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ORIGINAL RESEARCH PAPER in FLORISTICS AND PLANT CONSERVATION

Marsupella subemarginata (Gymnomitriaceae, Marchantiophyta) Newly Found in the Carpathians in the Polish and Slovak Tatras

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Abstract

Marsupella subemarginata Bakalin & Fedosov is a semi-cryptic Eurasian species. Recently, it has been found in the Far East (Kamchatka and Japan) and Swiss Alps, as well as the Giant Mountains (Sudetes, Czech Republic). The plant was also observed in the Carpathians for the first time. A revision of the herbarium collections of *M. emarginata* (Ehrh.) Dumort. consisting of 102 specimens from the Polish and Slovak Tatra Mountains revealed the occurrence of *M. subemarginata* at 24 localities, eight of which were in the Polish Tatras. Most of the localities of this species were concentrated in the High Tatras, and only four sites were discovered in the Western Tatras. *Marsupella subemarginata* has been briefly characterized morphologically and illustrated. The habitat requirements of the species have been described in detail, and the floristic composition of its phytocoenoses has been shown in a phytosociological table consisting of 10 relevés. *Marsupella subemarginata* is a valuable addition to the liverwort flora of Poland and Slovakia, which currently consist of 241 and 232 species, respectively. Currently, the liverwort flora of the Tatras comprises 195 species, including 185 species in Poland and 186 species in Slovakia.

Keywords

Marsupella emarginata complex; semi-cryptic species; liverworts; mountain flora

1. Introduction

Currently, there are 194 species of liverworts in the Tatra Mountains (Mts), which are the highest range in the Carpathians (Górski & Váňa, 2014). The history of research on this group of plants in the Tatra Mts dates back over 200 years. It began with a comprehensive study *Flora Carpathorum Principalium...* (Wahlenberg, 1814). The list of species growing in these mountains can be considered almost complete, although the data on the distribution or threats to various liverworts need to be supplemented (Górski, 2020). Since 2000, only two unreported species have been identified in the entire Tatra Mts: *Gymnomitrium adustum* Nees and *Nardia compressa* (Hook.) Gray (Górski, 2010; Górski & Váňa, 2011). All the other additions to the flora have been mountain liverworts, which were not found in the Polish Tatras or in Poland, but instead found only in the Slovak Tatras: *Cephaloziella massalongii* (Spruce) Müll. Frib.; *C. varians* (Gottsche) Steph.; *Jungermannia borealis* Damsh. & Váňa; and *J. exsertifolia* Steph. subsp. *cordifolia* (Dumort.) Váňa (Górski & Váňa in Ellis, Asthana et al., 2013; Klama in Ellis et al., 2011; Váňa & Górski in Ellis, Bakalin, et al., 2013; Górski & Váňa, 2013). Some species were identified for the first time in the Slovak Tatras, for example, *Neoorthocaulis binsteadii* L. Söderstr., De Roo & Hedd. (Górski in Ellis et al., 2012). All the plants listed above are morphologically well-defined taxa, which do not raise any doubts about their taxonomic status. They were found only recently since most of these species are rare (though not all of

them), and because in recent years, scientists have intensified hepaticological research in the Tatra Mts.

In recent years, scientists have also been conducting intense molecular research on bryophytes. Cryptic species of bryophytes are particularly interesting. First, they are usually detected using genetic or biochemical methods, and then their morphological diagnostic traits are recognized, e.g., in the *Conocephalum conicum* complex (Szweykowski et al., 2005). This was also the case with *Marsupella emarginata* (Ehrh.) Dumort., from which a new species, *Marsupella submarginata* Bakalin & Fedosov (Bakalin et al., 2019), was distinguished and described. This new species is distributed in both amphi-Pacific and amphi-Atlantic areas, and its localities were found in the Kamchatka Territory (Russia), Honshu (Japan), and Canton de Valais (Switzerland) (Bakalin et al., 2019). Soon after the new species had been described, another European locality was found in the Giant Mts (Czech Republic) (Kučera in Ellis et al., 2021).

The presence of *M. submarginata* in two vast European mountain ranges (the Alps and the Sudeten) suggests that this plant might also be found in the Carpathians. The author of this study decided to investigate this hypothesis using the rich herbarium material from the High Tatras and Western Tatras in Poland and Slovakia. The material represented all altitude levels of this mountain range and its diverse microhabitats. *Marsupella emarginata* is a common species in the Tatras. It was first found there in the second half of the nineteenth century (Hazslinszky, 1885; Krupa, 1878, 1882, 1888; Limpricht, 1877a, 1877b; Szyszyłowicz, 1884). Currently, this plant has been found in 228 localities recorded in 37 publications (they are listed by Górski & Váňa, 2014; see also Górski, 2015, 2016). Most of the localities were found in the High Tatras in Slovakia (120 sites). This liverwort is a multizonal mountain species that can be found in the Tatras at altitudes of 800–2,633 m a.s.l. (Duda & Váňa, 1981; Szyszyłowicz, 1884). It occurs in damp or wet habitats, where it grows on stones in streams, or on rocks sprinkled with dripping water. *Marsupella emarginata* can also grow completely submerged. This article presents the results of the revision of the herbarium holdings of the broadly conceived *M. emarginata*. The author confirmed the presence of *M. submarginata* in the Carpathians.

2. Material and Methods

2.1. Herbarium Data

The original material consisted of 102 specimens named *M. emarginata*, which were collected in the Polish and Slovak Tatras between 2003 and 2020 and deposited in the herbarium of the Poznań University of Life Sciences, Poland (POZNB). The revised material represents nearly 45% of all known localities of *M. emarginata* in the Tatra Mts. In total, there are 228 localities (see Górski, 2015, 2016; Górski & Váňa, 2014). The identification of the newly described species *M. submarginata* was based on the following two traits indicated by Bakalin et al. (2019): the thickness of cell walls in the hyaloderm layer as seen in a cross-section of the stem and the size of mid-leaf cells. Other differences, i.e., the color of the plants and their size, were used only as auxiliary criteria for identification of the species. The research material came only from the herbarium; therefore, it was not possible to observe oil bodies. The locations of all *M. submarginata* sites were shown in a Military Grid Reference System (MGRS) sized 1 km × 1 km (e.g., 34UDV2752; see Specimens Examined).

2.2. Description of the Study Area

The Tatra Mts are the highest mountain ridge in the Carpathians (Figure 1). They are a part of the Central Western Carpathians. The Tatra Mts ridge is 80 km long (56.5 km in a straight line) and has a maximum width of 18.5 km (15 km on average). The ridge forms a border separating Poland and Slovakia. The area covers 785 km², including 610 km² (77.7%) in Slovakia and 175 km² (22.3%) in Poland (Radwańska-Paryska & Paryski, 2004). The massif is divided into the Belianske Tatra Mts (“a” in Figure 1A), the High Tatra Mts (Tatry Wysokie and Vysoké Tatry; “b” and “c” in Figure 1A and Figure 1C,D), and the Western Tatra Mts (Tatry Zachodnie and Západné Tatry Mts; “d” and “e” in Figure 1A and Figure 1E,F). The Belianske Tatry

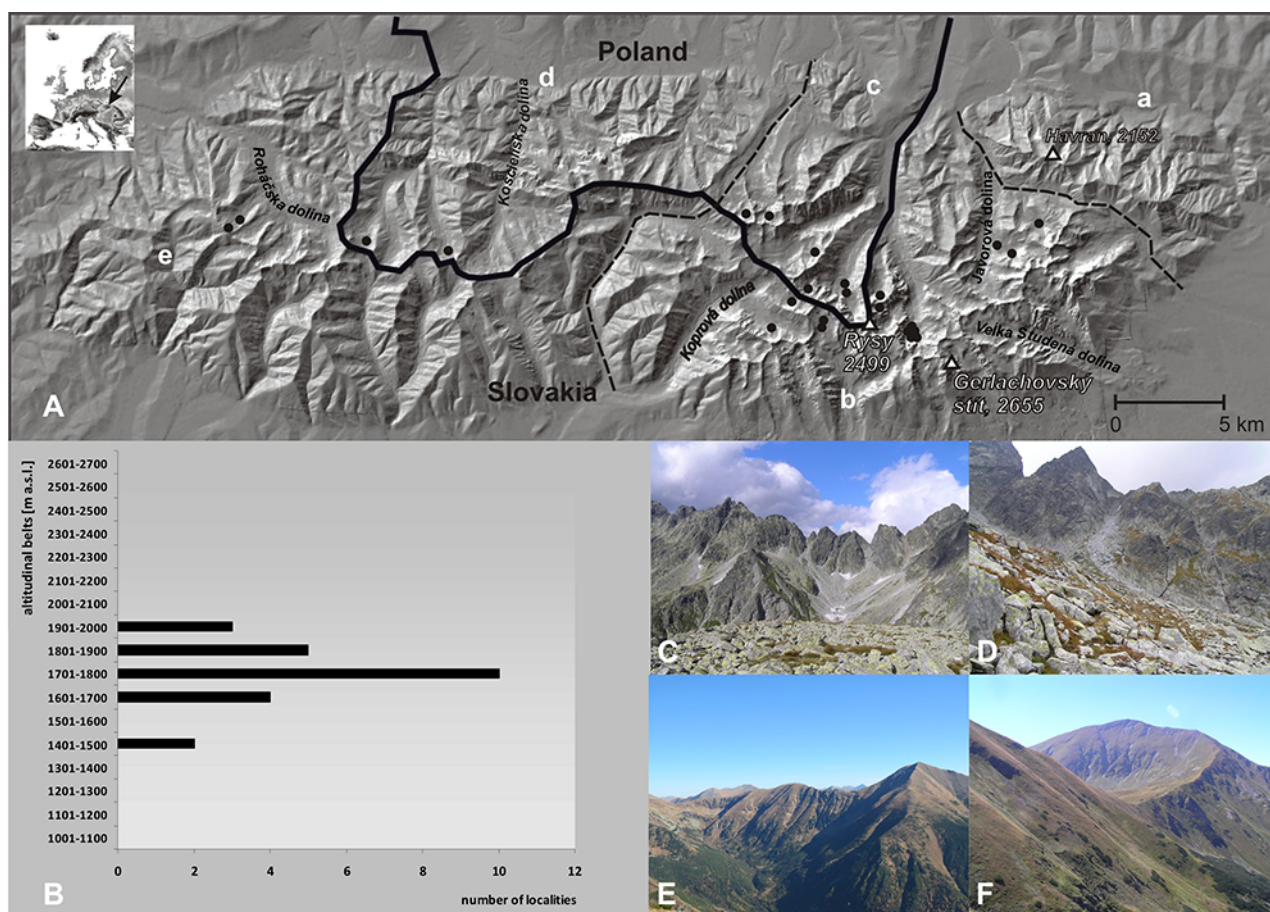


Figure 1 Distribution of *Marsupella submarginata* Bakalin & Fedosov in the Tatra Mountains. (A) Localities of the liverwort (black dots) and geobotanical division of the massive: a – Belianske Tatra Mts; b, c – High Tatra Mts; d, e – Western Tatra Mts. (B) Vertical distribution of *M. submarginata* in altitudinal belts: (C–F) landscapes of the High Tatra Mts (C,D) and Western Tatra Mts (E,F).

Mts are located entirely in Slovakia. They cover an area of 67.5 km², and their main ridge is ~13 km long. They consist entirely of sedimentary rocks, mostly limestone, marl, and dolomite. The highest peak is Havran (2,152 m a.s.l.). The High Tatra Mts cover an area of 335 km². They are the highest mountain range with Mt Gerlachovský štít (Gerlach; 2,655 m a.s.l.) being the highest peak in the Carpathians. In this part of the massif, in Slovakia, the next highest peaks of the Tatra Mts are Mt Lomnický štít (Łomnica; 2,634 m a.s.l.), Mt Ladový štít (Łodowy Szczyt; 2,627 m a.s.l.), and Mt Pyšný štít (Durny Szczyt; 2,623 m a.s.l.). On the Polish side, on the borderline ridge, the highest peak is Mt Rysy (2,499 m a.s.l.), which is the highest peak in Poland. Most of the High Tatra Mts, 253 km², is located in Slovakia (Nyka, 2000). The length of the ridge is 16.5 km (Radwańska-Paryska & Paryski, 2004). The High Tatra Mts are built mostly of a crystalline core of granitoid with little sedimentary rock.

The average annual temperature in the vertical profile of the Tatra Mts ranges from +8 °C to <−2 °C, a difference of approximately 0.5 °C per 100 m (Łupikasza & Szypuła, 2019). The spatial layout of the vegetation is associated with changes in temperature (accounting for 2 °C). The upper limit of the lower mountain belt corresponds to an isotherm of +4 °C, the upper limit of the upper mountain belt to +2 °C, that of dwarf mountain pines to 0 °C, and the alpine belt to −2 °C (Hess, 1996). Average annual rainfalls are as follows: Zakopane (844 m a.s.l.) 1,138 mm, Mt Kasprowy Wierch (1,987 m a.s.l.) 1,876 mm, Tatranská Lomnica (840 m a.s.l.) 833 mm, and Mt Lomnický štít (2,634 m a.s.l.) 1,561 mm (Konček, 1974).

3. Results

3.1. Distribution and Ecology of *Marsupella submarginata* in the Tatras

In total, 24 localities of *M. submarginata* were found in the entire Tatra Mts

(Figure 1, Figure 2). This is nearly a quarter of the revised collection of *M. emarginata* s. l. The species has the following number of localities and altitude range in individual regions of the Tatra Mts: (i) High Tatra Mts, Poland, six localities (minimum altitude 1,405 m a.s.l.; maximum altitude 1,870 m a.s.l.); (ii) High Tatra Mts, Slovakia, 14 localities (1,415–1,945 m a.s.l.); (iii) Western Tatra Mts, Poland, two localities (1,700–1,715 m a.s.l.); and (iv) Western Tatra Mts, Slovakia, two localities (1,720–1,760 m a.s.l.). *Marsupella submarginata* is a high mountain species, which has the most localities within the altitude range 1,701–1,800 m a.s.l. (Figure 1B).

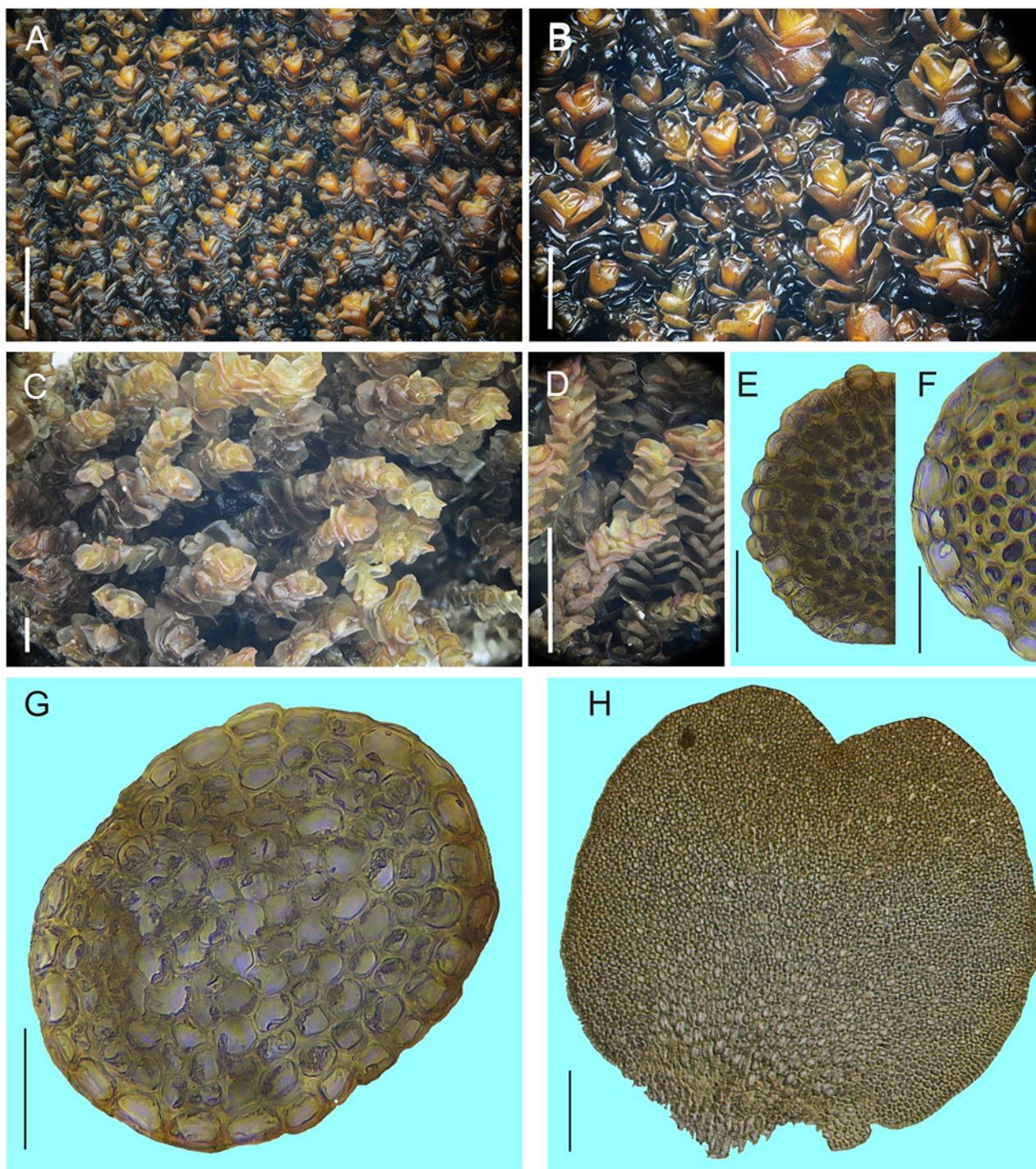


Figure 2 *Marsupella submarginata* Bakalin & Fedosov from the Tatra Mountains. (A–D) Plant habit; (E–G) stem cross section; (H) leaf. (A,B,G) from POZNB 4037; (C,D) from POZNB 4036; (E,H) from POZNB 565; (F) from POZNB 4036.

Scale bars: (A) 2 mm; (B) 1 mm; (C) 1 mm; (D) 3 mm; (E) 50 µm; (F) 50 µm; (G) 50 µm; (H) 200 µm. Photographs by R. Witkowski (A–D) and P. Górski (E–H).

Most of the localities can be found in the central part of the High Tatras (Kačacia dolina, Spádová dolina, Žabia Bielovodská, and Dolina Rybiego Potoku valleys).

Patches with *M. submarginata* were mostly found on the lower part of rocky slopes, at the transition into the debris slope, in glacial cirques with cool exposure (north, northwest). These were the places where melting snow adhered to the debris slope. The phytocoenoses of *M. submarginata* had both saxicolous and snowbed nature (see Table 1). The liverwort was accompanied by typical bryophytes of the *Grimmietaea alpestris* Hadač et Vondráček in Ježek et Vondráček 1962 class [e.g., *Bucklandiella sudetica* (Funck) Bedn.-Ochyra & Ochyra] and snowbed bryophytes of the *Salicetea herbaceae* Br.-Bl. in Br.-Bl. et Jenny 1926 class [especially *Kiaeria starkei* (F. Weber & D. Mohr) I. Hagen]. Melting snow and water running down the rocky slopes kept these patches moist. This fact was confirmed by the presence of hygrophilous species, such as *Schistochilopsis opacifolia* (Culm. ex Meyl.) Konstant., *Solenostoma obovatum* (Nees) C. Massal., and *Lophozia wenzelii* (Nees) Steph. The phytocoenoses with less steep rocky walls and small rocky ledges enabled the accumulation of sediments and the formation of shallow soil. Such places were also abundantly overgrown with *Nardia scalaris* Gray. The described phytocoenoses with *M. submarginata* on the rocky slope were very often accompanied on the debris slope by snowbed patches of *Pohlietum ludwigii* (Balcerkiewicz 1984) Górski 2015, *Polytrichetum sexangularis* Frey 1922, or *Luzuletum alpino-pilosae* Rübél 1911. It is noteworthy that most of the sites were located along the main ridge of the Tatras.

3.2. Specimens Examined

POLAND, HIGH TATRA MOUNTAINS: Dolina Gąsienicowa (Gąsienicowa Valley), in the cirque below Mt Świnica, above Czerwone Stawki (Czerwone Lakes), Grzędy, below rocky walls on Mt Skrajna Turnia, 34UDV2752, alt. 1,870 m above sea level (a.s.l.), *leg.*, *det.* P. Górski, 2005-08-20 (POZNB 19/2005); Dolina Gąsienicowa, above Zmarzły Staw (Zmarzły Lake), below Dolinka Kozia (Kozia Valley), 34UDV2852, alt. 1,805 m, *leg.*, *det.* P. Górski, 2005-08-21 (POZNB 564); Dolina za Mnichem (Za Mnichem Valley), rocky walls below Wrota Chałubińskiego (Wrota Chałubińskiego Pass), 34UDV3049, alt. 1,850 m a.s.l., *leg.*, *det.* P. Górski, 2004-08-16 (POZNB 4039; KRAM B-262601); Dolina Pięciu Stawów Polskich (Pięciu Stawów Polskich Valley), rocky walls below Marchwiczna Przełęcz (Marchwiczna Pass), 34UDV3151, alt. 1,810 m a.s.l., *leg.*, *det.* P. Górski, 2005-07-26 (POZNB 9/2005); Dolina Rybiego Potoku (Rybiego Potoku Valley), below Czarny Staw pod Rysami (Pod Rysami Czarny Lake), rocky outcrops, 34UDV3248, alt. 1,715 m a.s.l., *leg.*, *det.* P. Górski, 2004-08-18 (POZNB 24/2004); Dolina Rybiego Potoku, near Morskie Oko (Morskie Oko Lake), on rock near route to Czarny Staw pod Rysami, 34UDV3249, alt. 1,405 m a.s.l., *leg.*, *det.* P. Górski, 2004-08-18 (POZNB 565); **POLAND, WESTERN TATRA MOUNTAINS:** Dolina Wyznia Chochołowska (Wyznia Chochołowska Valley), rocky walls below Mt Łopata, 34UDV1051, alt. 1,715 m a.s.l., *leg.*, *det.* P. Górski, 2004-08-12 (POZNB 4036; KRAM B-262600); Dolina Starorobociańska (Starorobociańska Valley), Zadnie Zagony, 34UDV1450, alt. 1,700 m a.s.l., *leg.*, *det.* P. Górski, 2004-08-11 (POZNB 12/2004).

SLOVAKIA, HIGH TATRA MOUNTAINS: middle part of Hlinská dolina (Hlinská Valley), rocky walls below Veľká Záhradka, 34UDV2947, alt. 1,719 m a.s.l., 49.17650° N, 20.02956° E, *leg.*, *det.* P. Górski, 2017-08-11 (POZNB 3196); Temnosmrečinská dolina (Temnosmrečinská Valley), NE shore of Vyšné Temnosmrečinské pleso (Vyšné Temnosmrečinské Lake), on stone near stream, 34UDV2948, alt. 1,720 m a.s.l., 49.18958° N, 20.03903° E, *leg.*, *det.* P. Górski, 2012-08-01 (POZNB 3499); Hincova dolina (Hincova Valley), rocky outcrops near NW shore of Veľké Hincovo pleso (Veľké Hincovo Lake), 34UDV3148, alt. 1,940 m a.s.l., *leg.*, *det.* P. Górski, 2008-08-12 (POZNB 28/2008); Hincova dolina, near NW shore of Veľké Hincovo pleso, small rocks with a northern exposure, 34UDV3148, alt. 1,945 m a.s.l., *leg.*, *det.* P. Górski, 2008-08-12 (POZNB 702); Žabia Bielovodská dolina (Žabia Bielovodská Valley), rocky walls between Mlynárovo sedlo (Mlynárovo Pass) and Mt Veľký Žabi štít, 34UDV3448, alt. 1,885 m a.s.l., *leg.*, *det.* P. Górski, 2009-08-19 (POZNB 53/2009); Spádová dolinka (Spádová Valley), boulder dripping water, 34UDV3448, alt. 1,945 m a.s.l., *leg.*, *det.* P. Górski, 2009-08-25

Table 1 Floristic composition of phytocoenoses with *Marsupella submarginata* in the Tatra Mountains.

	Successive number of relevé										Constancy
	1	2	3	4	5	6	7	8	9	10	
Number of relevé in the field	17	14	9	53	19	16	12	28	24	6	
Moss layer cover d [%]	98	85	70	60	95	65	85	70	98	98	
Herb layer cover c [%]	0	0	0	0	0	0	0	10	0	zn	
Size of the patch [cm]	30 × 40	50 × 20	35 × 30	60 × 40	90 × 90	90 × 90	70 × 40	90 × 90	80 × 40	30 × 60	
Altitude a.s.l. [m]	1,850	1,715	1,810	1,885	1,870	1,720	1,740	1,940	1,715	1,700	
Exposure	NNE	N	N	N	W	NW	NE	N	NNW	N	
Inclination [°]	90	85	80		90	50–90	90	10–90	35–45	50	
Date	2004-08-16	2004-12-08	2005-07-26	2009-08-19	2005-08-20	2006-07-23	2004-08-11	2008-08-12	2004-08-18	2007-08-22	
Number of species	3	5	8	9	8	6	9	14	11	10	
Country (PL/SL)	PL	PL	PL	SL	PL	SL	PL	SL	PL	SL	
High/Western Tatra Mts	HT	WT	HT	HT	HT	WT	WT	HT	HT	HT	
<i>Marsupella submarginata</i>	8	8	4	.2	7	5	1	5	1	5	V
ChCl. <i>Salicetea herbaceae</i>											
<i>Kiaeria starkei</i>	.4	.1	.	1	.2	.2	1	.4	.4	1	V
<i>Polytrichastrum sexangulare</i>	.	.	.4	.	.	.	.2	.1	.	.	II
<i>Fuscocephaloziopsis albescens</i>	.	.	.4	.1	.	.	.	.	.	.	I
<i>Anthelia juratzkana</i>	.	.	.1	.	.	.	.	.	.1	.1	II
<i>Luzula alpino-pilosa</i>	.	.	.	.	.	.	.	1	.4	.	I
<i>Leucanthemopsis alpina</i>	.	.	.	.	.	.	.	.1	.	.	I
<i>Pohlia ludwigii</i>	.	.	.	.	.	.	.	.	.1	.	I

Continued on next page

	Successive number of relevé										Constancy
	1	2	3	4	5	6	7	8	9	10	
ChCl. <i>Grimmieta alpestris</i>											
<i>Bucklandiella sudetica</i>	.	.1	.1	3	.4	2	.2	2	.	.	IV
<i>Diplophyllum taxifolium</i>2	.1	.1	.	.	1	II
<i>Gymnomitrium concinnatum</i>4	.2	.	.1	.1	.	II
<i>Gymnomitrium adustum</i>	.	.	2	.4	.	.	.	.	.	.	I
<i>Andreaea nivalis</i>2	.	.	.	.	.	.	I
<i>Bucklandiella affinis</i>1	I
Others											
<i>Barbilophozia sudetica</i>	.2	.	.4	1	.2	.4	2	.4	.	.2	IV
<i>Nardia scalaris</i>	.	.1	.4	.	.	.	.2	.	5	5	III
<i>Schistochilopsis opacifolia</i>	.	.	.	1	.1	.	4	.4	.	.	II
<i>Lophozia wenzelli</i>1	.	.	.2	.	.2	.1	II
<i>Solenostoma obovatum</i>	2	.	.	I
<i>Cephalozia bicuspidata</i>1	.	.	.2	5	.	I
<i>Oligotrichum hercynicum</i>	.	.1	.	.	.	.	.	.	.1	.	I
<i>Mutellina purpurea</i>1	.	.	I
<i>Poa laxa</i>1	.	.	I
<i>Geum montanum</i>1	.	.	I
<i>Solenostoma sphaerocarpum</i>	1	.	I
<i>Athyrium alpestre</i>1	I
<i>Hupezia selago</i>1	I

(POZNB 325); Kačacia dolina (Kačacia Valley), upper part of the valley, 34UDV3546, alt. 1,800 m a.s.l., *leg., det.* P. Górski, 2009-09-16 (POZNB 313; KRAM B-262603); Kačacia dolina, near Zelené Kačacie pleso (Zelené Kačacie Lake), rocky outcrops, 34UDV3547, alt. 1,675 m a.s.l., *leg., det.* P. Górski, 2006-08-17 (POZNB 427); Kačacia dolina, in gully coming down from Mt Zlobivá, 34UDV3547, alt. 1700 m a.s.l., *leg., det.* P. Górski, 2007-08-22 (POZNB 6/2007); Kačacia dolina, blocks of rock with a northern exposure, 34UDV3547, alt. 1,700 m a.s.l., *leg., det.* P. Górski, 2007-08-22 (POZNB 31; KRAM B-262604); Kačacia dolina, rocky walls below Kačači žlab (Kačači Gully), 34UDV3547, alt. 1,770 m a.s.l., *leg., det.* P. Górski, 2013-09-28 (POZNB 1711); Čierna Javorová dolina (Čierna Javorová Valley), on stone in spruce forest *Plagiothecio-Piceetum*, unmarked path, 34UDV3951, alt. 1,415 m a.s.l., *leg., det.* P. Górski, 2010-08-25 (POZNB 268); Čierna Javorová dolina, Čierna záhrada, base of rocky walls at the mouth of Ladova dolinka (Ladova Valley), 34UDV4050, alt. 1,660 m a.s.l., 49.20685° N, 20.17762° E, *leg., det.* P. Górski, 2010-08-25 (POZNB 24/2010); Kolová dolina (Kolová Valley), SEE from Kolové pleso (Kolové Lake), rocky walls below Hrebeň Kolových veži (Hrebeň Kolových veži Ridge), 34UDV4151, alt. 1,645 m a.s.l., 49.21667° N, 20.19438° E, *leg., det.* P. Górski, 2010-08-28 (POZNB 256); **SLOVAKIA, WESTERN TATRA MOUNTAINS:** Mt Brestová, below the summit on the north side, on stone, 34UDV0453, alt. 1,760 m a.s.l., *leg., det.* P. Górski, 2006-07-23 (POZNB 435); Roháčska dolina (Roháčska Valley), in the cirque below Mt Brestová, 34UDV0453, alt. 1,720 m a.s.l., *leg., det.* P. Górski, 2006-07-23 (POZNB 4037; KRAM B-262602).

3.3. Excludenda

The aforementioned herbarium vouchers were listed under the name *Marsupella emarginata* in the article by Górski and Váňa (2014, pp. 431–432). Currently they belong to *Marsupella submarginata*: POZNB 31, 256, 268, 313, 325, 427, 435, 564, 565, 702, 1711, 12/2004, 14/2004, 17/2004, 9/2005, 19/2005, 16/2006, 6/2007, 28/2008, 53/2009, 24/2010.

4. Discussion

Marsupella submarginata is a semi-cryptic species distinguished from *M. emarginata*. Bakalin et al. (2019, p. 65), who provided the diagnostic characteristics of the new species, stressed the fact that there were minor morphological differences and that their stability was uncertain. The most important traits of *M. submarginata* that distinguish it from *M. emarginata* are the thickened cell walls of the hyaloderm layer (contrary to the thin walls in *M. emarginata*) and the relatively small (12–18 µm wide) mid-leaf cells in *M. submarginata* (Bakalin et al., 2019). The observations of the *M. submarginata* specimens collected in the Tatras showed that the thickened cell walls of the hyaloderm layer in *M. submarginata* seem to be a basic qualitative trait. This observation was based on a perpendicular cross-section of the stem between the leaf bases. When interpreting the image of the stem cross-section, the area where the base of the leaf adheres to the stem should be excluded, because this might be misinterpreted as the hyaloderm (the leaf cells of both species always have thickenings). It seems that *M. submarginata* usually has a single-layered hyaloderm, whereas the hyaloderm of *M. emarginata* has two layers. It is noteworthy that the scleroderm of *M. submarginata* is not as well developed as that of *M. emarginata*. This can be related to the size of both species as well as their habitats. The height of *M. submarginata* does not exceed 20 mm (cf. Bakalin et al., 2019), as evidenced by the specimens collected in the Tatras. *Marsupella submarginata* grows in humid places, where water periodically slowly drips down rocks. *Marsupella emarginata* can be found around streams and waterfalls, where water flows more or less rapidly.

According to Bakalin et al. (2019), the color of the plants is another good distinguishing feature. The specimens found in the Tatras were light or dark brown, or rusty, but never red or purple. It seems that the specimens of *M. submarginata* from the Tatras have deeper emarginate leaves, which slightly resembled those of *M. sphacelata* at first glance. However, this trait is not constant, so it is difficult to

precisely define it in the identification key. To sum up, the specimens of *M. submarginata* from the Tatras are small altimontane plants with a height of up to 20 mm. They are light or dark brown, golden, or rusty in color. The hyaloderm is usually unistratose and composed of thick-walled cells and mid-leaf cells up to 18 µm wide. Unfortunately, the examined herbarium material also contained some specimens which caused identification problems and could not be classified with certainty as the distinguished species.

According to Bakalin et al. (2019), in addition to in Eastern and Northeastern Asia, *M. submarginata* might occur in the temperate Atlantic climate zone in Europe. The discovery of this liverwort in the Sudetes and Carpathians extended the range of the species to areas under less influence of the Atlantic climate but with high rainfall. The annual rainfall at the localities of *M. submarginata* in the Giant Mts is 1,200–1,400 mm, whereas in the Tatra Mts it is 1,400–2,000 mm (read from the map provided by Ustrnul et al., 2015).

Currently, in total there are 10 plant species of *Marsupella* in the Tatra Mts, including the newly identified species. Below is the key to their identification.

Key to the *Marsupella* species occurring in the Tatra Mountains:

1. Leaf margin narrowly revolute 2
- 1*. Leaf margin plane 4
2. Sinus descending less than 1/5 of leaf length, lobes very wide, obtuse to rounded *Marsupella aquatica* (Lindenb.) Schiffn.
- 2*. Sinus descending for 1/5–1/4 of leaf length, lobes broadly triangular, obtuse to obtusely pointed 3
3. Stem hyaloderm with slightly thickened walls, cells 12–18 µm wide in the middle of the leaf; plants small (up to 2 cm) with light or dark brown, rusty pigmentation *Marsupella submarginata* Bakalin & Fedosov
- 3*. Stem hyaloderm with thin walls, cells 18–23 µm wide in the middle of the leaf; plants small to large (2–10 cm), with green, red, purple, brown, or blackish pigmentation *Marsupella emarginata* (Ehrh.) Dumort.
4. Leaves on sterile shoots not or hardly wider than stem; plants filiform 5
- 4*. Leaves on sterile shoots wider than stem; plants not filiform 7
5. Leaf margin composed by thin-walled and easily destroying one–two rows hyaline cells along the whole margin; lobes with apex composed of one–two superimposed elongate hyaline cells (apiculus); *Gymnomitrium*-like . . *Marsupella apiculata* Schiffn.
- 5*. Leaf margin with more thick cells, not disintegrating; apiculus absent 6
6. Leaves with lunate sinus, mostly imbricate; *Gymnomitrium*-like [the leaves must be carefully detached from the middle of sterile stems and flattened under the coverglass!] *Marsupella condensata* (Ångstr. ex C. Hartm.) Lindb. ex Kaal.
- 6*. Leaves with acute to somewhat obtuse sinus, distant to contiguous; *Cephaloziella*-like [see note above] *Marsupella boeckii* (Austin) Lindb. ex Kaal.
7. Paroicous 8
- 7*. Dioicous 9
8. Sinus to 0.05–0.25 of the leaf length; leaves barely cordate at base, not sheathing; plants small, 0.2–0.3 cm *Marsupella sprucei* (Limpr.) Bernet
- 8*. Sinus to 0.3–0.5 of the leaf length; leaf base cordate to slightly sheathing; plants 0.3–3 cm long *Marsupella sparsifolia* (Lindb.) Dumort.
9. Leaf cells mostly 10–20 µm, leaf base not sheathing the stem
..... *Marsupella funckii* (F. Weber & D. Mohr) Dumort.
- 9*. Leaf cells mostly 20–30 µm, leaf base sheathing the stem
..... *Marsupella sphacelata* (Giessecke ex Lindenb.) Dumort.

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