Lichen flora of the Czech Republic

Lišejníková flóra České republiky

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This review of the lichen flora of the Czech Republic deals with the history of the research and highlights the most important summarizing publications. The diversity of the lichen flora is discussed and compared with that recorded in neighbouring countries. The main phytogeographic elements are outlined and illustrated with representative examples. The threat to the lichen flora in the Czech Republic is discussed in terms of the recently published Red List (version 1.1) and several endangered ecological groups of lichens with examples of the most threatened and extinct species are identified. Changes in the lichen flora along with the main causal factors are discussed. Air pollution, in particular sulphur dioxide was the most serious damaging factor in the 20th century. However, there has been a change in the trend in air pollution over the last two decades, with a decrease in sulphur and increase in nitrogen emissions, which has resulted in recolonization by formerly vanishing species of nitrophytic lichens (e.g. *Xanthoria parietina*) and decrease in the abundance of the toxitolerant acidophytic species *Lecanora conizaeoides*. Ongoing present changes are very dynamic and not yet fully recognized. Therefore, field surveys are very important and will result in the recording of further species new to the Czech lichen flora.

Key words: changes, Czech Republic, history of research, lichens, phytogeography, pollution, species diversity, threat, trend

History of surveys of lichens in the Czech Republic

The survey of lichens occurring in the Czech Republic (previously part of Austria-Hungary and after WW I Czechoslovakia) started at the end of the 18th century. However, there were several periods of intense activity alternating with periods when only few surveys were undertaken. In addition, the research was always carried out by a limited number of researchers. In spite of this long tradition there has not been a publication summmarizing the results for a very long time (see below). Records of distribution of Czech lichens are dispersed in almost 1100 papers of Czech and foreign lichenologists (Fig. 1). There is a checklist and bibliography of the papers on lichens occurring in the Czech Republic in the catalogue of Vězda & Liška (1999) and subsequent checklist revisions (Liška 2005, Liška et al. 2008, Liška & Palice 2010). Recent literature by Czech and Slovak lichenologists is regularly published in the newsletter Bryonora.

There are many records of lichens for the geologically and geomorphologically varied surroundings of Prague, northern and south-western Moravia and more recently for the Šumava Mts in south-western Bohemia. On the other hand, some areas are still insufficiently explored. In addition, many old records need to be confirmed (cf. Liška 1992) and a lot of herbarium material has not been investigated recently.

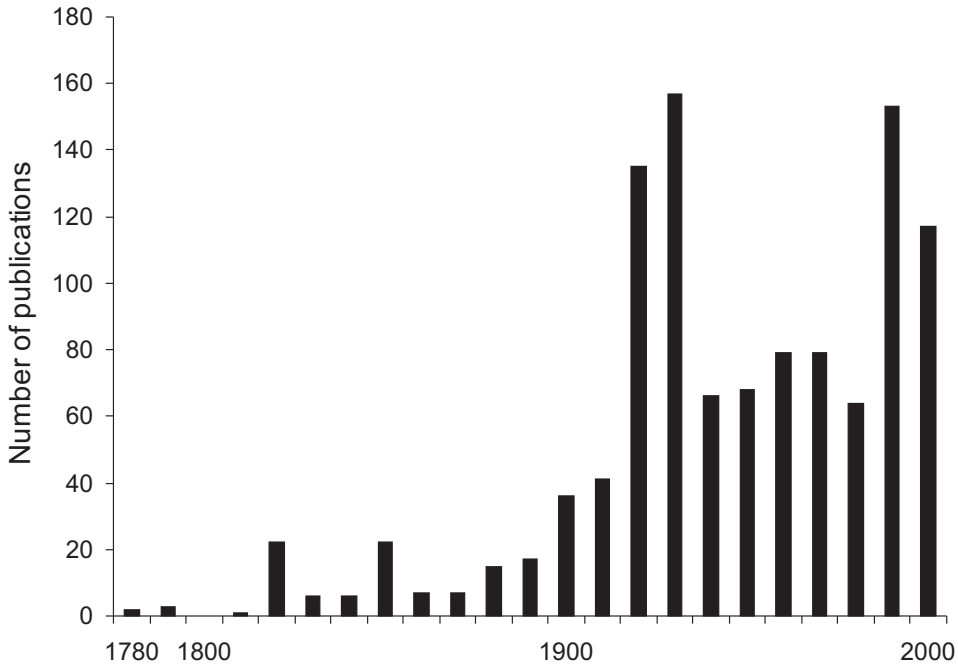

Fig. 1. – Decadal output of publications up to the end of 2010. Note that the last decade does not include papers of foreign lichenologists.

There are several lists of Czech lichens that were published in the 19th century (Mann 1825, Opiz 1852, Veselsky 1858) but they only deal with a small part of what is currently included in the Czech lichen flora. Anders (1928) published an important central-European flora of macrolichens (i.e. fruticose and foliose lichens) together with identification keys. After the end of WW II, a project on the Czechoslovak lichen flora was initiated, but only the first part that deals with macrolichens was published (Černohorský et al. 1956). Several books with keys to selected common species were published later (Pišút 1965, 1974, Smola 1976). Monographs on several taxonomical groups were published, e.g. *Physciaceae* (Nádvorník 1947), *Verrucariaceae* (Servít 1954) and *Umbilicariaceae* (Lisická 1980) families and several genera (e.g. *Thelopsis*, *Gyalecta* and *Pachyphiale*) by A. Vězda. In addition, a monograph on lichenicolous fungi was published (Kocourková 2000).

A survey of lichen communities using a phytosociological approach (Scandinavian or Uppsala school) was started in the 20th century. Most of the work on this project was done by A. Hilitzer, a person with a wide knowledge, but who unfortunately died relatively young. His most important paper is a monograph on epiphytic vegetation (Hilitzer 1925), which is still cited. A phytosociological overview of lichens in the Czech Republic was published by Liška (1984).

Distribution maps are only available for a few of the lichens in the Czech Republic. Some of them are in papers by J. Suza (e.g. Suza 1925, 1936, 1937, 1938, 1939, 1942, 1948, 1950). In the second half of the 20th century, distribution maps were published in taxonomic papers (e.g. Černohorský 1965, 1966, 1967, Lisická 1980), the Red Data Book (Liška & Pišút 1995) and chorological studies (e.g. Kocourková-Horáková 1998, I. Pišút 1982 and papers by J. Liška and his colleagues, e.g. Liška & Pišút 1990, Liška 1994, 1996, Liška et al. 1996, 1998a, b, 2006). There is a list of all the maps (regardless scale) in papers published by Czech and Slovak authors in Liška (1995).

Diversity of the lichen flora in the Czech Republic

The exact total number of species of lichens in the Czech Republic was unknown until the publication of a bibliographic survey, which includes over 800 papers by Czech and foreign lichenologists, in the catalogue of Czech lichens (Vězda & Liška 1999). There are 1534 species, including several taxa of lichenicolous fungi traditionally treated as lichens and some published dubious records, in this catalogue. Following a critical evaluation a new checklist and Red List was published (Liška et al. 2008) from which almost 100 species in the original catalogue were excluded and several new taxa were added, giving a revised total number of 1497 lichens. The next revision (Liška & Palice 2010) excluded only 3 species and added 30 recently recorded new species giving 1526 species in total, which is similar to the number cited in Vězda & Liška (1999), see Table 1. Total number of lichenicolous fungi is currently greater than the 156 species recorded in Kocourková (2000) and still increasing.

As indicated above, the number of new species recorded in the Czech Republic has increased continuously over the last few years (ca 10 new taxa per year). This is due to the discovery of small and inconspicouos species as well as the identification of new taxa (cf. Palice 1999, Liška & Palice 2010). In addition, changes in the taxonomical concepts used also affect the total number of species (e.g. family *Verrucariaceae*). Further, delimitation of lichens as a biological group of lichenized fungi is not fully clarified and there are, for example, species with facultative lichenization among them. Unlike German and Austrian checklists, those of Czech lichens include only lichens s. str. and not lichenicolous fungi (with the few exceptions cited in Vězda & Liška 1999, see above) and questionable species are excluded over the course of time.

Table 1. – Total numbers of lichens in the Czech Republic reported in 1999, 2008 and 2010.

	Vězda & Liška 1999[a]	Liška et al. 2008	Liška & Palice 2010
Total number of species	1534	1497[b]	1526[b]
Excluded species		–48	–3
Newly recorded species		+97	+30
Lichenicolous fungi		–40	

[a] This catalogue (Vězda & Liška 1999) included also some not fully reliable published records as well as some taxa of lichenicolous fungi traditionally treated as lichens.
[b] Further differences in the total number of species are due to changes in taxonomical concepts (splitting or fusion of taxa).

Many taxa were described as new to science by Czech and foreign lichenologists based on material collected in the Czech Republic. The total number is unknown at present but thought to be in the region of hundreds of taxa. In terms of species, ca 180 species of lichen (incl. taxa described at infraspecific ranks and later combined to species rank) and ca 80 species of lichenicolous fungi are known. The most species-rich genera are *Lecanora* s.l., *Lecidea* s.l., *Physcia* s.l., *Polyblastia* s.l. and above all *Verrucaria*. The majority of these taxa were synonymized with other taxa, but ca one-sixth of them stood the test of time although some of them are now included in other genera. Among the macrolichens, there are the following species: *Collema undulatum*, *Dermatocarpon bachmannii*, *Parmelia submontana*, *Physcia aipolioides*, *P. vitii* and *Peccania cernohorskyi*. The most important herbaria where type material can be found (namely original material of lichens described by M. Servít and A. Vězda, respectively, collected in various countries over the whole world) are PRM and PRA. This type material is being searched, catalogued, digitized and the nomenclature revised by J. Liška. Results will be available online on the Internet.

Comparison of the diversity of the lichen flora with that in neighbouring countries

Czech lichen flora is relatively very diverse and includes about one-tenth of the estimated world diversity. For Europe there is no checklist but the list of 7600 species (incl. lichenicolous fungi – see Feuerer 2012) compiled from national lists (not all European countries are covered); this list is provisional and likely to increase in the future. Based on this, the Czech lichen flora represents almost one-fourth of the diversity of lichens in Europe. Richness of the Czech lichen flora is similar to that of Slovakia and Poland. In terms of area, the diversity is greater in Slovakia (owing to presence of high mountains and frequent occurrence of limestone together with other types of rock e.g. dolomites and volcanic rocks) where almost the same total number of lichens occur in a markedly smaller area. A considerably greater diversity (about 2000 and more species) is recorded for Alpine countries (Table 2).

Table 2. – Comparison of the diversity of the lichen flora of the Czech Republic with that in neighbouring countries. The figure for Austria is the number of lichens including lichenicolous fungi.

Country	Area (km^2)	Total number of species	Sources
Czech Republic	79,000	1526	Liška & Palice 2010
Slovakia	49,000	1478	Pišút 1998, Pišút et al. 2001
Poland	313,000	1600	Cieśliński et al. 2003
Germany	357,000	1946	Wirth et al. 2011
Austria	84,000	2101	Hafellner & Türk 2001

Phytogeographical aspects

Generally, the distribution ranges of cryptogams are larger than those of flowering plants, not only for families and genera but also species. The main reason for this is that their spores and vegetative diaspores are more easily distributed than the seeds of phanerogams. The complete distributions of most species of lichen are not fully known, therefore sur-

veys of less explored areas are likely to result in an increase in the distributions of many lichens (cf. Galloway 1996). On the other hand, distributions may become smaller when taxa are revealed to consist of several species after taxonomic revision. Maps of distributions are published for a few selected species (cf. Litterski 1992, Galloway 1996, Otte et al. 2002, 2005, Litterski & Ahti 2004, Martínez et al. 2005). Terminology of the phytogeography of lichens is the same as that used for phanerogams and is based on climatic and vegetation zones. However, microclimate, ecological niches and substrates are very important and often crucial for the occurrence of lichens that differ in being poikilohydric and able to survive in habitats not suitable for vascular plants. Therefore, the distributions of lichens are more complex or tend to be azonal. However, less is known about the phytogeography of lichens than of phanerogams.

Generally, endemism is rarer in lichens than phanerogams but this may be a consequence of little research and poor knowledge of lichens, e.g. of the approximately one-hundred formerly assumed endemic lichens in the Carpathians (see Verseghy 1958) it is likely that few if any are endemic. Endemic taxa occur mainly in isolated countries in the Southern Hemisphere (Antarctica, Australia, New Zealand). Several species were described as new for the Czech Republic that are only known from their locus classicus. They are often inconspicuous and taxonomically difficult (e.g. *Verrucaria* spp.) or recently described (e.g. *Lecanographa aggregata* in Egea & Torrente 1994), so it is premature to regard them as endemic species. Therefore, our current knowledge of taxonomy is also an important factor. Several lichens formerly assumed to be good species are now synonyms of other taxa (e.g. *Cetraria bohemica* Anders). *Physcia aipolioides* seemed to be a central-European endemic lichen (its known distribution was in the area where southern Moravia, south-western Slovakia and north-eastern Austria converge) but its distribution is larger than previously assumed as it is now known to occur in central Bohemia, northern Moravia, eastern Slovakia, Hungary, Bulgaria and Montenegro (see Lisická et al. 2008). Similarly, e.g. *Cladonia magyarica* was assumed to be an endemic Pannonian species of steppe areas (south-western Slovakia and Hungary only), but it also occurs on other continents (central Asia, Canada and Nebraska in North America) and has a disjunct distribution in the Northern Hemisphere (Litterski & Ahti 2004).

Other central-European lichens, which grow on rarely occurring substrates (e.g. loess, serpentine rocks, copper ore etc.) or occupy narrow niches have limited distributions but are also found in other distant areas (e.g. *Gyalidea asteriscus* in Norway, *Lecanora gisleriana* in south-eastern Turkey).

Most Czech lichens are widely distributed; this concerns even saxicolous, terricolous and epiphytic species (substrate specificity sensu stricto is rare among lichens or may only be for a particular type of substrate). Many lichens have cosmopolitan distributions (e.g. *Xanthoria parietina*, *Physcia adscendens* and *P. stellaris*). The sterile lichen, *Thamnolia vermicularis,* has a cosmopolitan distribution even though it does not produce special vegetative diaspores but depends on fragments of thallus being dispersed by wind and/or water. The reason for its broad distribution is unknown, but it could be an old evolutionary group. Holarctic lichens are frequent (e.g. *Melanelia disjuncta*, *Melanelixia fuliginosa*, *Melanohalea exasperatula*, *Peltigera aphthosa*, *P. degenii*, *P. leucophlebia*, *P. venosa* and *Physconia enteroxantha*) and often have zonal distributions: arctic-alpine (*Flavocetraria cucullata*, *F. nivalis*) and boreal temperate (*Cladonia amaurocraea*, *C. arbuscula*, *C. botrytes, C. stellaris*, *C. turgida*, *C. uncialis*, *Cetrariella commixta*, *Melanelia hepatizon* etc.), or

their current distributions are a consequence of spreading during the postglacial period: temperate (*Cladonia incrassata*), temperate-meridional (*Cladonia ciliata* and *Melanelixia glabra*) and mainly mediterranean (*Cladonia convoluta*). Bipolar distribution in which species occur in both hemispheres (mainly on mountains) with a break in the tropics is represented by e.g. *Alectoria nigricans*, *Arthrorhaphis citrinella*, *Cladonia bellidiflora, Physconia muscigena*, *Solorina crocea*, *S. spongiosa* and *Xanthoria elegans*. Widely distributed lichens growing in central Europe are absent from the tropics except in the mountains (*Lecanora polytropa*, *Parmelia sulcata* and *Xanthoria elegans*). However, even among the Czech lichens there are species that are distributed from the tropics to temperate areas (namely epiphytes e.g. *Graphis scripta*, *Pyrenula nitida* and *Thelotrema lepadinum*, which occur even in central Fennoscandia) or pantropic species (e.g. *Hypotrachyna revoluta*, *H. sinuosa*, *Parmotrema crinitum* and *P. perlatum*). The centres of the distributions of some genera of Czech lichens are in the tropics (*Fellhanera*, *Pyrenula* and *Thelotrema*) or the Southern Hemisphere (*Placopsis*).

Many Czech lichens have Eurasian distributions and may even occur in northern Africa (e.g. *Gyalecta ulmi*, *Lobaria amplissima*, *Parmelina tiliacea* and *Pleurosticta acetabulum*) and others mainly a European distribution (*Anaptychia ciliaris*, *Cladonia polydactyla*, *C. rangiformis*, *Melanohalea laciniatula*, *Parmelia submontana*, *Parmelina pastillifera* and *Physconia grisea*). A few lichens have mainly a central-European distribution and mostly occur on special substrates or in particular habitats, e.g. the small terricolous lichen, *Gyalidea asteriscus*, which occurs on loess.

In the Czech Republic, there are rare lichens that occur mainly in northern Europe, i.e. they have arctic or boreal distributions. In addition to northern Europe (and even also Asia and North America), they also occur in mountain areas in central Europe (*Cladonia bellidiflora*, *Flavocetraria cucullata*, *F. nivalis* and *Stereocaulon alpinum*) and sometimes even at low altitudes. Some of these lichens are assumed to be glacial relicts (e.g. saxicolous *Arctoparmelia centrifuga*) and occur mainly in subalpine areas and peat-bogs (e.g. epiphytic *Cetraria sepincola*). Other relict lichens occur mainly in Slovakia in the High Tatra Mts (e.g. *Nephroma arcticum*).

The following group of lichens occur mainly in western Europe where the climate is humid – oceanic and suboceanic lichens (e.g. *Cladonia portentosa*, *C. zopfii*, *Diploicia canescens* and *Xanthoparmelia mougeotii*). Some of these lichens have an atlantic-mediterranean distribution (e.g. *Diploicia canescens*). Others have wider distributions even occuring on other continents, but the factor that mainly determines their distribution is oceanity (e.g. arctic-oceanic lichen *Baeomyces placophyllus).* Species with amphiatlantic distributions, which include eastern North America and western Europe, are rare (e.g. *Lasallia pustulata*, and *Stereocaulon dactylophyllum*).

Some of the epiphytic lichens that occur in humid virgin forests are often termed oceanic species (*Lobaria pulmonaria*, *Nephroma parile*, *Parmeliella triptophylla* etc.), but their distributions in Europe are more extensive, include, for example, the Carpathians and are determined by favourable micro- and mezoclimate conditions (they grow also on mossy soil and rocks in humid areas). Several epiphytic lichens of virgin forests, although in areas with a humid climate, have, at least in Europe, a continental distribution (e.g. *Evernia divaricata*, *E. mesomorpha* and *Hypogymnia bitteri*).

Another group includes thermophilous and xerophilous lichens with mediterranean distributions and their northern limit in central Europe (*Caloplaca demissa*, *Lecanora*

garovaglii, *Squamarina lentigera*) and some of them grow even further north (e.g. *Fulgensia fulgens*). They are calciphilous species occurring mainly on limestone but also other rocks in the lowlands of the Czech Republic.

A Pannonian distribution is rather rare among Czech lichens (e.g. *Physcia aipolioides*).

Changes in and the threat to the lichen flora

Lichens are often thought to be stress-tolerant and adapted to extreme conditions. This is true for natural conditions such as extreme climate, scarce nutrients or inhospitable habitat (e.g. bare rocks). However, lichens are well adapted to such severe conditions and decline in abundance when their habitats become more hospitable (e.g. receive a higher input of nitrogen compounds). Lichens are sensistive indicators of environmental change, namely air pollution, even at low concentrations. Central Europe is one of the most severely affected areas on the continent in terms of concentrations and duration of emissions. Therefore, some formerly common species of lichen are now sparsely distributed or extinct in the Czech Republic (Table 3). The total number of species has decreased and the distribution of many epiphytic lichens has changed (Liška 1994, 1996, 1997).

Currently more than one-third of the species are classed as threatened according to the last version (1.1) of the Red List of Czech lichens (Liška & Palice 2010): 9% are in the CR category, 12% in EN and 16% in VU, i.e. 37% in total (see Table 3). A part of the lichen flora is potentionally threatened (11% NT category) and 13% (LC category) not threatened. Moreover, 138 species (9%) are now extinct. The threat to the lichen flora in the Czech Republic is greater than that to the flora in Slovakia and Poland (see Table 3). Many epiphytic lichens of virgin forests are extinct, e.g. *Collema nigrescens*, *Hypotrachyna sinuosa*, *Leptogium saturninum*, *Lobaria scrobiculata*, *Sticta sylvatica* and *Usnea longissima*, cf. Liška et al. 1998b). Mountain lichens growing on mosses and soil (in limestone areas and those with a silicate substrate) are another ecological group that is threatened. Among the extinct species in this group are, e.g. *Caloplaca ammiospila*, *C. nivalis*, *Catolechia wahlenbergii*, *Rinodina mniarea*, *R. turfacea*, *Solorina crocea* and *Squamarina gypsacea*. Terricolous lichens growing at low altitudes are also threatened, mostly in limestone areas, and the following are now extinct, e.g. *Heppia lutosa*, *Moelleropsis nebulosa*, *Psora vallesiaca* and *Trapeliopsis wallrothii*, or endangered, e.g. *Squamarina lentigera*. The relict species among the peat-bog lichens are endangered (e.g. *Cetraria sepincola*), some of them extinct (epiphytic *Melanohalea olivacea* and *M. septentrionalis*; Liška 1996). Also saxicolous lichens, which mostly occur in humid habitats, are threatened and *Dermatocarpon bachmannii*, *D. leptophyllum* and *D. meiophyllizum* are extinct (Liška & Palice 2010).

The number of extinct species of lichen is roughly the same as that of critically endangered, many of which now only occur at their last localities, e.g. *Alectoria sarmentosa*, *Hypotrachyna revoluta*, *Nephroma parile*, *N. resupinatum*, *Peltigera aphthosa*, *P. collina, Ramalina thrausta*, *Sphaerophorus fragilis* and *S. globosus* (see Liška et al. 1996, 1998a, b). By contrast, some lichens assumed to be extinct have been found again recently, e.g. *Letharia vulpina* and *Lobaria amplissima* (see Liška et al. 1996), but many of these reports are of individual young thalli, survival of which is uncertain. There has been a considerable decrease in the distributions of some formerly scattered and common species,

Table 3. – Comparison of the threat to the lichen flora in the Czech Republic and that in neighbouring countries (only countries with published Red Lists using IUCN categories are included).

Country	Czech Republic	Slovakia	Poland
Source	Liška & Palice 2010	Pišút 1998, Pišút et al. 2001	Cieśliński et al. 2003
Total number of species	1526	1478	1600
Number of regionally extinct species (RE)	138	88	141
RE (%)	9	6	9
Number of endangered species (CR+EN+VU)	569	357	545
CR+EN+VU (%)	37	24	34

e.g. *Candelaria concolor*, *Flavoparmelia caperata*, *Parmelina tiliacea*, *Peltigera horizontalis*, *P. polydactylon* and *Ramalina* spp. (see Liška 1994, 1996, Liška et al. 2006). This is worrying as it includes species of lichen that are used in textbooks and popular encyclopedias as didactic types.

In contrast, the distributions of some lichens have been increasing recently. Generally, this phenomenon is not so frequent among lichens as in flowering plants and animals, where many species become successful invaders. It has been hypothesized that occurrence of some species in distant regions, e.g., *Lecanora conizaeoides* in North America, *Xanthoria parietina* in Australia and some lignicolous lichens in polar areas, may have been due to introduction by man rather than natural dispersal. However, these cases are very rare and some are speculative. *Anisomeridium polypori* (*A. nyssaegenum*) was assumed to be a neophyte in Europe (Poelt & Türk 1994). This lichen was described as new from North America, but it is an inconspicuous species and therefore the likelihood of it being overlooked is rather high. In addition, recent revisions reveal that this lichen is described under various names in other continents (Aptroot 1999).

Reasons for the recent spread of several lichens are perhaps the same as those thought to account for the retreat and extinction of other lichens: air pollution with accompanying effects (acid rain and change in pH). However, the trend in air pollution has changed over last two decades. Emissions of sulphur dioxide have declined considerably in central Europe, but nitrogenous emissions are still increasing and lichens reflect this change. The crustose epiphytic lichen, *Lecanora conizaeoides,* is a classical example, because it is very tolerant of high levels of sulphur dioxide. Due to its ability to colonize new substrates and rapid growth, it became one of the most common lichens on various substrates in the second half of the 20th century. It spread into industrial areas and into cities where it was often the only lichen able to survive the high levels of sulphur dioxide. It spread also into acidophytic lichen communities, often in mountain areas with background concentrations of air pollution. The high tolerance to sulphur dioxide and acidity of this lichen together with the niche clearing and decrease in competition that occurred when the sensitive species became extinct are the main factors responsible for its rapid increase in abundance and distribution. Similar behaviour is documented for several species with similar ecology: *Scoliciosporum chlorococcum*, *Hypocenomyce scalaris* and *Parmeliopsis ambigua* (Liška & Pišút 1997).

However, the decrease in sulphur dioxide emissions and increase in the level of nitrogen compounds in the environment resulted recently in a considerable decrease in the distribution of *Lecanora conizaeoides,* which is a nitrophobous lichen. First reports of the decline of this lichen came from the Netherlands, which is known to be the country with the highest levels of nitrogenous pollution.

There is another group of lichen species with different ecology that are now increasing, of which *Physcia aipolioides* is an example. It is a nitrophytic, photophilous and toxitolerant lichen growing at low altitudes predominantly on solitary deciduous trees (Liška & Pišút 1997, Lisická et al. 2008). *Amandinea punctata* and particularly *Xanthoria paretina* are further examples of nitrophytic species that are spreading. The latter species is very showy and was formerly very common in the Czech Republic, but became rare due to air pollution and even extinct in large areas in northern and north-western Bohemia in the 1970s and 1980s (Liška 1994). Nowadays, it frequently occurs in towns and in the formerly most polluted regions. However, not only epiphytic lichens are increasing, but also the saxicolous lichens, *Lecanora dispersa* and *L. saxicola*, which occur also on artificial substrates, such as concrete, plaster, bitumen etc., and are perhaps the most common species of lichen in cities at present.

The noticeable changes in the distributions of many lichens in the Czech Republic that have occurred with the changes in levels of air pollution are similar to those reported in the Netherlands, United Kingdom, Germany etc. Coincidental with the decrease in the formerly widely distributed lichen, *Lecanora conizaeoides*, there has been an increase in formerly decreasing and vanishing species, e.g., *Evernia mesomorpha*, *E. divaricata* and *Usnea* spp., and spreading of some xerophilous lichens possibly in response to global warming.

Regardless of the poor knowledge of the present distribution of many lichens, there have been considerable changes in the distribution of many species in Europe. The distributions are very dynamic and it is important to record them in order to be better able to determine the causes and predict future changes. However, in addition to the above mentioned changes, field surveys still discover new species for the Czech Republic (e.g. Palice 1999, Liška 2005, Liška & Palice 2010; see also Table 1).

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Souhrn

Historie lichenologických výzkumů je dokladována nejvýznamnějšími publikacemi, především taxonomickými monografiemi a shrnujícími pracemi. Diversita lišejníkové flóry České republiky je porovnávána s diversitou okolních zemí. Krátce je diskutován fenomén endemismu. Zmíněny jsou hlavní fytogeografické elementy zastoupené v naší lišejníkové flóře, vždy s vybranými příklady: lišejníky s rozšířením kosmopolitním, holarktickým a bipolárním s disjunktním areálem a dále s rozšířením eurasijským či evropským. Pokud jde o evropský charakter areálu, zmíněny jsou lišejníky s rozšířením arkto-alpinským, boreálně temperátním, temperátním, temperátně mediterránním a panonským. Na území ČR však zasahují i druhy či rody, které mají převážně mediterránní rozšíření nebo dokonce s centrem rozšíření v tropech nebo na jižní polokouli. Krátce jsou diskutovány oceánické lišejníky a glaciální relikty. Ohrožení lišejníkové flóry ČR je pojednáno na základě nové verze červeného seznamu lišejníků

(verze 1.1) a celkové ohrožení je porovnáno se stavem na Slovensku a v Polsku, kde existují červené seznamy se shodnými kategoriemi IUCN. Uvedeny jsou příklady nejohroženějších ekologických skupin lišejníků s vyjmenovanými příklady vyhynulých či kriticky ohrožených druhů. Změny lišejníkové flóry jsou demonstrovány na vybraných příkladech. Nejvýznamnějším negativním faktorem je znečištění ovzduší, kde však v poslední době došlo ke změně trendu: zatímco emise oxidu siřičitého významně poklesly, emise dusíkatých látek nadále stoupají. Na tyto změny citlivě reagují i některé druhy lišejníků. Například acidofilní toxitolerantní druh *Lecanora conizaeoides,* který se dříve značně rozšířil, v současnosti ustupuje. Naopak nápadný nitrofilní druh *Xanthoria parietina*, který díky své citlivosti na imise síry z mnohých nejznečištěnějších oblastí ČR v druhé polovině 20. století prakticky zmizel, po poklesu koncentrací oxidu siřičitého se však opět značně rozšířil, na čemž se podílejí i vysoké koncentrace dusíkatých látek v prostředí. Podobně je zajímavý návrat těch druhů, které patřily mezi kriticky ohrožené. Současné změny v rozšíření mnoha druhů jsou značně dynamické a u řady druhů zatím nepříliš zdokumentované. Proto pro zachycení změn a pochopení jejich příčin je velmi důležitý terénní výzkum, který zároveň stále přináší i nálezy druhů, které z našeho území dosud nebyly udávány.

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