

ANACAMPTODON SPLACHNOIDES (AMBLYSTEGIACEAE):
HUNGARIAN POPULATIONS OF A MOSS SPECIES WITH A
PECULIAR HABITAT

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Abstract: Twenty-seven colonies of *Anacamptodon splachnoides*, a rare and endangered species throughout its distributional range, and protected by law in Hungary, were discovered in the Transdanubian Mountain Range, Balaton Uplands, Vértes and Gerecse Mts, as well as in the North Hungarian Mountains, Börzsöny Mts. They grow in decaying hollows of *Quercus cerris* filled with rain water (dendrotelma) or in wet holes without standing water. The sites are enumerated, the size of populations is estimated, and distribution maps, illustrations and a short description of the species are provided.

Key words: *Anacamptodon splachnoides*, dendrotelma, knot-hole moss, *Quercus cerris*, wet tree cavity

INTRODUCTION

Some groups of mosses have very special habitats, since they require as substrate nitrogen rich organic matter in some state of decay. The alpine endemic *Tayloria rudolphiana* (Garov.) Bruch et Schimp., a member of the Splachnaceae family, lives as an epiphytic species nearly exclusively on *Acer pseudoplatanus* L., where the remains of bird droppings accumulate in branch forks (Martiny and Urmi in ECCB 1995, KIEBACHER *et al.* 2012). *Zygodon forsteri* (Dicks.) Mitt., a member of the Orthotrichaceae family, grows mainly around knotholes and similar hollows of *Fagus sylvatica* L., often on the callus tissue of old wounds, where water enriched with organic matter from the damaged tree runs down on the bark (Martiny and Stewart in ECCB 1995, ATHERTON *et al.* 2010). The European species of *Leptodontium* in the family Pottiaceae are found on old thatched roofs (*L. flexifolium* (Dicks.) Hampe, *L. gemmascens* (Mitt.) Braithw.) or on decaying grass matter (Blockeel in BLOCKEEL *et al.* 2014, MEINUNGER and SCHRÖDER 2007), whilst the alpine *L. styriacum* (Jur.) Limpr. grows above 2000 m altitude on decaying grass tussocks over sunny siliceous rocks, on rotten wood of shingle roofs, or in humus-filled crevices of mica-schists (GRIMS 1999, AMANN 1912,

FREY *et al.* 2006, and own observations). In the family Amblystegiaceae the species *Amblystegium radicale* (P. Beauv.) Schimp. is also confined to decaying vegetation in moist habitats, mainly on the remains of *Phragmites*, *Juncus*, and *Molinia*, whereas in the same family *Anacamptodon splachnoides* (Froel. ex Brid.) Brid. inhabits wet knotholes (dendrotelmata), and moist decomposing tree bark. Among the species mentioned above, only the latter two occur in Hungary, and both are rare (BOROS 1968, PAPP *et al.* 2010).

All across Europe, *Anacamptodon splachnoides* is rare and threatened (France, Italy, Austria, Czech Republic, Germany, Poland, Slovakia, Switzerland, Hungary, Romania, Serbia, Slovenia, Ukraine); according to DÜLL (1985) it is part of the sub-Mediterranean-suboceanic-montane element. In the Red data book of European bryophytes (ECCB 1995), *A. splachnoides* is classified as endangered (EN), but also in all of the national Red Lists it is assigned a threatened status (LUDWIG *et al.* 1996, KUČERA *et al.* 2012, SCHNYDER *et al.* 2004, ŞTEFĂNUŢ and GOIA 2012). In Hungary the species is also red-listed, in the EN category, and is also protected by law with an ideal value of 5000 HUF (ANON. 2012). Outside Europe it is found in North America (MAJESTYK 2002) and the Caucasus (CZERNYADJEVA 2007).

The genus *Anacamptodon* was described by BRIDEL (1819) and placed in the family Fabroniaceae, but according to molecular phylogenetic results, it is now ascribed to Amblystegiaceae (GOFFINET and BUCK 2004).

The rarity of *A. splachnoides* can in part be attributed to its special microhabitat, which is not very stable over time. We find its turfs, usually of small extension, mainly and characteristically in knotholes (dendrotelmata) filled with rain water and enriched with organic matter from the slow decay of the wood as well as decomposing tree leaves falling into the pool, around moist hollows, bark wounds, and at the fork of tree trunks in moist bark fissures. Most European populations are found on *Fagus sylvatica* (BEDNAREK-OCHYRA *et al.* 1994, SANDRON and HUGONNOT 2012, PLÁŠEK 2012), but other tree species with acidic bark are also reported as host trees, e.g. *Carpinus betulus* L., *Picea abies* (L.) H. Karst., *Abies alba* Mill., *Quercus* and *Betula* spp. (AHRENS 2001). The decaying horizontal surface of tree stumps is also suitable (AHRENS 2001, PIERROT and PIERROT 1975, SCHNYDER 2011, PLÁŠEK 2012), in particular of spruce, where the species colonizes a ring of resin in slow decay (SCHRÖDER and MEINUNGER 1994, 2000), or the water-filled surface inside a circular callus (AHRENS 2001). In North America host trees include *Acer rubrum* Lam., *A. saccharum* Marshall, *Quercus montana* Willd. (DAVIS and PURSELL 2007), *Fagus grandifolia* Ehrh., *Betula* spp. and *Acer* spp. (MAJESTYK 2002). *A. splachnoides* has also been reported in North America once from a rock surface (SHARP and ANDERSON 1981) and from three collections on moist basidiocarps of the common wood decay fungus *Oxyporus populinus* (Schumach.) Donk, which was fruiting on wounds of *Acer rubrum* (DAVIS and PURSELL 2007).

Nearly all reports from Hungary are from oak (*Quercus*), a few on beech (*Fagus sylvatica*), and a single find on birch (*Betula pendula* Roth) (SZEPESFALVI 1938, BOROS 1915–1971, specimens in BP).

The first Hungarian occurrence was found in 1871 in the Buda Mts by Lajos Simonkai (SIMONKAI 1879). Since then, the species has been found in several counties and regions, so far from 24 grid cells (Fig. 1) (SZEPESFALVI 1938, BOROS 1968, PAPP and ERZBERGER 2003, specimens in BP). From the 1960s up to the present there were only two reports; in 1978 Sándor Orbán made a collection in the Ózd Hill region, and in 2001 the second author found a small population in the Buda Mts (PAPP and ERZBERGER 2003). On the basis of this latter find, the growth site was selected as an IBrA (Important Bryophyte Area) (PAPP 2008).

MATERIAL AND METHODS

Geographical coordinates were determined using a Garmin eTrex Legend GPS. The drawings of details of *A. splachnoides* were made by the second author from the following specimens: B-Erzberger 19015; HCsN 6085. The morphological description of the species is based on CRUM and ANDERSON (1981), AHRENS (2001), and CZERNYADJEVA (2007). The nomenclature of the bryophytes, fungi

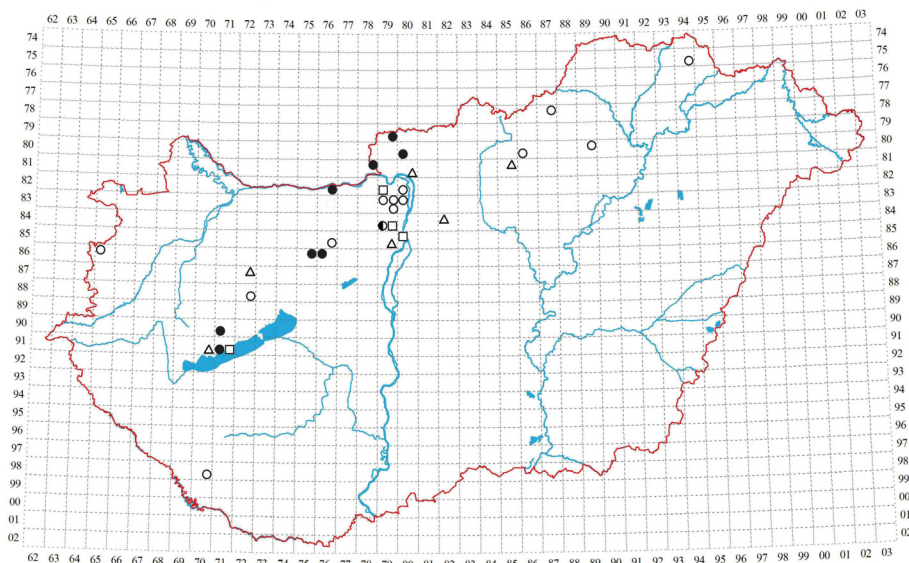


Fig. 1. Occurrences of *Anacamptodon splachnoides* in Hungary. (non-shaded symbols – before 1978; full shaded symbols – after 2000; half shaded symbols – observed before 1978 and after 2000 as well; circle – data supported by herbarium samples; square – literature data without herbarium vouchers; triangle – literature data with uncertain location and without herbarium voucher).

and the vascular plants follow HILL *et al.* (2006), ROBERT *et al.* (2005) and ANON. (2010), respectively. The detailed point map is based on the bryophyte collection of the Hungarian Natural History Museum (BP) and the herbaria of the authors (B-Erzberger = herbarium of P. Erzberger, HCsN = herbarium of Cs. Németh).

Some occurrences cited by SZEPESFALVI (1938) cannot be attributed precisely to a given grid cell, therefore in the map these data are displayed by a separate symbol.

RESULTS

During grid cell recording of the bryophyte flora of Hungary, as well as in the framework of a research project 'Amount of dead wood and its effect on biodiversity in the Hungarian Carpathians' managed by Centre for Ecological Research (Hungarian Academy of Sciences), *A. splachnoides* was discovered in 8 grid cells of the Hungarian Mountain Ranges in 27 tree hollows (Table 1, Fig. 1). Of the 27 sites, 3 are situated in the Börzsöny Mts at Diósjenő, Bernecebaráti, and Letkés (Csehvár Hill, Dedre-bérc, Valley of Letkés stream), 2 in the Vértes Mts at Gánt and Csákberény (Gém Hill, Ugró Valley), 2 in the Gerecse Mts at Lábatlan (Nagy-irtás), and 20 in the Balaton Uplands. Among the latter, the site at Badacsonytomaj (Örsi Hill), with a single tree hollow occupied by *Anacamtodon*, is geographically disjunct from the populations at Szentbékállá (Kopácsi Hill), where the species can be found in the hollows of 19 distinct individual trees in a 20 ha coppiced Turkey oak woodland surrounding the pond Füzes-tó, on the basaltic plateau (Fig. 2).

All populations were found in decaying, moist tree hollows or their surroundings at the stem base of *Quercus cerris* L., in most cases immediately above the water level of the dendrotelma (Fig. 3), more rarely on the margins of moist hollows that lack a body of water, but where continuous seepage from the tree trunk provides the necessary moisture (Fig. 4). It should be emphasized that all Hungarian populations were found at the base of trees, at most 0.5–1 m above the ground, whereas reports from other countries mention their occurrence in higher parts of the tree trunk (SOLBERG 1977, CRUM and ANDERSON 1981, BREIL 2003, SANDRON and HUGONNOT 2012).

The general rarity of the species is evident from the fact that in spite of the examination of several hundred seemingly appropriate dendrotelmata during the last 15 years, the species was found in only 27 tree hollows. The ratio of examined trees and populations of *A. splachnoides* found is in accord with the observations of SANDRON and HUGONNOT (2012), who examined 119 tree hollows in a beech forest of 30 ha and found the plant in 29. A similar conclusion can be drawn from the fact that Ádám Boros and László Vajda, whose field studies covered the whole country, report a total of only 15 Hungarian occurrences (BOROS 1915–1971,

Table 1. Detailed data of new *A. splachnoides* occurrences in Hungary.

Locality	Coordinates	Coverage (ca)	Grid cell	Date of collection	Collectors	Herbarium specimens
Veszprém County, Balaton Uplands, Badacsonytomaj, Őrsi Hill	46.81922° N, 17.53453° E, 238 m	120 cm ²	9171.3	27.05.2012	Cs. Németh	HCSN 4313
Fejér County, Vértes Mts, Csákbéreny, Ugró Valley	47.37794° N, 18.31081° E, 432 m	120 cm ²		08.08.2014	A. Mesterházy, Cs. Németh	HCSN 6085
Fejér County, Vértes Mts, Gánt, Gém Hill	47.39447° N, 18.39675° E, 240 m	50 cm ²	8675.2	13.07.2014	Cs. Németh	HCSN 5818
Veszprém County, Balaton Uplands, Szentbékállya, Kopácsi Hill	46.90675° N, 17.55964° E, 299 m	30 cm ²	8676.1	18.07.2014	Cs. Németh	HCSN 5904
	46.90622° N, 17.56158° E, 294 m	20 cm ²				
	46.90547° N, 17.56203° E, 272 m	160 cm ²				
	46.90633° N, 17.55794° E, 288 m	260 cm ²				
	46.90639° N, 17.55806° E, 286 m	100 cm ²				
	46.90628° N, 17.55989° E, 309 m	60 cm ²		15.11.2014	A. Mesterházy, Cs. Németh	HCSN 6395
	46.90625° N, 17.55989° E, 309 m	70 cm ²				
	46.90631° N, 17.56072° E, 278 m	220 cm ²				
	46.90631° N, 17.56381° E, 286 m	190 cm ²				
	46.90583° N, 17.56472° E, 277 m	60 cm ²				
	46.90547° N, 17.56453° E, 276 m	30 cm ²				
	46.90514° N, 17.56617° E, 243 m	190 cm ²				
					P. Erzberger, Cs. Németh	B-Erzberger 19015, HCSN 6316
						HCSN 6317
						HCSN 6319
						HCSN 6320
						HCSN 6321
						HCSN 6396
						HCSN 6398
						HCSN 6399
						HCSN 6400
						HCSN 6401
						HCSN 6402

Table 1. (cont.).

Locality	Coordinates	Coverage (ca)	Grid cell	Date of collection	Collectors	Herbarium specimens
	46.90641° N, 17.56111° E, 289 m	300 cm ²		17.01.2015	L. Vókó, Cs. Németh	HCsN 6491
	46.90653° N, 17.56117° E, 289 m	300 cm ²				HCsN 6492
	46.90658° N, 17.56128° E, 293 m	70 cm ²				HCsN 6493
	46.90594° N, 17.56156° E, 293 m	70 cm ²				HCsN 6494
	46.90586° N, 17.56167° E, 293 m	300 cm ²				HCsN 6495
	46.90600° N, 17.56194° E, 288 m	190 cm ²				HCsN 6496
	46.90622° N, 17.56383° E, 286 m	250 cm ²				HCsN 6497
Nógrád County, Börzsöny Mts, Diósjenő, Csehvár Hill	47.94619° N, 19.02147° E, 360 m	-	8080.3	12.06.2014	E. Guba, V. Papp	HCsN 6514
Pest County, Börzsöny Mts, Letkés, Valley of Letkés stream	47.88778° N, 18.80022° E, 210 m	-	8178.2	10.09.2014	E. Guba, V. Papp	HCsN 6606
Pest County, Börzsöny Mts, Bernecebaráti, Dedre-bérc	48.01467° N, 18.97203° E, 420 m	8 cm ²	7979.4	04.06.2015	P. Erzberger	B-Erzberger 19807
Komárom-Esztergom County, Gerecse Mts, Lábatlan, Nagyirtás	47.70139° N, 18.48358° E, 305 m	160 cm ²	8276.4	01.04.2015	P. Erzberger, Cs. Németh	B-Erzberger 19700, HCsN 6587
	47.70147° N, 18.48336° E, 305 m	480 cm ²		01.04.2015	P. Erzberger, Cs. Németh	HCsN 6588

BOROS 1968, specimens in BP), and according to Boros's field notes there was only one site where *A. splachnoides* was found on more than one individual tree.

Our experience shows that not all kinds of tree hollows are suitable for the establishment of the species. Permanently dry hollows can be excluded a priori. Only those hollows that are filled with water for a longer or shorter period can be considered potential microhabitats, as well as bark wounds or hollows where seepage from the tree provides the necessary moisture.

Adding up the recently discovered occurrences of the species results in a total cover of ca 4,208 cm². Associate bryophytes are regularly *Hypnum cupressiforme* Hedw., more rarely *Pylaisia polyantha* (Hedw.) Schimp., *Bryum moravicum* Podp., and *Amblystegium serpens* (Hedw.) Schimp. In the absence of data from continuous monitoring, we know little about the development of populations in time. We can only state that the dendrotelma where the population at Örsi Hill

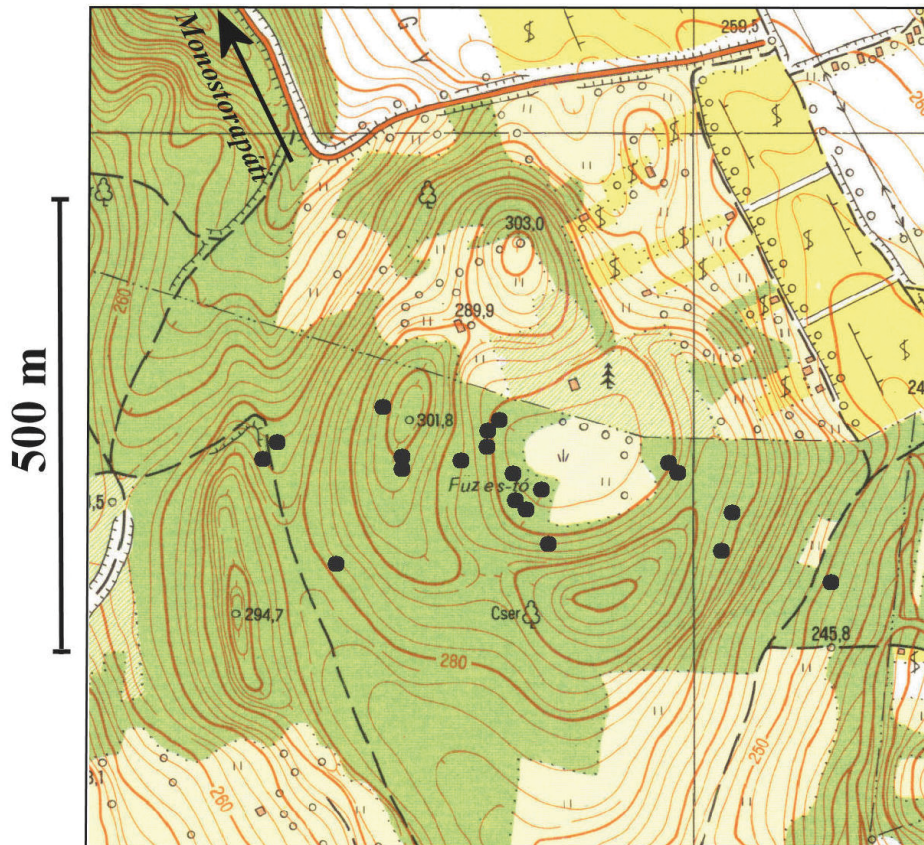


Fig. 2. Occurrences of *Anacamptodon splachnoides* on Kopácsi Hill near Szentbékállá (grid cell 9071.3).



Fig. 3. Typical habitat of *Anacamptodon splachnoides* on Kopácsi Hill; knothole with pool.



Fig. 4. Typical habitat of *Anacamptodon splachnoides* on Kopácsi Hill; wet knothole without dendrotelma.

was found, was filled with water in 2012, when first noted, as well as in 2014 when checked, and the cover of the population at the edge and on the somewhat drier margin had not changed within that period.

Short characterization of *Anacamptodon splachnoides*

Small plants, irregularly branched, dark green prostrate shoots, densely foliated in 5 rows. Leaves ovate-lanceolate, patent when moist, erect when dry, often curved in one direction, slightly concave, gradually tapering, margins entire. The nerve reaches up to 1/2–2/3 the leaf length. Laminal cells smooth, oblong-rhomboidal, rectangular at leaf base. Monoicous, usually producing numerous sporophytes. Capsule borne on a smooth seta, erect, symmetric, oblong-cylindric with a characteristic contraction below the orifice. Lid obliquely rostrate. Peristomium double, exostome consisting of 16 yellowish-brown, lanceolate, papillose teeth in 8 pairs, which are characteristically strongly recurved when dry; endostome consisting of 16 or 8 reddish-brown segments with smooth surface (Figs 5, 6).



Fig. 5. Habit of *Anacamptodon splachnoides*.

Characters that help identification:

- turf characteristically dark emerald green when moist
- leaf areolation clearly visible against the light with a 10× hand lens, with relatively large (ca 13 μm wide and – depending on position – 30–52 μm long) cells
- capsule erect, contracted below mouth
- outer peristome teeth strongly reflexed when dry

CONCLUSIONS

Remarkably each newly discovered Hungarian population of *A. splachnoides* as well as the overwhelming majority of the earlier finds are from *Quercus cerris*

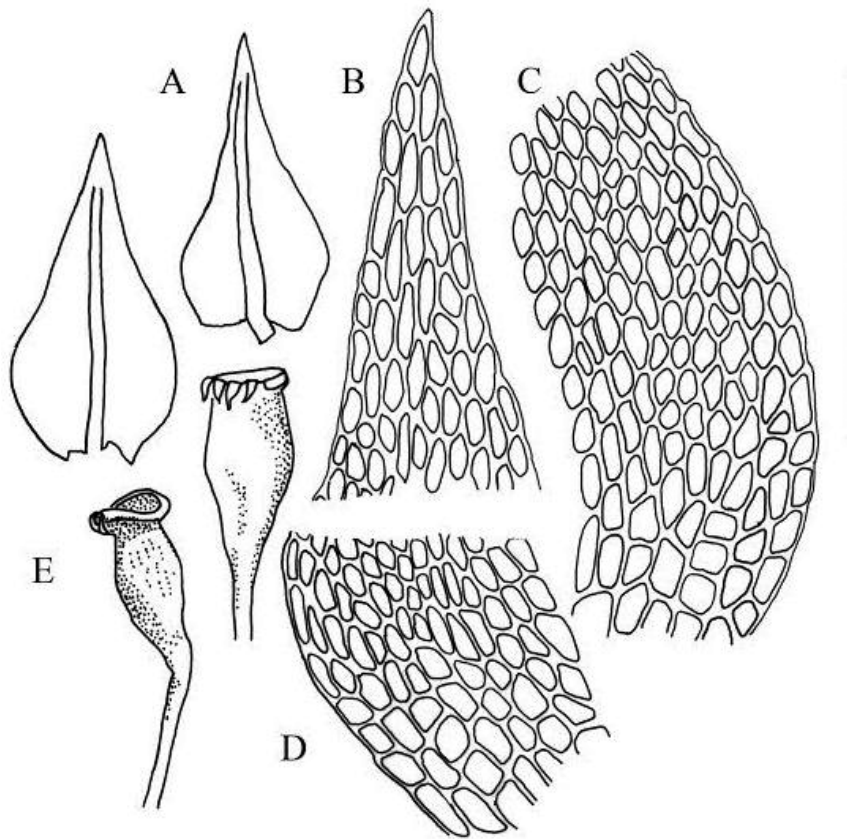


Fig. 6. Leaf and capsule of *Anacamptodon splachnoides*. (Length of scale bar is given in parentheses), A leaves (2 mm); B laminal cells near leaf apex (200 μm); C mid leaf and marginal cells (margin to the right) (200 μm); D basal and marginal cells (margin to the left) (200 μm); E capsules, dry (2 mm).

knotholes, whereas most European colonies reported in the literature were found on miscellaneous tree species, mainly *Fagus sylvatica*. In Hungary, previously 29 occurrences in 24 grid cells have been encountered, and there was only one occasion when *A. splachnoides* was found on more than one individual tree at a given site. With the recently found colonies reported here the number of grid cells in which *A. splachnoides* has been observed in Hungary is increased to 32. One of these new populations (Kopácsi Hill) with its relatively high total coverage on 19 different Turkey oak trees is of great significance not just from a regional point of view but also on a European scale.

Anacamptodon splachnoides is a rare and threatened species all across Europe. It is under legal protection in Hungary, and therefore its populations must be kept safe. In the case of *Anacamptodon* this must mean the protection not only of host trees where the species is already present, but also of those oak trees with hollows that might be considered potential habitats. In order to preserve the microclimate of a closed deciduous forest, very careful forest management strategies are proposed for the whole area of Kopácsi Hill with the application of selective cutting and the prevention of clear felling. As an initial practical conservation measure to preserve existing colonies of *A. splachnoides* on Kopácsi Hill, host trees were labelled by the Balaton Uplands National Park. In order to ensure long-term survival of the moss in the territory consultations were initiated with forestry management not to cut any oaks with knotholes at the growth site regardless of the presence or absence of the species on the individual trees.

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Összefoglaló: Az *Anacamptodon splachnoides* egy különleges életmódú, fejlődésében bomló szerves anyaghoz, nitrogénben gazdag, organikus szubsztráthoz kötődő, nedvességigényes, ritka mohafaj. Ritkasága részben speciális, időben kevésbé stabil mikroélőhelyének tulajdonítható. Kis kiterjedésű gyepei elsősorban és jellemzően csapadékvizes korhadéklével feltöltődött faüreggek (dendrotelmák) falán és peremén, valamint nedves odúk, kéregrepedések környékén, a fatörzsek repedező, nedvedző, villás elágazásainál találhatók. Az elmúlt esztendők mohafloisztikai kutatásai, kvadrát alapú mohatérképezése, illetve a faj célzott keresése során az *A. splachnoides* 27 kis populációja került elő a Magyar Középhegység területéről, minden esetben csertölgy (*Quercus cerris*) talajfelszín közeli, nedves odújából. Az előfordulások közül 3 a Börzsönyben, 2 a Vértesben, 2 a Gerecsében, 20 pedig a Balaton-felvidéken található. Utóbbiak közül a badacsonytomaji (Örsi-hegy) élőhely egyetlen faodújával földrajzilag elkülönül a szentbékállai (Kopácsi-hegy) populációktól, ahol a faj kolóniái a bazaltplatón elterülő, lefolyástalan Füzes-tó környékének 20 hektáros sarjaztatott tölgyesében, 19 különböző faegyed üregében élnek. Az *A. splachnoides* Európa-szerte ritka és

veszélyeztetett, Vörös Könyves faj, mely Magyarországon is törvényi oltalom alatt áll. Populációinak védelme a mohának otthont adó faegyedek védelme mellett a még nem kolonizált, de a megtelepedés szempontjából potenciálisnak tekinthető, odvas fák megóvását is kell, hogy jelentse. Továbbá a zárt lomberdei mikroklímaviszonyok megőrzése érdekében a faj élőhelyein a kíméletes, tarvágyt kerülő, száraló erdőművelés alkalmazása az irányadó.

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