

PRELIMINARY DATA ABOUT THE PRESENT HUNGARIAN LOCAL POPULATIONS OF RARE EUROPEAN BRYOPHYTES

B. PAPP¹, P. ÓDOR² and P. ERZBERGER³

¹*Department of Botany, Hungarian Natural History Museum
H-1476 Budapest, Pf. 222, Hungary*

²*Department of Botany and Ecology, Loránd Eötvös University
H-1087 Budapest, Ludovika tér 2, Hungary*

³*Belziger Str. 37, D-10832 Berlin, Germany*

Fourteen new and 13 confirmed, earlier Hungarian records of 16 species, included in the “Red data book of European bryophytes”, are given in this paper. Observations about the local population size, accompanying bryophytes, habitat conditions, and threats are discussed. Maps of the Hungarian distribution of *Lophozia ascendens*, *Buxbaumia viridis*, *Pyramidula tetragona*, *Fissidens arnoldii* are included. The IUCN categorization of *Fissidens arnoldii* is given on the basis of its recent Hungarian distribution compared with distribution data of the period 1930–1970.

Key words: rare and threatened bryophytes, Hungarian distribution, IUCN categorization

INTRODUCTION

In the last few decades many species have become extinct and others are in danger of extinction because of the degradation of their natural habitats. At present there are some international efforts to conserve biodiversity and prevent the extinction of species (The convention on conservation of European wildlife and natural habitats (Bern Convention) 1979, European Community directive on the conservation of natural habitats and wild fauna and flora, 1992). Since current knowledge concerning threatened species and species-rich natural habitats still shows great differences with respect to different groups of organisms and areas, it is an important task for specialists of different groups of organisms in different regions to contribute to a better understanding of endangered species, including their taxonomy, their distribution, the size and the ecological demands of their populations.

Although the European bryoflora is relatively well-known and the distribution of species has been summarised recently DÜLL (1983, 1984, 1985, 1992), there are still areas in special need of work and the state of knowledge is far from being the same in different parts of Europe. Most European countries have red lists or red data books of bryophytes (e.g. CORTINI and ALEFFI 1993, DRUZHININA 1984, GRIMS 1986, LUDWIG *et al.* 1996, OCHYRA 1986, RAJCZY 1990). However, these national lists are written from a national perspective, often use different categories of rarity and do not take into account rarity or abundance of species on a larger geo-

graphical scale (SÖDERSTRÖM 1995). In an attempt to coordinate the conservation efforts of bryologists of different countries, the European Committee for Conservation of Bryophytes (ECCB) published the "Red data book of European bryophytes" (ECCB 1995). The bryophyte species rare in Europe are listed in it using standard IUCN categories (IUCN 1978) modified for bryophytes. After the publication of revised IUCN threat categories (IUCN 1994), these should also be applied to bryophytes (HALLINGBÄCK *et al.* 1998) when updating the information of the RDB.

The Hungarian bryoflora was thoroughly investigated mainly by the tireless work of Ádám Boros and László Vajda. Their numerous bryofloristical publications were summarised in some handbooks (BOROS 1953, 1968, ÖRBÁN and VAJDA 1983). Their data concerning the localities of relatively rare bryophytes are also documented in their collections and their field diaries, which are kept in the Hungarian Natural History Museum (BOROS 1915–1971, VAJDA 1933–1978). However, these data mainly cover the period from 1930 to 1970. Today it is an important task to obtain information about the actual Hungarian distribution and population size of bryophyte species, which are rare or insufficiently known in Europe (which are, or potentially will be, included in the RDB). This floristical work is essential for the assessment of their conservation status, for finding their appropriate IUCN categorization, monitoring of their populations, conservation of species and their habitat and understanding of their ecological demands. Fifty bryophyte species occur in Hungary that are included in the RDB. Three of these are endangered (E), 12 are vulnerable (V) and the remaining species are rare (R) or insufficiently known (K) (Appendix). The aim of the authors' studies is to assess the actual rarity of these species by checking their earlier occurrences and by trying to find unknown local populations in their potential habitat. By the comparison of the present and earlier numbers of their occurrences and population sizes the change of their populations in Hungary could be estimated. Concerning these species similar studies are carried out in other European countries.

This paper contains (1) some preliminary data of this floristical work, and (2) a case study about *Fissidens arnoldii* (a rare species in Europe), of which the actual Hungarian distribution and population size has been explored to a large extent, thus enabling the assessment of its threat category by IUCN criteria.

METHODS

To obtain the earlier distribution data of the investigated species the Bryophyte Herbarium of the Hungarian Natural History Museum, Budapest (BP)

and Eger Teacher's College (EGR) were consulted. The retrieval was mainly based on locality descriptions of herbarium specimens and the diaries of Ádám Boros and László Vajda about their field trips (BOROS 1915–1971, VAJDA 1933–1978). The earlier localities were thoroughly examined; if the bryophyte looked for was found the size of its population was estimated, some of its abiotic and biotic conditions were examined and the localities were marked for further monitoring. If the search for an earlier occurrence was not successful, habitat conditions of the site were taken into consideration in order to arrive at a decision as to whether the potential habitat of species had been destroyed and hence the local population was likely to be extinct, or else the habitat had remained in good quality so that the species could still be expected to be found.

Nomenclature and the European distribution of the species is given according to DÜLL (1983, 1984, 1985, 1992).

Information about the habitat demands of the species is summarised according to BOROS (1968), ORBÁN and VAJDA (1983) and field experience of the authors.

RESULTS

Hepaticae

Asterella saccata (Wahlenb.) Evans is a subcontinental species. It lives in calcareous open grasslands. It is vulnerable in Europe according to the RDB.

Old occurrence confirmed: Baranya county, Szársomlyó, Nagyarsány, SW slope of the hill, on soil in limestone open grassland, ca 300 m a. s. l., 01.05.1999, leg. Dénes, A., Papp, B. det. Papp, B. Two 10 × 10 cm² patches were found. Earlier data from here: 22.03.1925, 16.05.1926, 27.04.1962, leg. and det. Boros, Á., on the SE slope: 25.03.1965, leg. and det. Vajda, L.

Lophozia ascendens (Warnst.) Schust. is a boreal, montane species, it lives on well-decayed logs (obligate epixylic species). It is a rare species according to RDB. At present, it occurs in two localities in Hungary (Fig. 1).

New occurrences: Heves county, Mátra Mts, Mátraháza, N slope of the Kékes hill in the Kékes North Forest Reserve, on decaying logs, 20.06.1999, leg. and det. Ódor, P. (ÓDOR 2000). It occurs on 4 well-decayed logs, the size of the patch inhabited by the population is ca 1 m². The habitat is a collapsing phase of a semi-natural ravine-like beech-lime-maple forest, ca 900 m a. s. l. It occurs together with *Anastrophyllum hellerianum* (Nees ex Lindenb.) Schust., *Nowellia curvifolia* (Dicks.) Mitt. in Godman, *Calypogeia suecica* (H. Arn. et J. Perss.) K. Muell., *Herzogiella seligeri* (Brid.) Iwats., *Lophocolea heterophylla* (Schrad.) Dum., *Rhizomnium punctatum* (Hedw.) Kop., *Hypnum cupressiforme* Hedw. – Heves county, Bükk Mts, Nagyvisnyó,

in valley Leány-völgy at Holló-kő rocks, on decaying beech log, 720 m a. s. l., 17.11.1999, leg. Ódor, P., Papp, B. det. Ódor, P. It occurs in a well-decayed log, the size of the patch inhabited by the population is *ca* 100 cm². The habitat is a north-facing ravine.

Locality checked without success: Borsod-Abaúj-Zemplén county, Bükk Mts, Jávorkút, on decaying log in a planted old spruce forest, 27.08.1959, leg. and det. Vajda, L. The habitat has dramatically changed; a young spruce plantation was found, where decaying logs are missing, thus this local population of the species has become extinct.

Unchecked locality: Borsod-Abaúj-Zemplén county, Zemplén Mts, on decaying log near the stream in valley Határ-völgy at Kőkapu near Pálháza, 24.06.1953, leg. and det. Vajda, L.

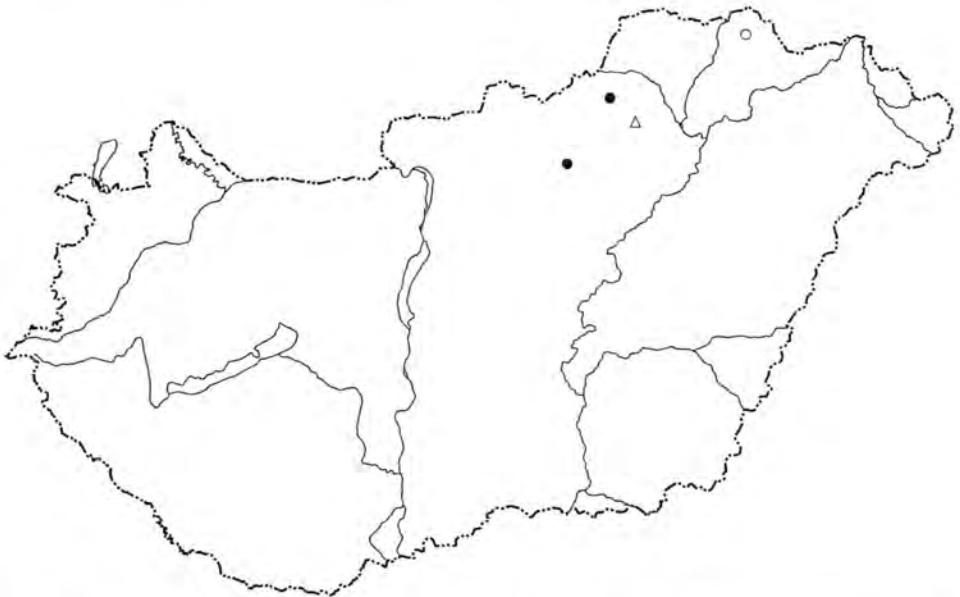


Fig. 1. Hungarian distribution of *Lophozia ascendens*. – solid circle = data after 1970; – hollow circle = data before 1970, unchecked; – triangle = habitat destroyed, population extinct; – square = data checked without success, repeated search needed.

Musci

Anomodon rostratus (Hedw.) Schimp. is a sub-Mediterranean, montane species. It occurs on shaded calcareous rocks, in rock crevices. Rare according to the RDB.

Old occurrences confirmed: Borsod-Abaúj-Zemplén county, Aggtelek karst, Szögliget, Ménes-valley, on shaded limestone rocks, *ca* 270 m a. s. l., 13.06.1998, leg. and det. Papp, B. Earlier data: 11.01.1937, leg. and det. Boros, Á. – Pest county, Pilis Mts, Pilisszentlélek, Fekete-hegy, shady limestone rocks SE of Sasfészek tourist house, *ca* 560 m a. s. l.,

13.04.1998, leg. and det. Erzberger, P. Total area covered is about 100 cm². Earlier data: 13.05.1928, leg. and det. Boros, Á. – Pest county, Pilis Mts, Pilisszentkereszt, south of Két-bükkfa-nyereg, surroundings of the cave Ördög-lyuk barlang, limestone boulders in mixed beech forest, ca 480 m a. s. l., 14.03.1997, leg. and det. Erzberger, P. Total area covered is about 400 cm². Earlier data: 02.06.1946, leg. and det. Boros, Á., Vajda, L.

New occurrence: Borsod-Abaúj-Zemplén county, Bükk Mts, Cserépfalu, in Hór-valley at Ódorvár hill, ca 320 m a. s. l., 04.08.1998, leg. and det. Erzberger, P. and 21.08.1999, leg. and det. Ódor, P., Papp, B., Erzberger, P. A shady place on the eastern slope of the Ódorvár hill, in some limestone rock crevices. The total area covered was about 200 cm².

Brachydontium trichodes (Web.) Milde is a subatlantic, montane species. It occurs on shaded, non-calcareous rocks. Rare according to the RDB. In Hungary, it has only 3 known localities, all are in the Börzsöny Mts.

Old occurrence confirmed: Pest county, Börzsöny Mts, Kemence, Kopolya-kövek rocks (Sasfészek in Boros 1915–1971) at Királyháza, on andesitic rocks, ca 600 m a. s. l., 04.08.1999, leg. and det. Papp, B., Erzberger, P. Earlier data: 01.05.1958 and 28.09.1959, leg. and det. Boros, Á., Vajda, L. A few small patches of ca 10 cm diameter were found on the eastern side at the middle part of the rock mass in shady places and at the northeastern end on the top of the ridge in a very exposed, sunny outcrop. It was associated with *Racomitrium heterostichum* (Hedw.) Brid. and *R. aquaticum* (Schrad.) Brid. These species are also rare in Hungary.

Buxbaumia viridis (Moug. ex Lam. et DC.) Brid. ex Moug. et Nestl. is a boreal, montane species. It lives on decaying wood or sometimes on humus-rich, acidic soil in forests. It is included in the Bern Convention and in the Habitat Directives; it is vulnerable according to the RDB. It has 7 known localities in Hungary (Fig. 2).

Old occurrence confirmed: Borsod-Abaúj-Zemplén county, Bükk Mts, Nagyvisnyó, in valley Leány-völgy at Holló-kő rocks, on decaying beech log, 720 m a.s.l., 01.10.1999, leg. and det. Ódor, P., Papp, B., Szurdoki, E. The population found in valley Leány-völgy is very small. In total 14 sporophytes were counted on three logs in a very advanced stage of decay. It was associated with *Riccardia palmata* (Hedw.) Carruth., *Rhizomnium punctatum* (Hedw.) Kop., *Lophocolea heterophylla* (Schrad.) Dum., *Brachythecium velutinum* (Hedw.) B., S. et G. Earlier data from here: 07.08.1953, leg. and det. Boros, Á.

Localities checked without success: Baranya county, Mecsek Mts, in valley Éger-völgy at Magyarürög (Pécs), 27.06.1952, leg. and det. Vajda, L. The specimen was collected growing on soil mixed with *Leucobryum glaucum* (Hedw.) Aongstr. The valley was visited twice in 1999, in spring and in summer. The forests in the valley are very dry. The habitat seems not to be adequate for the species. – Borsod-Abaúj-Zemplén county, Zemplén Mts, Nagy-Hemzső hill at Telkibánya 19.06.1960, leg. and det. Vajda, L. The specimen was collected growing on soil in an oak forest. It was accompanied by *Dicranum scoparium* Hedw. The hill was visited in June 2000. The weather had been very dry and hot for a long time, but the habitat seems to be suitable for the species. – Heves county, Mátra Mts, Hársas-tető hill, growing on soil above the valley of Kőszörű-patak at Parád 01.10.1956, leg. and det. Boros, Á. The site was visited in June 2000. The old habitat is very small, but about 100 m away there are extended similar

places with the following species mentioned in the diary of Boros (1915–1971) as well: *Leucobryum glaucum* (Hedw.) Aongstr., *Dicranum scoparium* Hedw. – Nógrád county, Börzsöny Mts, in the upper part of valley Bacsina-völgy at the Királyháza hill at Királyháza, growing on soil, 08.05.1959, leg. and det. Vajda, L. The valley was checked in spring 1999. The species was not found but the habitat seems in intact condition. The presence of the species could be expected here. – Pest county, Budai-hegység Mts, Hárs-hegy hill, above Hűvösvölgy near Budapest, growing on soil, 10.02.1957, leg. and det. Vajda, L. The site was visited in 1999 and 2000. The habitat is very dry. The presence of the species is very doubtful. Unchecked locality: Veszprém county, in the Viszló forest near Tapolca, 02.05.1959, leg. and det. Vajda, L.

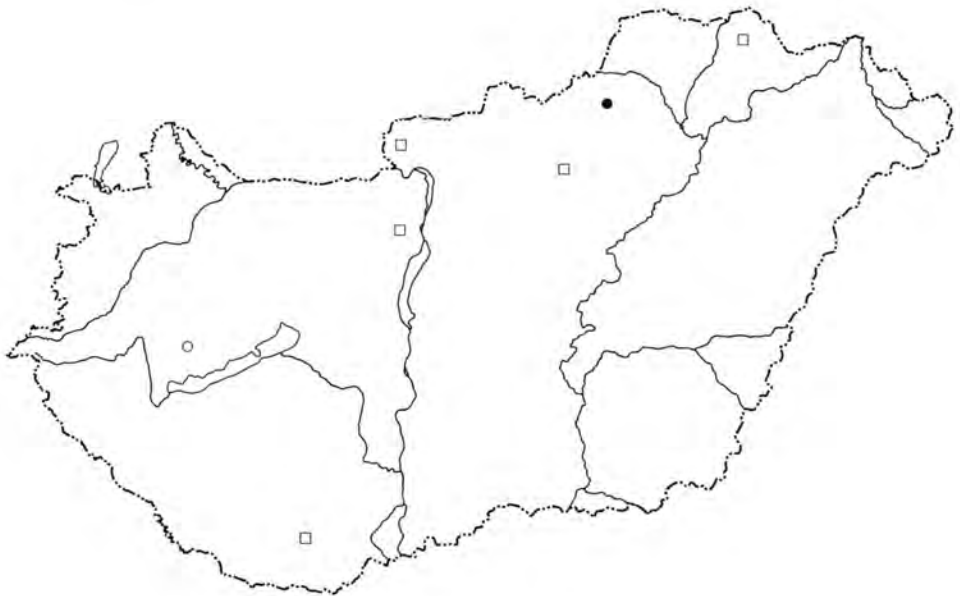


Fig. 2. Hungarian distribution of *Buxbaumia viridis* (for symbols see Fig. 1).

Campylostelium saxicola (Web. et Mohr) B., S. et G. is an atlantic, montane species. It lives on shaded andesitic rocks. Rare according to the RDB. In Hungary, it occurs in the Zemplén Mts at one locality and in some rock masses in the Börzsöny Mts.

Old occurrence confirmed: Pest county, Börzsöny Mts, Kemence, Kopolya-kövek rocks (Sasfészek in Boros 1915–1971) at Királyháza, on andesitic rocks, ca 600 m a. s. l., 29.06.1998, leg. and det. Papp, B. and 04.08.1999, leg. and det. Papp, B., Erzberger, P. Earlier

data: 01.05.1958 and 18.06.1958, leg. and det. Boros, Á., Vajda, L.; 03.05.1958 and 28.09.1959, leg. and det. Boros, Á. Two small patches of ca 10 cm diameter were found on the northeastern end of the rock wall on a N and an E facing site, respectively. It was mixed with *Rhizomnium punctatum* (Hedw.) Kop. and *Racomitrium aquaticum* (Schrad.) Brid.

Desmatodon cernuus (Hueb.) B., S. et G. is a boreal, montane species, occurring mainly on calcareous soil, frequently in maritime habitats in W Europe. Rare according to the RDB. In Hungary, it was collected once, 100 years ago, on sunny phyllitic rocks at Kőszeg city, leg. Latzel, A., det. Loeske, L. A new locality was discovered in the Kiskunság National Park (PAPP and RAJ CZY 2000, PAPP and RAJ CZY in press).

New occurrence: Bács-Kiskun county, on alkali soil at lake Szappanszék near Fülöpháza, 100 m a.s.l., 21.07.1977, leg. Rajczy, M., det. Papp, B.; and 09.04.1999, leg. Rajczy, M., Papp, B., Szurdoki, E., det. Papp, B. In 1999 it occurred on the shore of the lake about 10 m from the water behind the zone predominated by *Drepanocladus aduncus* (Hedw.) Warnst. It forms patches of 1–2 cm diameter. The total area covered is about 20 cm². It lives together with *Didymodon tophaceus* (Brid.) Lisa, *Bryum algovicum* C. Muell., *Drepanocladus aduncus* (Hedw.) Warnst.

Dicranum viride (Sull. et Lesq.) Lindb. is a subcontinental, montane species. It occurs on tree trunks in humid forests, mainly on the lower part of the trees. It is included in the Bern Convention and in the Habitat Directives; it is vulnerable according to the RDB. It was already known from 10 localities in the Bükk Mts and 9 from other parts of Hungary (ERZBERGER 1999).

New occurrence: Borsod-Abaúj-Zemplén county, Bükk Mts, Répáshuta, Őserdő, in semi-natural montane beech forest, on the base of a beech snag, 850 m a. s. l., 03.09.1999, leg. Papp, B., det. Papp, B. It forms patches of about 2 cm diameter. It covers about 120 cm² on the tree from the base to ca 60 cm high. It was associated with *Dicranum montanum* Hedw., *Dicranum scoparium* Hedw., *Dicranum tauricum* Sap., *Paraleucobryum longifolium* (Hedw.) Loeske. The abundance of *Dicranum tauricum* Sap., which is somewhat similar to *D. viride* and is possibly expanding its area in Hungary (ERZBERGER 1999), was higher in the same habitat of the forest.

Neckera pennata Hedw. is a subboreal species. It lives mainly on tree trunks. It is a vulnerable species in Europe according to the RDB.

Old occurrence confirmed: Szabolcs-Szatmár county, Téb-erdő forest at Tarpa, in *Quercus-Fraxinus* grove forest, on *Fraxinus* tree trunks, ca 110 m a. s. l., 10.05.1999. and 05.09.1999, leg. and det. Papp, B., Ódor, P. Earlier data: 14.03.1961, leg. and det. Boros, Á., Vajda, L. It was found in a humid, old-growth part of the forest. We found it on two trees. The covered area was 200 cm² and 100 cm², respectively.

Orthotrichum sprucei Mont. is a euoceanic species endemic of Europe, normally occurring in Western Europe, growing on roots of trees or more rarely on stones near water. It is rare according to RDB. This species has been discovered in Hungary, more than 1000 km from its usual distributional area in 1998 in a place of special microclimate (ERZBERGER and PAPP 2000).

New occurrence: Bács-Kiskun county, plain of Solt, canal Kelemen-széki táp csatorna, concrete sluice in the vicinity of Bordatanya (warden house), W of Fülöpszállás, inside wall of sluice chamber on wood attached to concrete, exposure NE, 90°, ca 90 m a. s. l., 16.04.1998, leg. Erzberger, P., Papp, B., det. Erzberger, P. The population covers only a few cm². The occurrence in this kind of man-made habitat seems to be unique.

Pyramidula tetragona (Brid.) Brid. is a sub-Mediterranean, subatlantic species. It is a short-lived species occurring in open grasslands mainly in spring and autumn. It is included in the Bern Convention and in the Habitat Directives; it is vulnerable according to the RDB. It was already known from 8 localities in Hungary (Fig. 3).

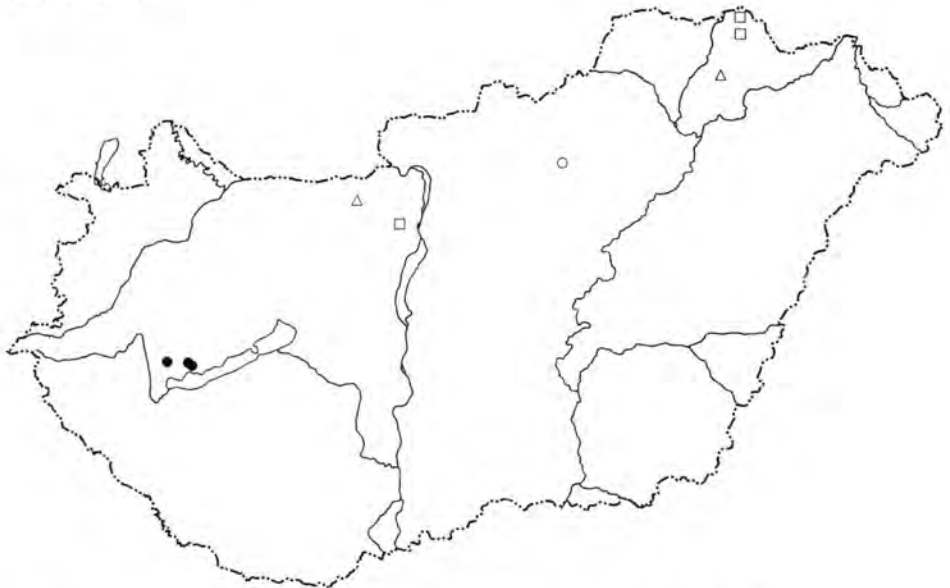


Fig. 3. Hungarian distribution of *Pyramidula tetragona* (for symbols see Fig. 1).

Old occurrences confirmed: Zala county, Balaton-felvidék, Mt Tátika at Zalaszántó. On soil in open basalt grassland facing NW, ca 300 m a. s. l., 22.04.1999, leg. and det. Papp, B., Ódor, P. Earlier data from here: 03.05.1954, leg. and det. Boros, Á. – Zala county, Balaton-felvidék, Mt Gulács at Nemesgulács. On soil in open, SE facing basalt grassland, ca 360 m a. s. l., 29.04.2000, leg. and det. Erzberger, P., Papp, B., Ódor, P. Earlier data: 02.05.1955, leg. and det. Boros, Á.

New occurrence: Zala county, Balaton-felvidék, Szent György hill, on soil of SE facing open basalt grassland, ca 350 m a. s. l., 13.08.1999, leg. Papp, B., Lőkös, L., Bérces, S., det. Papp, B. In each locality it was frequently mixed or associated with the following bryophytes: *Phascum cuspidatum* Hedw., *Bryum argenteum* Hedw., *Bryum capillare* Hedw., *Pottia intermedia* (Turn.) Fuernr., *Mannia fragrans* (Balb.) Frye et L. Clark, *Riccia sorocarpa* Bisch., *Weissia longifolia* Mitt. Usually it grows in patches of 1–2 cm diameter. Frequently several patches can be found near to each other within a 1 m² square. In extended grasslands, as e.g. in Szent György hill, 5–10 m away from such a square, other groups of 2–5 patches can often be found.

The population sizes of the species in the investigated localities can be seen in Table 1. The localities were visited in 1999 and 2000. As the life strategy of this species is annual shuttle (AS), it appears in spring, produces spores very quickly, then it dies in the dry season and in autumn it may appear again. The size of the population could be very variable in different years, because the presence of the species is strongly connected with the weather conditions as e.g. the time and quantity of rains.

Table 1. Population size of *Pyramidula tetragona* in the investigated localities. Patch: ca 1 cm² dense turf of shoots probably growing from the same prothallium. Group: assemblage of closely occurring patches within ca 1 m².

Years	Tátika		Szent György hill		Gulács
	1999	2000	1999	2000	2000
No. of patches	7	4	8	29	10
No. of groups	1	1	1	9	6
No. of sporophyte	66	19	76	246	84

In Tátika hill, the size of the population was smaller in 2000 than in 1999. Fewer patches were observed. In 1999 the population of Szent György hill was found late in August. Only the most abundant group of the population, which had survived the summer, was detected then. In April 2000 several new patches were found and this population proved to be the largest in the region. In 2000 the population of Gulács hill also was discovered. Scattered patches form this population.

Localities checked without success: Borsod-Abaúj-Zemplén county, Zemplén Mts, Kopasz-hegy hill at Tállya. 27.05.1952, leg. and det. Vajda, L. – Komárom-Esztergom county, Gerecse Mts, Sárási-kő hill at Bajna. 04.04.1949, leg. and det. Boros, Á. Both localities were visited in 2000. Mining activity was observed at the sites. Large parts of the hill-sides are missing. The species is probably extinct in both places, its habitats are destroyed. – Borsod-Abaúj-Zemplén county, Zemplén Mts, in Vajda-völgy valley at Pálháza. 06.10.1953, leg. and det. Boros, Á. – Borsod-Abaúj-Zemplén county, Zemplén Mts, Nagy-Milic hill at Füzér. 03.10.1953, leg. and det. Boros, Á., Vajda, L. Both sites were temporary habitats for *Pyramidula*; the species occurred on the bank of a ditch at a roadside, and at a forest edge. The localities were visited in 2000. – Pest county, Budai-hegység Mts, Vihar-hegy hill at Budapest. 24.02.1921, leg. and det. Györfy, I. The locality was checked in spring 1999 and 2000. The species was not found but the habitat is adequate for it. Although the grasslands are not very extended on the hill, there are some steep slopes with open soil surface, which is the typical habitat of the species in other localities.

Unchecked locality: Heves county, Mátra Mts, Remete-bérc hill at Mátraháza. 31.10.1960. and 27.04.1961, leg. and det. Boros, Á.

Rhynchostegiella jacquinii (Garov.) Limpr. is an atlantic, sub-Mediterranean, montane species. It is mentioned in the RDB as a rare species. One third of the old data of this species represent localities from the Visegrád Mts. Here, two new localities were discovered and in one old locality the search for the species was successful.

Old occurrence confirmed: Komárom-Esztergom county, Dömös, Rám-szakadék, on andesitic rock walls in the gorge, 380 m a. s. l., 22.03.1997, leg. and det. Papp, B. It was mainly near the water in association with *Fissidens pusillus* (Wils.) Milde. Earlier data from here: 07.08.1949, leg. and det. Boros, Á., Vajda, L.

New occurrences: Pest county, Visegrád Mts, Apátkúti-völgy at Pilisszentlászló, on andesitic rocks in the stream, 320 m a. s. l., 07.06.1992, and 20.06.1993, leg. and det. Papp, B. and 08.02.1994, leg. and det. Erzberger, P. – Pest county, Visegrád Mts, Apátkúti-völgy at Visegrád, on andesitic rocks in the stream at spring Magda-forrás, 160 m a. s. l., 20.06.1993, leg. and det. Papp, B. Along the Apátkúti-stream it lives on the rocks of the stream near the water, 5–10 cm from the water surface in association with *Fissidens pusillus* (Wils.) Milde.

Rhynchostegium rotundifolium (Brid.) B., S. et G. is a sub-Mediterranean-subatlantic species. Rare according to the RDB. It lives on shaded, humid rocks, rock walls, rock crevices, sometimes on decaying logs.

Old occurrence confirmed: Borsod-Abaúj-Zemplén county, Bükk Mts, Nagyvisnyó, in valley Leány-völgy at Holló-kő rocks, on decaying beech log, 720 m a. s. l., 01.10.1999, leg. and det. Ódor, P., Papp, B., Szurdoki, E. Patches of ca 5 cm² size occurred on three logs. Earlier data: 05.07.1934, leg. and det. Boros, Á. He has found it on calcareous rock.

New occurrences: Pest county, Visegrád Mts, Apátkúti-patak, on andesitic rocks in the stream at spring Kaán-forrás at Visegrád, 280 m a. s. l., 07.06.1992, leg. and det. Papp, B. It was mixed in a patch of *Brachythecium populeum* (Hedw.) B., S. et G. and *Amblystegium serpens* (Hedw.) B., S. et G. on a rock of 40–50 cm diameter about 20 cm from the surface of the water.

Taxiphyllum densifolium (Lindb. ex Broth.) Reim. is a pontic, montane species. It lives in humid habitats, on shaded rocks. Rare species according to the RDB.

New occurrence: Borsod-Abaúj-Zemplén county, Aggtelek karst, Lófej-valley at Jósvalfő, on shaded calcareous rocks, ca 350 m a. s. l., 25.05.1989, leg. Rajczy, M., det. Papp, B.

Tortula brevissima Schiffn. is a continental moss growing in open desert-like habitats like gypsum soils or vertical loess cliffs. Its only known Hungarian population was discovered in 1997 (ERZBERGER 1998). It is rare according to the RDB.

New occurrence: Borsod-Abaúj-Zemplén county, southern limit of Bükk Mts, ca 3 km north of the village Cserépfalu, roadside composed of rhyolite tuff in southeast exposure, ca 250 m a. s. l., 06.07.1997, leg. and det. Erzberger, P. It forms a patch of ca 200 cm². It occurs together with *Bryum argenteum* Hedw. and a *Pottia* species.

A case study for estimating population size and IUCN status of the bryophyte *Fissidens arnoldii* Ruthe

There is one species, *Fissidens arnoldii* Ruthe, of which all known localities in Hungary have been checked recently (Fig. 4). This species typically lived near

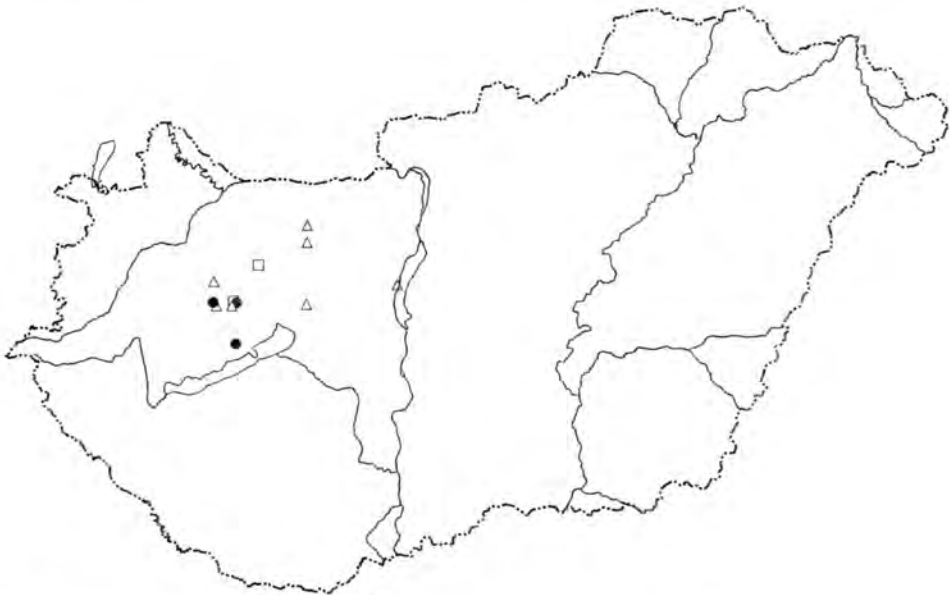


Fig. 4. Hungarian distribution of *Fissidens arnoldii* (for symbols see Fig. 1).

old water mills, and since most of these mills have been destroyed, the species appears to be very much threatened in Hungary.

It is a species of the temperate zone. Rare according to the RDB. In Hungary, it was usually found on rocks at water mills and sometimes on calcareous rocks of streams in ravines. It has been found at present only in two localities, and one new site was discovered.

Old occurrences confirmed: Veszprém county, Bánd, at the mill Deszkametsző-malom at the hill Essegvár, on the rocks in the ditch of the mill, 04.07.1998, leg. and det. Papp, B. Earlier data: 23.10.1949, leg. and det. Boros, Á. It forms 2–3 small patches of 4–5 cm in diameter near the water. The rocks and the wall of the ditch of the mill are covered mainly by *Rhynchostegium riparioides* (Hedw.) C. Jens. and *Cratoneuron filicinum* (Hedw.) Spruce. – Veszprém county, Kislőd, at the mill Vashátori malom, on the wall of the ditch, 03.07.1998, leg. and det. Papp, B. Earlier data: 05.06.1949, leg. and det. Boros, Á. The mill is almost a ruin; there is no water in the ditch. Some patches of the species (in total ca 250 cm²) are still alive at the base of the wall, shaded by high growing weeds. This population is greatly threatened.

New occurrence: Veszprém county, Örvényes, on the stones of the stream Pécsely-patak in the Szakadék-valley, ca 150 m a. s. l., 31.07.1994, leg. and det. Papp, B. It lives on the vertical surfaces of some rocks of 40–50 cm in diameter near the water. The total area covered is about 40–50 cm². It is associated with *Cratoneuron filicinum* (Hedw.) Spruce, *Amblystegium varium* (Hedw.) Lindb., *Eurhynchium speciosum* (Brid.) Jur.

Checked former locations, from which *Fissidens arnoldii* has disappeared (with corresponding dates and collector names): Fejér county, Pusztavám, Szép-víz, mill (05.09.1937 and 05.10.1948, leg. and det. Boros, Á.), the mill still exists, there is no water in the ditch. It is covered by dense vascular plant weed vegetation. – Komárom-Esztergom county, Környe, mill (21.07.1935, leg. and det. Boros, Á.), the mill is destroyed, the two ditches with water exist, but the water comes from a fish pond and seems to be highly eutrophicated. The species was not found. – Pest county, Szigetújfalu, Kőhíd bridge (09.05.1954, leg. and det. Boros, Á., Vajda, L.), the bridge has been reconstructed, the rocks near the water have been replaced by concrete elements. Water can be found only temporarily in the stream bed. – Veszprém county, Ajka, Ciglic-mill (05.06.1949, leg. and det. Boros, Á.), ruins, it has not been working ca 15 years. – Veszprém county, Ajka, Trummer-mill (05.06.1949, leg. and det. Boros, Á.), it was destroyed ca 15 years ago. – Veszprém county, Bánd, Steinecker-mill (23.10.1949, leg. and det. Boros, Á.), ruins, there is no water in the ditch. On the rocks only *Fissidens pusillus* (Wils.) Milde was found. – Veszprém county, Herend, Legalsó-malom, mill (23.10.1949, leg. and det. Boros, Á.), it has been reconstructed, the ditch is filled with soil. – Veszprém county, Kislőd, Községi mill (05.06.1949, leg. and det. Boros, Á.), it is destroyed. – Veszprém county, Márkó, Márkó mill (23.10.1949, leg. and det. Boros, Á.), it has been reconstructed, the ditch is covered by concrete elements. – Veszprém county, Nagygyanna, Rózsa-mill (21.10.1950, leg. and det. Boros, Á.), there is no water in the ditch and it is full of dense vascular plant weed vegetation. – Veszprém county, Ősi, Külső-malom, mill (30.10.1949, leg. and det. Boros, Á.), it is destroyed. – Veszprém county, Városlőd, mill (23.10.1950, leg. and det. Boros, Á.), it is destroyed.

Further search is needed at: Veszprém county, Gézaháza, Ördög-árok gorge, 05.07.1969, leg. and det. Boros, Á., Vajda, L. – our recent checking was unsuccessful, but the place is in good condition, no disturbance can be observed, there is water in the stream. – Veszprém county, Bánd, mill at Menyeke-puszta, 23.10.1949, leg. and det. Boros, Á., the mill is still there. It is situated on a closed private area, and the checking was impossible without the presence of the owner.

The following is a specific example of a species in which case we have checked all known localities in order to establish its IUCN category in Hungary. Criteria of this are the following (IUCN 1994):

A) Large decline: CR (Critically Endangered) = major population decline observed, estimated, inferred or suspected in the last 10 years or 3 generations, whichever is the longer, based on: 80% or more; EN (Endangered) = 50% or more, VU (Vulnerable) = 20% or more.

It is not applicable in this case. Declined, but the decline occurred mostly over 10 years ago.

B) Restricted area of occupancy, few localities: CN = Recently recorded within only one 10 km × 10 km square and found in only one locality or the populations are severely fragmented. It means small subpopulations that are all more or less isolated. – EN = Recently recorded in five or fewer 10 km × 10 km squares and found in two to five localities or the populations are severely fragmented. – VU = Recently recorded in ten or fewer 10 km × 10 km squares and found in ten or fewer localities or the populations are severely fragmented.

Fissidens arnoldii has been recorded recently from three 10 km × 10 km squares and it has three localities. It corresponds to the EN category.

C) Small population and decline: Small population: CR = fewer than 250 mature individuals; EN = fewer than 2500 mature individuals; VU = fewer than 10,000 mature individuals.

In the case of *Fissidens arnoldii* we take a leafy shoot as one individual. About 60–80 individuals of *Fissidens arnoldii* can be counted in a 1 cm × 1 cm square. It frequently forms about 5 cm × 5 cm patches. It means, that at one locality for example at the Deszkametsző malom near Bánd village the size of the population is more than 5,000 individuals. The total population size in Hungary at 3 localities is probably over 10,000 individuals. The species does not correspond to the above mentioned categories, but it is close to qualifying as vulnerable (VU). The species can be put into the Lower risk (LR) category, into the near threatened (nt) subcategory.

D) Very small or restricted populations: CR = fewer than 50 mature individuals; EN = fewer than 250 mature individuals; VU = fewer than 1,000 mature individuals (subcriterion D1) or an area of occupancy less than five 5 km × 5 km squares, or 4 or fewer localities (subcriterion D2).

According to this criteria our species corresponds to the vulnerable (VU) category according to the subcriterion D2.

Since always the highest IUCN category of the species has to be taken into consideration we can conclude that *Fissidens arnoldii* is an endangered (EN) species in Hungary as it is defined as endangered, EN by the criteria B (although according to criterion D it would be vulnerable, VU).

* * *

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REFERENCES

- BOROS, Á. (1915–1971): *Florisztikai jegyzetek*. [Field diaries.] – Hungarian Natural History Museum, Budapest (manuscript).
- BOROS, Á. (1953): *Magyarország mohái*. (Bryophyta Hungariae). – Akadémiai Kiadó, Budapest, 360 pp.
- BOROS, Á. (1968): *Bryogeographie und Bryoflora Ungarns*. – Akadémiai Kiadó, Budapest, 466 pp.
- CORTINI, C. and ALEFFI, M. (1993): *Lista rossa delle bryophite d'Italia*. – In: CONTI, F., MANZ, A. and PEDROTTI, F. (eds): *Libro rosso delle piante d'Italia*. World Wildlife Fund, Roma.
- DRUZHININA, O. A. (1984): Bryophytes. – In: *USSR Red data book*. Moscow, Sadki-Znamenskoye, All-Unios research institute of nature conservation and reserves, pp. 23–24.
- DÜLL, R. (1983): Distribution of the European and Macaronesian liverworts (Hepaticophytina). – *Bryologische Beiträge* 2: 1–115.
- DÜLL, R. (1984): Distribution of the European and Macaronesian mosses (Bryophytina) I. – *Bryologische Beiträge* 4: 1–109.
- DÜLL, R. (1985): Distribution of the European and Macaronesian mosses (Bryophytina) II. – *Bryologische Beiträge* 5: 110–232.
- DÜLL, R. (1992): Distribution of the European and Macaronesian mosses (Bryophytina). Annotations and progress. – *Bryologische Beiträge* 8/9: 1–223.
- ECCB (European Committee for the Conservation of Bryophytes) (1995): *Red data book of European bryophytes*. Trondheim, 291 pp.
- ERZBERGER, P. (1998): *Tortula brevissima* Schiffn. – eine für die Flora Ungarns neue Moosart. – *Bot. Közlem.* 85: 63–72.
- ERZBERGER, P. (1999): Distribution of *Dicranum viride* and *Dicranum tauricum* in Hungary. – *Studia bot. hung.* 29: 35–47.
- ERZBERGER, P. and PAPP, B. (2000): *Orthotrichum sprucei* Mont. discovered in continental Central Europe. – *Herzogia* 14: 213–215.
- GRIMS, F. (1986): Rote Liste gefährdeter Laubmoose (Musci) Österreichs. – In: NIKLFELD, H. (ed.): *Rote Liste gefährdeter Pflanzen Österreichs*. Grüne Reihe, Bundesminist. Gesundh. und Umweltschutz 5: 138–151.
- HALLINGBÄCK, T., HODGETTS, N., RAEYMAEKERS, G., SCHUMACKER, R., SÉRGIO, C., SÖDERSTRÖM, L., STEWART, N. and VAÑA, J. (1998): Guidelines for application of the revised IUCN threat categories to bryophytes. – *Lindbergia* 23: 6–12.

- IUCN (1978): *The IUCN plant red data book*. – International Union for the Conservation of Nature, Richmond.
- IUCN (1994): *IUCN red list categories*. – IUCN, Gland.
- LUDWIG, G., DÜLL, R., PHILIPPI, G., AHRENS, M., CASPARI, S., KOPERSKI, M., LÜTT, S., SCHULZ, F. and SCHWAB, G. (1996): Rote Liste der Moose (Anthoceroophyta et Bryophyta) Deutschlands. – *Schriftenreihe für Vegetationskunde* 28: 189–306.
- OCHYRA, R. (1986): *List of threatened mosses in Poland*. – In: ZAZYCKY, K. and WOJEWODA, W. (eds): *List of threatened plants in Poland*. Polska Akad. Nauk., Warsaw, pp. 117–128.
- ÓDOR, P. (2000): A Kékes Észak Erdőrezervátum mohafldrája és mohavegetációjának jellemzése. (Description of the bryoflora and bryophyte vegetation of Kékes North Forest Reserve in Mátra Mts, N Hungary.) – *Kitaibelia* 5(1): 115–123.
- ORBÁN, S. and VAJDA, L. (1983): *Magyarország mohafldrájának kézikönyve*. [The handbook of the Hungarian bryoflora.] – Akadémiai Kiadó, Budapest, 518 pp.
- PAPP, B. et RAJ CZY, M. (2000): Bryophytes of the Kiskunság National Park and the southern part of the Danube–Tisza Interfluve. – In: Lőkös, L. and Rajczy, M. (eds): *The Flora of the Kiskunság National Park. Vol. 2. Cryptogams*. Magyar Természettudományi Múzeum, Budapest, pp. 363–413.
- PAPP, B. and RAJ CZY, M. (in press): Bryophytes of saline-alkali areas of the Danube–Tisza interfluve, Hungary. – *Lindbergia*.
- RAJ CZY, M. (1990): Mohák – Bryophyta. – In: RAKONCZAI, Z. (ed.): *Vörös könyv*. Akadémiai Kiadó, Budapest, pp. 322–325.
- SÖDERSTRÖM, L. (1995): Red data listed hepatics of Scandinavia in a regional and world wide perspective – a preliminary study. – *Cryptogamica Helvetica* 18: 57–66.
- VAJDA, L. (1933–1978): *Kiránduló naplók*. [Field diaries.] – Hungarian Natural History Museum, Budapest, (manuscript).

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Appendix. List of bryophytes included in RDB and occurring in Hungary. (E = endangered; V = vulnerable; R = rare; K = insufficiently known; Bern = included in the Bern Convention.)

Hepaticae

<i>Asterella saccata</i> (Wahlenb.) Evans	V
<i>Cephalozia laciniolata</i> Jack ex Spruce	V
<i>Frullania inflata</i> Gott.	V
<i>Jungermannia subulata</i> Evans	R
<i>Lophozia ascendens</i> (Warnst.) Schust.	R
<i>Mannia triandra</i> (Scop.) Grolle	R, Bern
<i>Riccia frostii</i> Aust.	R
<i>Riccia huebeneriana</i> Lindenb.	R

Musci

<i>Aloina bifrons</i> (De Not.) Delg.	R
<i>Amblystegium saxatile</i> Schimp.	R
<i>Anacamptodon splachnoides</i> (Froel. ex Brid.) Brid.	E
<i>Anomodon rostratus</i> (Hedw.) Schimp.	R
<i>Brachydontium trichodes</i> (Web.) Milde	R
<i>Brachythecium oxycladum</i> (Brid.) Jaeg.	R
<i>Bryum neodamense</i> Itzigs. ex C. Muell.	V
<i>Bryum stirtonii</i> Schimp.	K
<i>Bryum versicolor</i> A. Br. ex B. et S.	R
<i>Bryum warneum</i> (Roehl.) Bland. ex Brid.	R
<i>Buxbaumia viridis</i> (Moug. ex Lam. et DC.) Brid. ex Moug. et Nestl.	V, Bern
<i>Campylosteleum saxicola</i> (Web. et Mohr) B., S. et G.	R
<i>Desmatodon cernuus</i> (Hueb.) B. et S.	R
<i>Dicranella humilis</i> Ruthe	R
<i>Dicranum viride</i> (Sull. et Lesq.) Lindb.	V, Bern
<i>Didymodon rigidulus</i> Hedw. var. <i>glaucus</i> (Ryan) Wijk et Marg.	V
<i>Drepanocladus vernicosus</i> (Mitt.) Warnst.	K, Bern
<i>Entosthodon hungaricus</i> (Boros) Loeske	R
<i>Ephemerum cohaerens</i> (Hedw.) Hampe	E
<i>Ephemerum recurvifolium</i> (Dicks.) Boul.	R
<i>Fissidens algarvicus</i> Solms	K
<i>Fissidens arnoldii</i> Ruthe	R
<i>Fissidens exiguus</i> Sull.	R
<i>Grimmia plagiopodia</i> Hedw.	R
<i>Grimmia sessitana</i> De Not.	R
<i>Grimmia teretinervis</i> Limpr.	V
<i>Hilpertia velenovskyi</i> (Schiffn.) Zander	R
<i>Homalothecium geheebii</i> (Milde) Wigh	R
<i>Neckera pennata</i> Hedw.	V
<i>Orthotrichum rogeri</i> Brid.	V, Bern
<i>Orthotrichum scanicum</i> Groenv.	E
<i>Orthotrichum sprucei</i> Mont.	R

<i>Orthotrichum stellatum</i> Brid.	R
<i>Phascum floerkeanum</i> Web. et Mohr	K
<i>Physcomitrium sphaericum</i> (Ludw.) Brid.	R
<i>Pterygoneurum lamellatum</i> (Lindb.) Jur.	V
<i>Pyramidula tetragona</i> (Brid.) Brid.	V, Bern
<i>Rhynchostegiella jacquinii</i> (Garov.) Limpr.	R
<i>Rhynchostegium rotundifolium</i> (Brid.) B., S. et G.	R
<i>Taxiphyllum densifolium</i> (Lindb. ex Broth.) Reim.	R
<i>Tortula brevissima</i> Schiffn.	R
<i>Weissia rostellata</i> (Brid.) Lindb.	R