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**PHYTOSOCIOLOGICAL STRUCTURE
OF CLADONIO-PINETUM JURASZEK 1927
OF THE WESTERN POLISSYA OF UKRAINE**

*FITOSOCJOLOGICZNA STRUKTURA BORÓW
CHROBOTKOWYCH CLADONIO-PINETUM JURASZEK 1927
Z POLESIA NA TERENIE ZACHODNIEJ UKRAINY*

Słowa kluczowe: sosna, suchy las sosnowy, bór chrobotkowy Cladonio-Pinetum Juraszek 1927, Ukraińskie Polesie Zachodnie

Key words: Scots pine, dry pine forest, Cladonio-Pinetum Juraszek 1927, Western Polissya of Ukraine

Abstract. The article presents species composition of lichens occurring in the *Cladonio-Pinetum* Juraszek 1927 dry pine forests that have been identified in the Western Polissya. On 14 sample plots established in the above association, there were found altogether 15 lichen species representing two genera, *i.e.* *Cladonia* L. and *Cetraria* Ach., that were accompanied by four species of mosses. The area of lichen cover varied significantly within the range of 0.4-34.1%. Four species (*Cladonia rangiferina*, *C. mitis*, *C. uncialis*, and *C. gracilis* out of 15 occurred on all sample plots, while *C. digitata* was slightly represented on three sample plots, only. There was found a clear relationship between the size of the area covered with lichens and the age of dry pine forests. The dynamics and type of these time related changes varies depending of the dynamics of each individual species of lichen.

INTRODUCTION

Lichen forests are sub-oceanic formations to be found in Northern and, partly, Middle Europe, in the zone of influence of the Atlantic air masses [Faltynowicz 1986]. In Ukraine, the largest areas of such forests occur on the territory of Western Polissya.

Taking into account the unique value of lichen forests as biodiversity hotspots and their role in soil conservation the 91T0 *Cladonio-Pinetum* was enlisted into priority habitats that have to be protected within a frame of the European Ecological Network *Natura* 2000 [Danielewicz 2004].

In Ukraine the research has recently been started [Kurylyak, Pasichnyk 2015] aiming at the identification of the areas that could fulfil the criteria presented in the

Habitat Directive [1992] that provides guidelines to implementation of the Natura 2000 in the European Union. So far, the only reference document, that regulates the protection of valuable/unique habitats in Ukraine, is “The Green Book of Ukraine”. However, it is based on the dominant principle of vegetation classification, according to which the threatened forest type (in this case *Pinetum (sylvestris) juniperoso (communis) - cladinosum*) should be protected [Didukh 2009]. Unfortunately, due to the ecologically-floristic approach [Flora Europaea 1980], as implemented in the Habitat Directive [1992] the habitat 91T0 *Cladonio-Pinetum* is not fully comparable with classification adopted in Ukraine.

It seems that the efficient preservation and restoration of the dry pine forests in Ukraine in a way as it takes place in the European Union calls for an urgent undertaking of the detailed investigations in the forests in matter. It has to be done by means of regular phytosociological studies of the species composition of the association of *Cladonio-Pinetum* in this part of the country where it could be found most likely. This work aims to substantially contribute to the fulfillment of the above task.

MATERIAL AND METHODS

In the Western Polissya 14 sample plots have been established in typical patches of the association of *Cladonio-Pinetum* Juraszek 1927 – that occur there in the poorest, xeromorphic *Pinus sylvestris* L. forests – in order to study species composition of their lowest, *i.e.* lichen/mossy layer of the ground vegetation (Fig. 1).

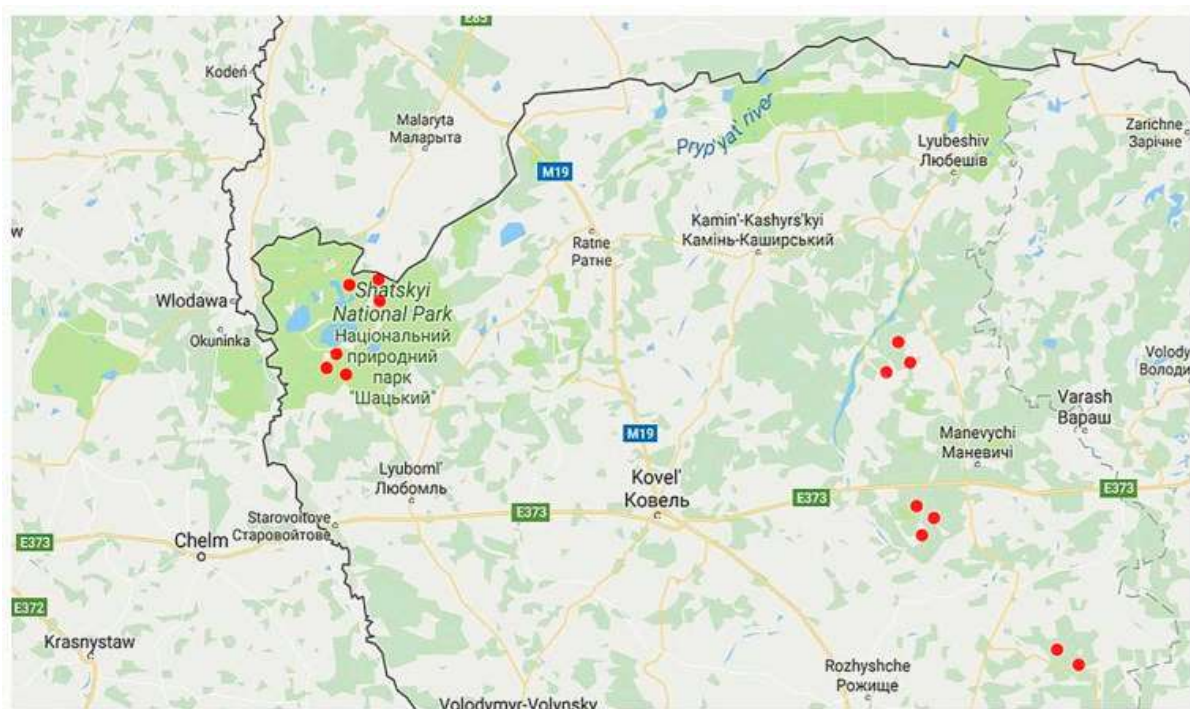


Fig.1. Location of the sample plots on the territory of Western Polissya
Source: M. Mertsalo.

The studies of the condition and structure of lichen-rich forests were carried out according to the results gained on sample plots, which were established in forests of different age and origin.

Phytosociological records of vegetation occurring on sample plots were executed in a way that it uses to be done when collecting the data on rare biotopes in Europe, as set out by W. Mróz [2010], *i.e.* by using the Braun-Blanquet [1964] approach. Thus, we used a seven-stage combined scale: *r* – the species appears extremely rarely, with insignificant cover; *t* – it occurs occasionally, the degree of cover is about 1%; *1* – the number of specimen is significant, but the degree of the species cover does not extend 5%; *2* – the number of specimen is large, the degree of the cover by the species varies from 5 to 25%; *3* – the number as above, but the degree of the species cover is between 25% and 50%; *4* – the number of specimen is even larger, and the degree of the species cover varies from 50% to 75%; and *5* – the number of specimen is very large, and the degree of covering by the species exceeds 75%.

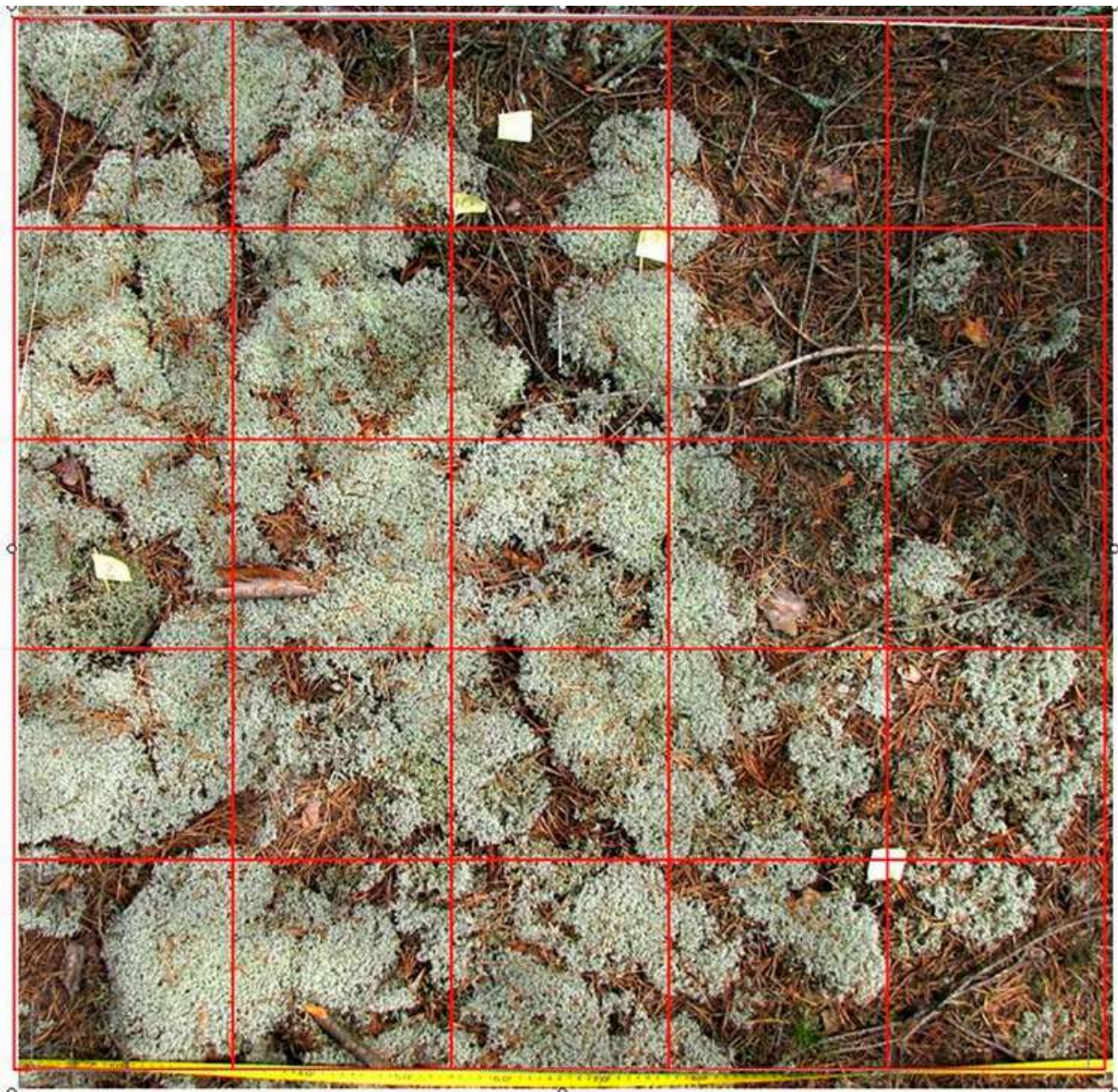


Fig. 2. Determination of the area covered by lichen species
Source: M. Mertsalo.

Each species appearing in the lichen/mossy layer was described in terms of its quantitative (percentage of coverage, abundance, frequency of appearance, and constancy) and qualitative (life form, phenostan, and vitality) characteristics [Braun-Blanquet 1964].

Projective cover of each species was determined using a grid (1m×1m) (Fig. 2). The number of grids established varied from 20 to 40 depending on the size of individual sample plots.

Besides the abundance we also determined the regularity of a particular species in the groups on the five-point scale. The regularity of species on the samples was estimated by the size of the cover area divided into five classes: I – 1-20%, II – 21-40%, III – 41-60%, IV – 61-80%, V – 81-100% [Mirkin 1978].

The main indicators for determining the lichen plantains were the species composition and the structure of the sinuses of the typical species of bush lichens, mainly from the genera *Cladonia* (Hill.) Vain. and *Cetraria* Ach.: *Cladonia arbuscula* (Wallr.) Flotow, *C. rangiferina* (Wallr.) Flotow, *C. gracilis* (L.) Willd., *C. uncialis* (L.) Web., *C. furcata* (Huds.) Schrad., *Cetraria islandica* (L.) Ach. [Oksner 1993].

Syntaxonomy of vegetation, volumes, structure and names of syntaxons were adopted from W. Matuszkiewicz [2008], while Latin names of species - after A. Oksner [1993].

RESULTS

The natural lichen forests, as the only ones suitable for a spontaneous appearance of the association of *Cladonio-Pinetum* Juraszek 1927, always occupy extreme oligotrophic dry areas on poorly developed sandy soils with the deep groundwater level. One of the necessary conditions for formation of such associations is low moisture content, acidic reaction and a strong washing regime of soils. In Ukraine, such phytocoenoses are typical for the Western Polissya (Fig. 3).

As a result of the floristic analysis, 15 species of lichens and four species of mosses were identified. Some of them are presented below (Figs. 4, 5, 6, and 7):



Fig. 3. Pine lichen forest of the *Cladonio-Pinetum* Juraszek 1927 association
Source: M. Mertsalo.



Fig. 4. *Cladonia rangiferina* (L.) Weber ex F.H. Wigg
Source: M. Mertsalo.



Fig. 5. *Cladonia furcata* (Huds.) Schrad
Source: M. Mertsalo.



Fig. 6. *Cladonia gracilis*(L.)Willd
Source: M. Mertsalo.



Fig. 7. *Cladonia uncialis* Hoffm
Source: M. Mertsalo.

The syn-taxonomic position of lichen planks is as follows:

Cl. VACCINIO-PICEETEA Br.-Bl. 1939

Ord. *Cladonio-Vaccinietalia* Kiell.-Lund 1967

All. *Dicrano-Pinion* Libb. 1933

SAll. *Dicrano-Pinenion* Seibert in Oberd. (ed.) 1992

Ass. *Cladonio-Pinetum* Juraszek 1927

The composition and syn-taxonomic structure of lichen forests are presented in Table 1:

Tab. 1. Syn-taxonomic structure of the *Cladonio-Pinetum*

Syntaxon	<i>Cladonio-Pinetum</i>													
№ of phytosociological record	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Projective total cover (%) by all species	67	74	43	65	68	46	62	38	76	44	63	41	57	62
Area (m ²)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Number of species	14	11	14	16	15	15	10	13	16	13	15	12	18	15
<i>Cladonio-Pinetum:</i>														
<i>C. rangiferina</i>	3	4	1	3	3	2	4	2	3	2	3	2	3	4
<i>C. furcata</i>	1	2	1	-	2	1	2	-	2	-	2	2	2	2
<i>C. mitis</i>	1	2	1	1	2	1	2	1	2	1	2	1	2	2
<i>C. uncialis</i>	1	2	t	2	1	1	t	1	2	t	1	t	2	2
<i>C. cornuta</i>	t	2	t	2	2	t	2	-	1	r	2	1	2	2
<i>C. gracilis</i>	2	1	1	1	2	1	1	2	1	2	t	2	2	2
<i>C. coniocrea</i>	t	-	-	1	t	1	-	r	1	-	t	-	t	1
<i>C. subulata</i>	1	-	-	2	1	2	-	t	1	-	1	-	1	t
<i>C. phyllophora</i>	r	1	t	1	2	2	1	t	2	-	1	t	1	2
<i>C. arbuscula</i>	-	2	-	2	1	r	1	t	2	t	2	1	2	1
<i>C. coccifera</i>	-	r	-	t	1	1	-	-	r	t	r	-	t	1
<i>C. fimbriata</i>	t	-	t	r	-	t	r	1	r	1	r	-	r	t
<i>C. pyxidata</i>	-	-	-	t	t	-	-	-	r	-	-	-	r	-
<i>Cetraria islandica</i>	-	-	r	-	-	r	r	-	-	r	-	r	r	r
<i>C. digitata</i>	r	-	r	-	-	-	-	-	-	r	-	-	-	-
<i>a – Vacciniuo-Piceetea; b – Cladonio-Vaccinietalia, and Dicrano-Pinion</i>														
<i>a Dicranum scoparium</i>	r	-	1	r	r	1	-	1	r	t	r	1	t	r
<i>a Pleurozium schreberi</i>	-	-	r	r	-	-	-	r	-	r	-	-	r	-
<i>b Polytrichum commune</i>	1	r	1	t	t	r	-	t	t	1	t	1	t	r
Other														
<i>Polytrichum juniperinum</i>	r	-	r	r	r	-	-	t	r	-	r	t	r	-

Source: Own research.

The number of lichen and moss species identified on individual plots varied from 10 to 18, thus not all lichen species occurred on all sample plots. E.g. four of them (*Cladonia rangiferina*, *C. mitis*, *C. uncialis*, and *C. gracilis*) were represented on all sample plots, while *C. pyxidata* and *C. digitata* appeared only on four and three sample plots, respectively.

The abundance of the lichen species on the sample plots substantially varied, from 25 to 50% (grade 3) for *Cladonia rangiferina*, through 5 to 25% (grade 2) for nine other lichen species, to less than 2% for five remaining species. The same has been found when compared the average area of cover by individual species in the grids (Table 2).

Generally, it could be stated that the Western Polissyan *Cladonio-Pinetum* resembles to a large extent the same association as described by the Polish Authors [Fałtynowicz 1986; Matuszkiewicz 1996, 2008; Danielewicz 2004].

Tab. 2. Average indicators of lichens' abundance on sample plots and their cover in grids

Species of lichens	Average abundance grade	Average area of cover, %
<i>Cladonia rangiferina</i>	3	34,1
<i>C. furcata</i>	2	15,4
<i>C. mitis</i>	2	12,2
<i>C. uncialis</i>	2	10,5
<i>C. cornuta</i>	2	9,3
<i>C. gracilis</i>	2	8,9
<i>C. coniocrea</i>	2	7,8
<i>C. subulata</i>	2	6,7
<i>C. phyllophora</i>	2	6,6
<i>C. arbuscula</i>	2	6,3
<i>C. coccifera</i>	1	1,7
<i>C. fimbriata</i>	1	1,2
<i>C. pyxidata</i>	<i>t</i>	0,9
<i>Cetraria islandica</i>	<i>r</i>	0,5
<i>C. digitata</i>	<i>r</i>	0,4

Source: Own research.

The regularity of lichens in the grids [Mirkin 1978] indicates that only *Cladonia rangiferina* occurs on all sample plots, while the remaining species are periodically encountered.

Investigating the correlation between the species composition of lichens and the tree-stands' age it was found that there are three types of lichens that express different kinds of dynamics with this respect. They are as follows:

- the falling type (decrease of the area covered with increasing age of tree-stands);
- the intermediate type (gradual increase of the cover area up to 30-year-old tree-stands followed by the decrease of this area with increasing age of pine tree-stands);
- the growing type (continuous increase of the covered area with increasing age of the pine tree-stands).

The falling type is appropriate for: *Cladonia coccifera* (L.) Willd., *C. cornuta* (L.) Hoffm., and *C. furcata* (Huds.) Schrad.; the intermediate type is characteristic for: *Cladonia rangiferina* (L.) Weber ex F.H. Wigg. and *C. subulata* (L.) F. Weber ex F.H. Wigg.; and the growing type is typical for: *Cladonia gracilis* (L.) Willd., *C. arbuscula* (Wallr.) Flot. ssp. *mitis* (Sandst.) Ruoss, *C. mitis* Sandst., *C. phyllophora* Ehrh. ex Hoffm., and *C. pyxidata* (L.) Hoffm.

CONCLUSIONS

The lichen forests of the Western Polissya of Ukraine are of an unique environmental significance.

According to the results of phytosociological studies and the dominance of the lichens from the genus *Cladonia* L., the dry pine forests of Western Polissya well represent the association of *Cladonio-Pinetum* Juraszek 1927. 19 species of lichens and mosses, that are typical for this association, have been identified in the forests studied.

The analysis of the cover area of each lichen species is characterized by considerable variability; some species can occupy up to 35% of the area of grids, while others are found singly.

It was found that the area of cover by certain lichen species changes with the age of the of pine tree-stands. These changes represent three types of the lichens' dynamics called as: falling, intermediate and growing.

The results of phytosociological research carried out in the dry pine forests of Western Polissya are the basis for further studies and for the development of methods for their preservation, restoration and protection on the territory of Ukraine.

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SUMMARY

The study was conducted on the territory of Western Polissya of Ukraine where 14 sample plots have been established. The purpose of the study was to assess the condition and structure of lichen forests and prove their identity with the association of *Cladonio-Pinetum* Juraszek 1927. Phytosociological records on vegetation on the sample plots were carried out using the J. Braun-Blanquet [1964] method. The species composition includes 15 lichen species of the genera *Cladonia* L. and *Cetraria* Ach. and four species of mosses. The area covered with lichens significantly varies within the range of 0.4-34.1%, with some species occurring on the sample plots constantly, while others appear periodically. There is a clear relationship between the area covered with lichens and the age of pine tree-stands; the dynamics and type of these changes depending on the species of the lichen.

STRESZCZENIE

Badania przeprowadzono na terenie Polesia w Zachodniej Ukrainie, gdzie założono 14 powierzchni próbnych. Przedmiotem badań była ocena stanu i struktury borow chrobotkowych *Cladonio-Pinetum* Juraszek 1927. Opisy fitosocjologiczne roślinności na powierzchniach próbnych przeprowadzono metodą J. Braun-Blanqueta [1964]. Stwierdzono występowanie 15 gatunków porostów z rodzajów *Cladonia* L. i *Cetraria* Ach. oraz czterech gatunków mszaków. Pokrycie powierzchni warstwą porostów różni się znacząco w przedziale od 0,4-34,1%; niektóre gatunki porostów występują w drzewostanach sosnowych stale, podczas gdy inne – okresowo. Istnieje wyraźny związek między wielkością pokrycia powierzchni dna lasu warstwą porostów a wiekiem drzewostanów; dynamika i kierunek zmian wielkości pokrycia u poszczególnych gatunków porostów różnią się od siebie.