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Dedicated to Professor Krystyna Czyżewska
in honour of 40 years of her scientific activity

Lichens of abandoned zinc-lead mines

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A list of lichens from areas of zinc-lead ores in Southern Poland and a review of the characteristic lichen biota of these sites is provided. In spite of the devastated and heavy metal contaminated environment, a highly diverse epigeic and epilithic lichen biota was found, including species characteristic of various anthropogenic habitats, particularly zinc and lead enriched substrates (*Diploschistes muscorum*, *Steinia geophana*, *Sarcosagium campestre*, *Vezdaea aestivalis* and *V. leprosa*). Also, the high-mountain species *Leucocarpia biatorella*, as well as very rare in Europe *Thelocarpon imperceptum*, and several species categorized as very rare, endangered and protected in Poland were recorded. Crustose lichens are the most abundant; among fruticose forms *Cladonia* spp. predominate and *Stereocaulon incrustatum* is common.

Key words: lichenized fungi, anthropogenic habitats, heavy metals, galena, Silesian-Kraków Upland

INTRODUCTION

The largest resources of zinc and lead ores in Poland occur in Silesian-Krakow monocline, where they have been mined and processed since the Middle-Ages. Those deposits are often bound to the Triassic carbonate rocks – ore-bearing dolomites (Żabiński 1960). The oxidized zinc and lead ores (galena) are often defined as galmani (Żabiński 1978). Due to the mining and metallurgy in southern Poland, numerous scars to the landscape have been developed such as excavations (voids), shafts, mining adits and mine waste heaps (Molenda 1963). Such activities have significantly influenced the status of surface and ground water, soils, and consequently the flora and fauna; in addition, the presence of heavy metals (zinc, lead, cadmium) considerably influenced organisms, such species as colonize such habitats have various features which help them to adapt to these adverse, or even toxic, conditions. Zinc and lead ores are colonized those organisms with a wide tolerance of environmental stress, producing unique communities with an interesting biology (Jędrzejczyk 2004; Szarek-Łukaszewska, Grodzińska 2008).

In habitats contaminated by heavy metals, lichens, usually accompanied by mosses, are of great importance, forming unique plant communities (Wirth 1972; Purvis, Halls 1996; Paus 1997; Cuny et al. 2004). Thus, mining or metallurgy sites provide a particular field laboratory to follow natural processes of interest to lichenologists in terms of their taxonomy, physiology, threats and protection, monitoring abilities, etc. In Europe, 291 lichen species have been noted from habitats rich in metals such as iron, copper, zinc, lead, chromium, nickel (Purvis, Halls 1996; Heibel 1999; Cuny et al. 2004). Lichens often thrive on substrates rich in zinc and lead, and some genera such as *Gyalideopsis*, *Sarcosagium*, *Steinia* and *Vezdaea* appear to be limited to such habitats and can be used as good indicators of Zn and Pb (Cuny et al. 2004). Some new species have been described from the Zn and Cd polluted areas, such as *Micarea confusa* (Coppins, van den Boom 1995), *Pyrenocollema chlorococcum* (Aptroot, van den Boom 1998) and *Coppinsia minutissima* (Lumbsch, Heibel 1998).

Limited information on species composition and their behaviour on post-exploitation areas (e.g., Seaward, Bylińska 1980; Kiszka 2003), but there has been no detailed documentation of lichen species from zinc and lead ores areas in Poland. The results presented below sum up current knowledge and establish a basis for future studies on the characteristic lichen biota of abandoned zinc-lead mining areas in Poland, as well contributing to our knowledge of species distribution.

STUDY AREA

Studies were carried out in five sites of former mining and metallurgical sites based on zinc and lead ores, where there has been no subsequent development and spontaneous succession of vegetation has occurred (Fig.1). Studies were conducted on the three mineral deposit zones of the Silesian-Kraków monocline: Tarnowskie Góry-Bytom area (two sites in Tarnowskie Góry), Chrzanów-Jaworzno area (grassland in Jaworzno-Długoszyn and in Balin near Chrzanów), and Siewierz-Olkusz area (in Bolesław). Study sites vary in age and nature of their development.

Bolesław (Fig.1, I). Soil-rock bank and grassland (4.5 km^2) covered partially by shrubs and trees (coniferous and sporadically deciduous). On reasonably large area was planted with pine during restoration work. In the S-E part, an area is protected as "ecological arable land" [in Polish: użytek ekologiczny] due to the occurrence of *Biscutella laevigata*.

"Warpie" Wood in Balin near Chrzanów (Fig.1, II). This study area (1.8 km^2) is covered by pine forest, with some birch and larch. Forest bottom morphology suggest a post-mining character of the area. Part of the study site is open grassland, with blackthorn shrubs. Some arable land is present in the vicinity.

Jaworzno Długoszyn (Fig.1, III). This study area (3.5 km^2) is situated is within the city limits of Jaworzno, where signs of zinc-lead ore mining are still visible between

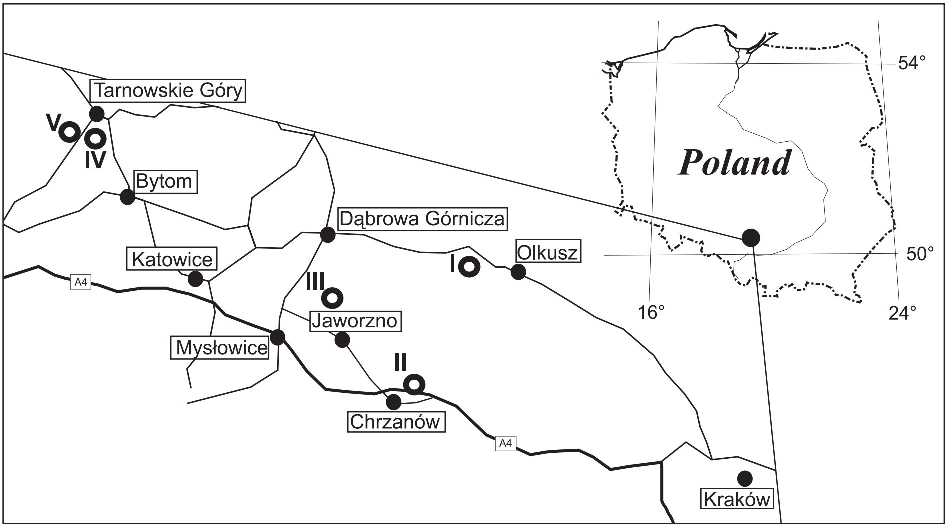

Fig. 1. Location of the investigated areas:
I – Bolesław next to Olkusz; II – "Warpia" Wood in Balin next to Chrzanów; III – Jaworzno-Długoszyn; IV – Tarnowskie Góry dolomite heap; V – Tarnowskie Góry "Planeta" Wood.

built-up areas. Part of the site is covered by mixed forest, part by grassland, and part transformed into farmland.

Tarnowskie Góry – dolomite heap (Fig.1, IV). This study area (1.5 km^2) is essentially a mining spoil heap located in a place where 120 years of drilling for the "Fryderyk" mine undertaken. The heap was formed of the ore-bearing dolomites, which were processed (sorted and rinsed) to provide zinc-lead ore (containing silver) and iron ore (limonite). It is surrounded by farmlands and there are two inlets of the drainage shaft in the vicinity.

Tarnowskie Góry – "Planeta" Wood (Fig.1, V). This study area (1.2 km^2) of post-mining of zinc-lead ores, situated on the city limits of Bytom and Tarnowskie Góry, is covered by degenerated forest, with a small, anthropogenic pond and some open ground of mainly by grassland.

Soils of zinc-lead ores from former mining and metallurgy are characterized by the presence of primary and secondary ores of zinc, lead and cadmium. Most soils here are skeletal and the rock soils are composed of clay and silt, with no profile differentiation. Such soils are characterized by their low nitrogen and phosphorus content.

All study areas have elevated concentration of heavy metals, highest zinc concentration exceeding 46 000 mg/kg, lead 24 500 mg/kg, and cadmium 500 mg/kg (Jędrzejczyk 2004; Jędrzejczyk-Korycińska 2006). Bioaccessibility varies according to the metal form.

A major edaphic determinant of spontaneous vegetation development is water shortage or availability. A specific feature of the studied areas is the tendency to the soil surface to rapidly over-dry. Such areas are often subjected to strong solar insolation and strong winds (Dobrzańska 1955; Wierzbicka 2002).

MATERIAL AND METHODS

Data gathered in 2002-2004 were analyzed, the collected species being assigned to appropriate morphological and ecological groups. Collected material was analysed according to standard morphological and anatomical methodology. In this paper we follow Fałtynowicz (2003) lichen nomenclature, excluding the genus *Coenogonium* (Kauff, Büdel 2005), and Mirek et al. (2002) for plant nomenclature. Documentation and collected material is deposed in the Herbarium of the Department of Biology, Institute of Biology, Pedagogical University of Kraków (KRAP-L).

For the identified species, their frequency on the study sites was determined according to three categories: 1 – rare (1-3 records), 2 – frequent (4-10 records) and 3 – common (over 10 records) on one observed sites.

RESULTS

The number of known lichen species from the post-mining, ore-bearing areas of the Silesian-Kraków Upland reached 89 taxa, of which 76 are listed in Table 1.

Table 1
Lichen species in studied sites

B – Bolesław, W – "Warpia" Wood in Balin, JD – Jaworzno-Długoszyn, TGD – Tarnowskie Góry dolomite spoil heap, TGP – Tarnowskie Góry "Planeta" Wood

No	Taxon	Substrate preferency/ies	Frequency scale				
			B	W	JD	TGD	TGP
1.	*Agonimia tristicula* (Nyl.) Zahlbr.	soil, bryophytes	1				
2.	*Arthonia exilis* (Flörke) Anzi	*Thymus* sp.	1				
3.	*Arthonia lapidicola* (Tayl.) Branth & Rostr.	pebbles	1				
4.	*Aspicilia contorta* (Hoffm.) Kremp. subsp. *hoffmanniana* Ekman & Fröberg	stones		1			
5.	*Aspicilia moenium* (Vain.) G. Thor & Timdal	stones	1				
6.	*Bacidia bagliettoana* (A. Massal. & De Not.) Jatta	soil, bryophytes	3		3	3	
7.	*Bacidina phacodes* (Körb.) Vězda	soil, bryophytes	2		2	2	
8.	*Baeomyces rufus* (Huds.) Rebent.	soil		3		2	
9.	*Caloplaca holocarpa* (Hoffm.) A. E. Wade	stones, pebbles			1		
10.	*Candelariella aurella* (Hoffm.) Zahlbr.	stones, pebbles	2	2	3	2	
11.	*Cetraria islandica* (L.) Ach.	soil	2		2		2
12.	*Cladonia cariosa* (Ach.) Spreng.	soil	1				
13.	*Cladonia cervicornis* subsp. *verticillata* (Hoffm.) Ahti	soil	2				
14.	*Cladonia coniocraea* auct.	bark	1				
15.	*Cladonia fimbriata* (L.) Fr.	soil	1				
16.	*Cladonia furcata* (Huds.) Schrad.	soil	3		3	2	
17.	*Cladonia glauca* Flörke	soil	2			2	3
18.	*Cladonia pocillum* (Ach.) Grognot	soil, bryophytes	3		3	3	
19.	*Cladonia pyxidata* (L.) Hoffm.	soil, bryophytes	3	2	3	3	2
20.	*Cladonia rangiformis* Hoffm.	soil	1		2		
21.	*Cladonia subulata* (L.) Weber	soil			2	2	

22.	*Cladonia symphycarpia* (Flörke) Fr.	soil	2	2	2	2	
23.	*Coeniogonium pineti* (Ach.) Lücking & Lumbsch	bark	1			3	
24.	*Collema limosum* (Ach.) Ach.	soil	2				
25.	*Collema tenax* (Sw.) Ach.	soil	1			1	2
26.	*Diploschistes muscorum* (Scop.) R. Sant.	*Cladonia* spp., bryophytes	3		3	2	
27.	*Diploschistes scruposus* (Schreb.) Norm.	stones	1			2	
28.	*Endocarpon pusillum* Hedw.	soil				1	
29.	*Hypocenomyce scalaris* (Ach.) M. Choisy	bark	1				2
30.	*Hypogymnia physodes* (L.) Nyl.	bark	1			2	
31.	*Lecania cyrtella* (Ach.) Th. Fr.	*Dianthus* sp.	1				
32.	*Lecanora albescens* (Hoffm.) Branth & Rostr.	rock, stones	2		2		
33.	*Lecanora conizaeoides* Cromb.	bark	2	3	3	3	3
34.	*Lecanora dispersa* (Pers.) Sommerf.	rock, stones	3		3	2	
35.	*Lecanora hagenii* (Ach.) Ach.	wood	2				
36.	*Lecanora saligna* var. *sarcopis* (Ach.) Hillmann	bark	2		2	2	
37.	*Lecidella stigmatea* (Ach.) Hertel & Leuckert	rock	1				
38.	*Lepraria* sp.	bark			2		2
39.	*Leptogium biatorinum* (Nyl.) Leight.	soil	2				
40.	*Micarea denigrata* (Fr.) Hedl.	wood	1			2	
41.	*Micarea prasina* Fr.	bark	2	3			3
42.	*Mycobilimbia tetramera* (De Not.) Vitik., Ahti, Kuusinen, Lommi & T. Ulvinen	soil, bryophytes	3			3	
43.	*Myxobilimbia sabuletorum* (Schreb.) Hafellner	soil, bryophytes	1				
44.	*Parmelia sulcata* Taylor	bark			1		
45.	*Peltigera didactyla* (With.) J.R. Laundon	soil, bryophytes	2			2	
46.	*Peltigera rufescens* (Weiss) Humb.	soil	2		3	2	
47.	*Phaeophyscia nigricans* (Flörke) Moberg	stones			1		
48.	*Phaeophyscia orbicularis* (Neck.) Moberg	stones			2		
49.	*Physcia adscendens* (Fr.) H. Olivier	stones			2		
50.	*Physcia caesia* (Hoffm.) Fürnr.	rock, stones	2				
51.	*Physcia tenella* (Scop.) DC.	bark	1				
52.	*Placynthiella icmalea* (Ach.) Coppins & P. James	bark	1			2	2
53.	*Polyblastia albida* Arnold	rock	1				
54.	*Porpidia crustulata* (Ach.) Hertel & Knoph	stones	1			2	
55.	*Protoblastenia rupestris* (Scop.) J.Steiner	rock,	1				
56.	*Protoparmeliopis muralis* (Schreb.) Choisy	rock, stones	1				
57.	*Sarcosagium campestre* (Fr.) Poetsch & Schied.	soil, bryophytes	3			2	
58.	*Scoliciosporum chlorococcum* (Stenh.) Vězda	bark	3	3	3	3	3
59.	*Scoliciosporum umbrinum* (Ach.) Arnold	stones	2				
60.	*Steinia geophana* (Nyl.) Stein	soil, bryophytes	3				
61.	*Stereocaulon incrustatum* Flörke	soil	2				
62.	*Strangospora moriformis* (Ach.) Stein	wood	1				
63.	*Thelidium papulare* (Fr.) Arnold	stones	1				
64.	*Trapelia coarcatata* (Sm.) M. Choisy in Werner	stones	1		2	2	
65.	*Trapelia placodioides* Coppins & P. James	stones	1				
66.	*Trapeliopsis flexuosa* (Fr.) Coppins & P. James	soil, bryophytes	2			2	
67.	*Verrucaria aethiobola* Wahlenb.	rock, stones	2	2	2	2	
68.	*Verrucaria bryoctona* (Th. Fr.) Orange	soil, bryophytes	2		2	2	
69.	*Verrucaria dolosa* Hepp	rock, stones	2		2	2	
70.	*Verrucaria fatrana* Servít	stones			2		
71.	*Verrucaria muralis* Ach.	stones, pebbles	3	2	3	3	2
72.	*Verrucaria nigrescens* Pers.	stones, pebbles	3		2	2	
73.	*Verrucaria obfuscans* Nyl.	stones				2	
74.	*Verrucaria procopii* Servít	stones, pebbles	2		2		
75.	*Vezdaea aestivalis* (Ohlert) Tscherm.-Woess & Poelt	soil, bryophytes	1		2	1	
76.	*Vezdaea leprosa* (P. James) Vězda	soil, bryophytes	1	2	2	2	

A clearer picture of lichens is completed by 13 other species published earlier: *Leucocarpia biatorella* (Kiszka, Kościelniak 2006), *Thelocarpon imperceptum* (Kiszka 2006), *Cetraria aculeata*, *Cladonia foliacea*, *Sarcogyne regularis* and *Thelidium velutinum* (Kiszka, Szarek-Łukaszewska 2006), *Micarea botryoides*, *M. micrococca* (Czarnota 2007), *Cladonia squamosa*, *C. arbuscula* subsp. *mitis*, *Lepraria elobata*, *L. jackii* and *Candelariella reflexa* (Pawlik-Skowrońska et al. 2008). Studied area, in spite of its serious environmental transformation, can be characterized by the lichen species richness, but the number of species on a particular site varies according to surface, size, local edaphic conditions, degree of transformation. Only four species were noted from all five study sites, namely *Cladonia pyxidata*, *Lecanora conizaeoides*, *Scoliciosporum chlorococcum* and *Verrucaria muralis*. *Candelariella aurella*, *Cladonia symphycarpia*, *Vezdaea leprosa* and *Verrucaria aethiobola* were noted from four sites, 18 species from 3 sites, and 33 from only one. The highest diversity, 69 species, was found in Bolesław, of which 25 were only found at that site. Species abundance also varies, and most of them are rare and very rare species. They form the most interesting part of the lichen biota and give the studied area distinctive and characteristic features.

Taxonomically the most numerous groups are represented by *Cladonia* and *Verrrucaria*, with 13 and 8 species respectively. Morphologically, crustose lichens are dominant (62 species), many of which have small, often inconspicuous thalli; some are pioneer species, with an ability of to rapidly colonize rocks and soils. Foliose forms are represented by 17 species, and only 10 species have fruticose forms.

Every type of substrate available for lichens was investigated. Terricolous lichens (40 species), growing directly on soil or on mosses, or plant debris, were dominant. *Diploschistes muscorum* is particularly interesting due to its specific biology: in the first phase of the development it grows on other lichen thalli (especially on *Cladonia* species), but afterwards colonizes plant debris, soil or gravel. Epilithic lichens (29 species) are found on rock exposures, gravel, small stones and local ore, as well as imported building materials. Only small fraction of recorded species were epiphytic due to the shortage of forest complexes or old trees. At the same time, epiphytic lichens are most vulnerable to atmospheric pollution, so were represented by common, toxitolerant species such as *Scoliciosporum chlorococcum* and *Lecanora conizaeoides*. *Hypogymnia physodes* rarely occurs and *Parmelia sulcata* was noted only once. Due to the lack of suitable habitats, epixylic lichens are also scarce, but on small pieces of wood lying on the ground, *Lecanora hagenii*, *Micarea denigrata* and *Strangospora moriformis* were noted.

DISCUSSION

The number of species noted from zinc-lead ore-bearing areas in Poland is relatively high and can be compared to analogous lists from other European areas. Purvis and Halls (1996) mention 61 species of epigeic lichens characteristic of lead/zinc-rich environments from the United Kingdom, Belgium, the Netherlands, France and Germany. The species composition of lichen on metalliferous sites is very diverse and depends not only on the heavy metals present, but also on other edaphic characteristics, such as the chemical and physical features of the substrate (Cuny et al. 2004) and local microclimatic conditions. The biodiversity depends on the ore type and its chemical composition, post-mining waste granularity, storage method, land restoration procedures, and level of air pollution.

The current status of the environment in the vicinity of mines and heavy metal processing works does not favour epiphytic lichens, especially the toxic effect of sulfur dioxide (Kiszka 1993) which is exacerbated by high concentrations of heavy metals in the air (Godzik 1993). Studies carried on selected epiphytic lichen species from Bukowno showed high accumulations of Zn and Pb in their thalli (Pawlik-Skowrońska et al. 2008). Other features can be observed in the case of terricolous and epilithic species which rapidly and effectively colonize such substrates. Some, for example *Protoparmeliopsis muralis*, are common in various anthropogenic habitats. Others, of similar characteristics, but rarely noted due to their inconspicuous size and short existence, such as *Steinia geophana* and *Sarcosagium campestre*, are ruderals (Gilbert 1990). *Vezdaea leprosa* and *V. aestivalis*, recently found on many sites in Poland (Czarnota, Kiszka 2004), were frequently noted, and other species, regularly observed in Europe on Zn and Pb substrates, included *Bacidia bagliettoana*, *Cladonia cariosa*, *C. glauca*, *C. furcata*, *C. rangiformis*, *Collema tenax*, *Diploschistes muscorum*, *Myxobilimbia sabuletorum*, *Scoliciosporum umbrinum* and *Trapelia coarctata*. Yet, it would be hard to classify which of them are obligatory metallophytes and which are metallotolerant. It is though doubtless that *Diploschistes muscorum* is simultaneously tolerant and indicator for Zn and Pb presence in the substrate, species very frequent on the studied area. In the case of fruticose species, *Cetraria islandica*, *C. aculeata* and many *Cladonia* species, as well as several *Stereocaulon* species, especially *S. nanodes*, are characteristic of zinc and lead habitats. In Poland, only *Stereocaulon incrustatum* was noted, but not recorded from the similar areas; in the studied area it is quite common and forms a large population, with high concentration of Zn and Pb in their thalli (Pawlik-Skowrońska et al. 2008).

In spite of the high level of environment degradation and pollution, the post-mining and zinc-lead ore processing areas, support a number of unique and exceptional lichens. This specific feature of the ore-bearing part of the Silesian-Kraków Upland is manifested by the presence of several interesting plant species, with the extremely rare *Biscutella laevigata*, recorded only from Tatra Mountains (Wierzbicka, Pielichowska 2004) or *Arabidopsis halleri*, which accumulates extremely high concentrations of various heavy metals (Pauwels et al. 2006). From a lichenological point of view, apart from lichen species mentioned above, mention should be made of other rarities in Poland, namely *Leptogium biatorinum*, *Arthonia exilis*, *Endocarpon pusillum*, *Collema limosum*, *Polyblastia albida*, *Thelidium papulare* and *Verrucaria fatrana*. Species protected by law, such as *Cetraria aculeata*, *C. islandica*, *Peltigera didactyla*, *P. rufescens* and *Stereocaulon incrustatum* were also recorded, and seven species listed are endangered, with EN, VU and NT threat categories (Cieśliński et al. 2006). Two species, *Peltigera rufescens* and *P. didactyla* have especially interesting ecology, as they contain symbiotic cyanobacteria in their thalli, with the ability to fix atmospheric nitrogen, and as such are an important part of trophic chain.

Apart from the species defined as toxitolerant, genuine lichen rarities, such as *Peltigera venosa*, normally an arctic-alpine species, can be found on metalliferous sites in lowland areas (Purvis, Halls 1996); montane species were also found in post-mining, lowland areas in Poland. *Leucocarpia biatorella* (Kiszka, Kościelniak 2006), to date known only from high elevations in the Tatras and Western Beskidy Mts. (Olech 1999; Flakus 2007), was also recorded. Another species, *Agonimia tristicula*, found in the study area, although widely distributed in some parts of Europe, is rare in Poland where to date it has only been recorded from the Carpathians (Olech, Kiszka 1999; Kościelniak 2004; Flakus 2007). The extremely rare terricolous *Thelocarpon imperceptum* was also found on a restored post-mining site in the vicinity of Bolesław (Kiszka 2006); it is exceptionally rare in Europe, to date being recorded only from Switzerland (locus classicus) and Russia (Salisbury 1966), and recently from the Netherlands (van den Boom 2000).

CONCLUSIONS

The studies herewith provide a basis for the statement that the post-mining areas of the Silesian-Kraków Upland is a unique region for lichen species, not only for Poland, but also at the European scale. These studies are on-going within the project „Vegetation of calamine soils and its importance for biodiversity and landscape conservation in post-mining areas" (FM EEA PL 0265). This work will be crucial for a better understanding of ecosystem functioning under stress conditions in areas subjected to post-mining and post-processing zinc-lead ores. At the same time, the complex character of these sites, including various edaphic factors, will increase our knowledge of the ecological conditions and the tolerance of heavy metal concentrations by various species, and the value of particular lichen species as bioindicators. A further aim of these studies is to find suitable methods for biodiversity restoration of degraded areas. Effective restoration may in turn provide an opportunity for the continued existence of many interesting lichen species.

Polish zinc-lead ore bearing areas, due to the presence of numerous interesting species, including lichen species, generate particular environmental conditions with exceptional biocenosis representing the heritage of regional culture. The lichen species present in the studied area are one of the specialized elements of low grasslands the community *Violetea calaminariae*, supported on soils with above average heavy metal concentrations. These habitats are listed as rare and endangered in the Habitats Directive (Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora) and therefore protected in most of Western Europe. In Poland, those areas were often devastated. Currently, the situation is only slightly better, but as interest of zinc-lead ore bearing areas increase, some have been included in the Natura 2000 network.

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Porosty na terenach pogórniczych rud cynkowo-ołowiowych

Streszczenie

Praca prezentuje wyniki badań lichenologicznych przeprowadzonych na wybranych powierzchniach Wyżyny Śląsko-Krakowskiej związanych z eksploatacją rud cynkowo-ołowiowych. Lista porostów tego terenu liczy 89 taksonów, z których 76 zawartych jest w tabeli 1. Pomimo trudnych warunków siedliskowych (brak wody oraz niektórych składników pokarmowych, wysoka zawartość metali ciężkich – głównie cynku, ołowiu i kadmu, - silna insolacja oraz silne działania wiatrów), występuje tu bardzo zróżnicowana i specyficzna biota porostów. Porosty były badane na wszystkich dostępnych substratach. Najmniej liczne są epifity i epiksylity, ograniczone do kilku najpospolitszych, toksytolerancyjnych gatunków. Dominują gatunki naziemne i naskalne, z których te ostatnie rosną głównie na kamieniach i drobnych kamykach. Wśród form morfologicznych zdecydowanie liczebną przewagę mają porosty skorupiaste, choć o fizjonomii zbiorowisk decydują porosty krzaczkowate, zwłaszcza *Cladonia* spp., które występują obficie i tworzą duże populacje. Z nielicznych form listkowatych obecne są *Peltigera rufescens* i *P. didactyla*, które poprzez zdolność wiązania wolnego azotu przez symbiotyczne sinice, są ważnym ogniwem łańcucha troficznego. Występują gatunki związane z substratami zawierającymi cynk i ołów, które mogą być wskaźnikami ich obecności w podłożu: *Diploschistes muscorum*, *Sarcosagium campestre*, *Steinia geophana*, *Vezdaea aestivalis* i *V. leprosa*. Wiele spośród odnotowanych porostów to gatunki rzadkie lub bardzo rzadkie w Polsce, pięć z nich podlega ochronie prawnej, a siedem – znajduje się na krajowej czerwonej liście. Badany teren jest również ostoją rzadkich porostów górskich, na przykład *Leucocarpia biatorella* oraz bardzo rzadkiego w Europie *Thelocarpon imperceptum*. Analizowana lichenobiota jest porównywalna ze składem gatunkowym porostów z innych terenów pogórniczych Europy.