Teka Kom. Ochr. Kszt. Środ. Przyr. – OL PAN, 2010, 7, 5–15

CHANGES IN THE STRUCTURE AND SPECIES COMPOSITION OF VASCULAR PLANTS OF *Rhynchosporetum albae* PHYTOCOENOSES ON THE SITE OF ECOLOGICAL INTEREST „BOGS IN ANTONIÓW" (SILESIAN UPLAND) AFTER 30 YEARS[1]

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Summary. The paper presents changes which took place after a period of 30 years in the vascular flora and in the structure of phytocoenoses of *Rhynchosporetum albae* in the area of a mire located in Dąbrowa Górnicza (Silesian Upland, south Poland) due to human impact. Floristic comparison and analysis of phytosociological records showed small changes in the flora and in the structure of the plant community due to processes of succession towards alder carr *Fraxino-Alnetum*. It is manifested by an increase of cover and constancy of seedlings and saplings of trees, increase of competitive species share (strategy C), participation of species of higher trophy requirements and preferring soils with higher pH.

Key words: mire, *Rhynchosporetum albae*, plant functional groups, vegetation changes

INTRODUCTION

The plant communities of hydrogenetic mires and moist meadows of the *Molinietalia* order are very rare components of vegetation cover of the Silesian Upland at present. In comparison with results obtained many years ago [Kuc 1959], a decrease of area occupied by meadow and mire vegetation is observed. It is probably connected with the decrease level of underground waters due to exploitation of coal and surface exploitation of sands for mining and building industry. Other causes are land reclamation and urbanisation.

[1] This study was supported by the Polish Ministry of Science, Grant No. N N305 384938.

Desiccation of the ground accelerates natural processes of succession towards scrub communities, which leads to impoverishment of flora. In the recent decade there was a regression in industry, which improved the environmental state in the area. However, it is commonly known that wetlands play a key role in the maintenance of biodiversity, being habitats for numerous rare, protected and endangered species of plants and animals [Pawlaczyk 2009]. Thereupon, the goal of this study was to examine changes which took place after 30 years in the floristic composition as well as in the structure of *Rhynchosporetum albae* phytocoenoses developing in a mire situated in Dąbrowa Górnicza – in an area under direct human impact.

MATERIALS AND METHODS

Study area

The mire is situated in the Kotlina Dąbrowska in north-eastern part of Upper Silesian Industrial District (Silesian Upland, south Poland). This is a transitional mire and lies in the valley of Trzebyczka river in the territory of Dąbrowa Górnicza (N 50°22'22'', E 19°14'27''). It occupies ca 3 ha. From the south-east it neighbours with a pine forest on a high scarp. From the south-west river Trzebyczka and fragments of alder-ash carr pose the border of the mire. This mire has been treated as an area especially precious from the environmental point of view due to the presence of many rare and protected vascular plant species and relic mosses [Kuc 1959, Jędrzejko and Żarnowiec 1980, Olesiński and Sendek 1980, Jędrzejko 1983, Sendek 1984, Jędrzejko *et al.* 1991, Jędrzejko and Walusiak 2003]. In the area of the mire there are well-develop patches of *Rhynchosporetum albae*, *Eriophoro angustifolii-Sphagnetum recurvi* and patches of *Menyanthes trifoliata-Comarum palustre*. Long drawn out efforts [e.g. Kuc 1959, Olesiński and Sendek 1980, Jędrzejko *et al.* 1991, Jędrzejko and Walusiak 2003] resulted in the foundation of an ecological site of interest under the name „Bogs in Antoniów" („Bagna w Antoniowie"). There is also projected NATURA 2000 site „Fen Orchids in Dąbrowa Górnicza" („Lipienniki w Dąbrowie Górniczej"), where apart from the mentioned mire there is the worked out sand-pit „Kuźnica Warężyńska" [www.natura2000.mos.gov.-pl/natura2000/pl/ dkumenty/n5/SDF/lipienniki_-w_dabrowie_gorniczej.pdf].

Field methods and data analysis

Detailed floristic and phytosociological studies in phytocoenoses *Rhynchosporetum albae* were carried out in the area of ecological site of interest „Bagna w Antoniowie" in the years 2008 – 2009. Phytosociological relevés were performed by the classic method of Braun-Blanquet [1964]. This plant community was studied also earlier, i.e. in the years 1977–1979 [Olesiński and Sendek 1980, Jędrzejko *et al.* 1991]. Based on own data and literature data from 70s of

the 20th century [Olesiński and Sendek 1980, Jędrzejko *et al.* 1991] floristic lists for further comparisons were made. The nomenclature of vascular plants was accepted according to Mirek *et al*. [2002]. Analysis of flora was conducted on the basis of the concept of functional groups. The functional group is a group of non-related species [Lavorel *et al.* 1997, Duckworth *et al.* 2000, Diaz and Cabido 2001] with similar role [Lavorel *et al.* 1997, Kahmen and Poschold 2004] and type of influence on processes of ecosystem [Diaz and Cabido 2001, Richardson-Kageler 2004], such as productivity or circulation of elements [Diaz and Cabido 2001], and similar plant traits [Lavorel *et al.* 1997, Kahmen and Poschold 2004], being a response to diversified environmental conditions [Lavorel *et al.* 1997, Duckworth *et al.* 2000, Diaz and Cabido 2001, Kahmen and Poschold 2004] such as, e.g. temperature, water and nutrients [Diaz and Cabido 2001]. Functional groups are defined on the basis of morphological and physiological traits [Duckworth *et al.* 2000, Pokorny *et al.* 2005, Leniere and Houle 2009], phenological properties [Leniere and Houle 2009], life histories [Duckworth *et al.* 2000] or life strategies [Domingues *et al.* 2007]. This concept is commonly used in analyses of vegetation changes over time [e.g. Kahmen and Poschold 2004, Dzwonko and Loster 2007].

To characterise changes in floristic composition of studied community analyses of plants biotopic requirements were performed characterised by: ecological indicator values [Ellenberg *et al.* 1991], life forms [Zarzycki *et al.* 2002], Grime's life strategies, life span, reproduction manner [www. biolflor.de], and syntaxonomical affinity [Matuszkiewicz 2001].

In order to show changes in the structure of this phytocoenosis also phytosociological relevés taken at present and in the past [Olesiński and Sendek 1980] were included. In synoptic table floristic composition and cover data in the patches of the community now and then were compared. Moreover, the phytosociological relevés (old and new ones) were subjected to Principal Components Analysis (PCA) using Canoco for Windows 4.5 [ter Braak and Šmilauer 2001]. In these analyses only cover data of species were used.

RESULTS

The comparison of ecological requirements and biological traits of vascular plants building the patch of *Rhynchosporetum albae* in the mire in Dąbrowa Górnicza Antoniów does not show distinct changes in the ecological spectrum of the flora after 30 years, which suggests that habitat conditions changed a little. Amongst distinguished functional groups the only changes observed were in the participation of species of different trophy requirements, preferring soils of various pH as well as participation of species of different syngenetic groups and representing different life strategies. The remaining properties, such as life span, type of reproduction, life forms, turned out to insignificant. Figure 1 shows a comparison of the ecological spectrum of Ellenberg indicator values (L – light indicator, F – moisture, R – soil reaction and N-trophy) of flora before 30 years and currently.

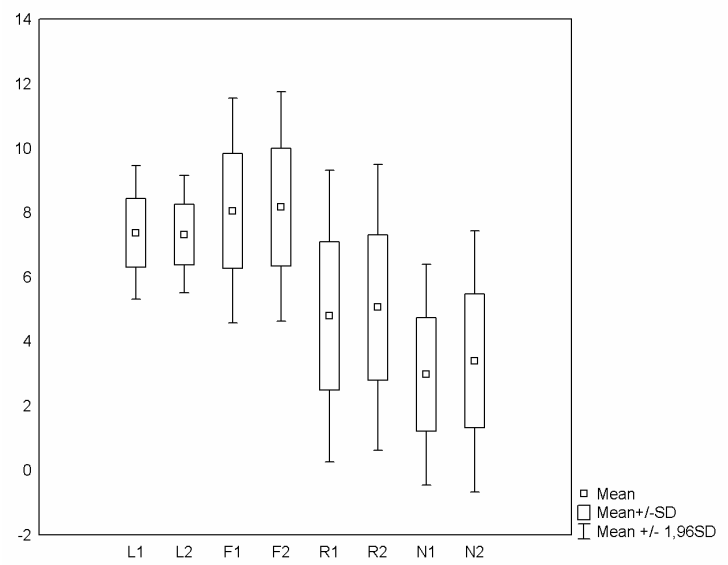

Fig. 1. Ecological spectrum of the flora of *Rhynchosporetum albae* in the past and at present: L – light, F – moisture, R – soil reaction, N – trophy; 1 – in the past, 2 – at present

The changes concern increase of participation of species of higher trophy and preferring more alkaline soils. The mean value of acidity increased from 4.78 to 5.05 and trophy from 2.96 to 3.38. There was no distinct difference in the light indicator in spite of the increase in the share of trees and shrubs in the mire and in humidity, which is confirmed by observation of the presence of waters in the object. The results of comparative analysis of participation of species of different life strategies indicate an increase of representatives of strategy C (competitors), R (pioneer species, preferring disturbances) and strategy CR, when compared to the relations 30 years earlier (Fig. 2). In comparison with the flora of the

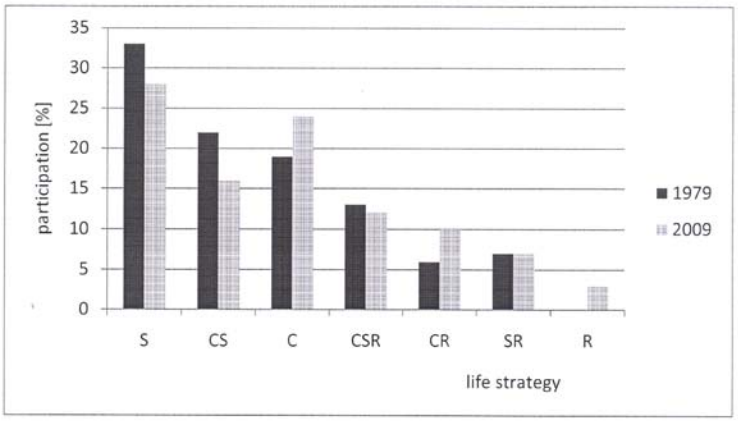

Fig. 2. Participation of life strategy in the flora of *Rhynchosporetum albae* phytocoenoses in 1979 and 2009

1970s, the percentage of species of *Molinio-Arrhenatheretea* class increased, as did that of the rush species i.e. *Phragmitetea* class representatives, while there was a minimal decrease in the percentage of mire species both of the *Scheuchzerio-Caricetea nigrae* class and the *Oxycocco-Sphagnetea* class. Especially strong differences are apparent in the case of the percentage of species of the order *Caricetalia davallianae* (Fig. 3).

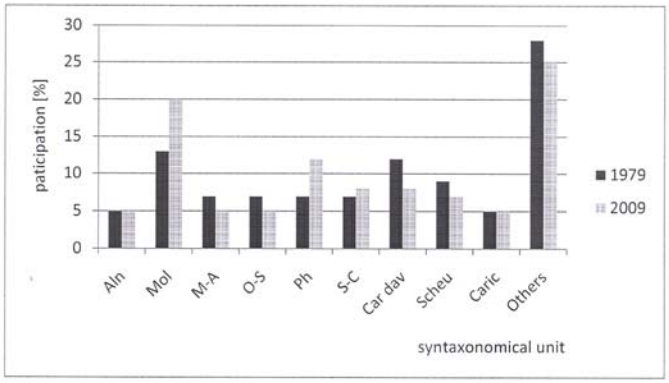

Fig. 3. Changes in the participation of species from syntaxonomical units in the flora of *Rhynchosporetum albae* phytocoenoses after 30 years: Aln – *Alnetea glutinosae*, Mol – *Molinietalia,* M-A – *Molinio-Arrhenatheretea*, O-S – *Oxycocco-Sphagnetea*, Ph – *Phragmitetea*, S-C – *Scheuchzerio-Caricetea nigrae*, Car dav – *Caricetalia davallianae*, Scheu – *Scheuchzerietalia palustris*, Caric – *Caricetalia nigrae*

More distinct changes concern the structure of phytocoenoses of *Rhynchosporetum albae*. This is manifested by, among others, an increase of the total cover of herb species and of the cover of shrubs (on average from 3 to 22% – Tab. 1). Also Principal Components Analysis (PCA – Fig. 4) demonstrates the distinctiveness of contemporary relevés. On the basis of this analysis it can be concluded that a major factor arranging the location of relevés on the diagram is time. The new records are agglomerated on one side of the plot and show more similarity between one another than older records. It is a result of differences in species composition (decline of some species and appearance of new ones) and changes in the cover of species in analysed patches. These changes are shown in Tab. 1.

The increase of cover and/or frequency concern some species of the *Scheuchzerio-Caricetea nigrae* class (*Rhynchospora alba, Triglochin palustre, Juncus articulatus, Menyanthes trifoliata*). Other species which currently occur more frequently are *Eriophorum angustifolium, Molinia caerulea* and *Carex panicea.* The studies in 2008 and 2009 did not confirm the presence of very rare in the Silesian Upland species of the *Rhynchosporion albae* alliance: *Carex limosa* and *Hammarbya paludosa.* However, a population of *Liparis loeselii*-species of European significance is still well established. In 2009 its abundance amounted to 57 (38 generative specimens) [Błońska unpbl.]. The remaining differences in species composition of the examined phytocoenoses concern mainly

Table 1. Changes in the floristic composition of *Rhynchosporetum albae* phytocoenoses occurring in the „Bogs in Antoniów" mire in the past and at present

Year		1979		2009	
Number of relevés in the table		10		12	
Number of species in the table		61		53	
Mean cover of shrub layer c, %		3		22	
Mean cover of herb layer c, %		62		89	
Mean cover of moss layer d, %		89		61	
Rhynchospora alba	c	V	2710	V	5625
Ch. *Rhynchosporion albae*					
Drosera intermedia	c	II	105	III	179
Carex limosa	c	I	55		
Hammarbya paludosa	c	I	5		
Ch. *Scheuchzerio-Caricetea nigrae*					
Triglochin palustre	c	IV	255	V	708
Viola palustris	c	IV	345	V	238
Agrostis canina	c	III	250	IV	442
Juncus articulatus	c	II	20	IV	146
Drosera anglica	c	III	120	III	171
Parnassia palustris	c	III	75	III	21
Carex lepidocarpa	c	II	390	III	246
Carex echinata	c	II	15	II	54
Eleocharis quinqueflora	c	I	100	II	333
Menyanthes trifoliata	c	I	5	III	58
Liparis loeselii	c	I	6	II	9
Carex lasiocarpa	c	I	425	I	54
Valeriana simplicifolia	c	I	55	I	4
Juncus alpino-articulatus	c	II	60		
Ch. *Oxycocco-Sphagnetea*					
Drosera rotundifolia	c	V	685	V	871
Oxycoccus palustris	c	IV	1725	V	942
Andromeda polifolia	c	II	575	III	21
Eriophorum angustifolium	c	I	100	V	775
Ch. *Molinio-Arrhenatheretea*					
Molinia caerulea	c	IV	260	V	542
Briza media	c	II	15	III	29
Cirsium palustre	c	II	20	III	29
Lysimachia vulgaris	c	II	16	II	12
Dactylorhiza majalis	c	I	1	II	17
Festuca rubra s. s.	c	II	101	I	4
Filipendula ulmaria	c	I	6	I	4
Others					
Potentilla erecta	c	V	260	V	383
Alnus glutinosa	b	IV	125	III	342
Alnus glutinosa	c	II	20	V	117
Betula pubescens	b	I	5	II	608
Betula pubescens	c	II	15	III	29

Carex panicea	c	II	110	V	917
Frangula alnus	b	II	15	II	92
Frangula alnus	c	II	20	III	100
Lysimachia thyrsiflora	c	II	15	III	58
Peucedanum palustre	c	II	20	III	25
Pinus sylvestris	b	III	115	I	83
Pinus sylvestris	c	I	10	IV	38
Eupatorium cannabinum	c	II	16	I	8
Galium uliginosum	c	II	15	I	8
Lycopus europaeus	c	I	10	III	96
Lythrum salicaria	c	I	6	II	17
Phragmites australis	c	II	1300	I	8
Trientalis europaea	c	I	5	II	13
Equisetum palustre	c	I	50	I	4
Galium palustre	c	II	15		
Eleocharis acicularis	c			I	12
Mentha aquatica	c			II	50

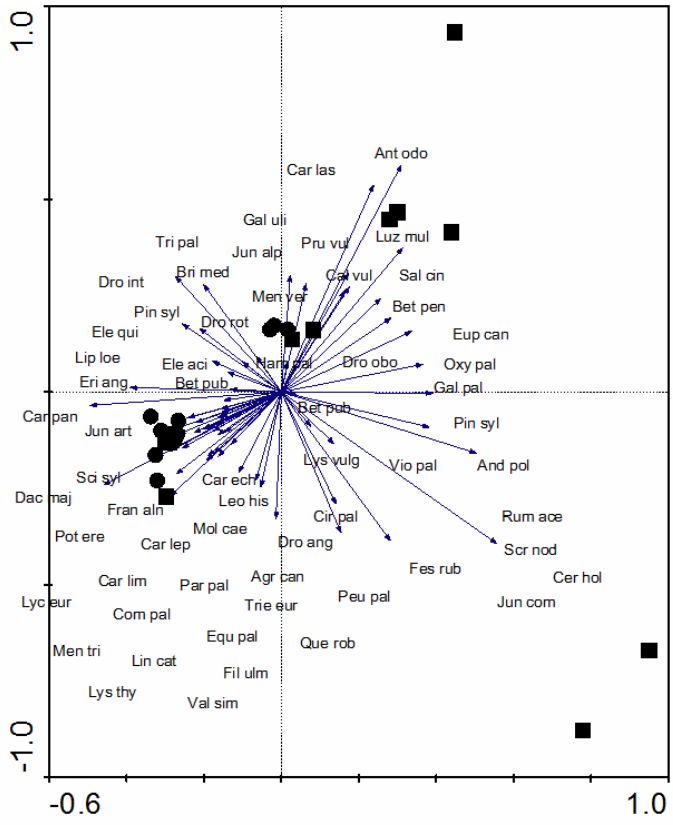

Fig. 4. Principal Correspondence Analysis of *Rhynchosporetum albae* relevés occurring in the „Bogs in Antoniów" mire at present • and in the past ■ (species abbreviation: first 3 letters – genus name, second 3 letters – species name)

accompanying species of low constancy and cover in records taken earlier and currently. A majority of species noted in the phytosociological relevés from 1970s still occur in the phytocoenosis of the mire but were absent in analysed phytosociological relevés, which also applies to a group of species which in Table 1 occur in new samples. These plants were used in flora analysis. An increase is observed in the cover of trees and shrubs, both in shrub and herb layers. These are mainly light-seeded tree species of high moisture requirements: *Alnus glutinosa* and *Betula pubescens*, as well as *Frangula alnus*. The detailed analysis of phytosociological relevés from 2009 indicated that the community is not uniform in its nature. In some records, mainly those located in the central and north-western part of the mire in the vicinity of alder carr, there is higher participation of meadow species, particularly from the *Molinietalia* order, but in other parts species of the *Phragmitetea* class prevail, which shows moisture diversity.

DISCUSSION

In the patches of *Rhynchosporetum albae* in the area of the „Bogs in Antoniów" changes in species composition and the structure of the community showing tendency to succession towards *Fraxino-Alnetum* alder carr are observed. It is reflected in the increase of cover of seedlings and saplings of trees (basically *Alnus glutionosa* and *Betula pubescens*). Also the increase of competitors (strategy C) can be connected with succession. In Grime's concept of strategy CSR it is assumed that increasing role of competitors is typical for succession when frequency of disturbances is decreasing. It was confirmed, among others, in studies on grassland communities [Huhta and Rautio 1998]. Moreover, according to Grime [1979], the competition strategy is confined to the trophy of a habitat.

The characteristic traits of competitors include, among other, high rate of growth, high biomass and ability of vegetative reproduction. Species of C-strategy are characterised as fast-growing, well-adapted to competition for resources. Positive relationships between the participation of competitors and the trophy of habitat were observed e.g. by Pywell *et al.* [2003]. Furthermore, those authors demonstrated that competitive species are confined to more moist soils with higher pH. The obtained results seem to confirm this pattern. The general tendency of changes in the participation of species of different traits (representing various functional groups) revealed an increasing role of competitive species, which is manifested by increase of acidity and trophy indicators. An interesting fact is the increase of participation of R-ruderal species, treated as good colonisers [Grime 1979, Bullock *et al*. 2001]. These are species connected with open habitats, disturbed conditions, and represent a group of traits such as fast germination, short life span [Pywell *et al*. 2003]. Perhaps in this case these species are associated with sites disturbed by wild boars or grounds with changeable level of underground waters.

The participation of meadow and rush species in some „new" phytosociological records make the community more similar to the variants distinguished by Denisiuk and Grynia [1969] from the Valley of the Upper Warta river and show heterogeneous moisture conditions. Those authors explain such differentiation by phytosociological position of *Rhynchosporetum albae* between sedge communities (*Phragmitetea* class) and moist meadows of the *Molinietalia* order. In the case of the mire in Antoniów the participation of meadow species concentrates in the central and north-western part of the mire, in the vicinity of alder carr, and indicates more advanced succession in that part of the mire.

CONCLUSION

It seemed that changes after 30 years in the analysed phytocoenosis would be high. Meanwhile it turned out that the core of species typical for this phytocoenosis remained and only in the central and north-western part succession processes are observed. This can be associated with decreasing level of underground waters in the past due to changes in water relations and sand exploitation. The dying out of Scots pine and birch, high level of underground waters and quite well-preserved structure of patches of *Rhynchosporetum albae* allow to optimistically predict the future of this object.

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ZMIANY W STRUKTURZE I SKŁADZIE FLORY NACZYNIOWEJ FITOCENOZ *Rhynchosporetum albae* NA TERENIE UŻYTKU EKOLOGICZNEGO „BAGNA W ANTONIOWIE" (WYŻYNA ŚLĄSKA) PO 30 LATACH

Streszczenie. Praca przedstawia zmiany, jakie zaszły po 30 latach w składzie florystycznym roślin naczyniowych oraz w strukturze fitocenoz *Rhynchosporetum albae* rozwijających się na torfowisku zlokalizowanym w Dąbrowie Górniczej (Wyżyna Śląska, Polska południowa), na terenie podlegającym antropopresji. Analiza porównawcza flory i zdjęć fitosocjologicznych wskazuje na niewielkie zmiany w składzie flory naczyniowej i strukturze zbiorowiska, świadczące o zachodzącej sukcesji w kierunku łęgu jesionowo-olszowego *Fraxino-Alnetum* Przejawia się to wzrostem pokrycia oraz stałości siewek i podrostu drzew, wzrostem udziału gatunków konkurencyjnych (strategia C), gatunków o wyższych wymaganiach troficznych i preferujących podłoże o wyższym pH.

Słowa kluczowe: torfowisko, *Rhynchosporetum albae*, grupy funkcjonalne roślin, zmiany roślinności