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PEATLAND VEGETATION OF THE SYRA POGONIA MASSIF OF THE RIVNENSKYI NATURE RESERVE (POLISSIA, UKRAINE): ECOLOGICAL CHARACTERISTICS

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Background. Peat bog complexes are self-sufficient ecosystems in which unique microclimatic conditions leading to a significant diversity of valuable plant communities are formed. Such communities are sensitive to the effects of climate change or any anthropogenic intervention. The lack of reliable information on their distribution on the territory of the Syra Pogonia peat-bog massif of the Rivnenskyi Nature Reserve necessitates a detailed study of the bog vegetation. Therefore, the purpose of the work was to classify the community of peatland vegetation of the Syra Pogonia massif and to determine the features of their syntaxonomic and ecological differentiation for further development of environmental management strategies.

Materials and Methods. The study of the peculiarities of peatland vegetation was conducted on transects that represent the variety of local conditions of the complex system. A total of 141 relevés were analysed using the Braun–Blanquet method. The material was analysed using TURBOVEG 2.79 and JUICE 7.0.83 software. Vegetation units were separated using the method of two-factor indicator species analysis (TWINSPAN). Diagnostic species of syntaxa were determined by the fidelity coefficient *phi*, the fidelity threshold for which was > 25 %. The statistical significance of the phi coefficient was determined with the Fisher's test at P < 0.001. The DCA-ordination method was used to identify an ecological differentiation of units.

Results. Peatland vegetation of the Syra Pogonia massif of the Rivnenskyi Nature Reserve was analysed. We identified 7 associations belonging to 6 alliances, 6 orders and 4 classes and compiled a vegetation syntaxonomic scheme. The leading factor of ecological differentiation of community is humidity of the area. The greatest diversity is inherent in mesotrophic areas, rare species are found and grouped according to different ecological conditions. The species composition of 7 associations includes 79 plant species, of which 65 are vascular and 14 are bryophytes. Using methods of phytosociological analysis, we established that the distribution of community in multidimensional space of ecological factors occurs under the conditions of their complex action. At the same time, changes in the humidity regime are of crucial importance for the selected syntaxa (*Andromedo polifoliae-Sphagnetum magellanici*). The results of the phytoindicative analysis proved that the associations identified on the territory of the Syra Pogonia peat-bog complex are acidophilic in terms of acidity, and oligotrophic in terms of the requirements for the content of nutriens.

Conclusions. As orders, and result of the analysis of relevés, 7 associations, which belong to 6 alliances, 6 orders and 4 classes were selected. Based on the results of the dataset analysis, a vegetation classification scheme was compiled. As a result of the cluster analysis of 7 associations, a significant difference between communities of watered and wet habitats was revealed. We established that the differentiation of the vegetation on the territory of the peat massif of Syra Pogonia mainly depends on the change in the moisture regime.

Keywords: peat bog, plant cover, syntaxonomy, ordination, ecological factors, Ukrainian Polissia

INTRODUCTION

The important role of wetland ecosystems in preserving biodiversity is indisputable, nevertheless, in many countries of the world, bogs are under threat of extinction (Ahmad *et al.,* 2024; Alikhani *et al.,* 2023; Aslam *et al.,* 2021). The use of marsh complexes as peat deposits, fodder lands, or land reserves has led to the degradation of large areas of marshlands as a result of reclamation and the use of fertilizers, which has caused irreversible succession changes in vegetation (Hambäck *et al.,* 2022). However, complex studies of wetlands and the determination of the optimal size of the territories for their performance of the most complete spectrum of ecosystem services are currently being actively conducted (Åhlén *et al.,* 2020). Research on the sustainability of restored peatlands and their ability to influence climate change is relevant (Brancaleoni, 2022; Loisel, & Gallego-Sala, 2022; Humpenöder *et al.,* 2020).

The classification of peatland vegetation in different countries is not the same due to distinctive methodological approaches. Two main concepts of vegetation classification are usually used:

- the determination of specific groups based on hydrological conditions and vegetation physiognomy (Dierssen, & Dierssen, 1985; Steiner, 1992; Oberdorfer, 1994; Gerdol, & Tomaselli, 1997; Lawesson, 2004; Matuszkiewicz, 2007; Coldea *et al.,* 2008; Graf *et al*., 2010; Chytrý, 2011, 2013; Dubyna *et al.,* 2019). In these classification systems, a clear distinction is made between watered areas (for example, communities of *Caricion lasiocarpae* and *Rhynchosporion albae*) and areas of swamps and marshy meadows (*Caricion fuscae*). The dominance of different vascular plant species (*Carex lasiocarpa*, *C. limosa*, *C. nigra* or *Rhynchospora alba*) is usually used as the main delimitation criterion. This concept leads to the definition of a wide range of communities covering localities with different or even contrasting ecological conditions and causes a clear demarcation into associations and sub-associations;

- the determination of vegetation types along a certain determining gradient of chemical composition and environmental response in bogs, which correspond to pH and calcium concentration (Du Rietz, 1949; Dahl, 1956; Malmer, 2011; Tahvanainen, 2004; Hajek *et al.,* 2006).

A planned research on the territory at the beginning of the last century was carried out by scientists of the "Western Expedition to Drain Bogs" under the leadership of J. Zhilynskyi (Bachurina, 1964). The classification of bog vegetation was developed by D. Zerov (1938), and for Polissia within Poland – by S. Kulczyński (Kulczyński, 1949). Considering its to ecological properties, S. Kulczyński divided the swamp into lowland, transitional and upland, which differ in the life forms of the main dominants and their species or genera. This classification was developed with a focus on ecological and phytocenological features, however the volume of transitional bogs was interpreted somewhat differently: they included almost all sedge bogs with *Sphagnum* cover. D. Zerov's classification was largely built on his own material and elaborated to the level of associations. It covered all the main types of Ukrainian bogs within Ukraine until 1939. It was based on the division into series by life forms of edifiers. The principles of bog vegetation classification are also detailed in the work of E. Bradis (1973). T. Andrienko, O. Pryadko, and V. Onyshchenko presented materials for studies of the peat bog of the Rivne region. Their sozological component (Andrienko *et al.,* 2006) and classification schemes of the two classes (*Scheuchzerio-Caricetea*, *Oxycocco-Sphagnetea*) for separate peat bog massifs were presented in the subsequent works by these authors (Onyshchenko *et al.*, 2009; 2015; 2016). The characteristics and sozological assessment of the main types of habitats (raised bogs, drained raised bogs, transition mires and quaking bogs) were explicated by M. Yuskovets *et al*. (2023); ecological and biomorphological peculiarities of the bryoflora on the territory of the Syra Pogonia massif were studied by I. Rabyk & M. Yuskovets (2023).

Due to a certain inconsistency of modern ecological and floristic classifications and the lack of reliable information for individual syntaxa of association ranks in the form of publicly available phytocoenotic tables (for example, for associations of the class *Oxycocco-Sphagnetea*) on their distribution in Ukraine, further research is needed (Mucina *et al*., 2016). In particular, it is important to coordinate the classification of peatland vegetation syntaxa and to determine their ecological characteristics in protected areas (Onyshchenko *et al.*, 2009; 2015; 2016).

The aim of this work was to compile the inventory of peatland vegetation of the Syra Pogonia massif including identification of the peculiarities of their syntaxonomic and ecological differentiation for the determination classes, orders, alliances and associations.

MATERIALS AND METHODS

Study area. The peat bog massif of Syra Pogonia (**Fig. 1**) is located on the territory of two united parts of the Rivnenskyi Nature Reserve: Bilsky (north of the village of Bilsk) and Grabunsky (south of the village of Grabun) within the Sarnenskyi district of the Rivne region. The total area of the massif is 9.926 hectares, of which forests occupy 5.059 (51 %), swamps – 4.650 (46.9 %) and water bodies – 12.2 (0.1 %) (Litopys pryrody, 2023).

Syra Pogonia belongs to the natural region of Volynske Polissia, the climate of which is relatively humid and warm, characterized by less continentality, a longer duration of the frost-free period, and more precipitation compared to other physiographic regions of Ukrainian Polissia (Lipinskyi *et al.,* 2003).

The humidity coefficient in the entire study area is more than 2.4 (Lipinskyi *et al.,* 2003). The average long-term temperatures of the summer months are typical for an area with a moderate continental climate: in June – +17 °C, in July – +18 °C, and in August +17–17.5 °C. The amount of summer precipitation is 146.4 mm. However, during the research period (2020–2022), the average daily temperature in July was 1.5 °C higher than the climatic norm and equalled +19.7 °C, and the amount of precipitation was 64.7 mm, which is 16.3 mm less than average (80 mm). The annual rainfall is characterized by a maximum in July (80–95 mm) and a minimum in January (40–50 mm). The transition to the frost-free period occurs in the middle of the last decade of April, its duration is 170 days (Malytska & Balabukh, 2020).

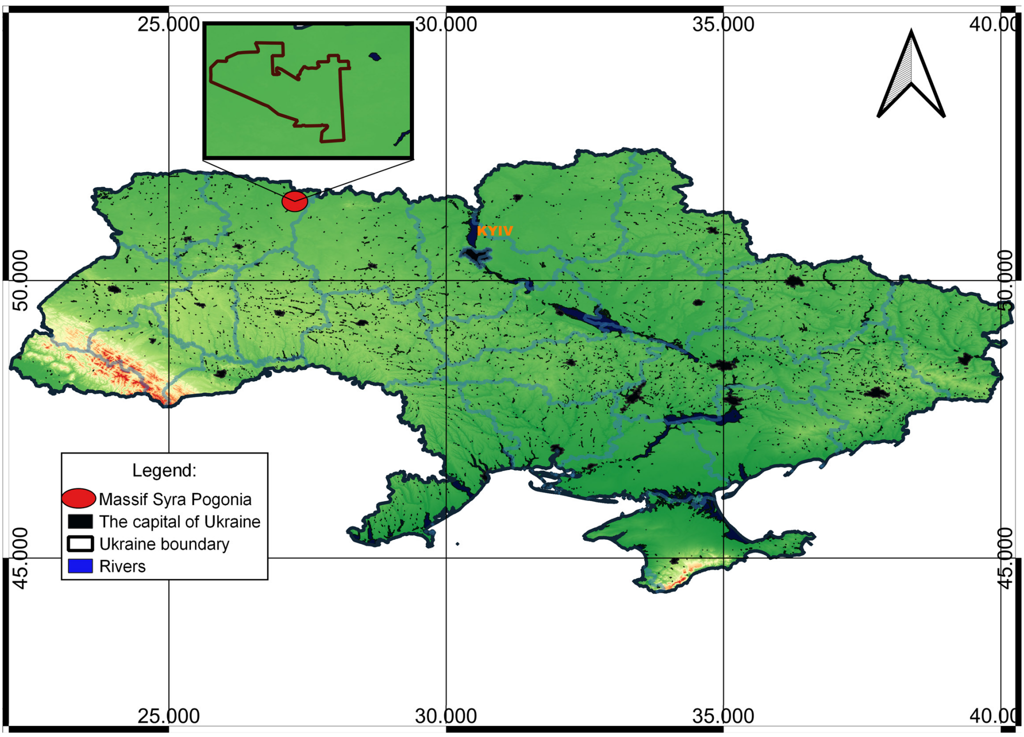

Fig.1. The location of the Syra Pogonia peat bog massif

Data collection and management. A total of 141 relevés were analysed, made on plots with an area of 25 m^2 during 2020–2022 according to the method of J. Braun-Blanquet (Dierschke, 1994; Chytrý & Otypkova, 2003). The study of the features of the swamp vegetation was carried out on transects that reflect the variety of local conditions of the complex. A total of three such transects have been laid. Relevés were made on each of them, taking into account the continuous changes of the communities. The data management was carried out using TURBOVEG 2.79 software (Hennekens, 2001), and its analysis – by JUICE 7.0.83 (Tichý, 2002). Vegetation units were obtained using the method of two-factor indicator analysis of species (TWINSPAN), in particular according to its modified algorithm (Roleček *et al.*, 2009). The cut level for „pseudospecies" was 0.5; 15; 25 %. Diagnostic species of syntaxa were determined according to the values of the *phi*-coefficient (Chytrý *et al.,* 2002). The confidence threshold for identifying diagnostic species was more than 25 %. Statistical reliability of the coefficient was determined by Fisher's test at $P < 0.001$. In the phytocoenotic tables, a modified scale of cover of species according to Braun–Blanquet was used, classes of constancy of species were determined according to the conventional scale (Dierschke, 1994).

The DCA-ordination (Hill & Gauch, 1980; Venables & Smith, 2011) was used to identify the features of the ecological differentiation of clusters and to find out the ecological optimums in relation to the leading factors of the environment – a basic statistical analysis in the PAST 4.03 program using ecological scales (Ellenberg, 1992, 1996).

The names of species of vascular plants are indicated according to the electronic database Plants of the World Online (2023), bryophytes – Prodromus of Sporen Plants of Ukraine: Bryophytes (Virchenko & Nyporko, 2022).

RESULTS AND DISCUSSION

As a result of vegetation classification using the method of two-factor indicator analysis, seven clusters were obtained. Based on these clusters, we identified 7 associations. The vegetation classification scheme (7 associations, 6 alliances, 6 orders and 4 classes) is given below. We follow L. Mucina *et al.* (2016) for the names and authors of higher syntaxa, the name of associations according by D. Dubyna *et al.* (2019):

Cl. *PHRAGMITO-MAGNOCARICETEA* Klika in Klika et Novák 1941
- Ord. *Phragmitetalia* Koch 1926
  - All. *Phragmition communis* Koch 1926
    - Ass. *Phragmitetum australis* Savič 1926

Cl. *SCHEUCHZERIO PALUSTRIS-CARICETEA FUSCAE* TX. 1937
- Ord. *Sphagno warnstorfii-Tomentypnetalia* Lapshina 2010
  - All. *Stygio-Caricion limosae* Nordhagen 1943
    - Ass. *Caricetum limosae* Osvald 1923
    - Ass. *Caricetum lasiocarpae* Osvald 1923
- Ord. *Caricetalia fuscae* Koch 1926
  - All. *Sphagno-Caricion canescentis* Passarge (1964) 1978
    - Ass. *Caricetum rostratae* Rubel 1912
- Ord. *Scheuchzerietalia palustris* Nordhagen ex Tx. 1937
  - All. *Scheuchzerion palustris* Nordhagen ex Tx. 1937
    - Ass. *Rhynchosporetum albae* Allorge ex Koch 1926

Cl. *OXYCOCCO-SPHAGNETEA* Br.-Bl. et Tx. ex Westhoff, Dijk et Paschier 1946
- Ord. *Sphagnetalia medii* Kästner et Flössner 1933
  - All. *Sphagnion medii* Kästner et Flössner 1933
    - Ass. *Andromedo polifoliae-Sphagnetum magellanici* Bogd.-Ginev 1928

Cl. *VACCINIO-PICEETEA* Br.-Bl. in Br.-Bl. et al. 1939

Ord. *Vaccinio uliginosi-Pinetalia sylvestris* Passarge 1968

All. *Vaccinio uliginosi-Pinion sylvestris* Passarge 1968

Ass. *Vaccinio uliginosi-Pinetum sylvestris* Kleist 1929

Diagnostic species of associations obtained as a result of processing relevés using the modified TWINSPAN algorithm are presented in the **Table**:

Synoptic table of associations of the Syra Pogonia massif

Associations	1	2	3	4	5	6	7
No. of relevés	18	21	26	9	19	24	24
No. of species	29	27	23	15	32	21	39
Dg. s. ass. *Phragmitetum australis*							
Phragmites australis	80	-	-	-	-	-	-
Utricularia intermedia	45	-	-	-	-	-	-
Eriophorum polystachion	27	-	-	-	-	-	-
Dg. s. ass. *Caricetum limosae*							
Carex limosa	-	70	-	18	-	-	
Scheuchzeria palustris	-	11	8	27	-	-	
Dg. s. ass. *Rhynchosporetum albae*							
Rhynchospora alba	-	-	55	-	-	-	-
Dg. s. ass. *Caricetum rostratae*							
Carex rostrata	-	-	-	87	-	-	-
Caltha palustris	-	-	-	31	-	-	-
Dg. s. ass. *Caricetum lasiocarpae*							
Carex lasiocarpa	10	-	-	-	69	-	-
Naumburgia thyrsiflora	-	-	-	-	27	-	-
Dg. s. ass. *Andromedo polifoliae-Sphagnetum magellanici*							
Sphagnum medium	4	-	3	-	-	38	-
Dg. s. ass. *Vaccinio uliginosi-Pinetum sylvestris*							
Pinus sylvestris	-	-	10	-	-	-	35
Betula pubescens	-	-	7	-	2	-	26

Note: the table shows the value of the *phi*-coefficient multiplied by 100; highly diagnostic species are highlighted in dark green, diagnostic species in light green

The communities of the *Phragmitetum australis* (see **Table**) association correspond to the oligomesotrophic variant of high-herb reed bogs in terms of floristic composition and ecological conditions. *Phragmites australis* is the species that dominates the main (first) herb layer. According to biological and ecological parameters, it belongs to aquatic long-rooted hemicryptophytes, hygrophytes, helophytes and heliosciophytes. The lower one or two sublayers are formed by helophilic grasses and mosses, which are also common in adjacent areas. Two rare species, *Utricularia intermedia* and *Salix myrtilloides,* with national status Vulnerable (Chervona knyha Ukrainy. Roslynnyi svit, 2009), are presented in separate relevés. These phytocoenoses occur sporadically within the peat bog massif. They are limited to the most low-lying flooded areas, up to 1 m deep and swampy shores of reservoirs and are characteristic of the first stage of overgrowth of reservoirs. The projective cover of the herb layer varies from 20 to 80 %, that of mosses – from 15 to 95 %.

The dominant herb layer of the *Caricetum limosae* association is *Carex limosa*. Other components of the herb layer include: *Rhynchospora alba*, *Comarum palustre*, *Eriophorum angustifolium*, *Menyanthes trifoliata*. *Sphagnum fallax* is present in the developed moss layer. Among the rare species listed in the Red Book Data of Ukraine (2009), *Scheuchzeria palustris* (Vulnerable) was found. Within the peat bog massif, the mentioned communities occur sporadically on small areas in overmoistened ecotopes, the projective cover of the herb layer is 95%, and the moss layer varies between 50–90 %.

Rhynchospora alba forms the *Rhynchosporetum albae* association with an admixture of other oligomesotrophic helophytes. *Scheuchzeria palustris* belongs to rare species with a national level of protection. The specified phytocoenoses occur quite often on flat areas of the meso-relief, bordering grass-moss areas of the class *Oxycocco-Sphagnetea*. The projective cover of the herb layer varies from 35 to 85 %, that of mosses – from 35 to 90 %.

The dominant herbaceous association of *Caricetum rostratae* is *Carex rostrata*. Other components of the association include: *Caltha palustris*, *Menyanthes trifoliata*, *Lysimachia thyrsiflora*, *Drosera rotundifolia*. A relatively dense moss layer of communities is formed by species of the genus *Sphagnum*: *S. divinum*, *S. fallax*, and *S. subsecundum*. Within the peat bog massif, the mentioned communities occur sporadically in small watered areas with silty-sandy and silty-peat bottom deposits, in particular, in closed and low-flow reservoirs with a water layer of 0.5–0.6 m. *Scheuchzeria palustris* is also noted in the floristic composition of phytocenoses. The cover of the shrub layer is on average 80 %, that of mosses – 70 %.

In addition to the dominant *Carex lasiocarpa*, the floristic complex of the *Caricetum lasiocarpae* association is formed by *Lysimachia thyrsiflora*, *Peucedanum palustre*, *Lysimachia vulgaris*, *Eriophorum angustifolium*, and *Agrostis canina*. Among the rare species found were *Drosera intermedia*, a perennial insectivorous plant with conservation status – Vulnerable, and *Scheuchzeria palustris*. The moss layer is dominated by *Sphagnum fallax*. Within the peat bog massif, these groups occur quite often. The cover of the shrub layer is from 10 to 95 %, that of mosses – from 25 to 95 %.

Communities of the *Andromedo polifoliae-Sphagnetum magellanici* association are characterized by forms of micro- and nanorelief and a relatively complex vertical structure. The shrub-herb layer is formed by *Andromeda polifolia*, *Eriophorum vaginatum*, *Vaccinium oxycoccos*, *Carex nigra*, *Calla palustris*, *Menyanthes trifoliata*, and *Drosera rotundifolia*. The sparse understory of trees is concentrated on the elevations of the microrelief, represented mainly by juvenile plants *Betula pendula* and *Pinus sylvestris*. The dense moss layer is dominated by *Sphagnum medium*, *Sphagnum subse-*

cundum, *Sphagnum fallax*, and *Polytrichum strictum*. The identified rare species of the national protection level include: *Scheuchzeria palustris* and *Carex chordorrhiza*. Within the boundaries of the marsh massif, these phytocenoses occur frequently and cover large areas. The cover of the herb layer varies from 50 to 95 %, that of moss – from 35 to 98 %.

Communities of the *Vaccinio uliginosi-Pinetum sylvestris* association are represented by developed tree and shrub layers. The tree layer is dominated by *Pinus sylvestris* with an admixture *of Betula pendula*. The components of the shrub layer are as follows: *Frangula alnus*, *Rhododendron tomentosum, Sorbus aucuparia,* and *Rubus fruticosus*. The herb layer is formed by *Pteridium aquilinum*, *Molinia caerulea*, *Lysimachia vulgaris,* etc. The moss layer contains typical forest and swamp species, such as *Polytrichum commune*, *Sphagnum palustre*, *Dicranum polysetum*, and *Pleurozium schreberi*. The specified phytocenoses are concentrated along the perimeter of the peat bog massif and represent the final stage of successional changes in the bog genetic series.

The species composition of plants reflects the conditions of water supply, chemical composition, and changes in the water level, so it is advisable to use different approaches for the classification of vegetation, taking into account the peculiarities of the research region.

The vegetation of the Polissia peat bogs mainly belongs to the classes *Oxycocco-Sphagnetea* and *Scheuchzerio palustris-Caricetea fuscae*. However, plant communities of different classes in the same territory usually border due to the peculiarities of the microrelief, which makes their identification much more difficult. As a result of the analysis of the relevés (**Fig. 2**), 7 clusters were combined into two groups: one formed by associations 1–3, confined to watered localities, and the other by associations 4–7, among which 5 and 6 are meso- and oligotrophic communities of wet ecotopes, from which the association of overmoistened areas 4 is separated. Association 7 is a transitional stage from swamp to forest.

According to the results of the ecological ordination of the selected groups, it is quite difficult to separate a single factor that determines their distribution along the main abiotic gradients on the territory of the peat-bog massif (**Fig. 3**).

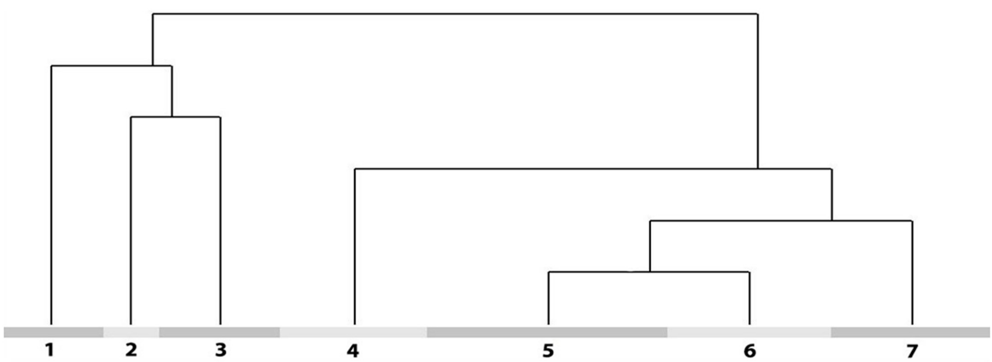

Fig. 2. Hierarchical cluster analysis of phytosociological relevés: 1 – association *Phragmitetum australis*; 2 – association *Caricetum rostratae*; 3 – association *Caricetum lasiocarpae*; 4 – association *Caricetum limosae*; 5 – association *Rhynchosporetum albae*; 6 – association *Andromedo polifoliae-Sphagnetum magellanici*; 7 – association *Vaccinio uliginosi-Pinetum sylvestris*

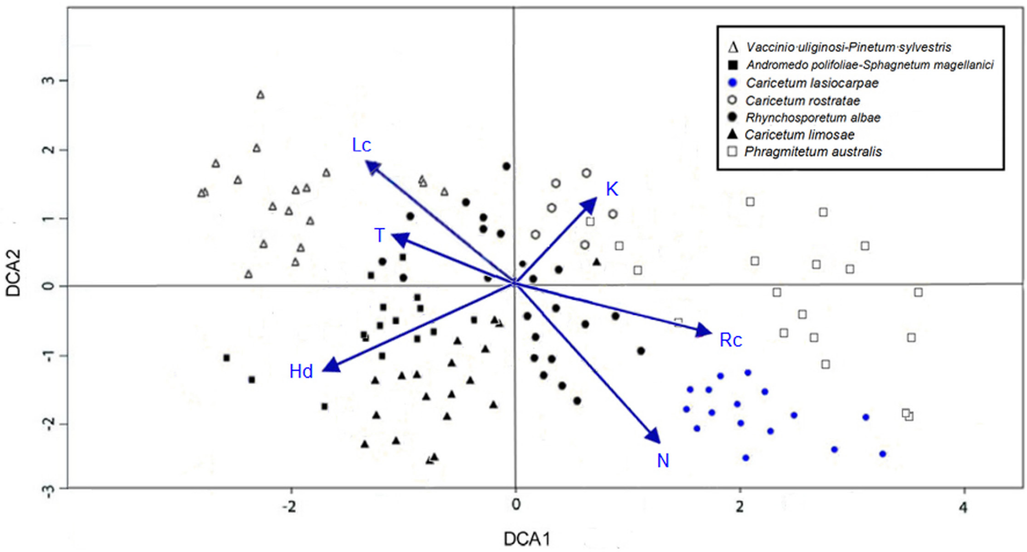

Fig. 3. The DCA-ordination results of plant communities of the Syra Pogonia massif. Hd – moisture; Rc – soil reaction; N – nutrients; T – temperature; K – continentality; Lc – light

This is probably due to the eurytopy of the coenoses, their ecological affinity, as well as a significant overlap of ecological amplitudes. Therefore, it can be concluded that the distribution of syntaxa in space is influenced by a complex of interconnected environmental factors.

The common feature of all associations spread on the territory of the peat bog massif is their more significant dependence on changes in moisture than being confined to certain conditions of moisture. The *Andromedo polifoliae-Sphagnetum magellanici* association is the most sensitive to changes in moisture conditions.

CONCLUSIONS

In this study, 141 phytocenotic relevés were analysed, and 79 species were found that form the vegetation cover of the peat bog complex, of which 65 are vascular and 14 are bryophytes. We identified 7 associations belonging to 6 alliances, 6 orders, and 4 classes and presented a vegetation classification scheme. As a result of the cluster analysis of 7 associations, a significant difference was established between the groups of watered and wet habitats.

It was found that the differentiation of the vegetation cover on the territory of the peat-swamp massif of Syra Pogonia mainly depends on moistening, however, a complex combination of factors (the content of nutrients in the substrate, the reaction of the soil, illumination, and continentality) as well as the mode of use of phytocenoses are of great importance.

COMPLIANCE WITH ETHICAL STANDARDS

Conflict of Interest: the authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

AUTHOR CONTRIBUTIONS

Conceptualization, [I.D.; O.K.]; methodology, [I.D.; O.K.; M.Y.; I.R.]; data analysis, [I.R.]; investigation, [I.D.; O.K.; M.Y.]; data curation, [I.D.]; writing – original draft preparation, [M.Y.; O.K.; I.R.]; writing – review and editing, [I.D.; O.K.]; visualization, [M.Y.; I.R.]. All authors have read and agreed to the published version of the manuscript.

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БОЛОТЯНА РОСЛИННІСТЬ МАСИВУ СИРА ПОГОНЯ РІВНЕНСЬКОГО ПРИРОДНОГО ЗАПОВІДНИКА (ПОЛІССЯ, УКРАЇНА): ЕКОЛОГІЧНА ХАРАКТЕРИСТИКА

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Обґрунтування. Болота є самодостатніми екосистемами, у яких формуються унікальні мікрокліматичні умови, що зумовлює існування значного різноманіття цінних рослинних угруповань. Такі угруповання можуть зникнути внаслідок інтенсивної господарської діяльності на прилеглих територіях. Брак для окремих синтаксонів достовірної інформації про їхнє поширення в Україні зумовлює необхідність детально досліджувати болотяну рослинність, особливо на територіях природно-заповідних об'єктів. Тому метою роботи було класифікувати угруповання болотяної рослинності масиву Сира Погоня Рівненського природного заповідника і виявити особливості їхньої синтаксономічної та екологічної диференціації для подальшого планування заходів природоохоронного менеджменту.

Матеріали та методи. Вивчення особливостей рослинності болота здійснювали на постійних трансектах, які відображають різноманітність локальних умов складного комплексу. Загалом проаналізовано 141 геоботанічний опис, виконаний за методикою Браун–Бланке. Матеріал аналізували за допомогою програмного забезпечення TURBOVEG і JUICE. Фітоценони виділяли за допомогою методу двофакторного індикаторного аналізу видів (TWINSPAN). Діагностичні види синтаксонів визначали відповідно до значень коефіцієнта вірності *phi*, поріг вірності для яких становив > 25 %. Достовірність коефіцієнта визначали за критерієм Фішера за P < 0,001. Щоб виявити особливості екологічної диференціації угруповань, використано метод DCA-ординації.

Результати. Проаналізовано рослинність торфово-болотного масиву Сира Погоня Рівненського природного заповідника. Встановлено 7 асоціацій, які належать до 6 союзів, 6 порядків і 4 класів, та складено продромус рослинності. Провідними факторами територіальної диференціації угруповань є вологість і трофність місцезростань. Найбільше видове різноманіття притаманне мезотрофним ділянкам, локалітети рідкісних видів і угруповань виявлено в різних екологічних умовах. Видовий склад 7 асоціацій налічує 79 видів рослин, із них 65 судинних і 14 мохоподібних. У результаті методами фітосоціологічного аналізу встановлено, що розподіл угруповань у гіперпросторі абіотичних факторів відбувається в умовах їхньої комплексної дії. Водночас для окремих синтаксонів вирішальне значення мають зміни режиму вологості (*Andromedo polifoliae-Sphagnetum magellanici*). Результати фітоіндикаційного аналізу засвідчили, що асоціації, ідентифіковані на території болотного комплексу Сира Погоня, за умовами кислотності середовища є ацидофільними, а за вимогами до вмісту поживних речовин – оліготрофними.

Висновки. У результаті аналізу фітоценологічних описів виявлено 7 асоціацій, які належать до 6 союзів, 6 порядків і 4 класів. На основі результатів обробки масиву даних складено класифікаційну схему рослинності. Внаслідок кластерного аналізу 7-ми асоціацій встановлено суттєву різницю між угрупованнями обводнених і вологих місцезростань. Установлено, що диференціація рослинного покриву на території торфово-болотного масиву Сира Погоня головно залежить від змін режиму зволоження.

Ключові слова: торфове болото, рослинний покрив, синтаксономія, ординація, екологічні фактори, Українське Полісся

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SUPPLEMENT 1

Header data of the authors' relevés

Relevé	Latitude	Lontitude	Altitude	Water level, m	Cover tree layer (c), %	Height trees layer, м	Cover shrub layer, %	Height schrub layer, м	Cover herb layer, %	Height herbs layer, м	Cover moss layer, %
1	2	3	4	5	6	7	8	9	10	11	12
1	51.498872	27.286964	156	0					93	1.05	7
2	51.499182	27.290730	154	0.5					42	0.62	92
3	51.498795	27.291420	154	0.2					94	1.55	35
4	51.498897	27.293362	154	0.15					72	0.31	45
5	51.499026	27.295440	153	0.1					50	0.33	90
6	51.499110	27.296880	153	0.15					35	1.0	87
7	51.499024	27.297162	153	1.2					15	0	60
8	51.498855	27.298114	154	0.3					80	0.31	30
9	51.499020	27.300307	154	0.2					55	0.27	70
10	51.499107	27.301668	154	0.15					25	0.22	85
11	51.499062	27.303238	153	0.15					30	0.25	0
12	51.498887	27.304583	154	0,15	1	2			45	0.48	75
13	51.498732	27.306263	154	0.1					40	0.42	75
14	51.498505	27.307766	154	0.1					35	0.23	85
15	51.498208	27.309188	155	0.05	1	2			75	0.41	50
16	51.497813	27.310745	158	0	15	5			77	0.47	65
17	51.530118	27.211110	150	0	3	2			50	0.46	90
18	51.531030	27.211472	150	0					35	0.39	90
19	51.531567	27.212203	150	0	3	2			45	0.32	87
20	51.532415	27.212857	150	0	3	2			55	0.2	85

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1	2	3	4	5	6	7	8	9	10	11	12
21	51.533088	27.214006	150	0	15	3			55	0.31	85
22	51.533980	27.214580	149	0.05					0	0.22	80
23	51.534604	27.214979	148	0.05					60	0.35	75
24	51.535465	27.215000	148	0.05					67	0.3	80
25	51.536017	27.215020	148	0.05					75	0.67	55
26	51.536812	27.214500	148	0.05					75	0.34	27
27	51.537587	27.215355	148	0.1					65	0.31	5
28	51.538275	27.216186	148	0,1					35	0.27	1
29	51.539518	27.216980	148	0.15					60	0.2	0
30	51.540074	27.217880	148						65	0.69	7
31	51.519835	27.189315	151		2	2			70	0.31	35
32	51.519342	27.190442	149	0.05					42	0.22	85
33	51.519157	27.191953	149	0.1	1	2			35	0.25	72
34	51.518927	27.193342	150	0.05					55	0.35	85
35	51.518653	27.194833	151	0.05					65	0.32	77
36	51.518407	27.196277	150	0.1					42	0.22	85
37	51.518223	27.197730	150	0.1					45	0.3	60
38	51.517978	27.199172	150	0					42	0.23	85
39	51.517942	27.200725	150	0					42	0.29	85
40	51.518005	27.202070	151	0					52	0.22	80
41	51.517492	27.203152	151	0.1					35	0.22	85
42	51.517664	27.204527	152	0.2					42	0.25	96
43	51.517828	27.206043	151	0.3					62	0.49	20
44	51.517670	27.207430	151	0.25					55	0.39	82

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1	2	3	4	5	6	7	8	9	10	11	12
45	51.517550	27.208858	151	0.3					55	0.25	85
46	51.516473	27.210273	151	0.5					72	0.90	60
47	51.517283	27.211713	151	0.7					75	1.12	0
48	51.498872	27.286964	156	0					95	1.44	90
49	51.499182	27.290730	154	0.4					90	0.5	95
50	51.498795	27.291420	154	0.3					90	1.5	95
51	51.498897	27.293362	154	0.2					85	0.4	95
52	51.499026	27.295440	153	0.05					85	0.4	98
53	51.499110	27.296880	153	0.1					90	0.5	75
54	51.499024	27.297162	153	1					85	0.4	95
55	51.498855	27.298114	154	0.2					85	0.35	95
56	51.499020	27.300307	154	0.1					90	0.34	95
57	51.499107	27.301668	154	0.2					90	0.58	95
58	51.499062	27.303238	153	0.2					90	0.48	85
59	51.498887	27.304583	154	0,2	1	2			95	0.51	85
60	51.498732	27.306263	154	0.1					95	0.58	85
61	51.498505	27.307766	154	0.1					95	0.6	90
62	51.498208	27.309188	155	0.1	2	3			80	0.55	90
63	51.497813	27.310745	158	0	60	10	10	1.6	80	0.7	50
64	51.530118	27.211110	150	0					80	0.4	95
65	51.531030	27.211472	150	0					80	0.4	95
66	51.531567	27.212203	150	0	3	2			80	0.4	95
67	51.532415	27.212857	150	0					80	0.5	95
68	51.533088	27.214006	150	0	12	3			90	0.4	95

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1	2	3	4	5	6	7	8	9	10	11	12
69	51.533980	27.214580	149	0.05	2	2			90	0.32	95
70	51.534604	27.214979	148	0.05	3	3			90	0.41	95
71	51.535465	27.215000	148	0.05	2	3			90	0.4	95
72	51.536017	27.215020	148	0.05					80	0.5	95
73	51.536812	27.214500	148	0.05	2	2			80	0.45	90
74	51.537587	27.215355	148	0.05					90	0.65	70
75	51.538275	27.216186	148	0.05					95	0.6	30
76	51.539518	27.216980	148	0.15					50	0.35	0
77	51.540074	27.217880	148	0					80	0.45	10
78	51.519835	27.189315	151	0	2	2			80	0.4	90
79	51.519342	27.190442	149	0.1					80	0.36	98
80	51.519157	27.191953	149	0.1					80	0.42	95
81	51.518927	27.193342	150	0.05					85	0.45	95
82	51.518653	27.194833	151	0	2	2			70	0.45	80
83	51.518407	27.196277	150	0.05					85	0.35	95
84	51.518223	27.197730	150	0.05					90	0.4	95
85	51.517978	27.199172	150	0					80	0.38	95
86	51.517942	27.200725	150	0					80	0.4	95
87	51.518005	27.202070	151	0					85	0.35	95
88	51.517492	27.203152	151	0.1					85	0.4	95
89	51.517664	27.204527	152	0.2					80	0.39	95
90	51.517828	27.206043	151	0.2					85	0.42	95
91	51.517670	27.207430	151	0.2					85	0.45	95
92	51.517550	27.208858	151	0.4					85	0.43	95

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1	2	3	4	5	6	7	8	9	10	11	12
93	51.516473	27.210273	151	0.5					95	1.75	70
94	51.517283	27.211713	151	0.6					95	1.75	85
95	51.498872	27.286964	156	0					87.5	1.05	90
96	51.499182	27.290730	154	0.3					82.5	1.55	90
97	51.498795	27.291420	154	0.3					87.5	0.32	95
98	51.498897	27.293362	154	0.3					72.5	0.32	95
99	51.499026	27.295440	153	0.1					72.5	0.29	98
100	51.499110	27.296880	153	0.1					90	0.31	80
101	51.499024	27.297162	153	1					75	0.32	95
102	51.498855	27.298114	154	0.15					67.5	0.28	98
103	51.499020	27.300307	154	0.1					77.5	0.32	95
104	51.499107	27.301668	154	0.2					72.5	0.42	95
105	51.499062	27.303238	153	0.15					77.5	0.36	95
106	51.498887	27.304583	154	0,2	1	2			75	0.38	90
107	51.498732	27.306263	154	0.1	6	1.8			87.5	0.41	95
108	51.498505	27.307766	154	0.1	6	1.8			85	0.42	95
109	51.498208	27.309188	155	0.1	25	2.7			75	0.39	90
110	51.497813	27.310745	158	0	65.5	11.5	7.5	1.25	65	0.49	55
111	51.530118	27.211110	150	0	7.5	3			82.5	0.34	80
112	51.531030	27.211472	150	0	3	3			80	0.29	95
113	51.531567	27.212203	150	0					75	0.32	95
114	51.532415	27.212857	150	0	37.5	5			77.5	0.32	95
115	51.533088	27.214006	150	0	5	5			87.5	0.31	90
116	51.533980	27.214580	149	0.1	5	5			87.5	0.23	95

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1	2	3	4	5	6	7	8	9	10	11	12
117	51.534604	27.214979	148	0.1	45	4			87.5	0.33	90
118	51.535465	27.215000	148	0.1	5	4			87.5	0.31	95
119	51.536017	27.215020	148	0.05					70	0.61	98
120	51.536812	27.214500	148	0.05	1.5	2.5			75	0.48	95
121	51.537587	27.215355	148	0.05					87.5	0.61	80
122	51.538275	27.216186	148	0.05					87.5	0.47	20
123	51.539518	27.216980	148	0.1					27.5	0.25	5
124	51.540074	27.217880	148	0					77.5	0.55	25
125	51.519835	27.189315	151	0	7.5	4			77.5	0.35	90
126	51.519342	27.190442	149	0.15					75	0.33	98
127	51.519157	27.191953	149	0.1					82.5	0.31	90
128	51.518927	27.193342	150	0.05					87.5	0.3	95
129	51.518653	27.194833	151	0					82.5	0.32	95
130	51.518407	27.196277	150	0.05					87.5	0.27	95
131	51.518223	27.197730	150	0.05					82.5	0.32	95
132	51.517978	27.199172	150	0					82.5	0.31	98
133	51.517942	27.200725	150	0					87.5	0.29	95
134	51.518005	27.202070	151	0	1.5	2.5			85	0.25	98
135	51.517492	27.203152	151	0.1					85	0.29	95
136	51.517664	27.204527	152	0.2					82.5	0.27	98
137	51.517828	27.206043	151	0.2					72.5	0.3	98
138	51.517670	27.207430	151	0.2					82.5	0.31	98
139	51.517550	27.208858	151	0.3					85	0.29	95
140	51.516473	27.210273	151	0.4					97.5	1.12	80
141	51.517283	27.211713	151	0.5					85	1.1	85

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SUPPLEMENT 2

Vegetation table of the authors' relevés

Species \ Assotiations	Layer	*Vaccinio uliginosi-Pinetum sylvestris*	*Andromedo polifoliae-Sphagnetum magellanici*	*Caricetum lasiocarpae*	*Caricetum rostratae*	*Rhynchosporetum albae*	*Caricetum limosae*	*Phragmitetum australis*
1	2	3	4	5	6	7	8	9
Phragmites australis	[6]	....	....	...........+1+11.	....	....	....	..1453451111441134
Utricularia intermedia	[6]	....	....	..............+..	....	....	....	.111..1.....1.....
Pinus sylvestris	[1]	...+1+1..1.1+..3..+1....	....	1.......+........	....	..+.+.........1......r....	................+.3.	........+.....1..
Pinus sylvestris	[8]	.1.+++1r.1.++...1.+1....	........+.......+1.......	1.......+........	....	+...+.......1.1+.r..r.....	................+.1.	........+.....1..
Rubus fruticosus	[4]	.........3....1+........	....	....	....	....	....	....
Potentilla erecta	[6]	........1......1......11	....	....	....	....	....	..+..............
Rumex acetosella	[6]	.........1....+........1	....	.........+........	....	....	....	....
Betula pubescens	[1]	.1.+........+........+..	........+...............	....	....	+.+......................	....	....
Sphagnum medium	[9]	....	r.......1...1111343554445	.........3...1...	...+.1...	1.1..........333.3+......	3..........3........	...5....3.13.1....
Carex lasiocarpa	[6]	....	........1...............	...113151133433411	....	........1.................	....1......1......1..	.1531.......+.....
Persicaria hydropiper	[6]	....	....	............+1+..	....	....	....	....
Thelypteris palustris	[6]	....	....	.....r..1....1.1..	....	....	....	...1r............
Lysimachia thyrsiflora	[6]	....	11..........1...........	...1.1..1....1111.	...+.....	....	....1.1....1........	+.1.1.1..........
Carex rostrata	[6]	....	....	....	..45+41++	....	....	....
Vaccinium uliginosum	[5]	1......................	...........1............	....	....+...+	....	.........+..........	....
Scheuchzeria palustris	[6]	....	..1.....3......3........4	113......3........	..31.155.	11.1.11..1.3.........3..3.	......153....3434..1.	.......1.1...1....
Rhynchospora alba	[6]	....	........1..........3333+.	..........11.1..+3	....1.1..	1+11111113411+113311112134	..4......1..33..1.1.1	...1.1...114..3.3.
Carex limosa	[6]	....	........+............+11	................+	1111	....	+++11111111111111111	............1+...
Vaccinium oxycoccos	[5]	344344443413...........	+.3............1114...1.	433....113...1.1..	3	...3311...34...1.........	.333..14433...3333333	1.11....43.....3.1
Eriophorum angustifolium	[6]	.....1.................	.............+.........	.......1.......111	1	.........1..11...........	.....+.1...1........	..+....11.+1.1.1..

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1	2	3	4	5	6	7	8	9
Erechtites hieracifolia	[6]	....	....	.............1.1..	....	....	....	..+.+.....r.......
Peucedanum palustre	[6]	....	....	....	....	....	.......r.............	..+...+...........
Salix myrtilloides	[4]	....	....	......+...........	....	....	....	.....+......+.....
Sphagnum rubellum	[9]	....	+1...............+.....+.	...+.......+......	....	......1.1.........+.......	....+.....+.+........	......1+....+1....
Sphagnum palustre	[9]	....	....	..............+...	....	....	....	..1...............
Drosera intermedia	[6]	....	....	...............1..	....	....	....	..1...............
Salix aurita	[8]	.............+.......r+	....	......r.1.........	....	....	....	......rr..........
Sphagnum cuspidatum	[9]	.....+.................	....	.+................	......1..	...........1..............	....	....+..+..........
Polytrichum commune	[9]	..............1........	.......................+.	....	....	....	....	....1.............
Lysimachia vulgaris	[6]	..............1...1....	1........+...............	.....1.......1.11.	.......+.	..........++..............	...+1.+....1.........	..1...+...1.....+.
Carex chordorrhiza	[6]	....	....	....	....	....	......1....1.........	..............1...
Agrostis canina	[6]	.....................1.	11........r..............	..............1...	....	....	..........1..........	..1.......1.......
Carex canescens	[6]	....	..............+........+.	....	....	....	......1..............	....1.............
Juncus effusus	[6]	r.+..........41......3.	.5.........1.r.........1.	...5....1.........	....	....	.....+1....1.........	..1....1......1...
Warnstorfia fluitans	[9]	....	........................+	....	......+..	....	....	+.................
Menyanthes trifoliata	[6]	..1..1..1..............	..1......................	.....1.+1........3	.......1.	.........1..............1.	11.................3.	...........13...3.
Salix cinerea	[4]	.....................r.	....	........1.........	...r.....	....	....	...r..............
Sphagnum fuscum	[9]	.......+........1......	....	....	....	......................1...	..1..........1...+...	...............1..
Pinus sylvestris	[7]	r.r+++1.r1+++....++1...	++....1r+....r.++1.+..1..	1+.+....1++.+.....	....+...r	+++1+.+..rr...1+..+.rr+.r.	.+.....r..+......++1.	...+r..+r+.+.+.1..
Populus tremula	[7]	.............+r......++	r........r...............	....	....	....	................r....	.......r..........
Carex nigra	[6]	+............1..+......	11.......................	...1..............	....	............1+............	..........1..........	.......1..........
Sphagnum fallax	[9]	54554555555534.3.554.5..	4455.555354.44433.3113311	554231.434353....5	.44543555	3.3533533.555533.535555555	35535.455555355545555	45.134.534.3455555
Drepanocladus aduncus	[9]	..................+....	......+.....+..+.........	....	..++.....	........................+.	....	..........+.......

End of the Supplement 2

1	2	3	4	5	6	7	8	9
Sphagnum centrale	[9]	.....1....1.............	............+....1....+.	....	....	..............1...1......	..1......1...1.......	............1....
Polytrichum strictum	[9]	.........1.3....11......	....	.3..........1.11.	...1.....	.............1........3..	.31..............113	..11.............
Betula pendula	[7]	.....1r.+.....+..+11..r+	............r...........	.....+..++......+.	....	.+...............+.++.+..	................++rr	.......+......r...
Sorbus aucuparia	[4]	...............r........	..........r............	....	....	....	....	....
Molinia caerulea	[6]	...............1........	....	....	....	....................+.....	.........+..........	....
Pleurozium schreberi	[9]	......r.................	....	....	....	....	......+....+.........	....
Calamagrostis canescens	[6]	...................1....	11.......................	........1.........	....	....	..........+.........	....
Frangula alnus	[4]	.............r1...1....	....	.......r1.........	....	....	....	....
Comarum palustre	[6]	.............+.........	......................+..	.............1.1.	....	....	..........+.........	....
Aulacomnium palustre	[9]	....	....	.......1........1.	.......+.	........1................	....	....
Rhododendron tomentosum	[4]	...................1.1..	....	........1.........	........r	.............1..........	....	....
Betula pubescens	[3]	+1r+........+..+.....+..	rr......+++....+.........	+..+..++1.+.+.....	....	+.+.r.......1++.....+.....	........r.+..........	........++........
Sphagnum subsecundum	[9]	....	...............333..33..	....3............	33.......	333..3.33......33.3.......	3..........3........	..........3......
Betula pubescens	[7]	.1.+........+........+..	.r......+...............	........1.........	....	+.+................+.....	....	....
Calla palustris	[6]	................1......	........+11..+........1.	....	....	............1.....1......	.....1...11..........	....
Sphagnum angustifolium	[9]	.+.........+++.........	1......................	................+	+.+......	+++.........+...........	....	....
Andromeda polifolia	[5]	..11.3..34453....+..1...	....3145.....1....34.33++	.4..11+.143.1..1..	....1.1r.	...1.3433+.1.1.3.3..33433.	34.11......1.1+1..435	.1...1...3r...1...
Drosera rotundifolia	[6]	........+11111..111.....	....11+11.....11111+11111	.1+.1..+.11......1	11.+1.11.	1111+11..+11111..+111.++11	.11.1111111111111.1+1	.+.......1.11.+.1.
Eriophorum vaginatum	[6]	43.341331443....1.4.33..	.131..33133..3.13..1.3.1.	33.1+..1.1.......	1.......5	1.1.311.1...434...3131343.	.3......144.3....4.14	.........1.....1..

Other species: *Caltha palustris* [6] 100: 1; *Dryopteris carthusiana* [6] 140: r; *Juncus articulatus* [6] 76: r; *Betula pendula* [7] 85: +; *Dactylorhiza incarnata* [6] 19: +; *Juncus tenuis* [6] 124: +; *Calamagrostis epigeios* [6] 77: 1; *Sieglingia decumbens* [6] 63: 1; *Polygonum minus* [6] 77: 1; *Calluna vulgaris* [5] 63: 1; *Nardus stricta* [6] 63: 1; *Pteridium aquilinum* [6] 63: 1; *Vaccinium vitis-idaea* [8] 63: +; *Cladonia pyxidata* [9] 25: 1; *Epilobium palustre* [6] 5: 1; *Viola palustris* [6] 75: +; *Agrostis stolonifera* [6] 1: +

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