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# FORMATION OF FLORISTIC DIVERSITY OF COMMUNITY OF *Eleocharitetum Palustris* ŠENNIKOV 1919 ASSOCIATION ACCORDING TO HABITAT CONDITIONS

*Summary*

*Research on the formation of floristic diversity of Eleocharitetum palustris Šennikov 1919 association according to habitat conditions was conducted in the years 2009-2013 in the Noteć valley, between Czarnków – Nowe Dwory – Lubcz Wielki. On the basis of floristic data collected in this area, syntaxons were differentiated, research on floristic variability was conducted and Shannon-Wiener's diversity ratio was calculated. The selected community underwent natural valorization, and its utility value was estimated on the basis of dry mass crop and the figure of utility value. The research was supplemented with a soil science assessment of the analyzed habitats. The habitats had a little floristic diversity and a small percentage share of farm-valuable species. They are, however, a valuable element of local ecosystems. Soil parameters in the investigated habitats were differentiated and typical for the represented systematic units. Their system of air-water parameters was influenced mainly by texture as well as content and quality of organic mater.*
***Key words****: habitat conditions, grassland community, ponds, floristic diversity, soil conditions*

# KSZTAŁTOWANIE SIĘ RÓŻNORODNOŚCI FLORYSTYCZNEJ ZBIOROWISKA ZESPOŁU *Eleocharitetum Palustris* ŠENNIKOV 1919 POD WPŁYWEM WARUNKÓW SIEDLISKOWYCH

*Streszczenie*

*Badania nad kształtowaniem się różnorodności florystycznej zespołu Eleocharitetum palustris Šennikov 1919 pod wpływem warunków siedliskowych przeprowadzono w latach 2009-2013, w dolinie Noteci, na odcinku Czarnków – Nowe Dwory – Lubcz Wielki. Na podstawie zebranych w terenie danych florystycznych wydzielono syntaksony, przeprowadzono badania różnorodności florystycznej, obliczono wskaźnik różnorodności Shannona-Wienera. Wybrane zbiorowisko zostało poddane waloryzacji przyrodniczej, a także oszacowano jego wartość użytkową na podstawie plonu suchej masy oraz liczby wartości użytkowej (LWU). Badania uzupełniono oceną gleboznawczą analizowanych siedlisk. Siedliska charakteryzowały się małym zróżnicowaniem florystycznym oraz niewielkim procentowo udziałem gatunków wartościowych gospodarczo. Są one jednak cennym elementem lokalnych ekosystemów. Gleby badanych siedlisk wykazywały właściwości zróżnicowane, typowe dla reprezentowanych przez nie jednostek systematycznych. O występującym w nich układzie właściwości powietrzno-wodnych decydowały głównie: uziarnienie oraz zawartość i jakość materii organicznej.*
***Słowa kluczowe****: warunki siedliskowe, zbiorowisko łąkowe, oczka wodne, różnorodność florystyczna, warunki glebowe*

## 1. Introduction

Habitat conditions are one of the factors which influence possible functions of grassland and pastures. Under the influence of a human activity, plant communities are subject to significant deformations (Nawrocki) [28]. Long-term arable utilization modifies their habitat conditions, which results in numerous changes in ecosystems [12]. In case of a grassy ecosystem, its deformations usually lead to the mosaicism of plant system. This results in a decrease of floristic diversity of grassland communities and influences the amount of biomass as a consequence. Phytocenoses of this association usually develop in ponds located in grasslands and pastures, and represent a low type of reed bed. Common spike rash is usually accompanied by species from *Phragmitetea* class. Due to a usually shallow soil-ground water level, these plants are often flooded, yet for short periods of time. On the other hand, an anthropogenic origin of *Eleocharitetum palustris Šennikov* 1919 association is noted by Matuszkiewicz [24]. Phytocenoses of *Eleocharitetum palustris* happen to be used as pastures as they are resistant to trampling and nibbling by cattle. In Wielkopolska, depressions in grasslands and pastures have not been well investigated yet. They are usually naturally-valuable barrens which form biotopes for various plant communities in an arable landscape [40]. They show great biodiversity and are often biological props and local banks of genes of wild plants and animals in a monotonous arable landscape [2, 3, 23]. Their great significance is emphasized by soil scientists and hydrologists who pay special attention to retention abilities of ponds in water balances of endorheic areas [6, 16].

The paper contains a characteristic of *Eleocharitetum palustris* association's habitat, which covers a floristic composition and an assessment of its soil conditions.

## 2. Object and methodology

The material was collected in vegetation seasons in the years 2009-2013 during floristic and soil scientific research conducted in the Noteć valley between Czarnków – Nowe Dwory – Lubcz Wielki. Due to small research areas and representativeness of the patches, only eighteen phytosociological relevés taken with Braun-Blanquet's method were used [4]. On the basis of the collected floristic data, syntaxons were diversified and classified to a phytosociological system after Matuszkiewicz [24]. Research on floristic diversity was connected with the analysis of: species composition, (botanical structure), total number of species in the community and Shannon'Wiener's variability ratio: H' = -∑ (pi x log pi ). Plant nomenclature was cited after Mirek et al. [26]. The selected community underwent a natural valorization. Species richness (an average number of species in a phytosociological relevé), floristic variability and the level of synanthropization were assessed. An assessment of natural values was conducted with Oświt's method [29]. A utility value was estimated on the basis of dry mass crop and the figure of utility value according to Filipek [7].

In the investigated area, three soil exposures were made and described. In the most representative spheres for the examined communities, there were: *Sapric Histosol* (organic sapric-mucky soils) – prof. 1 (Czarnków) and 3 (Lubcz Wielki); *Gleyic Phaeozem* (mucky soils) – prof. 2 (Nowe Dwory) [14, 32]. The depth of ground water level was 0,50 m (profile 1); 0,60 m (profile 2) and 0,80 m (profile 3). According to the classification provided by Rząsa et al. [34], all the soils represented a ground type of water management. Arable and utilization values of soils were estimated at 3rd bonitation class and 2z (profiles 1 and 3) and 3z (profile 2) of the complex of arable suitability [27].

From each genetic horizon, samples of disturbed and undisturbed structure were collected, in order to determine such properties as: texture – with a sewage method (sand) and aerometric method (loam and silt) after dispersion with sodium hexametaphosphate [27], particle density of mineral horizons with a picnometric method and with Okruszko's formula [26] – of organic horizons [13, 27], soil density – with Nitzshe's vessels of 100 $cm^3$, total porosity – calculated on the basis of particle density and bulk density [38], calcination loss after being burnt in 550$^o$C [27], filtration ratio – with the method of constant pressure loss [20], maximum hygroscopic capacity (moisture at pF=4.5) – in a vacuum chamber at a negative pressure of 0,8atm and with a saturated $K_2SO_4$ solution [27], water bonding potential of a soil – with the method of Richard's pressure chambers [21], total and readily available waters – calculated on the basis of pF, the content of carbon and total nitrogen – with Vario Max CNS analyzer and reaction – potentiometrically at 1 M KCl. All the published results are averages from five replications.

## 3. Results and discussion

### 3.1. Floristic research

The examined association of *Eleocharitetum palustris Šennikov* 1919 was classified to (Cl.) *Phragmitetea* R. Tx. et Prsg 1942 class, (O.) *Phragmitetalia* Koch 1926 order, (All.) *Phragmition* Koch 1926 association. Due to a semi-natural character of habitats, the community was rather poor in flora. Similar observations were made by Kryszak et al. [22]. According to these authors, a multi-year cultivation changes habitat conditions, which results in the decrease of species of grassland communities. In terms of natural values, the association was of little diversity (Tab. 1). A total number of species in the patches was from fourteen to twenty-four (nineteen on average), in some patches even twenty-nine species were observed, though. A dominant and characteristic species in this association – (Ch.), *Eleocharis palustris*, had high phytosociological constancy of V=4815 and a coverage ratio of D=3550. An average valorization number was 3,1 (valorization class V-VI). It was a community of hygrophilous flora, with the domination of reed species and of moderately high natural values. Because of high moisturization of the habitat, a naturally valuable community had little arable value and some of its patches were barrens. There was little percentage of economically valuable species (18% on average) and an increased share of synantropic species (68,6% on average). Crops of sward's dry mass from the first regrowth oscillated from 3,9 to 4,9 t.ha$^{-1}$, and collected sward was of poor utility value (LWU from 2,4 to 2,6) (Tab. 2).

Table 1. Natural values of *Eleocharitetum palustris* association
*Tab. 1. Wartość przyrodnicza zespołu Eleocharitetum palustris*

| Locality | Number of relevés | Number of plant species | Mean in relevés | Natural value | | | |
|---|---|---|---|---|---|---|---|
| | | | | Mean evaluation number | Evaluation category | Natural values | H' |
| Czarnków | 4 | 14 | (9-18) | 3.5 | VI | moderately large | 2,5 |
| Nowe Dwory | 8 | 24 | (18-29) | 2.8 | V | average-moderate | 2,2 |
| Lubcz Wielki | 6 | 18 | (13-22) | 3.4 | VI | moderately large | 2,1 |
| Total /Average | 18 | 19 | - | 3.1 | V-VI | - | 2,3 |

*Source: own work / Źródło: opracowanie własne*

Table 2. Yielding and utility value number of *Eleocharitetum* palustris association
*Tab. 2. Plonowanie i wartość użytkowa zespołu Eleocharitetum palustris*

| Locality | DM yields of first cut (t·ha$^{-1}$) | Utylitarian value number (Uvn) | Share of economically valuable species (%) | Proportion of synanthropic species |
|---|---|---|---|---|
| Czarnków | 4.4 | 2.4 | 20 | 65.8 |
| Nowe Dwory | 4.9 | 2.6 | 16 | 70.6 |
| Lubcz Wielki | 3.9 | 2.6 | 18 | 69.5 |
| Average | 4.4 | 2.5 | 18 | 68.3 |

*Source: own work / Źródło: opracowanie własne*

### 3.2. Soil scientific research

Epipedons of profiles 1 and 3 were formed from muck. Both horizons shallowly transformed into low peat. Top mucky deposit in profile 2 had a grainy structure and was strongly mineralized. It was shallowly transformed into SiL (content of loamy fraction – 12%); it was underlain by sand (loam – 1%) at medium depth. The bedrock of profile 3 was formed of sand (content of loam – 1%) [5] (Tab. 3). In hydrogenic soils and especially in organic soils, the amount and quality of organic matter was the main parameter which shaped physical and chemical properties. The lowest content of organic matter was observed in peats (from 761,1 to 841,6 $g \cdot kg^{-1}$), lower – in mucky epipedons (from 65,4 to 551,2 $g \cdot kg^{-1}$), and the lowest – in mineral endopedones (from 1,1 to 1,4 $g \cdot kg^{-1}$) (Tab. 4). The values are within a range cited by numerous authors in Polish and foreign literature for hydrogenic soils [10, 15, 18, 35]. Due to the state of decomposition of most of the peats, they were qualified to *hemic* materials.

Particle density of the analyzed organic deposits oscillated from 1,62 (prof. 1; Oei) to 2,29 $Mg \cdot m^{-3}$ (prof.3; M1). In a strongly mineralized mucky deposit and in mineral horizons, it was much higher – from 2,52 (prof. 2.; Au) to 2,65 $Mg \cdot m^{-3}$(prof. 2; 2Cg, 3Cg, prof. 3; Cg) (Tab. 4). Bulk density of peats and epipedons was low and oscillated from 0,56 (prof. 1.; M) to 1,18 $Mg \cdot m^{-3}$ (prof. 2.; Au) in epipedons and from 0,27 (prof. 1; Oei) to 0,38 $Mg \cdot m^{-3}$ (prof. 1; Oe1) in peats. It was higher in mineral endopedones: from 1,40 (prof. 2; Cg) to 1,69 $Mg \cdot m^{-3}$ (prof. 2; 3Cg) (Tab. 4). Total porosity was the highest in organic deposits: from 67,25 (prof. 3; M1) to 83,33%v (prof. 1; Oei). Values of this property in mineral horizons were much lower and decreased systematically with the depth: from 36,23 (prof. 2; 3Cg) to 46,97%v (prof. 2; Cg). (Tab. 4). Similar results for the discussed parameters were obtained by other authors [1, 35, 39].

The content of hygroscopic water (H) and maximum hygroscopic capacity (MH) were characteristic to deposits of a given content of colloid fractions, both mineral (loamy fraction) and organic [27]. The highest values of these properties were observed in endopedones formed from peats: from H = 4,98; MH = 7,80% v (prof. 3; Oa) to H = 10,12; MH = 14,22% v (prof. 1;Oei); lower in epipedons: from H = 2,10; MH = 3,65% v (prof. 2; Au) to H = 3,50; MH = 5,54% v (prof. 1; M); the lowest – in mineral endopedones: from H = 0,65; MH = 0,90% v (prof. 2;3Cg) to H = 3,80; MH = 5,41% v (prof. 2; Cg) (Tab. 4, 5). In case of organic soils, natural moisture is not only a parameter, but also a factor, which forms such traits as: the content and quality of organic matter, density and total porosity. Water is a dominant soil-forming factor in their origin. Natural or anthropogenic dehydration of these soils results in significant changes of their physical, chemical and biological properties [28]. These changes proceed with time (sometimes in tens of years) and lead to the transformation of these deposits into mineral soils [34]. Scope and speed of these changes depend on, inter alia, primeval soil, water and metrological conditions. Ecosystems which are most susceptible to dehydration, are the ones that are dependent on water, e.g. hydrogenic habitats used as grazing lands. Such habitats are often located in river valleys and local depressions [25, 31]. The highest natural moisture (81.23% v) was observed in Oei horizon (prof. 1). This value was close to maximum water capacity as this horizon was located within a local aquafier. It also had the highest content of organic matter and the biggest total porosity. In a mucky epipedon of the same soil, moisture was over twice as high. Due to a shallow soil-ground water level (0,6 and 0,8 m), high natural moisture was also observed in mineral endopedones of profiles 2 and 3 (Tab. 4).

Table 3. Texture of mineral horizons of the studied soils
*Tab. 3. Uziarnienie poziomów mineralnych badanych gleb*

| Profile number | Horizon | Depth (cm) | Percent of fractions (mm) | | | | | | Texture acc. FAO |
|---|---|---|---|---|---|---|---|---|---|
| | | | 2.0-0.1 | 0.10-0.05 | 0.05-0.02 | 0.02-0.005 | 0.005-0.002 | <0.002 | |
| 2 | Cg | 26-77 | 37 | 9 | 20 | 18 | 4 | 12 | SiL |
| | 2Cg | 77-82 | 80 | 7 | 7 | 4 | 1 | 1 | S |
| | 3Cg | 82-220 | 90 | 3 | 4 | 1 | 1 | 1 | S |

Explanation: S – sand, SiL – silty loam

*Source: own work / Źródło: opracowanie własne*

Table 4. Basic physical and chemical properties of the studied soils
*Tab. 4. Podstawowe fizyczne i chemiczne właściwości badanych gleb*

| Profile number | Horizon | Depth (cm) | Particle density ($Mg \cdot m^{-3}$) | Bulk density ($Mg \cdot m^{-3}$) | Total porosity (%v/v) | Organic mater ($g \cdot kg^{-3}$) | Natural moisture (%v/v) | Hygroscopic water (%v/v) | Saturated hydraulic conductivity ($\mu m \cdot s^{-1}$) | pH in 1M KCl | Total nitrogen ($g \cdot kg^{-3}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | M | 0-35 | M | 0-35 | 1.94 | 0.56 | 71.13 | 551.2 | 35.12 | 3.50 | 15.7 |
| | Oe1 | 35-45 | Oe1 | 35-45 | 1.71 | 0.38 | 77.78 | 761.1 | 38.17 | 5.41 | 6.1 |
| | Oe2 | 36-74 | Oe2 | 36-74 | 1.69 | 0.34 | 79.88 | 778.6 | 62.96 | 4.98 | 4.0 |
| | Oei | 74-220 | Oei | 74-220 | 1.62 | 0.27 | 83.33 | 841.6 | 81.23 | 10.12 | 12.5 |
| 2 | Au | 0-26 | Au | 0-26 | 2.52 | 1.18 | 53.17 | 65.4 | 18.17 | 2.10 | 21.8 |
| | Cg | 26-77 | Cg | 26-77 | 2.64 | 1.40 | 46.97 | 1.4 | 9.24 | 3.80 | 0.7 |
| | 2Cg | 77-82 | 2Cg | 77-82 | 2.65 | 1.57 | 40.75 | 1.2 | 7.81 | 0.99 | 49.2 |
| | 3Cg | 82-220 | 3Cg | 82-220 | 2.65 | 1.69 | 36.23 | 1.1 | 6.97 | 0.65 | 76.4 |

*Source: own work / Źródło: opracowanie własne*

Table 5. Soil water potentials and the total and readily available water in the studied soils
*Tab. 5. Potencjał wiązania wody oraz potencjalna i efektywna retencja użyteczna badanych gleb*

| Profile number | Horizon | Depth (cm) | Water capacity at pF: (%v) | | | | | | Total available water (%v) | Readily available water (%v) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0.0 | 2.0 | 2.5 | 3.7 | 4.2 | 4.5 | 2.0-4.2 | 2.0-3.7 |
| 1 | M | 0-35 | 69.39 | 50.12 | 42.38 | 25.14 | 11.08 | 5.54 | 39.04 | 24.98 |
| | Oe1 | 35-45 | 75.61 | 56.33 | 43.29 | 20.08 | 10.57 | 8.98 | 45.76 | 36.25 |
| | Oe2 | 36-74 | 78.55 | 57.39 | 45.97 | 22.19 | 12.37 | 9.87 | 45.02 | 35.20 |
| | Oei | 74-220 | 81.08 | 68.19 | 51.26 | 35.74 | 25.66 | 14.22 | 42.53 | 32.45 |
| | Au | 0-26 | 51.28 | 24.91 | 19.28 | 10.02 | 8.71 | 3.65 | 16.20 | 14.98 |
| 2 | Cg | 26-77 | 45.27 | 18.48 | 12.32 | 9.66 | 7.50 | 5.41 | 10.98 | 8.82 |
| | 2Cg | 77-82 | 39.74 | 8.41 | 5.63 | 3.21 | 1.80 | 1.14 | 6.61 | 5.20 |
| | 3Cg | 82-220 | 35.96 | 6.58 | 5.91 | 3.08 | 1.41 | 0.98 | 5.17 | 3.50 |

*Source: own work / Źródło: opracowanie własne*

The speed of filtration was diversified yet high. The values of a filtration ration oscillated from 4,0 (prof. 1; Oe2) to 12,5 $\mu m \cdot s^{-1}$ (prof. 1; Oei) – in peats; from 15,7 to 21,8 $\mu m \cdot s^{-1}$ – in mucks and from 49,2 (prof. 2; 2Cg) to 76,4 $\mu m \cdot s^{-1}$ (prof. 2; 3Cg) – in sands. A horizon of SiL composition was least permeable – the filtration ratio was only 0,7 $\mu m \cdot s^{-1}$ (Tab. 4). Similar values were obtained in river valleys in other works [9]. High permeability of a mineral bedrock in the analyzed soils is a proof of potential danger of fast dehydration of the habitats and, what follows, the degradation of sward.

Values of maximum water capacity were close (slightly lower) to total porosity. Field capacity (pF=2,0) was the highest in horizons rich in organic matter. In peats it oscillated from 55,17 (prof. 3; Oa) to 68,19% v (prof. 1; Oei). The values were lower in mucks: from 24,91 (prof. 2; Au) to 50,12%v (prof. 2; M). In horizons of SiL composition, which are almost non-humic, field capacity was shaped by texture – field capacity grew with the increase in the share of loam fraction (Tab. 3, 4). At a water bonding potential pF=2,5, each water capacity decreased by several (mineral deposits) or over a dozen (peats and mucks) percent. At a production water point (pF=3,7), moisture was very diversified: from od 18,08% v (prof. 3; M2) to 35,74% v (prof. 1, Oei) in organic deposits and from 2,90 (prof. 3; Cg) to 9,66% v (prof. 2; Cg) in mineral deposits. At a wilting point (pF=4,2) each moisturization was by 1,3-1,4 percent lower, respectively. They oscillated from 1,30 (prof. 3; Cg) to 25,66% v (prof. 1; Oei) (Tab. 5). Readily available water was the highest in peats and mucks: from 14,98 (prof. 2; Au) to 36,25% v (prof. 1; Oe1). Its values dropped in mineral endopedones: from 3,50 (prof. 2; 3Cg) to 8,82% v (prof. 2; Cg). Total available water oscillated from 16,20 (prof. 2; Au) to 45,76% v (prof. 1; Oe1) in peats and mucks, and from 5,17 (prof. 2; 3Cg) to 10,98% v (prof. 2; Cg) (Tab. 5) in mineral endopedones. The values of total and readily available waters were slightly higher than the values provided by Ślusarczyk [37] and Kaczmarek [16, 17] for various soils and mineral deposits.

The main parameters which differentiated the discussed values of water-soil constants included the content and level of decomposition of organic matter, the content of mineral colloids and total porosity. Similar conclusions were drawn by other authors [11, 30, 33]. In case of organic horizons, attention should be drawn to the high content of strongly bound water. High moistures at a potential pF 3,7;4,2 were also observed, inter alia, in some hydrogenic soils in eastern Wielkopolska [8]. Smólczynski et al. [36] suggest that along with the level of peats' decomposition, the amount of strongly bound water grows.

The reaction of top horizons and most of the endopedones was slightly acid and oscillated from 5,4 (prof. 2; 2Cg) to 6,3 (profil 1; Oei). A bit lower pH values in a mucky horizon, compared to the underlying peats, was probably a result of mucking. An acidifying character of this process was presented, inter alia, by Kalisz et al. [19]. Profiles 1 and 3 were rich in total nitrogen; the amount of it was much lower in profile 2 (Tab. 4).

## 4. Summary

In the investigated area, the association of *Eleocharitetum palustris Šennikov* 1919 developed in a form of numerous patches, which were poor in species and little differentiated in facies. This naturally valuable area formed biotopes for various plant communities in an arable landscape, and their system was a reflection of habitat conditions and anthropogenic activity. The intensiveness of utilization caused little floristic variability. High, sometimes even excessive, moisturization led to the fact that the community had very little economical and utility value and some patches were barrens.

Soils in the investigated areas had varied properties, which were typical for the represented systematic units. A system of air-water properties depended mainly on texture and the content and quality of organic matter. Low density, high total porosity and high natural moisture of epipedons formed favorable habitat conditions for hydrophilic communities of this area. A potential threat to their existence results from the danger of dehydration degradation whose scope and speed may be enhanced by high permeability of a mineral bedrock. The examined habitats had a favorable reaction and high content of total nitrogen. They are a valuable element of local ecosystems and need protection. Maintaining a hydrological balance should be a primary aim.

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