Appendix 2.2.

SELF-REVIEW AND PRESENTATION

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NAME AND FAMILY: **Anna Matwiejuk**

1. **SCIENTIFIC DEVELOPMENT**

Diplomas, scientific degrees:

1994 **master of biology (M.Sc.)**, Warsaw University, Bialystok Branch, Faculty of Mathematic and Natural, Institute of Biology,
Title of the MSc thesis: *Lichens of Monkinie reserve and Studziany Las reserve in Wigry National Park*,
Supervisor: Prof. Jan Bystrek.

2004 **doctor of biological sciences (Ph.D.)**, University of Bialystok, Faculty of Biology and Chemistry, Institute of Biology,
Title of the PhD dissertation: *The influence of anthropogenic factors on lichens of Bialystok,*
Supervisor: Prof. Jan Bystrek.
Reviewers: Prof. Maria Olech (Jagiellonian University),
Prof. Ewa Bylińska (University of Wroclaw).

2. **PROFESSIONAL EXPERIENCE**

1994-1995 **Department of Animal Histology and Embryology, Institute of Biology, Faculty of Mathematics and Natural Sciences, University of Warsaw, Branch in Bialystok, Świerkowa 2B, PL-15-950 Bialystok**; assistant.

1995-2005 **Department of Botany, Institute of Biology, Faculty of Mathematic and Natural Sciences, University of Warsaw, Branch in Bialystok and University of Bialystok**, **Świerkowa 2B, PL-15-950 Bialystok**; assistant.

2005- **Department of Botany and Department of Plant Ecology, Institute of Biology, Faculty of Biology and Chemistry, University of Bialystok**, Konstanty Ciołkowski 1J, PL-15-245 Bialystok; adiunkt (adjunct)

3. ACHIEVEMENT PROPOSED AS THE BASIS FOR OBTAINING THE RANK OF *DOKTOR HABILITOWANY* (according to the Art. 16 Par. 2 of the Act of March 14, 2003 on scientific degrees and scientific titles as well as degrees and titles in the arts (Dz. U. 2016 r. poz. 882 ze zm. w Dz. U. z 2016 r. poz. 1311.)

A) title of the scientific achievement:

According to the Art. 16 Par. 2 of the Act of March 14, 2003 on scientific degrees and scientific titles as well as degrees and titles in arts (Dz. U. 2016 r. poz. 882 ze zm. w Dz. U. z 2016 r. poz. 1311) below are listed eleven original publications I presented as the basis for habilitation

Lichen biota of North-Eastern Poland relating to habitat-anthropogenic conditioning

B) the publications as a basic for habilitation

1. **Matwiejuk** A. 2015. Lichens of Narew National Park. Parki nar. Rez. przyr. 34.2: 3-37.

MSHE points2015 – 5

2. **Matwiejuk** A. 2014. Study materials of lichen biota of central part of landscape park "Podlasie Bug Water Gap". Rocz. AR Pozn., Seria: Botanica-Steciana 18(1): 13-20.

MSHE points2014 – 4

3. **Matwiejuk** A. 2016. The occurrence of epigeic lichens in different habitats around the Siemianowka Lagoon in the Upper Narew Valley. Forest Research Papers 77(2): 94-103.

MSHE points2016 – 13

4. **Matwiejuk A.** 2016. The revision of specimens of the *Cladonia pyxidata-chlorophaea* group (lichenized Ascomycota) in NE Poland from herbarium of University of Bialystok. Acta Mycol. 51(2): 1-11. DOI: http://dx.doi.org/10.5586/am.1087

MSHE points2016 – 14

5. **Matwiejuk A.** 2017. Lichens of Sokółka (Podlasie, North-Eastern Poland). Polish Journal of Natural Science 32(1): 71-89.

MSHE points2016 – 14

6. **Matwiejuk** A. 2015. Lichens of Supraśl town (Podlasie, North-Eastern Poland). Rocz. AR Pozn., Botanica-Steciana 19(3): 133-142.

MSHE points$_{2015}$ – 7

7. **Matwiejuk** A., Wójtowicz E. 2013. Lichens of Elk in Warmian – Masurian voivodeship. [In:] Ciereszko I., Bajguz A. (eds.), Biodiversity - from cell to ecosystem. Plants and fungi in changing environmental conditions, Bialystok, Polish Botanical Society 21: 291-306.

MSHE points$_{2013}$ – 4

8. **Matwiejuk** A. 2011. Anthropogenic changes of lichen biota of the Białowieża (Podlasie, Eastern Poland). Rocz. AR Pozn., Botanica Steciana 15: 129-138.

MSHE points$_{2011}$ – 5

9. **Matwiejuk** A. 2015. The effect of habitat conditions on the lichens of selected Jewish cemeteries in Podlasie (Poland NE). Israel Journal of Plant Sciences 63.2: 85-95.

IF$_{2014/2015}$ – 0,319/ IF$_{5–letni}$ – 0,323 / MSHE points$_{2015}$ – 15

10. **Matwiejuk** A. 2014. Lichens of larch *Larix* sp. in places of the Podlasie province (NE Poland). Ecological Questions 19: 9-24.

MSHE points$_{2014}$ – 6

11. **Matwiejuk** A. 2011. Lichens of alien trees and shrubs of Białystok (North-Eastern Poland). Rocz. AR Pozn., Seria: Botanica Steciana 15: 139-148.

MSHE points$_{2011}$ – 6

MSHE points – 93; IF – 0,319

The average share is: 99%

C) elaboration on the scientific purpose of the works subjected as the basis for obtaining the degree of *doktor habilitowany* and the achieved results

INTRODUCTION

Lichens (lichenized fungi) are organisms of the result of symbiosis between fungi (Ascomycota or Basidiomycota) and green algae (Chlorophyta) and / or Cyanobacteria (Cyanobacteria). They are widely spread organisms (grow on the bark of trees and shrubs, wood, soil, rocks, etc.) and play a significant role in all ecosystems around the world, especially in the most extreme conditions, in polar areas, high in the mountains and in the deserts. Because of the dual nature of the thallus, lichens are valuable objects of scientific research, including ecological, physiological, evolutionary, but are also bioindicators of environmental changes under the influence of anthropopression. Environmental changes are one of the reasons for the change in the number of lichen species, their composition and frequency of occurrence.

Area of north-eastern Poland is considered one of the largest biodiversity center, including lichens, in the lowlands of our country. One of the most valuable places in this respect is the Podlaskie voivodeship, where they are located, e.g. Forests: Bialowieza, Knyszynska, Augustowska, Biebrza Marshes (Biebrza Valley) - the centers of biodiversity in Poland (Cieśliński 2003). Podlaskie is distinguished by above average natural values. It consists of natural areas relatively unchanged, protected by law, a developed network of rivers and lakes, rich fauna and flora, high forest cover of 30.5% (Poland 29%). Significant share – 32% (645 990.7 ha) are protected areas of special natural value: national parks – 92 169.9ha, nature reserves – 23 755.5ha, landscape parks – 83 531.9 ha, protected landscape areas – 444 209.4 ha. The largest share of protected areas – 69% are protected landscape areas. National parks make up 14% (Dziemianowicz et al. 2013).

The area of the voivodeship (20 187 km^2) accounts for 6.5% of the country's territory (6th among 16 voivodeships). Podlaskie is classified as a province with a typical agricultural character. In 2012, rural areas accounted for 95.5% (93.1% nationwide). The region extends along the Podlasie Lowland and the Polish part of the Lithuanian Lakeland, adjacent to the Masurian Lake District, the North Plain and the Southern Plains. Western parts of Łomża are part of the Mazovian Lowlands. The voivodeship was border with Belarus from the east and with Lithuania from the north (Dziemianowicz et al. 2013). This isolated area is a well-defined territorial unit with specific characteristics.

The climate of Podlaskie voivodeship is more severe than in other regions of Poland. It is heavily influenced by masses of continental air. It is one of the cooler regions in the country (the average annual temperature of the air is below 7 ° C). The precipitation amounts to an average of 550 mm in the south to 700 mm in the north of the voivodeship. West and southwest winds are predominant in the region. The climatic conditions result in a shortened vegetation period of the plant - 190-205 days (Dziemianowicz et al. 2013).

In terms of geobotanical, North-Eastern Poland stands out from other regions of Poland with a large accumulation of boreal species (Cieśliński 2003). This is reflected in the geobotanical nature of forest communities. The non-forest vegetation is frequently a secondary and anthropogenic character (Cieśliński 2003).

In Podlaskie vovodeship, there are 40 cities, including 3 cities with powiat status. According to the data of 30 June 2016, the voivodeship had 1 187 587 inhabitants, which constituted 3.1% of the population of Poland (GUS 2016).

The main sources of air pollution are anthropogenic emissions from industrial, residential and communications sectors. The sectoral emission structure shows that the main source of SO_2 emissions is the heat supply sector. The source of particulate pollutants is mainly energetics, which also results in the majority of gaseous pollutants in the form of SO_2 and nitrogen oxides (NOx). Between 2004 and 2012, SO_2 emissions systematically decreased. NOx emissions have not substantially changed (Dziemianowicz et al. 2013). High biodiversity of this region of Poland coexists with very low emission of pollutants (average pollution in Poland is ten times higher than in Podlaskie voivodship).The assessment of the environmental status of the Podlaskie voivodeship with unique natural values indicates that it is the region with the highest environmental quality standards in Poland.

Even though beginnings of lichenological examinations in North-Eastern Poland might be dated as 150 years ago (Ohlert 1870, Błoński 1888, 1889, Savič 1923, Krawiec 1938,), until the 60s of the 20th century, a large portion of this region of Poland lacked detailed lichenological data. After the Second World War, Rydzak (1961, 1969) and Bystrek (1963, 1964, 1965, 1970, 1974) started the study on lichen biota in this region of Poland. The lichen distribution of this area of Poland covers about 500 lichen taxa (Cieszyn 2003).

The best known as regards of lichenological studied are selected forest areas, as Białowieza Forest (Cieśliński and Tobolewski 1988, Cieśliński 2003, 2010 and others), Knyszyn Forest (Cieśliński and Zielińska 1994, Cieśliński 1995, Bystrek and Kolanko 2000, Cieśliński 2003 and others), Augustow Forest (Fałtynowicz 1994a, Cieśliński 2003), Romincka Forest (Zalewska et al. 2004a), Borecka Forest (Zalewska 2012) and protected areas, including national parks (NP), as Wigry NP (Fałtynowicz 1994a, Bystrek and Matwiejuk 1999), Biebrza NP (Kolanko 2005), Białowieza NP (Rydzak 1961, Cieśliński 2010) and landscape parks (LP), as Suwalski LP (Zalewska et al. 2004b, c) and nature reserves (Bystrek and Anisimowicz 1981, Bystrek and Chwojko 1982, Kolanko 2001, 2008, 2009, Fałtynowicz and Kukwa 2002, Jando and Kukwa 2003, Kubiak 2008 and others).

In this region of Poland, what is noticeable is the lack of basic research documenting the resources of lichen species in cities (Rydzak 1957, Jastrzębska 2002, Kubiak 2005, Matwiejuk 2007, Kukwa and Kubiak 2008).

In Poland, detailed studies of species composition and lichen coverage in urbanized areas were conducted mainly in Western Pomerania, Małopolska and mountain areas, while the remaining areas are less well known (Matwiejuk and Korobkiewicz 2012 and others). Cities as anthropogenic ecosystems that are the site of lichen vegetation are studied worldwide (Brodo 1968, Rose and Hawksworth 1981, Farkas et al 1985, Loppi et al 2002, Biazrov 2006, Dymytrova 2009 et al.). The lichen biota status, changes in species composition and lichen occurrence over time and lichens as bioindicators to assess the state of the environment through the use of various bioindication methods are analysed in urban environments.

In North-Eastern Poland, there are relatively few studies analysing the participation of lichens in areas with varying degrees of anthropogenic transformation, including agricultural landscape (Bystrek 1964, Bystrek and Kolanko 2000, Cieśliński 2003, Szymczyk and Zalewska 2008, Kubiak and Bobińska 2012, Kiercul 2015a, b and others).

Repeatedly emphasized that the change in land use has a large impact on the diversity of lichens (Lipnicki 1990, Fałtynowicz 1997, Kościelniak 1998, 2004, Ruoss 1999, Stofer et al. 2006, Szymczyk and Zalewska 2008, Lipnicki and Sobieralska 2009, Optyke et al. 2011, Zarabska 2011, Zarabska – Bożejewicz 2016 and others). Agricultural activity promotes the formation of new habitats and artificial substrates, which affects the process of the spread of lichens. On the other hand, as a result of intensive land use is observed mean decrease in the number of rare species of lichens (Zielińska 1980, Fałtynowicz 1997, Ruoss 1999, Stofer et al. 2006 and others). Agricultural economy, according to Zielińska (1980), affects the impoverishment of epiphytic lichen communities on boulders lying in meadows, fields, among rural buildings.

National data on the presence of lichens in the agricultural landscape primarily include epiphytes (Kuziel 1964a, b, Kościelniak 1998, Śliwa 1998, Czarnota 2000, Zarabska et al. 2009, Zarabska 2011, Łubek and Biskup 2012 and others) and saxicolous lichens growing on the roadside and field stones or used for the construction of different fences (Olech 1973, Zielińska 1980, Karczmarz et al. 1988, Lipnicki 1990, Kiszka and Piórecki 1991, Fałtynowicz 1997, Śliwa 1998, Czarnota 2000, Kościelniak 2004 and others). Fewer data, were collected for lichens of other habitat groups, including terricolous lichens growing in pastures, wastelands, roadsides (Lipnicki 1990, Czarnota 2000, Śliwa 2006 and others) and lignicolous lichens colonizing wood of various wooden structures (Bystrek 1964, Kiszka and Piórecki 1991, Śliwa 2006, Szymczyk and Zalewska 2008 and others).

In the lichenological literature are often cited examples of colonization by lichens various substrates and habitats of anthropogenic origin (Brightam and Seaward 1977, Hickmott 1980 Martins et al. 2004, Szymczyk and Zalewska 2008, Zarabska 2011, Kościelniak and Betleja 2013, Zarabska-Bożejewicz 2016 and others). An example of human activity, which contributes to increasing ranges by certain species of lichens, is setting up of fruit orchards in urban areas (Kuziel 1964a, b, Kiszka and Piórecki 1991, 1992, Kościelniak 1988, 2004, Lipnicki and Sobieralska 2009, Zarabska et al. 2009, Zarabska 2011, Łubek and Biskup 2012, Zarabska-Bożejewicz 2016), as well as planting trees along the roads (Rydzak 1970, Lipnicki 1990, Kiszka 1994, Czarnota 2000).

An interesting objects of study are also cemeteries and parks, which clearly increases the mosaic of landscape and help to increase biodiversity. National data on lichens of cemeteries are few (Kiszka and Lipnicki 1994, Kozik 1994, Grochowski 2002, Jastrzębska 2005). The colonization of gravestones by lichens in England, Scotland, Wales (Wade 1978, Chester 1992, 1997, Hill 1994, Leger and Forister 2009) and in Germany (Buchholz et al. 2016) were studied. The researches on the biodiversity of lichens in rural, city and manors parks were conducted in different regions of Poland (Czarnota 1994, Kubiak and Sucharzewska 2004, Dimos 2005, Sadowska-Deś 2008, Kubiak et al. 2015), and in foreign countries, e.g. in Estonia (Sander 1988), in Belarus, in Minsk Region (Yatsyna 2014).

The phenomenon of the impact of human activities on lichen biota has been observed for a long time, mainly in terms of extinction and withdrawal of lichens. The importance of individual factors causing regression of species within the major ecological groups of lichens varies. The main factors responsible for the elimination of lichens, among others, are: air pollution, elimination of substrates and habitat destruction, change of climate and water relations (Nylander 1866, Rydzak 1953, Hawksworth and Rose 1970, Kiszka 1977, 1999, Cieśliński and Czyżewska 1992, Bystrek 1997, Bystrek and Kolanko 1994 and others).

Rydzak (1953) saw the cause of lichen extinction in the specific conditions of the city microclimate, especially the humidity and temperature (dry hipotesis). Bystrek (1997) suggested that the lichens is not insignificant atmospheric water pollution, either similarly, every twenty-four hour water shortage in lichens thalli is correlated with the daily changes in relative humidity (physiological drought hypothesis). Numerous studies of lichens in the cities indicate that a key factor in limiting the incidence and survival of lichens in the urban environment is the degree of air pollution of sulphur dioxide SO_2 (toxic hypothesis) (Nylander 1866, Hawksworth and Rose 1970, Kiszka 1977, 1999, Fałtynowicz et al. 1991, Cieśliński and Czyżewska 1992, Kubiak 2005, Matwiejuk and Korobkiewicz 2012 and others). Recent studies have reported the effects of air pollution on ammonia NH_3 (Ruoss 1999, van Herk 1999, 2001, van Herk et al. 2003, Frati et al. 2006, Wolseley et al. 2006, Zarabska 2011). This association results in changes in lichen biota of composition in rural areas, manifested by the decline or increase in the proportion of nitrophilous and acidophilous species (van Herk 1999, 2001, Wolseley et al 2006, Zarabska 2011).

The increase in the proportion of nitrophilous species observed since the 1990s has become an important issue in modern lichenoindication studies (Ruoss 1999, van Herk 1999, 2001, van Herk et al. 2003, Frati et al. 2006, Wolseley et al. 2006) . In the Netherlands, a map of atmospheric pollution with ammonia was made based on the distribution of nitro- and acidophilus lichens (van Herk 1999). In Poland, there is little data available on the effects of nitrogen compounds on lichens (Szymczyk and Zalewska 2008, Zarabska 2011). Zarabska (2011) made a detailed analysis of impact of the air pollution from the agricultural sources was investigated based on the measurements of the lichen diversity value (LDV) for reference species and indicators of eutrophication in rural landscape of Nowotomyski Sandr.

The presence of nitrophilous and acidophilous species in area is depends on, among others the pH of the bark of trees and shrubs, contents of ammonia NH_3 in air, concentrations of ammonium ion NH_4^+ and nitrate ion NO_3^- in atmospheric precipitation (van Herk 2001, van Herk et al. 2003, Wolseley et al. 2006, Zarabska 2011). Ammonia is the main contributor to eutrophication and elevation of bark (van Herk 2001). Nitrophilous species have the ability to tolerate elevated amounts of nitrogen compounds and elevated pH (Welch et al. 2006).

The main sources of nitrogen compounds in the agricultural landscape are ammonia NH_3 and ammonium ion NH_4^+ (Ruoss 1999, van Herk 1999, Zarabska 2011). The emission of these compounds is caused by agricultural activity, mainly animal husbandry and the use of fertilizers in plant cultivation. Nitrogen source are also of nitrogen oxides NO_x, whose emissions are primarily related to traffic (automobile exhaust) in urban environments or close to roads and motorways (van Herk 2001, Wolseley et al. 2006).

In Polish literature, the significant proportion of nitrophilous lichens in areas with varying degrees of anthropogenic influence was repeatedly emphasized (Kościelniak 2004, Śliwa 2008, Zarabska 2011, Zarabska-Bożejewicz 2016 and others). They were listed on a variety of substrates, such as bark of trees growing within buildings, trees standing in the fields, roadsides, bark of trees with elevated pH values of bark such as poplars and artificial rock beds containing calcium carbonate and erratic boulders lying on the fields, meadows or within human settlements. Among the most commonly genus of nitrophilous species of lichens are: *Caloplaca, Calogaya, Flavoplaca, Candelariella, Physcia, Phaeophyscia, Physconia, Polycauliona, Ramalina, Xanthoria* (Bystrek 1966, Kuziel 1964 a, b, Kiszka and Piórecki 1991, Fałtynowicz 1997, Śliwa 1998, Bystrek and Kolanko 2000, Kościelniak 2004, Szymczyk and Zalewska 2008, Zarabska 2011, Łubek and Biskup 2012, Zarabska-Bożejewicz 2016 and others).

The undeniable need, or even the necessity for systematic research related to the development of condition of lichen biota depending on land cultivation by humans and research on the transformations occurring in the lichen biota under the influence of human activity provoked me to undertake studies on the issue. I have conducted studies aimed at broadening the knowledge on the diversity of lichens in North-Eastern Poland, their participation in different habitat types, their ecology and their distribution. As the study area I chose the North-Eastern Poland, and in particular Podlaskie voivodeship, as this area meets the conditions necessary to conduct out lichenological studies, it is characterized by a great diversity in terms of the possibility of habitat for lichens.

The occurrence and characterization of lichen biota in areas subjected to human activity in North-Eastern Poland have not been fully recognized. Existing data on lichens records in areas with varying levels of anthropopression are causal. These shortcomings will largely eliminate these detailed studies. They are an attempt to determine lichen resources in this region of Poland taking into account habitat-anthropogenic conditions, distribution of species, their dynamics, threats and protection. The basis for these assumptions was the list of lichen species and their positions occurring in areas with varying degrees of anthropogenic influence.

During many years of research in North-Eastern Poland, I gathered extensive data on the condition of lichen biota in different habitats within communities with different degrees of anthropogenic transformation, in the communities of anthropogenic (land urbanized – cities, villages, cemeteries, roadsides and wasteland), in seminatural communities (grasslands, woodlots and rivers) and in the communities of natural (pine, greenwood pine). Material for analysis degree of differentiation of species of lichens collected within two protected areas, 32 cities, towns and villages, 14 cemeteries, 100 research stands located at roadsides, grasslands, fallow agricultural lands, etc. In total, the study was conducted on approximately 500 stands, which were made in 1200 quotations (lists) and a set of more than 500 herbarium specimens representing at the same time documentary material.

The above-mentioned papers as a leading scientific achievement give an image of contemporary lichen biota in areas with diverse habitat conditions in this region of our country. The results of these studies may provide the basis for further lichenological studies. My research complete and expand the existing knowledge of nature about some of the most important centers of biodiversity in Poland.

PRESENTATION OF ACHIEVED RESULTS OF THE FOREGOING PAPERS

1) **Matwiejuk** A. 2015. Lichens of Narew National Park. Parki nar. Rez. przyr. 34.2: 3-37.
2) **Matwiejuk** A. 2014. Study materials of lichenbiota of central part of landscape park "Podlasie Bug Water Gap". Rocz. AR Pozn., Botanica-Steciana 18(1): 13-20.

The main aim of these two papers was to identify and document the diversity of lichen species present in two protected areas in the Podlaskie voivodeship. Attempts have been made to determine:

- Whether the study areas under legal protection, forming a mosaic of natural, seminatural and anthropogenic elements, have influence on the diversity of lichens, particularly by current diversity of the habitat and substrate?
- Whether on their areas there are specific lichens refuges of anthropogenic origin?
- Whether the observed changes to human activity have positive or rather negative impact on lichens?

I conducted the research in two protected areas bordering the river valleys, in similar habitat conditions. The chosen research subjects were the Narew National Park and Landscape Park "Podlasie Bug Water Gap". The main objectives of the parks' establishment were to preserve and protect the natural condition of the most valuable cultural parts of the river valleys in terms of nature and the landscape: in the case of the Landscape Park "Podlasie Bug Water Gap"- the left bank of the Bug – the oxbow, lakes, river meanders, swamps and forests, and in the case of the Narew National Park - a fragment of the natural, marshy valley of the Narew, from Suraż to Rzędziany. Modern vegetation of parks is a mosaic of natural, seminatural and anthropogenic elements. The areas of parks include trough oxbow lakes and rivers branches, terrestrial ecosystems interpenetrating of aquatic ecosystems, edging river valleys and urban areas.

No lichenological studies of these protected areas of NE Poland motivated me to begin my research aimed at understanding and development of the species composition of lichens on this land and determine the anthropogenic transformation of the environment, including lichens.

On the area of the Narew National Park and its protective zone I discovered 155 species of lichens. Due to the nature of the landscape Park and its buffer zone, the degree of differentiation of lichens species is typical for areas subjected to anthropogenic activities and can be considered as similar to that found on the Kalisz Plateau, in the agricultural landscape (Krawiec 1955) – 142, in Pszczewski Landscape Park (Lipnicki 1991) – 175, or in rural areas of Sandr Nowy Tomyśl (Zarabska 2011) – 174.

The results of my research have shown that a significant number of taxa of Park lichens are connected with habitats in which the dominating communities are seminatural (riparian woodlands, meadows and pastures, grasslands) and anthropogenic (country houses, fields and the surrounding field margins). The unique richness of lichens characterized by old cemeteries, parks, avenues of trees and roadside and mid-field boulders. It is associated with the accumulation of new habitats (heaps of stones, orchards, avenues of trees, woodlots, roadside, and buildings) and artificial substrates (tombstones, monuments, walls, columns). Anthropogenic transformation of the environment Narew National Park and its protective zone clearly affect the process of the lichen spread and they have a close relationship with human colonization of habitats and substrates.

The lichen biota of the studied area consists mainly of common and widespread species. The presence and distribution of individual species in the dominant agricultural landscape of the Park is dependent on many factors, from the availability of substrates, habitats, distance to roads and buildings. These results are confirmed by other researchers (Ruoss 1999, van Herk 1999, Frati et al. 2006, Pinho et al. 2008a, b, Zarabska 2011).

Studies have shown that the largest habitat group of lichens, which significantly increases over a number of stands, are epilithic, calciphilous species associated with artificial rock substrates. Widespread anthropogenic rock substrates, such as concrete, plaster, brick, present mainly in urban areas, have become available to this group of lichens. The most common species colonizing anthropogenic substrate, rich in calcium carbonate, are: *Athallia holocarpa, Calogaya pusilla, C. decipiens*, *Candelariella aurella, Myriolecis albescens, M. dispersa, Protoparmeliopsis muralis*, and others. There was also a large share of calciphilous, nitrophilous, and higrophilous species growing on stones in open places (eg. the fields, roadsides, field margins, meadows). The obtained data confirm results of Zielińska (1980), Faltynowicz (1997).

Another substrate, which promotes the spread of such species is wood. Wooden structures, such as fences, poles, benches, widely prevalent in rural areas, parks and their surroundings have become a habitat for many lichens. They are mostly common species growing on the bark of trees, for example *Hypogymnia physodes, Parmelia sulcata, Lecanora pulicaris, L. saligna* and others. These substrates are inhabited not only by the common species but also the rare taxa, for example *Bryoria fuscescens, Cetraria sepincola*.

The results of my research suggest that the ability to increase the occurrence stands also concerns epiphytes that colonize bark alone growing in the fields, meadows, water courses, roads, cemeteries and parks. The bark of trees growing near the human dwellings are abundantly covered by nitrophilous species (especially of the genus *Physcia*, *Phaeophyscia*, *Physconia*, *Ramalina, Xanthoria*). Favoring factors of the presence of nitrophilous lichens are includes, for example, the large area of cultivated fields, farms associated with livestock farming in buffer zone of the Park.

The richest epiphytic biota were founded of the bark of *Fraxinus excelsior, Populus nigra, Betula pendula, Salix* spp., *Tilia cordata, Acer platanoides*. The bark of trees occurring in the rural landscapes is an important habitat conducive to the development of lichens under protection, e.g. *Ramalina farinacea, R. fraxinea, Tuckermanopsis chlorophylla* and others.

The high share of synanthropic taxa in the general state of the lichen biota of Park shows the importance of the agricultural landscape in the formation of habitats occupied by lichen and thus its impact on the degree of differentiation lichen biota. The occurrence of synanthropic lichens is conditional on the creation of new habitats and changing habitat conditions caused by human activity. This is particularly evident in the case of lichens colonizing the bark of trees in rural landscapes and lichens colonizing stones in open areas, enriched in nitrogen compounds.

The study in the Park shows that some lichen species from the *Red list of lichens in Poland* (Cieśliński et al. 2006) were classified as near threatened category (NT), for example *Evernia prunastri* or *Hypogymnia tubulosa* in this part of Poland, are common and are not threatened, and even you can say that they are in the expansion of colonizing more and more new areas. *Ramalina farinacea, Tuckermanopsis chlorophylla* (category vulnerable - VU) also were reborn and are commonly found.

The development of terrestrial lichens in the park and its buffer zone is limited by due to the small number of appropriate habitats.

On the area of the Landscape Park “Podlasie Bug Water Gap”, in the central part I discovered 94 species of lichens. I have argued that the park is an exceptional habitat for the southern part of the region of Podlasie due to the presence of terrestrial lichens. The core constitutes acidophilic non-forest lichens related to grasslands sand. Most of them are a constant component of the thickets and pine forests *Peucedano-Pinetum*. The greatest diversity of lichens was recorded for the genus *Cladonia*. Numerous presence of lichens is associated with suitable habitats. Sterile, loose, sandy soil conducive to the development of inland forests. The most represented tree species in the forests and the parks is the Scottish pine *Pinus sylvestris*, which creates many hectares of pine forests - *Peucedano-Pinetum*. This is conducive to the spread of heliophilous, xerophilous and acidophilic lichen species. Commonly growing here is *Hypocenomyce scalaris*. There is also a frequent addition of: *Hypogymnia physodes, Parmeliopsis ambigua, Imshaugia aleurites,* and *Pseudevernia furfuracea.* These are characteristic lichens of manager forests (Cieśliński 2003). I observed that the number of species and coverage of *Pinus sylvestris* increase with the age of trees and the thinning of the tree density. The list of lichen species of pine forests grows significantly thanks to the presence of deciduous trees, mainly birch trees, which grow mainly on branch lines or forest paths.

Many species of lichens in the park inhabits the anthropogenic and seminatural habitats.

In conclusion, my research showed that the lichen in the studied parks, mainly in the Narew National Park and its protective zone, predominate among lichens of non-forest habitats, which indicates that the expansion has been caused by the anthropogenic changes in the communities and the presence of seminatural communities (plantings riverside meadows and pastures, grasslands) and anthropogenic (country houses, cemeteries, orchards, fields and accompanying field margins). The specific lichens refuges of anthropogenic origin are avenues of trees, cemeteries ("anthropogenic refuges") and grasslands, riparian woodlands ("seminatural refuges"). These areas are characterized by the occurrence of locally rare, endangered and protected of lichen species. An important role is played by the fact that these areas of parks are more than twenty years, under protection of area, which is beneficial for conditions of vegetation lichens.

The results of the studies of lichen biota of Narew National Park and Landscape Park "Podlasie Bug Water Gap", were contributed to a better understanding of biodiversity in our country and will, in practice, the effective protection of these protected areas.

3) **Matwiejuk** A. 2016. The occurrence of epigeic lichens in different habitats around the Siemianowka Lagoon in the Upper Narew Valley. Forest Research Papers 77(2): 94-103.

The good condition of lichen biota of the North-Eastern Poland and the persistence of biocenotic relationship with the participation of lichens, as well as the human impact anthropogenic offer an opportunity to track and describe the processes and dependencies that are not possible in other Polish regions (Cieśliński 2003). For these reasons, I undertook research related to interesting and important stream of research which is the problem of the spread of lichens as a result of human activity.

I conducted the research around the Siemianówka Lagoon in the Upper Narew Valley. The main objective of the study was to determine the species diversity of lichens present on the soil in different types of habitats. In addition, I estimated the species coverage and compare the overall percentage of lichens in each habitat and the share of protected and threatened species from the Red List of Lichens in Poland (Cieśliński et al. 2006). The analysis covered areas located in various conditions, i.e. *Peucedano-Pinetum* fresh pine forest community, *Cladonio-Pinetum* dry pine forest, *Spergulo-Corynophoretum* grasslands, pine thickets and their edges, roadsides, and fallow.

I analyzed the data using a variety of fundamental statistical methods: analysis of variance (AVON) and Kruskal – Wallis test.

I was recorded 48 species of lichens of 7 genera as growing on the soil of the study area. The most numerous genus were *Cladonia* (33 species), *Cetraria* and *Stereocaulon* (3 species of each).

The psammophilous grasslands of the *Spergulo-Corynophoretum* association and pine thickets and their edges were characterized by the richest lichen biota (27 species of each). This is facilitated by high light intensity and that in stands of young lichens have the ability to maintain the as the layer of moss just beginning to play. This confirms the results of other research (Fałtynowicz 1980, 1986, Czyżewska 1992, Stefańska–Krzaczek and Fałtynowicz 2013) on the presence of the greatest number of terricolous species of lichens, including *Cladonia* lichens, in young tree stands. Lichens, mainly of the genus *Cladonia*, which are heliophilous species, prefers forests with a high level of sunlight. Good habitats for the development of terrestrial lichens are also areas of the *Cladonio-Pinetum* inland dry pine forest (23 species) and the roadsides and roadside sandy slope (20). The smallest species diversity of lichens have indicated on fallow agricultural lands (12 species) and in the *Peucedano-Pinetum* continental fresh pine forest (12).

I found that the average number of lichen species was highest on the surfaces of the psammophilous grasslands, and the smallest average was found in the *Peucedano-Pinetum* continental fresh pine forest. The average percentage of coverage of terrestrial lichen species was the highest in the areas of the *Cladonio-Pinetum* inland dry pine forest, the lowest in the *Peucedano-Pinetum* continental fresh pine forest. Despite these differences, both the number and coverage of lichens were relatively large.

The strictly protected species were found in the pine thicket edges, psammophilous grasslands, roadsides and *Cladonio-Pinetum* inland dry pine forests, while the endangered species from various categories were noted in the psammophilous grassland and pine thicket edges.

Biota of terrestrial lichens of study area includes some interesting and rare taxa, such as *Cladonia botrytes, Peltigera praetextata, Cladonia caespiticia* and *Pycnothiella papillaria*. New species, which were recorded in this area, directly adjacent to the Białowieża Forest are: *Cladonia novochlorophaea, C. stellaris, Peltigera didactyla, P. horizontalis* and *Stereocaulon tomentosum*.

During the present study is not confirmed, several species from the area of the Bialowieza Forest served by Cieśliński and Tobolewski (1988) and Czyżewska (1992). The following species were not found again: *Cladonia foliacea*, *C. symphycarpa*, *C. turgida, Diploschistes muscorum*, *Peltigera malacea, Placynthiella oligotropha, Stereocaulon condenstatum* and others.

In conclusion, my research showed that the epigeic lichens in different habitats around the Siemianowka Lagoon in the Upper Narew Valley, mainly non-forest (grasslands, the coast of the thickets of pine, roadsides), which indicates that the expansion brings with anthropogenic changes communities and the formation of non-forest habitats. The results of the analysis also show a great biodiversity of terricolous lichens in the study area and the lichen species diversity is positively correlated with the types of communities. The lower number of the recorded species may be evidence of the progressing succession. With succession, habitats colonised by lichens, such as grasslands and pine thicket edges, are transforming naturally, which also means the withdrawal of lichen species.

4) **Matwiejuk A.** 2016. The revision of specimens of the *Cladonia pyxidata-chlorophaea* group (lichenized Ascomycota) in NE Poland from herbarium of University of Bialystok. Acta Mycol. 51(2): 1-11.
DOI: http://dx.doi.org/10.5586/am.1087

I conducted a revision of lichen specimens from *Cladonia pyxidata-chlorophaea* gropup in North-Eastern Poland from herbarium of University of Bialystok. These specimens were not chemically determined to distinguish species that differed in the composition of lichen secondary metabolites. As a great part of the herbal material was misidentified, I found my studies to be necessary and decided to continue our revision. The aim of this paper is to present the results of studies on the chemistry, morphology, habitat requirements and distribution of members of the species of the *Cladonia pyxidata-chlorophaea* group in NE Poland. The area of study includes protected areas (e.g., Wigry National Park, Biebrza National Park, Narew National Park, Podlaski Przełom Bugu Landscape Park, Puszcza Knyszyńska Landscape Park) and areas not protected in the vicinity of the villages or small towns (e.g., Suchowola, Kaniuki, Ciechanowiec, Boćki) and agricultural landscape.

The paper contains the exact characteristics of the species with the most important diagnostic features, ecology, distributions in Poland and in the world and maps of the distribution of species in North-Eastern Poland. The paper presents further positions of species in the lowlands compared to the distribution in the country (Kowalewska et al. 2008).

The species of *Cladonia pyxidata-chlorophaea* complex are characterized by scyphose podetia covered with farinose to granular soredia, corticated granules and cortical layer, and brown apothecia. In this paper, I accept a conception to support chemically defined taxa at the species level (Kowalewska et al. 2008). In such cases, secondary metabolites of lichens play a decisive role in the identification of the research material.

Nine species of the *Cladonia pyxidata-chlorophaea* group were found in the examined material (*Cladonia chlorophaea, C. conista, C. cryptochlorophaea*, *C. fimbriata, C. grayi, C. merochlorophaea, C. monomorpha, C. novochlorophaea, C. pyxidata*), out of 12 recorded in Poland (Kowalewska et al. 2008). Three taxa, C*. conista, C. cryptochlorophaea, C. merochlorophaea* are known only from very few locations in Poland. In the study area, *Cladonia fimbriata* appeared to the most common species of the investigated lichen group in NE Poland (33% of study specimens).

The lichens from the group *Cladonia pyxidata-chlorophaea* were found in NE Poland on soil, in open and sun-exposed sites, and in pine forest. Three species (*Cladonia chlorophaea*, *C. fimbriata*, *C. novochlorophaea*) have been reported on bark of trees. *Cladonia chlorophaea*, *C. fimbriata*, *C. grayi*, and *C. novochlorophaea* have been found on wood (wooden constructions, stumps, dry branches, etc.). Only one specimens of *Cladonia fimbriata* has been reported on rock.

The studies have shown, that species from the *Cladonia pyxidata-chlorophaea* group were differed in their chemical characteristics. In four species of this group, the only chemical component is fumarprotocetraric acid complex (*Cladonia chlorophaea*, *C. fimbriata*, *C. monomorpha*, *C. pyxidata*). In other species have been occur fumarprotocetraric acid and other acids. Bourgeanic acid was detected in one species (*Cladonia conista*). Gyrophoric acid has been found only in *Cladonia grayi*. Cryptochlorophaeic acid and paludosic acid have been detected in *Cladonia crypto-chlorophaea*. In *Cladonia merochlorophaea*, substances detected by TLC, have been include merochlorophaeic acid and 4-*O*-methylcryptochlorophaeic acid. Homosekikaic acid and sekikaic acid have been detected in *C. merochlorophaea*. Similar chemical content for many species were reported by Kowalewska et al. (2008). Presented study were confirmed utility of chemical methods in the diagnosis of the species of *Cladonia pyxidata-chlorophaea* group.

A great part of herbarium collections of Institute of Biology of University of Bialystok from NE Poland was misidentified. Except for the samples of *Cladonia fimbriata*, many studied specimens were misidentified.

5) **Matwiejuk** A. 2017. Lichens of Sokółka (Podlasie, North-Eastern Poland). Polish Journal of Natural Science 32(1): 71-89.
6) **Matwiejuk** A. 2015. Lichens of Supraśl town (Podlasie, North-Eastern Poland). Rocz. AR Pozn., Botanica-Steciana 19(3): 133-142.
7) **Matwiejuk** A., Wójtowicz E. 2013. Lichens of Ełk in Warmian-Masurian voivodeship. [In:] Ciereszko I., Bajguz A. (eds.) Biodiversity - from cell to ecosystem. Plants in changing environmental conditions, Bialystok, Pol.. Bot. Society 21: 291-306.
8) **Matwiejuk** A. 2011. Anthropogenic changes of lichen biota of the Białowieża (Podlasie, Eastern Poland). Rocz. AR Pozn., Botanica Steciana 15: 129-138.

My research in urban areas should be considered pioneering in the Podlaskie voivodeship. I made a study aimed at broadening knowledge of the lichen diversity of urban areas, and their participation in selected towns, their ecology and distribution. Knowing of the lichen biota is important for assessing the biodiversity of this region of Poland. Continuing the research which started during the preparation for the doctoral dissertation on *The influence of anthropogenic factors on lichens of Bialystok* undertook an extensive analysis of the urbanized areas in North-Eastern Poland. In the course of my research, I have been made detailed studies of lichens in 13 towns. The selected results of my research are presented in four publications that make up my scientific achievements. They present an analysis of lichenological data collected from selected, four positions located in North-Eastern Poland.

Urbanized areas are a significant part of the environment and space. Their development is characterized by high dynamics of local lichen biota, which makes the impact of cities on shaping calculated biocoenoses is high. The lichenological research of urban areas are important and valuable. This is due to the following reasons:
a) biota of lichens cities a substantial proportion of the overall composition of the biota of Poland;
– lichens urban areas account for 30% lichen biota of Poland (Faltynowicz 2003, Matwiejuk and Korobkiewicz 2012);
b) without the knowledge of urban lichens, knowledge of the lichen biota of Poland would be incomplete;

c) the lichen biota in cities is highly specificity and rapid variability in time;

– research conducted in the cities again shows the direction of anthropogenic changes: the emergence and spread of new species and the extinction of others, including the most vulnerable (e.g. Kiszka 1977, Adamska 2012);

– in the cities, in addition to well-documented examples of regression taxa caused by environmental pollution and destruction of habitats and substrates. You can also observe the processes of recolonization of some species due to the improvement of environmental conditions and the emergence of new taxa, accompanying man (apolichens) (e.g. Rose and Hawksworth 1981, Adamska 2012);

– in response to changes in habitat conditions, which lately occur in areas urban, inter alia, reduction of emissions to the atmosphere (mainly SO_2) changing species composition of lichens (e.g. Adamska 2012);

– observed an increase in the degree of eutrophication and pH of bark and its dust (Farmer 2004);

– many species of acidophilic withdrawing from the cities for nitrophilous taxa (e.g. Bystrek 1997, Seaward and Coppins 2004, Spier et al. 2010).

d) the cities are often the sources of spread of synanthropic lichens on agricultural areas, forests, etc. (e.g. Optyke et al. 2011).

The main objectives of this study were:

- determine the species composition of lichens in the surveyed localities,
- distinction of species particularly associated with urban areas,
- demonstrate the role created by man the new, anthropogenic habitats and artificial substrates,
- analysis of the share of protected species and placed on the national red list,
- determine the degree of differentiation of species of lichens in different areas of the city.

As reported from the literature, it is not clear whether the degree of using and the size of the village and city have an impact on lichen species diversity. I conducted of the research on areas four cities (three in Podlaskie and one in Warmia and Mazury voivodeship) differing in size, the degree of use, and geographical location. They were:

1. **Supraśl** lying on a wide clearing on the Supraśl river, Bialystok Upland, in the middle of Knyszyn Forest,

2. **Bialowieza** situated in the clearing of Białowieża, on the Narewka river, Bielsk Plain,
3. **Sokółka** located in the northern part of the Podlaskie voivodeship, 16 km from the Polish-Belarusian border crossing in Kuźnica Białostocka,
4. **Elk**, the largest and most populous city on Ełk Lake District, situated on the Elk Lake, Sunowo Lake, Selmet Mały Lake and Szyba Lake, the Elk River, which is a tributary of the Biebrza.

The city of Elk is a medium-sized town, calculating approx. 60 thousand residents, Sokółka the town, with a population of approx. 19 thousand and Supraśl – a small town, with the status of the spa below 5 thousand, and Bialowieza is a village of a small-town, less than 2 thousand. Research undertaken in Bialowieza were the repetition analyses carried out after several decades. The first reports about the occurring species of lichens in Bialowieza were made by Rydzak (1957), Lecewicz (1954), later in Cieśliński and Tobolewski (1988), Kukwa (2002), Kukwa et al. (2008), Cieśliński (2003, 2010). I conducted my own research on a much larger area compared to the previous studies, providing data on lichens of Bialowieza from the 50s, the 80s, and today.

The differences between the number of species in the stands located in the different types of urban land were verified by using the Kruskal–Wallis test.

These cities and towns, although diverse in terms of area size, degree of urbanization and population, is associated with each other especially large convergence of climatic and geomorphological and the similarity forms and elements utilized space.

I have argued that the lichen biota of surveyed cities and villages is characterized by high biodiversity (Izydorek 2005, Matwiejuk and Korobkiewicz 2012 and others). I found the presence of 109 species (83 today) – in Bialowieza, 89 – in Suprasl, 78 – in Elk and 76 – in Sokółka. In addition to the number of species determinant of richness of lichen biota of towns and villages is also attended by representatives of various systematic groups. In many localities the most numerous genus were represented: *Lecanora*, *Cladonia* and *Physcia*.

The study showed that regardless of the size of the locality, distribution and species composition of lichens on their premises depends on the habitat factors, both natural and anthropogenic. The basic criterion for the occurrence of individual species of lichenized fungi is the presence of suitable substrates and habitats.

I discovered lichens on various types of substrates. Availability and diversity of these substrates was an indicator species composition. I have argued that the most numerous were the epiphytic lichens. Lichen biota of individual phorophytes are differed, both in terms of quantity and quality. The richest in lichens proved deciduous trees, including maples *Acer* spp., linden *Tilia* spp., poplar *Populus* spp. and ash *Fraxinus* spp. Of particular importance for the occurrence of lichen epiphytic have phorophytes growing in large concentrations (parks, cemeteries, avenues of trees), the roads and the standing trees. The stem of epiphytic biota are a common nitrophilous lichens as *Phaeophyscia orbicularis, Physcia adscendens, P. tenella, Polycauliona polycarpa, Xanthoria parietina*. In addition to the current common lichens are sensitive taxa of the fruticose thalli *Anaptychia ciliaris* (Bialowieza, Sokółka, Supraśl), *Bryoria fuscescens* (Sokółka), *Ramalina farinacea*, *R. fraxinea* and *R. pollinaria* (Bialowieza, Elk, Sokółka, Supraśl), *R. fastigiata* (Sokólka, Supraśl), *Usnea filipendula* (Bialowieza), *U. hirta* (Bialowieza, Elk, Sokółka) and foliose thalli, as *Cetraria sepincola, Melanelixia subargentifera* and *Parmelina tiliacea* (Sokólka, Supraśl), *Physconia perisidiosa* (Elk, Supraśl), *Pleurosticta acetabulum* (Bialowieza, Sokółka) *Tuckermanopsis chlorophylla* (Bialowieza, Elk, Supraśl). This appearance is typical of urban lichen biota in the cities where there are diverse habitat conditions, high density and species diversity of phorophytes.

Subsequently, there were epilithic and epixylic lichens. Least likely were found lichens grow on unusual substrates, and epigeic and epibryophytic lichens.

I found that among epilithic lichens the most strongly represented habitat group are lichens colonizing anthropogenic substrata. They are characterized by wide amplitude and have good environmental durability. These are the lichens, which, thanks to man are increasing their ranges, inhabiting the substrate free of competition. Often they cover large areas, especially in old houses plaster, mortar, walls and pillars. Many of these species are common and very common. These include: *Calogaya decipiens, C. pusilla, Candelariella aurella, Myriolecis albescens, M. dispersa, Phaeophyscia orbicularis* and *Xanthoria parietina*. Some of them are very expansive and are characterized by rapid growth. Just a few years after the introduction into the environment of concrete structures colonize the thallus of many species of lichens. Among the pioneer species predominate of crustose thalli of lichens. Much less lichens noted with substrates quartzite available as pillars, stone walls, tombstones and boulders, stones (e.g. *Candelariella vitellina, Phaeophyscia orbicularis, Physcia adscendens, Physcia caesia*). These properties are also frequent for lichens, which were grown in rural areas (Zielińska 1980, Faltynowicz 1997, Zarabska 2011). It is a rare lichen species of preference for natural substrates. Occupied by the epilithic of anthropogenic substrates are the main substrates enabling the development of this group of lichens in areas almost devoid of natural rock surfaces.

Expansion many epixylic species conducive to all kinds of structures and wooden structures (fences, bridges, buildings, crosses). The list of species entering this type of substrate is significant. They are mostly common species growing on the bark of trees. On wooden constructions many grows lichens of crustose thallus from genus *Lecanroa, Micarea* and foliose (e.g. *Hypogymnia physodes, Parmelia sulcata, Xanthoria parietina*) and fruticose (e.g. *Pseudevernia furfuracea*).

In the cities, terricolous lichens are outside of developed urban, mostly in fragments of forest, grassland, on the sandy wasteland located in the vicinity of the administrative boundaries of cities and on the outskirts.

In the cities, lichens colonized the specific anthropogenic substrate, such as metal, cardboard, plastic, unavailable to other organisms.

The urban areas were characterized by a high proportion of nitrophilous species. The most commonly appearing lichens in the studied places are *Physcia adscendens* and *Xanthoria parietina*. These two species are also referred to by van Herk (1999), who determined the order of the nitrophilous lichens according to the frequency of their quotations under conditions of higher air pollution with ammonia in the Netherlands.

The degree of dissemination of different species is varies. Breakdown of frequency classes is typical to the lichen biota in other cities (Matwiejuk and Korobkiewicz 2012, and the references cited there). Urban areas are characterized by a significant share of taxa considered to be very rare and rare, including occurring in the study area for the individual stands. I recorded about 30% of the lichen biota on individual locations in most towns.

In order to assess the impact of habitat conditions on the occurrence of lichens, I suggested division of the city into three main areas: 1. built-up areas, including located in the centre and on the outskirts, 2 green areas (squares, parks, cemeteries, avenues of trees, forests) and 3. areas located around the roads leading out of town.

I have argued that the most valuable areas of occurrence of lichens in the cities are its green areas, parks, squares, cemeteries and forests. They are mostly epiphytic lichen habitats, including protected species and placed on the *Red list of lichens in Poland*

(Cieśliński et al. 2006). Built-up areas, situated both in the centre and the periphery are the locations of many rock lichens colonized anthropogenic substrates.

I found a diverse part of morphological forms of thallus in different areas of the city. The largest share of foliose lichens, including wide foliose thallus type *Parmelia* is in parks and forests, and crustose and narrow foliose thallus type *Physcia* in built-up areas located in the centre and the periphery.

The group of taxa which is particularly sensitive to human pressure, in addition to the endangered species are also the lichens under legal protection. Percentage of protected taxa in the cities accounted for 10% of the lichen biota, in Suprasl, and 14%, 15% and 20% respectively in the Elk, Sokółka and Bialowieza, threatened species with 14% in the Elk, 16% in Sokółka and approx. 20 % in Bialowieza, and Suprasl.

The impact of changing urban conditions, anthropopressure as emphasized Faltynowicz (1994b) and Śliwa (1998) appears as two processes: regression of some species previously held positions and the spread of others in the area.

By comparing the composition of the lichen biota today occurring in Bialowieza with historical list of species you can see the dynamics of these changes, by the tendency to withdraw from the study area several species of lichens and the emergence of new, previously unlisted. With regard to Bialowieza has a special meaning. These processes take place, in the village, located near Bialowieza Forest. While the current study did not confirm, 36 lichen species (representing 33%) given Bialowieza. Many of them are considered to be extinct in the area, and the other may still occur, but during recent studies have not been confirmed. The group of extinct species in Bialowieza are mainly macrolichens, for example *Bryoria implexa, Flavoparmelia caperata, Hypotrachyna revoluta, Lobaria pulmonaria, Melanelixia subaurifera, Melanohalea elegantula, M. olivacea, Punctelia subrudecta, Ramalina obtusata* and crustose lichens *Lecanora albella*, *L. impudens*, *L. intumescens*, *L. subrugosa, Loxospora elatina*. Extinct species are epiphytes forest growing in the past on the bark of trees, mainly in Bialowieza Forest adjacent to Białowieża and the nearby parks (Palace Park and Park Dyrekcyjny). New species of lichen taxa are the taxa which have been known for a long time, of well-established taxonomic status or associated with one type of habitat, which has not been confirmed in the previous studies. They are: *Aspicilia cinerea, Buellia griseovirens, Cladonia floerkeana, Lecanora pulicaris, Myriolecis albescens, Parmeliopsis ambigua, Rusavskia elegans,* *Scoliciosporum umbrinum* and species, which are the result of progressive human pressure, as *Calogaya* cf. *pusilla, Lecanora conizaeoides*.

The observed changes in the species composition of lichen biota of Bialowieza are caused by spatial development of the village and the changes in its management, which directly changed habitat conditions by destroying substrates occurrence of lichens and indirectly, by changing the microclimate conditions and increase air pollution.

The study confirmed that one of the basic criteria of particular species of lichenized fungi in urban areas is the presence of suitable substrates and habitats. High availability of anthropogenic habitats conducive to the spread of particular nitrophilous species, and the presence of artificial epilithic substrates – calciphilous species. These lichens often very exponentially colonize surrendered areas of a high anthropogenic pressure, increasing the number and great number of records. The processes of propagation processes are affected by changes in habitat conditions, often in conjunction with increased nitrogen pollution. As a result of habitat changes, which are observed in ecological systems, such as anthropogenic ecosystems (cities), form the one side, groups of narrowly specialized species are disappearing, or noted only on individual sites, mainly in green areas (e.g. in urban forests, parks, cemeteries), but from the second, they will be spread, often ecologically-large species are spreading, to which in turn is conducive to colonization. As a result, it is the result of progressive synatropisation, that is, changes in which some species pass away under the influence of human activity, while others spread.

A larger number of lichen species recorded in Bialowieza and Suprasl compared to Sokółka and Elk, is due to better aero-sanitary conditions and special microclimate prevailing in the towns located near large forest complexes. These studies were complete and expand existing knowledge of lichen biodiversity in urban areas in Poland.

9) **Matwiejuk** A. 2015. The effect of habitat conditions on the lichens of selected Jewish cemeteries in Podlasie (Poland NE). Israel Journal of Plant Sciences 63(2): 85-95.

While research in the cities noticed that cemeteries play a very important role of factor increasing the mosaic and the diversity of anthropogenic landscape, thus affecting the species diversity of lichens of the area. Species inhabiting cemeteries increasing the number and abundance of stands, often invading alien taxa for the area are increasing their ranges. In lowland England, where natural outcrops of rock are absent, the churchyard is the most important site for lichens growing on stone. Because of its origin, cemeteries have high ecological and natural value, as well as cultural and historical. Cemeteries, are a unique cultural heritage in many countries, including in Poland. As well as representing many years of history and the lives of those living nearby, they conserve important aspects of our natural history.

Species inhabiting cemeteries increasing the number and size of stands, often invading alien taxa for the area are increasing their ranges. Because of its origin, cemeteries have high ecological value of nature and landscape, as well as cultural and historical. The data from national literature about lichens of cemeteries are few (Kiszka i Lipnicki 1994, Kozik 1994, Grochowski 2002, Jastrzębska 2005).

The main objective of the study was documentation showing the biodiversity of lichens Jewish cemeteries and assessment of habitat conditions of species. The main objective were to serve specific tasks:

1. analysis of the diversity of lichen species,
2. award especially species associated with cemeteries in Podlasie in relation to the rarity of their listing on the area of Poland and North-Eastern Poland and / or protection status and the degree of threat in the country,
3. determine the diversity of lichen species in cemeteries located in different habitat conditions,
4. characteristics of habitat group of lichens typical of the cemeteries.

The study should also be considered as complementary studies, conducted in Jewish cemeteries by sociologists and historians, to provide special care and protection of cemeteries not only as a cultural heritage, but also natural.

By joining the research in cemeteries characterized by different habitat conditions I set the following working hypothesis: the existence of lichens is closely related to and modified by abiotic and biotic factors of the cemetery, where: the occurrence and of epilithic lichens is dependent on the availability and type of substrates and microclimate conditions, including sunlight, humidity and the presence of epiphytic lichens is dependent on the species variety of phorophytes trees and the degree of compaction. I assumed that species richness and total share valuable species will be significantly higher in the cemeteries located in open areas than in cemeteries found in forest areas, with significant shading. I analyzed the data using a variety of fundamental statistical methods: analysis of variance (AVON) and Kruskal – Wallis test.

The study was conducted in 14 cemeteries located in Bielsk Podlaski, Białystok, Choroszcz, Gródek, Krynki, Kuźnica Białostocka, Michałowo, Narew, Narewka, Orla, Sokółka, Tykocin, Wasilków, Zabłudów, in Podlaskie voivodeship.

They showed that the Jewish cemeteries are valuable positions of 83 species of lichens, including 11 placed on the *Red list of lichens in Poland* (Cieśliński 2006). The richest in species are the genus of *Cladonia* (13 species), *Physcia* (6), and *Rhizocarpon* and *Xanthoparmelia* (such as 4). Most lichens for algal partner have green algae (99%), have crustose thallus (49%) and showed a vegetative reproduction (68%). Among them are lichens, which increase their incidence ranges, thanks to its ability to reproduce vegetative (soredia, isidia, fragmentation of thallus).

Considering their habitat preferences, I divided lichens growing on cemeteries into five groups: epilithic lichens (50 species), epiphytic lichens (28), epigeic lichens (11), epibriophytic lichens (3) and epixylic lichens (2). The most specific group are epilithic lichens. Of all the species recorded on epilithic substrates 38 species (48%) had an exclusive attachment to the substrate. I have shown different species composition of lichens colonizing gravestones and sarcophagus made of epilithic material differing physical properties and chemical composition. On stone, granite tombstones made mainly of boulders grow acidophilus lichens prefer acid substrates, such as *Acarospora fuscata, Candelariella coralliza, Lecidea fuscoatra, Xanthoparmelia conspersa, X. loxodes, X. pulla* and others. The common calciphilous lichens were colonized the concrete monuments. The most common taxa are *Myriolecis albescens, M. dispersa, Candelariella aurella, Flavoplaca citrina, Calogaya decipiens, Protoparmeliopsis muralis*. These species are widely distributed in the country and region. Among the calciphilous species are also the rare species: *Circinaria calcarea, Myriolecis crenulata, Sarcogyne regularis*. They are accompanied by the nitrophilous lichens, eg. genus *Physcia* and *Xanthoria*. On the few gravestones, I met epiphytic lichens in nature, such as *Hypogymnia physodes, Parmelia sulcata* and others. A particular group are epibryophytes, who grow on rocks. Among them are: *Biatora tetramera, Diploschistes muscorum, Lecania erysibe* and common species: *Cladonia cornuta, C. macilenta*.

I also observed that on gravestones in cemeteries, which were located in open areas, among fields, wasteland, heliophilous, nitrophilous lichens were common, as confirmed earlier results (Zielińska 1980, Fałtynowicz 1997).

On gravestones located in open areas, there were numerous species that require of low humidity of substrata, e.g. *Acarospora fuscata, Candelariella aurella, Flavoplaca citrina, Calogaya decipiens, Scoliciosporum umbrinum, Xanthoparmelia conspersa, X. loxodes, Xanthoria parietina* and others. On monuments located in shaded areas, among the trees, lichens were less frequent and among them species with higher requirements, such as species of the genus *Lepraria*.

The lichen biota of cemeteries includes a number of interesting and rare species in the lowlands, as *Porpidia soredizodes* (Narewka), *Rhizocarpon lavatum* (Wasilków), *R. petraeum* (Orla), *R. grande* (Tykocin). *Rhizocarpon grande* is a new species observed for the first time in the North-Eastern Poland (Cieśliński 2003).

Rhizocarpon species are rare in lowland of Poland, and they were listed on the National Red List (Cieśliński et al. 2006), *Rhizocarpon lavatum* in critically endangered category (CR), *R. grande* in endangered category (EN) and *R. petraeum* in vulnerable category (VU). *Rhizocarpon lavatum* is similar to *R. reductum*, both species are characterized by the areolate, grey, brown thallus, hyaline, muriform ascospores, and differ in the composition of lichen secondary metabolites. *Rhizocarpon reductum* contains stictic acid, which is not produced by *R. lavatum*. *Rhizocarpon petraeum*, similar to the species of mentioned above, is characterized by the hyaline, muriform ascospores, and characteristic concentrically distributed apothecia on a grayish-white thallus and produces sticic acid. *Rhizocarpon grande* has dark and muriform spores. The chemical substances of this species are gyrophoric acid, norstictic acid and stictic acid. *Porpidia soredizodes* is a rare species in the North-Eastern Poland (Cieśliński 2003), although it is common in Northern and Central Europe, where it grows on the silicate rocks and stones (Galloway and Coppins 1993). Lipnicki (1998) reported that, it is a species which inhabits boulder areas along with the *Rhizocarpon* species (*R. geographicum, R. obscuratum*) about 17 to 21 years after their unveiling.

A Jewish cemeteries also create favourable conditions for the vegetation of many species of epiphytic lichens. This type of habitat is beneficial for lichen because the prevailing good conditions of light, and the bark of trees is enriched in addition to various types of minerals contained in depositing the dust. In particular, many species are heliophilous and nitrophilous.

My research has shown that the highest degree of differentiation of lichens species have the Jewish cemeteries located in open areas compared to those located on the outskirts of cities, in the woods. This is due, among others the favourable impact of higher intensity on the development of natural strains and the greater availability of minerals in the air.

I discovered the high degree of diversity of lichen biota in cemeteries, which, in addition to accumulation of rock substrates, monuments and walls are also rich in high greenery. Epiphytic of lichen biota of cemeteries differ in terms of quantity and quality, which was conditioned by the diversity of phorophytes species and frequency of their occurrence.

Richness of epilithic lichens species on cemeteries depended on the intensity of maintenance and use, as well as the mineral composition of the gravestones and sarcophagus and their place of occurrence, shading and humidity.

In relation to other comparable objects, the lichen diversity of Jewish cemeteries in Podlaskie voivodeship is considered to be relatively high. In England, 58 species were recorded from the area of 41 cemeteries in the county of Glamorgan, in South Wales (Wade 1978), 104 species in the south of England (Hill 1994), in Germany, in the Berlin Jewish Cemetery, 72 species (Buchholz et al. 2016). The number of 50 taxa found in Jewish cemeteries is comparable with the data from other parts of Poland, England and Germany. The epilithic biota in Weißensee Jewish Cemetery in Germany (Buchholz & al. 2016) consisted of 47 species, in cemeteries in the Carpathian Foothills (Kozik 1994) – 46, in Bogusław village (Grochowski 2002) – 44, in Tuchola Forest (Kiszka and Lipnicki 1994) – 43. The poorest epilithic lichen biota (14 species) was determined in Ugoszcz village (Jastrzębska 2005), and richness in England (Hill 1994) and in Jewish cemetery in Bieszczady Niskie, Poland (Kościelniak 2004) – such as 92. Studies were clearly show that cemeteries contribute to increasing the diversity of epilithic lichens. Kozik (1994) additionally pointed to the role of cemeteries in the spread of epilithic, mountainous species and lowers their ranges.

In conclusion, my research has showed that the cemeteries clearly contribute to the mosaic and heterogeneity of anthropogenic landscape, and lichen biota occurring on tombstones and trees clearly affect the species diversity of lichenized fungi within the area. A Jewish cemeteries served as anthropogenic lichens refuges. Among the lichenological advantages of cemeteries should be emphasized the presence of *Rhizocarpon grande,* who having here, the only one location in North-Eastern Poland.

10) **Matwiejuk** A. 2014. Lichens of larch *Larix* sp. in places of Podlasie province (NE Poland). Ecological Questions 19: 9-24.
11) **Matwiejuk A.** 2011. Lichens of alien trees and shrubs of Białystok (North-Eastern Poland). Rocz. AR Pozn., Seria: Botanica Steciana 15: 139-148.

Analysing the data from literature on the state of research on lichens in Polish cities I have observed a clear lack of data on lichen biota of larch *Larix* spp. and trees of alien origin (Matwiejuk and Korobkiewicz 2012 and others). In many lichenological studies of lichen biota in urban land, these phorophytes have been ignored.

The main objective of the research was to evaluate the diversity of lichen species colonizing bark of larch *Larix* spp. and trees of alien origin. The study involved of trees growing in different habitats, areas built.

Larch is not a tree, whose bark is particularly privileged by lichens. On its bark in Poland it reported about 100 species, and for comparison on the bark of spruce *Picea* spp. – 250 (Faltynowicz 2003). In relation to the data from the second half of the twentieth century, it is clear that this biota of phorophyte impoverishment. Currently 62% of the species of the bark of Polish *Larix decidua* subsp. *polonica* no were confirmed. Today, the lichen biota of these trees, which grown in the Chełmowa Gora Reserve (Góry Świętokrzyskie) is very poor, limited to about 20 species (Łubek 2007).

Larch species diversity of lichens, especially European larch *Larix decidua* and Japanese larch *L. kaempferi* was not the subject of separate studies in urban areas.

To increase knowledge of the settlement and the occurrence of lichens on the bark of larch *Larix* spp. I made an attempt to assess the diversity of lichen species that phorophyte in 18 cities of the Podlaskie voivodeship (e.g. Augustow, Bielsk Podlaski, Krynki, Łapy, Mielnik, Narew, Poczopek, Siemiatycze, Suraż, Waliły, Zabłudów) have different levels of anthropogenic transformation (city size, population, usage).

My observations have shown that the richness of lichens (quality and quantity) of larch depends essentially from many factors, of which the most important of which are the chemical properties of the bark, microclimate conditions and habitat conditions. Larch is a tree with oligotrophic, acidic bark (low pH) and nutrient deficient.

I found the presence of 27 species of epiphytic lichens in the surveyed cities. These include acidophilus taxa. Acidophilous lichens as *Lecanora conizaeoides, Hypocenomyce scalaris, Lepraria incana, Scoliciosporum chlorococcum* are the most widespread. These lichens, which are an acidophilous species, may be composed of the appropriate lichen biota of this phorophyte, developing in habitats, where the trees have lower pH of the bark in natural conditions. It is related to the strongly acidic nature of its bark and a small water capacity of the bark.

I observed that in many places the bark of phorophyte settle nitrophilous lichens of the genus *Physcia*, *Phaeophyscia*, some *Xanthoria*, preferring neutral or slightly alkaline nature of the substrate and substrate rich in additional amounts of nitrogen. This may suggest that elevated air pollution with ammonia in the study locations. This is confirmed by the results of van Herka (2001) that in the built-up areas and rural areas, the effects of nitrogen compounds, mainly ammonia NH_3, are high, which is reflected in the composition and the degree of diversification of lichen biota, including in particular a reduction in the share of acidophilic lichen and increased frequency trading lichens nitrophilous (van Herk 2001). This also may confirm the hypothesis put forward by Spier et al. (2010) that the reduction in atmospheric pollution, mainly decrease in the concentration of sulphur dioxide and ammonia in the last two decades and bark corresponding increase in pH, caused the epiphytic lichens have become less sensitive to the pH of the bark.

I observed that the roots of the trees growing along the roads and streets are often strongly dusty, hence their bark were overgrown by frequent nitrophilous lichens.

A higher share of nitrophilous and heliophilous lichens of foliose thalli (of the genus *Physcia, Phaeophyscia, Xanthoria*) on the bark of larch growing in urban areas also show the favourable impact of the higher intensity of light reaching the lower parts of tree trunks, growing as a single tree and the fact that unlike other conifer tree branches larch are free needles for at least six months. Only in the forest settlement Poczopek, located in Knyszyn Forest, I noted a greater share of fruticose thallus, mainly *Evernia prunastri*. The research has shown that the composition of epiphytes, their quantity and morphological structure change depending of habitat conditions. This is connected with the change of the properties of the bark, as a result of the large impact of nitrogen compounds on built-up areas.

The rare species that inhabit the bark of larch in the surveyed villages and towns in Podlasie include: *Candelariella xanthostigma* (Suraż), *Evernia prunastri* (Augustow, Narew, Poczopek) *Hypogymnia tubulosa* (Narew, Poczopek) *Melanelixia fuliginosa* (Krynki) *Melanohalea exasperatula* (Ciechanowiec) *Platismatia glauca* (Poczopek) *Pseudevernia furfuracea* (Augustow Bialowieza, Narew, Poczopek).

For a more complete presentation of these issues I compiled database based from literature and my own research which consists of lichen species found on the phorophyte in Poland. Lichen biota of larch in Poland consists of 107 species, of which 20 species are today extinct, represented mainly by macrolichens of genus *Bryoria* and *Usnea*.

My research has shown, as in other regions of Poland that lichen biota of larch is scarce. The degree of species richness did not differentiate statistically significantly depending on the size and population of the village.

Urbanized areas are locations to a large number of trees, from planting. Among them are species native and foreign origin, planted mainly for decoration, in parks, squares, along the roads.

Many alien species are invasive species. The greatest threat to native biodiversity is the introduction of trees and bushes to protected areas, such as national and landscapes parks, nature reserves and Natura 2000. This is crucial for the preservation of native flora and vegetation. There are no known long-term effects dominate the urban green by alien species. However, there are postulates to prefer native species in urban areas, instead of converting green areas into botanic gardens.

The aim of this paper is to discuss the occurrence of alien species of trees and lichens growing on their bark in Bialystok. This paper is the first such comprehensive study on diversity of lichen biota of foreign origin trees oin urban areas.

In the area of Bialystok 42 species of foreign origin were found. The amount of species of these trees outnumber native species. The most widely represented are the representatives of the Pinaceae family – 10 species, Cupressaceae – 4, Aceraceae and Oleaceae – 3 each. Alien species in the city are mostly ornamental trees, growing in the parks (such as *Abies concolor, Aesculus × carnea, A. hippocastanum, Fraxinus latifolia, F. pennsylvanica, Metasequoia glyptostroboides, Phellodendron amurense, Picea pungens,* *Pinus nigra, Ptelea trifoliata, Quercus rubra, Thuja occidentalis, Tsuga canadensis*), in the cemeteries (eg. *Aesculus hippocastanum*, *Chamaecyparis lawsoniana, C. pisifera, Juniperus scopulorum*, *Robinia pseudoacacia, Thuja occidentalis*), in the squares (eg. *Abies koreana, Catalpa bignonioides, Elaeagnus angustifolia, Juglans regia, Rhus typhina, Syringa vulgaris*), roadside trees (e.g. *Acer negundo, A. saccharinum, Aesculus hippocastanum, Robinia pseudoacacia, Pseudotsuga menziesii, Tilia tomentosa*), fruit trees (eg. *Juglans regia, Malus × purpurea*) and forest trees (*Padus serotina, Pinus nigra, Robinia pseudoacacia*).

Few trees of foreign origin occur frequently and an masse. These are mainly*: Aesculus hippocastanum, Robinia pseudoacacia, Acer negundo, Fraxinus pennsylvanica, Thuja occidentalis*. Others are found in few places (*Gleditsia triacanthos, Metasequoia glyptostroboides, Phellodendron amurense, Ptelea trifoliata, Tsuga canadensis*, and others). The origin of Białystok trees is very diverse and in addition to national specimens one can find trees from North America, Asia, Southern and Western Europe. Most trees are North American species (22).

Bark of trees of foreign origin is a substrate for 41 lichen species. The most dominant lichens are those with foliose thalli. The most abundant numbers of species represented here are those of genera *Lecanora* (6), *Physcia* (5), *Cladonia* (3), *Hypogymnia* (2).

The lichen biota of individual phorophytes were differed significantly, both in terms of quantity and quality. The richest lichen biota was reported on the bark of trees – *Robinia pseudoacacia* (26), *Aesculus hippocastanum* and *Quercus rubra* (25 each), *Acer saccharinum* (14), *Rhus thypina* and *Fraxinus pennsylvanica* (13 each), *Phellodendron amurense* (12) and *Thuja occidentalis* (11). The epiphytic species composition on individual tree species is the result of specific features of their bark, and above all, pH, water capacity, mineral content and micro sculpture.

On the largest number of phorophytes, I have indicated *Physcia dubia* (33), *Phaeophyscia orbicularis* and *Xanthoria parietina* (each 21), *Parmelia sulcata* (18), *Physcia adscendens* (17), *Candelariella xanthostigma* (16). The group of species attached to one phorophyte include: *Cetraria sepincola* (*Pinus nigra*), *Cladonia glauca* and *Lecidella elaeochroma* (*Robinia pseudoacacia*), *Flavoparmelia caperata*, *Platismatia glauca* and *Usnea hirta* (*Quercus rubra*), *Lecanora argentata* (*Acer negundo*), *Lecanora expallnes* and *Physcia caesia* (*Aesculus hippocastanum*), *Myriolecis hagenii* (*Phellodendron amurense*).

The presence of trees of foreign origin in the city significantly increases species diversity of lichens. Some lichens taxa were recorded only in their bark, for example *Flavoparmelia caperata* (*Quercus rubra*).

In relation to national data, for example lichen biota of *Quercus rubra* in Poland consists of 63 species (Kubiak 2006). The number of taxa colonising the bark of *Quercus rubra* in its native occurrence range is small (Stubbs 1989; May 2001). Hale (1955) reports 45 lichen species from the southern part of Wisconsin, and Culberson (1955) reports 41 species from the northern part of the state. Stubbs (1989) presents 32 taxa from the sites in Main. The number of lichens of this important phorophyte in this region usually does not exceed 10 in regional studies from the north-western part of North America (May 2001).

Larger species diversity have been recorded on bark of native trees in Bialystok, e.g. *Fraxinus excelsior* – 51, *Acer platanoides* – 51, *Quercus robur* – 50, *Tilia cordata* – 31, *Pinus sylvestris* – 26. These trees are widespread throughout the city in different habitats.

My research has shown that these trees of foreign origin which are decorative and utilitarian elements in the cities, were effect of increasing the diversity of lichens. Their presence in the cities is an example of human activity, which contributes to increasing ranges by certain species of lichens. Another interesting taxa of lichens in the city were include: *Cetraria sepincola, Flavoparmelia caperata, Usnea hirta.*

CONCLUSSION

The study allowed for a deeper and fuller understanding of the problem of occurrence of lichens in areas with varying degrees of anthropogenic transformation of North-Eastern Poland, particular attention to Podlaskie voivodeship including in urban and agriculture areas. Lichen biota characterized in terms of diversity of species, the share of morphological forms, habitat requirements. Analysis of species composition of individual areas was the basis for the award of rare, protected and endangered. The study leads to the following conclusions:

1. The obtained results of presented studies carried out in selected and unspecified ecosystems of North-Eastern Poland, including urbanized and agricultural areas, clearly confirm that this area is an important place of lichen diversity in the country.
2. The way of development, degree of urbanization and long-term agricultural economy in North-Eastern Poland probably have been influenced the specifics of lichen biota in

areas of varying degrees of anthropogenic influence, distinguishing it on a local, regional and superregional scale.

3. Most of the recorded lichen was previously reported in the area of North-Eastern Poland. *Rhizocarpon grande* is a new species for this region of Poland.
4. In the process of the spread of lichens affected by anthropogenic processes of transformation of the environment associated with the creation of human habitat suitable for settlement (buildings, avenues of trees, cemeteries, gardens, roadsides, etc.) and substrates (monuments, tombstones, fences, poles, etc.) in this area.
5. These anthropogenic habitats were conducive to the development of lichens, including species from the "red list" and protected by law. Most of them are epiphytic lichens, and especially important for their occurrence have been found of the bark of the phorophytes, which growing in large focus of trees in urban areas and roadside trees, among fields, watercourses and trees standing.
6. The research has shown that some species from the Red list of lichens in Poland (Cieśliński et al. 2006) were classified as NT category (*Evernia prunastri, Hypogymnia tubulosa*), and VU category (*Ramalina farinacea, Tuckermanopsis chlorophylla*) are common and are not threatened in this part of Poland, and indeed it can be said that they are in the expansion of colonizing more and more new areas.
7. High availability anthropogenic habitats and artificial substrates conducive to the spread of the heliophilous, nitrophilous and calciphilous species. Lichens are not invasive species and will not threaten native lichen biota with constraints in the expansion of their own habitat requirements.
8. Spread of some lichen species was due to the characteristics of habitat, already existing, e.g. by enriching nitrogen compounds to the trunks of trees next to the buildings and fields and stones and boulders lying in open areas in an agricultural landscape.
9. Among the lichens found in urbanized areas, epiphytes were dominate, although the lichen biota of particular phorophytes was rather poorly differentiated and not specific. Epiphytic lichens especially related to urbanized areas and also of interesting on the studied area are *Anaptychia ciliaris, Parmelina tiliacea, Physconia perisidiosa.*
10. Next to the native tress, trees of alien origin significantly increase the species diversity of lichens of area subject to human pressure.

11. Among the listed areas of the city, only green areas have a specific biota of lichens. They are characterized by a significant proportion of fruticose lichens.
12. In the lowland landscape of north-eastern Poland, the presence of epilithic lichens is mainly observed in the habitats of anthropogenic origin.
13. Artificial substrates enable both the spread of lichens, as well as the survival of the position in the absence or a limited number of natural habitats and substrates
14. Cemeteries play a very important role factor increasing the mosaic and the diversity of anthropogenic landscape, thus affecting the species diversity of lichens of the area. These habitats because of the presence of lichens on them under legal protection, endangered and rarely quoted in North-Eastern Poland are an important mainstay of lichen on the urban areas of the test region.
15. Human activity contributes to the spread of lichens from different habitat groups, including many epilithic, epigeic and epiphytic species.
16. The psammophilous grasslands of the *Spergulo-Corynophoretum* association and pine thickets and their edges were characterized by the richest lichen biota.
17. The study confirms that the lichen biota of North-Eastern Poland, including areas with different levels of anthropogenic transformation is rich and diverse, so it is with the point of a view of the natural precious.
18. The lichenological analyses of areas with different levels of anthropogenic transformation are the starting material for further long-term studies of the lichen biota against changing habitat conditions of these areas.

4. REVIEW OF OTHER RESEARCH AND SCIENTIFIC ACHIEVEMENTS

A) The course of my scientific work prior to the award of the doctoral degree

In the fourth year of Biology study at the University of Warsaw, Branch in Bialystok, I learned about the opportunity to participate in research on the lichen in North-Eastern Poland. Tutor and lecturer was prof. dr. John Bystrek, lichenologist, head of the Department of Botany, Institute of Biology of Warsaw University Branch. An interesting personality, making the potential promoter and the prospect research lichenological made volunteered their interest in carrying on the studio master. This step determined the direction in which rolled up my professional life. My candidature for the postgraduate student is by prof. John Bystrek accepted. For two years I was responsible for documenting the lichen biota two reserves: Monkinie and Studziany Forest in Wigry

National Park, marking specimens, development results. The results of these studies are presented in the thesis Fri. *Lichens of Monkinie reserve and Studziany Forest reserve in Wigry National Park*.

The Department of Botany, being under the supervision of prof. dr. John Bystrek, I conducted research on the diversity of lichens floristic protected areas, including nature reserves in Bialystok [items 4, 7, 9, annex 3, point II D], in the Wigry National Park [items 10, 12, annex 3, point II D], Knyszyn Forest Landscape Park [items 5, 11, annex 3, point II D] and the residential areas with varying degrees of human pressure [items 6, 8, annex 3, point II D]. An important part of my research was focused on studying terrestrial lichens demand for water in the diurnal cycle and the annual [item 1, annex 3, point II A].

Scientific achievements in this period mainly include scientific publications related to biodiversity lichens in NE Poland. There are ten scientific articles [item 1, annex 3, point II A; items 4-12, annex 3, point II D].

(Links included in the text refer to the individual items in Annex 3)

TABLE 1. Summary of scientific achievements before the title of Doctor of Biological Sciences

	Publication in		Total
	English	Polish	
Science publications	1	9	10
Conference presentations	0	7	7
Total	17		

B) The course of my scientific work after the doctoral degree

The main trends in research

My other achievements of scientific research can include up to eight research trends, including the four: 1. related to the assessment of lichen biota of towns and villages, 2. cemeteries and places of worship and 3. protected areas and 4. revision of the herbarium materials of selected taxa of lichens, coinciding with the leading mainstream research my main scientific achievement.

1. **Studies on the species and habitats diversity of lichens from selected villages and towns of North-Eastern Poland and impact assessment of habitat conditions on the occurrence of lichen in urban areas.**

As part of systematic research related to the development of the lichen biota depending on land use by man, my research interests are mainly related to the lichen biota of villages and towns of North-Eastern Poland.

I developed data on lichens of many towns in Podlaskie voivodeship, as **Łomża** [item 22, annex 3, point II D], **Ciechanowiec** [items 58, 60, annex 3, point II D], **Mielnik** [items 54, 92, annex 3, point II D], **Drohiczyn** [item 47, annex 3, point II D], **Bocki** [item 48, annex 3, point II D], **Narew** [item 36, annex 3, point II D], **Sokolka** [items 28, 74, annex 3, point II D], **Choroszcz** [items 25, 64, 81, annex 3, point II D], **Klukowicze** [item 17, annex 3, point II D], **Kaniuki** [item 14, annex 3, point II D] and Bialystok [items 27, 61, 68, 72, 77, 78, 87, 93, annex 3, point II D, the aim of these works was to fill the data on the lichen biota of the capital of Podlasie].

The total number of cities whose biota of lichens has been known by me, there are the town belong to all size and functional groups. The examined areas were large cities (over 200 thousand inhabitants), e.g. Bialystok and (60 thousand) - Łomża, and smaller, such as a small-town of the population, less than 10 thousand or 5 thousand residents, as Ciechanowiec and Drohiczyn, as well as villages, such as Bocki, Kaniuki, Klukowicze, Mielnik and Narew.

The lichen biota of the surveyed towns and villages are characterized by high biodiversity. I have proven the presence of 118 species of lichens in Boćki, 114 – in Ciechanowiec, 97 – in Narew, 91 – in Mielnik, 86 – in Drohiczyn, 74 – in Choroszcz, 72 – in Kaniuki, 70 – in Łomża and 49 – in Klukowicze. The level of lichen diversity in the tows in Podlasie is higher than that observed in the nine Polish coastal cities (Izydorek 2005), where 68 species in Międzyzdroje, 66 in Kołobrzeg, 59 in Władysławowo, 52 in Darłowo-Darłówko and 46 in Hel were found. The conditions prevailing in Podlaskie voivodeship, which are Green Lungs of Poland, favor the development of lichens. The number of lichen species surveyed is about 24% of lichens known from North-Eastern Poland.

Lichens have been discovered on various types of substrates. I have shown that in most towns and villages epiphytic lichens were the most numerous. Thanks to the preserved old wooden buildings, only in Narew epixylic constituted the largest habitat group. Lichen biota of individual phorophytes were differentiated both in terms of quantity and quality. Furthermore, there were epilithic, epixylic and epigeic lichens. The least popular, because spotted only in several towns, were epibryophytes and lichens growing on unusual substrates.

Most of the known taxa were reported from all towns. Particularly many records lichens of the genus *Calogaya, Lecanora, Myriolecis, Phaeophysia, Physcia, Polycaulion* and *Xanthoria*. I have shown that the core of lichen biota are common, nitrophilous species. I have proven that centers for the occurrence of lichen species diversity in urbanized areas are located in green areas (parks, squares, cemeteries). These clearly were contribute to increasing the diversity of epiphytic and epilithic lichens.

The articles clearly have enriched knowledge of the diversity and conservation status of the lichen biota of areas subject to human activities in the North-Eastern Poland. The papers are important and valuable documentation for future research, including monitoring.

Summary and important study of lichen biota in cities is paper The state of research on lichen cities in Poland [item 35, annex 3, point II D]. The paper presents an overview of research on lichens in Polish cities (from the end of the eighteenth century. to the beginning of the twenty-first century). Characterized main trends research in cities. The occurrence of 481 species of lichens, which represents 30% of the lichen biota of Poland. The common species in the cities and towns have been reported, *Parmelia sulcata, Physcia adscendens* and *Xanthoria parietina* (in 48 cities), *Hypogymnia physodes, Physconia grisea* and *Phaeophyscia orbicularis* (in 46), *Candelariella xanthostigma* and *Melanohalea exasperatula* (in 44). The study has been shown a clear dominance of epiphytic lichens and zonal distribution of lichens in urban lands.

2. Lichenoindication study of selected towns in Podlaskie voivodeship.

Lichens are widely known and used as bioindicators of air purity. Urban areas are ecosystems affected by a particularly high human pressure. Monitoring urban areas is therefore particularly important, and studies on the living conditions of organisms, including lichens, provide essential information about the state of their natural conditions as well as threats.

Parallel to the study of species of lichen biodiversity in urban areas I led a lichenoindication study. In order to assess the state of their environment I used two methods: floristic and analytical chemical analysis.

Most frequently, I have been using floristic bioindication method, the method of indicator species, namely the lichen zone scale, which made it possible to establish groups of species with different sensitivity to environmental conditions of urban areas and the removal of lichen vegetation zones. For each studied city - **Sokolka** [item 28, annex 3, point II D], **Narew** [item 37, annex 3, point II D] and **Lomza** [item 18, annex 3, point II D], a lichen zone scale was developed based on detailed surveys, inventories and assignment of indicator species, both epiphytic and epilithic colonizing anthropogenic concrete surfaces (power poles) for each zone. Modifications of the scale resulted from the need to consider local habitat conditions and species composition of the lichen biota. The city of Podlasie characterized by good aero-sanitary conditions, which is confirmed by lichenoindication tests carried out. In the area of Sokolka [item 28, annex 3, point II D], there was no presence of lichen deserts: zone I (absolute desert lichen) and zone II (relative desert lichen). Narew [item 37, annex 3, point II D] distinguishes of spot the occurrence of lichen desert zones. In the area of Lomza [item 18, annex 3, point II D], there was no I zone, while zone II only two stands.

Preparing lichenoindication maps for cities, I have been compiled lists of species, including nitrophilous lichens that were characterizes the internal and central zones of limited vegetation. The presence of these species in these zones is associated with high levels of air pollution, including nitrogen compounds and a high degree of eutrophication of the substrates (bark of trees and shrubs and concrete structures).

The lichenoindication maps illustrate the state of preservation of the lichen biota in the study area and indicate the location of the poorest and the richest diversity of the lichen biota.

By using the analytical and chemical method – atomic absorption spectrophotometry (AAS), in order to compare and supplement the data assessed again the level of concentration of toxins (Cu, Ni, Fe, Pb, Zn) in thalli transplanted species *Hypogymnia physodes* in different areas of the city of Bialystok [item 42, annex 3, point II D]. I have argued that the greatest concentrations of accumulated metals are noted in thalli exposed stands, the arrangement of which coincides with the location of the areas with the highest emissions. The results show that the eastern districts of the city are more vulnerable to contamination. The reason for this may be the predominance of western winds. Testing points located in green areas were much less polluted than the centre and the periphery. The concentration of the studied elements in the thalli of the transplanted *Hypogymnia physodes* after ten years remained at a similar level.

3. Research on the species and habitat diversity of lichens of places of worship and cemeteries of Podlaskie voivodeship.

I have conducted detailed observations on the lichen biota of cemeteries and places of worship in Podlaskie voivodeship. The research on the cemeteries aimed to provide documentation which would illustrate the diversity of lichen biota, taking into account the diversity of species and habitat conditions of individual taxa. I have indexed the total number of lichen biota on 34 cemeteries, including 14 Jewish cemeteries in the Podlasie region [item 9, annex 3, point I B, the results of which were presented as the major scientific achievement], 18 cemeteries in Bialystok [items 49, 52, 95, annex 3, point II D, the purpose of the study was to supplement the data on lichen biota in the capital city of Podlasie], the historic Roman Catholic cemetery in **Wasilkow** [item 28, annex 3, point. II D], the old Orthodox cemetery in **Mostowlany** [item 19, annex 3, point II D] and the **Holy Mount Grabarka** [item 55, annex 3, point II D], the most important religious sites for followers of the Orthodox Church in Poland.

As part of my research on lichen places of worship and cemeteries in North-Eastern Poland, I found 64 species of lichens in the Holy Mount Grabarka, including interesting lichens, as *Usnea filipendula, U. hirta*. The lichen biota of the historic cemetery in Wasilków and the old Orthodox cemetery in Mostowlany have been count such as 58 species. The lichen biota consist mainly of common lichen species. Particularly noteworthy taxa such as *Parmelina tiliacea, Platismatia glauca, Pleurosticta acetabulum, Ramalina fraxinea, Tuckermanopsis chlorophylla, Usnea hirta, Xanthoparmelia loxodes.*

My research has shown that cemeteries are valuable places growing number of lichen species, including rare in the lowlands and play a very important role factor in a variety of anthropogenic landscape.

4. Research on species diversity of roadside trees in Podlaskie voivodeship

A common habitat of lichen occurrence on the human-interfered areas are roadside trees. They grow in different conditions, often in fields, close to buildings and forests. Roadside trees have many natural functions, e.g. they create a habitat for many organisms and act as ecological corridors linking spatially separated ecosystems. On the other hand, it takes the dispute over to the necessity of felling roadside trees posing a potential threat to humans. What often follows from this that the Polish road infrastructure is not adapted to the traffic and size of vehicles.

One of the most prevalent types of trees growing on roadsides in Poland is poplar *Populus* spp., represented by three native species (*Populus alba, P. nigra, P. tremula*), and several foreign species from North America (e.g. *Populus deltoides, P. trichocarpa*) and many hybrids (e.g. *Populus × berolinensis*, *P. × canadensis*).

The lack of detailed studies on species diversity, particularly important in the case of *Populus* spp., the most widespread of common species which grows on roadsides, encouraged the author to assessment of share the lichen biota of this phorophyte growing on roadsides in Podlaskie voivodeship in depth [item 2, annex 3, point IIA].

The main aim of the research was to show the diversity of lichen species of poplar in different habitat conditions and a detailed analysis of biota present in three different tree zones, 1) the base trunk - 0-50 cm, 2) tree trunk - 50-250 cm and 3) crown. In this respect, work is pioneering.

I reported 65 species of lichens on the bark of trees. The spatial distribution of lichens in different tree zones, i.e. basal part, stem and crown, revealed the most taxa are confined to the tree trunk (50-250 cm) – 61 species, while 25 species were found in butt zone and 28 species in crown.

I proved the fact that on the trunk, along with its height, there was a change in the share of morphological forms of lichen observed. Foliose lichens dominate at the trunk base, representing 52% of the total species found in this part of tree. The trunk base is characterized by a small number of exclusive species (2).

On the trunk (50-250 cm) of trees dominated by crustose and foliose thalli, representing, respectively 45% and 42% of total biota found in this part of the tree. This part of the trunk was characterized by a big number of exclusive species – 28, i.e. *Hypogymnia tubulosa, Physcia aipolia, Parmelina tiliacea, Physconia perisidiosa* and others.

I said also a high proportion of lichen of foliose and crustose thalli (respectively 44% and 41%) in the crown of the trees. The tree crown is a unique place for such interesting and rare lichens in Poland as *Hypogymnia farinacea, Usnea hirta*. These species were not found in other parts of this phorophyte.

I was showed different species composition of lichens growing on the bark of poplars along the roads in different habitat conditions. On the bark of trees occurring in the agricultural landscape in rural areas, fields and buildings, they are dominated by nitrophilous, heliophilous species (mainly genus *Physcia, Phaeophyscia, Physconia, Ramalina, Xanthoria*). These roadside trees are favourable habitat for lichen vegetation, as prevailing here, good lighting conditions, and the bark of trees is enriched in addition to various types of minerals, including rich in nitrogen compounds contained in the deposition of dust and dirt. Increasing the pH of the bark of phorophyte occurs by adsorption of NH_3. On the poplars, a group that clearly shows their presence are the species belonging to the community of *Pyscietum adscendentis* Frey et Ochsn. 1926 from association of *Xanthorion parietinae* (Ochsn. 1928) Barkm. 1958.

On the bark of roadside poplars growing in the forests, I observed a smaller share of nitrophilous and heliophilous species and a significant share of species associated with forest complexes, as *Hypogymnia physodes, Pertusaria amara, P. coccodes, P. muitpuncta, Pseudevernia furfuracea, Usnea hirta*. This is due to the changes in habitat conditions, including limited supply of mineral salts necessary for lichens on the more demanding trophic (nitrophilous species) and an increase in shading, which inhibits the development of heliophilous species typical of roadsides located in open areas.

In conclusion, my research has shown that roadside poplars significantly increase the species diversity of lichenized fungi in the area subjected to human interference. Nitrophilous lichens represent the specificity lichen biota of poplars growing on the higher pH of bark. A large number of lichen species occurring in the roadside poplars (65 species) can classify it to a group phorophytes, lichen biota rich in terms of diversity. Lichen biota of poplar includes some interesting and rare taxa, as *Hypogymnia farinacea, Pertusaria multipuncta, Physconia perisidiosa, Ramalina fastigiata, R. motykana, Usnea hirta* and others.

5. Research on the lichen species diversity of endangered habitats and protected areas (National Parks, Landscape Parks, Nature Reserves) and lichens under legal protection in North-Eastern Poland.

An important part of my research are studies of lichen biodiversity in protected areas of North-Eastern Poland, such as national parks – **Wigry National Park** [item 44, annex 3, point II D], **Biebrza National Park** [item 97, annex 3, point II D], **Narew National Park** [item 1, annex 3, point I B, the results of which were published as the major scientific achievement], landscape parks - **Landscape Park "Podlaski Przełom Bugu"** [item 2, annex 3, point I B, the results of which were published as a major scientific achievement], **Lomza Landscape Park** [item 21, annex 3, point II D] and nature reserves – **Góra Uszeście** [item 42, annex 3, point II D], **Las Zwierzyniecki** [item 31, annex 3, point II D], **Las Antoniuk** [item 73, annex 3, point II D], **Mały Borek** [item 21, annex 3, point II D], **Studziany Las** [item 44, annex 3, point II D] and studies on the diversity of legally protected and endangered lichen species in North-Eastern Poland [items 23, 61, 72, 76, 82, 93, annex 3, point II D].

In the study of the lichen biota of the Studziany Forest in Wigry National Park, I documented 91 species of lichens. They represent 35% of the total number of species found in the Park. It is worth emphasizing the occurrence of species known to date from the Wigry National Park, with few stands such as: *Arthonia radiata, Chaenotheca furfuracea, C. phaeocephala, Cladonia pleurota, Lecanora subrugosa, Melanelixia subaurifera, Pyrenula nitidella, Zwackhia viridis.* From the Mały Borek reserve, in the Augustowska Primeval Forest, I found 45 species of lichens, including six species previously unknown from the reserve area, such as *Cetraria sepincola, Lecanora conizaeoides, Hypogymnia tubulosa, Peltigera didactyla, Pseuderovera furfuracea*. In the reserve of Uszeście Mount, including moraine hill in the Drohiczyn Upland, near the village of Mielnik, I found 52 species of lichens, including rare species in the country, characteristic of xerothermic grasslands, such as *Bacidia bagliettoana, Cetraria aculeata, Cladonia pocillum, Diploschistes muscorum.* I conducted a re-examination of the lichen biota of two nature reserves located in the capital of Podlasie. I have shown that the lichen biota of the Zwierzyniecki Forest reserve is represented by 45 species, including eight species previously unknown from its area, such as *Hypogymnia tubulosa, Lecanora polytropa, Leparia elobata, L. finkii, L. incana, Myriolecis dispersa, Pyrenula nitida*

Opegrapha vermicellifera, Verrucaria muralis. In the second reserve, Antoniuk, I found 41 species of lichens, including six new taxa, such as *Chaenotheca furfuracea, Cladonia grayi, C. merochlorophaea, Lepraria elobata, L. incana, Tuckermanopsis chlorophylla*. I have developed an atlas of the lichens of the Łomża Landscape Park of the Narew Valley, which contains 51 selected species of lichens. The diagnosis, habitat requirements, protection status and threat category are given for each species. The graphic page complements the photographs of the individual species.

These studies clearly fit into the current of basic research aimed to analyze the diversity of lichen biota depending on protection status area and the land use by man on the example of Podlaskie voivodeship.

To sum up, the results of my research confirmed high natural values of this region of Poland, which can still be considered the background for monitoring research in contaminated regions of Poland and in Central Europe.

Summary and important study on lichen biota of protected areas is paper *The state of research on lichen in landscape parks in Podlaskie voivodeship* [item 15, annex 3, point II D]. The paper presents the state of research of lichens in four landscape parks (Podlasie Bug Gorge Landscape Park, Łomża Landscape Park of the Narew Valley, Suwalski Landscape Park, Knyszyn Forest Landscape Park them. Professor Witold Sławiński) in podlaskie voivodeship. The richest biota of lichens has the Knyszyn Forest Landscape Park. Among 369 species of lichens found in landscape parks, 47 species are covered by legal protection (26 – strictly protected, 21 – partially protected). The occurrence 369 species of lichens, which represents 24% of the lichen biota of Poland and 53% of the total biota of North-Eastern Poland.

In addition, I prepared a checklist of lichens of the Augustow Forest [item 13, annex 3, point II D]. The paper contains of checklist of lichens which have been noted in the Augustow Forest since the beginning of lichenological investigations (since the beginning of the 20s of the twentieth century) up to now. 363 species have been found. Among them, 11 species come from historical data. 279 species have been found in the Wigry National Park. Nearly 39% of the lichen species of Augustow Forest are noted in the Red list of lichens in Poland.

6. Revision of the herbarium materials of selected taxa of lichens in Poland, Belarus and Russia.

In my scientific work also I paid much attention to the research on the genus of ***Rhizocarpon*** in Poland [items 34, 38, 40, 45, 46, 51, 56, 57, 59, 79, 80, 89, 90, 94, annex 3, point. II D], Belarus [items 51, 67, 69, 79, annex 3, point II D] and Russia [item 39, annex 3, point II D].

Rhizocarpon in its current sense is polyphyletic (Ihlen and Ekman 2002). *Rhizocarpon* is a large lichen genus (approximately 200 species) containing approximately species worldwide, especially in mountain and polar areas. These lichens have crustose, areolate or verrucose, ashy, brown, yellow, greenish or white thallus, usually with a black hypothallus. The species of *Rhizocarpon* grow predominantly on siliceous rocks, and few are parasites on other lichens (Purvis et al. 1992). This genus, which due to the differences in morphology and spore the thallus in connection with the production of secondary metabolites of various type is an interesting object of study.

With the available national herbarium collections (herbaria: KRAM, KRAP, LBL, private collections), using classical methods of taxonomy, I studied about 1,000 specimens. In the study material, I have singled out 20 species recorded in Poland, including seven species of non-yellow thallus, with hyaline and muriform ascopores (*Rhizocarpon amphibium, R. distinctum, R. lavatum, R. petraeum, R. postumum, R. reductum, R. umbilicatum*), two species of non-yellow thallus, with hyaline and 2-celled spores (*R. hochstetteri, R. polycarpum*), three species of non-yellow thallus, with dark and muriform spores (*R. disporum, R. eupatraeum, R. grande*), two species of non-yellow thallus, with dark and 2-celled spores (*R. badioatrum, R. rittokense*) and four species of yellow thallus (containing rhizocarpic acid), with dark and muriform spores (*R. geographicum, R. lecanorinum, R. saanaënse, R. viridiatrum*) and two species of yellow thallus (containing rhizocarpic acid), with dark and 2-celled spores (*R. alpicola, R. eupetraeoides*). For all species, I have compiled characteristics, ecology and occurrence in Poland and in the world. The few species of lichens are common or widespread in Poland. Most species favors a specific region of the country, mainly of mountain areas. All included in the revision of specimens were tested in terms of chemical properties.

As part of the revision of the herbarium materials deposited in many Polish Herbaria I discovered a new species - ***Rhizocarpon timdalii***, which was not previously recorded in our country. Article [item 40, annex 3, point II D] contains detailed characteristics of the species with an indication of the most important diagnostic characteristics and data on the ecology and distribution in Poland and in the world.

I have quoted listing of new species of the genus of *Rhizocarpon* in many regions of the country, eg. from Gorce [item 34, annex 3, point II D], Beskidy Mountains [item 38, annex 3, point II D], North-Eastern Poland [item 57, annex 3, point, II D].

The results will be summed up in the monograph, that are currently in being preparated. The monograph will present information about *Rhizocarpon* species in Poland. It will be a modern taxonomic revision containing descriptions of more than 20 species, keys to the species, data about their distributions and ecology.

In cooperation with the Belarusian lichenologist Dr. Vladimir Golubkov from Yanka Kupala State University of Grodno I have conducted revision of the genus of *Rhizocarpon* in Belarus. As a result, our research has identified a new species, *Rhizocarpon hochstetteri, R. lavatum* and *R. polycarpum* for Belarus and new taxa *Rhizocarpon distinctum, R. grande, R. hochstetteri, R. lavatum, R. petraeum, R. polycarpum* and *R. reductum* for North-Western Belarus [item 51, annex 3, point II D]. The paper presents a diagnosis of each species, their ecology and distribution in Belarus.

As part of the revision of the herbarium materials by V. Golubkov, we have nominated new species of the genus of *Rhizocarpon distinctum* and *R. superficiale* for the Yamal Peninsula in the Russian Federation [item 39, annex 3, point II D].

I conducted, also in cooperation with Belarusian lichenologists with Dr. Vladimir Golubkov, Dr. Pavel Bely from the Central Botanical Garden of the National Academy of Sciences of Belarus in Minsk and Dr. Alexander Tsurykau from the Francisk Skorina Gomel State University, revision of the lichen herbarium specimens of ***Cetrelia*** genus deposited in Belarusian herbaria (GRSU, MSK, MSKH, private collections) from the area of Bialowieza Forest, in the Belarusian part [item 24, annex 3, point II D]. Three species (*Cetrelia cetrarioides, C. monachorum, C. olivetorum*) were found in the study area. The results showed that *Cetrelia monachorum* and *C. cetrarioides* are the most widespread species, and *C. cetrarioides* is known only from a few records. In addition, within the framework of master's thesis, Lichens of the genus *Cetrelia* in the Bialowieza Forest, assessed the current species diversity, habitat requirements, distribution and status of population lichen species from this rare and endangered genus in the Polish part of the Bialowieza Forest.

Analysis of the chemical composition of lichen thallus is often a basic instrument in their taxonomic identification. In the Department of Botany, University of Bialystok, I organized a chemical laboratory in which it is possible to conduct studies detecting lichen secondary metabolites by thin layer chromatography (TLC). This laboratory served with a lichenologist from other centers, mainly from Belarus. Possession base and knowledge was the basis for conducting research of lichens, in particular belonging to the genera are very similar in terms of morphological features, but with different chemical features. An example of such genus are *Rhizocarpon*, *Cetrelia* and species from *Cladonia pyxidata-chlorophaea* group. Chemical analyzes made it possible to conduct a review of herbarium specimens of these taxa of lichens in Poland and abroad. Conducting inventory research, there is a need for chemical testing of many genus of lichens, for example *Lepraria*.

7. Research for new species for lichenicolous fungi biota of Poland and rare species of lichens.

In the course of systematic inventorying research in North-Eastern Poland, I discovered a new rare species of lichens in Poland, including *Bryoria capillaris* [item 30, annex 3, point II D] and *Usnea florida* [item 50, annex 3, point II D] in Bialowieza Forest and *Lobaria pulmonaria* with apothecia in Augustow Forest [item 33, annex 3, point II D] and Bialowieza Forest [item 32, annex 3, point II D].

In addition, I found the first new stands in Poland of two species of lichenicolous fungi – *Skyttea nitschkei* on thallus of *Thelotrema lepadinum,* in Augustow Forest [item 17, annex 3, point II D] and the first contemporary location in Poland – *Plectocarpon lichenum* on thallus of *Lobaria pulmonaria,* in Bialowieza Forest [item 44, annex 3, point. II D]. In papers, next to diagnosis of species, their habitat requirements, distribution in Poland and abroad were characterized and lists of species of lichenicolous fungi for the Bialowieza Forest and the Augustow Forest were given.

8. Daily water content in epiphytic lichens.

By conducting intensive research in urbanized areas, I understood that the natural determinants of lichen survival are, e.g. water availability and degree of hydration of the thallus. Particularly noteworthy are my study on daily water content of epiphytic lichen thallus in urban areas [item 3, annex 3, point II A]. These are pioneering studies on the daily water content, correlating the hydration of the thallus with daily changes in relative humidity.

Some recent studies also suggest that the availability of water is also important and significant for lichen vegetation in cities. Bertuzzi et al. (2016) suggest that one of the key factors determining the survival of lichens in the urban environment is the availability of water and its level in thalli affects the activation of metabolic processes. Which confirms the validity of the controversial hypothesis of drought, put forward by Rydzak (1953), which has accepted that the main cause regression of lichens of the cities are climate conditions, primarily reduced air humidity.

Lichens are poikilohydric organisms and their water content, therefore, is strongly dependent on environmental conditions. The sorption possibilities of lichen thallus were described by Blum (1973), Bystrka (1997), Kershaw (1975), Larson (1979, 1981, 1987) and others. The dried lichen thalli easily absorb a liquid water. The water content in dried thalli *in situ* is about 15-30% and can grow to 250-400% - in the case of thalli containing greens, or even 600-2000% - in the case of lichens with the primary photobiont component of cyanobacteria (Nash1996).

Numerous studies were reported how lichens of different morphology respond to a frequently and rapidly changing availability of water (Lange et al. 1988, Kappen and Valladares 1999). The dependence of photosynthesis activation to the degree of hydration of the thallus was investigated. Lichens can be photosynthetically active at water contents as low as 20% d.wt. Lichens with cyanobacteria (Cyanobacteria) as photobionts need liquid water for activation of their photobionts. Their water content for starting photosynthesis (85%–100% d. wt.) is 3–6 times higher than that of green-algal lichens (15%–30% d. wt.). Since both types of lichen rehydrate to about 50% water content by water vapour uptake only green lichens will show positive net photosynthesis (Lange et al. 1988).

In order to verify the hypothesis of drought by Rydzak, I conducted research related to the daily content of water in the thalli of epiphytic lichens (*Evernia prunastri, Parmelia sulcata, Pseudevernia furfuracea, Ramalina farinacea, R. fraxinea, Usnea filipendula*) in urban conditions. These are studies of innovative.

I have shown a high correlation between the processes of absorption and evaporation of water from natural strains of lichens weather conditions, especially the

24-hourly changes in relative atmospheric humidity and changes in air temperature. These studies clearly increase the knowledge about the absorption and evaporation of water by the lichens in natural conditions.

The evaporation in all the samples was correlated with weather conditions and ended with drying up of the thalli. In the afternoon and early afternoon, during sunny weather and at high temperature and the lowest within 24 hours relative air humidity the thalli were air–dry and they remained in such a state for 1-2 hours. They activated together with the increase in air humidity. It results from the experiments carried out in various months that irrespective of the season of the year the absorption started in the early afternoon and ran successively, 0.5 – 3 per hour on the average. Within 24 hours it did not exceed 35% in relation to the dry mass of the thalli. It was correlated with weather conditions (recorded during the investigations: temperature, relative air humidity, pressure configurations); increase in relative air humidity simultaneous lowering of temperature. In the samples examined on the turn of April when the pressure was high, the absorption ended at 4-5 a.m. and the amount of water fluctuated from 27.74% to 32.26%. Mean 24-hour water content in the thallus ranged from 13.79% (*Usnea filipendula*) to 17.12% (*Ramalina fraxinea*). In the samples exposure in July the values of absorption were lower, from 4.28% to 15.69%. In summer, mean 24-hour water content in the thallus ranged from 2.33% (*Ramalina fraxinea*) do 9.28% (*Usnea filipendula*). In September, during depression and total cloud cover in the evening and at night, and at high relative humidity keeping up to 6 a.m. on ± the same level, the absorption in the samples exposed lasted to 6 a.m. and was 13.44% to 33.33%. In autumn, mean 24-hour water content in the thallus ranged from 19.58% (*Ramalina fraxinea*) do 28.27% (*Parmelia sulcata*). In urban conditions the amount of water absorbed from the atmosphere does not exceed 35%.

The study showed that examined lichens absorbed and desorbed water under the influence of varying within 24 hours weather conditions independently of the season of the year. I found the high index of correlation between the moisture content in the thalli and 24-hour changes in relative air humidity. The absorption and evaporation were distinctly correlated with 24 hour changes in relative air humidity and 24-hour fluctuations in air temperature. The lichen thalli absorbed much water in autumn, which makes them an increased metabolic activity. It is also the period in which lichens are the most exposed to anthropogenic air pollution, as in the cities continues the heating period.

The study confirmed results of the Kershaw and Rouse (1971), Kershaw (1975), that the regulation of water loss depends on the intensity of the sun's rays on the thallus. The evaporation of the thallus is most intense during high solar radiation. According to Lange et al. (1970) and Kappen et al. (1979), it is extremely fast between 9:00 and 10:30.

The results of my studies clearly indicate relatively a low level of water absorbed (up to 35% by dry weight) by the thalli of epiphytic lichens in urban conditions. This may confirm the hypothesis drought Rydzak (1953) that the availability of water and the degree of hydration of the fronds are important factors determining the survival of lichens in anthropogenic environment.

REFERENCES

Adamska E. 2014. Biota porostów Torunia na tle warunków siedliskowych miasta. Wyd. Naukowe Uniwersytetu Mikołaja Kopernika, Toruń.

Bertuzzi S., Bove F., Kodnik D., Panepinto F., Pellegrini E., Nali C., Lorenzini G. Tretiach M. 2016. A revised Rydzak's Drought Hypothesis for a changing environment. The 8th IAL Symposium Lichens in Deep Time August 1–5, 2016, Helsinki, Finland.

Biazrov L. G. 2006. Changes of Epiphytic Lichen Species Diversity of Moscow City – Comparison between the Surveys of 1988-1991 and 2006. www.sevin.ru

Blum O. B., 1973. Water relations. [In:] Ahmadijan V., Hale M. E. (eds.). The Lichens. Academic Press, New York, London 11: 381- 400.

Błoński F. 1888. Spis roślin skrytokwiatowych zebranych w r. 1887 w Puszczy Białowieskiej. Pamiętn. Fizjogr. 8: 75–96.

Błoński F. 1889. Spis roślin zarodnikowych zebranych lub zanotowanych w lecie w r. 1887 w Puszczach: Białowieskiej, Świsłockiej i Ladzkiej. [In:] Błoński F., Drymer K. (eds.). Sprawozdanie z wycieczki Botanicznej, odbytej do Puszczy Białowieskiej, Ladzkiej i Świsłockiej w 1888 roku. Pamiętn. Fizjogr. 9: 55–115.

Brightman F. H. & Seaward M. R. D. 1977. Lichens of man-made substrates. [In:] M. R. D. Seaward (eds.). Lichen Ecology, s. 253–293. Academic Press, London.

Brodo I. M. 1968. The Lichens of Long Island, New York: A Vegetational and Floristic Analysis. New York State Mus. & Sci. Service Bulletin 410: 1-330. Albany, New York.

Buchholz S., Blick T., Hannig K., Kowarik I., Lemke A., Otte V., Scharon J., Schönhofer A., Teige T., von der Lippe M., Seitz b. 2016. Biological richness of a large urban cemetery in Berlin. Results of a multi-taxon approach. Biodivers. Data J. 4: 7057.

Bystrek J. 1963. De variabilitate *Alectoriae fuscescentis* Gyel. Annales UMCS, set. C 18: 411-419.

Bystrek J. 1964. Przyczynek do poznania porostów Suwalszczyzny. Annales UMCS Sect. C , 19: 261–272.

Bystrek J. 1965. *Ramalina motykana* Bystr. nova sp., nowy dla Polski gatunek porostu odkryty na Suwalszczyźnie. Annales UMCS, sec. C 20: 219-222.

Bystrek J. 1970. Lichenum nova species in Europa media (*Alectoria motykana* Bystr.). Acta Mycol. 6(1): 3-5.

Bystrek J. 1974. *Lecanora subalbella* Nyl. (Lichenes, Lecanoraceae) na Suwalszczyźnie. Fragm. Flor. et Geobot. 20 (2): 257-258.

Bystrek J. 1997. Podstawy lichenologii. Wydawnictwo Uniw, M. Curie-Skłodowska, Lublin.

Bystrek J., Anisimowicz A. 1981. Porosty rezerwatu leśnego Budzisk w puszczy Knyszyńsko- Białostockiej. Annales UMCS Sect. C 36(9): 109 –117.

Bystrek J., Chwojko A. 1982. Porosty rezerwatu Karczmisko w Puszczy Knyszyńsko-Białostockiej. Annales UMCS Sect. C 37(19): 215–222.

Bystrek J., Kolanko K. 2000. Porosty (*Lichenes*) Puszczy Knyszyńskiej. Zakład Poligraficzny BiS, Lublin.

Bystrek J., Matwiejuk A. 1999. Porosty obszarów chronionych i proponowanych do ochrony w lasach wigierskich. Annales UMCS, sec. C, 54: 93–124.

Chester T. 1992. To all aspergers anonymous. British Lichen Society Bulletin 71: 22-25.

Chester T. 1997. And Some Fell On Stony Ground The Saxicolous Churchyard Lichens of Lowland England. British Wildlife Vol.8 No.3 (February 1997) pp 161–172.
Cieśliński S. 1995. Porosty Puszczy Knyszyńskiej. [In:] Puszcza Knyszyńska. Monografia przyrodnicza. Czerwiński A. (ed.). Zespół Parków Krajobrazowych w Supraślu, 173–202.
Cieśliński S. 2003. Atlas rozmieszczenia porostów (*Lichenes*) w Polsce północno-wschodniej. Phytocoenosis 15 (N.S.), Suppl. Cartographiae Geobotanicae 15: 1-430.
Cieśliński S. 2010. Wykaz gatunków porostów (grzybów zlichenizowanych) Puszczy Białowieskiej (NE Polska). Parki nar. Rez. przyr. 29(2): 3–39.
Cieśliński S., Czyżewska K. 1992. Problemy zagrożenia porostów w Polsce. Wiadomości Botaniczne 36(1/2): 5-17.
Cieśliński S., Czyżewska K., Fabiszewski J. 2006. Red list of the lichens in Poland.[In:] Mirek Z., Zarzycki K., Wojewoda W., Szeląg Z. (eds.). Red list of plants and fungi in Poland. W. Szafer Institute of Botany, Polish Academy of Sciences, Krakow: 71–89.
Cieśliński S., Tobolewski K. 1988. Porosty (*Lichenes*) Puszczy Białowieskiej i jej zachodniego przedpola. Phytocoenosis 1 (N.S.), Suppl., Cartographiae Geobotanicae 1: 3–216.
Cieśliński S., Zielińska J. (red.) 1994. Materiały do flory porostów Puszczy Knyszyńskiej. Fragm. Flor. Geobot. Ser. Polonica 1: 49–61.
Culberson W. L. 1955. The corticolous communities of lichens and bryophytes in the Upland forest of Northern Wisconsin. Ecoll. Monogr. 25 (1): 215-231.
Czarnota P. 1994. Porosty zabytkowego parku dworskiego w Porębie Wielkiej w Gorcach. Fragm. Flor. Geobot. Polonica 1: 91–95.
Czarnota P. 2000. Porosty Gorczańskiego Parku Narodowego. Cz. I. Wykaz i rozmieszczenie gatunków. Parki nar. Rez. przyr. 19: 3–73.
Czyżewska K. 1992. Syntaksonomia śródlądowych pionierskich muraw napiaskowych. Monogr. Bot. 74: 1–174.
Dimos M. 2005. Porosty Parku Szczytnickiego we Wrocławiu. Acta Botanica Silesiaca 2: 173–179.
Dymytrova L. 2009. Epiphytic lichens and bryophytes as indicators of air pollution in Kyiv city (Ukraine). Folia Cryptog. Estonica, Fasc. 46: 33–44.
Dziemianowicz W., Nowicka P., Peszat K. 2013. Diagnoza strategiczna województwa podlaskiego. Geoprofit, Warszawa.
Fałtynowicz W. 1980. Zmiany we florze porostów naziemnych w zależności od wieku nasadzeń sosnowych na siedlisku *Cladonio–Pinetum*. Zeszyty Naukowe Wydziału Biologii i Nauk o Ziemi UG, Biologia 2: 81–90.
Fałtynowicz W. 1986. The dynamics and role of lichens in a managed *Cladonia* – Scotch Pine Forest (*Cladonio-Pinetum*). Monogr. Bot. 69: 1-95.
Fałtynowicz W. (red.) 1994. Porosty Wigierskiego Parku Narodowego. Parki nar. Rez. przyr. 13(3): 9–28.
Fałtynowicz W. 1997. Porosty głazów narzutowych Parków Krajobrazowych Trójmiejskiego i Kaszubskiego. Monographiae Botanicae 81: 1–54.
Fałtynowicz W. 2003. The lichens, lichenicolous and allied fungi of Poland – an annotated checklist. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.
Fałtynowicz W., Izydorek I., Budzbon E. 1991. The lichen flora as bioindicator of air pollution of Gdańsk, Sopot and Gdynia. Monogr. Bot. 73: 1–53.
Fałtynowicz W., Kukwa M. 2002. Porosty rezerwatu „Głazowisko Bachanowo nad Czarną Hańczą" i przyległego lasu łęgowego w Suwalskim Parku Krajobrazowym. Parki nar. Rez. przyr. 21(4): 375–384.
Farkas E., Lőkös L., Verseghy K. 1985. Lichens as indicators of air pollution in the Budapest Agglomeration. I. Air pollution map based on floristic data and heavy metal concentration measurements. Acta Bot. Hung. 31: 45-68.
Farmer A. 2004. Wpływ zanieczyszczeń pyłowych. [In:] Bel J. N. B., Treshow M. (red.) Zanieczyszczenie powietrza w życiu roślin, Wydawnictwo Naukowo-Techniczne, Warszawa, s. 209–220.
Frati L., Caprasecca E., Santoni S., Gaggi C., Guttová A., Gaudino S., Pati A., Rosamilia S., Pirintsos S.A., Loppi S. 2006. Effects of NO_2 and NH_3 from road traffic on epiphytic lichens. Environmental Pollution 142: 58–64.
Galloway D. J., Coppins B. J. 1992. *Porpidia* Körber (1885). [In:] The Lichen Flora of Great Britain and Ireland. Purvis O.W., Coppins B. J., Hawksworth D. L., James P. W., Moore D. W. (eds.): 494–499. London: Natural History Museum Publications.
Grochowski, P. 2002. Lichens cemetery in Bogusław (north-western Poland). Fragm. Florist. Geobot. 2: 237–244.
GUS 2016. Tabele demograficzne, stan z 30 czerwca 2016 r.

http://demografia.stat.gov.pl/bazademografia/StartContact.aspx
Hale M. E. 1955. Phytosociology of corticolous cryptogams in the upland forests of Southern Wisconsin. Ecol. 36 (1): 45-63.
Hawksworth D. L., Rose F. 1970. Qualitative scale for estimating sulphur dioxide air pollution in England and Wales using epiphytic lichens. Nature 227: 145–148.
Hickmott M. 1980. Lichens on Lead. Lichenologist 12: 405–406.
Hill D. J. 1994. The succession of lichens on gravestones: A preliminary investigation. Cryptogamic Botany 4:179–1186.
Ihlen P.G., Ekman S. 2002. Outline of phylogeny and character evolution in *Rhizocarpon* (Rhizocarpaceae, lichenized Ascomycota) based on nuclear ITS and mitochondrial SSU ribosomal DNA sequences. Biological Journal of the Linnean Society 77: 535–546.
Jando K., Kukwa M. 2003. Porosty, grzyby naporostowe i nażywiczne projektowanego rezerwatu "Wiszące Torfowiska nad jeziorem Jaczno" w Suwalskim Parku Krajobrazowym (Północno-Wschodnia Polska). Parki nar. Rez. przyr. 22(1): 3–17.
Jastrzębska B. 2002. Porosty (*Lichenes*) miasta Siedlce. Zesz. Nauk. Akademii Podlaskiej 62: 143-151.
Jastrzębska, B. 2005. Porosty cmentarza w Ugoszczy oraz jego okolicy (Nadbużański Park Krajobrazowy). Fragm. Florist. Geobot. 12: 194–197.
Kappen L., Lange O. L., Schulze E. D., Evenari M., Buschbom U. 1979. Ecolophysiological investigations on lichens of the Negev Desert. VI. Annual course of photosynthetic production of *Ramalina maciformis* (Del.) Bory. Flora 168: 85-108.
Kappen L, Valladares F. 1999. Opportunistic growth and desiccation tolerance: the ecological success of poikilohydrous autotrophs. In: Pugnaire F.I., Valladares F. (eds.). Handbook of functional plant ecology. New York: Marcel Dekker, Inc, 10-80.
Karczmarz K., Mickiewicz J., Olech M. 1988. Epilityczna flora głazów narzutowych Pojezierza Suwalsko-Augustowskiego i Wysoczyzny Siedleckiej. Ochr. Przyr. 46: 121-158.
Kershaw K. A. 1975. Studies on lichen–dominated systems. XII. The ecological significance of thallus color. Canadian Journal of Botany, 53: 660-667.
Kershaw K. A., Rouse W. R, 1971. Studies on lichen–dominated systems. I. The water relations of *Cladonia alpestris* in spruce-lichen woodland in northern Ontario. Canadian Journal of Botany, 49: 1389-1399.
Kiercul S. 2015a. Notes on the distribution of lichen biota of Podlasie I. Nowosady village, Podlaskie province (north-eastern Poland). Acta Mycol. 50(1): 1053.
Kiercul S. 2015b. Bogactwo gatunkowe porostów wsi Hermanówka. Chrońmy Przyr. Ojcz. 71(2): 116–121.
Kiszka J. 1977. Wpływ emisji miejskich i przemysłowych na florę porostów (*Lichenes*) Krakowa i Puszczy Niepołomickiej. Wyd. Naukowe WSP w Krakowie, Prace Monogr. 19: 1-137.
Kiszka J. 1994. Badania i obserwacje porostów w siedliskach antropogenicznych i naturalnych przeprowadzone podczas sympozjum „Porosty apofityczne jako wynik antropopresji". [In:] J. Kiszka, J. Piórecki (red.), Porosty apofityczne jako wynik antropopresji. Materiały z Sympozjum Bolestraszyce, 4–9 wrzesień 1993. Arboretum Bolestraszyce 2: 67–78.
Kiszka J. 1999. Porosty (*Lichenes*) oraz warunki bioekologiczne Przemyśla. Arboretum Bolestraszyce 6: 1-86.
Kiszka, J., Lipnicki, L. 1994. Porosty na głazach na prehistorycznym cmentarzysku „Kręgi Kamienne" w Borach Tucholskich. Fragm. Florist. Geobot. 1: 97–105
Kiszka J., Piórecki J. 1991. Porosty (*Lichenes*) Pogórza Przemyskiego. Zakład Fizjografii i Arboretum w Bolestraszycach, Wydawnictwo Uniwa, Warszawa.
Kiszka J., Piórecki J. 1992. Porosty Gór Słonnych w Karpatach Wschodnich. s. 95. Wydawnictwo Zakładu Fizjografii i Arboretum w Bolestraszycach, Bolestraszyce.
Kolanko K. 2001. Porosty rezerwatów przyrody Puszczy Knyszyńskiej. Parki nar. Rez. przyr. 19(3): 55–64.
Kolanko K. 2005. Porosty Biebrzańskiego Parku Narodowego i terenów przylegających. [In:] Dyrcz A., Werpachowski C. (red.) 2005. Przyroda Biebrzańskiego Parku Narodowego. Monografia. BPN, Osowiec-Twierdza: 149-160.
Kolanko K. 2008. Porosty rezerwatu "Krasne" w Parku Krajobrazowym Puszczy Knyszyńskiej (północno-wschodnia Polska). Parki nar. Rez. przyr. 27(3): 3–15.
Kolanko K. 2009. Porosty rezerwatu przyrody „Starodrzew Szyndzielski" w Parku Krajobrazowym Puszczy Knyszyńskiej (północno-wschodnia Polska). Parki nar. Rez. przyr. 28(2): 29–43.
Kościelniak R. 1998. Porosty drzew owocowych w Bieszczadach Niskich. W: Botanika polska u progu XXI wieku. Materiały konferencji i obrad sekcji 51 Zjazdu PTB, Gdańsk 5–19 września 1998 (Miądlikowska J. red.). S. 228. Bogucki Wydawnictwo Naukowe, Poznań.

Kościelniak R. 2004. Porosty (*Lichenes*) Bieszczadów Niskich. Fragm. Flor. et Geobot. Polonica, Suppl. 5: 1–164.
Kościelniak R., Betleja L. 2013. Porosty na nietypowych podłożach antropogenicznych w Bieszczadzkim Parku Narodowym. Roczniki Bieszczadzkie 21: 35–41.
Kowalewska A, Kukwa M, Ostrowska I, Jabłońska A, Oset M, Szok J. 2008. The lichens of the *Cladonia pyxidata-chlorophaea* group and allied species in Poland. Herzogia 21: 61–78.
Kozik R. 1994. Porosty epilityczne na pomnikach cmentarzy z I Wojny Światowej (1914-1915) rozmieszczonych na Pogórzu Karpackim. [In:] Porosty apofityczne jako wynik antropopresji. Kiszka J., Piórecki J. (eds.). Materiały z sympozjum Bolestraszyce, 4-9 wrzesień 1993, Arboretum Bolestraszyce 6: 47-53.
Krawiec F. 1938. Materiały do flory północno-wschodniej Polski. Spraw. Komisji Fizjogr. PAU 71: 65-82.
Krawiec F. 1955. Porosty Wysoczyzny Kaliskiej. Prace Komisji Biologicznej Poznańskiego Towarzystwa Przyjaciół Nauk 17: 39–54.
Kubiak D. 2005. Lichens and lichenicolous fungi of Olsztyn Town (NE Poland). Acta Mycol. 40(2): 293–332.
Kubiak D. 2006. Lichens of red oak *Quercus rubra* in the forest environment in the Olsztyn Lake District (NE Poland). Acta Mycol. 41(2): 319–328.
Kubiak D. 2008. Porosty rezerwatów torfowiskowych "Mszar" i "Redykajny" na Pojezierzu Olsztyńskim. Parki nar. Rez. przyr. 27(1): 3-14.
Kubiak D., Biedunkiewicz A., Koźniewski D. 2015. Porosty epifityczne parku przypałacowego w Opinogórze Górnej (Północne Mazowsze). Chrońmy Przyrodę Ojczystą 71(4): 257–265.
Kubiak D., Bobińska A. 2012. The lichen biota of Warmia and Mazury Forest Arboretum in Kudypy (N Poland). Rocz. AR Pozn. 391, Botanica Steciana 16: 101-107.
Kubiak D., Kukwa M. 2008. Uzupełnienie do bioty porostów miasta Olsztyna (NE Poland). Fragm. Flor. Geobot. Polonica 15(1): 107–115.
Kubiak D., Sucharzewska E. 2004. Porosty parku wiejskiego w Gogolewie (południowa Wielkopolska). Badania Fizjograficzne nad Polską Zachodnią Ser. B 53: 147–151.
Kukwa M. 2002. Porosty z rodzajów *Lepraria* i *Leproloma* w Puszczy Białowieskiej. Parki nar. Rez. przyr. 21: 253–262.
Kukwa M., Schiefelbein U., Czarnota P., Halada J., Kubiak D., Palice Z., Naczk A. 2008. Notes on some noteworthy lichens and allied fungi found in the Białowieża Primeval Forest in Poland. Bryonora 41: 1–11.
Kuziel S. 1964a. Porosty epifityczne drzew owocowych w Kotlinie Łącka i okolicy. Łódzkie Towarzystwo Naukowe, Prace Wydziału III, Nauk Matematyczno-Przyrodniczych 98: 1–42.
Kuziel S. 1964b. Zespoły porostów epifitycznych na drzewach owocowych w sadach doliny Dunajca. Acta Agrobotanica 16: 55–65.
Lange O. L., Schulze E. D., Koch W. 1970. Experimentell-ökologische Untersuchungen an Flechten der Negev-Wüste. II. CO_2- Gaswechsel und Wasserhaushalt von *Ramalina maciformis* (Del.) Bory am natürlichen Standort während der sommerlichen Trokkenperiode. Flora, 159: 38-62.
Lange O.L., Green T.G.A., Ziegler H. 1988. Water status related photosynthesis and carbon isotope discrimination in species of the lichen genus *Pseudocyphellaria* with green and blue-green photobionts and in photosymbiodemes. Oecologia 75: 394–411.
Larson D. W. 1979. Lichen water relations under drying conditions. New Phytologist, 82: 713-731.
Larson DW. 1981. Differential wetting in some lichens and mosses: the role of morphology. Bryologist 84: 1-15.
Larson DW. 1987. The absorption and release of water by lichens. [In:] Peveling E. (ed.) Progress and problems in lichenology in the eighties. Berlin, Stuttgart: J. Cramer, 351-360.
Lecewicz W. 1954. Porosty Białowieży. Fragm. Flor. et Geobot. 1(2): 38–47.
Leger E.A., Forister M. L. 2009: Colonization, abundance, and geographic range size of gravestone lichens. Basic and Applied Ecology 10(3): 279–287. http://dx.doi.org/10.1016/j.baae.2008.04.001
Lipnicki L. 1990. Udział porostów w zbiorowiskach leśnych i na siedliskach silnie zmienionych przez człowieka. [In:] Andrzejewski R. (red.) Taktyka adaptacyjna populacji i biocenoz poddanych antropopresji. Warszawa: Szkoła Główna Gospodarstwa Wiejskiego – Akademia Rolnicza w Warszawie, p. 94–113.
Lipnicki L. ed. 1991. Porosty (*Lichenes*) Pszczewskiego Parku Krajobrazowego. [In:] Lipnicki L. (ed.). V Meeting of Polish Lichenologists, S. 5–32. Instytut Badań i Ekspertyz Naukowych, Gorzów Wlkp.
Lipnicki L. 1998. Kształtowanie się flory porostów zasiedlających głazy narzutowe. [In:] Lipnicki L. (red.) Kształtowanie się flor porostów na podłożach o cechach pionierskich. Monographiae Botanicae 84: 5-38.

Lipnicki L., Sobieralska R. 2009. Porosty epifityczne w starych sadach w Dolinie Dolnej Wisły. Parki nar. Rez. przyr. 28: 37–49.
Loppi S., Ivanov D., Boccardi R. 2002.Biodiversity of epiphytic lichens and air pollution in the town of Siena (Central Italy). Environmental pollution 116 (1): 123-128.
Łubek A. 2007. Antropogeniczne przemiany bioty porostów Świętokrzyskiego Parku Narodowego i otuliny. Fragm. Flor. et Geobot. Polonica 10: 1-94.
Łubek A., Biskup E. 2012. Porosty epifityczne i grzyby naporostowe drzew owocowych w gminie Sławno (Polska Środkowa). Chrońmy Przyrodę Ojczystą 68(3): 186–197.
Martins M. F. N., Spielmann A. A., Putzk E. J., Pereira A. B. 2004. Lichenized Fungi on men-made substrata in Deception Island, South Shetlands, Antarctica. [In:] V Simposio Argentino y I Latinoamericano de Investigaciones Antarticas, 2004, Buenos Aires – Argentina. Actas del V Simposio Argentino y I Latinoamericano de Investigaciones Antarticas. Buenos Aires – Argentina: Instituto Antartico Argentino, 1: 1–4.
Matwiejuk A. 2007. Porosty Białegostoku. Analiza florystyczno-ekologiczna, Tom I. Wydawnictwo Ekonomia i Środowisko, Białystok.
Matwiejuk A., Korobkiewicz K. 2012. Stan bioty porostów w miastach Polski. Ochrona Środowiska i Zasobów Naturalnych 51: 85-105.
May P. F. 2001. Lichen survey of Mount Everett Summit, Southwest Berkshire County, Massachusetts. htttp://www.mounteverett.org/Studies/Lichen.pdf
Nash III T. H. (eds.). 1996. Lichen biology. Cambridge: Cambridge University Press.
Nylander W. 1866. Les lichens du Jardin du Luxemburg. Bulletin de la Société Botanique de France. Paris 13: 364–372.
Ohlert A. 1870. Zusammenstellung der Lichenen der Provinz Preussen. Schrift. Kgl. Phys.-ökon. Ges Königsberg 11: 1-51.
Olech M. 1973. Porosty Beskidu Sądeckiego. Zeszyty Naukowe Uniwersytetu Jagiellońskiego, Prace Botanicze 1: 87–192.
Optyke M. R., Dolney B. E. Frost L. L., Roy J. D. 2011. Of epiphytic lichens communities in urban and rural environments in Southwestern Pennsylvania. A study Journal of the Pennsylvania Academy of Science 85(4): 151–158.
Pinho P., Augusto S., Martins–Lação, Pereira M.J., Soares A., Máguas C., Branquinho C. 2008a. Causes of change in nitrophytic and oligotrophic lichen species in Mediterranean climate: Impact of land cover and atmospheric pollutants. Environmental Pollution 154: 380–389.
Pinho P., Augusto S., Máguas C., Pereira M.J., Soares A., Branquinho C. 2008b. Impact of neighborhood land–cover in epiphytic lichen diversity: Analysis of multiple factors working at different spatial scales. Environmental Pollution 151: 414–422.
Purvis O.W., James P.W., Holtan-Hartwig J., Timdal E., Clayden S.C. 1992. *Rhizocarpon* Lam. ex DC. (1805). [In:] Purvis O.W., Coppins B.J., Hawksworth D.L., James P.W., Moore D.M. (eds.). The lichen flora of Great Britain and Ireland. London: Natural History Museum Publications, 531–542.
Rose C. I., Hawksworth D. L. 1981. Lichen recolonization in London's cleaner air. Nature 289: 289-292.
Ruoss E. 1999. How agriculture affects lichen vegetation in Central Switzerland. Lichenologist 31: 63–73.
Rydzak J. 1953. Rozmieszczenie i ekologia porostów miasta Lublina. Annales UMCS, Sect. C 8(9): 233–356.
Rydzak J. 1957. Wpływ małych miast na florę porostów. Część IV. Lubelszczyzna- Kieleckie – Podlaskie – Puławy – Busko – Siedlce – Białowieża. Annales UMCS, Sect. C 10(14): 321–398.
Rydzak J. 1961. Tree lichens in the forest communities of the Białowieża National Park. Annales UMCS, Sect. C 16: 17-47.
Rydzak J. 1969. Badania nad stanem ilościowym flory porostów nadrzewnych Puszczy Białowieskiej i Puszczy Ludzkiej. Annales UMCS, Sect. C 24(6): 65–72.
Rydzak J. 1970. Flora i ekologia porostów drzew przydrożnych. Annales UMCS, sect. C 25: 149–157.
Sadowska-Deś A. 2008. Porosty Parku Zdrojowego w Cieplicach Zdrój (Jelenia Góra, SW Poland). Acta Botanica Silesiaca 3: 167–174.
Sander E., 1988: Comparative analysis of the epiphytic lichen floras of seven rural parks in north Estonia. [In:] Parmasto E., Trass H. (eds), Abstracts of the 11 Symposium of the Mycologists and Lichenologists of the Baltic Republics and Byelorussia, Tallinn: 169-172.
Savič V.P. 1923. Lisajnikovaja i mochovaja rastitielnost bora v blizajsich okrestnostiach Avgustova b. Suvalskoj gub. Izw. Glav. Bot. Sada 22(2): 135–141.
Seaward M. R. D., Coppins B. J. 2004. Lichens and hypertrophication. Contributions to Lichenology, 561–572.
Spier C., van Dobben H., van Dort K. 2010. Is bark pH more important than tree species in determining the composition of nitrophytic or acidophytic lichen floras? Enviromnental Pollution 158: 3607–3611.

Stefańska–Krzaczek E., Fałtynowicz W. 2013. Wzrost różnorodności gatunkowej chrobotków jako efekt rębni zupełnej na ubogich siedliskach borowych. Sylwan 157(12): 929–936.
Stofer S., Bergamini A., Aragón G, Carvalho P., Coppins B. J., Davey S. , Dietrich M., Farkas E., Kärkkäinen K., Keller C., Lökös L., Lommi S., Máguas C., Mitchell R., Pinho P., Rico V. J., Truscott A.-M., Wolseley P.A., Watt A., Scheidegger C. 2006. Species richness of lichen functional groups in relation to land use intensity. The Lichenologist 38(4): 331-353.
Stubbs C. S. 1989. Patterns of distribution and abundance of corticolous lichens and their invertebrates associates in *Quercus rubra* in Main. Bryologist 92: 453-460.
Szymczyk R., Zalewska A. 2008. Lichens in the rural landscape of the Warmia Plain. Acta Mycol. 43: 215–230.
Śliwa L. 1998. Antropogeniczne przemiany lichenobioty Beskidu Sądeckiego. Instytut Botaniki Uniwersytetu Jagiellońskiego. Prace Bot. 31: 1–158.
Śliwa L. 2006. Additions to the lichen flora of the Tatry National Park and its surroundings (Polish Carpathians). [In:] Lackovičová A., Guttová A., Lisická E., Lizoň P. (eds.). Central European lichens – diversity and threat. Mycotaxon Ltd., Ithaca, s. 305–314.
van Herk C.M. 1999. Mapping of ammonia pollution with epiphytic lichens in the Netherlands. Lichenologist 31: 9–20.
van Herk C.M. 2001. Bark pH and susceptibility to toxic air pollutants as independent causes of changes in epiphytic lichen composition in space and time. Lichenologist 33: 419–441.
van Herk, C.M., Mathijssen–Spiekman, E.A.M., de Zwart, D. 2003. Long distance nitrogen air pollution effects on lichens in Europe. Lichenologist 35: 347–359.
Wade A.E. 1978. Churchyard lichens in the Vale of Glamorgan. Trans. Cardiff Nat. Soc. 98: 30–36.
Welch A.R., Gillman M.P., John E.A. 2006. Effect of nutrient application on growth rate and competitive ability of three foliose lichens species. Lichenologist 38: 177–186.
Wirth V. 1995. Die Flechten Baden–Württembergs. II Aufl. Stuttgart, Verl. Eugen Ulmer, Stuttgart, 1006 pp.
Wolseley P.A., James P.W., Theobald M.R., Sutton M.A. 2006. Detecting changes in epiphytic lichen communities at sites affected by atmospheric ammonia from agricultural sources. Lichenologist 38: 161–176.
Yatsyna A. 2014. Lichens from Manor Parks in Minsk Region (Belarus). Botanica Lithuanica 20(2):159-168.
Zalewska A. 2012. Ecology of lichens of the Puszcza Borecka (NE Poland). W. Szafer Institute of Botany, Polish Academy of Sciences Kraków.
Zalewska A., Fałtynowicz W., Krzysztofiak A., Krzysztofiak L., Picińska-Fałtynowicz J. 2004a. Lichens of Romincka Primeval Forest. [In:] Zalewska A., Fałtynowicz W. (eds.). Lichens of the protected areas in the Euroregion Niemen., Helios, Suwałki: 51–109.
Zalewska A., Fałtynowicz W., Krzysztofiak A., Krzysztofiak L., Picińska-Fałtynowicz J. 2004b. Lichens of Suwalski Landscape Park. [In:] Zalewska A., Fałtynowicz W. (eds.). Lichens of the protected areas in the Euroregion Niemen. Helios, Suwałki: 5–50.
Zalewska A., Fałtynowicz W., Krzysztofiak A., Krzysztofiak L., Picińska-Fałtynowicz J. 2004c. Porosty Suwalskiego Parku Krajobrazowego. Stowarzyszenie „Człowiek i Przyroda", Suwałki.
Zarabska D. 2011. Porosty w krajobrazie rolniczym Sandru Nowotomyskiego [PhD thesis]. Uniwersytet im. Adama Mickiewicza, Poznań.
Zarabska –Bożejewicz D. 2016. Lichens in the agricultural land of Poland – diversity, threats, and protection: a literature review. Acta Mycol. 51(1): 1-14. DOI: http://dx.doi.org/10.5586/am.1076
Zarabska D., Guttová A., Cristofolini F., Giordani P., Lackovičová A. 2009. Epiphytic lichens of apple orchards in Poland, Slovakia and Italy. Acta Mycol. 44 (2): 151–163.
Zielińska 1980. Porosty głazów narzutowych Wysoczyzn Podlaskich. Acta Mycol. 16: 257–272.

5. SUMMARY OF SCIENTIFIC ACHIEVEMENTS (SEE ATTACHED LIST OF PUBLICATION AND LIST OF ACHIEVEMENTS, ANNEX 3)

After obtaining a doctoral degree in the mainstream of my interests there remained studies related to the biodiversity of lichens in North-Eastern Poland with particular emphasis on the areas of varied degrees of anthropogenic transformation in Podlaskie voivodeship. At the same time the scope of research and the area of studies significantly expanded. More attention was devoted to habitat factors and their impact on the conservation status of the lichen biota in urban areas. In addition to regular analyses conducted in the villages of the region of Podlasie, my research was extended on to agricultural areas and areas under legal protection (nature reserves, national parks, landscape parks) in North-Eastern Poland. In the centre of my interests there also appeared analyses related to the revision of the lichen herbarium materials concerning selected genus of lichens. Due to the high usability of this kind of research I plan to continue it in the future. In cooperation with the lichenologists from the Republic of Belarus, I plan to take part in an international project on *Lichens of border areas in the area of Augustow Canal*. I also examined the daily water demand of epiphytic lichens. The collected results in many cases contributed to a better assessment of natural conditions based on the assessment of biodiversity of lichens, the effect of habitat conditions for their occurrence, and are the starting material for further research. As an expert I conducted active conservation measures lichen and I was a reviewer of the two nature conservation plans and I conducted workshops and field activities on: Recognition and ways to protect protected lichen species in the implementation of economic activities in the State Forests, where the participation of forest workers.

After obtaining a doctoral degree I received the awards of the Rector of the University of Bialystok for scientific achievements in the years: 2004, 2009, 2012, 2016. In 2015 I was awarded National Education Committee Medal for outstanding contribution to education, issued by the Ministry of Education. Five times I have been the winner of the award "Zak" granted by the students of the Faculty of Biology and Chemistry for the best lecturer.

I conduct scientific studies in cooperation with scientific institutions from abroad, mainly from the Republic of Belarus in the framework of implemented statutory research. I completed numerous internships and trainings in educational centres in Poland and abroad. I was a reviewer in 4 scientific journals and several monographs both in Polish and English. I am an active participant in numerous workshops and training courses on ecology and mainly lichenology. I worked on the organizing committee of many scientific conferences. I am a member of the Polish Botanical Society (Lichenological Section), in which I have held responsible positions, including membership of the Branch of the Bialystok of Polish Botanical Society in the years 2004-2010. I took care of a large group of Bachelor students - BSs (24) and MSc students (14). The MA thesis written by Mrs. Emilia Wójtowicz (MA) "*Lichens of Elk in Warmia-Mazurian voivodeship"* was awarded with distinction for the best thesis in the competition *"Award of the Mayor of the City of Elk for outstanding thesis related to the city of Elk."* in 2015. I have been the supervisor of a scientific club for biology students of University of Bialystok (lichenology section), conducting research on lichens in North-Eastern Poland. I have been actively involved in organizational activities of the Faculty of Biology and Chemistry, University of Bialystok, accepting responsible functions, such as: Plenipotentiary of the Dean for the MOST program (2015-2016), Vice-President of the Regional Committee of the National Biological Knowledge Competition (Olympics) (2016-2017), and member of the Faculty Team for Education Maintenance and Quality Improvement, Member of the Program Committee for Studies Program at the Institute of Biology, Member of Directional Didactic Team, Member of the Scientific Council of the Institute of Biology. I am also involved in the development of new curricula and popularizing biological and ecological knowledge.

Since obtaining the doctoral degree, my academic achievements have included 2 monographs, 1 album, 9 chapters in books, 70 articles published in national and international journals (including 3 published in journals from the Philadelphia List) and 26 news conference (including: 108). The total impact factor of my publications published after the doctorate, according to the list Journal Citation Reports (JCR), according to the publication year is 2.293. MSHE points I have been awarded for all post-doctoral publications equal 425. The total number of citations in the database of Web of Science and Google Scholar are respectively 3 and 120; h-index in the database of Web of Science, Google Scholar: 1 and 6, respectively.

TABLE 2. Summary of scientific achievements after obtaining the title of Doctor of Biological Sciences

Publications from the list of Journal Citation Reports (JCR)	3
Reviewed publications	70
Compact publications (books)	2
Chapter in the monograph in English	3
Chapter in the monograph in Polish	6
Total IMPACT FACTOR (IF)	2,293
MSHE points	425
The number of citations by Web of Sciences	3
Index Hirsh by Web of Sciences	1
The number of citations according to Google Scholar, Research Gate and other	295
Index H by Google Scholar	6

Bialystok, 20.06.2017. **Anna Matwiejuk**