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FLORAL AND HABITAT DIVERSITY OF ECOLOGICAL GRASSLANDS IN THE BYSTRA NOTEC VALLEY

Summary

The paper presents floral and soil diversity of selected soils of ecological grasslands in the Bystra Noteć Valley. The state of vegetation cover was described on the basis of floral composition and such soil properties as the: content of organic matter, specific density, soil density, total porosity, maximal hygroscopic capacity, soil potential of water bonds, total and readily available water and reaction were analysed. The analysed soils showed high diversity in the scope of the examined properties. They resulted mostly from the content and state of transformation of organic matter. Meadow grasslands were diversified in terms of flora and natural qualities. They were dominated by species characteristic to Phragmitetea class. The highest floral diversity was observed on grasslands from Phalaridetum arundinaceae group H'=3,1of medium natural qualities. It depended mostly on current habitat and agricultural use.
***Key words**: habitat conditions, floral communities, soil properties*

ZRÓŻNICOWANIE FLORYSTYCZNE I SIEDLISKOWE EKOLOGICZNYCH UŻYTKÓW ZIELONYCH W DOLINIE NOTECI BYSTREJ

Streszczenie

W pracy przedstawiono zróżnicowanie florystyczne i glebowe wybranych gleb ekologicznych użytków zielonych w Dolinie Środkowej Noteci. Scharakteryzowano stan pokrywy roślinnej na podstawie składu florystycznego oraz przeanalizowano takie właściwości gleb, jak: zawartość materii organicznej, gęstość fazy stałej, gęstość gleby, porowatość całkowita, maksymalna pojemność higroskopowa, potencjały wiązania wody przez glebę, potencjalna i efektywna retencja użyteczna oraz odczyn. Analizowane gleby wykazywały silne zróżnicowanie w obrębie badanych właściwości. Wynikały one głownie z zawartości i stopnia przeobrażenia materii organicznej. Zbiorowiska łąkowe wykazały zróżnicowanie florystyczne oraz zróżnicowanie walorów przyrodniczych. Dominowały na nich gatunki charakterystyczne dla klasy Phragmitetea. Najwyższą różnorodnością florystyczną charakteryzowały się łąki zespołu Phalaridetum arundinaceae H'=3,1, o średnio umiarkowanej wartości przyrodniczej. Uzależnione było to w głównej mierze od aktualnie panujących tam warunków siedliskowych i użytkowania.
***Słowa kluczowe**: warunki siedliskowe, zbiorowiska roślinne, właściwości gleby*

1. Introduction

Changing habitat conditions such as moisturization level, trophism, geomorphological structure and climate play an important role in forming and diversifying the flora of phytocenoses [8, 9, 10, 15]. River freshets and their frequency is one of the most important factors which influences forming and changes in the structure of phytocenoses [4]. These changes often have a form of degeneration and regression. Human and his activity – especially intensity and kind of tillage – have large influence on changes in the flora of river valleys and habitat formation [10]. According to numerous research, both abandonment and excessive use, cause a total change in the species structure of flora [28]. Humidity and, what is strictly connected with it – content of organic matter – are also important soil-forming and, what follows, habitat-forming factors. They gain special importance in case of river valleys ecosystems often formed on hydrogenic soils. The aim of the research was to characterize floral variability and natural qualities of Bystra Noteć Valley against soil conditions.

2. Object and methodology

Terrain research was conducted in the vegetation season of 2014 in Marianowo (a town in Wielkopolski Voivodeship, czarnkowsko-trzcianecki district, Krzyż municipality). The object of the research was located in the valley of Bystra Noteć within 100-160 m from the river. On the basis of soil-agriculture maps of 1:5000 scale, 4 profiles of variable and formed by water and air conditions systematic adherence were located and then done. Two soils (profiles 1 and 4) represented Umbric Gleysol whereas the other two (profile 2 and 3) - Sapric Histosol [12]. In case of Umbric Gleysol, epipedones were built of mucky deposits of 20 and 18 cm thickness of alluvial sands, which lay directly on the mineral ground. Surface horizons of organic soils were of mucky character; they lay narrowly on strongly decomposed peat and deeper transformed into sands [6]. All the allotments were utilized as grasslands. Profiles 1 and 4 were classified to the 5th soil quality class and 3z complex of agricultural suitability whereas profiles 2 and 3 – to the 4th soil quality class and 2z complex of agricultural suitability [22]. The presence of soil-ground water in the soil profile was only confirmed in case of organic soils (profiles 2 and 3). It lay at the depth of 0.90 and 0.85 [m] in profiles 2 and 3, accordingly (tab.4). In accordance with the classification proposed by Rząsa et al. [27], this fact classifies these allotments to water-precipitation management (profiles 1 and 4) and alternating one – profiles 2 and 3. Samples of affected and of intact structure were collected from each genetic horizon. Such properties were defined as specific density (with pyctometric method in mineral deposits [22] and according to Okruszko's pattern [25] in mineral-organic and organic deposits), soil density – with Nitsche's vessels of 100cm^3 capacity, total porosity (calculated on the basis of specific and soil densities [22], maximal hygroscopic capacity – in a vacuum chamber of 0.8 atm vacuum and with K_2SO_4 saturate solution, soil's water bond potential – with Richard's method of vacuum chambers [18], total (TAW) and readily (RAW) available water were calculated on the basis of pF markings and the content of organic matter – by weight on the basis of ignition loses. All the published results are the averages of five replications. Floral research was conducted in the vegetation season of 2014 and included:

- phytosociological research - taking 33 phytosociological relevés with Braun-Blanquet's method on the areas of 10x10m^2. The selected phytocenoses were classified to the phytosociological system according to Matuszkiewicz [21];
- floral variation of the groups was done on the basis of the analysis of species composition i.e. botanical structure (in percentage), a total number of species in the phytocenosis, an average number of species in a phytosociological relevé and calculation of Shannon-Weiner's variability indicator according to the pattern $H' = -\sum (pi \times \log pi)$,

where : H'- Shannon – Wiener's indicator,

Σ – number of all species in a phytocenosis

pi - number of species' appearance in a relevé

- calculating the number of natural valorisation which was estimated in valorisation classes according to Oświt [26].

3. Results

Characteristics of the selected phytocenoses

A number of phytocenoses were selected in the valley of Brystra Notec in Marianowo and classified to the phytosociological system according to Matuszkiewicz [21] (table 1).

Currently, the largest areas in the examined grasslands are occupied by phytocenoses from *Phragmitetea* class: *Phalaridetum arundinaceae*, *Glycerietum maximae*, *Caricetum gracilis*, *Caricetum acutiformis* and *Eleocharietum palustris*. Among the selected phytocenoses, groups of *Glycerietum maximae* and *Caricetum gracilis* are the most developed in the most typical form, which is connected with their location in a valley and their habitat. Their floral composition is dominated by species characteristic to *Phragmitetea* class. Flora of *Phalaridetum arundinaceae* groups is strongly diversified, especially in wet habitats, which is typical for this group, whereas species composition of those located in drier habitats is similar to alopecurus grasslands. In the recent years, significant changes in habitats' moisturization have been observed; they are connected with extensive utilization and climate conditions (lack of backwaters). The most visible floral diversity was observed in the grasslands of *Phalaridetum arundinaceae* H'=3,1. Owing to this fact, a floral structure of undergrowth contains almost 72.2 % of popular synathropic species (table 2).

Undergrowth of some habitats of *Phragmitetea* class have resisted excessive anthropic pressure and therefore have maintained significant natural qualities. Now these habitats are lies for water birds. Current natural value of most of these habitats is moderately high of valorisation classes VIC and VI. Carex habitats show moderate natural qualities of valorisation class IVB (table 3). In accordance with soil systematics valid to 2011, all the soils chosen for the analysis would be classified as hydrogenic soils [29]. This section contained units whose origin and evolution were strictly connected with air-water conditions [22]. A group of these parameters, especially moisture and the depth of soil-ground water, forms the most important quality of such deposits i.e. the amount and quality of organic matter. The dominating influence of organic matter on physical and water properties was already noticed and emphasized in the previous research [11, 23]. The content of organic matter in the analyzed soils varied strongly, which was also visible in the profile setup. Epipedones of mucky soils contained 60.2 and 71.4 g·kg^{-1} of organic matter. It was much higher in the epipedons of organic soils where it amounted from 216.7 to 282.2 g·kg^{-1}. Minor amount of organic matter – from 12.0 to 20.1 g·kg^{-1} – was found in sandy endopedones. This property was completely different in organic endopedones of organic soils, though. They were built of sapric peat and the content of organic matter was 474.1 and 657.7 g·kg^{-1} (table 4). The content of organic matter, its character and vertical, profile amount distribution are an evidence of dehydration in the examined area. The problem of natural dehydration caused by low precipitation and, as a consequence, systematic decrease of soil-ground waters, was also noticed by Rząsa et al. [27].

Table 1. Phytosociological classification of featured plant communities

Tab. 1. Klasyfikacja fitosocjologiczna wyróżnionych zbiorowisk

Plant association	Number of relevés	[%]
Phragmitetea R.Tx.et Persg 1942		
Phragmitetalia Koch 1926		
Phragmition Koch 1926	2	
Glycerietum maximae Hueck 1931	5	3,6
Eleocharietum palustris Šennikov 1919		7,9
Magnocaricion Koch 192	2	
Caricetum acutiformis (Sauer 1937)	11	14,2
Caricetum gracilis (Graebn.et Hueck 1931) R.Tx.1937	7	33,3
Phalaridetum arundinaceae (Koch 1926 n.n.)Libb.1931	6	41,00

Source: own work / Źródło: opracowanie własne

Table 2. Floral diversity of the selected phytocenoses

Tab. 2. Różnorodność florystyczna wyróżnionych zbiorowisk roślinnych

Plant community	Number of plant species		H'	Participation of synanthropic species [%]
	Total	Mean in relevés		
Phalaridetum arundinaceae	28	11 (10-12)	3.1	72.2
Glycerietum maximae	7	-	-	51.0
Eleocharietum palustris	16	8.0 (5-11)	2.6	70.6
Caricetum acutiformis	21	12.0 (8-16)	2.1	61.8
Caricetum gracilis	18	11.0 (10-12)	1.6	73.3

Source: own work / Źródło: opracowanie własne

Table 3. Nature value index according to Oświt [26]
Tab. 3. Wskaźnik waloryzacji przyrodniczej według Oświta [26]

Plant community	The average rate of value	Class valorisation	Natural values
Phalaridetum arundinaceae	3.4	VIC	Moderately high
Glycerietum maximae	1.7	II	Medium low
Eleocharietum palustris	3.1	VI	Moderately high
Caricetum acutiformis	2.4	IVB	Moderate
Caricetum gracilis	2.6	IVB	Moderate

Table 4. Basic physical properties of analysed soils
Tab. 4. Podstawowe właściwości fizyczne analizowanych gleb

Profile No	Genetic horizon	Depth [cm]	Organic matter [g·kg^{-1}]	Specific density [Mg ·m^{-3}]	Bulk density [Mg ·m-3]	Total porosity [m^{3}·m^{-3}]	pH in 1M KCl	Ground water level [m]
1.	Au	0-20	60.2	2.48	0.92	0.6290	5.7	1.90
	C1	20-41	15.0	2.65	1.52	0.4264	5.5	
	C2	41-100	12.0	2.65	1.64	0.3811	5.4	
2.	M	0-30	282.2	2.24	0.71	0.6830	5.8	0.90
	Oa	30-78	474.1	2.03	0.60	0.7044	6.2	
	C1	85-102	18.2	2.65	1.66	0.3736	5.5	
	C2	102-115	14.4	2.65	1.71	0.3547	5.4	
3.	M	0-45	216.7	2.31	0.70	0.6970	5.8	0.85
	Oa	45-80	657.7	1.83	0.52	0.7158	6.2	
	C1	80-120	20.1	2.65	1.62	0.3887	5.5	
	C2	120-150	16.1	2.65	1.74	0.3434	5.6	
4.	Au	0-18	71.4	2.47	0.82	0.6680	5.6	1.70
	C1	18-62	18.2	2.65	1.54	0.4189	5.4	
	C2	62-100	13.4	2.65	1.63	0.3849	5.4	

Source: own work / Źródło: opracowanie własne

These authors emphasize the impact of those transformations on the properties of hydrogenic soils – mainly, on the decession of organic matter and lower quality of physical properties, whereas Jankowska-Huflejt [14] focuses on the connection between these transformations and flora's species composition. Specific density decreased along with the increase of organic matter. This dependence stemmed from the pattern for the calculation of this trait on the basis of Okruszko's pattern [25]. Ilnicki [11], among all, claims the reasons for using the pattern instead of the pyctometric method. The author pays attention to the difficulties connected with the venting the sample. It was also proved by long-term laboratory experience of the paper's authors. In mucky and peat depositions its parameter oscillated between 1.83 and 2.48 Mg·m^{-3}. In sandy ground, probably due to the domination of quartz in mineral composition and low content of organic matter, specific density was 2.65 Mg·m^{-3} (table 4). Clear influence of organic matter was also visible in case of density and total porosity. In mucky epipedones (profiles 1 and 4) density was higher (0.92 and 0.82 Mg·m^{-3}) and total porosity - lower (0.6290 and 0.6680 m^{-3}·m^{-3}) than in mucky horizons (profiles 2 and 3) where these parameters were, respectively, 0.71 and 0.70 Mg·m^{-3}, and 0.6830 and 0.6970 m^{3}·m^{-3}). In peat endopedones density amounted to 0.52 (profile 3) and 0.60 (profile 2) Mg·m^{-3} and the corresponding total porosities: 0.7158 and 0.7044 m^{3}·m^{-3} (table 4). Similar values of the presented parameters were also gained by the author [1.31]. The results of density and porosity, confronted with the content of organic matter, prove unfavourable changes in the triphase soil setup. A visible increase of density and decrease of porosity may be observed. It is probably connected with the mucking process of maternity organic materials which is taking place in the analyzed deposits. Similar changes were also described by Bieniek and Łachacz [2], whereas Włodarczyk and Witkowska-Walczak [31] pay attention to the fact that the conditions in which they emerge influence the quality of mucks. The influence of peat soils mucking was also observable in reaction changes.

Ilnicki [11] noticed that this process causes increase of acidification. This was confirmed by the obtained results – pH of mucky epipedones was lower than pH of peats located beneath (table 4). Some authors [20] claim that there is a possibility of leaching calcium from the organic soils as a result of acidification processes connected with the mineralisation of organic compounds. Higher pH values in peats can also be a result of soil-ground waters, rich in alkaline cations, which appear in these horizons periodically. Growth of pH is explained with such a phenomenon by Nicia et al [24]. From an agricultural and natural point of view, soil's retention capabilities are one of the most important parameters. They are formed by total porosity, which – in hydrogenic habitats – is determined by the content and quality of organic matter. Apart from productive functions, in hydrogenic habitats, water plays also an important role as a soil-forming factor [24]. Nicia et al. [24] noticed that water is an important habitat factor which has impact on flora's species composition. Maximal water capacity differed significantly in the examined soils. It was of 1-3% v/v lower than total porosity which stemmed the fact that the air was not fully pressed out of pores during their saturation with water [11].

Table 5. Soil water bonds and the total and readily available water
Tab. 5. Potencjał wiązania wody przez glebę oraz efektywna i potencjalna retencja użyteczna

Profile No	Genetic horizon	Depth [cm]	Water capacity at pF [%]					RAW [%]	TAW [%]
			0.0	2.0	3.7	4.2	4.5	2.0-3.7	2.0-4.2
1.	Au	0-20	60.30	39.28	29.12	25.14	11.14	10.16	18.14
	C1	20-41	41.12	12.10	3.50	2.20	1.02	8.60	9.90
	C2	41-100	37.14	9.31	3.30	2.09	1.04	6.01	7.22
2.	M	0-30	67.20	57.87	45.17	29.80	15.14	12.70	28.07
	Oa	30-78	68.99	61.47	45.98	32.38	20.31	15.49	29.09
	C1	85-102	35.21	11.12	4.20	2.50	1.32	6.92	8.62
	C2	102-115	33.98	10.09	4.01	2.14	1.21	6.08	7.95
3.	M	0-45	67.81	52.17	41.12	27.41	15.07	11.05	24.76
	Oa	45-80	70.36	65.09	47.17	33.18	24.17	17.92	31.91
	C1	80-120	37.40	13.14	3.20	2.24	1.41	9.94	10.90
	C2	120-150	33.38	11.34	3.07	2.01	1.20	8.27	9.33
4.	Au	0-18	65.08	44.41	35.18	28.15	14.38	9.23	16.26
	C1	18-62	40.27	10.01	4.11	2.31	1.08	5.90	7.70
	C2	62-100	37.12	9.87	3.17	2.19	1.14	6.70	7.68

Source: own work / Źródło: opracowanie własne

Moisture corresponding to field water capacity (pF 2.0) – apart from the mineral ground – oscillated from 39.28% (Au, prof. 1) to 65.09% (Oa, prof. 3). Higher values are given by Jaros [13]. In footwall sands, moisture at field water capacity was much lower: from 9.31 to 13.14% v/v. The figures show that in mucky epipedones at field water capacity, moisture was lower than in peats and was decreasing along with the growth of transformation level. It is an evidence of unfavorable changes – the increase of the number of micropores - in drainage porosity as an effect of muckying. Similar observations were also done by Bieniek et al. [3]. The authors associate it with the development of fine grained structure, which is typical to musky deposits. Moisture corresponding to the point of easily available water – pF 3.7 – in epipedones oscillated between 29.12 (profile 1) and 45.17 %v/v (profile 2), whereas in peats – around 46 - 47% v/v. Moisture corresponding to the wilting point – at pF 4.2 – was of about 4-15% v/v lower. Apart from the mineral ground, maximal hygroscopic capacity was very high and oscillated around 11-24 % v/v (tab. 5). The obtained water capacities served for the calculation of soils' capability for the retention of readily and total available water. In the most important epipedones from the floral productive point of view, readily available water was between 9.23 (Au, prof. 4) and 12.70% v/v (M, prof. 2). In highly decayed peats it was higher: 15.49 and 17.92 %. Taking into consideration strongly bound water, total available water was higher and oscillated from about 16-28% (in epipedones) and 29 and 32%v/v in peats (table 5). From an agrotechnical and natural point of view, such distribution of water capacities seems "impractical". Large part of water is not easily available and does not play a productive role. Low readily available water may also be connected with the periods of water deficiency in the vegetation season. Large amount of strongly bound water in peats was also noticed by Gnatowski et al. [7]. Kalisz et al. [16] discuss transformations in dehydrated peats in terms of their hydrophobicity. Wallis and Horne [30] claim that hydrophobic organic substances in the top horizon may contribute to the decrease of water absorptivity (the appearance of hydrophobe). Lichner et al. [19] emphasize that such transformations lead to the debilitation of retention capabilities. The issue was also raised by Doerr et. al. [5]. According to the mentioned authors, hydrophobe may limit infiltration and boost erosion. Another aspect of proper water relationships in peats is emphasized by Kechevarzi et al. [17]. Authors claim that they are crucial in the protection and balanced management of these lands.

4. Summary

The examined grass and reed areas located in the valley of Bystra Notec vary in terms of flora and have a moderate natural value. Their formation, richness, flora's diversity and natural and agriculture qualities are influenced mainly by moisturization which is the result of habitats' mosaicism and tillage intensity. The investigated soils formed in hydrogenic habitats were characterized by high content of organic matter. Simultaneously, the presence of mucked epipedones proved the ongoing dehydrating degradation in the area. Large differences in the content of organic matter formed other soil properties. Along with its growth, specific soil density was decreasing, whereas total porosity and retention capabilities – increasing. Despite significant potential water bond abilities, the amount of water available for plants was low. Such unfavourable water properties were probably the effect of changes in differential porosity (decrease of mezopores number) as a result of organic matter transformation. This valuable area – from an ecological point of view - needs special protection which should focus on how to block already advanced degradation. Proper tillage in the area may be a key element of the protection strategy.

5. References

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