PALYNOLOGICAL STUDIES ON SWAMPS OF THE ZEMPLÉN MOUNTAINS

by

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Introduction

For fifteen years the present Institute has been dealing with phytogeography, coenology of forests and rock turfs (Simon, in Jakucs 1961, Simon – Jurassa 1970, Simon 1970) and on the ecology of meadows (Juhász-Nagy 1964) in the Zemplén Mountains. In order to elucidate some details in the development of the actual vegetation and in the history of boreal species, of pine and of the swamps, palynological examinations were starded in 1967) Magda Járai-Komlódi) in two central sites of the mountains, i. e. on the Kőkapu swamp in the valley of Kemence Creek and on Tokártető, a peaty depression of a plateau.

This paper deals with the results of these studies.

General description

The Zemplén Mountains to the volcanic tertiary mountainous region of the north-eastern part of the Hungarian Central Mountains; in respect to climate, soil, flora, fauna and vegetation they constitute transition between the north-eastern part of the Hungarian Central Mountains and the higher mountainous regions of Eastern Slovakia consisting of sandstone, crystalline and volcanic rocks.

On their south-eastern (Hegyalja) and western border (Hernád valley) the continental climatic effects have resulted in the formation of schrubberies and steepes, while the sub-mediterranean climatic effects developed a xerotherm forest steppe vegetation; at altitudes from 400 m upwards above sea-level the sloping table-lands are covered with Central European deciduous associations; mainly with sessile oakwoods and hornbeam-oakwoods – as a zonal vegetation – in a distribution comparable to that of medium mountain forests. Farther to the north the subatlantic-mountain climate asserts itself (annual average rainfall: 6 – 800 mm, ave-

rage temperature: +7 — 8 °C, with a more balanced yearly trend); small enclaves of zonal beech forests can be found over 700 m. above sea-level (the largest ones in the Milic group), but they exist also on very slight slopes in northern exposition from 600 m on. The fir and pine forests planted at the site of hornbeam-oak and beech forests on sour basic rock (riolit, potassium trachit), clearings with birch-trees, covered with moss and some temporary swamps are the sites of the alpine and boreal elements.

Description of the model areas

1. Kőkapu swamp (about 240 m above sea-level. Fig. 1.) Swampy area, developed before the formation of natural rocky barrage "Kőkapu" obstructing the Kemence Creek, with a few 100 m² of peaty-mossy bog *(Carici stellulatae – Sphagnetum recurvi-palustris*; Site of sampling), while the rest of the valley is covered over a length of about 800 m with alder trees *(Alnetum glutinosae-incanae)*.

2. Tokártető swamp (about 680 m above sea-level. Fig. 2.) Peaty area with poor outlet on the northern slope of Mount Pengőkő (743 m above sea-level), at the head of the valley of Ósva Creek where the process of stagnation during the last millenia has reduced) the forest. This area belongs to the beech zone and is bordered to the west over 2 km by the planted fir forest of Mount Dorgó, and to the north by the north-eastern slope of Mount Hosszúkő (744 m over sea-level). A fine rocky formation about, 1 km long is situated on the upper third part of the slope. Exposed to the west, the slight slopes of Hosszúkő are already covered with sessile-oak forests and with meadows rich in flowers *(Festuco-rubrae-Cynosuretum, Junco-Molinietum* s. l.).

Methods

The soil samples were taken with a Hiller type peat-cutter at intervals of 5 cm. Sampling was made with the acetolysis method (E r d t m a n 1943). At sampling site No. 1 (Kőkapu) the drill was running through Sphagnum peat and the hole ended at 0,55 m in sandy alluvial gravel. At sampling site No. 2 (Tokártető) the basic rock was reached at 0,95 m. The upper layers were peaty, while the lower ones consisted of peaty loam rich in organic substances.

A microscope type NfpK was used for pollen statistics and for making microscopic photos. The pollen and the spores of both the trees (AP) and the herbaceous plants (NAP) were indentified. The unknow ones were marked with "Varia".

The occurrence of the different taxons is shown on Tab. I. II. on a percentage basis. The graphic representation of every taxon is to be found in a pollen diagram (Fig. 3. 4.). 100 per cent are obtained by the sum of AP + NAP, except for the aquatic plants and spores of the ferns.

Chronological division and the denomination of the different pollen phases were carried out according to the nomenclature of F i r b a s (1949, 1954).

The percentages of sporomorphs in the samples of „Kőkapu" swamp

Table 1.

Pinus	Betula	Alnus	Salix	Populus	Fagus	Carpinus	Acer	Fraxinus	Quercus	Corylus	Tilia platyphyllos typ.	Tilia cordata typ.	Ulmus	Juglans	Abies	Piceae	AP %	Artemisia
5,0	6,1	16,7	0,3	2,2	7,3	2,2	0,3	–	9,6	6,9	0,3	–	0,3	0,3	0,3	1,4	59,2	0,6
3,0	5,8	17,6	0,5	1,0	11,3	1,5	–	–	5,2	3,3	0,2	–	0,2	0,2	0,2	0,2	50,2	0,2
4,2	6,9	14,4	–	0,6	14,1	2,7	–	–	5,3	7,5	0,3	0,3	0,6	0,8	0,3	0,6	58,5	0,5
3,8	7,8	16,1	1,0	0,5	8,3	6,3	–	–	3,8	3,8	–	0,5	–	–	–	0,7	52,6	1,2
6,1	3,9	31,1	0,3	1,3	14,2	3,1	0,3	–	5,3	3,1	0,5	0,3	0,3	–	0,5	1,1	71,4	1,6
6,1	5,7	45,1	0,3	0,3	14,3	5,8	–	–	2,8	2,5	1,1	–	–	–	0,3	0,3	84,6	0,3
4,6	3,2	62,2	–	–	3,9	1,5	–	–	2,1	1,1	1,1	–	0,4	–	0,3	2,1	82,7	0,3
3,1	2,6	66,4	–	–	11,3	2,2	–	–	3,5	1,7	0,4	–	0,4	–	–	0,4	92,0	0,3
3,1	4,1	57,1	0,4	–	14,6	5,1	–	–	2,4	0,4	–	–	–	–	0,4	0,4	88,0	–
3,2	8,1	50,7	–	–	16,8	4,2	–	0,4	3,1	0,4	0,4	–	–	–	0,4	0,8	88,5	0,4

Campanulaceae	Caryophyllaceae Dianthus typ.	Caryophyllaceae Lychnis typ.	Chenopodiaceae	Compositae tubuliflorae	Carduus-Cirsium typ.	Centaurea scabiosa typ.	Centaurea cyanus typ.	Centaurea jacea typ.	Compositae liguliflorae	Cruciferae	Cyperaceae	Dipsacaceae	Ericaceae cf. Ledum	Ericaceae cf. Vaccinium	Calluna	Ephedra dystachai typ.	Euonymus	Fabaceae Vicia-Lathyrus typ.
–	–	0,8	1,3	–	0,3	–	0,3	0,8	0,6	0,3	14,5	0,3	–	0,6	–	–	0,6	–
–	–	0,3	1,3	0,5	–	–	0,3	–	0,3	–	25,0	0,5	–	–	0,5	–	–	0,3
–	–	–	2,9	0,3	0,5	0,3	0,5	0,3	0,3	–	21,0	0,5	–	0,3	–	–	–	0,3
0,5	0,3	0,7	2,5	0,3	–	–	1,2	0,3	0,3	–	16,0	0,3	–	0,3	0,3	–	–	–
–	–	–	3,7	0,3	–	–	0,3	0,3	0,6	–	8,4	–	0,3	–	–	–	–	–
–	–	0,3	2,5	–	–	0,3	0,3	–	0,3	–	4,5	0,3	0,3	–	–	–	–	–
–	0,4	–	0,7	–	–	–	0,4	–	0,4	–	7,0	0,3	–	–	0,3	0,7	–	–
–	0,3	0,3	0,3	0,3	–	–	0,3	–	0,3	–	1,7	–	–	–	–	–	–	0,3
–	0,3	–	0,3	0,3	–	–	–	0,3	0,3	–	3,3	0,3	0,3	–	–	–	–	0,3
–	0,4	0,4	0,4	0,2	0,2	–	–	0,4	0,2	–	2,8	0,4	–	0,4	–	–	–	–

Fabaceae Trifolium typ.	Fagopyrum	Frangula	Filipendula	Galium typ.	Geranium	Gramineae	Gramineae, Cerealia	Labiatae	Ligustrum	Linum cf. catharticum	Lysimachia	Pedicularis	Plantago lanceolata typ.	Polygonum aviculare typ.	Polygonum lapathifolium typ.	Polygonum amphibium typ.	Ranunculaceae	Ribes	Rosaceae
–	–	–	–	0,6	–	10,3	1,8	–	–	0,3	–	0,3	1,1	–	0,3	–	–	0,2	3,2
–	–	0,3	–	0,5	–	10,5	–	–	0,5	0,3	0,3	–	1,3	0,5	0,3	–	1,0	0,5	2,3
–	–	0,3	–	0,3	–	7,2	0,3	–	0,3	0,3	0,3	–	1,3	0,3	0,3	–	–	–	1,3
–	–	0,5	0,3	0,7	–	11,1	1,5	–	0,5	0,3	0,7	–	1,0	0,3	0,3	–	0,5	–	2,1
–	–	–	–	0,3	–	5,8	0,5	0,3	–	0,3	–	–	0,5	–	–	–	–	0,3	1,3
0,3	–	–	–	0,3	0,3	1,1	1,1	0,3	–	–	–	–	0,3	–	0,3	0,3	–	0,8	0,8
–	0,3	–	–	–	–	3,2	–	0,3	–	–	–	–	–	–	–	1,1	–	0,7	0,4
–	–	–	–	–	–	0,3	0,3	0,3	0,3	–	–	–	–	–	–	0,3	0,3	0,3	0,3
–	–	0,3	–	0,3	–	4,2	–	–	–	–	0,3	–	–	–	–	0,3	–	–	–
0,2	–	0,4	–	–	–	2,7	–	–	–	0,4	–	–	0,2	–	–	–	–	0,4	–

Rosaceae cf. Comarum-Potentilla typ.	Rumex acetosa typ.	Rumex hydrolapathum typ.	Thalictrum	Umbelliferae	Vitis	Varia	Sphagnum	Equisetum	Lycopodium clavatum	Polypodiaceae	Thelypteris palustris	Pteridium	Alisma plantagoaquatica	Myriophyllum spicatum	Potamogeton coelogeton typ.	Sparganium-Typha angustifolia	Typha latifolia
–	–	–	0,3	–	–	1,4	7,6	0,3	0,3	11,5	–	0,6	–	0,3	–	0,6	–
–	–	0,3	–	1,8	–	0,2	6,7	0,2	–	5,0	–	0,2	–	–	–	–	–
0,3	0,3	0,3	–	–	0,3	0,4	5,9	–	–	6,6	–	–	–	–	–	0,3	0,3
1,0	–	–	–	0,5	–	1,9	4,1	0,7	–	7,8	–	0,3	–	–	–	–	–
0,3	0,3	0,3	–	–	–	2,9	3,3	–	0,8	8,7	–	–	–	–	0,5	–	0,3
–	–	–	–	–	–	0,4	1,8	0,3	0,8	5,7	–	–	0,3	–	–	0,3	–
0,3	–	–	–	–	0,3	0,2	4,3	0,7	–	2,8	0,3	0,3	–	–	–	0,3	–
–	–	0,5	–	–	0,5	0,5	3,2	0,4	0,4	1,7	–	–	–	–	0,4	–	–
0,3	–	–	–	–	0,3	0,3	3,9	–	–	1,4	–	–	–	–	0,6	0,9	–
0,4	–	–	–	–	0,4	0,2	2,8	–	0,4	3,1	–	–	–	–	–	0,8	–

The percentages of sporomorphs in the samples of „Tokár" swamp

Table 11.

Pinus	Betula	Alnus	Salix	Populus	Fagus	Carpinus	Acer	Quercus	Corylus	Tilia platyphyllos	Tilia cordata	Ulmus	Juglans	Abies	Picea	AP %	Artemisia	Calystegia sepium	Caryophyllaceae	Centaurea cyanus typ.	Centaurea jacea typ.	Chenopodiaceae	Compositae liguliflorae	Compositae tubuliflorae	Cirisium-Carduus typ.	Cyperaceae	Dipsacaceae	Ephedra cf. distachya	Ephedra cf. fragilis	Ericaceae cf. Sedum	Calluna	Vaccinium	Fagopyrum	Frangula	Galium
23,6	24,1	3,7	–	0,7	4,0	1,0	–	1,3	1,3	–	–	–	–	0,7	10,4	70,8	–	–	0,2	0,7	0,2	3,7	0,2	0,2	0,2	2,7	–	–	–	–	0,4	–	3,7	0,3	0,2
27,4	39,8	2,6	–	–	2,3	0,3	–	1,5	2,3	–	–	–	–	0,7	6,3	83,2	0,6	–	0,2	1,0	–	2,6	0,2	–	–	0,2	–	–	–	–	0,2	–	2,9	–	–
33,7	10,6	8,2	–	–	1,8	1,8	–	1,2	0,6	–	–	–	0,6	1,8	1,8	62,1	4,1	–	1,6	1,4	–	7,1	0,6	1,8	–	2,9	0,6	–	–	–	0,6	0,6	1,3	1,1	0,6
29,2	4,1	3,6	–	–	4,1	1,4	–	0,9	12,3	1,4	–	–	–	–	0,5	57,5	3,6	–	1,1	2,3	–	10,2	–	–	–	2,5	–	–	–	–	1,3	0,5	0,5	–	0,5
40,5	5,5	28,5	–	–	2,4	0,8	–	1,6	3,2	0,8	–	–	–	0,8	1,6	85,7	–	–	–	0,8	3,6	3,9	–	0,4	–	0,4	–	–	–	–	1,6	–	–	–	–
45,8	6,8	18,8	–	–	1,7	0,8	–	1,7	5,0	0,8	–	–	–	1,7	4,2	87,3	–	–	–	1,8	–	1,7	–	–	–	0,2	–	–	–	–	0,8	1,6	–	–	–
34,7	3,0	16,7	–	–	12,0	0,7	–	2,2	9,0	2,2	1,5	–	–	3,0	2,2	87,2	0,3	–	–	0,7	–	3,6	–	–	–	0,3	–	–	–	–	1,5	1,0	–	0,5	–
22,8	4,1	8,2	–	–	10,5	1,2	–	2,3	10,5	1,7	0,6	–	–	1,2	1,2	64,3	3,5	–	0,6	1,2	4,7	9,8	0,6	0,6	–	1,2	0,6	–	–	–	–	0,6	–	1,2	0,6
40,3	2,3	8,6	–	–	10,4	0,4	–	1,3	7,2	0,4	–	–	–	0,4	1,5	72,8	5,0	–	2,4	0,8	6,0	5,9	–	–	–	0,4	–	–	–	–	0,4	0,8	–	–	0,4
22,2	1,8	4,4	–	–	23,3	0,6	–	0,7	6,3	0,7	0,8	0,4	–	2,2	2,2	65,6	4,9	0,4	1,5	1,5	4,4	4,9	–	1,1	–	2,6	–	–	–	1,8	1,5	0,4	0,4	–	–
7,6	2,2	2,7	1,1	–	30,2	2,2	–	2,2	13,2	1,1	2,7	–	–	1,6	–	66,8	12,6	–	–	2,1	–	4,4	–	–	–	0,6	–	–	–	–	2,3	0,6	–	0,6	–
1,9	1,3	1,9	–	–	48,4	1,9	–	1,2	8,3	2,5	1,3	–	–	1,3	–	70,0	5,1	–	0,7	2,5	–	1,3	–	–	–	0,6	–	–	–	–	1,3	0,7	–	–	1,3
12,2	5,0	6,1	0,4	0,4	46,4	0,4	0,4	3,4	11,1	1,9	–	–	–	–	0,4	88,1	1,9	–	–	0,8	–	3,4	0,3	–	–	0,3	–	–	–	–	0,3	0,3	–	–	0,3
17,9	3,7	5,8	–	–	42,6	0,8	–	0,4	7,9	3,1	–	–	–	2,1	0,4	84,7	3,1	–	–	1,2	1,2	1,2	–	–	–	0,8	–	–	–	0,8	1,3	–	–	–	0,4
25,8	1,7	7,3	–	–	40,2	0,7	–	2,9	8,1	1,5	–	–	–	1,5	–	89,7	0,8	–	–	1,4	–	1,4	–	–	–	0,8	–	–	–	1,5	–	–	–	–	–
18,5	2,2	4,9	–	–	37,5	1,1	–	4,3	9,2	0,6	–	–	–	1,6	–	79,9	6,0	–	–	–	0,6	1,6	–	1,6	–	1,1	–	–	1,1	–	0,6	–	–	–	–
16,2	2,5	6,8	–	–	22,4	0,6	–	18,6	9,9	2,5	1,2	2,0	–	–	1,2	83,9	3,7	–	0,6	–	1,3	1,2	0,6	0,6	–	0,6	–	0,6	1,2	–	–	–	–	–	–
22,8	1,5	8,3	–	–	13,6	1,4	–	21,0	9,0	2,1	7,1	4,2	–	–	–	91,0	2,6	–	–	–	–	1,1	–	–	–	0,6	–	0,6	–	0,6	0,7	–	–	–	–
10,5	0,8	6,8	–	–	16,6	0,7	–	25,8	15,0	1,4	3,4	4,1	–	2,0	–	87,1	7,7	–	–	–	–	0,7	–	–	–	0,7	–	0,6	–	0,6	–	–	–	–	–

Gramineae	Cerealia typ. (Secale)	Helianthemum	Hippophae	Labiatae	Ligustrum	Lysimachia	Lythrum	Plantago lanceolate typ.	Polygonum amphibium	Polygonum aviculare	Polygonum persicaria	Ranunculaceae	Rosaceae	Rumex acetosa typ.	Rumex hydrolapathum typ.	Thalictrum	Trifolium typ.	Umbelliferae	Vitis	Varia	Sphagnum	Lycopodium annotinum	Lycopodium clavatum	Lycopodium selago	Lycopodium complanatum	Polypodiaceae	Polypodium vulgare	Botrychium	Alisma plantagoaquatica	Batrachium	Nymphaeaceae	Potamogeton
13,6	0,3	–	–	–	–	–	–	0,7	0,3	1,0	–	–	–	–	–	–	–	–	–	0,6	–	–	–	–	–	10,9	0,3	2,7	–	4,6	–	–
7,1	–	–	–	–	–	–	–	–	0,2	1,0	–	0,2	–	0,2	–	–	–	–	–	0,2	0,4	–	–	–	–	9,2	1,4	7,4	–	0,7	–	–
6,7	–	–	–	0,6	–	–	–	0,6	0,3	2,2	–	–	0,8	–	0,6	0,6	–	0,6	–	0,6	1,8	0,6	3,0	–	–	65,1	4,2	4,1	–	7,9	–	–
2,4	–	–	–	–	–	–	–	0,5	1,7	10,7	–	–	1,4	0,5	1,3	–	–	0,5	0,5	0,5	0,5	–	2,8	–	–	50,2	0,9	3,2	0,5	9,1	–	–
1,6	–	–	–	–	–	–	–	–	0,4	1,2	–	–	–	–	–	–	–	–	–	0,4	1,6	–	2,4	–	–	32,5	2,4	1,6	–	9,7	–	–
0,8	–	–	–	–	–	–	–	–	2,1	2,9	–	–	–	–	–	–	–	–	–	0,8	–	–	9,3	–	–	67,8	0,8	0,8	–	15,3	–	–
0,7	–	–	–	–	–	–	–	–	2,0	1,5	–	–	–	–	–	–	–	–	0,7	–	–	–	1,5	–	–	37,5	2,3	0,8	–	8,1	–	–
1,2	1,2	–	–	–	0,6	–	–	1,2	0,6	0,6	–	–	–	0,6	0,5	0,6	1,2	0,6	–	1,6	0,6	–	5,8	–	–	35,1	2,6	1,9	0,6	2,7	–	–
0,4	–	–	–	–	–	0,4	–	–	1,4	1,3	–	–	0,4	–	–	–	–	0,4	–	0,8	0,4	0,4	4,1	–	–	16,4	0,4	4,1	–	0,4	–	0,4
0,4	–	–	–	–	–	0,4	–	0,7	3,1	1,7	0,4	–	–	0,4	–	–	–	1,1	–	0,8	1,5	–	4,4	–	–	22,3	1,5	2,6	–	0,7	–	1,1
3,3	–	–	–	–	–	0,6	–	1,6	2,2	0,6	–	0,6	–	–	–	–	–	0,5	–	0,6	0,6	–	0,6	–	–	18,6	4,4	4,8	–	–	–	0,5
2,5	–	–	–	–	0,6	1,3	–	0,4	6,1	2,2	–	0,6	–	–	–	2,0	–	–	–	0,8	3,0	0,6	0,6	0,7	–	9,6	0,6	0,6	10,0	–	1,8	–
2,3	–	–	–	–	0,4	–	–	0,4	0,4	0,4	–	–	0,4	–	–	–	–	–	–	–	6,2	0,4	1,8	0,4	0,6	11,5	1,1	6,2	–	–	–	2,0
1,2	–	–	–	–	–	–	–	0,4	1,0	1,1	–	0,4	–	–	–	–	–	0,4	–	0,9	8,4	0,8	1,8	–	–	20,8	3,3	4,8	–	2,1	–	0,8
2,2	–	–	–	–	–	–	–	0,8	–	0,7	–	–	–	–	–	–	–	–	–	0,7	4,1	0,8	0,7	–	–	22,1	29,4	7,1	–	–	–	1,5
1,1	–	–	–	–	–	–	–	1,1	–	1,1	–	–	–	–	1,1	1,1	–	0,5	–	1,5	2,1	–	3,8	–	–	32,6	16,3	0,5	–	–	–	1,6
3,2	–	–	–	–	–	–	–	–	–	1,9	–	–	–	–	–	–	–	–	–	0,6	0,6	–	3,1	–	–	18,6	12,4	1,2	–	–	–	–
0,7	–	–	0,7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0,7	–	0,7	1,4	–	8,3	–	–	10,4	4,9	1,4	–	–	–	–
0,6	–	0,6	–	–	–	–	0,7	–	–	–	–	–	–	–	–	–	–	–	–	0,7	2,7	–	8,1	–	–	31,3	10,9	2,7	–	–	–	–

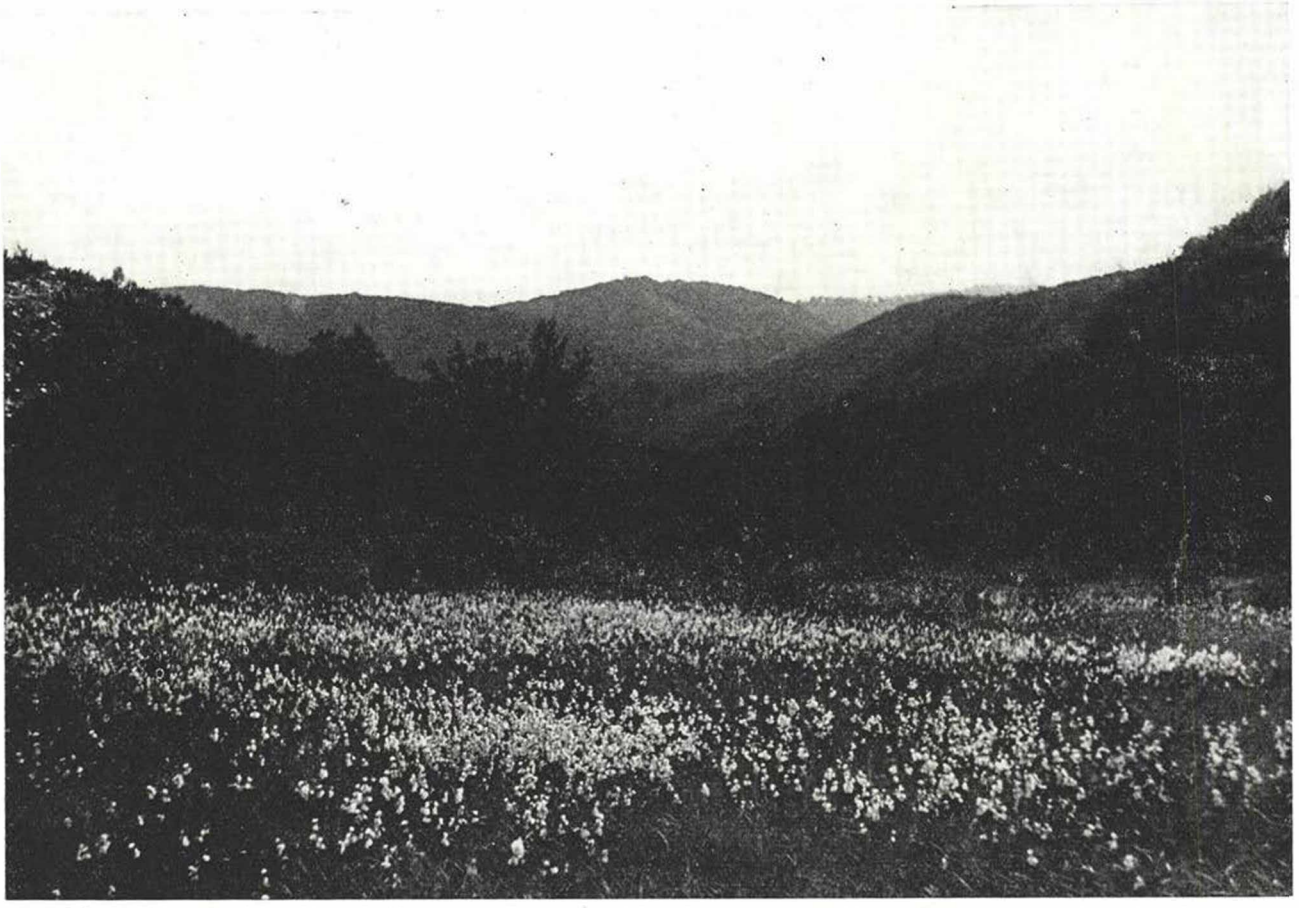

Fig. 1. The site of the borehole No. 1. „Kőkapu" swamp. In the foreground peat with Sphagnum and Eriophorum, in the background alder groves. Photo T. Simon

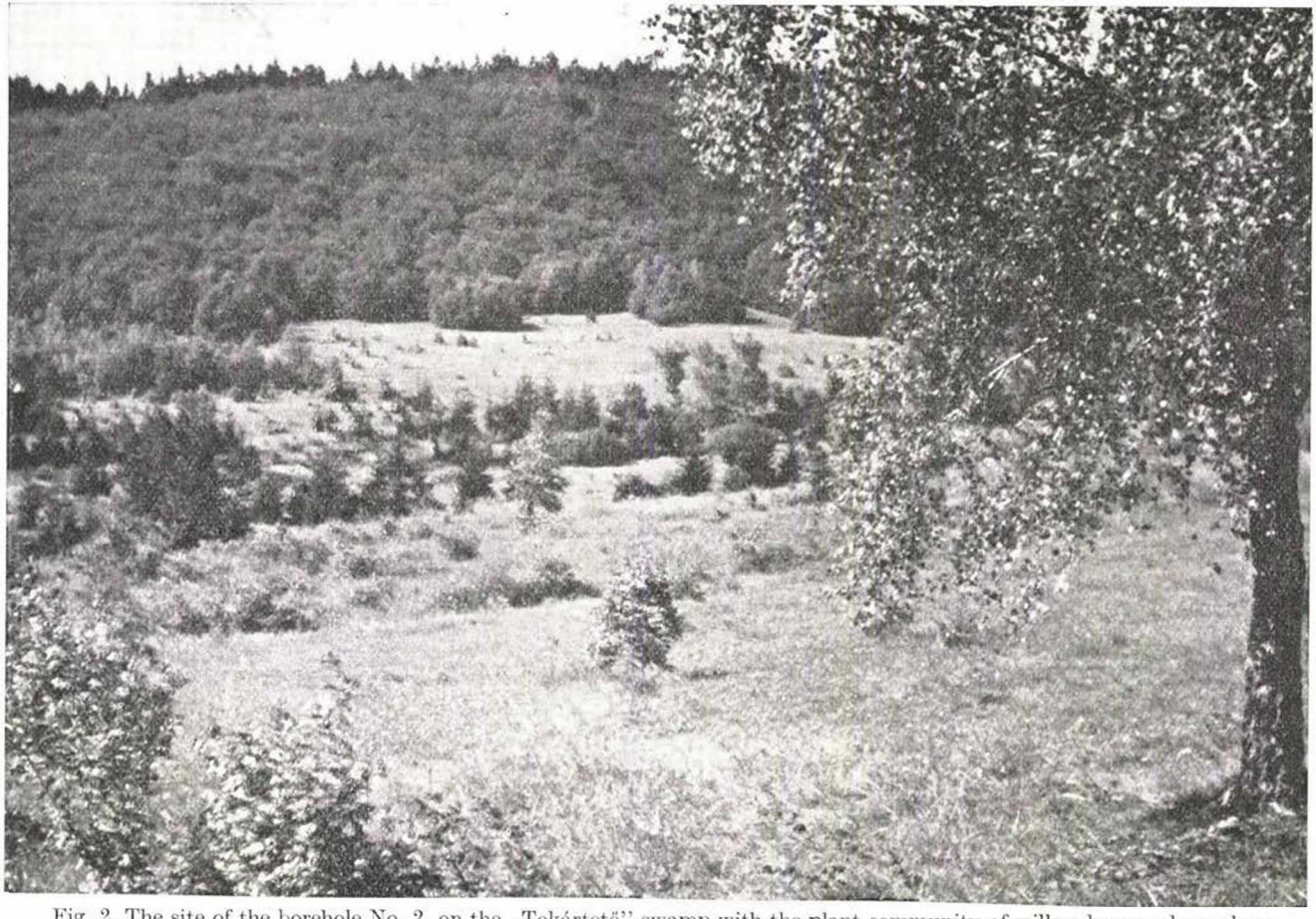

Fig. 2. The site of the borehole No. 2. on the „Tokártető'' swamp with the plant community of willow-bogs and meadows.
Photo T. Simon

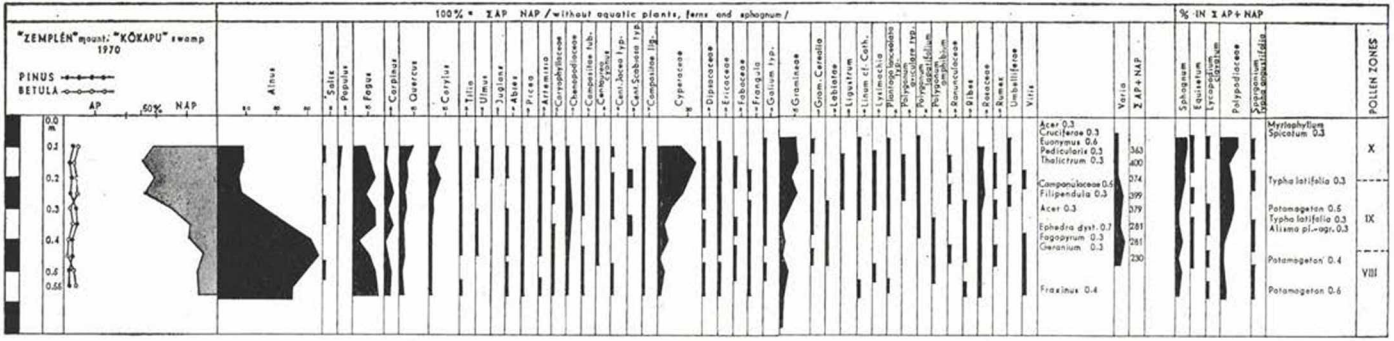

Fig. 3. Pollendiagram of "Kőkapu" swamp in the Zemplén Mountains

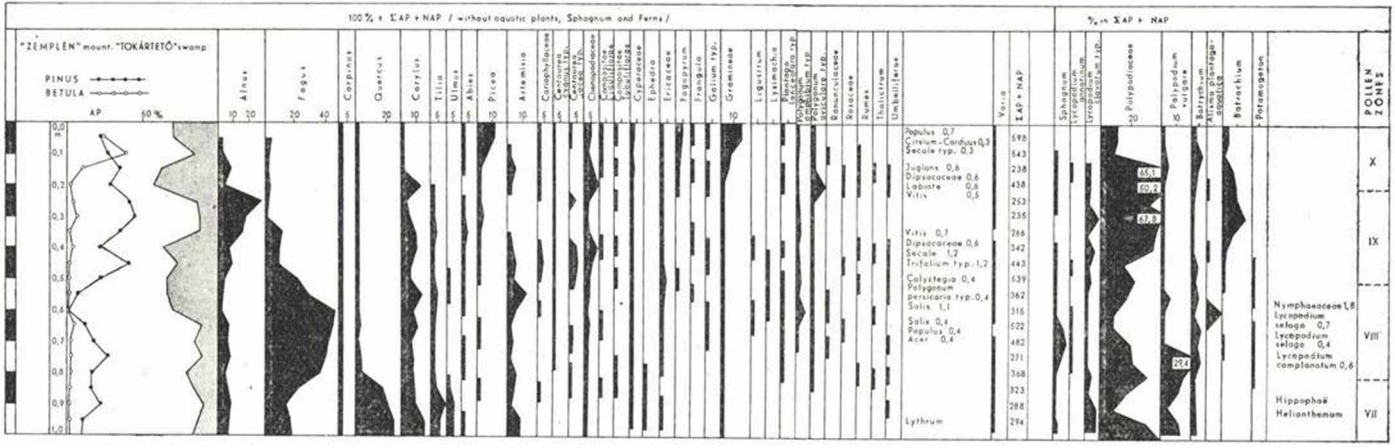

Fig. 4. Pollendiagram of "Tokár" swamp in the Zemplén Mountains

Discussion

1. Kőkapu swamp

Its development reaches back to the end of the Sub-Boreal and the beginning of the Sub-Atlantic. According to pollen spectra the dominant forests of the region were oak and beech. The most important local species is the alder. *Pinus, Abies* and *Picea* pollens are always secondary and may have been imported by the wind from afar. The birch is not significant, but always present. 60—90 per cent of the area was wooded. There is not much change to be found in the history of the forest. Fagus is dominant among the deciduous trees in the three lower samples. Fewer pollen of *Quercus* and other thermophilous trees. *Tilia* pollens all belonged to *T. platyphyllos*. This period may be regarded as the Sub-Boreal phase. The quantity of beech did not decrease as far as our days, but that of trees and shrubs requiring more warmth and sunshine, particularly that of oak and hazel-nut, gradually increased. At that time the *Tilia* pollens included those of *T. platyphyllos* and *T. cordata* alike.

The history of the swamp proved to be more variable. The constantly large quantity of alder in the lower samples seems to indicate a rather large alder wood. At the same time pollen grains of *Ribes* and *Vitis* can also be found.

At that time the *Ericaceae* were mainly represented by the *Ledum* type pollen, while the younger layers presented only pollens of *Calluna* and *Vaccinium* type. Several *Rosaceae* pollens belonging to the *Potentilla-Comarum* type were also found.

All this suggests that there may have been at first an extensive alder grove with wild vine, *Frangula*, while the *Sphangum* spots were covered with birch; in this cool and humid micro-climate there might have been *Ledum* and possibly *Comarum* too (the occurrence of the latter is purely hypothestical).

Later on the alder wood gradually diminished, while aquatic plants, *Cyperaceae* and *Gramineae* seemed to gain ground. Most of the reed-grasses left pollens belonging to the *Carex-Scirpus* and *Eriophorum* types. By that time the micro-climate was probably somewhat warmer and dryer, but the edaphic water supply from the creek in the valley continued to maintain the *Sphagnum* swamp up to the present day.

Juglans pollens to be found in the uppermost samples are indicative of the present culture. The pollen spectrum includes at every stage pollen grains of cultivated plants and weeds, such as Cerealia, *Polygonum aviculare* and *Centaurea cyanus* which seem to prove the existence of agricultural production in the environments. In this respect the loess-covered slopes facing the Hernád valley and particularly the loess ridge of Harangod may be taken into consideration. The Cerealia pollens are larger than 40 μ but smaller than 60 μ, and belong mostly to the *Secale* type.

2. Tokártető swamp

The pollen spectrum at the bottom of the drill hole may belong to the atlantic phase. At all time the region was, and still is covered with forest up to 60—90 per cent. The forests consist primarily of oaks and beeches, their ratio changing with time. *Alnus* is local. *Pinus* is presumably secondary, imported by the wind from afar. However, it cannot be excluded that there have been native *Pinus* forests in the region during the Sub-Atlantic period.

The pollen diagram presents the material of three different ecotops: deciduous forest, swamp and steppe, playing a different role and being of unequal importance at the different periods.

The bottom samples included the largest quantity of pollens belonging to thermophilous deciduous trees *(Quercus, Corylus, Ulmus)*. The dominant forest of the region may have consisted of oaks, with expositional beeches. Although the region was almost entirely wooded, there are still pollens of heliophilous species present which are indicative of an uncovered steppe vegetation *(Artemisia, Helianthemum, Ephedra, Hippophaë)*. They were growing presumably on the rocky steppes of the near-by Hosszúkő, on the slopes of the Hernád valley and on the steppes of Hegyalja. The pollen grains of these steppe elements dating back eventually to the Boreal phase may have been carried by the wind into the water of Tokártető swamp where they fossilated. At that time there might have been here a small *Sphagnum* swamp similar to that of Kőkapu. *Ericaceae* pollens belonging to the Ledum type were also found here.

Deposited probably during the Atlantic phase, this pollen spectrum is presented by the lower four samples.

Henceforth the quantitative distribution of the dominant trees underwent a rather substantial change. Development took another trend. The thermophilous deciduous trees withdrew and *Fagus* gained ground.

Besides the spore of *Lycopodium clavatum* which was present throughout the drill hole, these samples included also the spores of three other Lycopodia *(L. annotinum, L. selago, L. complanatum)*, as well as a considerable amount of *Botrychium*. The *Sphagnum* swamp seems to have been the largest at that time. A greater variety of aquatic plants was identified; for the last time we found pollen grains of the *Ledum* type.

Simultaneously the steppe elements diminished. There was less *Artemisia*, while pollens of *Ephedra, Helianthemum* and *Hippophaë* were found no more. Former steppe spots were possibly wooded by that time. However, it is also possible that the steppe spot still existed (perhaps expositionally), but the pollen grains were prevented by the considerable afforestation from getting into the swamp. Finally, it is equally possible that the steppe spot existed but the macroclimate became cooler and more rainy the sunshine was less and caused the more delicate steppe plants such as *Ephdara* to die out, while others, such as *Artemisia*, were merely repressed.

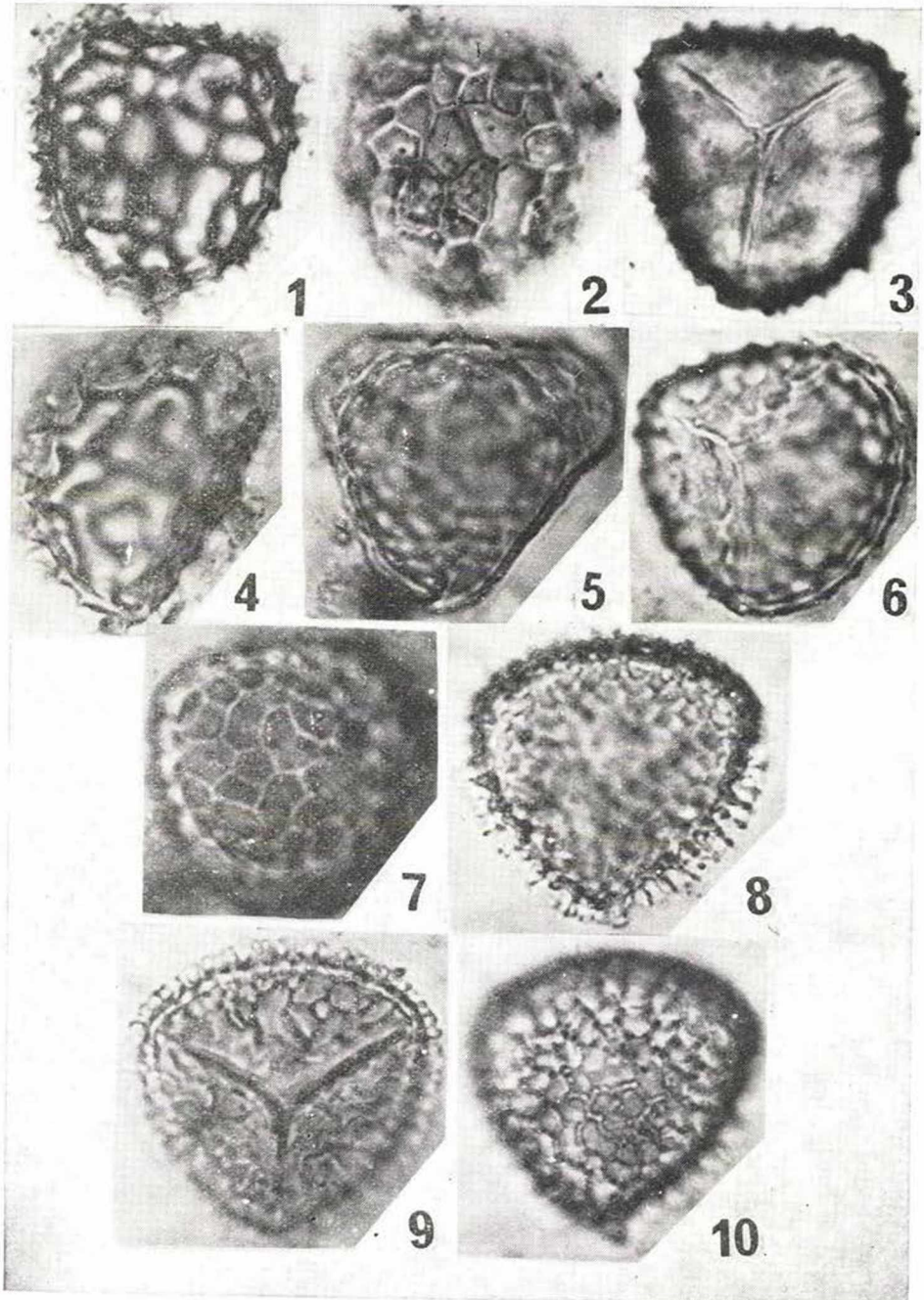

Fig. 5. 1 – 4. Lycopodium annotiunm, 5. Lycopodium selago 6 – 7. Lycopodium complanatum, 8 – 10. Lycopodium clavatum,

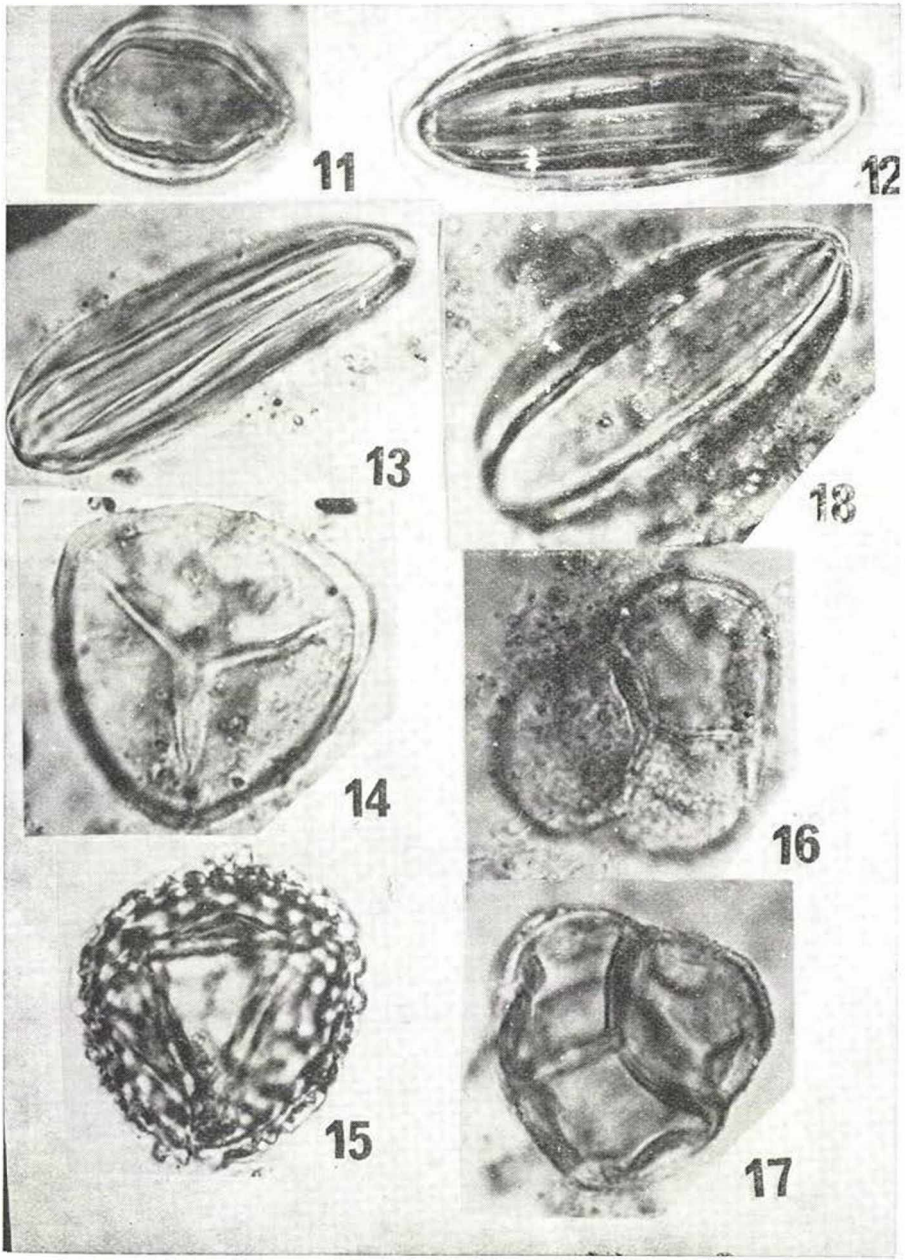

Fig. 6. 11. Vitis sp., 12–13. Ephedra fragilis typ., 14. Sphagnum sp. 15. Botrychium sp., 16. Calluna, 17. Ericacea cf. Ledum, 18. Ephedra dystachya – x 1000
Foto: Járai–Komlódi

The six samples characterized by the above-mentioned pollen spectra and the advance of *Fagus* may belong to the Sub-Boreal following the Atlantic period.

In the following samples, *Fagus* is reduced to 5—10 per cent, the other trees hardly change while *Alnus* increases considerably. The *Sphagnum* swamp seems to diminish, while local aquatic conditions seemed to be advantageous for the development of a ferny alder grove with *Vitis* and aquatic plants.

Fern spores and *Batrachium* occur in considerable quantities.

The withdrawal of beeches in the forests resulted in better light conditions, indicated probably by the spreading of *Corylus*.

This period may be considered as the Sub-Atlantic period when the forests of the Zemplén Mountains resembled the present ones and the interference of human culture did not yet cause any major change.

As shown by the pollen spectrum found in the samples nearest the surface, the composition of the region's forests did not change too much any more. The ratio of wooded surfaces slightly decreased. Sylviculture accompanied by deforestation resulted in the spreading of the heliophilous pioneering birch, as a local phenomenon. The increase of *Picea* pollen indicates the plantation of cultivated forests. The pollen grains of *Juglans* appeared too, and the place of the alder grove and the *Sphagnum* swamp was occupied by a moor with grasses and *Cyperaceae*.

The spreading of agriculture is indicated by the appearance and the increase of the pollen of weeds and domesticated plants *(Secale, Fagopyrum, Chenopodiaceae, Gramineae, Polygonum)*.

Summary

The samples taken from the Kőkapu swamp reach back as far as the end of the Sub-Boreal phase and furnish informations about ecological conditions similar to the present ones, i.e. beechwoods with a few birches, lime-trees, oaks and hornbeams, and an alder grove with ferns, *Vitis* and *Ribes* in the valley. On *Sphagnum* spots covered with a few trees (birch) or eventually in the beechwood intermingled with birches and transgressing on the swamp there is a periglacial relic, *Ledum palustre*. The occurrence of *Artemisia*, *Compositae* and *Chenopodia* indicates the vicinity of loess steppes (cf. samples of Tokártető).

The pollen spectrum of Tokártető includes the period ranging from the Atlantic phase to our days (a history of about 6000 years!) and permits to deduce the history of three ecotops. 1. The deciduous forest started with oak-woods rich in thermophilous species (Atlantic), then the accompanying beeches became dominant (Sub-Boreal) and were somewhat eclipsed later (Sub-Atlantic). By that time, the modest and hypothetical presence of *Pinus* may be taken into account. Some of the actually growing species, such as *Lycopodia* and *Botrychium*, can be found already in the Sub-Boreal, *L. clavatum*, *L. annotinum* and *Botrychium* being continuously present from the Atlantic nearly to our days.

2. The (recent Atlantic) steppe with *Artemisia* and *Ephedra* is presumably a relic of the Boreal phase and existed probably on the rocky surface nearly (Hosszúkő), withdrew (Sub-Boreal) with afforestation *(Ephedra)*, but recovered later (after the Sub-Atlantic).

3. At first, the *Sphagnum* swamp was of small size (Atlantic), increased considerably (Sub-Boreal), then decreased again and was covered with willow and alder (Sub-Atlantic) to disappear by now, with only willowy swamps existing.

The two model areas yielded interesting informations which increased our present scope of knowledge in many respects. From the end of the Sub-Boreal, they actually confirm each other. The exact informations on the composition of the atlantic steppe *(Artemisia, Ephedra, Hippophae* etc.) are the first of this kind on the Hungarian Central Mountains. The evidence on the Sub-Boreal occurrence of the four still existing Lycopodia suggests that they are relics. This applies also to *Botrychium*. The quantity of *Pinus* permits a hypothesis on its sub-atlantic presence, apparently supported by the presence of heliophilous *Lycopodia*. The occurrence of *Ledum palustre* in the Atlantic and Sub-Boreal phases indicates a far cooler and more temperate climate. In addition, the relic character of several vegetation types (steppes = Atlantic, presumably Boreal; *Sphagnum* swamps = Atlantic, willowy and alder swamps = Sub-Atlantic; oaks with lime = Atlantic; andesite rocky forests = Atlantic), and this calls for urgent measures in nature conservation

The diagrams presented include several data that were disregarded in the present paper. However, further borings must be worked up and older layers discovered to obtain a better picture.

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