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THE INFLUENCE OF HABITAT CONDITIONS ON THE DEVELOPMENT AND FLORAL DIVERSITY OF GRASS COMMUNITIES

Summary

This study is devoted to floral and soil science research conducted in Samica Leszczyńska Valley (Dolina Samicy Leszczyńskiej). The investigated hydrogenic soils contained a large amount of organic substance. It determined low specific density, low bulk density and high total porosity. Furthermore, water capacity was high at each pF potential, also within highly-bound water. Despite high soil-ground water level, the process of moorshing process has already begun the investigated soils. In epipedones, negative effects of organic matter decession were visible, especially the decrease of porosity and the increase of acidification. The investigated area is endangered with natural dehydrating degradation. Taking into consideration its unique ecological character, it requires special protection.
***Key words**: hydrogenic soils, plant community, habitat conditions, floral variety*

WPŁYW WARUNKÓW SIEDLISKOWYCH NA WYKSZTAŁCENIE SIĘ I ZRÓŻNICOWANIE FLORYSTYCZNE ZBIOROWISK TRAWIASTYCH

Streszczenie

Przedstawiono wyniki badań florystycznych i gleboznawczych, przeprowadzonych w Dolinie Samicy Leszczyńskiej. Badane gleby hydrogeniczne charakteryzowały się dużą zawartością materii organicznej. Cecha ta determinowała niską gęstość fazy stałej, niską gęstość gleby oraz wysoką porowatość całkowitą. Wysoka była także pojemność wodna przy poszczególnych potencjałach pF, również w zakresie wody silnie związanej. Pomimo wysokiego zalegania zwierciadła wód glebowo- gruntowych badane gleby objęte zostały już procesem murszenia. W epipedonach widoczne były negatywne efekty decesji substancji organicznej, przede wszystkim spadek porowatości i wzrost zakwaszenia. Obszar badań zagrożony jest naturalną degradacją odwodnieniową. Zważywszy na jego unikalny, ekologiczny charakter wymaga on szczególnej ochrony.
***Słowa kluczowe:** gleby hydrogeniczne, zbiorowisko roślinne, warunki siedliskowe, różnorodność florystyczna*

1. Introduction

In Wielkopolska landscape, Samica Leszczyńska Valley is a noteworthy area, with unique nature and rich flora. The state of Central Polish Plains' flora has changes significantly over the last decades. Bad amelioration and intensive agricultural management led to deep and irreversible changes in green habitats [24]. The main factors which influence the floral diversity are soil conditions, moisturization and intensification of usage [5, 6, 10, 18]. These factors work complex and sometimes contribute to large mosaicism of habitats. Moisturization is also one of soil-forming factors [16]. Air-water conditions influence mainly the properties of organic and mineral-organic soils, which are often covered with agricultural grassland. These soils usually contain a lot of organic substance. Organic soil mass is accumulated in constant or periodical anaerobiosis which undergoes mineralization and moorshing process at the presence of oxygen [8, 19]. These processes are accompanied by changes in physical, chemical and biological properties of soils, which further contribute to floral changes. The bond between soil forming processes and the flora of grasslands is also emphasized by Kryszak et al. [15]. The aim of the research was to prove the influence of habitat conditions and utilization on the formation of floral variety in naturally valuable grass habitats in Samica Leszczenska Valley.

2. Research object and methodology

Floral and habitat research were conducted in the vegetation period of 2012-2013 in Samica Leszczynska Valley, nearby Sepno, in Poznanski district.

2.1. Habitat research

Four soil profiles were done and described. All the analyzed soils were used as arable land. They were described as the 4th and 5th soil quality class and 2z and 3z complex of soil utility complex. Epipedones were represented by muck horizons of various organic matter content. They lay on a ground composed of loose sands (prof. 1 and 2) or on rush peats in different stadiums of disaggregation (prof. 3 and 4). Profiles 1 and 2 represented Molic Gleysol, whereas profiles 3 and 4 were represented by organic soils and, respectively, Hemic Sapric Histosol (Dranic) and Sapric Histosol Dranic [23].

From individual genetic horizons, samples of affected and intact structure were collected. Such properties were defined: specific density (with a picnometric method in mineral formations [16] and according to Okruszko's model in mineral-organic and organic formations [20], bulk density (with Nitzsh's cylinders of 100 cm^3), total porosity (on the basis of specific and bulk densities [16], maximal hygroscopic capacity (in a vaccum chamber of 0,8atm vacuum and with a saturated solution of K_2SO_4), water bonding potential (with Richard's vacuum chamber method [13]; total (TAW) and readily (RAW) available water were calculated on the basis of pF, the content of organic substance – by weigh, on the basis of ignition loss. All the results are average from five replications.

On the basis of the analysis of 27 phytosociological plots, habitats were classified into 4 groups of various moisturization levels: I. Farm valuable communities of wet and humid localities, II. Farm valuable communities of fresh and humid localities, III. Farm moderately and poorly valuable communities of wet and marshy localities, IV. Farm moderately and poorly valuable communities of strongly humid and flooded localities.

2.2. Floristic research

Apart from habitat research, floral variability of the selected grassland habitats was assessed by the analysis of: their species composition i.e. their botanical structure and floristic utilization groups (in %), a total number of species in the habitat, an average number of species in a phytosociological plots. Furthermore, green growth of habitats was assessed in respect of their performance in the first crop in $t \cdot ha^{-1}$, in respect of potential annual crop in $t \cdot ha^{-1}$ and their utility value which was calculated on the basis of the floristic composition and the numbers of species utility values according to Filipek [3].

3. Results

A very important habitat forming factor, which also determines air-water relations, is the level of soil-ground water [4]. This property forms soil humidity and therefore, determines soil forming processes. Numerous authors [12, 24] point out that this trait determines the susceptibility of hydrogenic soils to dehydration. As it was noticed by Rząsa et al. [24], unfavorable moisture changes are one of the main factors which lead to the degradation of green growth of grasslands. In the examined soils, ground water level was between 0,45 and 0,80 m (tab. 1). These lands were characterized with ground and precipitation-ground water management [24]. Despite high ground water level, the process of organic substance decession was very noticeable which was very visible in the number of moorshes epipedones.

The moorshing process is composed of decession and humification of organic substance. It is accompanied by changes in physical, chemical and biological properties [8]. This often natural process starts when the conditions of anaerobiosis are broken – caused by the excess of free (gravity) water. It can also be significantly accelerated as a result of rash anthropogenic actions eg. intensive utilization. The soils on which the research was conducted, excluded from agricultural exploitation, though, are still endangered with dehydrating degradation. It was proved by Rząsa et al. [24]. The authors claim that low precipitation and, what follows, lowering of ground water level, are one of the main factors which lead to natural dehydration. Jankowska-Huflejt [9] also reports this problem. This author suggests that the ongoing degradation of organic soils consistently contributes to the changes in botanical composition of grasslands. She also emphasizes crucial functions which they have in the protection and formation of environment. Therefore, there is no doubt that the examined area requires special protection, taking into consideration its unique ecological character and climate and hydrological conditions.

In hydrogenic soils, the basic factor which shapes physical and chemical properties, is the amount and level of dissolution of organic substance [8, 17]. In the epipedones of the analyzed soils, the content of organic substance oscillated between 32,5 and 172,5 $g \cdot kg^{-1}$. In endopedones below them, this property varied significantly and depended in their character (type). In loose sands, respectively, (profile 1 and 2) the presence was 13,9 and 3,0 $g \cdot kg^{-1}$, whereas in sapric peat (profile 3) and hemic peat (profile 4): 302,1 and 802,0 $g \cdot kg^{-1}$, respectively (tab. 1). Specific density in mineral-organic and organic horizons was linearly correlated with the content of organic matter (tab. 1). Such a strong connection was a result of the marking method (Okruszko's model) [12], yet it appears to be the most appropriate taking into consideration methodological problems while deaeration of organic soil samples while conducting the analysis with a pictonometric method [8]. Specyfic density in mineral-organic and organic horizons oscillated between 1,67 and 2,61 $Mg \cdot m^{-3}$. In the mineral bed, it was typical for the formations of similar origin and

Table. 1. Basic physical and chemical properties
Tab. 1. Podstawowe właściwości fizyczne i chemiczne

Profile No	Genetic horizon	Depth [cm]	Organic substance [$g \cdot kg^{-1}$]	pH in 1M KCl	Specific density [$Mg \cdot m^{-3}$]	Bulk density [Mg ·m-3]	Total porosity [%]	Ground water level [m]
1	Au	0-27	100,9	5,8	2,44	0,82	66,39	0,45
	Cg	27-48	13,9	5,5	2.63	1,48	43,73	
2	Au	0-44	172,5	5,7	2,36	0,84	64,41	0,50
	Cg	44-52	3,0	5,4	2,64	1,77	32,95	
3	A	0-16	80,9	5,5	2,46	0,90	63,41	0,80
	A2	16-37	132,0	5,8	2,41	0,82	65,98	
	Oa1	37-55	192,0	6,0	2,34	0,70	70,09	
	Oa2	55-102	302,1	6,0	2,22	0,52	76,58	
4	A	0-14	32,5	5,5	2,61	1,24	52,49	0,70
	A2	14-21	55,6	5,8	2,58	1,02	60,47	
	Oa	21-40	215,5	6,0	2,31	0,60	74,03	
	Oe	40-150	802,0	6,2	1,67	0,28	83,23	

Source: Own work / Źródło: opracowanie własne organic matter content: between 2,63 (profile 1) and 2.64 Mg·m^{-3} (profile 2). A visible influence of the amount of organic matter was noticed also in case of dry soil density and porosity (tab.1). The lowest density and the highest total porosity (0,28 Mg·m^{-3} and 82,23 %) was reached at the horizon of hemic peat Oe (profile 4) (tab.1). Similar traits of these soils were also pointed out by different authors [17, 25]. In the mineral-organic epipedones, significantly higher values of density at respectively lower porosity, were noticed. Such a rule was also proved in the formation profile of peat soils (profiles 3 and 4). The effect of their moorshing process, was much higher density and lower porosity of epipedones. Unfavorable changes in the values of physical hydrogenic soils as a result of moorshing process , has been also mentioned by various authors [1, 8, 17]. The reaction of the examined soils was pH: 5,4-6,2 (tab. 1). Muck horizons were characterized by a lower pH than peat horizons independently on their disaggregation . Also other authors mention a little acid and acid solution of similar soils [14, 22]. The results show that the moorshing process leads to the decrease of pH. Also Kalisz et al. [11] admit such a possibility. Some authors [2] claim there is a possibility of leaching calcium from organic soils as a result of acidification processes which stem from the mineralization of organic compounds, diffusing nitrogen and forming ammoniums of this particle. Bieniek [2] connects these processes with the deterioration of soil properties and calls them acid degradation.

Water bonding potential is a significant soil property. In hydrogenic soils, it is mostly determined by porosity and the content of organic matter, the state of its dissolution and mineralization [4, 7]. Maximal water capacity in each level was a bit (2-4%) lower than total porosity. It is connected with the fact that not all the air is displaced from the pores while saturating them with water [8]. In mineral-organic and organic horizons, field water capacity (at pF 2,0) was high and oscillated between 37,99 (prof 4; A) to 70,18 % v/v (prof. 3; Oa2,). In the mineral ground it was low (10-12% v/v), typical for the formations of similar origin and texture [24]. It was pointed out that in epipedones which underwent moorshing process, moisturization at field water capacity was much lower than in peat horizons. It proves very unfavorable changes in differential porosity and is a result of the growth of the number of macropores after moorshing process. Ilnicki [8] pays attentions to such reformations. The content of water at the potential pF 2,5 was a bit (usually 4-9%) lower than at field water capacity. Taking into consideration the accessibility of water for plants, another important factor is moisture which corresponds with pF 3,7 and 4,2 potential. These moistures are, respectively, limits for production water and water potentially available for plants [16]. Moisture at the limit of production water (pF 3,7), in crucial epipedones for plant production, oscillated between 23,09 (prof. 4; A,) and 40,47 % v/v (prof. 1; Au). In case of moisture at the permanent wilting point (pF 4,2), the values were between 17,21 and 21,17%v/v. They were much higher in peat horizons. Maximal hygroscopic capacity (pF 4,5) was high, usually from a few to a dozen percent and in strongly dissoluted peats - even of 20-30%v/v (tab. 2). On the basis of pF values, water storage ability in various genetic horizons was calculated within total and readily available water In top horizons, readily available water (pF 2,0-pF 3,7) was between 13,71 and 19,75% v/v. Total available water was even twice higher. Such a significant difference was a result of the high content of difficultly available water (within pF 3,7 – pF 4,2) (tab. 2).. Specific character of hydrogenic soils with high moistures at various potentials pF (especially at strongly bound water) was also noticed by other authors [26].

When analyzing the floristic structure of the selected plant habitats and their part in various grassland types, it was noticed that their composition differed and was connected with habitat conditions (mainly the level of ground water) which determine the formation of bio-variable flora (tab. 3). In farm valuable communities both of strongly wet and humid localities and of fresh and humid ones grasses dominate (apart from *Potentillo–Festucetum arundinaceae* community), whereas there are no or just a few carexes. On the other hand, in moderately and poorly valuable communities, of both wet and marshy and strongly humid and flooded localities, carexes dominate, apart from *Phragmitetum australis* community. Fabaceae appear occasionally (tab. 3). Plants and crop of the examined communities depends strongly on current moisture conditions [21]. These communities were located in wet, humid, waterlogged, very humid and even marshy areas (tab. 4). Hay from the first crop from various communities varied in quantity and quality. The highest value was noted in *Arrhenatheretum elatioris* community, where Lwu= 6,1, and the lowest – in *Carex nigra* (Lwu=2,1). In spite of it, if stored properly, hay is a rich source of proteins, vitamins, minerals and crude fiber.

Table 2. Soil water bonds and the total and readily available water
Tab. 2. Potencjał wiązania wody przez glebę oraz efektywna i potencjalna retencja użyteczna

Profile No.	Genetic horizon	Depth [cm]	Water capacity at pF [%]						RAW 2,0-3,7 [%v/v]	TAW 2,0-4,2 [%v/v]
			0,0	2,0	2,5	3,7	4,2	4,5		
1	Au	0-27	62,18	54,18	49,99	40,47	21,47	10,09	13,71	32,71
	Cg	27-48	40,17	12,07	9,02	3,60	2,01	1,07	8,47	10,06
2	Au	0-44	61,32	52,17	47,84	32,42	18,07	8,04	19,75	34,10
	Cg	44-52	30,20	10,08	7,50	2,61	1,62	1,10	7,47	8,46
3	M1	0-16	60,27	54,69	48,56	40,33	20,01	7,13	14,36	34,68
	M2	16-37	60,50	51,28	45,61	37,01	17,08	13,41	14,27	34,2
	Oa1	37-55	66,22	61,31	55,66	48,09	34,02	20,18	13,22	27,29
	Oa2	55-102	74,21	70,18	67,40	60,02	46,03	32,07	10,16	24,15
4	M1	0-14	48,70	37,99	30,90	23,09	17,21	8,90	14,90	20,78
	M2	14-21	56,54	44,29	36,50	30,01	23,01	15,08	14,28	21,28
	Oa	21-40	72,18	67,08	63,14	50,09	30,11	11,54	16,99	36,97
	Oe	40-150	78,44	68,26	58,47	54,04	31,02	12,78	14,22	37,24

Source: Own work / Źródło: opracowanie własne

Table 3. Floral structure of selected plant communities
Tab. 3. Struktura florystyczna wyróżnionych zbiorowisk roślinnych

Association	Number of species	% part					
		Total grass	Including		Fabaceae	Carex and carex-like	Herbs and weeds
			farmlands	Of low farm value			
Farm valuable communities of wet and humid localities							
Phalaridetum arundinaceae	28	63,5	38,8	24,7	2,9	4,4	29,2
Alopecuretum pratensis	31	61.9	39.6	22.3	6.6	3.7	27,8
Farm valuable communities of fresh and humid localities							
Arrhenatheretum elatioris	26	60,5	29,4	31,1	5,1	2,3	32,1
Potentillo–Festucetum arundinaceae	19	35,9	21,11	14,8	3,0	-	61,07
zb. Poa pratensis - Festuca rubra	25	44,9	22,11	22,8	2,7	-	52,4
Farm moderately and poorly valuable communities of wet and marshy localities							
Phragmitetum australis	14	64.2	54.2	10,0	-	7.1	28,6
Caricetum gracilis	19	19.6	10.1	9,5	1.8	56.7	21,9
Eleocharitetum palustris	19	22,2	16,8	5,4	5.2	50.5	22.1
Sparganio-Glycerietum fluitantis	10	37,9	21,1	16,8	-	31.9	30,2
zb z *Carex nigra*	21	12.2	3.9	12.9	0,4	69.6	17.8
Farm moderately and poorly valuable communities of strongly humid and flooded localities							
Caricetum vesicariae	13	8,3	5.6	2,7	0.9	73.7	17.1
Scripetum sylvatici	9	18,2	11.1	7,1	5.1	31.1	45.5

Source: Own work / Źródło: opracowanie własne

Table 4. Farm value of selected plant communities
Tab. 4. Wartość gospodarcza wyróżnionych zbiorowisk roślinnych

Association	Dry mass yields of 1st cut $t \cdot ha^{-1}$	Potential annual dry mass yields $t \cdot ha^{-1}$	Lwu	Σ species of farm value
Farm valuable communities of wet and humid localities				
Phalaridetum arundinaceae	5.5	8.0-15.0	4.6	18.3
Alopecuretum pratensis	4.2	7.0-8.0	5.6	26.2
Farm valuable communities of fresh and humid localities				
Arrhenatheretum elatioris			6,1	
Potentillo–Festucetum arundinaceae			5,1	
zb. Poa pratensis - Festuca rubra			5,2	
Farm moderately and poorly valuable communities of wet and marshy localities				
Phragmitetum australis	6,1	12,0- 24.0	2.6	28.5
Caricetum gracilis	4.3	5.0-6.0	3.2	15.2
Eleocharitetum palustris	2,2	2.8-4.4	3.2	31.5
Sparganio-Glycerietum fluitantis	2.5	1.5-2.8	3.1	20.0
zb z Carex nigra	3.8		2.1	6.4
Farm moderately and poorly valuable communities of strongly humid and flooded localities				
Caricetum vesicariae	4.5	3.0-5.8	2.7	15.3
Scripetum sylvatici	3,2	3.5-5.4	3.7	22.2

Source: Own work / Źródło: opracowanie własne

4. Conclusions

1. The examined hydrogenic soils contained a lot of organic matter, which is typical to them. Due to this factor, specific density and bulk density were low and porosity was high.
2. Another typical phenomenon was high values of moisture at various pF potentials, especially within strongly bound water.
3. In spite of high ground water level, the process of moorshing process started. The process resulted in the growth of density and the decrease in porosity of epipedones when compared to the values in peat horizons. What was also unfavorable and visible in mucks, was the level of acidification.
4. Despite having being excluded from use, the examined soils are not free from the danger of dehydrating degradation, which may precede the degradation of green growth.
5. Taking into consideration undoubtedly significant ecological values of Samica Leszczynska Valley, it requires special protection. The state of the exanimated grasslands should be monitored successively for many years.
6. Ecological management gives fodder of lower nutrition value but rich in numerous biochemical and pharmaceutical

substances which may influence animals' health and the quality of obtained products. Furthermore it has an impact on floristic variability.

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