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Xerothermic bryoflora in selected areas of Slovak Karst National Park

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Abstract: The aim of this article is to present the results of the bryfloristic and ecological research carried out in selected areas of the Slovak Karst National Park in 2008. We detected 29 xerothermic bryophytes in total. Furthermore, the ecological characteristics evaluation of the recorded bryophyte species according to various factors is included, and we also described the occurrence of two potentially endangered species.

Keywords: bryophytes, the Slovak Karst National Park, xerothermic biotopes, ecological factors.

Introduction

Generally, bryophytes as organisms are not very attractive for botanists. Although their direct benefit for people is much smaller than the benefits of other plants, nonvascular plants form an integral part of ecosystems. In ecosystems they function in many ways, e. g. with respect of their ability to hold large amounts of water, they are the first colonisers of open ground, bryophytes create a more hospitable environment for many other organisms. Among the main factors which cause their vanishing is the rarity of certain species. The most serious threat facing bryophytes is habitat loss through direct site destruction or

through the lack of suitable management. In the Slovak Karst National Park the bryophytes are highly threatened by tourism pressures. The conservation of bryophytes lies mainly in preserving their natural habitats.

The Slovak Karst National Park belongs to the most beautiful areas in Slovakia due to its great nature diversity. It is the most extensive karst area of tableland type in Central Europe, and it is strongly marked by the dominance of xerothermic flora including the occurrence of endemic taxa (PRUŽINOVÁ 2012). Indisputably, bryophytes play an important role in this area.

As far as the geomorphological aspect is concerned, the Slovak Karst National Park is a subprovince of Western Carpathians and a part of the Slovak Ore Mountains. In geological and geomorphological terms, Slovak Karst is a model area, having undergone an intricate development, from the initial folding phases and the formation of nappes, karst formation during the Upper Cretaceous series, until the Quaternary, which is proved to be the time of many ground ascents and descents (PETRVALSKÁ 2010).

The geological structure of the Slovak Karst area is mainly influenced by the secondary (mesozoic) rocks referred to as Silica nappe, or Silicikum. The stratiform nappe succession usually starts with Lower Triassic rocks (sandstone, shale, marlstone and calcite). The Middle and Upper Triassic rocks are represented by massive calcite complexes. The Tertiary rocks in this area are represented by Pliocene gravel filling the area of Rožňava Basin where they are mostly covered by Quaternary sediments or younger rubbles (ĎUREČEK et al. 1989). The subsoil of this area consists of pure calcite originally sedimented in the Secondary tropical sea. It is highly permeable and it is further modelled by an intensive underground karst forming process. Besides calcite, the geological formation of Slovak Karst is also influenced by dolomite and shale rocks (KOLLÁR & MUCHA 2004).

In the Slovak Karst National Park area the soils are red. This is caused by products of weathering during earlier geological periods. More fertile brown and alluvial soils were formed in basins and river bottomlands. On the calcite substrate of these karst areas rendzina soils were created. A great part of Volovec Mountains and Stolica Mountains consists of brown forest soils which pass into podzolic soils in the top zones (KOLLÁR & MUCHA 2004).

In the Slovak Karst National Park there is no surface water outflow. The precipitation water soaks the soils and reaches the underground hollows which results in formation of springs and wells (Kečovská, Brzotínska, Zádielska, Vidovská vyvieračka etc.). This area is drained by the allochthonous river of Slaná with its autochthonous feeders, such as Štítnik, Muráň and Turňa. There are also some little water ponds in this area, e. g. the Big Lake, Hrhov Lake, and a few highly wet zones in the valley of Štítnik Brook (ROZLOŽNÍK & KARASOVÁ 1994).

As far as the phytogeographical categorization is concerned, Slovak Karst is a part of the Pannonian flora area, a part of the old Matra subarea with xeric and thermophilic flora; in the east it reaches the Pannonian area, in the north it reaches the Carpathian area. In terms of flora, Slovak Karst is one of the richest

and most interesting places in Slovakia (ĎURČEK et al. 1989).

The Slovak Karst territory has the greatest botanical variety in Central Europe. The karst phenomenon of this area is reflected in the dominance of xerothermic flora on sunlit hillsides, edges and plains. There are a few xerothermic species, calcites, mountains de-alpine and pre-alpine species preserved in inverse locations, and also scarce endemic, sub-endemic and relic species (ROZLOŽNÍK & KARASOVÁ 1994).

In 1973 Slovak Karst was declared a protected landscape area (KILÍK 2008). On March 1, 1977 it was included, the first out of all Slovak landscape areas, in the international network of biospheric reserves under the UNSECO programme – Man and the Biosphere. Slovak Karst was declared a national park on March 1, 2002 (KOLLÁR & MUCHA 2004).

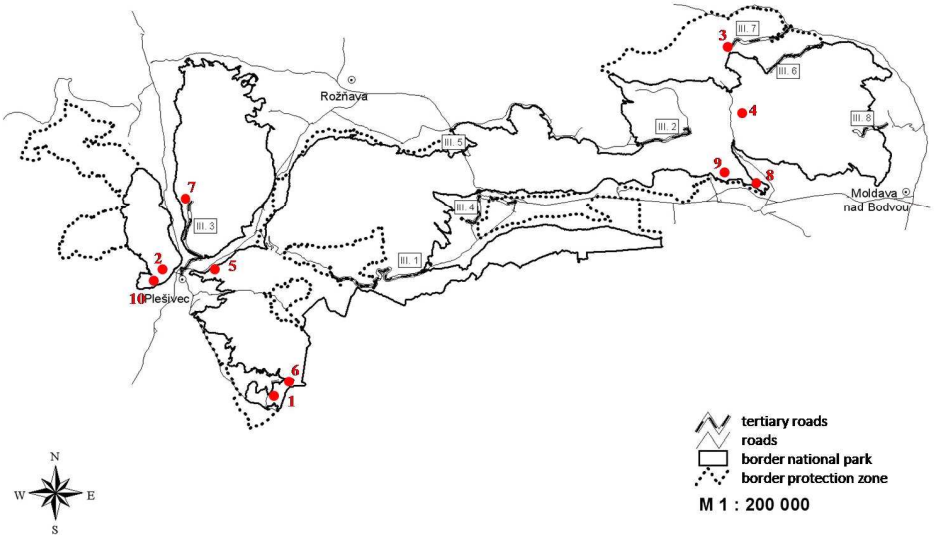

Fig. 1. The map of the Slovak Karst National Park highlighting the studied bryophyte localities
(Source: http://www.sopsr.sk/slovkras/navstevny_poriadok_mapy.pdf)

The oldest data on bryophyte distribution in Slovak Karst were published by ŠMARDA (1940, 1947, 1948) and the Czech lichenologists SUZA in 1950. In his work SUZA mentions several bryophyte species, such as *Mannia fragrans, Riccia sorocarpa, Asterella saccata* and *Tortella inclinata*.

Later on, the Hungarian bryologist BOROS followed Suza´s research of bryoflora in this territory. Among the species that BOROS characterised in his

work on bryophyte species in Slovak Karst are *Frullaria dilatata, Amblystegium subtile, Isothecium striatulum, Lophozia bantriensis, Eurhynchium hians, Rhynchostegium murale, Pedinophyllum interruptum, Cephaloziella divaricata* and *Tortella squarrosa* (BOROS et al. 1960).

Further on, PECIAR recorded several selected bryological taxa occurring in the Slovak Karst National Park in a couple of his articles, thus enriching the documentation of Slovak Karst bryoflora (PECIAR 1970, 1974, 1979, 1986, 1990). Moreover, he is the author of the first complex bryofloristic research (PECIAR 1994). In this great work he compiled all the pieces of knowledge on the subject he possessed, consulting all the available and published bryofloristic data. Besides, PECIAR recorded bryophyte species occurring on rock faces, e.g. *Ctenidium molluscum, Encalypta streptocarpa, Neckera crispa, Porella platyphylla, Schistidium apocarpum, Orthotrichum rupestre, Orthotrichum anomalum, Tortella inclinata* and *Tortella squarrosa*. In total, there are 206 bryotaxa recorded in Slovak Karst, out of which 46 are liverworts, and the other 160 are mosses.

VALACHOVIČ & HADAČ (1986) were also involved in the study and investigation of the plant kingdom, especially of rock detritus in Zádielská Valley. They recorded also *Anomodon viticulosus, Homalothecium lutescens, Homalothecium sericeum,* and *Tortella tortuosa,* which are typical for this kind of landscape location.

Another bryologist who did a lot of research was KUBINSKÁ (1994). She mentions 84 bryotaxa, out of which 10 are liverwort, e.g. *Blepharostoma trichophyllum, Lophocolea minor, Metzgeria conjugata,* and 74 are bryophyte species, such as *Brachythecium campestre, Cirriphyllum tenuinerve, Encalypta vulgaris, Mnium thomsonii, Plagiomnium elatum, Plagiothecium curvifolium, Pleurozium schreberi, Tetraphis pellucida.*

Nowadays, there are still a few scientists who are devoted to the bryological research. One of them is KOCHJAROVÁ (KOCHJAROVÁ et al. 2003), recorded 21 bryophyte species occuring in several wet meadows and peatbogs of Muránska Plain. ŠOLTÉS et al. (2004) compiled a list of bryophytes recorded by many Slovakian bryologists who have published their results up to the present time.

Another paper focused on xerothermic biotopes in Slovakia is the one written by DAVID et al. (2007). The authors paid attention to the overall importance of xerophytes in terms of pedology, flora and fauna. They study the reasons of xerothermic biotopes endangerment in Slovakia, and they point out the importance of xerophytes preservation.

Petrášová & Šuvada (2008) also wrote a work discussing bryological and ecological characteristics of the Slovak Karst National Park. They recorded 91 bryophyte species – 10 liverwort species and 81 moss species. Out of these many species, 12 bryophytes had not been detected before in Slovak Karst. This is the list of them: *Barbula unguiculata, Brachythecium mildeanum, Brachythecium reflexum, Brachythecium starkei, Dicranum bonjeanii, Didymodon fallax, Eurhynchium speciosum, Herzogiella seligeri, Isothecium myurum, Sanionia uncinata, Timmia bavarica* and *Weissia controversa*. The authors

recorded four redlisted bryophytes, of the status lr-NT (Lower Risk, Near Threatened; KUBINSKÁ et al. 2001). The four ones are *Dicranum bonjeanii, Grimmia anodon, Tortella squarrosa* and *Rhodobryum ontariense*.

Recent paper on bryophytes is the one written by MIŠÍKOVÁ & KUBINSKÁ (2010) in which they studied nonvascular plants occurring at historical graveyards of selected Central European towns. There they recorded 63 moss species and 4 liverwort species out of which six species are rare in towns – *Weissia controversa, Weissia rutilans, Syntrichia virescens, Fissidens gracillifolius, Dicranella schreberiana* and *Dicranella staphylina*.

The usually omitted issue of moss occurrence at the castle and stronghold ruins has been recently elaborated on by UHERKOVÁ-ŠMELKOVÁ & MIŠÍKOVÁ (2010). Having researched 20 selected localities, they registered 41 bryotaxa in total; four of these are liverwort species – *Plagiochila porelloides, Porella platyphylla, Marchantia polymorpha, Metzgeria furcata* – which showed the lowest incidence. The highest incidence was manifested by the following moss species: *Tortula muralis, Homalothecium sericeum, Hypnum cupressiforme, Bryoerythrophyllum recurvirostrum, Bryum capillare, Ceratodon purpureus, Homalothecium lutescens, Anomodon viticulosus* and *Abietinella abietina.*

Material and Methods

The field research was conducted during September-October 2008 in selected localities of the Slovak Karst National Park (Fig. 1). Al the relevés were taken following standard procedures of the Zürich-Montpellier School (BRAUN-BLANQUET 1964). The relevé record includes: the name of the locality, geographical coordinates, altitude, inclination, the date and the list of the bryophytes collected. The samples were collected from an area of 5 cm x 5 cm at maximum, so that it would not be negatively reflected in the ecosystem biodiversity. The bryophytes collected in one relevé were put in a paper bag marked with the date location. After the sampling, the mosses were dried at the room temperature. The specimens which are studied in a bachelor thesis (PRUŽINOVÁ 2012), are stored at the Department of Botany and Genetics, the Faculty of Natural Sciences, Constantine the Philosopher University in Nitra.

For bryophyte determination we used PILOUS & DUDA (1960), FRAHM & FREY (1992) and SMITH (2004). The list of species is arranged within the classis liverworts or mosses alphabetically. The bryophyte nomenclature follows KUČERA et al. (2012). Each item is followed by the literature source referring its occurrence in the Slovak Karst territory. If there is a dash after the item, it means there are no such literary sources yet. In case the item is referred to as endangered (KUBINSKÁ et al. 2001), the IUCN category is right after the name of the taxon. The detected items were subjected to ecological examination following the methodology of ELLENBERG et al. (1992) and KRIŽOVÁ (2001). The result of this examination is the ecological profile of the biotope(s) at selected localities of Slovak Karst, based on qualitative and quantitative signs. The *Ellenberg´s indicator values* serve to quantify, statistically evaluate and characterise the biotopes in terms of relations to the environmental factors, such as the light,

temperature, terrestriality, humidity, and soil reaction. For each of these factors a ten-value scale is used, plus the “X” mark means that a species is indifferent to the factor.

The list of the examined localities:

1. *Domické škrapy*; grassy-herbal ground cover xerotherm; long. 20°28'20" E; lat. 48°28'37" N; alt. 380 m; exp. S; incl. 10°; 2. 9.2008
2. *Gerlaská skala*; grassy-herbal ground cover xerotherm; long. 20°25'28" E; lat. 48°39'33" N; alt. 734 m; exp. N; incl. 20°; 24 .10.2008
3. *Hačava*; grassy-herbal ground cover xerotherm; long. 20°49'56" E; lat. 48°40'08" N; alt. 692 m; exp. S-E; incl. 25°; 2.9.2008
4. *Háj, Hájska tiesňava*; grassy-herbal ground cover xerotherm; long. 20°50'41" E; lat. 48°39'11" N; alt. 460 m; ex p. S; incl. 20°; 23.10.2008
5. *Holá skala*; grassy-herbal ground cover xerotherm; long. 20°23'50" E; lat. 48°37'18" N; alt. 670 m; exp. W; incl. 20°; 23 .10.2008
6. *Kečovské škrapy*; grassy-herbal ground cover xerotherm; long. 20°29'32" E; lat. 48°29'41" N; alt. 381 m; exp. S; incl. 15°; 2. 9.2008
7. *Plešivecká stráň*; grassy-herbal ground cover xerotherm; long. 20°24'17" E; lat. 48°34'49" N; alt. 486 m; exp. S-W; incl. 10°; 24.10.2008
8. *Turnianska stráň*; grassy-herbal ground cover xerotherm; long. 48°36′39″ E, lat. 20°52′16″ N, alt. 303 m; exp. S-W, incl. 25°; 24.10.2008
9. *Zemné hradisko*; grassy-herbal ground cover xerotherm; long. 20°48'58" E; lat. 48°36'14" N, alt. 253 m; exp. E; incl. 20°; 24 .10.2008
10. *Železné vráta*; grassy-herbal ground cover xerotherm; long. 20°23'48" E; lat. 48°38'34" N; alt. 712 m; exp. W; incl. 30°; 23 .10.2008

Results and Discussion

During the field investigation in the Slovak Karst National Park in 2008 we have recorded 29 bryotaxa at 10 localities of grassy-herbal xerotherm formation (2 liverwort and 27 moss species). Four of these bryotaxa had never been detected in Slovak Karst before: *Bryum moravicum, Campylium chrysophyllum, Ceratodon purpureus* and *Encalypta vulgaris.*

Liverworts

Plagiochila porelloides: KUBINSKÁ (1994), PECIAR (1994), PETRÁŠOVÁ & ŠUVADA (2008).

Porella platyphylla: BOROS et al. (1960), PECIAR (1974, 1979), DUDA & VÁŇA (1979), KUBINSKÁ (1994), PECIAR (1994), PETRÁŠOVÁ & ŠUVADA (2008).

Mosses

Barbula unguiculata: PECIAR (1990), PETRÁŠOVÁ & ŠUVADA (2008).

Brachythecium salebrosum: ŠMARDA (1947, 1948), KUBINSKÁ (1994), PETRÁŠOVÁ & ŠUVADA (2008).
Bryum argenteum: KUBINSKÁ (1994), PECIAR (1974, 1994), PETRÁŠOVÁ & ŠUVADA (2008).
Bryum moravicum: -.
Campylium chrysophyllum: ŠMARDA (1948).
Ceratodon purpureus: PECIAR (1986).
Ditrichum flexicaule: ŠMARDA (1947), BOROS et al. (1960), PECIAR (1986), KUBINSKÁ (1994), PECIAR (1994), PETRÁŠOVÁ & ŠUVADA (2008).
Encalypta streptocarpa: ŠMARDA (1947), KUBINSKÁ (1994), PECIAR (1974, 1994), PETRÁŠOVÁ & ŠUVADA (2008).
Encalypta vulgaris: KUBINSKÁ (1994).
Grimmia anodon, LR: PECIAR (1994), PETRÁŠOVÁ & ŠUVADA (2008).
Grimmia pulvinata: ŠMARDA (1948), PECIAR (1974, 1979, 1986), KUBINSKÁ (1994), PECIAR (1994), PETRÁŠOVÁ & ŠUVADA (2008).
Homalothecium lutescens: PECIAR (1974), VALACHOVIČ & HADAČ (1986), KUBINSKÁ (1994), PETRÁŠOVÁ & ŠUVADA (2008).
Hypnum cupressiforme: PECIAR (1974, 1991), KUBINSKÁ (1994), PECIAR (1994), PETRÁŠOVÁ & ŠUVADA (2008).
Leucodon sciuroides: BOROS et al. (1960), PECIAR (1974), KUBINSKÁ (1994), PECIAR (1994), PETRÁŠOVÁ & ŠUVADA (2008).
Orthotrichum cupulatum: PECIAR (1994), PETRÁŠOVÁ & ŠUVADA (2008).
Plagiomnium cuspidatum: PECIAR (1994), PETRÁŠOVÁ & ŠUVADA (2008).
Pseudoleskeella catenulata: ŠMARDA (1948), BOROS et al. (1960), PETRÁŠOVÁ & ŠUVADA (2008).
Rhytidium rugosum: BOROS et al. (1960), PECIAR (1974, 1986), PETRÁŠOVÁ & ŠUVADA (2008).
Schistidium apocarpum: ŠMARDA (1948), PECIAR (1974), VALACHOVIČ & HADAČ (1986), PECIAR (1990), KUBINSKÁ (1994), PECIAR (1994), PETRÁŠOVÁ & ŠUVADA (2008).
Tortella inclinata: ŠMARDA (1947), SUZA (1950), PECIAR (1979, 1986, 1994), PETRÁŠOVÁ & ŠUVADA (2008).
Tortella squarrosa, LR: ŠMARDA (1947, 1948), BOROS et al. (1960), PECIAR (1986, 1994), PETRÁŠOVÁ & ŠUVADA (2008).
Tortella tortuosa: PECIAR (1974), VALACHOVIČ & HADAČ (1986), PECIAR (1990), KUBINSKÁ (1994), PETRÁŠOVÁ & ŠUVADA (2008).
Tortula intermedia: BOROS et al. (1960), KUBINSKÁ (1994), PECIAR (1994), PETRÁŠOVÁ & ŠUVADA (2008).
Tortula ruralis: ŠMARDA (1947), BOROS et al. (1960), PECIAR (1974, 1986, 1994), PETRÁŠOVÁ & ŠUVADA (2008).
Weissia condensa: ŠMARDA (1948), ŠMARDA & VANĚK (1955), BOROS et al. (1960), PECIAR (1974, 1994), PETRÁŠOVÁ & ŠUVADA (2008).

Based on the ten relevés mentioned above, a phytosociological table has been made, and this is the groundwork for characterisation of territorial and bryofloristic conditions (Tab. 1).

Tab. 1. Phytosociological table with the Ellenberg´s indicator values for recorded bryophytes

Number of relevé	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average**	**Fidelity**	**Class**	**L**	**T**	**K**	**F**	**R**
Coverage E_0 %	**40**	**45**	**20**	**25**	**45**	**35**	**55**	**30**	**35**	**25**	**cover**							
Barbula unguiculata						+					0,03	10	I	7	x	5	2	7
Brachythecium salebrosum			+								0,09	10	I	6	4	5	4	6
Bryum argenteum					+						0,03	10	I	7	x	x	x	6
Bryum moravicum				+							0,03	10	I	5	x	5	5	6
Campylium chrysophyllum							+				0,05	10	I	9	2	6	2	8
Ceratodon purpureus										+	0,03	10	I	8	x	x	2	X
Ditrichum flexicaule						1	1		1		1,10	30	II	6	x	6	5	9
Encalypta streptocarpa							+				0,07	10	I	5	x	5	5	5
Encalypta vulgaris								+			0,03	10	I	9	5	5	4	8
Grimmia anodon					+						0,03	10	I	9	x	5	1	8
Grimmia pulvinata	1					1	1	1	1		1,60	50	III	9	5	5	1	7
Homalothecium lutescens	2b	2b		2b	2b	2b	2b		2b	2b	17,4	80	IV	9	4	5	2	8
Hypnum cupressiforme	2a	2m			2a	2a	1				5,9	50	III	5	x	5	4	4
Leucodon sciuroides		1									0,3	10	I	8	5	5	4	6
Orthotrichum cupulatum	1				+		+		1		0,7	40	II	9	3	5	2	8
Plagiomnium cuspidatum		+									0,08	10	I	4	3	4	5	7
Plagiochila porelloides		+									0,09	10	I	6	3	5	4	7
Porella platyphylla		1			2a						1,9	20	I	5	3	5	4	6
Pseudoleskeella catenulata		1			2a						1,7	20	I	8	3	6	4	8
Rhytidium rugosum	1				1	1	1	1	2m		2,5	60	III	9	x	6	3	7
Schistidium apocarpum	1	+			1	+	+	1	1	+	1,74	80	IV	4	x	5	3	7
Tortella inclinata							1	1	1	1	1,5	40	II	9	3	5	2	8
Tortella squarrosa						+	+	+			0,15	30	II	9	8	5	2	6
Tortella tortuosa		2a	2b	2a			2b	2b			9,5	50	III	5	x	6	4	8
Tortula intermedia					+						0,04	10	I	9	6	5	1	8
Tortula ruralis		+					+				0,09	20	I	9	x	5	2	6
Weissia condensa				+							0,03	10	I	9	6	5	1	9
Number of species	**6**	**10**	**2**	**4**	**10**	**8**	**12**	**7**	**7**	**4**								

Ellenberg's eco indices (L – light, T – temperature, K – continentality, F – soil moisture, R – soil pH).

According to average values, the ecotope may be characterised as half-lit or half-shaded, represented by subalpine or alpine species. The average ecological number of terrestriality expresses that in the examined ecotope there are intermediate species growing on dry soils with pH value ranging from 6.5 to 8. This means that the soils are basically neutral, not acid in any case.

Our special attention should be paid to these two species – *Grimmia anodon* and *Tortella squarrosa* – since they are included into the Red List of Bryophytes in Slovakia (KUBINSKÁ et al., 2001) among other potentially endangered species (LR: nt). These two species have special requirements on biotopes which are nowadays threatened by anthropogenic activities.

Grimmia anodon

This species has been recorded only at the locality no. 5 *Holá Skala.* The total size of its population is only a few specimens, usually accompanied by *Bryum argenteum*, *Thuidium abietinum*, *Orthotrichum cupulatum*, *Porella platyphylla*, *Schistidium apocarpum*, *Rhytidium rugosum*, *Homolothecium lutescens*, *Hypnum cupressiforme* and *Tortula intermedia*. More information about its occurence in Slovak Karst is provided in the works of PECIAR (1994) and PETRÁŠOVÁ & ŠUVADA (2008) who has recorded this species in the *Turniansky Hradný Vrch* National Nature Reserve (Turňa Castle Hill).

Tortella squarrosa

This species has been recorded at more than one of the researched localities. At the locality no. 6 *Kečovské škrapy,* the total size of its population represents only a few specimens, accompanied by *Barbula unguialata*, *Homolothecium lutescens*, *Ditrichum flexicaule*, *Schistidium apocarpum*, *Grimmia pulvinata*, *Thuidium abietinum*, *Hypnum cupressiforme* and *Rhytidium rugosum*. At the locality no. 7 *Plešivecká stráň*, the total size of its population represents only a few specimens, accompanied by *Campylium chrysophyllum*, *Orthotrichum cupressiforme*, *Grimmia pulvinata*, *Thuidium abietinum*, *Rhytidium rugosum*, *Homolothecium lutescens*, *Tortella inclinata*, *Tortella tortuosa*, *Ditrichum flexicaule*, *Eucalypta streptocarpa*, *Schistidium apocarpum*, *Hypnum cupressiforme* and *Tortula ruralis*. At the locality no. 8 *Turnianska stráň,* the total size of its population also represents only a few specimens, accompanied by *Rhytidium rugosum*, *Thuidium abietinum*, *Encalypta vulgaris*, *Grimmia pulvinata*, *Schistidium apocarpum*, *Tortella tortuosa* and *Tortella inclinata*. Some information about its incidence in Slovak Karst has been published by BOROS et al. (1960), PECIAR (1994) and PETRÁŠOVÁ & ŠUVADA (2008). BOROS et al. (1960) detected this species at calcite rock sidehills near the cave of *Domica*, in the village of *Kečov*. PECIAR (1994) did not state the exact incidence locality of this species, whereas PETRÁŠOVÁ & ŠUVADA (2008) detected it in three xerotherm localities – *Domické škrapy, Turniansky hradný vrch* and *Zemné hradisko*.

Among the most frequent bryophyte species at the examined territories are the following ones: *Schistidium apocarpum*, *Homalothecium lutescens, Orthotrichum cupulatum, Tortula ruralis, Tortella tortuosa, Encalypta streptocarpa, Anomodon viticulosus, Porella platyphylla, Plagiochila porelloides, Ctenidium molluscum, Cirriphyllum piliferum, Taxiphyllum wissgrillii, Conocephalum conicum, Hypnum cupressiforme, Brachythecium rutabulum, Bryum argenteum, Didymodon rigidulus,* which were registered even almost half a century ago in the publications of PECIAR (1970, 1974, 1978, 1981, 1990). Having compared these works with the species diversity in the paper ŠMARDA (1953), we may confirm the occurence of only four xerothermic bryophytes: *Tortella tortuosa, Tortella squarrosa, Grimmia anodon* and *Grimmia pulvinata*. The rock plant biotopes in *Zádielská tiesňava* are discussed in the paper VALACHOVIČ & HADAČ (1986) who recorded *Ctenidium molluscum, Homalothecium lutescens, Homalothecium sericeum, Rhytidiadelphus triquetrus*, *Schistidium apocarpum, Thuidium* sp., *Tortella tortuosa*. In comparison with ROZLOŽNÍK & KARASOVÁ (1994), we have recorded the occurrence of *Grimmia anodon, Bryum argenteum, Schistidium apocarpum, Tortula ruralis, Tortula muralis, Porella platyphylla, Plagiochila porelloides, Ditrichum flexicaule, Tortella squarrosa, Tortela inclinata, Tortela intermedia, Hypnum cupressiforme* and *Ceratodon purpureus.* Compared to PETRÁŠOVÁ & ŠUVADA (2008), we have noticed more abundant occurrence of indicator xerotherm species.

Conclusion

The article enriches knowledge on bryophytes including their ecological conditions in selected xerothermic localities of the Slovak Karst National Park. This study, however, is not complex, therefore it is still necessary to fill in the information on the occurence of nonvascular plants, examining as many territories as possible.

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