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CONTENTS OF MACRONUTRIENTS AND MICROELEMENTS IN SOILS OF BAGNO SEREBRYSKIE PEAT-BOG (BOG-MOOR SOILS)

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Summary. The study was carried out on Bagno Serebryskie peat-bog located in Lublin region, in Chełm and Ruda Huta communes that, in accordance to physico-geographical division, it is situated in Obniżenie Dubienki as a part of Polesie Wołyńskie. Bagno Serebryskie is under legal protection as natural reserve and is a fragment of Chełmski Landscape Park and Nature 2000 area Chełm Carbonate Peat-Bogs. The study dealt with the peat-bog soil developed from sedge-form short peat (sedge, sedge-fen-sedge, and sedge-common-reed) as well as moss-form (sedge-moss). In total, 36 samples were collected from 6 profiles, and acidity, ash content as well as macronutrient and microelement contents were determined. Variable ash, macronutrient, and microelements contents were found both between analysed profiles and within them. Achieved results of macronutrients and microelements are comparable (in the case of a majority of them) with adjacent soils and sediments, i.e. Uherka stream valley and peat-bog Cichy Kąt.

Key words: peat-bog, bog-moor soils, macorelements content, microelements content

INTRODUCTION

Chełm vicinity is an area abundant in peat-bogs [Borowiec 1990]. The short carbonate peat-bogs are characteristic for areas located at the edge of Pagóry Chełmskie and Obniżenie Dubienki. Chełm Carbonate Peat-Bogs are considered to be one of the most valuable natural peat-bogs in Poland and even Europe. Their most precious fragments are under legal protection as natural reserves: Brzeźno, Bagno Serebryskie, Roskosz, and Sobowice, as well as Nature 2000 (SOO and OSO areas).

The research upon the soils and peat has recently begun within Chełm Carbonate Peat-Bogs [Urban 2006, Urban *et al*. 2000, 2004]. The aim of present study was to analyse macronutrients and microelements contents in peat-bog soils of Bagno Serebryskie natural reserve.

STUDY OBJECT, MATERIAL AND METHODS

The study included peat-bog soils of Bagno Serebryskie natural reserve. The peat-bog is located in Chełm and Ruda Huta communes of Lublin region. According to physico-geographical division, it is situated in Obniżenie Dubienki as a part of Polesie Wołyńskie. Bagno Serebryskie is under legal protection as natural reserve and is a fragment of Chełmski Landscape Park and Nature 2000 area Chełm Carbonate Peat-Bogs. It occupies an area of 376.62 ha.

The peat-bog Bagno Serebryskie was formed due to accumulation of organic and mineral matter in land depressions (werteby). Dead waters accumulated in those depressions that were filled with sediments composed of sedge, reed, sedge-reed, moss, and sedge-moss peat forms [Dobrowolski 2000]. The peat-bog is classified among those so-called short carbonate ones (characteristic for Pagóry Chełmskie and Obniżenie Dubienki). Bagno Serebryskie is located in a wide out-of-valley depression surrounded by hills consisting of chalk marls with high contents of calcium carbonate. Average thickness of the peat layer is 1.33 m, mean ash content in peat – 18%, mean decomposition level – 30% [Borowiec 1990]. Hydrogenic soils – peat-bog and peat-mud – as well as post-bog peat-muck, and semi-hydrogenic – specific chernozem and degraded muck ones, occupy the largest area. Podzolic soils make up a small percentage of the reserve area. Rushes with dominating sedge-beds (*Cladietum marisci*) grow in its central part. The most valuable plant communities are also: brown bog-rush (*Schoenetum ferruginei*), Davall's sedge (*Caricetum davallianae*), and Buxbaum's sedge (*Caricetum buxbaumii*), as well as fen-meadows (*Molinietum caeruleae*).

In total, 30 soil pits were made within the reserve. Among 6 profiles (down to the bedrock at the depth of 150 cm), 36 samples were collected, and the following items were determined: pH – electrometrically in H_2O and 1 mol KCl·dm^{-3}, ash content by means of combusting at 560°C, and calcium carbonate content (Scheibler's method). Other samples were digested in concentrated nitric, perchloric, and hydrochloric acids mixture [Sapek and Sapek 1997], and then calcium, sodium, and potassium concentrations (FEAS), phosphorus (colorimetry with reducing agent), magnesium, iron, manganese, copper, zinc, and lead (AAS) were determined.

RESULTS

Moors soils occupy quite a large area of the reserve. Analysed profiles are represented by soils developed from short sedge-form peat (sedge and sedge-fen-sedge – profiles 1, 2, 6, sedge-reed – profiles 4, 5), and moss-form (sedge-moss – profile 3). These peat types are characterised by different decomposition and silting level and most often are abundant in calcium carbonate. Studied soils showed basic or neutral reaction, sparsely acidic (peat soil developed from moss-form peat), and their pH_{KCl} ranged from 5.57 to 7.80.

Calcium carbonate contents varied. No $CaCO_3$ was found in profile No. 6 (soil developed from sedge-moss peat), and in several horizons of profiles No. 2, 4, 6. Other studied soils contained high levels of calcium carbonate: from 2.3 to 52.5% (the highest in the peat layer strongly silted with calcium carbonate – profile No. 1, horizon 0–10 cm).

Ash content in analysed peat samples oscillated from 12.33 to 68.20%. The highest ash content was found in peat layers strongly silted with calcium carbonate, while the lowest – in peat horizons (sedge-moss peat) in profile No. 3 (20–80 cm). According to Liwski *et al.* [1981], the peat type and its decomposition level, as well as peat deposit silting, have an influence on ash content.

Analysed sediments (peat, gythia) contained from 0.7 to 5.8 gkg^{-1} of phosphorus. Layers of moderately decomposed sedge-form peat in profile No. 6 (60–150 cm horizon) were characterised by the highest P concentration (from 3.6 to 5.8 gkg^{-1}).

Potassium content was low, oscillating from 0.8 to 2.1 gkg^{-1}. Higher potassium levels were recorded in upper layers (0–10, 10–20 cm), and in bottom layers of profiles No. 1, 2, 4, where organic-mineral forms as well as detritus loam of writing chalk were present. Studies carried out by numerous authors indicate that increase of mineral parts in hydrogenic forms affected the element percentage increase [Okruszko and Oświt 1973, Okruszko and Churska 1988, Urban 2004, Smólczyński *et al.* 2006].

The results obtained in this study indicate (Tab. 1) that sodium content was within the range from 0.2 to 3.2 gkg^{-1}. Layer 50–80 cm in profile No. 5 was characterised by the highest Na concentration. Significant positive correlation between Na and Ca contents was observed (r = 0.963545). Similar dependence between Ca and Na levels was recorded in peat deposits in river valleys of Lubelska Upland [Urban 2004], Olszowieckie Błoto in Warsaw Basin [Konecka-Betley *et al.* 1988], and peat-bog Wilków in Kampinoska Forests [Konecka-Betley *et al.* 1996].

Studied soils were distinguished by high and diverse calcium content, from 2.8 to 164.9 gkg^{-1}, and its distribution within profiles was similar to that of calcium carbonate. The highest Ca amounts were present in peat layers silted with carbonate in profiles No. 5 and 6. In the case of four profiles, a decrease of calcium content was recorded in upper layers (0–10 cm). Tendency to decrease that element content in upper layers of peat soils was also confirmed by Sapek *et al.* [1991], Banaszuk [1996] and Piaścik [1996].

Magnesium content in analysed profiles, similar to that of calcium, varied and ranged from 0.3 to 3.9 gkg^{-1}. Only in two profiles an increase of Mg concentration in 0–10 cm horizon was recorded. In the opinion of many authors, magnesium amounts increase along with the silting of peat formations [Liwski *et al.* 1981, Okruszko and Churska 1988, Piaścik *et al.* 2001, Smólczyński *et al*. 2006], although that dependence was not confirmed in the present study.

Moor soils are characterised by high iron levels. In the present study, the element content oscillated from 1.4 to 16.5 gkg^{-1}, and in general it was the highest in 0–10 cm layer. According to Liwski *et al.* [1981], iron is precipitated in upper horizons of the soil profiles of hydrogenic forms. Research by Smólczyński *et al*. [2006] performed in Vistula river delta revealed that Fe content in peat increased along with the silting level.

Manganese concentrations in studied profiles amounted from 21 to 390 $mgkg^{-1}$. The highest level of Mn was recorded in upper layers (0–10 cm). In the opinion of Sapek *et al*. [1991], manganese shows great mobility in the soil profile and is weakly complexed by humus substances. It is accumulated in upper soil layers, to which it is transported with water, and then precipitates at the redox potential changing interface. Studies of other authors suggested similar dependencies [Trąba and Wyłupek 1996, Urban 2004].

Lead in analysed soil profiles was present at the amounts from 49 to 201 $mgkg^{-1}$. In a majority of the profiles, the highest Pb concentrations were found in upper layers (0–10 cm). Studies performed by Sapek [1976] and Urban [2004] indicated that deeper peat horizons were more deficient in Pb, while surface layers of organic soils were enriched in that element.

Total zinc content varied ranging from 8 to 115 $mgkg^{-1}$. Differentiation of zinc abundance was observed in all profiles, which can be attributed to the organic forms silting processes [Sapek and Churski 1983, Smólczyński *et al*. 2006], and condensing the soil matter and blowing in the mineral parts from adjacent areas [Choromańska and Gotkiewicz 1983, Okołowicz and Sowa 1997].

Copper concentrations in analysed peat profiles oscillated from 16 to 110 $mgkg^{-1}$. The highest Cu contents were recorded in layers of moderately decomposed sedge-moss peat in profile No. 6 (40–50 cm). In the opinion of Smólczyński *et al.* [2006], copper content in peat is influenced by its silting level.

Achieved results referring to macronutrients and microelements contents are comparable (for a majority of analysed elements) with those for soils and profiles of adjacent sites, e.g. Uherka stream valley [Urban *et al.* 2004] or Cichy Kąt [Urban 2006]. Copper, zinc, lead, and manganese concentrations were within the range of natural soil abundance in these elements [Kabata--Pendias *et al*. 1993].

Table 1. Content of macro- and microelements in bog-moor soils of Bagno Serebryskie peatland

No. of pro-file	Horizon	Depth in cm	pH		$CaCO_3$	Ash	Content of macroelements gkg^{-1}						Content of microelements $mgkg^{-1}$			
			H_2O	KCl	%	%	P	K	Na	Ca	Mg	Fe	Pb	Mn	Zn	Cu
1	POtnituca	0–10	8.42	7.80	52.5	57.10	1.1	0.5	2.5	162.0	0.6	4.7	201	193	21	23
	POtnituca	10–20	7.53	7.11	7.8	17.23	0.9	0.2	0.9	45.4	0.3	1.4	64	21	9	16
	Otnituca	30–40	7.43	7.01	15.3	20.33	2.4	0.1	1.2	65.7	0.6	2.9	57	25	8	23
	Otnituca	60–70	7.59	7.17	11.0	18.76	1.9	0.1	1.2	57.8	0.5	2.8	85	21	11	18
	Otnituca	70–80	7.20	6.50	8.3	30.00	1.6	0.3	0.8	33.1	1.0	5.0	92	27	26	21
	Dggca	80–90	7.02	6.43	7.1	86.10	1.1	1.3	0.2	23.3	0.7	3.6	74	34	13	23
2	POtnituca	0–10	7.40	7.01	4.4	30.11	1.7	0.8	0.8	27.9	0.9	6.7	136	80	16	20
	Otnituca	20–30	7.02	6.46	3.8	18.99	1.6	0.3	0.7	27.9	0.9	6.4	114	86	29	26
	Otnituca	40–50	7.54	7.05	3.9	18.10	1.4	0.2	0.7	34.1	1.0	5.6	85	53	36	25
	Otnituca	70–80	7.24	6.63	3.8	31.43	1.8	0.2	0.8	33.1	1.1	5.1	92	274	66	31
	Dggca	80–90	7.12	6.56	3.8	88.10	1.0	1.3	0.2	33.3	0.7	3.4	71	34	13	23
3	POtnime	0–10	6.96	5.57	0.0	31.10	1.9	0.5	0.8	21.7	1.5	6.7	49	390	16	20
	POtnime	20–30	6.23	5.81	0.0	13.24	1.4	0.2	0.6	25.1	3.9	8.3	107	125	21	25
	Otnime	40–50	6.18	5.74	0.0	12.33	2.9	0.2	0.7	30.6	1.3	9.3	92	125	18	25
	Otnime	60–80	6.09	5.58	0.0	12.45	0.8	0.1	0.8	35.3	1.2	9.4	107	286	19	21
	Otnimegy	80–90	6.14	5.78	0.0	68.20	2.1	0.4	0.7	14.3	1.1	6.7	78	320	26	20
	Dgg	140–150	6.70	6.12	0.0	96.12	0.7	0.2	0.3	2.8	1.6	10.0	71	47	16	52

4	POtnituca	0–10	7.12	6.85	2.3	22.78	1.8	0.7	0.7	20.1	1.1	5.4	114	263	115	20
	Otnituca	10–20	7.00	6.59	0.0	18.56	1.6	0.4	0.7	25.9	1.0	5.0	85	162	80	66
	Otnituca	20–40	7.24	687	8.2	17.34	1.1	0.2	0.7	41.1	0.7	3.8	78	90	28	57
	Otnituca	50–60	6.98	6.60	0.0	14.33	1.3	0.1	0.7	37.1	0.6	3.0	71	32	19	49
	Otnitugyca	70–80	7.09	6.52	0.0	26.21	2.0	0.3	0.6	28.0	1.1	4.4	50	32	22	57
	Dggca	100–110	8.01	7.19	16.3	92.10	1.0	2.1	1.2	40.60	0.7	10.1	64	131	35	41
5	POtnituca	0–10	7.30	7.01	45.1	39.00	0.8	0.4	2.1	132.5	1.6	11.9	78	187	29	23
	Otnituca	20–30	7.45	7.12	23.5	30.55	0.8	0.2	1.3	75.0	1.6	12.1	82	145	29	20
	Otnituca	30–40	7.65	7.21	13.6	25.67	0.9	0.2	1.2	64.0	1.7	12.1	92	158	30	20
	Otnitucagy	50–60	7.68	7.31	48.9	62.10	1.7	0.2	3.2	217.2	1.1	10.4	128	107	15	21
	Dgg	70–80	7.73	7.36	1.9	87.12	1.3	0.1	2.4	154.2	1.4	7.4	71	53	13	21
6	POtnituca	0–20	8.10	7.12	7.8	34.80	1.7	0.7	1.2	70.5	0.9	16.5	136	90	95	65
	Otnituca	30–35	7.55	7.23	17.9	42.12	2.9	0.4	1.7	117.3	0.7	5.6	128	66	71	47
	Otnituca	40–50	7.23	7.03	21.9	40.65	2.7	0.3	1.8	132.5	0.5	7.3	114	70	31	110
	Otnituca	60–75	7.12	6.99	17.0	38.77	4.6	0.2	1.7	121.2	0.5	8.6	85	60	37	54
	Otnituca	80–90	7.10	6.88	15.4	34.98	5.0	0.2	1.0	98.0	0.5	9.0	80	55	30	54
	Otnituca	100–110	7.15	6.96	7.8	14.23	5.4	0.1	0.7	43.0	0.5	10.1	71	32	21	50
	Otnituca	120–125	7.30	7.10	28.5	50.32	5.8	0.3	2.5	164.9	0.7	4.2	107	53	40	47
	Otnituca	140–150	7.22	7.00	24.8	39.43	3.6	0.1	2.0	130.1	0.5	5.1	64	25	34	58

CONCLUSIONS

1. Differentiation of ash, macronutrients, and microelements contents was recorded in analysed soil profiles – both between profiles and within them.
2. Performed studies revealed that, in general, the peat layers strongly silted with calcium, carbonate were characterised by the highest ash content, while peat horizons (sedge-moss peat) by the lowest.
3. In general, the surface layers of studied sols contained more potassium, iron, manganese, and lead than deeper ones. Strongly silted peat was characterised by higher calcium and potassium concentrations.

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ZAWARTOŚĆ MAKRO- I MIKROELEMENTÓW W GLEBACH TORFOWISKA BAGNO SEREBRYSKIE (GLEBY BAGIENNE)

Streszczenie. Badania prowadzono na terenie torfowiska Bagno Serebryskie położonego w województwie lubelskim, w gminach Chełm i Ruda Huta, a zgodnie z podziałem fizyczno-geograficznym leżącego w Obniżeniu Dubienki wchodzącym w skład Polesia Wołyńskiego. Bagno Serebryskie objęte jest ochroną prawną jako rezerwat przyrody i znajduje się na terenie Chełmskiego Parku Krajobrazowego i obszaru Natura 2000 Chełmskie Torfowiska Węglanowe. Badaniami objęto bagienne gleby wytworzone z torfu torfowiska niskiego turzycowiskowego (turzycowego i turzycowo-kłociowego i turzycowo-trzcinowego) oraz mechowiskowego (turzycowo--mszystego). Z 6 profili pobrano 36 próbek, w których oznaczono odczyn, popielność oraz zawartość makro- i mikroelementów. W analizowanych glebach stwierdzono zróżnicowanie zawartości popiołu oraz makro- i mikroelementów zarówno pomiędzy analizowanymi profilami, jak i w ich obrębie. Uzyskane wyniki zawartości makro- i mikroelementów są porównywalne (w przypadku większości makro- i mikroelementów) z wynikami analiz chemicznych gleb i osadów obiektów sąsiednich, tj. torfowisk doliny Uherki i torfowiska Cichy Kąt.

Słowa kluczowe: torfowisko, gleby bagienne, zawartość makro- i mikroelementów