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Rare ferns of Hungary III.
The establishment of fern species in a planted pine forest

By

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Abstract: Near the river Danube at the foot of the Gerecse Mountains, there is a protected area which contains 13 fern species in the spot of 'Ebgondolta' forest. The results of cenological investigations are presented. The data of the sample plots were processed with the help of computer.

INTRODUCTION

The protected area encompasses the sand slopes and low loess hills at the foot of the Gerecse Mountains, near the village Almásneszmély. These hills face the river Danube and the mouth of the river Zsitva. The studied 'Ebgondolta' forest is part of the protected area and the discovery of the ferns is connected with the work of the late I. SKOFLEK, museologist in the town of Tata. The 'Ebgondolta' forest lies between the abovementioned loess hills and the inundation area of the river Danube. Near to the edge of the forest the brook 'Általér' is to be found, it conducts the water of the 'Öreg-tó' from Tata (Map.). The forest has sandy soil, its height above see level is about 50 m and the loess hills lie at about 150 m. It faces mildly to N and its area is about 5 hectares. In the area 30-40 years old black pine (Pinus nigra) are planted, where 13 fern species have become established in the grass layer.

The reasons of the fern establishment

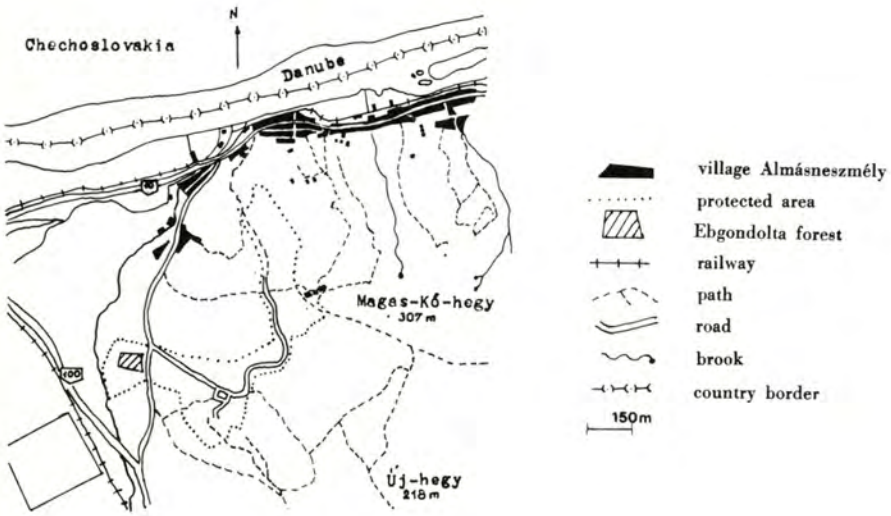
The first most important feature we have to point out is the species richness of the fern company completely unique in Europe. BREMER (1980) published similar occurrence in the Netherlands, where 23 species had become established in a considerably larger area (1100 hectares). That assemblage I consider interesting rather than unique because of the Atlantic climate. I attach great importance, however, to the presence of the ferns in the study area because of the Continental climate.

The reasons of the establishment of the ferns could be e.g. good water supply at the sand-loess border, optimal moisture content, optimal quantity of light and the initiator role of the mosses developing humid microclimate ensure the conditions for the survival of the seedling fern sporophytes.

The circumstances of the establishment

After having grown up, the black pine seedlings formed a closed tree stratum and a grass layer poor in species, containing only those which tolerate small amount of light. It must have been similar to the common grass layer of pine forests. At that time there were no ferns at all.

Map of the protected area



After the pine forest had thinned as a result of damage by Fomes annosus, several mosses became established nearby the light spots. The moss carpet and its moisture content afforded chance for the establishment of the first fern species (e.g. Dryopteris filix-mas). We have to attach great importance to the leaf-litter cover. The pine-leaf litter covering decreases the evaporation unlike deciduous leaf-litter. The growing sporophytes need light, however.

The species composition

Not only the number of fern species but their composition is also remarkable. Thirteen species occur here out of the 43 fern species of Hungary. Asplenium trichomanes in the grass layer is completely unexpected here. The presence of Polystichum species is also unusual. Phyllitis scolopendrium occurs as a result of planting here, but it occurs naturally near the 'Ebgondolta' forest in a brook valley.

The following ferns are found in the protected area

Dryopteris filix-mas (L.) Rich., Dryopteris carthusiana (Vill.) H.P., Dryopteris borreri Newm., Asplenium adiantum-nigrum L., Asplenium trichomanes L., Phyllitis scolopendrium (L.) Newm., Athyrium filix-femina (L.) Roth., Polystichum setiferum (Forsk.) Moore ex Woyn., Polystichum aculeatum (L.) Roth., Cystopteris fragilis (L.) Bernh., Polypodium vulgare L., Polypodium interjectum Shivas and Polystichum lonchitiforme (Halácsy) Becherer, detected VIDA & PINTÉR in 1981.

Changes since the establishment of the ferns

The moss islands formed in the grass layer acted as "cradles" of the sporohytes. When the ferns became established there were only some species in the grass layer and there were several empty patches. The spores may have come from anywhere as the wind could carry them to many hundreds of kilometres. The spores probably originated from the Gerecse Mountains or the Transdanubian Mountains. Later having grown up and increased in numbers, the ferns formed spots and

islands. These include about 10-40 ferns and their area is about 1-3 square metres. Probably the common species became first established and later followed them the rare species. I have observed that the moss carpet retires, at several places disappears under the fern groups. The Polystichum individuals occur almost under the Dryopteris filix-mas groups, in the places rich in moisture content and poorly illuminated. The reason for this could be the deficiency in optimal light intensity. So the formation and development of the moss and fern patches change with time and space. When this state of dynamic equilibrium was reached, the fern composition became the richest in species.

Changes came after damage by Fomes annosus greatly increased. This incurred the drying of the trees and finally the thinning of the forest. As a consequence of this the tree stratum opened up, the grass layer became richer in species than some years previously. Several species of weeds became established and this put an end to the spread of the ferns. In the last two years I observed that weed species tried to invade the grass layer. The weeds compete for the free places now. This condition is instable as it changes every year. Nevertheless it is worth while to try to characterize the role of the fern groups in the grass layer of the forest. The purpose of this study is to search into the causes of the establishment of the ferns.

MATERIAL AND METHOD

The cenological investigations were carried out in July 1982. Fifty 2 by 2 m sample plots were taken. Cover values according to the BRAUN-BLANQUET scale were assigned to the species (Table). On Figure 1 we indicated the distribution of the sample plots in 'Ebgondolta' forest. The sample plots were taken from places where the fern groups were in the thickest part of the forest. The distributions of the floral elements in the species list and the ecological indexes are depicted in Fig. 2. These are: R (soil requirement), T (temperature requirement), F (water requirement) and N (nitrogen requirement). These ecological indexes are plotted against percentile relative contribution of the group to total counts. The data of the sample plots were clustered by a computer programme, using three functions, namely Jaccard's, Czekanowski's and Hummon's (see the dendrogram of Czekanowski's index in Figure 3).

Table 1. Species and their cover values in sample plots

Species	Samples				
	1 - 10	11 - 20	21 - 30	31 - 40	41 - 50
Achillea sp.	+				+ + +
Agrostis alba	3	2	+	+	2 +
Agropyron intermedium	21				+ 2
Agropyron repens	1				+ + 22
Asplenium ad.-nigrum	++	+	+	+1 1	+ +
Asparagus officinalis			+		
Asplenium trichomanes	+ ++1	1++ 1	++ ++		
Astragalus glycyphyllus		+			
Athyrium filix-femina	2				
Atriplex patula	++++ ++	+	+		+
Berberis vulgaris			2+		
Brachypodium pinnatum		++			
Brachypodium silvaticum	2 11	421 1 +2	+21 + 2	+ +	1 + 12+2
Bromus ramosus					+ +
Bromus sterilis		1			
Calamagrostis epigeios					+
Cannabis sativa	+				
Carpinus betulus				+	
Carex hirta			1	5	
Carex pairei					+
Carlina vulgaris					+
Celtis occidentalis		+			
Cerastium brachypetalum	+ +		+++++ + +	++	+

Species	Samples
	1 - 10 | 11 - 20 | 21 - 30 | 31 - 40 | 41 - 50
Chelidonium majus	3 + + + 1+ ++
Cirsium arvense	+ + + +
Cirsium eriophorum	+ + +
Cirsium vulgare	+++
Convolvulus arvensis	1 +
Crataegus monogyna	+
Cucubalus baccifer	12
Cynoglossum officinale	+
Cystopteris fragilis	+ + +++ +
Dactylis glomerata	+ 1 + ++
Dactylis polygama	+ ++ +
Dryopteris carthusiana	+ + +21 2 + 1 2 22
Dryopteris filix-mas	12223242222322232 242523322332322++11 + +2 12332 2
Dryopteris seedlings	+ + ++ + +
Echium vulgare	+ 1
Epilobium sp.	+
Equisetum arvense	+
Erigeron canadensis	++11+ +++ + + + + ++
Erysimum sp.	+ +
Eupatorium cannabinum	21+1 + 2 1 + +2 +1
Euphorbia cyparissias	+ ++ 1 + 1+ +
Festuca sp.	5
Galium aparine	+
Galeopsis speciosa	1 ++ + 1 13 +22121221 +++2+2 ++++ + + + 11
Geranium robertianum	+ +2 1+ + ++
Gleditsia triacanthos	+ +
Hieracium sp.	2
Humulus lupulus	1+ 14 1+2 2+1 +
Hypericum perforatum	+
Juglans regia	+
Ligustrum vulgare	1 2 2 +
Linaria genistifolia	+ + + +
Melilotus albus	++ + +
Moos synusium	1 32+1++3 235321223 55123355554+2+243 +5533345+3
Morus alba	+ +
Muscari comosum	+
Mycelis muralis	+1111+1+ 1++ ++2+++ +++ +++ +++ ++ + +++++++++
Myosoton aquaticum	1
Myosotis arvensis	+
Parietaria erecta	+ + + 12 2233224 +
Phyllitis scolopendrium	1
Pinus nigra A layer	334343353243322353 342234433422342433444222222322
Poa angustifolia	32+ 3 +2 ++ ++ ++ + + + 2
Poa nemoralis	+2 +
Polystichum aculeatum	+ + + + 1+ + + + 1 1
Polystichum hybrids	+
Polygonum convolvulus	+ + +2
Polygonum persicaria	+
Polypodium vulgare	1 + 1+ 1 +
Quercus cerris	+ + + ++ + + + 2 + + +++
Quercus sp. cult.	+
Robinia pseudo-acacia	+ +1 +
Rosa sp.	+ +
Rumex acetosella	+ ++++ + +
Sambucus nigra B layer	+3 +
Sambucus nigra C layer	+1 2 + + +

Species	Samples									
	1 - 10	11 - 20	21 - 30	31 - 40	41 - 50					
Senecio vulgaris					+1+					
Serratula tinctoria					+					
Setaria lutescens	+									
Solanum dulcamara	++1	11++	+++++++	+ 1 +	+	1		++	++	
Solidago virga-aurea					2					
Stellaria media	1++	+	+ +	++	++					
Taraxacum officinale					+ + + ++ +					
Teucrium chamaedrys		++								
Tilia platyphyllos		+								
Urtica dioica	+ 1	+1	1+	11+	+	221 1	++	+ +1	1	
Veronica officinalis			+	22						
Viola arvensis			+		+1	+				
Viola sp.					+					
Vitis vinifera		1								



Fig. 1. Distribution of the 50 sample plots in 'Ebgondolta' forest

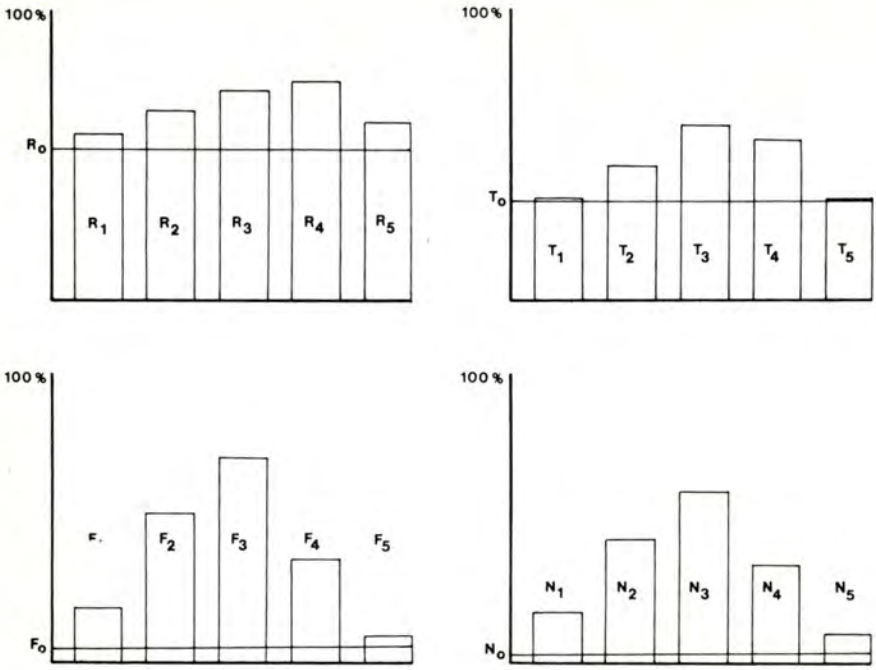


Fig. 2. R, T, F, and N values in percentage of the group pro rata

RESULTS AND DISCUSSION

I found that the floral elements of the species list is distributed as follows: 46 per cent Eurasian, 15 per cent Circumpolar, 11 per cent Cosmopolitan, 19 per cent European, 5 per cent are species of Asia Minor and the rest (4 per cent) are species of N-American, Mediterranean and Amphiatlantic.

Figure 2 we can see that the R value is high, meaning that several species have no special requirements of soil. The main part of the species are indifferent to the type of soil. The T value is lower than R but it is nevertheless rather high. I have not detected any special temperature requirement among the species. The F value is very low, meaning that most of the species have definite water regime. The N value is very low, similarly to the F value.

In Figure 3 we can see the dendrogram of clustering a matrix of CZEKANOWSKI's similarity index. Twelve groups are obtained at 0.425 similarity value. In some instances it is readily seen that sample plots in the vicinity of one another form groups. One sample plot (40) was completely separated. The reason for this is the location of this sample plot, namely the plots near to cutting are drier, receive more light and the moistore content is lower than in the forest.

The other groups were formed probably because of the similar water requirements of the species.

About the future of the forest

The condition of the forest deteriorates from day to day. Increasing number of trees break because of wind and snow-slide. During the spring of 1981 the part of the forest richest in ferns was almost completely burnt. when it was set to fire twice within 3 days. After the litter fire the main part of the grass layer died. A lot of ferns were burnt and the stand thinned out. But the

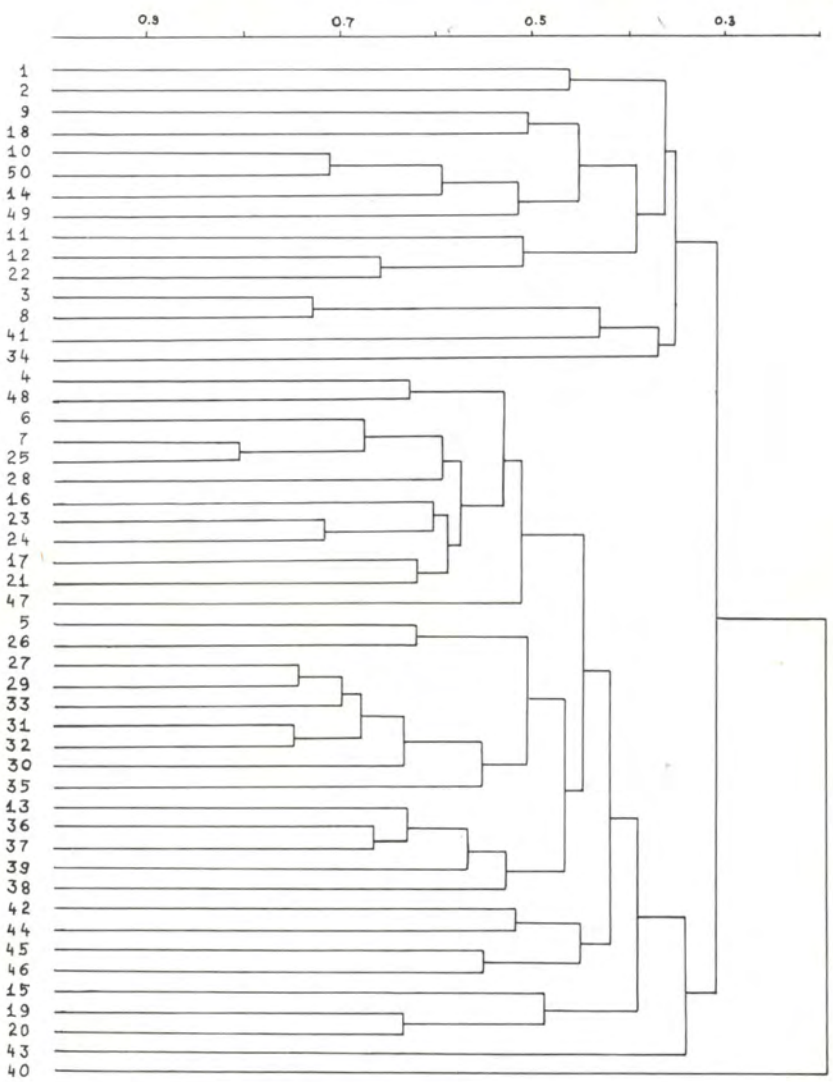


Fig. 3. The dendrogram of Czekanowski index

remaining plants and many weed seedling came up suprisingly quickly. The spring of 1982 supplied with Tilia and Quercus seedlings the gaps of the thinned clearings. At present we cannot judge whether the tree seedlings will grow up while the old Pinus nigra stand dies. Nobody knows what kind of change will be caused in the grass layer because of the changes in the litter. Changes in the pine and deciduous leaf litter involve complete changes in the decomposer microfungal flora. This results in changes in part of the moss flora. It is to be expected that the ferns of the 'Ebgondolta' forest will gradually die because of the changes in the woodland.

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