

DIVERSITY AND VERTICAL DISTRIBUTION OF LICHENS ON THE BARK OF ROADSIDE POPLARS IN PODLASKIE VOIVODESHIP (NORTH EASTERN POLAND)

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Abstract

A list of 65 species of lichens including interesting and rare lichen species recorded on the bark of poplar in Podlaskie Voivodeship (NE Poland) is given. Herbal data and the results of field studies conducted on roadsides in Podlaskie Voivodeship between 2010 and 2015 are used in the report. Sixteen species of lichens are threatened facing extinction in Poland, e.g., *Hypogymnia farinacea*, *Physconia persidiosa*, *Pleurosticta acetabulum*, *Ramalina fastigiata*, *Usnea hirta*. An analysis of the occurrence of lichens in different parts of the tree is presented.

Key words: Lichens, Poplar, Poland.

Introduction

Poplar (*Populus*) is a deciduous tree of Salicaceae family. Currently, c. 30 species of *Populus* are known worldwide (Evelyn Jonescu, 1970, Kuusinen 1996a). In Poland, only three native species have been reported: *Populus alba*, *P. nigra*, *P. tremula*. However, several alien species from North America: *Populus deltoides*, *P. trichocarpa* and many hybrids, e.g. *Populus* × *berolinensis*, *P.* × *canadensis* are also recorded from Poland.

Some authors drew attention to the interesting lichen biota of *Populus* in Europe (Kuusinen, 1994, 1996a, 1996b; Hedenås & Ericsson, 2000, 2004; Cieśliński, 2003; Jürriado *et al.*, 2003), North America (Evelyn Jonescu, 1970; Sheard & Evelyn Jonescu, 1974; Boudreault *et al.*, 2000) and Asia (Kinalhoölu, 2009, 2010).

Some species of cyanobacterial macrolichens (*Lobaria* spp., *Nephroma* spp., *Pannaria* spp., *Peltigera* spp.) on bark of aspen (*Populus tremula*) have been used as indicator species of a high ecological continuity of forest (e.g. Kuusinen, 1996b). Many lichens from bark of *Populus* in urban areas are air pollution indicators (e.g. Hawksworth & Rose, 1970; LeBlanc *et al.*, 1972; Matwiejuk, 2007).

The bark pH and structure are the most important factors in lichens distribution on the trees (Hawksworth & Hill, 1984). Some deciduous (for example birch-tree) and coniferous trees (fir, larch, pine, spruce) have normally acidic bark (pH 3.0–4.0). Aspen, linden and maple have subneutral bark pH (pH 4.9–7.5) in clean air areas (Wirth, 1995).

The lack of detailed studies of species diversity, particularly in the case of *Populus* spp., the most widespread of common species which grows on roadsides, encouraged the author to examine the lichen biota of this phorophyte in depth.

Study area: Podlaskie Voivodeship is located in the north-east Poland. It borders with three other provinces: Warmińsko-Mazurskie, Mazowieckie and along a short section with Lubelskie Voivodeships. It also borders with Lithuania in the north-east and with Belarus in the east. Podlaskie Voivodeship marks the internal (Lithuanian) and external (Belarusian) border of the European Union. Mainly agricultural region with dynamically developing sector of food, milk, meat, poultry and cereals, as well as

the sectors: light, wood, construction and engineering. Podlaskie Voivodeship has the lowest population density of the sixteen Polish voivodeship, and its largely unspoiled nature is one of its chief assets. Around 30% of the area of the voivodeship is under legal protection.

Material and Methods

The research is based on lichen specimens present in the Herbarium of the Institute of Biology, University of Białystok (collected mainly in 1962-2002) and original data. Detailed field studies were conducted in 2010-2015. In total 19 stands were analyzed, including 9 stands from previously studied lichenological (herbal materials) and 10 stands were from actual research. Species of genus *Lepraria* and from *Cladonia pyxidata-chlorophaea* group were determined using thin-layer chromatography (TLC) in solvents A and C following the methods of Orange *et al.* (2001). Names of lichens are given from Index Fungorum. The categories of threat in Poland are given by Cieśliński *et al.* (2006) and status of protection according to Regulation (2014). The collected herbarium material is deposited in the Herbarium of the Institute of Biology, University of Białystok.

Results and Discussion

Sixty five species of lichens were recorded on the bark of *Populus* spp. (Table 1). Of these, 45 species were found during field studies and 49 were identified from the herbarium material. 10-24 species per sample plot were recorded. Amongst the lichens colonizing bark of *Populus* sp., species with crustose thalli (29 species) were dominant. The second largest group consisted of foliose lichens (26 species). Lichens with fruticose thalli were less numerous group comprising around 7% of the overall number of biota. Lichens from dimorphic group (*Cladonia* spp.; 2 species) was insignificant and amounts to around 3%.

The following species were reported from bark of *Populus* spp. most frequently: *Xanthoria parietina*, *Phaeophysia orbicularis*, *Physcia adscendens*, *P. dubia*, *P. tenella*, *Parmelia sulcata*, *Lecanora carpinea*, *L. pulicaris*. This group is responsible for the formation of epiphytic communities, with dominant foliose and crustose thallus of lichens, typical of this phorophyte.

Table 1. List of species of roadside *Populus* spp. in the Podlaskie voivodeship, with particular reference to their position on the trunk.

Species	Site no.	Trunk - height (cm)		Crown	The threat in Poland	Species protection
		0-50	50-250			
<i>Hypogymnia physodes</i> (L.) Nyl.	2,3,5,6,9-19	+	+	+		
<i>Evernia prunasti</i> (L.) Ach.	2,3,5,7,9,14,16-19	+	+	+	NT	
<i>Lecanora carpinea</i> (L.) Vain.	1,3-6,8,16-19	+	+	+		
<i>Lecanora pulicaris</i> (Pers.) Ach.	1,3,5,7,9,10	+	+	+		
<i>Lecidella elaeochroma</i> (Ach.) M. Choisy	2,5,6,8-11,16,17	+	+	+		
<i>Lepraria incana</i> (L.) Ach.	1,3,5,6,10	+	+	+		
<i>Melanelixia fuliginosa</i> (Fr. ex Duby) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch	2,6-10	+	+	+		
<i>Melanohalea exasperatula</i> (Nyl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch	3,5,6,7,9,10,12	+	+	+		
<i>Parmelia sulcata</i> Taylor	1-,6,7,9,12,13,16-18	+	+	+		
<i>Phaeophyscia orbicularis</i> (Neck.) Moberg	1-10,16-18	+	+	+		
<i>Physcia adscendens</i> (Fr.) H. Olivier	1-6,8-10,16-19	+	+	+		
<i>Physcia dubia</i> (Hoffm.) Lettau	1-10,12,13,16-19	+	+	+		
<i>Polycauliona polycarpa</i> (Hoffm.) Frödén, Arup & Søchting	1-10,16	+	+	+		
<i>Ramalina farinacea</i> (L.) Ach.	4,5,9,10,14,16,17	+	+	+	VU	pp
<i>Ramalina fraxinea</i> (L.) Ach.	3,4,6,9,10,14,15-19	+	+	+	EN	sp
<i>Xanthoria parietina</i> (L.) Th. Fr.	1-10,13,16-19	+	+	+		
<i>Candelaria concolor</i> (Dicks.) Arnold	1,5,8,10,12	+	+			
<i>Candelariella xanthostigma</i> Pers. ex Ach.) Lettau	1-6, 9,10	+	+			
<i>Phaeophyscia nigricans</i> (Flörke) Moberg	2,6,9	+	+			
<i>Phlyctis argena</i> (Ach.) Flot.	2,6,9,10	+	+			
<i>Physconia enteroxantha</i> (Nyl.) Poelt	1-5,7,9,10	+	+			
<i>Pleurosticta acetabulum</i> (Neck.) Elix & Lumbsch	4,5,9,13,16-19	+	+		EN	pp
<i>Scoliosporum chlorococcum</i> (Graewe ex Stenh.) Vězda	1-9, 13,16-19	+	+			
<i>Caloplaca cerina</i> (Hedw.) Th. Fr.	1-6,9,12		+	+		
<i>Flavoplaca oasis</i> (A. Massal.) Arup, Frödén & Søchting	1-10		+	+		
<i>Lecania cyrtella</i> (Ach.) Th. Fr.	18		+	+		
<i>Lecanora allophana</i> (Ach.) Nyl.	2,3,5,6,8,9,11,13-15		+	+		
<i>Myriolecis hagenii</i> (Ach.) Śliwa, Zhao Xin & Lumbsch	1-6,8-11		+	+		
<i>Lecanora filamentosa</i> (Stirt.) Elix & Palice	13		+	+		
<i>Physcia stellaris</i> (L.) Nyl.	1-10,11,12,16-19		+	+		
<i>Physcia tenella</i> (Scop.) DC.	1-10,11,12,13,16-19		+	+		
<i>Ramalina pollinaria</i> (Westr.) Ach.	5,7,9,14-16,19		+	+	VU	pp
<i>Cladonia coniocraea</i> (Flörke) Spreng.	2,4,8,9	+				
<i>Cladonia fimbriata</i> (L.) Fr.	2,5	+				
<i>Amandinea punctata</i> (Hoffm.) Coppins & Scheid.	1-9,13		+			
<i>Bacidia phacodes</i> Körb.	2		+			
<i>Bacidia populorum</i> Trevis	17,18		+			
<i>Athallia pyracea</i> (Ach.) Arup, Frödén & Søchting	16		+			
<i>Catillaria nigroclavata</i> (Nyl.) J. Steine	17		+			
<i>Hypocenomyce scalaris</i> (Ach. ex Lilj.) M. Choisy	16-19		+			
<i>Hypogymnia tubulosa</i> (Schaer.) Hav.	1,6,8-10,12,16		+		NT	pp
<i>Lecanora argentata</i> (Ach.) Röhl.	2,6,7-9		+			
<i>Lecanora chlarotera</i> Nyl.	15		+			
<i>Lecanora expallens</i> Ach.	1-3,5,6,8-10,16		+			
<i>Lecanora leptyroides</i> G.B.F. Nilsson	16		+			
<i>Lecanora subrugosa</i> Nyl.	5,7,10,12,13,16		+		LC	
<i>Lecanora varia</i> (Hoffm.) Ach.	16		+			
<i>Lecidella flavosorediata</i> (Vězda) Hertel & Leuckert	12		+			
<i>Parmelia tiliacea</i> (Hoffm.) Hale	2,6,8,10,15		+		VU	sp
<i>Physcia aipolia</i> (Ehrh. ex Humb.) Fürmr.	3,8,10		+		NT	
<i>Physconia distorta</i> (With.) J.R. Laundon	14,15,17		+			
<i>Physconia grisea</i> (Lam.) Poelt	14		+			
<i>Physconia perisidiosa</i> (Erichsen) Moberg	3,8		+		EN	
<i>Pertusaria amara</i> (Ach.) Nyl.	14,15		+			
<i>Pertusaria coccodes</i> (Ach.) Nyl.	16-19		+		NT	
<i>Pertusaria multipuncta</i> (Turner) Nyl.	12		+		EN	
<i>Platismatia glauca</i> (L.) W.L. Culb. & C.F. Culb.	16-19		+			
<i>Pseudevernia furfuracea</i> (L.) Zopf	6,7,16-19		+			
<i>Polycauliona candelaria</i> (L.) Frödén, Arup & Søchting	13,16,18		+			
<i>Ramalina fastigiata</i> (Pers.) Ach.	5,6		+		EN	sp
<i>Ramalina motykana</i> Bystrek	17		+		DD	sp
<i>Tuckermannopsis chlorophylla</i> (Willd.) Hale	2,5,7,10,12		+		VU	pp
<i>Usnea hirta</i> (L.) Weber ex F.H. Wigg.	17			+	VU	pp
<i>Rinodina pyrina</i> (Ach.) Arnold	2,9,10,15			+		
<i>Hypogymnia farinacea</i> Zopf	12			+	VU	sp

Explanations: The categories of threat: EN – Endangered, VU – Vulnerable, NT – Near Threatened, LC – Least Concern, DD – Data Deficient; sp – strict protection, pp – partial protection

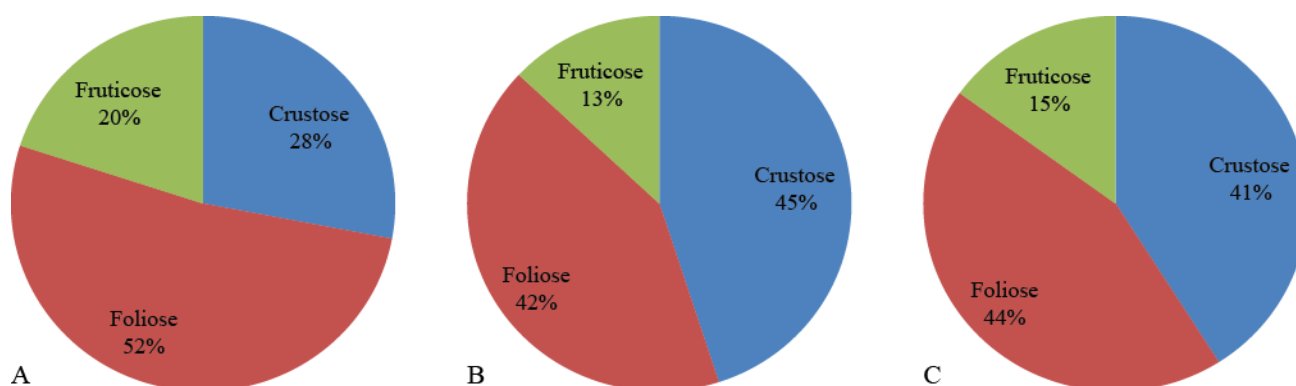


Fig. 1. The share of morphological forms of lichens in different parts of the trunk of *Populus* spp. – A – the trunk (0-50 cm), B – the trunk (50-250 cm), C – crown.

Of the 65 lichen species, 16 species (24.6%) are included in the Red list of lichens of Poland (Cieśliński *et al.*, 2006). Of these, five species (*Pertusaria multipuncta*, *Physconia perisidiosa*, *Pleurosticta acetabulum*, *Ramalina fastigiata*, *R. fraxinea*) are in endangered (EN) category, five species are vulnerable (VU) (*Hypogymnia farinacea*, *Parmelina tiliacea*, *Ramalina farinacea*, *R. pollinaria*, *Usnea hirta*), four species are in the near threatened (NT) category (*Evernia prunastri*, *Hypogymnia tubulosa*, *Physcia aipolia*, *Pertusaria coccodes*), one taxon (*Lecanora subrugosa*) is in the category least concern (LC), and one species (*Ramalina motykana*) belongs to data deficient (DD) category.

Of the 65 lichen species, eleven (17%) are under legal protection, six of which are partially protected (*Hypogymnia tubulosa*, *Pleurosticta acetabulum*, *Ramalina farinacea*, *R. pollinaria*, *Tuckermannopsis chlorophylla*, *Usnea hirta*) and five are strictly protected (*Hypogymnia farinacea*, *Parmelina tiliacea*, *Ramalina fastigiata*, *R. fraxinea*, *R. motykana*).

The spatial distribution of lichens in different tree zones, i.e. basal part, stem and crown, revealed that the most taxa were confined to the tree trunk (50-250 cm) – 61 species, while 25 species were found in butt zone and 28 species in crown.

On the trunk, along with its height, different morphological forms of lichen were observed (Fig. 1). Foliose lichens dominated at the trunk base, representing 52% of the total species found in this part of tree. The trunk base was characterized by a small number of exclusive species (2), where *Cladonia coniocraea* and *C. fimbriata* were recorded. On the trunk (50-250 cm) of trees crustose and foliose thalli were dominant representing, respectively 45% and 42% of total biota found in this part of the tree. This part of the trunk was characterized by a large number of species (28 species) exclusively found on this part including *Hypogymnia tubulosa*, *Physcia aipolia*, *Parmelina tiliacea*, *Physconia perisidiosa* and others.

The following foliose species were most common in tree crown, namely *Xanthoria parietina*, *Phaeophyscia orbicularis*, *Physcia adscendens*, *P. dubia*, *P. tenella*, *P. stellaris*. The taxa accounted for 44% recorded biota. The tree crown is a unique place for such interesting and rare lichens in Poland as *Hypogymnia farinacea*, *Usnea hirta*. These species were not found in other parts of this phorophyte.

List of collecting cites

Stands

1. National road no 19, Białystok-Zabłudów, 53°02'51.4"N 23°17'21.8"E
2. National road no 63, Kolno-Łomża, 53°21'25.9"N 21°58'57.2"E
3. National road no 63, Mały Płock, before the village, 53°22'19.6"N 21°57'59.6"E
4. Augustowo, the road to cemetery, 52°46'37.8"N 23°06'26.4"E
5. Strabla, agricultural landscape, 52°54'27.8"N 23°05'18.4"E
6. National road no 61, a cross between Łuby Kurki to Łomża, 53°09'04.3"N 21°50'38.3"E
7. National road no 66, near Pruszancka Baranki, 52°47'03.7"N 22°42'18.3"E
8. National road no 66, Patoka – Brańsk, 52°45'20.5"N 22°47'16.1"E
9. Road Popławy – Oleksin, 52°42'52.4"N 22°51'28.2"E
10. National road no 66, Szepietowo – Brańsk, 52°46'12.1"N 22°44'37.5"E

Stands of specimens from herbarium

11. Prudziszki, road Suwałki–Jeleniewo, *Populus* spp. leg. M.A. Dreyer, 1995; 12. Kazimierówka, road Jeleniewo – Błaskowizna, *Populus* spp., leg. M.A. Dreyer, 1995; 13. Kruszki, road, *Populus* spp., leg. M.A. Dreyer, 1995; 14. Maćkowa Ruda, road, *Populus* sp., leg. M.A. Dreyer, 1995; 15. Wysoki Most, road, *Populus* spp., leg. M.A. Dreyer, 1995; 16. Waliły – Słuczanki, road, *Populus* spp., leg. A. Karpowicz, 1994; 17. Sokole, road, *Populus* spp., leg. A. Karpowicz, 1994; 8. Słuczanka, road, *Populus* spp., leg. A. Karpowicz, 1994; 19. Waliły, road, *Populus* spp., leg. A. Karpowicz 1994.

In comparison with other areas in Poland and Europe, this phorophyte is characterized by a high number of species found in Podlaskie Voivodeship. A similar number of species (60 species) was recorded, e.g., in Białystok city – 59 (Matwiejuk, 2007), in forest area near Uppsala, in Sweden – 60 species (Gustafsson & Eriksson, 1995), in Pripyatsky National Park in Belarus – 70 (Golubkov, 2011). A higher number of lichen species on the bark of poplar was reported in Knyszyńska Forest in NE Poland – 108 species (Bystrek & Kolanko, 2000) were recorded. In Sweden, there are 82 lichen species that preferably grow on aspen (Hedenäs & Ericsson, 2000). A lower number of lichen species was recorded in Amasya, Çorum, and Tokat regions, Turkey – 20 (Kinalioğlu, 2009). in Ordu Province, Turkey – 21

(Kinalioölu, 2010), in Świętokrzyski National Park – 9 (Łubek, 2007), Śnieżnik Massif and Białskie Mountains – 2 species only (Szczepańska, 2008).

The lichens from the roadside trees are similar to the trees other cities (Matwiejuk, 2007). On the bark of *Populus* sp. common and nitrophilous species such as *Physcia adscendens*, *P. dubia*, *P. tenella*, *P. stellaris*, *Phaeophyscia orbicularis*, *Xanthoria parietina* were recorded. Furthermore, protected, threatened and rare species (*Pleurostictum acetabulum*, *Physconia perisidiosa*, *Ramalina farinacea*, *R. fastigiata*, *R. fraxinea*, *R. pollinaria*, *Usnea hirta*) were observed on the bark of poplar in Podlaskie Voivodeship (NE Poland).

Cyanobacterial macrolichens were not recorded on roadside Poplars despite they grew on bark of aspen in forest. Among the cyanobacterial macrolichens, *Lobaria pulmonaria*, *Nephroma bellum*, *N. parile*, *Parmeliella triptophylla*, *Peltigera canina* and *P. praetextata* were the most common in one of the studies in Finland (Kuusinen, 1996b).

The research in Estonian forests showed that aspen had the highest number of lichen species on the basal trunk and twigs, and also the highest number of host-specific lichen species (Jüriado *et al.*, 2003). The current study revealed the largest number of lichen species in the central part of the trunk of roadside trees, which is associated with a high proportion of foliose lichens, preferring light.

Conclusions

1. The lichen biota of *Populus* spp. is rich, and comprises 65 species.
2. Specific microclimate conditions, bark pH and structure are thought to promote lichen growth on bark of *Populus* spp.
3. Protected, threatened and rare species (*Pleurostictum acetabulum*, *Physconia perisidiosa*, *Ramalina farinacea*, *R. fastigiata*, *R. fraxinea*, *R. pollinaria*, *Usnea hirta*) were recorded on the bark of poplar in NE Poland.
4. Common, nitrophilous lichens (*Physcia adscendens*, *P. tenella*, *P. stellaris*, *Phaeophyscia orbicularis*, *Physconia enteroxantha*, *Xanthoria parietina*) were recorded on the bark of poplar in NE Poland.
5. The poplar may play an important role in preserving lichen biodiversity in the roads environment.

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