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CONTRIBUTION TO THE KNOWLEDGE OF LICHENS OF PAPUK NATURE PARK (SLAVONIA, EASTERN CROATIA)

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Labak, I., Ozimec, S., Dumbović, V. & Topić, J.: Contribution to the knowledge of lichens of Papuk Nature Park (Slavonia, eastern Croatia). Nat. Croat., Vol. 20, No. 1., 35–52, 2011, Zagreb.

This paper presents a checklist of 129 lichens recorded for the Papuk Nature Park, including one species new for Croatia, *Umbilicaria hirsuta*, and eight species new for the area. The fieldwork was carried out at 17 localities in the period 2005-2007. The rare lichen *Lobaria pulmonaria* was found on old trees at three new sites. A further survey of forest-associated lichens will enable better integration of biodiversity conservation issues in forest management.

Key words: Papuk, biodiversity, *Umbilicaria*, *Lobaria*, forest, management

Labak, I., Ozimec, S., Dumbović, V. & Topić, J.: Prilog poznavanju lišajeva Parka prirode Papuk (Slavonija, istočna Hrvatska). Nat. Croat., Vol. 20, No. 1., 35–52, 2011, Zagreb.

Rad donosi popis 129 lišajeva zabilježenih za Park Prirode Papuk, uključujući i jednu novu vrstu, *Umbilicaria hirsuta*, za Hrvatsku, te osam vrsta novih za područje Parka. Terensko istraživanje provedeno je na 17 lokaliteta u razdoblju 2005.-2007. godine. Rijetki lišaj *Lobaria pulmonaria* pronađen je na starim stablima, na tri nova nalazišta. Daljnja istraživanja lišajeva vezanih za šumske sastojine omogućit će bolje uključivanje problematike očuvanja biološke raznolikosti u šumsko gospodarenje.

Ključne riječi: Papuk, biološka raznolikost, *Umbilicaria*, *Lobaria*, šuma, gospodarenje

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INTRODUCTION

The first research on lichens from Papuk Nature Park can be dated to the second half of 19th century when Stephan Schulzer von Müggenburg, Augustin Kanitz and Josef Armin Knapp reported eight species (SCHULZER v. MÜGGENBURG *et al.*, 1866), and Carl Stoitzner 43 (STOITZNER, 1869). The Austrian botanist August Ginzberger and his wife collected lichen material in the Papuk area in August 1918 (GINZBERGER, 1935). This material was determined by the Croatian lichenologist Fran Kušan, who added collections from an excursion he made together with Ivo Horvat in June 1930. The complete results of these investigations, with a list of 100 species, were the last contribution to the lichen flora of the Papuk for long time (KUŠAN, 1935). Some voucher specimens collected by Ginzberger and Kušan are stored in the Herbarium Croaticum (ZA) of Botanical Institute, Faculty of Science in Zagreb.

The Slavonian Mountains are located in northeastern Croatia, along the southern edge of the Pannonian basin. Two parallel chains extending in the west-east direction form them. The northern chain consists of Papuk (954 m) and Krndija (792 m), while the southern chain is made up of Psunj (984 m), Požeška gora (618 m) and Dilj (461 m). The protection of parts of the Slavonian Mountains as Nature Park promoted extensive inventories on biodiversity, with the purpose of providing checklists of plants and animals.

The vascular flora consists of 121 families, 497 genera and 1,223 species and subspecies (SAMARĐIĆ, 2005; PANDŽA, 2010).

Due to scarcity of data on the lichens of the Papuk Nature Park, we decided to revive lichenological research in order to provide an updated checklist of lichens (LABAK, 2007), based on the older lichenological papers, data from herbaria collections and fieldwork. This makes a continuation of a recent lichenological survey started over the last decade in Croatia, with the aim of creating checklists, and identifying rare or endangered lichens and habitats valuable for their conservation. Thus, a better knowledge on lichens as an important component of the total biodiversity should be achieved. Up to now, the status of the lichen flora of two protected areas in Croatia: Medvednica Nature Park (PARTL & ASTA, 2003), and Risnjak National Park (OZIMEC *et al.*, 2010), has been reported.

MATERIAL AND METHODS

Study area

The area of Papuk was proclaimed a Nature Park in 1999. The protected area extends between 17°29'18'' and 17°54'38'' E, and 45°24'54'' and 45°36'46'' N (Fig. 1). The lowest altitude (162 m) is located in the northern part, while the highest is the peak of Papuk (953 m) in the middle part. Papuk Nature Park extends over a 336-km^2 surface and is mostly covered by forests (about 95%); settlements and agricultural areas being restricted to small areas.

Papuk is geologicaly the most diverse Croatian mountain, consisting of rocks originating in a time span of 350 million years, from Palaeozoic to Cenozoic (PAMIĆ *et al.*, 2005). The main rock types are: igneous rocks (basalt, andesite, granite), metamorphic rocks (schist, quartzite, sandstone), and limestones as sedimentary rock.

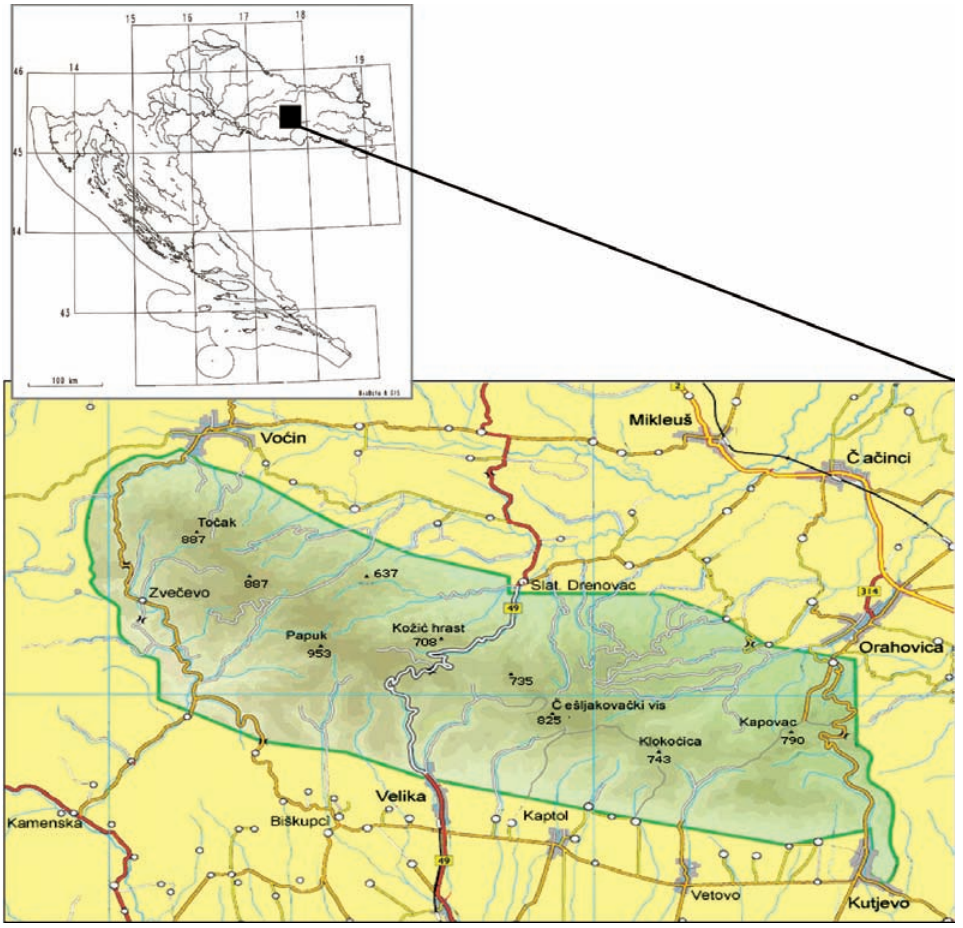

Fig. 1. Map of Papuk Nature Park.

Rock type affects diversity of saxicolous lichens through difference in texture, hardness, water retention and especially chemical composition. The metamorphic rocks contain a silica (SiO_2) component, an adequate substrate for specific acidophilic lichens. On the other hand, calcicolous lichens prefer limestone and dolomite as calcium rich substrates. In 2007, the Park became the first Croatian Geopark, and the 30th member of the European and UNESCO Global Geopark Network.

The climate is moderately warm and rainy. Mean annual temperature is 10.0 °C, the lowest in January (–0.1 °C), and the highest, 20.0 °C in July. Precipitation averages 959 mm per year, the highest amount occurring in June (107 mm), and lowest in February (55 mm). Mean annual number of days with snow is 49, and air humidity is 77 %.

Forest vegetation includes 13 communities, distributed into three altitudinal belts (VUKELIĆ *et al.*, 2008). The hills (100–250 m) are characterized by forests of sessile oak and common hornbeam (*Epimedio-Carpinetum betuli*). Beech forest with sweet

woodruff (*Asperulo odoratae-Fagetum*) prevails in the montane belt (250–800 m). The altimontane belt (above 800 m) is covered by the Pannonian beech-fir forest (*Festuco drymeiae-Abietetum)* and forest of sycamore and the perennial honesty (*Lunario redivivae-Aceretum pseudoplatani*), in the north western part of the Papuk area. Thermophilous forests of Hungarian oak and Turkey oak (*Quercetum frainetto-cerris)* can be found in the southeastern area of the Park, reaching the westernmost border of their distribution range. The warmer exposition and basic soil reaction favours the occurrence of thermophilous forest of pubescent oak and manna ash (*Fraxino orni-Quercetum pubescentis)* in the southern Papuk area. The majority of forests and forest lands (87 %) are state owned and managed by the company Croatian Forests Ltd., according to forest management plans. Middle-age forest stands, aged 60–80 years prevail in the Park. Only 1,600 ha of oak and beech forest stands are more than 100 years old (SAMARĐIĆ, 2005).

Collection sites

Lichens were collected during the fieldwork carried out in the period 2005–2007, at 17 localities shown in the Fig. 2 and listed below.

1 – Brezova voda, 820 m, Pannonian beech-fir forest (*Festuco drymeiae-Abietetum)*, MTB 0471/322; 2 June 2005

2 – Gudnoga, 500 m, beech forest with sweet woodruff (*Asperulo odoratae-Fagetum)*, MTB 0471/234; 7 September 2005

3 – Ivačka Glava, 913 m, forest of sycamore and perennial honesty (*Lunario redivivae-Aceretum pseudoplatani)*, MTB 0471/441; 13 June 2005

4 – Jankovac, 475 m, beech forest with sweet woodruff (*Asperulo odoratae-Fagetum)*, MTB 0472/332; 17 August 2006

5 – Lukinac, 522 m, Pannonian beech-fir forest (*Festuco drymeiae-Abietetum)*, MTB 0471/322; 2 June 2005

6 – Kamengrad, 610 m, forest of sessile oak with woodrushes (*Luzulo luzuloidi--Quercetum)*, MTB 0471/344; 15 November 2006

7 – Kutjevo-Hajderovac, 210 m, forest of Hungarian oak and Turkey oak (*Quercetum frainetto-cerris)*, MTB 0573/144; 1 August 2006

8 – Lapjak: Velički grad (452 m), Tauberove stijene (667 m), top of Lapjak hill (667 m); beech forest with sweet woodruff (*Asperulo odoratae Fagetum)*, forest of pubescent oak and manna ash (*Fraxino orni-Quercetum pubescentis)*, MTB 0571/224; 15 June 2005; 21 July 2006

9 – Mališćak, 350-600 m, beech forest with sweet woodruff (*Asperulo odoratae-Fagetum)*, forest of sessile oak with woodrushes (*Luzulo luzuloidi-Quercetum)*, forest of pubescent oak and manna ash (*Fraxino orni-Quercetum pubescentis)*, MTB 0571/223; 12 October 2005

10 – Slavonian hiking trail, branch towards Lom, 800 m, Pannonian beech-fir forest (*Festuco drymeiae-Abietetum)*, MTB 0471/322; 2 June 2005

11 – Pištanica, 460 m, forest of sessile oak with roadside fescue (*Festuco drymeiae--Quercetum)*, beech forest with sweet woodruff (*Asperulo odoratae-Fagetum)*, MTB 0472/441; 13 May 2005

12 – Pliš, 350-600 m, forest of pubescent oak and Manna ash (*Fraxino orni-Quercetum pubescentis)*, MTB 0571/242; 19 July 2005

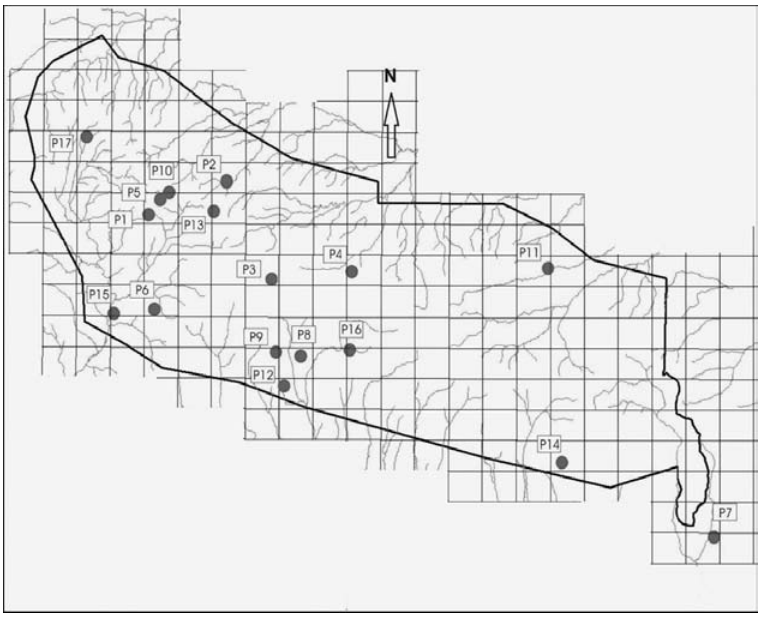

Fig. 2. Map of the study area with designated investigated localities.

13 – Sekulinačka planina, 851 m, Pannonian beech-fir forest (*Festuco drymeiae-Abietetum)*, MTB 0471/412; 13 May 2005

14 – Vetovo, 550-600 m, forest of sessile oak and common hornbeam (*Epimedio-Carpinetum betuli)*, MTB 0572/422; 27 September 2005

15 – Vučjak Kamenski, 260 m, an old neglected orchard, MTB 0471/343; 10 May 2005

16 – Tisica quarry, 427 m, beech forest with sweet woodruff (*Asperulo odoratae-Fagetum)*, forest of sessile oak and common hornbeam (*Epimedio-Carpinetum betuli)*, MTB 0572/114; 19 July 2005

17 – Zvečevo, 548 m, Pannonian beech-fir forest (*Festuco drymeiae-Abietetum)*, MTB 0471/132; 14 July 2006

Breast height (DBH) diameter was measured on each tree supporting characteristic lichens from the community of *Lobarion pulmonariae*, and given as a mean value. The investigated localities were mapped using the MTB grid squares of the Central European grid (NIKOLIĆ *et al.*, 1998).

Historical data

Selected specimens from Papuk collected by Ginzberger and Kušan were studied in the ZA herbarium. The voucher sample of *Sticta sylvatica* was studied in the herbarium of Natural History Museum in Vienna (W). We try to identify and translate old records and toponyms in the most accurate way possible. However, some of the localities are described too generally. In the case of nomenclatural changes, citations are followed by the name used in the original publication in brackets

Identification and nomenclature

The specimens were identified in the field by a hand lens, and in the laboratory using a dissecting microscope, a light microscope and the usual spot tests, according to the reference books: DOBSON (2005), PURVIS *et al.* (1992), VITIKAINEN (1994), and WIRTH (1995). Nomenclature mainly follows SANTESSON *et al.* (2004) and NIMIS & MARTELLOS (2008). The species in the checklist are given in alphabetical order. For each species, the citations with data about locality are given in chronological order, followed by the records from the field investigation, which contain data about substrate. Newly recorded taxa for the Papuk area are marked with an asterisk (*)

RESULTS AND DISCUSSION

Species list

Acarospora fuscata (Schrad.) Th.Fr.
Vučjak Kamenski, 310 m (KUŠAN, 1935)

Anaptychia ciliaris (L.) Körb.
Near Voćin and Drenovac towards Jankovac (SCHULZER v. MÜGGENBURG *et al.*, 1866) – Zvečevo (STOITZNER, 1869 as *Anaptychia ciliaris* var. *muscicola*) – Northern side of the ruins of Kamengrad, 550–600 m, western ridge of the main peaks, 660 m (KUŠAN, 1935) – 9 *Quercus petraea*; 14 *Quercus petraea*; 16 *Quercus pubescens*

Aspicilia calcarea (L.) Mudd
Top area of the main peaks, 950 m; Turski grad near Voćin, 300 m (KUŠAN, 1935 as *Lecanora calcarea*)

Aspicilia cinerea (L.) Körb.
Rupnica near Voćin, 250 m; northern side of the ruins of Kamengrad, 550 m, Vrani kamen, 817 m, by the road from Vučjak Kamenski to Zvečevo, 300–350 m, peak Dubrave, 600 m (Kušan, 1935 as *Lecanora cinerea*)

Aspicilia contorta (Hoffm.) Kremp.
Johannesberg near Zvečevo (STOITZNER, 1869 as *Aspicilia calcarea* var. *contorta*) – Turski grad near Voćin, 300 m; Western ridge of the main peaks, 700 m; by the road from Velika to Duboka glazier's workshop, 300–400 m; southern of Mrkopolje, by the path from peak designated on 417 m towards the road (KUŠAN, 1935 as *Lecanora contorta*)

Aspicilia gibbosa (Ach.) Körb.
Vučjak Kamenski, 310 m (KUŠAN, 1935 as *Lecanora gibbosa*)

Bagliettoa calciseda (DC) Gueidan & Cl. Roux
Western ridge of the main peaks with their southern side, 800 m; Turski grad near Voćin, 300 m (KUŠAN, 1935 as *Verrucaria calciseda*)

Bryoria fuscescens (Gyeln.) Brodo & D. Hawksw.
In the area of main peaks, 800 m, with *Parmelia sulcata* (KUŠAN, 1935 as *Alectoria jubata* var. *prolixa* f. *chalybeiformis*)
Note: The original specimen collected by Kušan (June 18, 1930) was checked in ZA.

Caloplaca chalybaea (Fr.) Müll. Arg.
Summit area, 950 m; southern side of the western ridge of the main peaks, 800 m (KUŠAN, 1935)
Note: The original specimens collected by Ginzberger (August 12, 1918) were checked in ZA.

Caloplaca citrina (Hoffm.) Th. Fr.
Ruins of Kamengrad, 612 m (KUŠAN, 1935)

Caloplaca crenularia (With.) J.R. Laundon
Velinca valley near Vučjak, 430 m, on greenschist (KUŠAN, 1935 as *Caloplaca ferruginea*).
Note: The original specimen collected by Ginzberger (August 5, 1918) was checked in ZA. Determination was incorrect, because *Caloplaca ferruginea* is a corticolous species. The correct determination of the specimen is *Caloplaca crenularia* (VONDRAK, pers. comm.)

Caloplaca holocarpa (Ach.) A.E. Wade
Turski grad near Voćin, 300 m (KUŠAN, 1935 as *Caloplaca pyracea*)

Caloplaca lactea (A. Massal.) Zahlbr.
Korlati (STOITZNER, 1869 as *Callopisma luteo album* var. *lactea*)

Caloplaca scotoplaca (Nyl.) H. Magn.
Vučjak Kamenski, 310 m (KUŠAN, 1935 as *Caloplaca caesiorufa*)

Caloplaca oasis (A. Massal.) Szatala
Western ridge of the main peaks, 700 m (KUŠAN, 1935 as *Caloplaca velana* var. *oasis*)

Candelariella vitellina (Hoffm.) Müll. Arg.
Rupnica near Voćin, 250 m; between the main peak and Dubrave peak, 700 m (KUŠAN, 1935)

Cetrelia cetrarioides (Duby) W.L. Culb. & C.F. Culb
Vrani Kamen, 700 m; in the forest western of Vučjak Kamenski, 400 m; near Stambulić hut in Velinca valley, 460 m; by the road near Zvečevo 440 m; by the path from Jankovac towards the main peak (Kušan, 1935 as *Parmelia cetrarioides*)

Cladonia chlorophaea (Flörke) Spreng.
By the road from Vučjak Kamenski towards Zvečevo, 300–350 m (KUŠAN, 1935)

Cladonia coniocraea (Flörke) Spreng.
Vučjak Kamenski, 310 m (KUŠAN, 1935 as *Cladonia coniocraea* f. *ceratodes*) – 9 *Quercus petraea*; 14 *Quercus petraea*

Cladonia decorticata (Flörke) Spreng.
Papuk (STOITZNER, 1869)

Cladonia fimbriata (L.) Fr.
Brzaja near Zvečevo (STOITZNER, 1869) – 2 *Prunus avium*

Cladonia furcata (Huds.) Schrad.
Rastova kosa near Zvečevo (STOITZNER, 1869 as *Cladonia furcata* var. *racemosa*) – In a mountain forest between Voćin and Zvečevo (SCHULZER v. MÜGGENBURG *et al.*, 1866) – By the road from Vučjak Kamenski towards Zvečevo, 300–350 m (KUŠAN, 1935 as *Cladonia furcata* var. *pinnata*) – 9 *Quercus petraea*

Cladonia gracilis (L.) Willd.
Točak (STOITZNER, 1869)

* *Cladonia macilenta* Hoffm.
9 on tree stump; 17 on soil

Cladonia pocillum (Ach.) O.J. Rich.
Western ridge of the main peaks, 740 m (KUŠAN, 1935 as *Cladonia pyxidata* var. *pocillum*)

Cladonia pyxidata (L.) Hoffm.
In forests of Papuk near Voćin (SCHULZER v. MÜGGENBURG *et al.*, 1866 as *Cladonia pyxidata*) – Vrani kamen, 700 m (KUŠAN, 1935 as *Cladonia pyxidata* var. *neglecta*) – 9 *Quercus petraea*; 16 siliceous rocks

Cladonia rangiferina (L.) F.H. Wigg.
Northern side of the ruins of Kamengrad, 550 m (KUŠAN, 1935)

Cladonia squamosa Hoffm.
Between Voćin and Drenovac (SCHULZER v. MÜGGENBURG *et al.*, 1866)

Cladonia uncialis (L.) F.H. Wigg.
Brzaja near Zvečevo (STOITZNER, 1869 as *Cladonia stellata*)

Collema auriforme (With.) Coppins and J.R. Laundon
In the top area of the main peaks, 900 m (KUŠAN, 1935 as *Collema auriculatum*)

* *Collema crispum* (Huds.) F.H. Wigg.
3 on limestone rock, 913 m

Collema cristatum (L.) F.H. Wigg.
Western ridge of the main peaks, 800 m (KUŠAN, 1935 as *Collema multifidum*)

Collema flaccidum (Ach.) Ach.
By the path from Jankovac towards the main peak, 800 m (KUŠAN, 1935 as *Collema rupestre*) – 4 on moss covered stone

Dermatocarpon miniatum (L.) W. Mann
Brzaja near Zvečevo (STOITZNER, 1869 as *Endocarpon miniatum*)

Dibaeis baeomyces (L. fil.) Rambold & Hertel
Točak (STOITZNER, 1869 as *Baeomyces roseus*)

Diploschistes scruposus (Schreb.) Norman
Western ridge of the main peaks, above 900 m; Turski grad near Voćin, 300 m; by the road from Velika towards Duboka glazier's workshop (KUŠAN, 1935); between the main peak and Dubrave peak, 750–950 m (KUŠAN, 1935 as *Diploschistes scruposus* f. *flavicans*)

Diplotomma alboatrum (Hoffm.) Flot.
Rupnica near Voćin, 250 m (KUŠAN, 1935 as *Buellia alboatra*)

Diplotomma venustum Körb.
Western ridge of the main peaks and its southern side, 800 m (KUŠAN, 1935 as *Buellia epipolia* var. *venusta*)

Evernia divaricata (L.) Ach.
Točak (STOITZNER, 1869)

Evernia prunastri (L.) Ach.
Zvečevo (STOITZNER, 1869) – Near Vučjak Kamenski, 300 m; upper part of Velinca valley, 400 m (KUŠAN, 1935) – 4 *Picea abies*; 7 *Quercus cerris*; 9 *Quercus petraea*; 12 *Quercus pubscens*; 14 *Quercus petraea*; 15 dry tree branch; 16 *Fagus sylvatica*; 17 *Picea abies*, *Acer pseudoplatanus*

Flavoparmelia caperata (L.) Hale
Kamengrad (STOITZNER, 1869 as *Imbricaria caperata*) – Near Stambulić hut in Velinca valley, 460 m; Zvečevo, by the road, 440 m; Vučjak Kamenski, 310 m; upper part of Velinca valley, 400 m; Jankovac; peak Dubrave, 750 m (KUŠAN, 1935 as *Parmelia caperata*) – 2 *Fagus sylvatica*; 6 *Carpinus betulus*; 7 *Quercus frainetto*; 8 *Quercus petraea*; 9 *Quercus petraea*; 11 *Quercus petraea*; 12 *Quercus pubescens*; 14 *Quercus petraea*; 17 *Picea abies*

Fulgensia fulgens (Sw.) Elenkin
Papuk (STOITZNER, 1869 as *Psoroma fulgens*)

Graphis scripta (L.) Ach.
Sovjak, Zvečevo (STOITZNER, 1869) – Near the Stambulić hut in Velinca valley, 460 m, (KUŠAN, 1935)

Gyalecta jenensis (Batsch) Zahlbr.
Papuk (STOITZNER, 1869 as *Gyalecta cupularis*)

Heterodermia speciosa (WULFEN) Trevis.
Rastova kosa near Zvečevo (STOITZNER, 1869 as *Parmelia speciosa*)

* *Hypocenomyce scalaris* (Ach.) M. Choisy
8 *Pinus* sp.; 9 *Fagus sylvatica*

Hypogymnia physodes (L.) Nyl.
Zvečevo (STOITZNER, 1869 as *Imbricaria physodes*) – Very frequent in the overall area (KUŠAN, 1935 as *Parmelia physodes*) – 1 *Betula pendula*; 2 *Prunus avium*; 8 *Pinus* sp.; 9 *Quercus petraea*, *Betula pendula*; 10 *Quercus petraea*; 11 *Quercus petraea*; 14 *Quercus petraea*; 17 *Picea abies*

Hypogymnia tubulosa (Schaer.) Hav.
Very frequent in the overall area (KUŠAN, 1935 as *Parmelia tubulosa*)

Lasallia pustulata (L.) Mérat
Korlati (STOITZNER, 1869 as *Umbilicaria pustulata*) – 8 Tauberove stijene, siliceous rocks

Lecanora allophana Nyl.
Zvečevo (STOITZNER, 1869 as *Lecanora subfusca*) – Very frequent in the overall area, (KUŠAN, 1935 as *Lecanora subfusca*)

Lecanora campestris (Schaer.) Hue
Vučjak Kamenski, 310 m; Turski grad near Voćin, 300 m; Rupnica near Voćin, 250 m, (KUŠAN, 1935)

Lecanora crenulata Hook.
Top area of the main peaks, 950 m (KUŠAN, 1935)

Lecanora dispersa (Pers.) Sommerf.
Turski grad near Voćin, 300 m; south of Mrkopolje, by the path from peak designated on 417 m towards the road, 300–400 m (KUŠAN, 1935)

Lecanora glabrata (Ach.) Malme
Near the Stambulić hut in Velinca valley, 460 m (KUŠAN, 1935)

Lecanora intumescens (Rebent.) Rabenh.
Brzaja stream (Stoitzner, 1869) – Near the Stambulić hut in Velinca valley, 460 m (KUŠAN, 1935)

Lecanora pulicaris (Pers.) Ach.
By the path from Vučjak towards ruins of Kamengrad, 380 m (KUŠAN, 1935 as *Lecanora chlarona*) – 12 *Pinus nigra*

* *Lecanora subrugosa* Nyl.
4 Acer pseudoplatanus

Lecidea plana (J. Lahm) Nyl.
Voćin, Turski grad, 300 m (KUŠAN, 1935 as *Lecidea latypea*)

Lecidella anomaloides (A. Massal.) Hertel & H. Kilias
Velinca valley, 370–430 m; Vučjak Kamenski, 310 m; Krivalski kamen stony peak, 730 m (KUŠAN, 1935 as *Lecidea pungens*)

Lecidella carpathica Körb.
Točak (STOITZNER, 1869 as *Lecidella sabuletorum*)

Lecidella elaeochroma (Ach.) M. Choisy
Točak (STOITZNER, 1869 as *Lecidella olivacea*) – Near the Stambulić hut in Velinca valley, 460 m (KUŠAN, 1935 as *Lecidea parasema*)

Lecidella stigmatea (Ach.) Hertel & Leuckert
Western ridge of the main peak, 800 to 900 m (KUŠAN, 1935 as *Lecidea vulgata*)

Leptogium lichenoides (L.) Zahlbr.
Between the main peak and Dubrave peak, 800 m (KUŠAN, 1935)

Lobaria pulmonaria (L.) Hoffm.
Near Voćin and Klokočevac (SCHULZER v. MÜGGENBURG *et al.*, 1866 as *Sticta pulmonaria*) – Upper part of Velinca valley, 420 m; near the Stambulić hut in Velinca valley, 460 m (KUŠAN, 1935) – 2 *Fagus sylvatica*; 6 *Quercus petraea*; 12 *Quercus pubescens*
Note: The original specimens collected by Kušan (June 18, 1930) were checked in ZA.

Melanelixia fuliginosa (Duby) O. Blanco et al. subsp. *fuliginosa*
Vrani kamen, 817 m (KUŠAN, 1935 as *Parmelia fuliginosa*)

Melanelixia fuliginosa (Duby) O. Blanco et al. subsp. *glabratula* (Lamy) J.R. Laundon
By the path from Jankovac towards main peak (KUŠAN, 1935 as *Parmelia fuliginosa*); near the Stambulić hut in Velinca valley, 460 m (KUŠAN, 1935 as *Parmelia laetevirens*) – 2 *Fagus sylvatica*; 4 *Acer platanoides*; 7 *Quercus frainetto*; 8 *Quercus petraea*; 14 *Quercus petraea*; 17 *Fagus sylvatica*

Melanelixia olivacea (L.) O. Blanco et al.
Zvečevo, near the forester's cottage (STOITZNER, 1869 as *Imbricaria olivacea*)

Melanelixia subaurifera (Nyl.) O. Blanco et al.
Near the Stambulić hut in Velinca valley, 460 m (KUŠAN, 1935 as *Parmelia subaurifera*)

Melanohalea exasperata (De Not.) O. Blanco et al.
Voćin (STOITZNER, 1869 as *Imbricaria aspera*)

Mycobilimbia lurida (Ach.) Hafellner & Türk
Rupnica near Voćin, 250 m (KUŠAN, 1935 as *Lecidea lurida*)

Nephroma parile (Ach.) Ach.
Between the main peak and Dubrave peak, 800m (KUŠAN, 1935) – 2 *Fagus sylvatica*

Opegrapha viridis (Ach.) Behlen & Desberger
Velinca valley near the Stambulić hut, 460 m (KUŠAN, 1935)

Parmelia saxatilis (L.) Ach.
Točak (STOITZNER, 1869 as *Imbricaria saxatilis*) – Near the Stambulić hut in Velinca valley, 460 m; upper part of Velinca valley, 400 m; northern side of the ruins of Kamengrad, 550 m; between the main peak and Dubrave peak, 800 m (KUŠAN, 1935); Krivalski kamen, 730 m (KUŠAN, 1935 as *Parmelia saxatilis* var. *aizoni*) – 9 decaying stump

Parmelia sulcata Taylor
Vicinity of Vučjak Kamenski, 310 m; near Zvečevo, by the road, 440 m; very frequent in the overall area (KUŠAN, 1935) – 3 limestone rocks; 4 *Acer platanoides*; 6 *Carpinus betulus*; 7 *Quercus frainetto*; 8 siliceous rocks; 11 *Quercus petraea*; 14 *Quercus petraea*; 17 *Fagus sylvatica*

Parmeliella triptophylla (Ach.) Müll.Arg.
Rastova kosa (STOITZNER, 1869 as *Pannaria triptophylla*)

Parmelina tiliacea (Hoffm.) Hale
Below the main peaks (KUŠAN, 1935 as *Parmelia scortea*) – Turski grad near Voćin, 300 m; near Vučjak Kamenski, 310 m; Krivalski kamen, 730 m (KUŠAN, 1935 as *Parmelia tiliacea*)

Parmeliopsis ambigua (Wulfen) Nyl.
South slopes of the main peaks, 800 m (KUŠAN, 1935)

Parmotrema perlatum (Huds.) M. Choisy
Brzaja and Točak (STOITZNER, 1869 as *Imbricaria perlata*) – 7 *Quercus petraea*; 8 *Quercus petraea*; 9 *Fagus sylvatica*; 12 *Fagus sylvatica*; 14 *Quercus petraea*

Peltigera canina (L.) Willd.
Meadow within forest near Voćin towards Zvečevo (SCHULZER v. MÜGGENBURG *et al.*, 1866) – Below the main peaks, 700 m (KUŠAN, 1935)
Note: The original specimen collected by Kušan (June 18, 1930) was checked in ZA.

Peltigera collina (Ach.) Schrad.
Korlati (STOITZNER, 1869 as *Peltigera limbata*)

Peltigera horizontalis (Huds.) Baumg.
Zvečevo, in forests (STOITZNER, 1869) – Velinca valley, 370m (KUŠAN, 1935) – 4 on moss cover on rock

Peltigera polydactylon (Neck.) Hoffm.
Southern slopes of the main peaks, c. 800 m (KUŠAN, 1935) – 12 on decaying stump of *Fagus sylvatica*
Note: The original specimen collected by Kušan (June 18, 1930) was checked in ZA.

Peltigera praetextata (Sommerf.) Zopf
Between the main peak and peak Dubrave, c. 750 m (KUŠAN, 1935 as *Peltigera subcanina*) – 3 limestone rocks; 4 on rock; 7 *Quercus frainetto*; 11 moss covered stone; 17 *Fraxinus excelsior*
Note: The original specimens collected by Kušan (June 18, 1930) were checked in ZA.

Peltigera venosa (L.) Hoffm.
Brzaja near Zvečevo (STOITZNER, 1869)

Pertusaria albescens (Huds.) M. Choisy & Werner
By the road between Vučjak Kamenski and Zvečevo, 300-350 m (KUŠAN, 1935 as *Pertusaria globulifera*) – 4 *Fagus sylvatica*; 12 *Quercus pubescens*; 14 *Quercus petraea*

Pertusaria amara (Ach.) Nyl.
Path from Vučjak Kamenski towards ruins of Kamengrad, 380 m; near the Stambulić hut in Velinca valley, 460 m; by the path from Jankovac towards the main peak, 800 m (KUŠAN, 1935)

Pertusaria flavida (DC.) J.R. Laundon
Between the main peak and Dubrave peak, c. 750 m (KUŠAN, 1935 as *Pertusaria lutescens*)

Pertusaria pertusa (Weigel) Tuck.
Near the Stambulić hut in Velinca valley, 460 m (KUŠAN, 1935)

* *Phlyctis argena* (Spreng.) Flot.
4 *Acer pseudoplatanus*

Physcia adscendens H. Olivier
Turski grad near Voćin, 300 m; Vučjak Kamenski (KUŠAN, 1935) – 11 *Juglans regia*

Physcia caesia (Hoffm.) Fürnr.
Turski grad near Voćin, 300 m (KUŠAN, 1935)

Physcia leptalea (Ach.) DC.
Near the Stambulić hut in Velinca valley, c. 460 m (KUŠAN, 1935)

Physcia stellaris (L.) Nyl.
Brzaja (STOITZNER, 1869 as *Parmelia stellaris*) – Videly distributed in the area (KUŠAN, 1935) – 8 on dry tree branch; 14 *Quercus petraea*

Physcia tenella (Scop.) DC.
Velinca valley, 460 m; above Kantrovci, 300 m (KUŠAN, 1935)

Physconia distorta (With.) J.R. Laundon
Frequent on various trees (Stoitzner, 1869 as *Parmelia stellaris*) – Widely distributed in the area (KUŠAN, 1935 as *Physcia pulverulenta*)

* *Platismatia glauca* (L.) W.L. Culb. & C.F. Culb.
14 *Quercus petraea*; 17 *Prunus avium*

* *Pleurosticta acetabulum* (Neck.) Elix & Lumbsch
8 near Velički grad, *Quercus pubsecens*

Porpidia albocaerulescens (Wulfen) Hertel & Knoph
Kamengrad (STOITZNER, 1869 as *Lecidea albocaerulescens*)

Porpidia macrocarpa (DC.) Hertel & A.J. Schwab
By the road between Vučjak and Zvečevo, 300–330 m (KUŠAN, 1935 as *Lecidea macrocarpa*)

Protoblastenia rupestris (Scop.) J. Steiner
Papuk (STOITZNER, 1869 as *Biatora rupestris*)

Protoparmeliopsis muralis (Schreb.) M. Choisy
Western ridge of the main peaks, 740 m; Turski grad near Voćin, 300 m (KUŠAN, 1935 as *Lecanora muralis*)

Pseudevernia furfuracea (L.) Zopf
Path from Jankovac towards the main peak; Jankovac (KUŠAN, 1935 as *Parmelia furfuracea*) – 2 *Fagus sylvatica*; 4 *Picea abies*; 8 *Quercus petraea*; 9 *Quercus petraea*; 10 *Abies alba*; 11 *Quercus petraea*; 17 *Picea abies*

Pyrenula nitida (Weigel) Ach.
Velinca valley, 370 and 460 m; near the Stambulić hut in Velinca valley, c. 460 m; path from Jankovac towards the main peak, c. 800 m (KUŠAN, 1935)

Ramalina farinacea (L.) Ach.
Near the Stambulić hut in Velinca valley, c. 460 m; near Zvečevo, 440 m; very frequent on *Fagus sylvatica* (KUŠAN, 1935) – 7 *Quercus frainetto*; 12 *Fraxinus ornus*; 14 *Quercus petraea*; 17 *Fraxinus excelsior*

Ramalina fastigiata (Pers.) Ach.
Upper part of Velinca valley, 400 m (KUŠAN, 1935 as *Ramalina populina*) – 9 *Fraxinus ornus*; 14 *Quercus petraea*

Ramalina fraxinea (L.) Ach.
Rastova kosa near Zvečevo (STOITZNER, 1869) – Between the main peak and Dubrave peak, 800 m (KUŠAN, 1935) – 12 *Quercus pubescens*

Ramalina pollinaria (Westr.) Ach.
Path from Vučjak Kamenski towards ruins of Kamengrad, 380 m; very frequent in the overall area; western ridge of the main peaks, 660 m (KUŠAN, 1935)

Rhizocarpon distinctum Th. Fr.
Northern side of the ruins of Kamengrad, 550 m (KUŠAN, 1935 as *Rhizocarpon ambiguum*)

Rhizocarpon geographicum (L.) DC.
Ruins of Kamengrad, 612 m; Rupnica near Voćin, 250 m; Turski grad near Voćin, 300 m (KUŠAN, 1935) – 8 on siliceous rock
Note: The original specimen collected by Ginzberger (August 23, 1918) was checked in ZA.

Rhizocarpon grande (Floerke) Arnold
Northern side of the ruins of Kamengrad, 550 m (KUŠAN, 1935)

Rhizocarpon reductum Th. Fr.
From Vučjak to Zvečevo, on the road, 300–330 m; from Velika to Duboka glazier's workshop, 300–400 m (KUŠAN, 1935 as *Rhizocarpon obscuratum*)

Sarcogyne regularis Körb.
East of Mihajlić (KUŠAN, 1935 as *Biatorella pruinosa*)

* *Squamarina cartilaginea* (With.) P. James
12 on rock

Squamarina lentigera (Weber) Poelt
Rastova kosa (STOITZNER, 1869 as *Psoroma lentigerum*)

Sticta sylvatica (Huds.) Ach.
Brzaja near Zvečevo (STOITZNER, 1869 as *Sticta fuliginosa*).
Note: The original specimen was checked in the herbarium of Natural History Museum in Vienna (W). The specimen was revised as *Sticta sylvatica* by Du Rietz.

Tephromela atra (Huds.) Hafellner
Between the main peak and Dubrave peak, 800 m (KUŠAN, 1935 as *Lecanora atra*)

Toninia sedifolia (Scop.) Timdal
Near Zvečevo (STOITZNER, 1869 as *Thalloidima vesiculare*) – Turski grad near Voćin, c. 300 m (KUŠAN, 1935 as *Toninia coeruleo-nigricans*)

Umbilicaria hirsuta (Westr.) Hoffm.
8 Tauberove stijene (N 45°28.953' E 17°39.240'), on vertical, well lit and nutrient-enriched faces of siliceous rocks
Note: This is new record for the lichen flora of Croatia. The occurrence of this lichen was reported for Serbia and Macedonia (KUŠAN, 1953). It is also present in Slovenia.

Usnea florida (L.) F.H. Wigg
Turski grad near Voćin (SCHULZER v. MÜGGENBURG *et al.*, 1866) – Near Vučjak Kamenski, 300 m; upper part of Velinca valley, 400 m; very frequent in the overall area (KUŠAN, 1935)
Note: The original specimen collected by Kušan (June 18, 1930) was checked in ZA.

Usnea hirta (L.) F.H. Wigg
Johannesberg near Zvečevo (STOITZNER, 1869 as *Usnea barbata* var. *hirta*) – Very frequent in the overall area (KUŠAN, 1935)

Verrucaria denudata Zschacke
Near the Stambulić hut in Velinca valley, c. 480 m (KUŠAN, 1935)

Verrucaria muralis Ach.
Northern side of the western ridge, 700 m; area of the main peaks, 950 m (KUŠAN, 1935 as *Verrucaria rupestris*)

Verrucaria nigrescens Pers.
Western ridge of the main peaks, 700 m; by the road from Velika to Duboka glazier's workshop, 300–400 m; east of Mihajlić, 400 m (KUŠAN, 1935)

Xanthoparmelia conspersa (Ach.) Hale
Korlati (STOITZNER, 1869 as *Imbricaria conspersa*) – Turski grad near Voćin, 300 m; Rupnica near Voćin, 250 m; northern side of the ruins of Kamengrad, 550 m; peak

Dubrave; near Jankovac (KUŠAN, 1935 as *Parmelia conspersa*); Vrani kamen, 817 m (KUŠAN, 1935 as *Parmelia conspersa* f. *isidiata*) – 8 Tauberove stijene, siliceous rocks

Xanthoparmelia pulla (Ach.) O. Blanco et al.
Turski grad near Voćin, 300 m (KUŠAN, 1935 as *Parmelia prolixa*)

Xanthoparmelia sublaevis (Cout.) Hale
Vrani kamen, c. 700 m (KUŠAN, 1935 as *Parmelia conspersa* var. *hypoclista*)

Xanthoria parietina (L.) Th. Fr.
On tree trunks and decayed wooden boards (SCHULZER v. MÜGGENBURG *et al.*, 1866 as *Physcia parietina*) – Turski grad near Voćin, 300 m (KUŠAN, 1935) – 8 on dry tree branch; 12 *Quercus pubescens*; 15 *Fraxinus ornus*

Doubtful records

Caloplaca lobulata (Flörke) Hellb.
Turski grad near Voćin, 300 m, on heavily decomposed rocks (KUŠAN, 1935)
Note: This lichen is a corticolous or lignicolous species. Determination was probably incorrect, but the original specimen for checking was not found in herbaria ZA and W.

Chrysothrix candelaris (L.) J.R. Laundon
Kovačica stream near the forester's house at Jankovac, 450 m, on calcareous tuff (KUŠAN, 1935 as *Lepraria candelaris*)
Note: This lichen is strictly corticolous species. Determination was probably incorrect, but the original specimen for checking was not found in herbaria ZA and W.

The checklist includes 129 species belonging to 63 genera. Data for 120 species originated from the historical records and for 37 species are from the recent survey. The lichen *Umbilicaria hirsuta* is new to Croatia (Fig. 3), and eight species: *Cladonia macilenta*, *Collema crispum*, *Hypocenomyce scalaris*, *Lecanora subrugosa*, *Phylctis argena*, *Platismatia glauca*, *Pleurosticta acetabulum* and *Squamarina cartilaginea*, are new for Papuk Nature Park.

The most diverse genera are *Cladonia* (12 species), *Caloplaca* (8), *Lecanora* (8), *Peltigera* (6) and *Physcia* (5 species). Crustose lichens were dominant (50 %), foliose were also numerous (33 %), followed by fruticose lichens (17 %).

The lichens were recorded on 20 organic (trees, shrubs and mosses) and two inorganic substrata (soil and rocks). Saxicolous lichens with 88 species (70% of total flora) dominate. This is due to the particular geological diversity of the Papuk area, with numerous varieties of rock types. Four lichens are terricolous. The most frequent host-trees of epiphytic lichens are *Fagus sylvatica*, supporting 52 species, *Quercus petraea* (41), *Picea abies* (8), and *Carpinus betulus* (7 species).

Forest management activity affects species richness and composition of forest-associated lichens (NASCIMBENE *et al.*, 2007). Two types of management are present in the Papuk Nature Park. In unmanaged forests, single trees or small groups are periodically logged, ensuring the presence of a continuous canopy.

This is prevalent in mixed and multilayered stands with beech, manna ash, and pubescent oak. In managed forests, mainly stands with pure beech or sessile oak,

Fig. 3. Umbilicate lichens at the locality »Tauberove stijene«: a) *Umbilicaria hirsuta*, b) *Lasallia pustulata* (photo: S. Ozimec, 9 May 2010)

the intensive shelterwood-cutting is based on a progressive thinning of even-aged trees, and it is concluded in ca. 100-120 years. In the past, sizeable final clear-cutting was done up to 70 years ago, with an intensity of 260 ha/year, while during the last 20 years the intensity was reduced to 100 ha/year (SAMARĐIĆ, 2005). Since commercial forests make up 89% of total forest stands, dominance of beech and sessile oak trees, and the rotation period of 100 years, further final clear-cutting is planned for the next 20–30 years.

Forest management in Croatia combines principles of sustainability, productivity and biological diversity (VUKELIĆ *et al.*, 2008). However, the importance of lichens for assessing forest sites worthy of conservation is not included as an additional criteria of natural forest management.

Some epiphytic lichens are considered good indicator species of undisturbed forest ecosystem and environmental continuity (WOLSELEY & JAMES, 2000; CAMPBELL & FREDEEN, 2004). Among those species, ten foliose macrolichens belonging to the genera *Leptogium*, *Lobaria*, *Nephroma*, *Parmeliella*, *Peltigera* and *Sticta* were recorded in the Papuk Nature Park. The flagship species is *Lobaria pulmonaria*, which is in dramatic decline across Europe, due to negative impact of air pollution and destruction of old forests, caused by intensified forest management practice (GAUSLAA, 1995; JÜRIADO & LIIRA, 2009). In the Papuk Nature Park, *Lobaria pulmonaria* was historically recorded at two sites, and during our fieldwork it was found at three new sites: Kamengrad (on *Quercus petraea*, DBH=43 cm), Gudnoga (on *Fagus sylvatica*, DBH=56cm), and Pliš (on *Quercus pubescens*, DBH=56 cm).

The abundance of *Lobaria pulmonaria* proved to be a potential indicator of forest stands hosting rare lichens species (NASCIMBENE *et al.*, 2010).

An extensive survey of diversity and distribution of forest-associated lichens in unmanaged and managed forest stands is needed. Distributional data should enable

identification of priority conservation zones for *Lobaria pulmonaria*, and other rare lichen species in the Papuk Nature Park, in order to improve the focus on biodiversity conservation in the forest management.

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SAŽETAK

Prilog poznavanju lišajeva Parka prirode Papuk (Slavonija, istočna Hrvatska)

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Obnovljenim lihenološkim istraživanjima Parka prirode Papuk utvrđeno je da aktualna lišajska flora broji 129 vrsta, svrstanih u 63 roda. Podaci za izradu florne liste prikupljeni su iz literaturnih izvora, publiciranih u 19. i 20. stoljeću, te nadopunjeni s podacima zabilježenima tijekom terenskog istraživanja na 17 lokaliteta u razdoblju 2005.–2007. godine. Po prvi puta je za lišajsku floru Hrvatske zabilježena vrsta *Umbilicaria hirsuta*, a za Park prirode Papuk osam je novih vrsta: *Cladonia macilenta, Collema crispum, Hypocenomyce scalaris, Lecanora subrugosa, Phlyctis argena, Platismatia glauca, Pleurosticta acetabulum* i *Squamarina cartilaginea.* Vrstama su najbrojniji rodovi: *Cladonia, Caloplaca, Lecanora, Peltigera* i *Physcia.* Prema životnom obliku, prevladavaju lišajevi korastog talusa (50 %), zatim slijede listasti (33 %) i grmasti (17%) lišajevi. Zabilježene su 22 organske i anorganske podloge na kojima rastu lišajevi. Epilitski lišajevi su najzastupljeniji s 88 vrsta (70 % ukupne flore). Epifitski lišajevi su najčešće zabilježeni na stablima bukve (*Fagus sylvatica*), hrasta kitnjaka (*Quercus petraea*) i smreke (*Picea abies*), te na mahovini i panjevima. Potvrđena je prisutnost rijetke i ugrožene lišajske vrste *Lobaria pulmonariea*, indikatora starih i očuvanih šumskih ekosistema te je pronađena na još tri nova nalazišta.