Vegetation change and the protection of the Csaroda relic mires, Hungary

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Abstract

Study of vegetation change of the protected mires situated near Csaroda and Beregdaróc (the Great Hungarian Plain) are presented. These are the southernmost mires with raised bog communities in the plains of Europe. In the past few decades (by the early 80-s) vegetation showed both qualitative and quantitative signs of degradation. These changes were caused by natural (climatic variation, succession) and by human effects. Natural changes were following: the decline or extinction of hygrophytes, the expansion of hydromesophytes and mesophytes and the acceleration of forest growth. The most important human-caused change was the drainage of the bogs. The harmful processes had slight effect on the *Sphagnum*-dominated associations. The „original” (i.e. before drying out) state of mires has been recovered by blocking drainage canals, plantation of a buffer zone and prohibition of using chemicals.

Key words: bog, vegetation change, climatic variation, drainage, mire protection, Hungary

INTRODUCTION

The Bábtava and Nyírestó mires are situated near Csaroda and Beregdaróc, at the northeastern border of the Great Hungarian Plain, and are surrounded by gallery forests. These topogenic *Sphagnum* bogs were formed as a result of succession in postglacial (boreal) river-beds of the river Tisza. The climate is moderately warm with cold winters (continental character) and moderately dry (mean annual temperature 8-9° C, mean temperature in January below - 3.5° C, annual precipitation 600-700 mm).

They were discovered in 1952 (Simon 1952). The following wet meadow, mire, swamp and wooded communities were described: *Agrostetum albae hungaricum caricetosum vulpinae*, *Alopecuretum pratensis hungaricum*, *Scirpo-Phragmitetum austro-orientale et glycerietosum*, et *urticetosum kioviensis*, *Caricetosum elatae et comaretosum*, *Calamagrostidetum canescentis*, *Caricilasiocarpae-Sphagnetum recurvi*, *Eriophoro vaginato-Sphagnetum recurvi-magellanicum*, *Calamagrosti-Salicetum cinereae*, *Dryopteridi-Alnetum thelypteridetosum* (c.f. Simon 1960).

In the *Sphagnum*-dominated communities relic species with circumpolar and boreal distribution like *Vaccinium oxycoccus*, *Eriophorum vaginatum*, *Drosera rotundifolia*, *Menyanthes trifoliata*, *Salix aurita*, *Sphagnum magellanicum*, *Sphagnum palustre*, *S. recurvum*, *Drepanocladus exannulatus*, etc. occur. Species with similar character also occur in wooded bogs (e.g. *Salix pentandra*) and in swamps, too (e.g. *Comarum palustre*, *Urtica kioviensis*). The occurrence of this vegetation is unique in the Great Hungarian Plain, and these are the southernmost mires with raised bog communities in the plains of Europe. Bábtava and Nyírestő have been protected since they were discovered. Now they both are strictly protected areas within the Szatmár-Bereg Landscape Protection Area. The state of these mires is regularly studied by a team of biologists, and proposals for conservation activities are made when it is necessary.

THE STATE AND CHANGES OF VEGETATION

In the past few decades, more significantly by the early eighties the whole vegetation, especially the swamp communities showed both qualitative and quantitative signs of degradation. Protected and natural species declined. Meadow, forest and weed species inhabited the area. To show this the analysis of the flora on the basis of conservation ranks was performed in 1984 (Simon 1984, 1988). By comparing the results with the same analysis of the data collected in 1960, the indicated degradation was confirmed. In both analyses species were weighted by their A-D values (Fig. 1). The signs of these changes were e.g. the extinction of *Drosera rotundifolia*; the decline of *Vaccinium oxycoccus* and *Menyanthes trifoliata*; the deterioration of some *Eriophorum vaginatum* tufts; the mass appearance of some weeds.

These changes were caused by partly natural (climatic variation, succession) and partly by human effects. According to our results associations as supraindividual structures were more stable than floristic composition. The physiognomy and extension of associations have only slightly changed. Comparing with the state in 1950 considerable change has occurred only in Bábtava, where fire caused damage.

Fig. 1. Conservation rank spectra of the vascular flora of Csaroda mires in 1952 and 1984. U — unique or rare species (endemics, relics); KV — strongly protected species; V — protected species in Hungary; E — natural species predominating in plant communities; K — natural species; TP — natural pioneer elements, TZ — native species that tolerate disturbance; A — adventives; GY — cosmopolitan weeds

NATURAL CHANGES

Characteristic natural changes were the following: the decline or extinction of sensitive hygrophytes such as *Menyanthes trifoliata* and *Urtica kioviensis*; the expansion of hydromesophytes and mesophytes such as *Lycopus europaeus*, *Luthrum salicaria*, *Bidens* spp., *Cirsium arvense*, *Polygonum* spp., especially at the dried banks; the acceleration of forest growth partly caused by climatic changes.

The annual course of precipitation from 1952 to 1985 was studied by using the method of Z ó l y o m i (1958). Considering annual sums there were 4 local minima (Fig. 2), where annual precipitation was below 500 mm. These droughts, especially the ones in 1971 (480 mm) and 1973 (438 mm) could accelerate drying out and degradation. These 4 dry years had different annual courses, namely typical continental, continental-montane-submediterranean, continental-sub-mediterranean, submediterranean-continental, and all had relatively numerous months with little precipitation (Fig. 3). The diagram showing the mean annual course of precipitation of the past 50 years is quite similar to the one showing that of the studied 34 years (Fig. 4), though in the latter early autumn is drier.

This annual course of precipitation with critical minima could help succession i.e. forest formation endangering raised-bog communities. During this process the abundance of *Populus tremula*, *Betula pubescens*, *Salix cinerea*, *S.*

Fig. 2. Annual precipitation at Csarods from 1952 to 1985

Fig. 3. Annual course of precipitation climatic character of dry years. 1956 — continen-
tal-montane-submediterranean; 1961 — continental-submediterranean; 1971 — submediterranean-continental; 1973 — continental

Fig. 4. Average annual course of precipitation at Csaroda (1901-1950 annual mean 618 mm (left), 1952-1985 annual mean 625 mm (right))

Fig. 5. Sketch of Nyirestó. 1 — *Sphagnum* peat; 2 — water chamber; 3 — impermeable gleyic clay; 4 — sandy bedding; 5 — reed and sedge peat. In 1983 (above) the bog settled, it was drying. In 1987 (below) as a result of water replenishing the bog was raised, the peat layer became thicker. I — visitors bridge; II — willow bog; III — *Betula pubescens*; IV — raised bog communities; V — *Populus tremula*; VI — alder bog; VII — marsh communities

aurita, *Alnus glutinosa* and *Frangula alnus* has increased. In the meantime silting up and ageing of alder- and willow bogs have been taking place. The increase of *Juncus effusus* may be the result of treading.

HUMAN EFFECTS

The most important human-caused change was the partial drainage of the bogs. This together with climatic effects discussed above caused the disappearance of water from beneath the floating part of the bogs, the settling of the raised bog islands (Fig. 5), the drying of the lagsgs. Parts of the alder- and willow bogs and reed marshes at Bábtava were burnt in the early 1960-ties. A slow regeneration of alder bog has been going on, whereas most of the damaged area of willow bog and reed marsh is still open water surface (Fig. 6). The pollution caused by fertilizers came from maize fields reaching the banks of the bog. The combined effect of these 3 processes caused the degradation of the marsh communities at Bábtava. The effects of fertilizers are not significant at Nyírestő because it is surrounded by natural forest belt.

Fig. 6. Plant communities of Bábtava after the fire in the early 1960-ties with the open water surface. 1 — *Eriophoro vaginatae-Sphagnetum*; 2 — *Carici lasiocarpae-Sphagnetum*; 3 — *Dryopteridi-Alnetum thelypteridetosum*; 4 — *Calamagrosti-Salicetum cinereae*; 5 — *Caricetum elatae*; 6 — *Scirpo Phragmitetum urticetosum kioviensis*; 7 — *Scirpo-Phragmitetum glycerietosum maximae*; 8 — *Agrostetum albae caricetosum vulpinae*; 9 — *Alopecuretum pratensis*; 10 — burnt area, nowadays open water surface

CHANGES OF THE TWO *SPHAGNUM* BOG COMMUNITIES

The harmful processes discussed above had relatively slight effect on the most valuable *Sphagnum*-dominated relic associations (*Eriophoro vaginatae-Sphagnetum*, *Carici lasiocarpae-Sphagnetum*). The changes of these associations are illustrated by using the means of 5-5 samples and are shown in Tables 1 and 2. Their stands have mainly changed in their own species structure, but they have resisted invasions of alien species, probably owing to the dominant bog species that are strong competitors. The resemblance of the relevés from 1952 and 1989 were studied by using different similarity indices (Jaccard 1901, Kulczyński 1928, Soerensen 1948). In his methodologically pioneering work Kulczyński (1928) worked out a new similarity index for the quantitative comparison of communities. His index was used by weighing the species by the average per cent cover values corresponding to their A-D values. So the calculated resemblance reflects both textural and structural differences. The measure of change for *Eriophoro vaginatae-Sphagnetum* and *Carici lasiocarpae-Sphagnetum* is 18% and 32%, respectively. The higher value may be attributed to the peripheral position of the stands. The direct contact with willow- and alder bogs and reed marsh helps immigration and succession. The stability of *Eriophoro vaginatae-Sphagnetum* is due to the strong *Eriophorum* tufts. In the past 30 years they increased by 12% on the average, although at peripheral parts after the critical droughts in the early 1970-ties they were destroyed (Table 3).

Considering the changes of the conservation rank spectra more expressed changes took place in *Eriophoro vaginatae-Sphagnetum* on the basis of both Soerensen and Jaccard indices (Table 4). The results suggest that *Eriophoro vaginatae-Sphagnetum* stands have slightly degraded, since the proportion of protected and other natural species decreased, whereas that of disturbance-tolerators increased.

RESCUE OF BÁBTAVA AND NYÍRESTÓ

These disadvantageous environmental and structural changes of the mires were reported to the National Board of Environmental Protection and Nature Conservation in 1984. The following urgent measures were proposed: 1) regular replenishment of missing water for saving the bogs; blocking drainage canals; 2) plantation of a buffer zone of natural forest belt around Bábtava; 3) prohibition of using chemicals (fertilizers, herbicides, insecticides) within a circle of at least 1 km radius around the bogs.

According to our previous proposals *Populus tremula* was intensively, whereas *Betula pubescens*, *Salix cinerea*, *S. aurita* and *Alnus glutinosa* were moderately controlled in the *Sphagnum* dominated communities of the mire. The surrounding marshes and wet meadows were moved (Fig. 7).

Fig. 7. *Eriophoro vaginato-Sphagnetum* of Nyírestő

Table 1
Eriophoro vaginato-Sphagnetum recurvi-magellanicum (Nyirestó,
 Bábatava, 1960–1989)

	1960	1989
E <i>Alnus glutinosa</i>	–	1
V <i>Aulacomnium palustre</i>	+	+–1
KV <i>Betula pubescens</i>	2	2
TZ <i>Bidens cernuus</i>	+	+–1
TZ <i>B. tripartitus</i>	–	1
E <i>Carex elata</i>	–	+–1
V <i>C. lasiocarpa</i>	+–1	1
V <i>Calamagrostis canescens</i>	+	+
KV <i>Drosera rotundifolia</i>	+	–
A <i>Erechtites hieracifolia</i>	–	+–1
K <i>Eriophorum latifolium</i>	+–1	+–1
KV <i>E. vaginatum</i>	4–5	5
K <i>Frangula alnus</i>	+	+–1
TZ <i>Hieracium umbellatum</i>	–	1
TZ <i>Juncus effusus</i>	–	2–3
K <i>Lycopus europaeus</i>	+	+–1
K <i>Lythrum salicaria</i>	–	+–1
K <i>Peucedanum palustre</i>	+–1	+–1
E <i>Phrygmites communis</i>	–	1
V <i>Polytrichum commune</i>	+	–
V <i>P. strictum</i>	+	+
TZ <i>Populus tremula</i>	1–2	2
KV <i>Salix aurita</i>	+	+–1
E <i>S. cinerea</i>	+	+–1
V <i>Sphagnum magellanicum</i>	1	+–1
V <i>Sph. palustre</i>	+–1	+–1
V <i>Sph. recurvum</i>	4	4
E <i>Typha latifolia</i>	–	+–1
U <i>Vaccinium oxycoccus</i>	1	+–1

Table 2
Carici lasiocarpae-Sphagnetum (Nyirestó, Bábatava, 1960–1989)

	1960	1989
1	2	3
E <i>Alnus glutinosa</i>	–	1
K <i>Amblystegium riparium</i>	+–1	+–1
V <i>Aulacomnium palustre</i>	+–1	+
KV <i>Betula pubescens</i>	1–2	2–3
TZ <i>Bidens tripartitus</i>	+	1
V <i>Calamagrostis canescens</i>	1–2	2
E <i>Carex elata</i>	+	+–1
V <i>Carex lasiocarpa</i>	2–3	3
K <i>Chrysanthemum serotinum</i>	–	+–1
KV <i>Comarum palustre</i>	+	–
V <i>Drepanocladus exannulatus</i>	+	–
KV <i>Drosera rotundifolia</i>	+	–

1		2	3
K	<i>Eriophorum angustifolium</i>	+	+
K	<i>E. latifolium</i>	+	+
KV	<i>E. vaginatum</i>	1	1-2
K	<i>Frangula alnus</i>	1-2	1-2
TZ!	<i>Juncus effusus</i>	+ -1	2-3
K	<i>Lycopus europaeus</i>	+	+ -1
K	<i>Lysimachia vulgaris</i>	+ -1	1
K	<i>Lythrum salicaria</i>	+	+ -1
KV	<i>Menyanthes trifoliata</i>	1-2	+
K	<i>Peucedanum palustre</i>	+ -1	+ -1
E	<i>Phrygmites communis</i>	+	1
K	<i>Poa palustris</i>	1	1
V	<i>Polytricum commune</i>	+ -1	-
V	<i>P. strictum</i>	+	+ -1
TZ	<i>Populus tremula</i>	1-2	2
KV	<i>Salix aurita</i>	+	1
E	<i>S. cinerea</i>	+	1
V	<i>S. pentandra</i>	1-2	1-2
TZ	<i>Solanum dulcamara</i>	+	+ -1
K	<i>Sparganium erectum</i>	+	+ -1
V	<i>Sphagnum magellanicum</i>	+	+
V	<i>Sph. palustre</i>	2-3	+ -1
V	<i>Sph. recurvum</i>	4	4-5
V	<i>Thelypteris palustris</i>	-	1
U	<i>Vaccinium oxycoccus</i>	1	+ -1

Table 3
Comparison of three similarity indices (Kulczyński, Soerensen and Jaccard) for two associations

Community	Kulczyński %		Soerensen %		Jaccard %	
	S	D	S	D	S	D
<i>Eriophoro vaginato- -Shagnetum</i>	82	18	76	24	62	38
<i>Carici lasiocarpae- -Sphagnetum</i>	68	32	89	11	81	19

S — similarity, D — dissimilarity.

Table 4
Changes of conservation rank spectra in two communities from 1952 to 1989 expressed by means of Soerensen and Jaccard indices.
(Explanations for the abbreviations see Fig. 1)

	<i>Eriophoro v.- -Sphagnetum</i> , %		<i>Carici l.- Sphagnetum</i> , %	
	1952	1989	1952	1989
U	5.0	3.7	3.0	3.0
KV	20.0	11.1	17.6	12.1
V	40.0	29.7	29.4	27.4
E	5.0	18.5	8.8	12.1
K	20.0	18.5	29.4	33.3
TZ	10.0	18.5	11.8	12.1

In 1985 plans were made to realize the proposals, and in 1986 they were accomplished. A water replenishing system was built, which carries water of good quality from an artesian well with high output from 3 km in pipe. Drainage canals were blocked and the filling up of the bogs has started. According to our calculations the annual precipitation reaching the bogs has been risen upto 1000-2000 mm with the help of water replenishing in the past few years. *Quercus robur* forest has been planted around Bábtava. The use of chemicals was forbidden in the surroundings of the bogs.

In 1987 the inner raised bog islands started to float again, laggs became filled with water. Vitality of relic plant populations got better. In 1989 mire communities and relic species are in good condition. The "original" (i.e. before drying out) state has recovered. The importance of weeds has declined, because high water level increased the competitive ability of mire and marsh species. *Eriophorum vaginatum* and *Vaccinium oxycoccus* bloomed again and a few *Drosera rotundifolia* individuals appeared.

We hope, that in the future the only task will be to control coenological succession. Many thanks to Zoltán Rakoczay and István Keszthelyi for quick and effective conservational measures.

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Zmiany szaty roślinnej i ochrona reliktowych torfowisk w pobliżu Csaroda, Węgry

Streszczenie

Badano zmiany roślinności na chronionych torfowiskach w pobliżu Csaroda i Beregdaróc (Węgry). Torfowiska te są najdalej na południe wysuniętymi na Niżu Europejskim obiektami z roślinnością ombrotroficzną. W ciągu ostatnich 30 lat stwierdzono ilościowe i jakościowe zmiany

roślinności świadczące o degradacji torfowisk. Zmiany te spowodowane były czynnikami naturalnymi (fluktuacje klimatyczne, sukcesja) i antropogenicznymi. Zanotowano następujące zmiany naturalne: zanikanie hygrofitytów, ekspansję hygromezofitytów, mezofitytów i lasu. Wśród wielu zmian antropogenicznych największe znaczenie ma osuszanie torfowisk. Najniższy stopień degradacji roślinności stwierdzono w zbiorowiskach z dominacją mchów z rodzaju *Sphagnum*. Udało się odtworzyć pierwotny (tzn. sprzed osuszenia) stan torfowisk poprzez zablokowanie kanałów odwadniających, stworzenie strefy roślinności otulinowej i wstrzymanie stosowania środków chemicznych.