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**Present condition and changes in the lichen flora
of the reserve "Świnia Góra" in the Góry Świętokrzyskie Mts.
(Central Poland)**

Stanisław CIEŚLIŃSKI and Krzysztof TOBOROWICZ

1. INTRODUCTION

Man's long-term pressure on the biocenoses and whole ecosystems is usually conducive to the retreat of numerous species and their communities. The result of this is a rapid regression of epiphytic lichens observed in the recent years (CIEŚLIŃSKI and CZYZEWSKA 1989). The range and the rate of negative changes is sometimes so high that it is not always possible to document these processes. Hence the necessity arises for intensifying the studies in this field. The reserves and national parks are particularly useful objects for observations on the floristic composition and structure of plant communities from the point of view of the effect of anthropogenic factors.

The present study presents an assessment of the actual condition of the lichen flora of the "Swinia Gora" reserve in Gory Swietokrzyskie Mts. (Holy Cross Mts.) The study is also an attempt to present the changes in the lichen flora of this particular object within the last 30 years (1960-1989).

2. OBJECT OF STUDIES

The forest reserve "Swinia Gora" is one of the most interesting protected areas of Poland. According to naturalists and foresters this is the best preserved and the most precious fragment of the once vast forest complex known as the

Primaeval Swietokrzyski Forest (BARANSKI et al. 1965, PIEKOS 1971). It is conspicuous for its well-preserved forest communities of natural character. The vascular flora of the reserve is rich as it is composed of 346 species, including many interesting taxa of Poland and rare to the lowlands (PIEKOS 1971, BROZ 1989).

The stand of the reserve is particularly interesting due to its great specific diversity. The most conspicuous species is *Abies alba*, with a marked proportion of *Fagus sylvatica*, *Quercus sessilis*, *Pinus sylvestris*. The other compo-



Fig. 1. Plant communities in the "Swinia Gora" reserve: 1- *Dentario glandulosae-Fagetum*, 2 - *Quercus-Carpinetum*, 3 - *Circae-Alnetum* (fragment), 4 - *Abies alba-Sphagnum girgensohnii*, 5 - *Abies alba-Sphagnum girgensohnii*, peat facies, 6 - *Alnus glutinosa-Athyrium filix-femina*, 7 - transition patches of *Fagetalia* and *Vaccinio-Piceetalia* in a mosaic-like arrangement, 8 - *Fagus sylvatica-Vaccinium myrtillus*, 9 - *Pino-Quercetum*, 10 - *Vaccinio myrtilli-Pinetum* (variant with *Molinia coerulea*), 11 - *Vaccinio uliginosi-Pinetum* (fragment), 12 - *Pinus sylvestris-Sphagnum apiculatum* community on raised areas surrounded by bog, 13 - fragments of *Phragmition* and *Magnocaricion*, 14 - *Molinietalia* with *Cirsium oleraceum*, 15 - *Molinietum nardetosum*, 16 - *Filipendulo-Geranie-tum*, 17 - Patches with species of *Molinietalia* and *Arrhenatheretalia* in mosaic-like arrangement, 18 - *Carici-Agrostetum caninae*, 19 - *Nardo-Juncetum squarrosi*, 20 - boundary of the reserve (FABIJANOWSKI and ZARZYCKI 1965, slightly modified).

nents occurring in small proportions are *Larix polonica*, *Betula verrucosa* and *B. pubescens*, *Carpinus betulus*, *Acer pseudoplatanus*, *A. platanoides*, *Tilia cordata*, *Picea abies*, *Alnus glutinosa*, *Ulmus scabra*, *Populus tremula*. The stand is dominated by 200-300 year-old-trees. The fir, unlike in other parts of the Gory Swietokrzyskie Mts., is characteristic of marked vitality and dynamics (JAWORSKI 1991). An inventory of communities comprises 15 syntaxonomic units (FABIJANOWSKI and ZARZYCKI 1965). The greatest surface proportion is covered by *Dentario enneaphyllidis-Fagetum*, *Luzulo-Fagetum*, *Pino-Quercetum* variety with *Abies alba*, and *Sphagno girgensohnii-Piceeteum* (Fig. 1).

The reserve has had the status of a strictly protected reserve since 1938. Its area is 50.78 ha, located in the forest district of Wilczy Bor, of the Suchedniow forestry division. The reserve is a fairly interesting object of lichenological studies. It is conspicuous for a great diversity of habitats, which is the result of specific abundance of stands and of a marked proportion of old monumental trees and diverse forest communities. Beside the abundance of decaying wood in the form of standing stems and lying logs at different stages of decay is to be found in the reserve.

3. LICHENOLOGICAL STUDIES OF THE RESERVE

The lichen flora of the "Swinia Gora" reserve has never been studied thoroughly before. In some fragments of the forest complex in which the reserve is located studies were carried out in 1928 by TYSZKIEWICZOWA (1935) and provided a view of the conditions of the lichen flora of the Swietokrzyski Primeval Forest at the beginning of the 20th century. First data on the lichen flora of the reserve date from the end of the fifties (NOWAK 1960). In the materials published the author mentions 45 species and several further ones, mainly of the genera: *Bryoria* and *Usnea*, collected in the period 1962-1965 are recorded by HALICZ and CIESLINSKI (1967), BYSTREK and CIESLINSKI (1976), CIESLINSKI and BYSTREK (1981). In the unpublished study by LIBERA (1976) c. 69 species from the reserve are mentioned. All these studies are the starting-points for the quantitative and qualitative evaluation of the lichen flora of the past. The present results of studies date from 1989 and partially from 1990.

4. PRESENT CONDITION OF THE LICHEN FLORA OF THE RESERVE

The lichen flora of the reserve "Swinia Gora" is fairly rich. Together with the results of earlier studies, it includes about 127 species. At present 86 species have been recorded, including 39 species found for the first time.

The forest flora of the lichens occurring on trees and on decaying wood is characteristic of the reserve. Other ecological groups are of no major significance. On small stone blocks only two species have been found at present, namely, *Lecidea tumida* and *Trapelia obtegens*. No species have been found directly on the ground.

A few species only add to the lichenological character of the forest communities of the reserve. These are widely distributed lichens, occurring in diverse forest communities on the bark of the majority of trees. The main lichens presented possess a crustose and pulverulent thallus (*Lepraria incana*, *Lecanora conizaea*, *Scoliciosporum chlorococcum*, *Phlyctis argena*, *Graphis scripta*, *Pyrenula nitida*). They are accompanied, though in small numbers, by *Opegrapha niveoatra*, *O. varia*, *Arthonia spadicea*, *Porina aenea*, *Lecanora pulicaris*, *Lepraria membranacea*, and by lichens occurring on the wood (*Rapeliopsis granulosa* and *Placynthiella uliginosa*). One of the most frequent lichens with a foliaceous thallus in the reserve is solely *Hypogymnia physodes*. Even more rare are the thalli of *Parmelia sulcata* and *P. glabrata* var. *fuliginosa*. The lichens with a fruticose thallus are represented mainly by common species from the genus *Cladonia*, occurring at the bases of tree stems and on decaying wood, e.g. *Cladonia coniocraea*, *C. digitata*, *C. cenotea*, rarely *C. macilenta*, *C. ochrochlora*. On the twigs of the crown there sporadically occur *Pseudevernia furfuracea*, *Platismatia glauca* and in small quantities *Cetraria chlorophylla* and *Evernia prunastri*.

The bark of the pine and less frequently of the larch occurring in *Pino-Quercetum* is abundantly covered with *Hypocenomyce scalaris*, while *Parmeliopsis ambigua* and *P. aleurites* occur here very rarely, forming tiny, often fragmentary thalli.

Other species composing the current image of the lichen flora of the reserve occur fairly sporadically and their proportion is often scarce. Their presence was indicated only as a result of detailed investigations. Among them are the lichens which, not long ago, were frequent or even widespread in the forest communities of the Gory Swietokrzyskie Mts., e.g. *Catillaria globulosa*, *Chaenotheca chrysocephala*, *C. ferruginea*, *Hypogymnia tubulosa*, *Pertu-*

saria amara, *P. coccodes*, *Lecidella elaeochroma*, *L. euphorea*, *Lecanora subfuscata* and others.

In the lichen flora of the reserve "Swinia Gora" a fairly large group of important species which have disappeared from many regions of Poland should be distinguished as they are on the verge of extinction or endangered (CIESLINSKI et al. 1986). At present they occur solely in the well-preserved, big forest complexes, in areas of low atmospheric contamination. In the lowlands, the majority of localities is concentrated in northeastern Poland (CIESLINSKI and TOBOLEWSKI 1988). In the "Swinia Gora" reserve they are relicts of the primary forest, occurring on the bark of old trees or on the wood of the communities of deciduous forests, especially *Dentario enneaphyllidis-Fagetum* and *Luzulo-Fagetum*. Their presence enhances the natural values of the reserve. This group includes *Arthonia xyloxena* (only sterile), *Cetrelia olivetorum*, *Chaenotheca xyloxena* (on wood), *Chrysothris candelaris*, *Coniocybe sulphurea* (on wood), *Gyalecta truncigena*, *Graphis scripta*, *Lecanora intumescens*, *Menegazzia terebrata*, *Micarea melaena* (on wood), *Opegrapha viridis*, *Peltigera praetextata*, *Pyrenula nitida*, *Thelotrema lepadinum*. Somewhat close in their character are: *Acrocordia gemmata*, *Arthotelium ruanum*, *Bacidia rubella*, *Calicium salicinum*, *Pertusaria coronata*, *P. hemisphaerica*, *P. pertusa*, *Catillaria globulosa*, *Dimerella pineti*, *Ochrolechia androgyna*, *Opegrapha niveoatra*, *O. varia* and other. The majority of them were recorded from singular localities, in small proportions. In spite of this, their presence emphasizes the natural character of the forest communities of the "Swinia Gora" reserve and give an idea of the qualitative character of epiphytic communities in the forests of the Gory Swietokrzyskie Mts. in the past.

In a mixed wood (*Pino-Quercetum*) very rare species were found: *Hypoconomyce anthracophila* (on pine bark) and *H. caradocensis* (on wood). Their distribution in Poland is still little known.

5. CHANGES IN THE LICHEN FLORA OF THE RESERVE

The range of changes in the lichen flora of the "Swinia Gora" reserve is considerable. At present the occurrence of 41 species has not been confirmed (Table 1). The list takes no account of some species reported in earlier studies of an obscure taxonomic position, or, most probably, wrongly determined.

At present some further species listed in Table 1 (*Cetraria pinastri*, *Lecanora subrugosa*, *Opegrapha rufescens*) occur in the reserve. Field investigations are indispensable.

The disappearance of many other species from the reserve might be connected with the change of habitat after the establishment of the reserve. The elimination of any kind of human activity released natural succession tendencies of forest communities. A marked development of undergrowth causes an increase in the shading of the forest ground. The inter-forest glades, which

Table 1. Inventory of species which have retreated from the "Swinia Gora" reserve.

Ecological group	Species	
epiphytic	<i>Bryoria crispa</i>	extinct
	<i>Bryoria fuscescens</i>	extinct
	<i>Bryoria positiva</i>	extinct
	<i>Bryoria subcana</i>	extinct
	<i>Bryoria vrangiana</i>	extinct
	<i>Calicium viride</i>	extinct
	<i>Cetraria sepincola</i>	
	<i>Cetraria pinastri</i>	
	<i>Evernia divaricata</i>	extinct
	<i>Lecanora varia</i>	
	<i>Lecanora pallida</i>	extinct
	<i>Lecanora subgrugosa</i>	
	<i>Lobaria pulmonaria</i>	extinct
	<i>Opegrapha rufescens</i>	
	<i>Parmelia caperata</i>	extinct
	<i>Parmelia exasperatula</i>	
	<i>Pertusaria albescens</i>	
	<i>Phaeophyscia orbicularis</i>	
	<i>Physcia adscendens</i>	
	<i>Physcia aipolia</i>	
	<i>Ramalina farinacea</i>	extinct
	<i>Usnea ceratina</i>	extinct
	<i>Usnea filipendula</i>	extinct
	<i>Usnea glauca</i>	extinct
	<i>Usnea hirta</i>	extinct
	<i>Usnea hirtella</i>	extinct
	<i>Usnea subfloridana</i>	extinct
epigeal	<i>Cladina arbuscula</i>	
	<i>Cladonia crispata</i>	
	<i>Cladonia cornuta</i>	
	<i>Cladonia furcata</i>	
	<i>Cladonia gracilis</i>	
	<i>Cladonia phyllophora</i>	
	<i>Placynthiella oligotropha</i>	
epilithic	<i>Acarospora fuscata</i>	
	<i>Aspicilia cinerea</i>	
	<i>Candelariella vitellina</i>	
	<i>Huilia crustulata</i>	
	<i>Parmelia conspersa</i>	
	<i>Rhizocarpon distinctum</i>	

were mowed and grazed in the past, were almost totally dominated by forest. Only small patches are left. The hilotophilous lichens which used to occupy both forest or exposed and light positions, receded. This refers to all species recorded in the past from the bed-rock and also terrestrial lichens. Similar habitat demands are exhibited by some epiphytes, e.g. *Physcia adscendens*, *P. aipolia*, *Phaeophyscia orbicularis*, *Parmelia exasperatula*, *Lecanora varia* (Table 1). They probably still occur in the reserve in the crowns of *Populus tremula*. At present, from a blown-down *Populus tremula* near the overgrown glade, fragmentary thalli of formerly recorded lichens were collected with a much ecologically close character to the above-mentioned, namely: *Physcia stellaris* and *Xanthoria parietina*. Similar examples of the retreat of light-demanding species of lichens are currently observed in the Bialowieza National Park (CIESLINSKI and TOBOLEWSKI 1988, 1990).

The retreat of other species from the reserve given in the Table 1 (17 species, 13% of the total flora of the reserve) was caused by other factors. These lichens are known to be greatly susceptible to any changes in habitat conditions and especially to atmospheric pollution. Their regress is caused by anthropogenic factors. These lichens retreated from other parts of the Gory Swietokrzyskie Mts., e.g. the Swietokrzyski National Park (CIESLINSKI 1985). They are already absent from many other regions of Poland and neighbouring countries. The species were included in the Red List under the category "vulnerable" (CIESLINSKI et al. 1986). Particular attention should be paid to the lichens from the genus *Bryoria* and *Usnea*, whose extinction in the reserve is complete. A fragmentary thallus of *Usnea* could not be identified. From the neighbourhood of the reserve a little developed sample of *Bryoria crispa* was collected. In spite of intensive investigations (on the branches of blown-down trees) no samples of the genus *Bryoria* were found.

The losses in the lichen flora of the "Swinia Gora" reserve are probably much greater. Unfortunately, they are beyond of documentation. Many further epiphytic species (e.g. *Hypogymnia bitteriana*, *Parmelia revoluta*, *P. olivacea*, *P. exasperata*, etc.) were collected by TYSZKIEWICZOWA (1935) from the forest complex in which the reserve is located.

The proportion of species which exhibit characteristics of threatened plants is remarkable. In spite of the accessibility of habitats and detailed investigations, their occurrence was noted in singular localities. They usually form very small populations of markedly decreased vitality, occurring sometimes in small quantities. The number of their localities in the Gory Swietokrzyskie Mts., similarly to many other regions of Poland, is diminishing. They have

only survived in well-preserved fragments of forest communities. These are dying-out organisms. In the "Swinia Gora" reserve the list of these lichens includes 23 species, which makes 18% of the lichen flora of the reserve. This refers to the majority of the most interesting species formerly mentioned. The list includes: *Acrocordia gemmata*, *Arthonia byssacea**, *Arthothelium ruanum*, *Bacidia rubella*, *Calicium salicinum*, *Cetraria chlorophylla*, *Chaenotheca ferruginea*, *C. xyloxena**, *Chrysothris candelaris*, *Coniocybe sulphurea**, *Evernia prunastri*, *Gyalecta truncigena*, *Hypogymnia tubulosa*, *Lecanora intumescens*, *Menegazzia terebrata**, *Ochrolechia androgyna*, *Opegrapha viridis*, *Peltigera praetextata*, *Pertusaria coronata*, *P. leioplaca*, *P. pertusa*, *Ramalina pollinaria*, *Thelotrema lepadinum**. The localities of the species in the reserve marked with an asterisk (*) are currently the only ones in the Gory Swietokrzyskie.

6. DISCUSSION

The lichen flora of the "Swinia Gora" reserve is rich and diversified. It distinguishes this object on a national scale and gives an idea of the quantitative and qualitative diversity of the epiphytic flora in forest communities of the Gory Swietokrzyskie Mts. in the past.

The current state of the flora is branded with traces of man's activity. During the last 30 years 13% of species have died out, further 18% are markedly threatened and will most probably disappear totally if the destructive factors are still at work. The first to die out are vulnerable species of narrow ecological amplitude, most often fruticose with big thalli, i.e. species mainly from the genera *Bryoria* and *Usnea*, whose destruction in the reserve and in Poland is total. In the sixties, the most common species from these genera occurred abundantly in the reserve. The herbarium material from that period has been preserved (CIESLINSKI and BYSTREK 1976, BYSTREK and CIESLINSKI 1982). Further species connected with natural forests have also been destroyed: *Lobaria pulmonaria*, *Evernia divaricata*, *Parmelia caperata*, *Lecanora pallida*, *Calcium viride*, *Ramalina farinacea*.

The impoverishment of epiphytes in the "Swinia Gora" reserve is particularly significant. This has been a strictly protected area for 50 years now. It is located in the centre of a marked forest complex, far from the direct sources of atmospheric pollution (big urban centres, busy roads, etc.). Moreover, the reserve is conspicuous for its great proportion of old trees, which preserve epiphytic flora for longer periods. It is obvious that the decisive effect on the

impoverishment of epiphytes in the reserve is exerted by supraregional and global threats, which make the reserve protection insufficient for securing the whole specific diversity of lichens. The impoverishment of the epiphytic flora in the "Swinia Gora" reserve exhibits a great concurrence in time with similar processes occurring in other parts of the Gory Swietokrzyskie Mts., especially in the Swietokrzyski National Park (CIESLINSKI 1985), and also in other regions of Poland (BYSTREK and KARCZMARZ 1987, CIESLINSKI and CZYZEWSKA 1989). The range and rate of unfavourable changes in the flora of epiphytic lichens in the last 25-30 years is related to a general degradation of the natural environment of Poland, especially to the global increase in atmospheric pollution, changes in local climates, water relations, etc.

The chances for the preservation of the complete specific diversity of lichens are decreasing even in protected areas. The impoverishment of lichen flora in the "Swinia Gora" reserve should be considered as a symptom of the degeneration of forest ecosystems of the reserve. One of the components of biocenoses is dying out and impoverishment of their diversity. The dying out of epiphytic lichens is a warning sign about the imminent threat to forest communities in the reserve.

SUMMARY

The forest reserve "Swinia Gora" has been a strictly protected area for over 50 years. It is situated within the forest complex far from direct sources of pollution. It is characterized by a great number of old trees. Over the last 30 years, 30% of lichens have died out and more than 18% are on the verge of extinction. The process refers to the vulnerable species of narrow ecological amplitude with big thalli characteristic of natural woods. However, the lichen flora of the reserve is still rich and diversified. It includes 86 species, most of which can be regarded as relicts of the primary forest.

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