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HABITAT CONDITIONS AND DIVERSITY OF FLORA BASED ON TRANSITIONAL PEAT BOG IN BLEDOW ON THE SILESIAN UPLAND

WARUNKI SIEDLISKOWE A ZRÓŻNICOWANIE ROŚLINNOŚCI NA PRZYKŁADZIE TORFOWISKA PRZEJŚCIOWEGO W BŁĘDOWIE (WYŻYNA ŚLĄSKA)

Abstract: Presented research focused on determining the characteristics of soils, waters and vegetation covering a transitional peat bog in Bledow and potential hazards which might cause its degradation. Four soil pits were made for this purpose and piezometers were installed in their immediate vicinity. It allowed investigation of physical and chemical properties of this habitat waters.

Diversity of the peat bog vegetation was determined on the basis of 17 phytosociological relevés made by Braun-Blanquet's method. The results demonstrated that the analysed peat bog is at the accumulation phase and the main factor shaping the habitat conditions in the peat bog itself and on its edge was high groundwater level. On the other hand, the feeding water and its level affected chemical and physical properties of the analysed peat bog soils. Low value of the studied peat bog water mineralisation and low share of calcium and magnesium ions in the mineralisation influenced low pH values and low degree of base cation saturation, which has been reflected in the floristic composition of the peat bog. In conditions of high moisture content, a process of organic matter accumulation was taking place in the surface horizons, whereas on the peat bog and on its edge an apparent soil and vegetation zonation was visible. On the edge of the peat bog trees encroaching into *Sphagno recurvi-Eriophoretum angustifolii* peat bog patches was observed on semi-hydrogenic soils and disappearance of species of the *Scheuchzerio-Caricetea nigrae* class. It was found that disturbance of natural water relationships poses the most serious potential hazard to the analysed peat bog.

Keywords: transitional peat bog, hydromorphic soils, Bledow

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Introduction

Hydrogenic and semihydrogenic habitats are the part of the natural environment to a great extent responsible for increasing biodiversity. Numerous rare and endangered animal [1] and plant [2] species, as well as mushrooms [3] under legal protection occur on wetlands. However, these are habitats largely susceptible to degradation and the balance may be easily disturbed even by a small lowering of groundwater level, eutrophication of hydrogenic oligotrophic habitats or in result of abandoning of the previous land use [4, 5].

One of such habitats in the western part of the Bledow Desert is transitional peat bog in Bledow. Despite the fact that it covers only about 0.2 ha, it is a key element of the natural environment in this area, increasing its biodiversity and being the habitat for many stenotypic plant and animal species [6]. Occurrence of these species and their forming plant communities is connected with specific habitat conditions.

The aim of the paper was a characterisation of soils, waters and vegetation covering the peat bog, but also determining potential hazards which might cause its degradation.

Materials and methods

The analysed peat bog is located on the Silesian Upland, in the eastern part of Bledow bogs in the Biala Przemsza River Valley (N 50^{o} 20′ 22″, E 19^{o} 27′ 05″). Four soil pits were made (profiles P1, P2, P3 and P4) to determine the properties of peat bog soil and soils situated on its edge. Samples for analyses were collected once from genetic horizons of the individual studied soils. Piezometers were installed in each place where a soil pit was made (PI, PII, PIII and PIV) to determine physical and chemical properties of the habitat waters. Water was sampled in March, May, July, September and November 2012. Because of a low groundwater level in the place where P1 pit was made, no water samples were collected from PI piezometer. The peat bog location was established using GPS technique.

The following assessments were made in the analysed soils: pH (by potentiometric method in H_2O and 1 mol · dm^{-3} KCl solution), mineral content (in organic horizons as weight loss at calcination at 550 ^{o}C), organic carbon and total nitrogen content on LECO CNS 2000 apparatus and sorption capacities [7]. The taxonomic classification of the studied peat bog soils was made on the basis of criteria in the Taxonomy of the Soils of Poland [8].

In the water samples collected from the investigated fens assessed were: oxygenation, mineralization, electrolytic conductivity and ionic composition, using the methods suggested by Dojlido [9].

In order to identify the diversity of the vegetation on the peat bog in Bledow, 17 phytosociological relevés were made by means of Braun-Blanquet method [10]. The relevés were distributed evenly over the whole area of the peat bog to obtain the vegetation picture. The names of communities and their syntaxonomical affiliation were based on [11], names of plant species are given in compliance with the paper by Mirek et al [12] and names of bryophytes after Ochyra et al [13].

Results and discussion

Among the natural environment elements affecting the habitat conditions one may mention geological substratum, high level of groundwater together with its chemical and physical properties [14]. The investigated peat bog formed in a depression with relative depth of about 2.5 m, on sandy substratum underlain with hardly permeable loam layer. Owing to this fact water affecting the trend of pedogenic processes and species composition of the vegetation accumulated in this concavity. On the other hand, high level of groundwater favoured the development of hydrogenic plant communities gradually passing into more dry peat bog edges.

The analysed peat bog is surrounded by fresh pine forest, developed on carbonateless initial soils – arenosols, characterised by very low groundwater level. Gleysols occur on the edges of the peat bog adjoining the forest; their bedrocks are carbonateless fluvioglacial sands, more deeply underlain with heavy loam or clay. Peat soils and patches of compact sphagnum moss mats formed in the most waterlogged central part of the peat bog.

Therefore the following vegetation zones may be identified on this peat bog:

– ecotonal (the peat bog edge) – between the peat bog and the forest, where overgrowing with trees and bushes patches of *Sphagno recurvi-Eriophoretum angustifolii* alliance formed on ground-gley soils occur (profile P1),

– bog plant formations (peat bog) – *Sphagno recurvi-Eriophoretum angustifolii* on peat fibrous-heme soils,

– mat of *Rhynchosporetum albae* and *Caricetum limosae* sphagnum mosses forming flowing layers of compact sphagnum moss mats (fibrous soils), (profiles P3 and P4).

The properties of hydrogenic habitat soils are associated with a number of factors among which the most important are chemical and physical properties of the mineral substratum on which these habitats are formed, the type of hydrological water feeding, its oxygenation and ionic composition. These factors affect the species composition of the flora settling hydrogenic habitats [4, 5, 15].

The investigated peat bog developed on a carbonateless substratum, however the type of its hydrological feeding cannot be determined unanimously. The more so, as its location in the vicinity of the Biala Przemsza River causes that during high water stages, the river water may feed the peat bog. Undoubtedly, precipitations also play a crucial role, moreover the share in the feeding of surface runoffs flowing into in the concavity should not be disregarded, either. The above mentioned agents variously influence the ionic composition of the feeding waters. A lack of carbonates in the substratum in place of peat bog formation and low mineral content, including calcium and magnesium ions, in the feeding waters affected low pH values of the studied soils and their sorption properties. It concerns among others low base saturation (Table 1). Similar relationships in mezotrophic mountain fen soils were described by Nicia and Niemyska-Lukaszuk [16].

Waters feeding the peat bog reveal low mineralization (Table 2). On the basis of minerals content, water collected in the piezometers may be classified, after Macioszczyk [17], to ultra-sweet waters with mineralization below 100 mg $\cdot$ dm^{-3}. Despite this, diversified

Table 1

Physical and chemical properties of the studied soils

Thickness of the horizon	Horizon	Ash	pH		C_{org}	N_{tot}	C/N	Sorption properties							
								Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	S	K_h	CEC*	BS**
			KCl	H_2O	[g · kg^{-1}]			[mmol(+) · kg^{-1}]							[%]
Profile P1															
0–6	Ol	36.5	4.7	3.6	368.5	7.9	47	75.5	18.7	10.5	1.9	106.6	676.5	783.1	13.6
6–12	Oa	66.3	4.8	3.8	195.3	4.5	43	46.7	6.9	3.7	0.9	58.1	364.0	422.1	13.8
12–26	AG	—	5.2	4.4	2.6	0.3	9	5.4	0.4	0.1	0.3	6.2	25.7	32.0	19.5
> 26	G	—	5.3	4.8	1.2	0.1	12	3.4	0.3	0.1	0.1	3.9	14.7	18.6	21.0
Profile P2															
0–17	Oi	61.5	4.7	3.5	223.6	5.9	38	214.3	23.4	11.7	3.1	252.4	757.4	1009.7	25.0
17–35	Oie	67.3	4.8	4.2	189.7	5.2	36	215.6	23.7	1.5	2.1	242.9	595.6	838.5	29.0
35–107	C	—	5.4	4.8	0.7	0.1	7	4.7	0.4	0.1	0.2	5.3	12.9	18.2	29.3
Profile P3															
0–10	O1i	13.6	4.5	3.6	501.2	8.9	45	5.2	1.2	1.4	1.9	9.6	415.6	425.2	2.3
10–50	O2i	38.3	4.6	3.8	358.1	8.1	38	3.2	1.3	1.6	2.1	8.1	405.2	413.3	2.0
Profile P4															
0–9	O1i	14.2	4.4	3.8	497.4	8.5	42	6.2	1.3	1.4	1.7	10.6	412.5	423.1	2.5
9–45	O2i	40.2	4.5	3.9	346.9	8.2	35	3.7	1.3	1.1	1.4	7.6	398.3	405.9	1.9

* CEC – cation exchange capacity; ** BS – base saturation.

mineralization was noted among the samples collected from individual piezometers. Water collected from piezometer PII installed in peat soil of the transitory peat bog was characterized by the highest content of minerals, whereas almost twice lower was assessed in waters collected from piezometers PIII and PIV.

Table 2

Properties of studied groundwater

Property* ± SD**				
Piezometer		PII	PIII	PIV
Temperature	°C	11.1*± 5.1**	12.5 ± 6.4	12.6 ± 6.4
pH	—	5.6 ± 1.0	4.9 ± 0.8	4.9 ± 1.1
Conductivity	[μS · cm^{-1}]	66.1 ± 33.1	47.3 ± 19.3	45.4 ± 20.1
Mineralization	[mg · dm^{-3}]	52.2 ± 24.8	35.6 ± 14.5	34.0 ± 15.1
O_2		0.6 ± 0.3	0.5 ± 0.3	0.6 ± 0.4
HCO_3^-		12.1 ± 8.7	8.9 ± 4.6	9.4 ± 6.7
SO_4^{2-}		18.3 ± 4.6	10.0 ± 4.2	8.8 ± 4.0
Cl^-		1.6 ± 1.5	0.5 ± 0.3	0.4 ± 0.3
NO_3^-		6.0 ± 2.8	5.6 ± 3.0	5.4 ± 1.9
NH_4^+		0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1
PO_4^{3-}		0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1
Ca^{2+}		5.5 ± 2.4	4.4 ± 2.2	3.1 ± 1.9
Mg^{2+}		1.5 ± 0.9	1.0 ± 0.6	0.9 ± 0.4
Na^+		2.4 ± 1.9	1.2 ± 0.6	1.3 ± 0.5
K^+		4.5 ± 1.8	3.7 ± 1.3	4.4 ± 1.3

* Means for the investigated period; ** SD – standard deviation.

Higher content of calcium and magnesium ions and higher mineralization of the peat bog waters (piezometer PII) in comparison with the waters collected from the compact mat of sphagnum moss (piezometers PIII and PIV) affected chemical properties of the analyzed soils. Soil samples collected from the peat bog were characterized by higher pH values, higher cation exchange capacity and higher share of calcium and magnesium ions in the sorption complex in comparison with the samples taken from the compact mat of sphagnum moss.

Basing on the Priklonski-Szczukariew classification [17] waters of the central peat bog part (P2) may counted among the four-ion waters of the 39th class, *ie* bicarbonate--sulphate-magnesium-calcium waters. On the other hand, a lower proportion of magnesium in the ionic composition of the water from compact mat of sphagnum moss (P3 and P4) allowed to classify them to three-ion waters, of the 18th class, *ie* bicarbonate-sulphate-calcium waters. Higher values of total mineralization and higher contents of calcium and magnesium ions in the ionic composition of the peat bog waters may be explained by their enrichment in minerals from the substratum on which the peat bog was formed. Wolanin and Zelazny [18] described similar relationships in

mountain spring waters, whereas Nicia and Miechowka [19] in waters feeding hydrogenic habitats.

Gleying process encompassing lower parts of the soil profile was going on in the soils of the peat bog edge, on which *Sphagno recurvi-Eriophoretum angustifolii* phytocenoses, overgrowing with birch and pine trees formed. Because groundwater in the peat bog edge occasionally reached only 0.15–0.25 m from the soil level, during a major part of the period of investigations, no water was found in piezometer P1. On the other hand, organic matter accumulated in the top layers of these soils. Despite high moisture content, it should not be associated with organic matter accumulation process, but rather with the deposition of needles and leaves from the trees growing on these patches. The matter occurred as forest litter. The soils on the outer part of the peat bog edge were characterized by a lower groundwater level and lower thickness of organic horizons in comparison with the soils located closer to the central part of the peat bog.

Higher than in the peat bog edge groundwater level in the soil of the central peat bog part favoured development of vegetation typical for wetlands and represented by *Sphagno recurvi-Eriophoretum angustifolii* phytocenoses. Apart from *Eriphorum angustifolium*, which is the species dominant in the structure of these patches, also *Viola palustris*, *Agrostis canina*, *Carex echinata* and *Comarum palustre* played a crucial role, as well as representatives of the *Oxycocco-Sphagnetea* class: *Drosera rotundifolia* and *Andromeda polifolia*. Sphagnum moss blankets were formed mostly from *Sphagnum fallax* and *Sphagnum teres*. In conditions of high groundwater level, dead peat bog plant remnants were deposited as partly decomposed organic matter, but high groundwater level in the central part of the peat bog slowed down organic matter decomposition process. Surface horizons in the central part of the peat bog and of the compact mat of sphagnum moss in anaerobic conditions caused by high groundwater level were characterised by a low degree of organic matter decomposition (H_{2-3} acc. to von Post scale) [8]. The thickness of organic horizon was increasing gradually towards the central part of the peat bog with lowering depth of mineral substratum. In the central part of the peat bog in places where the mineral substratum lay at the depth of over 1.5 m, patches of *Sphagno recurvi-Eriophoretum angustifolii* vegetation were gradually passing into *Rhynchosporetum albae* and in the most waterlogged places in *Caricetum limosae* phytocenoses. These phytocenoses formed dense mats of sphagnum moss, between 0.5 to 1.0 m thick gradually overgrowing a water filled cavity in which the peat bog developed.

Rhynchosporetum albae occured in complex with *Caricetum limosae* and S*phagno recurvi-Eriophorertum angustifolii* phytocenoses in slightly more dry places than *Caricetum limosae* phytocenoses. Still, these habitats were characterised by high moisture content. The dominant species, determining the character of the discussed alliance patches was *Rhynchospora alba*, accompanied by among others: *Eriophorum angustifolium*, *Menyanthes trifoliate* and *Carex limosa*. The permanent components of this phytocenosis included also: *Oxycoccus palustris* and *Drosera rotundifolia*. On the other hand, *Sphagnum palustre*, *S. flexuosum* and *S. fallax*. were present in the moss layer.

The most precious components of this peat bog vegetation were well developed patches of *Caricetum limosae*, observed in the central, lowered part of the peat bog in

strongly waterlogged places where water was always stagnating. The moss layer was poorly developed and did not exceed 40 %. On the other hand the appearance of the discussed patches is shaped by *Carex limosa* – the species under legal protection [2] which also belongs to extinct flora species, not only in the Silesia region [20], but throughout Poland [21]. *Carex limosa* was accompanied by plants from *Scheuchzero-Caricetea nigrae* class – mainly *Menyanthes trifoliata*, *Comarum palustre* and *Eriophorum angustifolium*. Also a small share of species typical for wet meadows and bulrushes.

Beside *Carex limosa*, also other protected species occurred in the species composition of vegetation covering the studied peat bog (Table 3).

Table 3

Share of protected species in the investigated phytocenoses

Caricetum limosae	*Rhynchosporetum albae*	*Sphago recurvi-Eriophoretum angustifolii*
Carex limosa	*Utricularia intermedia*	*Drosera rotundifolia*
Menyanthes triforiata	*Drosera anglica*	*Menyanthes trifoliata*
Drosera rotundifolia	*Drosera rotundifolia*	*Pedicularis palustris*
	Carex limosa	*Dactylorhiza incarnata*
	Menyanthes trifoliata	*Ledum palustre*

The floristic values and phytecenotic diversity of this peat bog as an object worth of protection have been already emphasized in the subject literature [6, 22]. The investigations demonstrated that the peat bog values remain very high, the more so, as the habitat with the code 7140, which occurs here, represented by transitory peat bogs and quagmire (prevalently with *Scheuchzerio-Caricetea nigrae* vegetation is a habitat protected by the European legislation (Habitat Directive 92/43/EWG) and very rare in the region).

Conclusions

1. High groundwater level was the factor to the greatest extent shaping the habitat conditions, influencing the vegetation and the trend of pedogenic processes both in the ecotone zone between the studied peat bog and pine forest, and in the peat bog itself.

2. Low value of water mineralization, its small share of calcium and magnesium ions influenced low pH values and base saturation in the soils of the peat bog itself and its edge.

3. Lowering of groundwater level on the peat bog edge favoured occurrence of trees and bushes in the patches of S*phagno recurvi-Eriophorertum angustifolii* formation but disappearance of the species from *Scheuchzerio-Caricetea nigrae* class.

4. High groundwater level favours organic matter accumulation in the peat bog. However, changes in water relationships in this area may cause disturbances of dynamic equilibrium and lead to extinction of many stenotypic, legally protected plant species from this area.

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WARUNKI SIEDLISKOWE A ZRÓŻNICOWANIE ROŚLINNOŚCI NA PRZYKŁADZIE TORFOWISKA PRZEJŚCIOWEGO W BŁĘDOWIE (WYŻYNA ŚLĄSKA)

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Abstrakt: Badania dotyczyły określenia charakterystyki gleb, wód oraz roślinności porastającej torfowisko przejściowe w miejscowości Błędów oraz potencjalnych zagrożeń, mogących spowodować jego degradację. W tym celu wykonano 4 odkrywki glebowe, a w ich bezpośrednim sąsiedztwie zainstalowano piezometry. Umożliwiło to zbadanie właściwości fizycznych i chemicznych wód tego siedliska.

Zróżnicowanie roślinności torfowiska określono na podstawie 17 zdjęć fitosocjologicznych wykonanych metodą Braun-Blanqueta. Wyniki badań dowiodły, że badane torfowisko znajduje się w fazie akumulacji, a głównym czynnikiem kształtującym warunki siedliskowe w samym torfowisku, jak i jego okrajku był

wysoki poziom wód gruntowych. Z kolei woda zasilająca oraz jej poziom kształtowały właściwości chemiczne i fizyczne gleb badanego torfowiska. Niska wartość mineralizacji wód badanego torfowiska oraz mały udział w mineralizacji jonów wapnia i magnezu były przyczyną małych wartości pH oraz niskiego stopnia wysycenia kompleksu sorpcyjnego badanych gleb kationami o charakterze zasadowym, co znajduje odzwierciedlenie w składzie florystycznym torfowiska. W warunkach dużego uwilgotnienia w poziomach powierzchniowych zachodził proces akumulacji materii organicznej, a na torfowisku oraz jego okrajku stwierdzono wyraźną strefowość gleb i roślinności. W okrajkach torfowiska, na glebach semihydrogenicznych obserwowano wkraczanie drzew i krzewów w płaty mszaru S*phagno recurvi-Eriophorertum angustifolii* i zanikanie gatunków klasy *Scheuchzerio-Caricetea nigrae.* Stwierdzono, że największe potencjalne zagrożenie badanego torfowiska stanowi naruszenie naturalnych stosunków wodnych.

Słowa kluczowe: torfowiska przejściowe, gleby hydrogeniczne, Błędów