

Occurrence and chemical diversity of the genus *Bryoria* in the Sučí Potok Valley, Veporské Vrchy Mountains (Central Slovakia)

Communication

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Abstract: Four species of the genus, *Bryoria* were found in the Sučí Potok Valley: *B. capilaris* (Ach.) Brodo & D. Hawksw., *B. fuscescens* (Gyeln.) Brodo & D. Hawksw., *B. implexa* (Hoffm.) Brodo & D. Hawksw., *B. nadvornikiana* (Gyeln.) Brodo & D. Hawksw. The most common species in the valley was *B. implexa*. Four chemotypes of this lichen were recognized.

Keywords: *Bryoria* • Chemotype • Lichen substances • Western Carpathians

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1. Introduction

The genus *Bryoria* Brodo & D. Hawksw. is a boreal, temperate genus consisting of approximately 45 species worldwide [1]. Eleven of these have been reported in Slovakia [2]. The species of the genus *Bryoria* are fruticose lichens, with semi-erect to decumbent or pendent branches. They grow on bark, rock or on the ground in exposed sites [1]. Some species show a great morphological variation. This is probably due to differences in environmental conditions, which are known to play an important role for many pendulous, fruticose lichens [3–5].

The genus *Bryoria* is not well-known in Slovakia [6]. Six species of the genus are regarded as endangered (*B. bicolor*, *B. capillris*, *B. implexa*, *B. lanestris*, *B. nadvornikiana*, *B. subcana*) [2]. *Bryoria bicolor*, *B. chalybeiformis*, *B. implexa*, *B. lanestris* and *B. nadvornikiana* are protected by law [7]. However, *Bryoria* occurs abundantly in Veporske Vrchy Mountains. The specimens were noted and studied from the Za Dlhým Grúňom Valley [8], in the Studená Jama Valley

[9], in the Kamenistá Dolina Valley, in the Čierny Potok Valley, Hukavská Dolina Valley, in the Rakytovo Valley and other valleys (M. Lukáč, unpublished data).

The aim of this investigation was to document species of the genus *Bryoria* in the Sučí Potok Valley and to analyze their chemical diversity.

2. Experimental Procedures

The valley of the Sučí potok is located in the Veporské Vrchy Mountains, (Western Carpathian). The specimens were collected in 10 localities. Their geographical positions were as follows: Locality 1: 19° 34' 15" E, 48° 36' 25" N; altitude 590 m; Locality 2: 19° 34' 50" E, 48° 35' 50" N; altitude 640 m; Locality 3: 19° 35' 45" E, 48° 35' 35" N; altitude 680 m; Locality 4: 19° 36' 10" E, 45° 35' 20" N; altitude 715 m; Locality 5: 19° 36' 00" E, 48° 35' 40" N; altitude 705 m; Locality 6: 19° 36' 05" E, 48° 35' 50" N; altitude 740 m; Locality 7: 19° 36' 15" E, 48° 35' 40" N; altitude 735 m; Locality 8: 19° 36' 15" E, 48° 35' 50" N; altitude 740 m; Locality 9: 19° 36' 25" E, 48°

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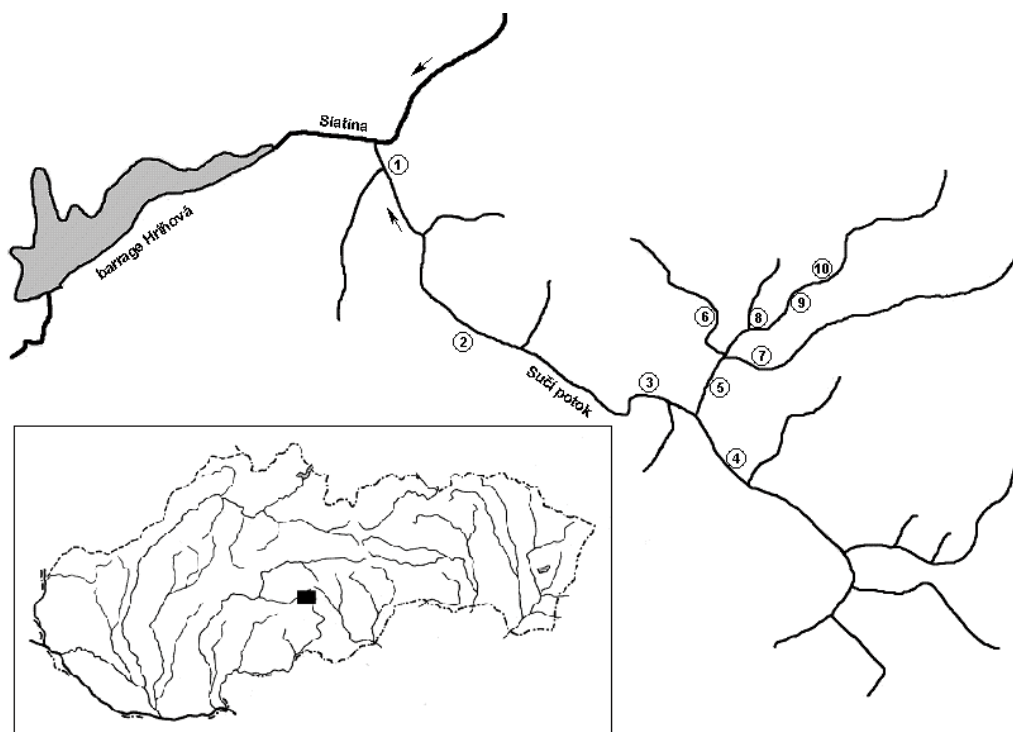


Figure 1. Study area and location of sampling sites in the Sučí Potok Valley.

35° 55' N; altitude 765 m; Locality 10: 19° 36' 30" E, 48° 36' 00" N; altitude 790 m (Figure 1). System WGS-84 was used on determination of geographical position of the localities. The material was collected on August 17, 2004 in locality 5, on May 2, 2008 in localities 1, 4, 5, 7, on May 30, 2008 in localities 2, 3, 6, 8 – 10. A mixed forest grows in the valley. The main trees in the forest crop are *Picea abies* and *Fagus silvatica*. All examined specimens grew on branches of *Picea abies*. Collected samples were identified using methods described in the literature [1,3,10]. The specimens employed are listed in Table 1, and are preserved in the author's private collection.

All of the specimens studied were subjected to colour reagent tests and TLC, according to the standard method described by Culberson *et al.* [11–13]. The control substances in lichen, atranorin and norstictic acid, were obtained by extracting a fragment of *Lobaria pulmonaria* (norstictic acid) and *Evernia prunastri* (atranorin). Extraction of the lichen compounds from the samples was carried out according to Lukáč and Onderka [14].

3. Results

The area of the valley Sučí Potok Brook is approximately 12.5 km². Thirty-seven specimens of *Bryoria* were collected in ten localities. Twenty-five of them are listed

in the Table 1. Seven specimens of *B. capillaris*, three specimens of *B. fuscescens*, fourteen specimens of *B. implexa* and one specimen of *B. nadvornikiana* were investigated. Another twelve specimens were collected as duplicate samples in the localities. *Bryoria* species were present in the lower and in the middle part of the valley. They grew on sun-exposed sites, on branches of *Picea abies* and near the water. They often grew on branches hanging over brook.

3.1 Description of collected specimens

***Bryoria capillaris* (Ach.) Brodo & Hawksw.** (1, 4, 5, 8, 11, 14, 17, see Table 1). The *Thallus* was subpendent or pendent, 3.5 – 14 cm long, whitish-grey, greyish-green or brownish grey, and dull. The branches were primarily even, however were sometimes uneven and twisted. The branching was isotomic dichotomous to anisotomic dichotomous with acute angles. The angles between the main branches were V-shaped. Soralia was mostly absent, but when present, it was tuberculate. Pseudocyphellae was present, and either linear or fusiform, and apothecia was absent. *Results of Chemical analysis:* Alectorialic acid, barbatolic acid, ± atranorin in the thallus.

***Bryoria fuscescens* (Gyeln.) Brodo & D. Hawksw.** (3, 18, 24, see Table 1). The *Thallus* was pendent, 7 – 13 cm long, brown to blackish-brown, dull. The branching was isotomic dichotomous to anisotomic dichotomous,

No.	locality	species	size	colour	BS	pseudocyphellae	soralia	chemistry	CT
1	1	<i>B. capillaris</i>	7.5 cm	whitish-grey, dull	V	fusiform	-	Al, Ba	-
2	1	<i>B. implexa</i>	4 cm	brown, shiny	U	fusiform, linear	fissural	At, Fu(s), Cph-2	V
3	2	<i>B. fuscescens</i>	9 cm	brown, dull	V	-	large, broadly fissural	At, Fu(s), Cph-2	-
4	2	<i>B. capillaris</i>	7 cm	whitish grey, dull	V	-	-	Al	-
5	2	<i>B. capillaris</i>	9 cm	brownish grey, dull	V	linear	-	Al, Ba	-
6	2	<i>B. implexa</i>	12 cm	brown, dull	V	linear	tuberculate	Fu(s), Cph-2	V
7	2	<i>B. implexa</i>	10 cm	olivaceous, shiny	V	-	tuberculate, fusiform	At, Ps	I
8	3	<i>B. capillaris</i>	8.5 cm	whitish-grey, dull	V	fusiform	-	Al, Ba	-
9	3	<i>B. implexa</i>	14 cm	greynish-brown, dull	V	linear	-	At, Ps	I
10	3	<i>B. implexa</i>	9 cm	greyish-brown, dull	U	linear	tuberculate – same colour as the thallus	At, Ps	I
11	4	<i>B. capillaris</i>	14 cm	greyish-green, in some part brownish, dull	V	fusiform or linear	tuberculate	At, Al, Ba	-
12	4	<i>B. implexa</i>	23 cm	dark brownish-green, dull	U	linear	fissural or tuberculate	At, Fu(s), Cph-2	V
13	4	<i>B. implexa</i>	8.5 cm	brown, dull	U	fusiform	tuberculate, large	At, Fu, Cph-2	IV
14	5	<i>B. capillaris</i>	6 cm	grey, dull	V	fusiform	-	Al, Ba	-
15	5	<i>B. implexa</i>	10 cm	dark olivaceous brown, dull	U	fusiform	fissural	At, Fu(s), Cph-2	V
16	5	<i>B. implexa</i>	5.5 cm	brown, dull	V	linear	tuberculate	At, Ps	I
17	6	<i>B. capillaris</i>	3.5 cm	whitish-grey, dull	V	-	-	Al	-
18	6	<i>B. fuscescens</i>	13 cm	greenish-brown, dull	U	-	broadly fissural	At, Fu(s), Cph-2	-
19	7	<i>B. implexa</i>	17 cm	olivaceous, dull	V	linear, fusiform	small tuberculate	Gy, Fu(s)	III
20	7	<i>B. implexa</i>	10 cm	olive-brown, dull	V	linear	tuberculate or fissural	At, Fu(s), Cph-2	V
21	7	<i>B. implexa</i>	5 cm	olivaceous, shiny	U	fusiform	fissural	Fu(s), Cph-2	V
22	8	<i>B. nadvornikiana</i>	7 cm	grey – blackened towards the base, dull	U	fusiform	tuberculate	Al, Ba	-
23	8	<i>B. implexa</i>	10 cm	dark olivaceous brown, dull	V	linear	tuberculate	At, Fu(s)	V
24	9	<i>B. fuscescens</i>	7 cm	brown to blackish-brown, dull	V	-	large, broadly fissural	Fu(s), Cph-2	-
25	10	<i>B. implexa</i>	6 cm	dark, olive-green, dull	V	linear	tuberculate and fusiform	At, Fu(s), Cph-2	V

Table 1. The main characters of the genus *Bryoria* collected in the Sučí Potok Valley.

No. = number of specimen; BS = Branching shape; U = U-shaped; V = V-shaped; CT = chemotype; Al = alectorialic acid; At = atranorin, Ba = barbatolic acid; Cph-2 = confumarprotocetraric; Fu = fumarprotocetraric acid; Gy = gyrophoric acid; Ps = psoromic acid; (s) = occurs in the soralia

mostly with acute angles. The angles between main branches were V-shaped. The branches were even. Soralia were present, large, and broadly fissural, and white in color. Pseudocyphellae were absent. Apothecia were also absent. *Results of Chemical analysis:* Fumarprotocetraric acid and confumarprotocetraric acid in the soralia; $\pm$ atranorin in the thalus.

***Bryoria implexa* (Hoffm.) Brodo & D. Hawksw.** (2, 6, 7, 9, 10, 12, 13, 15, 16, 19–21, 23, 25, see Table 1). The *Thallus* was subpendent or pendent, up to 23 cm long, pale brown to dark, olivaceous brown, dull or shiny. The branching was mainly isotomic dichotomous, with obtuse angles. The angles between the main branches were U-shaped or V-shaped. The branches were $\pm$ even, slender or robust, twisted, and flattened. Soralia were $\pm$ present, tuberculate or fissural, grayish, white or the same color as the thallus. Pseudocyphellae were present, and were linear or fusiform. Apothecia were absent. *Results of Chemical analysis:* Chemotype I (7, 9, 10, 16): Psoromic acid, $\pm$ atranorin in the thalus, Psoromic acid, $\pm$ Fumarprotocetraric acid in the soralia. The chemotype II reported by Holien [3] was not observed. Chemotype III (19): Gyrophoric acid in the thalus. Fumarprotocetraric acid in the soralia. Chemotype IV (13): Fumarprotocetraric acid, confumarprotocetraric acid, and atranorin in the thalus and soralia. Chemotype V (2, 6, 12, 15, 18, 20, 21, 23, 25): $\pm$ Atranorin in the thalus. Fumarprotocetraric acid and $\pm$ confumarprotocetraric acid in the soralia.

***Bryoria nadvornikiana* (Gyeln.) Brodo & Hawksw.** (22, see Table 1). The *Thallus* was subpendent, 7 cm. long, grey, and blackened towards the base, and dull. The branching was isotomic dichotomous with obtuse angles; the angles between the main branches were U-shaped. The branches were even and spinulose. Branches were present. Soralia were present and tuberculate. Pseudocyphellae were present and fusiform. Apothecia were absent. *Results of Chemical analysis:* Alecatorialic acid and barbatolic acid in the thallus.

4. Discussion

The Sučí Potok Valley is host to rich populations of four species of the genus *Bryoria*: *B. capillaris*, *B. fuscescens*, *B. implexa* and *B. nadvornikiana*. The occurrence of the lichens is related to sun-exposed sites and proximity of watercourses. Specimens of *Bryoria* are most frequent in the middle part of the valley. There was less frequent occurrence of *Bryoria* in the lower part of the valley, close to the junction between the Sučí Potok Brook and the Slatina River. The reasons for reduced frequency of lichens in this area may be due to a higher degree of

air pollution and less sun-exposed sites. Specimens of *Bryoria* were absent from the upper part of the valley. A slightly less humid climate may be one reason; open forest areas or pastures are present there, and the water flow is weak in the upper part of the valley.

Bryoria capillaris is a commonly found lichen in the valley. The variation in the chemical make-up of the species is high. The thallus did not contain only alecatorialic acid, barbatolic acid, and $\pm$ atranorin but also some specimens had other substances, which Holien [3] designated as unknown acids (UA1, UA2, UA3, UA4, UA5). The composition of these substances were not studied. They probably are related to alecatorialic acid (alecatorialin, 5,7-dihydroxy-6-methylphthalide), and barbatolic acid (barbatolin, barbatol, 6-formyl-5,7-dihydroxyphthalide). The discovery of these substances in *B. nadvornikiana* and *Alectoria nigricans* has been cited by Elix & Jayanthi [15].

Three specimens of *Bryoria fuscescens* were found in the area studied, one in locality 2, one in locality 6 and one in locality 9. The thallus of the last one was partly destroyed. *B. fuscescens* was separated from *B. implexa* (Chemotype IV, V) by the absence of pseudocyphellae.

Bryoria implexa was the most common species of the genus in the valley. Four of the five chemotypes reported by Holien [3] were recognized. Chemotype I was observed in four cases, chemotype III and IV in one case each. Chemotype V was the most common one, and was observed in eight cases. Specimen 13 contained one unknown acid, with R_f identical with that of succinprotocetraric acid (TLC; G solvent system [13]). The small specimen from locality 1 resembled *B. glabra* in morphology [16]. Its thallus was brown and shiny. Angles between main branches were U-shaped. The branches had small, fissural, white, and round soralia. Few short pseudocyphellae were also observed. The thallus contains atranorin and the soralia reacted PD+ red.

Bryoria nadvornikiana was observed only in one case. Chemical composition of its lichen substances was similar to *B. capillaris*. *B. nadvornikiana* is considered to be an old forest indicator [3]. The collected sample grew on 60 – 100 year old tree.

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