RAZŠIRJENOST LIŠAJEV IZ SKUPINE *LOBARIA* S. LAT. V SLOVENIJI

DISTRIBUTION OF LICHENS FROM THE *LOBARIA* S. LAT. GROUP IN SLOVENIA

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http://dx.doi.org/10.3986/fbg0022

IZVLEČEK

Razširjenost lišajev iz skupine *Lobaria* s. lat. v Sloveniji

V Sloveniji iz skupine *Lobaria* s. lat. zasledimo najdbe petih vrst, in sicer *Lobaria pulmonaria* (L.) Hoffm. in *Lobaria linita* (Ach.) Rabenh., *Lobarina scrobiculata* (Scop.) Nyl. ter *Ricasolia virens* (With.) H.H. Blom. & Tønsberg in *Ricasolia amplissima* (Scop.) De Not. Epifitske vrste iz skupine *Lobaria* s. lat. se pojavljajo v združbi *Lobarion*, ki je zelo občutljiva na gozdarske posege in zračno onesnaženje. Za naštete vrste smo pregledali zgodovinske in sodobne vire, in izrisali njihove karte razširjenosti. Hkrati smo pregledali, na katerih substratih uspevajo ter v katerih habitatih oz. združbah. Preverili smo status teh vrst v bližnjih evropskih državah, kjer je lihenologija bolje razvita. Naštete vrste so v Sloveniji vezane na območja z veliko količino padavin, največ najdb je z območja alpsko-dinarske pregrade. Za vse vrste, razen za navadnega pljučarja (*L. pulmonaria*), smo uspeli najti zelo majhno število navedb. Status populacij vrst ni znan. Izpostavili smo možne dejavnike, ki ogrožajo obstoj vrst iz skupine *Lobaria* s. lat. v Sloveniji.

Ključne besede: lihenizirane glive, epifitski lišaji, karte razširjenosti, *Lobaria*

ABSTRACT

Distribution of lichens from the *Lobaria* s. lat. group in Slovenia

In Slovenia, findings of five species from the *Lobaria* s.lat. group of lichens are recorded, namely *Lobaria pulmonaria* (L.) Hoffm. and *Lobaria linita* (Ach.) Rabenh., *Lobarina scrobiculata* (Scop.) Nyl., *Ricasolia virens* (With.) H. H. Blom. & Tønsberg and *Ricasolia* amplissima (Scop.) De Not. Epiphytic species from the *Lobaria* s. lat. group occur in *Lobarion* community, which is very sensitive to forestry interventions and air pollution. For these species, the historical and contemporary sources were investigated and distribution maps produced. At the same time, it was examined which substrates, habitats and forest communities are preferred by the species. The status of these species in neighbouring lichenologically better developed European countries, was checked. Listed species are related to areas of high mean annual precipitation areas in Slovenia, most of the finds are from the area of the Alpine-Dinaric barrier. For all species except for *L. pulmonaria*, we managed to find a very small number of entries. The status of populations is unknown. The potential factors that threaten the existence of species from the group *Lobaria* s. lat. in Slovenia are highlighted.

Keywords: lichenized fungi, epiphytic lichens, distribution maps, *Lobaria*

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1 UVOD

Lobaria s. lat. je skupina lišajev iz družine Lobariaceae. V družino Lobariaceae spadajo največji lišaji na svetu, ki lahko v premeru dosežejo tudi več decimetrov. Filogenetske raziskave so pokazale, da skupino *Lobaria* s. lat. tvori sedem manjših ločenih skupin, ki so taksonomsko na ravni rodu. Od teh rodov v Sloveniji najdemo tri, in sicer *Lobaria* s. str. z vrstama *L. pulmonaria* (L.) Hoffm. in *L. linita* (Ach.) Rabenh., *Lobarina* z vrsto *L. scrobiculata* (Scop.) Nyl. ter *Ricasolia* z vrstama *R. virens* (With.) H.H. Blom. & Tønsberg in *R. amplissima* (Scop.) De Not. Za rod *Lobaria* s. str. so značilne steljke s satastimi vdolbinami, pri katerih je tomentum razvit v obliki žil med izboklinami na spodnji površini. Spore so kratke in široko vretenaste. Rod *Lobarina* je podoben rodu *Lobaria* s. str. po obliki krp (lobulov), ima pa gostejši tomentum na spodnji površini, med katerimi so bela gladka območja, ki pa se ne ujemajo z mesti izboklin na spodnji površini. Askospore so ozko vretenaste do iglaste in veliko daljše. Za rod *Ricasolia* so značilne steljke z gladkimi krpami ter enakomeren tomentum po celotni spodnji površini. Rodovi se razlikujejo tudi po vsebnosti lišajskih snovi (Moncada s sod. 2013).

Epifitske vrste iz skupine *Lobaria* s. lat. se pojavljajo v združbah iz zveze *Lobarion*, ki so glavne epifitske lišajske klimaksne združbe gozdnega drevja na območju Evrope. Poleg vrst iz skupine *Lobaria* s. lat. te združbe gradijo tudi velike listaste vrste iz rodov *Sticta* in *Pseudocyphellaria*, manjši listasti lišaji iz rodov *Parmeliella*, *Pannaria*, *Nephroma*, *Peltigera* in *Parmelia*, številni skorjasti lišaji ter mahovi. Združbe iz zveze *Lobarion* niso vedno izključno epifitske, lahko se pojavljajo tudi na skalovju. Najbolj značilna in stalna vrsta združb je vrsta *L. pulmonaria*. Bogat herbarijski material ter notice v lokalnih naravoslovnih revijah potrjujejo nekdanjo široko razširjenost združb iz zveze *Lobarion* v večini Zahodne Evrope, kjer so imele oceansko-montanski značaj (Rose 1988).

Zgodovinski podatki kažejo, da so druge vrste iz združb zveze *Lobarion* upadle celo bolj drastično kot sama *L. pulmonaria*, posebno rodovi s cianobakterijskimi fotobionti, kot so *Collema*, *Leptogium*, *Nephroma*, *Pannaria*, *Parmeliella* in *Sticta* ter tudi vrsta *L. scrobiculata* (Rose 1988).

Vzroki za propadanje združb iz zveze *Lobarion* so spremembe v načinu gospodarjenja z gozdovi (npr. zamenjava listnatih vrst z iglastimi, vzdrževanje gostih sestojev brez osončenih vrzeli, selektivna sečnja dreves, ki merijo v premeru 30-40 cm, prekratka obhodna doba sečnje) (Gauslaa 1995, Rose 1988). Sprememba zgradbe gozda v smislu fragmentacije lahko vpliva na epifitske vrste z lokalnimi spremembami klime ter z vplivom na učinkovitost razširjanja med ustreznimi gozdnimi fragmenti (Ellis & Coppins 2007). V drugi polovici 20. stoletja so združbe iz zveze *Lobarion* propadale tudi zaradi onesnaženja z žveplovim dioksidom (Gauslaa 1995, Rose 1988).

2 MATERIAL IN METODE

Zbrani so bili podatki za vse vrste iz skupine *Lobaria* s. lat., za katere obstaja kakršnakoli informacija o njihovem pojavljanju na območju Slovenije: *Lobaria pulmonaria*, *L. linita*, *Lobarina scrobiculata*, *Ricasolia amplissima* (vključujoč »*Dendriscocaulon umhausense*«) ter *R. virens*. Nomenklatura je povzeta po Nimisu (2016), kratki opisi ob slikah pa po Wirthu (1995). Podatke smo zbrali s pomočjo Kataloga lihenizirani in lihenikolnih gliv Slovenije (Suppan s sod. 2000), podatkovne zbirke Boletus informaticus (Ogris 2008) ter objavljenih popisov lišajev oz. omemb navedenih vrst za območje Slovenije v literaturi. Za vse navedbe smo izpisali lokacijo pojavljanja, nadmorsko višino, substrat, na katerem je bila lišajska vrsta zabeležena, ter podatke o habitatih ali združbah, v katerih je bila vrsta najdena, v kolikor so bili ti podatki navedeni. Kjer so bile gozdne združbe poimenovane z neveljavnimi imeni, smo poiskali veljavna imena s pomočjo literature (Kutnar s sod. 2012, Šilc & Čarni 2012). Lokacije pojavljanja smo izrisali v obliki karte razširjenosti na MTB mreži. Znotraj vsakega MTB kvadranta, v katerem je bila vrsta zabeležena, je lahko več lokacij pojavljanja. Posebej smo izrisali podatke za obdobje pred letom 1950 in po njem. Pri virih izpred leta 1950 so podatki o nahajališčih zelo skopi, zato smo vrisali približne lokacije. Npr. če vir navaja, da se lišaj pojavlja v okolici Idrije, smo poiskali, v kateri MTB kvadrant spada mesto Idrija. Pri vrsti *L. pulmonaria* je bilo v nekaterih primerih nahajališče podano tako široko, da ga ni bilo mogoče vrisati v karto. Kot avtorji kart razširjenosti so navedeni določitelji vrst (po abecednem redu), v kolikor ta podatek ni znan, pa avtorji vira, v katerem je najdba objavljena.

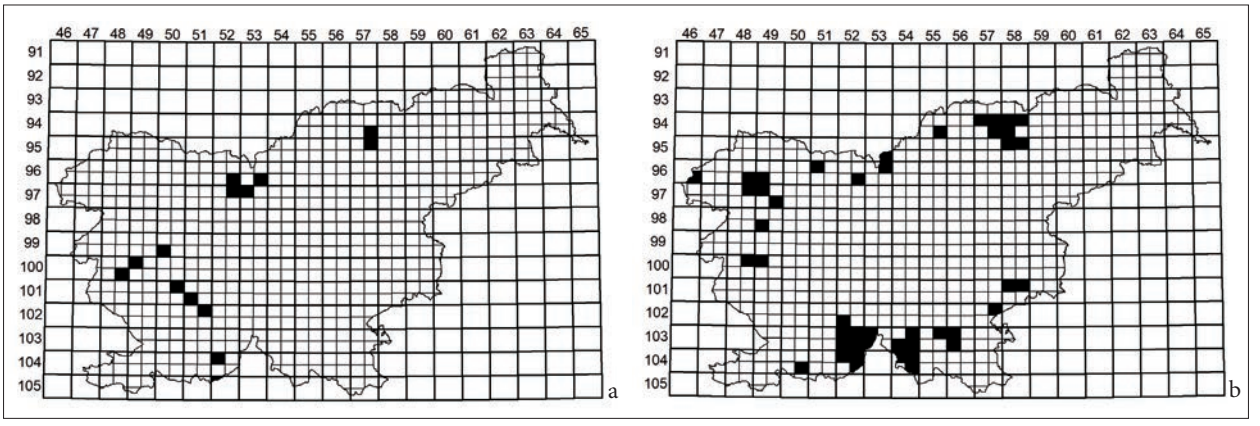
3 IZSLEDKI

3.1 *Lobaria pulmonaria* (L.) Hoffm.

V Sloveniji je bila vrsta po letu 1950 zabeležena 158x, največkrat na gorskem javorju (46,8 %), sledila je bukev (15,2 %), na ostalih podlagah se je pojavljala v manj kot 5 % (*Ulmus glabra*, *Fraxinus excelsior* > *Abies alba* > *Picea abies*, *Tilia* sp. > *Quercus* sp. > *Coryllus avellana* > *Juglans regia*, *Pyrus communis*, *Salix caprea*, *Sorbus*

Slika 1: Lobaria pulmonaria; navadni pljučar – steljka je v navlaženem stanju intenzivno zelena (zgoraj), saj je primarni fotobiont zelena alga, v posušenem stanju pa olivno zelena do rjava (spodaj levo). Zgornja stran steljke je mrežasto-vdolbinasta, z razvitimi sorali in/ali izidiji, občasno tudi z apoteciji (razvidni na sliki zgoraj). Spodnji del prekriva temno rjav tomentum, ki se razrašča na izboklinah v obliki žil, proti robu prehaja v svetlo rjavo barvo (spodaj desno).
Figure 1: Lobaria pulmonaria; tree lungworth, lung lichen – thallus in wet condition intensively green (above), as primary photobiont is green algae, and olive-green to brown in dry condition (below to the left). Upper side of the thallus with the comb-like structure, with soralia and/or isidia, apothecia infrequent (visible on picture above). Lower side of the thallus covered by dark brown tomentum on vein like ridges, getting light brown towards the edges.

aucuparia, *Populus tremula*). V 12,7 % je bila podlaga nedefinirana. Uspeva na skorji, dnišču debla, mahovih na deblu, mahovih na dnišču debla, mahovih na lesu, štorih, skalah. Najdemo jo predvsem v bukovih gozdovih (*Omphalodo-Fagetum* (Tregubov 1957) Marinček et al. 1993, *Anemono trifoliae-Fagetum* Tregubov 1962, *Ranunculo platanifoli-Fagetum* Marinček et al. 1993, *Polysticho lonchitis-Fagetum* (Horvat 1938) Marinček in Poldini et Nardini 1993, *Stellario montanae-Fagetum* (Zupančič 1969) Marinček et al. 1993, mešanih listnatih gozdovih, smrekovih gozdovih s primesjo listavcev (*Hacquetio-Piceetum* Zupančič (1980) 1999, *Lonicero ceruleae-Piceetum* Zupančič (1976) 1994, *Stellario montanae-Piceetum* Zupančič (1980) 1999, *Adenostylo glabrae-Piceetum* M. Wraber ex Zukrigl 1973), na gozdnih robovih, na gozdnih jasah z osamelimi drevesi in na osamelih drevesih v zaselkih.



Slika 2: Karta razširjenosti vrste Lobaria pulmonaria v Sloveniji: (a) pred letom 1950 (Arnold F., Biasoletto B., Glowacki J., Kernstock E., Lämmermayr L., Pötsch J.S., Schuler J., Scopoli I.A.) (b) po letu 1950 (Arup U., Batič F., Bilovitz P., Christensen S.N., Grube M., Koch M., Kruhar B., Mayrhofer H., Mrak T., Primožič K., Prügger J., Suppan U., Surina B.)
Figure 2: Distribution map of Lobaria pulmonaria in Slovenia: (a) before 1950 (Arnold F., Biasoletto B., Glowacki J., Kernstock E., Lämmermayr L., Pötsch J.S., Schuler J., Scopoli I.A.) (b) after 1950 (Arup U., Batič F., Bilovitz P., Grube M., Koch M., Kruhar B., Mayrhofer H., Mrak T., Primožič K., Prügger J., Suppan U., Surina B.)

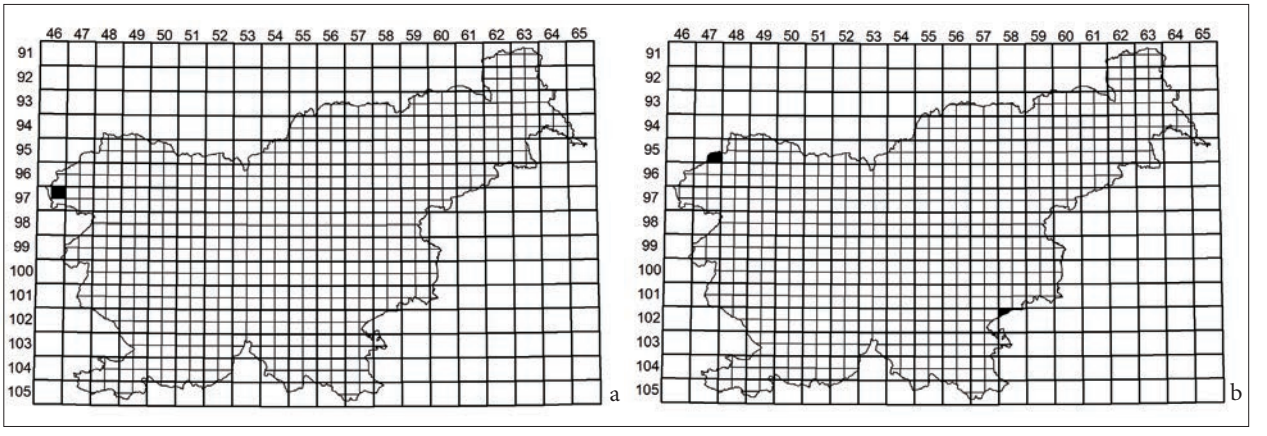
Karta razširjenosti vrste *L. pulmonaria* kaže, da je tudi vrsta vezana na območja z večjo količino padavin, v nasprotju z ostalimi epifitskimi vrstami iz skupine *Lobaria* s. lat. pa jo najdemo tudi na Pohorju. Od vseh vrst iz skupine *Lobaria* s. lat. je tudi najbolj razširjena. Najmanjša nadmorska višina, na kateri je bila vrsta zabeležena je bila 150 m (Krakovski gozd), največja pa 1460 m v Julijskih Alpah.

Vrsta je še prisotna na večini območij, kjer se je pojavljala tudi v preteklosti oz. je bila najdena na območjih, ki v preteklosti niso bila lihenološko raziskana. Historična navedba z Javornikov ni bila ponovno potrjena. Historični viri so jo navajali kot pogosto, npr. Glowacki & Arnold (1871): »posebno v okolici Idrije pogosta«. V nekaterih predelih Slovenije (npr. območje Snežnika) je status vrste še vedno zadovoljiv, steljke so velike in zdrave, na mnogih nahajališčih pa najdemo samo po par primerkov ali celo eno samo steljko, steljke pa so slabo razvite ali poškodovane.

3.2 *Lobaria linita* (Ach.) Rabenh.

V celotni zgodovini lihenoloških raziskav vemo na Slovenskem samo za tri najdbe (Glowacki 1874, Hočevar s sod. 1985, priprave na BLAM ekskurzijo l. 2003 - neobjavljeno), od tega je ena (Hočevar s sod. 1985) dvomljiva. Pri tej najdbi gre verjetno za mlado steljko vrste *L. pulmonaria*, ki še nima razvitih soralov in/ali izidijev (Suppan s sod. 2000). Obe zanesljivi najdbi izvirata iz gora v okolici Bovca (nad gozdno mejo), kjer med apnencem najdemo silikatne vložke. Najdba iz leta 2003 je z nadmorske višine 1880 m. Glede na to, da gre za vrsto, ki običajno uspeva nad gozdno mejo na svežih, kislih humoznih tleh, na mahovih, med silikatnimi skalnatimi bloki (Wirth 1995), je v Sloveniji je možnih rastišč vrste *L. linita* malo, saj zaradi prevlade karbonatnih kamnin primanjkuje substratov zanjo. Poznavanje lišajske flore nad gozdno mejo je v Sloveniji izjemno slabo, tako da ne poznamo njene dejanske pogostnosti ter velikosti populacij. Poleg tega so steljke na alpskih tratah izjemno težko

Slika 3: Lobaria linita; mali pljučar – steljka mrežasto nagubana, zeleno-rjave barve, v navlaženem stanju intenzivneje zelena (primarni fotobiont je zelena alga), brez soralov in izidijev. Apoteciji se pojavljajo redko. Tomentum svetlo rjav, prisoten med izboklinami na spodnjem delu steljke.
Figure 3: Lobaria linita; cabbage lung lichen – thallus with net-like structure of ridges, greenish-brown, intensively green when wet (primary photobiont is green algae), without soralia or isidia. Apothecia rarely present. Tomentum of light brown colour, developed between protrusions on the lower side of the thallus.



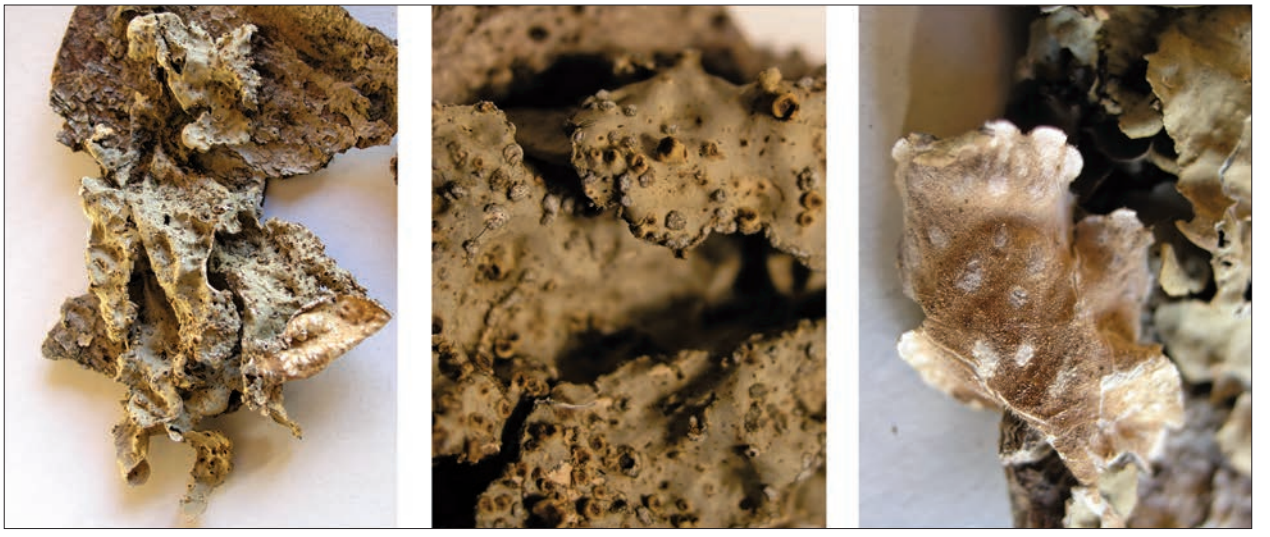
Slika 4: Razširjenost vrste Lobaria linita v Sloveniji: a) pred letom 1950 (Glowacki J.) in b) po letu 1950 (Batič F., Mayrhofer H.)
Figure 4: Distribution of Lobaria linita in Slovenia: a) before 1950 (Glowacki J.) and b) after 1950 (Batič F., Mayrhofer H.)

opazne, sploh v suhem stanju. Glede na pogostnost silikatnih kamnin nad gozdno mejo v slovenskem prostoru lahko domnevamo, da je zelo redka ter da so populacije zelo majhne.

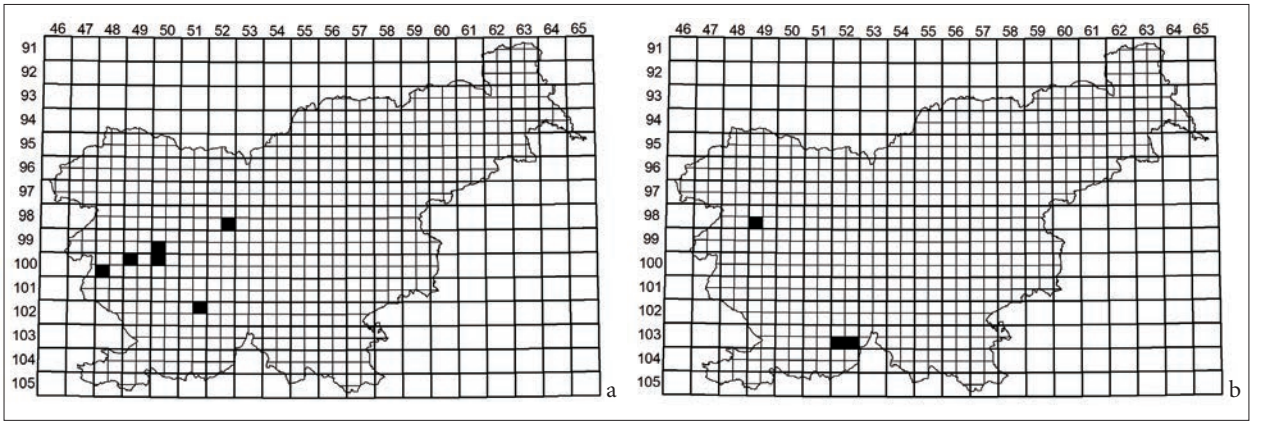
3.3 *Lobarina scrobiculata* (Scop.) Nyl.

Vrsto je prvi opisal Scopoli v svojem delu Flora Carniolica iz leta 1772 pod imenom *Lichen scrobiculatus*, in sicer iz okolice Idrije. Tipski Scopolijev material je izgubljen, zato so za lektotip izbrali primerek, ki odgovarja Dilleniusovemu opisu (Lichenoides pulmoneum villosum, superficie scrobiculata et peltata) in ilustraciji »Lichenoides no. 114« v delu Historia Muscorum iz leta 1741 (navaja ju že Scopoli), in je shranjen v oxfordskem herbariju (Yoshimura & Isoviita 1969).

Število najdb vrste *L. scrobiculata* je majhno tako pred letom 1950, kot tudi po njem. Najdbe po l. 1950 so zabeležene na substratih: *Ulmus glabra*, *Acer pseudoplatanus*, *Populus tremula* ter *Quercus robur*, historični viri poleg hrasta navajajo tudi vrsti *Fagus sylvatica* in *Abies alba*. Uspeva na deblih ali dniščih debla. Podatki o habitatih, kjer se vrsta pojavlja v Sloveniji, so zelo skopi. Vrsta naj bi uspevala v mešanih listopadnih gozdovih in na osamelih drevesih. Zabeležena je bila na nadmorskih višinah med 600 in 880 m.



Slika 5: Lobarina scrobiculata; sivi pljučar - steljka plitvo vdolbinasta, svetlo zeleno-siva, v navlaženem stanju svinčeno siva, saj so primarni fotobiont cianobakterije. V herbariju postane bledo rumene ali sivo-rumene barve (slika levo). Na površini s točkastimi sivo obarvani sorali, ki se med seboj združujejo, na robovih pa so sorali črtalasti (slika v sredini). Izidijev ni. Apoteciji so zelo redko razviti. Tomentum s posameznimi majhnimi belimi golimi mesti (slika desno), na robovih svetlo rjav, v sredini temno rjav.
Figure 5: Lobarina scrobiculata; textured lungworth - thalli with shallow indentations, pale green-grey, lead grey when wet (primary photobiont cyanobacteria). In herbarium, colour changes to pale yellow or grey-yellow (figure to the left). With roundish grey coloured soralia on the surface, which are getting confluent, and edge soralia (figure in the middle). Isidia are not developed. Apothecia rarely developed. Lower side with distinct small tomentum-free spots of white colour (figure to the right). Tomentum light brown on edges and dark brown in the middle.



Slika 6: Razširjenost vrste Lobarina scrobiculata v Sloveniji: a) pred letom 1950 (Arnold F., Dolšak F. Glowacki J., Pötsch J.S., Scopoli I.A.), in b) po letu 1950 (Batič F., Mayrhofer H., Primožič K., Prügger J., Suppan U.).
Figure 6: Distribution map of Lobarina scrobiculata in Slovenia: a) before 1950 (Arnold F., Dolšak F. Glowacki J., Pötsch J.S., Scopoli I.A.) and b) after 1950 (Batič F., Mayrhofer H., Primožič K., Prügger J., Suppan U.).

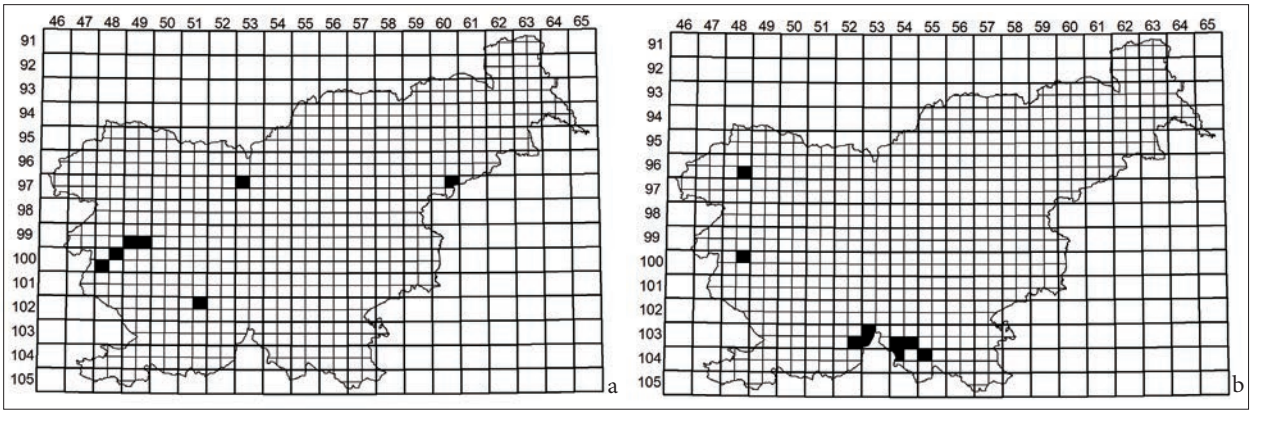
Razširjenost vrste se ujema z območji največje količine padavin na padavinski karti Slovenije. Nekatera območja, kjer bi vrsto lahko pričakovali glede na veliko količino padavin, bodisi niso bila nikoli v zadostni meri raziskana (npr. Kamniško-Savinjske Alpe, Karavanke) bodisi so bila podvržena korenitim gozdarskim posegom (npr. Pohorje). V Panovcu, okolici Idrije in Medvod, na Javornikih in Trnovskem gozdu po letu 1950 *L. scrobiculata* ni bila več najdena, kljub temu, da so na tem območju potekale intenzivne raziskave lišajske flore. Štiri od petih najdb po letu 1950 so z območja Snežnika.

3.4 *Ricasolia amplissima* (Scop.) De Not. & »Dendriscocaulon umhausense«

Pri vrsti *R. amplissima* naletimo na taksonomsko in nomenklaturno težavo. »Cefalodiji« te vrste namreč lahko uspevajo samostojno in so bili obravnavani kot samostojen takson z imenom *Dendriscocaulon umhausense* (Auersw.) Degel. Pogosto jih najdemo skupaj z listasto obliko na istem rastišču. Z molekularnimi raziskavami so dokazali, da »*Dendriscocaulon umhausense*« gradi ista gliva kot listasto obliko z zelenim primarnim fotobiontom. Ker lišaj nosi ime po glivi, dveh imen preprosto ne more biti, saj oba rastna tipa gradi ista gliva. Za poimenovanje cianobakterijske različice je predlagano citiranje nepravilnega imena v narekovajih: »*Dendriscocaulon umhausense*« ali pa dodajanje pridevka cyan. ali chlor. za nomenklaturno pravilnim imenom, npr. *R. amplissima* cyan., kar nam prav tako poda informacijo o rastni obliki (Jorgensen 1998).

Kot podlage *R. amplissima* so po letu 1950 zabeležene naslednje drevesne vrste: *Ulmus glabra* > *Acer pseudoplatanus* > *Fagus sylvatica*, *Pyrus communis*, v

Slika 7: Ricasolia amplissima; bledi pljučar - Lobuli so gladki do valoviti (niso mrežasto nagubani). Primarni fotobiont je zelena alga. Zgornja površina je svetlo siva, v navlaženem stanju zeleno-siva; v herbariju postane svetlo rjava (slika levo). Izidiji in soral niso razviti, apoteciji pa so razmeroma pogosti. Skoraj vedno so prisotni 0,2-1 cm veliki olivno rjavi do črni zunanji grmičasti cefalodiji (desno). Tomentum je rjav, enakomerno razporejen.
Figure 7: Ricasolia amplissima – Thalli with smooth to wavy lobules (not with net-like ridges). Primary photobiont green algae. Upper surface pale grey when dry and green-grey when wet; light brown in herbarium (to the left). Isidia and soralia developed, apothecia relatively common. Upper surface with 0.2-1 cm olive brown to black external ramified cephalodia (to the right). Tomentum brown, even.



Slika 8: Razširjenost vrste Ricasolia amplissima v Sloveniji pred (Arnold F., Glowacki J., Lettau G., Pötsch J.S., Scopoli I.A., Suza J., Zahlbruckner A.) in po letu 1950 (Arup U., Batič F., Grube M., Mayrhofer H., Mrak T., Prügger J., Spribille T., Surina B.).
Figure 8: Distribution of Ricasolia amplissima in Slovenia before (Arnold F., Glowacki J., Lettau G., Pötsch J.S., Scopoli I.A., Suza J., Zahlbruckner A.) and after 1950 (Arup U., Batič F., Grube M., Mayrhofer H., Mrak T., Prügger J., Spribille T., Surina B.).

Slika 9: Ricasolia virens; zelenkasti pljučar – Temno olivno rjava do zeleno-siva, v namočenem stanju zelena. Herbarijski material je svetlo rjave barve. Primarni fotobiont je zelena alga. Zgornja površina gladka, starejši deli rahlo nagubani. V sredini steljke primarni lobuli pogosto tvorijo majhne sekundarne lobule, ki se medsebojno prekrivajo. Spodnji del steljke svetlo rjav z zelo kratkim tomentumom. Apoteciji razviti na lamini steljke.
Figure 9: Ricasolia virens – Thallus dark olive brown to green-grey; green when wet. Herbarium material light brown. Primary photobiont green algae. Upper surface smooth, older parts slightly wrinkled. In the middle of the thallus, primary lobules often form small secondary lobules which are overlapping. Lower part of the thallus light yellow-brown with very short tomentum. Apothecia developed on thallus lamina.

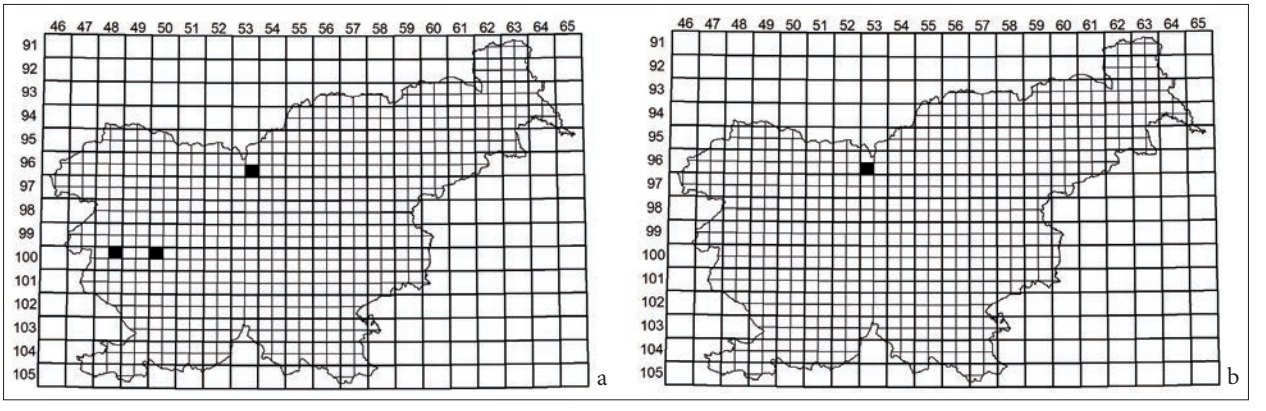
nekaterih primerih podatka o podlagi ni. V preteklosti so kot podlage omenjeni tudi *Abies alba*, *Castanea sativa*, *Quercus* sp., *Picea abies* ter iglavci. Uspeva na drevesni skorji ali na lesu, na gozdnih robovih, gozdnih jasah z osamelimi listavci, prostostoječih drevesih na območjih, kjer je gospodarska raba omejena na košnjo in krmljenje divjadi (Prügger 2005), mešanih gozdovih. Zabeležena je bila na nadmorskih višinah med 720 m (Babno polje) ter 1400 m (Julijske Alpe).

Razširjenost vrste (razen historičnega nahajališča na Donački gori) se ujema z območji največje količine padavin. Nekatera območja, kjer bi vrsto lahko pričakovali glede na veliko količino padavin, bodisi z lihenološkega vidika niso bila nikoli v zadostni meri raziskana (npr. Kamniško-Savinjske Alpe, Karavanke) bodisi so bila v preteklosti podvržena korenitim gozdarskim posegom (npr. Pohorje). Po letu 1950 je znanih dvanajst najdb. Raziskave lišajske flore v 90. letih 20. stol. in začetku 21. stol. so pokazale, da vrsta *R. amplissima* ne uspeva več na območju Panovca, Javornikov, Trnovskega gozda, Šenturške in Donačke gore. Za Panovec že Glowacki (1871), navaja, da je vrsta zelo redka. V Julijskih Alpah, za katere ni historičnih zapisov, ki bi poročali o tej vrsti, je bil po letu 1950 najden samo en primerek. Vsi ostali primerki so bili najdeni na Snežniku ali Goteniški gori.

3.5 *Ricasolia virens* (With.) H.H. Blom. & Tønsberg

V Sloveniji je bila vrsta *R. virens* najdena na drevesnih vrstah *Abies alba* in *Fagus sylvatica*. Podatkov o habitatih ali gozdnih združbah, v katerih se pojavlja, ni.

Za Slovenijo obstaja samo pet historičnih navedb o pojavljanju vrste *L. virens*, od tega je ena neobjavljena (herbarij F. Dolšak). Po letu 1950 je navedba samo ena, vendar potrjuje širše območje pojavljanja v preteklosti. Glede na to, da naj bi bila *R. virens* vrsta zmernega pasu z blago klimo ter vlažnih subtropskih predelov (Wirth 1995), je zanimivo, da se te navedbe nanašajo na območje Kamniško-Savinjskih Alp. Ker je v ostalih območjih, ki bi glede na ohranjenost gozdnih ekosistemov in količino padavin lahko bile potencialni habitat vrste, novejše lihenološke raziskave niso zabeležile, je v Sloveniji verjetno blizu izumrtja oz. je že izumrla.



Slika 10: Karta razširjenosti vrste Ricasolia virens v Sloveniji pred (Arnold F., Degelius G., Dolšak F., Glowacki J.) in po letu 1950 (Batič F.).
Figure 10: Distribution of Ricasolia virens before (Arnold F., Degelius G., Dolšak F., Glowacki J.), and after 1950 (Batič F.) in Slovenia.

4 RAZPRAVA

Vrste iz skupine *Lobaria* s. lat. so v Sloveniji večinoma omejene na območje z veliko količino padavin (alpsko-dinarska pregrada, Pohorje). Nekateri predeli Slovenije, kjer bi bile klimatske razmere lahko ustrezne za vrste iz skupine *Lobaria* s. lat. (Kamniško-Savinjske Alpe, Karavanke) lihenološko še vedno niso v zadostni meri raziskani. Na Pohorju je bila zabeležena samo vrsta *L. pulmonaria*, kar je najverjetneje povezano s korenitimi gozdarskimi posegi v preteklosti. Za območja pojavljanja velikosti populacij večinoma niso poznane, v nekaterih primerih pa gre za najdbo samo ene lišajske steljke oz. so steljke slabo razvite ali poškodo-

vane, nobenega podatka pa ni o genski pestrosti, razen za dve lokaciji vrste *L. pulmonaria*, ki so bile zajete v raziskavo Scheideggerja s sod. (2012). V tej raziskavi so ugotovili, da sta slovenski populaciji v Rajhenavskem Rogu in Notranjskem Snežniku mešani saj sta vsebovali gene iz dveh različnih genetskih bazenov, kar prispeva k večji genetski pestrosti. Majhne populacije so ne glede na genetsko pestrost močno ogrožene, saj jih lahko uniči že en sam katastrofični dogodek (Zoller s sod. 1999). Sicer je Zoller s sod. (1999) na švicarskih populacijah vrste *L. pulmonaria* ugotovil, da genetska pestrost in velikost populacije nista povezani. Večjo genetsko pestrost so zasledili v populacijah, kjer se je glivni simbiont razmnoževal spolno. Vendar pa je za vrsto *L. pulmonaria* znano, da naj bi bil delež spolnega razmnoževanja še manjši od 30 % (dal Grande s sod. 2012), po nekaterih podatki pa še precej manj (Scheidegger s sod. 2012). Tudi v primerih, ko so apoteciji razviti, so pogosto okuženi z glivnim parazitom in nefunkcionalni (Jordan 1973). Poleg vrste *L. pulmonaria* naj bi se tudi vrsti *L. scrobiculata* in *L. linita* razmnoževali predvsem vegetativno (Nimis 2016). Za vrsto *L. pulmonaria* so ugotovili, da se njene vegetativne propagule lahko razširjajo le na kratke razdalje, identične genotipe so ugotovili le na največ 230 m oddaljenosti med seboj (Walser 2004). Pri populacijah, ki se razmnožujejo le vegetativno, ob fragmentaciji habitatov torej zelo hitro lahko pride do stanja, kjer se sosednji fragmenti ne morejo kolonizirati, kljub temu, da so razmere za uspevanje vrste tam ugodne. Za vrsto *L. pulmonaria* je bilo ugotovljeno, da celo blago gospodarjenje z gozdovi znatno zmanjšajo genetsko pestrost, še preden se pojavijo spremembe v pogostnosti vrste, kar naj bi bilo povezano ravno s fragmentacijo populacije v več manjših prostorsko izoliranih populacij, zaradi česar se prostorsko mešanje genotipov zmanjša (Scheidegger s sod. 2012). Podobno je tudi v primeru, ko vrsta naseljuje prosto stoječa, osamela drevesa. Ker se kulturna krajina s prosto stoječimi osamelimi drevesi ne vzdržuje več, v bližini ni novih ustreznih substratov za kolonizacijo. Za lokacijo vrste *L. amplissima*, kjer je vrsta uspevala na gorskem brestu, je bilo ugotovljeno, da so prav vsa drevesa, ki jih je bilo 15, v letih 2006-2009 odmrla zaradi okužbe z glivo *Ophiostoma novo-ulmi* (Obermayer 2011), s tem pa tudi vrsta *L. amplissima* na tej lokaciji. Vrste iz skupine *Lobaria* s. lat. ogroža tudi intenziviranje kmetijstva s povečanim vnosom dušikovih spojin, saj vrste bodisi ne prenesejo evtrofikacije ali pa le v majhni meri (*L. amplissima* in *L. pulmonaria*; Wirth 1995, Nimis 2016), pa tudi zaraščanje, saj za uspevanje potrebujejo večinoma zadostno količino difuzne svetlobe (Nimis 2016). Ker so vrste higrofilne, jih lahko prizadene tudi lokalno zmanjšana vlažnost zaradi gozdarskih posegov. Vrsta *L. linita*, za katero je potencialnih habitatov v Sloveniji zelo malo, bi bila lahko prizadeta zaradi globalnega segrevanja ozračja, saj gre za arktično-alpsko vrsto, daljinskega onesnaženja z dušikovimi spojinami ter uničevanja habitatov zaradi športnih dejavnosti v gorah. Glede na navedeno ni presenetljivo, da so v številnih evropskih državah vrste iz rodu *Lobaria* umeščene na rdeči seznam ogroženih vrst. V Italiji imajo vrste *R. amplissima*, *L. virens* in *L. scrobiculata* status potencialno ogrožene vrste, *L. pulmonaria* pa status najmanj ogrožene vrste (Nimis 2016). V Nemčiji je vrsta *L. virens* veljala za izumrlo, a so pred cca. desetletjem odkrili eno lokacijo, kjer se je ohranila (Fischer & Killman 2008), tudi v Švici velja za izumrlo (Scheidegger s sod. 2002), v Avstriji pa se ne pojavlja (H. Mayrhofer, os. komunikacija). *R. amplissima* je v Avstriji zelo redka, prav tako *L. scrobiculata*. *R. amplissima* in *L. scrobiculata* sta v Švici ogroženi (Scheidegger s sod. 2002). *L. pulmonaria* velja za ranljivo vrsto v Švici (Scheidegger s sod. 2002). O terikolnih vrstah (*L. linita*) je podatkov manj, Scheidegger s sod. 2002 jo opredeljuje kot vrsto zunaj nevarnosti, kar gre na račun velike površine, ki ga v Švici zavzemajo kristalinske Alpe. V Italiji je vrsta odsotna povsod, razen v alpski in predalpski regiji, kjer velja za zelo do ekstremno redko (Nimis 2016).

ZAHVALA

Članek je nastal v okviru raziskovalnega programa št. P4-0107, ki ga sofinancira Javna agencija za raziskovalno dejavnost Republike Slovenije iz državnega proračuna, vodi pa prof. dr. Hojka Kraigher. Najlepše se zahvaljujem dr. Nikici Ogris (Gozdarski inštitut Slovenije) za izdelavo kart razširjenosti, dr. Aleksandru Marinšku (Gozdarski inštitut Slovenije) za pomoč pri iskanju veljavnih imen gozdnih združb ter prof. dr. Helmutu Mayrhoferju (Karl-Franzens Universität, Graz) za podatke o novejših omembah vrst iz skupine *Lobaria* s. lat. v literaturi za območje Slovenije.

SUMMARY

5 INTRODUCTION

Lobaria s. lat. is a group of lichens from Lobariaceae family. Lobariaceae family includes some of the largest lichens in the world that can reach several decimetres in diameter. Phylogenetic studies have shown that the group *Lobaria* s. lat. is formed from seven distinct groups that were given the genus level. Of these genera, three are found in Slovenia, namely *Lobaria* s. str. with species *L. pulmonaria* (L.) Hoffm. and *L. linita* (Ach.) Rabenh., *Lobarina* with *L. scrobiculata* (Scop.) Nyl. and *Ricasolia* with *R. virens* (With.) H. H. Blom. & Tønsberg and *R. amplissima* (Scop.) De Not. *Lobaria* s. str. is characterized by thalli with a honeycomb structure where tomentum is developed in the form of veins between the protrusions on the lower surface. Spores are short and broadly fusiform. Genus *Lobarina* is similar to genus *Lobaria* s. str. in the shape of lobes, but has a dense tomentum on the lower surface, leaving out smooth circular white areas that do not match with the position of protrusions on the lower surface. Ascospores are narrowly fusiform to acicular and much longer than in *Lobaria* s. str. For genus *Ricasolia*, plane lobe surface with smooth and uniform tomentum on the lower side is characteristic. Genera also differ in the content of lichen substances (Moncada et al. 2013).

Epiphytic species from the group *Lobaria* s. lat. form a *Lobarion* alliance, which communities are the main lichen climax communities of forest trees in Europe. In addition to species of *Lobaria* s. lat. group, large foliose species from *Sticta* and *Pseudocyphellaria* genera are present in these communities, as well as smaller foliose lichens from *Parmeliella*, *Pannaria*, *Nephroma*, *Peltigera* and *Parmelia* genera, and many crustose lichens and mosses. Communities from the *Lobarion* alliance are not always exclusively epiphytic and may also occur on rocks. The most significant and permanent species in communities of the *Lobarion* alliance is *L. pulmonaria*. A rich herbarium material and notices in the local scientific journals confirmed the former wide prevalence of *Lobarion* communities in most of Western Europe, where they had an oceanic-montane character (Rose 1988).

Historical data show that other species of *Lobarion* alliance declined even drastically than *L. pulmonaria* itself, specifically genera with cyanobacterial fotobionts, such as *Collema*, *Leptogium*, *Nephroma*, *Pannaria*, *Parmeliella* and *Sticta*, as well as *L. scrobiculata* (Rose 1988).

The causes for decline of communities from the *Lobarion* alliance are changes in forest management (eg. the replacement of deciduous for coniferous species, maintenance of dense stands with no forest gaps, selective logging of trees, which measure 30-40 cm in diameter, too short rotation period) (Gauslaa 1995, Rose 1988). Changes in the structure of the forest in terms of fragmentation can affect the epiphytic lichen species due to local climate changes and due to impact on the effectiveness of dispersion between the respective forest fragments (Ellis & Coppins 2007). In the second half of the 20th century, strong decline in communities from the *Lobarion* alliance was observed due sulphur dioxide pollution (Gauslaa 1995, Rose 1988).

6 MATERIAL AND METHODS

Data for all species from *Lobaria* s. lat. group, for which there is any information about their occurrence in Slovenia, were collected: *Lobaria pulmonaria*, *L. linita*, *Lobarina scrobiculata*, *Ricasolia amplissima* (including "*Dendriscocaulon umhausense*") and *R. virens*. The nomenclature is following Nimis (2016). Short descriptions accompanying figures are based on Wirth (1995). Data were collected with the help of Catalogue of the lichenized and lichenicolous fungi of Slovenia (Suppan et al. 2000), Boletus informaticus database (Ogris 2008) and published inventories of lichen or references of those species for the territory of Slovenia in the literature. For each reference, the following information was gathered, where available: location, altitude, the substrate on which the lichen species was recorded and habitat or community where the species was found. Invalid names of forest communities were substituted with corresponding valid names according to Kutnar et al. (2012) and Šilc & Čarni (2012). Locations were translated into MTB network distribution maps. Within each MTB quadrant, where the species was recorded, there might be several locations included. Data for the period before and after 1950 were mapped separately. For the period before 1950, data for locations were very scarce, therefore only approximate locations could have been drawn, eg. if it was referred

that the lichen was occurring in the vicinity of Idrija, the MTB quadrant was assigned to the town of Idrija. In the case of *L. pulmonaria*, sometimes the location was given so widely that it was not possible to plot it. As authors of distribution maps, determinators of lichens are given in alphabetical order. Where information on determinator was not known, author of the reference was given.

7 RESULTS

7.1 *Lobaria pulmonaria* (L.) Hoffm.

After 1950, there were 158 records for *L. pulmonaria* in Slovenia, in 46.8 % it was reported from *Acer pseudoplatanus*, followed by *Fagus sylvatica* (15.2 %). Other substrates were occurring in less than 5 % (*Ulmus glabra*, *Fraxinus excelsior* > *Abies alba* > *Picea abies*, *Tilia* sp. > *Quercus* sp. > *Coryllus avellana* > *Juglans regia*, *Pyrus communis*, *Salix caprea*, *Sorbus aucuparia*, *Populus tremula*). In 12.7 % of cases, the substratum was not defined. The species was growing on bark, tree bases, mosses on trunks and trunk bases, mosses on wood, stumps and rocks. It is reported mainly from beech forests (*Omphalodo-Fagetum* (Tregubov 1957) Marinček et al. 1993, *Anemono trifoliae-Fagetum* Tregubov 1962, *Ranunculo platanifoli-Fagetum* Marinček et al. 1993, *Polysticho lonchitis-Fagetum* (Horvat 1938) Marinček in Poldini et Nardini 1993, *Stellario montanae-Fagetum* (Zupančič 1969) Marinček et al. 1993), mixed broadleaved forests, spruce forests with admixed broadleaved trees (*Hacquetio-Piceetum* Zupančič (1980) 1999, *Lonicero ceruleae-Piceetum* Zupančič (1976) 1994, *Stellario montanae-Piceetum* Zupančič (1980) 1999, *Adenostylo glabrae-Piceetum* M. Wraber ex Zukrigl 1973), from forest edges, forest clearings with solitary treed and solitary trees in small settlements.

From distribution map of *L. pulmonaria* it is evident that this species is present in areas with high amount of precipitation. In contrast to other species from *Lobaria* s. lat. group, *L. pulmonaria* was found also in Pohorje area. It is the most widespread of all species from *Lobaria* s.lat. group. It was reported from 150 m a.s.l. in Krakovski gozd to 1460 m a.s.l. in Julian Alps.

It is still occurring in areas where it was present in the past and additionally in some areas that were lichenologically not investigated before. Historical record from Javorniki in Dinaric mountains was not confirmed any more. In historical records, L. pulmonaria was referred as common, e. g. as in Glowacki & Arnold (1871): »especially in the vicinity of Idrija common«. Nowadays, in some areas of Slovenia (eg. Snežnik), the status of the species is still satisfactory, thalli are big and healthy, while on many locations only some specimens or even single thallus is evidenced, thalli are badly developed or damaged.

7.2 *Lobaria linita* (Ach.) Rabenh.

In the whole history of lichenological investigations there are only three findings known for Slovenia (Glowacki 1874, Hočevar et al. 1985, BLAM excursion preparations in 2003 - unpublished), one of them is regarded as doubtful (Hočevar et al. 1985). This record may refer to young poorly developed thallus of *L. pulmonaria*, with no developed isidia or soralia (Suppan et al. 2000). Both reliable findings are from the mountains near Bovec (above tree line), where siliceous inclusions are found in carbonaceous rocks. The finding from 2003 is from 1880 m a.s.l. As this species is occurring on acid soil rich in humus, on bryophytes and between siliceous blocks (Wirth 1995), there are few potential sites for *L. linita* in Slovenia, due to prevalence of carbonate rocks. Knowledge of lichen flora above tree line is extraordinary low, therefore its frequency and the size of populations are not known. Besides all, thalli are hardly noticeable between alpine vegetation, especially in dry condition. As siliceous rocks above tree line in Slovenia are rare, it can be assumed that it is very rare and that the populations are small.

7.3 *Lobarina scrobiculata* (Scop.) Nyl.

Species was first described by Scopoli in his Flora Carniolica from 1772 under the name *Lichen scrobiculatus*, it originated from the vicinity of Idrija. Type Scopoli's material was lost, therefore a lectotype was chosen, that corresponded to Dillenius's description (Lichenoides pulmoneum villosum, superficie scrobiculata et peltata) and to illustration »Lichenoides no. 114« in Historia Muscorum from 1741 (already referred by Scopoli), and is kept in Oxford herbarium (Yoshimura & Isoviita 1969).

The number of findings of *L. scrobiculata* is small, both before and after 1950. Findings after 1950 are from the substrates *Ulmus glabra*, *Acer pseudoplatanus*, *Po-*

pulus tremula and *Quercus robur*, in historical records also *Fagus sylvatica* and *Abies alba* are mentioned besides oak. *L. scrobiculata* is found on trunks or trunk bases. There is very little information on habitats where it was found. It was reported from mixed broadleaved forests and solitary trees from 600 to 880 m a.s.l.

Distribution of species corresponds to areas with the highest amount of precipitation in Slovenia. Some areas, where it could potentially occur based on amount of precipitation, either have not been investigated in detail (e.g. Kamniško-Savinjske Alps, Karavanke) either were intensively managed (e.g. Pohorje). In Panovec (close to Nova Gorica), vicinity of Idrija and Medvode, on Javorniki and Trnovski gozd *L. scrobiculata* has not been found any more after 1950, although these areas were thoroughly investigated by lichenologists.

7.4 *Ricasolia amplissima* (Scop.) De Not. & »Dendriscocaulon umhausense«

In *R. amplissima* species, there is taxonomic and nomenclature problem. »Cephalodia« of this species can grow independently and were treated as independent taxon named *Dendriscocaulon umhausense* (Auersw.) Degel. Often, they are found together with foliose form on the same site. Molecular studies have revealed that »*Dendriscocaulon umhausense*« is built by the same fungus as foliose form with green primary photobiont. As lichens are named after fungus, two names cannot exist as both growth types are formed by the same fungus. To name a cyanobacterial form, a citing of incorrect name in quotation marks was suggested: »*Dendriscocaulon umhausense*« or adding of a corresponding adjective cyan. or chlor. after the correct name, e.g. *R. amplissima* cyan. In this way, information on growth form is given (Jorgensen 1998).

As substrates for *R. amplissima*, the following tree species were recorded after 1950: *Ulmus glabra* > *Acer pseudoplatanus* > *Fagus sylvatica*, *Pyrus communis*, in some cases there was no record on the type of the substratum. In the past, it was reported also from *Abies alba*, *Castanea sativa*, *Quercus* sp., *Picea abies* and conifers. It grows on tree bark or wood on forest edges, forest clearings with solitary broadleaved trees, solitary trees in areas where management is limited to hay harvesting and feeding of wild animals (Prügger 2005), and in mixed forests. It was recorded between 720 m.s.l (Babno polje) to 1400 m (Julian Alps).

Distribution of the species (except for the historical record from Donačka gora) is matching the areas with the highest amount of precipitation in Slovenia. Some areas, where it could potentially occur based on amount of precipitation, either have not been investigated in detail (e.g. Kamniško-Savinjske Alps, Karavanke) either were intensively managed (e.g. Pohorje). After 1950, there are twelve findings known. Investigations of lichen flora in 90ties of 20th century and in the beginning of 21st century have shown that *R.amplissima* does not occur anymore in Panovec (close to Nova Gorica), Javorniki, Trnovski gozd, Šenturška and Donačka gora. For Panovec it was already noted by Glowacki (1871) that it is very rare. For Julian Alps, where there were no historical records, after 1950 only one specimen was found. All other specimens were found at Snežnik or Goteniška gora.

7.5 *Ricasolia virens* (With.) H.H. Blom. & Tønsberg

In Slovenia, *R. virens* was reported from tree species *Abies alba* and *Fagus sylvatica*. There is no information available on habitats or forest communities where it was found.

There are only five historical records on occurence of *R. virens* in Slovenia, one of them is unpublished (herbarium F. Dolšak). After 1950, there is only one record, but is confirming wider area of occurrence in the past. Considering that *R. virens* is a species of mild temperate to humid subtropic climate (Wirth 1995), it is interesting that these records are referring to alpine region – Kamniško-Savinjske Alps. As recent lichenological investigations have not discovered it in its potential habitats (areas with high amount of precipitation in combination with low disturbance of forest ecosystems), it can be assumed that it is close to extinction or it is already extinct in Slovenia.

8 DISCUSSION

Species from the *Lobaria* s. lat. group are mostly limited to an area with high annual amount of precipitation (Alpine-Dinaric barrier, Pohorje) in Slovenia. Some parts of Slovenia, where the climatic conditions may be appropriate for the species from the *Lobaria* s. lat. group (Kamniške Alpe, Karavanke) are lichenologically still understudied. At Pohorje, only *L. pulmonaria* was recorded, which is most likely related to the radical forest

management measures in the past. The sizes of populations for locations are mostly not known. However, in some cases, a single lichen thallus of the species was found at a location or the thalli were badly developed and damaged. There is no data on genetic diversity, except for two locations of *L. pulmonaria*, which were included in the study of Scheidegger et al. (2012). This study found that the Slovenian populations from Rajhenavski Rog and Notranjski Snežnik are admixed i.e. contain genes from two different genetic pools, which contributes to greater genetic diversity. Anyway, small populations are highly endangered regardless of genetic diversity as they may be destroyed by a single catastrophic event (Zoller et al. 1999). Otherwise, Zoller et al. (1999) found out that in Swiss populations of *L. pulmonaria* genetic diversity and size of the population were not linked. Greater genetic diversity was observed in populations where the fungal simbiont reproduced sexually. However, *L. pulmonaria* is known that, the sexual reproduction occurs in even less than 30 % (dal Grande et al. 2012), furthermore, according to some data the percentage of sexual reproduction is even significantly smaller (Scheidegger et al. 2012). In general, it is known that even when apothecia are developed, they are often infected with a fungal parasite and therefore nonfunctional (Jordan 1973). Besides *L. pulmonaria*, also *L. scrobiculata* and *L. linita* reproduce primarily by vegetative means (Nimis 2016). For *L. pulmonaria* it was reported that its vegetative propagules may disperse only on a short distance and that identical genotypes are found only at a maximum distance of 230 m from each other (Walser 2004). In populations, which are propagated only vegetatively, fragmentation of habitats can lead to situations where neighbouring fragments cannot be colonized due to distance in between, although they might be ecologically suitable. Even mild forest management significantly reduces genetic diversity of *L. pulmonaria* populations before changes in frequency occur due to fragmentation of one population into several small populations isolated in space, resulting in reduced mixing of genotypes (Scheidegger et al. 2012). Similar effects occur in cases where species occupies free-standing isolated trees. As the cultural landscape of free standing isolated trees is not maintained anymore, there are no appropriate substrates for colonization in the vicinity. For the location, where *R. amplissima* was known to flourish on *Ulmus glabra* (Prügger 2002), it was found out that all 15 trees died in 2006-2009 due to infection with *Ophiostoma novo-ulmi* fungus (Obermayer 2011), as well as *R. amplissima* disappeared with from this location. As lichens from the *Lobaria* s.lat. group cannot tolerate eutrophication or only to a small extent (*L. pulmonaria* and *R. amplissima*) (Wirth 1995, Nimis 2016), they are also threatened by intensification of agriculture with increased levels of nitrogen compounds. They also need a sufficient amount of diffused light for their growth (Nimis 2016), therefore abandonment of extensive agricultural land use is not advantageous. All lichens from *Lobaria* s. lat. group are hygrophilous (Nimis 2016), so they can be affected by reduced air humidity as a result of forestry measures. *L. linita*, with only a small number of potential habitats in Slovenia could be affected by global warming, as it is arctic-alpine species, remote pollution with nitrogen compounds and destruction of habitats due to sports activities in the mountains. Taking all the presented issues into account, it is not surprising that in many European countries, species of the *Lobaria* s.lat. group are placed on the red list of endangered species. In Italy, *R. amplissima*, *R. virens* and *L. scrobiculata* have a status of potentially endangered species, whereas *L. pulmonaria* is least threatened (Nimis 2016). In Germany *L. virens* considered to be extinct, but before approx. a decade a location where it has preserved was discovered (Fischer & Killman 2008). It is also considered extinct in Switzerland (Scheidegger et al. 2002), whereas in Austria it does not occur (H. Mayrhofer, pers. communication). *R. amplissima* in Austria is very rare, as well as *L. scrobiculata*. *L. amplissima* and *L. scrobiculata* are endangered, and *L. pulmonaria* is considered as vulnerable in Switzerland (Scheidegger et al. 2002). Terricolous species *L. linita* is out of danger in Switzerland (Scheidegger et al. 2002), probably due to large area that is occupied by crystalline Alps. In Italy, the species is absent everywhere except in alpine and subalpine region, where it is very to extremely rare (Nimis 2016).

ACKNOWLEDGEMENTS

Author acknowledges the financial support from the Slovenian Research Agency (research core funding No. P4-0107, lead by prof. dr. Hojka Kraigher). Author thanks dr. Nikica Ogris (Slovenian Forestry Institute) for the preparation of distribution maps, dr. Aleksander Marinšek (Slovenian Forestry Institute) for the help with syntaxonomical nomenclature and prof. dr. Helmut Mayrhofer (Graz) for data on recent references on *Lobaria* s. lat. species for Slovenia.

9 LITERATURA - REFERENCES

Arso. Vreme in podnebje. Napovedi in podatki. Padavinska karta. Obdobje 1961-1990. Ministrstvo za okolje in prostor, Agencija za okolje. http://www.arso.gov.si/vreme/napovedi %20in%20podatki/padavinska_karta.html (april 2017)

Arup, U., A. Wilfling, J. Prügger & H. Mayrhofer, 2001: *Contributions to the lichen flora of SLovenia VIII. Lichenized and lichenicolous fungi from Veliki Snežnik*. Bibliotheca Lichenologica (Berlin & Stuttgart) 78: 17-25.

Batič, F., 1976: *Prispevek k flori lišajev (Lichenophyta) na Slovenskem I.* Biološki vestnik (Ljubljana) 24(1): 61-67.

Batič, F., 1976: *Prispevek k flori lišajev (Lichenophyta) na Slovenskem II.* Biološki vestnik (Ljubljana) 26(1): 1-8.

Batič, F., 2001: *Lišajska flora.* V: Papež J. (ur.): *Panovec.* Mestna občina Nova Gorica & Zavod za gozdove Slovenije, Območna enota Tolmin: 70-75.

Batič, F., K. Primožič, B. Surina, T. Trošt & H. Mayrhofer, 2003: *Contributions to the lichen flora of Slovenia X. Lichens from the Slovenian Julian Alps*. Herzogia (Halle (Saale)) 16: 143-154.

Bilovitz, P. O., U. Arup & H. Mayrhofer, 2010: *Contributions to the lichen biota of Slovenia XII. Some lichens from Logarska dolina*. Hladnikia (Ljubljana) 26: 15-20.

Bilovitz, P. O., F. Batič & H. Mayrhofer, 2011: *Epiphytic lichen mycota of the virgin forest reserve Rajhenavski Rog (Slovenia)*. Herzogia (Halle (Saale)) 24(2): 315-324.

Christensen, S. N., 1987: *Contribution to the lichen flora of Yugoslavia.* Acta Bot. Croat. 46: 161-171.

Dal Grande, F., I. Widmer, H. H. Wagner & C. Scheidegger, 2012: *Vertical and horizontal photobiont transmission within populations of lichen symbiosis.* Molecular Ecology (Oxford) 21: 3159-3172. https://doi.org/10.1111/J.1365-294X.2012.05482.X

Elllis, C. J. & B. J. Coppins, 2007: *Changing climate and historic-woodland structure interact to control species diversity of the 'Lobarion' epiphyte community in Scotland.* Journal of Vegetation Science (Uppsala) 15: 725-734. https://doi.org/10.1111/J.1654-1103.2007.TB02587.X

Fischer, E. & D. Killmann, 2008: *Wiederfund von Lobaria virens in Deutschland*. Herzogia (Halle (Saale)) 21: 79–84.

Gauslaa, Y., 1995: *The Lobarion, an epiphytic community of ancient forests threatened by acid rain.* Lichenologist (London) 27(1): 59-76. https://doi.org/10.1006/lich.1995.0005

Glowacki, J., 1871: *Prodromus einer Flechten-Flora von Görz.* V: Gatti F. (ur.): *Elfter Jahresbericht der K. K.* Ober-Realschule in Görz: 1-31.

Glowacki, J., F. Arnold, 1870: *Flechten aus Krain und Küstenland*. Verh. K. K. Zool.- Bot. Ges. Wien, 20: 431-466.

Glowacki, J., 1874: *Die Flechten des Tommasini'schen Herbars, ein Beitrag zur Flechtenflora des Küstenlandes.* Verh. K. K. Zool. — Bot. Ges. (Wien) 24: 539-552.

Grube, M., F. Batič & H. Mayrhofer, 1995: *Contributions to the lichen flora of Slovenia I. Epiphytic lichens of the Snežnik Area*. Herzogia (Halle (Saale)) 11: 189-196.

Grube, M., H. Mayrhofer & F. Batič, 1998: *Contributions to the Lichen Flora of Slovenia III. Epiphytic lichens from Goteniški Snežnik and Krokar Area*. Herzogia (Halle (Saale)) 13: 181-188.

Jordan, W. P., 1973: *The Genus Lobaria in North America North of Mexico.* The Bryologist (College Station, TX) 76(2): 225-251. https://doi.org/10.2307/3241326

Jorgensen, P. M., 1998: *What shall we do with the blue-green counterparts?* The Lichenologist (London) 30(4-5): 351-356. https://doi.org/10.1006/lich.1998.0146

Kranner, I., 2002: *Glutathione status correlates with different degrees of desiccation tolerance in three lichens of desiccation tolerance in three lichens.* New Phytologist (London) 154: 451–460. https://doi.org/10.1046/j.1469-8137.2002.00376.x

Kutnar, L., Ž. Veselič, I. Dakskobler & D. Robič, 2012: *Tipologija gozdnih rastišč Slovenije na podlagi ekoloških in vegetacijskih razmer za potrebe usmerjanja razvoja gozdov = Typology of Slovenian forest sites according to ecological and vegetation conditions for the purposes of forest management*. Gozdarski vestnik (Ljubljana) 70(4): 195-214.

Mayrhofer, H., M. Koch & F. Batič, 1996: *Beiträge zur Flechtenflora von Slowenien II. Die Flechten des Pohorje*. Herzogia (Halle (Saale)) 12: 111–127.

Mayrhofer, H., M. Matzer & Z. Belec, 1998: *Beiträge zur Flechtenflora von Slowenien V. Nachträge zur Flechtenflora des Pohorje*. Hladnikia (Ljubljana) 10: 5-10.

Moncada, B., R. Lücking & L. Betancourt-Macuase, 2013: *Phylogeny of the Lobariaceae (lichenized Ascomycota: Peltigerales), with the reappraisal of the genus Lobariella.* The Lichenologist (London) 45(2): 203-263. https://doi.org/10.1017/S0024282912000825

Mrak, T., H. Mayrhofer & F. Batič, 2004: *Contributions to the lichen flora of Slovenia XI. Lichens from the vicinity of Lake Bohinj (Julian Alps).* Herzogia (Halle (Saale)) 17: 107-127.

Nimis, P. L., 2016: *The Lichens of Italy.* A Second Annotated Catalogue. EUT. Trieste.

Obermayer, W., 2011: *Dupla Graecensia Lichenum (2011, nos 681-800).* Fritschiana (Graz) 69: 17-53.

Ogris, N., 2008: *Podatkovna zbirka gliv Slovenije Boletus informaticus.* Računalniški program.

Pötsch, J. S., *Lichenes Welwitschiani. Aufzählung mehrerer von Dr. F. Welwitsch in österreich gesammelten Flechten*. Verh. K.K. Zool.-Bot. Ges. (Wien) 13: 581-583.

Prügger, J., 2005: *Lišajska flora Snežnika in Javornikov. Die Flechtenflora des Snežnik und der Javorniki mit besonderer Berücksichtigung der epiphytischen Arten.* Studia Forestalia Slovenica, Strokovna in znanstvena dela: 122, Gozdarski inštitut Slovenije. Ljubljana.

Prügger, J., H. Mayrhofefr & F. Batič, 2000: *Beiträge zur Flechtenflora von Slowenien IV. Die Flechten des Trnovski gozd.* Herzogia (Halle (Saale)) 14: 113–143.

Prügger, J., B. Surina & H. Mayrhofefr, 2000: *The lichens of the Ždrocle forest reserve.* Zbornik gozdarstva in lesarstva (Ljubljana), 63: 7-25.

Robič, S., 1895: *Kranjski lišaji (Lichenes).* Izvestja muzejskega društva za Kranjsko: 33-42, 83-85, 118-121, 153-159.

Rose, F., 1988: *Phytogeographical and ecological aspects of Lobarion communities in Europe.* Botanical Journal of the Linnean Society (London) 96: 69-79. https://doi.org/10.1111/j.1095-8339.1988.tb00628.x

Scheidegger, C., P. O. Bilovitz, S. Werth, I. Widmer & H. Mayrhofer, 2012: *Hitchhiking with forests: population genetics of the epiphytic lichen Lobaria pulmonaria in primeval and managed forests in southeastern Europe.* Ecology and Evolution (Oxford) 2(9): 2223-2240. https://doi.org/10.1002/ece3.341

Scheidegger, C., P. Clerc, M. Dietrich, M. Frei, U. Groner, C. Keller, I. Roth, S. Stofer & M. Vust, 2002: Rote Liste der gefährdeten Arten der Schweiz. Baum und erdbewohnende Flechten. BUWAL, Bern, WSL, Birmensdorf & CJBG Geneve: 124 str.

Suppan, U., J. Prügger & H. Mayrhofer, 2000: *Catalogue of the lichenized and lichenicolous fungi of Slovenia.* Bibliotheca Lichenologica, Band 76. J.Cramer. Berlin. Stuttgart.

Šilc, U. & M. Čarni, 2012: *Conspectus of vegetation syntaxa in Slovenia*. Hacquetia (Ljubljana) 11(1): 113–164. https://doi.org/10.2478/v10028-012-0006-1

Walser, J.-C., 2004: *Molecular Evidence for Limited Dispersal of Vegetative Propagules in the Epiphytic Lichen Lobaria pulmonaria.* American Journal of Botany (Ames, Iowa) 91(8): 1273-1276. https://doi.org/10.3732/ajb.91.8.1273

Wirth, V., 1995: *Flechtenflora, Bestimmung und ökologische Kennzeichnung der Flechten Südwestdeutschland und angrenzender Gebiete.* 2.Auflage. Ulmer. Stuttgart.

Yoshimura, I. & P. Isoviita, 1969: *Scopoli's lichen specimens and the typification of Lobaria scrobiculata (Scop.) DC.* Annales Botanici Fennici (Helsinki) 6(4): 348-352.

Zoller, S., F. Lutzoni & C. Scheidegger, 1999: *Genetic variation within and among populations of the threatened lichen Lobaria pulmonaria in Switzerland and implications for its conservation.* Molecular Ecology (Oxford) 8: 2049-2059. https://doi.org/10.1046/j.1365-294x.1999.00820.x