



## LICHENS OF THE CEMETERIES IN BIAŁYSTOK (NORTH-EASTERN POLAND)

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**ABSTRACT.** The paper presents a list of lichen species collected in cemeteries in Białystok (north-eastern Poland). In total 97 species, have been recorded five of which belong to the group of threatened lichens in Poland (*Bryoria crispa*, *Pleurosticta acetabulum*, *Ramalina fastigiata*, *R. fraxinea*, *Stereocaulon tomentosum*, *Usnea subfloridana*). Epilithic lichens (55 species) predominate. Other ecological groups are represented by smaller number of species – epiphytic (45), epibryophytes (17), epigeic (14) and epiksylic (8).

**KEY WORDS:** lichens, cemeteries, distribution, Białystok, north-eastern Poland

### INTRODUCTION

Cemeteries are inseparable elements of city landscape. They constitute both a unique cultural, religious and natural value. These are places where numerous plant species occur. One can find there a diversity of habitats and substrata colonized by numerous lichen species.

Publications concerning lichens on the territories of Polish cemeteries are rare. This might result from the difficulties caused by the way the study material is collected in places of worship. A dozen or so lichen species colonizing monuments of municipal cemeteries in Lublin and small towns of a resort character have been reported by RYDZAK (1953, 1956 a, b, 1957 a, b), the ones in Słupsk have been reported by ŚPIEWAKOWSKI and IZYDOREK (1981) and those in Przemyśl by KISZKA (1999). Lichens on the monuments of cemeteries dating back to World War I in the Carpathian Foothills (Pogórze Karpackie) have been listed by KOZIK (1994). The rock lichenbiota found on boulders on the prehistorical burial ground “Stone Circles” („Kręgi Kamienne”) in the Tuchola Forest (Bory Tucholskie) has been described by KISZKA and LIPNICKI (1994). Lichens of the cemetery in Bogusław have been studied by GROCHOWSKI (2002), lichens in Ugoszcz situated on the territory of the Nadbużański Landscape Park (Nadbużański Park Krajobrazowy) by JASTRZĘBSKA (2005) and the Jewish cemetery in Białystok by MATWIEJUK (2008).

The investigations on the territory of the cemeteries in Białystok aimed to present floristic documentation illustrating biodiversity of lichenbiota including habitat conditions of species.

### STUDY AREA

Białystok is the biggest city of north-east Poland, the capital of the Podlaskie Province. It lies on the Podlasie Lowland (Nizina Podlaska), in the western part of the Białystok Upland (Wysoczyzna Białostocka) (KONDRACIKI 2002). Białystok is a city where urban greens comprise around 32% of its area. Their considerable part lies within the range of 18 cemeteries, including 10 parish cemeteries, two closed religious cemeteries, four closed National Memorial cemeteries, and two liquidated Jewish cemeteries which now function as a square and park. All the cemeteries are situated within administrative boundaries of the city (Fig. 1). A special importance of cemeteries for nature comes from the fact that apart from many trees and shrubs these objects abound in different types of substrata for epilythic organisms, mainly bryophytes and lichens. On all the parish cemeteries the dominant material of which gravestones are made is decorative concrete called terrazzo. There are also concrete gravestones and those made of stone such as granite, sandstone and marble. On the Jewish cemetery stone macevas of granite and sandstone dominate along with concrete sarcophaguses. Symbolic gravestones can be found on the Cemetery of Victims of Fascism, Cemetery of Soviet Soldiers and Memorial Place in the Bacieczki Forest. On the evangelical cemetery there can be found few destroyed and moved gravestones. Many cemeteries, especially those founded earlier are rich in high greenery. The dominant tree species here are *Betula pendula*, *Acer platanoides*, *A. negundo*, *Tilia cordata*, *Pinus sylvestris*, *Fraxinus excelsior*, *Quercus robur*, *Robinia pseudacacia*, *Thuja occidentalis*. Cemeteries founded in recent years (the Holy Spirit and St. Euphrosyne’s cemeteries) and new plots on old cemeteries are poor in greenery.

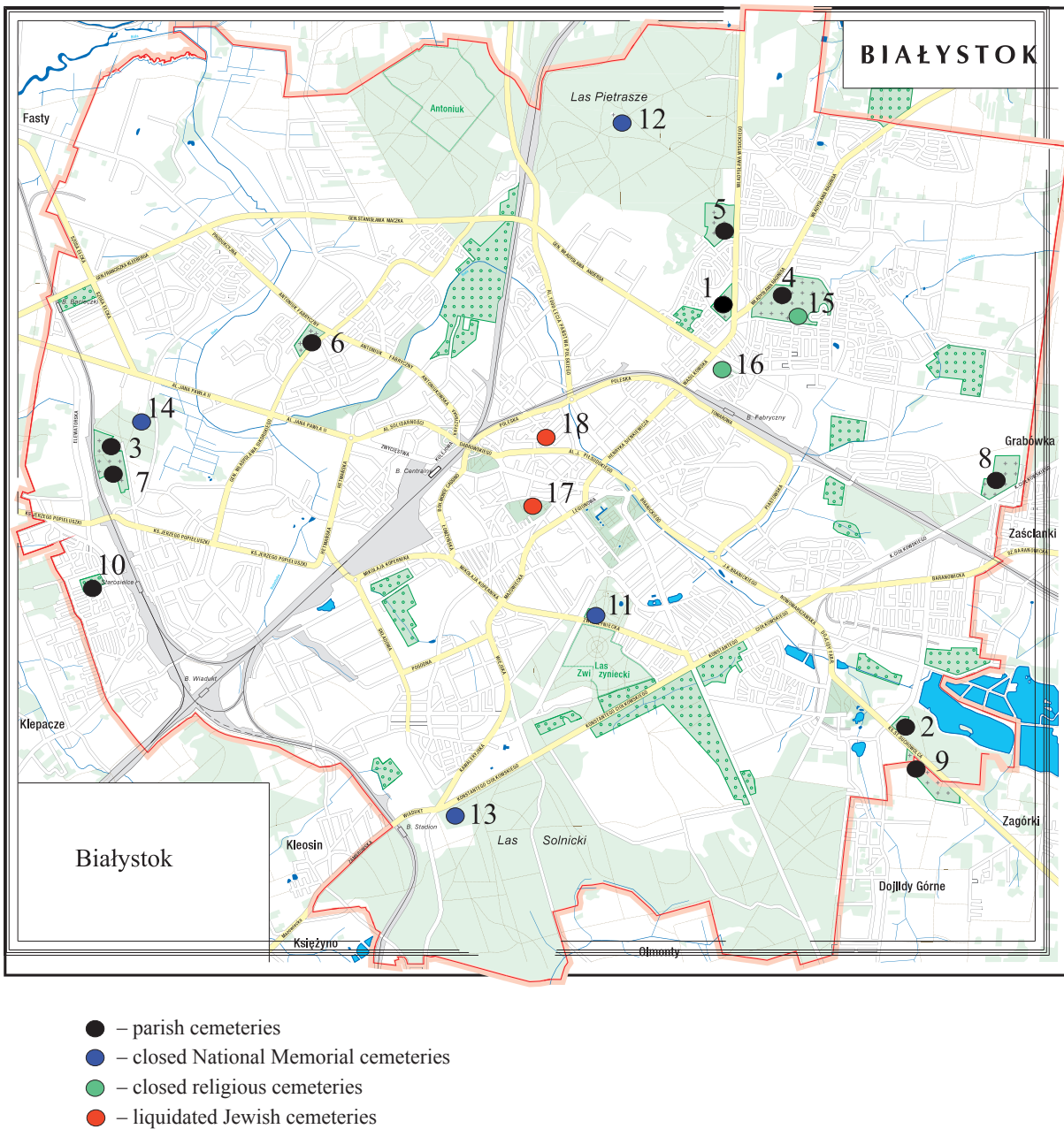


FIG. 1. Localization cemeteries in Białystok

**MATERIAL AND METHODS**

The investigations were carried out in the years 2005 and 2006. Eighteen cemeteries of Białystok have been included in the studies. They have all been put into four different groups:

- I group – includes 10 parish cemeteries,
- II group – includes four closed National Memorial cemeteries,
- III group – includes two closed religious cemeteries,
- IV group – includes two liquidated Jewish cemeteries (Table 1).

Each cemetery have been treated as a separate stand. Notes have been made in the field, registering species and specifying the type of substratum. In order not to deplete wildlife in the places of worship, single specimens and those needing laboratory work have been collected into the herbarium.

The lichen material and floristic documentation have been deposited at the Herbarium of the Institute of Biology, University of Białystok. The species have been named according to SANTESSON et AL. (2004), genera *Bryoria* and *Usnea* according to Bystrek (1986, 1994) and old genus *Melanelia* according to BLANCO et AL. (2004).

Chemical analyses from species of the genus *Lepraria* were performed using thin-layer chromatography (TLC) by dr M. Kukwa (University of Gdańsk).

The alphabetical list of lichen species has been compiled.

**RESULTS**

On the territory of Białystok cemeteries there have been 97 species registered representing 52 genera. Genus *Cladonia* (10 species), *Lecanora* (9), *Caloplaca*

TABLE 1. List of cemeteries in Białystok

Group	Number of cemetery	Name of cemetery	Localization	Religious fixture	Date of foundation	Surface (ha)
I	1	The All Holy	Władysław Wysocki Street	Orthodox	end of the 19th century	6.7
	2	St. Holy Prophet Elias	Plażowa Street	Orthodox	second half of the 19th century	1.6
	3	St. Euphrosyne's	St. Andrzej Bobola Street	Orthodox	1990	6
	4	Farny, Wniebowzięcia NMP	Władysław Raginis Street	Roman Catholic	1888	19.45
	5	City	Władysław Wysoki Street	Roman Catholic and Orthodox	end of the 19th century	16
	6	St. Roch	Antoniuk Fabryczny Street	Roman Catholic	1926	6.2
	7	St. Andrzej Bobola	St. Andrzej Bobola Street	Roman Catholic	1952	4.34
	8	The Holy Spirit	Dębowa Street	Roman Catholic	1991	10.72
	9	Immaculate Hearts Maryi	Rev. Stanisław Suchowolec Street	Roman Catholic	1920	7
	10	Zaśnięcia NMP	Rev. Paweł Grzybowski Street	Roman Catholic and Orthodox	second half of the 19th century	2
II	11	Military	11 Listopada Street	Ecumenical	1919	1.25
	12	Victims of Fascism	Pietrasze Forest	Ecumenical	1941	0.4
	13	Soviet Soldiers	Konstanty Ciołkowski Street	Unreligious	1944	0.36
	14	National Memorial Place	Baciczki Street Baciczki Forest	Ecumenical	1980	0.1
III	15	Jewish	Wschodnia Street	Moses confessions	1890	8.31
	16	Evangelical and Augsburg	27 Lipca Street	Evangelical	end of the 19th century	1.32
IV	17	Jewish	Konstanty Kalinowski Street	Moses confessions	1760	0.4
	18	Jewish	Żabia Street	Moses confessions	1943	0.2

Numeration as on Figure 1.

(6), *Physcia* (5) and *Lepraria* (4) are most abundant in species. Taking into consideration habitat preferences lichens can be divided into five groups: epilythes (55 species), epiphytes (45), epibryophytes (17), epigeits (14) and epixylous lichens (8). With many species it is difficult to explicitly include them in the specific group as lichens preferring one type of substratum willingly colonize other substrata. The most numerous groups are epilythes (57% of all biota) and epiphytes (46%), whereas the participation of other groups is significantly lower (18%, 14%, 8%). Epilythes comprise the most specific group. Among all the species recorded on rock substratum, 53% of taxa showed exclusive preference for this habitat.

**Epilythes.** Cemeteries are objects of anthropogenic origin and as such create good conditions for lichen growth. Gravestones, monuments, cemetery walls are vegetation habitats for many lichens. Species differentiation depends mainly on the age and kind of

material they were made of as well as on sun exposure and humidity. Epilythes are most frequently found on gravestones and other cemetery objects dating back to the second half of the 19th century and 20th century, placed there after the war until the 1970s and 1980s. They show preference mainly for exposed and sunny places. Particularly rich lichenbiota has been recorded on the abandoned Jewish cemetery founded at the end of the 19th century (MATWIEJUK 2008), while the poorest lichenbiota has been found on the new cemeteries dating from the 90s of the 20th century and in National Memorial Places with symbolic graves, on the evangelical cemetery and the two liquidated Jewish cemeteries.

Lichens show preference for concrete substrata with rough surface. This kind of surface forms when a bigger number of aggregate (sand, gravel) is used in proportion to concrete binder, cement. Rainwater does not flow down so easily, stopping in substratum cracks

and in favourable sun exposure conditions microclimate forms there for young thalli to grow. The pioneer species colonizing younger concrete surfaces include *Lecanora albescens*, *L. dispersa*, *Candelariella aurella*, *Lecidella stigmata*, later *Caloplaca decipiens*, *C. saxicola*, *C. holocarpa*. No lichens have been recorded on gravestones made of stone, granite and marble which were thoroughly ground and polished. Concrete tombstones support common growth of calciphilous and nitrophilous lichens preferring substrata rich in calcium carbonate. The most frequently encountered taxa are *Lecanora albescens*, *L. dispersa*, *Candelariella aurella*, *Caloplaca citrina*, *C. decipiens*, *Phaeophyscia orbicularis*, *Protoparmeliopsis muralis* and *Xanthoria parietina*. Stone tombstones mainly made of granite and sandstone become colonized by lichens showing preference for acid substrata – *Acarospora fuscata*, *Neofuscelia loxodes*, *N. pulla*, *Rhizocarpon reductum*, *Xanthoparmelia conspersa*. Rare species have been recorded on single stands – *Catillaria chalybeia* (stand 1), *Lecanora rupicola* (stand 15), *Lecidea fuscoatra* (stand 15), *Neofuscelia pulla* (stand 15), *Rinodina gennarii* (stand 4), *Staurothele ambrosiana* (stand 8).

Lichens of epiphytic nature have been found on few gravestones – *Hypocenomyce scalaris*, *Hypogymnia physodes*, *Parmelia sulcata*, *Melanelixia fuliginosa* and *Xanthoria polycarpa*.

**Epiphytes.** Some cemeteries in Białystok are refuge for high greenery in the city, e.g. parish cemetery, military cemetery, National Memorial Place in the Bacieczki Forest. Many tree trunks lack lichens or their bark becomes colonized by synanthropes with wide ecological amplitude which occupy significant parts of numerous trunks and boughs. They are most often colonized by *Phaeophyscia orbicularis*, *Physcia dubia*, *P. adscendens*, *Lepraria* sp., in some places by *Candelariella xanthostigma*, *Amandinea punctata*, *Xanthoria parietina*. *Hypogymnia physodes* and *Parmelia sulcata* are also ordinary.

Rich epiphytic biota is characteristic for: the military cemetery situated within the Zwierzyniecki Forest, in its park section, National Memorial Place located in the Bacieczki Forest, Roman Catholic cemetery at the Rev. Stanisław Suchowolec Street and parish cemetery located on the outskirts of the city. Phorophytes with unusually rich lichenbiota on cemeteries are poplars and maples. However, noteworthy is the small number of species associated with coniferous trees (pine, spruce, larch, thuja). Interesting biota has been noted on aspen growing in National Memorial Place in Bacieczki Forest. A lot of rare species under strict legal protection have been identified here. These include: *Bryoria crispa*, *B. fuscescens*, *Cetraria sepincola*, *Hypogymnia tubulosa*, *Pseudevernia furfuracea*, *Ramalina fastigiata*, *R. farinacea*, *R. fraxinea*, *Tuckermanopsis chlorophylla*, *Vulpicida pinastri*. Trunks and branches of the black poplar on the military cemetery were also colonized by interesting taxa: *Evernia prunastri*, *Parmelina tiliacea*, *Pertusaria albescens*, *Pleurosticta acetabulum*, *Tuckermanopsis chlorophylla*.

**Epibryophytes.** A large number of lichens growing on bryophytes are terricolous species optionally developing on dying moss which occupies gravestones, e.g. *Cladonia chlorophaea*, *C. fimbriata*, *C. furcata*, *C. pyxidata*, *C. macilenta*, *C. rei*, *C. squamosa*, *C. subulata*,

*Diploschistes muscorum*. Lichens of genus *Lepraria* are quite numerous represented here. Altogether the occurrence of 17 lichen species, including five exclusive ones has been recorded on moss.

**Epigeits.** The development of terricolous lichens on cemeteries is strongly suppressed by the lack of appropriate habitats. Only 14 species have been recorded on soil and humus. Exclusive epigeits include *Cetraria islandica*, *Peltigera rufescens*, *Cladonia grayi*, *Stereocaulon tomentosum* and *S. condensatum*.

**Epixylous lichens.** On the cemeteries of Białystok there can be found a small number of habitats appropriate for this ecological group. These are wooden crosses and benches. As few as eight species have been identified there. They are ubiquitous lichens or those preferring other substrata, they sometimes colonize wood.

The majority of lichens recorded on the cemeteries of Białystok have green algae as their algal partner (99%), form crustose thalli (41%) and exhibit vegetative reproduction (68%). The most frequently registered species are *Hypogymnia physodes* (17 stands), *Phaeophyscia orbicularis* (17 stands), *Lecanora dispersa* (16 stands), *Xanthoria parietina* (15 stands), *Lecanora albescens* (15 stands), *Caloplaca saxicola* (15 stands). Among them, there are taxa with relatively wide ecological range which grow on many species of trees and shrubs, on rock substratum, on dead and rotting wood, in different habitat conditions. A numerous group is composed of very rare lichens encountered on single stands. These include generally rare species, but also species sporadically found in Białystok due to the lack of habitat or those which become extinct as a result of eliminating anthropogenic habitats as well as those which are dying out, previously common, registered on the Red List at different threat levels.

#### Participation of vulnerable and protected lichens

Of the 97 lichen species identified in cemeteries in Białystok, 19 species have been put on the Red list of extinct and vulnerable lichens of Poland (CIEŚLIŃSKI ET AL. 2006), including six species in the endangered category – EN (*Bryoria crispa*, *Pleurosticta acetabulum*, *Ramalina fastigiata*, *R. fraxinea*, *Stereocaulon tomentosum*, *Usnea subfloridana*), eight species in the vulnerable category – VU (*Bryoria fuscescens*, *Catillaria chalybeia*, *Cetraria islandica*, *Parmelina tiliacea*, *Ramalina farinacea*, *Staurothele ambrosiana*, *Tuckermanopsis chlorophylla*, *Usnea hirta*), four species in the category of near threatened – NT (*Evernia prunastri*, *Hypogymnia tubulosa*, *Neofuscelia pulla*, *Vulpicida pinastri*) and one species in the category least concern – LC (*Psilolechia lucida*), as well as five species on the Red List of lichens vulnerable in north-eastern Poland (CIEŚLIŃSKI 2003), including one – EN (*Stereocaulon tomentosum*), one – NT (*Catillaria chalybeia*) and three in the category data deficient – DD (*Cladonia rei*, *Micarea peliocarpa*, *Psilolechia lucida*).

The level of threat for lichens in north-eastern Poland, compared to other regions in lowland Poland is lower, which is reflected in a small number of vulnerable lichens of the cemeteries in Białystok placed on the local Red list (CIEŚLIŃSKI 2003) compared to the national Red list (CIEŚLIŃSKI ET AL. 2006).

Of all the 97 lichen species, 24 have been put under legal protection, 21 of which are totally and three partially protected.

*Usnea hirta* and *U. subfloridana* are the species which requires a protection zone to be established within a 50-metre radius from the stand border.

#### Species index

The register comprises 97 lichen species in alphabetical order. The species have been described following the pattern: species name and type of substratum it is found on, and the cemetery number according to Table 1.

*Acarospora fuscata* (Schrad.) Th. Fr. – stone tombstones  
Stands: 2, 4, 5, 6, 7, 10, 15

*Amandinea punctata* (Hoffm.) Coppins & Scheid. – bark of *Acer platanoides*, *Betula pendula*, *Fraxinus excelsior*, *Tilia cordata*, *Populus alba* and *P. tremula*  
Stands: 4, 5, 9, 11, 13, 15, 16

*Aspicilia calcarea* (L.) Mudd – concrete tombstones  
Stands: 2, 5, 6, 15

*Aspicilia cinerea* (L.) Körb. – stone tombstones  
Stands: 15, 16

*Bryoria crispa* (Mot.) Bystr. – bark of *Populus tremula*  
Stand: 14

*Bryoria fuscescens* (Gyeln.) Brodo & D. Hawksw. – bark of *Populus tremula*  
Stand: 14

*Caloplaca arenaria* (Pers.) Müll. Arg. non. aut. – concrete walls  
Stands: 6, 9

*Caloplaca citrina* (Hoffm.) Th. Fr. – concrete tombstones and walls  
Stands: 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16

*Caloplaca decipiens* (Arnold) Blomb. & Forssell – concrete tombstones  
Stands: 2, 4, 5, 6, 7, 8, 9, 10, 15

*Caloplaca erythrocarpa* (Pers.) Zwackh – concrete tombstones and walls  
Stands: 6, 11, 13

*Caloplaca holocarpa* (Hoffm. ex Ach.) A.E. Wade – stone and concrete tombstones  
Stands: 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 15, 16

*Caloplaca saxicola* (Hoffm.) Nordin – stone and concrete tombstones, concrete walls  
Stands: 2, 3, 4, 5, 6, 7, 8, 9, 11, 15, 12, 13, 14, 15, 16

*Candelaria concolor* (Dinks.) Stein. – bark of *Aesculus hippocastanum* and *Tilia cordata*  
Stands: 5, 9

*Candelariella aurella* (Hoffm.) Zahlbr. – stone and concrete tombstones  
Stands: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 15

*Candelariella coralliza* (Nyl.) H. Magn. – stone tombstones  
Stands: 1, 2, 4, 5, 9, 15

*Candelariella vitellina* (Hoffm.) Müll. Arg. – stone and concrete tombstones  
Stands: 1, 2, 4, 5, 6, 7, 9, 10, 11, 15

*Candelariella xanthostigma* (Ach.) Lettau – bark of *Aesculus hippocastanum*, *Fraxinus excelsior*, *Populus alba*, *P. tremula* and *Tilia cordata*  
Stands: 6, 9, 11, 13, 16

*Catillaria chalybeia* (Borrer) A. Massal. – granite tombstone  
Stand: 1

*Cetraria islandica* (L.) Ach. – soil

Stand: 14

*Cetraria sepincola* (Ehrh.) Ach. – bark of *Juniperus communis*

Stand: 14

*Cladonia chlorophaea* (Flörke ex Sommerf.) Spreng. – layer of the hummus and bryophytes growing on concrete and stone tombstones

Stand: 15

*Cladonia coniocraea* (Flörke) Spreng., nom. cons. – bark of *Acer platanoides*, *Betula pendula*, *Pinus sylvestris*, *Robinia pseudacacia* and concrete tombstone

Stands: 1, 4, 9, 11, 12, 13, 15

*Cladonia fimbriata* (L.) Fr. – layer of the hummus and bryophytes growing on concrete and stone tombstones, concrete tombstones and bark of *Betula pendula*, *Pinus sylvestris* and *Populus tremula*

Stands: 4, 5, 11, 12, 14, 15

*Cladonia furcata* (Huds.) Schrad. – layer of the hummus and bryophytes growing on concrete and stone tombstones

Stand: 15

*Cladonia grayi* G. Merr. ex Sandst. – layer hummus on stone tombstone

Stand: 15

*Cladonia macilenta* Hoffm. – layer of the hummus and bryophytes growing on concrete and stone tombstones

Stand: 15

*Cladonia pyxidata* (L.) Hoffm. – layer of the hummus and bryophytes growing on concrete and stone tombstones

Stand: 15

*Cladonia rei* Schaer. – layer of the hummus and bryophytes growing on concrete tombstones

Stand: 15

*Cladonia squamosa* Hoffm. – layer of the hummus and bryophytes growing on concrete tombstones

Stand: 15

*Cladonia subulata* (L.) Weber ex F.H. Wigg. – layer of the hummus and bryophytes growing on concrete and stone tombstones

Stand: 15

*Diploschistes muscorum* (Scop.) R. Sant. – layer of the hummus and bryophytes growing on concrete and stone tombstones

Stand: 15

*Evernia prunastri* (L.) Ach. – bark of *Acer platanoides*, *Fraxinus excelsior*, *Populus alba*, *P. tremula*, *Quercus robur* and *Tilia cordata*

Stands: 4, 5, 6, 9, 11, 14, 15

*Hypocenomyce scalaris* (Ach.) M. Choisy – bark of *Acer platanoides*, *Betula pendula*, *Pinus sylvestris*, *Populus alba*, *P. tremula*, *Robinia pseudacacia*, *Tilia cordata*, *Ulmus laevis*, concrete and stone tombstones, and wooden crosses

Stands: 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 13, 14, 15

*Hypogymnia physodes* (L.) Nyl. – bark of *Acer platanoides*, *Aesculus hippocastanum*, *Betula pendula*, *Fraxinus excelsior*, *Picea excelsior*, *Pinus sylvestris*, *Populus alba*, *P. nigra*, *P. tremula*, *Quercus robur*, *Robinia pseudacacia*, *Symphoricarpos albus*, *Tilia cordata*, *Ulmus laevis*, stone tombstones and wooden crosses

Stands: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

- Hypogymnia tubulosa* (Schaer.) Hav. – bark of *Betula pendula* and *Populus tremula*  
Stands: 4, 5, 13, 14
- Imshaugia aleurites* S.L.F. Meyer – bark of *Pinus sylvestris*  
Stand: 14
- Lecania erysibe* (Ach.) Mudd – bryophytes growing on concrete tombstone and directly on concrete tombstone  
Stands: 4, 6, 10, 11, 12, 15
- Lecanora albescens* (Hoffm.) Branth & Rostr. – concrete tombstones  
Stands: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16
- Lecanora allophana* Nyl. – bark of *Betula pendula* and *Quercus robur*  
Stand: 5
- Lecanora carpinea* (L.) Vain. – bark of *Fraxinus excelsior*, *Pinus sylvestris*, *Populus nigra* and *Quercus robur*  
Stands: 4, 9, 12, 14
- Lecanora conizaeoides* Nyl. ex Cromb. – bark of *Betula pendula*, *Carpinus betulus*, *Pinus sylvestris*, *Quercus robur*, *Robinia pseudacacia* and *Tilia cordata*  
Stands: 1, 2, 3, 4, 5, 6, 10, 11, 12, 13, 14, 15, 16
- Lecanora dispersa* (Pers.) Sommerf. – concrete tombstones  
Stands: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16
- Lecanora hagenii* (Ach.) Ach. – bark of *Tilia cordata*  
Stand: 9
- Lecanora polytropa* (Ehrh. ex Hoffm.) Rabenh. – stone tombstones and concrete cross  
Stands: 5, 11, 15
- Lecanora pulicaris* (Pers.) Ach. – bark of *Fraxinus excelsior*, *Populus tremula* and *Tilia cordata*  
Stands: 2, 6, 9, 14
- Lecanora rupicola* (L.) Zahlbr. – stone tombstones  
Stand: 15
- Lecidea fuscoatra* (L.) Ach. – stone and concrete tombstones  
Stand: 15
- Lecidella stigmathea* (Ach.) Hertel & Leuckert – concrete tombstones  
Stands: 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16
- Lepraria* sp. – stone and concrete tombstones, bark of *Acer platanoides*, *Aesculus hippocastanum*, *Betula pendula*, *Carpinus betulus*, *Fraxinus excelsior*, *Juniperus communis*, *Picea excelsior*, *Pinus sylvestris*, *Populus alba*, *P. nigra*, *Quercus robur*, *Robinia pseudacacia*, *Thuja occidentalis*, *Tilia cordata* and *Ulmus laevis*  
Stands: 1, 2, 4, 6, 9, 10, 11, 12, 13, 14, 15, 16
- Lepraria caesia* (de Lesd.) J.R. Laundon – bryophytes growing on tombstone  
Stand: 9
- Lepraria incana* (L.) Ach. – bryophytes growing on tombstone  
Stand: 11
- Lepraria lobificans* Nyl. – bryophytes growing on tombstone  
Stands: 10, 11
- Lepraria vouauxii* (Hue) R.C. Harris – bryophytes growing on tombstone  
Stand: 1
- Melanelixia fuliginosa* (Duby) O. Blanco et al. – bark of *Acer platanoides*, *Aesculus hippocastanum*, *Fraxinus excelsior*, *Populus alba*, *Quercus robur*, *Tilia cordata*, stone tombstone and metal cross  
Stands: 4, 5, 6, 9, 10, 11
- Melanohalea exasperatula* (Nyl.) O. Blanco et al. – bark of *Populus tremula* and *Tilia cordata*  
Stands: 9, 14
- Micarea peliocarpa* (Anzi) Coppins & R. Sant. – bryophytes growing on concrete wall  
Stand: 4
- Mycobilimbia tetramera* (De Not.) Vitik. et al. – bryophytes growing on tombstones  
Stands: 1, 2, 4, 10, 11, 15
- Neofuscelia loxodes* (Nyl.) Essl. – stone tombstones, numerous and big thallus  
Stands: 5, 15
- Neofuscelia pulla* (Ach.) Essl. – stone tombstones, numerous and big thallus  
Stand: 15
- Parmelia sulcata* Taylor – concrete tombstones, wooden crosses and benches, bark of *Acer negundo*, *A. platanoides*, *Aesculus hippocastanum*, *Betula pendula*, *Fraxinus excelsior*, *Populus alba*, *P. tremula*, *Robinia pseudacacia*, *Salix alba* and *Tilia cordata*  
Stands: 1, 3, 4, 5, 6, 7, 9, 10, 11, 13, 14, 15, 16, 17, 18
- Parmelina tiliacea* (Hoffm.) Hale – bark of *Populus alba* and *Quercus robur*  
Stand: 11
- Parmeliopsis ambigua* (Wulfen) Nyl. – bark of *Populus tremula*  
Stand: 14
- Peltigera rufescens* (Weiss) Humb. – layer of the hummus on concrete tombstones  
Stands: 14, 15
- Pertusaria albescens* (Huds.) M. Choisy & Werner – bark of *Carpinus betulus* and *Populus alba*  
Stand: 11
- Phaeophyscia nigricans* (Flörke) Moberg – concrete walls and tombstones, bark of *Salix alba*  
Stands: 1, 3, 4, 5, 8, 9
- Phaeophyscia orbicularis* (Neck.) Moberg – bark of *Acer negundo*, *A. pseudoplatanus*, *Populus alba*, *Salix alba*, *Tilia cordata*, *Ulmus laevis*, concrete tombstones and wooden benches  
Stands: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18
- Phlyctis argena* (Spreng.) Flot. – bark of *Acer platanoides*, *Fraxinus excelsior*, *Populus tremula*, *Quercus robur* and *Tilia cordata*  
Stands: 1, 4, 5, 6, 9, 10, 11, 13, 16
- Physcia adscendens* H. Olivier nom. cons. – bark of *Acer platanoides*, *Populus alba*, *Salix alba*, *Tilia cordata* and concrete tombstones  
Stands: 1, 3, 4, 5, 6, 7, 9, 10, 11, 15, 17
- Physcia caesia* (Hoffm.) Fűrnr. – concrete and stone tombstones, bark of *Salix alba*  
Stands: 1, 3, 4, 5, 7, 9, 10, 11, 12, 13, 15
- Physcia dubia* (Hoffm.) Lettau – bark of *Acer negundo*, *A. platanoides*, *Aesculus hippocastanum*, *Betula pendula*, *Fraxinus excelsior*, *Populus alba*, *P. nigra*, *P. tremula*, *Quercus robur*, *Salix alba*, *Tilia cordata*, *Ulmus laevis*, concrete and stone tombstone, wooden benches, wooden and metal crosses  
Stands: 3, 4, 5, 6, 9, 10, 11, 13, 15, 16
- Physcia stellaris* (L.) Nyl. – bark of *Populus tremula*  
Stand: 13

- Physcia tenella* (Scop.) DC. – bark of *Acer pseudoplatanus*, *Fraxinus excelsior*, *Populus tremula*, *Tilia cordata* and stone tombstones  
Stands: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16
- Physconia enteroxantha* (Nyl.) Poelt – bark of *Acer platanoides*, *Populus alba*, *P. nigra*, *P. tremula*, *Quercus robur* and *Tilia cordata*  
Stands: 4, 5, 9, 11, 13
- Platismatia glauca* (L.) W.L. Culb. & C.F. Culb. – bark of *Betula pendula* and *Quercus robur*  
Stand: 4
- Pleurosticta acetabulum* (Neck.) Elix & Lumbsch, Kothe & Elix – bark of *Populus alba*  
Stand: 11
- Porpidia crustulata* (Ach.) Hertel & Knoph – stone tombstones  
Stands: 9, 15
- Protopermatia muralis* (Schreb.) M. Choisy – concrete tombstones  
Stands: 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15
- Pseudevernia furfuracea* (L.) Zopf – bark of *Betula pendula*, *Pinus sylvestris*, *Populus tremula* and *Tilia cordata*  
Stands: 9, 13, 14
- Psilolechia lucida* (Ach.) M. Choisy – concrete tombstones  
Stands: 4, 15
- Ramalina farinacea* (L.) Ach. – bark of *Fraxinus excelsior* and *Populus tremula*  
Stands: 6, 14
- Ramalina fastigiata* (Pers.) Ach. – bark of *Populus tremula*  
Stand: 14
- Ramalina fraxinea* (L.) Ach. – bark of *Populus tremula*  
Stand: 14
- Rhizocarpon reductum* Th. Fr. – concrete and stone tombstones  
Stands: 1, 5, 15
- Rinodina gennarii* Bagl. – stone tombstones  
Stand: 4
- Sarcogyne regularis* Körb. – concrete tombstones and walls  
Stands: 2, 3, 4, 9, 12, 13
- Scoliosporum chlorococcum* (Graeve ex Stenh.) Vězda – bark of *Acer platanoides* and *Betula pendula*  
Stands: 1, 3, 5, 15, 16
- Scoliosporum umbrinum* (Ach.) Arnold – stone tombstones  
Stands: 4, 10, 15
- Staurothele ambrosiana* (Massal.) Zsch. – concrete walls  
Stand: 8
- Stereocaulon condensatum* Hoffm. – layer of the hummus and concrete tombstones  
Stand: 15
- Stereocaulon tomentosum* Fr. – layer of the hummus on tombstones  
Stand: 15
- Trapeliopsis granulosa* (Hoffm.) Lumbsch – wooden cross  
Stand: 1
- Tuckermanopsis chlorophylla* (Willd.) Hale – bark of *Carpinus betulus*, *Fraxinus excelsior*, *Juniperus communis*, *Pinus sylvestris*, *Populus alba* and *P. tremula*  
Stands: 3, 11, 14
- Usnea hirta* (L.) Weber ex F.H. Wigg. – bark of *Acer platanoides* and *Pinus sylvestris*  
Stands: 9, 10
- Usnea subfloridana* Stirt. – bark of *Populus tremula*  
Stand: 14
- Verrucaria* sp. – concrete and stone tombstones  
Stands: 1, 2, 5, 6, 9, 10, 11, 14, 15
- Verrucaria nigrescens* Pers. – concrete and stone tombstones  
Stand: 15
- Vulpicida pinastri* (Scop.) J.-E. Mattsson & M.J. Lai – bark of *Betula pendula* and *Juniperus communis*  
Stands: 5, 14
- Xanthoparmelia conspersa* (Ach.) Hale – big thallus (biggest for to 0.5 m in diam), on stone tombstones  
Stands: 5, 6, 15
- Xanthoria elegans* (Link) Th. Fr. – concrete and stone tombstones, concrete walls  
Stands: 4, 5, 6, 9, 15
- Xanthoria parietina* (L.) Th. Fr. – bark of *Acer negundo*, *A. platanoides*, *A. pseudoplatanus*, *Fraxinus excelsior*, *Populus alba*, *P. tremula*, *Quercus robur*, *Salix alba*, *Tilia cordata*, *Ulmus laevis*, concrete tombstones, wooden and metal crosses  
Stands: 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 15, 17, 18
- Xanthoria polycarpa* (Hoffm.) Th. Fr. ex Rieber – bryophytes growing on concrete tombstones, stone tombstones, wooden benches, bark of *Acer platanoides*, *Fraxinus excelsior*, *Populus alba*, *Quercus robur*, *Salix alba* and *Tilia cordata*  
Stands: 1, 5, 6, 7, 9, 10, 11, 15, 17.

## DISCUSSION AND CONCLUSION

Cities, being individual ecological systems, are extremely heterogenous in terms of habitat and biocenosis because apart from primal conditioning which diversifies the landscape and its natural components there can be added numerous anthropogenic factors. An inseparable element of the city landscape is a cemetery. It is a set of graves and has considerable meaning for national heritage, for preserving and handing down the testimony of history for next generations, it is also a treasured monument which consists of sculptures, memorials, gravestones, vaults or chapels reflecting the character and origin of the dead or of the period it was built in. Cemeteries are also valuable nature objects, ecological systems, vegetation places for many plants and living organisms.

Lichenological richness of cemeteries depends on many factors, among others on the balance of two processes: spreading of some and retreating or even extinction of other species; on the accumulation of habitats and formation of new substrata (completely artificial), on the way of use of the cemetery, its age and degree of afforestation. The highest degree of taxonomic diversification of lichenbiota can be found on cemeteries situated on the outskirts of the city. And this confirms a general ecological rule according to which moderate intensity of anthropopressure favours biodiversity increase, especially species richness.

A high degree of diversity is exhibited by the cemeteries which apart from the accumulation of rock substrata of gravestones, monuments, walls are

concentrations of high greenery in the city. The degree of development of epilythic lichens on cemeteries depends on their age, use, mineral composition of the substratum, exposure, shading and humidity. By building anthropogenic habitats for rock lichens man often contributes to their spreading and crossing geographical barriers.

Many authors have described old, abandoned cemeteries as habitats which contribute to the floristic diversity increase of epilythic lichens. The importance of this kind of habitat was valued by KOZIK (1994), who pointed out the role of cemeteries in spreading rock mountain taxa and lowering their range. KISZKA and LIPNICKI (1994) analysing lichens on stone circles on prehistoric burial ground "Stone Circles" („Kęgi Kamienne") in the Tuchola Forest (Bory Tucholskie) stated that an interesting group of lichens consists of those whose centre of occurrence are the mountains, and they were recorded on very few stands on lowland.

The results of the investigations carried out on the lichenbiota of the cemeteries in Białystok show that it encompasses many species which are adapted to anthropogenic environmental conditions and is characterised by a complex of interactions on biological and ecological levels.

Many species are common synanthropes, nitrophilous, coprophilous (ornithocoprophilous) and coniofilous. The significant importance is reflected in two taxonomic species grouped mainly in orders *Buelliales* and *Lecanorales* which show preference for the bark of deciduous trees, mainly aspen. These are hemerophilous lichens whose favourable growth conditions have been caused by environmental changes. This category also comprises some calciphilous epilythic species, e.g. *Caloplaca citrina*, *C. holocarpa*, *Candelariella aurella*, *Lecanora albescens*, *L. dispersa*, *Protoparmeliopsis muralis*. The retreat of sensitive taxa has made way for new ecological niches colonized by lichens which are resistant to pollution and also by nitrophilous species. It has been indicated by a big number of stands of the species which are most resistant to environmental pressure, e.g. *Lecanora conizaeoides*, *Scoliosporum chlorococcum*. On cemeteries located in forests (National Memorial Place or military cemetery) species connected with forest communities are present on tree bark (*Imshaugia aleurites*, *Pertusaria albescens*, *Usnea hirta*, *U. subfloridana*).

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