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HETEROCLADIUM DIMORPHUM (HETEROCLADIACEAE, BRYOPHYTA) – AN OLD ELEMENT OF THE HUNGARIAN BRYOPHYTE FLORA REDISCOVERED

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Abstract: *Heterocladium dimorphum* is considered to be a data-deficient moss species that has been neither collected nor observed in the last 46 years in Hungary. During the systematic field studies aimed at exploring the recent bryophyte flora of the Kőszeg Mts and in the framework of grid-cell based bryophyte recording, *H. dimorphum* was discovered in two new locations of the Kőszeg Mts and re-found in one of the old locations in the Visegrád Mts. The size of populations is estimated and the habitats are characterized. Illustrations and a short description of the species are provided. The previous occurrences of *H. dimorphum* in Hungary are listed based on the specimens of the bryophyte collection of the Hungarian Natural History Museum, Budapest (BP). Based on the extant populations, the species is considered as endangered (EN).

Key words: data-deficient, *Heterocladium*, illustrations, Kőszeg Mts, red-listed bryophyte, Visegrád Mts

INTRODUCTION

The genus *Heterocladium* Schimp. comprises only eight species distributed in Europe, Asia, Macaronesia, North and South America (Smith 2004). In Europe, four species occur: *H. dimorphum* (Brid.) Schimp., *H. heteropterum* (Brid.) Schimp., *H. flaccidum* (Schimp.) A. J. E. Smith, and *H. wulfsbergii* I. Hagen. The latter two can be found nearly exclusively in Northern and Western Europe (Hodgetts 2015). The phylogenetic position of this small genus has been uncertain for a long time. Initially, Schimper (1852) placed it within Hypnaceae. Later, Fleischer (1922) transferred the genus to the family Thuidiaceae. This placement was accepted by the Hungarian bryologists Boros (1953, 1968) and Orbán and Vajda (1983). Brotherus (1924) divided the Thuidiaceae into four subfamilies and put the genus *Heteropterum* into the sub-

family Heterocladioideae. This division was followed by Hedenäs (1995). Later, Buck and Crum (1990) revising the subfamily Heterocladioideae noted that the gametophytes of the species of *Heterocladium* show a remarkable resemblance to the genera *Pterigynandrum* Hedw., *Habrodon* Schimp., *Iwatsukiella* Buck et Crum, and *Myurella* Schimp. These five genera share similar areolation, costal development, sexuality and distribution, and also most of them have reduced peristomes. Therefore, Buck and Crum (1990) put these five genera into the family Pterigynandraceae. Although this classification was accepted later by Buck and Goffinet (2000) and Goffinet and Buck (2004), the analysis of nucleotide sequence data suggested that Pterigynandraceae sensu Buck and Crum (1990) is not monophyletic (Budyakova *et al.* 2003). According to Newton and Tangney (2007) the correct phylogenetic position of the genus *Heterocladium* is certainly out of Pterigynandraceae. In the most recent taxonomic studies the genus was placed into the monotypic family Heterocladiaceae (Ignatov and Ignatova 2004, Ignatov *et al*. 2006). This was followed by Frey and Stech (2009) and Sim-Sim *et al.* (2010).

One of the first described species of the genus is *Heterocladium dimorphum* that was published together with the descriptions of *H. heteropterum* and *H. kurzii* Schimp. (Schimper 1852). *H. dimorphum* is a boreal-montane moss species occurring in Europe, Western Asia, and North America (Smith 2004). In Europe, it is quite rare or absent in the western countries, while it is more widespread in the central and eastern regions. *H. dimorphum* is found in all countries surrounding Hungary (Hodgetts 2015).

The first report of *Heterocladium dimorphum* from Hungary appears to be Latzel (1930), who found the species (as *H. squarrosulum* (Voit) Lindb.) in the Kőszeg Mts ("Walkgraben"). Although Boros (1927) also reported the species from this cross-border region, he gave localities outside present-day Hungary. The oldest collections of the species in the bryophyte collection of the Hungarian Natural History Museum (BP) date from 1947 (near Tahi in the Visegrád Mts) (Table 1). These data obviously formed the basis of the area description in Boros (1953): "K. Pilis (Tahitótfalu felett). Dt. Kőszegi-hg." The later bryofloras (Boros 1968, Orbán and Vajda 1983) listed the additional regions Sopron Mts, Bakony Mts, and Vendvidék.

Heterocladium dimorphum has been neither collected nor observed in the last 46 years in Hungary. For that reason, it was categorised as data-deficient taxon without any recent data in the updated checklist and red list of the Hungarian bryophytes (Papp *et al*. 2010). In spite of the fact that *H. dimorphum* was systematically searched in some of the above mentioned regions by the authors and others (Németh, ex verb.) in the last years, it had not been found until very recently.

Table 1. Historical collections of *Heterocladium dimorphum*.

Collection date	Collection site	Grid cell	Collector(s)	Specimens in BP (* with sporophytes)	Text of etiquette label
01.06.1947	Tahi	8280.3	Boros, Vajda	127489, 20457, 20459	Comit. Pest. In argillosis ad marg. silvarum pedis montis Öregbükk pr. pag. Tahi, 200–300 m
01.06.1947	Tahi	8280.1	Boros, Vajda	127490*, 127491*, 127492*, 20447, 20456*, 20458*	Comit. Pest. In argillosis silvaticis andesit. sub monte Ábrahámbükk prope pagum Tahi, 300–350 m
25.06.1950	Tahi	8280.3	Pócs	58449	Comit. Pest. Prope pagum Tahi. In faginetis, ad solum. In decl. sept.-orient. montis Öregbükk, 300 m
25.06.1950	Tahi	8280.1	Timár	58451*	Comit. Pest. Montes Pilis, Tahitótfalu, Ábrahámbükk, 400 m
25.06.1951	Tahi	8280.1	Máthé	68239	Comit. Pest. Sup montis Ábrahámbükk prope pag. Leányfalu
23.07.1952	Sopron	8365.1	Boros	127498	Comit. Sopron. In argillosis humosis silvaticis ad fontem Ferenc-Vadász-forrás vallis rivi Kecskepatak prope Sopron, 400–450 m
21.05.1953	Sopron	8365.1	Vajda	127497, 25540	Comit. Sopron. Ad margines sylvarum ad Deák-kút prope pag. Sopron
05.04.1954	Ugod	8772.1	Boros, Vajda	127493, 26950	Comit. Veszprém. Ad terram silv. in Fagetis vallis Hamuházi-rét ad Hubertus-lak prope Ugod, 300 m
13.07.1954	Bozsok	8664.4	Pócs & Gelencsér	127496, 58450	Montes Kőszegi hegység, Abieto-Fagetum sub cacumine mt. Széles-kő, supra pg. Velem
14.06.1970	Bozsok	8664.4	Boros	127494	Comit. Vas. In decliv. silvat. Vaccin. sept.-or. montis Széles-kő prope Bozsok, 400–500 m
17.06.1970	Bozsok	8664.4	Vajda	75668*	Comit. Vas. In quercetis montis Széleskő, prope pag. Bozsok, montes Kőszegi hegység
13.07.1955	Alsószölnök	9063.3	Vajda	46484	Comit. Vas. In faginetis supra pag. Alsószölnök

MATERIAL AND METHODS

Geographical coordinates were determined using a Garmin eTrex-30 GPS. The drawings of details of *Heterocladium dimorphum* were made by the first author from the following specimens: B-Erzberger 21201, 21206. The identification key for the species of the genus *Heterocladium* and the morphological description of *H. dimorphum* are based on Orbán and Vajda (1983), Smith (2004), Casas *et al*. (2006), and Magill (2014). The nomenclature of the bryophyte taxa follows Schimper (1852), Hill (2006), Papp *et al.* (2010), and Ignatov and Ignatova (2004). In the case of the vascular plants the nomenclature follows Király (2009).

RESULTS AND DISCUSSION

During the exploration of the recent bryophyte flora of the Kőszeg Mts and grid-cell based bryophyte recording (Erzberger 2012, Erzberger and Németh 2013), *Heterocladium dimorphum* was discovered in two locations of the Kőszeg Mts and confirmed in the location of one of the oldest records known from Hungary in the Visegrád Mts (Fig. 1). In 2015 and 2016, Baráth and Erzberger unsuccessfully searched the species at "Széleskő", one of the his-

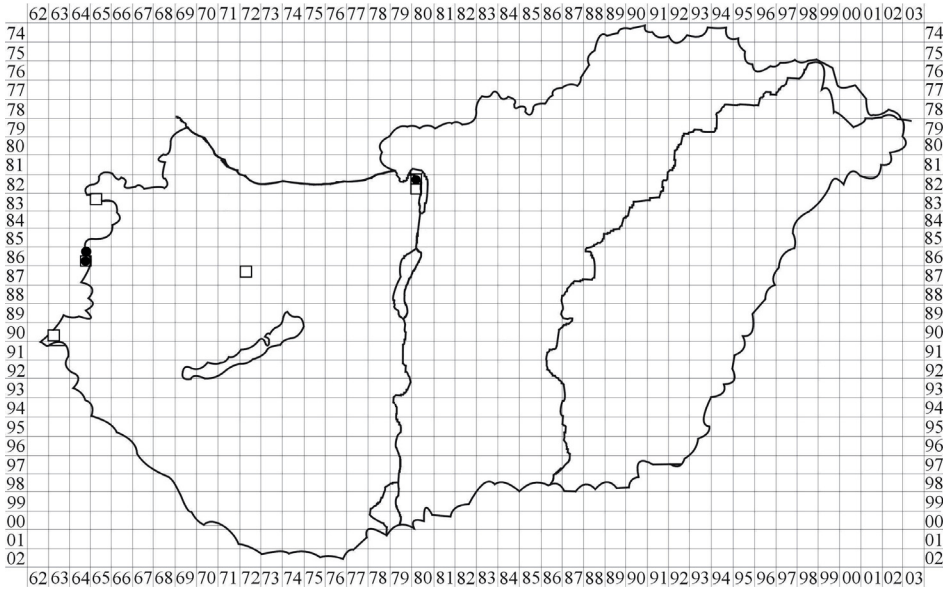

Fig. 1. Geographical locations of *Heterocladium dimorphum* in Hungary according to the grid of the Central European Mapping System (Niklfeld 1971): squares = collections before 1970; dots = collections in 2016.

torical collection sites of *H. dimorphum* in the Kőszeg Mts. In addition in 2015 Erzberger searched the area near Tahi without finding the species.

However, on 2nd April 2016 a remarkably extensive population of *Heterocladium dimorphum* was found in an acidophilous, mixed forest (Pino-Quercetalia) between Bozsok and Velem (B-Erzberger 21201, 21206, herbarium Cs. Németh s.n., herbarium K. Baráth s.n.). In total 11 colonies of *H. dimorphum* covering an overall area of *ca* 3400 cm^2 were observed on loamy and gritty soil. The centre of population was at 470 m, 47.339055° N, 16.477472° E, [8664.4] (Fig. 2). The associated bryophytes were the following: *Hypnum cupressiforme*, *Brachythecium velutinum*, *Plagiochila porelloides*, *Atrichum undulatum*, *Bryum capillare*, *Metzgeria furcata*, and *Dicranella heteromalla*. Vascular plants in the habitat include *Fagus sylvatica*, *Pinus sylvestris*, *Quercus cerris*, *Rubus caesius*, *Ligustrum vulgare*, *Campanula persicifolia*, *C. rotundifolia*, *Luzula luzuloides*, *Carex digitata*, *Hieracium lachenalii*, *Galium sylvaticum*, *Viola odorata*, and *Dryopteris filix-mas*.

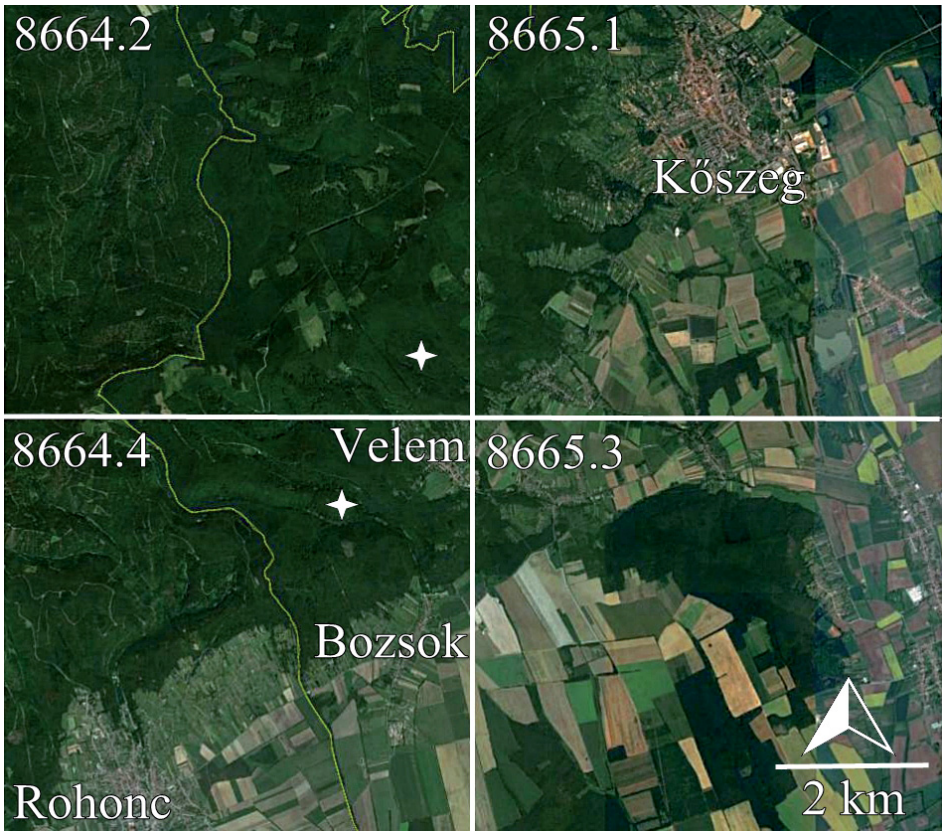

Fig. 2. Geographical location of the two new populations of *Heterocladium dimorphum* in the Kőszeg Mts.

On 4th July 2016 an additional population was found *ca* 1 km N of Velem, near the spring "Borha", at 543 m, 47.357777° N, 16.491000° E, [8664.2] (B-Erzberger 21754, herbarium K. Baráth).

Four colonies of *Heterocladium dimorphum* covering in total *ca* 1300 cm^2 were present in this site. The soil and the vegetation were quite similar to each other in these two locations (Fig. 3). In this habitat the associated moss species were *Hypnum cupressiforme*, *Atrichum undulatum*, *Dicranella heteromalla*, *Brachythecium velutinum*, and *Pogonatum aloides*, while the vascular plants were *Fagus sylvatica*, *Quercus cerris*, *Pinus sylvestris*, *Rubus caesius*, *Hieracium lachenalii*, and *Luzula luzuloides*.

On 1st October 2016 Papp, Erzberger, and Kovács searched the location of one of the oldest collections of *Heterocladium dimorphum* in BP, the forest margin at the northeastern slope of the hill called "Ábrahámbükk" above Tahi, and succeeded in finding a vigorous population of the species at *ca* 370 m , 47.750000° N, 19.041583° E [8280.1] (B-Erzberger 22145). In an area of approximately 50 m × 3 m numerous colonies were found, covering in total *ca* 3520 cm^2. Associated bryophytes were *Atrichum undulatum*, *Hypnum cupressiforme*, *Pogonatum aloides*, *P. nanum*, *Lophocolea minor*, *Lophozia bicrenata*, and *Barbilophozia barbata*.

Fig. 3. Habitat of *Heterocladium dimorphum* in the Kőszeg Mts (photo by K. Baráth).

The previous occurrences of *Heterocladium dimorphum* in Hungary are listed based on the specimens of the bryophyte collection of the Hungarian Natural History Museum, Budapest (BP) in Table 1. Whereas in some of these specimens sporophytes were noted, we did not detect sporophytes in the recently found populations.

Short characterisation of *Heterocladium dimorphum*

Syn.: *Heterocladium squarrulosum* Lindb., *Heterocladium squarrosulum* Voit, nom. inval., *Hypnum dimorphum* Brid.

Plants slender, forming dull or yellowish green patches. Stems procumbent, sometimes stoloniform, pinnately branched. Stem leaves 0.9–1 mm long, squarrose or squarrose-reflexed, broadly ovate, abruptly narrowed to usually long acuminate to filiform acumen, base excavate, decurrent. Margins of the leaves denticulate, serrate or serrulate. Costa short, double. Laminal cells unipapillose, median narrowly rectangular, 5–8 × 20–32 μm, 3–5 times as long as wide, towards margins ± abruptly rectangular, trapezoid or quadrate-hexagonal. Branch leaves smaller than stem leaves, erecto-patent, concave, ovate, obtuse to acute. Costa short, double. Seta reddish, slightly curved. Capsules elongated ovoid. Capsule lids obtuse.

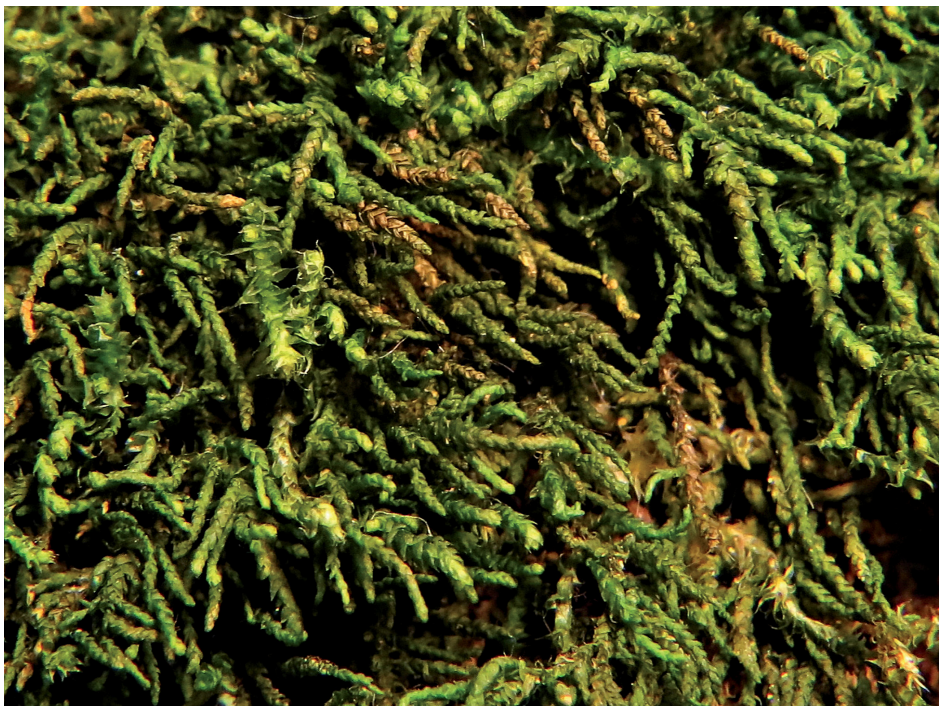

Fig. 4. Habit of *Heterocladium dimorphum* (photo by K. Baráth).

Although capsules are rare, its gametophyte is rather characteristic, therefore the species can be safely determined in the field with a 10× hand lens (Figs 4–5). *H. dimorphum* usually grows in shady, woody habitats on loamy or gritty soil and at tree bases. It is a boreal-montane moss species.

Based on the fact that now three extant populations of *H. dimorphum* are known in Hungary, the species can no longer be considered data-deficient, and as an amended red list status we propose endangered (EN), in accordance with the IUCN criteria (IUCN 2014) and recent treatment of similar cases (Erzberger *et al*. 2015).

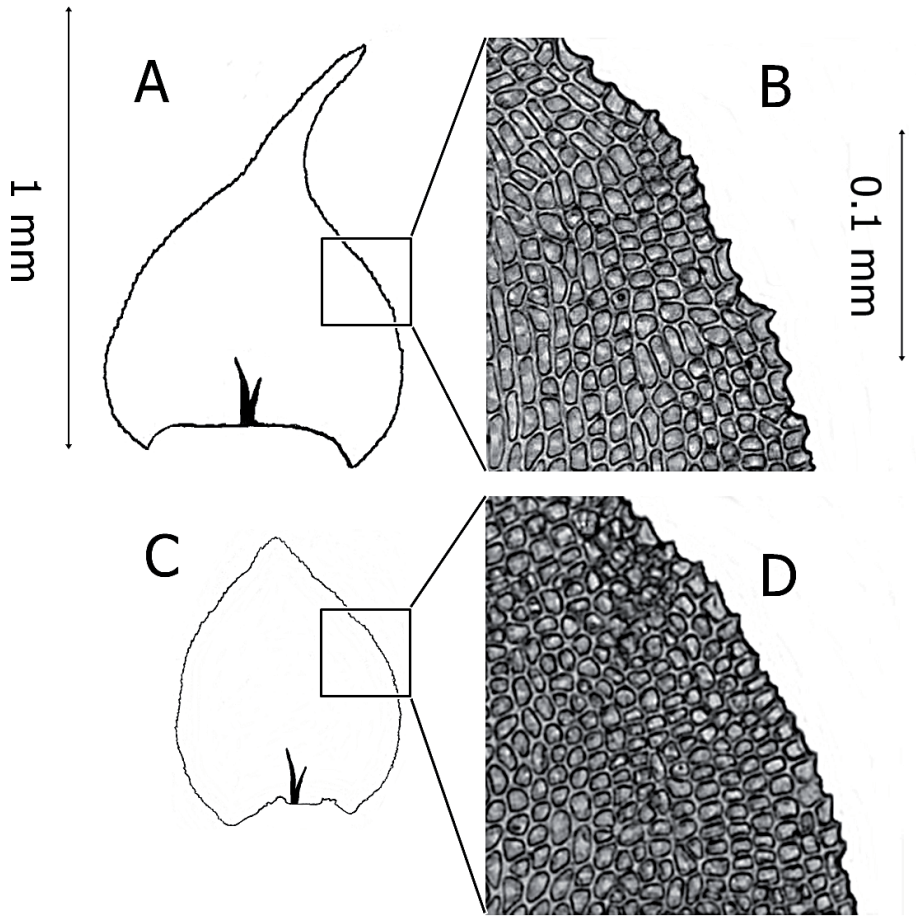

Fig. 5. Leaves and laminal cells of *Heterocladium dimorphum*. A = stem leaf; B = marginal and median laminal cells of stem leaf (margin to the right); C = branch leaf; D = marginal and median laminal cells of branch leaf (margin to the right).

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Összefoglaló: A *Heterocladium dimorphum* Európában, Nyugat-Ázsiában és Észak-Amerikában előforduló, boreális-montán elterjedésű mohafaj. A növényt a múlt század elején és közepén Magyarországon is gyűjtötték, de mivel az elmúlt 47 évben nem került elő, az ország legfrissebb vörös listájában aktuális előfordulás nélküli, adathiányos fajként szerepel. 2016-ban az ország kvadrát alapú mohatérképezése és a Kőszegi-hegység mohaflóráját feltáró terepmunkák során a faj újra előkerült a Kőszegi-hegység két új és a Visegrádi-hegység egy régebbről ismert lelőhelyén. A két újonnan felfedezett kőszegi-hegységi populáció mintegy 15 telepet foglalt magában, amelyek mészkerülő fenyőelegyes lomberdőben, agyagos talajon közel 4700 cm^2 borítással rendelkeztek, míg a Visegrádi-hegységben talált populáció alacsony növekedésű bükkös szélén, egy útrézsű 50 m × 3 m-es szakaszán található. A faj borítása itt megközelítőleg 3500 cm^2 volt.

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