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GEOBOTANICAL CONDITIONS OF GRASSLAND HABITATS IN THE SAMICA LESZCZYŃSKA RIVER VALLEY

Summary

The paper presents a complex characteristics of grassland communities situated in the valley of the Samica Leszczyńska River, in the village Błotkowo (Wielkopolskie Voivoidship, Leszczyński County). It contains a detailed description and interpretation of soil conditions and phytosociological research, which is connected with it. On the basis of phytosociological relevés, floristic composition of the sward was determined. The following communities were described: Phragmitetum australis, Scirpetum silvatici, Arrhenatheretum elatioris, Caricetum ripariae. Four soil profiles were made. Such soil parameters as pH, content of total carbon, soil texture, bulk density and particle density, total porosity, saturated hydraulic conductivity, maximal hygroscopic capacity, soil potential of binding water and its total and readily available water. The investigated soils represents various soil types. They were formed from peat sediments, moorshiefied in various stage, overlying gyttja (peat and moorsh soil types), as well as from river sediments (Haplic Fluvisol). Their trophism differed. The groundwater level in soils appeared on various depths. A system of basic physical and chemical properties was typical to Polish soils of similar origin, texture and organic matter content.
Key words: *grassland communities, floristic composition, soil properties, habitat*

WARUNKI GEOBOTANICZNE SIEDLISK ŁĄKOWYCH W DOLINIE SAMICY LESZCZYŃSKIEJ

Streszczenie

W pracy przedstawiono kompleksową charakterystykę siedlisk łąkowo-pastwiskowych usytuowanych w obrębie doliny Samicy Leszczyńskiej, na odcinku Murkowo-Błotkowo (województwo wielkopolskie; powiat leszczyński). Zawiera ona szczegółowy opis i interpretację warunków glebowych oraz, powiązanych z nimi, badań fitosocjologicznych. Przeanalizowano 38 zdjęć fitosocjologicznych. Wyróżnione syntaksony zidentyfikowano i zaklasyfikowano do systemu fitosocjologicznego. Sklasyfikowano następujące zbiorowiska: Phragmitetum australis, Scirpetum silvatici, Arrhenatheretum elatioris, Caricetum ripariae. Na badanym terenie wykonano 4 odkrywki glebowe. W pobranym materiale glebowym oznaczono takie właściwości, jak: pH, zawartość węgla ogólnego, skład granulometryczny, gęstość objętościową i fazy stałej gleby, porowatość całkowitą , współczynnik filtracji, maksymalną pojemność higroskopową, potencjał wiązania wody przez glebę oraz jej potencjalną i efektywną retencję użyteczną. Badane gleby reprezentowały różne typy. Wytworzone z osadów torfowych – w różnym stopniu zmurszałych - posadowionych na gytii reprezentowały gleby torfowe i murszowe, natomiast wytworzone z nanosów rzecznych zakwalifikowano jako mady właściwe. Ponadto charakteryzowały się zróżnicowaną troficznością. Zwierciadło wód glebowo-gruntowych występowało w nich na znacznie zróżnicowanych głębokościach. Układ podstawowych właściwości fizycznych i chemicznych był typowy dla gleb Polski o zbliżonych: genezie, uziarnieniu i zawartości materii organicznej.
Słowa kluczowe: *zbiorowiska łąkowe, skład florystyczny, właściwości gleb, siedlisko*

1. Introduction

The formation of grass communities, their wealth and floristic diversity, as well as natural and agricultural values depend mainly on soil moisture which results from the heterogeneity of communities, their trophism and the intensity of utilization [2, 4]. Floristic composition of grass communities and their biological diversity are also conditioned by the intensity of anthropogenic factor, including both intensification and lack of management.

Soils covered by grasslands are usually formed from organic materials (peat, organic mud or gyttja) [11] or alluvial sediments of various origin [14]. Their properties, which are an integral parameter of a habitat, depend mainly on the character of parent rock and air-water conditions. Key role is played also by climate and anthropopressure, which can modify the above mentioned factors [4, 18]. The aim of paper was to present complex geobotanical characteristics of grassland habitats situated in the valley of the Samica Leszczyńska River, having taken into consideration the connection between a phytosociological factor and soil properties.

2. Object and methodology

2.1. Floristic research

The research was carried out during a growing season in 2015 and conducted in a complex of grassland-pasture communities (ca. 150 ha) in the valley of the Samica Leszczyńska River, within Leszczyńska Upland, between Murkowo and Błotkowo (Wielkopolskie Voivodeship, Leszczyński County). The results were prepared on the basis of 38 phytosociological relevés taken with the classic Braun-Blanquet's method [1]. The identification of species was based on the nomenclature of *Polish Plant*s key, as well as on *Vascular Plant of Poland. A checklist* [9]. Exibited syntaxons were identified and classified to a phytosociological system according to Matuszkiewicz [8].

2.2 Soils science research

Soil cover of the object varied in terms of typology. Four different types of soils and plant communities which covered them were described: profile 1 – *Limnic Fibric Histosol*, soil covered by *Phragmitetum australis* complex; profile 2 - *Haplic Fluvisol* - *Scirpetum silvatici* complex; profile 3 – *Fluvic Cambisol* - *Arrenatheretum elatioris* complex; profile 4 – *Sapric Histosol* – *Caricetum ripariae* complex [3]. Agriculture and utility values were various. They were estimated at: VI bonitation class and 3z. complex of agricultural suitability (profile 1), IV class, 2z (profile 3), III class, 2z (profiles 2 and 4) [10]. In profile 1 water appeared on surface, in profile 2 at the depths of 0.8 m. In profiles 3 and 4 – up to the depth of 2.5 m no groundwater was found. The degree of peat material decomposition was determined in the field, using the von Post method [17]. Soil materials for laboratory analysis were sampled both, as disturbed and undisturbed soil samples, collected by genetic soil horizons. In soil samples following analysis were performed: soil texture of mineral soil horizons using the sieve-hydrometer method [12], particle density using the picnometric method and – in mineral-organic and organic horizons using Zawadzki's formula [15], bulk density using Nitzsh's stainless steel rings of 100 cm^3 capacity, total porosity was calculated on the basis of particle and bulk density [10], saturated hydraulic conductivity using the method of constant pressure loss [6], maximal hygroscopic capacity in a vacuum chamber at subpressure of 0.8 atm, with a saturated solution of K_2SO_4, soil water binding potential using the method of Richards' pressure chambers [5], total (TAW) and readily (RAW) available water based on the pF determination, content of total carbon using Vario Max CNS analyser and pH in 1M KCl (soil to liquid ratio of 1:2.5 v/v) potentiometrically. All the analyses were performed in five replications, results presented in tables represents mean values.

3. Results and discussion

3.1 Floristic research

The exhibited communities showed varied natural values. Their use and utility values were conditioned mainly by the moisturization of communities. Cultivated lands, covered by communities formed in the optimal environmental conditions with balanced use, were characterized by high harvest. This included a highly harvesting community with the domination of Phragmites australis i Caricetum ripariae, which was harvested at a level of 8.4-14.0 and 6.8-8.2 t.ha-1sm. Slightly lower, yet still high, harvesting was observed in Lolio-Cynosuretum glassland-pasture flora. Low utility value was ascertained in the area covered with Scirpetum silvatici community.

Phytosociological classification of the selected communities was:

Communities of rushes and salty *Carex* grasslands

1. Class: *Phragmitetea* R. Tx. et Prsg 1949
   Community of grassy rushes, *Magnocaricion*
   O.: *Phragmitetalia* Koch 1926
   All.: *Phragmition* Koch 1926
   Ass.: *Phragmitetum australis* (Gams 1927) Schmale 1939
   Magnocaricion
   All.: *Magnocaricion* Koch 1926
   Ass.: *Caricetum riparie* Soo. 1928
   Semi-natural and anthropogenic sod grassland and pasture communities
2. Class: *Molinio-Arrhenatheretea* R.Tx. 1937
   Group of moist grasslands, partially marshed
   Ass. *Scirpetum sylvatici Ralski 1931*
   Communities of fertile grasslands on fresh mineral soil
   O.: *Arrhenatheretalia elatioris* Pawł. 1928
   All.: *Arrhenatherion elatioris* (Br.-Bl. 1925) Koch 1926
   Ass. *Arrhenatheretum elatioris* Br.-Bl. ex Scherr. 1925

3.2 Soil properties

Investigated mineral topsoil horizons had sand (profile 3) or loamy sand (profile 2) texture (Tab. 1) [3, 13].

Content of total carbon was strongly diversified and depended on the type of a deposit, texture and degree of organic material decomposition (in case of peats and moorsh). In mineral horizons it was low: from 0.34 (Ck horizon in profile 4) to 14.2 $g·kg^{-1}$ (A horizon in profile 3). In peat horizons the values were very high and ranged from 141 in OiLc2 horizon in profile 1 to 560 $g·kg^{-1}$ in Oi horizon in profile 2, while in moorsh horizon recorded content of total carbon was lower – 140 $g·kg^{-1}$ (profile 4) (Tab. 2).

Soil reactions were very much diversified among the investigated soils. The values of pH were definitely low in surface soil horizons – from 4.49 (profile 3) to 5.79 (profile 4) – apart from profile 2 (pH 6.81), where the reaction of an epipedon was conditioned by a horizon of lime gyttja occurred at 26 cm. Reaction of mineral horizons differed from acidic (pH = 4.49) (profile 3; A) to alkaline (pH = 8.65) (profile 2; Lck). The pH values in peat and moorsh horizons oscillated within a wide range from 5.18 (profile 2; Oi) to 7.89 (profile 1; OiLc2) (Tab. 2).

Table 1. Texture of mineral soil horizons [3, 13]
Tab. 1. Uziarnienie poziomów mineralnych badanych gleb [3, 13]

Profile number	Soil horizon	Depth [cm]	Percentage content of particle-size fraction [mm]						Texture class acc.	
			2.0 - 0.10	0.10 - 0.05	0.05 - 0.02	0.02 - 0.005	0.005 - 0.002	<0.002	PTG 2008	FAO/ USDA
2	Ak	0-18	69	26	15	6	3	1	pg	LS
	ACk	18-26	45	29	18	6	1	1	pg	LS
3	A	0-49	87	3	3	4	1	2	ps	S
	Bw	49-72	9	21	28	12	17	13	pyi	SiL
	C	72-110	42	17	29	5	5	2	gp	SL
	Ck	138-160	95	2	1	1	1	0	pl	S
4	Ck	>210	96	2	1	1	0	0	pl	S

Explanation: S - sand, LS – loamy sand, SL – sandy loam, SiL – silty loam /
Objasnienia: pl – piasek luźny, ps – piasek słabo gliniasty, pg – piasek gliniasty, gp – glina piaszczysta, pyi – pył ilasty

Particle density of mineral soil horizons was in a narrow range 2.63 – 2.65 Mg·m^{-3}, and oscillated around the density of quartz [10]. In organic and mineral-organic horizons particle density values were between 1.62 (profile 2; Oi) and 2.22 Mg·m^{-3} (profile 1; OiLc2) (Tab. 2).

Soil bulk density and total porosity, which are strictly connected, depended mainly on the character of deposite, soil texture (mineral soils), content of total carbon and the degree of peat decomposition (organic soil horizons). Peat, moorsh and gyttja had low density and high porosity – from 0.36 Mg·m^{-3} and 81.9 % v (profile 3; Oe) to 0.84 Mg·m^{-3} and 61.8 %v (profile 4; M). In mineral soil horizons bulk density was much higher at a relatively lower porosity. Values of these properties were between 1.33 Mg·m^{-3} and 49,8%v (profile 4;Ck), and 1.64 Mg·m^{-3} and 38. 1%v (profile 3; Ck) (Tab. 2).

Saturated hydraulic conductivity was rather balanced – from 4.1 (profile 1; OiLc1) to 19.7 µm·s^{-1} (profile 4; Oa2). Its values grew only in sand textured horizons in A horizon in profile 3 (37.2 µm·s^{-1}) and from 74.2 to 107 µm·s^{-1} in profile 3, Ck horizon and profile 4, Ck horizon, respectively (Tab. 2). Observed values were similar to those reported by various authors, for soils of similar origin and texture [7, 18].

Natural moisture of the soils was high – from 48.1 (profile 4; Oa1) to 79. 6%v (profile 1; Oi) in peat and gyttja horizons. Lower values of it were found in moorsh – 41.2 %v (profile 4; M). The lowest natural moisture was observed in mineral soil layers, where it oscillated between 10.0 (profile 3; Ck) and 28. 9%v (profile 3; Bw) (Tab. 2).

Maximal water capacity was by a few percent (ca. 2-3%) lower than total porosity in all the genetic soil horizons. Field water capacity (pF 2.0) in peats was high: from 42.08 (profile 4; Oa3) and 69.50%v (profile 1; OiLc1). At pF 2.5 respective values were lower (from 6.53%v – profile 4; Oa3 to 32.58%v – profile 1; OiLc2). Distribution of these moistures in gyttja and moorsh was similar. Far lower **c**apacity was found in the mineral layers, where the values oscillated from 6.75% – sand (profile 3; Ck) to 24.33 %v – loamy sand (profile 2; ACk). At the pF 3.7 and at the permanent wilting point (pF 4.2), moistures dropped and sustained the highest values in organic deposits. They were, respectively, from 3.89 and 2.25%v (profile 3; Ck – sand) to 38.70 – pF 3.7 (profile 1; Oi – fibric peat) and 24.11%v – pF 4.2 (profile 3; Oe – hemic peat) (Tab. 3). Maximal hygroscopic capacity (MH – pF 4,5) was within a wide range from 0.98 (profile 4; Ck – sand) to 15.60%v (profile 1; OiLc1 – peat/gyttja). The values of MH depended significantly on texture and content of total carbon. Along with the growth of the content of colloid fraction (mineral and organic), MH also grew (Tab. 1, 2, 3).

Indices of readily and total available water, calculated on the basis of pF determination, were on a level which is typical for Polish soils of given origin, texture and content of organic matter [16]. In the investigated mineral deposits, RAW oscillated between 3.57 (profile 3; Ck – sand) to 12.46%v (profile 3; Bw – silty loam) at TAW from 5.04 to 15.45 (in the same cases). In peat, gyttja and muck, the indices were far higher: for RAW from 11.55 (profile 4; Oa2 – sapric peat) to 40.02%v (profile 3; Lck - gyttja), at TAW from 26.58 (profile 4; Oa4 - peat) to 49.21%v (profile 3; Lck - gyttja). What should be emphasized, is the fact that – in case of organic deposits – a significant part of water accessible for plants was bond with strong forces (pF 3.7 – 4.2) (Tab. 3).

Table 2. Basic properties of studied soils
Tab. 2. Podstawowe właściwości badanych gleb

Profile number	Soil horizon	Depth [cm]	Natural moisture [%v]	Particle density [Mg·m^{-3}]	Bulk density [Mg·m^{-3}]	Total porosity [%v]	Saturated hydraulic conductivity [µm·s^{-1}]	pH in 1M KCl	Total carbon [g·kg^{-1}]
1	Oi	0-14	79.6	1.75	0.37	78.9	12.4	5.73	320
	OiLc1	14-80	75.4	2.21	0.52	76.5	4.1	6.87	160
	OiLc2	80-150	72.9	2.22	0.56	74.8	5.8	7.89	141
2	Ak	0-18	19.6	2.63	1.47	44.1	7.4	6.81	11.8
	ACk	18-26	16.7	2.65	1.53	42.3	4.2	7.87	9.20
	Lck	26-51	58.7	2.63	0.80	69.6	11.2	8.65	3.90
	Oi	51-75	69.8	1.62	0.41	75.6	15.6	5.18	560
3	A	0-49	12.5	2.64	1.38	47.7	37.2	4.49	14.2
	Bw	49-72	28.9	2.65	1.62	38.9	4.5	4.87	4.70
	C	72-110	16.3	2.65	1.56	41.1	4.9	5.19	2.02
	Oe	110-130	63.8	1.99	0.36	81.9	10.2	6.47	391
	Lck	130-138	59.8	2.16	0.50	76.9	5.4	7.07	280
	Ck	138-160	10.0	2.65	1.64	38.1	74.2	7.28	0.56
4	M	0-29	41.2	2.20	0.84	61.8	11.3	5.79	140
	Oa1	29-36	48.1	1.86	0.42	77.4	13.2	6.80	351
	Oa2	36-77	51.3	1.84	0.45	75.5	19.7	7.15	360
	Oa3	77-188	61.7	1.74	0.50	71.3	17.9	7.22	390
	Oa4	180-210	67.9	1.70	0.52	69.4	11.4	7.06	400
	Ck	>210	28.8	2.65	1.33	49.8	107,0	6.90	0.34

Source: own work / Źródło: opracowanie własne

Table 3. Soil water potentials and the readily and total available water
Tab. 3. Pojemności wodne oraz efektywna i potencjalna retencja użyteczna

Profile number	Soil horizon	Depth [cm]	Water capacity at pF [%v]						Readily available water [%v]	Total available water [%v]
			0.0	2.0	2.5	3.7	4.2	4.5	2.0 – 3.7	2.0 – 4.2
1	Oi	0-14	75.80	50.51	42.12	38.70	22.30	8.11	11.81	28.21
	OiLc1	14-80	74.21	69.50	37.44	31.20	20.31	15.60	38.30	49.19
	OiLc2	80-150	72.37	66.23	33.65	29.80	22.14	13.24	36.43	44.09
2	Ak	0-18	42.46	17.45	15.88	9.79	7.24	3.67	7.66	10.21
	ACk	18-26	40.12	16.57	24.33	9.15	6.76	2.34	7.42	9.81
	Lck	26-51	67.21	57.01	53.20	32.13	15.47	10.18	24.88	41.54
	Oi	51-75	73.54	53.66	46.39	33.27	16.54	8.41	20.39	27.12
3	A	0-49	44.54	12.67	11.28	7.74	5.47	1.88	4.93	7.20
	Bw	49-72	36.78	28.73	23.85	16.27	13.28	4.62	12.46	15.45
	C	72-110	38.77	25.01	21.71	13.50	9.93	3.00	11.51	15.08
	Oe	110-130	79.20	62.30	52.11	35.70	24.11	15.41	26.60	38.19
	Lck	130-138	73.90	68.76	35.61	28.74	19.55	13.21	40.02	49.21
	Ck	138-160	36.69	7.46	6.75	3.89	2.25	1.17	3.57	5.04
4	M	0-29	58.09	51.41	40.21	30.25	15.40	10.87	21.16	36.01
	Oa1	29-36	73.28	48.70	40.54	35.60	19.80	12.90	13.10	28.9
	Oa2	36-77	71.40	45.32	38.50	33.77	16.11	10.30	11.55	29.21
	Oa3	77-188	67.14	42.08	35.55	29.80	14.01	9.80	12.28	28.07
	Oa4	180-210	66.51	44.12	36.57	31.20	17.54	10.84	12.92	26.58
	Ck	>210	46.75	9.24	8.47	4.76	2.42	0.98	4.48	6.99

Source: own work / Źródło: opracowanie własne

4. Summary

Grass and carex communities in the valley of the Samica Leszczyńska River form various ecosystems. Their formation, harvesting, arable and natural value as well as wealth and floristic diversity are conditioned mainly by soil moisture, which results from the heterogeneity of environments and the intensity of utilization.

Properties of the studied soils were typical for Polish mineral and organic soils of similar origin, texture and content of organic matter. These traits influenced the soil water and physical properties, as well as diverse agricultural values. These soils provided a good air-water conditions for flora, although often a significant part of their retention was a difficultly available water. Soil moisture of surface genetic horizons strongly determined floristic composition of the communities.

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