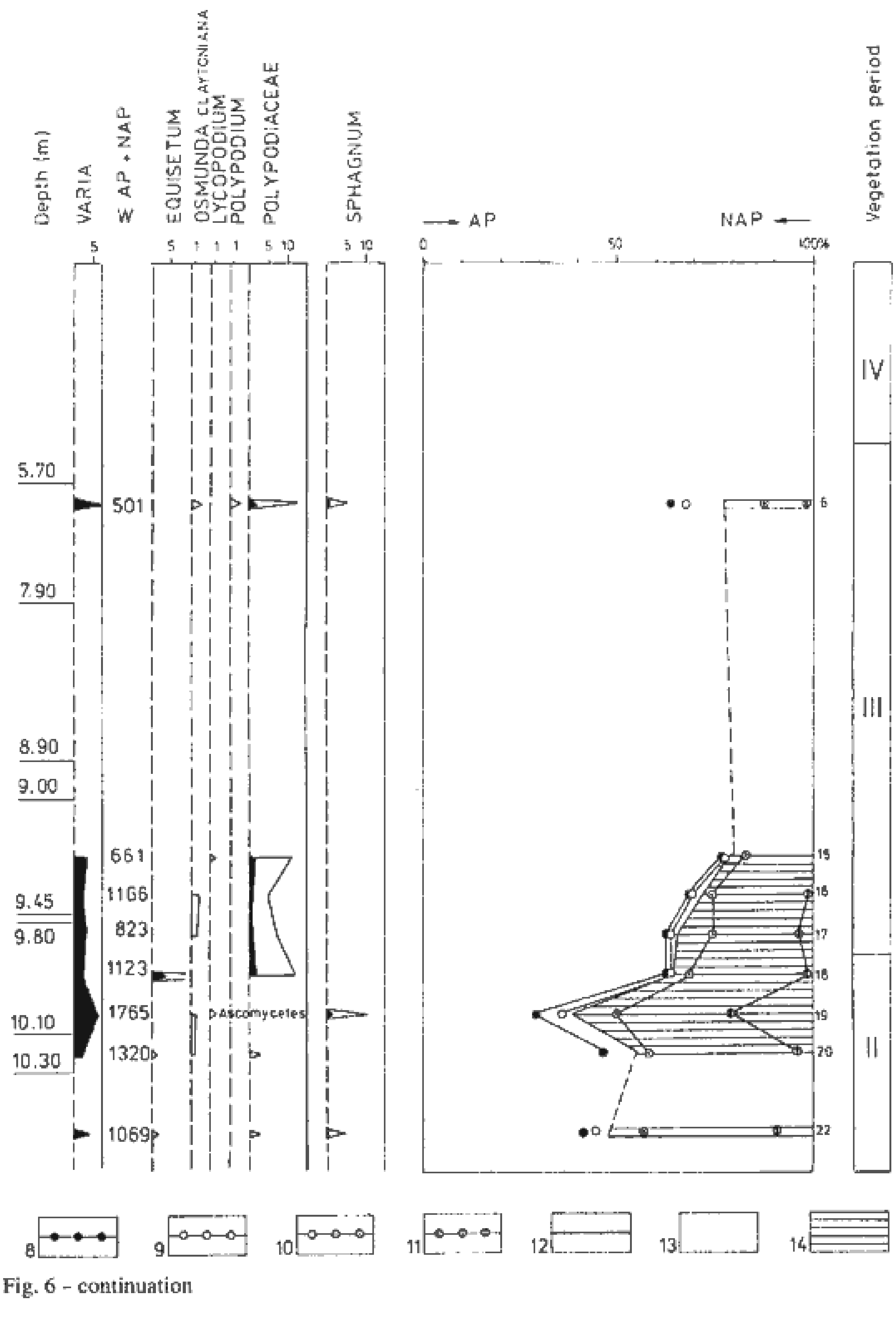


Fig. 6 - continuation

were underlain by grey till identified as deposits of the Elsterian (Mindel) glaciation (Macoun et al. 1965). Locally the organic sediments were overlain by gravel and gravelly sand with pebbles of Scandinavian rocks referred to the recession stage of the Saalian glaciation, the same as the overlying grey sands representing already calm water sedimentation.

Above the organogenic sediments yellow sands of post-Holsteinian (Mindel-Riss) age belonging apparently to the advance phase of the Saalian glaciation were found.

The thickest are sandy to clayey loams overlying these sands or directly the peat and loamified peat. In the Suchá-Stonava environs these are probably glacigene sediments of the Saalian glaciation (Macoun et al. 1965).

The vegetation development was interpreted on the basis of the compiled pollen diagrams and correlated with that at other localities, particularly Barkowice Mokre (Sobolewska 1952), Biala Podlaska (Krupiński et al. 1986), Ciechanki Krzesimowskie (Brem 1953), Gościecin (Klimaszewski 1952, Środoń 1957), Kaznów and Krępiec (Janczyk - Kopikowa 1981), Lublin (Środoń 1957), Nowiny Żukowskie (Dyakowska 1952), Olszewice (Lilpop 1929, 1932, Passendorfer et al. 1929, Sobolewska 1956a, Trela 1929, 1932), Susznie koło Włodawy (Stachurska 1961), Syrniky (Sobolewska 1956b), Tarzmiechy (Środoń 1954), Włodawa and Koszar nad Bugiem (Stachurska 1955, 1957), Żydowszczyzna (Jaroń 1933), Wylezina (Dyakowska 1956), Afonasovo and Lichvin (Gričuk 1950), Kopyš (Dokturovskij 1931), Węgorzewo (Krause - Gross 1941), Münster (Woldstedt 1947), Neu Ohe (Gistl 1928), Schillingsbrücke (Heck 1930), localities of NW Germany (Rein 1955), Ummendorf (Selle 1941), Stonava (Kneblová 1957, 1958a, c, Kneblová-Vodičková 1961b, in Macoun et al. 1965), a.o. Their mutual comparison is not within the scope of this paper. But it can be stated here that the main criteria of the vegetation conditions show the same character, the specificities of the individual localities are controlled by local environment. According to my studies, the vegetation cover corresponds with the so far known information from the Holsteinian (Mindel-Riss) interglacial.

In agreement with J. Dyakowska (1952), in this paper the course of the interglacial in Stonava Lake is being divided into four stages:

Ist stage (A) falling into two phases, i.e. the older phase I_1 (A_1) and the younger one I_2 (A_2). This period of pine-birch forests is recorded in pollen diagrams Nos. 1 and 3.

IInd stage (B) is considered as the onset of the climatic and vegetation optimum of this interglacial. It is best observable in pollen diagrams Nos. 1 and 3, in diagrams Nos. 2 and 4 just partially.

IIIrd stage (C) covers the vegetation and climatic optimum of this interglacial (see especially diagrams Nos. 1 and 3, in 2 and 4 the situation is less prominent).

IVth stage (D) is divided into an older IV_1 (D_1) and a younger IV_2 (D_2) phase. Within the older phase there was a sudden cooling probably resulting from a short readvance of the Scandinavian glacier. During the younger phase it got warmer again. This stage is best reflected in the pollen diagram No. l, other diagrams indicate just the older phase.

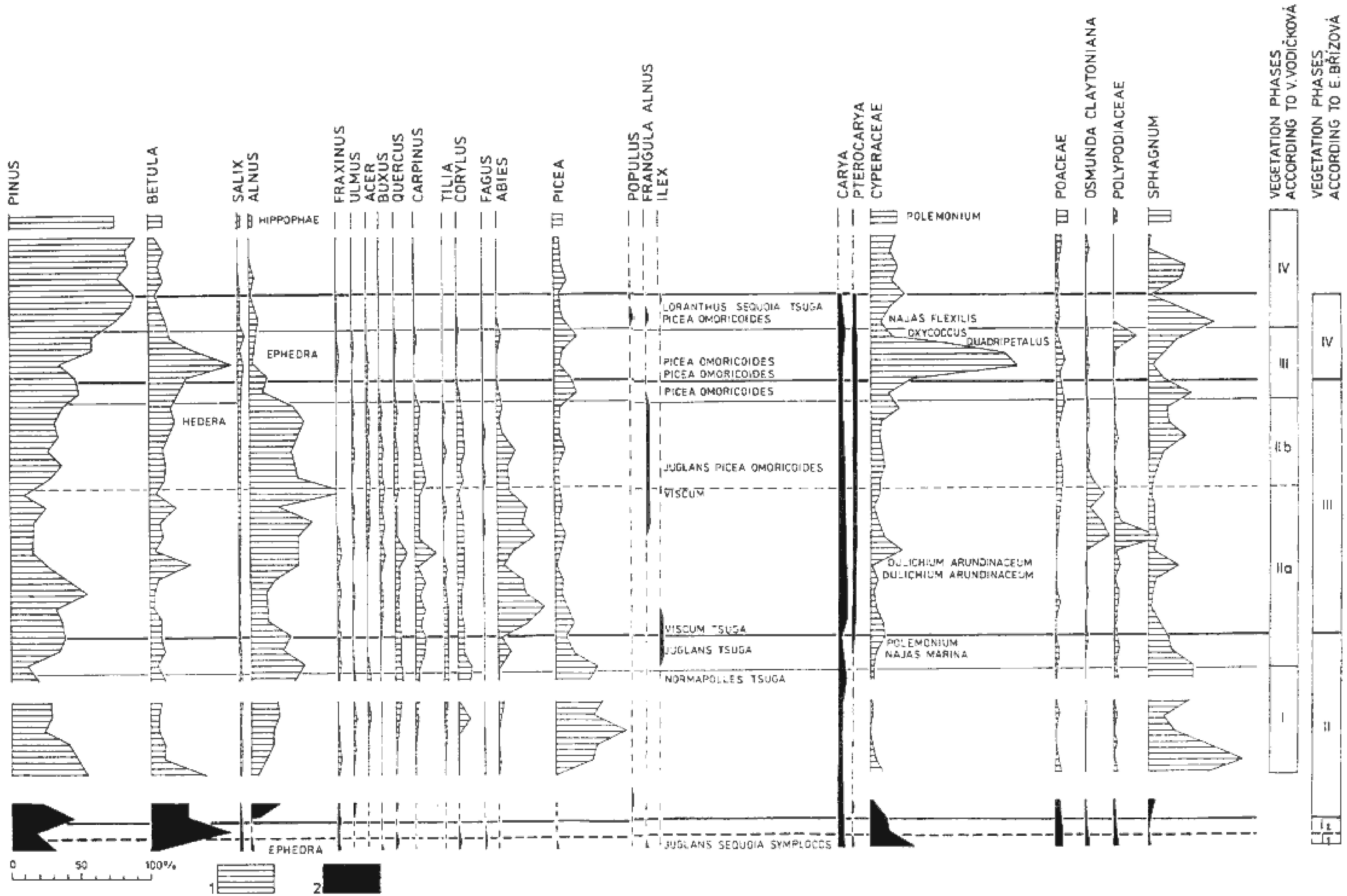
From the analysis of the vegetation development it implies that my pollen diagrams cover the older period toward the Elsterian glacial terminating shortly after the optimum. The diagrams of V. Vodičková (l.c.) start even after my IInd stage and end after my IVth stage, and this period is not recorded in my diagrams any more. All the diagrams cover the period of vegetation and climatic optimum, therefore can serve for reconstruction of a similar vegetation cover and development of the sedimentary basin (fig. 7).

Based on the vegetation succession during this interglacial we may judge that its climate was comparatively warm, maybe warmer than today, and very humid (Kneblová-Vodičková 1961b, in Macoun et al. 1965) which was probably influenced by the local conditions of the Ostrava region.

Following the stratigraphic classification in Central and

Table 1
Stratigraphic scheme of part of the Middle Pleistocene: Elsterian-Saalian interglacial s.l.

General stratigraphy	former CSFR (Macoun 1987)	Poland (Linder 1984, 1988)	former GDR (Wiegank 1979)	former USSR (Nikiforova in Lindner 1984)
Saalian s.l.	Oldřišov	Odra	Saale I, II	Dněpr
	Neplachovice	Zbójno	Dömnitz	Lichvin
	Palhanec	Liwiec	Fuhne	
Elsterian-Saalian (Holsteinian)	Stonava, Jaktař	Barkowice Mokre	Holstein	
Elsterian s.l.	Kravaře 2	San 2 (Wilga)	Elster II	Oka
	?Ostrava-Muglinov, ?Skřečoň I, II	Ferdynandów	Voigstedt	
	Kravaře 1	San 1 (Mogielanka)	Elster I	



7. Schematic reconstruction of the vegetation cover in the Holsteinian interglacial according to the results of paleobotanical analysis of the Stonava Lake sediments in the Ostrava region (modified pollen diagrams of V. Kneblová-Vodičková and the author). 1 - modified after V. Kneblová-Vodičková, 2 - modified after the author. Macroremains determined by V. Kneblová-Vodičková: *Picea omoricoides, Dulichium arundinaceum, Najas flexilis, N. marina, Oxycoccus quadripetalus.*

NW Europe (see Table I) the Stonava Lake sediments correlate with the Holsteinian interglacial (Elsterian-Saalian, Mazovian I, Barkowice Mokre, etc.). In the conception of the Polish palynological school they correspond to the vegetation scheme by J. Dyakowska (1952) at the locality Nowiny Żukowskie, which is the type locality of this interglacial on the Polish territory and, according to my verification, in the Ostrava region too.

In the former stratigraphic conception, the Mindel-Riss interglacial in Poland included all the following (today separate) interglacials: Ferdynandów, Barkowice Mokre, Zbójno. On the former GDR territory they correspond to the Voigtstedt, Holstein and Domnitz interglacials. The pollen analysis not infrequently contributed to the present more precise stratigraphic assessment of these periods.

In Saxony the type localities were palynologically studied by K. Erd (1970) and based on his results the stratigraphic position of the Holsteinian interglacial (its upper and lower boundary) was acknowledged on the 8th session of the SEQS in Hamburg (Jerz - Linke 1987). In Poland, the Ferdynandów interglacial was distinguished on the basis of paleobotanical analyses of Z. Janczyk-Kopikowa (1975). At first, despite some differences, she placed her profile to the Mazovian interglacial. The stratigraphic position on the territory of the former CSFR (Macoun 1985, 1987) and USSR was correlated with these schemes.

Sediments from the Ostrava region, evaluated even paleobotanically, were formerly placed to the Holsteinian interglacial (Mindel-Riss) (Macoun et al. 1965). This concerns the localities Ostrava-Muglinov (Kneblová-Vodičková in Macoun et al. 1965, Opravil 1964) and Skřečoň I, II near Bohumín (Kneblová-Vodičková in Macoun et al. 1965). The stratigraphic interpretation of these sediments was problematic. Originally, based on the geological position, V. Kneblová-Vodičková (l.c.) classified them as the older warm oscillation of the Mindel-Riss interglacial, and Stonava as the younger warm oscillation.

My complementary study and reevaluation of V. Vodičková's conclusions confirmed, that the sediments of Stonava Lake really belong to the Holsteinian interglacial. However, profiles of Skřečoň and Muglinov type are hitherto exceptional on our territory, therefore reevaluation of their stratigraphic position without new, verified finds, is problematic. In accord with V. Vodičková's opinion (Macoun et al. 1965) I suppose that the vegetation of both localities represents some climatically less demanding phase younger than the vegetation and climatic optimum of an interglacial resembling the Ferdynandów.

To compare with the Holsteinian, the vegetation development of the Ferdynandów interglacial is as follows:

I. forest-tundra - 1st phase: thin pine forests with birch and spruce

II. mixed forests - 2nd phase: mixed pine, oak and birch forests with Pteridium aquilinum in the undergrowth

III. the first climaoptimum - 3rd phase: mixed deciduous forests: oak with elm, linden and hazel, in wetter places alders with elms. 4th phase - mixed forests with fir and yew (oak, elm, linden, hazel)

IV. coniferous forests - 5th phase: boreal forests: pine-birch with spruce, climate cool, humid. 6th phase - climate cool, drier than within the previous phase

V. the second climaoptimum - 7th phase: hornbeam forests (with oak, linden, elm, hazel), in lower situated places alders

VI. coniferous forests - 8th phase: pine forests (with birch, spruce and alder). 9th phase - pine-birch forests with increasing proportion of herbs, 10th phase - pine forests with admixed birch and spruce and a high proportion of herbs

VII. forestless period - 11th phase - tundra: just shrub willows and birches, meadows with light-loving herbs.

The floristical development of the Ferdynandów interglacial (Janczyk - Kopikowa 1975) differs from that of the Holsteinian mainly in the presence of the 1st and 2nd climaoptimum characterized by the absence and presence of hornbeam and a higher proportion of deciduous wood species. During the whole period deciduous forests alternate with coniferous and spruce displays wider extension except the vegetation optimum.

The differences between the localities Skřečoň, Ostrava-Muglinov and Ferdynandów are, among other, caused also by ecological conditions of the individual regions. The vegetation in the time of the peat sedimentation at Skřečoň and Ostrava-Muglinov points to semiclosed forests with prevalence of conifers. The sedimentation did not markedly changed its character too. There was also a slight development of termophilous deciduous woods. Even V. Kneblová-Vodičková (Macoun et al. 1965) presumed that in the more completely preserved profile Ostrava-Muglinov a colder phase after the vegetation optimum could be recorded. Comparing the profiles Skřečoň (I,II) and Muglinov, it can be stated that it could contingently be some climatically less demanding phase similar to the succession of the vegetation of the Polish Ferdynandów.

There is no locality in the Ostrava region with any index phase providing reliable climatic or stratigraphic classification.

The interglacial from the Zbójno locality (Janczyk - Kopikowa - pers. communication) is out of speculations. From all the above described vegetation successions it differs in the amount of pollen grains of g. *Tilia* (48 %) in the climatic and vegetation optimum.

The presented analysis revealed that the sediments from Skřečoň and Ostrava-Muglinov are probably older than the Stonava profiles. In correlation with Polish investigations, they can be with the highest probability referred to the cool phase corresponding to the Ferdynandów, while Stonava to the Barkowice Mokre (Holsteinian) interglacial.

Summary

The paper presents results of a palynological analysis of fossil organic sediments of Stonava Lake in the Ostrava region and reconstruction of vegetation in the course of development of this sedimentary basin in the Holsteinian interglacial.

Based on the development of the vegetation cover, particularly the wood formations, the peat bog development can be divided into four stages: I.(A_1 and A_2), II. (B), III. (C), IV. (D_1 and D_2). The individual developmental stages of the vegetation cover of the wider surroundings of Stonava Lake can be briefly characterized as follows:

I. stage (A)

phase A_1 – thin pine-birch forests

phase A_2 – thin birch-pine forests

II. stage (B) – spruce

onset of climatic and vegetation optimum, development of climatically more demanding deciduous and mixed graves and alder clumps

III. stage (C) – fir-hornbeam

interglacial optimum, final stage of mixed, climatically demanding graves and alder clumps

IV. stage (D)

phase D_1 – cooling down, development of climatically demanding graves fades out, recession of alder clumps, wider reextension of pine-birch forests in both sections

phase D_2 – slight warming, reextension of spruce clusters and alder clumps, climate colder than during the stages II and III, but warmer than in the phase D_1.

These vegetation developmental stages have been reconstructed on the basis of compiled pollen diagrams Nos. 1–4 of which 1 and 3 were the most complete.

The climate of the Holsteinian interglacial was warmer in this region than today and also considerably humid, especially in the climaoptimum, as is documented by the plants discovered here. The humid climate probably supported the alder clumps development and influenced the poor development of *Q-M*, which seems to be typical of this interglacial and region.

During the Holsteinian interglacial also climatically demanding plants occurred in the Ostrava region, which in fact reversely characterized this period. The arboreals were represented by *Ilex* cf. *aquifolium, Buxus cf. sempervirens, Pterocarya, Juglans, Vitis*, of ferns *Osmunda claytoniana* occurred. Some of them do not grow on our territory any more.

Moreover, in my pollen diagrams pollen grains of exotic woods typical rather of the Tertiary or even older periods have been distinguished: g. *Carya, Sequoia, Tsuga, Symplocos*, group *Normapolles*. Their origin can be explained in different ways. They could be redeposited from older sediments in the case they occur in the lower or upper part of the pollen diagram and the redeposition is of course more frequent e.g. at clays, sands and other suitable deposits. The plants could also survive in this area from climatically more favourable periods, or can originate from an advance growth from not very remote refuge areas.

Other problem was a find of pollen grains of *Abies* different from a normal type temporarily designated as *Abies-Typ.* Whether it is *Abies fraseri*, distinguished at several profiles in Poland by a macroscopic analysis only, is uncertain.

Principal woods were *Pinus, Betula, Picea, Alnus*, lesser important were deciduous species *Q-M, Carpinus, Abies, Corylus*. The already mentioned climatically demanding plants complete the characteristics of this interglacial.

The course of pollen curves of significant plants suggests the delimitation of the individual periods inferrable from the increase or decrease of the main woods representation. Less demanding woods *Pinus* and *Betula* still prevailed even in periods generally characterized as periods of mixed or deciduous graves (IInd and IIIrd stage). A typical feature of this interglacial is the absence or low occurrence of pollen grains of g. *Fagus.*

From the analysis of the pollen diagrams it follows that my diagrams cover the older period toward the Mindelian interglacial and end sooner, shortly after the optimum. The pollen diagrams of V. Vodičková (l.c.) started later but ended closer to the Riss. Roughly all the diagrams cover the same period and on their basis a similar vegetation cover can be reconstructed (see fig. 7).

The results of the pollen analysis are an important indicator of the vegetation cover development and they also contributed to resolution of some geological problems in the investigated region.

Stratigraphically, Stonava can be correlated (according to Macoun 1987) with the Barkowice Mokre interglacial (Lindner 1984, 1988) in Poland, the Holsteinian (Wiegank 1979) in the former GDR classification (see Table 1).

K tisku doporučil J. Macoun
Přeložila G. Vladyková

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Vegetace holsteinského interglaciálu ve Stonavě-Horní Suché (Ostravsko)

(Resumé anglického textu)

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Práce obsahuje výsledky pylové analýzy čtyř rašelinných profilů z lokality Stonava na Ostravsku. Mým úkolem bylo vyhodnotit nové profily a srovnat závěry s výsledky palynologického výzkumu organických sedimentů Stonavského jezera (V. Vodičkové), a přispět tak k objasnění problematiky paleogeografického a stratigrafického vývoje tohoto fosilního jezera a jeho okolí.

V pylových diagramech sestavených na základě pylových analýz všech profilů je možné rozlišit několik vegetačních fází během části holsteinského interglaciálu. Nejkompletnější byly dva pylové diagramy: č. 1 Stonava-Horní Suchá 1986 (SHS) a č. 3 Stonava-Horní Suchá 1986 (SS), které zachycují počátek interglaciálu (chladnou fázi), vegetační a klimatické optimum a závěrečnou chladnější fázi.

Vývoj vegetačního pokryvu byl porovnán s paleobotanickými analýzami V. Vodičkové (Kneblová 1957, 1958a,1958c, Kneblová-Vodičková 1961b, Macoun et al. 1965) a hlavně s profilem Nowiny Żukowskie (Dyakowska 1952) v Polsku.

Společenstva rostlin zjištěných palynologickými analýzami ze všech odkryvů odebraných na lokalitách Stonava potvrdila, že šlo o fosilní přechodové rašeliniště.

Na základě vývoje vegetačního pokryvu, zejména formací dřevin, je možné rozdělit vývoj rašeliniště do čtyř fází: I. (A) - úseky - starší A_1 a mladší A_2; II. (B); III. (C); IV. (D) - úseky - starší D_1 a mladší D_2.

Jednotlivé vývojové etapy, jakými procházela vegetační pokrývka na samotné lokalitě a v širším okolí Stonavského jezera, jsem ve stručnosti charakterizovala takto:

I. (A) - A_1 - chladné boro-březové lesy, A_2 - chladné březo-borové lesy;

II. (B) - počátek klimatického a vegetačního optima, fáze smrková, rozvoj teplomilných smíšených hájů a olšin;

III. (C) - interglaciální optimum, fáze jedlo-habrová, klimaxové stadium smíšených teplomilných hájů, rozvoj olšin;

IV. (D) - ochlazení, opět boro-březové lesy, D_1 - doznívání rozvoje teplomilných hájů a ústup olšin, výrazné ochlazení, D_2 - rozvoj smrčin, méně olšin, opětovné oteplování.

V holsteinském interglaciálu rostly na tomto území klimaticky náročné rostliny, které byly pro něho charakteristické: cesmína ostrolistá (*Ilex* cf. *aquifolium*), zimostráz vždyzelený (*Buxus* cf. *sempervirens*), lapina (*Pterocarya*), ořešák (*Juglans*), kapradina *Osmunda claytoniana* (podezřeň), dnes se na našem území již nevyskytují.

Problematický byl výskyt terciérních dřevin: r. *Carya* (ořechovec), *Tsuga* (jedlovec), *Sequoia* (sekvoje), *Symplocos*, *Abies-Typ*, *Normapolles*.

Hlavními dřevinami byla borovice (*Pinus*), bříza (*Betula*), smrk (*Picea*), olše (*Alnus*), menší význam měly listnaté dřeviny *QM*, habr (*Carpinus*) a jedle (*Abies*), líska (*Corylus*).

Klima holsteinského (mindel-riss) interglaciálu bylo na tomto území teplejší než dnes a rovněž značně humidní (vlhké), jak dokazují rostlinné typy zde nalezené. Vlhké podnebí ovlivnilo pravděpodobně velký rozvoj olšin a slabý dřevin *QM*, což se zdá pro tuto meziledovou dobu typické.

Vysvětlivky k tabulce

Stratigrafické schéma části středního pleistocénu: elstersko-sálský interglaciál s. l.

Vysvětlivky k obrázkům

1. Přehledná mapa širšího okolí lokality Stonava.
1 - významné fytopaleontologické lokality; 2 - státní hranice; 3 - hranice předpokládaného rozsahu elsterského zalednění; 4 - hranice předpokládaného rozsahu sálského zalednění; 5 - hranice orografických celků; 6 - Nízký Jeseník; 7 - Opavská pahorkatina; 8 - ostravská glacigenní pánev; 9 - Moravská brána - oderská část; 10 - Podbeskydská pahorkatina; 11 - Moravskoslezské Beskydy.
2. Mapka oblasti Suchá-Stonava se sedimentační pánví a palynologicky zpracovanými sedimenty.
1 - profil Stonava-Kateřina; 2 - profily zpracované V. Kneblovou-Vodičkovou; 3 - profily zpracované autorkou; 4 - sedimenty Stonavského jezera (podle M. Růžičky a J. Tyráčka).
3. Pylový diagram č. 1: Stonava-Horní Suchá 1986 (SHS).
1 - rašelina s jílem a zbytkem dřev; 2 - rašelina s úlomky dřev a semeny; 3 - rašelina s úlomky dřev na bázi; 4 - rašelina se semeny; 5 - silt; 6 - *Pinus*; 7 - *Betula*; 8 - *Cyperaceae*; 9 - *Poaceae*; 10 - AP/NAP; 11 - AP; 12 - NAP.
4. Pylový diagram č. 2: Stonava-Horní Suchá 1986 (SHS/OV).
1 - sprašová hlína s humózním horizontem; 2 - siltové jíly s humózní čočkou; 3 - jílovitá rašelina s polohami písku; 4 - *Pinus*; 5 - *Betula*; 6 - *Cyperaceae*; 7 - *Poaceae*; 8 - AP/NAP; 9 - AP; 10 - NAP.
5. Pylový diagram č. 3: Stonava- Horní Suchá 1986 (SS).
1 - jíl; 2 - písčité jíly s příměsí rašeliny; 3 - šedé až šedožluté písčité jíly s rašelinou; 4 - písčité jíly s organicou příměsí; 5 - rašelina s anorganickou příměsí; 6 - slatinná rašelina; 7 - *Pinus*; 8 - *Betula*; 9 - *Cyperaceae*; 10 - *Poaceae*; 11 - AP/NAP; 12 - AP; 13 - NAP.
6. Pylový diagram č. 4: Stonava-Kateřina 1986 (SK).
1 - jíl promíšený s rašelinou; 2 - písčitý jíl; 3 - rašelina se šmouhami jílu a písku; 4 - rašelina s jílem a polohami písku; 5 - rašelina; 6 - jíl; 7 - kuřavka; 8 - *Pinus*; 9 - *Betula*; 10 - *Cyperaceae*; 11 - *Poaceae*; 12 - AP/NAP; 13 - AP; 14 - NAP.
7. Schematická rekonstrukce rostlinného pokryvu v období holsteinského interglaciálu podle výsledků paleobotanických rozborů ze sedimentů Stonavského jezera na Ostravsku
1 - upraveno podle V. Kneblové-Vodičkové; 2 - upraveno podle autorky. Makrozbytky určené V. Kneblovou-Vodičkovou: *Picea omoricoides*, *Dulichium arundinaceum*, *Najas flexilis*, *N. marina*, *Oxycoccus quadripetalus*.

Vysvětlivky k přílohám

Příl. I

Pylová zrna: 1 - *Pinus* sp. (SS 0,94 m), 2 - *Sequoia* sp. (SS 1,70 m), 3 - *Ilex* cf. *aquifolium* L. (SS 0,58 m), 4 - *Carya* sp. (SS 0,98 m), 5 - *Pterocarya* sp. (SHS 0,05 m). Zvětšeno 1 000x.

Příl. II

Pylová zrna: 1 - *Pinus* sp. (SS 0,72 m), 2 - *Carpinus* sp. (SS 1,06 m), 3 - *Fagus* sp. (SS 1,65 m), 4 - *Normapolles* (SS 1,65 m), 5 - *Tsuga* sp. (SS 1,60 m). Zvětšeno 1 000x.

Příl. III

Pylová zrna: 1-3 - *Alnus* sp. (SS 1,40 m), 4 - *Betula* sp. (SS 1,50 m), 5 - *Ulmus* sp. (SS 1,01 m), 6 - *Quercus* sp. (SS 1,20 m), 7-8 - *Hedera* sp. (SS 1,40 m), 9 - *Alisma plantago-aquatica* L. (SS 0,21 m), 10 - *Lathyrus* sp. (SS 0,69 m), 11 - *Rosaceae* (SS 0,98) m). Zvětšeno 1 000x.

Příl. IV

Pylová zrna: 1-2 - *Brassicaceae* (SS 0,96 m), 3-5 - *Ericaceae* (SS 0,39 m), 6 - *Chenopodiaceae* (SS 1,40 m), 7-8 - *Sanguisorba* sp. (SS 1,55 m). Zvětšeno 1 000x.

Příl. V

Pylová zrna: 1 - *Poaceae* (SS 1,40 m), 2 - *Cyperaceae* (SS 1,35 m), 3 - *Bistorta* sp. (SHS 0,10 m), 4 - *Ranunculaceae* (SS 1,06 m). Spory: 5 - *Equisetum* sp. (SS 1,65 m). Zvětšeno 1 000x.

Příl. VI

Spory: 1-4 - ?spory - terciérní (SHS 0,30 m). Zvětšeno 1 000x.

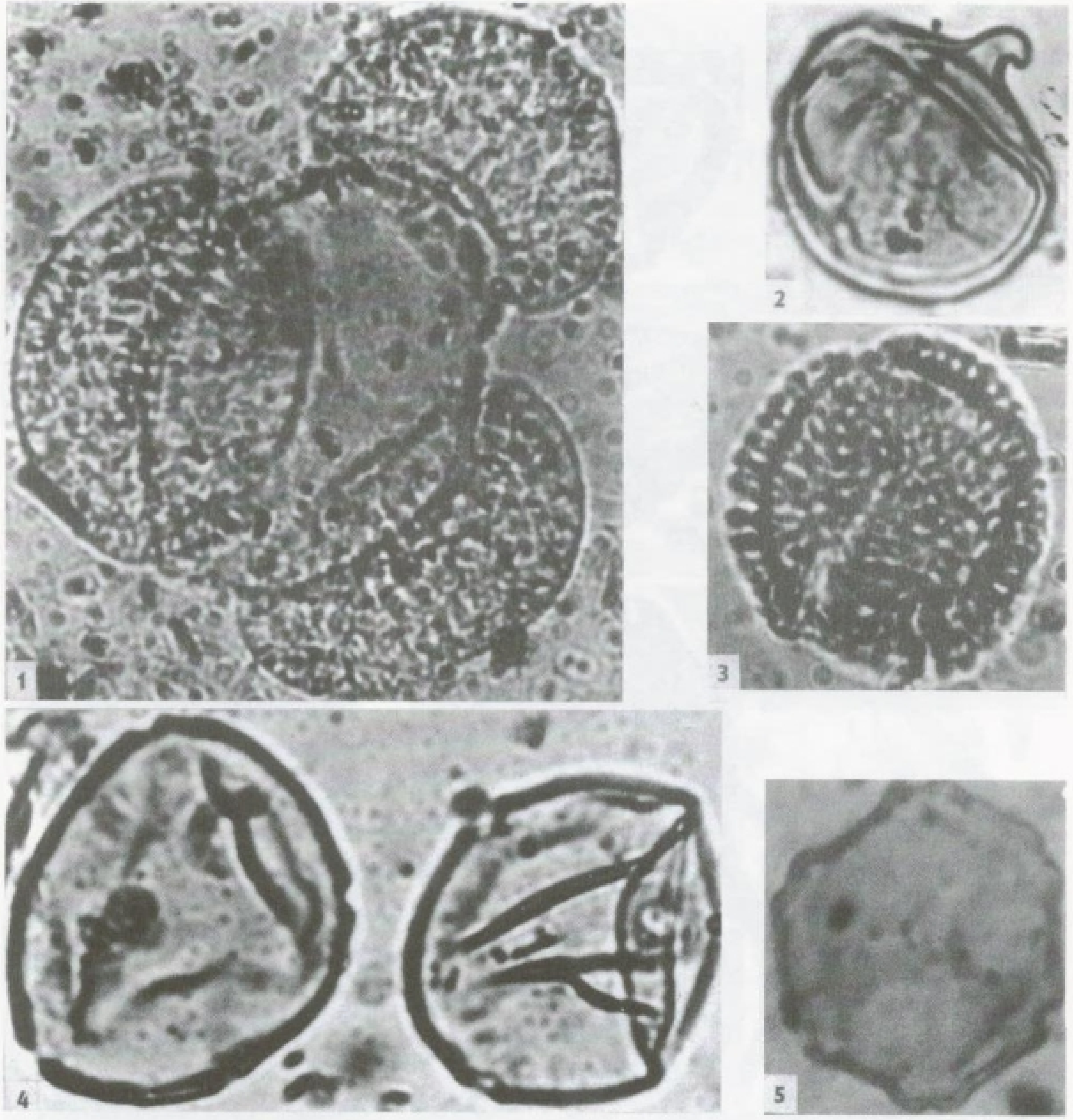
Příl. VII

Spory: 1 - *Polypodium vulgare* L. (SS 1,70 m), 2-3 - *Ephedra* cf. *fragilis* (SS 1,60 m). Zvětšeno 1 000x.

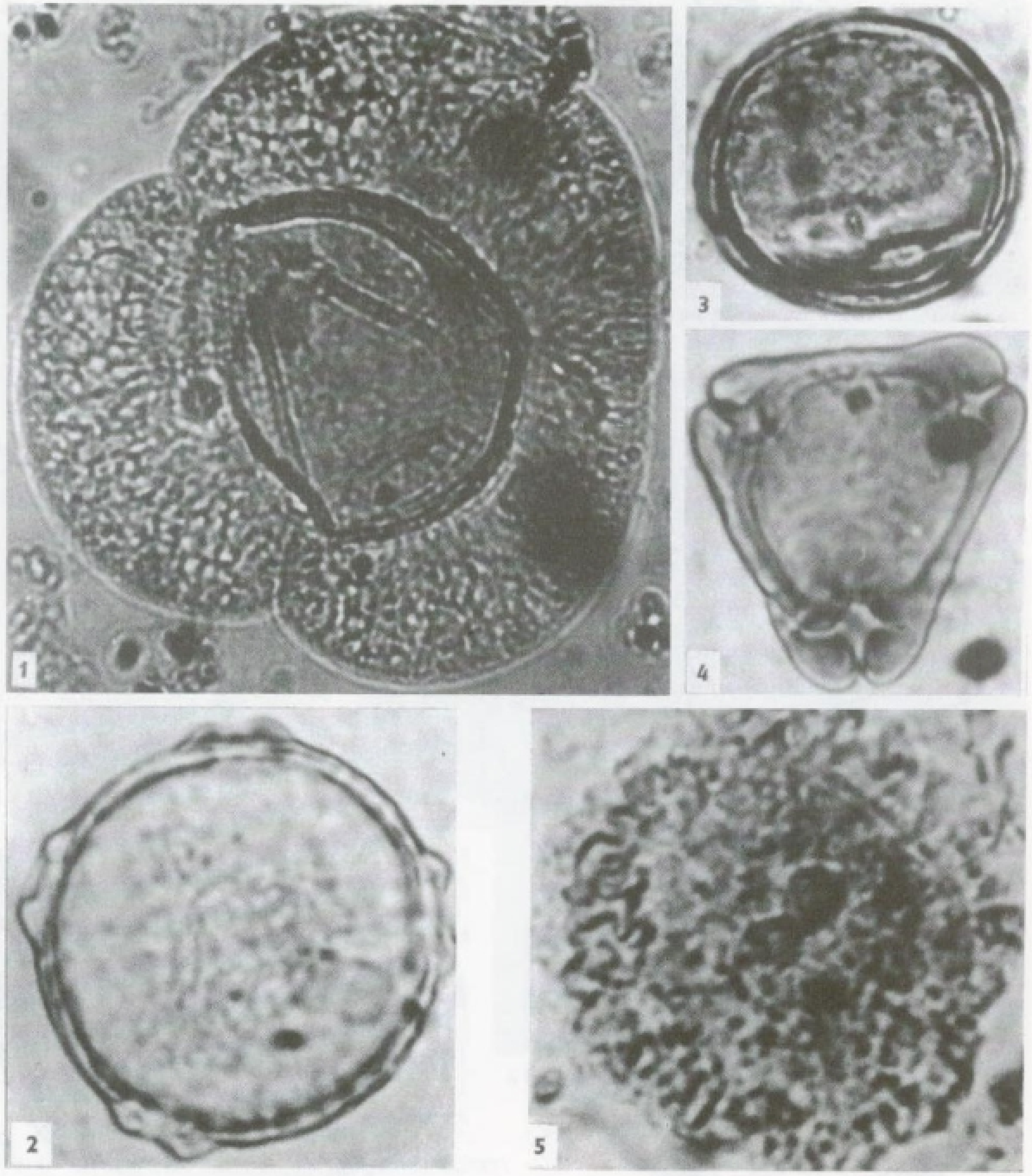
Příl. VIII

Spory: 1-2 - *Osmunda claytoniana* (SHS 0,05 m). Zvětšeno 500x.
Pylová zrna: 3 - *Abies-Typ* (SHS 0,90 m), 4 - *Picea* sp. (SHS 0,05 m). Zvětšeno 250x.

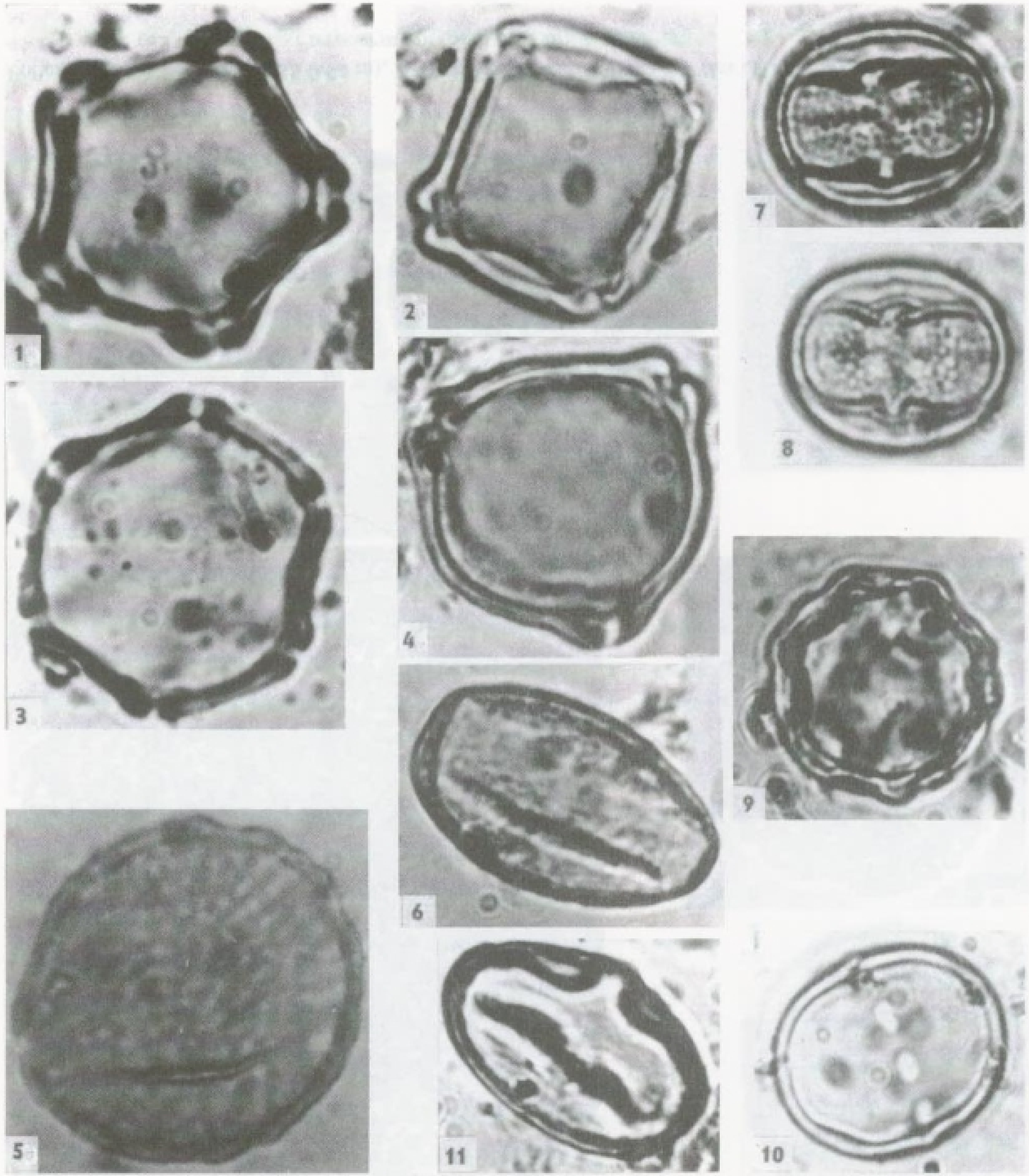
Foto E. Břízová



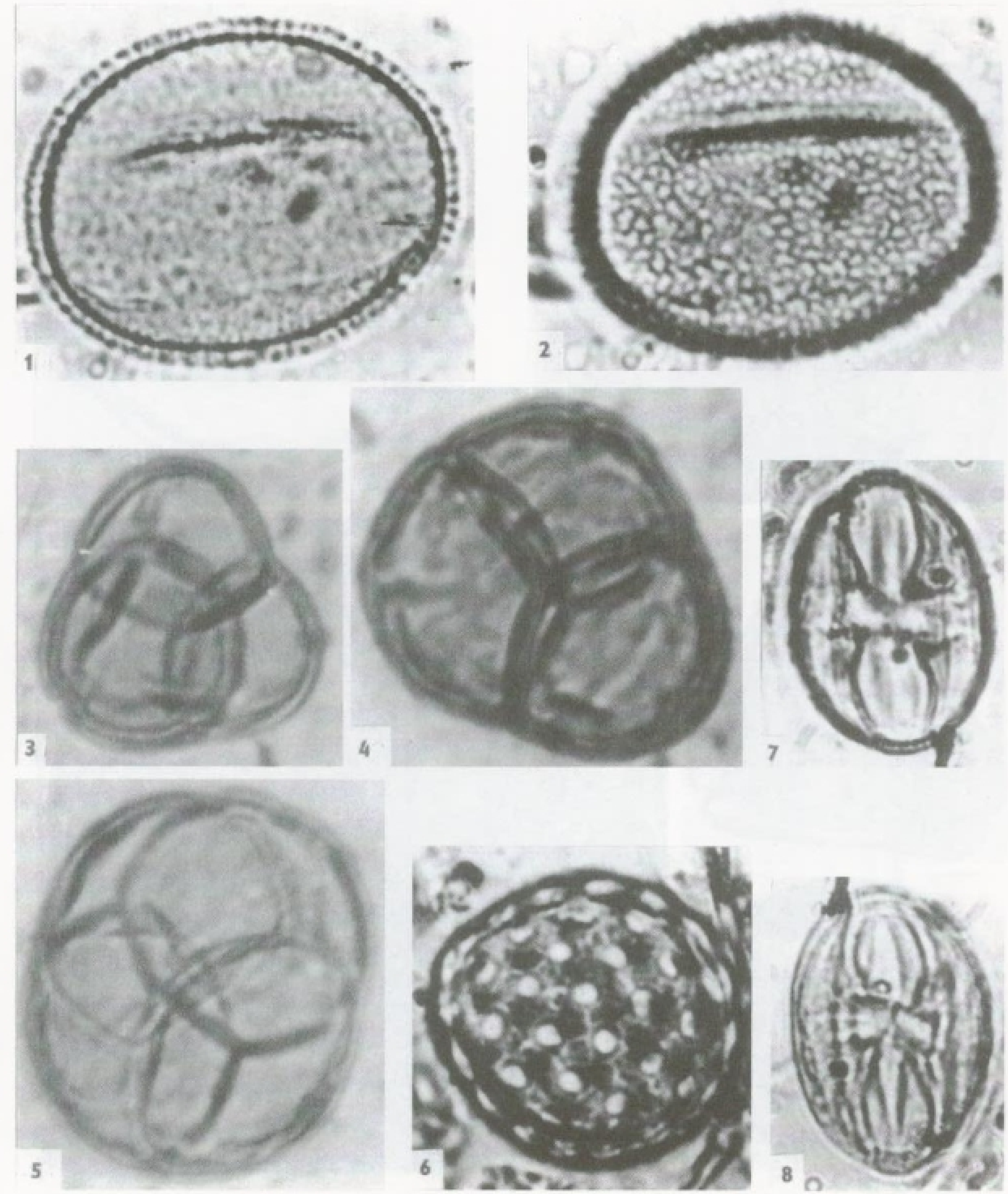
Pollen grains: 1 - *Pinus* sp. (SS 0.94 m), 2 - *Sequoia* sp. (SS 1.70 m), 3 - *Ilex* cf. *aquifolium* L. (SS 0.58 m), 4 - *Carya* sp. (SS 0.98 m), 5 - *Pterocarya* sp. (SHS 0.05 m). x 1000.



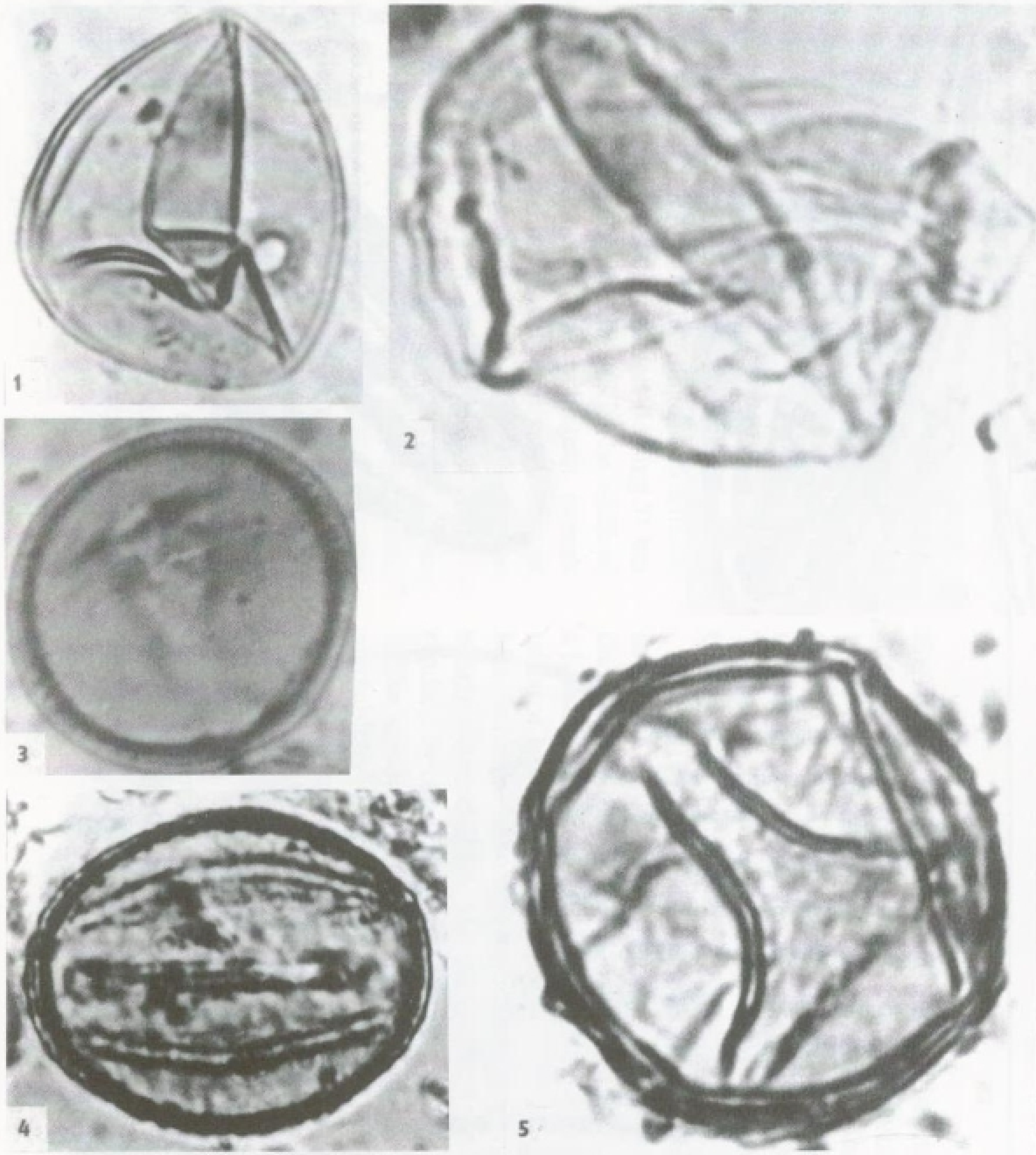
Pollen grains: 1 - *Pinus* sp. (SS 0.72 m), 2 - *Carpinus* sp. (SS 1.06 m), 3 - *Fagus* sp. (SS 1.65 m), 4 - *Normapolles* (SS 1.65 m), 5 - *Tsuga* sp. (SS 1.60 m). x 1000.



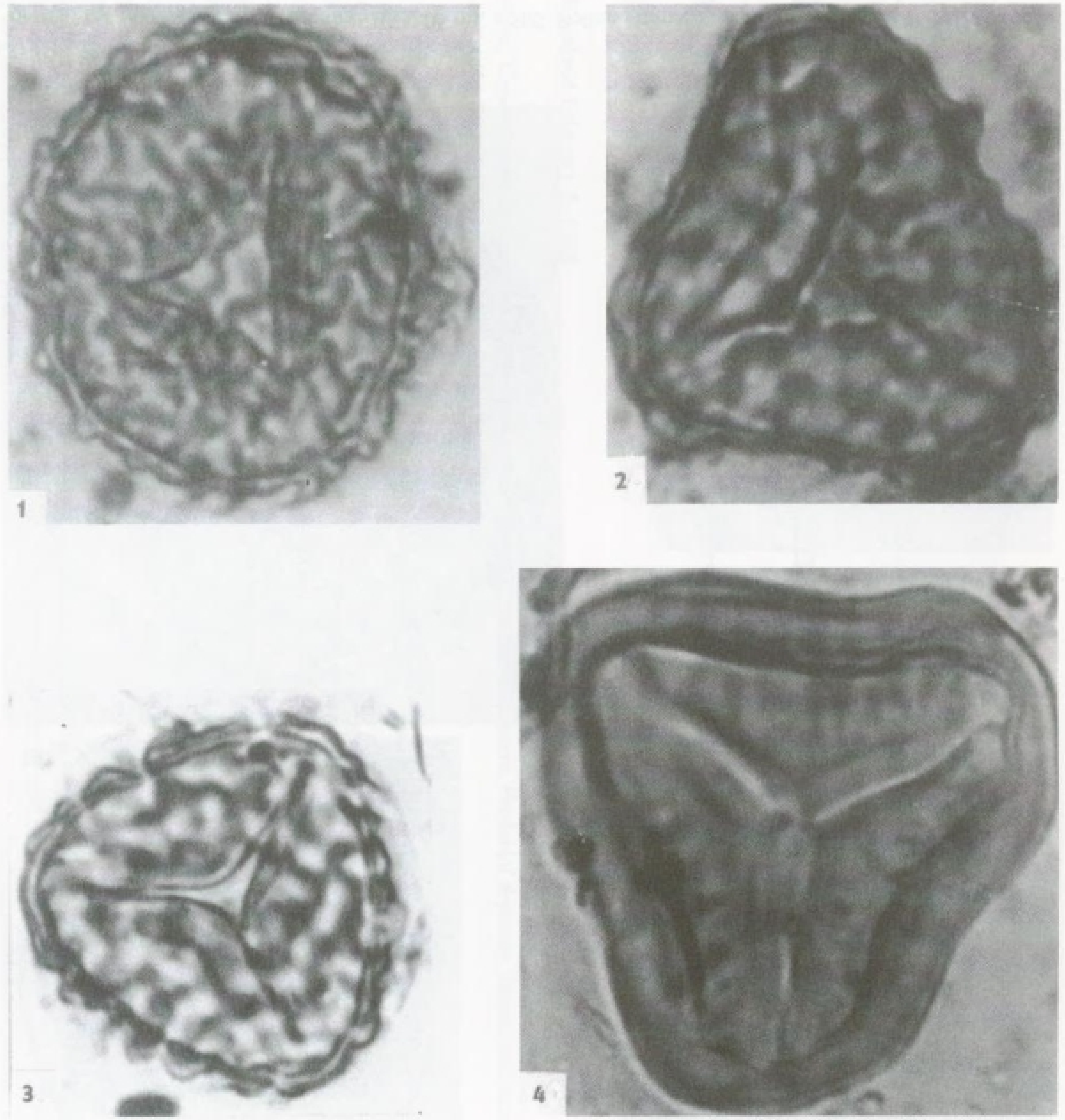
Pollen grains: 1-3 - *Alnus* sp. (SS 1.40 m), 4 - *Betula* sp. (SS 1.50 m), 5 - *Ulmus* sp. (SS 1.01 m), 6 - *Quercus* sp. (SS 1.20 m), 7-8 - *Hedera* sp. (SS 1.40 m), 9 - *Alisma plantago-aquatica* L. (SS 0.21 m), 10 - *Lathyrus* sp. (SS 0.69 m), 11 - *Rosaceae* (SS 0.98 m). x 1000.



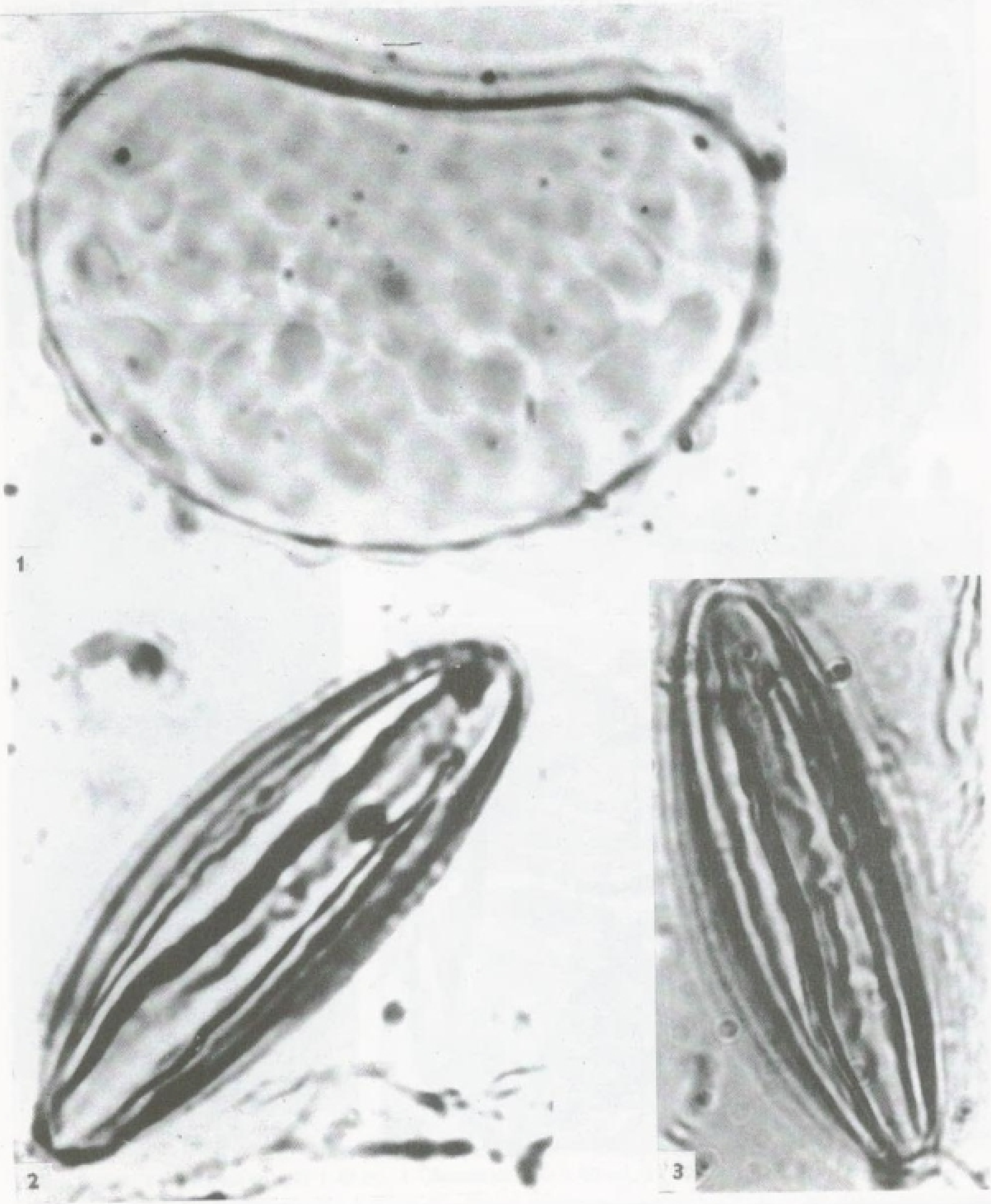
Pollen grains: 1-2 - *Brassicaceae* (SS 0.96 m), 3-5 - *Ericaceae* (SS 0.39 m), 6 - *Chenopodiaceae* (SS 1.40 m), 7-8 - *Sanguisorba* sp. (SS 1.55 m). x 1000.



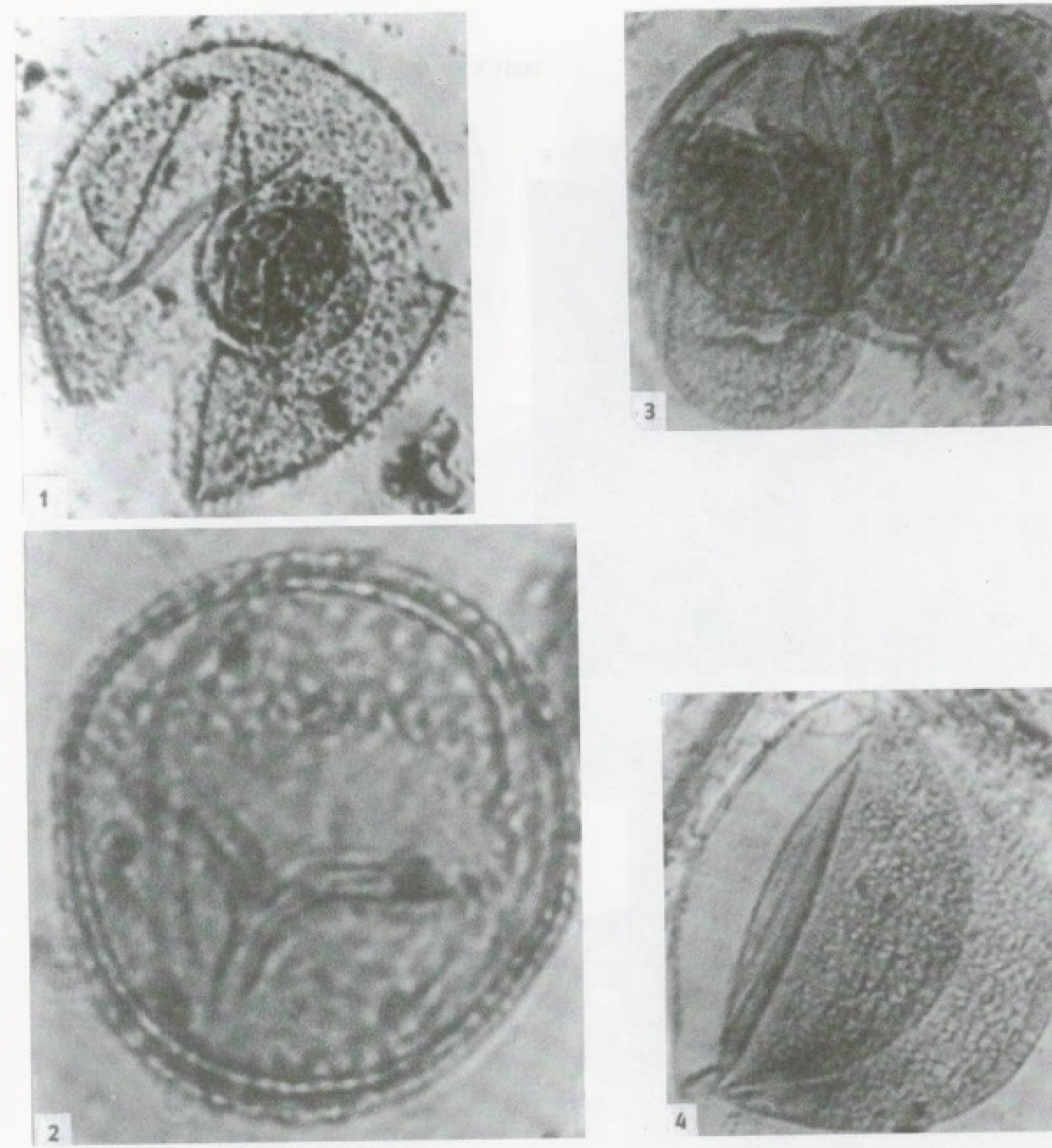
Pollen grains: 1 - *Poaceae* (SS 1.40 m), 2 - *Cyperaceae* (SS 1.35 m), 3 - *Bistorta* sp. (SHS 0.10 m), 4 - *Ranunculaceae* (SS 1.06 m). Spores: 5 - *Equisetum* sp. (SS 1.65 m). x 1000.



Spores: 1-4 - ?spores - Tertiary (SHS 0.30 m). x 1000.



Spores: 1 - *Polypodium vulgare* L. (SS 1.70 m), 2-3 - *Ephedra* cf. *fragilis* (SS 1.60 m). x 1000.



Spores: 1-2 - *Osmunda claytoniana* (SHS 0.05 m). x 500. Pollen grains: 3 - *Abies-Typ* (SHS 0.90 m), 4 - *Picea* sp. (SHS 0.05 m). x 250

All photos by E. Břízová