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Lichens of fruit trees in the selected locations in Podlaskie Voivodeship [North-Eastern Poland]

Porosty drzew owocowych w wybranych miejscach województwie podlaskim [Polska Północno-Wschodnia]

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Abstract

The aim of this paper is to present the diversity of the lichen species on fruit trees (*Malus* sp., *Pyrus* sp., *Prunus* sp. and *Cerasus* sp.) growing in orchards in selected villages and towns in the Podlaskie Voivodeship. Fifty-six species of lichens were found. These were dominated by common lichens found on the bark of trees growing in built-up areas with prevailing heliophilous and nitrophilous species of the genera *Physcia* and *Phaeophyscia*. A richer lichen biota is characteristic of apple trees (52 species) and pear trees (36). Lichens of the apple trees constitute 78% of the biota of this phorophyte growing in the fruit orchards in Poland. Of the recorded species, only two (*Ramalina farinacea*, *Usnea hirta*) are covered by partial protection in Poland.

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1. INTRODUCTION

Fruit orchards, as agricultural lands, are a constant element of the agricultural landscape of Poland. They are the place of occurrence of many species of plants and animals, mainly birds and insects, as well as lichens, fungi and mosses that colonise the bark of fruit trees. Establishing of fruit orchards is an example of human activity, which leads to the increase in the coverage of some species of lichens. Their presence in the agricultural landscape clearly enhances the mosaic and heterogeneity of the natural environment.

Research on fruit tree lichens was discussed in several papers, for example, by Kuziel [1964a, b], Kiszka and Piórecki [1991], Kościelniak [1998, 2004], Lipnicki and Sobieralska [2009], Zarabska et al. [2009], Zarabska [2011], Łubek and Biskup [2012]. The studies on lichen biota in different areas usually mention only single species of lichens from individual fruit trees, often growing at the periphery of forests or in built-up areas [Wilkoń-Michalska et al. 1988, Kiszka, Piórecki 1994, Kościelniak 2004, Łubek 2007, Szczepańska 2008, Matwiejuk, Korobkiewicz 2012 and others]. The data concerning lichens of fruit trees in north-eastern Poland, including the Podlaskie Voivodeship, are largely incomplete. They mostly come from the individually growing fruit trees, for

Streszczenie

Głównym celem pracy było przedstawienie zróżnicowania składu gatunkowego porostów występujących na korze drzew owocowych (*Malus* sp., *Pyrus* sp., *Prunus* sp. i *Cerasus* sp.) rosnących w sadach w wybranych miejscowościach w województwie podlaskim. Stwierdzono 56 gatunków porostów. Odnotowane gatunki to w większości porosty pospolite, notowane na korze drzew rosnących na terenach zabudowanych. Dominują gatunki światłolubne, pyłolubne i nitrofilne z rodzaju *Physcia*, *Phaeophyscia*, *Polycauliona*, *Xanthoria*. Najbogatszą biotą porostów charakteryzują się jabłonie (52 gatunki) i grusze (36). Porosty jabłoni badanego terenu stanowią 78% bioty tego forofitu, rosnących w sadach owocowych w Polsce. Spośród odnotowanych gatunków tylko dwa (*Ramalina farinacea*, *Usnea hirta*) objęte są ochroną częściową w Polsce.

example, from the Wigry National Park [Fałtynowicz 1994], from Białystok region [Matwiejuk 2007] or the Warmia Plain [Szymczyk, Zalewska 2008].

The subject of this study are lichens growing on the bark of the following fruit trees: *Malus* sp., *Pyrus* sp., *Prunus* sp. and *Cerasus* sp. in the cultivated fruit orchards.

The main objective of this study is to present the diversity of lichen species of fruit trees growing in the orchards of the Podlaskie Voivodeship. So far, no similar lichenological work has been carried out in this region.

2. STUDY AREA

The study area embraces selected villages located in seven municipalities (Białystok, Janów, Krynkki, Michałowo, Narewka, Zabłudów and Zambrów) in the Podlaskie Voivodeship. The study area belongs to several mezoregions, including: Białystok Upland, Wysokomazowiecka Upland, Sokólskie Hills, Bielsk Plain and Upper Narew Valley, which are parts of the macroregion of the North Podlasie Plain [Kondracki 2002].

3. METHODS AND MATERIAL

The field research was conducted in 10 stands, in the years 2015—2016 (Fig 1). A group of trees in old fruit orchards was accepted as an individual stand. From each stand, lichens were recorded from the bark of fruit trees up to 1.6 m. The geographical coordinates of the study sites in the Podlaskie Voivodeship were established using GPS. GPS coordinates used the WGS84 datum.

List of research stands:

1. Ryboły [52°55'57"N 23°15'49"E], *Cerasus* sp., *Malus* sp., *Pyrus* sp.
2. Kryнки [53°15'55"N 23°46'20"E], *Cerasus* sp., *Malus* sp., *Pyrus* sp.
3. Białystok [53°09'16"N 23°13'15"E], *Cerasus* sp., *Malus* sp., *Pyrus* sp., *Prunus* sp.
4. Stary Laskowiec [52°56'39"N 22°18'28"E], *Malus* sp., *Prunus* sp.
5. Nowy Laskowiec [52°56'39"N 22°18'29"E], *Malus* sp., *Prunus* sp.
6. Wdziękoń Pierwszy [52°57'47"N 22°18'51"E], *Malus* sp., *Prunus* sp.
7. Wasilówka [53°27'43"N 23°16'31"E], *Malus* sp., *Prunus* sp., *Pyrus* sp.
8. Studzieńczyna [53°27'41" N 23°18"E], *Malus* sp.
9. Narewka [52°50'10"N 23°45'27"E], *Malus* sp., *Pyrus* sp.
10. Pieńki [53°03'18"N 23°37'25"E], *Malus* sp., *Prunus* sp., *Pyrus* sp.

The lists of species of lichenized fungi at individual sites were made. Herbarium material was collected for lichenological documentation and identification of some taxa. Specimens were studied morphologically and anatomically by microscopy. The material collected was determined using lichen identification keys by Nowak and Tobolewski [1975], Wirth [1980, 1995] and Purvis et al. [1992]. The specimens of genus *Lepraria*, *Cladonia pyxidata-chlorophaea* group and *Lecanora expallens* were determined by TLC in solvent systems A and C [Orange et al. 2003]. The lichen species nomenclature followed Fałtynowicz, Kossowska [2016]. Specimens were stored in the Herbarium of the Institute of Biology of the University of Białystok.

4. RESULTS

In the fruit orchards in the Podlaskie Voivodeship, 56 species of lichens were found. Most of the species are representatives of the genus *Lecanora* (10 species), *Physcia* (5), *Cladonia* and *Lepraria* (such as 3).

The number of identified taxa varied from 10 (in stand 8) to 34 (in stand 3). In all the studied orchards, *Candelariella xanthostigma*, *Hypogymnia physodes*, *Physcia dubia*, *P. tenella*, *Polycauliona polycarpa* and *Xanthoria parietina* were recorded. *Cladonia chlorophaea*, *Lecania cyrtella*, *Lecanora allophana*, *L. symmicta* and *L. varia* have individual sites.

The highest number of lichen species was found on bark of *Malus* sp. – 52 species and *Pyrus* sp. – 36 species.

Amandinea punctata, *Candelaria concolor*, *Candelariella xanthostigma*, *Hypogymnia physodes*, *Lecanora carpinea*,

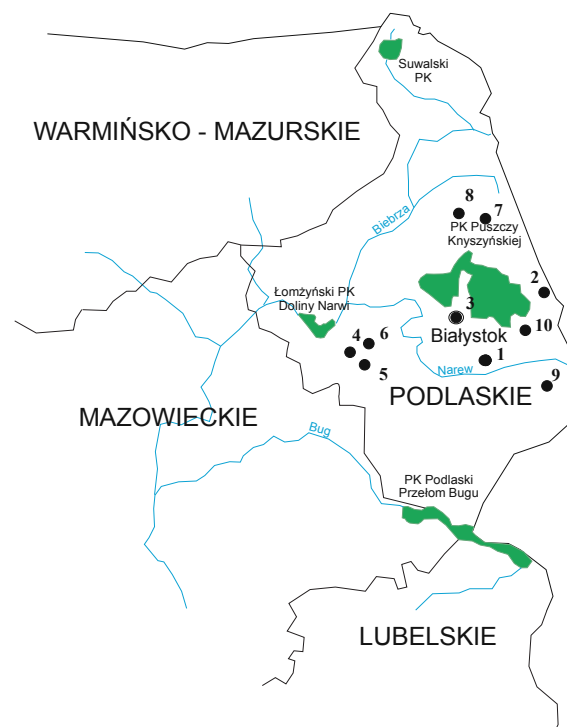


Figure 1. Locations of investigation sites of lichen species of fruit trees in Podlaskie Voivodeship.

Lepraria incana, *Melanohalea exasperatula*, *Phaeophyscia orbicularis*, *Physcia adscendens*, *P. tenella*, *Polycauliona polycarpa* and *Xanthoria parietina* were often recorded, among others, on the bark of *Malus* sp. *Malus* sp. is characterized by the largest number of exclusive species. Among them are: *Caloplaca cerina*, *Cladonia coniocraea*, *Lecania cyrtella*, *Lecanora allophana*, *L. saligna*, *Micarea denigrata*, *Physcia aipolia*, *Ramalina farinacea* and *Usnea subfloridana*. Lichen thalli were found on the bark of this phorophyte throughout the height of the tree, mostly in the middle of the trunk and in the crown. Almost all the morphological forms can be distinguished among them, although crustose and foliose lichens dominate. Numerous genera of *Lecanora*, *Physcia* and *Phaeophyscia* are represented. The bark of *Pyrus* sp., similar to the bark of *Malus* sp., is dominated by the lichens of genus: *Hypogymnia*, *Lecanora*, *Physcia*, *Phaeophyscia* and *Xanthoria*. There are no exclusive species found on *Pyrus* sp.

A smaller number of lichen species was found on the bark of *Prunus* sp. and *Cerasus* sp. (30 species). *Rinodina pyrina* is an exclusive species for *Prunus* sp. and *Hypocenomyce scalaris* is exclusive for *Cerasus* sp. (Tab. 1).

From among the epiphytes growing on the bark of fruit trees, two species (*Ramalina farinacea* and *Usnea hirta*) are legally protected [Regulation of the Minister of the Environment 2014]. Six species have been put on the Red list of lichens in Poland [Cieśliński et al. 2006], including *Melanelixa subargentifera*, *Ramalina farinacea*, *Usnea hirta* in the vulnerable category – VU, *Evernia prunastri*, *Hypogymnia tubulosa* in the category of near threatened – NT and *Strangospora pinicola* in the category of least concern (LC).

Table 1. The list of lichen species found in fruit orchards at different sites in Podlaskie Voivodeship.

Species	Stands	Substrate
<i>Amandinea punctata</i> (Hoffm.) Coppins & Scheid.	1-6, 9, 10	Ce, Ma, Pr, Py
<i>Athalia pyracea</i> (Ach.) Arup, Frödén & Søchting	1, 3, 9	Ce, Ma, Pr, Py
<i>Buellia griseovirens</i> (Turner & Borrer ex Sm.) Almb.	2, 3	Ce, Ma, Pr, Py
<i>Caloplaca cerina</i> (Ehrh. ex Hedw.) Th. Fr.	1, 3	Ma
<i>Candelaria concolor</i> (Dicks.) Stein	1-6, 9, 10	Ce, Ma, Pr, Py
<i>Candelariella xanthostigma</i> (Ach.) Lettau	1-10	Ce, Ma, Pr, Py
<i>Cladonia chlorophaea</i> (Flörke ex Sommerf.) Spreng	1	Ma, Py
<i>Cladonia coniocraea</i> auct.	1, 10	Ma
<i>Cladonia fimbriata</i> (L.) Fr.	1, 2, 3	Ce, Py
<i>Evernia prunastri</i> (L.) Ach.	1-3, 9, 10	Ce, Ma, Pr, Py
<i>Hypocenomyce scalaris</i> (Ach.) Choisy	3, 7	Ce
<i>Hypogymnia physodes</i> (L.) Nyl.	1, 2-10	Ce, Ma, Pr, Py
<i>Hypogymnia tubulosa</i> (Schaer.) Hav.	1, 3, 9, 10	Ma, Py
<i>Lecania cyrtella</i> (Ach.) Th. Fr.	3	Ma
<i>Lecanora allophana</i> (Ach.) Nyl.	1	Ma
<i>Lecanora argentata</i> (Ach.) Malme	2, 9	Ma
<i>Lecanora carpinea</i> (L.) Vain.	1-3, 5, 6, 10	Ce, Ma, Pr, Py
<i>Lecanora chlorotera</i> Nyl.	1, 3	Ce, Ma, Pr, Py
<i>Lecanora conizaeoides</i> Nyl.	1-4, 9, 10	Ce, Ma, Pr, Py
<i>Lecanora expallens</i> Ach.	1, 3, 9	Ce, Ma, Pr, Py
<i>Lecanora pulicaris</i> (Pers.) Ach.	1-3, 9	Ce, Ma, Pr, Py
<i>Lecanora saligna</i> (Schrad.) Zahlbr.	1, 9	Ma
<i>Lecanora symmicta</i> (Ach.) Ach.	3	Ce, Ma, Pr, Py
<i>Lecanora varia</i> (Hoffm.) Ach.	3	Ma
<i>Lecidella elaeochroma</i> (Ach.) Choisy	1, 9, 10	Pr, Py
<i>Lepraria elobata</i> Tønberg	6, 9	Ma
<i>Lepraria incana</i> (L.) Ach.	3, 4	Ce, Ma, Pr, Py
<i>Lepraria jackii</i> Tønberg	5, 10	Ma
<i>Melanelixia glabratula</i> (Lamy) O. Blanco & al.	1-7, 10	Ce, Ma, Pr, Py
<i>Melanelixia subargentifera</i> (Nyl.) O. Blanco & al.	3, 9	Ce, Ma, Pr, Py
<i>Melanohalea exasperatula</i> (Nyl.) O. Blanco & al.	1, 2, 4-10	Ma, Pr, Py
<i>Micarea denigrata</i> (Fr.) Hedl.	9	Ma
<i>Myriolecis hagenii</i> (Ach.) Śliwa, Zhao Xin & Lumbsch	1-6, 9	Ce, Ma, Pr, Py
<i>Parmelia sulcata</i> Taylor	1-10	Ce, Ma, Pr, Py
<i>Parmeliopsis ambigua</i> (Wulfen) Nyl.	3	Ce, Ma, Pr, Py
<i>Pertusaria coccodes</i> (Ach.) Nyl.	5, 7, 8	Ma
<i>Phaeophyscia nigricans</i> (Flörke) Moberg	4, 5, 6	Ma, Pr
<i>Phaeophyscia orbicularis</i> (Neck.) Moberg	1-7, 9, 10	Ce, Ma, Pr, Py
<i>Phlyctis argena</i> (Ach.) Flot.	3	Ce, Ma, Pr, Py
<i>Physcia adscendens</i> (Fr.) H. Olivier	1-6, 9, 10	Ce, Ma, Pr, Py
<i>Physcia aipolia</i> (Ehrh. ex Humb.) Fűrrohr subsp. <i>aipolia</i>	9	Ma
<i>Physcia dubia</i> (Hoffm.) Lettau	1-10	Ce, Ma, Pr, Py
<i>Physcia stellaris</i> (L.) Nyl. subsp. <i>stellaris</i>	1-3, 6, 9, 10	Ce, Ma, Pr, Py
<i>Physcia tenella</i> (Scop.) DC.	1-10	Ce, Ma, Pr, Py
<i>Physconia enteroxantha</i> (Nyl.) Poelt	1, 2, 5, 6, 9	Ma, Py
<i>Physconia grisea</i> (Lam.) Poelt	1, 9	Ma, Py
<i>Polycauliona candelaria</i> (L.) Frödén, Arup & Søchting	2	Ma, Py
<i>Polycauliona polycarpa</i> (Hoffm.) Frödén, Arup & Søchting	1-10	Ce, Ma, Pr, Py
<i>Pseudevernia furfuracea</i> (L.) Zopf	9	Ma
<i>Ramalina farinacea</i> (L.) Ach.	8	Ma
<i>Rinodina pyrina</i> (Ach.) Arnold	1, 2	Pr
<i>Scoliciosporum chlorococcum</i> (Graeve ex Stenh.) Vězda	3-6, 9	Ce, Ma, Pr, Py
<i>Strangospora pinicola</i> (A. Massal.) Körb.	9	Ma
<i>Trapeliopsis flexuosa</i> (Fr.) Coppins & P. James	10	Ma
<i>Usnea hirta</i> (L.) Weber ex F.H. Wigg.	3	Ma
<i>Xanthoria parietina</i> (L.) Th. Fr.	1-10	Ce, Ma, Pr, Py

Explanations: Ce – *Cerasus* sp., Ma – *Malus* sp., Pr – *Prunus* sp., Py – *Pyrus* sp.

5. DISCUSSION

The lichen biota of fruit trees (56 species) in selected localities in the Podlaskie Voivodeship is typical and comparable with other areas in Poland. The recorded lichen species are mostly common lichens, found on the bark of trees growing in built-up areas. Heliophilous and nitrophilous species of genus *Physcia*, *Phaeophysia*, *Polycauliana* and *Xanthoria* are dominant. These lichen species have also been recorded from the bark of fruit trees in other studies dealing with rural areas [Kuziel 1964 a, b, Kiszka, Piórecki 1991, Śliwa 1998, Kościelniak 2004, Szymczyk, Zalewska 2008, Zarabska 2011, Łubek, Biskup 2012, Zarabska-Bożejewicz 2016]. The list of species found in this study includes several more interesting taxa, such as *Melanelixia subargentifera*, *Physcia aipolia*, *Strangospora pinicola*.

A similar number of lichen species (53) was recorded in the selected fruit orchards in the Lower Vistula Valley [Lipnicki, Sobieralska 2009]. Among these species are those not found in the Podlaskie Voivodeship, such as *Alyxoria varia*, *Bryoria vrangiana*, *Physcia dimidiata*, *Physconia distorta*, *P. perisidiosa*, *Tuckermanopsis chlorophylla*, *Vulpicida pinastri* and others.

A large number of lichen species has been found on the bark of fruit trees in the Bieszczady Niskie [Koscielniak 2004] — 105, in Łącka Basin [Kuziel 1964a] — 86, in the Przemyskie Foothills [Kiszka, Piórecki 1991] - 71. Kościelniak [2004] found many rare species of lichens that have not been recorded in the Podlaskie Voivodeship, including, among others, *Acrocordia gemmata*, *Bacidia subincompta*, *Flavoparmelia caperata*, *Melanelixia subaurifera*, *Ochrolechia turneri*, *Pamelina tiliacea* and *Punctelia subrudecta*.

A smaller number of epiphytic lichen species has been found, among others, 47 species — in the Beskid Sądecki [Śliwa 1998], 40 — in the Przemyskie Foothills within the boundaries of the planned Turnicki National Park [Kiszka, Piórecki 1994], 37 — in the Śnieżnik Massif and Białskie Mountains [Szczepańska 2008], 32 — in the Wielkopolska Voivodeship, in Tomysł municipality, in apple orchards [Zarabska et al. 2009], 32 — in the agricultural landscape of Sandr Nowotomyski, in apple orchards [Zarabska 2011], 22 — in Torun [Wilkoń-Michalska et al. 1988], 16 — in Świętokrzyskie National Park [Łubek 2007].

The abundance of epiphytic lichens on the tree bark depends mainly on the bark structure, the nutrient content of the bark and the bark pH [Barkman 1958, Wirth 1995]. Tree bark pH is one of the most important factors affecting the lichen species' distribution [Barkman 1958]. Deciduous trees usually have lower bark acidity than coniferous trees [Barkman 1958], which varies according to the tree species; for example, *Picea abies*, *Pinus sylvestris* and *Betula pendula* have normal acidity (pH 3.4–4.0) and *Acer platanoides*, *Fraxinus excelsior*, *Tilia cordata* and fruit trees have subneutral (pH 4.9–7.5) bark in clean-air areas [Wirth 1995].

Differences between the epiphytic lichen biota of trees with similar bark chemistry, were attributable to differences in bark rugosity, dust trapping, microclimate conditions and content of air pollution.

Specific microclimate conditions of phorophytes are thought to promote lichen growth in old orchards. Particularly, lichens are

more abundant within and under tree crowns, where there is high air humidity and diffuse solar radiation [Łubek, Biskup 2012]. The diversity of trees and their age within an orchard, types and intensity of human activities in this ecosystem (e.g., agroecosystem, city and village lands) and its surroundings, including levels of air pollution as well as the general environmental conditions affect the epiphytes [Zarabska-Bożejewicz 2016]. Łubek, Biskup [2012] found that the biota of lichens of fruit trees growing in orchards and along roads differed as to the number of species and the degree of coverage. More species diversity was reported in orchards (48 species) than on the bark of fruit trees growing alone or in small groups on the roads (44).

Among the fruit trees under study, the highest number of epiphytic lichens was found on the bark of *Malus* sp. (52 species). Lichens of this phorophyte in the Podlaskie Voivodeship account for 78% of the lichen biota of apple trees growing in fruit orchards in Poland [Zarabska et al. 2009, Zarabska 2011, Łubek, Biskup 2012]. In the study area, the following lichens were not recorded on the bark of this phorophyte: *Acrocordia gemmata*, *Alyxoria varia*, *Bacidia adastrata*, *B. rubella*, *Candelariella reflexa*, *Cladonia merochlorophaea*, *Coenogonium pineti*, *Flavoplaca citrina*, *Flavoparmelia caperata*, *Lecania naegelii*, *Lecanora piniperda*, *L. persimilis*, *Lecidella flavoseriata*, *Melanelixia glabra*, *M. subaurifera*, *Parmelia saxatilis*, *Parmelina tiliacea*, *Pertusaria albescens*, *P. amara*, *Phaeophyscia chloantha*, *P. hirsuta*, *Physconia detersa*, *P. distorta*, *P. perisidiosa*, *Piccolia ochrophora*, *Placynthiella icmalea*, *Scoliciosporum sarothamni* and *Xanthomendoza fallax*. The new taxa for this phorophyte in Poland are: *Cladonia chlorophaea*, *Lecanora allophana*, *L. argentata*, *L. pulicaris*, *L. varia*, *Micarea denigrata*, *Ramalina farinacea* and *Rinodina pyrina*. Apple orchards feature favourable light conditions, difficult access to the water on the trunk and higher pH of the bark of *Malus* sp. [Kuziel 1964b], and these allow for establishment and persistence of relatively rich and interesting lichen biota in the nearly deforested countryside [Zarabska et al. 2009, Zarabska-Bożejewicz 2016]. Moreover, favourable conditions for some lichens can be also be created by bark pH of *Malus* sp., which is naturally higher in comparison with some other trees, for example, *Quercus* sp., and can promote occurrence of some specific, group of lichens such as the nitrophytic lichen species [Zarabska et al. 2009]. Orchards are biodiversity hotspots, home to a wide range of organisms including epiphytic lichens. The fruit orchards are considered as important refuges of rare lichen species increasing the biodiversity of the region. Traditional orchards are now included as a priority habitat in the United Kingdom Biodiversity Action Plan [Whitelaw 2012].

6. CONCLUSIONS

1. The lichen species diversity of the fruit trees in the study area is comparable with other regions in the country.
2. The lichen species typical for the lichen biota of fruit trees in built-up areas are dominating.
3. The fruit trees growing in orchards are significantly increasing the heterogeneity of the anthropogenic landscape.

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