

# *Fissidens osmundoides* Hedw. (Bryophyta) in Slovakia

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**Abstract.** The paper presents current knowledge on ecology and distribution of the bryophyte species *Fissidens osmundoides* in Slovakia. Phytocoenological variation of the species has been processed. Threat status using new criteria was re-assessed.

**Key words:** Bryophytes, *Fissidens osmundoides*, ecology, distribution, phytocoenology, threat status, Slovakia.

## Introduction

Synonyms:

*Conomitrium osmundoides* (HEDW.) MÜLL. HAL.  
*Dicranum bryoides* SW.

*Dicranum bryoides* var. *elongatum* HOOK & TAYL.

*Dicranum osmundoides* (HEDW.) TUTNER.

*Dicranum palmatum* var. *osmundoides* (HEDW.) AM.

*Dicranum viridulum* var. *osmundoides* (HEDW.) DUBY

*Fissidens bryoides* var. *osmundoides* (HEDW.) MATHIEU

*Fissidens dicarpor* BRID.

*Hypnum asplenioides* DICKS.

*Osmundula fissidentoides* RABENH.

*Schistiphyllum osmundoides* (HEDW.) LINDB.

*Skitophyllum osmundoides* (HEDW.) BACH. PYL.

The moss species *Fissidens osmundoides* Hedw. is a member of the *Fissidentaceae* family with a sub-arctic-subalpine distribution (Düll 1994). *Fissidens osmundoides* is found growing on damp rock crevices and in flushes. The species is easily recognized by its unbordered, relatively short and wide leaves, wide cells and purple seta. Smith (1978) reported its distribution as Europe, the Faroe Islands, Iceland, Siberia, Central Asia, Japan, Malaya, North America, Greenland and southern South America. In Slovakia, the moss found its optimum habitat in the alpine zone of the Tatra Mts. The oldest known record of the species is in the Slovak National Museum in Bratislava, where an item collected in 1921 is stored: "*Fissidens osmundoides* (Sw.) Hedw., Europa centralis, Tatra magna, prope lacum Batizovské, dense caespitosa ad rupes humosas, 1800m, leg. et det. J. Podpěra, VII 1921, rev. Valent. Pospíšil 1972, est". Dickson (1973) recorded findings of sub-fossils of *Fissidens osmundoides* in the counties of Caernarvon, Cumberland and Westness.

## Methods

### Sampling

Data on distribution of *Fissidens osmundoides* in Slovakia were obtained from the available literature, searching different herbaria and by our own research in the field. The relevés were taken following standard procedures of the Zürich-Montpellier School (Braun-Blanquet 1964; Westhoff and Van der Maarel 1978), using the modified 9-degree Braun-Blanquet's sampling scale (Barkman *et al.* 1964) transformed into the ordinal scale of Van der Maarel (1979) and stored in the TURBOVEG database (Hennekens and Schaminée 2001). Shrub- and herb-layer records for any one taxon were merged; data were exported into JUICE 7.0 software for analysis (Tichý and Holt 2006). Geographic coordinates were recorded in the WGS 84 system using a Garmin e-Trex Vista device or were taken from Google Earth geographic information.

### Nomenclature

Nomenclature of vascular plants follows the Checklist by Marhold (1998), that of the syntaxa the list of Mucina and Maglocký (1985). Nomenclature of bryophytes follows Kučera *et al.* (2012) or, for those not included in this list, Hill *et al.* (2006).

### Threat categories

Threat status has been re-assessed using criteria suggested by Hallingbäck *et al.* (1998) and tested on Swedish bryophytes Hallingbäck (1998).

### Instrumental analysis

Aqueous aluminium was determined spectrophotometrically using pyrocatechin violet (Driscoll 1984) and ammonium nitrate using a spectrophotometric method with Nessler reagent (Horáková *et al.* 1989). Chlorides, sulphates and nitrates were determined using capillary zonal electrophoresis, EA 101 device, with a buffer solution of 7 mM succinic acid + 0.5 mM BTP (bis-tris-propen) + 5% PVP (polyvinylpyrrolidone) + 0.1 % MHEC (methylhydroxyethylcellulose). Cations (K<sup>+</sup>, Na<sup>+</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>) were determined using isotachophoretic methods in the first colony, ZKI 02 device. The following electrolytes were used:

LE: 10 mmol.l<sup>-1</sup> NH<sub>4</sub>OH + CH<sub>3</sub>COOH + 30% PEG (polyethylene glycol) + 0.1% HEC (hydroxyethylcellulose).

TE: 8 mmol.l<sup>-1</sup> tetraethylammonium perchlorate. Conductivity was determined using OK-104 device, pH by pH-meter WTW pH 91.

Shortcuts of herbaria follow INDEX HERBARIORUM, Missouri Botanical Garden, U.S.A. Missouri, Saint Louis ([www.sweetgum.nybg.org](http://www.sweetgum.nybg.org).2013) All specimens were stored at the Tatras National Park Museum in Tatranská Lomnica, Slovakia.

## Results

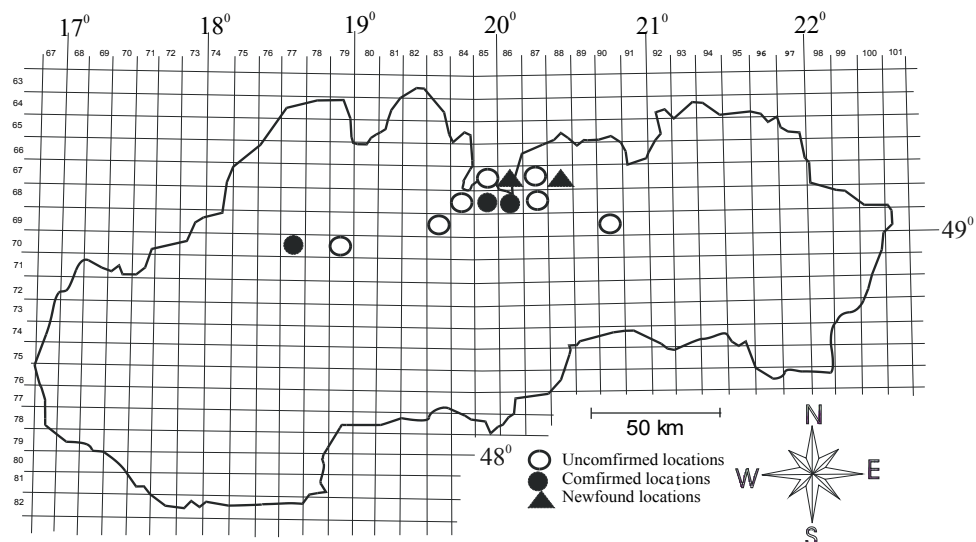
### *Distribution in Slovakia, published data (Fig. 1)*

Belianske Tatry, Košiare, 2011m a.s.l. (Šmarda 1948); Hornádska Basin, Sivá brada, travertine, 506m a.s.l. (Šmarda 1948); Nízke Tatry, between Ďumbier and Kráľový stol, 1600m a.s.l. (Šmarda 1948); Veľká Fatra, Blatnická and Gaderská Valley, *Caricetum davallianae* (Cvachová *et al.* 1980); Turčianska Basin, Kláštorské meadows around Turiec, *Caricetum davallianae* (Škovirová 1971); Vysoké Tatry, Malá Studená Valley, around 2000m a.s.l. (Chaľubinski 1886); Vysoké Tatry, Veľká Studená Valley, by Zbojnica Lodge, 1970m a.s.l., (Pilous 1992); Vysoké Tatry, W slope of Ostervy, 1600m a.s.l. (Šmarda 1948); Vysoké Tatry, Mlynická Valley, tarn above Skok, 1811m a.s.l. (Šmarda 1948); Vysoké Tatry, Temnosmrečinská Valley, spring between tarns, 1680m a.s.l. (Šmarda 1948); Vysoké Tatry, Nefcerka, Terianske Tarn, 1947m a.s.l. (Šmarda 1948); Vysoké Tatry, Valley of Bielé Tarns, W of former Votrubová Lodge, 1700m a.s.l. (Šmarda 1948); Vysoké Tatry, Valley of Zelené Tarn, around Zelené kežmarské Tarn, 1550m a.s.l. (Šmarda 1952); Vysoké Tatry, Batizovské Tarn, 1900m a.s.l. (Šmarda 1954b); Vysoké Tatry, Batizovská Valley, by Batizovské Tarn, 1880m a.s.l. (Šmarda 1958); Vysoké Tatry, Mengusovská Valley, by Hincové Tarns, 1950m a.s.l. (Šmarda 1958); Vysoké Tatry, Nefcerka, 1850m a.s.l. (Šmarda 1958); Vysoké Tatry, Žabia Bielovodská Valley, 1750m a.s.l. (Šmarda 1958); Vysoké Tatry, Slavkovská Valley, 1850m a.s.l. (Šmarda 1958); Vysoké Tatry, Zlomisková Valley, 1800m a.s.l. (Šmarda 1958); Vysoké Tatry, Velická Valley, 1880m a.s.l. (Šmarda 1961c);

Vysoké Tatry, Osterva, 1700m a.s.l. (Šmarda 1961c); Vysoké Tatry, Mengusovská Valley, below Žabie Tarn, 1700m a.s.l. (Šmarda 1961c); Vysoké Tatry, Mengusovská Valley, above Žabie Tarn, 2000m a.s.l. (Šmarda 1961c); Vysoké Tatry, Mengusovská Valley, lower edge of Červený žlab, 1610m a.s.l. (Šmarda 1961c); Vysoké Tatry, Mengusovská Valley, between Hincové Tarn and Kôprovské Saddle, 2040m a.s.l. (Šmarda 1961c); Vysoké Tatry, Mengusovská Valley, foot of Bášt, 1700m a.s.l. (Šmarda 1961c); Vysoké Tatry, Mengusovská Valley, below Kôpky, 1700m a.s.l. (Šmarda 1961c); Vysoké Tatry, Velická Valley, Velická próba, 1800m a.s.l. (Šmarda 1961c); Vysoké Tatry, Mlynická Valley, Kozie Tarn, 2010m a.s.l. (Šmarda and Vaněk 1955; Pilous 1992); Západné Tatry, Smutná Valley, terraced rock wall below Plačlivé ridge, 1650m a.s.l. (Dúbravcová 1993); Západné Tatry, Jamnická Valley, banks of the Jamnické Tarns, 1720m a.s.l. (Chaľubinski 1886); Západné Tatry, Nové Tarns S of Bystrá, 2000m a.s.l. (Šmarda 1948); Západné Tatry, Smutná Valley, Roháčske Tarns, 1600m a.s.l. (Šmarda 1952); Západné Tatry, Tomanova Valley, Rozpadliny, 1615m a.s.l. (Šmarda 1961c); Západné Tatry, Smutné Saddle, 1950m a.s.l. (Šmarda 1961c); Západné Tatry, Smutná Valley, 1800m a.s.l. (Šmarda and Vaněk 1955; Pilous 1992).

### *Collection deposited in the Tatras National Park Museum (Fig. 1)*

Liptovská Basin, moorland on bank of Belanský Brook, 934m a.s.l., leg., det. 29.7.1997 Šoltés; Popradská Basin, Belianske fen meadows, 665m a.s.l., leg., det. 10.7.1998 Šoltés; Popradská Basin, Belianske fen meadows, 665m a.s.l., leg., det. 31.7.1998 Šoltés; Vysoké Tatry, Temnosmrečinská Valley, by H. Temnosmrečinské Tarn, leg., det. 13.7.2001 Šoltés; Strážovské vrchy, moorland Cobrial, N of Čavoj village, *Caricetum davallianae*, 29.6.2002, leg. M. Janišová, det. R. Šoltés (Hb. Janišová); Vysoké Tatry, Žabia Bielovodská Valley, above V. Žabie Tarn, 2000m a.s.l., leg., det. 23.7.2002 Šoltés; Vysoké Tatry, Osterva, above Popradské Tarn, 1680m a.s.l., mylonity, leg., det. 26.7.2002



**Fig. 1** Distribution map of *Fissidens osmundoides* in Slovakia.

Šoltés; Vysoké Tatry, Žabia Bielovodská Valley, below Mlynár, 1750m a.s.l., leg., det. 27.7.2002 Šoltés; Vysoké Tatry, Nefcerka, bank of Nižné Teriánské Tarn, 1941m a.s.l., leg., det. 6.8.2002 Šoltés.

Collection deposited in other herbaria (Fig.1)

"*Fissidens osmundioides* (Sw.) Hedw., Europa centralis, Tatra magna, prope lacum Batizovské, dense caespitosa ad rupes humosas, 1800m, leg. et det. J. Podpěra, VII. 1921, rev. Valent. Pospíšil 1972 est" (BRA); "*Fissidens osmundoides* Sw., Slovakia, Montes Liptovské hole. In saxis irrigatis vallis Smutná dolina, ca 1800m, VIII.1947, leg. Zd. Pilous., rev. Pospíšil 1972 est!" (BRA); "*Fissidens osmundoides* Hdw., Slovakia, Montes Vysoké Tatry: In terram humosam prope lacum Kozí pleso, vallis Mlynica, ca 2010m, VIII.1948, leg. Zd. Pilous, rev. Pospíšil 1972 est!" (BRA); "*Fissidens osmundoides* Hdw. fo. *microcarpa* Br. eur., Slovakia, Montes Vysoké Tatry: In terra humosa prope hospitium Zbojnická chata in valle Velká Studená dolina, ca 1970m, VIII. 1948, leg. Zd. Pilous. rev. Pospíšil 1972 est!" (BRA); "*Fissidens osmundoides* Hedw. v. *microcarpus* Br. eur., CSR. Slovakia, Vysoké Tatry, dolina Mlynica, ad saxa granitica humida, VII.1956, leg. Zd. Pilous" (BRA); "*Fissidens osmundoides* Hedw. v. *microcarpus* Br. eur., CSR, Slovakia, Vysoké Tatry, dolina Mlynica, ad saxa granitica humida, VII.1956, leg. Zd. Pilous, rev. Pospíšil 1972 est!" (BRA); "*Fissidens osmundoides* Hedw., CSR, Slovakia, Vysoké Tatry: Dolina Mlynica, 1690 m., VIII.1957, leg. Zd. Pilous, rev. Pospíšil 1972 est!" (BRA); "*Fissidens osmundoides* Hedw., CSR. Slovakia. Vysoké Tatry: Dolina

Mlynica, 1690 m., VIII.1957, leg. Zd. Pilous" (BRA); "*Fissidens osmundoides* Hedw., Slovakia septentr., montes Vysoké Tatry, decl. occid. montis Kopky prope lac. Žabie plesa, ca 2000m s. m., 3.9.1973, leg. J. Váňa" (BRA); "*Fissidens osmundoides* Hedw., Slovensko, Strážovské vrchy, slatina Cobrial, S od obce Čavoj, *Caricetum davallianae*, 29. 6. 2002, leg. M. Janišová, det. R. Šoltés (Hb. Janišová); "*Fissidens osmundoides* Hdw., Tatra. Mergl. rev. Pospíšil 1972 est!" - without date (BRA).

*Habitat and phytocoenological variation of the species Fissidens osmundoides*

We have recorded the species *Fissidens osmundoides* in the following communities (Table 1):

Alliance *Caricion davallianae* KLIKA 1934

A. *Caricetum davallianae* DUTOIT 1934

B. *Carici flavae-Eriophoretum latifolii* SOÓ 1944

Alliance *Juncion trifidi* KRAJINA 1933

C. *Festuco supinae-Racomitrietum lanuginosi* (HADAČ 1956) DÚBRAVCOVÁ 1985

Alliance *Loiseleurio-Vaccinion* BR.-BL. in BR.-BL. et JENNY ex KRAJINA 1933

D. *Salicetum kitaibellianae* KRAJINA 1933

Alliance *Trisetion fusci* KRAJINA 1933

E. *Trisetetum fusci* KRAJINA 1933

Alliance *Salicion herbaceae* BR.-BL. in BR.-BL. et JENNY 1926

F. *Sedo alpestre-Salicetum herbaceae* (KRAJINA 1933) DÚBRAVCOVÁ 1985

Alliance *Androsation alpinae* BR.-BL. in BR.-BL. et JENNY 1926

G. *Oxyrio digynae-Saxifagetum carpaticae* PAWŁOWSKI et al 1928

Relevé No	1	2	3	4	5	6	7	8	K
Community	A	B	C	D	E	F	G	G	
Area (m <sup>2</sup> )	16	16	1.5	1	9	16	6	6	
Altitude (x10)	93	78	172	194	180	185	200	170	
Aspect	W	S	S		NW		W	N	
Inclination in°	3	3	15		35		50	80	
Total cover (%)	100	100	90	50	80	75	30	15	
E1 cover (%)	100	95	70	10	60	75	5	10	
E0 cover (%)	90	60	60	50	20	10	30	10	

**Diagnostic species**

as. *Caricetum davallianae*

*Carex davalliana* 2b . . . . . I

as. *Carici flavae-Eriophoretum latifolii*

*Carex flava* agg. 3 + . . . . . II

*Eriophorum latifolium* + 1 . . . . . II

as. *Festuco supinae-Racomitrietum lanuginosi*

*Festuca supinae* . . 3 . . + . . . . II

as. *Salicetum kitaibellianae*

*Salix kitaibelliana* . . . . 2a . . . . . I

as. *Trisetetum fusci*

*Trisetum fuscum* . . . . 3 . . . . . I

as. *Sedo alpestre-Salicetum herbaceae*

continued...

<i>Salix herbacea</i>	.	.	.	.	.	2b	.	.	I
as. <i>Oxyria digynae</i> – <i>Saxifragetum carpaticae</i>									
<i>Saxifraga carpatica</i>	.	.	.	.	.	.	+	+	II
<i>Oxyria digyna</i>	.	.	.	.	+	.	.	1	II
<b>Other species</b>									
E1									
<i>Ligusticum mutellina</i>	.	.	1	.	1	1	+	+	IV
<i>Carex *silvicola</i>	.	.	1	1	+	.	.	.	II
<i>Pedicularis verticillata</i>	.	.	+	.	+	.	.	+	II
<i>Swertia *alpestris</i>	.	.	.	.	2m	3	.	+	II
<i>Cardaminopsis neglecta</i>	.	.	.	.	1	.	+	+	II
<i>Soldanella carpatica</i>	.	.	+	.	+	.	.	+	II
<i>Viola biflora</i>	.	.	.	+	+	.	.	+	II
<i>Carex nigra</i>	2b	1	.	.	.	.	.	.	II
<i>Carex panicea</i>	2a	+	.	.	.	.	.	.	II
<i>Pinguicula vulgaris</i>	2m	+	.	.	.	.	.	.	II
<i>Succisa pratensis</i>	1	2m	.	.	.	.	.	.	II
<i>Potentilla erecta</i>	1	2b	.	.	.	.	.	.	II
<i>Dactylorhiza majalis</i>	+	+	.	.	.	.	.	.	II
<i>Juncus articulatus</i>	+	2m	.	.	.	.	.	.	II
<i>Geum rivale</i>	+	1	.	.	.	.	.	.	II
<i>Anemone narcissiflora</i>	.	.	3	.	.	.	.	+	II
<i>Rhodiola rosea</i>	.	.	1	.	+	.	.	.	II
<i>Leontodon pseudotaraxaci</i>	.	.	+	.	+	.	.	.	II
<i>Luzula alpino pilosa</i>	.	.	.	.	.	1	+	.	II
<i>Cystopteris fragilis</i>	.	.	.	.	.	.	+	1	II
<i>Poa alpina</i> subsp. <i>vivipara</i>	.	.	.	.	+	.	.	+	II
<i>Primula minima</i>	.	.	.	.	+	.	.	+	II
<i>Alchemilla</i> sp.	+	+	.	.	2b	.	.	.	II
E0									
<b><i>Fissidens osmundioides</i></b>	<b>1</b>	<b>r</b>	<b>1</b>	<b>2b</b>	<b>+</b>	<b>r</b>	<b>+</b>	<b>+</b>	<b>V</b>
<i>Dicranoweisia crispula</i>	.	.	.	+	+	.	+	+	II
<i>Aulacomnium palustre</i>	2a	2b	.	.	.	.	.	.	II
<i>Philonotis fontana</i>	2m	.	.	.	.	.	.	+	II
<i>Breidleria pratensis</i>	+	r	.	.	.	.	.	.	II
<i>Sarmentypnum exannulatum</i>	1	.	.	2b	.	.	.	.	II
<i>Tomentypnum nitens</i>	r	2a	.	.	.	.	.	.	II
<i>Meesia uliginosa</i>	.	.	+	.	.	.	.	+	II
<i>Campylium stellatum</i>	.	.	2m	.	.	.	.	+	II
<i>Philonotis tomentella</i>	.	.	.	.	1	.	2b	.	II
<i>Jungermannia subbelliptica</i>	.	.	.	.	.	.	+	+	II
<i>Sciuro-hypnum reflexum</i>	.	.	.	.	.	.	+	+	II
<i>Bryum pseudotriquetrum</i>	.	.	.	.	2a	.	.	+	II

**Table 1.** Communities with *Fissidens osmundioides*

**Species in one relevé only:**

**Relevé No. 1**

E1: *Alnus incana* 1, *Valeriana simplicifolia* 1, *Crepis paludosa* 1, *Cirsium palustre* +, *Anthoxanthum*

*odoratum* +, *Filipendula ulmaria* +, *Galium uliginosum* +, *Angelica sylvestris* +, *Cardamine pratensis* agg. +, *Ajuga reptans* +, *Ranunculus acris* +, *Juncus conglomeratus* +, *Equisetum pratense* +, *Picea abies* +,

E0: *Scorpidium revolvens* 2a, *Calliergonella cuspidata* 2b, *Plagiomnium elatu*, 2a, *Hypnum lindbergi* 2b, *Campylium stellatum* 2m, *Pellia epiphylla* r

#### Relevé No. 2

E1: *Molinia caerulea* 3, *Lysimachia vulgaris* 2b, *Briza media* 1, *Equisetum fluviatile* 1, *Lathyrus pratensis* 1, *Lotus corniculatus* 1, *Vicia cracca* 1, *Parnassia palustris* +, *Primula farinosa* +, *Drosera rotundifolia* +, *Festuca ovina* +, *Pinus sylvestris* r, *Betula pubescens* r

E0: *Paludella squarrosa* r, *Drepanocladus aduncus* r, *Sphagnum quinquefarium* 2b

#### Relevé No. 3

E1: *Bistorta vivipara* 1, *Hieracium alpinum* +, *Vaccinium myrtillus* +, *Poa annua* +

E0: *Tortella inclinata* 3, *Sciuro-hypnum glaciale* 2b, *Bryum intermedium* +

#### Relevé No. 4

E1: *Festuca picturata* +

E0: *Grimmia incurva* 2a

#### Relevé No. 5

E1: *Deschampsia cespitosa* +, *Veratrum \*lobelianum* +, *Bartsia alpina* +, *Silene pusilla* 1, *Carex atterrима* +, E0: *Palustriella commutata* 2a, *Blindia acuta* +, *Jungermannia obovata* +

#### Relevé No. 6

E1: *Juncus castaneus* 2a, *Bistorta major* r, *Pedicularis oederi* 2a, *Caltha \*laeta* 1

E0: *Kiaeria blyttii* 2a, *Cladonia arbuscula* r, *Cladonia coccifera* r

#### Relevé No. 7

E1: *Poa laxa* 1, *Ranunculus glacialis* +

E0: *Racomitrium sudeticum* 2a, *Sciuro-hypnum plumosum* +, *Bryum schleicheri* +, *Bartramia ithyphylla* +, *Jungermannia confertissima* +, *Philonotis caespitosa* +, *Conostomum tetragonum* +, *Kiaeria starkei* +, *Dichodontium pellucidum* +

#### Relevé No. 8

E1: *Saxifraga moschata* +, *Alchemilla flabellata* +,

*Salix kitaibelliana* +, *Calamagrostis villosa* +, *Silene acaulis* +, *Taraxacum tatrense* +

E0: *Polytrichastum alpinum* +, *Lophozia sudetica* +, *Gymnomitrium concinatum* +, *Mnium thomsonii* +, *Amphidium mougeotii* +, *Rhytidium rugosum* +, *Ditrichum flexicaule* +, *Bryum boreale* +, *Tayloria tenuis* +, *Tortella tortuosa* +, *Blepharostoma trichophyllum* +, *Plagiochila porelloides* +, *Pohlia drummondii* +, *Bryum elegans* +, *Pohlia filum* +, *Gymnostomum aeruginosum* +

#### Relevé localities:

1. Liptov Basin, fen meadow on left bank of Belanský Brook, *Caricetum davallianae*, 29 July 1998, N 49° 07.450'; E 19° 56.733'.

2. Liptov Basin, fen meadow on right bank of the rivulet above Pribylina, transition between plant communities *Carici flavae-Eriophoretum latifolii* and *Molinietum coeruleae*, 29 July 1998, N 49° 06.600'; E 19° 48.783'.

3. High Tatra Mts, Temnosmrečinská Valley, bank of the Upper Temnosmrečinské Tarn, *Festuco supinae-Racomitrietum lanuginosi*, 13 July 2001, N 49° 11.333'; E 20° 02.266'.

4. High Tatra Mts, Nefcerka Valley, *Salicetum kitaibellianae*, bank of Lower Terianske Tarn, 6 August 2002, N 49° 11.400'; E 20° 01.816'.

5. High Tatra Mts, Žabia Bielovodská Valley, *Trisetetum fuscii* below Mlynár Peak, 27 July 2002, N 49° 11.468'; E 20° 05.781'.

6. High Tatra Mts, Mengusovská Valley, Hincove Tarn Basin, *Sedo alpestre-Salicetum herbaceae*, 26 July 1994, N 49° 10.133'; E 20° 04.050'.

7. High Tatra Mts, Žabia Mengusovská Valley, *Oxyrio digynae-Saxifragetum carpaticae* above Veľké Žabie Tarn, 23 July 2002, N 49° 10.416'; E 20° 04.893'.

8. High Tatra Mts, Osterva Peak, *Oxyrio digynae-Saxifragetum carpaticae* above Popradské Tarn, 26 July 2002, N 49° 09.095'; E 20° 05.123'.

pH.	Vod.	Al <sup>3+</sup>	NH <sub>4</sub> <sup>+</sup>	K <sup>+</sup>	Na <sup>+</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	NO <sub>3</sub>	SO <sub>4</sub> <sup>2-</sup>	Cl <sup>-</sup>
	µS	µg.1000ml <sup>-1</sup>				mg.1000 ml <sup>-1</sup>				
7.05	314	66.11	10.46	21.79	6.77	42.11	8.90	3.05	9.47	21.10

**Table 2.** Results of chemical and physical analysis of groundwater from habitats of *Fissidens osmundoides*. Sampling site: Liptovská Basin, fen meadow on left bank of Belanský Brook, *Caricetum davallianae*, 29 July 1998 (relevé No. 1, Table 1).

## Discussion

In the alpine level, the moss occurs in the moist, humic rocks crevices and on the humic soil, both on limestone and granite substrata, but prefers the silicate substratum. Rarer occurs in the fen communities, where endures a higher content of bivalent basic cations (Table 2). We have recorded species in the communities of the alliance *Caricion davallianae*, the presence of relic species like *Paludella squarrosa*, *Breidleria pratensis* and *Tomentypnum nitens* suggest relic habitat. The trend of higher concentration of chlorides is common for *Fissidens osmundoides*, but high concentrations of potassium are not the limiting factor. Janišová (ined., pers. cont.) collected *Fissidens osmundoides* on the site Bulíková, land register Tajov (Starohorské vrchy Hills) in the community of the alliance

*Caricion davallianae*, the species like *Campylium stellatum*, *Cratoneuron filicinum*, *Bryum pseudotriquetrum* and *Palustriella commutata* were recorded as accompanying species.

In the high-altitudinal level the species occurs more often, always in humic habitats. We have recorded the species in the communities of the alliances *Juncion trifidi* (as. *Festuco supinae-Racomitrietum lanuginosi*), *Loiseleurio-Vaccinon* (as. *Salicetum kitaibellianae*), *Trisetion fuscii* (as. *Trisetetum fuscii*), *Salicion herbaceae* (as. *Sedo alpestre-Salicetum herbaceae*) and in the alliance *Androsation alpinae* (as. *Oxyrio digynae-Saxifragetum carpaticae*). Krajina (1933) recorded species in the as. *Trisetetum fuscii*.

In the middle boreal zone of Norway with oceanic climate the species more often enters the forest bogs (Frisvoll 1997).



## Threat

The species has been recorded in the following habitats (Table 3):

Code	Catalogue of habitats of Slovakia	Natura 2000	Emerald	CORINE	EUNIS
Ra6	Alkaline fens	7230	54.2	54.2	D4.1
A11	Siliceous alpine and boreal grasslands	6150	-	36.34	E4.34
A12	Siliceous alpine and boreal grasslands	6150	-	36.111	E4.1
A16	Alpine tall grass communities	-	-	37.82	E5.52
A19	Alpine and boreal heaths	4060	31.2	31.4	F2.2
Sk3	Siliceous scree of montane to alpine levels	8110	-	-	H2.31

**Table 3.** The habitats of the species occurrence

The habitat of *Fissidens osmundoides* is placed in the list of Habitats of European Interest (Annex Nr. 1, Act No. 24/2003). In some published sites we could not confirm the species, despite intensive searching, e.g. Zelené pleso kežmarské (Šmarda 1952).

*Test by revised IUCN threat categories:*

A. Large decline

Very small decline observed, < than 20% in the last 10 years. Not applicable.

B. Restricted area of occupancy, few localities. Not applicable. Recorded recently in 53 sites in 12 10x10km squares

C. Small population and decline.

Not applicable. No detailed information available on population size.

D. Very small or restricted populations.

Not applicable. No detailed information available on population size.

## Conclusion

At a regional level the new criteria have been tested in Slovakia (Kubinská *et al.* 2001), *Fissidens osmundoides* was considered as LR:nt (Lower Risk, Near Threatened). This species, which occurs in moist rock crevices in the alpine level and in fen communities, does not qualify for the Slovakian Red List. However, it may become Vulnerable in the near future unless adequate protection of wetlands is secured, so the status "near threatened" LR(nt) is confirmed.

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