

ORIGINAL PAPER

The first observation of *Lobaria pulmonaria* (L.) Hoffm. on *Malus domestica* Borkh. in the Białowieża Forest

Tomasz Ginszt^(1, 2)✉, Agnieszka Laskowska-Ginszt⁽³⁾, Marek Wołkowycki⁽¹⁾

⁽¹⁾ Institute of Forest Sciences, Faculty of Civil Engineering and Environmental Sciences, Białystok University of Technology, Wiejska 45A, 15-351 Białystok, Poland

⁽²⁾ Białowieża Forest District, Wojciechówka 4, 17-230 Białowieża, Poland

⁽³⁾ Hajnówka Forest District, Kolejki Leśne 12, 17-200 Hajnówka, Poland

ABSTRACT

North-eastern Poland is an area of high natural values, including a well-preserved, varied and rich biota of lichens. It is a kind of refuge for many lichen species. Lichens are much more frequent and more abundant here than in other regions of the country. The Białowieża Forest is distinguished by the presence of the best-preserved natural habitats in the Polish lowlands. The lichen biota of the Białowieża Forest has been studied by many lichenologists. The data were provided by numerous studies dating back to the 19th century. Lichens belong are of significant importance for the natural environment; moreover, they are most sensitive to contemporary anthropogenic changes in natural environments. Many species occurring in Poland are threatened with extinction. One of the flagship lichen species in Poland is the lungwort lichen *Lobaria pulmonaria* (L.) Hoffm. It is a characteristic representative of the lichen biota of the whole country and an icon for protection of these organisms. The thalli are easily visible and their identification is unquestionable. The lungwort lichen is one of the most impressive lichens in Poland. It is mainly found in old, undisturbed forests where it is often accompanied by other rare lichen species with similar ecological requirements. The lungwort lichen is an umbrella species, protecting other valuable and rare species. It grows mainly on the bark of deciduous trees, but it has been recorded on exception from the bark of conifers (spruce, fir, pine). A new location of *L. pulmonaria* was found on *Malus domestica* Borkh. in 2021. The home apple tree bearing the lungwort lichen is located in the Podcerkwa nature reserve in Polana Berezowo. The tree grows in an open space, a former hunting ground, now a mid-forest meadow mowed as part of a nature reserve protection plan or species protection program. The lichen thallus is located on the north-eastern side of the tree (N-E). The largest thallus is about 17 cm wide, at a height of about 2 m. The tree also has a few smaller thalli, 2 to 10 cm in size, located up to a height of about 3.5 m. Thanks to the discovery of a new site in the Białowieża Forest District, the home apple tree *M. domestica* Borkh. should also be added to the phorophytes of the lungwort lichen. Until now, in the Polish literature, the lichen has not been recorded from this tree species.

KEY WORDS

home apple tree, lichens, lungwort lichen, phorophyte, Polana Berezowo

✉e-mail: t.ginszt@pb.edu.pl, tomasz.ginszt@bialystok.lasy.gov.pl

Received: 15 April 2022; Revised: 19 July 2022; Accepted: 25 July 2022; Available online: 30 August 2022

Introduction

Lichens belong to the kingdom of fungi and are a group of organisms of great importance to the natural environment. At the same time, they are sensitive to contemporary anthropogenic changes in natural environments. Many species occurring in Poland are endangered with extinction. Succeeding editions of the 'Red List of Threatened Lichens in Poland' Cieśliński *et al.* (1986, 1992, 2003, 2006) report that the number of species requiring urgent protection is systematically increasing. Because the habitats in the Białowieża Forest are relatively natural and undisturbed, extinction processes are not of high intensity in the area (Cieśliński and Czyżewska, 2003).

North-eastern Poland is recognized as an area of high natural values, including a well-preserved, varied, and diverse biota of lichens. Many lichen stands are known only from this region of Poland. The Białowieża Forest is distinguished by the presence of the best-preserved natural habitats in the Polish lowlands.

The main factor shaping the lichen biota of the Białowieża Forest is the high degree of diversity of the local flora and the preservation of forest communities. Oak-hornbeam forests dominate the landscape of the Białowieża Forest. The most characteristic epiphytic biota is concentrated on the bark of oaks, hornbeams, and maples. In mixed forests, especially upon dead wood, there are also very interesting species of lichens. Fresh coniferous forests are less important for this group of organisms. Riparian forests and alder forests are of great importance for the species diversity of lichens. Ash trees are especially preferred by lichens. However, due to the disease and dieback of this phorophyte, valuable habitats of many rare lichens are disappearing at the same time. The relatively good condition of atmospheric air in the area of the Białowieża Forest helps to support varied biocenosis of epiphytic lichens on trees outside forest communities, *e.g.*, along roads, buildings, cemeteries, or in open clearings. On postglacial boulders and small stones, we can find a number of epilithic lichens, both within the Białowieża Forest and on its outskirts (Cieśliński and Tobolewski, 1988).

The lichen biota of the Białowieża Forest is relatively well known. The data have been provided by numerous studies dating back to the 19th century. A summary of previous studies (Błoński, 1888; Krawiec, 1938; Leczewicz, 1954; Rydzak, 1957, 1961) and extensive information on the distribution and ecological preferences of 309 species of lichens occurring in the Białowieża Forest can be found in the work by Cieśliński and Tobolewski (1988). The biota of lichenized fungi is the most fully characterized in terms of ecology in the V-100 research area of the Crypto project in the Białowieża National Park (compartment 256 of the strict protection zone). A total of 164 species have been found within one forest division (Cieśliński *et al.*, 1996; Cieśliński and Czyżewska, 1997). The critical list of lichenized fungi of the Białowieża Forest (Cieśliński, 2010) includes 450 species, including 268 species within the Białowieża National Park. The current number of ~500 species of lichenized fungi and ~50 lichenicolous fungi known from the Białowieża Forest also includes data published in recent years (Kukwa *et al.*, 2012a, b; Łubek and Jaroszewicz 2012; Guzow-Krzemińska *et al.*, 2016; Łubek and Kukwa, 2016). The species identified so far in the Białowieża Forest represent ~30% of the lichen biota known in Poland and ~20% of the accompanying non-lichenized lichen fungi (Fałtynowicz 2003; Czyżewska and Kukwa 2009; Fałtynowicz and Kossowska, 2016).

Flagship species draws the attention of people to conserve the biodiversity of an ecosystem. *Lobaria pulmonaria* (L.) Hoffm. is one of the flagship lichen species in Poland. It is an icon of lichen protection in the country, due to its beauty, easy observation of its thallus, and indisputable identification (Fałtynowicz, 2021). A flagship species draws the attention of people to

conserve the biodiversity of an ecosystem. The lungwort lichen is one of the most impressive and magnificent lichens in Poland. Its leaf-shaped thalli, adhering to the substrate with short fibre grippers, can reach a diameter of up to 40-60 cm. Sometimes they create large carpets up to 2 m in length (Ryś, 2007).

The colour of the lichen is light brown, or greenish-brown, and after drying it takes on a copper shade. The parts of the thallus may be up to several centimetres wide. The ends are blunt, dimpled, with a grid of lath-shaped elevations on which there are light grey soralia. The lower sides of the thallus are distinguished by protrusions, dark brown in the centre and light brown around the perimeter. The apothecia with red-brown discs are very rare (Fałtynowicz, 2012). In Poland, the information published about the occurrence of *L. pulmonaria* with apothecia comes from the areas of the Białowieża Forest (Krawiec, 1938; Matwiejuk and Bohdan, 2019), Bieszczady (Kościelniak, 2008), Augustów Forest (Matwiejuk and Zbyryt, 2013) and the Wigry National Park (Fałtynowicz, 2011).

The lungwort lichen is a cosmopolitan species, absent only from Australia and Antarctica. Most of the sites are located in Europe and North America, with some in Asia and southern Africa (Fałtynowicz, 2021). *L. pulmonaria* is considered an endangered species in many countries in Europe. For this reason, it is included in many regional (national) red lists, e.g., in Slovakia (Pisut *et al.*, 2001), Poland (Cieśliński *et al.*, 2006), the Netherlands (Siebel *et al.*, 1992), Denmark (Wind and Pihl, 2010), Estonia (Lõhmus *et al.*, 2019), and Finland (Carlsson and Nilsson, 2009).

The lungwort lichen in Poland is very rare. It can be found in great numbers only in Mazury, Podlasie and the Bieszczady (Fałtynowicz, 2021). Its conservation status in Poland is defined as EN, (endangered) (Cieśliński *et al.*, 2006), while in the Białowieża Forest it is NT (near-threatened) (Czyżewska and Cieśliński, 2003). In Poland, it has been subject to legal protection since 1957, and in accordance with its current legal status, it is under strict protection and is also under zone protection (Rozporządzenie, 2014). Data from forests managed by the State Forests show that the conservation situation in some regions is good (Ryś, 2005). Locations where the largest number of thalli have been inventoried are: Regional Directorate of State Forests in Białystok – forest districts: Białowieża, Hajnówka, Browsk, Borki, Czerwony Dwór, Płaska, Augustów, Pomorze, Regional Directorate of State Forests in Olsztyn – forest districts: Strzałowo, Nowe Ramuki, Miłomłyn, Regional Directorate of State Forests in Krosno – forest districts: Wetlina, Cisna, Bałigród (Ryś, 2005).

The lungwort lichen has a well-known biology and ecology. About 180 articles have been written about it in the past 20 years (DGLP, 2016). Because *L. pulmonaria* grows mainly in old, undisturbed forests, where it is often accompanied by other rare lichen species with similar ecological requirements, it is considered an umbrella species (Fałtynowicz, 2021). An umbrella species is one whose conservation indirectly conserves many other species in an ecosystem. It makes conservation-related decisions easier. *L. pulmonaria* grows on the bark of trees, mainly deciduous ones, mostly on maple (including sycamore), hornbeam, beech, ash, oaks (pedunculate and sessile), and linden (small-leaved and broad-leaved). It is much less common on alder, birch, aspen, willows, elm, and rowan. It was recorded on exception from the bark of conifers (spruce, fir, pine). (Tobolewski and Kupczyk, 1976; Cieśliński, 2003; Fałtynowicz, 2003, Ryś, 2007; Wołkowycki, 2008). In the mountains, it was also found on mossy rocks (Fałtynowicz, 2012).

Materials and methods

The surveyed forest clearing is located in the Podcerkiew forest range (sub-compartment 578Ad), with an area of about 2.5 ha, in the shape of an inverted letter 'L'. A sprawling oak grows in the

eastern part, indicating that this place has been open for at least 150 years. The edges of the clearing are marked by trees with monumental dimensions. An old pine grows on the northern edge of the meadow with a probable heat, *i.e.* the place where the beekeeper collected the bow used to smoke bees while harvesting forage from forest beehives. During excavations conducted by archaeologists in the vicinity of Polana Berezowo, traces of former human settlements were found (Olczak *et al.*, 2018).

Written sources from the 16th and 17th centuries indicate that in the vicinity of the clearing there were areas of traditional forest use, the so-called entrances, where it was allowed to mow meadows and set hives (Samojlik and Jędrzejewska, 2004; Samojlik, 2007). In the second half of the 18th century, when numerous changes were made to the Białowieża Forest, the production of charcoal began here (Samojlik, 2007). At the end of the 19th and early 20th centuries, in the clearing or in its close vicinity, there were a feed warehouse and feeders, set up as part of the hunting economy introduced after 1888 (Karcov, 1903). In the 1970s, Polana Berezowo was used for agriculture, and on August 1, 1995, it was included in the nature reserve 'Podcerkwa'. As part of the protective measures resulting from the reserve protection plan, work is carried out here to maintain the habitats of rare species of butterflies by removing bushes and mowing the meadow.

The data for this study come from observations made in May and November 2021. During the research, the thalli were measured, their viability was observed, and photographic documentation was made. In order to fully characterize the new site and the phorophyte, where the thallus of the lungwort lichen *L. pulmonaria* was found, a list was made of all species of bryophytes, lichens and large-fruited fungi accompanying the lichen. Data on the number of species protection zones of the lungwort lichen in the forest districts of the Forest Promotional Complex 'Puszcza Białowieska' as of December 31, 2021, were obtained from the Regional Directorate of State Forests in Białystok.

Results and discussion

Apart from the tree species on which *L. pulmonaria* was found, the specific location is anomalous. The apple tree grows in an open space, a former hunting plot, now a mid-forest meadow mowed as part of a nature reserve protection plan or species conservation program. The observation is characteristic in other countries (Scheidegger and Werth, 2009; Jüriado and Liira, 2010), but in the Białowieża Forest it is unique. The lungwort lichen on the home apple tree is located in the Podcerkwa nature reserve in an area called Polana Berezowo (Fig. 1). The tree grows in the western part of the clearing, about 20 m from the western edge, about 40 m from the south edge of the forest and about 25 m from the north edge of the forest (N 52°39'19.41", E 23°44'3.99") (Fig. 2). The exposed lichen thallus is located in the northeast. There are two large thalli on the tree. The largest thallus is about 17 cm in size and at a height of about 2 m (Fig. 3). The tree also has seven smaller thalli ranging in size from 2 to 10 cm, at a height of about 3.5 m. The nearest *L. pulmonaria* is about 1000 meters west of the described one, located next to a forest road on a maple tree and at a height of about 15 m.

In the new location of the lungwort lichen on the home apple tree, in addition to the lichen thalli, the following species of bryophytes, lichens and large-fruited fungi were also found:

– Bryophytes (det. Daniel Skowron):

1. *Leucodon sciuroides* (Hedw.) Schwägr – numerous at the base of the trunk
2. *Hypnum cupressiforme* Hedw. – in large numbers throughout the trunk
3. *Orthotrichum affine* Schrader ex Bridel kinship – sparse on thin twigs
4. *Rosulabryum laevifilum* (Syed) Ochya – sparse on the trunk

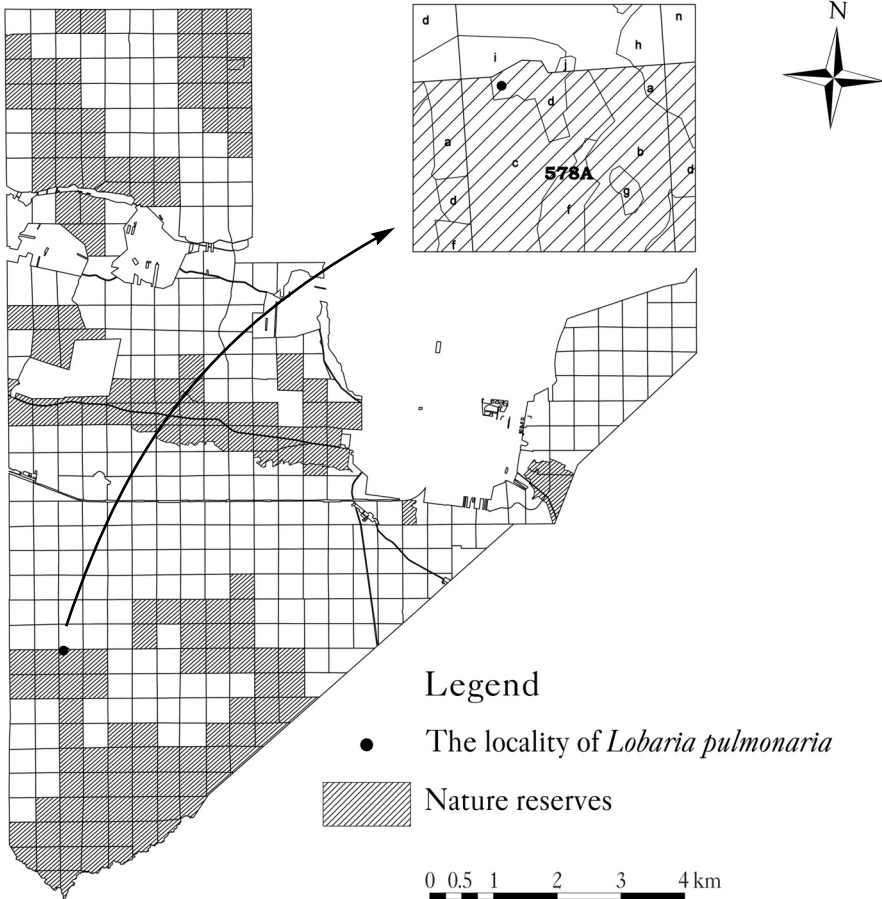


Fig. 1.

The Białowieża Forest District showing the location of *L. pulmonaria* on *M. domestica*

– Lichens:

1. *Evernia prunastri* (L.) Ah. – several hundred thalli on small branches
2. *Parmelia sulcata* Taylor – numerous on the entire trunk
3. *Usnea dasopoga* (Ah.) Röhl. – several dozen thalli on small twigs
4. *Hypogymnia physodes* (L.) Nyl. – in large numbers throughout the trunk
5. *Melanelixia glabrata* (Lamy) O. Blanco & al. – sparse on small twigs

– Fungi:

1. *Phellinus igniarius* (Linneus) Queleyt *s.l.* – three fruiting bodies. This species is a dangerous parasite that grows on living trees and continues to develop for a certain period after the host dies. It causes white rot of wood. Due to the presence of *P. igniarius*, the described position of the lungwort lichen is endangered.

The lungwort lichen is found mainly in moist deciduous forests, old, well-preserved stands, and in some regions of Europe, such as Great Britain, also in old parks (Wolseley and James, 2000). In the lowlands, it prefers hornbeam forests, and often grows also in riparian, alder, and beech forests, while in the mountains its habitat is beech and sycamore forests (Ryś, 2005). This lichen



Fig. 2.

Home apple tree *Malus domestica* in the Polana Berezowo (photo T. Ginszt)

is also considered one of the indicator species for natural forests. These forests collect typical forest species, they are very sensitive to anthropogenic influence, and they are dying out (Cieśliński, 2003). These are stenotopic lichens, the occurrence of which is conditioned by the presence of specific niches, characteristic of the least-disturbed forest environment. These lichens meet the criteria adopted for forest relics (Cieśliński *et al.*, 1996).



Fig. 3.
The biggest thallus of *Lobaria pulmonaria* on *Malus domestica* (photo T. Ginszt)

The lungwort lichen is one of the indicator species of lowland primeval forests. Primeval forests are biocoenoses corresponding to natural or close to the original ecological systems (Faliński, 1986; Cieśliński *et al.*, 1996; Holeksa, 1998), which form stable, compact forest complexes, existing and functioning without visible effects of previous human influences.

According to Cieśliński and Czyżewska (2003), indicator species of this type of forests should be distinguished, among others, by the following features:

1. They are native species occurring only in natural forest communities;
2. They are permanent, natural components of forest biocoenoses, and their biological and ecological properties are adapted to the phytoclimate and forest environment;
3. They are typical epiphytes and epixylics inhabiting specific forest habitats;
4. They do not grow in timberland;
5. They show no tendency to control anthropogenic habitats.

Undoubtedly, *L. pulmonaria* fits these indicator species criteria but does not fully adhere to the first and the last two criteria based on the observations reported here. Indeed, the species can persist and reproduce in a landscape moderately disturbed by human activity (Scheidegger and Werth, 2009; Jüriado and Liira, 2010; Brunialti *et al.*, 2015). These findings indicate the need for further research and a possible revision of the view on the ecological requirements and methods of species protection in Poland.

Our observation corresponds perfectly with the studies carried out in Estonia (Jüriado and Liira, 2010) and Switzerland (Scheidegger and Werth, 2009), where wooded meadows (or pastured woodlands) are considered the best habitat for *L. pulmonaria*.

The location found in this study indicates that the home apple tree *Malus domestica* Borkh. should also be added to the phorophytes of the lungwort lichen. The new occurrence is located in the Białowieża Forest District. This is the first described locality occurrence of *L. pulmonaria* on *M. domestica* in Poland. The home apple tree is not included in the stand description of State Forests. By analysing the health of the tree, it can be suspected that it is about 50 years old. The time of formation of the 20 cm thallus of *L. pulmonaria* is estimated at around 25 years ago and the lifetime of one generation at around 40 years (Scheidegger *et al.*, 1998). In this case, it can therefore be assumed that the largest thallus is about 20 years old. It should probably not be too surprising, because in the forest districts (Białowieża, Browsk, Hajnówka) there are currently 136 species protection zones with a total area of about 418 ha, with 278 localities of *L. pulmonaria* (Table 1). Additionally, many sites are located in nature reserves where no species protection

Table 1.

Species protection zones of *Lobaria pulmonaria* in the forest districts of the Białowieża Forest (data: Regional Directorate of State Forests in Białystok, 31/12/2021)

Forest District	Number of species protection zones	Number of stands	Area of protection zones [ha]
Białowieża	43	61	47.47
Browsk	37	129	310.18
Hajnówka	56	88	60.24
Total	136	278	417.89

zones are created. In the forest districts of the Regional Directorate of State Forests in Białystok, a total of 212 species protection zones are established on an area of approx. 719 ha (as of December 31, 2021).

Conclusions

- ✦ A new location of *L. pulmonaria* in the Białowieża Forest proves that the home apple tree *M. domestica* should be included among the phorophytes of the lungwort lichen. Until now, the lichen species has not been reported in the Polish literature on this tree species.
- ✦ Research and collected information confirm that despite the fact that the lungwort lichen is highly endangered or extinct in most of Poland, it finds good conditions in the Białowieża Forest and occurs there quite often.
- ✦ The location of phorophyte in an open space (mid-forest meadow) indicates that *L. pulmonaria* can persist and reproduce in moderately human-disturbed environment.
- ✦ The result of the study is the documentation of a wider ecological niche of the lungwort lichen, which indicates the need for further research and possible revision of the view on the ecological requirements and methods of species protection in Poland.

Authors' contributions

T.G. – research concept, field research, methodology, data analyses, manuscript preparation, review and editing; A.L.-G. – research concept, manuscript preparation, review and editing; M.W. – review and editing.

Conflict of interests

The authors declare no conflicts of interest.

Funding source

The research was financed from the authors' own funds.

References

- Błoński, F., 1888. Spis roślin skrytopłciowych zebranych w 1887 r. w Puszczy Białowieskiej. [List of cryptogamous plants collected in 1887 in the Białowieża Forest] [in Polish]. *Pamiętnik Fizjograficzny*, 8: 75-119.
- Brunialti, G., Frati, L., Ravera, S., 2015. Structural variables drive the distribution of the sensitive lichen *Lobaria pulmonaria* in Mediterranean old-growth forests. *Ecological Indicators*, 53: 37-42. DOI: <https://doi.org/10.1016/j.ecolind.2015.01.023>.
- Carlsson, R., Nilsson, K., 2009. Status of the red-listed lichen *Lobaria pulmonaria* on the Åland Islands, SW Finland. *Annales Botanici Fennici*, 46: 549-554.
- Cieślński, S., 2003. Atlas rozmieszczenia porostów (Lichenes) w Polsce północno-wschodniej. [Atlas of the distribution of lichens in north-eastern Poland] [in Polish]. *Phytocoenosis*, 15 (N.S.), *Supplementum Cartographiae Geobotanicae*: 151-426.

- Cieślński, S., 2010. Wykaz gatunków porostów (grzybów zlichenizowanych) Puszczy Białowieskiej (NE Polska). [List of lichen species (lichen fungi) of the Białowieża Forest (NE Poland)] [in Polish]. *Parki Narodowe i Rezerваты Przyrody*, 29 (2): 3-39.
- Cieślński, S., Czyżewska, K., 1997. Lichenes. In: J.B. Faliński, W. Mułenko, eds. *Cryptogamous plants in the forest communities of Białowieża National Park. Ecological Atlas (Project CRYPTO 4). Phytocoenosis*, 9 (N.S.), *Supplementum Cartographiae Geobotanicae*, 7: 123-163.
- Cieślński, S., Czyżewska, K., 2003. Porosty Puszczy Białowieskiej na tle innych kompleksów leśnych w północno-wschodniej Polsce. [Lichens of the Białowieża Forest in comparison to other forest complexes in north-eastern Poland] [in Polish]. *Kosmos*, 4: 443-462.
- Cieślński, S., Czyżewska, K., Fabiszewski, J., 1986. Czerwona lista porostów zagrożonych w Polsce. [Red list of endangered lichens in Poland]. In: K. Zarzycki, W. Wojewoda, eds. *Lista roślin wymierających i zagrożonych w Polsce* [in Polish]. Warszawa: PWN, pp. 83-107.
- Cieślński, S., Czyżewska, K., Fabiszewski, J., 1992. Czerwona lista porostów zagrożonych w Polsce. [Red list of endangered lichens in Poland]. In: K. Zarzycki, W. Wojewoda, Z. Heinrich, eds. *Lista roślin wymierających i zagrożonych w Polsce*. [in Polish]. Kraków: W. Szafer Institute of Botany, Polish Academy of Sciences, pp. 57-74.
- Cieślński, S., Czyżewska, K., Fabiszewski, J., 2003. Czerwona lista porostów zagrożonych w Polsce. [Red list of endangered lichens in Poland]. In: K. Zarzycki, W. Wojewoda, eds. *Lista roślin wymierających i zagrożonych w Polsce*. [in Polish]. Kraków: W. Szafer Institute of Botany, Polish Academy of Sciences, pp. 57-74.
- Cieślński, S., Czyżewska, K., Fabiszewski, J., 2006. Red list of the lichens in Poland. In: Z. Mirek, K. Zarzycki, W. Wojewoda, Z. Szczęga, eds. *Red List of Plants and Fungi in Poland*. Kraków: W. Szafer Institute of Botany, Polish Academy of Sciences, pp. 71-90.
- Cieślński, S., Czyżewska, K., Faliński, J.B., Klama, H., Mułenko, W., Żarnowiec, J., 1996. Relicts of the primeval (virgin) forest. Relict phenomena. In: J.B. Faliński, W. Mułenko, eds. *Cryptogamous plants in the forest communities of Białowieża National Park (Project CRYPTO 3) Phytocoenosis*, 8 (N.S.) *Archivum Geobotanicum*, 6: 197-216.
- Cieślński, S., Tobolewski, Z., 1988. Porosty (Lichenes) Puszczy Białowieskiej i jej zachodniego przedpola. [Lichenes of the Białowieża Forest and its western foreground, in Polish]. *Phytocoenosis* 1 [N.S.], *Supplementum Cartographiae Geobotanicae*, 1: 1-216.
- Czyżewska, K., Cieślński, S., 2003. Czerwona lista porostów zagrożonych w Puszczy Białowieskiej [Red list of endangered lichens in the Białowieża Forest] [in Polish]. *Monographiae Botanicae*, 91: 107-119.
- Czyżewska, K., Kukwa, M., 2009. Lichenicolous fungi of Poland. A catalogue and key to species. In: Z. Mirek, ed. *Biodiversity of Poland, vol. 11*. Kraków: W. Szafer Institute of Botany, Polish Academy of Sciences, pp. 1-133.
- DGLP, 2016. O ochronie granicznika płucnika. [On the protection of the lungwort lichen.] [in Polish] Warszawa: Dyrekcja Generalna Lasów Państwowych. Available from <https://www.lasy.gov.pl/pl/informacje/aktualnosci/O-ochronie-granicznika-plucnika> [accessed: 30.06.2022].
- Faliński, J.B., 1986. Vegetation dynamics in temperate lowland primeval forests. *Ecological studies in Białowieża Forest. Geobotany*, 8: 1-537.
- Fałtynowicz, W., 2003. The lichens, lichenicolous and allied fungi of Poland – an annotated checklist. Kraków: W. Szafer Institute of Botany, Polish Academy of Sciences, 435 pp.
- Fałtynowicz, W., 2011. Ochrona granicznika płucnika *Lobaria pulmonaria* (L.) Hoffm. [Protection of the lungwort lichen *Lobaria pulmonaria* (L.) Hoffm.] [in Polish]. A guide for employees of National Parks. Available from https://www.wigry.org.pl/inf_i_rozw/budowa_por/por3_5.htm [accessed: 30.06.2022].
- Fałtynowicz, W., 2012. Porosty w lasach. Przewodnik terenowy dla leśników i taksatorów. [Lichens in forests. Field guide for foresters and valuers] [in Polish]. Warszawa: Centrum Informacyjne Lasów Państwowych, 214 pp.
- Fałtynowicz, W., 2021. Jaka ma być ochrona gatunkowa? Część I. Ochrona gatunkowa porostów, czyli co tak naprawdę chronimy? [What the species protection should be? Part I. Species protection of lichens, or what are we really protecting?] [in Polish]. *Wiadomości Botaniczne*, 65: 1-41. DOI: <http://doi.org/10.5586/wb.653>.
- Fałtynowicz, W., Kossowska, M., 2016. The lichens of Poland. A fourth checklist. *Acta Botanica Silesiaca, Monographiae*, 8: 1-122.
- Guzow-Krzemińska, B., Czarnota, P., Łubek, A., Kukwa, M., 2016. *Micarea soralfera* sp. nov., a new sorediate species in the *M. prasina* group. *Lichenologist*, 48 (3): 161-169. DOI: <http://doi.org/10.1017/S0024282916000050>.
- Holeksa, J., 1998. Rozpad drzewostanu i odnowienie świerka a struktura i dynamika karpaccyjskiego boru górnoregłowego. [Breakdown of tree stand and spruce regeneration versus structure and dynamics of a Carpathian subalpine spruce forest.] [in Polish] *Monographiae Botanicae*, 82: 209 pp.
- Jürjado, I., Liira, J. 2010. Threatened forest lichen *Lobaria pulmonaria* – its past, present and future in Estonia. *Forestry Studies / Metsanduslikud Uurimused*, 53: 15-24. DOI: <https://doi.org/10.2478/v10132-011-0086-6>.
- Karcov, G., 1903. Białowieżskaja Puszcza 1382-1902 – historia, położenie geograficzne i klimat, fauna, polowania carskie. Sankt Petersburg: Instytut Artystyczny Marksa, 414 pp.
- Kościelniak, R., 2008. Znaczenie lasów o charakterze pierwotnym i naturalnym dla zachowania różnorodności gatunkowej porostów w Bieszczadach. [Importance of primeval and natural forests for the preservation of species diversity of lichens in the Bieszczady] [in Polish]. *Roczniki Bieszczadzkie*, 6: 67-76.

- Krawiec, F., 1938. Materiały do flory porostów północno-wschodniej Polski. [Materials for lichen flora of north-eastern Poland] [in Polish]. *Reports of the Physiographic Commission of the Polish Academy of Arts and Sciences*, 71: 65-82.
- Kukwa, M., Łubek, A., Szymczyk, R., Zalewska, A., 2012a. Seven lichen species new to Poland. *Mycotaxon*, 120: 105-118. DOI: <https://doi.org/10.5248/120.105>.
- Kukwa, M., Pietnoczko, M., Czyżewska, K., 2012b. The lichen family Parmeliaceae in Poland II. The genus *Cetrelia*. *Acta Societatis Botanicorum Poloniae*, 81 (1): 43-52. DOI: <https://doi.org/10.5586/asbp.2012.007>.
- Lecewicz, W., 1954. Porosty Białowieży. [Lichens of Białowieża] [in Polish]. *Fragmenta Floristica et Geobotanica*, 1 (2): 38-47.
- Lõhmus, P., Marmor, L., Jürjado, I., Suija, A., Oja, E., Degtjarenko, P., Randlane, T., 2019. Red List of Estonian lichens: revision in 2019. *Folia Cryptogamica Estonica*, 56: 63-76. DOI: <https://doi.org/10.12697/fce.2019.56.07>.
- Łubek, A., Jaroszewicz, B., 2012. New, rare and noteworthy species of lichens and lichenicolous fungi from Białowieża Forest. *Polish Journal of Natural Sciences*, 27: 275-287.
- Łubek, A., Kukwa, M., 2016. Grzyby naporostowe w zbiorowiskach leśnych Białowieżskiego Parku Narodowego. [Algae fungi in the forest communities of the Białowieża National Park]. In: E. Szczuka, G. Szymczak, M. Śmigąła, R. Marciniak, eds. *Botanika – tradycja i nowoczesność*. [Botany – tradition and modernity]. Abstracts of papers and posters of the 57th Congress of the Polish Botanical Society, Lublin 27 June – 3 July 2016 Lublin: Towarzystwo Wydawnictw Naukowych LIBROPOLIS, pp. 205-206.
- Matwiejuk, A., Bohdan, A., 2013. Plechy *Lobaria pulmonaria* z apotecjami w Puszczy Białowieżskiej. [Thalli of *Lobaria pulmonaria* with apothecia in the Białowieża Primeval Forest] [in Polish]. *Chrońmy Przyrodę Ojczyzny*, 69 (6): 522-529.
- Matwiejuk, A., Zbyryt, A., 2013. Nowe stanowisko *Lobaria pulmonaria* (Stictaceae) z apotecjami w Polsce. [A new stand of *Lobaria pulmonaria* (Stictaceae) with apothecia in Poland] [in Polish]. *Fragmenta Floristica et Geobotanica Polonica*, 20 (1): 154-158.
- Olczak, H., Krasnodębski, D., Samojlik, T., Jędrzejewska, B., 2018. Osada kultury ceramiki kreskowanej z produkcją żelaza na Polanie Berezowo w Puszczy Białowieżskiej. [An iron producing settlement of the stroked pottery culture at the Berezowo Clearing in the Białowieża Forest] [in Polish]. *Wiadomości Archeologiczne*, 69: 149-175.
- Pišút, I., Guttová, A., Lackovičová, A., Lisická, E., 2001. Červený zoznam lišajníkov Slovenska (December 2001). [Red list of lichens of Slovakia (December 2001)]. In: D. Baláž, K. Marhold, P. Urban, eds. *Červený zoznam rastlín a živočíchov Slovenska. Ochrana Prírody, Suplement*, 20: 23-30.
- Rozporządzenie, 2014. Rozporządzenie Ministra Środowiska z dnia 9 października 2014 r. w sprawie ochrony gatunkowej grzybów. Dz.U. 2014, poz. 1408.
- Rydzak, J., 1957. Wpływ małych miast na florę porostów. Część IV. Lubelszczyzna – Kieleckie – Podlaskie – Puławy – Busko – Siedlce – Białowieża. [The influence of small towns on the lichen flora. Part IV. Lubelszczyzna – Kieleckie – Podlaskie – Puławy – Busko – Siedlce – Białowieża] [in Polish]. *Annales Universitatis Mariae Curie Skłodowska, Sectio C, Biologia*, 10 (14): 321-398.
- Rydzak, J., 1961. Tree lichens in the forest communities of the Białowieża National Park. *Annales Universitatis Mariae Curie-Skłodowska, Sectio C, Biologia*, 16 (2): 17-47.
- Ryś, A., 2005. Granicznik płucnik *Lobaria pulmonaria* w Lasach Państwowych i jego ochrona. [*Lobaria pulmonaria* in the State Forests and its protection] [in Polish]. Olsztyn: Studio AVALON, 27 pp.
- Ryś, A., 2007. Granicznik płucnik *Lobaria pulmonaria* i jego ochrona w Lasach Państwowych. [*Lobaria pulmonaria* in the State Forests and its protection] [in Polish]. *Studia i Materiały Centrum Edukacji Przyrodniczo-Leśnej*, 9 (2-3): 288-302.
- Samojlik, T., 2007. Antropogenne przemiany środowiska Puszczy Białowieżskiej do końca XVIII wieku. [Anthropogenic changes in the environment of the Białowieża Forest until the end of the 18th century] [in Polish]. Typescript of doctoral dissertation at the Mammal Research Institute of the Polish Academy of Sciences, Białowieża – Kraków, 108 pp.
- Samojlik, T., Jędrzejewska, B., 2004. Użytkowanie Puszczy Białowieżskiej w czasach Jagiellonów i jego ślady we współczesnym środowisku leśnym. [Utilization of Białowieża Forest in the times of Jagiellonian dynasty and its traces in the contemporary forest environment] [in Polish]. *Sylvan*, 148 (11): 37-50. DOI: <https://doi.org/10.26202/sylvan.2004062>.
- Scheidegger, C., Frey, B., Walser, J.C., 1998. Reintroduction and augmentation of populations of the endangered *Lobaria pulmonaria*: methods and concepts. In: S. Kondratyuk, B. Coppins, eds. *Lobariion lichens as indicators of the primeval forests of the Eastern Carpathians*. Darwin International Workshop, Kostrino, pp.33-52.
- Scheidegger, C., Werth, S., 2009. Conservation strategies for lichens: insights from population biology. *Fungal Biology Reviews*, 23: 55-66. DOI: <https://doi.org/10.1016/j.fbr.2009.10.003>.
- Siebel, H.N., Aptroot, A., Dirkse, G.M., van Dobben, H.F., van Melick, H.M.H., Touw, A., 1992. Rode Lijst van in Nederland verdwenen en bedreigde mossen en korstmossen. *Gorteria*, 18: pp. 1-20.
- Tobolewski, Z., Kupezyk, B., 1976. Porosty (Lichenes). 3. Atlas rozmieszczenia roślin zarodnikowych w Polsce. [3. Atlas of the distribution of spore plants in Poland] [in Polish] series III. Warszawa-Poznań: PWN, 25 pp.
- Wind, P., Pihl, S., 2010. The Danish Red List. The National Environmental Research Institute, Aarhus University. 7 pp.

- Wolseley, P., James, P., 2000. Factors affecting changes in species of *Lobaria* in sites across Britain 1986-1998. *Forest, Snow and Landscape Research*, 75: 319-338.
- Wołkowycki, M., 2008. Inwentaryzacja stanowisk granicznika płucnika *Lobaria pulmonaria* na terenie Nadleśnictwa Hajnówka. [Inventory of the positions of *Lobaria pulmonaria* in the Hajnówka Forest District] [in Polish]. Manuscript, Sacharewo.

STRESZCZENIE

Pierwsze stanowisko granicznika płucnika *Lobaria pulmonaria* (L.) Hoffm. na jabłoni domowej *Malus domestica* Borkh. w Puszczy Białowieskiej

Puszcza Białowieska, ze względu na wyjątkowy charakter kompleksu, wyróżnia się obecnością najlepiej zachowanych na polskim niżu zbiorowisk leśnych ze stosunkowo dobrze poznaną biotą porostów. Danych dostarczyły liczne badania, których początki sięgają XIX wieku. Porosty należą do królestwa grzybów i są grupą organizmów o bardzo dużym znaczeniu dla środowiska przyrodniczego. Jednocześnie są najbardziej wrażliwe na współczesne przemiany antropogeniczne środowisk przyrodniczych. Wiele gatunków występujących w Polsce jest zagrożonych wymarciem.

Jednym z flagowych gatunków porostów jest granicznik płucnik *Lobaria pulmonaria* (L.) Hoffm. To „ikona” ochrony porostów w kraju, ze względu na swoją urodę, łatwość zaobserwowania plech i bezdyskusyjną identyfikację. W nadleśnictwach Puszczy Białowieskiej (Białowieża, Browsk, Hajnówka) ustanowionych jest obecnie 136 stref ochrony gatunkowej o łącznej powierzchni około 418 ha, na których znajduje się 278 stanowisk granicznika płucnika (tab. 1).

Nowe stanowisko stwierdzone na terenie Nadleśnictwa Białowieża dowodzi, że do forofitów granicznika płucnika należy dodać także jabłoń domową *Malus domestica* Borkh. Do tej pory porost nie był podawany w krajowej literaturze na tym gatunku drzewa. Rośnie on na korze drzew, głównie liściastych, przede wszystkim na klonie (w tym na jaworze), grabie, buku, jesionie, dębach (szypułkowym i bezszypułkowym) oraz lipach (drobnolistnej i szerokolistnej). Znacznie rzadziej podłożem jest osłza, brzoza, osika, wierzby, wiąz i jarzębina, wyjątkowo notowano go na korze drzew iglastych (świerk, jodła, sosna).

Oprócz gatunku drzewa, na którym został stwierdzony, nowe stanowisko porostu zadziwia także swoją lokalizacją. Jabłoń rośnie na otwartej przestrzeni, dawnym poletku łowieckim, obecnie śródlęśnej łące wykaszanej w ramach planu ochrony lub programów ochrony gatunkowej. Stanowisko granicznika płucnika na jabłoni domowej znajduje się na terenie rezerwatu przyrody Podcerkwa i nosi nazwę Polana Berezowo (ryc. 1). Śródlęsna polana ma powierzchnię około 2,5 ha i kształt odwróconej litery L. We wschodniej części rośnie mocno rozłożysty dąb, co świadczy o tym, że miejsce to jest odsłonięte od co najmniej 150 lat. Brzegi polany wytyczają drzewa o wymiarach pomnikowych.

Jabłoń rośnie w zachodniej części polany, około 20 m od zachodniej ściany lasu, około 40 m od ściany południowej oraz około 25 m od ściany północnej (ryc. 2). Plecha porostów ma ekspozycję północno-zachodnią. Największa plecha, o wielkości około 17 cm, znajduje się na wysokości około 2 m (ryc. 3). Na drzewie stwierdzono ponadto kilka mniejszych plech, o wielkości od 2 do 10 cm, zlokalizowanych do wysokości około 3,5 m.

Badania i zebrane informacje potwierdzają, że pomimo iż granicznik płucnik jest gatunkiem porostu silnie zagrożonym lub wymarłym na większości terytorium Polski, to w Puszczy Biało-

wieskiej znajduje dobre warunki i występuje tam dosyć często. Efektem przeprowadzonych badań jest udokumentowanie szerszej niszy ekologicznej granicznika płucnika, co wskazuje na potrzebę dalszych badań i ewentualnego zrewidowania poglądu na temat wymagań ekologicznych i sposobów ochrony gatunku w Polsce.