Contribution to the lichen biota of the Stawy Milickie nature reserve and its adjacent area (Lower Silesia, southwestern Poland)

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Abstract
The paper presents the results of lichenological investigations conducted in the eastern part of the Stawy Milickie nature reserve and its buffer zone (Barycz Valley, southwestern Poland). The study area is a famous waterfowl refuge, consisting of several fishpond complexes, together with adjacent forests, meadows, and villages. In total 72 lichen taxa were recorded, growing on bark and branches of trees and shrubs, stumps, wood, soil, and anthropogenic rock substrates (mortar, concrete, bricks, etc.). Six species, namely Evernia prunastri, Flavoparmelia caperata, Hypogymnia tubulosa, Parmelia tiliacea, Physconia distorta, and Pleurosticta acetabulum, are threatened in Poland. As represented by single young thalli, they indicate the recent improvement of environmental conditions. The lichen biota of the study area is typical for the lowland regions of western and southwestern Poland.

Keywords
lichens; lichenized fungi; species diversity; habitat groups; Barycz Valley

Introduction
In terms of lichenology Lower Silesia is very unequally recognized. The vast majority of publications concerning this region relates to its mountainous parts, namely the Sudety Mountains and their foreland. There is very little and incomplete information about the occurrence of lichens in the lowland part of the region. These “white spots” considerably impede research on the dynamics of lichen biota in the lowlands, which are exposed to significant anthropogenic pressure. Filling those gaps is particularly important due to the observed in many regions “great return” of epiphytes, after the almost complete extinction at the end of the twentieth century [1–4].

At the beginning of the studies on lichen biota in the lowland part of Lower Silesia the Stawy Milickie (Milicz Ponds) nature reserve was chosen. The aim of the study was to determine the lichen richness and diversity in the area with a large variety of potential habitats and relatively low anthropogenic impact (extensive fishery management and forestry). The results of the studies, in connection with the similar research conducted in other parts of the region, will be the basis for the further analysis of the lichen biota dynamics.

Study area
The study area is located in the northern part of Lower Silesia, approx. 50 km north of Wroclaw and 100 km south of Poznań, within the Dolina Baryczy Landscape Park.
Kaźmierska and Kossowska / Lichens of the Stawy Milickie nature reserve

(Fig. 1). Created in 1963, the Stawy Milickie nature reserve consists of five separate complexes of fish ponds: Stawno, Potasznia, Ruda Sułowska, Radziądz, and Jamnik, located on the eastern and western side of Milicz town, and adjacent fields, forests, and meadows. Nature reserve covers in total an area of 5324 ha. The main purpose of the reserve is to protect numerous species of rare mud and water birds for which the ponds are their natural habitat.

According to the classification by Kondracki [5] the area of the reserve lies within the macroregion Obniżenie Milicko-Głogowskie and consists the Kotlina Żmigrodzka, the Kotlina Milicka, and the Wzgórza Krośnickie, being a part of the Wal Trzebnicki.

The biggest complex of ponds in the reserve is the Stawno complex situated to the east of Milicz, which covers an area of 1629 ha. There are approx. 30 smaller and larger ponds, supplied by the rivers Barycz, Rybnica, and Prądnia and separated by dikes.

**Material and methods**

The study was conducted in the years 2014–2015 in the eastern part of the Stawy Milickie nature reserve (the Stawno complex), in selected villages in the buffer zone of the reserve: Ruda Milicka, Grabownica, Potasznia, Młodzianów, and Henrykowice, and in the forest complex between the villages Henrykowice, Borzynowo, and Wielgie Milickie (Fig. 2).

![Fig. 1](image1.png) Location of the Stawy Milickie nature reserve on the map of Poland (black circle).

![Fig. 2](image2.png) Study area. a Western part (the Stawno complex). b Eastern part (buffer zone with a forest complex).
The whole lichen biota of this area was analyzed and divided into habitat groups: epiphytic, epigeic, epixylic, and epilithic. Throughout the reserve, the research was carried out on a nature trail, selected dikes, and along the Barycz River on the stretch of approx. 2 km long. In the villages, we analyzed fences and walls of buildings (especially old and abandoned farms), roadside trees, wooden structures, etc. In the studied forest complex three research sectors (A, B, and C) were selected, differing in terms of location and habitat conditions. The distribution of the research sites is shown on Fig. 3 (Stawno complex in the western part of the investigated area) and Fig. 4 (eastern part of the investigated area). Descriptions of the sites are given in Tab. 1.

Fig. 3  Research sites in the Stawno complex of the Stawy Milickie nature reserve.

Fig. 4  Research sites in the buffer zone of the Stawy Milickie nature reserve and sectors (A, B, C) distinguished within the forest complex.
Lichens protected by law [6] and other easy to identify species were listed in the field without collection. In other cases small fragments of the thalli were collected for further detailed analysis in a laboratory.

The collected material was identified based on standard methods, using the stereoscopic and a light microscope. Lichens of the genus *Lepraria* were examined using thin layer chromatography (TLC) in accordance with the methods described by Orange et al. [7]. Nomenclature of the species follows Index Fungorum [8], Smith et al. [9], and Arup et al. [10]. All collected specimens were deposited in the lichen herbarium of the Department of Botany, University of Wrocław.

**Results**

**List of species**

In the investigated part of the Stawy Milickie nature reserve and its buffer zone 72 lichen species have been found (Tab. 2). Among them epiphytes definitely dominated (41 species). The share of lichens growing on wood (23 species) and rocks (20 species) in the analyzed lichen biota was much smaller. Terricolous lichens (nine species) were the least numerous habitat group and occurred almost only in the forest complex. Nearly one third of the recorded species were found in two or more types of habitat.

**Habitat preferences of lichen biota**

*Epiphytic lichens.* The differentiation of potential phorophytes for epiphytic lichens is huge in the study area. Within the Stawno complex there were tree stands consisting mainly of oak *Quercus robur*, poplar *Populus* spp., willow *Salix* spp. and elm *Ulmus* sp.; there was also a small area covered with alder carr *Ribo nigri-Abietum* [11]. In the analyzed forest complex, pine *Pinus sylvestris* prevailed, accompanied by *Q. robur*, birch *Betula pendula*, spruce *Picea abies*, and hornbeam *Carpinus betulus*. In the investigated villages deciduous trees dominated, namely: *Q. robur*, *B. pendula*, *C. betulus*, rowan *Sorbus aucuparia*, and lindens *Tilia* spp.

The lichen biota of particular phorophytes differed substantially (Fig. 5). The richest lichen vegetation was found to be connected with *Q. robur* (31 species), *Salix* spp. (16), *B. pendula* (9), and *P. sylvestris* (8). Among analyzed trees *Q. robur* was characterized by the richest and the most diverse lichen biota. Among the species found on trunks there were the only fruticose epiphytes of the study area: *Evernia prunastri* and *Pseudevernia furfuracea,*
Tab. 2  List of lichen species recorded in the Stawy Milickie nature reserve.

| Species                      | Sites and numbers of records | Substrate                        |
|------------------------------|------------------------------|----------------------------------|
| *Acarospora fuscata* (Nyl.) Arnold | 8(1)                        | S: tile                          |
| *A. smaragdula* (Wahlenb.) A. Massal. | 31(1)                      | S: brick                          |
| *Amandinea punctata* (Hoffm.) Coppins & Scheid. | 2(1), 5(1), 18(1), 23(1), 24(1), 26(1), 28(1), 31(2), 32(1), 33(6) | C: bark of *Ailurus glutinosus*, *Betula pendula*, *Quercus sp.*, *Salix sp.* |
| *Athallia holocarpa* (Hoffm.) Arup, Frödén & Søchting | 31(1)                      | C: bark of *Quercus sp.*          |
| *Calogaya decipiens* (Hoffm.) Arup, Frödén & Søchting | 5(1)                      | S: stone wall                     |
| *C. cfr. pusilla* (A. Massal.) Arup, Frödén & Søchting | 1(1)                      | S: concrete                       |
| *Candelaria concolor* (Dicks.) Stein | 16(1)                      | C: bark of *Quercus sp.*          |
| *Candelariella aurella* (Hoffm.) Zahlbr. | 4(1), 5(2), 31(1), 34(1) | C: bark of *Quercus sp.*          |
| *C. flexica* (Nyl.) Lettau | 3(1)                      | C: bark of *Quercus sp.*          |
| *C. xanthostigma* (Pers. ex Ach.) Lettau | 31(2)                      | C: bark of *Quercus sp.*, *Salix sp.* |
| *Cetraria islandica* (L.) Ach. | 11(1)                      | T: sandy soil                     |
| *Chaenotheca ferruginea* (Turner ex Sm.) Mig. | 3(1)                      | C: bark of *Quercus sp.*          |
| *Cladonia arbuscula* (Wallr.) Flot. | 9(3), 10(2), 11(5) | T: sandy soil                     |
| *C. cenotea* (Ach.) Schaer. | 11(3)                      | X: dead branches, stumps          |
| *C. chlorophaea* (Flörke ex Sommerf.) Spreng. | 9(5), 11(6), 32(1) | C: bark of *Pinus sylvestris*, *Quercus sp.* |
| *C. coniocraea* (Flörke) Spreng. | 11(5), 15(1), 19(1), 27(1) | X: stumps, logs, dead branches    |
| *C. deformis* (L.) Hoffm. | 9(2), 11(2) | T: sandy soil                     |
| *C. digitata* (L.) Hoffm. | 9(1), 11(2) | C: bark of *Pinus sylvestris*     |
| *C. floerkeana* (Fr.) Flörke | 9(1)                      | X: rotten stumps, logs, dead branches |
| *C. furcata* (Huds.) Schrad. | 9(5), 11(5) | T: sandy soil                     |
| *C. gracilis* (L.) Willd. | 9(3), 10(1), 11(4) | T: sandy soil                     |
| *C. macilenta* Hoffm. | 9(2), 10(1), 11(5) | X: rotten stumps, logs            |
| *C. ochrochlora* Flörke | 23(1)                      | X: rotten stump                   |
| *C. phyllophora* Hoffm. | 11(1)                      | X: rotten stump                   |
| *C. pyxidata* (L.) Hoffm. | 10(1), 11(1) | C: bark of *Betula pendula*       |
| *C. rangiferina* (L.) F.H. Wigg. | 9(2), 10(2), 11(3) | T: sandy soil                     |
| *C. subulata* (L.) F.H. Wigg. | 11(1)                      | X: rotten wood                    |
## Tab. 2  Continued

| Species                          | Sites and numbers of records | Substrate                                                                 |
|----------------------------------|-----------------------------|---------------------------------------------------------------------------|
| C. uncialis (L.) F.H. Wigg.      | 9(2), 11(2)                 | T: sandy soil                                                             |
| Dimerella pineti (Ach.) Lücking & Lumbsch | 10(1)                    | C: bark of Quercus sp.                                                    |
| Evernia prunastri (L.) Ach.      | 3(3), 4(1), 13(1), 16(7), 17(1), 30(1), 31(1), 32(1) | C: bark of Quercus sp.                                                   |
|                                  |                             | X: wooden handrail                                                        |
| Flavoparmelia caperata (L.) Hale | 3(2), 10(1)                 | C: bark of Betula pendula, Malus domestica, Pinus sylvestris              |
| Flavoplaca citrina (Hoffm.) Arup, Frödén & Søchting | 11(1), 33(1), 34(1) | S: concrete                                                               |
|                                  |                             | X: rotten wood                                                            |
| Hafellia disciformis (Fr.) Marbach & H. Mayrhofer | 2(1)                  | C: bark of Quercus sp.                                                    |
| Hypocenomyce scalaris (Ach. ex Lilj.) M. Choisy | 26(1),31(1), 9(1), 10(2), 11(2) | C: bark of Betula pendula, Pinus sylvestris, Salix sp.                   |
|                                  |                             | X: rotten stump                                                           |
| Hypogymnia physodes (L.) Nyl.    | 1(1), 2(1), 3(4), 9(6), 10(4), 11(10), 17(2), 22(1), 25(1), 30(1), 32(3), 33(2) | C: bark of Carpinus betulus, Fraxinus excelsior, Quercus sp., Salix sp., Sorbus aucuparia |
|                                  |                             | X: dead branches, wooden handrail                                          |
| H. tubulosa (Schaer.) Hav.       | 10(1)                       | C: bark of Pinus sylvestris                                               |
| Lecania cyrtella (Ach.) Th. Fr.  | 33(3)                       | C: bark of Populus sp., Salix sp.                                         |
|                                  |                             | X: dead twigs                                                             |
| Lecanora albescens (Hoffm.) Flörke | 1(1), 4(1), 5(1), 34(2) | S: concrete                                                               |
| L. cfr. cenisia Ach.             | 34(1)                       | S: bricks                                                                 |
| L. conizaeoides Nyl. in. Cromb.  | 4(1), 5(1), 9(1), 11(1), 18(2), 25(2), 30(1), 32(3), 33(8) | C: bark of Pinus sylvestris, Quercus sp., Salix sp.                      |
|                                  |                             | X: dead branches, wooden handrail                                          |
| L. dispersa (Pers.) Sommerf.     | 4(1), 5(1), 31(1), 32(2), 34(1) | C: bark of Quercus sp.                                                   |
|                                  |                             | S: concrete                                                               |
| L. saligna (Schrad.) Zahlbr.     | 18(1), 24(1), 28(1)         | C: bark of Betula pendula, Salix sp.                                      |
|                                  |                             | X: dead branches                                                          |
| Lecidella stigmataea (Ach.) Hertel & Leuckert | 32(1), 34(1) | S: concrete                                                               |
| Lepraria elobata Tønsberg        | 3(1), 7(1), 9(3), 10(2), 11(1), 14(1), 16(1), 23(1), 26(3), 30(1) | C: bark of Pinus sylvestris, Quercus sp.                                 |
| L. incana (L.) Ach.              | 7(1), 10(1)                 | C: bark of Quercus sp.                                                    |
| L. jackii Tønsberg               | 9(1), 10(1)                 | C: bark of Quercus sp.                                                    |
|                                  |                             | T: soil                                                                   |
| L. lobificans Nyl.               | 9(1), 10(2), 11(1), 23(1), 30(1) | C: bark of Betula pendula, Quercus sp.                                    |
| Melanohalea exasperatula (Nyl.) O. Blanco et al. | 31(1), 33(1) | C: bark of Quercus sp., Salix sp.                                         |
| Micarea prasina Fr. s. lat.      | 33(1)                       | X: dead branches                                                          |
| Species                        | Sites and numbers of records | Substrate                                                                 |
|-------------------------------|-----------------------------|---------------------------------------------------------------------------|
| *Parmelia sulcata* Taylor     | 1(1), 3(4), 5(1), 9(3), 11(1), 15(3), 18(2), 21(1), 25(3), 28(1), 31(2), 32(2), 33(12) | C: bark of *Malus domestica*, *Pinus sylvestris*, *Quercus* sp., *Salix* sp., *Ulmus* sp. |
| *Parmelia tilliacea* (Hoffm.) Hale | 3(1)                         | X: dead branches, wooden handrail                                         |
| *Parmeliopsis ambigua* (Wulfen) Nyl. | 4(1), 11(1)                  | X: dead branches, wooden handrail                                         |
| *Pheophyscia orbicularis* (Neck.) Moberg | 1(1), 4(1), 5(1), 6(1), 8(1), 16(1), 18(1), 25(1), 31(3), 32(3), 33(6) | C: bark of *Quercus* sp., *Salix* sp.                                    |
| *Physcia adscendens* H. Olivier | 1(1), 2(2), 3(2), 5(1), 9(1), 18(1), 23(1), 25(2), 31(2), 32(1), 33(16) | C: bark of *Betula pendula*, *Populus* sp., *Sambucus nigra*, *Quercus* sp., *Salix* sp. |
| *Ph. aipolia* (Ehrh. ex Humb.) Fürnr. | 3(1)                         | X: dead branches                                                          |
| *Ph. caesia* (Hoffm.) Fürnr.   | 1(1), 5(1), 8(1), 34(2)      | S: concrete, tile                                                        |
| *Ph. tenella* (Scop.) DC.      | 1(2), 2(2), 3(2), 5(1), 6(1), 8(1), 9(1), 15(1), 17(1), 18(3), 23(2), 24(1), 25(5), 28(1), 30(1), 31(3), 32(2), 33(11) | C: bark of *Betula pendula*, *Fraxinus excelsior*, *Populus* sp., *Quercus* sp., *Salix* sp., *Sambucus nigra* |
| *Physconia distorta* (With.) J.R. Laudon | 2(1), 31(1)                 | X: dead branches                                                          |
| *Ph. grisea* (Lam.) Poelt      | 31(2)                        | C: bark of *Populus* sp., *Quercus* sp.                                   |
| *Ph. enteroxantha* (Nyl.) Poelt | 33(1)                        | X: dead twig of *Salix* sp.                                              |
| *Pleurosticta acetabulum* (Neck.) Elix & Lumbsch | 4(1)                      | C: bark of *Quercus* sp.                                                |
| *Polycauliona candelaria* (L.) Frödén, Arup & Sochting | 1(2), 2(1), 5(1), 23(1), 31(3), 33(5) | C: bark of *Populus* sp., *Quercus* sp., *Salix* sp.                      |
| *P. polycarpa* (Hoffm.) Frödén, Arup & Sichting | 1(1), 33(2)                  | X: dead branches                                                          |
| *Protoparmeliopsis muralis* (Schreb.) M. Choisy | 4(1), 5(1), 25(1), 30(1), 34(1) | S: concrete, bricks, mortar                                              |
| *Pseudevernia furfuracea* (L.) Zopf | 3(3), 4(1), 9(1), 11(2)      | X: dead branches                                                          |
| *Rusavskia elegans* (Link) S. Y. Kondr. & Kärnefelt | 1(1), 5(1)                  | S: concrete, eternit                                                      |
| *Sarcogyne regularis* Körb.    | 1(1), 5(1), 25(1)            | S: concrete                                                               |
| *Scoliciosporum chlorococcum* (Graeve ex Stenh.) Vězda | 11(1)                      | X: dead branches                                                          |
| *Trapeliopsis flexuosa* (Fr.) Coppins & P. James | 3(1)                      | X: wooden handrail                                                        |
| *T. granulosa* (Hoffm.) Lumbsch | 11(1)                        | X: rotten stump                                                           |
The group of epiphytes in the research area stood out both in terms of the number of species and the diversity of morphological forms. Most of them were foliose lichens (approx. 44%). The proportion of crustose species was slightly lower (32%). In addition, fruticose (two species), leprose (4), and squamulose (1) lichens were recorded on trunks, as well as three Cladonia species on the bark in the basal part of trees.

Epixylic lichens. Potential substrates for epixylic lichens in the study area were both decaying wood in the forest (e.g., stumps, logs, and fallen branches) and all kinds of wooden structures (fences, bridges, walls, buildings, etc.). These objects were very common and often colonized by lichens.

Most of the 23 species found on dead wood were facultative epixylic lichens, growing also on other substrates, soil (especially the genus Cladonia), or tree trunks (e.g., Hypogymnia physodes, Lecanora conizaoides, Parmelia sulcata, and Parmeliopsis ambiguus). Typical lignicolous species were represented by Micarea praesina s. l. and Trapeliosp. flexuosa.

Among the lichens recorded on wood Cladonia species dominated (48%). The proportion of crustose (26%) and foliose (22%) lichens was slightly lower. Species with squamulose thalli were the least numerous (4%).

Epilithic lichens. Natural rocks were not found in the study area. However, anthropogenic rocky substrates (mortar, bricks, tiles, and concrete) were numerous and widespread. For obvious reasons, such substrates occurred mainly in villages and, less frequently, in the area of the Stawno complex, however, were almost absent within the studied forest.

Epilithic lichen biota of the investigated area turned out to be quite homogeneous and not very numerous. Due to the chemical properties of most substrates, calciphilous lichens such as Calogaya decipiens, C. cfr. pusilla, Candelariella aurella, Flavopla ca citrina, Lecanora albescens, L. dispersa, Lecidella stigmatera, Sarcogyne regularis, and Xanthoria calcicola quantitatively dominated. On the non-calcareous substrates

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Tab. 2 Continued

| Species | Sites and numbers of records | Substrate |
|---------|-----------------------------|-----------|
| Xanthoria calcicola Oxner | 1(1) | S: concrete |
| X. parietina (L.) Th. Fr. | 1(2), 2(2), 3(2), 6(1), 9(1), 18(2), 23(4), 24(3), 25(2), 28(1), 29(1), 30(2), 31(2), 32(3), 33(11) | C: bark of Quercus sp., Salix sp., Betula pendula, Sambucus nigra, Fraxinus excelsior, Malus domestica, Pinus sylvestris |

C – living trees; S – rock-like substrates; T – soil; X – wooden substrates.

Fig. 5 The number of species recorded on particular phorophytes.
bricks and tiles) single records of species typical for siliceous rocks were noted: *Aca-
rospora fuscata*, *A. smaragdula,* and *Lecanora cfr. cenisia*. Among the lichens found on
the concrete, there was a high proportion of nitrophilous species, such as: *Pheophyscia orbicularis*, *Physcia caesia*, *Ph. tenella*, *Polycauliona candelaria*, *Protoparmeliopsis mur-
rais*, *Rusavskia elegans*, and *Xanthoria parietina*.

Morphological diversity of epilithic lichens in the study area was limited to only
two forms, crustose (12 species) and foliose (8).

**Epigeic lichens.** Terricolous lichens were recorded mainly on dry and poor sandy
soil, characteristic for the investigated forest – pine wood with patches with a large
proportion of terricolous lichens, physionomically related to the *Cladonio-Pinetum*.
In these patches species of the genus *Cladonia* (*C. arbuscula*, *C. deformis*, *C. furcata*, *C.
gracilis*, *C. pyxidata*, *C. rangiferina*, and *C. uncialis*) dominated, together with *Cetraria islandica*.

Other analyzed habitats seemed to be not suitable for the development of epigeic
lichen biota, therefore terricolous lichens were recorded there only occasionally. Be-
cause of high humidity and fertility of the habitats in the Stawno complex, the exposed
soil was colonized there mainly by mosses and liverworts. In this part of the study area
only three species of terricolous lichens were recorded, namely *Cladonia chlorophea*,
*C. coniocrea*, and *C. ochrochlora*.

**Discussion**

The Stawno complex in the eastern part of the Stawy Milickie nature reserve and its
buffer zone have not been lichenologically explored till now. The only source of in-
formation on historical lichen biota in this area is the study by Glanc et al. [13] that
applies to the Barycz district in the Kraina Wielkopolsko-Kujawska region according
to geobotanical regionalization of Poland [14]. The area in which the lichenological
inventory was then conducted included only the western part of the reserve. How-
ever, the geological and climatic uniformity of both areas and the lack of significant
geographical barriers facilitated the extrapolation of the diversity of the lichen biota
of the whole region in the 70s of the twentieth century, and compare it to the current
situation (Tab. 3).

In the last 45 years the total number of lichens has decreased. What is more, there
has also been the decrease in their diversity, which is expressed in the share of differ-
ent groups of lichens varied in terms of habitat and morphological forms. Epiphytes
and epixylic lichens incurred the biggest quantitative losses. Compared with the pre-
vious studies [13], forty-seven species of this group, especially lichens of fruticose and
filamentous thalli, such as *Usnea hirta* and species of the genus *Ramalina*, have not
been identified in our research.

A smaller number of species recorded in our study may be a result of the relatively
restricted study area, the limited number of potential habitats (e.g., the lack of natu-
ral rock substrates in a form of glacial erratics) and incomparable character of forest
communities. However, the main cause of the smaller number of lichens recorded in
our study is probably connected with a change of habi-
tat conditions and anthropogenic transformation of the whole environment, which can be observed throughout the region [15,16]. It includes, among others, the develop-
ment of roads and the increased traffic congestion. All these changes resulted in the increase of air pollution
and dustiness, causing the current dominance of com-
mon lichens on a wide ecological scale, e.g., *Lecanora conizaeoides* and *Hypogymnia physodes*, and also high
proportion of nitrophilous lichens (*Physcia adscendens*,
*Ph. tenella,* and *Xanthoria parietina*).

Similar status of lichen biota has been also reported
recently from the forest reserves in southern Wielko-
polska, which is adjacent to our study area [17,18].

| Tab. 3 | Comparison of the number of species in particular habitat groups of lichens in 1970 [13] and 2015. |
|--------|-----------------|
|        | Barycz District (1970) | Stawy Milickie (2015) |
| Epiphytes and epixyles | 96 | 49 |
| Epilithes | 41 | 20 |
| Epigeites | 17 | 9 |
| All species | 140 | 73 |
Despite the completely different character of the nature reserves (oak-hornbeam forest, acidophilus oak wood, mixed coniferous forest), the number of epiphytes and epixyles discovered there is comparable or smaller than in the Stawy Milickie nature reserve (Tab. 4). These two habitat groups of lichens are considered to be the most sensitive indicators of the environment state. Therefore it seems that the results of the study reflect the general lichen biota condition of western part of Polish lowlands and indicate that the reserve and its buffer zone are under the moderate impact of the human pressure. At this point, it should also be highlighted that in the study some vulnerable species were recorded, which are included to the red list of Polish lichens [19] (Tab. 5). In addition, six of the recorded species are protected by law in Poland [6] (Tab. 6).

**Conclusions**

- The presented results of lichenological investigations conducted in the eastern part of the Stawy Milickie nature reserve document the current state of lichen biota typical for the lowland part of Lower Silesia, as well as provide reliable data for further studies of its dynamics.
- The observed impoverishment in lichen diversity over the last decades is primarily associated with various human activities in this area. Transformations of the natural environment in the reserve (creation of new ponds, tourist centers, etc.) and other changes of habitat conditions have led to the disappearance of some lichen species recorded here in the late sixties of twentieth century [13], particularly sensitive macrolichens like *Anaptyhia cillaris*, *Bryoria crispa*, *Platismatia glauca*, *Melanohalea exasperata*, *M. elegantula*, or *Melanelixia glabratula*.
- During the study several vulnerable lichen species were recorded, namely *Evernia prunastri*, *Flavoparmelia caperata*, *Hypogymnia tubulosa*, *Parmelia tiliacea*, and *Pleurosticta acetabulum*. They were generally represented by single young thalli, with only the exception of *Evernia prunastri*, which was widespread on the investigated area and particularly abundant in a plot of an alder carr. Their appearance may be the sign of the recent improvement of the environmental conditions in the region.
- The Stawy Milickie nature reserve, being a vast area under protection and with a large variety of potential habitats, is a suitable object for long-term studies on the dynamics of lichen biota. For this purpose further lichenological investigations in this and adjacent areas will be undertaken, including permanent monitoring of epiphytic lichens.
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