

SHORT COMMUNICATION

Terricolous and saxicolous occurrence of *Anacamptodon splachnoides* (Froel. ex Brid.) Brid. (Amblystegiaceae) in Hungary

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Abstract: On 14 May 2024, a new population of *Anacamptodon splachnoides* (Froel. ex Brid.) Brid. was found at the base of a large *Fagus sylvatica* tree on the steep northern bank of Hideg-völgy Creek, in the outskirts of Pécs (Southern Hungary). The discovery is unique for three reasons: i) the site is located at the southern limit of the species' European range, ii) it is the largest (2900 cm²) colony recorded in Hungary, and iii) instead of a knothole, the moss lives on the soil surface between the topmost root branches in the root flare and on the rock surface below. In this paper we briefly discuss the conditions under which the species occurs and possible explanations and consequences of this rare phenomenon.

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The North American and West Eurasian *Anacamptodon splachnoides* (Froel. ex Brid.) Brid. is known worldwide as a knothole specialist, but its colonies have also been found on wet stumps, fissures in tree bark, at the base of trees, exceptionally on polypores, and once on rock (SANDRON and HUGONNOT 2012, NÉMETH and ERZBERGER 2015, OCHYRA et al. 2023). It occurs mainly in the (sub)montane region, in dendrotelmata of *Fagus sylvatica*, but is not common anywhere, and is a Near Threatened (NT) species in Europe (SCHRÖCK et al. 2019). The estimated extent of occurrence (EOO_{est}), which is three orders of magnitude larger than the estimated area of occupancy (AOO_{est}), indicates a highly dispersed distribution (VAN ZUIJLEN et al. 2023). Due to its rarity, isolated populations and the difficulty of detecting gametophytic colonies, the dynamics of the species in Europe are uncertain (SCHRÖCK et al. 2019). Previously

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(ECCB 1995), the species was assessed as rare in Europe and thus was listed as Endangered (EN). However, the extent and significance of this underestimation has been questioned by some authors (OCHYRA et al. 2023). It is a legally protected and Endangered (EN) moss in Hungary (PAPP et al. 2010), mainly found on the edges of water-filled hollows of *Quercus cerris* in the colline-submontane region (NÉMETH and ERZBERGER 2015, SZŰCS et al. 2015, NÉMETH et al. 2023). The sudden, remarkable increase in the number of occurrences of *A. splachnoides* in Hungary must be due to a more intensive and targeted research of the species over the past decade (NÉMETH and ERZBERGER 2015, SZŰCS et al. 2015, ERZBERGER et al. 2023, NÉMETH et al. 2023).

The site was discovered in 2024 during an extensive research project on pteridophytes and mosses in the Mecsek Mts (Southern Hungary). The mosses and vascular plants collected or encountered in the field were identified according to ERZBERGER (2021) and KIRÁLY (2009). The identified specimens (confirmed by Peter Erzberger) were deposited in the herbarium of the University of Pécs (JPU). The bedrocks were identified based on the works of NAGY and HÁMOR (1964) and BABINSZKI et al. (2023). The new observation of *A. splachnoides* is on the north-facing, steep bank of Hideg-völgy Creek, on acidic substrate covered by beech forest, on the outskirts of the city Pécs. The site is located at an elevation of approximately 10 m above the valley floor of the intermittent creek. The area is in the more humid and temperate western part of the Mecsek Mts (SIMOR and KÉRI 1974, MOLNÁR et al. 2018). The discovered *A. splachnoides* colony consist of two distinct parts (Fig. 1). The upper part is made of two adjacent small subcolonies: a more robust ~750 cm² of light green, dense carpet, and a weaker ~150 cm² of darker loose mat. Both grow on shallow soil rich in organic debris between the roots of a beech tree and partially cover the root and its thinner overhanging branches (Fig. 2). The lower part is a larger (~2000 cm²), but discontinuous, mostly yellowish to tree-green mat, covered with occasional rock fragments, occurs on the yellowish fine-grained sandstone of the Upper Triassic-Lower Jurassic Mecsek Coal Formation and the dark grey clayey rock below (NAGY and HÁMOR 1964, BABINSZKI et al. 2023). About 1200 cm² of it grows directly on the rock surface, while ~800 cm² on parent material (shallow soil with some organic debris). On the surface, both rocks are highly fragmented and friable (larger surfaces last only in the shelter of the beech root system). In our test, these rocks did not react with HCl, thus are free of CaCO₃. The terricolous colonies between the roots are rich in sporophytes, with ~1100 capsules, whereas only ~100 capsules were found in the rocky part of the stand, scattered in small groups. This is well above the average of 28 and maximum of 300 sporophytes per colony in France (SANDRON and HUGONNOT 2012).



Fig. 1. The *Anacamptodon splachnoides* colony discovered in the Hideg-völgy (Mecsek Mts): saxicolous (red polygon) and terricolous (yellow polygons) colonies. Photo by J. Csiky, 28.08.2024.

1. ábra. A mecseki Hideg-völgyben felfedezett *Anacamptodon splachnoides* előfordulás: sziklalakó (piros poligon) és talajlakó teleprészek (sárga poligonok). Fotó: Csiky J., 2024.08.28.

Based on publications and experience with this species in Hungary and France, the terricolous and saxicolous mats in Hideg-völgy are the largest contiguous *A. splachnoides* mats in Hungary and probably in Europe. For comparison, NÉMETH et al. (2023) found colonies of the species on a total of 20 trees in two Hungarian forests, with a total area of 1010 cm². This suggests an average of 50 cm² of “palm-sized” individual colonies. A few years earlier, NÉMETH and ERZBERGER (2015) had estimated the total cover of *A. splachnoides* found in the 32 flora-mapping quadrats to be 4208 cm². As a consequence of targeted research conducted subsequently, the aforementioned estimate has become obsolete, with the largest individual colony size currently estimated to be 500–600 cm² (Csaba Németh in litt.). SANDRON and HUGONNOT (2012) observed similar mat sizes in a 30-ha beech forest in Southern France, where *A. splachnoides* was encountered in 29 tree holes with a total area of 1694 cm², in colonies of minimum 5, average 58 and maximum 200 cm². These values are far below the colony sizes of 750 and 2000 cm² in the newly discovered Hungarian stand.



Fig. 2. Terricolous/ epiphytic colony with many sporophytes on an overhanging root branch (A), and saxicolous thallus with few sporophytes (B). Photos by J. Csiky, 03.07.2024.

2. ábra. Talajlakó és lelógó gyökéren (A), valamint sziklán (B) fejlődő sporofitonos teleprészletek.

Fotók: Csiky J., 2024.07.03.

In Hideg-völgy, the moss lives at the edge of an acidic beech forest in the valley. The species composition of the phytosociological relevé of the stand is as follows:

Sample size: 2 m²; date: 3 July 2024; location: Pécs (Lámpásvölgy) Hideg-völgy (Hungary); latitude: 46.10690° N; longitude: 18.22819° E; exposition: 334° (N-NW); slope: 54°; elevation: 289 m; relevé made by: J. Csiky and A. Sipos; total cover: 100%; E3 total: 100%; height E3: 25 m; E2 total: 0.5%; height E2: 50 cm; E1 total: 2%, height E1: 54 cm; E0 total: 50%, height E0: 5 cm; canopy layer (E3): *Fagus sylvatica* 100%; shrub layer (E2): *Fagus sylvatica* 0.5%; herb layer (E1): *Fagus sylvatica* 1%, *Hieracium murorum* 1%; moss layer (E0): *Anacamptodon splachnoides* 15%, *Ptychostomum moravicum* 15%, *Hypnum cupressiforme* 6%, *Polytrichum formosum* 6%, lichen sp. 2% (primary thallus alone), *Plagiothecium curvifolium* 2%, *Cephalozia bicuspidata* 1%, *Dicranella heteromalla* 1%, *Atrichum undulatum* 0.5%, *Brachythecium salebrosum* 0.5%, *Leucobryum glaucum* 0.5%.

Although *A. splachnoides* occurs in tree holes close to rootstocks elsewhere in the country (NÉMETH and ERZBERGER 2015, SZŰCS et al. 2015, BARINA et al. 2015), it has not yet been reported from soil or bare rock surfaces. Similar occurrences have only been documented by SHARP and ANDERSON (1981) from the Great Smoky Mts of Tennessee (USA), where several colonies (with sporophytes) were observed on damp rock faces of metamorphic conglomerate, in a hemlock-mixed hardwood forest. While at the latter site the species was found on shady rock outcrops, the Mecsek Mts population is found in a more open, semi-shaded forest patch, in a large natural canopy gap created by a landslide. This last situation agrees with the observations of SANDRON and HUGONNOT (2012) in France, where the species prefers the knotholes at the edges of forest gaps to the dendrotelmata in closed forests. This is supported by the Ellenberg's light requirement value of 4 for this species in Europe (VAN ZUIJLEN et al. 2023).

The size and habitat of the sporophyte-rich population in the Hideg-völgy appear to be inconsistent with the hypothesis that the sticky spores of *A. splachnoides* are primarily spread by flies that reproduce in dendrotelmata (WYATT et al. 2022). However, the limited number of cases and the lack of research on Diptera species visiting sporophytes in Hungarian or American saxicolous colonies do not provide sufficient evidence to disprove the entomophily hypothesis. Conversely, birds foraging on trees for invertebrates may play a significant role in the spontaneous dispersal of epiphytic cryptogams, even in the absence of the assumption of entomophily (mutualistic interactions and coevolution). For example, a study in Finland showed that woodpeckers mainly spread mosses this way (i.e. epizoochory via commensalism), most often on their tail feathers used as support (JOHANSSON et al. 2021). It can be assumed that not only woodpeckers, but also other birds and even mammals that use dendrotelmata as a water source ([http1](http://)) may be involved in the dispersal of either the gametophyte fragments or the spores.

It is interesting that several dendrotelmata have been encountered in similar situations in Hideg-völgy, but no *A. splachnoides* was found in any of them. Similarly, the above-mentioned bedrocks can be found in several places on the northern slopes of the valley in similar situations (under acidic beech forest with beech on the edges), but in all cases without this moss. It is noteworthy that, despite recent intensive and extensive research, only one previous record of *A. splachnoides* is known from the whole of South Transdanubia (14 169 km², Hungary), and one recent record, discovered in 2023 (CSIKY et al. 2023). Both the latter (in Éger-völgy) and the new, terricolous and saxicolous (in Hideg-völgy) colonies are found in the Western Mecsek, in acidic beech forests, on *Fagus sylvatica* or at its base. In both cases, the tree's stem flow may play an important role in supplying water to the moisture-demanding *A. splachnoides* (VAN ZUIJLEN et al. 2023) by providing a large amount of run-off rainwater that drains into the base of the tree. The moss's association with forest edges (SANDRON and HUGONNOT 2012) can also be advantageous in this regard, as the canopy of a tree can be more extensive on the edges, thereby enabling it to collect and drain a greater volume of water down the trunk than a tree individual in a closed stand. Conversely, although the canopy of solitary trees is larger than those living on the edge or within the interior of the forest, the greater exposure of the trunk to solar radiation and winds makes dendrotelmata more likely to dry out. For the saxicolous stand, stem flow might also have been the vector for the moss (i.e. hydrochory). Both sites in the Mecsek Mts (i.e. Éger-völgy and Hideg-völgy) are quite rich in sporophytes. The stand in Éger-völgy in a dendrotelma supported ~800 sporophytes per 100 cm² in 2024. Both beech and Turkey oak are widespread in the mountains, and dendrotelmata are common in massive, homogeneous and mixed stands. The 700–800 mm yearly precipitation is above the national average and its annual course is relatively even (SIMOR and KÉRI 1974, MOLNÁR et al. 2018), hence providing a stable water supply for dendrotelmata. In the above circumstances, the local rarity of *A. splachnoides* on the southern edge of its range is surprising and needs explanation.

From this perspective, FRAHM's (2013) hypothesis that *A. splachnoides* would have been originally a North American species that only migrated to Europe during the Holocene is also worthy of note. Frahm based this hypothesis on the species' peculiar recent range in Europe (absent from N and S, although its American range is distributed from Nova Scotia to Florida and Texas). This may be the reason for its scarcity in the South Transdanubia (including the Mecsek Mts) in comparison to the northern submontane area of the Pannonian Basin (NÉMETH and ERZBERGER 2015, ERZBERGER et al. 2023). In any case, the high number of sporophytes in the Mecsek Mts suggests that *A. splachnoides* is undergoing further expansion in the region.

On the other hand, as the saxicolous colony in the Mecsek Mts is poor in sporophytes (and thus more difficult to detect), it is possible that the species occupies similar habitats elsewhere, but due to its previously observed habitat preference, its populations have not yet been spotted. Similarly, as evidenced by the case of *Buxbaumia viridis* (see VAJDA 1953, DEME et al. 2020), our adherence to established norms and the assumptions derived from existing literature (specifically, that *A. splachnoides* is a “knothole epiphyte”) may have previously prevented us from discovering some unusual (e.g. saxicolous) occurrences of this species.

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RÖVID KÖZLEMÉNY

Talaj- és sziklalakó *Anacamptodon splachnoides* (Froel. ex Brid.) Brid. (Amblystegiaceae) előfordulás Magyarországon

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Elfogadva: 2025. január 7.

Kulcsszavak: Bryophyta, észlelés, homokkő, hydrochoria, telep méret.

Összefoglalás: 2024. május 14-én, Pécs város szélén, a Hideg-völgy északi partoldalában, egy természetes *Fagus sylvatica* tövében előkerült az *Anacamptodon splachnoides* (Froel. ex Brid.) Brid. újabb mecseki állománya. A felfedezés különlegessége három dologból fakad: i) a lelőhely a faj elterjedésének D-i határán található, ii) az eddig regisztrált legnagyobb (2900 cm²) kiterjedésű magyarországi telepről van szó, valamint iii) a megszokottól eltérően nem dendrotelmában, hanem a gyökérfőnél talajon, valamint az alatta található sziklakibúváson él a moha. A dolgozatban röviden tárgyaljuk a faj előfordulási körülményeit, illetve kitérünk a ritka jelenség lehetséges magyarázataira és következményeire.

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