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SUBFOSSIL PLANT COMMUNITIES OF A BURIED PEATLAND IN THE VICINITY OF ZAKRZÓWEK (LUBLIN UPLAND)[1]

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Summary. The paper presents the results of a study concerned with the characteristics of subfossil plant communities of a buried peatland situated in the valley of a small water course (a right-side tributary of river Bystrzyca). Using an Instorf type peat drill, three bore-holes were drilled, from which 80 samples were taken for laboratory analyses that included determination of plant macro-remains, as well as the ash content and reaction (pH in H_2O and KCl). The study showed that in the valley of the water course there developed a low moor composed mainly of sedge peat and sedge-reed peat, with insertions of sedge-moss peat. The eastern part of the deposit is covered with a layer of mineral alluvial material with depth from 20 to 70 cm. Among the subfossil communities reed phytocenoses from the class *Phragmitetea* dominated. Less frequent were communities from the classes *Scheuchzerio-Caricetea fuscae* and *Potametea.*

Key words: buried peatland, valley, plant macro-remains, subfossil communities

INTRODUCTION

The Lublin Region is exceptionally rich in peatlands, though their distribution is not uniform. The greatest concentration of peatlands is characteristic of the Łęczna-Włodawa Lakeland, and the least of the western part of the Lublin Upland [Borowiec 1990]. Peatlands occurring in the upland of the Lublin Region are most often related with river valleys are characterised by considerable depth of the deposits, high ash content and high levels of calcium carbonate. One can also encounter there peat deposits covered with mineral alluvial layers, so-called buried peatlands. In the opinion of many authors [Nakonieczny 1967, Maruszczak 1988, Borowiec 1990, Urban 2004], such overlays were formed

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during the felling of forests and intensive agricultural use of loess areas. Material carried with surface runoff accumulated in the form of alluvial cones at the outlets of lateral valleys and on the surface of peatlands formed earlier. According to Borowiec [1990], mineral alluvial layers with depths from 25 to 200 cm (silt or clayey silt) are similar in their composition to the loess formations occurring in their vicinity and are characterised by low water permeability [Borowiec and Urban 1998]. The soils of such objects are frequently waterlogged, and gley processes can be observed in their profile.

The objective of the study was to examine the history of development of a buried peatland situated in the valley of a water course near the locality of Zakrzówek, and to determine, on the basis of analysis of plant macro-remains, the composition of peat-forming subfossil phytocenoses.

STUDY AREA, MATERIALS AND METHODS

The peatland studied is situated near the locality of Zakrzówek (commune Zakrzówek, Lublin Province), in the valley of a small name-less water course which is a right-side tributary of river Bystrzyca. According to the physical-geographical division, it is situated at the western edge of the Giełczew Rise which is a mesoregion of the Lublin Upland. The valley of the water course cuts deeply (6 to 8 m) into the surrounding lands and it5 is rather narrow (from 50 to 180 m). The peat deposit under study is partially covered with a layer of mineral alluvial material. At present in the valley (in the transect area) there are plant communities related with permanently or periodically waterlogged areas. Dominant are reed communities from the class *Phragmitetea* and forest and rush communities from the class *Alnetea glutinosae.* Less frequent are aquatic communities from the class *Lemnetea* and meadow communities from the class *Molinio-Arrhenatheretea*.

Stratigraphic examinations were made in a transect perpendicular to the axis of the water course. Three bore-holes were drilled down to the mineral substrate, using a peat drill type Instorf. Complete peat profiles (cores) were taken for laboratory analyses. Samples for the determination of plant macro-remains (with volume of 25 cm^3) were taken from the cores with relation to the differentiation of the deposits (on average at every 10 cm). The separation and identification of plant remains was performed in accordance with the method developed by Lubliner-Mianowska [1951] and Tobolski [2000]. For the determination of the quantitative relations 5 microscope specimens were prepared for each sample. The identification of plant macro-remains was made with the help of available keys and atlases [Dombrowska *et al*. 1969, Grosse-Brauckmann 1972, 1974, Grosse-Brauckmann and Streitz 1992, Tobolski 2000], and also of comparative specimens prepared from contemporary vegetation. The names of vascular plants were given after Mirek *et al.* [2002], and of mosses after Ochyra *et al.* [2003]. In 80 samples of sediments determinations were also performed of the reaction (pH in H_2O and KCl) and of ash content through incineration of samples in a muffle furnace at temperature of 550°C [Sapek and Sapek 1997].

RESULTS AND DISCUSSION

The peat deposit under study is of the low-moor type and it is composed of sedge, sedge-reed and sedge-moss peats and strongly alluvial peats. The peat deposit has the greatest depth in the central part of the valley (right side of the river), and the least in the bank parts. The peat layer sampled in profile III (on the right-hand side of the water course) from the depth of 85 to 285 cm was characterised by a relatively low ash content, from 9.1 to 18.8% (mean of 13.8%), and an acid reaction. In the top of that layer (from 85 to 95 cm) and in its foot (from 270 to 285 cm) there occurred deposits with alkaline reaction (Tab. 3). Both below and above it there were layers of medium-silty peat. On the bottom of the valley clayey silt was deposited, coloured grey or grey-blue, as well as sand with an admixture of gravel. The mineral overlay occurring on the surface of the deposit had thickness varying from 50 to 70 cm. The other profiles (left-hand side of the river) were characterised by a less diversified structure, with a presence of layers of weakly, medium and strongly alluvial peats (Tab. 1 and 2).

The studied deposits contained fairly well preserved plant remains. However, compared to valley peatalnds of the Lublin Region [Marek 1965, Urban 1997, 2004], and elswhere in Poland [Oświt 1991, Żurek 1991], only a small number of taxa were identified here. Most frequent were remains (roots) of sedges *Carex sp.* and reeds *Phragmites australis.* There was also a sparse admixture of other species from the class *Phragmitetea*: *Schoenoplectus lacustris*, *Typha sp.* and *Equisetum sp.*, and an even scarcer shares of species from the class *Scheuchzerio-Caricetea nigrae*, such as *Menyanthes trifoliata*, *Comarum palustre*, *Carex lasiocarpa* and *Eriophorum sp.* In a few samples the presence of mosses *Bryales sp.* was noted, including *Calliergonella cuspidata*. There was also an infrequent occurrence of remains of trees and bushes (bark, wood of *Alnus*, *Salix* and *Pinus*) and of seeds of sedges.

The results of the analyses indicate that the development of plant communities in he valley of the water course began with reed communities from the class *Phragmitetea*, characterised by a notable share of sedges from the association *Magnocaricion* and an admixture of *Phragmites australis*, *Schoenoplectus lacustris*, *Typha latifolia* and *Menyanthes trifoliata* (Tab. 2 and 3). In depressions of the valley bottom of those times (profile III –layer of 175–270 cm) there formed small water reservoirs in which aquatic communities from the class *Potamete* appeared. This is evidenced by the occurrence of plant macro-remains – fragments of leaves of *Potamogeton sp.* and *Nymphaea aba* (Tab. 3). The existence of small water reservoirs in other fragments of the peatland is confirmed by studies by Dresler [2010]. Water bodies with aquatic vegetation formed also in peatbogs in river valleys of the Lublin Upland [Bałaga and Maruszczak 1981, Urban

1997, 2004], and also in valleys of other regions of Poland [Oświt 1991] or Europe [Dembek *et al*. 1992].

Table 1. Botanical composition, ash content and reaction (pH) of studied formations (profile I)

Formation	Depth, cm	pH		Ash content, %	Content of plant macro-remains, %	Community
		KCl	H_2O			
Mineral-organic alluvial	0–20	5.9-6.0	5.6–5.8	69.7–85.5	Contemporary community of *Fraxino-Alnetum*	
Alluvial peat	20–40	5.7–5.9	5.6–5.8	36.4–37.5	*Phragmites australis* 10, *Carex sp.* 50, *Carex rostrata* 10, *Menyanthes trifoliata* 20, *Alnus glutinosa* (bark) 10	Communities from the association *Magnocaricion* with *Menyanthes trifoliata*
Sedge-moss peat	50–95	5.2–5.4	5.4–5.5	13.9–22.7	*Phragmites australis* 10, *Carex sp.* 50, *Menynthes trifoliata* 20, *Carex lasiocarpa* 13, *Comarum palustre* 5, *Pinus sylvestris* (bark) 2	Communities from the class *Scheuchzerio-Caricetea nigrae*
Alluvial sedge peat	90–105	5.4	5.5	48.5	*Phragmites australis* 10, *Carex sp.* 65, *Menyanthes trifoliata* 20, *Schoenoplectus lacustris* 5	Communities from the association *Magnocaricion* z *Menyanthes trifoliata*
Strongly alluvial sedge peat	105–120	6.6–6.7	6.3–6.4	62.0–70.0	*Phragmites australis* 10, *Carex sp.* 50, *Menyanthes trifoliata* 20, *Comarum palustre* 10, *Alnus* (bark) 10	
Mineral-organic alluvial	120–130	6.7	6.3	88.0	*Carex sp.* +, *Menyanthes trifoliata* +, *Equisetum* +	
Mineral-organic clay	130–160	6.7–7.0	6.3–6.4	90.0–97.1	*Carex sp.* +, *Menyanthes trifoliata* +	
Mineral-organic clay	160–200	7.1–8.2	6.3–7.1	93.6–97.5	*Carex sp.* +, *Menyanthes trifoliata* +, *Equisetum* +	

In the next sage, in the central part of the valley (profile III), reed communities continued to develop. They were characterised by a greater share (up to 60%) of *Carex sp.* and *Phragmites australis* (up to 30%), and of *Menyanthes trifoliata* (10%). The following stage of succession comprised phytocenoses in which the number of reed species from the associations *Phragmition* and *Magnocaricion* decreased, to the advantage of species from the class *Scheuchzerio-Caricetea nigrae.* The next subfossil community developing on mineral-organic and mineral formations was classified among reed phytocenoses from the association *Magnocaricion.* A high share of *Carex sp* was noted in that community, the admixture being *Menyanthes trifoliata*, *Comarum palustre*, *Carex rostrata* and *Calliergonella cuspidata.* In profile II, in peat layers at depths from 225 to 240 cm and from 110 to 220 cm there ccurred roots of *Carex lasiocarpa* (5–20%). In the phase corresponding to that horizon there appeared communties with a fairly high share of species from the class *Scheuchzerio-Caricetea nigrae* (Tab. 2). In some horizons of the deposit (layers of 20–40 and 105–120 cm in profile I; layers 40–55 and 190–200 cm – profile II) a slight presence of bark of *Alnus* and *Salix*

Table 2. Botanical composition, ash content and reaction (pH) of studied formations (profile II)

Formation	Depth, cm	pH		Ash content, %	Content of plant macro-remains, %	Community
		KCl	H_2O			
Mineral alluvial	0–45	6.0–6.1	5.6–5.7	92.0–96.0	Contemporary community of *Fraxino-Alnetum*	
Strongly alluvial sedge-reed peat	45–55	5.8	5.3	61.3	*Phragmites australis* 20, *Carex sp.* 35, *Comarum palustre* 10, *Carex rostrata* 20, *Menyanthes trifoliata* 10, *Salix sp.* (bark) 5	Communities from the class *Scheuchzerio-Caricetea nigrae*
Alluvial sedge-reed peat	55–65	5.2	5.1	23.1	*Phragmites australis* 10, *Carex sp.* 40, *Menyathtes trifoliata* 20, *Comarum palustre* 10, *Carex rostrata* 20	
Strongly alluvial peat	65–85	5.3–5.4	5.1–5.2	62.7–75.0	*Phragmites australis* 20, *Carex sp.* 45, *Menyanthes trifoliata* 30, *Typha sp.* 5	Communities from the association *Magnocaricion* with *Phragmites australis* and *Menyanthes trifoliata*
Alluvial sedge peat	85–100	5.1	5.0	39.8	*Phragmites australis* 25, *Carex sp.* 50, *Menyanthes trifoliata* 20, *Typha sp.* 5	
Sedge peat	100–110	5.2	5.0	14.9	*Phragmites australis* 20, *Carex sp.* 75, *Menyanthes trifoliata* 5	
Alluvial sedge peat	110–120	4.5	4.4	33.7	*Phragmites australis* 30, *Carex sp.* 45, *Comarum palustre* 5, *Carex lasiocarpa* 20	Communities from the association *Magnocaricion* with *Phragmites australis* and *Carex lasiocarpa*
Strongly alluvial peat	120–140	5.4	5.2	71.9	*Phragmites australis* 30, *Carex sp.* 60, *Menyanthes trifoliata* 5, *Carex lasiocarpa* 5	
Sedge peat	140–150	4.5	4.3	14.9	*Phragmites australis* 20, *Carex sp.* 65, *Menyanthes trifoliata* 5, *Carex lasiocarpa* 10	
Alluvial sedge peat	150–170	5.6–5.7	5.3–5.5	30.1–33.0	*Phragmites australis* 25, *Carex sp.* 50, *Menyanthes trifoliata* 5, *Carex lasiocarpa* 20	
Sedge-reed peat	170–190	5.8	5.5	15.6	*Phragmites australis* 30, *Carex sp.* 50, *Menyanthes trifoliata* 5, *Carex lasiocarpa* 15	

Alluvial sedge peat	210–220	5.1	4.8	33.0	*Phragmites australis* 10, *Carex sp.* 55, *Menyanthes trifoliata* 10, *Comarum palustre* 5, *Eriophorum* 5, *Carex lasiocarpa* 10, *Bryales* 5	Communties from the association *Caricion lasiocarpae*
Strongly alluvial peat	220–225	5.1	4.9	75.0	*Phragmites australis* 20, *Carex sp.* 60, *Menyanthes trifoliata* 20	Communities from the association *Magnocaricion* with *Menyanthes trifoliata*
Sedge peat	225–240	4.9–5.0	4.7–4.8	9.6–17.2	*Phragmites australis* 10, *Carex sp.* 55, *Menyanthes trifoliata* 10, *Carex lasiocarpa* 20, *Bryales* 5	Communities from the association *Caricion lasiocarpae*
Mineral-organic alluvial	240–260	5.2	5.0	82.6	*Phragmites australis* +, *Carex sp.* +, *Menyanthes trifoliata* +	Communities from the association *Magnocaricion*
Strongly alluvial sedge-reed peat	260–270	5.2	5.0	49.1	*Phragmites australis* 30, *Carex sp.* 40, *Menyanthes trifoliata* 30	
Clayey silt	270–290	5.4	5.0	92.2	*Phragmites australis* +, *Carex sp.* +, *Menyanthes trifoliata* +, *Typha sp.* +	

Table 3. Botanical composition, ash content and reaction (pH) of studied formations (profile III)

Formation	Depth, cm	pH		Ash content, %	Content of plant macro-remains, *%*	Community
		KCl	H_2O			
Mineral alluvial	0–35	4.9–5.0	5.4–5.5	94.8–96.0	Współczesne zbiorowisko *Scirpetum sylvatici*	
Alluvial sedge peat	35–50	5.0–5.0	4.5–4.8	27.5–30.8	*Phragmites australis* 15, *Carex sp.* 70, *Menyanthes trifoliata* 5, *Carex rostrata* 5, *Comarum palustre* 4, *Callierogonella cuspidata* 1	Communities from the association *Magnocaricion* with *Menyanthes trifoliata*
Mineral alluvial	50–70	5.0–5.7	4.9–5.3	89.8–96.0	*Phragmites australis* +, *Carex sp.* +, *Menyanthes trifoliata* +, *Carex rostrata* +, *Carex acutiformis* +, *Callierogonella cuspidata* +	
Alluvial sedge peat	70–80	7.3	7.2	36.4	*Phragmites australis* 2, *Carex sp.* 30, *Menyanthes trifoliata* 33, *Carex rostrata* 12, *Carex caespitosa* 22, *Carex pseudocyperus* (seeds) 1	Communities from the class *Scheuchzerio-Caricetea nigrae*
Sedge-moss peat	80–90	7.5	7.3	12.8	*Phragmites australis* 10, *Carex sp.* 35, *Menyanthes trifoliata* 35, *Equisetum* 9, *Comarum palustre* 8, *Carex rostrata* 3	
Sedge-reed peat	90–175	5.1–5.8	4.9–5.7	11.2–18.8	*Phragmites australis* 30, *Carex sp.* 50, *Menyanthes trifoliata* 10 *Equisetum* 5, *Eriophorum* 2, *Carex rostrata* 3	Communities from the association *Magnocaricion* with *Phragmites australis*
	175–270	5.0–5.8	4.8–5.5	9.1–17.0	*Phragmites australis* 25, *Carex sp.* 45, *Menyanthes trifoliata* 10, *Equisetum sp.* 10, *Schoenoplectus lacustris* 5, *Typha latifolia* 5	
	270–295	7.3–7.4	7.1–7.2	14.4–15.1	*Phragmites australis* 35, *Carex sp.* 60, *Schoenoplectus lacustris* 5	
Mineral-organic alluvial	295–300	5.9	4.9	39.8	*Phragmites australis* +, *Carex sp.* +, *Menyanthes trifoliata* +, *Carex rostrata* (seeds) +	Communities from the association *Mag-nocaricion*
Clayey silt	300–320	5.5–6.9	5.1–6.4	84.5–95.2	*Phragmites australis* +, *Carex sp.*+, *Menyanthes trifoliata* +	

or of wood of *Salix* (Tab. 1, 2) was noted among the analysed macro-remains. Studies by Dresler [2010] showed that in other fragments of tat deposit both bark and wood of *Alnus* occurred in larger amounts, which indicates proliferation of alders on the surface of the peatland of that time.

The subfossil communities identified corresponded with phytocenoses described from other valley peatlands of the Lublin Upland [Nakonieczny 1971, Urban 1997, 2004]. Studies conducted by other authors in small river valleys of the Giełczew Rise [Marek 1965, Nakonieczny 1967] and the Nałęczów Plateau [Urban 1997, Urban and Mikosz 1997] showed that the peat-forming process in those had also been started by reed communities from the class *Phragmitetea*, sometimes with a certain participation of *Alnus* and *Salix.* That was followed by the appearance of sedge and sedge-moss communities, and in certain fragments of the valleys – alders. According to Lipka [2000], sedge and sedge-moss communities played a major role in the development of peatlands in the catchment basin of river Vistula.

Studies by Dresler [2010], conducted in the eastern part of the peatland under analysis, showed that also communities from the classes *Phragmitetea* and *Scheuchzerio-Caricetea fuscae* developed there. Compared to the fragment of the peatland discussed here, however, better developed were aquatic communities from the class *Potametea*, as well as forest and brush communities from the class *Alnetea glutinosae*. Radiocarbon dating [Dresler 2010] indicates that the peat-forming processes in the studied valley began during the Subboreal period. In the valleys of the big rivers of the Lublin Region, such as Wieprz or Bystrzyca [Nakonieczny 1967, 1971, Bałaga and Maruszczak 1981], the accumulation of organic deposits took place since the beginning of the Holocene. In small river valleys of the Lublin Upland [Marek 1967, Nakonieczny 1967, Superson 1996, Urban 2004] those processes began in the period of the Atlantic.

CONCLUSIONS

1. In the studied profiles only a small number of taxa were identified. Analysis of plant macro-remains, however, permitted the identification of subfossil plant communities with the accuracy to the category of syntaxonomic class, less frequently to that of the association.

2. The first to develop in the valley were reed communities, mainly from the association *Magnocaricion*. In small pools of stagnant water there occurred communities from the class *Potametea.* In subsequent stages of succession there was an increase in the share of species from the class *Scheuchzerio-Caricetea fuscae.* The presence of fragments of bark and wood of *Alnus* and *Salix* among the macro-remains provides evidence of the past existence of forest and brush communities from the class *Alnetea glutinosae*.

3. The succession of plant communities in the studied fragment of the peatland followed the schematic: *Phragmitetea* → *Scheuchzerio-Caricetea nigrae* →

Phragmitetea (profile I, III) or *Phragmitetea* → *Scheuchzerio-Caricetea nigrae* → *Phragmitetea* → *Scheuchzerio-Caricetea nigrae* → *Phragmitetea* → *Scheuchzerio-Caricetea nigrae.*

4. In the development of the studied peatland one can distinguish the following phases: the initial phase related with the deposition of mineral formations, the phase of reed vegetation (subfossil communities from the class *Phragmitetea*), the phase of sedge-moss vegetation (subfossil communities from the class *Scheuchzerio-Caricetea fuscae*), and the deluvial phase (subfossil communities from the class *Phragmitetea).*

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SUBFOSYLNE ZBIOROWISKA ROŚLINNE TORFOWISKA POGRZEBANEGO W OKOLICACH ZAKRZÓWKA (WYŻYNA LUBELSKA)

Streszczenie. W pracy przedstawiono wyniki badań dotyczące charakterystyki subfosylnych zbiorowisk roślinnych torfowiska pogrzebanego leżącego w dolinie małego cieku wodnego (prawy dopływ Bystrzycy). Wykonano tu świdrem torfowym typu Instorf trzy wiercenia, z których do analiz laboratoryjnych pobrano 80 próbek. W próbkach oznaczono makroszczątki roślinne, a także popielność i odczyn (pH w H_2O i KCl). Z przeprowadzonych badań wynika, że w dolinie cieku wykształciło się torfowisko niskie, zbudowane głównie z torfu turzycowego oraz turzycowo-trzcinowego z wkładkami torfu turzycowo-mszystego. Wschodnią część złoża pokrywa warstwa namułu mineralnego o miąższości od 20 do 70 cm. Wśród zbiorowisk subfosylnych przeważały fitocenozy szuwarowe z klasy *Phragmitetea*. Rzadziej występowały zbiorowiska z klas *Scheuchzerio-Caricetea fuscae* i *Potametea*.

Słowa kluczowe: torfowisko pogrzebane, dolina, makroszczątki roślinne, zbiorowiska subfosylne