

## Changes in distribution and substrate preferences of selected threatened lichens in the Czech Republic

Jan VONDRÁK<sup>1</sup> & Jiří LIŠKA<sup>2</sup>

<sup>1</sup>Department of Botany, Faculty of Science, University of South Bohemia, Branišovská 31, CZ-37005 České Budějovice, Czech Republic; e-mail: j.vondrak@seznam.cz

<sup>2</sup>Institute of Botany, Academy of Sciences, Průhonice, CZ-25243 Czech Republic; e-mail: liska@ibot.cas.cz

**Abstract:** The distribution and ecology of four threatened lichens in the Czech Republic, *Evernia mesomorpha*, *Hyperphyscia adglutinata*, *Hypotrachyna revoluta* and *Parmotrema perlatum*, have been studied. All species are mainly epiphytic, but recent records from the Czech Republic are largely from siliceous rocks in river/brook valleys. Changes in distribution and substrate preferences are documented and discussed.

**Key words:** *Evernia mesomorpha*; habitat shrinking; *Hyperphyscia adglutinata*; *Hypotrachyna revoluta*; lichenized fungi; *Parmotrema perlatum*; substrate specificity; substrate switch

### Introduction

Lichens grow on a variety of substrates, but strong substrate specificity is rather rare within species. However, distribution of some lichens is restricted to specific, e.g. metal-rich rocks (e.g. ferrophilous, cuprophilous lichens) or type of bark. On the other hand, some species may be found on variety of substrates including trees, wood, rocks and soil (e.g. *Parmelia sulcata*). For most lichens, substrate specificity represents a broad scale, i.e. type of substrate (e.g. epiphytic v. saxicolous lichens) and is expressed as substrate preference rather than exclusive occurrence – even typical saxicolous lichens such as *Umbilicaria* species may grow occasionally on bark and wood (Davydov 2000). Unusual types of substrate are also exploited, such as mollusc shells, bones, metals and even the surface of living animals, as well as artificial materials (paper, felt, glass, plastics etc.). In general, substrate specificity of lichens decreases towards cold polar regions, as seen, for example, in the genus *Caloplaca*, which shows very low substrate specificity in the far north (Søchting 1989) in contrast to the temperate zone.

Lichens are rather stress tolerant organisms, which are highly resistant to extreme conditions (e.g. temperature, precipitation). However, they are susceptible to environmental changes even at a microhabitat scale (e.g. shading by surrounding shrubs). Lichens are well known as sensitive bioindicators of air pollution and an enormous literature is available on this topic, with many susceptible species vanishing in industrial and urban areas of the world (e.g. Hawksworth 1971). Not only increased concentrations of pollutants near pollution sources but also increased background concen-

trations are responsible for changes in distribution and the disappearance of many lichens (cf. red lists of European countries). However, increasing of some, mainly thermophytic and nitrophytic species in consequence of changed environment is recently detected in Europe.

Remarkable changes in distribution of mainly epiphytic lichens have been detected in the Czech Republic (e.g. Liška et al. 1996, 1998a,b, 2006), mainly due to high levels of air pollution (namely sulphur dioxide) and changes in a forest management. The change in substrate preferences has been detected e.g. in *Evernia divaricata* (Liška et al. 1996).

This contribution is focused on changes in the distribution and substrate preferences of four threatened species: *Evernia mesomorpha*, *Hyperphyscia adglutinata*, *Hypotrachyna revoluta* and *Parmotrema perlatum*.

### Material and methods

Specimens in herbaria CBFS, PRM, PRC and BRA have been searched and revised (revised specimens are marked!). Published records have also been abstracted from original papers listed in Vězda & Liška (1999). References without locality details (e.g. some records of W. Mann, P.M. Opiz and F. Veselsky) were not included. Non-revised records of *Parmotrema perlatum* under names *Parmelia/Imbricaria perlata* were omitted for their incredibility (one exception is Suza, 1914 as a credible source), because these names were often used for *Cetrelia olivetorum* s.l. (see Vězda & Liška, 1999: 43). Concerning other species, credible literary records were accepted.

Changes in frequency of records and in substrates (epiphytic v. saxicolous records) are demonstrated by bar graphs for three periods: up to 1950, 1951–2000, from 2001

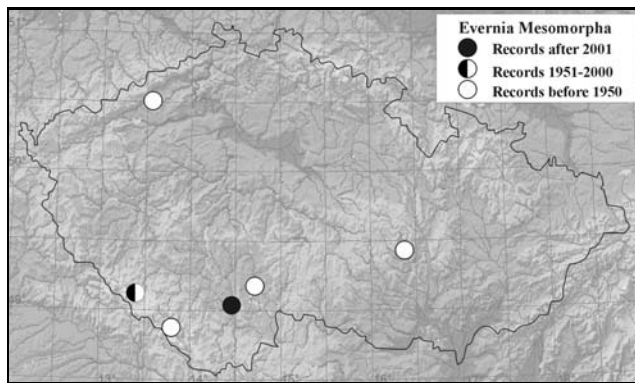


Fig. 1. Changes in distribution of *Evernia mesomorpha* in the Czech Republic.

(as recent records) and changes in distribution pattern are illustrated by maps.

## Results

### *Evernia mesomorpha* Nyl.

There are only six localities known from the Czech Republic (Fig. 1), five of which are pre-1960 and only one recent record. Its earlier occurrences were mostly epiphytic (mostly on pine bark) and rarely from siliceous rocks (Fig. 5). The only known recent population consists of a few well-developed epipetric thalli and a few tiny individuals on eroded pine roots. Although last mentioned substrate is epiphytic in fact, with respect to a character of the population which is originally epipetric, this locality is regarded as epipetric.

**Recent record:** SOUTH BOHEMIA: České Budějovice, Hluboká nad Vltavou, Záměstí, rock on E side of Vltava river 2 km NE of village, 49°04'20" N, 14°27'40" E, on small SE-exposed rocky outcrop in open pine-forest, 11 Nov. 2001, coll. J. Vondrák (CBFS JV436).

**Records between 1951–2000:** WEST BOHEMIA: Šumava Mts, Modrava, single locality on pine at forest edge (Smola, 1959).

**Records before 1950:** SOUTH BOHEMIA: Veselí nad Lužnicí, Bošilec – near spot height 427, on bark of old pine (PRM 578726!, Suza 1936, 1938); Volary, Černý Kříž – near railway station, on pine in peat-bog (PRM 578729!, Suza 1936, 1938). NORTH BOHEMIA: Most, in gardens on foot of Rösselberg [Koňský vrch] hill at W periphery of a town, on bark (Štika 1858). SOUTH MORAVIA: Tišnov, Říkonín, in valley of Libochůvka brook, on granite rock in pine forest (Suza 1944b).

### *Hyperphyscia adglutinata* (Flörke) H. Mayrhofer & Poelt

There are 15 localities for records older than 50 years (Fig. 2) situated in climatically mild South Moravia and at low altitudes of Bohemia, mainly in deep river valleys. Epiphytic occurrences prevailed and an epipetric substrate was indicated only at one locality in central Bohemia (Fig. 5). Concerning recent five records, three of them are epipetric, bound to nutrient-rich siliceous rocks in the Vltava river valley. In two cases of these

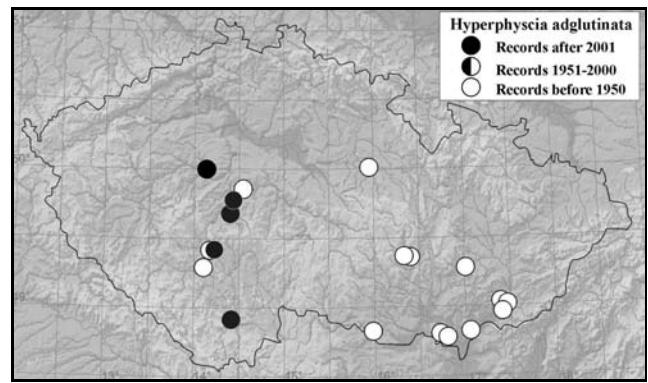


Fig. 2. Changes in distribution of *Hyperphyscia adglutinata* in the Czech Republic.

three epipetric records, rare epiphytic individuals were also recorded together with more abundant occurrences on rock and therefore we regard them as epipetric in Fig. 5. Two recent occurrences are epiphytic (oak and chestnut-tree bark) and at both localities, *Hyperphyscia adglutinata* is accompanied by the other generally terricolous or saxicolous lichens, e.g. *Endocarpon* sp., *Leprocaulon microscopicum* and *Physcia dimidiata*.

**Recent records:** CENTRAL BOHEMIA: Beroun, Svatý Jan pod Skalou, three microlocalities in S-facing slope with oak forest below view-point, on bark at bases of oak trunks, alt. 370–395 m, 29 March 2007, coll. Z. Palice (herb. ZP11131, 11124, 11128, 11134); Milín, Solenice, rocks on N side of Vltava river 1 km NE of village, alt. 300–400 m, 49°37'35" N, 14°12'20" E, on medium lit, base-rich S-exposed rock with *Aspicilia contorta* and *Caloplaca demissa*, 6 Dec. 2002, coll. J. Vondrák (CBFS JV902); Sedlčany, Kamýk nad Vltavou, Velká, rocks on NW side of Vltava river N of village, alt. 301 m, 49°40'00.1" N, 14°15'01.9" E, on shaded E-exposed base-rich granite rock and on stems of shrubs and *Alyssum saxatile*, 14 May 2005, coll. J. Vondrák (CBFS JV2967, 2968). SOUTH BOHEMIA: České Budějovice, Kamenný Újezd, ruin of Kotek (Maškovec) castle in Vltava river valley, alt. c. 420 m, 48°54'3.66" N, 14°25'14.98" E, on base-rich vertical-faced rock, in its lower, more humid but lit part and on bark of *Quercus petraea* at upper edge of S-exposed rock, 16 March 2007, coll. J. Vondrák (CBFS JV5013, 5018); Písek, Zvíkovské Podhradí, castle Zvíkov, alt. 360 m, 49°26'20" N, 14°11'40" E, on bark of solitary *Aesculus hippocastanum*, with *Physcia dimidiata*, 10 Jan. 2008, coll. J. Vondrák (CBFS JV6231).

**Records between 1951–2000:** none

**Records before 1950:** CENTRAL BOHEMIA: Praha, Pikovice, in valley of Sázava river, on schist rock (coll. J. Suza 1934a, PRM 639981!, 639982!, Suza, 1934a, Nádvořník, 1947). EAST BOHEMIA: Chroustovice, Jenišovice, on *Salix*, alt. 280 m (coll. J. Nádvořník 1942, BRA!). SOUTH BOHEMIA: Písek, on *Acer pseudoplatanus* in town (Víšek 1909); Písek, Zvíkov, at junction of Otava and Vltava rivers, abundant on *Robinia pseudacacia* (Suza 1940). SOUTH MORAVIA: Hodonín, by road to Mutěnice, alt. 170 m, on *Tilia* (PRM 639986!, Suza 1924); Mikulov, Dolní Věstonice, N-slopes of Pavlovské vrchy hills, on *Juglans regia* (PRM 639989!, Suza 1924); Mikulov, near Novohradský mlýn mill in valley of Dyje river, on *Robinia* sp., alt. 250 m (coll. J. Suza 1936, BRA!); Tišnov, in valley of Svratka

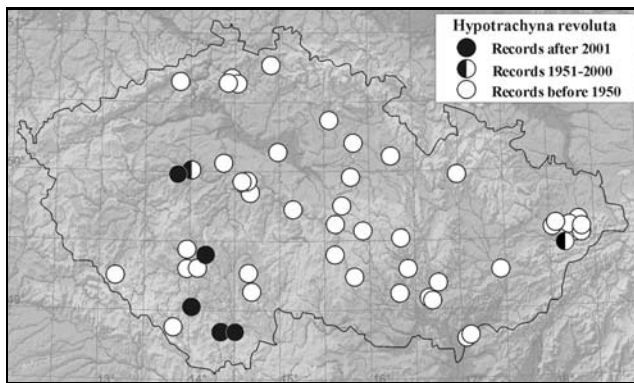


Fig. 3. Changes in distribution of *Hypotrachyna revoluta* in the Czech Republic.

river, alt. ca 300m, substrate not indicated (Suza 1924); Tišnov, Podolí near Borač, on bark of *Acer campestre* (PRM 639990!, Suza, 1929); Vyškov, Pustiměř, on *Juglans* (PRM 639988!, Suza 1944b); Znojmo, several localities around town, on *Acer campestre*, *Aesculus hippocastanum*, *Quercus*, *Robinia pseudacacia*, and *Tilia*, sometimes fertile (Oborný 1923, PRM 639983!, 639984!, 639985!, 639987!, 639991!, 639992!, 639993!, 639994!, 639995!, Suza 1922, 1933); Znojmo, Bítov, in valley of Dyje river, on bark (coll. J. Suza 1933, PRM 639996!); Uherské Hradiště, Hluk, on *Tilia*, 220 m (coll. J. Nádvořník 1942, BRA!); Uherské Hradiště, Veletiny, on *Populus*, alt. 210 m (coll. J. Nádvořník 1942, BRA!); Uherské Hradiště, Ostrožská Lhota, on *Populus*, alt. 200 m (coll. J. Nádvořník 1943, BRA!).

*Hypotrachyna revoluta* (Flörke) Hale (= *Parmelia revoluta* Flörke)

In the Czech Republic, there are numerous records (ca 50 localities) older than 50 years, which are more or less evenly distributed (Fig. 3) which give the impression that *H. revoluta* was not rare at that time; epiphytic substrates predominated (mainly *Alnus* bark) and only five records were epipetric (Fig. 5). Recent records at six localities are epipetric in general (often mossy siliceous rocks), but some thalli growing on mossy ground and pine bark (on exposed roots) were found at one locality. All recent records are in river valleys. An interesting find on a guard-stone at the Czech-Austrian border in the Novohradské hory Mts, South Bohemia, occurs at a fishpond in forest (not in river valley); however, this record should be ascribed to Austria (Liška, unpublished data).

**Recent records:** CENTRAL BOHEMIA: Rakovník, Skryje, Podmokly, valley of Mlečický potok brook (left affluent of Zbirožský potok brook) 2 km SE of village, alt. 350 m, 49°55'40" N, 14°43'40" E, on rocky slope, among mosses, 18 Sept. 2001, coll. J. Vondrák (CBFS JV935). SOUTH BOHEMIA: České Budějovice, Křemže, Trisov, rocks in Vltava river valley, ca 1.2 km NE of village, 48°52'30" N, 14°21'30" E, on gneiss rock, on mossy ground and on bases of *Pinus sylvestris* trunks, 16 May 2002 (CBFS JV528); České Budějovice, Straňany, Doudleby, rocks on E-SE side of Malše river, 0.5 km E of village, 48°53'45" N, 14°30'40" E, on gneiss rock, 7 March 2002, coll. J. Vondrák (CBFS JV574); Písek, Vráž, Žlíbky protected area,

on W side of Otava river, 49°22'50" N, 14°08'50" E, on half-shaded siliceous stone, 9 Sept. 2001, coll. J. Vondrák (CBFS JV408); Prachatic, Husinec, in slope above left bank of "Husinecká přehrada" water reservoir, alt. ca 550 m, 49°2'7.69" N, 13°59'24.1" E, on gneiss stone in open oak-pine forest, 24 June 2007, coll. J. Vondrák (CBFS JV 5148).

**Records between 1951–2000:** CENTRAL BOHEMIA: Rakovník, Nezabudice, on slate rock (Kocourková-Horáková 1998). NORTH MORAVIA: Vsetín, on exposed root of *Fagus sylvatica* (Vězda 1955).

**Records before 1950:** CENTRAL BOHEMIA: Březnice, on bark (coll. Bayer 1889, PRM 854306!); Čerčany, on stone (coll. Bayer 1902, PRM 854237!); Mnichovice, Habr [Struhařov], on *Alnus* (PRM 854286!, Hilitzer 1924); Mnichovice, Senohraby, on rock and boulders in open woodland (coll. Bayer 1902, PRM 854238!, 854302!, 854305!, 854310!, 854325!); Ibid: on *Alnus* at brook (coll. Bayer 1902, PRM 854293!, 854304!); Praha, loc. Závist [near Zbraslav], on bark (coll. Bayer 1889, PRM 854236!); Sadská, Velenka, Kersko, on *Quercus* (coll. Hilitzer 1924, PRM 854283!, Hilitzer 1924); Zruč nad Sázavou, Vlastějovice – Březina, on *Alnus glutinosa* (Suza 1947a). EAST BOHEMIA: Chotěboř, Obolce [wood between Chotěboř and Nová Ves], on *Alnus*, (coll. Carol Bayer 1887, PRC!); Chotěboř, on bark of *Alnus* (coll. Bayer 1885, 1887, 1889, PRM 854234!, 854308!, 854311!, 854327!); Chotěboř, Li-boháj, on bark of *Abies* (coll. Bayer 1888, 1900, PRM 854301!, 854313!, 854315!, 854316!); Ibid.: on rock (coll. Bayer 1888, PRM 854232!); Chrudim and Nasavrky area, on bark of roots in forests (Kalenský 1906); Havlíčkův Brod, Leithen [Letná?], Hamry and U Šídláků [Pohledští Dvořáci], on bark of *Alnus* and on stones (PRM 854324!, 854332!, Novák 1884, 1888, 1893, 1903); Hořice, Votuz, on *Alnus* (Podzimek 1939); Hradec Králové, Hrázka [Mlékosrby], sterile on *Alnus* (Novák 1913); Vamberk, Potštejn, in valley of Divoká Orlice river, on *Alnus glutinosa* (PRM 636731!, 636750!, 854321!, Suza 1914, 1926). NORTH BOHEMIA: Kriesdorf [Křižany], alley, rarely on bark (Anders 1917, 1922); Česká Lípa, on deciduous trees (namely fruit trees) near a town (Anders 1906a,b); Česká Lípa, between Strausnitz [Stružnice] and Niederlieblich [Dolní Libchavá], very rarely on *Prunus domestica* (Anders 1904; Wurm 1895; Zahlbruckner 1899); Česká Lípa, "Zickmantel" [Sosnová – Lesná], very rarely on *Prunus domestica* (Wurm, 1895, Zahlbruckner, 1899, Anders, 1904); Teplice, Doppelburg [Dvojhradí] near Dubí, on *Pinus sylvestris* (Rabenhorst 1870; Anders 1922). SOUTH BOHEMIA: Písek, on *Tilia* (Víšek 1909); Písek, Drhovle, on trees in alley (Víšek 1909); Soběslav, Borkovice, on old pines (PRM 636749!, Suza 1927); Třeboň, around Zlatá stoka canal, on *Alnus* and *Pinus* (coll. A. Weidmann 1886, PRM 636701!, 854322!, 865848!); Volary, Černý Kříž, Mrtvý luh peat-bog protected area, on *Picea abies* (PRM 636751!, Suza 1936). WEST BOHEMIA: Kdyně, locality "Peklo" [neighbourhood of Váchalovský mlýn mill between Kout na Šumavě and Kdyně], on *Alnus* (Hilitzer 1923, 1924) and in forest near Hyršov on *Fagus* (Hilitzer 1924, 1925). NORTH MORAVIA: Čeladná, near railway station, (fertile!) on *Alnus glutinosa* (PRM 636743!, 854335!, Suza 1924, 1944a); Frenštát pod Radhoštěm, Kunčice pod Ondřejníkem, on *Quercus* in village (PRM 636732!, 854320!, Suza 1924); Frenštát pod Radhoštěm, Kunčice pod Ondřejníkem, on foot of Mt Ondřejník, on *Alnus* (PRM 636740!, Suza 1924, 1944a); Frenštát pod Radhoštěm, in valley Ráztoka [SE of Mt Radhošť], rarely on bases of *Abies alba* (PRM 636746!, Suza 1921b, 1944a);

Frýdlant nad Ostravicí, in valley of Ostravice river, rarely on *Abies alba* (Suza, 1923, 1944a); Frýdlant nad Ostravicí, near Malenovice, on *Alnus* (Suza 1923, 1944a); Frýdlant nad Ostravicí, Ostravice, near railway station Šance-Řečice [recently flooded by Šance water reservoir], on *Tilia* (Suza 1923, 1944a); Příbor, below Hukvaldy ruin, on *Alnus* (PRM 636747!, Suza, 1924); Příbor, Měrkovice, near mill, on *Alnus glutinosa* (Suza 1944a); Šumperk, Sobotín, on *Alnus* (PRM 636741!, Suza, 1921b). SOUTH MORAVIA: Brno, on *Alnus glutinosa* (PRM 636735!, Suza 1944b); Brno, Šlapanice, on *Alnus* (PRM 636752!, Suza 1913); Bystřice pod Pernštejnem, below Pernštejn ruin, on *Alnus* (PRM 636742!, Suza 1922); Hodonín, near Ratíškovice in forest Dúbrava [between Hodonín and Bzenec], on *Betula* and *Pinus* (PRM 636736!, 636739!, Suza 1921b, 1944a); Hodonín, Ratíškovice, on *Alnus glutinosa* and *Pinus silvestris* (PRM 636734!, Suza 1944a); Ivančice, between Ketkovice and Senorady, in valley of Oslava river, frequently on *Alnus* (PRM 636737!, 636738!, 636744!, Suza 1921a, not refound by Vězda 1998); Jihlava, Pístov and several localities (Bedřichov, Staré Hory, Pančava) in town, on bark of *Sorbus aucuparia* (Picbauer 1923); Kroměříž, in chateau garden, on *Betula* (PRM 636722!, Picbauer 1910; Kovář 1911; Suza 1944a); Moravský kras karst, Skalský mlýn mill, on *Alnus* (Kovář, 1907); Třebíč, Dobrá Voda [near Pozdátky], on *Picea abies* (PRM 636753!, Suza 1913); Veverí Bytýška, on *Alnus* (PRM 636745!, Suza 1921b); Žďár nad Sázavou, Peperek hill, on rock (Spitzner 1893, 1897).

*Parmotrema perlatum* (Huds.) M. Choisy (= *P. chinense* (Osbeck) Hale & Ahti, *Parmelia trichotera* Hue). In the Czech Republic, there are 12 localities of records older than 50 years, more or less evenly distributed (Fig. 4). Epiphytic occurrences prevailed, only ca one fifth of records was saxicolous (Fig. 5). The only recent find represents a viable saxicolous population on a small serpentine outcrop in an open pine forest in a brook valley.

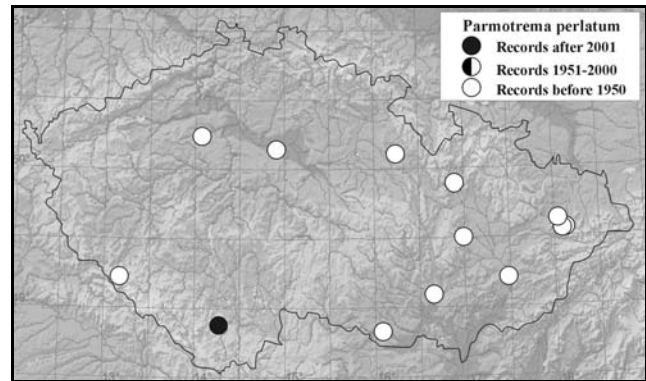


Fig. 4. Changes in distribution of *Parmotrema perlatum* in the Czech Republic.

**Recent records:** SOUTH BOHEMIA: Křemže, Holubov, Holubovské hadce protected area, alt. 470 m, 48°53'40" N, 14°20'20" E, on serpentine rock, 28 Oct. 2004, coll. J. Šoun (CBFS JV1777).

**Records between 1951–2000:** none

**Records before 1950:** CENTRAL BOHEMIA: Sadská, Kersko, on *Quercus* (PRM 850575, sub *Parmelia trichotera*, Hilitzer 1926); Slaný, Bílichov, corticolous on base of tree (coll. A. Hilitzer 1920, PRM 850574, sub *Parmelia trichotera*!). EAST BOHEMIA: Vamberk, Potštejn, on *Alnus glutinosa* (coll. J. Suza 1912, PRM 637313 sub *Parmelia trichotera*, Hilitzer, 1924). WEST BOHEMIA: Kdyně, woodland Průhon [E periphery of town], on *Populus* (PRM 850568, sub *Parmelia trichotera*, Hilitzer 1926). NORTH MORAVIA: Frenštát pod Radhoštěm, Kunčice pod Ondřejníkem, on *Quercus* in village (PRM 637318, sub *Parmelia trichotera*!, Suza 1924); Frenštát pod Radhoštěm, Kunčice pod Ondřejníkem, on foot of Mt Ondřejník, alt. 500 m, on *Tilia* (PRM 637315!, Suza 1924), Prostějov, Plumlov, locality "Zlechov", on rock (coll. V. Spitzner, PRM 637341, 637342, both sub *Parmelia revoluta*!; Spitzner 1890, 1893, 1897; Kovář 1911; Suza 1947b); Příbor, Hukvaldská obora

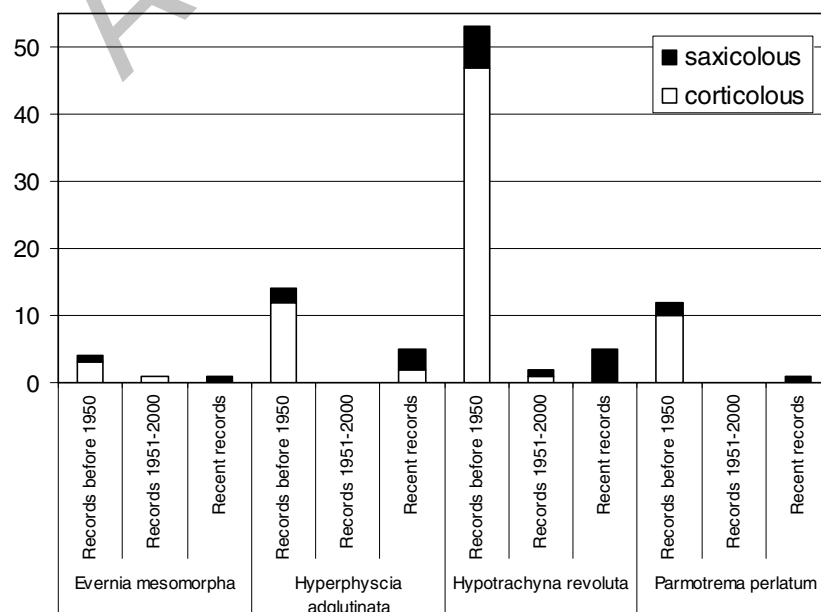


Fig. 5. Numbers of epiphytic and epipetric records of studied lichens in the Czech Republic in three periods of time.

deer-park, alt. 400 m, on *Quercus* (PRM 637316, 637317, both sub *Parmelia trichotera!*, Suza 1924); Jablunkov, Dolní Lomná, alt. 400 m, on *Alnus incana* (PRM 637328, sub *Parmelia trichotera!*, Suza 1923); Zábřeh, Rájec, alt. 440 m, on *Alnus* (PRM 637314, sub *Parmelia trichotera!*, Suza 1921b, 1947b). SOUTH MORAVIA: Brno, at two localities on *Quercus* (Suza 1914); Kroměříž, in chateau garden, on *Populus tremula* (coll. R. Picbauer, PRM 637364, sub *Parmelia perforata!*); Znojmo, among mosses on gneiss rocks (PRM 637322, sub *Parmelia trichotera!*, Suza 1933, 1947b).

## Discussion

### *Evernia mesomorpha*

This widespread circumboreal-montane species, is generally epiphytic, mainly on conifers, but is occasionally found on siliceous rocks; it is more frequently found in areas with a continental climate (Nimis 1993). Its distribution on rocky substrates is mainly related to sub-alpine regions, i.e. above timberline (Motyka 1962). It was also collected from soil in alpine belt of the Caucasus Mts (Otte 2004).

In the Czech Republic, this species was probably rare even in history and it has been considered to be extinct not long time ago (Liška & Pišút 1995; Liška et al. 1996). Recently, this threatened lichen is critically endangered in the Czech Republic (Liška et al. 2008), Germany (Wirth et al. 1996), Slovakia (Pišút et al. 2001) and Poland (Cieśliński et al. 2003).

*E. mesomorpha* is a sensitive lichen to air pollution and has been used in laboratory fumigation experiments (e.g. Huebert et al. 1985). However, some North American populations occur close to cities (Brodo et al. 2001) and high concentrations of pollutants have been detected in their thalli (Bennett 1995). Better ecological conditions or presence of different genotypes in North American populations may explain this tolerance to immissions. This lichen has ability to recover after emission reduction (data from the Sudbury area in Canada, see Gunn et al. 1995). Similar reason probably explains surprising finding of young thallus in the Lower Lusatia near Cottbus where *E. mesomorpha* has been found together with further beard lichens *Usnea* spp. in young larch forest (Otte et al. 2006).

Relict pine forests (either bog forests/mires or dry pine forests on rocks) are typical habitats of the former localities in the Czech Republic. The only recent finding from the Czech Republic represents a saxicolous population in a pine forest involving a large, several cm long individual and we suggest, it is rather relict population than a result of a recent migration.

### *Hyperphyscia adglutinata*

This is widespread lichen in both Hemispheres, being distributed in tropical, subtropical as well as temperate regions. In New Zealand, it is the most common follicolous lichen on leaves of garden shrubs with high growth rate of thallus (Green 1997). In Europe, it frequently occurs in oceanic areas, e.g. S and W England (Dobson 2000), in the Mediterranean (e.g. Seminago

2006) and in Balkan countries (Otte 2005; Vondrák, unpublished data). Its northern limit in Europe is reached in southern Sweden and Norway (Moberg 1977; Santesson et al. 2004). In Central Europe, it should be considered as a rare and threatened species: e.g. in the Czech Republic, it is endangered lichen (Liška et al. 2008), critically endangered in Slovakia (Pišút et al. 2001) and extinct in Poland (Cieśliński et al. 2003). The species is generally epiphytic, more rarely occurring on rocks and on exposed nutrient-rich/enriched (e.g. dust-impregnated) substrata (Nimis 1993; Dobson 2000). Interestingly some old as well as recent authors (e.g. Anders 1928; Lynge 1935; Türk & Obermayer 1998; Moberg 2002) do not mention saxicolous occurrence.

Nitrophilous lichens, such as *Hyperphyscia adglutinata*, are recently increasing in Europe. Moreover, *H. adglutinata* is probably tolerant to sulphur dioxide immissions, because it is increasing also in polluted Düsseldorf area (Stapper 2006). Further data on spreading of this species are from the Netherlands (van Herk et al. 2002). Increasing of this species is according these authors influenced by climate change – global warming (see also van Herk et al. 2002; Aptroot & van Herk 2007). However, nutrient demand is also important factor and changes in lichen flora (increasing nitrophytic lichens and decreasing acidophytic lichens) corresponds with eutrophy of environment similarly like changes in flora/vegetation of vascular plants.

In Sweden, it was regarded to be extinct, but it was recently found at three localities (Hultengren & Johansson 1996). In some countries, *H. adglutinata* is reported as a new species to the lichen flora (e.g. Bulgaria, Otte 2005; Israel, Galun 1996; Slovenia, Batič et al. 2003; Tasmania, Kantvilas 1989; countries in SE Asia, cf. Saipunkaew et al. 2005), but these new findings cannot be considered an evidence for spreading. Recent increase of *H. adglutinata* and its new records may be also explained by a minuteness of the species. The inconspicuous lichen could be overlooked in the past, whereas it attracts more attention recently. The effect of this factor on data on previous vs. present distribution of the species in the Czech Republic is difficult to estimate.

Recent localities in the Czech Republic are mainly in river valleys similarly like old localities. Characters of the saxicolous populations are rather relict, not suggesting spreading of the species in present time. In contrary, the increase in abundance of *H. adglutinata* reported from Germany and the Netherlands regards to epiphytic populations. Only Sparrius et al. (2007) reported the species from anthropogenous substrata, such as walls of old churches.

### *Hypotrachyna revoluta*

This is a widely distributed species in temperate to subtropical regions of both Hemispheres. However, in Central Europe, it is threatened lichen, critically endangered in the Czech Republic (Liška et al. 2008) and endangered in Poland (Cieśliński et al. 2003). In the Red

Data Book of the Slovak and Czech Republics (Liška & Pišút 1995), it was included in the category of extinct species. However, it has recently been discovered at two localities in East Slovakia (Guttová 2002) and in an alder swamp forest at Malacky in West Slovakia (Guttová & Pišút 2007); all the recent Slovak records are epiphytic.

It grows on acidic to (more rarely) subneutral bark of deciduous trees (rarely also coniferous trees) in more or less open woodlands (Nimis 1993) and beech forests (Wirth 1995), but it is also locally frequent on rocks and memorials (e.g. Dobson 2000). Some authors (e.g. Kopachevskaya et al. 1971; Nimis 1993) do not mention substrates other than epiphytic. In the Czech Republic, alder bark was the predominant substrate previously. Similarly in Scandinavia, it mainly was recorded from alder, with a bark pH between 4.5 and 5.0 (Almborn 1948). Its ability to compete with other macrolichens, such as *Hypogymnia physodes* and *Parmelia sulcata*, is poor (Almborn 1948). The species is susceptible to environmental changes as demonstrated by Kärnefelt et al. (1990) in the region of Skåne (S Sweden), where its presence at only two of 34 former localities was confirmed. However, other authors found it at a large number of new localities in SW Sweden (Fritz & Hultengren 1998).

*Hypotrachyna revoluta*, similarly as previously discussed species, is presented among epiphytic species with increasing abundances in the Netherlands, as a result of global warming (van Herk et al. 2002; Aptroot & van Herk 2007). However, as in *Hyperphyscia adglutinata*, characters of the Czech populations are different: saxicolous occurrences in river valleys we assume rather relict than recently spread.

A similar species, *Hypotrachyna rockii* (Zahlbr.) Hale, recently recorded in Central Europe (Schumm 2003), can be reliably distinguished by its chemistry only (atranorin, evernic acid and lecanoric acid vs. atranorin and gyrophoric acid in *H. revoluta*). All specimens of recent records from the Czech Republic were confirmed by TLC as *H. revoluta*. European records of *Parmelinopsis afrorevoluta* (Krog & Swinscow) Elix & Hale (e.g. Masson 2005; Clerc 2006; Spier et al. 2007), the closely similar species possessing short marginal cilia (e.g. Divakar et al. 2006), need to be verified by molecular methods (Hawksworth et al. 2008).

#### *Parmotrema perlatum*

This widespread pantemperate species is reported from all continents except Antarctica; in Europe it has a more or less oceanic distribution (Nimis 1993). It usually grows on bark, but occasionally occurs on siliceous rocks, often among mosses.

It is threatened lichen, susceptible to air pollution, and therefore, critically endangered in the Czech Republic (Liška et al. 2008), Slovakia (Pišút et al. 2001) and Poland (Cieśliński et al. 2003). In the Red Data Book of the Slovak and Czech Republics (Liška & Pišút 1995), it is included in the category of extinct species due to the lack of recent records at that time.

*P. perlatum* is also named as increasing lichen dur-

ing last decades in the Netherlands due to global warming (van Herk et al. 2002; Aptroot & van Herk 2007). However, a character of the locality in the Czech Republic, serpentine outcrops in a pine forest, suggests a relict population.

We can conclude that the four treated species were regarded as extinct in the Czech Republic until recently (cf. Liška & Pišút 1995), since there had been no records for a long period. Therefore, the recent records are surprising, more particularly for their occurrence on epipetric substrates. Studied species normally represent predominantly epiphytic lichens with more or less different ecologies and distributions. Circumboreal-montane lichen *Evernia mesomorpha* was probably rare species in the Czech Republic even in history and our localities are on a margin of its distribution area. On the other hand, *Hyperphyscia adglutinata* is species of a large area from tropical to temperate regions and even its ecology (nutrient demand) is different from the other discussed lichens. Whereas *H. revoluta* and *Parmelia perlata* are rather oceanic species, *E. mesomorpha* prefers continental climate. Despite the different ecology, the treated species are similar in their changes in distributions: they vanished or decreased in their abundances on tree barks and they are restricted largely to saxicolous occurrences now. Another special ecological phenomenon shared by all their recently known populations is their predominant occurrence in river or brook valleys. Favourable humid conditions and the buffering capacity of the substrate are perhaps the main factors affecting convenience of this ecological niche; for example, a lower sensitivity to pollutants is well known for lichens growing on rocks rather than on tree bark (e.g. Gilbert 1965).

A relict character of habitats of recent occurrences does not suggest recent spreading as response to global warming, a hypothesis introduced recently by some authors (Insarov et al. 1999; van Herk et al. 2002; Aptroot & van Herk 2007). Occasional saxicolous occurrences of epiphytic species, such as *Heterodermia speciosa*, *Leptogium cyanescens*, *Lobaria amplissima*, *L. scrobiculata*, *Nephromopsis laureri* and *Pannaria conoplea*, were mentioned by Suza (1934b) more than 70 years ago. Mentioned suboceanic species are highly susceptible to environmental changes, especially in Central Europe. Acidification caused by air pollution resulted in a strong decrease or vanishing of the epiphytic occurrences even in areas with background levels of pollution. Substrate acidification may cause in some lichens a switch from conifer bark (with low pH), to the bark of deciduous trees (Liška et al. 1996). Saxicolous occurrences of epiphytic species may represent withdrawal populations surviving when more susceptible epiphytic populations decreased or vanished. They can be important as reserve for a potential spreading under more suitable conditions in the future. Restrictions to saxicolous occurrences of treated species, we interpret as a protection against direct (i.e. toxicity) or indirect (i.e. acidification) stress factors. It is an example of avoid-

ance – a strategy facilitating to avoid negative factor(s).

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