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NATURAL VALUES OF SELECTED MIDFOREST BOGS AND TRANSITIONAL MIRES IN NATURA 2000 AREAS

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Abstract. The analysed midforest peatlands are located in Natura 2000 sites: PLH060034 Uroczyska Puszczy Solskiej and PLH060031 Uroczyska Lasów Janowskich. The aim of the study was to evaluate plant communities as well as identify rare and legally protected plant, fungal, and animal species occurring in these areas. The analysed peatlands are characterised by a high diversity of plant communities. They also provide habitats for legally protected and rare fauna and flora species. The peatlands exhibit high aesthetic and health-enhancing values.

Key words: natural and touristic values, midforest raised bogs and transitional mires, Biłgoraj Plain

INTRODUCTION

Wetlands, i.e. wet areas also called bogs, marshes, swamps, quaking bogs, muds, etc., are periodically or constantly swamped, flooded, or waterlogged areas with mineral or organic soils. The study area covers both large and small peatlands (mainly raised bogs and transitional mires). There are also interesting intra-dune lakes and closed depressions on sandy undulations of the terrain, called "smugi". As suggested by Łachacz [2004], an area can be classified as a wetland when it simultaneously fulfils three criteria, e.g. a water-permeated substrate (soil) rich in organic matter, anaerobic conditions, and appropriate hydrological conditions – visible signs of excess water, and the presence of living organisms that are morphologically and physiologically adapted to abiotic conditions. As shown by Dembek *et al*. [2000], wetlands in Poland occupy 13.9% of the area, with 3.9% of peatbogs and 10.0% of non-peatbog wetlands. In the

Lublin region, peatbogs cover an area of approximately 140 thousand ha [Borowiec 1990]. The basic functions of wetlands include global ecosystem function, determination of hydrological phenomena, maintenance of water quality, creation of habitats for plants and animals, and the use of the assets of these ecosystems by humans, i.e. recreation, education, ecotourism, land management, uniqueness, and natural and cultural heritage [Łachacz 2004].

In recent years, increasing attention has been focused on not only large peatland complexes, but also small and medium-size midforest peatlands located on the bottoms of relatively small terrain depressions. Their role in the conservation and enrichment of the biodiversity of agricultural and forest areas has been appreciated [Grootjans and Wołejko (red.) 2007, Lamentowicz 2007, Łachacz and Olesiński 2000, Tobolski 2003, Łachacz 2004]. Given their function in the environment and the occurrence of specific plant, animal, and fungal species, peatlands are regarded as extremely valuable natural areas (Natura 2000 network). Investigations conducted in the recent years in Poland [e.g. Lamentowicz 2007, Michalska-Hajduk and Woziwoda 2008, Woziwoda and Michalska-Hajduk 2008], including the Lublin region, has demonstrated that many of these objects (primarily fens and, less frequently, transitional mires and raised bogs) have preserved valuable plant communities and localities of rare plant and animal species [Wawer and Urban 1995, Fijałkowski *et al*. 1997, Urban 2007, Urban *et al*. 2006, 2007, Wójciak *et al*. 2000, Wójciak and Urban 2012, Urban and Wójciak 2013].

Wetlands, and especially peatbogs, are components of the natural environment, which rapidly undergoes substantial and usually irreversible changes. Wetlands, including peatbogs, located in forest areas have become objects of interest due to the small water retention program implemented by the State Forests [Zarządzenie Nr 11a… 1999]. Such objects are part of the natural retention system in forests [Pawlaczyk *et al*. 2001, Wołejko *et al*. 2004].

OBJECTS AND RESEARCH METHODS

The PLH060034 Uroczyska Puszczy Solskiej Natura 2000 site is located in the Sandomierska Basin mesoregion and the Roztocze escarpment zone (a small fragment). The PLH060031 Uroczyska Lasów Janowskich site is situated in the western and central parts of the Biłgoraj Plain. An important natural asset of these areas is the great number of wetlands, including midforest raised bogs and transitional mires. According to the division proposed by Borowiec [1990], the peatland objects are located mainly in the Janów-Biłgoraj region covering a small fragment of the Sandomierska Basin (Puszczańska Plain) at the foot of Roztocze (Fig. 1). The area comprises 160 peatlands, including 90 raised bogs and transitional mires.

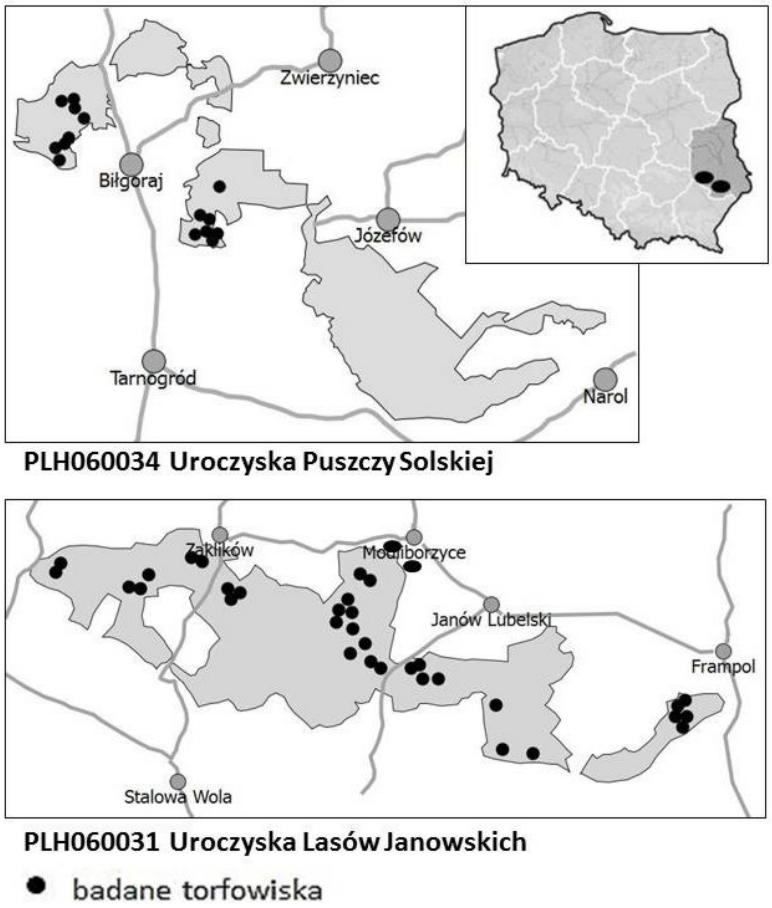

Fig. 1. Location of the peatbogs studied

The investigations were carried out in 50 midforest peatlands (mainly transitional mires and raised bogs) in the forest districts of Józefów, Biłgoraj, Gościeradów and Janów Lubelski. The phytosociological classification and nomenclature of plant communities was based on the paper by Matuszkiewicz [2008], and the names of vascular plants and bryophytes followed those proposed by Mirek *et al*. [2002] and Ochyra *et al*. [2003], respectively. The assessment of the touristic and recreational attractiveness (aesthetic and health-enhancing values) of the analysed phytocoenoses was based on the paper by Krzymowska-Kostrowicka [1999].

The main objective of the research was to assess the richness and diversity of plant communities as well as rare and legally protected plant and animal species inhabiting the midforest peatlands. The aesthetic and health-promoting values of these areas were evaluated as well.

RESULTS AND DISCUSSION

The analysed objects were characterised by a high diversity of plant communities, for instance those from the following phytosociological classes: *Potametea*, *Utricularietea intermedio-minoris*, *Phragmitetea*, *Scheuchzerio-Caricetea nigrae*, *Oxycocco-Sphagnetea*, *Alnetea glutinosae*, and *Vaccinio-Piceetea.*

The most frequent phytocoenoses covering the largest surface area in the peatlands included *Sphagno-Caricetum rostratae* (in 25 peatlands), *Eriophoro--Sphagnum* (in 26 peatlands), *Caricetum lasiocarpae* (in 26 peatlands), and the *Eriophorum angustifolium* community (in 25 peatlands). Aquatic communities that were noted infrequently in the objects included *Nymphaeetum candidae* (water bodies in 2 peatlands); rare peatland communities were represented by *Caricetum limosae* (in 6 peatlands) and *Ledo-Sphagnetum magellanici* (in 5 peatlands). The plant communities occurring in the analysed peatlands undergo dynamic changes depending on both the quantity and quality of water (Fig. 2).

The aquatic vegetation was represented by 2 associations from the class *Potametea*. Associations *Nypharo-Nymphaeetum albae* and *Nymphaeetum candidae* developed in some small water bodies.

A relatively small group was formed by rush communities from the class *Phragmitetea*. They formed small patches, mainly in the peatland zone and in some peat pits. These were patches of the associations *Phragmitetum australis* and *Typhetum latifoliae*. Communities from the alliance *Magnocaricion* were present in some old and shallow post-excavation pools, peat pits, and local terrain depressions. They were also found in marginal fragments of several transitional mires. They comprised different-sized patches of sedge phytocoenoses: *Caricetum rostratae* and *Caricetum elatae.*

The most frequent communities in the transitional mires were represented by associations *Sphagno-Caricetum rostratae* and *Caricetum lasiocarpae* from the class *Scheuchzerio-Caricetea nigrae*. There were also small patches of associations *Rhynchosporetum albae* and *Caricetum limosae*, but they were noted less frequently.

The association *Sphagno-Caricetum rostratae* covered large areas in some peatlands. It was characterised by a high share of *Carex rostrata* and *Eriophorum angustifolium* in some patches as well as *Oxycoccus palustris*. *Oxycoccus microcarpus* and *Andromeda polifolia* were less frequent. The bryophyte layer was dominated by peat mosses: *Sphagnum fallax*, *S. fuscum*, and *S. magellanicum.*

The association *Caricetum lasiocarpae* was noted in peat depressions in the marginal zone of transitional mires. It was characterised by a well-developed layer of herbaceous plants with *Carex lasiocarpa* as the dominant species, providing the community with characteristic physiognomy. *Carex canescens, C. vesicaria,* and *C. nigra* sedges as well as *Eriophorum angustifolium* and *Comarum palustre* constituted an abundant admixture. Some patches exhibited

a high share of *Oxycoccus palustris* and *Peucedanum palustre* (less frequently *Andromeda polifolia* and *Drosera rotundifolia*) and *Sphagnum* peat moss in the bryophyte layer.

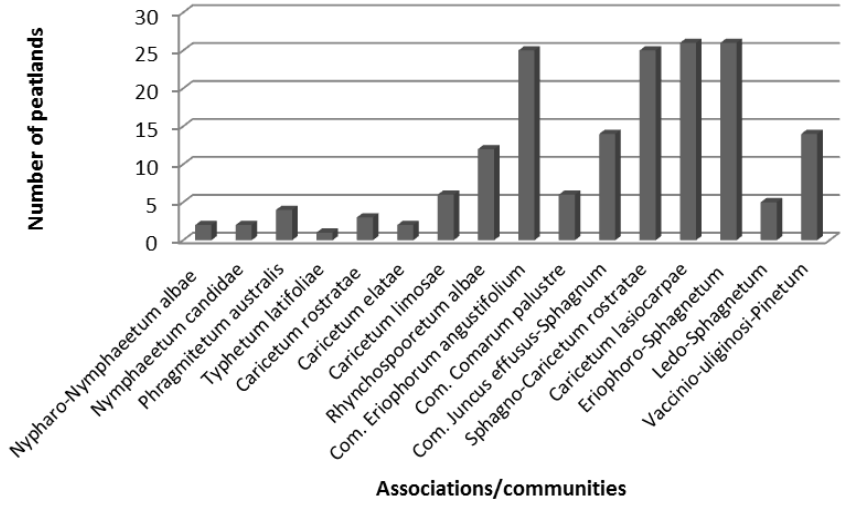

Fig. 2. Frequency of occurrence of associations and communities in the analysed peatlands

Patches of the association *Rhynchosporetum albae* were present in heavily waterlogged depressions in a few of the analysed peatlands. They usually occupied small areas and exhibited mosaic arrangement with other transitional mire communities. The dominant *Rhynchospora alba* was accompanied by other species from the class *Scheuchzerio-Caricetea nigrae*, i.e. *Drosera intermedia, D. anglica*, and *D. obovata* in some peatlands. Patches of the association *Caricetum limosae* were found in similar sites. As in the case of the association *Rhynchosporetum albae*, species from the class *Scheuchzerio-Caricetea nigrae* formed an admixture.

The surface of some old post-excavation peat pits and local terrain depressions (less frequently – drainage ditches) was covered by loose turf formed by almost single-species aggregations of *Eriophorum angustifolium*, *Carex nigra*, *Comarum palustre*, *Menyanthes trifoliata*, or *Calla palustris*. Rush species from the class *Phragmitetea* and transitional mire species from the class *Scheuchzerio-Caricetea nigrae* formed a small admixture. Some patches exhibited a high share of *Sphagnum cuspidatum* peat moss. Nearly all analysed objects comprised communities dominated by *Juncus effusus* and *Sphagnum fallax*, usually at the peatland margins. Similar patches from the midforest swamps in the Łęczyńsko-Włodawska Plain and Solska Forest were classified as the association *Junco effusi-Sphagnetum* by Fijałkowski and Chojnacka-Fijałkowska [1990].

Transitional mire communities from the class *Oxycocco-Sphagnetea* were found in many midforest peatlands. These were associations *Eriophoro-Sphagnetum* and, less frequently, *Sphagnetum magellanici* and *Ledo-Sphagnetum.* These communities exhibit a distinct hummock-hollow structure with a different species composition. Infrequently, they contained *Pinus sylvestris* with a small admixture of *Betula pubescens*. The layer of shrubs was poorly developed: it was mainly composed of undergrowth of *Pinus sylvestris* with a small admixture of *Betula pubesbens* and in some sites *Salix aurita* and *S. cinerea*. The hummocks were covered by *Oxycoccus palustris*, *Eriophorum vaginatum*, and *Andromeda polifolia* and, less frequently, by *Ledum palustre*. Some hummocks were covered by *Sphagnum magellanicum*, in some areas with an admixture of *Polytrichum strictum*. Peat mosses, i.e. mainly *Sphagnum fallax* and, less frequently, *S. cuspidatum* occupied the hollows.

Communities from the class *Alnetea glutinosae* were represented in the analysed objects by two alder associations: *Sphagno squarrosi-Alnetum* and *Ribeso nigri-Alnetum.* The tree stand of the former one was dominated by *Alnus glutinosa*, which were sometimes accompanied by birches. The understorey was mostly composed of the undergrowth of the trees mentioned above as well as *Frangula alnus* and *Salix cinerea* shrubs. The groundcover was formed by transitional mire species. The moss layer was mainly represented by *Sphagnum squarrosum*, *Calliergonella cuspidata*, and *Drepanocladus aduncus*. The association *Ribeso nigri-Alnetum* formed small patches, usually at the margins of the peatlands. The tree layer comprised primarily *Alnus glutinosa*, sometimes with an admixture of *Betula pubescens*. The understorey contained *Salix cinerea* and *Frangula alnus*. Rush species from the class *Phragmitetea* dominated in the groundcover. There were only few scrub associations in the analysed peatlands. These were small communities *Salicetum pentandro-cinereae*, which formed dense *Salix cinerea* scrubs (up to 90% coverage). The admixture was composed of *Alnus glutinosa* as well as *Betula pendula* and *B. pubescens*. The groundcover usually contained rush species from the class *Phragmitetea.*

The continental bog woodland *Vaccinio uliginosi-Pinetum* from the class *Vaccinio-Piceetea* was noted in several midforest peatlands. The tree stand of this forest, formed almost exclusively by *Pinus sylvestris*, was characterised by a relatively low density in the range from 40 to 70%. The poorly developed shrub layer exhibited the dominance of *Pinus sylvestris* undergrowth. The admixture was sometimes formed by *Frangula alnus.* The groundcover layer was richer and mainly comprised *Vaccinium uliginosum* and *Ledum palustre* shrubs and, less frequently, *Oxycoccus palustris* and *Andromeda polifolia*. In some patches, *Vaccinium myrtillus* and sometimes *V. vitis-idaea* and *Calluna vulgaris* exhibited greater density. The moss layer was formed by *Polytrichum commune,* peat mosses *Sphagnum capillifolium*, *S. magellanicum*, *S. rubellum*, and, less frequently, *S. compactum* and *S. palustre*.

Noteworthy is the abundant occurrence of *Cladonia incrassata*, a rare lichen species under strict protection growing at the base of decaying stumps and on rotting dykes.

The investigations were also conducted in several peatlands dissected by ridge beds. According to the Small Forest Encyclopaedia [1991], to elevate the tree-planting beds in marshy areas, parallel 0.5 m deep furrows (grooves) are ploughed or dug at a spacing of approx. 2.5 m and ridges are formed from the extracted soil on both sides of each furrow. In objects where such practice was employed last century (20–30 years ago), many furrows exhibited the presence of transitional mire communities from the class *Scheuchzerio-Caricetea nigrae*, and special attention should be focused on patches dominated by *Rhynchospora alba* (association *Rhynchosporetum albae*). *Molinia caerulea* clumps were most often noted on the ridges.

Legally protected vascular plant species [Rozporządzenie… 2014] were represented in the peatlands by:

– strictly protected: *Scheuchzeria palustris*, *Utricularia intermedia*, *Utricularia minor*, *Drosera anglica*, *Drosera rotundifolia*, *Drosera* × *obovata*, *Drosera intermedia*, *Osmunda regalis*;

– partially protected: *Menyanthes trifoliata*, *Nymphaea alba*, *Nymphaea candida*, *Ledum palustre*, *Andromeda polifolia*, *Dactylorhiza incarnata*, *Lycopodium annotinum* (at the margins of some peatlands);

– rare and endangered species: *Carex limosa*, *Utricularia vulgaris.*

The localities of legally protected bryophytes [Rozporządzenie… 2014] should be emphasised as well. These were *Leucobryum glaucum* (at the margins of some peatlands), *Climacium dendroides*, *Pleurozium schreberi*, *Aulacomnium palustre*, *Polytrichum strictum*, *P. commune*, *Thuidium tamariscinum*, *Sphagnum palustre*, *S. fuscum*, *S. rubellum*, *S. fimbriatum*, *S. magellanicum*, *S. capillifolium*, *S. cuspidatum*, *S. compactum*, and *Sphagnum fallax.*

Localities of an alien invasive species *Erechtites hieracifolia* were noted in several raised bogs and transitional mires. As reported by Dajdok and Pawlaczyk [2009], this pioneer species occurs in disturbed wet forest habitats. Currently, it is classified as a potentially threatening neophyte.

There were old post-excavation peat pits in some of the analysed objects. Similar to other objects of this type [Podbielkowski 1960, Fijałkowski *et al*. 1997, Iwaniuk 1999, Mosek and Miazga 1999, Trąba *et al*. 2004, Sugier 2006, Urban 2007], these pits are characterised by a high phytocoenotic and floristic diversity and offer habitats to rare plant species, which is associated with their age, depth, and size as well as the type of the peat deposit. A process of spontaneous renaturalization was observed in many of the exploited peatlands [Podbielkowski 1960, Ilnicki 1996, Iwaniuk 1999, Mosek and Miazga 1999, Trąba *et al*. 2004, Sugier 2006, Urban 2007]. The plant communities occurring in these peat pits exhibited different stages of development: initial, transitional, and final. As

suggested by Podbielkowski [1960], water is one of the determinants of the type of vegetation colonising post-excavation peat pits. A majority of the pits present in some of the analysed peatlands were colonised by species from the class *Scheuchzerio-Caricetea nigrae* in the initial stage, e.g. *Comarum palustre*, *Menyanthes trifoliata* or *Calla palustris*, and *Sphagnum cuspidatum*. The subsequent stages were represented by phytocoenoses from the classes *Scheuchzerio--Caricetea nigrae* and *Oxycocco-Sphagnetea.*

The wetlands of the analysed Natura 2000 sites are also characterised by the occurrence of rare animal species. Among interesting insects, there are 2 species of strictly protected dragonflies *Opchiogomhus Cecilia* and *Leucorrhinia pectoralis* as well as the *Mantis religiosa* mantis, the *Euphydryas aurinia* butterfly, and the partially protected *Somatochloa arctica* dragonfly. Representatives of reptiles *Lacerta vivipara*, *Natrix natrix*, and *Vipera berus* can frequently be encountered. *Coronella austriaca* specimens were observed at the margin of a dried peatbog. The avifauna is represented by *Tetrao urugallis*, *Circaetus gallicus*, and *Grus grus*.

The following habitats listed in Annex I of the Habitats Directive were noted in the analysed peatlands: 3160 Natural, dystrophic water reservoirs, 7110 raised bogs with peat-forming vegetation (live), 7140 Transitional mires and quaking bogs (mostly with *Scheuchzerio-Caricetera* vegetation), 7150 Depressions on peat substrates of the association *Rhynchosporion*, and *91D0 Bog woodland.

As reported by Krzymowska-Kostrowicka [1999], bog woodlands *Vaccinio uliginosi-Pinetum* as well as raised bog communities from the class *Oxycocco--Sphagnetea* and transitional mire communities from the class *Scheuchzerio--Caricetea nigrae* are characterised by high visual and fragrance aesthetic values. Such forests are dominated by shades of dark brown and dark green interwoven by red and white. The dominant colour in raised bogs and transitional mires is green or red with an admixture of black and light brown. Such a composition of colours has a stimulating effect on the human psyche. The bioclimate of bog woodlands, raised bogs, and transitional mires is characterised by high air humidity and a considerable (periodically, especially at the time of *Ledum palustre* flowering in raised bogs) concentration of plant pollen grains (strong allergens). This does not promote a prolonged stay in these communities. However, the considerable biotherapeutic effect exerted by phytoaerosols and the very low bacterial density provide favourable conditions. Given these properties, it can be claimed that bog woodlands and peatlands have a stimulating and antiseptic effect on the organism. Due to the low resistance to recreational use, the communities are not suitable for long-term stay and tourist traffic should be directed to roads (in close vicinity of midforest peatlands) or footbridges.

CONCLUSIONS

1. The floristic-phytosociological studies of the selected midforest peatlands indicate a high diversity of the plant communities. Thirteen associations and 3 communities from 6 phytosociological classes were found in the examined objects.

2. The analysed objects were characterised by a high diversity of plant communities representing the following phytosociological classes: *Potametea*, *Phragmitetea*, *Scheuchzerio-Caricetea nigrae*, *Oxycocco-Sphagnetea*, *Alnetea glutinosae*, and *Vaccinio-Piceetea.*

3. The post-excavation pits present in the analysed objects exhibited different stages of development, which was associated with their age, depth, and size as well as the type of the peat deposit. Communities from various phytosociological classes have evolved in the peat pits located in the raised bogs and transitional mires.

4. Rare and legally protected plant, animal, and fungal species were found to occur in the analysed objects and their immediate environment. The presence of habitats listed in Annex I of the Natura 2000 Habitats Directive is particularly noteworthy. The peatlands should be legally protected as ecological lands.

5. The communities present in the analysed objects are characterised by high aesthetic values, and their environment has a stimulating and antiseptic impact on the organism.

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WALORY PRZYRODNICZE WYBRANYCH ŚRÓDLEŚNYCH TORFOWISK WYSOKICH I PRZEJŚCIOWYCH W OBSZARACH NATURA 2000

Streszczenie. Badane śródleśne torfowiska znajdują się na terenie obszarów Natura 2000 PLH060034 Uroczyska Puszczy Solskiej i PLH060031 Uroczyska Lasów Janowskich. Celem badań było zarejestrowanie występujących tu zespołów roślinnych oraz rzadkich i objętych ochroną prawną gatunków roślin, grzybów oraz zwierząt. Omawiane torfowiska charakteryzują się dużym zróżnicowaniem zbiorowisk roślinnych. Odnotowano tu także stanowiska objętych ochroną prawną i rzadkich gatunków roślin, grzybów i zwierząt. Badane torfowiska odznaczają się dużymi walorami estetycznymi i zdrowotnymi.

Słowa kluczowe: walory przyrodnicze i turystyczne, torfowiska śródleśne wysokie i przejściowe, Równina Biłgorajska