

# INTERESTING RECORDS OF RARE BRYOPHYES IN OLD FEN DEPOSITS 3

## Zajímavé nálezy vzácných mechorostů ve starých sedimentech 3



Petra Hájková<sup>1,2</sup>, Tomáš Peterka<sup>1</sup> & Jan Roleček<sup>1,3</sup>

<sup>1</sup>Masaryk University, Faculty of Science, Department of Botany and Zoology, Kotlářská 2, CZ-611 37 Brno, Czech Republic, e-mail: buriana@sci.muni.cz; <sup>2</sup>Czech Academy of Sciences, Institute of Botany, Laboratory of Paleoecology, Lidická 25/27, CZ-602 00 Brno, Czech Republic, <sup>3</sup>Czech Academy of Sciences, Institute of Botany, Department of Vegetation Ecology, Lidická 25/27, CZ-602 00 Brno, Czech Republic



### Abstract:

Palaeoecological analyses of old peat deposits can bring information on the past distribution of bryophyte species. In this paper, we report historical occurrence of fen mosses that are currently rare and declining in Central Europe. This paper brings new data about the presence of fen mosses in old peat deposits in (i) the forest-steppe zone of Ukraine (*Drepanocladus trifarius*, *Meesia triquetra*, *Scorpidium scorpioides*), (ii) the Bohemian-Moravian Highlands in the Czech Republic (*Helodium blandowii*, *Paludella squarrosa*, *S. scorpioides*), and (iii) the Malé Karpaty Mts in Slovakia (*S. scorpioides*). The records suggest common occurrence of the mosses in the study regions during the Late Glacial and Early Holocene.



### Key words:

Central Europe, Eastern Europe, fossil record, Late Glacial, macro-remains, mosses, palaeoecology, relict species

## INTRODUCTION

Peat deposits serve as important natural archives providing information on the history of study localities and their surrounding landscapes (Berglund 1986, Barber 1993, Rehell & Virtanen 2016). In addition to pollen grains, plant seeds and wood fragments, peat deposits may also contain bryophyte macro-remains. Bryophytes are especially well

preserved in peat deposits with a high proportion of organic material and at sites with high and stable groundwater level. Such macro-remains, although being up to several millennia old, can still be easily identified at the species level. As bryophytes are abundant components of mire ecosystems and at the same time they are resistant to decomposition and thus well preserved in sediments (Janssens 1983), they can even form entire peat layers in old deposits. Under less favourable conditions, bryophytes can be preserved at least as individual leaves.

Information on fossil bryophytes may help us reconstruct the history of localities, including past vegetation, environmental conditions and their changes, because many of them are highly adapted to specific environmental conditions such as high or low water pH, mineral richness, water level or nutrient content (Dickson 1973, Birks 1982). Furthermore, several fen bryophytes are traditionally considered *glacial* or *postglacial relicts* (Rybniček 1966, Hájková et al. 2015, Dítě et al. 2018) in temperate Europe. These groups include species that are supposed to have been much more common in the glacial period and later retreated into refugia. The presence of such species in old deposits may help us to assess their relict status (Hájková et al. 2018).

In our previous papers (Hájková et al. 2012, 2017), we reported new records of fen moss species in old fen deposits. Since then, ongoing palaeoecological research in the Bohemian-Moravian Highlands and in the forest-steppe zone of the eastern part of Central Europe has brought new important fossil finds of fen bryophytes. The main aim of this paper is to report and comment these new records. All reported species are endangered and recently declining fen specialists and presumably (post)glacial relicts (for particular references see the Discussion).

## METHODS

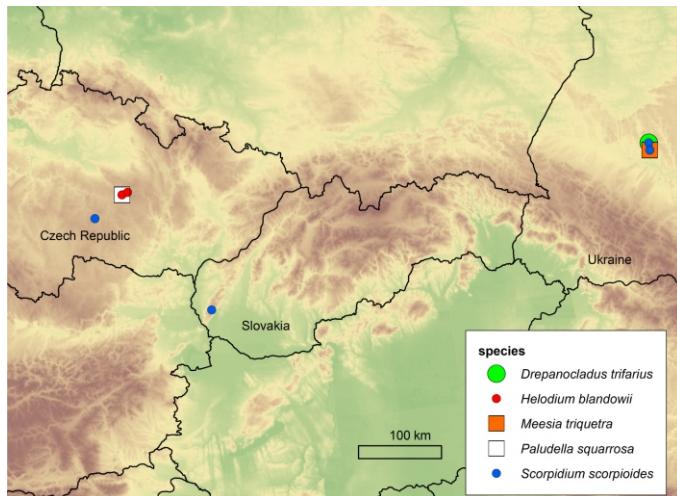
Cores were sampled using a gouge auger (6 cm diameter, 100 cm length) in the spring 2019 (Ukrainian localities) and in the autumn 2019 (Czech localities). Peat samples were rinsed with water running through 200 µm, 630 µm and 1 mm mesh sieves. Bryophyte macro-remains were picked out from the recovered fractions and examined under a stereomicroscope. The age of the layers is given in calibrated years before 1950 (years BP). Coordinates were obtained in the WGS-84 format. The finds from the Dářko site have already been published as part of a multi-proxy palaeoecological study (Roleček et al. 2020) and finds from the Šenkárka site in the palaeoecological paper of Gálová et al. (2016), but not commented on detail. The nomenclature follows Kučera et al. (2012) for bryophytes and Danihelka et al. (2012) for vascular plants.

## RESULTS AND DISCUSSION

We found some new palaeo-localities of recently rare fen bryophytes. For their distribution across study regions see Fig. 1 and Tab. 1.

	Czechia	Slovakia	Ukraine
<i>Drepanocladus trifarius</i>	-	-	1
<i>Helodium blandowii</i>	2	-	-
<i>Meesia triquetra</i>	-	-	1
<i>Paludella squarrosa</i>	1	-	-
<i>Scorpidium scorpioides</i>	1	1	2

**Tab. 1.** Number of localities of presented bryophytes in particular regions.



**Fig. 1.** Distribution of particular bryophyte species across study regions.

### *Drepanocladus trifarius*

- UA, Ivano-Frankivsk region, Pukiv by Rogatyn, disturbed calcareous fen below Mt Chortova hora, WGS-84: 49.39786°N, 24.68189°E; ca 250 m a.s.l.; in four layers dated to 14,603 cal. BP (together with macro-remains of *Betula nana*, *Carex rostrata*, *Chara* sp., *Eleocharis uniglumis*, *Scorpidium cossonei* and *Scorpidium scorpioides*), 10,636 cal. BP (with *Chara* sp., *Phragmites australis* and *Scorpidium scorpioides*), 7,454 cal. BP (with *Campylium stellatum*, *Cladium mariscus* and *Scorpidium scorpioides*) and 5,601 cal. BP (with *Scorpidium scorpioides*).

*Drepanocladus trifarius* is a specialist of quaking (i.e. waterlogged) rich fens (Joosten et al. 2017, Peterka et al. 2018). Several extant localities of *Drepanocladus trifarius* are known in the Ukrainian Polissya region, an isolated population occurs near the Hriada village in the Lviv region (Virchenko in Didukh 2009: 718). According to Bachuryna & Melnychuk (2003), the species has not been (sub-)recently recorded in the Ivano-Frankivsk region, where our fossil record originates from. Macrofossil records from Ivano-Frankivsk region are generally rare and do not contain any fossil bryophytes (Stachowicz-Rybka et al. 2009, Kołaczek et al. 2017, 2018).

### ***Helodium blandowii***

- CZ, Žďárské vrchy Hills, NPR Dářko, raised bog; WGS-84: 49.63790°N, 15.876°E; 622 m a.s.l.; in three layers dated between 11,753 and 11,538 cal. BP, together with macro-remains of the bryophytes *Paludella squarrosa*, *Straminergon stramineum* and *Tomentypnum nitens* and the vascular plants *Betula nana/humilis*, *Carex lasiocarpa*, *C. limosa* and *Comarum palustre*.
- CZ, Žďárské vrchy Hills, Pihoviny, 1.5 km north of Cikháj village, fen meadow; WGS-84: 49.65891°N, 15.97153°E; 675 m a.s.l.; in the bottom layer of 160–170 cm depth, dated to  $12,046 \pm 49$  (13,891 cal. BP); together with macrofossils of the vascular plants *Carex nigra* and *Viola cf. palustris*.

*Helodium blandowii* is a species with only three finds (Lužická Basin and the Jihlava Hills) in the peat deposits in the Czech Republic, so it is one of the rarest species documented in fossil material (Hájková et al. 2018). Here we present two new fossil finds of this species, one from the Late Glacial (Pihoviny) and one from the Early Holocene (Dářko), both from the Žďárské vrchy Hills. It seems the rarity of fossil finds of this species could be at least partially given by an insufficient intensity of palaeoecological research and that suitable sediments were rarely analysed for macrofossils. This species is also very rare at present, with only seven localities in the Czech Republic documented after the year 2000 (Hájková et al. 2018).

### ***Meesia triquetra***

- UA, Ivano-Frankivsk region, Yunashkiv, calcareous fen in a shallow valley; WGS-84: 49.31869°N, 24.67536°E; ca 260 m a.s.l.; in two dated layers of 435 cm ( $13,006 \pm 51$ , 15,564 cal. BP) and 421 cm ( $12,669 \pm 48$ , 15,086 cal. BP) depth, together with macro-remains of the bryophytes *Bryum pseudotriquetrum*, *Calliergon giganteum*, *Scorpidium cossonii* and *S. scorpioides* and the vascular plants *Betula nana/humilis*, *Carex nigra*, *C. oederi*, *C. paniculata*, *Eleocharis quinqueflora* and *Schoenoplectus tabernaemontani*.

*Meesia triquetra* is among the endangered bryophytes in Ukraine (Hodgetts & Lockhart 2020). It occurred in the Ukrainian Carpathians, Roztochia and Polissya regions, and in the forest-steppe zone on the right bank of the river Dnieper (Bachuryna & Melnychuk 1989). However, many localities have already been destroyed, especially in the vicinity of Lviv and Kyiv (Virchenko in Didukh 2009: 711).

### ***Paludella squarrosa***

- CZ, Žďárské vrchy Hills, NPR Dářko, raised bog; WGS-84: 49.63790°N, 15.876°E; 622 m a.s.l.; in two layers dated between 11,680 and 11,753 cal. BP, together with macro-remains of the bryophytes *Calliergon giganteum*, *Helodium blandowii*, *Straminergon stramineum* and *Tomentypnum nitens* and the vascular plants *Betula nana/humilis*, *Carex appropinquata*, *C. lasiocarpa* and *C. nigra*.

*Paludella squarrosa* has recently been documented at 19 sites in the Czech Republic. The majority of localities are situated in the Žďárské vrchy Hills and surrounding areas (Štechová et al. 2010, Hájková et al. 2018). Fossil evidence is available from 9 localities in the Czech Republic.

## ***Scorpidium scorpioides***

- UA, Ivano-Frankivsk region, Pukiv by Rohatyn, disturbed calcareous fen below the Mt Chortova hora; WGS-84: 49.39786°N, 24.68189°E; ca 250 m a.s.l.; in three glacial layers dated between 14,603 and 12,861 cal. BP, together with macro-remains of the bryophytes *Calliergon giganteum*, *Campylium stellatum*, *Drepanocladus trifarius*, *Palustriella commutata* and *Scorpidium cossonii*, the vascular plants *Carex flava* agg., *C. nigra*, *Linum catharticum* and *Schoenoplectus tabernaemontani* and the mollusc *Vertigo genesii*; in three Holocene layers dated between 10,636 and 5,601 cal. BP, together with macro-remains of *Chara* sp., *Cladonia mariscus*, *Drepanocladus trifarius* and *Phragmites australis*.
- UA, Ivano-Frankivsk region, Yunashkiv, calcareous fen in a shallow valley; WGS-84: 49.31869°N, 24.67536°E; ca 260 m a.s.l.; in two dated layers of 435 cm (13,006 ± 51, 15,564 cal. BP) and 421 cm (12,669 ± 48, 15,086 cal. BP) depth, together with macro-remains of the bryophytes *Bryum pseudotriquetrum*, *Calliergon giganteum*, *Meesia triquetra* and *Scorpidium cossonii* and the vascular plants *Betula nana/humilis*, *Carex nigra*, *C. oederi*, *C. paniculata*, *Eleocharis quinqueflora* and *Schoenoplectus tabernaemontani*.
- SK, Malé Karpaty Mts, PR Nad Šenkárikou, birch bog woodland; WGS-84: 48.31347°N, 17.17878°E; 558–569 m a.s.l.; in the dated layer of 79–82 cm depth (11,253 cal. BP), together with macro-remains of the vascular plants *Batrachium cf. trichophyllum*, *Carex rostrata*, *Hippuris vulgaris*, *Menyanthes trifoliata*, *Myriophyllum cf. spicatum*, *Potamogeton alpinus*, *P. pusillus* agg., *Ranunculus flammula*, *R. sceleratus* and *Sparganium minimum*.
- CZ, Bohemian-Moravian Highlands, PR Na Oklice, rich fen; WGS-84: 49.40433°N, 15.39422°E; ca 660 m a.s.l.; in the bottom layer of 75–85 cm depth dated to 2,221 ± 39 (2,230 cal. BP), together with macro-fossils of *Carex rostrata*, *Comarum palustre* and *Eriophorum vaginatum*.

*Scorpidium scorpioides* has similar ecological demands as *Drepanocladus trifarius* and they also co-occur in old deposits such as at the Ukrainian locality Pukiv by Rohatyn. Recently, the species belongs to the rarest fen bryophytes in the Czech and Slovak Republics, where it is included among critically endangered taxa in the red lists of both countries (Kučera et al. 2012, Mišíková et al. 2020). After the year 2000, the species has been recorded at eight sites in the Czech Republic (Hájková et al. 2018), including the Doksy region, Elbe river Basin and the Bohemian-Moravian Highlands. In the Bohemian-Moravian Highlands, *Scorpidium scorpioides* was still scattered at suitable sites in the 1960s (Rybniček 1964, 1966). Since then the species has declined as a result of drainage, fertilization, abandonment and consequent successional changes. In the Na Oklice fen, it was recorded for the last time in 1996 by J. Kučera (Hájková et al. 2018). In the Slovak Republic, *Scorpidium scorpioides* currently occurs at two close localities on Mt Kubínská Hoľa. In Ukraine, it is evaluated as vulnerable (Hodgetts & Lockhart 2020). Several extant localities are known in the north-western part of the country, mainly in the Polissya region (Bachuryna & Melnychuk 2003, Boiko in Didukh 2009: 719). With respect to the relatively high number of fossil records of *Drepanocladus trifarius* and *Scorpidium scorpioides* captured in rather low-volume samples of old peat deposits (Jankovská 1988, Bos et al. 2001, Krisai et al. 2016, Hájková et al 2018), we assume that these moss species as well as

the corresponding vegetation of quaking rich fens might have been quite common in Central Europe in the (late) Glacial and Early Holocene. The same probably holds for the other recorded fen bryophytes.

## **SHRNUTÍ**

Rašelinné sedimenty patří k důležitým archivům přírody. Krom jiného se z nich můžeme dozvědět více o historickém rozšíření slatiných mechů, které se dnes ve střední Evropě vyskytují jen velmi vzácně a jsou obvykle považovány za glaciální a post-glaciální reliikty. Ve třetím díle seriálu o zajímavých mechorostech ve starých sedimentech přinášíme nálezy získané rozborem paleoekologických vzorků odebraných (i) v lesostepní zóně na Ukrajině (*Drepanocladus trifarius*, *Meesia triquetra*, *Scorpidium scorpioides*), (ii) na Českomoravské vrchovině (*Helodium blandowii*, *Paludella squarrosa*, *S. scorpioides*) a (iii) v Malých Karpatech (*S. scorpioides*). Většina nálezů pochází z pozdního glaciálu nebo raného holocénu, což naznačuje, že zjištěné mechorosti byly v té době běžnou složkou středoevropských mokradů.

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