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LICHENS FROM THE ZEMPLÍNSKE VRCHY MTS AND *PHYSICIA LEPTALEA* NEW TO SLOVAKIA

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We present the results of lichenological survey in the area of Zemplínske vrchy Mts in this paper. The study area is underexplored regarding lichens and there are not many published resources on lichens. In total thirty-five localities were investigated and 68 lichen species were identified. Fifteen species of them are evaluated in the Red list of lichens of Slovakia. From interesting findings, *Cladonia crispata*, *Graphis scripta*, *Lecanora conizaeoides* and *Flavoparmelia caperata* are discussed here. *Physicia leptalea* is reported for the first time for the area of Slovakia.

Key words: central Europe, lichen diversity, lichenized fungi, Western Carpathians

INTRODUCTION

Zemplínske vrchy Mts (Western Carpathians, SE Slovakia) are small volcanic mountains with an area of 103 km² located in southeastern Slovakia as a western part of the Eastern Slovakian Lowland (Fig. 1). It represents one of the oldest volcanic mountains, composed of Palaeozoic-Mesozoic and partly neovolcanic rocks. The highest elevation point is Rozhľadňa hill (470 m a.s.l.). Forests cover approximately 39% of the territory. The oak-hornbeam forests with xeric and thermophilic species are the most predominant, however the beech and black locust forests represented in minority are also present. The secondary xerothermous pastures, grassland vegetation and the small quarries were formed by human activities on the periphery of the mountains (Fusán 1972, Futák 1972, Mártonfi 2014, Mráz *et al.* 2016). On the southern and southwestern slopes vineyards are located, which have been known as “Tokajská vinohradnícka oblasť” (“Slovakian or smaller Tokaj wine region”).

From geomorphological division of Slovakia, it belongs to the Inner Western Carpathians (Mazúr and Lukniš 1986), from phytogeographical point of view to the area of Pannonian flora region (Pannonicum) and phytogeographical district Eastern Slovakian Lowland (Futák 1984).

Calcareous area covers only 6.6% of the territory (Mráz *et al.* 2016), mainly near Ladmovce village. The most precious parts, Kašvár Nature Reserve and European protected area Ladmovské vápence (SKUEV0032) were estab-

lished to protect the limestone karst elements with thermophilic and calcicolous vegetation. Southern parts of the mountains are bordered by the Latorica Protected Landscape Area (CHKO Latorica).

The aims of the study are to fill the lack information about lichen diversity knowledge in the study area and to present a list of recent lichen flora collected from the Zemplínske vrchy Mts. This paper contributes to the knowledge of lichens of southeastern Slovakia.

MATERIALS AND METHODS

The field work was carried out from November 2014 to March 2015 in a period without snow cover in the Zemplínske vrchy Mts. Samples were collected for identification and are deposited in the private herbarium of the first author. Localities are shown in Figure 1. The investigated sites were georeferenced from Garmin eTrex 20 in the WGS-84 coordinate system.

The location map was processed using the ArcMap software (Department of Geography, Pavol J. Šafárik University, Košice), which shows collected coordinates from GPS receivers as point objects. The nomenclature of lichens follows Guttová *et al.* (2013a), the categories of threat are listed according to the Red list of lichens of Slovakia (Pišút *et al.* 2001). The nomenclature of vascular plants follows Marhold *et al.* (2007). Studies of herbarium collections were not included in this study. The specimen of *Physcia leptalea* is deposited in the private herbarium of the first author. All specimens were collected by the second author.

List of the studied sites

Information on localities is arranged as follows: the name of the closest village, locality, characterisation of the site, GPS coordinates, date of collection.

1. Cejkov, Vlčia hora hill (257 m), meadow at the top, 48° 28' 24.0" N, 21° 45' 21.6" E, 16.11.2014.

2. Cejkov, windbreak between fields, 48° 28' 45.5" N, 21° 45' 15.8" E, 16.11.2014.

3. Cejkov, Vlčia hora hill, old abandoned vineyard, 48° 28' 31" N, 21° 45' 24" E, 16.11.2014.

4. Cejkov, roadsides cross monument (God's torture) towards to Kašov village, 48° 28' 28.89" N, 21° 44' 53.02" E, 16.11.2014.

5. Cejkov, Castle hill (= Várhegy, hill 213), quarry, pine-birch forest, 48° 28' 2.01" N, 21° 46' 1.59" E, 23.11.2014.

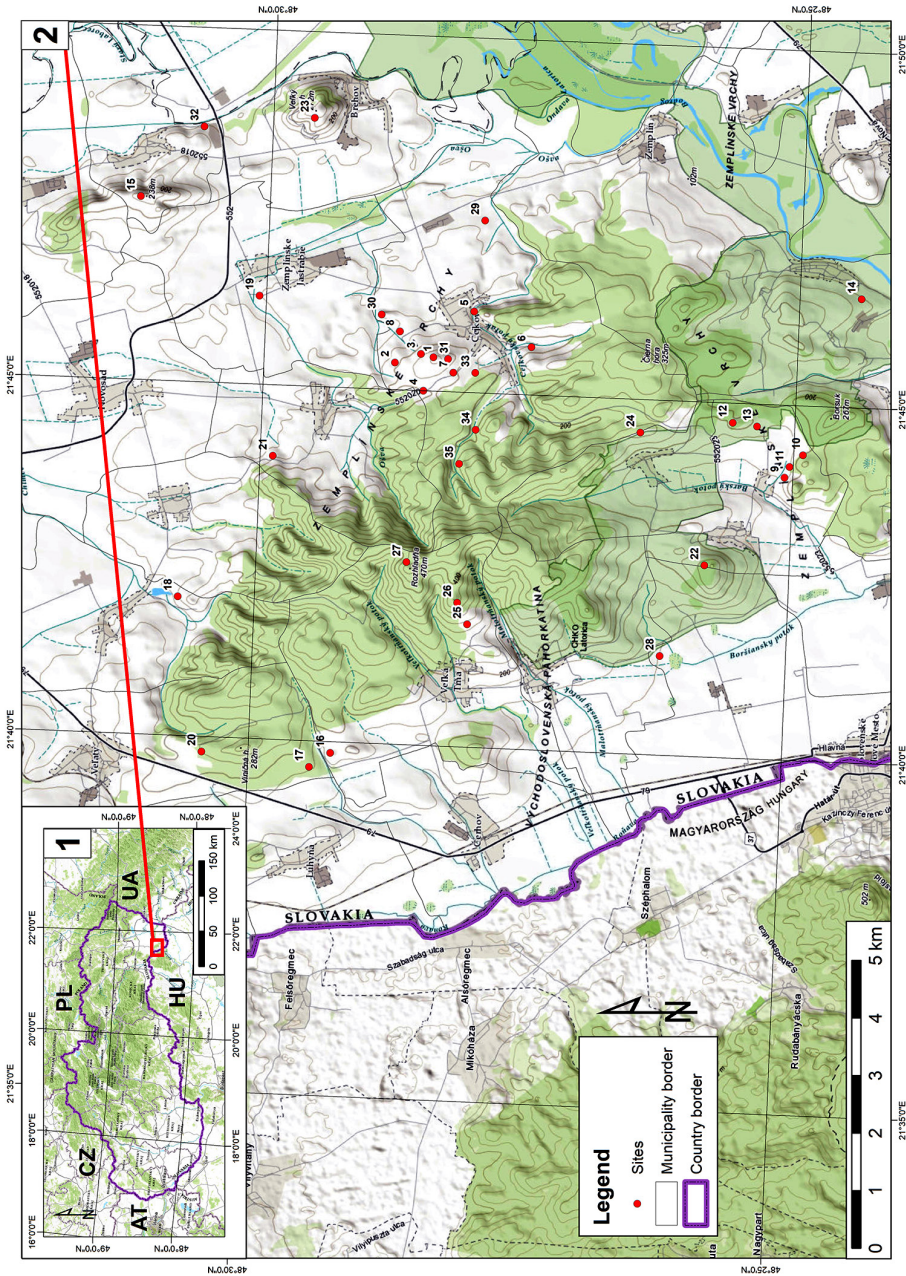


Fig. 1. Location of the Zemplínske Vrchy mountains in Slovakia (1) and investigated sites in the Zemplínske Vrchy Mts (2)

6. Cejkov, old abandoned pastures near game reserve, in terrain depression and on field roadside, 48° 27' 29.11" N, 21° 45' 33.47" E, 30.11.2014.
7. Cejkov, roadside scrubs towards to Kašov village, 48° 28' 12.47" N, 21° 45' 9.29" E, 29.11.2014.
8. Cejkov, Tokajík hill (= Tokajský hill, 159 m), abandoned quarry, 48° 28' 43.38" N, 21° 45' 42.31" E, 29.11.2014.
9. Malá Bara, Stredný vrch hill, solitary volcanic rocks on former pasture, 48° 25' 3.90" N, 21° 43' 51.81" E, 23.11.2014.
10. Malá Bara, Stredný vrch hill, abandoned quarry, 48° 24' 54.02" N, 21° 44' 11.44" E, 23.11.2014.
11. Malá Bara, Stredný vrch hill, xerothermous oak grove, 48° 25' 1.28" N, 21° 44' 1.04" E, 23.11.2014.
12. Malá Bara, Brezinka hill, southern slopes, beech forest, 48° 25' 34.25" N, 21° 44' 36.5" E, 6.12.2014.
13. Malá Bara, site Bečked, old quarry, 48° 25' 20.52" N, 21° 44' 34.13" E, 7.12.2014.
14. Ladmovce, Šomoš hill, Kašvár Nature Reserve, karst depressions, 48° 24' 53" N, 21° 46' 25" E, 20.12.2014.
15. Sírnik, hill 236, around transmitter on the top, on rocks and branches of *Crataegus* sp. and *Prunus spinosa*, 48° 31' 11.96" N, 21° 47' 28.12" E, 7.12.2014.
16. Veľká Trňa, old quarry, 48° 29' 13" N, 21° 39' 43.6" E, 6.12.2014.
17. Veľká Trňa, old quarry, 48° 29' 24.5" N, 21° 39' 31" E, 6.12.2014.
18. Hrčeľ, Baňa hill and quarry, 48° 30' 42.3" N, 21° 41' 50.8" E, 13.12.2014
19. Zemplínske Jastrabie, hill 127, sand quarry, 48° 30' 3.11" N, 21° 46' 7.8" E, 13.12.2014.
20. Veľaty, car camping ATC Mária, margin of oak forest near parking, 48° 30' 25.32" N, 21° 39' 40.22" E, 12.12.2014.
21. Kašov, Strekov site, scrub on meadow, 48° 29' 52" N, 21° 43' 53" E, 21.12.2014.
22. Veľká Bara, Piliš hill (278 m), scrubs on field roadside to the top, 48° 25' 47" N, 21° 42' 35" E, 20.12.2014.
23. Brehov, Veľký vrch hill (272 m), quarry, 48° 29' 36" N, 21° 48' 40" E, 21.12.2014.
24. Černochoch, scrubs on meadow, 48° 26' 26" N, 21° 44' 25" E, 20.12.2014.
25. Veľká Trňa, scrubs on forest edge, 48° 27' 59" N, 21° 41' 37" E, 30.12.2014.
26. Veľká Trňa, oak grove, 48° 28' 05" N, 21° 41' 55" E, 30.12.2014.
27. Veľká Trňa, Rozhľadňa hill (470 m), on decayed oak stump, 48° 28' 34.5" N, 21° 42' 27.6" E, 30.12.2014.
28. Bara, settlement Káty, scrubs on roadside, 48° 26' 10" N, 21° 41' 17" E, 30.12.2014.

29. Cejkov, site Piesky, sand quarry, 48° 27' 58" N, 21° 47' 19" E, 29.12.2014.
 30. Cejkov, Tokajík hill (159 m), scrubs on archaeological site, 48° 28' 54" N, 21° 45' 56" E, 21.12.2014.
 31. Cejkov, Vlčia hora hill (257 m), scrubs on field roadside to the top, 48° 28' 15.7" N, 21° 45' 20.6" E, 10.1.2015.
 32. Sirník, abandoned quarry near former collective farm, 48° 30' 37.8" N, 21° 48' 29.1" E, 31.1.2015.
 33. Cejkov, Potočková forest, 48° 28' 00.1" N, 21° 45' 09.9" E, 1.2.2015.
 34. Cejkov, Bocianí vrch hill (267 m), northern slope (local name Tistaš), 48° 27' 58.6" N, 21° 44' 21.8" E, 22.3.2015.
 35. Cejkov, Plochá hora hill (348 m), northern slope (local name Wambengerov I), 48° 28' 07.1" N, 21° 43' 52.4" E, 22.3.2015.

LIST OF THE RECORDED SPECIES

Abbreviations of phorophytes: Ac = *Acer campestre*, Bp = *Betula pendula*, Cb = *Carpinus betulus*, C = *Crataegus* sp., Pt = *Populus tremula*, Ps = *Prunus spinosa*, Psy = *Pinus sylvestris*, Pc = *Populus canadensis*, Qr = *Quercus robur*, Q = *Quercus* sp., Rc = *Rosa canina*, Sn = *Sambucus nigra*, Sc = *Salix caprea*. Remark: the first report for the area of Slovakia is indicated by an asterisk (*).

Acarospora cf. *nitrophila* H. Magn. agg. – 15 (on Pt), 23 (on Pt, Ps), 29 (on Pt);
Amandinea punctata (Hoffm.) Coppins et Scheid. – 1–8, 11–13, 15, 18, 21, 23–26, 28, 30, 31, 33 (on different substrates);

Caloplaca saxicola (Hoffm.) Nordin – 18 (on ryodacite rocks);

Candelariella aurella (Hoffm.) Zahlbr. – 14 (on limestone rocks), 15 (on andesite rocks);

Candelariella sp. – 35 (on Cb);

Chrysothrix candelaris (L.) J. R. Laundon – 22 (on Psy);

Circinaria contorta (Hoffm.) A. Nordin, S. Savić et Tibell – 14 (on limestone rocks);

Cladonia arbuscula (Wallr.) Flot. – 13 (on ground);

Cladonia cariosa (Ach.) Spreng. – 13 (on ground), 34 (on ground among mosses);

Cladonia coniocraea (Flörke) Spreng. – 20 (on Qr), 27 (on Q), 35 (on bark Cb at base);

Cladonia convoluta (Lam.) Anders – VU – 14 (on ground in grassy steppe);

Cladonia crispata (Ach.) Flot. – VU – 13 (on ground among mosses);

Cladonia fimbriata (L.) Fr. – 6, 12, 18, 23, 34 (at each sites on ground);

Cladonia foliacea (Huds.) Willd. – 12 (on red-grey sandstone);

Cladonia furcata (Huds.) Schrad. – 5, 10, 12–16, 23, 34 (at each sites on ground among mosses);

- Cladonia pocillum* (Ach.) Grognot – 23 (on andesite rocks);
Cladonia polydactyla (Flörke) Spreng. – 12 (on red-grey sandstone), 17 (on volcanic rocks), 26 (on ground);
Cladonia pyxidata (L.) Hoffm. – 10 (on volcanic rocks), 12 (on red-grey sandstone), 14 (between limestone rocks);
Cladonia rangiformis Hoffm. – 5 (on ground), 12 (on ground);
Cladonia squamosa (Scop.) Hoffm. – 12 (on red-grey sandstone);
Cladonia subulata (L.) F. H. Wigg. – 23 (on andesite rocks);
Dibaeis baeomyces (L. f.) Rambold et Hertel – 6 (on brown clay);
Evernia prunastri (L.) Ach. – EN – 2, 3, 6, 7, 11, 12, 14, 16, 18, 20–28, 30, 35 (mainly on Ps);
Flavoparmelia caperata (L.) Hale – EN – 5 (on Q), 7 (on Ac), 15 (on Ps), 26 (on Q), 30 (on Ps), 32 (on C);
Graphis scripta (L.) Ach. – EN – 35 (on Cb);
Hypogymnia physodes (L.) Nyl. – 3, 5–7, 11, 12, 14, 16, 18, 22–28, 30, 35 (on different phorophytes);
Hypogymnia tubulosa (Schaer.) Hav. – LR:nt – 6 (on Ps, Ac), 22 (on Ps, Qr), 28 (on Ps);
Lecania cyrtella (Ach.) Th. Fr. – DD – 2 (on Ps), 3 (on Ps), 24 (on Ps), 29 (on Pt), 31 (on Ps, Rc);
Lecania naegelii (Hepp) Diederich et van den Boom – 29 (on Pt), 30 (on Ps), 33 (on Pt);
Lecanora carpinea (L.) Vain. – 33 (on Cb), 35 (on Cb);
Lecanora chlarotera Nyl. – 20 (on Qr);
Lecanora conizaeoides Nyl. ex Cromb. – 20 (on Qr);
Lecanora crenulata Hook. – 18 (on ryodacite rocks);
Lecanora dispersa (Pers.) Sommerf. – 14 (on limestone rocks);
Lecanora saxicola (Pollich) Ach. – 14 (on limestone rocks), 15 (on andesite rocks), 32 (on andesite rocks);
Lecanora symmicta (Ach.) Ach. – 3 (on C, Ps), 6 (on Ps, Ac), 18 (on Ps), 28 (on Ps), 30 (on Ps, Rc);
Lecidella carpathica Körb. – 23 (on Pt);
Lecidella elaeochroma (Ach.) M. Choisy – 25 (on Ps), 35 (on Cb);
Lepraria sp. – 10 (on volcanic rocks), 17 (on Qr), 26 (on Q), 33 (on Qr);
Melanelixia glabratula (Lamy) Sandler et Arup (syn. *Parmelia glabratula*) – 33 (on Qr), 35 (on Qr);
Melanelixia subaurifera (Nyl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. et Lumbsch – 6 (on Ps), 12 (on Ps, Qr), 18 (on Ps), 21 (on Ps), 24 (on Ps), 25 (on Ps, Rc);
Melanohalea exasperatula (Nyl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. et Lumbsch – 35 (on Cb);

- Parmelia sulcata* Taylor – 1, 3–7, 11–13, 15, 19, 21, 22, 24, 25, 28, 31, 33, 35 (on different phorophytes);
- Peltigera horizontalis* (Huds.) Baumg. – 14 (between limestone rocks in grassy steppe);
- Peltigera rufescens* (Weiss) Humb. – 35 (on Qr);
- Pertusaria albescens* (Huds.) M. Choisy et Werner – **LR:nt** – 20 (on Qr, Sn);
- Phaeophyscia orbicularis* (Neck.) Moberg – 1 (on Qr), 2 (on Pc), 7 (on Ac, Ps), 8 (on Sn), 19 (on Pt, Sc), 28–31 (on Ps, Rc, Pt);
- Phlyctis argena* (Spreng.) Flot. – 17 (on Qr);
- Physcia adscendens* H. Olivier – 1, 2, 4–8, 13, 17–25, 28, 29, 31, 33, 35 (mainly on Ps, Rc, Qr);
- Physcia aipolia* (Ehrh. ex Humb.) Fürnr. – 3 (on Ps), 5 (on Qr), 7 (on Ps), 12 (on Qr, Bp), 16 (on Pt), 21 (on Ps), 24 (on Ps), 31 (on Ps, C), 32 (on C);
- **Physcia leptalea* (Ach.) DC. – 31 (on Ps);
- Physcia stellaris* (L.) Nyl. – 1, 6, 8, 25, 29, 30, 33 (mainly on Qr, Pt);
- Physcia tenella* (Scop.) DC. – 15 (on Ps, C), 28 (on Ps);
- Porina aenea* (Wallr.) Zahlbr. – 35 (on Cb);
- Porpidia crustulata* (Ach.) Hertel et Knoph – 18 (on ryodacite rocks);
- Pseudevernia furfuracea* (L.) Zopf – **LR:nt** – 3, 5, 6, 11, 12, 16, 18, 20–25, 28, 31 (on different phorophytes);
- Ramalina farinacea* (L.) Ach. – **EN** – 7 (on Ps), 28 (on Ps);
- Rinodina pyrina* (Ach.) Arnold – **VU** – 24 (on Ps), 28 (on Ps);
- Rinodina sophodes* (Ach.) A. Massal. – **VU** – 3 (on Ps);
- Sarcogyne regularis* Körb. – 14 (on limestone rocks);
- Scoliciosporum chlorococcum* (Graewe ex Stenh.) Vězda – 6 (on Ps), 25 (on Q, Ps), 26 (on Q), 28 (on Ps), 31 (on Ps, Rc);
- Usnea* cf. *hirta* (L.) F. H. Wigg. – **VU** – 18, 24, 25, 28, 30 (all on Ps, Rc);
- Verrucaria* cf. *rupestris* Schrad. – 18 (on ryodacite rocks);
- Xanthoparmelia conspersa* (Ehrh. ex Ach.) Hale – 9 (on volcanic rocks);
- Xanthoparmelia pulla* (Ach.) O. Blanco, A. Crespo, Elix, D. Hawksw. et Lumbsch – 9 (on volcanic rocks);
- Xanthoparmelia stenophylla* (Ach.) Ahti et D. Hawksw. – 9 (on volcanic rocks);
- Xanthoria parietina* (L.) Th. Fr. – **LR:nt** – 1–4, 6–8, 12–15, 18–21, 23–25, 28–30, 32, 33 (on different substrates);
- Xanthoria polycarpa* (Hoffm.) Th. Fr. ex Rieber – **LR:nt** – 20 (on Qr).

DISCUSSION

The records of lichens from the Zemplínske vrchy Mts. are not well known and the investigation of this area was more than necessary, although

the vascular plants in the territory were explored properly during the Floristical course (Mártonfi 2014). The area is underexplored regarding lichens and attractive habitats as limestones, volcanic rocks and sandstone soils exist here. The Hungarian adjacent Zempléni- and Tokaj-hegység mountains were explored during last centuries (e.g. Hazslinszky 1866, Versegly 1964).

During our field research in the Zemplínske vrchy Mts 68 lichen species were collected from 35 localities. Fifteen species are included in four categories of threat level in the red list of lichens of Slovakia: 5 vulnerable (VU), 4 endangered (EN), 5 lower risk: near threatened (LR:nt) and 1 data deficient (DD).

The highest diversity was recorded in the genus *Cladonia* (14 species), *Lecanora* (7 species), *Physcia* (5 species) and *Xanthoparmelia* (3 species). From the total amount of 68 recorded species we noted 10 species were observed growing in more than 8 localities, 9 species in 4–8 localities, 15 species in 2–3 localities and 35 species recorded only in a single locality.

The most frequent lichen species in the Zemplínske vrchy Mts growing in more than eight localities were *Amandinea punctata*, *Cladonia furcata*, *Evernia prunastri*, *Hypogymnia physodes*, *Parmelia sulcata*, *Phaeophyscia orbicularis*, *Physcia adscendens*, *Physcia aipolia*, *Pseudevernia furfuracea* and *Xanthoria parietina*. These species grow quite commonly in a number of populations in suitable habitats in the whole study area.

Twenty-four species were recorded from 2 to 8 localities, but it is probability of founded new places of occurrence in study area. In case of *Usnea* cf. *hirta*, many juvenile lichen thalli are distributed in village of Cejkov in orchards, mainly on branches of old plum and apple trees, but these sites were not included in this study. Lichen thalli grow hidden between branches of trees and the thallus is never longer than 5 cm, therefore it is easily overlooked.

The most important findings of species recorded from 34 one-locality are considered to be *Physcia leptalea*, *Cladonia crispata*, *Graphis scripta*, *Flavoparmelia caperata* and *Lecanora conizaeoides*.

***Physcia leptalea*:** This is the first report within the country. The species has not been listed in the checklists of lichens of Slovakia so far (Guttová *et al.* 2013a, Pišút *et al.* 2001). *P. leptalea* can be found on evergreen or on deciduous trees, very often on trunk of trees in open situations. It is a close relative of *P. adscendens* and *P. tenella* but apothecia are abundant and the appearance is more robust. The thallus is irregular, up to 4 cm in diameter. The colour of the upper side is white-grey to grey, rarely dark grey. Lobes are long and narrow, up to 1 mm wide but sometimes can be shorter and 2 mm wide. Soralia are not present. The underside is pale grey to brown colour with a few rhizines. Apothecia are common up to 3 mm in diameter. The size of spores is 17–22 × 7–10

µm (Wirth *et al.* 2013). The new record was discovered on Vlčia hora hill near Cejkov village in dense growth of shrubs with *Prunus spinosa* as dominant.

Cladonia crispata: Within Slovakia, the species is abundant in the Tatra Mts (cf. Lisická 2005), only a single locality was found in Borská nížina lowland (Dingová and Pišút 2009), Levočské vrchy Mts. (Szatala 1930) and Štiavnické vrchy Mts. (Sántha 1916). Verseghy (1964) recorded it from the adjacent north-eastern Hungary from the Zempléni-hegység Mts. No records are published from southeastern Slovakia. The newly discovered locality represents an old and abandoned small quarry near Malá Bara village. The small population growing here is endangered by an illegal waste dump. We expect to discover other populations in the nearest oak-birch forest on rocky clearings, where suitable habitats exist, but during field research we did not record it. The species is listed as vulnerable (VU) in the Red list of lichens of Slovakia (Pišút *et al.* 2001).

Graphis scripta: *G. scripta* occurs within the whole territory of Slovakia and it prefers beech, oak and hornbeam forests (Pišút 1999). A newly discovered location was recorded on bark of *Carpinus betulus* in Plochá hora hill in the central part of the Zemplínske vrchy Mts. The probability of new discoveries in this area is very high because the suitable habitats exist here. From adjacent Hungarian area, Farkas and Tuba (2005) reported this species from the northern parts of the Hungarian Great Plain. It is evaluated in category endangered (EN; Pišút *et al.* 2001).

Lecanora conizaeoides: *L. conizaeoides* grows on park trees in urban environments, and in other very acidic and polluted environments as well. *L. conizaeoides* is a common epiphytic lichen in industrial areas of western Europe (Stenroos *et al.* 2016) and was widespread in Slovakia in the past because of high SO₂ levels (Guttová *et al.* 2013b). When the air quality has improved (decrease of SO₂), the occurrence of this species declined or disappeared entirely (Stenroos *et al.* 2016). This species was recorded mainly in the western and the central parts of Slovakia (e.g. Guttová and Pišút 2007, Guttová *et al.* 2015, 2017, Lackovičová and Pišút 2004, Pišút 1985). The new locality in the Zemplínske vrchy Mts is located on the forest margin near a truck parking in Autocamping Mária resort.

Flavoparmelia caperata (syn. *Parmelia caperata*): The species is known in Slovakia from oak forests of the western and the central part of the country (e.g. Guttová and Pišút 2007, Lisická 2005). Six localities were discovered in the Zemplínske vrchy Mts, whereas the lichens grown on branches of deciduous shrubs (*Prunus spinosa*, *Crataegus* sp.) and trees (*Quercus robur*). From the adjacent Hungarian area, Verseghy (1964) reported the species from the Zempléni-hegység Mts and Farkas and Tuba (2005) reported only one historical occurrence from the Hungarian Bodrogeköz.

From the point of view of lichen diversity, two localities are considered as very important. The first and the most valuable is Kašvár Nature Reserve near Ladmovce village (site nr. 14) with karst elements and numerous of terrain depression on Šomoš hill with rich population of few *Cladonia* species (*C. convoluta*, *C. furcata*, and *C. pyxidata*) and calcicolous species (*Circinaria contorta* and *Sarcogyne regularis*). The second one is Brezinka hill near Malá Bara village (site nr. 12) composed of red-grey sandstone with rhyolite admixture. Approximately 0.2 ha large hillside is populated with low birch trees (*Betula pendula*), oaks (*Quercus* spp.) and aspen trees (*Populus tremula*) with poor herbaceous vegetation, but the coverage of lichens and mosses reaches the abundance of 90%. The most interesting records are *Cladonia foliacea*, *C. squamosa* and *C. rangiformis*, whereas the last species is forming the bunch of thallus over 20 cm in diameter in area over 10 m².

The lichen flora of the Zemplínske vrchy Mts has not been well studied so far. Our list of lichens brings the overview of 68 recent lichen species diversity in this area and can be extended in the future. The most important findings in the territory of southeastern Slovakia include the new record of *Physcia leptalea* for Slovakia and interesting records of lichens *Cladonia crispata*, *Graphis scripta*, *Flavoparmelia caperata* and *Lecanora conizaeoides*.

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