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Changes in the vegetation of "Wrzosiec" mire in 1991-2009 (Western Pomerania)

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Abstract: Changes in the vegetation of a mire developing in forest lake hinterland in 1991-2009 are analysed and documented three times by phytosociological method. Within peat bog "islands", situated in the southern part of the lake, the most visible change is the development of a sparse pine-stand and thick shrubs of *Salix* species, *Frangula alnus* as well as increase in the participation of *Molinia caerulea* and some species of *Scheuzerio-Caricetea* class (*Calamagrostis neglecta*, *Carex lasiocarpa* and *Sphagnum fallax*). Vegetation of the lag zone shows fluctuating changes in the composition of plant communities depending on the water level that periodically changes. In the north-eastern part of the lake, a consistent slow process of terrestrialization was recognised.

Key words: peatlands, vegetation of mires, vegetation changes, dynamics of vegetation, terrestralization, Western Pomerania

1. Introduction

In recent decades, there has been a marked interest in the use of phytosociological data and analysis for forecasting and monitoring of the effect of environmental changes on vegetation as well as identification of such changes (e.g. Dyguś 1997; Piórkowski 2002; Sugier 2005; Kozłowska 2005; Kurowski 2007). It is considered that phytocoenoses diagnose the environment better than single species (Falińska 1996). Therefore, regular and frequently repeated in the same vegetation patches phytosociological examinations become an important tool of biological measurement of the environment (e.g. Solon 1993); they provide a particularly important tool in relation to ecologically specialised natural habitats under protection developing under specific ecological conditions. These include, among others, peat-lands (peat-bogs).

The aim of the presented paper is the analyse changes in the vegetation of a peat-land object developing in a forest lake hinterland in 1991-2009, documented three times by phytosociological method.

2. Material and methods

In July 2009, based on distribution maps of plant communities in the "Wrzosiec" mire made in 1990 (Fudali 1991) and 1993 (Fudali & Popiela 1994), a site inspection visit was carried out preparing phytosociological relevés of all communities currently occurring there with the Braun-Blaunquet method. In relation to the phytocenoses recorded in 1990 and 1993, relevés were made in the same places as before (Fig. 1).

Classification of plant communities was adopted after Matuszkiewicz (2001). In the case of syntaxa not distinguished by this author, their names are given in the original wording after the authors of papers used for comparison.

Names of the species of vascular plants are given after Mirek *et al*. (2002), whereas those of mosses – after Ochyra *et al*. (2003).

ECOLOGY

3. General characteristics of the object

The object examined is a midforest mire (raised peat bog) situated in the Goleniów Forest woodlands (Nowogard Forest Division, Czernica Forest District) to the north of the locality Krzywice, near National Road No. 6 (geographic centre of the object with the following coordinates x: 14.962 and y: 53.616). It is composed of two parts (Fig. 1). The larger part is situated on the southern side of the lake, separated from it by a dyke with the area of about 8.5 ha. The analysis of maps and field observations clearly show substantial and repeating fluctuations in the water level of the lake in the past, from a full to a partial filling of the lake basin. In 1990, a high level of water in the lake was observed (Fudali 1991), like in July 2009, whereas in 1993 (Fudali & Popiela 1994), the surface of water table was considerably smaller. In the western part in the past, there was a dug up drainage ditch (Fudali 1991), not maintained at the present time, going away from the lake.

The raised peat-bog developed in the form of two islands concentrating the plants typical for raised bogs together with two Atlantic species, i.e. *Erica tetralix* and *Sphagnum papillosum*, which are surrounded by a broad lagg zone built almost entirely by reed communities. The vegetation of mire was described for the first time by Jasnowski (1962) who diagnosed two peatbogs communities: *Ericetum tetralicis* Tx 1937 and cfr. *Sphagnetum papillosi* Schwick. 1940. The same author also observed two plant communities making up the lagg zone: *Caricetum elatae* (=*hudsoni*) Koch 1926 and cfr. *Ranunculo-Juncetum bulbosi* Oberd. 1957. The picture of mire vegetation cover was completed in 1991 by Fudali (1991) who described 4 plant communities not observed earlier by Jasnowski (1962), i.e. a plant community of the swamp character with *Sphagnum denticulatum* (= *S. auriculatum*) developing in the contact zone of peat bog „islands" and *Caricetum elatae* as well as three lagg zone communities of the class *Phragmitetea* showing symptoms of degeneration: cfr. *Sparganietum erecti* Roll. 1938. cfr. *Oenantho-Rorippetum* Lohm. 1950 and a plant community with *Glyceria fluitans*. The vegetation cover of the lagg zone appears to be weakly stable as in 1993 Fudali and Popiela (1994) observed prevalence of a plant community with *Calamagrostis neglecta* and *Hydrocotyle vulgaris*. The same authors observed a thick up-growth of *Frangula alnus*, *Betula pubescens*, *Salix aurita* and *S. cinerea* at the edges of peatmoss "islands".

At the north-eastern end of the lake, a minerotrophic bog with *Sphagnum fallax* and *Eriophorum angustifolium* and patches of a community with *Sphagnum cuspidatum* (Fudali 1991) developed, undergoing a gradual overgrowing by alder buckthorn *Frangula*

Succesive No. of relevé		
No.of relevé in a field		
Area of sample plot [m^2]		
Cover of vegetation [%]	A	
	B	
	C	
	D	
Ch. *Scheuchzerio-Caricetea nigrae*		
Hydrocotyle vulgaris		
Calamagrostis stricta		
Carex lasiocarpa		
Straminergon stramineum		
Eriophorum angustifolium		
Carex limosa		
Carex canescens		
Drosera anglica		
Rhynchospora alba		
Comarum palustre		
Carex nigra		
Menyanthes trifoliata		
Juncus articulatus		
Ch. D. *Oxycocco-Sphagnetea*		
Aulacomnium palustre		
Drosera rotunditifolia		
Andromeda polifolia		
Oxycoccus palustris		
Sphagnum rubellum		
Sphagnum papillosum		
Erica teralix		
Sphagnum magellanicum		
Sphagnum fallax		
Ch. *Magnocaricion*, *Phragmitetea*		
Glyceria fluitans		
Iris pseudoacorus		
Phragmites australis		
Carex elata		
Peucedanum palustre		
Scutellaria galericulata		
Phalaris arundinacea		
Carex rostrata		
Galium palustre		
Other species		
Lysimachia vulgaris		
Sphagnum squarrosum		
Sphagnum palustre		
Hydrocotyle vulgaris		
Molinia caerulea		
Pinus sylvestris a		
Pinus sylvestris c		
Frangula alnus		
Frangula alnus b		
Betula pubescens c		
Salix aurita c		
Lycopus europaeus		
Lemna minor		
Sphagnum denticulatum		
Lythrum salicaria		
Quercus robur c		
Juncus effusus		
Agrostis canina		

Table 1. Plant communities recognised in 2009 within the "Wrzosiec" mire (distribution of relevés in the field – see Fig. 1)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
2	3	5	12	1	4	6	16	7	8	11	13	15	18	14	10	9	17	22	21	20	19
20	10	30	18	20	25	25	10	25	20	20	14	8	16	10	4	24	9	9	4	4	4
-	-	-	-	-	-	-	20	-	-	-	-	20	20	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	20	-	-	30	30	20	30	-	-	-	-	-	-	-	-
30	60	70	60	40	70	90	40	60	60	80	80	40	50	60	80	60	40	80	30	60	40
-	-	-	-	-	-	60	40	100	100	100	40	80	80	60	100	100	100	100	90	100	100
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.	.	.	+	.	.	3	2	3	3	.	3	.	1	.	+	2	.	.	.	.	.
.	.	.	.	.	.	.	.	3	2	3	3	3	+	2	.	2	.	.	.	.	.
.	.	.	.	.	.	1	.	1	2	.	1	+	1	.	.	+	+	.	.	.	.
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.	.	.	.	.	.	.	+	.	2	2	+	+	+	+	1	1	+	.	+	1	.
.	.	.	.	.	.	.	1	1	1	1	1	1	+	.	1	1	.	.	.	.	.
.	.	.	.	.	.	+	2	2	4	3	2	2	3	1	3	3	1	+	+	+	2
.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.
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.	.	.	.	.	.	1	3	3	2	2	+	3	3	3	3	3	4	5	4	5	5
5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Sporadic species: *Calliergon cordifolium* 1 (+), *Riccia fluitans* 2 (+), *Polygonum amphibium* 2 (+), *Calliergonella cuspidata* 6 (1), *Warnstorfia exannulata* 7 (1), *Salix caprea* c 9 (r), *Salix cinerea* 10 (1), *Dicranum bonjeanii* 15 (+), *Polytrichum commune* 21 (1)

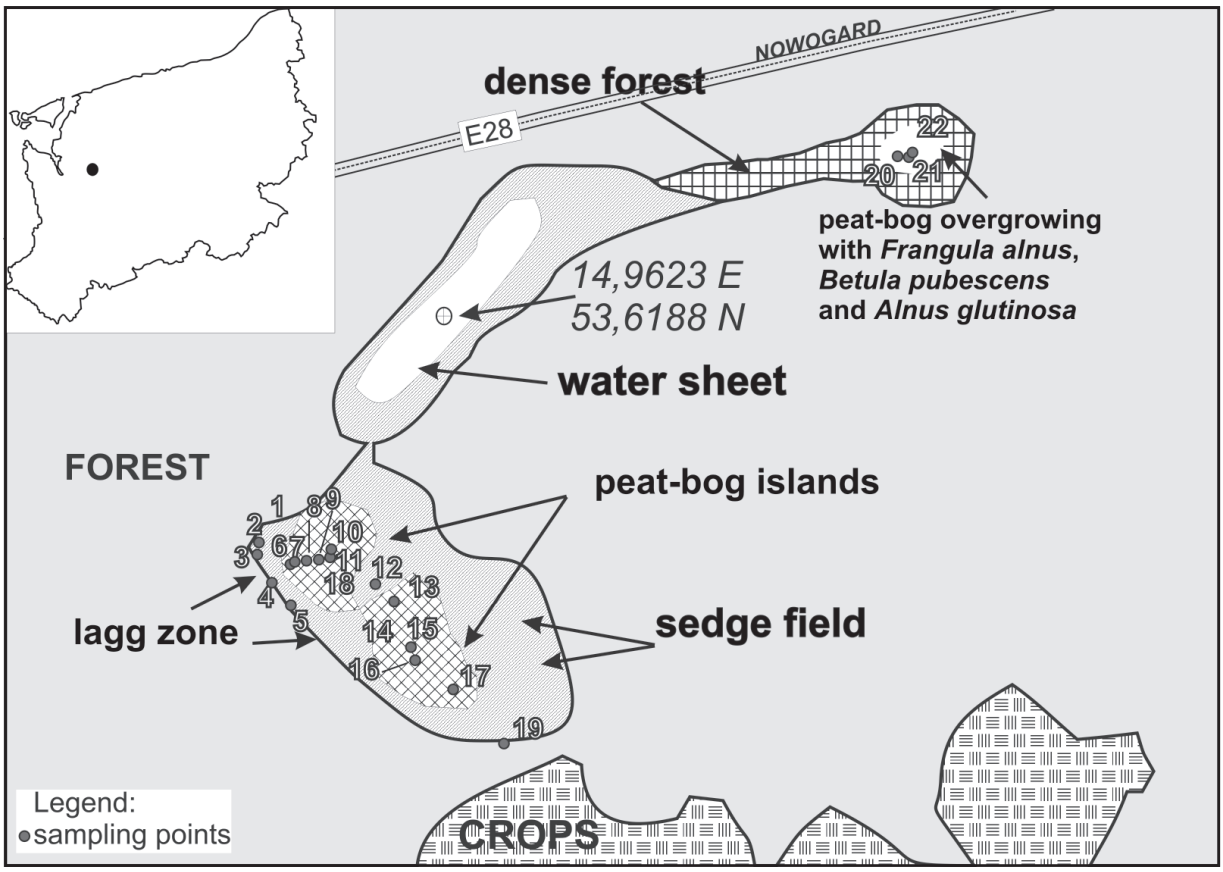

Fig. 1. Localization of the object studied and situation of relevés in the field

alnus, downy birch *Betula pubescens* and common alder *Alnus glutinosa* (Fudali & Popiela 1994).

4. Results and discussion

4.1. Vegetation cover of the southern part in 2009 and its changes in relation to the situation in 1990 and 1993

In 2009, almost the whole surface of the lagg zone was taken up by pure reed bed *Phragmitetum australis* (Table 1 relevé 3), locally interspersed with low clusters of *Caricetum elatae* (Table 1, relevés 4-7) or shrubs of alder buckthorn, willows (*Salix aurita, S. cinerea*) and common alder. Only from the western side, small patches of other rush communities occurred: cfr. *Sparganio-Glycerieteum fluitantis* (Table 1 relevé 1) and *Iridetum acori* (Table 1 relevé 2) creating a mosaic with reed bed, sedge bed *Caricetum elatae* and dense willow shrubs of *Salix cinerea*, *S. caprea* and *S. aurita*.

The latter form a thick, 2-3 m wide belt surrounding the peat-bog "islands" and enter into them reaching the density of 20-40%. The peat-bog "islands" themselves are heavily covered with shrubs – apart from *Salix aurita*, there is also *Pinus sylvestris* (medium density – 25%) and *Frangula alnus* (15-30%) to be found. Their vegetation cover is strongly homogenous, dominated in the herb layer by character species of the *Scheuchzerio-Caricetea nigrae* class, such as *Calamagrostis stricta* and *Carex lasiocarpa* with the permanent participation of *Hydrocotyle vulgaris*, *Molinia caerulea* and typical for raised peat bogs dwarf shrubs *Oxycoccus palustris*, *Andromeda polifolia* and *Erica tetralix*, whereas in the moss layer – by *Sphagnum fallax* with large participation of *S. palustre* and locally with peat mosses characteristic for the *Oxycocco-Sphagnetea* class as *Sphagnum papillosum, S. magellanicum* and *S. rubellum* (Table 1, relevés 9-15). The surface of the moss layer is fairly even, with hummock-hollow structure preserved only locally. Hummocks consist of *Sphagnum papillosum*, *S.magellanicum* or *S. palustre*. In the contact zone between peatbog "islands" and the lagg zone, a sedge community with *Carex limosa*, *Eriophorum angustifolium*, *Menyanthes trifoliata* and *Sphagnum denticulatum* developed, also undergoing a strong overgrowing with shrubs (Table 1, relevés 16-18). In relation to the picture of phytocenotic diversity and distribution of communities in 1990 (Fudali 1991), a tendency for the increase of participation of willow and alder buckthorn shrubs as well as common alder is marked both in the lagg zone and within peatbog "islands" and this process was in progress since 1990. According to Tobolski (2003), the increase of willow and alder shrubs within raised and transitional bogs can be interpreted as the effect of groundwater lowering and drainage. In

the opinion of this author, a sustained drainage of peat-bog leads to mass development of grass *Molinia caerulea* and, therefore, this species can be considered an indicator of the over-drying of hydrogenic habitats.

In comparison to 1993 (Fudali & Popiela 1994), participation of *Molinia caerulea* increased visibly (recorded in almost all the relevés done within peatbog's "island" in 2009 – Table 1, relevés 7-11, 13-15). So, on the basis of Tobolski's (2003) hypotheses, observations made in 2009 seem to indicate the process of the peat-bog over-drying. However, at the same time, participation of some species characteristic for the *Scheuchzerio-Cariceta* class (such as *Calamagrostis stricta* and *Carex lasiocarpa*) increased within patches of peat-bog vegetation dominated with species characteristic for the *Oxycocco-Sphagnetea* class (Table 1 relevés 10, 11, 13, 14).

The vegetation of the lagg zone shows more complex dynamics and action of the processes of the fluctuating character. With clear reduction of the surface of water table in 1993 (Fudali & Popiela 1994), the vegetation of the lagg zone responded with loss of low rush communities recorded in 1990 (Fudali 1991) and invasion of *Phalaris arundinacea* and *Calamagrostis stricta*, considered by Kozłowska (2005) to be indicators of peatlands drying. In 2009, the lake basin was fully filled with water and the presence of low rush communities was observed again but in a different arrangement than in 1990 – almost the whole lagg zone became dominated by a reed bed (*Phragmitetum australis*). At the same time, in 2009, presence of rush community *Sparganio-Glycerietum* recorded in 1990 and indentified as community with *Glyceria fluitans* (Fudali 1991) but not found in 1993 was observed again and yellow flag iris bed *Iridetum pseudacori* not reported earlier appeared. From the eastern and south-eastern sides, the belt of alder buckthorn, eared willow and common alder shrubs enlarged.

Also Sugier (2005) demonstrated large variation of the species composition of communities forming the lagg zones of transitional bogs of the Łęczna-Włodawa Lakeland in response to changes of water conditions within 4 years. This author observed that the rise of groundwater level determined an increase in the participation of species of the class *Phragmitetea*.

4.2. Vegetation cover of the north-eastern part in 2009 and its changes in relation to the situation in 1990 and 1993

In the north-eastern part, a prevalence of alder buckthorn, downy birch and common alder shrubs was observed in 2009. Their ground cover was mainly made up of peat mosses (*Sphagnum fallax* and *Sphagnum squarrosum*) and *Polytrichum commune*. In place of regenerating peat excavation pits where flooded hollows filled with *Sphagnum cuspidatum* were still recorded in 1990, patches of the community *Eriophorum angustifolium-Sphagnum fallax* (Table 1, relevés 19-21) developed, also one small patch of *Rhynchosporetum albae* was found (Table 1, relevé 22). These changes point to continuously progressing drainage of the end section of the lake and its terrestrialisation. The reason of the processes could be land melioration carried out in the past, the traces of which were still noticeable in 1990 (Fudali 1991).

5. Summary and conclusions

Within peat-bog "islands" developed in the southern part, two different directions of vegetation changes were recognised: 1) development of sparse pine-stand inside and a thick strip of hygrophilous shrubs at their edges as well as an increase in the participation of *Molinia caerulea* which can be interpreted following Tobolski (2003) as a response typical for peat lands drainage and 2) increase in the participation of some species characteristic or differential for the *Scheuchzerio-Caricetea nigrae* class (*Calamagrostis stricta, Carex lasiocarpa, Sphagnum fallax*) within vegetation belonging to the Oxycocco-Sphagnetea class suggesting changes in the ways of water supply to the object. But it requires separate hydrological studies.

In the lagg zone of this part, vegetation shows visible dynamics as manifested in the loss of certain communities, reappearance of patches of some low rush communities and changes in the size of area taken up by reed beds (*Phragmitetum australis*) and high-sedge beds (*Caricetum elatae*). Intensity of these changes and duration of communities clearly depend on the water level in the lagg zone which shows fluctuating variation, from the flooded aspect to drying. At the same time, a continuous process of the overgrowing of the lagg zone with shrubs is observed from the eastern and south-eastern side, indicating its drainage. It shows that hydrological condition of the object requires separate studies.

In the north-eastern part of the lake changes are clearly directional and have a character of a continuous slow terrestrialisation of water bodies.

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