Zeitschrift: Veröffentlichungen des Geobotanischen Institutes der Eidg. Tech. Hochschule, Stiftung Rübel, in Zürich

Herausgeber: Geobotanisches Institut, Stiftung Rübel (Zürich)

Band: 106 (1991)

Artikel: Threatened lichens in Poland and their conservation

Autor: Cieliski, Stanislaw / Czyewska, Krystyna

DOI: https://doi.org/10.5169/seals-308924

Veröff. Geobot. Inst. ETH, Stiftung Rübel, Zürich , *106* (1991), 133-149

Threatened lichens in Poland and their conservation

Stanislaw CIEŚLIŃSKI and Krystyna CZYŻEWSKA

1. INTRODUCTION

The lichen flora (1650-1700 species) is greatly endangered in a great part of Poland. An accelerating process of dying out of these organisms on a local or global scale has been observed in Poland for at least thirty years now.
It is in the interest of science and man himself to preserve the whole genetic diversity of the organic world, including lichens which are a plant group, representing a unique type of symbiosis in nature.

2. THE RANGE OF THREAT

2.1. GENERAL ESTIMATION

Despite supra-regional, and very often global range of many polluting factors, the threat degree to lichens is not the same in particular regions of the country. Apart from the regions characterized by almost catastrophic disappearance of the plants, especially epiphytes (the Sudeten Mts., Silesia, some parts of the Beskidy Mts., the district of Krakow, the Gory Swietokrzyskie, etc.), there are regions with relatively well preserved flora, e.g., the alpine communities of lichens in the Tatra Mts., and some regions in Northern and North-Eastern Poland.

The extinction of single lichen species, of their population and whole communities, is connected with the threat resulting from rapid changes in communities and habitats as well as from the devastation of the localities. According to CIESLINSKI et al. (1986) the main causative factors are: 1) local and extra-local air pollution by sulphur dioxide and "acid rain", 2) poor forest management (clear felling), 3) decrease in mountain and upland ecotypes of fir and spruce, 4) changes in water regimes, 5) water pollution, 6) mining industry, 7) urbanization, 8) motor transport and its influence on road-adjacent environment, and 9) tourism.

The actual condition of the lichen flora is presented in the "Red list of threatened lichens in Poland" (CIESLINSKI et al. 1986). The Red List includes 480 species which constitute 29% of the total number of lichen species in the Polish flora.

According to the Red Data Book categories (LUCAS and SYNGE 1978) the degree of threat to particular species of lichens in Poland is as follows:

Category	No. of species	% of total flora
Extinct and probably extinct (Ex)	10	0.6
Endangered (E)	142	8.6
Vulnerable (V)	167	10.1
Indeterminate (I)	10	0.6
Rare (R)	151	9.1

The degree of threat to particular taxonomic groups of lichens differs markedly. This results from their different sensitivity to anthropogenic factors and from the poor knowledge of the biology and distribution of lichens.

2.2. EPIPHYTIC LICHENS

Epiphytic lichens are the most endangered ecological group. They constitute ca. 56% of all the species included in the Red List, and in the category of endangered species (E) the index exceeds 80%. All taxonomic groups, especially those, which are dominated by epiphytic macrolichens, e.g. *Usnea*, *Bryoria*, *Nephroma*, *Lobaria*, *Evernia*, may currently be regarded as endangered.

The typical forest lichens are most threatened, and their disappearance is symbolic of today's unfavourable changes in forest ecosystems.

The authors claim that the retreat of forest epiphytes is caused by the follow-

ing factors: faulty forest economy (especially mass timber felling), reducing the age of the trees to be cut down, decreasing the number of old trees, replacing the heterogeneous deciduous and mixed stands with pine or spruce monocultures, and, finally, air pollution. The last factor is particularly active in the forests adjacent to industrial works and cities.
In the past the rich and diversified lichen flora occurred on lonely trees abundantly covered with lichens with big thalli, e.g. *Anaptychia ciliaris*, *Ramalina fraxinea*, *Parmelia acetabulum*, *Parmelia tiliacea*, *Parmelia subargentifera*, *Physconia perisidiosa*. At present, only in Northern and North-Eastern Poland the lichen flora of such trees is diversified and it is represented by many interesting and rare components. In other parts of the country, such trees were cut out in connection with the modernization of roads, while in places where they still occur, the lichens are dying out because of the great concentration of air pollution along the roads.

2.3. TERRESTRIAL LICHENS

Terrestrial lichens are less endangered. In the alpine belt of the Tatra Mts. there still occur well-preserved and very interesting communities of terrestrial lichens, which exhibit no signs of impoverishment (OLECH 1985). However, these lichens are subject to unfavourable changes in the Sudeten Mts. (FABISZEWSKI 1985). Very heavily endangered are the epigeic psammophilous and xerothermic lichens, occurring in the lowlands and uplands of Southern Poland.
The most frequent is the direct destruction of stands: exploitation of rock material, afforestation of grasslands (psammophilous and xerothermic) and waste lands, excessive utilization of the thalli (e.g. *Cetraria islandica*) for pharmacological purposes. Very often conservation of the fragments of xerothermic grasslands, which triggers successive processes, eliminates some plant species, including lichens.
A very serious threat to the existence of the terrestrial lichens is posed by industrial plants and urban agglomerations. In the neighbourhood terrestrial lichens die out because of excessive concentration of air and soil pollution.

2.4. EPILITHIC LICHENS

Epilithic lichens are a less endangered lichens group. Identical or markedly similar specific composition often occurs in the same stands for a very long

time. Relic, alpine community of epilithic lichens, occurring in the Gory Swietokrzyskie in the rocky fields of Lysa Gora, reported sixty years ago (KOBENDZA and MOTYKA 1928) has retained its unchanged composition up till now. Species which build up this community, e.g., *Umbilicaria hyperborea*, *Umbilicaria polyphylla*, *Umbilicaria deusta*, *Brodoa intestiniformis*, *Melanelia stygia*, *Xanthoparmelia incurva*, form here small isolated populations, ca. 200-300 km far from the nearest stands located in the Tatras and Sudeten.

Far more endangered are the epilithic lichens occurring in the uplands and erratic blocks in the lowlands. The main cause of their destruction is the exploitation of the rock and changes in habitat conditions. Water contamination possess threat to the lichens occurring on boulders immersed or sprayed by water.

2.5. EPIXYLIC LICHENS

The least numerous ecological group, though markedly endangered, is represented by the epixylites. The rich and diversified epixylic flora has been preserved only in the mountains, in the Bialowieza Forest and in other big forest areas of North-Eastern Poland. In other regions of lowland Poland there occurs rapid disappearance or impoverishment of localities with lichens growing on decaying wood: *Cladonia botrytes*, *Cladonia parasitica*, *Icmadophila ericetorum*, *Chaenotheca brunneola*, *Calicium trabinellum*, *Lecidea turgidula*, and others. In the secondary forest communities the flora of decaying wood is markedly poor and limited to some widely distributed species, especially those of the genus *Cladonia*.

3. CHANGES IN LICHENS

3.1. FOREST LICHENS

On the basis of the hitherto collected data it may be inferred that in the natural forests located in the lowlands and in the mountains the most conspicuous losses are endured by the lichen flora of the coniferous trees (Figs. 1, 2). Simultaneously, the taxa accompanying varied forest communities and tree species in the montane Carpathian forests die out, e.g. lichens connected with the beech: *Pyrenula nitida*, *Graphis scripta*, *Thelotrema lepadinum*, *Lobaria pulmonaria*, *Cetrelia olivetorum*, *Opegrapha* sp. div., *Pertusaria* sp. div.

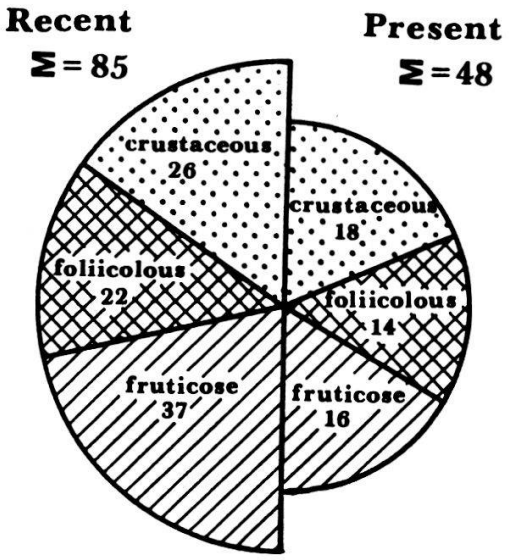

Fig. 1. Comparison of lichen flora on bark of *Picea abies* at Bialowieza Forest. (After CIESLINSKI and TOBOLEWSKI 1988).

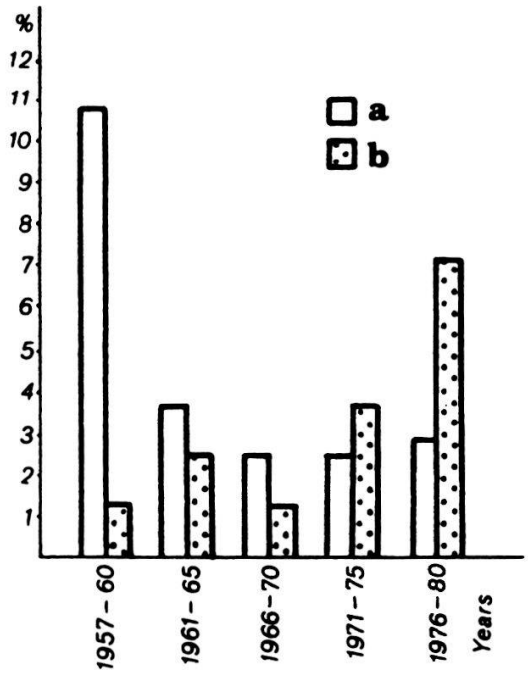

Fig. 2. Changes in frequency of *Usnea subfloridana* on bark of *Abies alba* (a), and *Betula pendula* (b) at Gory Swietokrzyskie. (After CIESLINSKI and BYSTREK 1982).

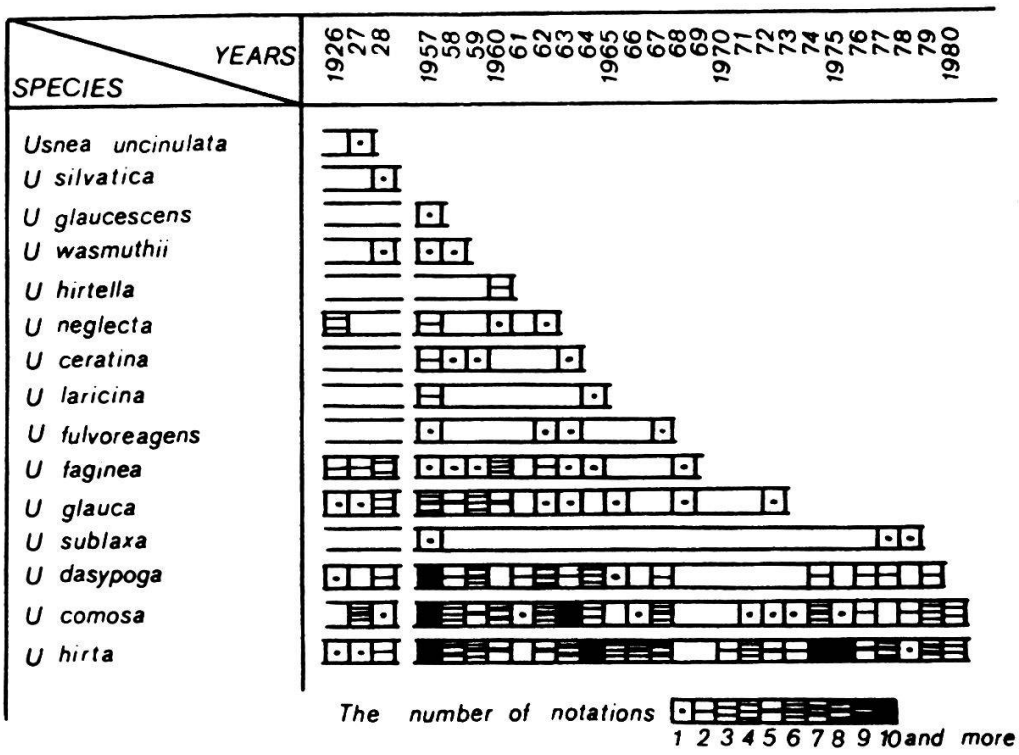

Fig. 3. Decrease of *Usnea* species at Gory Swietokrzyskie. (After CIESLINSKI and BYSTREK 1982).

Specific diversity of the epiphytes is decreasing also in the best preserved forest communities of the Bialowieza Forest. At present about 10% of the components of the lichen flora has been found to be missing from these forests (CIESLINSKI and TOBOLEWSKI 1988), e.g. out of 22 species of the genus *Usnea* occurring there in the past only 9 have been found recently. Even more drastic processes occur in the Gory Swietokrzyskie (Fig. 3).

The lichen flora does not recover its original composition among other in lowland Poland, where secondary forest communities developing in the habitats of deciduous forests located in total or partial forest clearings are common (Fig. 4). Total felling is responsible for drastic disappearance of epiphytes. Partial felling and the introduction of pine (pinetization) cause the reduction of lichen species from 40% to 80-90%, depending on the degeneration of the forest (CZYZEWSKA 1976). Stenothopic epiphytes (skiophytes, aerohyogrophytes, or even mesophytes) disappear, which is accompanied by the spread of some eutrophic species (including heliophytes and xerophytes).

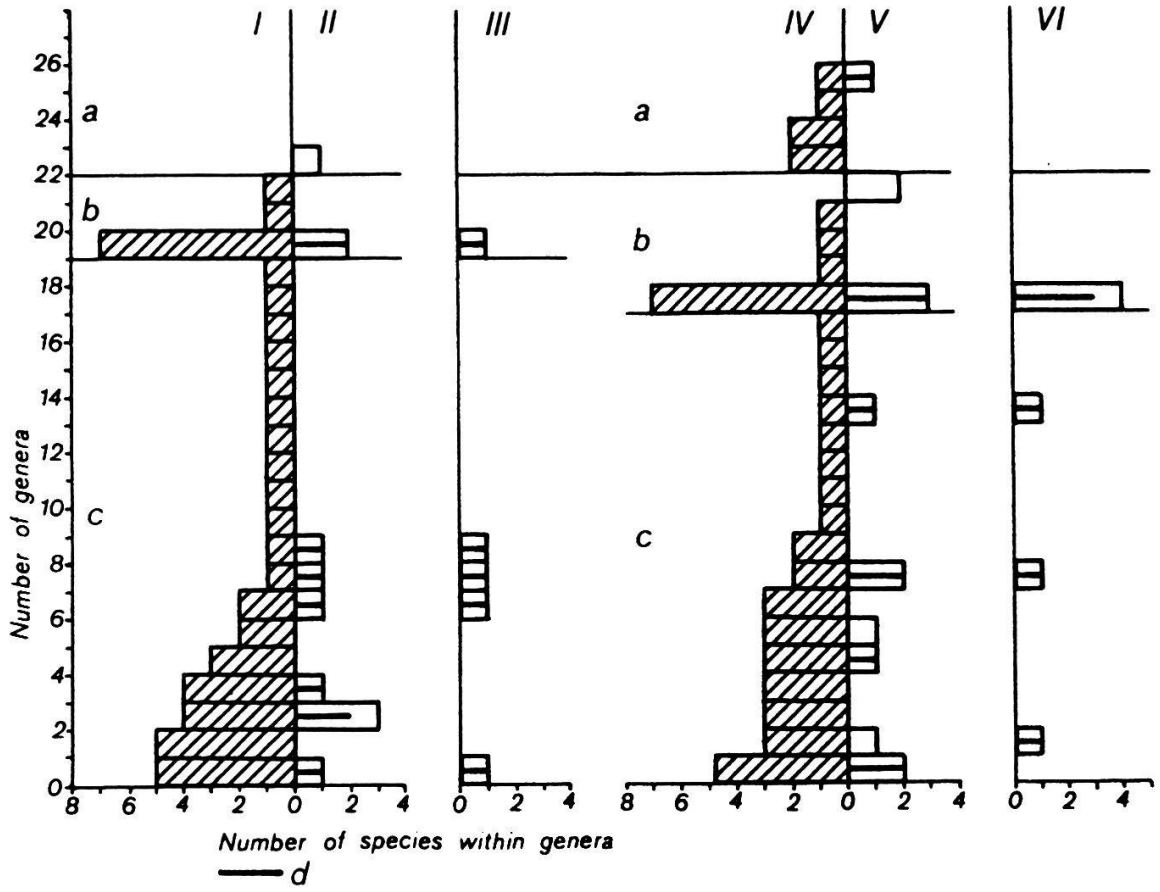

Fig. 4. Extinction of epiphytic lichens influenced by anthropogenic changes of deciduous forests in Puszcza Pilicka forest (Central Poland). Distribution of species and genera of lichens according to morphological groups on horn beams (I-III) and on oaks (IV-VI) in *Tilio-Carpinetum typicum* (I, IV), and on scotch pine-hornbeam and scotch pine-oak-hornbeam stands in *Tilio-Carpinetum* habitat (II, III, V, VI). (After CZYZEWSKA 1976).
I, IV = trees over 100 years, II, V = approx. 100 years, III, VI = 50-70 years
a = fruticose lichens, b = foliicolous lichens, c = crustaceous lichens, d = common species

3.2. LICHENS IN CITIES AND INDUSTRIAL REGIONS

The most destroyed and changed lichen flora is that occurring in the areas of big cities of e.g. Krakow, Lodz, Warszawa, and in the industrial regions of Lower Silesia.

In all big cities of Poland and in the neighbourhood of the sources of industrial emissions there occur varied lichen less zones ("lichen deserts") and with a very impoverished specific composition ("battle zones") (Fig. 5). Zones with "normal" development of species are located many kilometres from city centres and sources of emission. In the aggregate of the three neighbouring cities

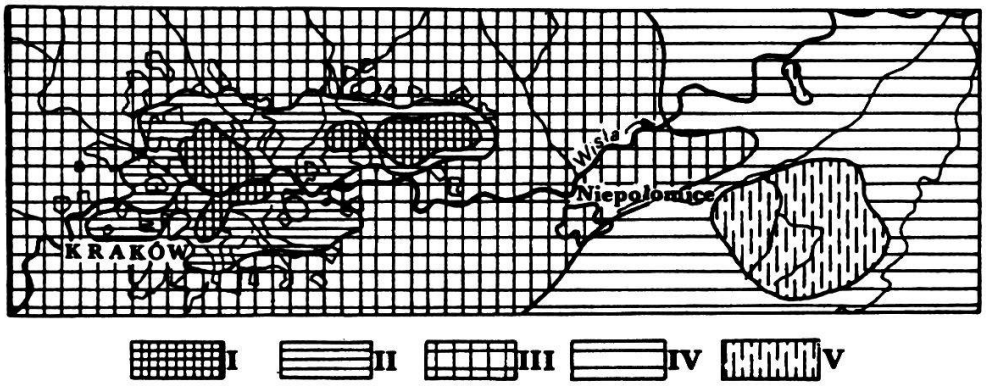

Fig. 5. Bioecological zones of Krakow and Puszcza Niepolomicka Forest on the basis of lichen flora condition. (After KISZKA 1986).
I = unlichened or lichen threshold limits zone of the most resistant to SO_2 pollution lichens
II = zone species resistant only, III = zone of threshold limits of more responsive species
IV = zone of very strong impact of pollution on lichens in forest
V = zone of pronounced impact of city and industrial pollution in forest

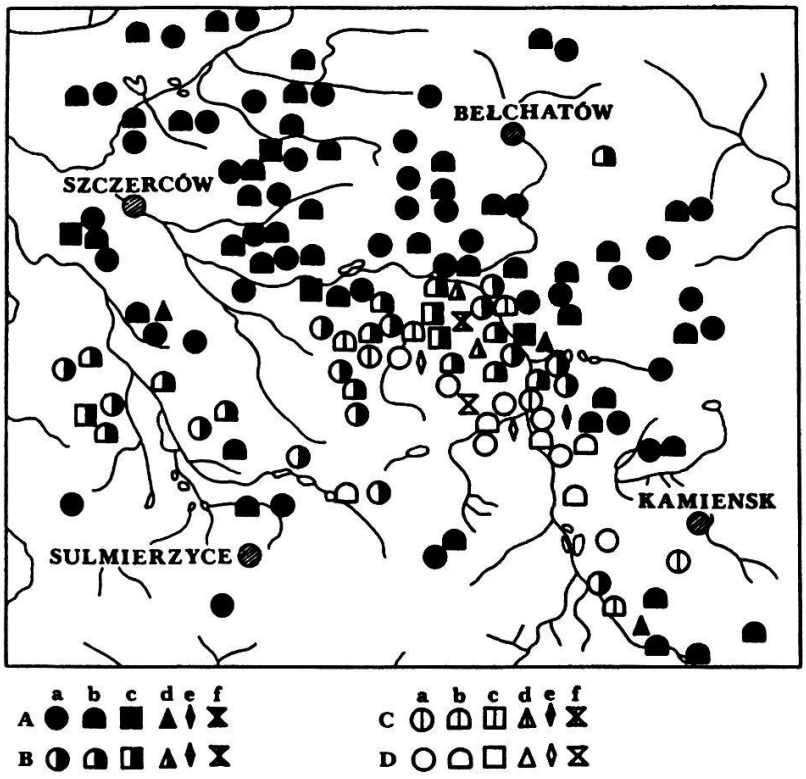

Fig. 6. Distribution of *Cetraria islandica* (a), *Cladina rangiferina* (b), *Cladina ciliata* (c), *Cladina portentosa* (d), *Cladonia scabriuscula* (e), and *Cladonia crispata* (f), and their changes caused by the Belchatow Industrial Region (Central Poland). (After CZYZEWSKA 1988).
A = localities in 1984-1985
B = localities evidently threatened in 1984-1985
C = localities partially destroyed
D = localities totally destroyed

of Gdynia, Sopot, and Gdansk about 85 species have died out within the last 100 years and many further species are threatened with extinction (FALTYNOWICZ et al. 1991). In Krakow the number of lichen species has decreased by about 37% (KISZKA 1986).

Changes in the local floras are also caused by brown coal-mines. The destruction of species and localities over a wide area occurs first as the result of mine and power station building and the influence of the cone of depression (Fig. 6), and only much later as the result of air pollution. In the Belchatow Industrial Region this second stage of changes began two years after the power station had started. The first recorded symptom was the mass occurrence of *Cetraria islandica* var. *sorediata*, which had been rarely found in this variety before (6 dispersed localities). Another species, which exhibits marked progress in its spread, is the epixylic-epilithic species of *Thelocarpon laureri* (CZYZEWSKA 1988).

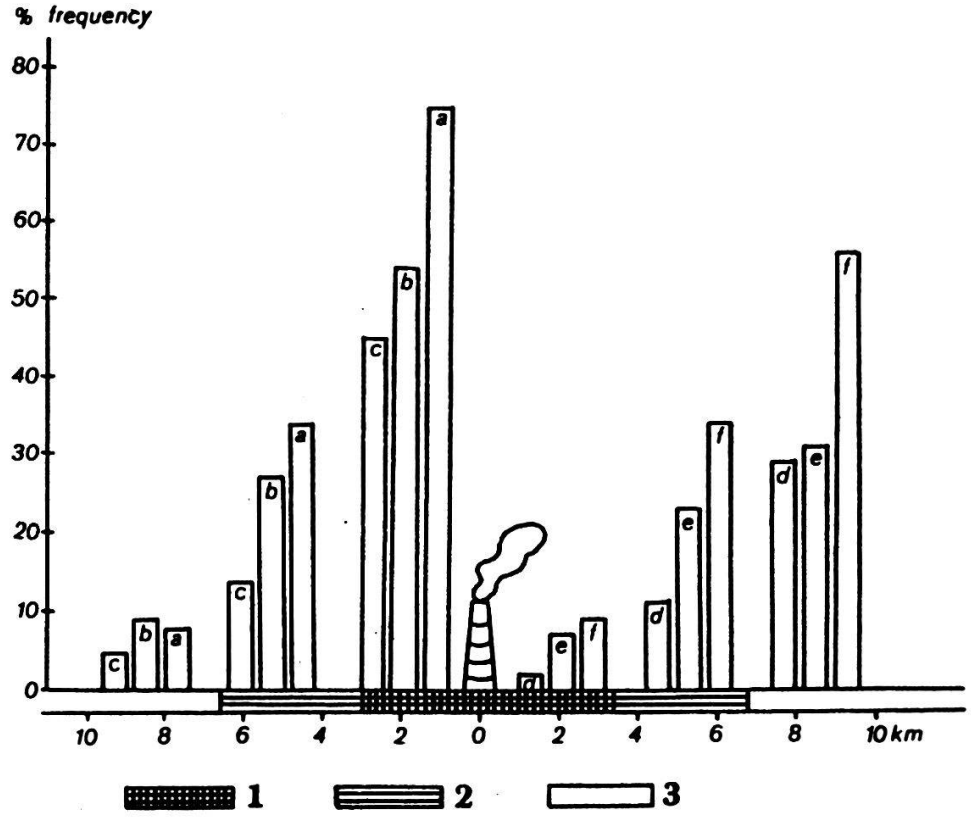

Fig. 7. Changes in frequency of epiphytic lichens. (After CIESLINSKI et al. 1982).

a = *Lecanora hageni*
b = *Caloplaca holocarpa*
c = *Lecania cyrtella*
d = *Pseudevernia furfuracea*
e = *Hypocenomyce scalaris*
f = *Hypogymnia physodes*

1 = Zone I
2 = Zone II
3 = Zone III

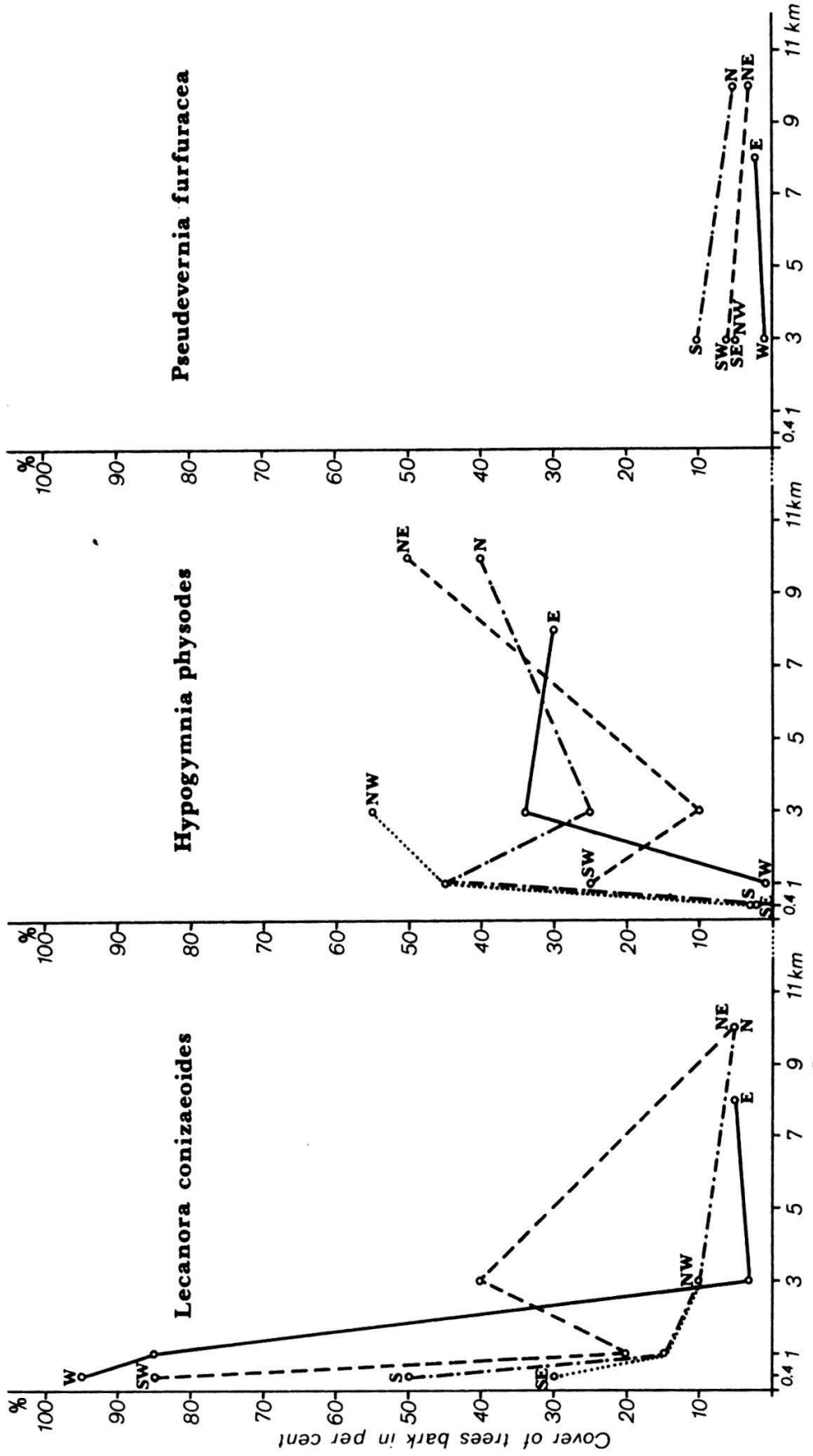

Fig. 8. Distribution of epiphytic lichens occurring on bark of *Pinus sylvestris* at the Tomaszow Mazowiecki region (Central Poland) according to transects of chosen wind rose direction. Emissions of SO_2, H_2S, and CS_2 from Tomaszow factory "Wistom". (After CZYZEWSKA unpubl.).

The phenomenon of lichen progression occurs in the areas under cement-lime emissions. The absence of lichen deserts is significant in such cases. The essence of the changes which occur consists in the substitution of ecologic species groups (Fig. 7). Progressing alkalization of the acidophilic bark of trees promotes the development of a specific flora and communities of nitrophilous and koniophilous lichens, absent from nature otherwise (CIESLINSKI and JAWORSKA 1986). Cement-lime dusts limit also diversification of natural habitats of the bark which is exemplified by a mass occurrence of *Lecanora hageni* and some other species (Fig. 7). The alkalization of the soil benefits the quantitative representation of certain calciphilic terrestrial lichens even in pine forest habitat, e.g. frequent occurrence of *Collema tenax* around the cement work "Nowiny" near Kielce.

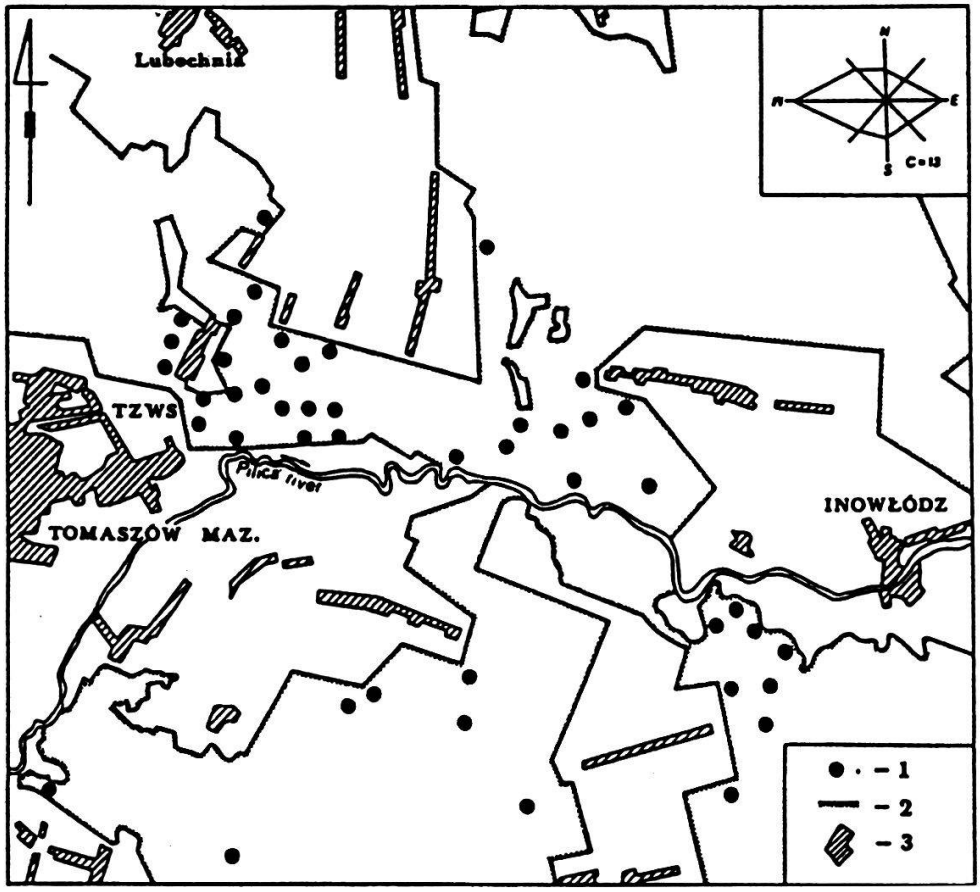

Fig. 9. Distribution of epixylic lichen *Thelocarpon laureri* at the Tomaszow Mazowiecki region (Central Poland). (After CZYZEWSKA unpubl.).
TZWS = Tomaszow Factory of Man-Made Fibres, 1 = localities of *Thelocarpon laureri*, 2 = forest border, 3 = settlements

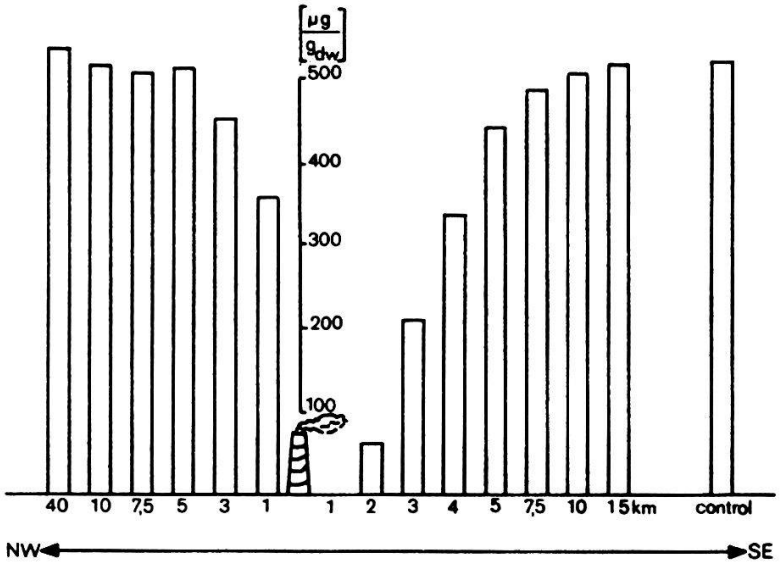

Fig. 10. Content of chlorophyll a and b in *Hypogymnia physodes* exposed for two months on NW-SE transect from copper smelter "Legnica" (SW Poland). (After FABISZEWSKI et al. 1983).

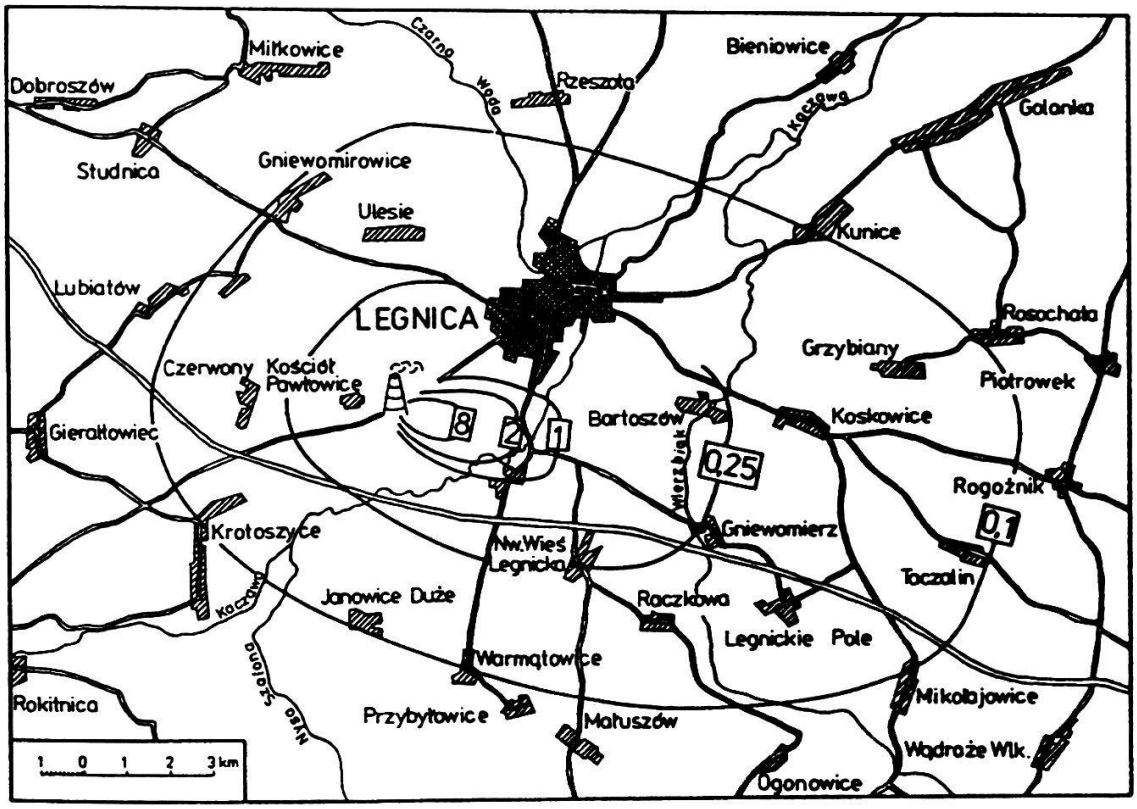

Fig. 11. Deposition isolines of copper (tons Cu/km^2/year) determined by intensity of Cu cumulation in *Hypogymnia physodes* transplanted along transects from copper smelter "Legnica". (After FABISZEWSKI et al. 1983).

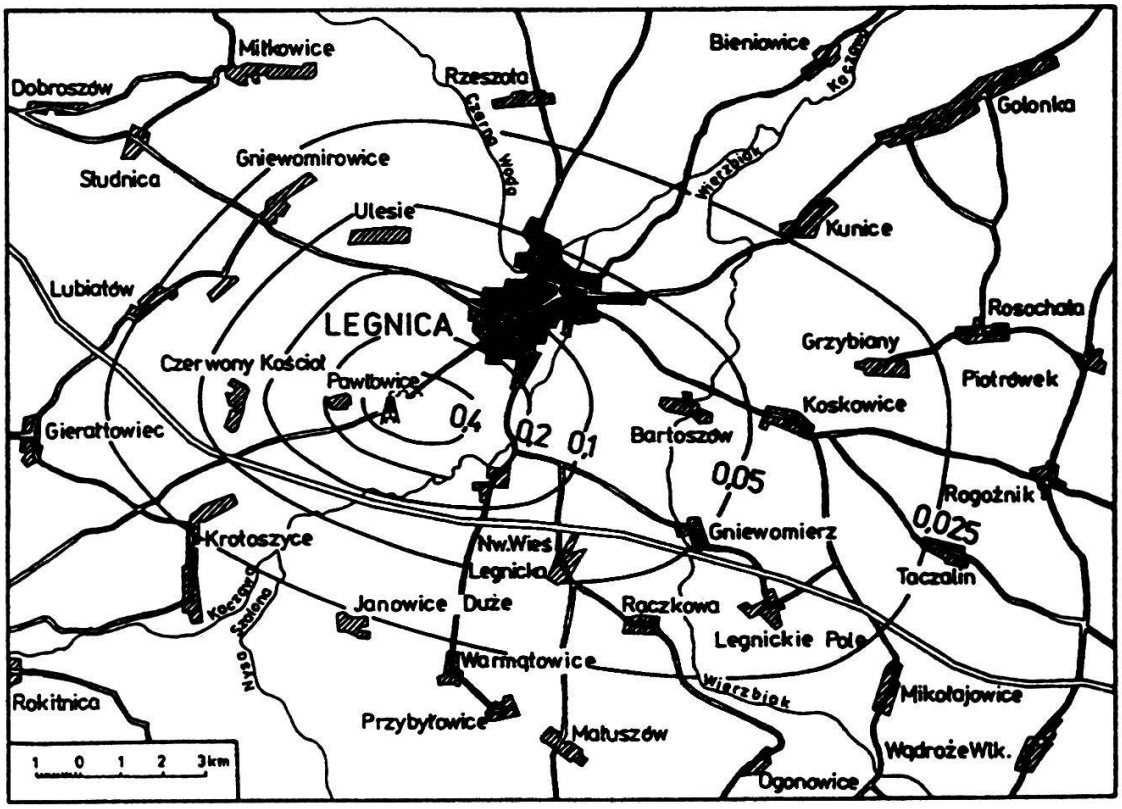

Fig. 12. Isolines of SO_2 concentration in the vicinity of copper smelter "Legnica" calculated from reduced photosynthesis intensity of transplanted *Hypogymnia physodes*. (After FABISZEWSKI et al. 1983).

The absence of a lichen desert in the neighbourhood of the sources of emissions may be observed also in the case of moderate or decreasing air pollution. Proportionally to the intensity of air pollution occurs marked simplification of the specific composition and degression, i.e., decrease in the number of species and the cumulation of only toxitolerant species in the zone nearest to the emission sources, e.g. *Lecanora conizaeoides* (Fig. 8) and *Scolicios-porum chlorococcum*. Another toxitolerant species is *Thelocarpon laureri* (Fig. 9). This fine, acidophilic epixylite exhibits marked cumulation of localities in the neighbourhood of emission sources and in the area of a more intensive drift of air pollution to the East.

In the cities and industrial regions lichens are also used as bioindicators of the natural environment condition (Figs. 10, 11, 12).

3.3. LICHENS IN NATIONAL PARKS AND NATURE RESERVES

It seems obvious that at present the best conditions for life and survival of the whole taxonomic variety of lichens are in the national parks and nature reserves. The recent studies imply, however, a far advanced impoverishment of flora and lichen communities, and its intensification depends upon the location of the protected subject in Poland. The most important destructive factors as increase in global and regional air pollution, change in local climates, and change in water and soil conditions, also on the protected areas are of anthropogenic character.

The most marked changes occur among epiphytes. Thus during the period of 100 years, the extinction of lichens in the Ojcow National Park amounts to 30% (KISZKA 1986), while in the Swietokrzyski National Park the extinction in the flora of epiphytes and epixyls amount to 23%, and another 13% of the flora is threatened (CIESLINSKI 1985). The Bialowieza National Park is not free from losses where about 25 species have not been found in the last few years (CIESLINSKI and TOBOLEWSKI 1988). Still in the fifties the following species occurred there: *Usnea longissima*, *Bryoria furcellata*, *Hypogymnia vittata*. These species are absent from the Park at present, and the first two are absent from Poland as well. Another species which are dying out in the Bialowieza National Park are: *Lobaria pulmonaria*, *Evernia divaricata*, *Icmadophila ericetorum*, and *Usnea florida*.

In the Roztocze National Park, in the strict reserve "Bukowa Gora" alone, in the early seventies about 122, and in 1986 only 44 species, occurred on the bark of beeches, pines, and firs (BYSTREK and KARCZMARZ 1987). Totally extinct are mainly lichens of the genera *Bryoria* and *Usnea*, as well as *Cetrelia olivetorum*, *Evernia divaricata*, *Evernia mesomorpha*, *Lecanora intumescens*, *Lobaria pulmonaria*, *Menegazzia terebrata*, *Parmelia quercina*, *Parmelia revolta*, *Parmelia trichotera*, *Ramalina crinalis*, *Theloterma lepadinum*, and others.

In the forest reserve "Lipowka" in the Niepolomice Forest (East of Krakow), the losses in the epiphytic flora amount to 11 species (*Parmelia caperata*, *Parmelia subrudecta*, *Evernia prunastri*, *Pseudevernia furfuracea*, and others) (KISZKA 1978). The degeneration and disappearance of epiphytic communities, especially of *Pyrenuletum nitidae*, *Thelotremetum lepadini*, and even of *Pseudevernietum furfuraceae*, has been recorded for about twenty years in many forest reserves in the lowlands of Central Poland.

4. PROTECTION OF LICHENS

In Poland lichens have been under partial protection since 1957. The species with medicinal properties are protected, these are: *Cetraria islandica*, *Lobaria pulmonaria* and all the species of the genus *Usnea*. During the last 30 years of protection, the number of localities of *Cetraria islandica* are several times smaller and other species under protection are dying out, or are already extinct.

The chances of maintaining the whole specific variety of lichens are decreasing. Different forms of conservation aim, above all, at postponing the processes of extinction. The "ex situ" methods used in vascular plant conservation cannot be applied in the conservation of these organisms (OLACZEK and LAWRYNOWICZ 1986). The only applicable method is "in situ" i.e., specific and reserve conservation.

No lichen protecting reserves have yet been created in Poland, though propositions have been made (LIPNICKI 1990). Obviously lichens as permanent components of biocenoses are generally conserved in animate and inanimate nature reserves, in national parks and in landscape parks. These are the places of diaspore banks from where they can spread to the adjacent territories. If air pollution lessens, this may accelerate their return to the habitats previously lost.

Chances of survival for many lichen species are also provided by monuments of animate and inanimate nature, e.g. erratic blocks, rock bassets, old trees and their stands, country parks, old cemeteries. Such habitats are a refuge for many species of lichens, and, at the same time, they constitute diaspore banks.

SUMMARY

The most endangered plant group in Poland are lichens (ca. 29% of the total flora, CIESLINSKI et al. 1986). The greatest losses are suffered by epiphytes. They constitute about 56% of all species included in the "red list". In the category of threatened species this index amounts to 80%. In some genera, e.g. *Bryoria*, *Usnea*, *Nephroma*, *Lobaria*, all species occurring in Poland are included in the category of threatened species. Epixyls are threatened similarly to epiphytes. This concerns other ecological groups but in a lesser degree.

Unfavourable changes in the lichen flora occur unevenly in all Poland. The best preserved is the alpine flora (e.g. Carpathians) and that occurring in some regions of North and North-Eastern Poland. Big forest complexes located there (e.g. Bialowieza Forest, Augustow Forest, etc.) still include many species which may be rendered as primeval forest relics. The poorest lichen flora is characteristic of lowland and upland area of Central Poland. In the strongly industrialized and urbanized regions, areas bereft of lichens develop. The

current forms of plant protection (species and reserve protection) do not give any desired effects, which is caused by their great sensitivity to atmospheric pollution.

REFERENCES

BYSTREK J. and KARCZMARZ K., 1987: Changes in lichen and bryophyte epiphytic flora in the "Bukowa Gora" forest reserve in the Roztocze National Park. (In Polish with English summary). National Parks and Nature Reserves *8(2)*, 5-14.

CIESLINSKI S., 1985: Transformations in the flora of the epiphytic and epixylic lichens on the territory of the Holy Cross National Park. (In Polish with English summary). Rocznik Swietokrzyski *12*, 125-142.

CIESLINSKI S. and BYSTREK J., 1982: Species of the genus *Usnea* Wigg. emend. Mot. in the Swietokrzyskie Mountains and their outskirts. (In Polish with English summary). Rocznik Swietokrzyski *10*, 101-118.

CIESLINSKI S. and JAWORSKA E., 1986: Changes in the lichen flora of pine-trees (*Pinus sylvestris* L.) under the effect of emission of cement-lime industrial works and lime pits. (In Polish with English summary). Acta Mycol. *22(1)*, 3-14.

CIESLINSKI S. and TOBOLEWSKI Z., 1988: Lichens (*Lichenes*) of the Bialowieza Forest and its western foreland. (In Polish with English summary). Phytocoenosis Cartogr.Geobot. n.s. *1*(suppl.), 1-216.

CIESLINSKI S., CZYZEWSKA K. and FABISZEWSKI J., 1986: Red list of threatened lichens in Poland. (In Polish with English summary). In: ZARZYCKI K. and WOJEWODA W. (eds), List of threatened plants in Poland. PWN, Warszawa. 83-107.

CIESLINSKI S., TOBOROWICZ K. and SEPSKI S., 1982: The influence of cement and lime plants on the epiphytic lichens flora in the Kielce region of exploitation of carbonate stock. (In Polish with English summary). Rocznik Swietokrzyski *10*, 69-100.

CZYZEWSKA K., 1976: Disappearance of epiphytic lichens under the influence of anthropogenic degeneration of deciduous forests in Pilicka Forest Complex. (In Polish with English summary). Phytocoenosis *5(3-4)*, 363-375.

CZYZEWSKA K., 1988: Changes in the lichen flora influenced by the Belchatow Industrial Region. Acta Mycol. *24(1)*, 93-100.

FABISZEWSKI J., 1985: Lichens. In: JAHN A. (ed.), The Polish Karkonosze Mountains. (In Polish). Ossolineum, Wroclaw. 247-256.

FABISZEWSKI J., BREJ T. and BIELECKI K., 1983: Plant indication examinations on environmental influence of copper smelter. (In Polish with English summary). Trav.Soc.Sci. Lett. Wroclaw, Ser. B, *207*, 1-109.

FALTYNOWICZ W., IZYDOREK I. and BUDZBON E., 1991: The lichen flora as bioindicator of air pollution of Gdansk, Sopot, and Gdynia. Monogr.Bot. *73*, 1-52.

KISZKA J., 1978: The lichens in the nature reserve of Lipowka in the Niepolomice Forest. (In Polish with English summary). Studia Nat., Ser. A, *17*, 149-158.

KISZKA J., 1986: Interdependence between the degree of air pollution with SO_2 and degradation and dying out of the lichen flora and given responsive species in selected areas of Southern Poland. (In Polish). In: WOJTUSIAK R. J. (ed.), Biometeorology and human and animal organism. PWN, Warszawa. 123-133.

KOBENDZA R. and MOTYKA J., 1928: Führer durch die "Goloborza"-Blockhalden des Lysogory-Höhenzuges. Guide des excursions en Pologne. XIIIe partie. V I.P.E., Orbis, Krakow. 8 p.

LIPNICKI L., 1990: Proposals of the protection of lichen (*Ascomycetes lichenisati*) localities in Tucholskie Forest area. (In Polish with English summary). National Parks and Nature Reserves.

LUCAS G. and SYNGE H., 1978: The IUCN plant Red Data Book. Morges, IUCN. 540 p.

OLACZEK R. and LAWRYNOWICZ M., 1986: Main problems connected with conservation of plant gene resources in natural conditions "in situ". (In Polish with English summary). Acta Univ.Lodz.,Folia Sozol. *3*, 3-19.

OLECH M., 1985: Lichen communities in the highland limestone grasslands of the West Tatra Mountains. (In Polish). Rozprawy Habilitacyjne, Uniw. Jagiellon. *90*, 1-132.

Address of the authors: Prof. Dr. hab. Stanislaw CIESLINSKI
Institute of Biology
Department of Botany
Pedagogical University
Warszawska 33
25-518 Kielce, Poland

Dr. Krystyna CZYZEWSKA
Institute of Environmental Biology
Department of Geobotany and Plant Conservation
Lodz University
Banacha 12/16
90-237 Lodz, Poland