



CHANGES IN BIOTA OF LICHENS IN LAS ZWIERZYNIECKI RESERVE IN BIAŁYSTOK

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ABSTRACT. The paper presents a list of lichen species collected in the woody reserve “Las Zwierzyniecki” in Białystok. In total 45 species, have been recorded nine of which belong to the group threatened lichens in Poland (CIEŚLIŃSKI *et al.* 2006), one is partially protected, and five are to be come totally protected (Regulation of 2004). The paper contains findings of lichenbiota changes after 10 years. During the current research seven species have not been confirmed, which represents 13% of the total reserve lichenbiota and nine new ones have been found.

KEY WORDS: lichens, reserve, “Las Zwierzyniecki”, Białystok

INTRODUCTION

The lichenbiota of the Las Zwierzyniecki reserve was described for the first time in the 90's of the 20th century by MATWIEJUK (2000). In 2009 along the northern boundary of the reserve a new dual carriageway was built – the Copernican Route, separating the park part of the Zwierzyniecki Forest from the reserve and for that purpose a cummerbund of trees, constituting the specific jacket of the reserve, was cut out. The purpose of the research was the evaluation of the changes in the biota of lichens of the Las Zwierzyniecki reserve after the period of over ten years.

STUDY AREA

The Las Zwierzyniecki reserve is located in the southern part of Białystok (capital of the Podlaskie voivodeship), in the vicinity of its centre, in the central part of the Zwierzyniecki Park. According to the physico-geographical division the area of the reserve is located in Subprovince Podlasko-Białoruska Upland (KONDRACKI 1978), Macroregion Północnopodlaska Lowland, Mesoregion Belarussian Upland, whereas according to the geobotanical division the area of the reserve is located in North Department, Białowiesko-Knyszyńska Land, Circuit of the Knyszyńska Forest (SZAFER and PAWŁOWSKI 1972). Natural-forest distribution according to TRAMPLER *et al.* (1990) accommodates it in the Mazursko-Podlaska Land, the district Białostocka Upland.

The Las Zwierzyniecki reserve was appointed by the order of the Minister of the Environment, Natural Resources and Forestry issued on 14.06.1996 and

appointing it as the nature reserve (Monitor Polski No. 37 from 21.06.1996, pos. 373) in order to preserve tree stands of humid broadleaved forest character for scientific and educational reasons. The area of the reserve is 33.84 ha and it constitutes the best-preserved forest excerpt of the park. The reserve covers the central and eastern part of the Park Zwierzyniecki. The entire surface of the reserve is a wooded area. The reserve by virtue of its location in the town, in a complex acting as an urban park, has a developed road network and alleys for pedestrians, which comprise a total area of 1.33 ha. The border of the reserve runs from the intersection of 11 Listopada and Zwierzyniecka Streets to the east along the southern edge of Zwierzyniecka Street to the Cienista Street, next along the western edge of the Cienista Street to the street Żwirko and Wigura, further in the south-eastern direction it runs along the south-western edge of this street up to Bolesława Prusa Street. From here it turns around westwards along the border of the forest to the route for pedestrians constituting the main pivot of the Park Zwierzyniecki, next along this road to the north to the place located 100 m to the south of the roundabout which joins pedestrian ways of the Park, from here westwards to the pedestrian route and from the intersection with this road through the forest in north-western direction to 11 Listopada Street and farther along its eastern edge to the intersection with Zwierzyniecka Street. From the north and west the reserve borders forested areas, from the south – allotments and only from the east – built-up areas, but in low buildings – an estate of detached houses.

The area of the reserve is sloping in north-eastern direction. It is located, on average, at the height of 145 m a.s.l. Two streams flow through the reserve along the artificially dug up ditches. One of them is in the vicinity

of the northern boundary, the other bigger one flows through the central part of the reserve.

The phytosociological identification and characteristics of the forest communities of the reserve along with the spacial distribution of singled-out units of the flora were described by SOKOŁOWSKI (1991). The main forest community within the reserve, occupying almost all of its area is broadleaved forest *Tilio-Carpinetum*. Elm-ash wetlands *Ficario-Ulmetum* appear in the north-eastern part of the reserve, and in the south-west a little swampy part, alder-ash wetlands *Circeo-Alnetum* associated with the valley of the stream and little effusions of underground waters.

In the reserve, the tree stand aging about 55 prevails. In some places, however, about 100-year-old hornbeams *Carpinus* and alder trees *Alnus* remain. The hornbeam *Carpinus betulus* prevails in the composition of the tree stands. The common oak *Quercus robur* constitutes a relatively big admixture. In places the European ash *Fraxinus excelsior* and Norway maple appear *Acer platanoides*, more rarely little-leaf linden *Tilia cordata*, European aspen *Populus tremula*, goat willow *Salix caprea*, silver birch *Betula pendula*, and in more humid places – common elm *Ulmus minor*. In a few places the European white elm *Ulmus laevis* grows, probably artificially introduced. The common spruce *Picea abies* also constitutes a little touch, at the same time demonstrating a clearly lowered vitality. In the north-eastern angle of the reserve about a 100-year-old alder tree stand can be found with the well-developed bottom layer of trees composed of ash maple, European white elm and bird cherry *Padus avium*. The flora of the reserve is of a typical forest character, it consists mainly of native species, characteristic of deciduous forests. Species of an alien origin appear in small numbers and are limited to the places subjected to the strongest anthropopressure i.e. roads, avenues and the square with a stone devoted to Stanisław Skarżyński.

MATERIAL AND METHODS

The investigations in the area of the reserve were carried in 2012. Lichens were described with methods adopted in lichenology. In laboratory works, methods of morphological-anatomical and chemotaxonomical analysis were applied (ORANGE et AL. 2001). The alphabetical list of lichen species has been compiled. For each taxon the type of substratum it can be found on, was specified.

The species have been named according to FAŁTYNOWICZ (2003) and species *Melanohalea exasperatula* to BLANCO et AL. (2004) and *Melanelixia fuliginosa* to ARUP and SANDLER BERLIN (2011).

RESULTS AND CONCLUSION

On the territory of the Las Zwierzyniecki reserve there have been recorded 45 lichen species of 28 genera (Table 1). The most abundant numbers of species represented here are those of genera *Lecanora* (7 species), *Physcia* (5) and *Lepraria* (3). However, the majority of genera is represented only by one species.

Lichens are represented by all morphological forms. The dominant lichens in the biota of the investigated area are those forming different types of crustose thalli (26 species). They constitute 58% of the overall number of species. The second largest group are foliose lichens (15 species). The lichen participation of other morphological groups (dimorphic, squamulose, fruticose) is infrequent and amounts to about 2%.

Lichens occur on all substrata likely to be colonized – on the bark of deciduous and coniferous trees and shrubs, wood, stones and concrete.

In the landscape of the reserve their participation is clearly visible, particularly epiphytic lichens. A vast majority of species demonstrate clear preferences towards the type of substrate. Only few, such as: *Lepraria incana*, *Hypogymnia physodes*, *Parmelia sulcata*, *Phlyctis argena* were noted on many kinds of substrates.

Epiphytes. This is the largest group represented by 35 species (which represents around 78% of the total biota). It is also a standing-out group – out of 35 species, as many as 21 are exclusive epiphytes. They appear in the entire reserve and on all species of trees. The degree of thallus coverage depends on the height on the trunk, humidity, access to light and the kind of forophyte.

The biggest taxonomical diversification of lichens was recorded in the broadleaved forest on the bark of hornbeam (18 species), oak (10) and pines and birches (7 respectively) and on the bark of aspen (16 species) growing mainly on the border of the reserve.

Few lichens create extensive mosaics of thalli on trunks. Crustose species, such as *Lepraria incana*, *L. elobata*, *Phlyctis argena* dominate. On the bark of hornbeam *Graphis scripta* covers many trunks in tight rings up to the height of 1m. Vacancies are occupied by other crustose species, among others *Arthonia radiata*, *Pertusaria amara*, *P. albescens* and from foliose lichens – *Hypogymnia physodes*, *Melanelixia fuliginosa*, *Melanohalea exasperatula*. Only in illuminated places, where trees grow in a smaller condensation *Parmelia sulcata*, *Parmelina tiliacea* and a few species from the genera *Physcia* and *Xanthoria* were recorded.

Lichens of foliose thallus dominate in the crowns of trees and on roadside trees growing on the border of the reserve, where there is fuller access to light.

Trees growing on the border of the reserve or in small concentrations in illuminated places and alongside park avenues have a richer lichenbiota than trunks of the phorophytes growing in the overshadowed tree stands. An increase of the number of epiphytic lichens and the percentage of their covering patches on trunks, as well as the production of more impressive thalli indicate that habitat conditions, mainly lighting for lichen growth, are more favourable here than in the clenched tree stand.

A great humidity of atmospheric air and bases also causes growth of numerous musci at basal parts of trunks of many trees.

For *Arthonia radiata*, *Graphis scripta*, *Opegrapha vemiceifera* and *Pyrenula nitida* the Las Zwierzyniecki reserve is the only stand of their appearance in Białystok (MATWIEJUK 2007). The first two species were already recorded on the area of this reserve but *Opegrapha vemiceifera* and *Pyrenula nitida* have been noted here for the

TABLE 1. Lichens of the Las Zwierzyniecki reserve in Białystok according to data from the 90's of the 20th century (MATWIEJUK 2000) and according to examinations conducted in 2012

| Species | Substrate | | The threat categories (CIEŚLIŃSKI et AL. 2006) |
|--|--|--|--|
| | 2000 | 2012 | |
| 1 | 2 | 3 | 4 |
| <i>Acarospora fuscata</i> (Nyl.) Arnold | granite rock | granite rock | |
| <i>Amandinea punctata</i> (Hoffm.) Coppins & Scheid. | Ap, Cb, Pt | Ap, Pt | |
| <i>Arthonia radiata</i> (Pers.) Ach. | Cb | Cb, wood | |
| <i>Buellia griseovirens</i> (Turner & Borrer ex Sm.) Almb. | Ap, Cb, Pt | Cb | |
| <i>Candelaria concolor</i> (Dicks.) Stein | Ap | - | |
| <i>Candelariella aurella</i> (Hoffm.) Zahlbr. | granite rock | granite rock | |
| <i>Candelariella xanthostigma</i> (Ach.) Lettau | Ap, Fe, Pt | Ap, Pt | |
| <i>Cetraria chlorophylla</i> (Willd) Vain. | Ag, Qr, wood | Qr | VU |
| <i>Cladonia coniocraea</i> auct. | Bp, Ps | Bp, Ps | |
| <i>Cladonia fimbriata</i> (L.) Fr. | - | Bp | |
| <i>Dimerella lutea</i> (Dicks.) Trevis. | Cb | - | CR |
| <i>Evernia prunastri</i> (L.) Ach. | Ag | wood | NT |
| <i>Graphis scripta</i> (L.) Ach. | Cb | Cb, wood | NT |
| <i>Hypocenomyce scalaris</i> (Ach.) Choisy | Ag, Bp, Cb, Fe, Ps, Ul | Bp, Fe, Ps | |
| <i>Hypogymnia physodes</i> (L.) Nyl. | Ag, Ap, Bp, Cb, Fe, Ps, Qr, wood | Ap, Cb, Fe, Ps, Pt, Qr, wood | |
| <i>Hypogymnia tubulosa</i> (Schaer.) Hav. | - | wood | NT |
| <i>Lecanora carpinea</i> (L.) Vain. | Cb, Pt | Pt | |
| <i>Lecanora conizaeoides</i> Nyl. in Cromb. | Ag, Bp, Cb, Ps, Pt | Bp, Cb, Pa, Ps | |
| <i>Lecanora dispersa</i> (Pers.) Sommerf. | | granite rock | |
| <i>Lecanora hagenii</i> (Ach.) Ach. | Pt | Pt | |
| <i>Lecanora polytropa</i> (Ehrh. ex Hoffm.) Rabenh. | | granite rock | |
| <i>Lecanora populicola</i> (DC. in Lam. & DC.) Duby | Pt | - | |
| <i>Lecanora pulicaris</i> (Pers.) Ach. | Pt, Ap, wood | Pt | |
| <i>Lecanora subrugosa</i> Nyl. | Ag | Cb | LC |
| <i>Lecidella elaeochroma</i> (Ach.) Choisy | Cb, Pt | Pt, wood | |
| <i>Lepraria elobata</i> Tønsberg | - | Ag, Bp, Cb, Ps, wood | |
| <i>Lepraria incana</i> (L.) Ach. | Ag, Ap, Bp, Cb, Fe, Ps, Pt, Qr, Ul, wood, granite rock | An, Ap, Ag, Bp, Cb, Fe, Pa, Ps, Pt, Qr, Tc, Ul, Um, wood, concrete | |
| <i>Lepraria lobificans</i> Nyl. | - | Cb | |
| <i>Melanelixia fuliginosa</i> (Fr. ex Duby) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch | Ag, Ap, Cb, Pt, Qr, wood | Ap, Cb, Qr, wood | |
| <i>Melanohalea exasperatula</i> (Nyl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch | Ap | Cb, Qr | |
| <i>Opegrapha vermicellifera</i> (Kunze) J.R. Laundon | - | Cb | EN |
| <i>Parmelia sulcata</i> Taylor | Ag, Ap, Cb, Fe, Pt, Qr, wood | Ap, Cb, Fe, Pt, Qr, wood | |

TABLE 1 – cont.

| 1 | 2 | 3 | 4 |
|--|----------------------------------|----------------------|----|
| <i>Parmelina tiliacea</i> (Hoffm.) Hale | Ag, Ap, Qr | Qr | VU |
| <i>Parmeliopsis ambigua</i> (Wulfen in Jacq.) Nyl. | Pt | – | |
| <i>Pertusaria albescens</i> (Huds.) Choisy & Werner in Werner | Cb | Cb, Pt | |
| <i>Pertusaria alpina</i> Hepp ex Ahles | Cb | – | CR |
| <i>Pertusaria amara</i> (Ach.) Nyl. | Ap, Cb, Qr | Cb, Fe, Qr | |
| <i>Phaeophyscia orbicularis</i> (Neck.) Moberg | Ap, Pt, Ul | Ap, Pt | |
| <i>Phlyctis argena</i> (Ach.) Flot. | Ag, Ap, Cb, Fe, Pt, Qr, Ul, wood | An, Cb, Fe, Tc, wood | |
| <i>Physcia adscendens</i> (Fr.) H. Olivier | Pt | Ap, Pt, wood | NT |
| <i>Physcia aipolia</i> (Ehrh. ex Humb.) Fürnrohr subsp. <i>aipolia</i> | Pt | wood | |
| <i>Physcia dubia</i> (Hoffm.) Lettau | Ap, Pt, Qr, Ul | Pt, Qr, wood | |
| <i>Physcia stellaris</i> (L.) Nyl. subsp. <i>stellaris</i> | Ap, Pt | Pt, Qr, wood | |
| <i>Physcia tenella</i> (Scop.) DC. in. Lam. & DC. | Ap, Pt | wood | |
| <i>Physconia enteroxantha</i> (Nyl.) Poelt | Ap, Pt, wood | – | |
| <i>Porpidia crustulata</i> (Ach.) Hertel & Knoph in Hertel | granite rock | granite rock | |
| <i>Pseudevernia furfuracea</i> (L.) Zopf. | Ag | – | |
| <i>Pyrenula nitida</i> (Weigel) Ach. | – | Cb, Qr, wood | VU |
| <i>Scoliosporum chlorococcum</i> (Graeve ex Stenh.) Vězda | Ag, Bp, Ps | Bp, Pa, Ps | |
| <i>Verrucaria muralis</i> Ach. | – | concrete | |
| <i>Xanthoria parietina</i> (L.) Th. Fr. | Ap, Fe, Pt, Ul | Fe, Pt, wood | |
| <i>Xanthoria polycarpa</i> (Hoffm.) Rieber | Ap, Fe, Pt, wood | Fe, Pt | |

Explanations: EN – species in the category of endangered, VU – species in the category of vulnerable, NT – species in the category of nearly threatened, LC – species in the category of least concern;

Ag – *Alnus glutinosa*, An – *Acer negundo*, Ap – *Acer platanoides*, Bp – *Betula pendula*, Cb – *Carpinus betulus*, Fe – *Fraxinus excelsior*, Pa – *Picea abies*, Ps – *Pinus sylvestris*, Pt – *Populus tremula*, Qr – *Quercus robur*, Tc – *Tilia cordata*, Ul – *Ulmus laevis*, Um – *Ulmus minor*.

first time and are new species not only for this protected area, but also for the city.

Epixyloous lichens. Their substrate is mainly stumps and logs. On the whole 18 species grow on wood, but only four are exclusive epixyloous lichens. They are common, photophilic species preferring open areas, such as: *Evernia prunastri*, *Hypogymnia tubulosa*, *Physcia aipolia* and *P. tenella*. These lichens have been seen on trunks and logs of recently felled trees with a very low degree of decay. Apart from that they grow mainly in the crowns of trees. It can be assumed that they also appear on many trees, in their highest parts with favourable illumination. Stumps and logs with a large degree of decay are being colonized by numerous species of bryophytes and leprolose, sterile thalli of *Lepraria incana*, *L. elobata*.

Epilythic lichens. The substrates for this group of lichens are occasionally found in the reserve. Six species grow on them, including four (*Acarospora fuscata*, *Candelariella aurella*, *Lecanora dispersa*, *Porpidia crustulata*), which colonized the rock – obelisk commemorating the

feat of the Polish Army colonel Stanisław Skarżyński (1899-1942), the military and sports pilot, the first Pole who flew across the Atlantic alone on 8 May 1933 (from Sant Lois in Senegal to Maceio in Brazil), and two (*Lepraria incana*, *Verrucaria muralis*) concrete low walls.

Participation of vulnerable and protected lichens

Of the 45 lichen species identified in the Las Zwierzyniecki reserve nine species have been put on the Red list of the lichens in Poland (CIEŚLIŃSKI et al. 2006), including one species in the endangered category – EN (*Opegrapha vermicellifera*), three species in the vulnerable category – VU (*Cetraria chlorophylla*, *Parmelina tiliacea*, *Pyrenula nitida*), four species in the category of near threatened – NT (*Evernia prunastri*, *Graphis scripta*, *Hypogymnia tubulosa*, *Physcia aipolia*) and one species in the least category – LC (*Lecanora subrugosa*). On the Red list of threatened lichens in North-Eastern Poland (CIEŚLIŃSKI 2003), one species has been put into the endangered category EN – *Opegrapha vermicellifera*.

The most threatened ecological group in the reserve are epiphytes.

Of all the 45 lichen species of reserve, six have been put under legal protection, five of which are totally (*Cetraria chlorophylla*, *Hypogymnia tubulosa*, *Melanelixia fuliginosa*, *Melanohalea exasperatula*, *Parmelina tiliacea*) and one of which is partially protected (*Evernia prunastri*).

CHANGES AND THREATS

Historical data

In the 90's of the 20th century in the area of the Las Zwierzyniecki reserve the appearance of 43 species of lichens was noted (MATWIEJUK 2000). During the current research the presence of seven species has not been confirmed, which constitutes 13% of the whole lichenbiota given from the area of the reserve (Table 1). These are the lichens which probably still appear, but during recent surveys have not been confirmed. They include, among others, lichens of crustose thallus, such as *Lecanora populicola*, squamulose thallus: *Candelaria concolor*, foliose thallus: *Parmeliopsis ambigua* and *Physconia enteroxantha* and fruticose thallus: *Pseudevernia furfuracea*. Among them there are species which are inherently difficult to find and grow in very small concentrations on the bark of a single phorophyte, such as *Dimerella lutea*, *Lecanora populicola*, *Pertusaria alpina*. Analysing the participation of the species of lichens from the Red list (CIEŚLIŃSKI et AL. 2006) in the lichenbiota of the reserve in the 90's the 20th century, eight endangered species out of 43 were recorded, including two in the category of critically endangered CR

TABLE 2. Participation of lichens endangered in the Las Zwierzyniecki reserve in Białystok according to data from the 90's of the 20th century (MATWIEJUK 2000) and according to examinations conducted in 2012

| Year | Threat categories (CIEŚLIŃSKI et AL. 2006) | | | | |
|------|--|----|----|----|----|
| | CR | EN | VU | NT | LC |
| 2000 | 2 | 0 | 2 | 3 | 1 |
| 2012 | 0 | 1 | 3 | 4 | 1 |

Explanations: CR – species in the category of critically endangered, EN – species in the category of endangered, VU – species in the category of vulnerable, NT – species in the category of nearly threatened, LC – species in the category of least concern.

TABLE 3. Number of lichens species on chosen phorophytes of the Las Zwierzyniecki reserve according to data from the 90's of the 20th century (MATWIEJUK 2000) and according to examinations conducted in 2012

| <i>Acer platanoides</i> | | <i>Alnus glutinosa</i> | | <i>Populus tremula</i> | | <i>Carpinus betulus</i> | | <i>Quercus robur</i> | | <i>Betula pendula</i> | | <i>Pinus sylvestris</i> | |
|-------------------------|------|------------------------|------|------------------------|------|-------------------------|------|----------------------|------|-----------------------|------|-------------------------|------|
| 2000 | 2012 | 2000 | 2012 | 2000 | 2012 | 2000 | 2012 | 2000 | 2012 | 2000 | 2012 | 2000 | 2012 |
| 20 | 8 | 13 | 3 | 21 | 16 | 17 | 18 | 9 | 10 | 7 | 7 | 7 | 7 |

(*Dimerella lutea* and *Pertusaria alpina*), which have not been found today. The participation of lichens from other categories of the threat (EN, VU, NT, LC) has currently increased (Table 2).

The heaviest loss within the last few years has been suffered by epiphytic lichenbiota of the reserve, seven species have not been found (Table 1, Fig. 1). However, a greater participation of lichens settling on dead and rotting wood and bedrock has been noted (Table 1, Fig. 1).

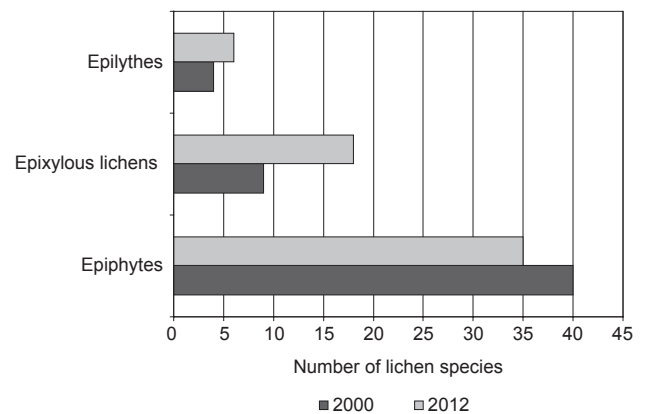


FIG. 1. Number of lichens species representing individual ecological groups of the Las Zwierzyniecki reserve according to data from the 90's of the 20th century (MATWIEJUK 2000) and according to examinations conducted in 2012

In recent years a reduction of the participation of the number of lichen species has also been observed on individual phorophytes, such as *Acer platanoides*, *Alnus glutinosa* (Table 3).

Contemporary stores of lichens and new species

Lichenological examinations conducted in 2012 in the reserve confirmed the occurrence of 36 species of lichens out of 52 of all well-known for this scope of research (according to data from the 90's of the 20th century (MATWIEJUK 2000) and according to examinations conducted in 2012) and demonstrated nine new species (Table 1).

It is possible to describe new species of lichens noted in the reserve as:

1. species known for ages, with a taxonomically established position or associated with one type of settlement which had not been recorded in examinations conducted a dozen or so years ago. They are: *Cladonia fimbriata*, *Hypogymnia tubulosa*, *Lecanora dispersa*, *L. polytropa* and *Verrucaria muralis*;

2. species which were indicated using chemotaxonomic methods (TLC), such as species of genus *Lepraria* (*L. elobata* and *L. lobificans*).

3. forest species, with photobiont *Trentepohlia* which can be an effect of global warming, such as *Pyrenula nitida* and *Opegrapha vermicellifera* (APTROOT and VAN HERK 2007).

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