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PHYTOINDICAL EVALUATION OF SOME MARSHY HABITATS BY MEANS OF ELLENBERG'S METHOD

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Summary. On the basis of the phytosociological research done with Braun-Blanquet method on the meadows of the Por river valley (the south-eastern Poland) there were distinguished 3 plant associations of the *Molinio-Arrhenatheretea* class order *Molinietalia* (*Cirsietum rivularis*, *Scripetum sylvatici* and *Holcetum lanati*).Ten representative plant records were chosen for each association and on the grounds of Ellenberg's phytoindical method the habitat conditions of the examined communities were evaluated. The evaluation included the following mean indices: relation to light (L), thermal relations (T), continentality (K), soil reaction (R), soil nitrogen availability (N) and humidity (F). On the basis of the results it was stated that *Holcetum lanati* occupied the driest, warmest habitats of the highest nitrogen availability; at the same time it showed the lowest continentality level. The *Cirsietum rivularis* association had the best light conditions as it occurred on the soils with the highest soil reaction. On the other hand *Cirsietum rivularis* association was accompanied by which were habitats the most humid and poorest in nitrogen, yet it exhibited the highest continentality degree.

Key words: phytoindication, ecological indices

INTRODUCTION

The assessment of the community floristic richness can be performed using the plant description with phytosociological records [Fijałkowski 1991, Szoszkiewicz and Szoszkiewicz 1998, Matuszkiewicz 2001].

Wójcik [1983], Szoszkiewicz and Szoszkiewicz [1998], Trąba and Wolański [1999] hold that natural evaluation of biocenoses realized only with the biological diversity indices like the total species number, total diversity index of Shannon-Wiener (H`), eveness index ($E$), Simpson`s index (D) prove to be of little use, unless values of the occurring species are considered.

The plant species recorded on the grasslands are characterized by various requirements concerning environmental conditions. Some of them develop by full sunlight and others at shading. A part of plants grow at dry habitats, while others in moist or even water conditions. There are plants found exclusively on soils rich in nutrients, whereas

others need only poor acid sands or peats [Wójcik 1983, Fijałkowski 1991, Trąba and Wolański 1999].

Plant associations prove to be more efficient bioindicators, as compared to single taxons, for habitat evaluation. A range of their habitat requirements is wider than a particular species making them up [Wójcik 1997].

In our conditions, plant community assessment is generally made by Ellenberg *et al.* [1992] index numbers. According to Wójcik [1997], the habitat evaluation realized on the basis of plant indices provides significant qualities for the comparative evaluation of habitats; yet, it is not likely to substitute the direct physical and chemical soil measurements.

The objective of the present paper is an attempt to evaluate the habitats of various meadow communities with Ellenberg`s method.

MATERIAL AND METHODS

The work presents the assessment of the habitat conditions of marshy associations *Molinietalia* order *Molinio-Arrhenathereta* class from the Por valley. The Por river constitutes the left-bank tributary of the Wieprz where it flows into in its upper course. It flows over the valley separating the Roztocze from the Zamojski Padół (Valley).

In a comprehensive phytosociological table including each species distinguished in the *Cirsietum rivularis*, *Scripetum sylvatici* and *Holcetum lanati* associations there are presented the coefficients of stability (S) (over 2nd grade) and cover (D) calculated on the grounds of 10 phytosociological records. They were performed with Braun-Blanquet`s method on the phytocenoses diversified in respect of the floristic composition and occurring at varied habitat conditions (soil and water).

On the basis of the floristic records the mean values of ecologic indices were computed, i.e. L, T, K, F, R, N [Ellenberg *et al.* 1992], which stand for: L – luminous requirements, T – thermal relations, K – continentality, optimum in a climatic zone, F – habitat moisture requirements, R – reaction requirements, N – nitrogen requirements. The index numbers come within 1-9 range.

The syntaxonomy and species characteristic of the communities are presented after the works of Fijałkowski [1991] and Matuszkiewcz [2001].

RESULTS AND DISCUSSION

The phytosociological syntaxonomy of some plant associations (marshy) in the Por river valley goes as follows:

Class: ***Molinio-Arrhenathertea*** T. Tx. 1937
Order: ***Molinietalia coeruleae*** W. Koch 1926
Connexion: ***Calthion palustris*** R. Tx. 1936 em. Oberd. 1957
1. *Cirsietum rivularis* Nowiński 1927
2. *Scirpetum sylvatici* Ralski 1931
3. *Holcetum lanati* Issler 1936

Thistle meadows often occurred in the depression near a river, old ditches and valley borders constituting phytocenoses of area ranging from 0.1 to 1 ha.They made about

10% of the total meadow area in the Por valley. The association grew mostly on organic soils, occasionally mineral-organic, with pH from 6.5 to 7.3 (Tab. 1). The sward level of organic and mineral-organic soils showed a varied phosphorus content, while low and very low potassium and magnesium availability. In summer the ground water occurred at 40-50 cm depth.

Table 1. Chemical properties of soils of the distinguished associations of *Molinio-Arrhenatheretea* class *Molinietalia* order
Tabela 1. Właściwości chemiczne gleb wyróżnionych zespołów klasy *Molinio-Arrhenatheretea* rzędu *Molinietalia*

Zespół Association	Number of samples Liczba prób	pH_{KCl}	Organic matter Substancja organiczna	$CaCO_3$	P	K	Mg
			%		mg · 100g		
Cirsietum rivularis	9	6.5-7.3*	14.9-55.1	3.6-22.4	13.1-244.2	13.3-44.0	9.5-162.3
Scirpetum sylvatici	2	7.1-6.8	31.6-34.6	2.3-12.3	41.8-173.3	14.1-21.6	17.8-16.2
Holcetum lanati	6	5.7-7.1	10.5-51.0	0.4-5.9	6.1-131.2	6.6-30.7	9.0-165.4

*range – zakres

Small phytocenoses of *Scripetum sylvatici* association developed in some local depressions along the river-bed and between alder thickets with *Alnus glutinosa* on organic and humic-mineral soils of the neutral reaction. The sward level of organic soils was characterized with high and very high phosphorus availability, yet potassium and magnesium deficiency. Ground water was recorded to occur at 20-30 cm in summer.

Holcetum lanati formed phytocenoses of varied size (from a few ares up to some hectares). It occupied around 10% of the total meadow area in the Por valley. The habitats studied in the Por valley demonstrated the neutral or slightly acid reaction. Ground water was found at 50-70 cm depth. The organic-mineral and organic soils phosphorus availability was differentiated (from very low to very high). Magnesium content oscillated from 9.0 up to 165.4 mg · 100 g soil. Potassium occurred at a low and very low level.

The mean L numbers in the examined communities *Molinietalia* order ranged substantially, from 6.77 in *Scirpetum sylvatici* association to 7.72 in *Cirsietum rivularis* association (Tab. 3). In *Cirsietum rivularis* association *Cirsium rivulare* proved to dominate and its L number according to Ellenberg *et al.* reaches 9. Similar values of the L index for an association were noted in the south-eastern part of Poland by Trąba and Wolański [1999]. The lowest L was recorded for *Scirpetum sylvatici,* where *Scirpus sylvaticus* with L = 6 was predominant. A high degree of stability and coefficient cover were shown by the species of L = 7, among others *Equisetum palustre*, *Ranunculus acris* and *Carex gracilis*.

Table 2. Some floristic characteristics of the distinguished associations
Tabela 2. Niektóre cechy florystyczne wyróżnionych zespołów

Species – Gatunki Associations – Zespoły	S[1]	D[2]	S	D	S	D
	Cirsietum rivularis		*Scirpetum sylvatici*		*Holcetum lanati*	
1	2	3	4	5	6	7
Ch. *Cirsietum rivularis*						
Cirsium rivulare	V	45000	IV	263	IV	885
Ch. *Scirpetum sylvatici*						
Scirpus sylvaticus			V	4375		
Ch. *Holcetum lanati*						
Holcus lanatus					V	4750
Ch. *Calthion*						
Trifolium hybridum	II	110	III	138	II	15
Caltha palustris	II	60	III	238		
Myosotis scorpioides	II	20	IV	94		
Crepis paludosa					II	15
Ch. *Molinietalia*						
Lychnis flos-cuculi	V	260	V	375	III	75
Equisetum palustre	II	485	V	638	II	110
Lythrum salicaria	II	15	IV	31	III	25
Galium uliginosum	II	60	IV	244		
Valeriana officinalis	III	415	III	81		
Climacium dendroides	IV	1750			III	1000
Angelica silvestris	III	1155			IV	340
Deschampsia caespitosa	III	205			IV	130
Cirsium palustre	II	60				
Filipendula ulmaria			III	81		
Lysimachia vulgaris			II	13		
Sanguisorba officinalis			II	13	II	185
Ch. *Arrhenatheretalia*						
Galium mollugo	II	235			III	400
Phleum pratense	II	110			II	65
Dactylis glomerata	II	60			IV	175
Heracleum sphondylium					III	620
Lotus corniculatus					III	615
Arrhenatherum elatius					III	160
Trifolium dubium					III	120
Leucanthemum vulgare					II	280
Trifolium repens					II	235
Taraxacum officinale					II	65
Geranium pratense					II	60
Ch. *Molinio-Arrhenatheretea*						
Ranunculus acris	V	570	IV	513	IV	220
Festuca rubra	IV	730	II	288	IV	435
Poa pratensis	IV	350	IV	419	III	205
Festuca pratensis	III	410	III	350	IV	175
Rhinanthus angustifolius	II	110	II	19	III	490
Poa trivialis	II	110	II	188	III	115
Alopecurus pratensis	II	235	III	138		

contd tab. 2

1	2	3	4	5	6	7
Holcus lanatus	II	105	II	131		
Rumex acetosa	IV	35			IV	35
Cerastium holosteoides	III	30			IV	35
Plantago lanceolata	II	110			III	75
Lathyrus pratensis	II	131			II	805
Trifolium pratense			II	75	IV	730
Vicia cracca					III	195
Avenula pubescens					II	20
Veronica chamaedrys					II	15
Ch. *Scheuchzerio-Caricetea nigrae*						
Dactylorhiza majalis	II	65	III	81	II	20
Valeriana simplicifolia	II	155	II	288		
Carex nigra	II	60	II	125		
Menyanthes trifoliate			II	538		
Pedicularis palustris			II	225		
Potentilla palustris			II	13		
Eriophorum angustifolium			II	13		
Ch. *Phragmitetea*						
Carex gracilis	III	120	IV	569	II	230
Phragmites autsralis	II	325	III	544	II	190
Equisetum fluviatile	II	230				
Lysimachia thyrsiflora	II	15				
Carex disticha			III	237		
Calliergon giganteum			II	906		
Phalaris arundinacea			II	225		
Galium palustre			II	75		
Carex rostrata			II	69		
Rumex hydrolapathum			II	13		
Accompanying/Towarzyszące						
Calliergon cuspidatum	IV	1900	II	1000	III	1105
Anthoxanthum odoratum	II	430	II	69	IV	340
Mentha arvensis	II	15	IV	88		
Acrocladium cuspidatum	IV	19000			II	275
Ranunculus repens	III	120			III	70
Medicago lupulina	II	15			III	115
Stellaria graminea	III	25				
Festuca arundinacea	II	155				
Calamgrostis epigeios	II	105				
Bryum ventricosum			II	281		
Lysimachia nummularia			II	69		
Polygonum amphybium			II	13		
Carex panicea			II	13	II	15
Rumex crispus					III	25
Briza media					II	105
Luzula campestris					II	15
Carex hirta					II	60

S – constancy degree – stałość/; D – coefficient of cover – współczynnik pokrycia

Table 3. Numerical values of the studied indices in the selected associations *Molinio-Arrhenatheretea* class, *Molinietalia* order
Tabela 3. Wartości liczbowe badanych wskaźników w wyróżnionych zespołach klasy *Molinio-Arrhenatheretea*, rzędu *Molinietalia*

Associations Zespoły	L	T	K	F	R	N
Cirsietum rivularis	7.51-8.04* 7.72**	5.06-5.64 5.28	3.63-4.26 4.04	6.41-7.37 7.00	6.45-7.66 7.31	4.36-5.65 4.75
Scirpetum sylvatici	6.42-7.24 6.77	5.01-5.61 5.19	3.74-4.73 4.16	7.12-8.44 7.78	4.52-6.10 5.26	3.56-5.16 4.41
Holcetum lanati	6.87-7.49 7.11	5.35-5.98 5.64	3.01-3.82 3.35	5.35-6.69 5.94	5.25-7.67 6.59	4.11-5.69 4.95

*range – zakres
**mean – średnia

The amplitude of T mean numbers in the examined communities was low, i.e. 5.64 in *Holcetum lanati* and 5.19 in *Scirpetum sylvatici* associations. In *Holcetum lanati* association from the Por valley (Tab. 3) there were observed slightly higher values of T index as compared to the habitats (T = 4.7) studied by Trąba and Wolański [1999]. Here the species *Holcus lanatus* dominated, whose number T in the Ellenbergs' *et al.* set [1992] was equal to 6. However, in *Scirpetum sylvatici* association the most numerous appeared to be the species with T = 5, which testifies to moderate warm habitats, among others, *Cirsium rivulare*, *Carex gracilis*, *Scirpus sylvaticus*, *Lychnis flos-cuculi* (Tab. 2).

Ellenberg *et al.* [1992] based the continentality K numbers on a plant range, that is plants appearance in zones from the Atlantic coast to the Eurasia. They mainly reflect plant resistance to temperature fluctuations and sustained droughts over the vegetation season. The range of the mean K numbers in the examined communities *Molinietalia* order showed fluctuations from 4.16 in *Scirpetum sylvatici* to 3.35 in *Holcetum lanati* (Tab. 3). The *Scirpetum sylvatici* association was dominated by *Scirpus sylvaticus* of K = 4 (Tab. 2), while *Holcetum lanati* by the species of K = 3 – *Lotus corniculatus*, *Holcus lanatus* and *Trifolium pratense*. Similar values of the K index were obtained by Działo [2001] on the meadows of the southern Pogórze (Plateau) Dynowskie.

The mean values of the F index range was fairly broad, which means the moisture conditions of the examined phytocenoses were differentiated. The highest mean number F = 7.78 was recorded in *Scirpetum sylvatici* (Tab. 3), where the species of F = 8 were most frequent, e.g. *Equisetum palustre* and *Scirpus sylvaticus* (Tab. 2). On the other hand, the lowest value F = 5.94 was noted in *Holcetum lanati* association with dominant species *Holcus lanatus* (Tab. 2) of F = 6 in Ellenberg's *et al.* set [1992].

The mean R number values computed on the basis of community species composition exhibited the span from 5.26 in *Scirpetum sylvatici* association up to 7.31 in *Cirsietum rivularis*. In *Scirpetum sylvatici* association (Tab. 3) compared to *Cirsietum rivularis* the acidification indices of low R number 4-6 were more numerous, among others *Scirpus sylvaticus*, *Carex gracilis* and *Festuca rubra* (Tab. 2). On the other hand, in *Cirsietum rivularis* association a species of R = 8 – *Cirsium rivulare* (Tab. 2) was most frequent, an index of high soil pH and calcium carbonate availability.

The mean N index values calculated from the phytosociological records taken in each community prove similar nitrogen availability of the habitats. The most abundant appeared to be the habitats of *Holcetum lanati* association N = 4.95 (Tab. 3). The habitats of meadow soft-grass of the Pogórze Dynowskie had higher nitrogen availability (N = 5.7) [Działo 2001] as against the analysed Por valley. The lowest mean N = 4.41 was shown by the habitats of *Scirpetum sylvatici* association (Tab. 3) dominated by a species of N = 4, i.e. *Scirpus sylvaticus* (Tab. 2).

CONCLUSIONS

1. The driest and warmest habitats with the highest nitrogen availability were occupied by *Holcetum lanati*. At the same time it showed the lowest continentality degree.

2. The best luminous conditions characterized *Cirsietum rivularis* association, which occurred on the soils of the highest reaction index.

3. The habitats poorest in nitrogen and the moistest accompanied *Scirpetum sylvatici* association, which was also characterized by the highest continentality degree.

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FITOINDYKACYJNA OCENA NIEKTÓRYCH SIEDLISK MOKRADŁOWYCH METODĄ ELLENBERGA

Streszczenie. Na podstawie badań fitosocjologicznych wykonanych metodą Braun-Blanqueta na łąkach doliny rzeki Por (w południowo-wschodniej Polsce) wyróżniono 3 zespoły roślinne klasy *Molinio-Arrhenatheretea* rzędu *Molinietalia* (*Cirsietum rivularis*, *Scirpetum sylvatici* i *Holcetum lanati*). Dla każdego zespołu wybrano po 10 reprezentatywnych zdjęć fitosocjologicznych i metodą fitoindykacji Ellenberga dokonano oceny warunków siedliskowych badanych zbiorowisk. Przy ocenie uwzględniono średnie wskaźniki: L (stosunek do światła), T (stosunki termiczne), K (kontynentalizm), R (odczyn gleby), N (zasobność gleby w azot) i F (uwilgotnienie). Na podstawie wyników badań stwierdzono, iż najsuchsze, najcieplejsze i najzasobniejsze w azot siedliska zajmował *Holcetum lanati*. Jednocześnie charakteryzował się najmniejszym stopniem kontynentalizacji. Najlepsze warunki świetlne panowały w zespole *Cirsietum rivularis*, który występował na glebach o najwyższym wskaźniku odczynu. Najwilgotniejsze i najuboższe w azot siedliska towarzyszyły zespołowi *Scirpetum sylvatici*, jednocześnie charakteryzował się on najwyższym stopniem kontynentalizacji.

Słowa kluczowe: fitoindykacja, wskaźniki ekologiczne