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LICHENS OF THE PARYŻ NATURE RESERVE (CIECHANÓW UPLAND, POLAND)

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A b s t r a c t

This paper presents the first data on the lichen biota of the Paryż Nature Reserve, established in 2025 as part of the "100 Reserves for the 100th Anniversary of the State Forests" initiative. The study was based on field investigations conducted in 2017 in an old-growth pine-oak forest area previously designated as an in situ forest genetic conservation area. A total of 63 lichen species and one non-lichenized saprobic fungus were recorded. Two legally protected species were identified: *Chrysothrix candelaris* (strict protection) and *Hypogymnia tubulosa* (partial protection). Twelve species are included in the Polish Red List of lichens, representing the following threat categories: CR (1 species), EN (2), VU (2), LC (1), and NT (6). Three taxa, *Chrysothrix candelaris*, *Fellhanera gyrophorica*, and *Microcalicium disseminatum* are regarded as indicators of lowland old-growth forests in Poland. In addition, several species that are widespread nationally but rarely recorded in managed forests were found. Until recently, the North Mazovian Lowland remained poorly studied from a lichenological perspective, and the results presented here demonstrate that intensified surveys in this region may significantly improve knowledge of the distribution ranges and habitat requirements of rare and insufficiently known lichen species in Poland.

Introduction

Studies of lichen diversity within a given area provide not only fundamental data on the distribution of individual species and their habitat preferences, but also valuable insights into local bioecological conditions. Due to their specific biology (NASH 2008a), lichens are particularly sensitive to a wide range of anthropogenic pressures (CIEŚLIŃSKI and CZYŻEWSKA 1992, KANYUNGULU and FARKAS 2026). In addition to air pollution (BATES 2004, NASH 2008b), lichens are strongly influenced by human activities such as agriculture (LOPPI and DE DOMINICIS 1996, RUOSS 1999, PAOLI et al.

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2006, ZARABSKA-BOŻEJEWICZ 2020), infrastructure development (BROWN 1996, MOTIEJŪNAITĖ and FAŁTYNOWICZ 2005), and intensive forestry (NASCIMBENE et al. 2013, BOCH et al. 2021, HUETTMANN and YOUNG 2022). Changes in land use result in habitat fragmentation and reduced availability of suitable substrates. In forested areas, the main effects of habitat fragmentation and isolation on lichens include changes in microclimate (edge effects), reduced population size and local extinctions, disrupted dispersal, decreased genetic diversity, loss of specialist species, and ecological debt (extinction debt) (BOUDREAULT et al. 2008, SCHEIDEGGER et al. 2012, LÄTTMAN et al. 2014, PYKÄLÄ 2019, ESSEEN et al. 2022, POTENZA et al. 2022, GHEZA et al. 2024, HÄMÄLÄINEN and FAHRIG 2024). At the same time, some species or species groups are among the most reliable bioindicators of forest quality or continuity (ROSE 1976, COPPINS and COPPINS 2002, CIEŚLIŃSKI et al. 1996, CZYŻEWSKA and CIEŚLIŃSKI 2003) as they are sessile, generally slow-growing, and highly specific to particular environmental conditions and substrates (GLOOR et al. 2024). Despite the widespread application of lichens in environmental assessment, the effectiveness of this group of organisms in monitoring ecological change depends on the availability of reliable and well-documented baseline data (SEAWARD 2004, GIORDANI and BRUNIALTI 2015). Such data remain unavailable for many areas or are incomplete or outdated, which is particularly problematic in the case of nature reserves. One of the principal objectives of reserve-based conservation is the preservation of biological diversity, which cannot be achieved without prior identification and assessment of the species resources that are, by definition, subject to protection (Ustawa z 16 kwietnia 2004… Dz.U. 2004, nr 92, poz. 880).

In Poland, more than 100 new nature reserves were established in the past year under the initiative *100 Reserves for the 100th Anniversary of the State Forests*, representing an unprecedented expansion of the protected area network. The Paryż Nature Reserve is one of four reserves created under this programme in the Mazowieckie Voivodeship and the second reserve designated within the Płońsk Forest District, alongside the Pieńki Rzewińskie Nature Reserve. Consequently, the total number of nature reserves within the district has increased to four; the Dziektarzewo and Noskowo Nature Reserves were established earlier, in 1964 and 1977, respectively.

The aim of the present study is to provide the first lichenological inventory of the area currently protected as the Paryż Nature Reserve, thereby supplying baseline data essential for future monitoring and management of this newly established protected area.

Study area

The Paryż Nature Reserve was established by an ordinance of the Regional Director for Environmental Protection in Warsaw dated 31 March 2025. It is located in Płońsk County, Sochocin Municipality, approximately 1 km north of the village of Zawady B. According to the physico-geographical regionalization of Poland (SOLON et al. 2018), the reserve is located within the North Mazovian Lowland, in the western part of the Ciechanów Upland. In the ATPOL grid system (ZAJĄC 1978), used for presenting the distribution of lichens in Poland (CIEŚLIŃSKI and FAŁTYNOWICZ 1993), the area is situated in grid square Ce63.

Under the above-mentioned ordinance, forest compartments 145 a, b, c, d, f and g of the Płońsk Forest District (Paryż Forest Range), with a total area of 44.16 ha, were placed under protection. The objective of protection is "the preservation of a fragment of oak-hornbeam forests constituting a valuable element of the landscape of the Płońsk Upland". Based on its primary conservation target, the reserve was classified as a phytocoenotic reserve (subtype: forest communities) and, in terms of its main ecosystem type, as a forest reserve (subtype: lowland mixed forests) (CRFOP 2026). Within the reserve, fresh mixed forest habitats (LMŚw) predominate, supporting a pine-oak tree stand up to 184 years old, with admixtures of hornbeam, lime, elm, black alder and European aspen. From a phytosociological perspective, these communities have been classified as subcontinental oak-hornbeam forest *Tilio-Carpinetum betuli* and continental mixed coniferous forest *Querco roboris-Pinetum* (Figure 1). Small fragments of the reserve are also



Fig. 1. A fragment of the pine-oak stand in forest compartment 145b

occupied by secondary forest communities with a notable share of Scots pine (BDOL 2026). A buffer zone covering 347.76 ha has been designated around the reserve. It consists mainly of pine stands aged 48–84 years, growing on similar fresh mixed forest habitats. Prior to the establishment of the reserve, part of its present area had already been protected as an in situ conservation area (Powierzchnia Zachowawcza in situ), with the Scots pine population as the object of protection. This area was established under the Programme for the Conservation of Forest Genetic Resources and Selective Breeding of Forest Trees in Poland (MATRAS 2013) and comprised forest compartments 145b and 154c, with a total area of 20.52 ha.

Material and Methods

Field studies were conducted in April 2017 within the conservation area. A systematic walk-through survey method was applied, involving thorough searches for lichen species across the entire study area, in all potential habitats and on all available substrates. Species that could be reliably identified in the field were recorded without collecting reference specimens. In other cases, small fragments of thalli were collected for detailed taxonomic analyses under laboratory conditions. During the identification of the collected material, particularly sterile crustose lichens, standard morphological and anatomical analyses and spot tests were supplemented with thin-layer chromatography (TLC), enabling the identification of secondary metabolites of lichen mycobionts (ORANGE et al. 2001, KUBIAK and KUKWA 2011). The preserved herbarium material was deposited in the herbarium of the Department of Microbiology and Mycology, University of Warmia and Mazury in Olsztyn. Taxonomic nomenclature follows FAŁTYNOWICZ et al. (2024). In the list of recorded species, taxa are arranged alphabetically. For each taxon, the colonised substrate is given, as well as information on species status, including legal protection, threat category (according to the national Red List, CIEŚLIŃSKI et al. 2006), and bioindicator value in the assessment of lowland old-growth forests in Poland (CZYŻEWSKA and CIEŚLIŃSKI 2003).

Results and Discussion

A total of 63 lichen species and one non-lichenized saprobic fungus, *Microcalicium disseminatum*, traditionally included in lichen inventories, were recorded within the reserve (Table 1). Considering the relatively small area of the reserve and the characteristics of the surrounding forests, this

Table 1

A list of lichen species recorded in the Paryż Nature Reserve

Species	Substrates	Conservation value
1	2	3
Agonimia repleta Czarnota & Coppins	Qr	–
Amandinea punctata (Hoffm.) Coppins & Scheid.	Qr	–
Anisomeridium polypori (Ellis & Everh.) M.E. Barr	Pt, Qr	–
Arthonia radiata (Pers.) Ach.	Cb	–
Bacidina modesta (Zwackh ex Vain.) S. Ekman	Cb, Tc	–
Biatora efflorescens (Hedl.) Räsänen	Cb	VU
Buellia griseovirens (Turner & Borrer ex Sm.) Almb.	Cb	–
Chaenotheca ferruginea (Turner ex Sm.) Mig.	Qr, Tc, Ps	–
Chaenotheca furfuracea (L.) Tibell	Qr,	NT
Chaenotheca trichialis (Ach.) Th. Fr.	Bp	NT
Chaenotheca xyloxena Nádv.	wd;	VU
Chrysothrix candelaris (L.) J.R. Laundon	Qr	SP, CR, Ind.
Cladonia chlorophaea (Flörke ex Sommerf.) Spreng	Qr	–
Cladonia coniocraea (Flörke) Spreng.	Cb, Tc, Ps, Pt, wd	–
Cladonia digitata (L.) Hoffm.	Ps, wd	–
Cladonia fimbriata (L.) Fr.	Qr	–
Coenogonium pineti (Schrad.) Lucking & Lumbsch	Qr, Ps, Tc	–
Diarthonis spadicea (Leight.) Frisch, Ertz, Coppins & P.F. Cannon	Qr	–
Evernia prunastri (L.) Ach.	Qr	NT
Fellhanera gyrophorica Sérus., Coppins, Diederich & Scheid.	Qr	LC, Ind.
Fuscidea pusilla Tønsberg	Cb	–
Graphis scripta (L.) Ach.	Cb	NT
Hypocenomyce scalaris (Ach.) M. Choisy	Ps	–
Hypogymnia physodes (L.) Nyl.	Qr	–
Hypogymnia tubulosa (Schaer.) Hav.	Qr	PP, NT
Lecanora argentata (Ach.) Malme	Cb	–
Lecanora carpinea (L.) Vain.	Cb	–
Lecanora expallens Ach.	Qr	–
Lecanora pulicaris (Pers.) Ach.	Cb	–
Lecanora stanislai Guzow-Krzem., Łubek, Malícek & Kukwa	Qr	–
Lecanora thysanophora R.C. Harris	Cb	–
Lepra albescens (Huds.) Hafellner	Cb	–

cd. Tabeli 1

1	2	3
Lepra amara (Ach.) Hafellner	Cb, Qr	–
Lepraria elobata Tønsberg	Cb	–
Lepraria finkii (B. de Lesd. ex Hue) R.C. Harris	Qr, Tc	–
Lepraria incana (L.) Ach.	Bp, Cb, Pt, Ps, Qr, Tc	–
Lepraria jackii Tønsberg	Ps	–
Melanelixia glabratula (Lamy) Sandler & Arup	Qr, Tc	–
Melanohalea exasperatula (Nyl.) O. Blanco et al.	Qr	–
Micarea soralifera Guzow-Krzem., Czarnota, Łubek & Kukwa	Qr, wd	–
Micarea tomentosa Czarnota & Coppins	wd	–
#*Microcalicium disseminatum* (Ach.) Vain.	Qr	Ind.
Parmelia sulcata Taylor	Qr	–
Pertusaria coccodes (Ach.) Nyl.	Cb	NT
Phaeophyscia endophoenicea (Harm.) Moberg	Cb	EN
Phaeophyscia orbicularis (Neck.) Moberg	Cb	–
Phlyctis argena (Ach.) Flot.	Cb, Qr	–
Physcia adscendens (Fr.) H. Olivier	Qr	–
Physcia stellaris (L.) Nyl.	Qr	–
Physcia tenella (Scop.) DC.	Qr	–
Placynthiella dasea (Stirt.) Tønsberg	Qr	–
Platismatia glauca (L.) W.L. Culb. & C.F. Culb.	Qr, Cb	–
Polycauliona polycarpa (Hoffm.) Frödén, Arup & Søchting	Qr	–
Porina aenea (Wallr.) Zahlbr.	Cb	–
Pseudevernia furfuracea (L.) Zopf	Qr	–
Rinodina degeliana Coppins	Qr	–
Rinodina efflorescens Malme	Cb	–
Ropalospora viridis (Tønsberg) Tønsberg	Cb	–
Scoliciosporum sarothamni (Vain.) Vězda	Qr	–
Toniniopsis separabilis (Nyl.) Gerasimova & A. Beck	Cb	EN
Trapeliopsis flexuosa (Fr.) Coppins & P. James	Pt, wd	–
Trapeliopsis granulosa (Hoffm.) Lumbsch	Qr, wd	–
Xanthoria parietina (L.) Th. Fr.	Pt, Qr	–
Xylospora caradocensis (Nyl.) Bendiksby & Timdal	Ps	–

Explanations: # – non-lichenized saprobic fungus; Bp – *Betula pendula*; Cb – *Carpinus betulus*; Ps – *Pinus sylvestris*; Pt – *Populus tremula*; Qr – *Quercus* sp.; Tc – *Tilia cordata*; wd – wood; SP – Strict protection; PP – Partial protection; CR – Critically Endangered; EN – Endangered; VU – Vulnerable; LC – Least Concern; NT – Near Threatened; Ind. – Indicator of lowland old-growth forest.

level of species richness is relatively high. The surrounding forests are highly fragmented, predominantly privately owned and dominated by Scots pine across most habitats.

It should be emphasised that prior to the Second World War, forest cover in this area was considerably lower, and the forests of the present reserve were largely surrounded by arable land (MAPA 1937). At that time, they were privately owned by the Krasiński family entail estate based in Opinogóra, which operated between 1839 and 1944. During the Second World War, the local forests were heavily degraded as a result of exploitative forest management. After the war, following the transfer of larger forest complexes to the State Treasury (State Forests), restoration measures were undertaken and large-scale afforestation of former agricultural land was initiated. These afforestation efforts were carried out mainly using Scots pine, often without sufficient consideration of local habitat conditions. In this context, the presence of several nationally rare and threatened lichen species within the reserve is especially remarkable. Two legally protected species were recorded: *Chrysothrix candelaris* (strict protection) and *Hypogymnia tubulosa* (partial protection). Twelve species are included in the national Red List of lichens, representing the following threat categories:

– CR – 1 (*Chrysothrix candelaris*),
– EN – 2 (*Phaeophyscia endophoenicea, Toniniopsis separabilis*),
– VU – 2 (*Biatora efflorescens*, *Chaenotheca xyloxena*),
– LC – 1 (*Fellhanera gyrophorica*),
– NT – 6 (*Chaenotheca furfuracea*, *Ch. trichialis*, *Evernia prunastri*, *Graphis scripta*, *Hypogymnia tubulosa*, *Pertusaria coccodes*).

Chrysothrix candelaris, *Fellhanera gyrophorica*, and *Microcalicium disseminatum* are stenoecious species regarded as indicators of lowland old-growth forests in Poland (CZYŻEWSKA et al. 2003). In addition, several species that are relatively frequent and not threatened at the national scale but are typically absent from managed forests (FAŁTYNOWICZ et al. 2024) were recorded in the reserve, including *Agonimia repleta*, *Lecanora stanislai*, *L. thysanophora*, *Micarea tomentosa*, *Rinodina degeliana*, and *R. efflorescens*.

The highest lichen species richness within the reserve was recorded on oak trees. The positive role of oaks in shaping epiphytic lichen diversity in forest ecosystems is well documented (CIEŚLIŃSKI and TOBOLEWSKI 1988, KUBIAK and SUCHARZEWSKA 2018, KUBIAK 2020). The exceptional richness of oak-associated lichens results, among other factors, from the long lifespan of individual trees and their occurrence across a wide range of forest community types (DANIELEWICZ and PAWLACZYK 2006). This specificity is also reflected in the fact that oaks typically host the highest number of lichen species exclusive to this phorophyte among all studied tree species (CIEŚLIŃSKI and TOBOLEWSKI 1988, KUBIAK 2013). Hornbeam

also played an important role, reaching several decades of age and forming a second tree layer within the stand. This species was most frequently found together with crustose, moisture-demanding and shade-tolerant lichens, such as *Arthonia radiata*, *Biatora efflorescens*, *Graphis scripta*, *Lecanora thysanophora*, and *Porina aenea*.

A proper assessment of species diversity within a given area requires consideration of a broader spatial context as well as knowledge of the history of anthropogenic landscape transformations. At the national scale, the North Mazovian Lowland is among the regions with a relatively high degree of environmental transformation, with particularly intensive changes occurring over the last 100 years (PLIT 1996). According to the classification proposed by FALIŃSKI (1975), this area corresponds predominantly to degrees V–VI of vegetation synanthropisation on a seven-degree scale. Consequently, the synanthropisation of local vegetation is markedly higher than in the Masurian Lakeland to the north or the North Podlasie Lowland to the east (FALIŃSKI 2015) – regions regarded as one of the centres of lichen biodiversity in Poland (CIEŚLIŃSKI 2003). As a result, the expected species richness of analogous natural objects and vegetation types differs between these regions of Poland. In terms of total species number, the lichen biota of the Paryż Nature Reserve is clearly poorer than that of comparable sites in north-eastern Poland (KOLANKO 2009, KUBIAK 2011a, KUBIAK et al. 2017). However, it includes several particularly noteworthy species that are extremely rare in lowland areas outside this part of the country. These include *Fellhanera gyrophorica* and *Phaeophyscia endophoenicea*, which exhibit relatively distinct and spatially limited centres of distribution in Poland.

Fellhanera gyrophorica is primarily distributed in Central and Eastern Europe (GBIF Secretariat. 2026). In Poland, most known localities are concentrated in the northern and north-eastern regions, where the species inhabits extensive, well-preserved forest complexes. In the eastern part of its range, it occurs mainly on oaks and less frequently on hornbeams and limes within oak-hornbeam forests (KUBIAK 2011b), whereas in western regions it is most often recorded on beech bark in beech forests (KUKWA et al. 2025). Outside this core area, the species has been recorded from only a few localities in central Poland and, more recently, from two sites in the Gorce Mountains, where it was found on beech bark in beech forest communities (CZARNOTA and TANONA 2020). In Poland and Lithuania, *F. gyrophorica* is regarded as an indicator of old-growth primeval forests (MOTIEJŪNAITĖ et al. 2004).

Phaeophyscia endophoenicea is a typical forest lichen preferring natural forest communities from lowland to montane zones. It grows on various deciduous tree species and is occasionally found in old parks. The species typically colonises moss-covered bark or bark enriched with nutrients. In Europe, it is widely distributed but not common (MALÍČEK et al. 2026).

In Poland, the species was until recently known exclusively from southern uplands and lower montane areas (FAŁTYNOWICZ 2003); however, it has since been recorded in light oak-hornbeam forests and beech forests in northern Poland (KUBIAK 2010, 2024, SZYMCZYK 2020, SZYMCZYK et al. 2025).

Considering the distribution of these species in Poland (Figures 2–3), the particular role of the North Mazovian Lowland – and the Paryż Nature Reserve in particular – as a potential connecting area shaping their current distribution ranges becomes apparent. In this context, the North Mazovian Lowland represents a particularly important and promising research area. The region may substantially contribute to improving knowledge of the actual distribution ranges of certain lichen species, as well as to a better understanding of their sensitivity to varying degrees of anthropogenic environmental transformation across different parts of the country. The reserve is located in the immediate vicinity of the ecological corridor

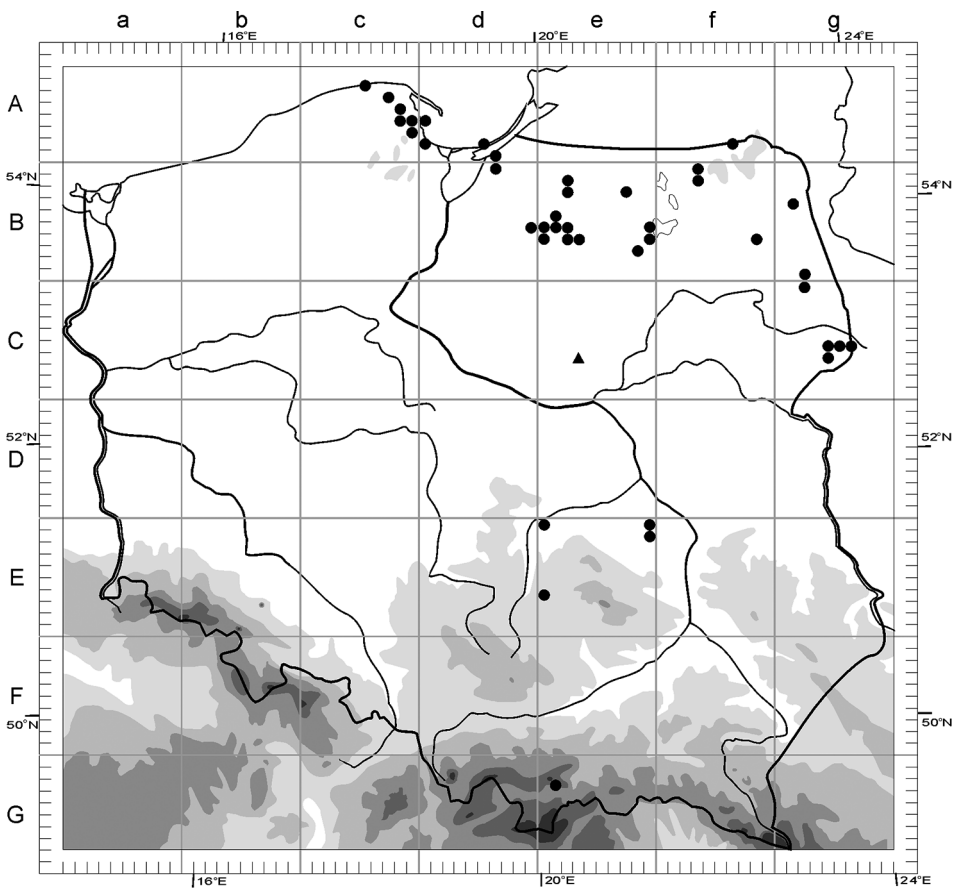


Fig. 2. Distribution of *Fellhanera gyrophorica* sites in Poland according to the ATPOL grid (● – known sites, ▲ – new site in the Paryż Nature Reserve)

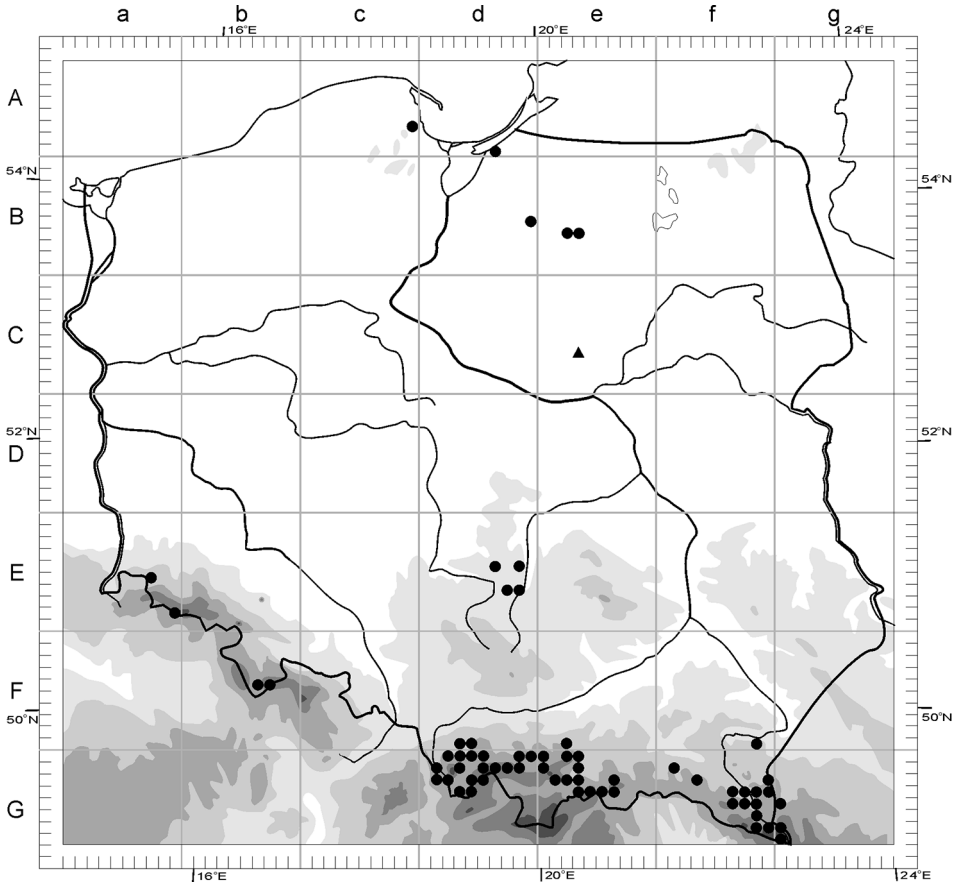


Fig. 3. Distribution of *Phaeophyscia endophoenicea* sites in Poland according to the ATPOL grid (● – known sites, ▲ – new site in the Paryż Nature Reserve)

of the Wkra River Valley (ECOLOGICAL CORRIDORS 2012). This corridor is of national importance and connects valuable natural areas within the Górzno-Lidzbark Landscape Park in the northwest with areas associated with the Vistula River valley in the southeast (STRZELECKI 2015). Unfortunately, despite the extension of corridor boundaries in 2012 compared to the 2005 version, the Paryż Nature Reserve was not included within its limits, which appears unjustified in light of the lichenological results presented here. The corridor should also encompass the second newly established reserve in the Płońsk Forest District, Pieńki Rzewińskie Nature Reserve, through which the corridor currently runs but covers only a small part of its area.

Conclusions

The results obtained, including the presence of several nationally rare and threatened lichen species, demonstrate the above-average natural value of the studied area and confirm the validity of establishing a nature reserve at this site. Nevertheless, further research on lichens is recommended. Such studies should cover areas of the reserve that have not yet been surveyed, as well as its buffer zone, and should also incorporate quantitative assessments of species occurrence. It is important to evaluate the current state of the local lichen assemblage in the context of its dynamic status. The assemblage may represent a remnant of a formerly more diverse assemblage that is currently declining. Alternatively, it may be in a phase of recovery following the cessation of certain negative factors, such as the establishment of an in situ conservation area and the reduction of air pollution. Finally, it is possible that the lichen assemblage is in a period of relative stagnation, in which the positive effects of improved air quality do not lead to an increase in species diversity due to specific habitat limitations. In this context, analysing the functional traits of lichens, including morphological, physiological, and reproductive traits such as growth form, photobiont type, and secondary metabolites (ELLIS et al. 2021), may prove especially useful. These traits influence species responses to environmental change and can help interpret patterns in species occurrence and sensitivity to anthropogenic pressures.

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