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THE GENUS *BRYUM* (BRYACEAE, MUSCI) IN HUNGARY

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All available specimens of *Bryum* collected in Hungary in Hungarian herbaria (BP, EGR) and collections of the first author (B), altogether more than 2,100 specimens, were revised. The following thirty-four taxa were found to occur in Hungary: *Bryum algovicum*, *B. alpinum*, *B. archangelicum*, *B. argenteum*, *B. bimum*, *B. caespiticium*, *B. capillare*, *B. creberrimum*, *B. dichotomum*, *B. elegans*, *B. funckii*, *B. gemmiferum*, *B. gemmilucens*, *B. intermedium*, *B. klinggraeffii*, *B. kunzei*, *B. lonchocaulon*, *B. mildeanum*, *B. moravicum*, *B. neodamense*, *B. pallens*, *B. pallescens*, *B. pseudotriquetrum*, *B. radiculosum*, *B. rubens*, *B. ruderale*, *B. stirtonii*, *B. subapiculatum*, *B. torquescens*, *B. turbinatum*, *B. uliginosum*, *B. violaceum*, *B. warneum*, and *B. weigelii*. Three more taxa, i.e. *B. badium*, *B. knowltonii*, and *B. tenuisetum*, are also possibly members of the Hungarian bryoflora, but the material was insufficient in some way or other to support full verification of their presence. The following species are excluded: *B. barnesii*, *B. bornholmense*, *B. cyclophyllum*, *B. schleicheri*, *B. veronense*, and *B. versicolor.* A key, detailed descriptions, illustrations, and distribution maps are provided, with notes on habitat, associated bryophytes, and red list status.

Key words: associated bryophytes, distribution maps, habitat requirements, illustrated key, morphological descriptions, mosses, redlisted species

INTRODUCTION

Recent checklists addressed the seemingly simple question: Which species form part of the Hungarian bryophyte flora? (Erzberger and Papp 2004, Papp *et al.* 2010). The latter also evaluated the threat status of many species in the form of a red list, and was updated with some recently discovered species. However, both checklists remain provisional with respect to some difficult groups where revisionary work had not yet been completed, in spite of substantial progress in the family of Grimmiaceae (Erzberger 2009, Erzberger and Schröder 2008).

Bryum, a genus of well-known complexity, is one of the groups of species hitherto not covered by a thorough revision, and the present work attempts to fill this gap in the understanding of the Hungarian bryoflora. Boros and Vajda, the two outstanding Hungarian bryologists of the 20th century, did not themselves master this difficult genus, but relied on specimens determined or revised by the *Bryum* specialist Podpera, as research in the bryophyte collections of the Hungarian Natural History Museum in Budapest (BP) and of the Eszterházy Károly College in Eger (EGR) revealed. Since Podpera's time, there have been

substantial changes in many aspects of taxonomy and nomenclature. Hundreds of infraspecific taxa described by Podpera (1957, 1973) are no longer thought to be of taxonomic relevance, but simply illustrate the variability of species. Holyoak (2003, 2004) has made some very relevant contributions, especially by merging taxa hitherto distinguished with great effort and not always successfully: *B. imbricatum*, *B. inclinatum*, *B. stenotrichum*, *B. amblyodon*, and *B. archangelicum* are now united under the latter name, and *B. rutilans*, *B. oeneum* and *B. subelegans* have been included in *B. pallens*. *B. mamillatum* is thought to be a form of *B. warneum*; several taxa related to *B. bicolor*, e.g. *B. barnesii*, are included in *B. dichotomum*, and *B. stirtonii* in *B. elegans*. *B. versicolor* and *B. dunense* are also included in *B. dichotomum* (Holyoak 2003), but according to recent DNA studies, at least part of "*B. dunense*" may represent a taxon distinct from "*B. bicolor*" (Lockhart *et al.* 2012: 530). *B. neodamense* is considered a mere form of *B. pseudotriquetrum* (Holyoak and Hedenäs 2006). On the other hand, some taxa have been upgraded to specific rank, e.g. *B. caespiticium* var. *imbricatum* is now considered a species, *B. kunzei*, by many authors (Guerra *et al*. 2010, Hallingbäck 2008, Holyoak 2004). In some groups of particularly difficult taxa, e.g. the *B. pallescens* group, new approaches have been put forward (Zolotov 2000, Meinunger and Schröder 2007), focussing on the polyoicous *B. lonchocaulon*.

When revising genera of Grimmiaceae, it turned out that many of the chorological data in the standard treatments of the Hungarian bryoflora (Boros 1953, 1968), Orbán and Vajda (1983) had to be amended to a larger or lesser degree, because some were based on misidentified specimens. These specimens can often be located, thus allowing erroneous conclusions to be corrected, only because the bryological collections in Hungarian herbaria (BP, EGR) are nearly complete. We presumed that in the large and difficult genus *Bryum* substantial corrections are overdue more than half a century after the original determinations.

The following questions are addressed in the present study:

Which species of *Bryum* occur in Hungary?

What is their distribution within the country?

What conclusions can be drawn by comparing the results with chorological data from the literature?

In order to promote further field research in *Bryum*, which seems necessary to gain up-to-date chorological data and an improved basis for red list assessments, we tried to provide the most accurate descriptions possible with illustrations and a key for species determination. In addition to the species verified for the Hungarian bryoflora by our revision, some species that are at present not known from the Hungarian territory, but might be found there in the future, are included in our treatment of the genus.

MATERIAL AND METHODS

All specimens labelled or inserted in *Bryum* (and collected in present-day Hungary) of the herbarium of the Natural History Museum, Budapest (BP), and the herbarium of the Eszterházy Károly College in Eger (EGR), altogether nearly 1,800 specimens, were revised by both authors, except for some specimens of *B. argenteum*, *B. capillare*, and *B. moravicum*, which were seen by the first author only. In addition, the Hungarian collections (more than 350 specimens *Bryum* housed in the Botanical Museum Berlin-Dahlem – B) of the first author were also revised. The total number of localised data complemented by evaluating mixed gatherings amounts to more than 2,600. These include, however, numerous duplicates. Not all specimens could be named, because the material was sometimes incomplete or otherwise unsuitable (about 200 specimens).

In addition to specimens inserted in *Bryum*, some Hungarian specimens of *Entosthodon longicolle* (= *Funaria hungarica*) in the herbarium of the Royal Botanical Garden Edinburgh (E) and in BP were also examined, because they were reported to possibly contain additional material of the *Bryum erythrocarpum* group (Crundwell and Nyholm 1964).

Herbaria are abbreviated according to Index Herbariorum (Thiers 2008).

Illustrations of individual species were prepared using a Leitz drawing apparatus.

Distribution maps were prepared on the basis of the Central European mapping scheme (Niklfeld 1971), that has also been adopted by many recent Hungarian geobotanical works (e.g. Király 2003, Barina 2006). Open circles represent collections before 1973 (the year of Á. Boros's death), closed circles after that year. In those cases where "old" and "recent" data were available for the same grid cell, only the recent data are shown in the map (i.e. "recent" overwrites "old"). Only specimens seen by the authors were evaluated for the maps. For some specimens the collection site could not be assigned unambiguously to a grid cell. These data have been omitted in the maps.

Since the genus *Bryum* is still controversial regarding its taxonomy and nomenclature, we decided to adopt pragmatic principles. We thus prefer binomials for taxa that are treated as infraspecific by many authors, for the simple reason, that subspecies and varieties, and even more so forms, have generally been and obviously will continue to be neglected by the majority of field bryologists, as can be seen in many examples from the German bryoflora (Meinunger and Schröder 2007). We do not want to claim that these taxa are in fact good species, and there may be sound reasons for not considering them so. However, since they are still controversial, it would, in our eyes, be the wrong decision to make them "disappear" behind other species. This treatment does not aim to reflect ev-

olutionary relations, but to provide a tool for further field research, and to summarise the present state of knowledge on the distribution of *Bryum* in Hungary. Another pragmatic principle is to stick to traditional nomenclature versus the use of split genera (e.g. Holyoak and Pedersen 2007), thus avoiding many nomenclatural changes for which the basis, in our opinion, is still insufficient. For most taxa of *Bryum*, we follow the nomenclature of Hill *et al.* (2006), with the exceptions listed below (Table 1). Nomenclature of associating bryophytes mainly follows Papp *et al.* (2010), with some exceptions: *Entosthodon longicolle* (= *E. hungaricus*, *Funaria hungarica*) (Ros and Cano 2008), *Syntrichia montana* (= *Tortula crinita*), *S. ruralis* (= *T. ruralis*) (Gallego 2002), *Tortula aestiva* (= *T. muralis* var. *aestiva*) (Meinunger and Schröder 2007).

Terminology used in the key and descriptions is based on Magill (1990).

Table 1. Nomenclature of *Bryum* taxa in comparison to Hill *et al.* (2006).

Accepted name	Treatment in Hill *et al.* (2006)	Reference
Bryum badium (Brid.) Schimp.	included in *B. caespiticium* Hedw.	Ahrens (2001)
Bryum barnesii J. B. Wood ex Schimp.	included in *B. dichotomum* Hedw.	Demaret (1993)
B. bimum (Schreb.) Turner	*B. pseudotriquetrum* var. *bimum* (Schreb.) Lilj.	Nyholm (1993)
B. lonchocaulon Müll. Hal.	included in *B. pallescens* Schleich. ex Schwägr.	Zolotov (2000), Meinunger and Schröder (2007)
B. stirtonii Schimp.	included in *B. elegans* Nees	Demaret (1993)
B. versicolor A. Braun ex Bruch et Schimp.	included in *B. dichotomum* Hedw.	Demaret (1993)

Glossary

of some botanical terms used in the key and descriptions (terms are explained with reference to *Bryum*; other use of terms, e.g. with respect to liverworts, is neglected)

acumen (pl. **acumina**): a slender, tapering point
acuminate (of a leaf apex): slenderly tapered, with an angle of less than 45°; longer than acute
acute (of a leaf apex): sharp pointed, with terminal angle less than 90° but greater than 45°
amphithecium: the outer tissue of a developing capsule, which forms the outer spore sack, the peristome and the capsule wall
androecium (pl. **androecia**): antheridia and surrounding leaves (perigonium), the "male inflorescence"
antheridium (pl. **antheridia**): male gametangium; a multicellular broadly cylindrical structure containing spermatozoids
anticlinal cell walls: perpendicular to the circumference (of the capsule)
apiculus: a short, abrupt point
appendages: short transverse projections formed from horizontal wall pairs, borne on endostomial cilia

appendiculate (of cilia): with short, thin, transverse projections (see appendages; cf. nodose)
appressed to seta: a pendulous capsule that is closely applied to the seta
archegonium (pl. **archegonia**): female gametangium or sex organ; a multicellular, flask-shaped structure consisting of a stalk, venter, neck and containing an ovum
areolation: the cellular network of a leaf
autoicous: with archegonia and antheridia in separate clusters on the same plant (see synoicous, dioicous, monoicous, polyoicous)
awn: hair point, usually formed by excurrent costa
axillary: in the leaf axils
basal membrane: a short tube or cylinder supporting the segments and cilia of the endostome
bistratose: composed of two cellular layers, e.g. marginal border
bulbil: vegetative propagule; a small, deciduous, bulb-like axillary propagulum with ± developed leaf primordia (cf. gemma, brood body, tuber)
brood body: a generalised term used to denote various types of specialised vegetative reproductive structures (propagules, gemmae)
capsule: the sporangium; terminal spore-producing part of the sporophyte, differentiated into an apical operculum, central urn (spore-bearing region) and a sterile basal neck or hypophysis
cauline: of the stem
cernuous: (nodding or drooping) orientation of a capsule with its longitudinal axis intermediate between horizontal and pendulous
cilium (pl. **cilia**): endostomial cilia: the structures found singly or in groups alternating with the segments of the inner peristome
cladium (pl. **cladia**): modified regenerant branch that arises from normal shoots and detaches readily for vegetative reproductive purposes, fragile shoot
clavate, **claviform**: thickened towards the apex; club-shaped
columella: the central, sterile tissues in the sporogenous region of a capsule
comal tuft: a tuft of leaves at the tip of a stem or branch
concolorous: of uniform colour throughout; the leaf base has the same colour as the rest of the lamina (opposed to discolorous)
confluent border: leaf borders merging at leaf apex into an apiculus
costa (pl. **costae**): nerve or midrib of a leaf, always more than one cell thick
cucullate: hood-shaped, used to describe leaves strongly concave and erect or inflexed at the tips
cylindrical: elongate and circular in cross section
decurrent, **decurrency**: with basal leaf margins extending down the stem past the leaf insertion as ridges or narrow wings
dentate: with sharp teeth directed outward (see denticulate)
denticulate (of a leaf margin): finely toothed (see dentate)
dioicous: with archegonia and antherida on separate plants
discolorous: the reddish leaf base (especially in older leaves) contrasts with the green colour of the lamina (opposed to concolorous)
ellipsoidal: an oval solid
elongate: stretched out, e.g. linear
endostome, **inner peristome**: the inner circle of the *Bryum* peristome, formed from contiguous periclinal wall-pairs of the primary and inner peristomial layers (PPL and IPL); a weak membraneous structure consisting of a basal membrane bearing segments and cilia (cf. exostome)
endothecium: the inner tissue of a developing capsule which gives rise to the columella and the sporogenic tissue
entire (of a leaf margin): without teeth; ± smooth

erect: upright; (of a straight, not curved capsule) orientation with its longitudinal axis perpendicular to the horizon, with the mouth pointing towards the sky; a character state normally not occurring in *Bryum*
erectopatent: spreading at an angle of 45° or less (cf. spreading, patent)
evenly foliated: with leaves evenly spaced along stem (opposed to leaves crowded in comal tuft)
excurrent: extending beyond the apical margin; e.g. an awn formed by a protruding costa
exostome, **outer peristome**: the outer circle of the *Bryum* peristome, formed from contiguous periclinal wall-pairs of the outer and primary peristomial layers (OPL and PPL)
exothecial: with reference to the exothecium
exothecium: the outermost layer of the capsule wall, consisting of exothecial cells, the capsule epidermis
filiform acumen: leaf tip ending in a slender, elongate thread-like hair point
filiform gemmae: thread-like gemmae found in leaf axils
flaccid: soft, limp (opposed to taut, stiff)
flexuose: slightly and irregularly bent, twisted, or wavy
foliate: with leaves or leaf primordia, e.g. bulbils
gametangium: vessel bearing gametes; e.g. antheridium, archegonium
gametoecium: gametangia and surrounding leaves (see androecium, gametangium, and gynoecium)
gametophyte: the haploid sexual generation; in bryophytes the dominant generation, consisting of green, leafy plants, bearing antheridia and/or archegonia
gemma (pl. gemmae): uni- or multicellular brood bodies, filamentous or of other shape, relatively undifferentiated, serving in vegetative reproduction (cf. brood body)
gibbous: swollen or bulging on one side
gynoecium (pl. **gynoecia**): the "female inflorescence", consisting of the archegonia and the surrounding leaves (perichaetial leaves)
horizontal: orientation of a capsule with its longitudinal axis parallel with the horizon
hyaline: colourless or transparent, without chlorophyll
imbricate: closely appressed and overlapping; e.g. with the leaf margins overlapping like shingles on a roof
inclined: orientation of a capsule intermediate between erect (upright) and horizontal, i.e. at an angle to the vertical of *ca* 20–60°
incrassate: thickened or with thickened cell walls
incurved: (of leaf margin) curved upward (adaxially) and inward (opposed to recurved); (of leaf primordia) curved inward (toward centre of bulbil)
insertion: (of the leaf) the point, where the base of the leaf is attached to the stem
julaceous: smoothly cylindrical; like a catkin, referring to stems or branches with strongly imbricate leaves
lamina (pl. **laminae**): the flattened, generally unistratose and green part of the leaf blade excluding the costa and border
laminal cell: cell of a lamina (see areolation)
lanceolate: lance-shaped, narrow and tapered from near the base; narrowly ovate-acuminate
leaf primordia: the beginning of a leaf in its earliest stage of differentiation, e.g. on bulbils
lid: see operculum
mamilla: a blunt central projection on the lid of a capsule
marginal: at the margin, especially as applied to a leaf
monoicous: bisexual; with antheridia and archegonia on the same plant, including autoicous, synoicous, and polyoicous (opposed to dioicous)
nodose: of endostomial cilia with short knob-like thickenings (cf. appendiculate)

oblique cross-walls: short skew connections between the horizontal lamellae on the inner face of exostome teeth
oblong: rectangular with rounded corners or ends
obovate: egg-shaped with apex broader than base
obtuse (of a leaf apex): blunt or rounded
operculum: the lid covering the mouth of a capsule
orbicular: nearly circular
ovate: outline of an egg with base broader than apex
patent: of leaves spreading from stem at an angle of 45° or more
pendulous: (hanging downward) orientation of a capsule with its longitudinal axis perpendicular to the horizon, the mouth directed downward, towards the ground
percurrent: extending to the apex
perichaetial leaves: the innermost leaves of a comal tuft with archegonia
perichaetium (pl. **perichaetia**): the gynoecium; strictly the ensheathing cluster of modified leaves enclosing the archegonia
periclinal cell walls: parallel to the circumference of the capsule
perigonial leaves: the innermost leaves of a comal tuft with antheridia
perigonium (pl. **perigonia**): the androecium; strictly the cluster of modified leaves enclosing the antheridia
peristome: a circular structure, in *Bryum* divided into 2 ×16 teeth, arranged in a double row around the mouth of a capsule; (see endostome, exostome)
pluristratose: (of a leaf border) consisting of several layers
polyoicous: with several forms of gametoecia on the same plant
process: (also called segment) the main divisions of the endostome, alternating with the exostome teeth
propagule (**propagulum**): reduced bud, branch or leaf serving in vegetative reproduction (syn. diaspora, see brood body)
protuberant: bulging
pyriform: pear-shaped
recurved (of leaf margin): curved downward (abaxially) and outward (opposed to incurved)
reduced: simplified during development, not fully developed, e.g. cilia with short appendages (cf. rudimentary)
reticulate: a pattern like a network
revolute (of leaf margin): rolled downward (abaxially) and backward (opposed to involute)
rhizoid: hair-like structure that functions in absorption and anchorage; usually brown to reddish, simple or branched, multicellular filaments, generally with oblique end-walls (see tomentum)
rhizoidal tubers: gemmae borne on rhizoids
rudimentary: incompletely developed, vestigial (cf. reduced)
segment: see process
serrate: saw-toothed; with marginal teeth pointing forward (towards apex)
serrulate: minutely serrate
seta (pl. **setae**): elongated portion of the sporophyte between the capsule and foot
spathulate: tapering proximally from a broad, rounded apex
spore: a reproductive unit produced in a capsule as a result of meiosis; usually minute, mostly spherical and generally unicellular bodies that give rise on germination to a protonema
sporophyte: the spore-bearing generation; initiated by the fertilisation of an egg; remaining attached to the gametophyte and partially dependent on it; typically consisting of foot, seta and capsule
spreading: forming an angle of 45° or more; e.g. the adaxial angle between leaf and stem

stratose: in layers; e.g. denoting thickness of leaf border; i.e. uni-, bi-, multistratose
synoicous: with antheridia and archegonia mixed in the same gametoecium
tomentum (pl. **tomenta**): a felt-like covering of abundant rhizoids, on some stems, e.g. in *B. pseudotriquetrum*
tuber: gemmae borne on rhizoids (rhizoidal tubers)
tumid: inflated, swollen
turbinate: shaped like an old-fashioned spinning top, obconic; turbinate capsules are strongly contracted below a wide mouth
unistratose: one-layered; comprised of a single cell layer (cf. stratose, bistratose, multistratose)
vegetative propagules: see gemmae, brood bodies
ventricose: bulging on one side below (like a stomach)
verrucose: covered with small wart-like elevations

Selected taxonomic characters

In this section we sum up the possible states of some taxonomically relevant characters, including some advice concerning methods of preparation etc. The arrangement is as in the species accounts.

Sexual condition

To assess the sexual condition, one of the key characters in *Bryum*, it is generally necessary to examine several plants carefully. It is usually not difficult to establish the synoicous condition (antheridia and archegonia within one perichaetium) by examining a sufficiently well-developed comal tuft or the base of a seta, where archegonia and antheridia will be found together. Care must be taken to properly identify antheridia; remnants of removed leaves may resemble antheridia! Young archegonia can also look like antheridia, when they are still rounded at the top and have not yet developed the long neck with the gaping mouth. Normally, antheridia are shorter than archegonia. Antheridia are often sparse in synoicous inflorescences and may readily be lost. Many species can have a variable sexual condition; therefore it is necessary to examine several plants. In order to assess the dioicous condition it is desirable to find male plants with purely male inflorescences (androecia), and not to rely only on the absence of male organs in several gynoecia examined. In autoicous plants, the main comal tuft is normally female, while on the same plant lateral shoots have androecia. Again, it is wise to examine several plants, as when trying to establish the polyoicous condition, where the main shoot normally has mixed sexuality and the side shoots are usually male.

Synoicous: *B. algovicum*, *B. archangelicum*, *B. bimum*, *B. bornholmense*, *B. creberrimum*, *B. intermedium*, *B. knowltonii*, *B. longisetum*, *B. tenuisetum*, *B. torquescens*; (rarely *B. pallescens*).

Autoicous: *B. bornholmense*, *B. pallescens*, *B. uliginosum*, *B. warneum*; rarely *B. algovicum*, *B. archangelicum*, *B. creberrimum* (according to DEMARET 1993).

Polyoicous: *B. lonchocaulon*, sometimes *B. algovicum*, *B. archangelicum*, *B. knowltonii*, *B. longisetum*.

Dioicous: all other species, but sometimes also *B. algovicum*, *B. bornholmense*.

Frequency of sporophytes

Sporophytes generally occur more often in monoicous taxa, but can also be frequent in some dioicous species (e.g. *B. caespiticium*): **unknown**: *B. demaretianum*; **rare**: *B. alpinum*, *B. cyclophyllum*, *B. elegans*, *B. funckii*, *B. gemmilucens*, *B. gemmiparum*, *B. kunzei*, *B. mildeanum*, *B. neodamense*, *B. radiculosum*, *B. ruderale*, *B. stirtonii*, *B. subapiculatum*, *B. violaceum*, *B. weigelii*; **not infrequent, occasional**: *B. barnesii*, *B. blindii*, *B. bornholmense*, *B. gemmiferum*, *B. klinggraeffii*, *B. moravicum*, *B. pallens*, *B. pseudotriquetrum*, *B. rubens*, *B. schleicheri*, *B. tenuisetum*, *B. turbinatum*; **frequent**: *B. argenteum*, *B. badium*, *B. caespiticium*, *B. capillare*, *B. dichotomum*, *B. donianum*, *B. knowltonii*, *B. torquescens*, *B. versicolor*; **(nearly) always present**: *B. algovicum*, *B. archangelicum*, *B. bimum*, *B. creberrimum*, *B. intermedium*, *B. lonchocaulon*, *B. longisetum*, *B. pallescens*, *B. uliginosum*, *B. warneum*.

Plants, gametophyte

Size

Overall size refers to the gametophyte only, i.e. without seta and capsule. Some species can grow to form tufts or turfs more than 4 cm tall if conditions are suitable. These include *B. alpinum*, *B. bimum*, *B. cyclophyllum*, *B. neodamense*, *B. pallescens*, *B. pseudotriquetrum*, *B. schleicheri*, *B. weigelii*. (Some of these species have typically a soft to flaccid consistency: *B. cyclophyllum*, *B. neodamense*, *B. weigelii*). Most species do not reach this size and grow only 1–2 cm high.

Growth form: solitary/tufts, dense/lax. Some species characteristically form dense tufts, the stems often interwoven with rhizoids, e.g. *B. kunzei*, *B. radiculosum*, sometimes *B. caespiticium*.

Colour

Some species exhibit a characteristic colour: silvery white: *B. argenteum*, *B. funckii*; whitish green to golden: *B. blindii;* red: *B. pallens* (often only pinkish), *B. turbinatum*, (*B. warneum*), sometimes *B. capillare*; flesh-coloured to pink: *B. weigelii*; dark red, often variegated green-golden-red with metallic sheen: *B. alpinum*; light yellowish (to brownish) green with mother-of-pearl sheen: *B. mildeanum*; green with red-brown rhizoid felt: *B. pseudotriquetrum*. A red tinge can often be

observed in *B. bimum*, *B. klinggraeffii*, *B. pseudotriquetrum*, *B. rubens*, *B. ruderale*, *B. subapiculatum*, *B. torquescens*, *B. tenuisetum*. Most species are yellow green.

Rhizoids

Rhizoids in most species are more or less brown, sometimes also yellowish; in some species, however, they exhibit a ± strong violet colour: *B. ruderale*, *B. violaceum*. Some species have conspicuously papillose rhizoids: *B. blindii*, *B. donianum*, *B. elegans*, *B. funckii*, *B. knowltonii* (strongly papillose), *B. longisetum* (coarsely papillose), *B. radiculosum* (older rhizoids strongly papillose), *B. ruderale* (coarsely papillose), *B. stirtonii* (coarsely papillose in older rhizoids), *B. torquescens*, *B. turbinatum* (papillose-verrucose), *B. warneum* (coarsely papillose), but this character may be variable and depend on the age of the rhizoids. The finely papillose character state is the most common among species of *Bryum*.

Vegetative propagules

Many species have specialised vegetative propagules. These are often sparse in fruiting plants.

Rhizoidal tubers are found in the species of the *B. erythrocarpum* complex (*B. bornholmense*, *B. demaretianum*, *B. klinggraeffii*, *B. radiculosum*, *B. rubens*, *B. ruderale*, *B. subapiculatum*, *B. tenuisetum*, *B. violaceum*), but also ± regularly in other species, e.g. *B. alpinum*, *B. torquescens*, *B. dichotomum*, *B. capillare;* in the literature also reported from *B. moravicum* (Crundwell in Hill *et al.* 1994), *B. caespiticium* (Nyholm 1993, Crundwell in Hill *et al.* 1994, possibly based on misidentifications: Lockhart *et al.* 2012), *B. barnesii* (Demaret 1993), *B. elegans* (Crundwell in Hill *et al.* 1994), *B. gemmiferum* (Demaret 1993; Wigginton in Hill *et al.* 1994: 118 – only in culture?), *B. gemmiparum* (Crundwell in Hill *et al.* 1994, possibly based on misidentifications: Lockhart *et al.* 2012). Important features of rhizoidal tubers are:

– **size**: *B. violaceum* and *B. klinggraeffii* have tubers < 120 μm; they are also small in *B. demaretianum* (100–150 μm). Particularly large tubers are found in *B. bornholmense* (to 450 μm), *B. subapiculatum* (to 300 μm), *B. torquescens* (to 280 μm), *B. capillare* (to 300 μm), and others.

– **shape of tuber cells**: Most tubers have non-protruding cells, giving the tuber a smooth outline. However, the tubers of *B. rubens* and *B. klinggraeffii* have distinctly bulging cells, making the tuber appear somewhat similar to a raspberry. Tubers must be well-soaked when examining this character, since dry or insufficiently rehydrated tubers with smooth, non-bulging cells may otherwise appear to have protuberant cells.

– **colour**: *B. demaretianum*, *B. tenuisetum* and *B. violaceum* have yellow (to orange) tubers, whereas in most species tubers are orange to red to brown. However, yellow (to orange) tubers have also been observed in *B. dichotomum* and *B. subapiculatum* (Lockhart *et al.* 2012). Tuber colour varies according to age, e.g. in *B. rubens* tubers are light pale green in spring, become orange later and are ruby when ripe.

– **position**: *B. rubens* is the only species with tubers often near the stem, even in leaf axils, but again this can vary according to the season: in autumn they are mostly found far from the plants at rhizoids in the soil. In *B. demaretianum*, *B. klinggraeffii*, *B. violaceum*, and *B. tenuisetum*, tubers are numerous at rhizoids not far from the stem basis, but never axillary. In *B. demaretianum*, tubers are usually in clusters of (1–)2–5.

Filiform gemmae are multicellular thread-like structures produced in the leaf axils in *B. moravicum*, *B. pallens* (f. *oeneum*, f. *rutilans)*, *B. pseudotriquetrum*, and rarely *B. bimum* (also in *B. cyclophyllum* and *B. donianum*), and very rarely and sparsely also in other species (*B. caespiticium*: BP 118692). They are not to be confused with rhizoids. Rhizoids have oblique cross-walls, whereas in filiform gemmae as in protonema the cross-walls are at right angles to the thread axis.

Bulbils (brood bodies with ± developed leaf primordia) are characteristic of *B. argenteum*, *B. barnesii*, *B. blindii*, *B. dichotomum*, *B. gemmiferum*, *B. gemmilucens*, *B. gemmiparum*, *B. versicolor*. Important features of bulbils are:

– **size** (numerical values of bulbil length): the largest bulbils are found in *B. gemmiparum* (200–700 μm), *B. versicolor* (to 500–600 μm), *B. blindii* (500–600 (–800) μm), *B. dichotomum* (200–500 μm), *B. argenteum* (to 700 μm); bulbils are particularly small in *B. gemmilucens* (150–250(–300) μm), and *B. gemmiferum* (75–150(–550) μm). In *B. barnesii*, bulbils are 100–250(–600) μm long. This is obviously correlated with their:

– **number per leaf axil**: usually solitary in *B. argenteum*, *B. gemmiparum*, *B. versicolor*, 1–3 per leaf axil in *B. dichotomum*, 3–10(–15) per leaf axil in *B. barnesii*, mostly 5 in *B. gemmilucens*, and up to 30 in *B. gemmiferum*. However, the size of bulbils increases with age, and their number per leaf axils decreases, until they are solitary in all species;

– **insertion and development of leaf primordia**: leaf primordia are inserted from the base to the top of the bulbils in *B. dichotomum*; they are found at the top only in *B. gemmiferum*, and they are hardly developed or lacking in *B. gemmilucens*.

Other propagules: *B. mildeanum* produces fragile branches (cladia) that break off and, after falling from leaf axils, round off and become turnip-like at their base.

Leaves

Whenever a comal tuft is developed, the leaf characters must be observed in the largest leaves of the comal tuft; the leaves below at the stem, leaves on innovations and perichaetial and perigonial leaves (the innermost leaves of a comal tuft) can differ greatly. Great caution is necessary when depauperate plants are at hand, because some characters may not be developed (e.g. the marginal border is not visible in depauperate plants of *B. bornholmense* or *B. rubens*).

Leaf arrangement

Most species (*B. algovicum*, *B. archangelicum*, *B. bornholmense*, *B. creberrimum*, *B. lonchocaulon*, *B. pallescens*, *B. rubens*, *B. ruderale*, *B. turbinatum*, *B. warneum*) develop a comal tuft when fertile, with usually narrow perichaetial leaves around the seta, surrounded by larger comal leaves, which normally best show the leaf characteristics of a species, and therefore these are the leaves that should be studied. Even non-fruiting plants may develop a comal tuft in which antheridia/archegonia can be found. Some species, however, most often have their leaves evenly spaced along the stem. These include *B. alpinum*, *B. argenteum*, *B. barnesii*, *B. bimum*, *B. cyclophyllum*, *B. demaretianum*, *B. dichotomum*, *B. elegans* (can grow bud-like as well), *B. gemmilucens*, *B. gemmiparum*, *B. klinggraeffii*, *B. mildeanum*, *B. neodamense*, *B. pallens*, *B. pseudotriquetrum*, *B. radiculosum*, *B. schleicheri*, *B. stirtonii*, *B. tenuisetum*, *B. weigelii.*

Leaf shape

In some species, leaves are characteristically shaped when dry: they are twisted around the stem in *B. capillare*; similarly, but usually to a lesser extent, in *B. torquescens*; in *B. moravicum* (and similarly in *B. donianum*) leaves are twisted around their own axes rather than around the stem. In most species, the dry leaves are slightly flexuose to sometimes slightly twisted.

Leaves are imbricate when dry in *B. alpinum*, *B. argenteum*, *B. blindii*, *B. elegans*, *B. funckii*, *B. gemmiferum*, *B. gemmiparum*, *B. kunzei*, *B. mildeanum*, *B. stirtonii*, *B. warneum* (loosely imbricate). In most species, the leaves are ± ovate, ovate-lanceolate, obovate, or triangular (see illustrations of individual species). Some particular features are: margins parallel in lower part: *B. alpinum*, *B. blindii*, *B. gemmiparum*; leaves widest at or above middle: *B. capillare*, *B. moravicum*, *B. torquescens*, *B. elegans*, *B. donianum*; strongly concave leaves occur in *B. funckii*, *B. neodamense*, to a lesser extent also in *B. kunzei*; leaf ending in an apiculus, which either consists of the excurrent costa (in most species), or in some species is formed mainly by the confluent border cells (e.g. in *B. argenteum* f. *lanatum*, in

some leaves of *B. capillare*, *B. elegans*, *B. moravicum*); leaf without apiculus, i.e. apex broadly acute to obtuse or rounded: *B. blindii*, *B. cyclophyllum* (rounded), *B. schleicheri*, *B. weigelii*, *B. neodamense*; shortly excurrent costa: *B. knowltonii*.

Leaf base

Most species have discolorous leaves, i.e. the reddish leaf base (especially in older leaves) contrasts with the green colour of the lamina; some species (sect. Amblyophyllum: *B. warneum*, *B. uliginosum*, *B. pallens*, *B. turbinatum*, *B. weigelii*, *B. schleicheri*, *B. cyclophyllum*), however, have concolorous leaves, i.e. the leaf base is of the same colour as the rest of the lamina, usually green, but leaf base and lamina are usually red in *B. pallens* and *B. turbinatum*. In *B. schleicheri*, the leaf base may be pinkish in contrast to the lamina.

Margin

In most species, the margin is entire below and ± denticulate towards the leaf apex, but this may vary within wide limits. It is conspicuously denticulate in the upper third of leaves of *B. tenuisetum*, *B. bornholmense* and *B. torquescens* (in the latter two to a lesser extent). The following species usually have an entire leaf margin: *B. argenteum*, *B. badium*, *B. blindii*, *B. cyclophyllum*, *B. dichotomum*, *B. funckii*, *B. gemmiferum*, *B. gemmilucens*, *B. gemmiparum*, *B. kunzei*, *B. mildeanum*, *B. neodamense*, *B. schleicheri*, *B. stirtonii*, *B. uliginosum*, *B. versicolor.*

The margin is plane or recurved in a variable way in most species. Species with a plane margin (but mostly slightly recurved in the lower part) include *B. argenteum*, *B. blindii*, *B. cyclophyllum*, *B. elegans*, *B. funckii*, *B. kunzei*, *B. neodamense*, *B. subapiculatum*, *B. turbinatum*, *B. weigelii*. The margin is ± conspicuously recurved in *B. algovicum*, *B. archangelicum*, *B. bimum*, *B. caespiticium*, *B. creberrimum*, *B. intermedium*, *B. knowltonii*, *B. lonchocaulon*, *B. longisetum*, *B. mildeanum*, *B. pallens*, *B. pallescens*, *B. pseudotriquetrum*, *B. radiculosum*, *B. uliginosum*, *B. versicolor*, *B. violaceum*.

Decurrency

Leaves are strongly decurrent in *B. weigelii*, *B. pseudotriquetrum*, *B. bimum*, *B. schleicheri*; weakly decurrent in *B. neodamense*, *B. turbinatum*, narrowly decurrent in *B. pallens;* decurrent in *B. stirtonii*; a short decurrency is observed in well-developed leaves of *B. violaceum;* leaves are shortly decurrent in *B. cyclophyllum*; very shortly decurrent in *B. knowltonii;* sometimes slightly decurrent in *B. donianum*. All other species have a non-decurrent leaf base, in particular *B. elegans*, *B. funckii*, *B. gemmilucens*, *B. intermedium*, *B. kunzei*.

Costa

The costa is particularly stout in *B. donianum* (100–150 μm thick at leaf base), *B. pseudotriquetrum* (to 140 μm wide at leaf base), *B. funckii* (to 100 μm thick at insertion), *B. bornholmense* (65–100 μm wide at leaf base), *B. gemmiparum* (to 100 μm wide at leaf base), *B. violaceum* (to 100 μm wide at leaf base), *B. pallens*, *B. stirtonii* (to > 100 μm wide at leaf base), *B. tenuisetum* (to 100 μm at leaf base), *B. turbinatum*, *B. alpinum* (to 80 μm wide at leaf base), *B. demaretianum* (60–80 μm wide at mid-leaf). The costa is rather thin in *B. argenteum*, *B. cyclophyllum*, *B. weigelii*. The costa ends below or in the leaf apex in *B. argenteum*, *B. cyclophyllum*, *B. gemmilucens*, *B. gemmiparum*, *B. neodamense*, *B. schleicheri*, *B. weigelii.*

In most species it is percurrent or excurrent into a short (rarely in *B. knowltonii*) or long apiculus, which can be smooth or denticulate (*B. mildeanum*) to dentate (e.g. *B. badium*). Dependent on these characters, the plants may appear taut (e.g. in *B. alpinum*, *B. badium*, *B. bimum*, *B. demaretianum*, *B. gemmiparum*, *B. lonchocaulon*, *B. mildeanum*, *B. pallescens*, *B. pseudotriquetrum*, *B. radiculosum*, *B. ruderale*, *B. subapiculatum*, *B. tenuisetum*, *B. turbinatum*, *B. versicolor*, *B. violaceum*) or soft (*B. caespiticium*) and flaccid (*B. weigelii*, *B. cyclophyllum*).

Laminal cells

Cell size (length × width) usually refers to median cells at mid leaf unless stated otherwise. These numerical values can vary within wide limits and should therefore not be overestimated.

Especially wide laminal cells are found in *B. weigelii*; in *B. alpinum*, they are rather narrow and incrassate.

Border

The leaf border is differentiated if the marginal cells are longer, narrower and more incrassate in ± strong contrast to the adjacent laminal cells. The border is distinct in *B. algovicum*, *B. archangelicum*, *B. bimum*, *B. bornholmense*, *B. capillare*, *B. creberrimum*, *B. donianum*, *B. lonchocaulon*, *B. longisetum*, *B. moravicum*, *B. neodamense*, *B. pallens*, *B. pallescens*, *B. pseudotriquetrum*, *B. schleicheri*, *B. rubens*, *B. torquescens*, *B. uliginosum*, *B. warneum*, *B. weigelii.*

Although partly bistratose, the border is very narrow and therefore inconspicuous in *B. turbinatum*, similarly in *B. cyclophyllum*. The border is rather indistinct in the species of the *B. erythrocarpum* group (*B. demaretianum*, *klinggraeffii*, *B. radiculosum*, *B. ruderale*, *B. subapiculatum*, *B. tenuisetum*, *B. violaceum*), except *B. bornholmense* and *B. rubens*. Other species with an indistinct border include *B. alpinum*, *B. argenteum*, *B. badium*, *B. barnesii*, *B. caespiticium*, *B. cyclophyllum*,

B. dichotomum, *B. elegans*, *B. funckii*, *B. gemmiferum*, *B. gemmilucens*, *B. gemmiparum*, *B. intermedium*, *B. knowltonii*, *B. mildeanum*, *B. stirtonii*, *B. versicolor.* The border is practically not differentiated in *B. funckii* and *B. kunzei*.

The leaf margin is regularly pluristratose in *B. donianum* and partially bistratose in sect. Amblyophyllum: *Bryum warneum*, *B. uliginosum*, *B. pallens*, *B. turbinatum*, *B. schleicheri*, *B. weigelii*, *B. cyclophyllum.* All other species have unistratose margins.

Since the margin is recurved in many species, a bistratose margin usually cannot be observed in surface view in the microscope, making it necessary to prepare leaf cross sections. This is easily achieved by placing a well soaked plant on a slide, removing excess water with a tissue, and making numerous cuts with a razor blade, using a needle as support. Some of the many sections obtained this way will usually be appropriate to show whether the margin is uni- or pluristratose. However, in *B. turbinatum* and *B. warneum*, it can be hard to find a bistratose spot. On the other hand, cross sections that are not easy to interpret (bistratose or very narrowly recurved – compare Fig. 8C*) rarely are observed in some species with usually unistratose margins.

Sporophyte

Seta

An exceptionally long seta is found in *B. longisetum* (6–10 cm). Most species have setae up to 3 cm or less. Occasionally longer setae are found in *B. archangelicum* (to 4 cm), *B. bimum* (to 5 cm), *B. bornholmense* (to 4 cm), *B. caespiticium* (to 5 cm), *B. creberrimum* (to 6 cm), *B. funckii* (to 4 cm), *B. knowltonii* (to 4.5 cm), *B. lonchocaulon* (to 4 cm), *B. neodamense* (to 4 cm), *B. pallens* (to 4 cm), *B. pallescens* (to 6 cm), *B. pseudotriquetrum* (to 8 cm), *B. schleicheri* (to 6 cm), *B. torquescens* (to 4 cm), *B. turbinatum* (to 4 cm), *B. uliginosum* (to 5 cm), *B. warneum* (to 6 cm), *B. weigelii* (to 6 cm). In higher mountains shorter setae are often found (e.g. to 1 cm in *B. algovicum*, 0.5 to 1 cm in *B. archangelicum*).

Capsule orientation

Capsule orientation can assume the following character states (see Fig. 1): erect (not observed in species of *Bryum*), inclined, horizontal, cernuous, and pendulous.

Most species have cernuous to pendulous capsules, notable exceptions are *B. pallescens* (rarely also *B. uliginosum* and *B. capillare*) with inclined to horizontal (to cernuous) capsules. Here the capsule mouth points upwards obliquely due to a torsion of the upper part of the seta. Another remarkable character state is

observed in *B. versicolor* (and also in *B. blindii*) where the pendulous capsule is closely appressed to the seta.

Although in *Bryum* the capsule mouth usually points downwards, when describing parts of a capsule, the mouth is thought of as pointing upwards, e.g. in descriptions of exothecial cells "below" the capsule mouth.

Capsule size

Particularly long capsules are found in the *B. capillare* complex: *B. capillare*, *B. moravicum*, *B. torquescens*, *B. donianum*, and in some other species (to 5 mm long): *B. algovicum*, *B. bimum*, *B. creberrimum*, *B. intermedium*, *B. pallescens*, *B. schleicheri*, *B. uliginosum*. Capsules are particularly small in *B. klinggraeffii* (1–1.5 mm long), *B. knowltonii* (1.5–2.5(–3.5) mm long), *B. argenteum* (1–2.5 mm long), *B. dichotomum* (to 2 mm long).

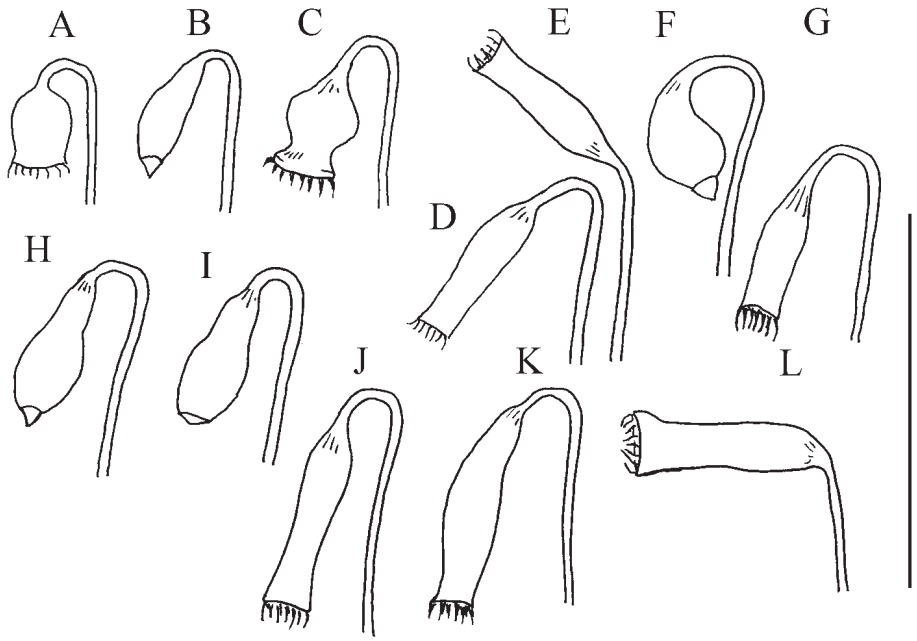

Fig. 1. Capsules (A = *Bryum dichotomum*, capsule pendulous; B = *B. intermedium*, capsule cernuous, curved, gibbous, narrow-mouthed; C = *B. schleicheri*, capsule cernuous, turbinate; D = *B. pallescens*, capsule cernuous; E = *B. pallescens*, capsule inclined; F = *B. pallens*, capsule cernuous, pyriform, asymmetric; G = *B. creberrimum*, capsule cernuous; H = *B. algovicum*, capsule cernuous, lid conical with acute mamilla; I = *B. archangelicum*, capsule cernuous, lid flat; J = *B. capillare*, capsule cernuous, straight; K = *B. capillare*, capsule cernuous, slightly curved; L = *B. capillare*, capsule horizontal. Scale bar: *ca* 8 mm, del. Schröder).

Capsule shape

In most species of *Bryum*, the capsule is ± pyriform (pear-shaped). The capsule is ± cylindrical in the *B. capillare* complex: *B. capillare*, *B. moravicum*, *B. torquescens*, to a lesser extent in *B. elegans.* A rather narrow and elongate capsule is also found in sect. Bryum subsect. Pseudotriquetra: *B. bimum*, *B. pseudotriquetrum*, *B. creberrimum*, *B. lonchocaulon*, and *B. pallescens*. In addition, *B. intermedium*, *B. pallens*, *B. radiculosum*, *B. rubens*, *B. subapiculatum*, *B. uliginosum* have elongate-pyriform capsules. The capsule is ± ovate and rather short and thick, with a short and thick neck, in *B. argenteum*, *B. blindii*, *B. dichotomum*, *B. versicolor.* It is shortly pyriform (but less apruptly narrowed into the seta) in *B. knowltonii*, *B. turbinatum*, *B. warneum*.

Capsule turbinate when dry and empty, i.e. (strongly) contracted below mouth: *B. funckii*, *B. klinggraeffii*, *B. schleicheri*, *B. turbinatum*. A slight contraction below the mouth can be observed in capsules of many species at a certain stage of ripening, e.g. in *B. argenteum*, *B. badium*, *B. caespiticium*, *B. gemmiferum*, *B. knowltonii*, *B. pseudotriquetrum*, *B. weigelii.* Capsule curved (slightly asymmetric): *B. intermedium* (gibbous), *B. capillare* and *B. moravicum* (sometimes slightly curved), *B. pallens* (strongly asymmetric), *B. radiculosum* (often curved), *B. rubens* (slightly curved), *B. uliginosum* (slightly), *B. longisetum* (ventricose).

Capsule mouth

According to Holyoak (2004) the size of the capsule mouth may be correlated with other capsule characters such as capsule shape, exothecial cell characters, shape of the lid, length of exostome teeth and development of cross-walls in exostome teeth. The capsule mouth is narrow in: *B. algovicum*, *B. archangelicum*, *B. funckii*, *B. intermedium*, *B. knowltonii* (when still operculate), *B. longisetum*, *B. pallens*, *B. radiculosum*, *B. uliginosum*, *B. warneum*. A wide capsule mouth is found in: *B. alpinum*, *B. badium*, *B. bimum*, *B. caespiticium*, *B. capillare*, *B. creberrimum*, *B. cyclophyllum*, *B. donianum*, *B. elegans*, *B. lonchocaulon*, *B. knowltonii* (when empty), *B. pallescens*, *B. pseudotriquetrum*, *B. rubens*, *B. versicolor*.

Colour

In some species, the capsule becomes very dark, almost blackish, when old: *B. argenteum*, *B. dichotomum*, *B. intermedium*, *B. weigelii*, it becomes only dark brown in *B. warneum*. Various shades of red are seen in capsules of *B. alpinum* (dark red), *B. argenteum* (when young), *B. badium*, *B. dichotomum*, *B. klinggraeffii*, *B. radiculosum*, *B. subapiculatum*, *B. tenuisetum* (dark purple), *B. torquescens* (dark red). Red-brown capsules are found in *B. blindii*, *B. pseudotriquetrum*, *B.*

violaceum, *B. donianum* (brown to red-brown), *B. tenuisetum* (red to red brown). Capsules are brown in *B. algovicum*, *B. archangelicum*, *B. bornholmense*, *B. caespiticium*, *B. capillare*, *B. creberrimum*, *B. lonchocaulon*, *B. argenteum* (light brown when ripe), *B. schleicheri*, *B. versicolor*, *B. turbinatum* (light to dark brown), *B. cyclophyllum* (yellow to pale brownish).

Lid (operculum)

Most species have a convex to conical capsule lid with a ± acute mamilla. The lid is flat in *B. archangelicum*. This character may vary to a certain extent, which led Holyoak (2004) to include *B. mamillatum* Lindb. (capsule with wide mouth and low convex lid) in the synonymy of *B. warneum* (with narrow mouth and conical lid).

Peristome development
(Fig. 2)

The double peristome of *Bryum* is a complicated structure of high taxonomic significance. It is helpful to understand how it is formed in the developing sporophyte. The sporophyte tissue consists of an inner and an outer part: the endothecium (the inner tissue which gives rise to the columella and the sporogenic

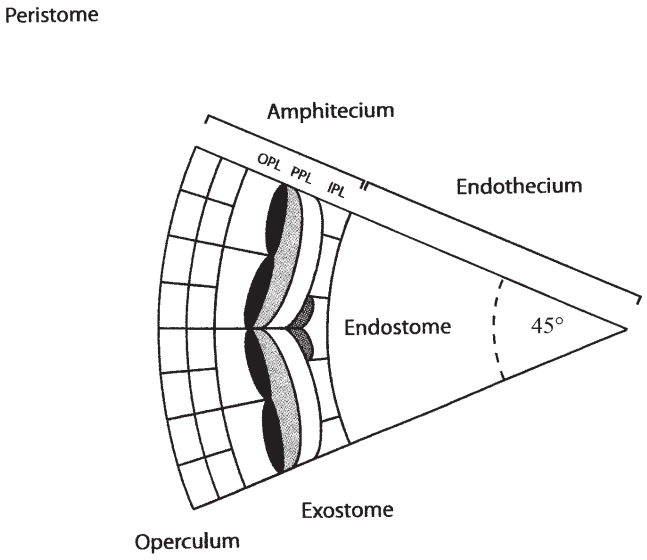

Fig. 2. Peristome development. Schematic cross section of young sporophyte (after Kungu *et al.* 2007).

tissue) and the five layers of the amphithecium (the outer tissue which forms the outer spore sack, the peristome and the capsule wall). The three innermost cell layers of the amphithecium form the peristome; they are therefore called OPL (outer peristomial layer), PPL (primary peristomial layer) and IPL (inner peristomial layer). The periclinal (parallel to the circumference of the capsule) cell walls of the OPL and the PPL together form the outer peristome or exostome, while the inner peristome or endostome is formed at the junctures of the PPL and the IPL. The cells and most of the cell walls of the peristome forming tissues are then resorbed, the exostome and endostome consist of the cell walls that remain. In the cross section of a developing capsule 32 cells of the OPL, and 16 cells of the PPL are visible. Therefore, the outer face of an exostome tooth is formed by 2 perpendicular columns of cells, whereas the inner face consists of the periclinal walls of 1 cell column. On the outside of an exostome tooth, the remainders of anticlinal (perpendicular to the circumference of the capsule) cell walls of the OPL are visible. Selective resorption of parts of periclinal and anticlinal cell walls of the PPL and IPL gives rise to the different parts of the endostome: the segments or processes, with perforations along the keeled midline, situated between the exostome teeth, and cilia, standing opposed to the exostome teeth. The cilia including their appendages are remnants of anticlinal cell walls that have been resorbed to a lesser or greater extent, resulting in appendiculate, nodose or rudimentary cilia, respectively.

The examination of peristomial characters is preferably done on capsules that still have their lid, because once the lid is shed, the peristome being a fragile structure is easily damaged; in particular it can be hard to decide whether endostome cilia are rudimentary or have been broken off. Before cutting the capsule, it should be well soaked, either for several hours in water (addition of detergent is helpful), or by boiling for some seconds in a drop of water under a cover slip on a slide using a commercial cigarette lighter. If the lid is still firmly attached after this procedure, short boiling in 2% KOH solution is recommended. The capsule should then be cut transversely at about 1/3 of capsule length below the mouth, the bulk of spores should be removed carefully, and by a subsequent longitudinal cut two pieces of capsule mouth with peristome will be obtained. Placing one with the outer side and the other with the inner side on top enables a quick examination of outer and inner peristome structures. Getting rid of excess spores may be a problem, since these may obscure features especially of the endostome. Very careful use of a soft (!) paintbrush may help, but even so cilia may be broken! Examination of recently deoperculate capsules that have already lost most of their spores avoids this problem.

It is important to distinguish the outer and inner surface of the exostome by differential focussing. On the outer surface, remnants of anticlinal cell walls of

the OPL (outer peristomial layer) can be observed, they usually form a zig-zag pattern in the lower part of the exostome tooth. On the inner surface, on the other hand, the remnants of anticlinal walls of the PPL (primary peristomial layer) can be seen in the form of horizontal lamellae, sometimes also called trabeculae.

Exostome

An exostome with cross-walls is observed in *B. algovicum* and *B. warneum*. In these species, the (basal part of the) exostome tooth appears blurred due to the attached endostome, and oblique cross-walls are numerous, giving rise to a reticulate structure. In some other species (e.g. *B. pseudotriquetrum*, *B. schleicheri*, *B. weigelii*) a few single cross-walls may rarely connect lamellae, but these appear clear-cut, not blurred, and never form a reticulate structure. Cross-walls have also been reported in populations of *B. knowltonii* (Holyoak 2004).

The following species exhibit exostome teeth with thick cell wall remnants in their upper part resembling a ladder: *B. archangelicum*, *B. intermedium*, *B. lonchocaulon*, *B. creberrimum*, *B. pallescens*.

Endostome

There is a strong correlation between spore size and the type of endostome cilia: in most species of *Bryum* cilia are long and appendiculate, and spores are small (usually < 20 μm). The appendages are obviously functional in preventing spore release in moist conditions, when the peristome is closed, keeping in mind that the capsule mouth is normally oriented towards the ground. On the other hand, species with large spores have mostly rudimentary cilia, perhaps due to reduction mutations, since the cilia are no longer needed to prevent the shedding of the large spores. There is a group of intermediate species with cilia nodose or with short appendages: cilia short: *B. algovicum*, *B. archangelicum*, *B. knowltonii*, *B. longisetum*, *B. uliginosum*, *B. warneum*; cilia nodose or with short appendages: *B. alpinum*, *B. badium*, *B. intermedium*, *B. pallens*, *B. pallescens*, *B. schleicheri* (also with long appendages), *B. turbinatum*; cilia appendiculate: *B. barnesii*, *B. bimum*, *B. blindii*, *B. bornholmense*, *B. caespiticium*, *B. capillare*, *B. creberrimum*, *B. dichotomum*, *B. donianum*, *B. elegans*, *B. funckii*, *B. gemmiferum*, *B. gemmilucens*, *B. klinggraeffii*, *B. moravicum*, *B. lonchocaulon*, *B. pseudotriquetrum*, *B. radiculosum*, *B. rubens*, *B. ruderale*, *B. schleicheri*, *B. subapiculatum*, *B. tenuisetum*, *B. torquescens*, *B. turbinatum* (appendages short), *B. versicolor*, *B. violaceum*, *B. weigelii*.

There is also a strong correlation between the size and structure of cilia and the width of the capsule mouth, perhaps because in narrow-mouthed capsules

there does not seem to be enough space for long cilia. An alternative explanation could be that in capsules with a narrow mouth and large spores, long cilia are not necessary to hold back the spores.

Spores

Most species of *Bryum* have smooth spores: *B. badium*, *B. caespiticium*, *B. creberrimum*, *B. torquescens*, and many others. The surface of the spores is papillose in *B. algovicum*, *B. archangelicum*, *B. intermedium*, *B. lonchocaulon*, *B. longisetum*, *B. pallens*, *B. pallescens*, *B. schleicheri*, *B. turbinatum*, *B. uliginosum*, *B. warneum*, *B. weigelii.*

Spore size range in species of *Bryum* (Fig. 3)

The largest spores are found in *B. longisetum* (40–50 μm) and *B. warneum* (> 40 μm). In *B. lonchocaulon*, spores of different size are often found in one capsule, often malformed, shrunk or deformed; this could suggest a hybridogenic nature of the taxon (Meinunger and Schröder 2007).

RESULTS AND DISCUSSION

This revision has resulted in definitely verifying the occurrence of thirty-four taxa of *Bryum* in Hungary. At the same time, however, new questions have come up, since there are some specimens that might represent species hitherto unknown from the Hungarian territory, but in some way or other leave doubts as to their true identity. We deliberately also communicate information on these doubtful cases, in the hope that further research might either confirm our assumptions or disprove them. These doubtful taxa are: *B. badium*, *B. knowltonii*, and *B. tenuisetum*. The following taxa have been mentioned in the literature as members of the Hungarian bryoflora, but are now excluded on the basis of our revision: *B. barnesii*, *B. bornholmense*, *B. cyclophyllum*, *B. schleicheri*, *B. veronense*, *B. versicolor.*

To facilitate the comparison between the results of this revision with earlier literature reports, Table 2 gives an overview over the use of names in the most important reference works of Hungarian bryology.

While the specific treatment of taxa for practical purposes is in alphabetical order, we here give a systematic overview (Nyholm 1993, with slight modifications) including also doubtful and excluded taxa (verified: ***bold italics***, doubtful: *italics*, excluded: regular letters in brackets):

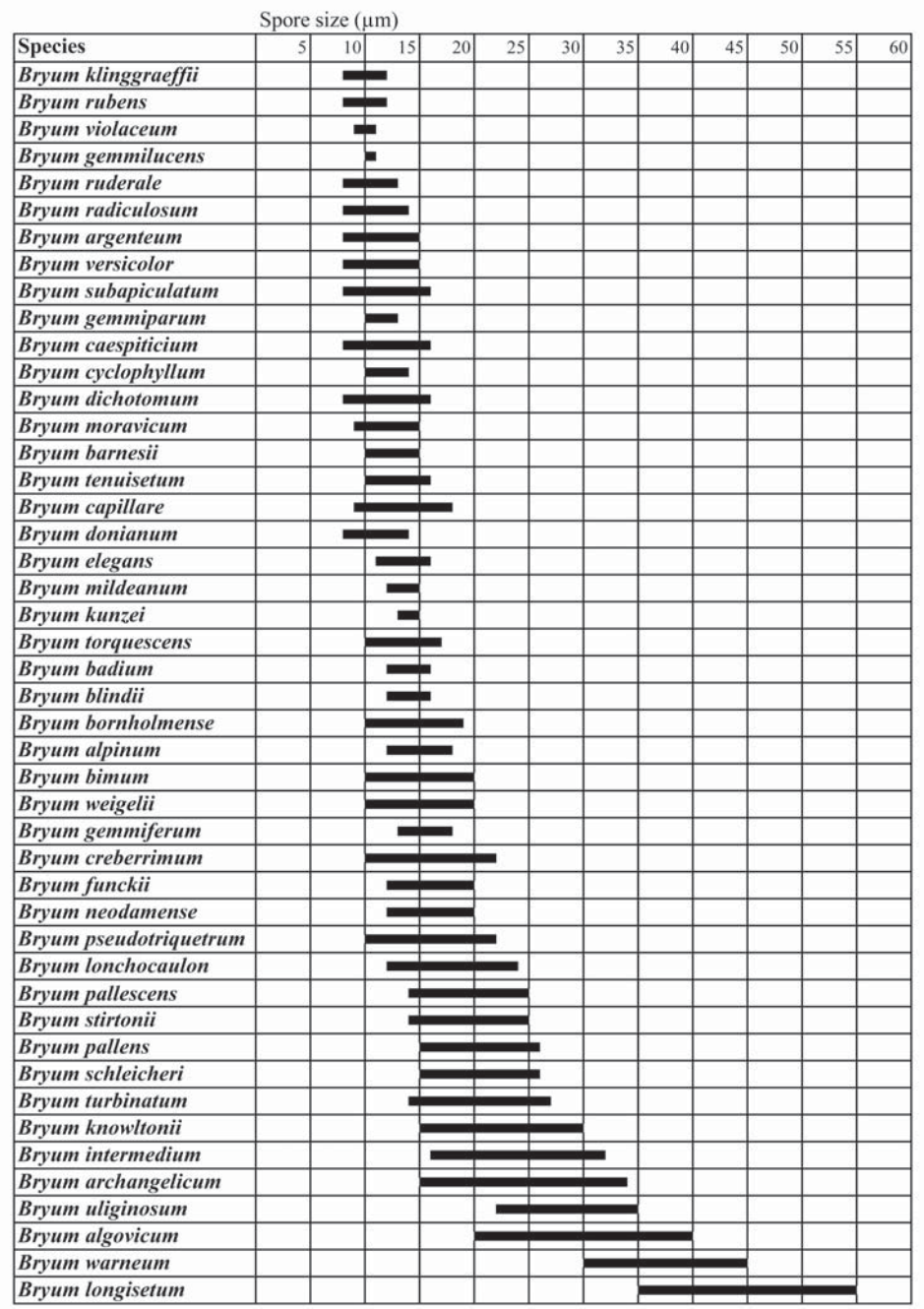

Fig. 3. Spore size. Range of spore size of selected *Bryum* species compiled from the references listed in the species accounts.

Sect. Amblyophyllum: ***B. warneum***, ***B. uliginosum***, ***B. pallens***, ***B. turbinatum***, ***B. weigelii***, (B. cyclophyllum), (B. schleicheri)
Sect. Trichophora (the "*B. capillare* complex"): ***B. moravicum***, ***B. elegans***, ***B. stirtonii***, ***B. capillare***, ***B. torquescens***
Sect. Bryum
subsect. Penduliformia: ***B. algovicum***, ***B. archangelicum*** (= *imbricatum*), ***B. intermedium***, *B. knowltonii*
subsect. Pseudotriquetra: ***B. pallescens***, ***B. lonchocaulon***, ***B. creberrimum*** (these three taxa often referred to as the "*B. pallescens* group"), ***B. pseudotriquetrum***, ***B. neodamense***, ***B. bimum***
subsect. Alpiniformia: ***B. alpinum***, ***B. mildeanum***
subsect. Caespitibryum: ***B. funckii***, *B. badium*, ***B. kunzei***, ***B. caespiticium***
subsect. Apalodictyon (the "*B. erythrocarpum* complex"): ***B. ruderale***, ***B. violaceum***, ***B. klinggraeffii***, ***B. subapiculatum***, ***B. rubens***, ***B. radiculosum***, *B. tenuisetum*, (B. bornholmense)
subsect. Doliolidium (the "*B. dichotomum* group"): ***B. dichotomum*** (= *bicolor*), (B. barnesii), ***B. argenteum***, ***B. gemmiferum***, ***B. gemmilucens***, (B. veronense), (B. versicolor)

HISTORICAL ASPECTS

The oldest *Bryum* specimen examined in this study dates from 1879 (*B. caespiticium* from Sátoraljaújhely ex herb. Chyzer, s. coll.).

Table 3 shows the most important collectors (with 20 specimens collected or more) of *Bryum* in Hungary, and the number of their specimens evaluated in this study (not corrected for duplicates).

The importance of the lifelong collecting activity of Ádám Boros (1900–1973) is obvious, 41% of the specimens studied were collected by him. Considering the number of *Bryum* specimens collected per year (not shown), the years 1972 and 1973 represent a gap in collecting activity. For this reason, the year 1973 has been chosen to discriminate between old and recent collections.

The overwhelming majority of specimens was determined by J. Podpera, some determinations were by A. Latzel, concerning mainly collections made by A. and S. Visnya from the areas around Pécs and Kőszeg. That Boros relied on Podpera as *Bryum* specialist is also documented by a footnote in Szepesfalvi (1941: p. 67): "Sämtliche im Gebiet von A. Boros gesammelte Arten der Gattung *Bryum* wurden von Prof. Podpera bestimmt (Boros in litt. ad me)." [all species of the genus *Bryum* collected in the area by Boros were determined by Prof. Podpera (Boros in letter to me)]. It must be emphasised that nearly all misidentifications detected in the course of this revision obviously are the responsibility of Podpera

Table 2. Nomenclatural and taxonomic overview (verified: ***bold italics***, doubtful: *italics*, excluded: (normal) print) (abbreviations: pp.: pro parte, in part; agg.: aggregate, collective species).

Name accepted in present paper	Name according to checklists (Erzberger and Papp 2004, Papp *et al.* 2010)	Name used in Boros (1953)	Name used in Boros (1968)	Name used in Orbán and Vajda (1983)
B. algovicum	*B. algovicum*	*B. pendulum*	*B. pendulum*	*B. angustirete*
B. alpinum	*B. alpinum*	*B. alpinum*	*B. alpinum* pp.	*B. alpinum* pp.
B. archangelicum	*B. imbricatum*	*B. inclinatum*	*B. inclinatum*	*B. inclinatum*
B. argenteum	*B. argenteum*	*B. argenteum*	*B. argenteum* pp.	*B. argenteum*
B. badium	*B. caespiticium* var. *badium* (2004), *B. caespiticium* (2010)	*B. badium*	*B. caespiticium* var. *badium*	*B. badium*
(B. barnesii)	–	–	–	–
B. bimum	*B. pseudotriquetrum* var. *bimum* (2004), *B. pseudotriquetrum* (2010)	*B. bimum*	*B. ventricosum* var. *bimum*	*B. bimum*
(B. bornholmense)	*B. bornholmense*	–	*B. bornholmense* in *B. erythrocarpum* agg.	*B. bornholmense*
B. caespiticium	*B. caespiticium* var. *caespiticium* (2004), *B. caespiticium* (2010)	*B. caespiticium* pp., *B. bakonyense*, incl. var. *tettyense*	*B. caespiticium* pp.	*B. caespiticium* pp.
B. capillare	*B. capillare*	*B. capillare* pp.	*B. capillare* pp.	*B. capillare*
B. creberrimum	*B. creberrimum*	*B. affine*	*B. cirratum var. affine*	*B. creberrimum*
(B. cyclophyllum)	–	*B. cyclophyllum*	–	–
B. dichotomum	*B. bicolor*	*B. bicolor*	*B. bicolor*	*B. bicolor*
B. elegans	*B. elegans*	*B. elegans*	*B. capillare* ssp. *elegans*	*B. elegans*
B. funckii	*B. funckii*	*B. Funckii*	*B. Funckii*	*B. funckii*
B. gemmiferum	*B. gemmiferum*	–	–	–
B. gemmilucens	*B. gemmilucens*	–	–	*B. gemmilucens*
B. intermedium	*B. intermedium*	*B. intermedium*	*B. intermedium*	*B. intermedium*
B. klinggraeffii	*B. klinggraeffii*	–	–	–
B. knowltonii	–	–	–	–
B. kunzei	*B. caespiticium*	*B. caespiticium* var. *Kunzei*	*B. caespiticum* ssp. *Kunzei*	*B. caespiticium* ssp. *kunzei*
B. lonchocaulon	–	*B. cirratum*	*B. cirratum*	*B. cirrhatum*
B. mildeanum	*B. mildeanum*	*B. Mildeanum*	*B. alpinum* var. *Mildeanum*	*B. alpinum* var. *mildeanum*
B. moravicum	*B. laevifilum* (2004), *B. moravicum* (2010)	*B. capillare* var. *flaccidum*	*B. capillare* f. *flaccidum*	*B. laevifilum*, *B. flaccidum*

Table 2 (continued)

B. neodamense	*B. neodamense*	*B. neodamense*	*B. neodamense*	*B. neodamense*
B. pallens	*B. pallens*	*B. pallens*	*B. pallens*	*B. pallens*
B. pallescens	*B. pallescens*	*B. pallescens*	*B. pallescens*	*B. pallescens*
B. pseudotriquetrum	*B. pseudotriquetrum* var. *pseudotriquetrum* (2004), *B. pseudotriquetrum* (2010)	*B. ventricosum*	*B. ventricosum* pp.	*B. pseudotriquetrum*
B. radiculosum	*B. radiculosum*	*B. murale*	*B. murale*	*B. radiculosum*
B. rubens	*B. rubens*	*B. erythrocarpum* pp.	–	–
B. ruderale	*B. ruderale*	–	*B. ruderale* in *B. erythrocarpum* agg.	*B. ruderale*
(B. schleicheri)	*B. schleicheri*	*B. Schleicheri*	*B. turbinatum* ssp. *schleicheri*	*B. schleicheri*
B. stirtonii	*B. stirtonii*	–	–	*B. stirtonii*
B. subapiculatum	–	–	–	–
B. tenuisetum	–	–	–	–
B. torquescens	*B. torquescens*	*B. torquescens*	*B. capillare* ssp. *torquescens*	*B. torquescens*
B. turbinatum	*B. turbinatum*	*B. turbinatum*	*B. turbinatum*	*B. turbinatum*
B. uliginosum	*B. uliginosum*	*B. cernuum*	*B. uliginosum*	*B. uliginosum*
(B. veronense)	–	–	*B. argenteum* ssp. *veronense*	*B. veronense*
(B. versicolor)	*B. versicolor*	*B. versicolor*	*B. versicolor*	–
B. violaceum	*B. violaceum*	–	–	–
B. warneum	*B. warneum*	*B. warneum*	*B. warneum*	*B. warneum*
B. weigelii	*B. weigelii*	*B. Duvalii*	*B. Weigelii*	*B. weigelii*

Table 3. Collectors of *Bryum* in Hungary.

Collector	No. of specimens	Collector	No. of specimens
Á. Boros	974	T. Pócs (et al.)	61
P. Erzberger	353	S. Polgár	37
L. Vajda	349	S. Orbán	30
B. Papp	297	G. Kis	27
M. Rajczy (et al.)	82	Á. de Degen	22
A. et S. Visnya	81	I. Galambos	22
Á. Károlyi	67	L. Balanyi	20

(and Latzel). In this context we also would like to quote Crundwell and Nyholm (1964: p. 597) who express their frequent disagreement with Podpera's determinations and taxonomic conclusions. Their criticism was related to the *B. erythrocarpum* complex, at the time not well understood since most bryologists

ignored rhizoidal tubers, but we must extend our disagreement with many of Podpera's determinations to the whole genus.

KEY TO SPECIES OF *BRYUM* IN HUNGARY

Apart from the verified taxa (in ***bold italics***), the following doubtfully recorded taxa are included: *B. badium*, *B. knowltonii*, *B. tenuisetum;* several species that occur in adjoining areas or might occur in Hungary are included as well: *B. barnesii*, *B. blindii*, *B. bornholmense*, *B. cyclophyllum*, *B. demaretianum*, *B. donianum*, *B. gemmiparum*, *B. longisetum*, *B. schleicheri*, *B. versicolor.* Each of these species is treated in a separate account following the key.

The key can only serve as a preliminary tool in identification. Since species of *Bryum* are variable, careful comparison of the plants with the descriptions is advised. Often it might also be necessary to compare with authentic material or consult specialists. In a difficult genus like *Bryum* it must be accepted that not every collection can be named. Additional illustrations are found in the references given at the individual species accounts, and photographs of most species can be found on the internet (e.g. www.milueth.de or www.bildatlas-moose.de, but be aware of possible errors! The picture of "*B. turbinatum*" in "bildatlas" was in fact *B. schleicheri*, but has now been corrected!).

1 Leaves concave, obovate to orbicular, apex rounded to obtuse; costa ending below leaf apex; marginal border inconspicuous, partially bistratose; plants evenly and distantly foliated, soft, flaccid; often with filiform gemmae in leaf axils ..... *B. cyclophyllum*
Note: compare also *B. blindii*.

– Leaves of different shape, mostly acuminate with an awn or apiculus often formed by the excurrent costa; marginal border conspicuous or inconspicuous, unistratose or (partially) pluristratose; filiform gemmae present or not ... **2**

2 Plants whitish green or silvery; leaves julaceous, closely imbricate when moist and when dry, concave, broadly ovate to ovate **3**
Note: compare also *Plagiobryum zierii*.

– Plants not conspicuously whitish green or silvery; leaves not or rarely julaceous **4**

3 Costa 60–100 μm wide at leaf base, excurrent as short, stout apiculus; upper leaf cells green (in young leaves); plants short and bud-like, (apex of male shoots) resembling miniature artichokes, julaceous, 1 mm wide or slightly more; capsules very rare, elongate-ovate, light brown when ripe; seta 2–4 cm long; spores 16–20 μm; bulbils in leaf axils lacking ..... ***B. funckii***

– Costa less wide, mostly ending distinctly below leaf apex, rarely percurrent or excurrent; upper leaf cells hyaline, without chlorophyll; plants slender,

thin, foliate shoots less than 1 mm wide, often silvery white; capsules not infrequent, small, ovate or obovate to ellipsoidal, dark red when ripe, getting blackish later; seta shorter, to 2 cm long; spores 8–14 μm; often with bulbils in leaf axils ..... ***B. argenteum***

4 Bulbils present in leaf axils, either foliate or with rudimentary leaf primordia **5**

– Bulbils in leaf axils lacking **11**

5 Costa very stout, *ca* 100 μm wide at leaf base; plants robust, 1–3 cm tall, densely and nearly evenly foliated; bulbils 200–700 μm long, with developed leaf primordia ..... *B. gemmiparum*

– Costa less stout, at most 80 μm wide at leaf base; plants smaller, 0.2–1.5 cm tall (*B. dichotomum* group, sect. Bryum subsect. Doliolidium) **6**

6 Bulbils < 200 μm long, several per leaf axil, leaf primordia either rudimentary or only in uppermost part (< 1/3) of bulbil 7

– Bulbils > 200 μm long, solitary or several per leaf axil, leaf primordia in upper third, half or two thirds of bulbil **8**

7 Bulbils brilliant yellow, usually *ca* 5 per leaf axil; leaf primordia rudimentary ..... ***B. gemmilucens***

– Bulbils not brilliant yellow, often 20–30 per leaf axil; leaf primordia peg-like, incurved or erect ..... ***B. gemmiferum***

8 Bulbils solitary (rarely 2) in leaf axils; leaf primordia acuminate, erect, not incurved, occurring in upper half or two thirds of bulbil 9

– Bulbils several per leaf axil; leaf primordia rounded to obtuse, incurved, occurring in upper third of bulbil ..... *B. barnesii*

9 Leaves obtuse at apex; bulbils to 600 μm long, with leaf primordia .... *B. blindii*

– Leaves acuminate **10**

10 Leaves ovate-lanceolate, gradually narrowed to long point; costa excurrent as 200–300 μm long awn; margin broadly recurved to revolute from base to near apex; bulbils solitary in leaf axils, up to 500(–600) μm long .... *B. versicolor*

– Leaves ovate to ovate-lanceolate, suddenly narrowed to short point or gradually narrowed to long point; margin narrowly recurved in lower part of leaf only; bulbils up to 400 μm long (rarely more) ..... ***B. dichotomum***

11 Filiform gemmae present in leaf axils **12**

Note: compare also *B. cyclophyllum*.

– Filiform gemmae lacking **14**

12 Leaves mostly abruptly narrowed to filiform acumen; leaves spirally twisted when dry; margin plane or recurved in lower part of leaf only .... ***B. moravicum*** *(B. flaccidum*, *B. laevifilum*, *B. subelegans*)

Note: compare also *B. donianum*.

– Leaves gradually narrowed to short acumen, flexuose, but not spirally twisted when dry; margin broadly or narrowly recurved from base to near apex **13**

13 Leaf base red, contrasting green part of leaf (discolorous); margin with distinct unistratose border of 3–5(–10) rows of narrow, incrassate cells, border distinctly decurrent along stem; usually ± robust plants with conspicuous tomentum of red rhizoids, to > 4 cm (up to 10 cm) tall **34**

– Leaf base not contrasting rest of leaf, concolorous (either green or if red then whole leaf red); marginal border partly bistratose, distinct, but narrower, to 3 cell rows wide, not decurrent; plants less robust, not tomentose ..... ***B. pallens*** (f. *rutilans*)

14 Leaves spathulate or obovate, often widest at or above middle, suddenly contracted into long, filiform point; cells at leaf base reddish, discolorous; laminal cells mostly ± 20 μm wide (sect. Trichophora) **15**

– Leaves usually widest below middle, more gradually narrowed to short or long point; cells at leaf base concolorous or discolorous; laminal cell width various **19**

15 Leaf margin with pluristratose (up to 4-stratose) border, often with double teeth (like in *Mnium*); laminal cells 14–22 μm wide ..... *B. donianum*

– Leaf border unistratose; laminal cells 18–30 μm wide **16**

16 Leaves spirally twisted when dry; margin with distinct border 2–5 cells wide; capsules not infrequent, to 5 mm long **18**

– Leaves not spirally twisted when dry, concave, ± closely imbricate and evenly arranged along stem; border often indistinct, 1–2(–3) cells wide; capsules very rare **17**

17 Leaves not decurrent, margin not recurved, except in lower part; stems julaceous; rhizoids coarsely papillose, papillae tall and to 5 μm wide; laminal cells 15–20 μm wide ..... ***B. elegans***

– Leaves slightly decurrent, margin often recurved to apex; stems not julaceous; rhizoids less coarsely, but densely papillose; laminal cells 16–23(–30) μm wide ..... ***B. stirtonii***

18 Plants dioicous; capsules brown when ripe, often slightly curved; rarely with rhizoidal tubers ..... ***B. capillare***

– Plants synoicous; capsules dark red when ripe, straight; often with rhizoidal tubers ..... ***B. torquescens***

19 Robust plants, often with metallic sheen and reddish colour, stem evenly foliated, leaves stiff, densely imbricate when dry; costa ending below leaf apex or percurrent to shortly excurrent; marginal border indistinct (sect. Bryum subsect. Alpiniformia pp.) **20**

– Characters different **21**

20 Plants glossy, with pronounced metallic sheen, mostly red to golden-green; leaves with ± parallel margins in lower half to two thirds of leaf; mid-leaf cells of older leaves elongate, narrow, 8–12 μm wide, incrassate; costa ending in or just below leaf apex, rarely shortly excurrent; rhizoidal tubers often present, 100–200 μm in diameter ..... ***B. alpinum***

– Plants without metallic sheen, green; leaves ovate to triangular lanceolate; mid-leaf cells 10–18(–28) μm wide, not incrassate; costa stout, excurrent into short point; rhizoidal tubers absent, but fragile shoots sometimes developed in leaf axils ..... ***B. mildeanum***

21 Plants with rhizoidal tubers (*B. erythrocarpum* group, sect. Bryum subsect. Apalodictyon) **22**

Note: several other species also can produce rhizoidal tubers; these occur regularly in *B. alpinum* and *B. torquescens*, rarely in *B. dichotomum*, *B. capillare*, *B. elegans*, *B. moravicum*, *B. barnesii*, *B. caespiticium* (?), *B. gemmiferum* (?), *B. gemmiparum* (?). These species are not keyed out here!

– Plants lacking rhizoidal tubers (but compare *B. caespiticium* sometimes with rhizoidal tubers) **30**

22 Rhizoidal tubers in fascicles of several [(1–)2–5] at the end of hyaline, thin branched rhizoids that branch off stronger rhizoids, in large numbers, pyriform, light orange, orange-brownish or yellowish, 100–150 μm long; rhizoids pale yellowish to brownish ..... *B. demaretianum*

– Rhizoidal tubers solitary, not in fascicles, ± spherical **23**

23 Fully developed rhizoidal tubers small, < 100(–115) μm **24**

– Fully developed rhizoidal tubers > 120 μm **25**

24 Rhizoids pale violet, finely papillose, tubers yellowish to orange or reddish brown, 70–80 μm, cells not to slightly protuberant ..... ***B. violaceum***

– Rhizoids pale yellowish brown, tubers bright crimson to reddish brown, to 100(–115) μm long, irregularly spherical, cells distinctly protuberant ..... ***B. klinggraeffii***

25 Rhizoids and tubers yellow; costa becoming dark purple with age ..... *B. tenuisetum*

– Tubers red, rhizoids not yellow **26**

26 Rhizoids usually deep violet (old rhizoids dark red and coarsely papillose, young rhizoids pale reddish and only weakly papillose); tubers red to reddish brown or orange, at the end of long rhizoids, never axillary, to 200 μm, cells not to slightly protuberant ..... ***B. ruderale***

– Rhizoids paler, not violet **27**

27 Leaves with distinct border of 2–3(–4) rows of elongate, narrow cells; laminal cells (10–)14–20 μm wide; tubers with cells protuberant or not **28**

– Leaves not or scarcely bordered; laminal cells 10–16 μm wide; tuber cells not protuberant; tubers never axillary **29**

28 Tubers matt, brownish red (when old), red or dark red in alkali, occurring on long, papillose rhizoids, never axillary, translucent in transmitted light, 160–350(–450) μm in diameter, tuber cells (30–)45–60 μm in diameter, not (to slightly) protuberant, with 1–2 μm thick walls as seen in profile, cell walls darker than the lumen; calcifuge plant ..... *B. bornholmense*

– Tubers glossy, bright crimson red, virtually black in alkali, on short rhizoids at the stem base, and frequently also in leaf axils above the soil, opaque in transmitted light, (130–)180–260 μm in diameter, tuber cells 30–35(–45) μm in diameter, strongly protuberant, with 2–3 μm thick walls as seen in profile, cell walls and lumen equally dark; plant of slightly acidic to highly basic habitats ..... ***B. rubens***

29 Plants growing in dense, nearly cushion-like yellowish to brownish green or green turfs, with numerous basal rhizoids forming a ± dense felt; costa stout, in upper leaves excurrent in long, denticulate point; basal laminal cells beside the costa quadrate or short-rectangular; mid-leaf cells 10–12 μm wide, incrassate; rhizoidal tubers 120–180(–220) μm in diameter, pale brownish to bright red, tuber cells usually < 45 μm long, not protuberant; plants of dry-warm calcareous habitats ..... ***B. radiculosum***

– Plants growing in lax turf, mostly reddish green, without conspicuous rhizoid felt; costa in upper leaves only shortly excurrent; basal laminal cells beside the costa rectangular; mid-leaf cells 10–14(–16) μm wide, slightly incrassate or thin-walled; rhizoidal tubers ± spherical, often somewhat irregular in shape, (180–)190–260(–330) μm, red, tuber cells usually not protuberant, (18–)24–55(–65) μm long; plants growing on base-rich non-calcareous soil ..... ***B. subapiculatum*** *(B. microerythrocarpum)*

30 Plants growing in turfs usually > 4 cm tall, leaves often strongly decurrent, plants often with dense tomentum of reddish rhizoids **31**

– Plants smaller, leaves usually not or scarcely decurrent **35**

31 Leaf base concolorous, not contrasting with upper lamina; border often bistratose; laminal cells 12–40(–60) μm wide; rhizoid tomentum scarce or lacking **32**

– Leaf base discolorous, reddish, contrasting with upper green lamina; border unistratose, conspicuous; laminal cells 12–24 μm wide; rhizoid tomentum often conspicuous **33**

32 Leaves conspicuously longly and broadly decurrent; soft plants to 10 cm tall, often pinkish to flesh-coloured; laminal cells 12–24 μm wide; plants of wetlands from the lowlands to the mountains ..... ***B. weigelii***

– Leaves only slightly and narrowly decurrent; plants light green, in often tumid tufts to 10 cm tall; laminal cells 10–40(–60) μm wide; plants of montane spring vegetation ..... *B. schleicheri*

33 Leaves ovate-oblong with short acute apex or obtuse, mostly spoon-like concave, weakly decurrent; costa ending in or below apex ..... ***B. neodamense***
– Leaves elongate-lanceolate, acuminate, not concave, not spoon-like, distinctly and strongly decurrent; costa percurrent or shortly excurrent **34**
34 Plants dioicous; sporophytes rare; spores usually 12–18 μm ..... ***B. pseudotriquetrum***
– Plants synoicous, nearly always with sporophytes; spores usually 15–25 μm ..... ***B. bimum***
35 Leaf base not contrasting upper lamina in colour, concolorous, plants often reddish to pinkish; marginal border often partially bistratose, sometimes inconspicuous; capsule narrow-mouthed, lid with ± acute mamilla (sect. Amblyophyllum pp.) **36**
– Leaf base red, in contrast with upper green lamina, discolorous (examine old leaves!); plants green or variegated red; border unistratose, conspicuous or indistinct to lacking; lid sharply or obtusely pointed **39**
36 Endostome cilia ± long, nodose or with short appendages; spores (15–)18–24 (–26) μm; plants dioicous; often with wine-red to pinkish colour **37**
– Endostome cilia short to rudimentary, rarely longer and nodose; spores > 28 μm; plants autoicous; seta usually long; leaf border yellowish; plants green or sometimes pale reddish **38**
37 Capsule elongate pyriform, with curved neck, not conspicuously contracted below mouth when dry and empty; marginal border conspicuous, to 3 cells wide, often bistratose (in well developed plants) ..... ***B. pallens***
– Capsule short, symmetric, turbinate when dry and empty, with conspicuous contraction below mouth; marginal border inconspicuous, often only 1–2 cells wide ..... ***B. turbinatum***
38 Exostome teeth usually with oblique cross-walls connecting lamellae, exostome partially united to endostome; spores usually > 40 μm; endostome segments with narrow, slit-like perforations; border less conspicuous, only locally bistratose; seta 3–6 cm long; plants sometimes pale reddish ..... ***B. warneum***
– Exostome teeth without cross-walls between lamellae, endostome free; spores smaller, 28(–35) μm; endostome segments with oval perforations; leaf margin with yellowish, conspicuous regularly bistratose border; seta 2–5 cm long; plants green ..... ***B. uliginosum***
39 Leaf margin without border or border indistinct **40**
– Leaf margin with distinct border **45**
40 Capsule with narrow mouth, cilia short or nodose, not appendiculate; plants synoicous **41**

– Capsule with wide mouth, cilia appendiculate or plants without capsules, dioicous **42**

41 Capsule short, rounded pyriform or ovate, brown; costa of comal leaves percurrent to rarely excurrent in short slender point; cilia short; spores (15–)18–25(–30) μm ..... *B. knowltonii*

– Capsule elongate-pyriform, mostly slightly asymmetric, gibbous, red brown to blackish when ripe; costa longly or sometimes shortly excurrent; cilia of variable length, nodose; spores 18–25 μm ..... ***B. intermedium***

42 Plants small, 0.5–1 cm tall, whitish green; leaves broadly ovate, strongly concave, imbricate, julaceous, crowded and bud-like at apex; costa excurrent as short, but stout apiculus (of *ca* 10% of total leaf length or less), 60–100 μm wide at leaf base; laminal cells thin-walled, lax, 20–35 ×15 μm; marginal border lacking (or consisting of a single row of incrassate, hardly narrowed cells); capsule turbinate (strongly contracted below mouth) when ripe and empty ..... ***B. funckii***

– Plants not bud-like, taller, 0.5–2 cm; leaves ovate to ovate-lanceolate, not strongly concave; costa excurrent as longer smooth or denticulate point (of *ca* 20–30% of total leaf length); laminal cells longer, 40–70 μm long; marginal border indistinct to lacking; capsule not turbinate or only slightly contracted below mouth **43**

43 Leaves elongate-ovate, acuminate, taut, with long, yellow, conspicuously denticulate point; leaves appressed when dry, giving shoot apex a paint brush-like appearance; capsule red, slightly contracted below mouth when dry ..... *B. badium*

– Leaves broadly ovate to ovate-lanceolate, costa excurrent in long point or not, but apiculus not or only slightly denticulate, shoot apex not like a paintbrush; capsule brown **44**

44 Leaves broadly ovate to ovate-elongate, suddenly narrowed to a short or long apiculus, very concave, imbricate; stems julaceous, leaves not enlarged towards shoot apex; leaf margin plane or slightly recurved in lower part only; marginal border indistinct to lacking ..... ***B. kunzei***

– Leaves ovate-lanceolate to ovate, gradually narrowed to long point formed by excurrent costa, entire or weakly denticulate, leaves enlarged and crowded towards shoot apex; leaf margin recurved to revolute from base to near apex; margin with ± indistinct border formed by 2–3(–4) rows of elongate, narrow cells; plants dioicous, but often with sporophytes; capsule large-mouthed, pendulous; cilia long appendiculate; spores 10–12 μm ..... ***B. caespiticium***

45 Plants without sporophytes .... ***plants cannot be identified without ripe capsules***

– Plants with ripe capsules **46**

46 Cilia short to rudimentary; spores large, usually > 20 μm (18–50 μm); plants usually synoicous; capsule narrow-mouthed **47**
– Cilia long, nodose or appendiculate; spores small, usually < 20 μm (10–24 μm); plants dioicous, synoicous, autoicous or polyoicous; capsule mouth wide or narrow **50**
47 Exostome teeth with oblique cross-walls between lamellae; endostome attached to exostome; lid with sharp point; costa longly excurrent ..... ***B. algovicum***
Note: compare also *B. warneum*.
– Exostome teeth usually without cross-walls; endostome free **48**
48 Leaves ± shortly acuminate; costa in comal leaves percurrent or excurrent in short, slender or stout point; seta often long **49**
– Leaves more longly acuminate; costa in comal leaves excurrent in long, smooth or slightly denticulate cuspidate point; seta often short; exostome teeth at tip with thickened cell wall remnants ..... ***B. archangelicum***
49 Capsule short, rounded pyriform or ovate; costa of comal leaves percurrent to rarely excurrent in short slender point; spores < 30 μm ..... *B. knowltonii*
– Capsule longer, larger; costa of comal leaves excurrent in short, but stouter point; spores 40–50 μm ..... *B. longisetum*
50 Spores 15–25 μm; capsule mouth wide or narrow **51**
– Spores (at least majority) not exceeding 16 μm; capsule large-mouthed **53**
51 Capsules ± gibbous, elongate pyriform, mostly somewhat curved and asymmetric, narrow-mouthed, cernuous to pendulous; leaf margin with indistinct border or 2–3 rows of narrow, elongate but usually not incrassate cells; plants synoicous ..... ***B. intermedium***
– Capsules cylindrical to clavate pyriform or elongate pyriform, not curved, symmetric, large-mouthed, sometimes inclined; leaf margin with distinct border of 2–6 rows of elongate, narrow incrassate cells; plants autoicous or polyoicous **52**
Note: compare also Table 4 (p. 132).
52 Plants autoicous, to 5 cm tall; capsules inclined to almost horizontal; growing on weakly calcareous, also on subneutral to weakly acidic substrates ..... ***B. pallescens***
– Plants polyoicous, to 3 cm tall; capsules pendulous; growing on calcareous substrates ..... ***B. lonchocaulon***
53 Plants synoicous; red leaf base distinct; leaf margin with distinct border of narrow, elongate, incrassate cells ..... ***B. creberrimum***
– Plants dioicous; leaf base often concolorous to indistinctly red; leaf margin with few rows of narrow, elongate cells forming indistinct border ..... ***B. caespiticium***

DESCRIPTION OF SPECIES

Preliminary remarks

Names of taxa that have been shown to occur in Hungary are printed in ***bold italics***. The following species which have either not (yet) been found in Hungary but might be expected, or which have been poorly recorded or even excluded, are deliberately included to increase the usefulness of the key and the descriptions for species determination: *B. badium*, *B. barnesii*, *B. blindii*, *B. cyclophyllum*, *B. demaretianum*, *B. donianum*, *B. gemmiparum*, *B. knowltonii*, *B. longisetum*, *B. schleicheri*, *B. tenuisetum*, *B. versicolor.*

Each section begins with a morphological description, including comments, which highlight the differences from similar species. The section on morphology ends with specific references concerning the descriptions. In the case of controversial taxa, a note on taxonomic status is added. Illustrations are based on Hungarian material whenever possible, but in some cases specimens from other countries were resorted to in order to show specific features that were not present in the Hungarian material (e.g. sporophytes).

Following the morphological details are accounts of the taxa occurring in Hungary based on information from the revised specimens: habitat and substrate as noted in the convolutes, associated bryophytes as found in the packets, and distribution in Hungary as shown by a map. The number of specimens, the total number of grid cells and the number of grid cells with recent finds are given. The range and the average altitude based on all specimens of the species are also given. The enumeration of selected specimens (or of all specimens, if there are only a few, i.e. in case of *B. archangelicum*, *B. badium*, *B. funckii*, *B. gemmiferum*, *B. gemmilucens*, *B. intermedium*, *B. knowltonii*, *B. kunzei*, *B. lonchocaulon*, *B. neodamense*, *B. ruderale*, *B. stirtonii*, *B. uliginosum*, and *B. warneum*) is arranged according to the bryogeographical regions of Boros (1968) with slight modifications, and gives specimen data of at least one specimen for each region, where the species occurs. After the region the Niklfeld grid (Niklfeld 1971) is given for each cited specimen. Since in some cases county boundaries and names have changed considerably, the county indicated for the specimen may not be the county to which the specimen's location belongs today. Annotation of specimens (e.g. det. Podpera, etc.) prior to our revision is cited only exceptionally. This section is closed by a note summarising salient features of the distribution in Hungary and possible conclusions with respect to an updated red list status in comparison with the recently published red list (Papp *et al.* 2010), using IUCN criteria (IUCN 1994, 2001, Hallingbäck *et al.* 1998).

Distribution in adjacent countries is compiled from the following sources: Austria (A): Grims (1999), Köckinger *et al.* (2008), Schlüsslmayr (2005, 2011), Slovenia (SLO): Martinčič (2003), Croatia (HR), Serbia (SRB): Sabovljević *et al.* (2008), Romania (RO): Ştefănuţ and Goia (2012), Ukraine (UA): Ignatov *et al.* (2006), Slovakia (SK): Kubinská *et al.* (2001).

In a final section published reports on Hungarian distributions of species are discussed with respect to the results of the revision. In view of the unreliability of literature reports no effort was made to achieve completeness, especially with respect to older records. The comprehensive accounts most consulted are: Szepesfalvi (1941), Boros (1953, 1968), Orbán and Vajda (1983), Papp and Rajczy (1999), Zanten (1999).

Bryum algovicum Sendtn. ex Müll. Hal.
[= *B. pendulum* (Hornsch.) Schimp., *B. angustirete* Kindb. ex Macoun]
(Figs 4, 5)

Synoicous or sometimes autoicous (also dioicous according to Nyholm (1993) and Guerra *et al.* (2010)), usually with sporophytes (in 95% of specimens seen). **Plants** 1–1.5(–3) cm tall, growing as solitary plants or in lax to dense tufts, rhizoids red-brown, finely papillose. **Leaves** forming comal tuft, erectopatent when moist, flexuose when dry, ovate-lanceolate, reddish at base, entire or slightly denticulate at apex; margin broadly recurved nearly to apex; costa longly (often > 300 μm) excurrent, apiculus denticulate. **Laminal cells** 40–60 × 10–15(–20) μm, marginal cells very narrow, up to 120 μm long, incrassate, forming unistratose border 2–6 cells wide. **Seta** 1–3 cm long. **Capsule** pendulous, to 5 mm long, obovate or pyriform, narrow-mouthed, brown when ripe, lid convex with acute mamilla. **Exostome** and endostome firmly attached to each other along their total length, therefore appearing opaque, exostome brown-orange, in lower part with vertical to oblique cross-walls between lamellae forming network. **Endostome** shorter than exostome, visible only in microscope, segments with oval perforations; cilia (2–3) short, irregular. **Spores** 25–35(–40) μm, green, finely papillose.

Similar species: *B. algovicum* cannot reliably be recognised without ripe capsules. In the field, the narrow-mouthed, obovate urns with the convex lid and an endostome invisible with a hand lens are good pointers. The exostome appears opaque and has cross-walls.

B. archangelicum: lid flat with a small mamilla, endostome free, clearly visible with a hand lens, exostome without oblique cross-walls (*B. algovicum*: lid convex, high, with sharp mamilla, endostome completely attached to exostome,

not visible with a hand lens, exostome with oblique cross-walls between lamellae, appearing opaque; endostome segments (microscope!) shorter than exostome).

B. intermedium: capsule narrowly pyriform, often delicate and thin, nearly always asymmetric, curved, gibbous, dark red to blackish when ripe; exostome and endostome free, exostome without cross-walls, endostome with nodose or shortly appendiculate cilia (*B. algovicum*: capsule not gibbous, brown, endostome and exostome fused, exostome with oblique cross-walls between lamellae, appearing opaque, cilia rudimentary).

B. pallescens group (*B. creberrimum*, *B. lonchocaulon*, *B. pallescens*): capsule large-mouthed, exostome without oblique cross-walls, exostome and endostome free and visible with a hand lens, ripe capsules often inclined; endostome with long, appendiculate cilia, spores 12–20(–24) μm. (*B. algovicum*: capsule narrow-mouthed, ripe capsules always pendulous, not inclined, endostome and exostome fused, exostome with oblique cross-walls between lamellae, appearing opaque; cilia short, spores 25–35(–40) μm).

For the differences between *B. algovicum* and *B. caespiticium*, *B. creberrimum*, and *B. longisetum*, see the notes under the latter species.

References: Limpricht (1895): 293–295, Nyholm (1993):188–189, Demaret (1993): 246–248, Ahrens (2001): 52–53, Guerra *et al.* (2010): 133–135.

Habitat: pioneer species in alkaline grasslands, in quarries, on walls, at roadsides, on the shore of lakes, nearly always in open vegetation (frequent in

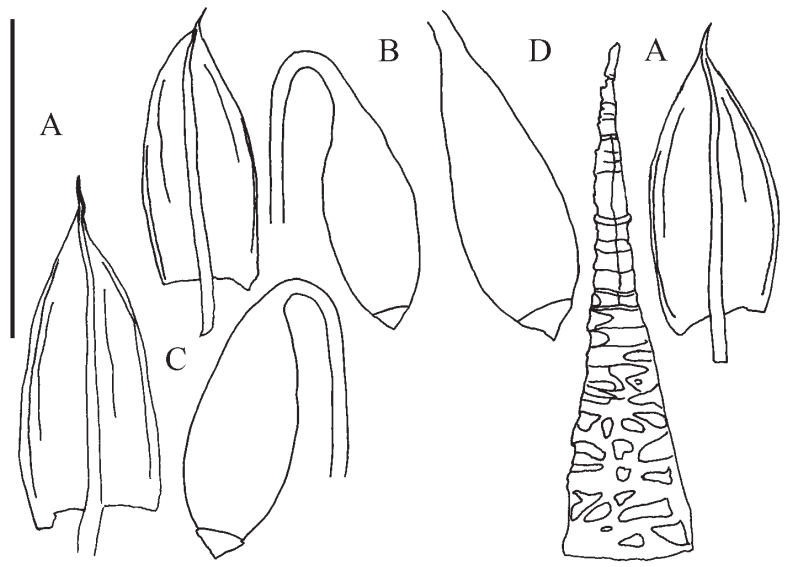

Fig. 4. *Bryum algovicum*. A = leaves; B; C = capsules (moist); D = exostome tooth. Scale bar: A: – 2 mm; B, C: – 4 mm; D: – 200 μm. [A, B, D: Erzberger 1922; C: Erzberger 11402, del. Erzberger].

saline grassland, in wetlands like magnocaricetis, near *Phragmites* stands, especially at the shore of saline lakes, near moist ditches, on moist clay, also in dolomite grassland; in forests in the plain, in *Abies*-forest and on andesite rock in the northern mountains, on old walls of limestone and of granite, on humus between decaying wood inside a well, rarely on the trunk of trees).

Substrate: (calcareous) sand, clay, soil, rocks, mortar, in dry or temporarily wet sites.

Associated bryophytes: *Bryum caespiticium*, *B. creberrimum*, *Didymodon fallax*, *Encalypta vulgaris*, *Funaria hygrometrica*, *Tortula muralis*.

Vertical distribution: 80–800 (mean 130) m a.s.l.

Distribution in Hungary (85 specimens, 60 grid cells, of which 7 represent recent finds): **Zemplén Mts** (7494.4): Comit. Abaúj-Torna. In rupibus andesit. montis Vár-hegy prope pag. Füzér, 4–500 m, 07.09.1947 leg. Á. Boros BP 7688 sub *B. pallescens*; **Bükk Mts** (7988.2): Com. Borsod. In pratis montanis Nagymező, prope pag. Szilvásvárad, 800 m, 13.05.1951 leg. L. Vajda EGR sub *B.* sp.; **Mátra Mts** (8185.4): Hungaria centr., com. Heves. In sylvestribus prope pag. Mátrafüred, montes Mátra, 15.05.1938 leg. L. Vajda EGR sub *B.* sp.; **Pilis Mts** (8378.2): Hungaria centr., com. Esztergom. Ad margines rivulorum prope pag. Csév, 01.05.1946 leg. L. Vajda BP 117672 sub *B. cirratum*; **Gerecse Mts** (8376.2): Comit. Esztergom. In rupestribus calc. mer.-or. montis Nagytekehegy prope pag. Süttő, 2–300 m. 17.05.1941 leg. Á. Boros BP 7642; **Vértes Mts**

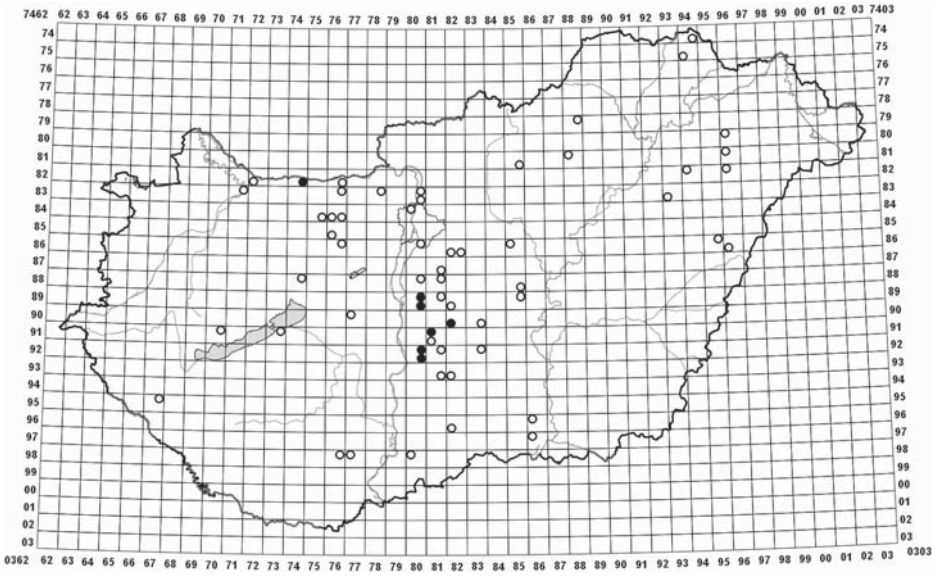

Fig. 5. Distribution of *Bryum algovicum*.

(8576.3): Comit. Fejér. In collibus dolomiticis supra viam publicam prope pagum Gánt, 250 m, 02.06.1940 leg. Á. Boros BP 116972; **Bakony Mts** (8874.2): Comit. Veszprém. Ad viam ferream pr. Várpalota, 140 m, 22.05.1927 leg. Á. Boros BP 116967; **Balaton Uplands** (9170.2): Comit. Zala. In muris ripae lacus therm. Malom-tó opp. Tapolca, 120 m, 03.04.1926 leg. Á. Boros BP 117364 sub. *B. pallescens*; **Zala** (9567.2): Flora hungarica, Comitat Zala. In arenosis humidis inter opp. Nagykanizsa et pag. Sormás, 150 m, 07.05.1948 leg. Á. Károlyi EGR sub *B.* sp.; **Mecsek Mts** (9877.1): Rácmecske, in ruderibus graniticis lapidicinarum contra stationem viae ferratae sitarum (elhagyott gránitbánya mellett), 185 m, 23.07.1934 leg. A. Visnya BP 117826 sub *B. caespiticium*; **Kisalföld** (8371.2): Comit. Győr, Kismegyer in fosse secus ferroviam, 19.05.1937 leg. S. Polgár BP 116984; **Danube–Tisza Interfluve** (8685.1): Comit. Pest. In natronatis ad Farmos, 100 m, 09.06.1937 leg. Á. Boros BP 116951; (collections not quoted in detail from 27 grid cells in this geographical region); **Tiszántúl** (8294.1): Comit. Hajdu. In natronatis Kajánszék prope Hajdunánás, 95 m, 26.05.1938 leg. Á. Boros BP 116926; **Nyírség** (8096.1): Comit. Szabolcs. In natronatis Mandameder prope Nyiregyháza, 110 m, 17.05.1927 leg. Á. Boros BP 116930; **Pest Plain** (8380.2): Comit. Pest. Insula Szentendrei-sziget. In arenosis ad Horányi-csárda prope Szentendre, 100 m, 15.06.1924 leg. Á. Boros BP 116936; 8680.2 Comit. Pest. In collibus arenosis insulae Csepel adversus pagum Soroksár, 100 m, 26.07.1919 leg. Á. Boros BP 116894 sub *B. pendulum* var. *hazslinszkyanum* det. Podpera.

This species has the majority of its growth sites in the plain, especially in the region between the rivers Danube and Tisza, where calcareous sand is the prevailing substrate. Recent records from only 7 grid cells (of a total of 60) might suggest a decline, but a focus on fewer localities in recent field research cannot be ruled out as an alternative explanation. Red list status: LC (Papp *et al.* 2010), should perhaps be modified to LC-att.

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB, UA.

Literature: In Boros (1953, 1968), Orbán and Vajda (1983) this frequent species is reported from nearly all regions, where it could be confirmed in our revision; specimens from the Zemplén Mts, Bükk Mts, Mátra Mts were not recognised previously, therefore these regions now can be added to the area of *B. algovicum*. Some other regions are mentioned in the literature, for which no confirmed specimens are available: Fertő Hills, Kőszeg Mts, shore of Lake Balaton. Nevertheless, also from regions in the plain, where *B. algovicum* is frequent, several specimens had to be revised to other species (*B. caespiticium*, *B. creberrimum*) or even more often could not be determined with certainty.

B. pendulum var. or f. *hazslinszkyanum* (Boros 1953, 1968) is reported from two localities: Esztergom and the Csepel Island. The specimen from the latter locality could be confirmed as *B. algovicum* (see above); the former record

is based on a collection by Csösz (Péterfi 1906, Szepesfalvi 1941), but no corresponding specimen was found.

Papp and Rajczy (1999) publish a number of records from the Danube–Tisza Interfluve, of which most could be traced back to confirmed specimens, with the following exceptions: no specimens could be located for Bugacmonostor (Igmándy) and Kelebia (Boros); the specimen BP 116962 (Kiskunhalas, Harkató, Boros) was indeterminable; BP 116866 (Ópusztaszer, Árpád monument, Boros) was revised to *B. dichotomum*.

Bryum alpinum Huds. ex With.
(Figs 6, 7)

Dioicous, usually without sporophytes (sporophytes in 1.2% of specimens seen, from 1 site: Remetebérc/Mátra Mts). **Plants** robust, to 5 cm tall, usually growing in dense tufts; dark red, in shaded situations also green or golden green, with pronounced metallic sheen, lustrous; rhizoids orange to wine-red or brownish, finely papillose. Round or ovate **rhizoidal tubers** to 200 μm diameter, wine-red, becoming brownish when old, often present. **Leaves** closely and evenly arranged along stem, appressed to stem when dry, not flexuose or curled, hardly altered when moist, taut; elongate-lanceolate, margins nearly parallel for the lower 2/3; margins entire, sometimes indistinctly denticulate near apex, plane or narrowly recurved, not decurrent; costa to 80 μm wide at leaf base, ending in or little below leaf apex. **Laminal cells** incrassate (especially in older leaves), narrow, elongate, 50–70 × 8–12 μm, hardly narrower or longer at margin; basal cells quadrate. **Seta** *ca* 1.5 cm long, red. **Capsule** cernuous to pendulous, 2–3 mm long, with long neck, slightly contracted below wide mouth, dark red when ripe. **Endostome** cilia nodose or appendiculate. **Spores** *ca* 15 μm.

Similar species: Well developed *B. alpinum* is easily recognised in the field. However, poor, ± green plants are often found growing on soil in saline areas. These may resemble *B. mildeanum*.

Confusion also might be possible with *B. pseudotriquetrum*: leaves erecto-patent, loosely arranged around the stem, somewhat twisted when dry; laminal cells shorter and broader, 40–50 × 20 μm, thin-walled; leaves ovate-lanceolate, costa not conspicuously stout; calciphilic (*B. alpinum*: leaves densely appressed; laminal cells incrassate, elongate, 50–70 × 8–12 μm; leaves lanceolate, margins parallel in lower 2/3, costa very stout; plants avoiding calcareous substrates).

B. gemmiparum: plants green or brown-green, without metallic sheen; vegetative propagation by bulbils, rhizoidal tubers unknown; grows near rivers (*B. alpinum*: plants dark red, with metallic sheen; bulbils unknown, but occasionally with rhizoidal tubers; grows on moist rock or walls and saline grasslands).

B. mildeanum: smaller plants, to 3 cm tall, without pronounced metallic sheen, green or brownish, faintly red at leaf base only, rhizoidal tubers lacking, but often with fragile shoots in leaf axils, laminal cells thin-walled. (*B. alpinum*: robust plants, to 5 cm tall, with pronounced metallic sheen, plants mostly red, often with red rhizoidal tubers, without fragile shoots in leaf axils, laminal cells incrassate).

B. subapiculatum: well-grown forms of this species look similar to *B. alpinum* and grow in similar habitats. However, they lack metallic sheen; their leaves are ovate-triangular-lanceolate, margins not parallel; laminal cells usually (but not always!) thin-walled, costa excurrent in long apiculus (*B. alpinum*: plants with metallic sheen, leaves elongate-lanceolate, parallel-sided below, laminal cells incrassate, costa ending in leaf apex).

References: Limpricht (1895): 393–395, Nyholm (1993): 200–202, Demaret (1993): 161–163.

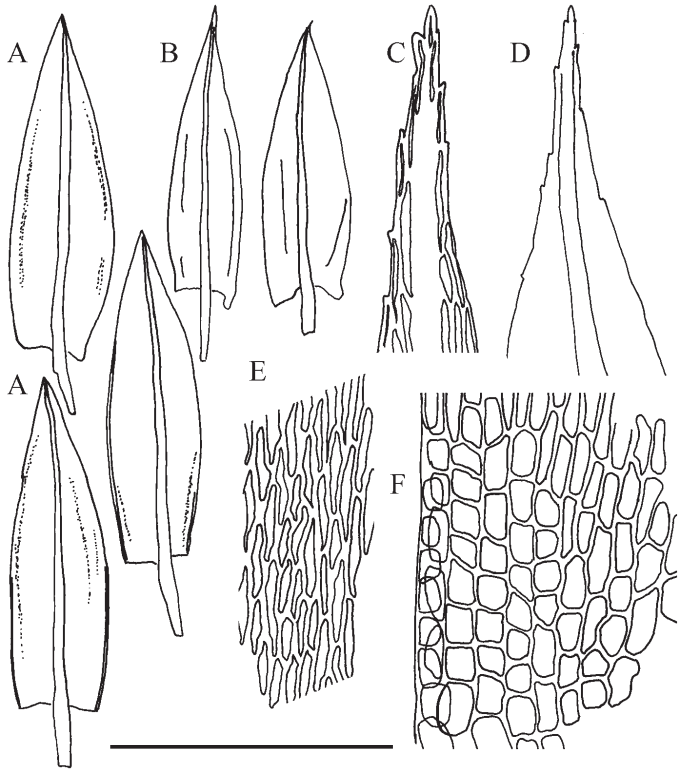

Fig. 6. *Bryum alpinum*. A, B = leaves; C, D = leaf apices; E = laminal cells in upper third of leaf; F = marginal and alar cells at leaf base. Scale bar: A, B: – 2 mm; C, E, F: – 200 μm; D: – 400 μm. [A: BP 117998, B–F: EGR Igmándy 1946 (Büdszentmihály), del. Erzberger].

Habitat: avoids limestone areas, grows in open vegetation, in at least temporarily moist sites (on rock outcrops in andesite grassland, in (moist) mountain meadows, in forest clearings and at the edge of forests, at road sides, at lake shores, near springs, in saline meadows – this is the typical habitat in the plain).

Substrate: siliceous rock, e.g. granite, volcanic rock, particularly andesite, dry, moist or irrigated; rocky soil, (moist) clay, moist sand, saline soil.

Associated bryophytes: *Bryum argenteum*, *B. capillare*, *B. dichotomum*, *B.* cf. *mildeanum*, *B. moravicum*, *B. pseudotriquetrum*, *B. rubens*, *Hypnum cupressiforme* var. *lacunosum*, *Brachythecium albicans*, *Ceratodon purpureus*, *Fissidens adianthoides*, *F. dubius*, *Hedwigia ciliata* var. *ciliata*, *Oxymitra incrassata*, *Phascum cuspidatum* var. *cuspidatum*, *P. cuspidatum* var. *piliferum*, *Pleurochaete squarrosa*, *Pottia intermedia*, *P. truncata*, *Racomitrium canescens*, *Scleropodium purum*, *Syntrichia ruralis*, *Thuidium abietinum*.

Vertical distribution: 80–900 (mean 227) m a.s.l.

Distribution in Hungary (161 specimens, 77 grid cells, of which 15 represent recent finds): **Zemplén Mts** (7494.2): Borsod-Abaúj-Zemplén County, Zemplén Mts, around a hunting house (Vadászház) at Füzér, on andesite grassland, N 48° 33.147', E 21° 27.217', 460 m, 05.04.2004 leg. B. Papp BP 171508; **Putnok Hills** (7788.3): Comit. Heves. In graminosis prope Sajómercse, 02.07.1960 leg. L. Vajda BP 63741; **Bükk Mts** (8087.2): Heves County, Bükk Mts, Szarvaskő hill, grassland northeast from the castle, on volcanic rocks, N 47° 59' 35.3", E 20° 19' 48.3",

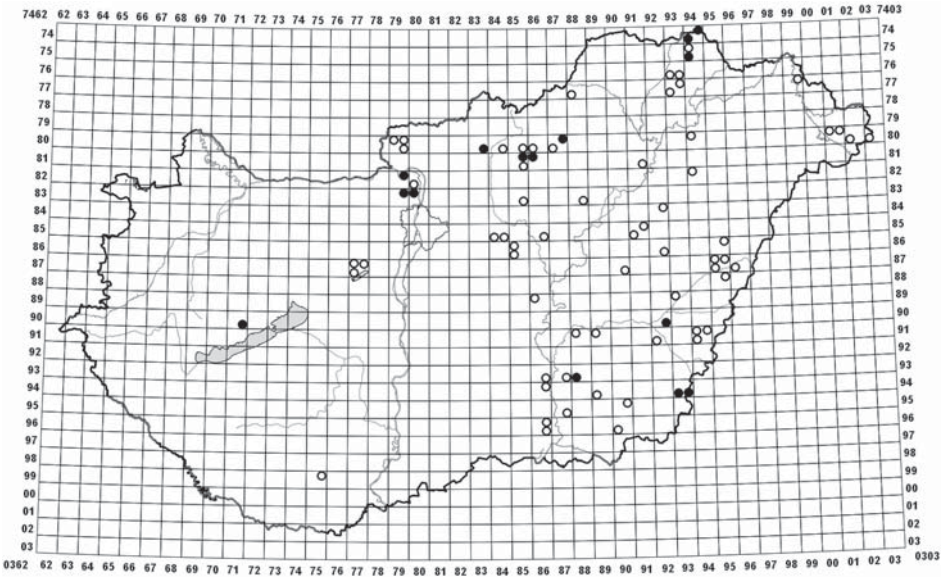

Fig. 7. Distribution of *Bryum alpinum*.

350 m, 04.06.2008 leg. B. Papp BP 176569; **Mátra Mts** (8084.4): Comit. Heves. In rupibus andesit. Báránykő prope Mátrakeresztes, 500 m, 28.08.1958 leg. Á. Boros BP 118082, EGR; **Cserhát Mts** (8083.4): Com. Nógrád, Cserhátszentiván, Berg Bézsma, Felsrasen, N 47° 56' 5", E 19° 35' 30", 320 m, 06.08.2001 leg. P. Erzberger B (Erzberger 7350); **Börzsöny Mts** (8079.1): Comit. Hont. In petrosis andesit. humidis Fekete-oldal montis Hollókő prope Perőcsény, 350 m, 21.04.1956 leg. Á. Boros BP 118065; **Visegrád Mts** (8379.2): Com. Pest, Visegrád-Geb., Berg Nagy-Csikóvár, unweit Gipfel, Felsrasen (Silikat, Andesit), N 47° 40' 40", E 18° 58' 50", 510 m, leg. P. Erzberger 10.08.2009 B (Erzberger 13583); **Velence Mts** (8777.1): Comit. Fejér. In locis humidis granit. circa Sor-hegy montis Meleg-hegy prope Sukoró, 250 m, 25.03.1939 leg. Á. Boros BP 118044; **Balaton Uplands** (9071.4): Veszprém County, Szentbékkálla, Fekete-hegy, Vaskapu-árok, on soil, N 46° 54' 9.74", E 17° 35' 42.43", 350 m, 27.06.2009 leg. B. Papp BP 178540; **Mecsek Mts** (9975.2): Comit. Baranya. In glareosis humidis versus Cserkut prope Pécs, 250 m, 30.04.1962 leg. Á. Boros BP 118034; **Danube–Tisza Interfluve** (8385.4): Comit. Jász-Nagykun-Szolnok. In pascuis natronatis versus Jászárokszállás prope Jászberény, 95 m, 01.06.1938 leg. Á. Boros BP 118007; **Tiszántúl** (8094.1): In pascuis natronatis apud silvam Grófi-erdő prope Büdszentmihály, com.: Szabolcs, 06.11.1949 leg. J. Igmándy EGR; (collections not quoted in detail from 31 grid cells in this geographical region); **Észak-Alföld** (8003.3): Comit. Szatmár. In pascuis Hármashatár prope Garbolc, 123 m, 31.03.1953 leg. Á. Boros BP 118057.

The distribution of *B. alpinum* in Hungary truly reflects the substrate preferences of this species. It occurs on andesitic rocks and on acidic soils in the volcanic (Zemplén Mts, parts of Bükk Mts, Mátra Mts, Börzsöny Mts, Visegrád Mts) and other siliceous mountain areas (Velence Mts, parts of Balaton Uplands and Mecsek Mts), but it avoids the calcareous sand regions between the Danube and Tisza. In Hungary, the main area of occurrence is the plain east of Tisza River, in saline areas with non-saliferous solonec soil (Boros 1942, 1968). With only 15 grid cells with recent records out of a total of 77, the red list category LC-att in Papp *et al.* (2010) seems appropriate.

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB, UA.

Literature: Boros (1953, 1968), Orbán and Vajda (1983): Three regions listed have to be deleted, since the specimens were doubtful or revised to other species: Gerecse Mts (BP 118263: Dunaalmás, not determinable with certainty), Bakony Mts (BP 118037: Herend, revised to *B. pseudotriquetrum*), Vas (BP 118039: Ostffyasszonyfa, revised to *B. mildeanum*). There is also no specimen from Pilis Mts, but probably the term Pilis Mts in Boros (1953) includes the Visegrád Mts.

Three regions can be added due to recent collections (see enumeration above): Putnok Hills, Bükk Mts, and Cserhát Mts.

Boros (1942) gives an account of *B. alpinum* in Hungary (within its historical borders), including a map. The records from Hungary within its present borders correspond to specimens in BP and have been confirmed. This appears to be the first mention of *B. alpinum* as a regular member of saline grassland vegetation.

Papp and Rajczy (1999) publish a number of records from the Danube–Tisza Interfluve, of which all could be traced back to confirmed specimens and are therefore included in the distribution map.

Bryum archangelicum Bruch et Schimp.
[= *B. amblyodon* Müll. Hal., *B. inclinatum* (Brid.) Bland., *B. imbricatum* auct. non (Schwägr.) Bruch et Schimp., *B. stenotrichum* Müll. Hal.]
(Figs 8, 9)

Synoicous (rarely autoicous according to Demaret (1993)) or polyoicous, usually with sporophytes (in all specimens seen). **Plants** 1–1.5 cm tall, growing as solitary plants or in lax turf, yellowish green; rhizoids red-brown, finely papillose. **Leaves** crowded in comal tuft, erect when moist, weakly flexuose-twisted when dry; elongate-lanceolate, base reddish; margins entire or slightly denticulate near apex, often narrowly recurved nearly to apex, not or very slightly decurrent; costa longly excurrent, mostly denticulate. **Laminal cells** cells 40–60 × 15–18 μm, sometimes porose, at margin cells very narrow, up to 150 μm long, incrassate, forming distinct unistratose border 2–8 cells wide. **Seta** 1–3(–4) cm long, reddish brown. **Capsule** cernuous, to 4 mm long, obovate or pyriform, narrow at mouth, brown when ripe, lid flat, hardly mamillate. **Exostome** and endostome attached to each other at base only, exostome yellowish brown below, in upper part hyaline with conspicuously incrassate cell wall remnants. **Endostome** shorter than exostome, segments with oval perforations; cilia (3) short, rudimentary, not visible with a hand lens. **Spores** (18–)22–30 μm, green, finely papillose.

Notes: *B. archangelicum* cannot be identified without ripe sporophytes. In the field, the ovate, narrow-mouthed capsules, the flat lid and the endostome segments that lack cilia (visible with a hand lens) are good pointers. Cell wall remnants are conspicuously incrassate in the apical part of exostome teeth (see illustration Limpricht (1895): 319).

In many specimens of this species the leaf margin is not recurved, which makes the leaves appear broader and similar to those of *B. capillare*. Such plants cannot be safely determined unless sporophytes are present.

In some specimens many plants are purely female, and synoicous plants are only found after prolonged search, often only one out of ten fruiting plants.

According to Holyoak (2004) the size of the capsule mouth may be variable within *B. archangelicum*.

Similar species: *B. intermedium*: capsule narrowly pyriform, often delicate and thin, nearly always asymmetric, gibbous, dark red to blackish when ripe, endostome free, with long, nodose cilia (*B. archangelicum*: capsule symmetric, obovate, pyriform, not gibbous, brown when ripe, endostome attached to exostome in basal part, with short to rudimentary cilia). Both species have incrassate cell wall remnants in the upper part of the exostome, but exostome teeth are more slender in *B. intermedium*.

B. pallescens group: capsule large-mouthed, endostome as long as exostome, free and visible with a hand lens, with long appendiculate cilia, ripe capsules often inclined (*B. archangelicum*: capsule narrow-mouthed, ripe capsules always cernuous, endostome with short to rudimentary cilia.)

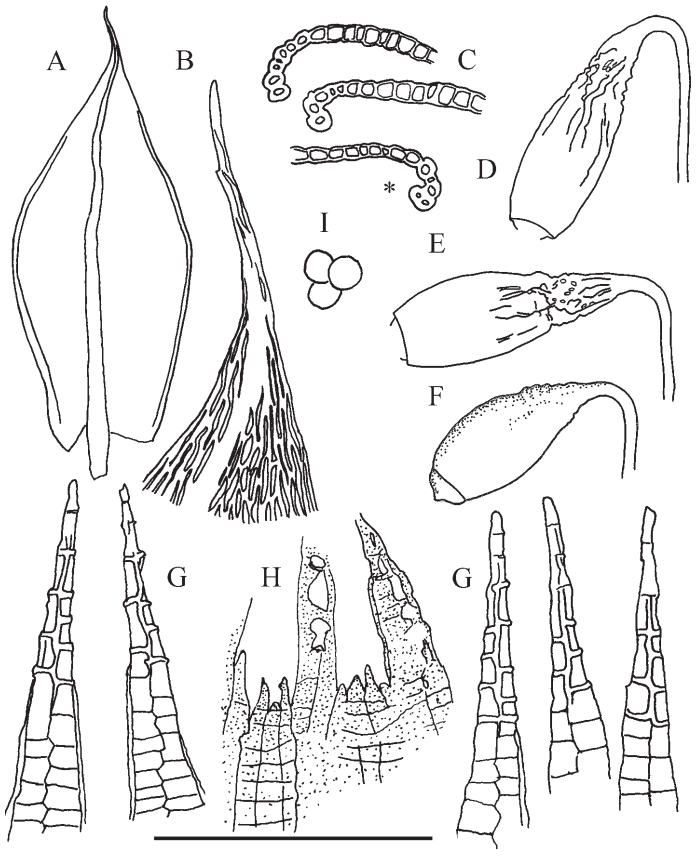

Fig. 8. *Bryum archangelicum*. A = leaf; B = leaf apex; C = cross sections of leaf margin (* – margin narrowly recurved, appearing bistratose); D–F = capsules (D, E: dry, F: moist); G = exostome teeth; H = detail of endostome; I = spores. Scale bar: A – 2 mm; B: – 400 μm; C, G–I: – 200 μm; D–F: – 4 mm. [A–D, G, I: EGR Vajda 1948 (Szentendre – Bükki puszta), E, F, H: BP 118335, del. Erzberger].

B. uliginosum: this species has spores of similar size and also short cilia; however, leaf characters are totally different: margin not recurved, bistratose, yellow, leaf base not red; plants autoicous (*B. archangelicum*: leaf margin recurved, unistratose, leaf base red, plants synoicous).

For the differences between *B. archangelicum* and *B. algovicum*, *B. caespiticium* and *B. knowltonii*, see the notes under the latter species.

References: Limpricht (1895): 319–320, Nyholm (1993): 191–193, Demaret (1993): 248–250, Ahrens (2001): 74–76, Hallingbäck (2008): 358–359, Guerra *et al.* (2010): 135–136.

Habitat: pioneer species on soil in moist or exposed sites, in open vegetation (in a swamp, on dry (andesite) rock, in sand grasslands, on walls).

Substrate: (calcareous) sand, soil, rocks, mortar, mostly in dry, rarely temporarily moist sites (bare soil, sand, at the trunk of trees).

Associated bryophytes: *Bryum pallescens*, *Thuidium abietinum*.

Vertical distribution: 100–350 (mean 113) m a.s.l.

Distribution in Hungary (11 specimens, 8 grid cells, of which 0 represent recent finds): **Zemplén Mts** (7594.3): Hungaria bor., com. Abaúj-Torna. In muris vallis Vajdavölgy, montis Sátorhegység prope pag. Pálháza, 24.05.1947 leg. L. Vajda EGR sub *B. caespiticium*; Comit. Abaúj-Torna. In abietis montis Dorgóhegy prope pag. Telkibánya, montes Sátorhegység, 14.09.1960 leg. L. Vajda EGR sub *B. cirratum* (revised to *B. archangelicum* + *B. pallescens*); **Mátra**

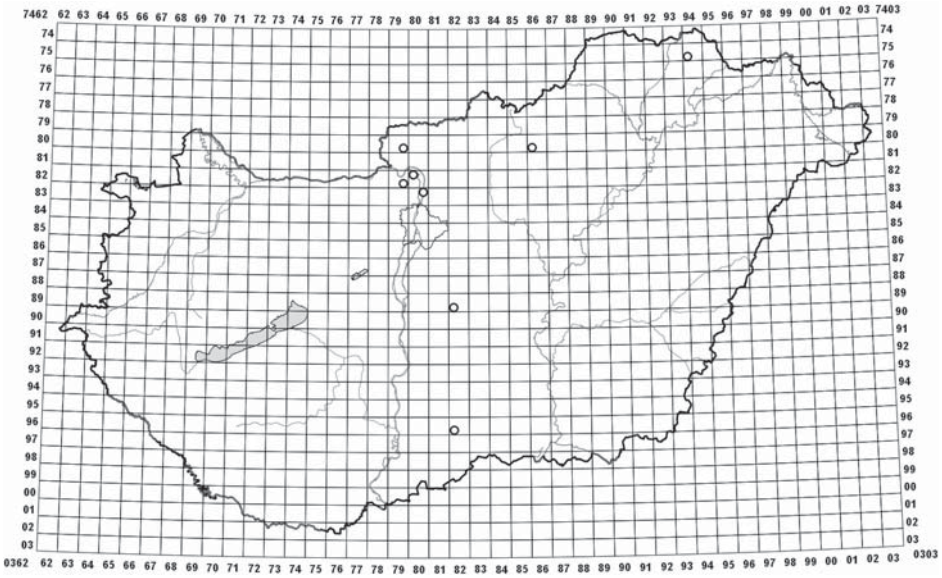

Fig. 9. Distribution of *Bryum archangelicum*.

Mts (8086.3): Locus natalis: Agrisense, in pratis (*Cynosureto-Festucetum rubrae*) pr. pag. Parádóhuta, 14.07.1960 leg. M. Kovács EGR sub *B.* sp.; **Börzsöny Mts** (8079.4): Comit. Nógrád. In rupibus siccis vallis rivi Nagyvasfazék-patak prope Királyrét, montes Börzsöny, 10.08.1958 leg. L. Vajda BP 59721 sub. *B. capillare*; **Visegrád Mts** (8279.4): Hungaria centr., com. Pest. In paludosis Bükki puszta vallis Bükkös-patak prope pag. Szentendre, 20.06.1948 leg. L. Vajda EGR; **8280.1** Comit. Pest. Ad stirpes arborum in lacune sub monte Ábrahámbükk prope pagum Tahi, 300–350 m, 01.06.1947 leg. Á. Boros BP 7742 sub *B. capillare*, BP 118335 sub *B. capillare*; **Danube–Tisza Interfluve** (8782.3–8781): Comit. Pest. In arenosis ad Új szőllő prope pag. Ócsa (versus Kakucs), 100 m, 06.06.1919 leg. Á. Boros BP 116858; (8982.3) Comit. Pest. In collibus arenosis fruticetis Borovicska-erdő ad Sarlósár prope Tatárszentgyörgy, 100 m, 25.06.1919 leg. Á. Boros BP 116871; (9682.3) Comit. Pest et Bács-Bodrog. In arenosis dumetosis territ. Vármegyehatár inter Városlanya et Terézhalom inter oppida Kiskunhalas et Jánoshalma, 150 m, 31.07.1919 leg. Á. Boros BP 116872; **Pest Plain** (8380.2): Comit. Pest. Insula Szentendrei-sziget. In arenosis ad Horány, 100 m, 21.05.1925 leg. Á. Boros BP 116856.

There are no recent records for *B. archangelicum*, although this species is not rare in other central European countries (e.g. Austria – Grims and Köckinger 1999, Germany – Meinunger and Schröder 2007). This would suggest that the species is under-collected at present. Red list status: DD (Papp *et al.* 2010).

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB, UA.

Literature: Boros (1953, 1968), Orbán and Vajda (1983) give three regions: "Pilis Mts" (Bükki puszta: see confirmed specimen above: Visegrád Mts), Mecsek Mts, and Danube–Tisza Interfluve (see confirmed specimens above, also Pest Plain). For Mecsek Mts, there is one doubtful specimen (not shown in the map): 9975.1 Pécs, fűzfa kérgén a bőrgyári tónál, 120 m, 08.04.1934 leg. A. Visnya BP 118711 sub *B. capillare* (det. by A. Latzel; revision: *B.* cf. *archangelicum*, sterile). There are several rejected specimens originally under *B. inclinatum*, also two from Mecsek Mts, and several from Danube–Tisza Interfluve. This may be the basis for the assertion in the literature that *B. inclinatum* is more frequent in the Danube region. We give a complete list of all unconfirmed specimens under *B. inclinatum*: Vértes Mts (8576.1): Comit. Komárom. In locis humidis silvat. ripae rivi vallis Bodony-völgy prope Oroszlány, versus fontem Buger-kút, 200 m, 21.06.1937 leg. Á. Boros BP 116864 sub *B. inclinatum* var. *laubacense* Roth det. Podpera; has been revised to *B. uliginosum*; Mecsek Mts (9876.2): Pécsvárad, a vár alatti út árkának kőfalán (in pencil: Auf Kalksteinmauer, sonnig, trocken), 240 m, 08.07.1934 leg. A. Visnya BP 116867 (original determination by A. Latzel; has been revised to *B. algovicum*); (9877.1) Rácmecske, a vasuti állomás rakodójának gránitkőből épült falán (in pencil: Mauer aus Granitsteinen, sonnig, trocken),

200 m, 23.07.1934 leg. A. Visnya BP 116868 (original determination by A. Latzel; has been revised to *B. algovicum*); Danube–Tisza Interfluve (8982.3): Comit. Pest. In collibus arenosis Borovicska-erdő ad Sarlósár prope pagum Tatárszentgyörgy, 100 m, 30.06.1920 leg. Á. Boros BP 116855 (original determination by Podpera; has been revised to *B. algovicum*); BP 116870 is a duplicate collected 25.06.1919 (revised to *B.* cf. *pallescens*); (8883.1) Comit. Pest. In silva Nagyerdő ad Puszta Vacs prope Örkény, 100 m, 05.07.1919 leg. Á. Boros BP 116869 (revised to *B. caespiticium*); (9485.1): Comit. Pest. In natronatis ripae lacus Szent Péteri-tó ad Fekete-halom prope Kiskunfélegyháza, 90 m, 07.06.1926 leg. Á. Boros BP 116857 (revision: synoicous *Bryum* without ripe sporophytes; may be *B. archangelicum*, *B. algovicum* or *B. lonchocaulon*); Nyírség (8296.1): Comit. Szabolcs. In natronatis ad viam ferream prope Újfehértó, 120 m, 17.08.1926 leg. Á. Boros BP 116865 (revised to *B.* cf. *algovicum*).

Boros (1968) also reports three varieties of *B. inclinatum*:

– var. *otoeides* Podp. – A single specimen from the locality was found, but qualified by Podpera as indeterminable: (9586.2) Comit. Csongrád. In muris Árpád szobor ad pusztaszeri Major, 85 m, 18.05.1938 leg. Á. Boros BP 116866 inserted under *B. pendulum*? with additional inscription "A termőhely a *B. inclinatum* var. *otoeides* Podp. Fol. Crypt. I. 1933: 1322.-re utalna!" (the site might suggest *B. inclinatum* var. *otoeides* Podp. Fol. Crypt. I. 1933: 1322) – (revised to *B. dichotomum* form).

– var. *laubacense* Roth, for which a single locality in the Vértes Mts is given. The corresponding specimen represents in fact the only specimen of *B. uliginosum* (see there).

– var. *hagenii* (Limpr.) Podp. – the corresponding specimen was revised to *B. lonchocaulon* (see there).

Papp and Rajczy (1999) publish several records from the Danube–Tisza Interfluve, apart from literature reports all specimens from BP that were originally under *B. inclinatum*; according to the results of our revision, these are for the most part unreliable or erroneous except the confirmed specimens listed above.

Bryum argenteum Hedw.
(Figs 10, 11)

Dioicous, sporophytes frequent (in 17.6% of specimens seen). **Plants** 0.5–1 (–2) cm tall, mostly in dense turf, but also scattered solitary plants, branched, fragile; moist plants glaucous green, dry plants appearing silver-whitish; rhizoids very light red-brown, nearly smooth. **Leafy bulbils** often present in leaf axils of plants. **Leaves** evenly arranged along julaceous stem, imbricate; ovate, concave, leaf tip short or longly cuspidate (f. *lanata*: in dry, exposed habitats); margin en-

tire, plane or slightly recurved below; upper part of leaves often without chloroplasts, therefore hyaline, whitish; costa thin, ending shortly above mid-leaf, rarely reaching into apex or shortly excurrent. **Laminal cells** thin to rather incrassate, very lax, 30–50 × 8–12(–16) μm, marginal cells narrower, border indistinct. **Seta** 1–2 cm long. **Capsules** pendulous, 1–2.5 mm long, short, ovate, contracted below mouth when dry, abruptly narrowed into seta, red when young, light brown when ripe, dark red to blackish when old. **Endostome** cilia longly appendiculate. **Spores** (8–)10–12(–14) μm, smooth or almost so.

Similar species: *B. argenteum* can hardly be mistaken for any other Hungarian species due to the characteristic julaceous whitish habit, except perhaps *Plagiobryum zierii*, which has, however, wider laminal cells: 14–25 μm (*B. argenteum*: 8–16 μm). In very dry places bulbils that somewhat resemble those of *B. dichotomum* are frequent, but in that species laminal cells are chlorophyllose to the apex; leaves are less concave and the shoots not julaceous (*B. argenteum*: whitish silvery, leaves without chlorophyll in upper part, leaves concave, shoots julaceous).

For the differences between *B. argenteum* and *B. funckii*, see the note under the latter species.

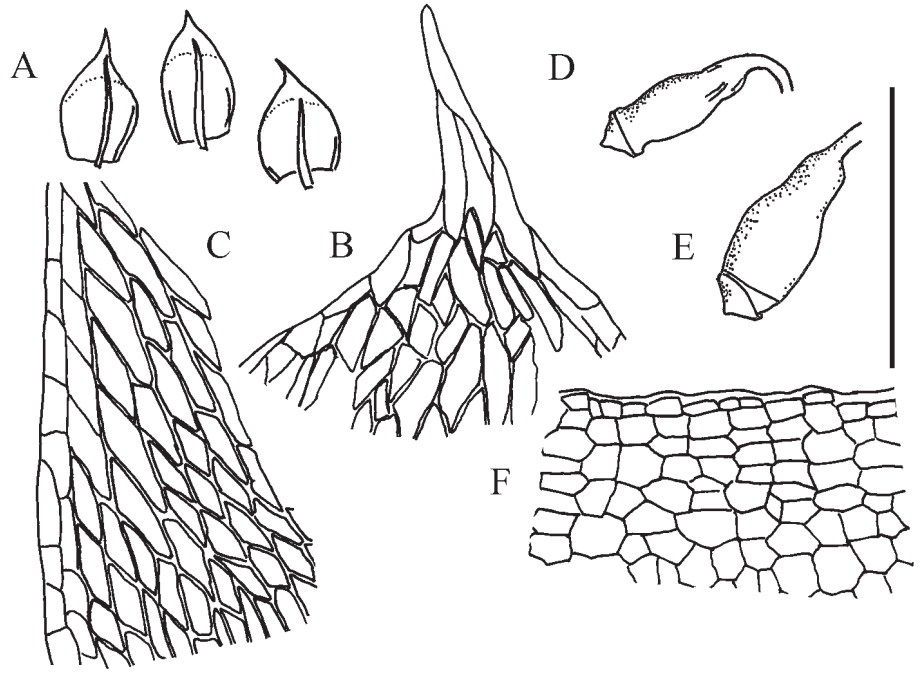

Fig. 10. *Bryum argenteum*. A = leaves (stippled line: transition from chlorophyllose to hyaline part); B = leaf apex; C = leaf margin; D, E = capsules (dry/moist); F = exothecial cells at capsule mouth. Scale bar: A: – 2 mm; B, C, F: – 200 μm; D, E: – 4 mm. [Erzberger 5, del. Erzberger].

References: Limpricht (1895): 422–424, Demaret (1993): 199–201, Nyholm (1993): 219–220, Ahrens (2001): 55–57, Smith (2004): 568–570.

Habitat: waste soil, in arable and fallow fields, in limestone, dolomite and open basalt grasslands, in saline meadows, at river banks, sandy ditches, on walls of vineyards, in a dried-up swamp; avoids very wet habitats.

Substrate: soil, gravelly soil, alkaline soil, clay, loess, trunks of trees, wooden fence, rotting wood, stone wall, brick wall, concrete, roof tiles, on thatched roofs, on stone pavement, dry and moist andesitic rock, basalt rock, sandstone, limestone, diabase.

Associated bryophytes: *Aloina* sp., *Barbula unguiculata*, *Bryum caespiticium*, *B. dichotomum*, *B. moravicum*, *B. radiculosum*, *B. rubens*, *B. subapiculatum*, *B. violaceum*, *Ceratodon purpureus*, *Didymodon acutus*, *D. luridus*, *D. rigidulus*, *Encalypta vulgaris*, *Entosthodon longicolle*, *Grimmia pulvinata*, *Homalothecium sericeum*, *Leptodictyum riparium*, *Phascum cuspidatum* var. *cuspidatum*, *P. cuspidatum* var. *piliferum*, *Pottia bryoides*, *P. lanceolata*, *Pseudocrossidium hornschuchianum*, *Pterygoneurum ovatum*, *Syntrichia ruralis*, *Tortula muralis*, *Weissia condensa*.

Vertical distribution: 80–710 (mean 216) m a.s.l.

Distribution in Hungary (303 specimens; 175 grid cells, 90 of which represent recent records): Probably present in all grid cells! Quotation of specimens seems unnecessary. *B. argenteum* occurs in probably all floristical regions (there are specimens from the Zemplén Mts, Aggtelek Karst, Putnok Hills, Bükk Mts,

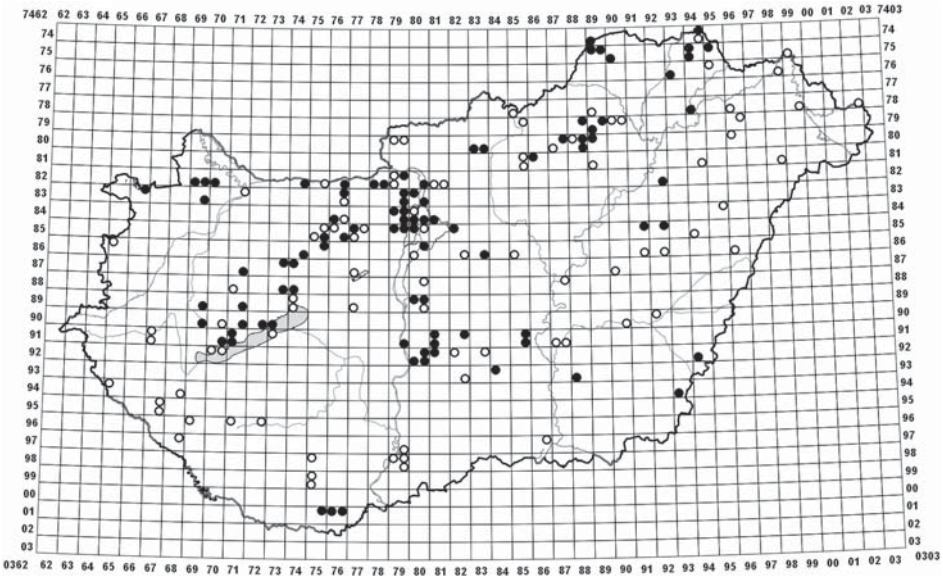

Fig. 11. Distribution of *Bryum argenteum*.

Mátra Mts, Karancs–Medves Mts, Cserhát Hills, Gödöllő Hills, Börzsöny Mts, Visegrád Mts, Pilis Mts, Buda Mts, Gerecse Mts, Vértes Mts, Velence Mts, Bakony Mts, Balaton Uplands, Keszthely Mts, Sopron Mts, Kőszeg Mts, Zala, Belső-Somogy, Külső-Somogy, Mecsek Mts, Villány Mts, Kisalföld, Hanság, Danube–Tisza interfluve, Tiszántúl, Nyírség, Észak-Alföld, Pest Plain); we have not seen specimens from Cserehát, Aggteleki-kavicshát, Naszály, Fertő Hills, Vendvidék, Őrség, Hetés, Vas, Göcsej, Zselic, Dráva-vidék, but surely *B. argenteum* can be found in many if not all of these as well. Red list status: LC (Papp *et al.* 2010).

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB, UA.

Literature: Papp and Rajczy (1999) publish a number of records from the Danube–Tisza Interfluve, but we did not try to trace these back to confirmed specimens. Zanten (1999) reports on *B. argenteum* in loess cliffs.

Bryum badium (Brid.) Schimp.
[= *B. caespiticium* var. *badium* Bruch ex Brid.]
(Figs 12, 13)

Dioicous; frequently with sporophytes (seen in both specimens). **Plants** only a few millimetres to 1 cm tall, growing as solitary plants or in lax turf; yellowish green, often with a reddish or brownish hue; rhizoids red-brown, papillose. **Leaves** erectopatent when moist, appressed when dry, elongate triangular lanceolate, taut, reddish at base; margin entire, plane or recurved; costa mostly very longly excurrent, flexuose, apically sharply dentate all round, not just at margins. **Laminal cells** 40–60 × 12–15(–20) μm; marginal cells narrow, elongate, hardly forming border. Due to the very longly excurrent yellowish costae the shoot tip resembles a paint brush. **Seta** 2–3 cm. **Capsule** cernuous to pendulous, short, thick, rather wide-mouthed when moist and when dry, slightly contracted below mouth when dry, red. **Exostome** yellow-brown. **Endostome** lemon-yellow, segments with circular perforations, cilia nodose or appendiculate. **Spores** 12–16 μm, smooth.

Similar species: *B. badium* has often been confused with other species, in particular with *B. caespiticium*: plants to 3 cm tall; capsules brown (*B. badium*: plants to 1.5 cm tall; capsules red).

B. erythrocarpum group: plants with rhizoidal tubers (*B. badium* without rhizoidal tubers).

B. intermedium: capsules gibbous, narrow-mouthed (*B. badium*: not gibbous, wide-mouthed).

Note on taxonomic status: The difficulties in separating this taxon from *B. caespiticium* have prompted many authors to regard it as a subspecific taxon of or include it in *B. caespiticium* (Hill *et al.* 2006, Ahrens 2001).

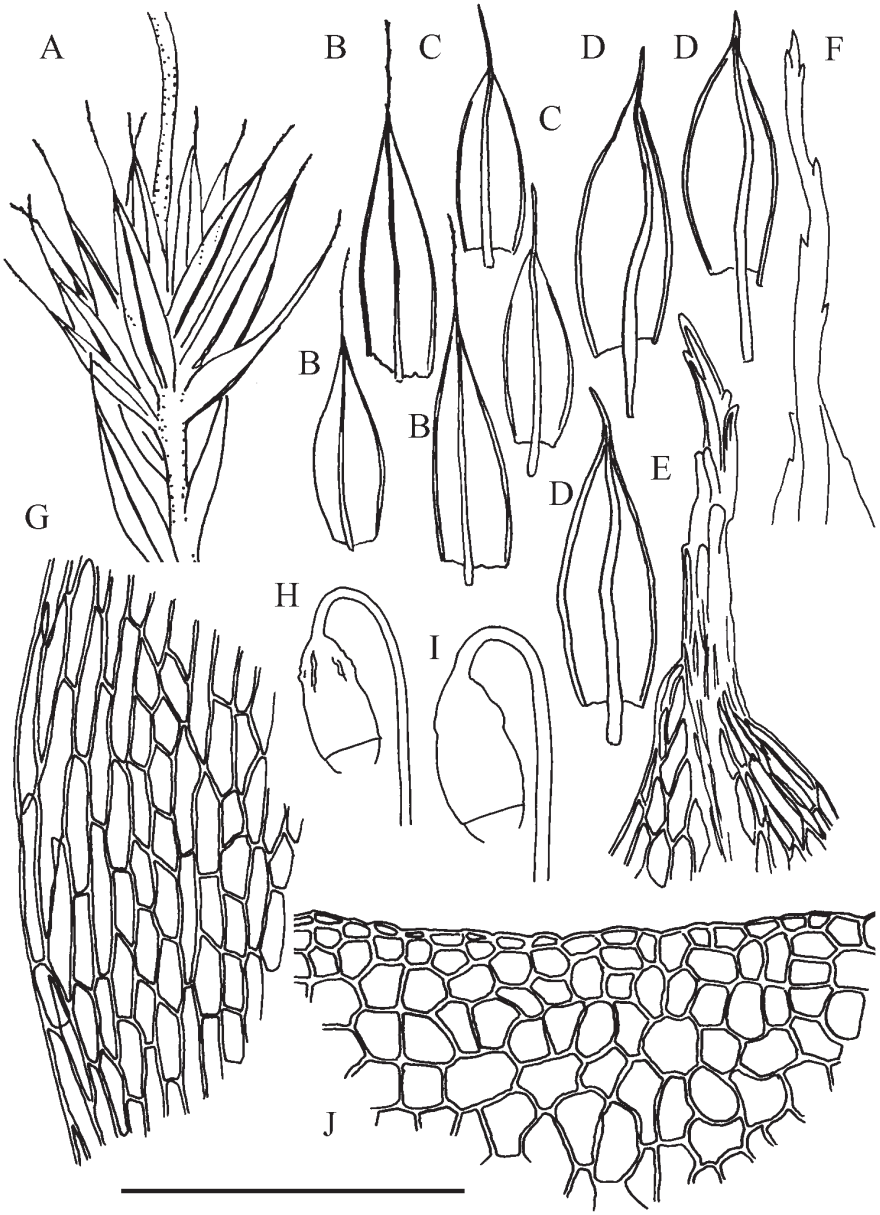

Fig. 12. *Bryum badium*. A = shoot apex of female plant with seta, habit (moist); B–D = leaves; E, F = leaf apices; G = leaf margin; H, I = capsules (dry/moist); J = exothecial cells at capsule mouth. Scale bar: A: – 3 mm; B–D: – 2 mm; E–G, J: – 200 μm; H, I: – 4 mm. [A, B: Reuter s.n. (Switzerland, Arve-Rhône 1839), C, H, I: BP 117668; D, E, G, J: Erzberger 11394, F: Holler s.n. (Germany: Memmingen 8027.1), A, B: del. Schröder, C-J: del. Erzberger].

References: Limpricht (1895): 383–385, Nyholm (1993): 204–205, Ahrens (2001): 61.

Habitat: in sand pits, on sand at riversides, often with *B. klinggraeffii* (at a forest edge, in saline grasslands).

Substrate: moist, calcareous sand, clay, alkaline soil.

Associated bryophytes: none.

Vertical distribution: 100–300 (mean 188) m a.s.l.

Distribution in Hungary: doubtfully recorded from Hungary (2 specimens, 2 grid cells, of which 1 represents a recent find): **Gerecse Mts** (8476.2): Comit. Komárom. In argillosis ad marg. silv. supra loc. Gödör dict. prope Alsógalla, 250–300 m, 01.05.1938 leg. Á. Boros BP 117668; **Danube–Tisza Interfluve** (8980.2): Com. Bács-Kiskun, Große Tiefebene, Donau–Theiß Interfluvium, Nationalpark Kiskunság, Apaj, Natronsteppe, N 47° 5' 11", E 19° 5' 53", 100 m, 12.04.2006 leg. P. Erzberger (B Erzberger 11394) sub *B. caespiticium*.

There is some uncertainty about the presence of this species in Hungary, because the plants in both specimens are not completely typical. In the specimen collected by Boros, the dentation of the excurrent costa is rather weak. Podpera determined this specimen as *B. badium*. The other specimen seems to have aborted spores, so that spore size could not be determined with certainty. In other respects, this specimen does show the typical features of *B. badium*, also with respect to the coloration of the peristome.

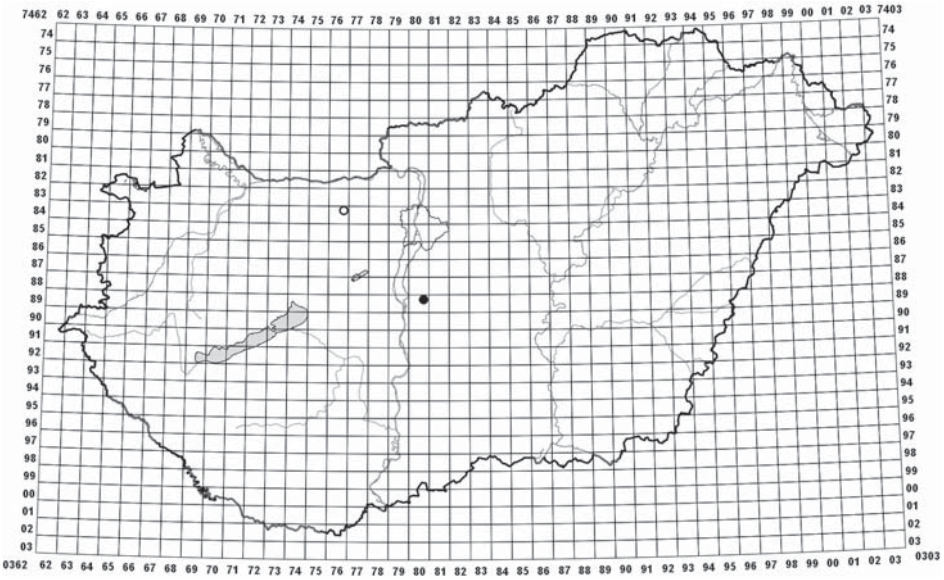

Fig. 13. Distribution of *Bryum badium*.

This taxon has been included in *B. caespiticium* in recent Hungarian checklists (Erzberger and Papp 2004, Papp *et al.* 2010) and therefore not been assigned to a red list category. DD appears appropriate.

Distribution in adjacent countries: A, SLO, UA; due to the controversial taxonomic status of the taxon this may not reflect the actual distribution.

Literature: Boros (1953, 1968), Orbán and Vajda (1983) give two localities, apart from the Gerecse site a second locality in the Pest Plain: Taksony, based on a report by Förster, for which no specimen could be located. One specimen from the Danube–Tisza Interfluve, published under *B. caespiticium* in Papp and Rajczy (1999), was originally doubtfully determined as *B. badium* by Podpera. However, we could not confirm his determination (could not safely be determined): (8781.4) Comit. Pest. In pratis prope pag. Sári, versus Inárcs, 100 m, 07.06.1931 leg. Á. Boros EGR, BP 117669. Another specimen, also doubtfully determined as *B. badium* by Podpera, was revised to *B. caespiticium*: (8696.3) Comit. Bihar. In natronatis ad viam ferream prope Konyár, versus Derecske, 97 m, 11.05.1937 leg. Á. Boros BP 117667.

Bryum barnesii J. B. Wood ex Schimp.
(Fig. 14)

Dioicous, occasionally with sporophytes. **Plants** to 1 cm tall, in lax tufts, often mixed with other species, golden green to olive green; rhizoids pale brown, finely papillose. **Bulbils** usually present, ovate, usually several, up to 10(–15) per leaf axil, 100–250(–450) μm long, with blunt, rounded, incurved leaf primordia. **Leaves** evenly arranged along stem, erectopatent when moist, appressed when dry, ovate, usually with blunt tip, concave; margin entire, plane; costa stout, ending in leaf apex or below, occasionally shortly excurrent. **Laminal cells** 30–60 × (10–)12–20 μm, only slightly narrower towards margin, not forming distinct border, thin-walled to moderately incrassate. **Seta** 1–1.5 cm. **Capsule** pendulous, short, thick, abruptly narrowed to seta. **Endostome** cilia appendiculate. **Spores** 10–12(–15) μm.

Similar species: *B. dichotomum*: costa mostly excurrent, only 1–3 bulbils per leaf axil, to 400 μm, leaf primordia mostly acute and erect (*B. barnesii*: costa mostly ending below or in leaf apex; up to 10 bulbils per leaf axil, 100–250 μm, leaf primordia blunt, incurved).

B. gemmiferum: up to 30 bulbils per leaf axil, 100–150 μm, leaf primordia hook-like, plants yellow-green (*B. barnesii*: up to 10 bulbils per leaf axil, 100–250(–450) μm, leaf primordia blunt, plants green).

References: Klawitter (1985), Demaret (1993): 210–212, Ahrens (2001): 57–58.

Note on taxonomic status: HOLYOAK (2004) considers the differences between *B. barnesii* and *B. dichotomum*, in particular the number of bulbils per leaf axil, to be variable and not reliable and includes *B. barnesii* in the synonymy of *B. dichotomum*.

Habitat: pioneer on sandy soil, at roadsides, in fallow fields.

Substrate: moist calcareous or neutral sand and gravel.

Distribution in Hungary: excluded from Hungary.

Distribution in adjacent countries: A (SCHLÜSSLMAYR 2005, 2011). Since many authors include *B. barnesii* in *B. dichotomum*, *B. barnesii* is missing from most checklists and the true distribution is not known.

Literature: *B. barnesii* was reported for Hungary in DÜLL (1985), but we did not find any specimen. Until appropriate material turns up, we consider this species as excluded from the Hungarian bryoflora.

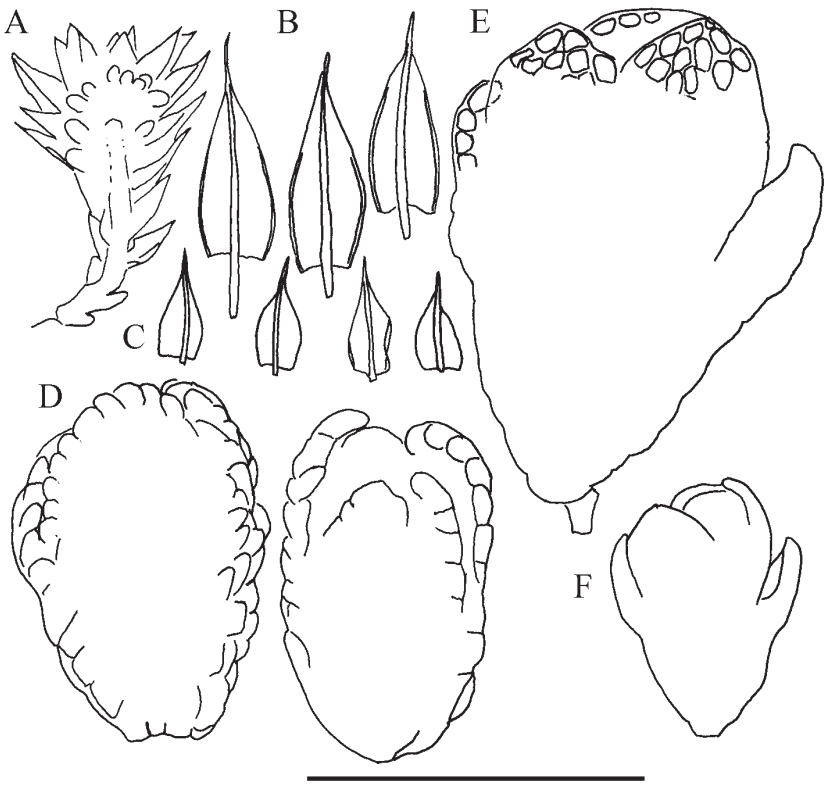

Fig. 14. *Bryum barnesii*. A = plant with bulbils; B–C = leaves; D–F = bulbils. Scale bar: A–C: – 2 mm; D, E: – 200 μm; F: – 400 μm. [A, C, D: Erzberger 1871 (Germany), B, E, F: Erzberger 7909 (Germany), del. Erzberger].

Bryum bimum (Schreb.) Turner
[= *B. pseudotriquetrum* var. *bimum* (Schreb.) Lilj., *B. pseudotriquetrum* subsp. *bimum* (Schreb.) Hartm.]
(Figs 15, 16)

Synoicous, nearly always with sporophytes (in 87% of specimens seen). **Plants** growing in 3–10 cm tall dense turf, green, often tinged red; tomentum of rhizoids reaching far up stem; rhizoids red, finely papillose. **Filiform gemmae** in leaf axils are extremely rare in this taxon. **Leaves** evenly arranged along stem, erectopatent when moist, flexuose to twisted when dry; very robust, taut, ovate-lanceolate, leaf base red; margin entire, but often denticulate at apex, ± recurved; costa red, ending in leaf apex or excurrent as short, denticulate apiculus. **Laminal**

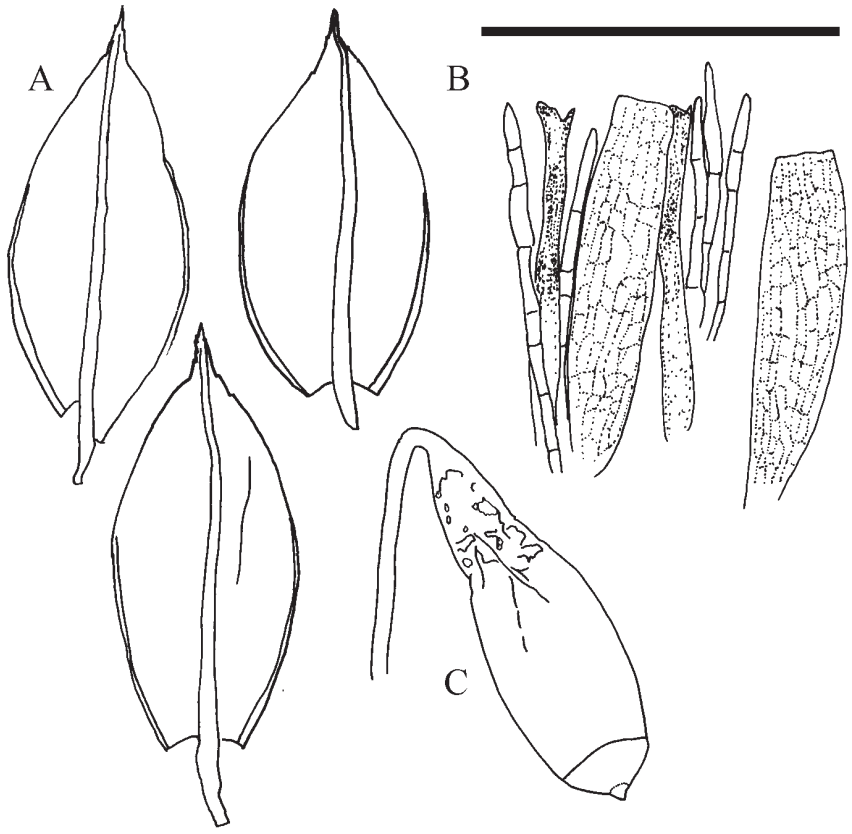

Fig. 15. *Bryum bimum*. A = leaves; B = detail of synoicous inflorescence; C = capsule. Scale bar: A: – 2 mm; B: – 200 µm; C: – 4 mm. [A, C: EGR Vajda 1948 (Sikáros/Visegrád), B: EGR Vajda 1952 (Tó-hegy/Zemplén), del. Erzberger].

cells very lax, areolation reticulate, 30–40(–50) × 15–20 µm, distinct unistratose marginal border of 5–8 rows of narrow, incrassate cells, distinctly decurrent along stem. **Seta** 2–5 cm. **Capsule** cernuous, 3–5 mm long, large-mouthed. **Endostome** cilia appendiculate. **Spores** 12–15(–25) µm, finely papillose.

Notes: *B. bimum* can be recognised in the field by its reddish coloration, the costa that is only shortly excurrent, the copiously developed sporophytes, and its occurrence mostly in disturbed habitats.

Similar species: *B. pseudotriquetrum*: usually more robust, to 10 cm tall, dioicous and rarely producing sporophytes, mostly growing in moist meadows, the surroundings of springs, plants calciphilic and basiphilic (*B. bimum*: to 5 cm tall, synoicous, mostly with sporophytes, growing often in disturbed habitats, moist sand pits, on gravel paths, even on wet tarmac).

References: Demaret (1993): 192–194, Nyholm (1993): 198–199, Zolotov (2000): 202–209.

Note on taxonomic status: Many authors include *B. bimum* in *B. pseudotriquetrum*, often as subspecies or variety (Demaret 1993, Ahrens 2001).

Habitat: mostly in disturbed habitats: in old quarries, sand pits; less frequent in wetlands (at the base of trees in ash-alder carr, near streams, in moist sand pits, in a moist meadow, in wetlands, on moist calcareous tufa at a thermal spring, on diabase rock).

Substrate: moist calcareous soil and sand.

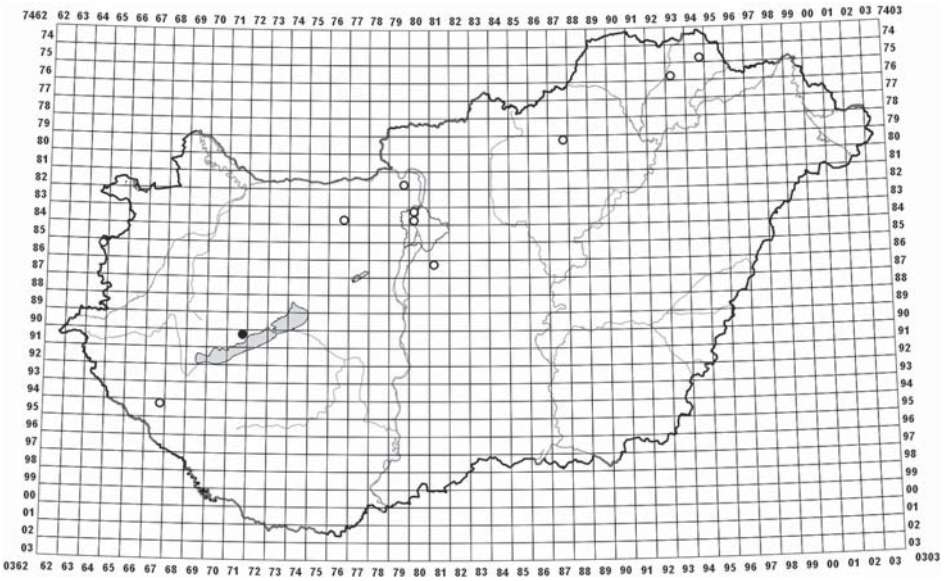

Fig. 16. Distribution of *Bryum bimum*.

Associated bryophytes: *Calliergonella cuspidata*, *Cratoneuron filicinum*, *Didymodon tophaceus*, *Funaria hygrometrica*, *Pohlia nutans*.

Vertical distribution: 100–540 (mean 187) m a.s.l.

Distribution in Hungary (15 specimens, 11 grid cells, of which 1 represents a recent find): **Zemplén Mts** (7693.3): Com. Abaúj-Torna. In pratis humidis montis Tóhegy prope pag. Boldogkőváralja, 26.05.1952 leg. L. Vajda EGR; **Bükk Mts** (8087.2): Comit. Heves. In rupestribus diabas. ad Szarvaskő, 300 m, 11.08.1924 leg. Á. Boros BP 117115; **Gödöllő Hills** (8381.2–8381.4): Comit. Pest. In pratis paludosis lacus ad Veresegyház, 150 m, 06.03.1919 leg. Á. Boros BP 117113; **Visegrád Mts** (8279.4): Hungaria centr., com. Pest. In valle Bükköspatak prope Sikáros, 08.05.1948 leg. L. Vajda EGR sub *B. capillare*; **Buda Mts** (8480.3): Budapest. Óbuda. In locis irrigatis calc. fontis therm. ad Árpádmalom, 100 m, 25.03.1933 leg. Á. Boros BP 117121; **Vértes Mts** (8476.4): Comit. Komárom. In arenosis humidis foveae Csákányi-szőllők pr. Felsőgalla, 200–260 m, 25.07.1937 leg. Á. Boros BP 117114; **Balaton Uplands** (9171.2): Comit. Veszprém. In loco paludoso Sásdi-rétek inter pag. Köveskál et Szentbékkála, 130 m, 04.08.1996 leg. B. Papp BP 163341 sub *B. pseudotriquetrum*; **Kőszeg Mts** (8664.2): Kőszeg, im Bächlein unter den Steirer Häusern, 540 m, 03.02.1931 leg. A. Visnya BP 117116; **Zala** (9567.2): Flora hungarica, mer.-occ. Com. Zala. In locis arenosis humidis inter Nagykanizsa et Sormás, 150 m, 07.02.1948 leg. Á. Károlyi EGR sub *B.* sp.; **Danube–Tisza Interfluve** (8781.1): Com. Pest. Ad stirpes arborum in fraxinetis paludosis prope Ócsa, versus Madencia, 100 m, 14.10.1928 leg. Á. Boros BP 117120.

Since the sexual condition must be studied to identify this taxon, it has certainly been much overlooked; therefore the distributional record is probably very incomplete. No red list status has been assigned, since *B. bimum* was not separated from *B. pseudotriquetrum* in Papp *et al.* (2010). LC-att is suggested, also because *B. bimum* is less restricted to wetlands, than *B. pseudotriquetrum*, but can colonise also disturbed habitats.

Distribution in adjacent countries: A, SLO, UA. Due to differences in taxonomic treatment (as infraspecific taxon of *B. pseudotriquetrum*), this may not reflect the true distribution.

Literature: Boros (1953) lists the four localities known at that time (Kőszeg, Óbuda, Veresegyház, and Ócsa). Boros (1968) adds the Bükk and Vértes Mts with a question mark, since the corresponding specimens (see above enumeration) were annotated as doubtful by L. Loeske (BP 117115) and J. Podpera (BP 117114), respectively, who determined them. These records can here be confirmed, and several others added, which were not recognised at the time of collection. Although the Zemplén specimen from EGR was correctly named by S. Orbán, this region is not mentioned under *B. bimum* in Orbán and Vajda (1983).

Bryum blindii Bruch et Schimp.

Dioicous, but often with sporophytes. **Plants** growing in 0.5–1 cm tall whitish green to golden coloured turf or as solitary plants; rhizoids dark red, coarsely papillose. **Bulbils** in leaf axils oblong with rounded leaf primordia, 500–600(–800) μm long, but not always present. **Leaves** imbricate, slightly patent when moist; dry plants nearly julaceous; leaves strongly concave, in sterile plants elongate-ovate, obtuse, margins parallel in lower 2/3, entire, plane; perichaetial leaves elongate-lanceolate, acuminate, margin recurved; costa stout, ending shortly below leaf apex. **Laminal cells** 50–70 × 10–12 μm in sterile plants, up to 100 μm long in perichaetial leaves. **Seta** 1–1.5 cm. **Capsule** pendulous, short, broadly ovate, thick-walled, red-brown when ripe, lid conical. **Endostome** cilia appendiculate. **Spores** 12–16 μm, finely papillose.

Similar species: *B. dichotomum*: plants green; leaves ovate-lanceolate with excurrent costa (*B. blindii*: plants whitish green to golden coloured; leaves oblong with costa ending below leaf apex).

B. funckii: capsule turbinate when dry; bulbils lacking; leaves broadly ovate (*B. blindii*: capsule broadly ovate; bulbils 500–800 μm long; leaves elongate-ovate).

References: Limpricht (1895): 419–421, Nyholm (1993): 216–217.

Habitat: at the bank of streams and rivers in siliceous mountain areas, but also in limestone regions in sites that are superficially decalcified.

Substrate: intermediate rocks; on basic sand and gravel.

Distribution in Hungary: not reported from Hungary.

Distribution in adjacent countries: A.

Bryum bornholmense Wink. et R. Ruthe
(Fig. 17)

Dioicous, synoicous or autoicous, sporophytes occasional. **Plants** 0.5–1.5 cm tall, growing in very lax tufts, green or reddish; rhizoids light red, papillose. **Rhizoidal tubers** 200–350(–450) μm, brownish yellow to brownish orange, cells thin-walled, not to slightly protuberant, (30–)45–60 μm in diameter; tubers found only in the substrate at long rhizoids, never near the stem. **Leaves** crowded in comal tuft in fruiting plants, erect when moist, flexuose when dry, ovate-lanceolate; margin denticulate near apex, entire below and slightly recurved; costa 65–100 μm wide at leaf base, ending in leaf apex or shortly excurrent. **Laminal cells** (50–)60–80(–120) × 15–20 μm, towards margin 1–2(–4) rows of narrower cells forming distinct border. **Seta** 2–4 cm, brown-reddish. **Capsule** pendulous, 2.4–4 mm long, neck slightly curved, similar to *B. intermedium*, red-brown. **Endostome** cilia appendiculate. **Spores** 10–15 μm, nearly smooth.

Similar species: *B. rubens*: very similar to *B. bornholmense* and only distinguishable with certainty by the rhizoidal tubers. These are rubin-red, turning very dark to nearly black with dilute alkali in *B. rubens*, to 250 μm, with protuberant, thick-walled cells 30–35(–45) μm in diameter (*B. bornholmense*: rhizoidal

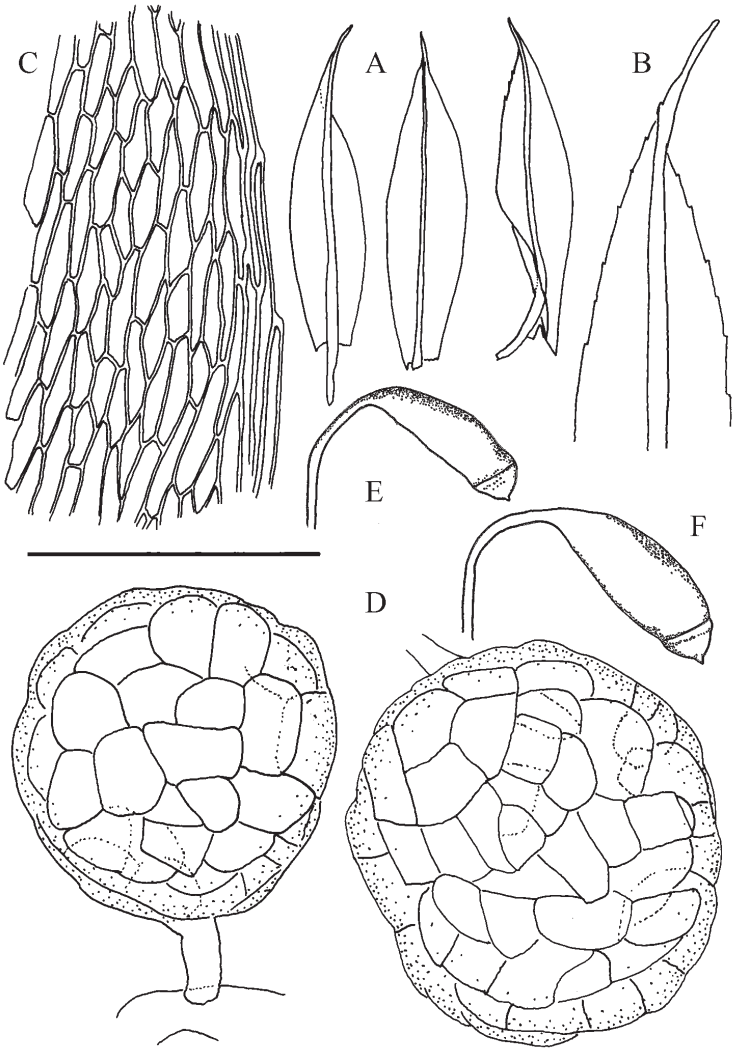

Fig. 17. *Bryum bornholmense*. A = leaves; B = leaf apex; C = marginal and median laminal cells; D = rhizoidal tubers; E, F = capsules (dry/moist). Scale bar: A: – 2 mm; B: – 800 μm; C, D: – 200 μm, E, F: – 4 mm. [A–D: Schröder s.n. (Germany: Saxonia 5245.33 Lengefeld, leg. S. Biedermann), E, F: Schröder s.n. (Germany: Lower Saxonia 2824.2 Wintermoor: Acker leg. W. Schröder), del. Erzberger].

tubers brownish, becoming red or turning dark red, but not nearly black with dilute alkali, often > 250 µm, cells not to very slightly protuberant, thin-walled, larger, (30–)45–60 µm in diameter).

B. subapiculatum: tubers 150–250(–300) µm, red, often somewhat irregular in shape, more oblong, less spherical, leaves not or only very indistinctly bordered by narrower cells, laminal cells 10–12 µm wide (*B. bornholmense*: tubers larger, 200–350 µm and more, brownish yellow to brownish orange in colour, ± spherical, leaves with a distinct border of narrow, elongate cells, laminal cells 15–20 µm wide).

In stunted or depauperate plants, the marginal leaf border can be less pronounced. Compare also the note under *B. rubens*.

References: Crundwell and Nyholm (1964): 626–629, Nyholm (1993): 211–212, Demaret (1993): 183–185, Crundwell and Whitehouse (2001), Smith (2004): 581–583, Hallingbäck (2008): 352–353, Guerra *et al.* (2010): 155–156.

Habitat: on open soil in ± stable habitats, e.g. pastures; not in arable fields.

Substrate: sandy or clayey soil, seemingly indifferent to pH and salt exposure.

Distribution in Hungary: excluded from Hungary.

Distribution in adjacent countries: –.

Literature: No specimen of *B. bornholmense* was found during our revision. Two specimens inserted in *B. bornholmense* in BP had to be revised to other species: Danube–Tisza Interfluve (9181.3): Comit. Bács-Kiskun, in *Festucetum vaginatae* prope pag. Fülöpháza, 100 m, 18.07.1977 leg. M. Rajczy det. B. Papp as *B.* cf. *bornholmense* BP 164677, revised to *B. subapiculatum*; Tiszántúl (7891.3): Borsod-Abaúj-Zemplén County. East from Miskolc town. Isolated twin loess hills near Onga. On soil on the smaller hill, in *Salvio-Festucetum rupicolae* association, 15.05.1998 leg. G. Kis det. B. Papp 04.2007 as *B. bornholmense* BP 170332, containing *B. rubens*, *B. dichotomum* and *B. klinggraeffii*. However, there are two literature reports (compare Erzberger and Papp 2004): Crundwell and Nyholm (1964) and Papp and Rajczy (1999). The latter is based on the specimen BP 164677 that was revised to *B. subapiculatum*. More interesting is the former report, which has also been quoted in Boros (1968) and Orbán and Vajda (1983): A. C. Crundwell found the plants reported as *B. bornholmense* as admixture in a specimen of *Entosthodon longicolle* (= *Funaria hungarica*) collected by Á. Boros: Comit. Pest. In natronatis ad Szabadszállás, 95 m, 13.04.1951 (in the herbarium of A. C. Crundwell, now E). It is not by chance that Crundwell and Nyholm found this admixture, but the result of deliberate search in specimens that were thought to contain plants of the *Bryum erythrocarpum* complex (Crundwell and Nyholm 1964). In a posthumous paper, Crundwell and Whitehouse (2001) give an amended description of *B. bornholmense* and re-

port that some specimens earlier thought to be *B. bornholmense* turned out to belong to *B. rubens*. They were able during their lives to correct the distribution for some areas, but not for Hungary. Therefore the above literature report had to be re-evaluated in the light of the amended description. We examined the specimen in Crundwell's herbarium and in addition some duplicates of the original *Funaria hungarica* collection. Most significantly, Crundwell had annotated the *Funaria hungarica* specimen "*Bryum* cf. *bornholmense* also present". We could not find *B. bornholmense* in the specimen annotated by Crundwell (E00619982), nor in any duplicates at E or BP. Thus at present there is no definite evidence that *B. bornholmense* occurs in Hungary, although its occurrence in Hungary does not seem impossible. Until proper material turns up, *B. bornholmense* has to be excluded from the Hungarian species list.

Bryum caespiticium Hedw.
[= *B. comense* Schimp., *Bryum bakonyense* Latzel]
(Figs 18, 19)

Dioicous, often in separate turfs, but sporophytes frequent (in 73% of specimens seen). Purely male turfs are frequent. **Plants** growing in dense pale-green turf, 1–3 cm tall; rhizoids brown, weakly verrucose-papillose. **Leaves** flaccid, erectopatent when moist, flexuose when dry, ovate-lanceolate, longly acuminate, leaf base red in older plants only; margin entire or slightly denticulate at apex, recurved; costa longly excurrent. **Laminal cells** 50–80 × 12–15 μm, unistratose border of narrow cells indistinctly delimited. **Seta** 2–5 cm, reddish. **Capsule** cernuous, 2.5–4.5 mm long, ovate or narrowly pyriform, large-mouthed, brown. **Endostome** cilia longly appendiculate. **Spores** 10–15 μm, smooth.

Note: *B. caespiticium* is reported to sometimes have red or pale brownish, spherical or ovate rhizoidal tubers 100–200 μm long (Nyholm 1993: 206, Ahrens 2001: 61, Smith 2004: 567; Crundwell in Hill *et al.* 1994: 109). These reports, however, are possibly based on misidentifications: Lockhart *et al.* (2012). We have also observed axillary filiform gemmae in this species.

Similar species: *B. pallescens / lonchocaulon*: monoicous, to 5 cm tall, taut; leaf base distinctly red; spores 16–25 μm, (slightly) papillose (*B. caespiticium*: dioicous, to 3 cm tall, soft; leaf base pale green; spores 10–15 μm, smooth).

B. algovicum: capsule narrow-mouthed; spores to 30 μm, papillose; endostome attached to exostome, with oblique cross-walls, opaque (*B. caespiticium*: capsule large-mouthed; spores 10–15 μm, smooth; endostome and exostome free, exostome without cross-walls).

B. badium: plants to 1.5 cm tall; capsules red (*B. caespiticium*: plants to 3 cm tall; capsules brown).

B. archangelicum: capsule narrow-mouthed; spores mostly 25 µm, papillose; cilia of endostome rudimentary (*B. caespiticium*: capsule large-mouthed; spores 10–15 µm, smooth; cilia of endostome longly appendiculate).

For the differences between *B. caespiticium* and *B. creberrimum*, *B. kunzei*, *B. radiculosum* and *B. rubens*, see the notes under the latter species.

References: Limpricht (1895): 385–386, Demaret (1993): 224–227, Nyholm (1993): 205–206, Ahrens (2001): 61–62, Guerra *et al.* (2010): 145–147.

Habitat: frequent species on wall tops, stony paths, on roofs, on wood, in disused fireplaces (together with *Funaria hygrometrica*), can tolerate strong draughts (open bushy vegetation, open (salt) steppe forests, fallow fields, loess fields, calcareous (limestone, dolomite), volcanic (andesite, basalt), and sandy grasslands, saline grasslands, road sides, forest edges, karst scrubland, forests (*Melico-Fagetum*), marlpits and sandpits, dried-out swamps, beside streams, ditches, at lake shores, in charcoal burning places, abandoned granite quarries, walls and stones in settlements, cemeteries and vineyards, at railways, bridges, roads, inside wells, in loess cliffs).

Substrate: indifferent to pH of substrate, on superficially decalcified substrates, not on pure limestone (exposed and shaded andesite rocks, crevices in siliceous (andesite, granite, basalt, sandstone) and calcareous (limestone, dolomite) rock, on soil, sand, clay, loess, on bark of *Fagus* and other trees, on walls, tarmac, concrete).

Associated bryophytes: *Amblystegium serpens*, *Atrichum angustatum*, *A. undulatum*, *Barbula convoluta*, *B. unguiculata*, *Brachythecium velutinum*, *Bryum algovicum*, *B. argenteum*, *B. capillare*, *B. dichotomum*, *B. elegans*, *B. moravicum*, *B. rubens*, *B. subapiculatum*, *Campylium calcareum*, *Ceratodon purpureus*, *Dicranella staphylina*, *D. varia*, *Dicranum scoparium*, *Didymodon acutus*, *D. fallax*, *D. insulanus*, *D. luridus*, *D. rigidulus*, *D. tophaceus*, *D. vinealis*, *Ditrichum flexicaule*, *Encalypta vulgaris*, *Entosthodon fascicularis*, *Entosthodon longicolle*, *Eurhynchium hians*, *Fissidens bryoides*, *Funaria hygrometrica*, *F. pulchella*, *Grimmia laevigata*, *Homalothecium lutescens*, *Hypnum cupressiforme* var. *cupressiforme*, *H. cupressiforme* var. *lacunosum*, *Lophocolea minor*, *Mannia fragrans*, *Phascum cuspidatum*, *Pleurochaete squarrosa*, *Pohlia melanodon*, *Pottia intermedia*, *P. lanceolata*, *P. mutica*, *Pseudocrossidium hornschuchianum*, *Pterygoneurum ovatum*, *Rhizomnium punctatum*, *Syntrichia ruralis*, *Thuidium abietinum*, *Tortella inclinata*, *Tortula muralis*, *T. schimperi*, *Trichostomum crispulum*, *Weissia brachycarpa*, *W. condensa*, *W. longifolia*.

Vertical distribution: 85–900 (mean 228) m a.s.l.

Distribution in Hungary (316 specimens, 159 grid cells, of which 56 represent recent finds): **Zemplén Mts** (7594.4): Hungaria bor., com. Abaúj-Torna. In sylvestribus montis Borzásoldal supra vallis Komlóskapatak, Sátorhegység prope pag. Pálháza, 25.05.1947 leg. L. Vajda EGR; **Bükk Mts** (7988.2): Com. Borsod-

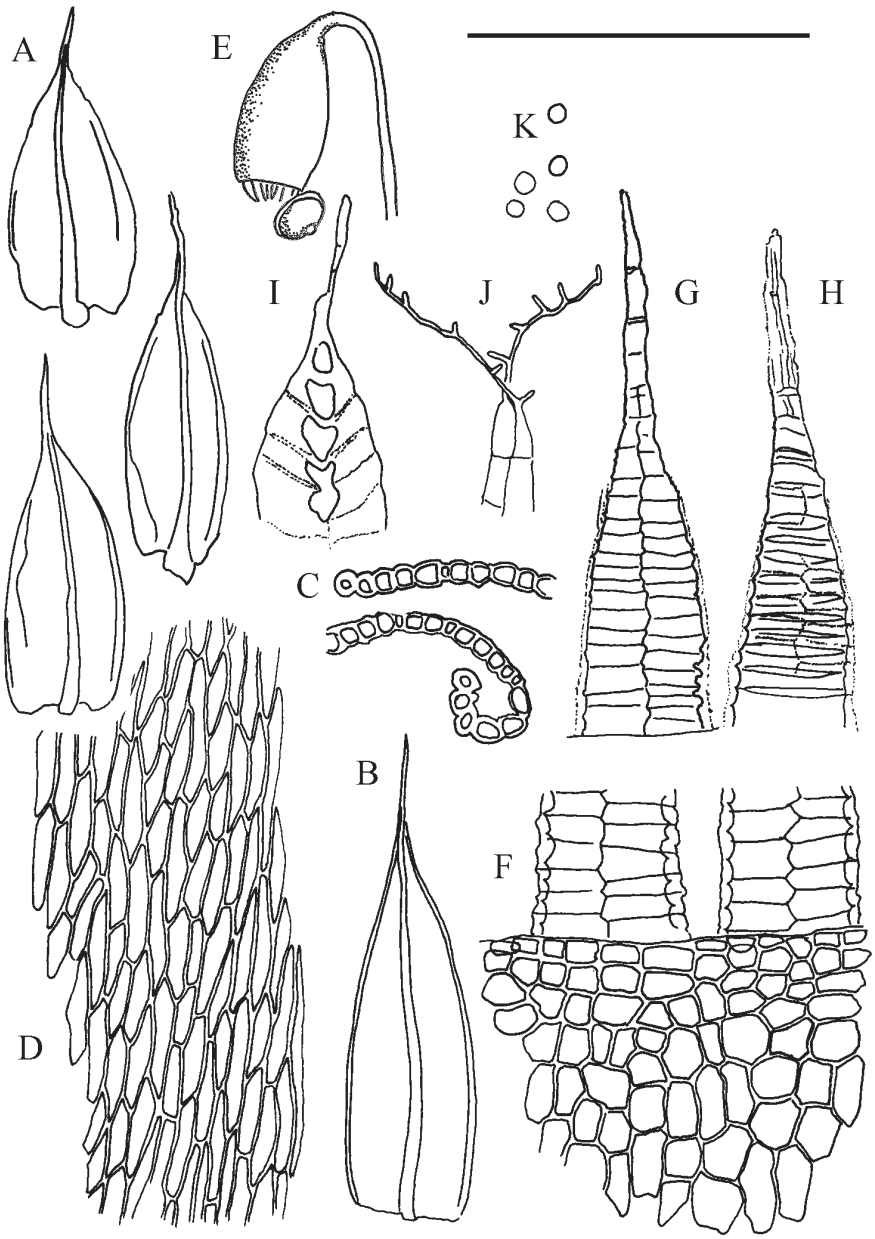

Fig. 18. *Bryum caespiticium*. A, B = leaves; C = cross sections of leaf margin; D = median laminal cells; E = capsule (moist); F = capsule mouth with basal part of exostome teeth; G, H = exostome teeth (outer/inner face); I, J = details of endostome (process, cilia); K = spores. Scale bar: A, B: – 2 mm; C, D, F–K: – 200 μm; E: – 4 mm. [A, C, E–K: EGR Vajda 1947 (Vajda-völgy/Zemplén), B, D: EGR Vajda 1948 (Borzás-oldal/Zemplén), del. Erzberger].

Abaúj-Zemplén, Bükk-Geb., unterhalb Három-kö, N 48° 3' 25", E 20° 29' 13", 650 m, 08.04.2007 leg. P. Erzberger B (Erzberger 12137); **Mátra Mts** (8186.1): Mátra, Kékes-Gruppe, unter dem Parád-er Sattel, Pyroxenandesit, 690 m, 17.04.1946 leg. I. Győrffy BP 88551; **Gödöllő Hills** (8482.1): Comit. Pest. Secus vias versus Perőc prope Gödöllő, sol. loess., 200 m, 13.04.1936 leg. Á. Boros BP 117775; **Börzsöny Mts** (8079.4): Comit. Hont. In silvis meridionalibus montis Magas Tax prope pag. Szokolya, 500–600 m, 06.10.1918 leg. Á. Boros BP 117786; **Visegrád Mts** (8379.2): Comit. Pest. In rupibus andesit. alvei rivi vallis Holdvilág-árok ad Margitliget prope Pomáz, 250–300 m, 30.04.1944 leg. Á. Boros BP 117874; **Pilis Mts** (8278.4): Com. Komárom-Esztergom, Pilis-Geb., Kesztölc, Kétágú-hegy, 400 m, 21.04.2000 leg. P. Erzberger B (Erzberger 6100); **Buda Mts** (8479.1): Budapest County, Nagykovácsi, Mt Kutya-hegy, N 47° 35' 18.5", E 18° 50' 36.8", 480 m, 22.05.2010 leg. B. Papp BP 180555; **Gerecse Mts** (8376.1): Komárom County, Gerecse Mts. Taliga Hill at the NW side of Agostyán village (4 km NE of Tata town). Abandoned agricultural land and medicago fields on a loess plateau, terricolous, N 47° 40.5', E 18° 22', 180 m, 07.11.1996 leg. T. Pócs, B. van Zanten, G. Kis *et al.* BP 177001; **Vértes Mts** (8476.3): Komárom-Esztergom County, arable fields at Környe. N 47° 32' 9.4", E 18° 21' 0.8", 170 m, 03.04.2010 leg. B. Papp BP 180350; **Velence Mts** (8777.2): Comit. Stuhlweissenburg. In monte Meleghegy prope Nadap, sol. trachyt., 26.3.1894 leg. Á. de Degen BP 40084; **Bakony Mts** (8770.2): Com. Veszprém. In muris in horto ad castell. pagi Pápakovácsi, 180 m, 01.05.1927

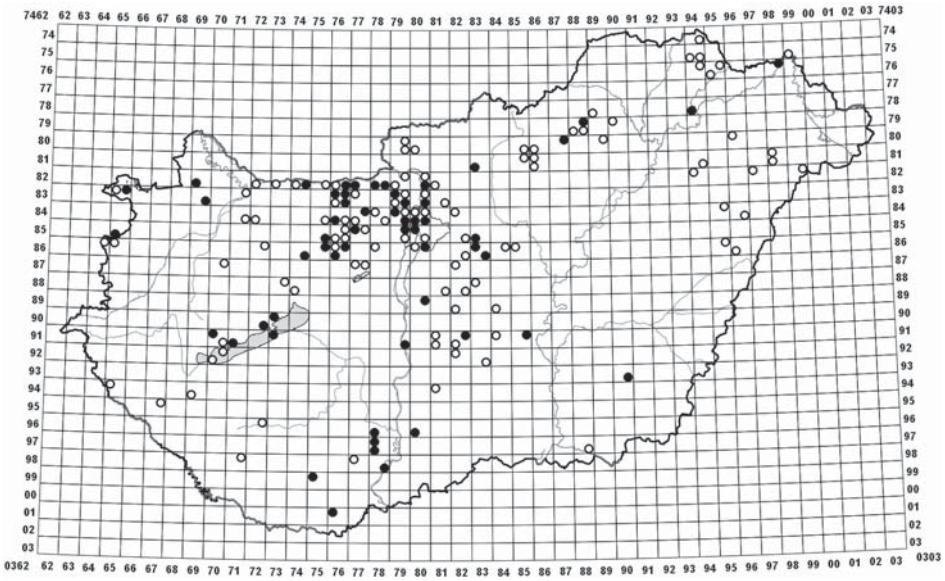

Fig. 19. Distribution of *Bryum caespiticium*.

leg. Á. Boros BP 117889; **Balaton Uplands** (9173.1): Veszprém County, calcareous rocks at Hálóeresztő at Tihany, N 46° 53' 32.9", E 17° 52' 49.0", 200 m, 19.06.2007 leg. B. Papp BP 175045; **Sopron Mts** (8365.2): Comit. Győr-Sopron, in rupibus calcareis collis Bécsi-domb supra opp. Sopron, 270 m, 08.11.1984 leg. I. Galambos BP 162167 sub *B. elegans*; **Kőszeg Mts** (8665.1): Kőszeg, in terra ad latus viae ad montem Calvariae ducentae, 350 m, 01.09.1930 leg. A. Visnya BP 118193 sub *B. bicolor*; **Zala** (9567.2): Flora hungarica, Comitat Zala. In arenosis humidis inter opp. Nagykanizsa et pag. Sormás, 150 m, 02.04.1950 leg. Á. Károlyi EGR sub *B.* sp.; **Belső-Somogy** (9871.2): Comit. Somogy. In locis loessaceis ad vias prope pag. Hedrehely, 150 m, 03.07.1942 leg. Á. Boros BP 117815; **Zselic** (9469.3): Kiskomárom [Zalakomár], 1957 s. coll. det. L. Vajda herb. A. Pénzes BP 89891; **Külső-Somogy** (9672.2): Comit. Somogy. Kaposvár, in muris ad viam ferream, 140 m, 06.08.1927 leg. Á. Boros BP 117816; **Mecsek Mts** (9877.1): Rácmecske, in ruderibus graniticis lapidicinarum contra stationem viae ferratae sitarum (elhagyott gránitbánya mellett), 185 m, 23.07.1934 leg. A. Visnya BP 117825; **Villány Mts** (0176.1): Com. Baranya, Villány-Geb., Nagyharsány, 350 m, 10.02.1994 leg. P. Erzberger B (Erzberger 876); **Kisalföld** (8272.3): Comit. Győr, in arenosi ad pusztam Esztergelő prope p. Győrszentiván, 13.04.1933 leg. S. Polgár BP 117828; **Hanság** (8269.3): Kom. Gy.-Moson-Sopron, Hanság, nahe Eisenbahnbrücke über Rábca bei Bősárkány, N 47° 42' 28.2", E 17° 13' 24.7", 110 m, 22.06.2012 leg. P. Erzberger B (Erzberger 15366); **Danube–Tisza Interfluve** (8582.4): Comit. Pest. In muris ad ripam rivi ad Gyömrő, 150 m, 12.04.1935 leg. Á. Boros BP 117774; (collections not quoted in detail from 26 grid cells in this geographical region); **Tiszántúl** (8294.1): Hajdunánás, com.: Hajdu in pratis humidis natronatis Verestenger, 06.05.1933 leg. J. Igmándy BP 117804; **Nyírség** (8198.1): Comit. Szabolcs. In arenosis ad viam ferream prope Nyirbakta, 150 m, 26.03.1927 leg. Á. Boros BP 117807; **Észak-Alföld** (7599.3): Comit. Ung. In muris pontis viae publ. ad Záhony, 100 m, 07.09.1925 leg. Á. Boros BP 117810; **Pest Plain** (8280.4): Kom. Pest, Brachacker zwischen Tahitótfalu und Pócsmegyer, 115 m, 27.07.2012 leg. P. Erzberger B (Erzberger 15600).

B. caespiticium is probably widespread throughout the country; the distribution map is very incomplete and indicates different intensity of bryological research rather than frequency of occurrence. Red list status: LC (Papp *et al.* 2010).

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB, UA.

Literature: In Szepesfalvi (1941), Boros (1953, 1968), Orbán and Vajda (1983) only general information on the distribution of this frequent species is given.

Papp and Rajczy (1999) publish numerous records from the Danube–Tisza Interfluve. Some are based on other literature reports; those based on specimens from BP could be confirmed with two exceptions: BP 117802 (Gyevi-fertő

prope Sándorfalva, Boros) could not be determined with certainty; BP 117669 (Sári near Inárcs, Boros) was originally determined as *B. badium* by Podpera, and then placed into *B. caespiticium* by the authors Papp and Rajczy (1999), but the specimen could not be determined with certainty.

Zanten (1999) mentions *B. caespiticium* as a member of loess cliff vegetation.

Bryum capillare Hedw.
(Figs 20, 22)

Dioicous, but sporophytes frequent (in 42% of specimens seen)**. Plants** in 1–4 cm tall lax turf, brilliant green, sometimes red in sun-exposed sites; rhizoids red, finely papillose. **Rhizoidal tubers** up to *ca* 300 μm diameter, occasionally, but not always present, dark red, opaque, with hardly protuberant cells. **Leaves** erectopatent when moist, twisted around the stem when dry, concave, elongate-ovate, mostly widest at or shortly above mid-leaf, suddenly contracted at apex; margin entire or weakly denticulate, only slightly recurved; costa mostly red, ending shortly below leaf apex or confluent with the marginal border in the apiculus. **Laminal cells** forming a regular network, 50–70 × 20–30 μm, at margin up to 5 rows of strongly incrassate, narrow cells forming a distinct border, confluent in apex to a long apiculus. **Seta** 2–4 cm, red. **Capsule** cernuous to inclined, up to 5 mm long, cylindrical-claviform, slim, slightly curved or straight, hardly contracted below large mouth, brown when ripe. **Endostome** cilia longly appendiculate. **Spores** 12–15 μm.

Notes: *B. capillare* is easily recognised in the field by the following three characters: (i) leaves characteristically spirally twisted around the stem when dry; (ii) moist leaves abruptly contracted at the apex from a broad apical part; (iii) capsules, if present, long, slim, brown, often slightly curved.

The end cell of male paraphyses of *B. capillare* is described and illustrated as rounded or truncate in Syed (1973) and in some floras (Nyholm 1993, Guerra *et al.* 2010), as opposed to the sharply pointed end cells in *B. torquescens*. However, also in *B. capillare* the end cell of male paraphyses is pointed to some extent, and the difference to *B. torquescens* is very slight. (See also the illustrations in Landwehr 1984: 315, 316). This character therefore appears not to be very useful for discrimination between the two species.

Similar species: *B. torquescens*: synoicous, sporophytes frequent, capsules dark red when ripe, straight, prefers calcareous substrates, usually with red rhizoidal tubers (*B. capillare*: dioicous, capsules brown when ripe, often slightly curved, on base-rich soil, occasionally with rhizoidal tubers).

For the differences between *B. capillare* and *B. donianum*, *B. elegans*, *B. moravicum*, and *B. stirtonii*, see the notes under the latter species.

References: Limpricht (1895): 375–377, Demaret (1993): 227–231, Nyholm (1993): 186, Ahrens (2001): 63–64, Guerra *et al.* (2010): 127–130.

Habitat: frequent in half shaded sites, along paths, on walls (sandy hills, forest soil, ash-elm-forest, dry and moist calcareous rock crevices, limestone wall, pine forest, beech forest, oak-hornbeam forest, alder grove, moist forest, forest edge, road side, abandoned quarry, basaltic grassland, open and closed dolomite grassland, margin of ditches, streams, soil between granite, dolomite, sandstone, diabase, loess cliffs, rarely in saline grassland).

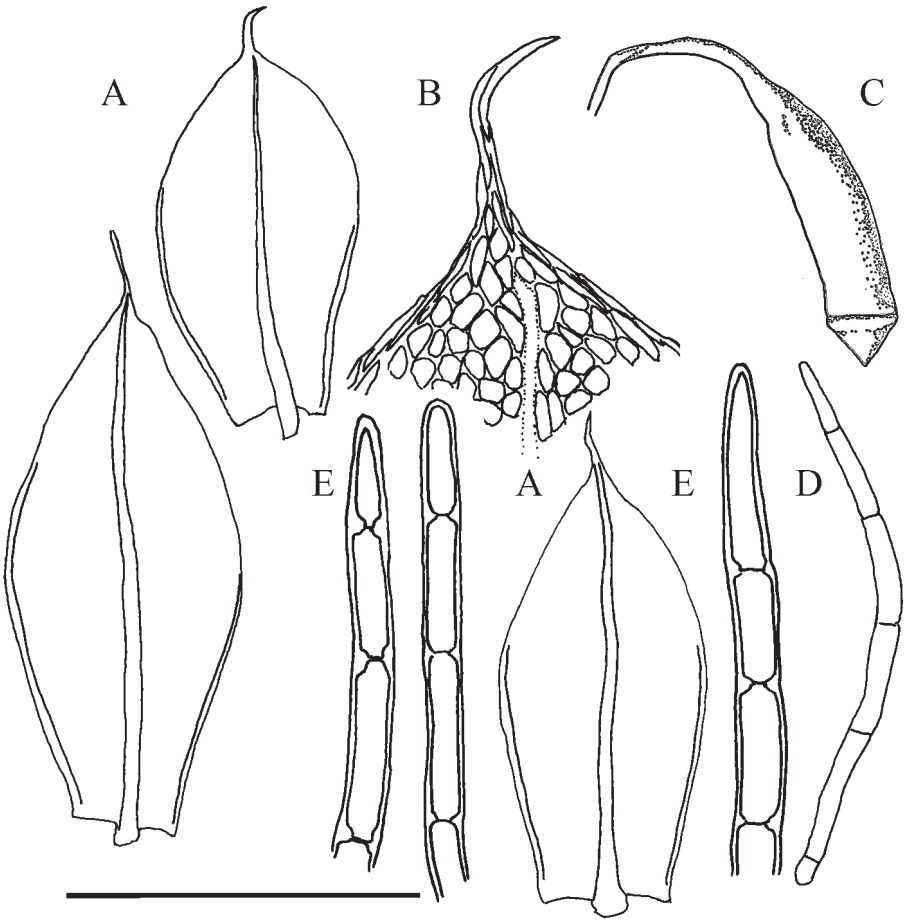

Fig. 20. *Bryum capillare*. A = leaves; B = leaf apex; C = capsule (dry); D, E, = male paraphyses, apical part. Scale bar: A: – 2 mm; B, E: – 200 µm; C: – 4 mm, D: – 400 µm. [A, B: Erzberger 173; C: EGR Vajda 1937 (Kőszeg); D, E: Erzberger 1606, del. Erzberger].

Substrate: tree bases, soil, rock; avoids acidic substrates (tree bark, tree bases, soil, loess, clay, moist sand, rotting wood, calcareous schist, calcareous phyllite, basaltic rock, dry and moist calcareous rocks (limestone, dolomite), dry and moist siliceous rocks (andesite, sandstone)).

Associated bryophytes: *Anomodon attenuatus*, *A. viticulosus*, *Atrichum undulatum*, *Barbilophozia barbata*, *Bartramia pomiformis*, *Brachythecium salebrosum*, *B. velutinum*, *Bryum alpinum*, *B. argenteum*, *B. caespiticium*, *B. moravicum*, *Campylium calcareum*, *Ceratodon purpureus*, *Ctenidium molluscum*, *Dicranum scoparium*, *Didymodon insulanus*, *Ditrichum flexicaule*, *Encalypta streptocarpa*, *E. vulgaris*, *Eurhynchium hians*, *E. pulchellum*, *E. striatum*, *Fissidens dubius*, *Grimmia ovalis*, *G. pulvinata*, *Hedwigia ciliata* var. *ciliata*, *Homalia trichomanoides*, *Homalothecium sericeum*, *Hypnum cupressiforme* var. *cupressiforme*, *H. cupressiforme* var. *lacunosum*, *Isothecium alopecuroides*, *Leskea polycarpa*, *Leucobryum glaucum*, *Lophocolea heterophylla*, *L. minor*, *Metzgeria furcata*, *Mnium marginatum*, *M. stellare*, *Orthotrichum anomalum*, *Phascum cuspidatum* var. *piliferum*, *Plagiochila porelloides*, *Plagiomnium affine*, *P. cuspidatum*, *P. rostratum*, *P. undulatum*, *Plagiopus oederianus*, *Plagiothecium cavifolium*, *P. curvifolium*, *P. laetum*, *Pleurochaete squarrosa*, *Pohlia cruda*, *P. nutans*, *Polytrichum formosum*, *Porella platyphylla*, *Pseudoleskeella nervosa*, *Pterigynandrum filiforme*, *Pyramidula tetragona*, *Radula complanata*, *Rhizomnium cuspidatum*, *Scapania calcicola*, *Schistidium crassipilum*, *Scleropodium purum*, *Syntrichia montana*, *S. ruralis*, *Thu-*

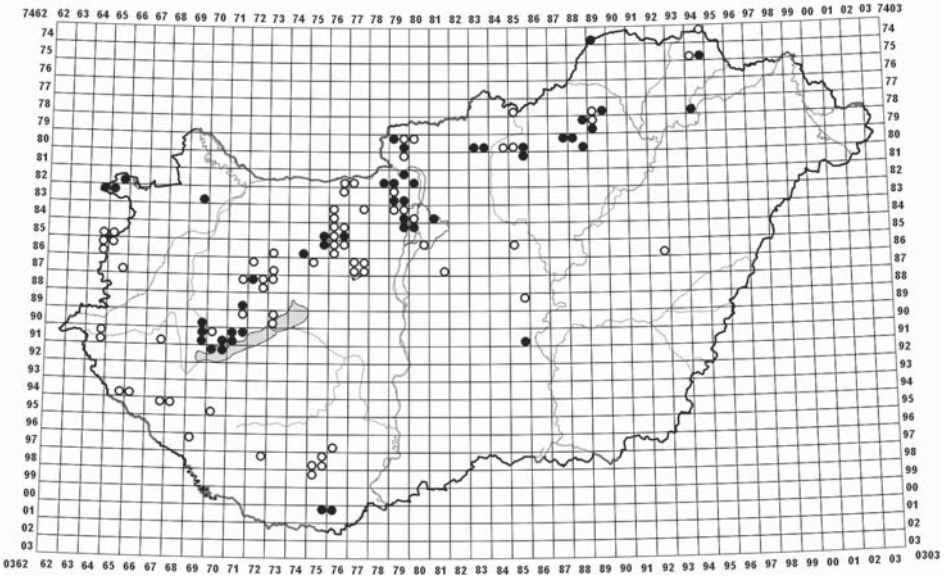

Fig. 22. Distribution of *Bryum capillare*.

idium abietinum, *T. recognitum*, *Tortella tortuosa*, *Tortula atrovirens*, *T. muralis*, *T. schimperi*, *T. subulata*, *Weissia controversa*.

Vertical distribution: 90–900 (mean 312) m a.s.l.

Distribution in Hungary (255 specimens, 115 grid cells, of which 47 represent recent finds): *B. capillare* can be expected in the majority of grid cells. Specimen quotation does not seem necessary. It probably also occurs in nearly all floristical regions (we have seen specimens from the Zemplén Mts, Aggtelek Karst, Bükk Mts, Mátra Mts, Karancs-Medves Mts, Cserhát Hills, Gödöllő Hills, Börzsöny Mts, Visegrád Mts, Pilis Mts, Buda Mts, Gerecse Mts, Vértes Mts, Velence Mts, Bakony Mts, Balaton Uplands, Keszthely Mts, Sopron Mts, Kőszeg Mts, Őrség, Vas, Zala, Belső-Somogy, Mecsek Mts, Villány Mts, Hanság, Danube–Tisza interfluve, Tiszántúl, Észak-Alföld, Pest Plain); there are no specimens from the Cserehát, Aggteleki-kavicshát, Putnok Hills, Naszály, Fertő Hills, Vendvidék, Hetés, Göcsej, Zselic, Külső-Somogy, Kisalföld, Nyírség, Drávavidék, but the species can probably be found in many of these as well.

According to the distribution map this species occurs predominantly in the mountain and hill regions of the northern and in particular of the western part of the country, where forests are more frequent than in the lowlands. The scarcity of records from the Small and Great Hungarian Plains is probably not caused by under-collecting. Red list status LC (Papp *et al.* 2010).

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB, UA.

Literature: No specific chorological information is given in Boros (1953, 1968) and Orbán and Vajda (1983).

Papp and Rajczy (1999) publish two records from the Danube–Tisza Interfluve, for one no specimen could be located, while the other one is based on a specimen confirmed during our revision.

Zanten (1999) reports 7 records of *B. capillare* from loess cliffs. However, contrary to the statement in his paper, no corresponding specimens were deposited in EGR. His records were ignored in the distribution map.

Note: In a specimen inserted in *B. kunzei*, peculiar plants were found (Fig. 21 – Gerecse Mts (8277.3): Comit. Esztergom. In rupibus calcareis montis Öregkő prope Bajót, 300–375 m, 05.04.1936 leg. Á. Boros BP 117683, originally determined by Podpera as *B. caespiticium* var. *kunzei* (Hornsch.) Warnst. ♂). Leaf shape and the leaves twisted when dry suggest *B. capillare* agg., but in contrast to most taxa of this group (except *B. elegans* and *B. stirtonii*), the marginal border is hardly differentiated, consisting of at most one row of narrow cells towards leaf base. In addition, the costa is distinctly excurrent, whereas in *B. capillare* the apiculus is mostly formed by the confluent marginal border cells. Spherical rhizoidal tubers to 300 μm in diameter where also found. Such tubers are reported for *B. capillare* in the literature (Demaret 1993, Ahrens 2001). The *B. erythrocarpum*

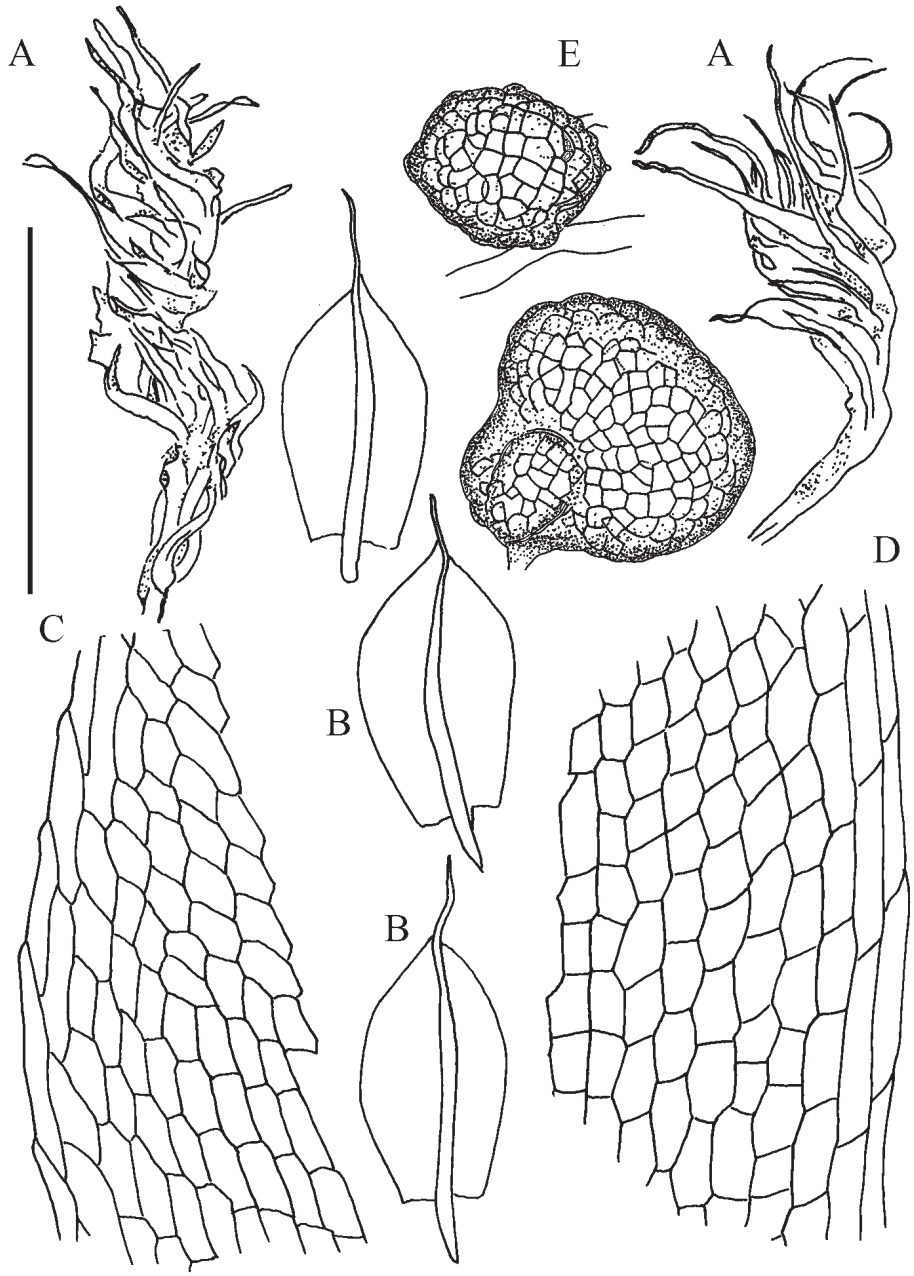

Fig. 21 *Bryum* aff. *capillare*. A = habit (dry); B = leaves; C = marginal and laminal cells near leaf apex; D = marginal and median laminal cells; E = rhizoidal tubers. Scale bar: A, B: – 2 mm; C, D: – 200 µm, E: – 400 µm. [BP 117688, del. Erzberger].

group can be ruled out because of the longly excurrent costa. We could not resolve the identity of these plants, and here report the details in order to draw attention to this peculiar form for further study.

Bryum creberrimum Taylor
[= *B. cuspidatum* (Bruch et Schimp.) Schimp., *B. bimum* var. *cuspidatum* Bruch et Schimp., *B. affine* Schultz]
(Figs 23, 24)

Synoicous, sporophytes frequent (in all specimens seen). **Plants** 1–2 cm tall, with comal tuft, growing solitary or in dense turfs, rhizoids red-brown, coarsely or finely papillose. **Leaves** erectopatent when moist, appressed and slightly twisted when dry, ovate-lanceolate, rigid, robust, longly pointed, leaf base red, margin entire below, slightly denticulate towards apex, revolute; costa longly excurrent in an often dentate point. **Laminal cells** 40–50 × 10–15 μm, at margin several rows of narrow, incrassate cells forming distinct unistratose border. **Seta** 2–6 cm long, brown. **Capsule** cernuous or pendulous, 3–4 mm long, cylindrical to pyriform, large-mouthed, brown, lid convex. **Exostome** and endostome free, not united. **Endostome** cilia longly appendiculate. **Spores** 12–16 μm, smooth.

Similar species: *B. creberrimum* cannot be named with certainty when ripe capsules are absent**.**

For the differences between *B. creberrimum* and *B. pallescens* and *B. lonchocaulon*, see also Table 4 (p. 132).

B. pallescens: autoicous, plants to 5 cm tall; grows also on weakly acidic substrates; spores papillose, 18–22 μm (*B. creberrimum*: synoicous, to 2 cm tall; grows on calcareous substrates; spores smooth, 12–16 μm).

B. lonchocaulon: plants polyoicous; spores (12–)15–20(–24) μm (*B. creberrimum*: always synoicous, spores 12–16 μm).

B. algovicum: capsule narrow-mouthed; exostome with oblique cross-walls between lamellae, attached to endostome, appearing opaque; spores 20–30 μm (*B. creberrimum*: capsule large-mouthed; exostome without oblique cross-walls; spores 12–16 μm).

B. archangelicum: capsule narrow-mouthed; endostome without cilia; spores 20–30 μm (*B. creberrimum*: capsule large-mouthed; endostome with long cilia; spores 12–16 μm).

B. caespiticium: dioicous; plants pale green, leaf base often concolorous to indistinctly red (*B. creberrimum*: synoicous; plants green, red leaf base distinct).

References: Limpricht (1895): 343–345, 354–355, Demaret (1993): 243–246, Nyholm (1993): 197–198, Ahrens (2001): 64–65, Guerra *et al.* (2010): 139–140.

Habitat: pioneer species, e.g. in disused quarries, at road embankments, in wall crevices, always in open situations (on soil near siliceous and calcareous rocks, in oak forest, in willow forest, on the wall of a swimming pool, inside a well).

Substrate: soil, mortar, (soil over) calcareous (limestone) and siliceous (andesite) rocks, (moist) sand.

Associated bryophytes: *Bryum algovicum*, *Funaria hygrometrica*, *Schistidium* sp., *Thuidium abietinum*, *T. delicatulum*.

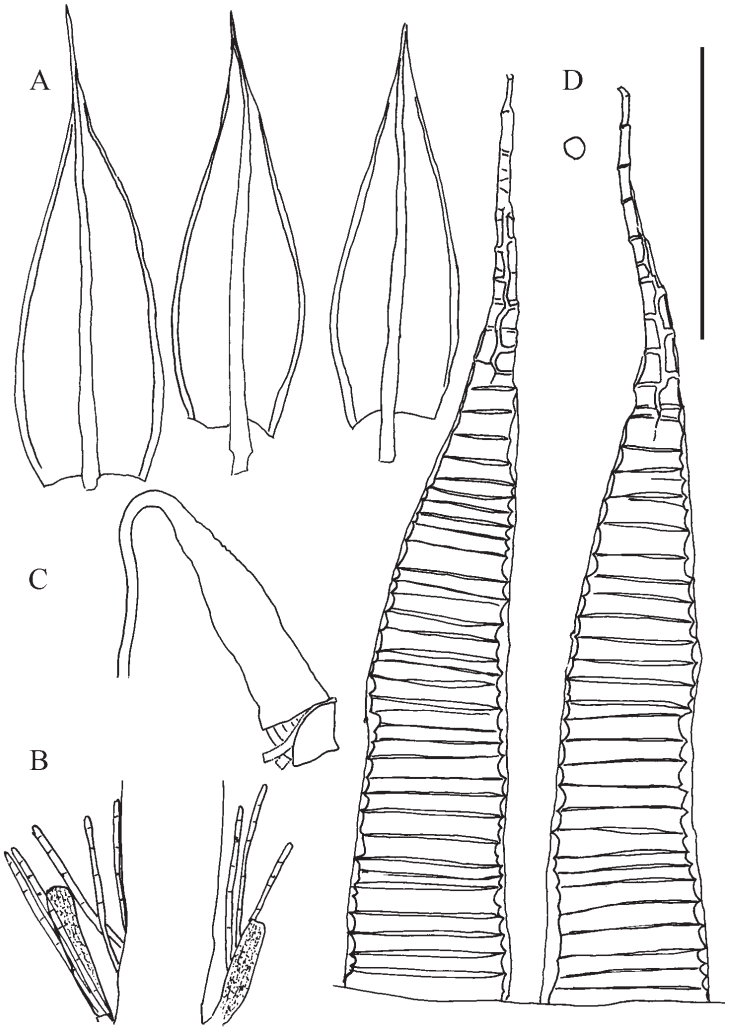

Fig. 23. *Bryum creberrimum*. A = leaves; B = antheridia and paraphyses at the base of a seta; C = capsule; D = exostome teeth and spore. Scale bar: A: – 2 mm; B, D: – 200 μm; C: – 4 mm. [EGR Vajda 1958 (Füzér/Zemplén), del. Erzberger].

Vertical distribution: 100–850 (mean 370) m a.s.l.

Distribution in Hungary (13 specimens, 11 grid cells, of which 0 represent recent finds): **Zemplén Mts** (7494.4): Comit. Abaúj-Torna. In rupibus andesit. montis Vár-hegy prope pag. Füzér, 400–500 m, 07.09.1947 leg. Á. Boros BP 117365 sub *B. pallescens*; **Bükk Mts** (7988.2): Comit. Borsod. In petrosis calc. sub monte Vörössár prope Szilvásvárad, 840 m, 10.07.1934 leg. Á. Boros BP 117368 sub *B. pallescens*; **Mátra Mts** (8186.1): Com. Heves. In rupibus andesiticis montis Saskő prope pag. Parád, 850 m, 25.03.1951 leg. L. Vajda EGR sub *B.* sp.; **Zala** (9567.2): Flora hungarica, Comitat Zala. In arenosis humidis inter opp. Nagykanizsa et pag. Sormás, 150 m, 11.07.1948 leg. Á. Károlyi EGR sub *B.* sp.; **Mecsek Mts** (9875.3): Pécs, Tubes, a János-kilátó oldalfalán (in pencil: Triaskalkmauer, sonnig, trocken), 613 m, 25.07.1937 leg. A. Visnya BP 118259 sub *B. intermedium*; **Kisalföld** (8272.3): Győrszentiván, Utkaparóház kútjának belső peremén, 29.05.1940 leg. S. Polgár BP 117660 sub *B. cirratum*; **Tiszántúl** (8495.4): Comit. Hajdu. In umbrosis ad murum in via lateralia "Hadházi ut 34." ad Debrecen, 16.06.1945 leg. L. Felföldy BP 82177 sub *B. caespiticium*; **Pest Plain** (8480.2): Com. Pest, Rákospalota. A Káposztásmegyeri homokpusztán, a 113-as pont alatt, 100 m, 23.06.1917 leg. Á. Boros BP 116943 sub. *B. pendulum*.

Although the distribution map shows only old records, *B. creberrimum* could probably be found today as well if more attention was paid to *Bryum* with

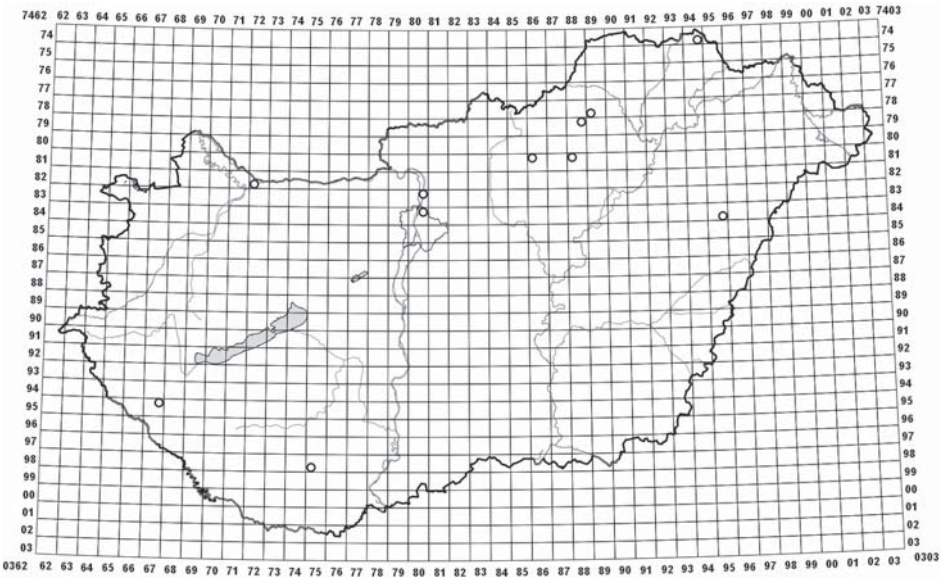

Fig. 24. Distribution of *Bryum creberrimum*.

sporophytes in field studies. The species is not threatened, e.g. in Austria and Germany (Grims and Köckinger 1999, Meinunger and Schröder 2007). Red list status: DD (Papp *et al.* 2010). See also the note added in proof (p. 192).

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB, UA.

Literature: Boros (1953) gives two localities: Eger (confirmed: BP 117085: 04.07.1927 leg. Á. Boros sub *B. affine*, BP 117661: 21.08.1929 leg. A. Bartha, sub *B. cirratum*, both from the wall of the men's swimming pool); and Monor (BP 117658 originally named *B. cirratum*, revised to *B. algovicum*); the latter has to be deleted. In Boros (1968), the two aforementioned localities appear under *B. cirratum* var. *affine*, and are complemented by two others which also have to be deleted: Sátoraljaújhely (no specimen seen), Dunaharaszti (BP 117089 sub *B. affine*; revised to *B. caespiticium*).

Note: Compare also the account on the collective *B. pallescens* group.

Bryum cyclophyllum (Schwägr.) Bruch et Schimp.

Dioicous, sporophytes rare. **Plants** 2–6 cm tall, green to dirty-green to reddish green, very soft, flaccid and lax; rhizoids light brown to red-brown, smooth to very finely papillose, at base of pale brown stem and also far up in leaf axils. Axillary **filiform gemmae** occasionally present. **Leaves** distantly spaced along stem, patent to erectopatent when moist, flexuose when dry, broadly ovate to nearly orbicular, rounded to obtuse at apex, concave; margin entire, plane or weakly recurved at concolorous leaf base, shortly decurrent; costa thin, vanishing below leaf apex; laminal cells 40–60 × 15–20(–28) μm, with thin walls; margin with 1–2 rows of very narrow thin-walled cells, hardly forming partly bistratose border, grading into one row of rectangular cells at the rounded leaf apex. **Seta** 2–3 cm long, reddish. **Capsule** pendulous to cernuous, 2–2.5 mm long, shortly pyriform, contracted below wide mouth, yellow to pale brownish when ripe; lid mamillate. **Endostome** cilia longly appendiculate. **Spores** 10–14 μm, yellow green, smooth.

Similar species: *B. neodamense* grows in similar places, but the leaves are reddish at base, cap-shaped, sometimes faintly denticulate near apex (*B. cyclophyllum*: leaves not reddish at base, concave but not cucullate, margin entire).

References: Limpricht (1895): 425–427, Nyholm (1993): 182–184, Demaret (1993): 188–189, Ahrens (2001): 65–67.

Habitat: on mud, at the margin of pools and ditches.

Substrate: sand poor in lime, peat.

Distribution in Hungary: excluded from Hungary.

Distribution in adjacent countries: A, SK, SRB.

Literature: No specimen of *Bryum cyclophyllum* was found during our revision. The species was listed as doubtful in Erzberger and Papp (2004). Already Boros (1953) considered the record unlikely based on data by Wolcsánszky from a Budapest locality (Lágymányos: Wolcsánszky 1905). Szepesfalvi (1941: p. 67–68) also discusses the possibility of an error in the locality. Nevertheless, this record is also mentioned in Podpera (1954: p. 361) and Düll (1992: p. 89). Until appropriate material turns up, we consider this species as missing from the Hungarian bryoflora.

Bryum demaretianum Arts

Dioicous, sporophytes unknown. **Plants** 0.3–0.8 cm tall, growing in groups or lax turf, greenish or reddish; rhizoids pale yellow to brownish, finely papillose. **Rhizoidal tubers** (95–)100–150(–170) μm long, pyriform, transparent, consisting of few cells, light orange, orange-brownish or yellowish, mostly in clusters of (1–)2–5, abundant between the rhizoids at the base of the plants, often also directly at the lower part of the stem, but not in leaf axils. **Leaves** evenly arranged along stem, erectopatent when moist, slightly twisted when dry, ovate-lanceolate, acuminate; margin entire or in larger leaves slightly denticulate in upper third, plane or narrowly recurved below; costa stout, 60–80 μm wide at mid-leaf, shortly excurrent as denticulate awn in upper leaves, ending in apex in lower leaves. **Laminal cells** 50–80 × 12–15(–20) μm, rather incrassate; narrower cells at margin hardly forming border.

Similar species: *B. tenuisetum*, like *B. demaretianum*, has yellowish rhizoidal tubers, but differs in the following characters: plants to 1 cm tall, often synoicous and therefore with sporophytes; leaves taut due to the very strong costa; laminal cells to 120 μm long; rhizoidal tubers spherical, to 200 μm in diameter, not in clusters (*B. demaretianum*: to 0.5 cm tall; laminal cells to 80 μm long; plants dioicous, sporophytes unknown; rhizoidal tubers ± pyriform, *ca* 100 μm long, numerous, mostly in clusters, often close to the stem).

B. klinggraeffii: rhizoidal tubers bright red, ± spherical with distinctly protuberant cells (*B. demaretianum*: rhizoidal tubers yellow, somewhat irregularly club-shaped, their cells hardly protruberant).

References: Arts (1992), Demaret (1993): 256–258, Ahrens (2001): 67.

Habitat: at the margin of ponds and ditches, on moist arable fields, often associated with *B. tenuisetum* or other members of the *B. erythrocarpum* group.

Substrate: clay, moist sand.

Distribution in Hungary: not known from Hungary.

Distribution in adjacent countries: A, SK.

Bryum dichotomum Hedw.
[= *B. bicolor* Dicks.]
(Figs 25, 26)

Dioicous, sporophytes frequent (in 5.7% of specimens seen). **Plants** 0.5–1 cm tall, growing in small yellow-green tufts or solitary, stems green or reddish; rhizoids pale brownish, finely papillose. Leafy **bulbils** in leaf axils, 1–3 per axil, of variable shape and size, 200–500 μm, often present and easily detected with a hand lens, spherical or oblong, leaf primordia inserted from base to top, erect or incurved, acuminate, reaching about half of the length of the bulbil. **Leaves** evenly arranged and increasing in size along stem, moist and dry leaves similar, ovate lanceolate, concave, margin mostly entire, slightly recurved below; costa either ending in leaf apex or excurrent as apiculus not longer than 200(–440) μm. **Laminal cells** *ca* 50 × 15 μm, at unistratose margin 1–2 rows of only slightly narrower cells hardly forming border. **Seta** 1–1.5 cm, red. **Capsule** pendulous, thick, to 2 mm long, abruptly narrowed to seta, red to black when ripe. **Endostome** basal membrane reaching 2/3 of peristome length, cilia appendiculate. **Spores** *ca* 10 μm, pale yellow, smooth or finely papillose.

Similar species: *B. gemmilucens*: bulbils yellow or reddish, mostly without distinct leaf primordia (*B. dichotomum*: bulbils red at base with green leaf primordia).

B. versicolor: capsule pendulous, appressed to seta, rare species on limestone gravel (*B. dichotomum*: capsule pendulous or cernuous, common species).

For the differences between *B. dichotomum* and *B. argenteum*, *B. badium*, *B. barnesii*, *B. blindii*, *B. gemmiferum*, *B. gemmiparum*, *B. kunzei* and *B. mildeanum*, see the notes under the latter species.

References: Demaret (1993): 201–205, Nyholm (1993): 214–216, Ahrens (2001): 58–59, Smith (2004): 573–575, Guerra *et al*. (2010): 164–166.

Habitat: frequent pioneer in sand pits and quarries, on road sides, river banks, pastures and fields (in arable fields, at road sides, in loess cliffs, ant hills in meadows, on glauconite sandstone, on sandstone outcrops, in open limestone and dolomite rocky grasslands, in basaltic grassland, in saline grasslands, in dry meadows, at the margins of ditches, at the bottom of a dried-up lake, on thatched roofs, on tiled roofs, on stone walls, in riparian forests).

Substrate: moist, calcareous or neutral sand, gravel, mud (soil, clay, moist sand, sandstone (glauconite), tarmac, thatched roof, soil over concrete, roof tiles).

Associated bryophytes: *Aloina* sp., *Barbula convoluta*, *B. unguiculata*, *Brachythecium albicans*, *Bryum argenteum*, *B. caespiticium*, *B. klinggraeffii*, *B. radiculosum*, *B. rubens*, *B. subapiculatum*, *B. violaceum*, *Ceratodon purpureus*, *Didymodon vinealis*, *Drepanocladus aduncus*, *Encalypta vulgaris*, *Entosthodon longicolle*, *Funaria hygrometrica*, *Hypnum cupressiforme* var. *lacunosum*, *Phascum cuspida-*

tum var. *cuspidatum*, *P. cuspidatum* var. *mitraeforme*, *P. cuspidatum* var. *piliferum*, *Pleurochaete squarrosa*, *Pohlia* sp., *Pottia bryoides*, *P. intermedia*, *P. lanceolata*, *P. truncata*, *Pseudocrossidium hornschuchianum*, *Pterygoneurum ovatum*, *Syntrichia montana*.

Vertical distribution: 80–685 (mean 178) m a.s.l.

Distribution in Hungary (147 specimens, 90 grid cells, of which 55 represent recent finds): **Zemplén Mts** (7494.2): Borsod-Abaúj-Zemplén County,

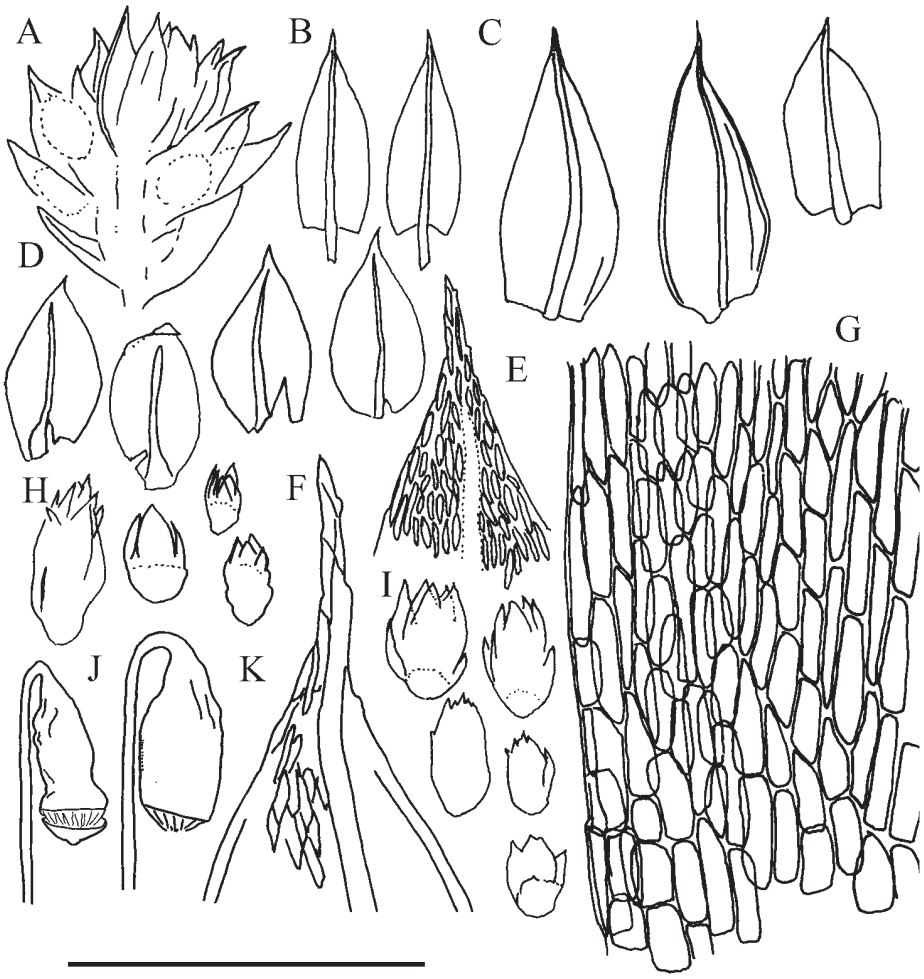

Fig. 25. *Bryum dichotomum*. A = shoot tip with bulbils; B–D = leaves; E, F = leaf apices; G = marginal and median laminal cells; H, I = bulbils; J, K = capsules (dry/moist). Scale bar: A–D, H, I: – 2 mm; E, F: – 400 μm; G: – 200 μm; J, K: – 4 mm. [A, D, I: EGR Vajda 1948 (Telki), B, F, H: Erzberger 1593; C, E, G, J, K: BP 118206, del. Erzberger].

Zemplén Mts, around a hunting house (Vadászház) at Füzér, on soil at the edge of arable fields, N 48° 33.147', E 21° 27.217', 460 m, 05.04.2004 leg. B. Papp BP 171500; **Bükk Mts** (8089.1): Bükk-Geb., Wegspur nach Hidegkútlaposa, 18.06.2012 leg. P. Erzberger B (Erzberger 15344); **Medves Mts** (7985.2): Com. Nógrád, Medves-Geb., Bárna, nahe dem Dorf, auf weichem Sandstein ("apoka", Glaukonit), 410 m, 24.03.2008 leg. P. Erzberger B (Erzberger 12835); **Gödöllő Hills** (8482.3): Pest County, Gödöllő hills. Loess cliff near Isaszeg village, at the railway crossing near Rákos brook, at 180 m alt., N 17[sic! corr.: 47]° 31.5', E 19° 22', coll. nr. 96122/C [more exact coord. of railway crossing, N 47° 31' 38", E 19° 23' 16"], 07.11.1996 leg. T. Pócs, B. van Zanten, G. Kis, A. Szabó EGR sub *B. rubens*; **Börzsöny Mts** (8079.2): Com. Pest, Börzsöny-Geb., Tal Bacsina-völgy bei Királyháza, Wiese mit Ameisenhügeln, 380 m, 04.04.1994 leg. P. Erzberger B (Erzberger 1096); **Pilis Mts** (8379.1): Pest County, Pilis–Visegrád Mts, Pilistető hill at Pilisszentkereszt, open limestone rocky grassland, N 47° 41' 16.5", E 18° 51' 56.5", 685 m, 12.04.2007 leg. B. Papp BP 174759; **Buda Mts** (8580.1): Budapest County, Mt. Sas-hegy in Budapest, open dolomite grassland, on soil, N 47° 28' 56.1", E 19° 1' 6.8", 250 m, 28.03.2008 leg. B. Papp BP 176239; **Gerecse Mts** (8376.2): Com. Komárom-Esztergom, Gerecse-Geb., zwischen Tardos und Vértestolna, Gorba-tető, SW-Seite "Vég-kő", Felsrasen, Kalkbänder, N 47° 39' 13", E 18° 25' 36", 350 m, 04.04.2010 leg. P. Erzberger B (Erzberger 13759); **Vértes Mts** (8476.3): Comit. Komárom. In arenosis humidis ripae rivi Szárazér pr. Környe, vers. Vértessomló, 160 m, 22.04.1935 leg. Á. Boros BP 118213; **Velence Mts** (8777.3): Comit. Fejér. In agris argilloso-glareosis ad pedem montis Ősi-hegy pr. Pákozd, 110 m, 15.03.1938 leg. Á. Boros BP 118202; **Bakony Mts** (8969.4): Veszprém County, bottom of a dried lake between Gyepűkaján and Szentimrefa, N 47° 2' 22.5", E 17° 17' 11.9", 150 m, 12.05.2009 leg. B. Papp BP 180750; **Balaton Uplands** (9070.4): Comit. Zala. In monte Halápi-hegy supra Haláp. Sol. basalt., 27.04.1913 leg. Á. de Degen BP 118186; **Sopron Mts** (8265.4–8365.2): Comit. Győr-Soporn (sic), ad margines fossarum concreto firmatium inter vineas in declivibus orientalibus silvae Szárhalmi erdő, 200 m, 25.10.1978 leg. I. Galambos EGR: **Zala** (9465.1): Flora hungarica, Comitat Zala. In silvaticis pr. pag. Kútfej, 200 m, 13.03.1948 leg. Á. Károlyi EGR sub *B.* sp.; **Mecsek Mts** (9975.1): Pécs, Szkókó, kőfalon, 05.08.1931 leg. A. Visnya BP 118110; **Villány Mts** (0176.1): Com. Baranya, Villány-Geb., Nagyharsány, 370 m, 10.02.1994 leg. P. Erzberger B (Erzberger 881); **Kisalföld** (8472.3): Győr-Sopron County, Sokoró Hills. On loess cliffs of hollow roads among vineyards, W of Écs village, at 200–250 m alt. (guided by I. Galambos), N 47° 33', E 17° 42', coll. nr. 9693/O [contrary to coll. date on envelope: 29.oct. 1997, should read 1996], 29.10.1996 leg. T. Pócs, B. van Zanten EGR; **Hanság** (8269.3): Kom. Gy.-Moson-Sopron, Hanság, nahe Eisenbahnbrücke über Rábca bei Bősárkány, N 47° 42' 28.2", E

17° 13' 24.7", 110 m, 22.06.2012 leg. P. Erzberger B (Erzberger 15368); **Danube–Tisza Interfluve** (8980.2): Com. Bács-Kiskun, Große Tiefebene, Donau–Theiß-Interfluvium, Nationalpark Kiskunság, Apaj, Natronsteppe, N 47° 5' 11", E 19° 5' 53", 100 m, 12.04.2006 leg. P. Erzberger B (Erzberger 11396); **Tiszántúl** (8392.3): Hajdú-Bihar County, at Hortobágyi halastó lake near Hortobágy village, on soil, N 47° 36' 34.1", E 21° 4' 9.55", 85 m, 12.04.2010 leg. B. Papp BP 180366; **Szigetköz** (8070.3): Comit. Győr-Sopron-Moson. In truncis ad ripam insulae Barkás prope pag. Dunasziget in Cikolaszigeti-ágrendszer, 120 m, 14.05.1992 leg. M. Rajczy and B. Papp BP 162496.

The distributional record of this widespread and frequent species is very incomplete. Red list status: LC (Papp *et al.* 2010).

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB, UA.

Literature: For some regions mentioned in Boros (1953, 1968) specimens were not confirmed or could not be found: Gödöllő Hills (no specimen seen), Visegrád Mts (BP 118217: Pomáz, Kis-Csikóvár – could not be determined with certainty), Naszály (no specimen seen), Kőszeg (BP 118193: revised to *B. caespiticium*; BP 118191: could not be named with certainty). However, it is likely that *B. dichotomum* occurs also in these regions and could probably be found in field studies.

Papp and Rajczy (1999) publish a number of records from the Danube–Tisza Interfluve, most of which could be traced back to confirmed specimens.

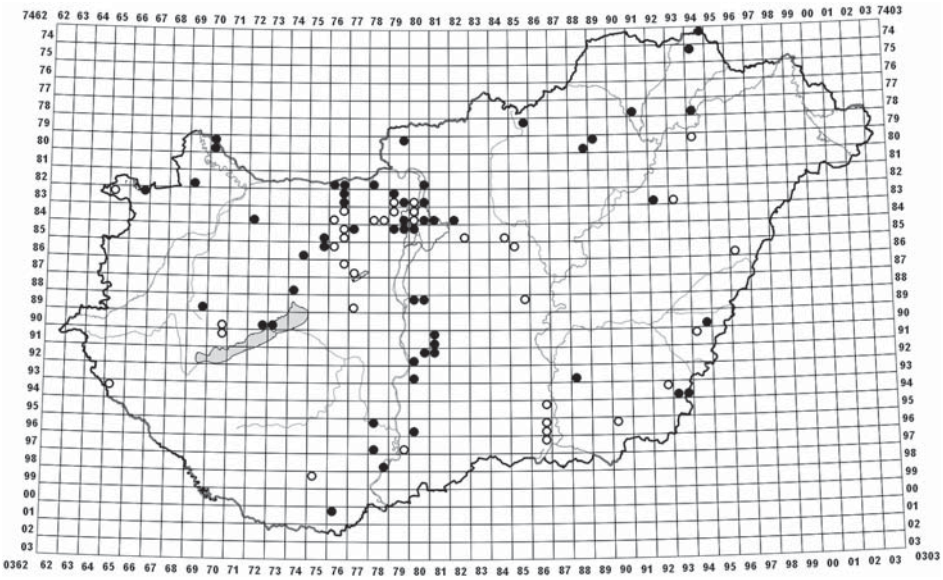

Fig. 26. Distribution of *Bryum dichotomum*.

Zanten (1999) mentions *B. bicolor* (= *B. dichotomum*) as a frequent species on loess cliffs without giving records. However, when examining 16 duplicates of his specimens from EGR, we could confirm his determination with respect to *B. dichotomum* only in 10 specimens (only these are included in the distribution map). Therefore, his data should not be accepted without revision.

Bryum donianum Grev.
(Fig. 27)

Dioicous, often with sporophytes. **Plants** 0.5–1.5 cm tall, growing in ± dense, yellowish green turf; rhizoids red-brown, strongly papillose. **Filiform,** simple or branched **gemmae** sometimes present in leaf axils. **Leaves** crowded towards stem apex, forming comal tuft, erectopatent when moist, slightly spirally twisted around their own axes when dry, broadly elliptical to obovate, sometimes spathulate, moderately concave, leaf base occasionally reddish; margin entire below, denticulate near apex, teeth sometimes in pairs, margin recurved in lower third to half; costa stout, *ca* 100–150 μm wide at base, excurrent in usually denticulate awn 100–200 μm long, sometimes ending in apex. **Laminal cells** 25–60 × 13–20 μm, moderately incrassate with slightly porose walls; border regularly bi- to tetrastratose, formed by 2–5 rows of narrow, incrassate cells, sometimes

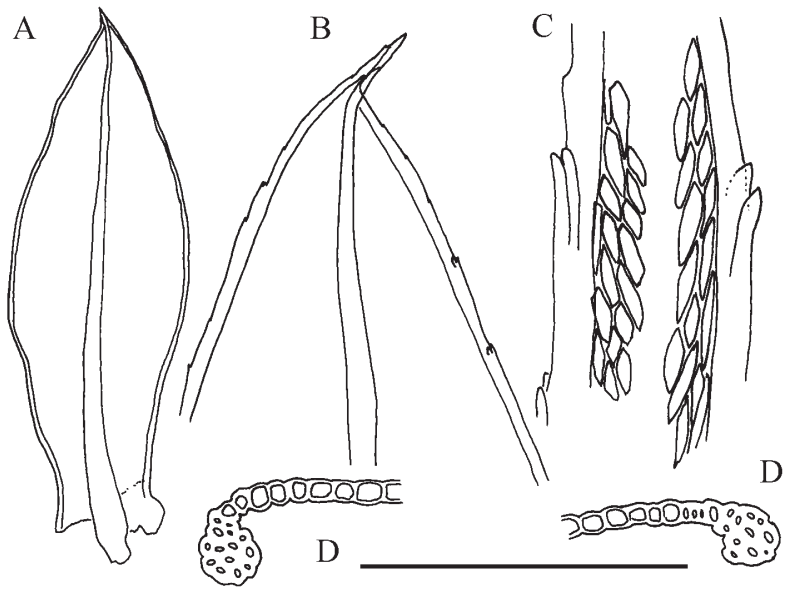

Fig. 27. *Bryum donianum*. A = leaf; B = leaf apex; C = double teeth at margin, adjacent laminal cells; D = cross sections of margin. Scale bar: A: – 2 mm; B: – 800 μm; C, D: – 200 μm. [Erzberger 3862 (Greece), del. Erzberger].

slightly decurrent. **Seta** to 3 cm long. **Capsule** pendulous, 3–3.5 mm long, cylindrical to pyriform, large-mouthed, sometimes slightly constricted below mouth when dry; brown to red-brown when ripe, lid conical, with acute tip. **Exostome** and **endostome** free, cilia longly appendiculate. **Spores** (8–)10–11(–14) μm, smooth to finely papillose.

Similar species: *B. capillare*: leaves spirally twisted around stem, leaf border unistratose; filiform gemmae lacking (*B. donianum*: leaves slightly twisted around their own axes; leaf border pluristratose; sometimes with filiform gemmae).

B. torquescens: synoicous, usually with sporophytes, capsules dark red when ripe; plants usually with brown-red rhizoidal tubers; leaf border usually unistratose, rarely locally bistratose (*B. donianum*: dioicous, sometimes with sporophytes, capsules brown when ripe; rhizoidal tubers unknown; leaf border pluristratose along its total length).

B. moravicum: similar in leaf shape and presence of filiform gemmae, but differs in the structure of the unistratose margin formed by 1–2 cell rows and the costa less stout, 60–100 μm thick at leaf base and usually not excurrent (*B. donianum*: border regularly pluristratose, formed by 2–5 cell rows; costa 100–150 μm thick at leaf base, usually excurrent in denticulate awn).

References: Demaret (1993): 222–224, Guerra *et al.* (2010): 121–122.

Habitat: at the base or in crevices of calcareous rocks, often near streams.

Substrate: moist soil.

Distribution in Hungary: not known from Hungary.

Distribution in adjacent countries: HR, Mediterranean-Atlantic species.

Bryum elegans Nees
(Figs 28, 29)

Dioicous, sporophytes rare (in 12.5% of specimens seen). **Plants** 0.5–3 cm tall, growing in green turf or cushions; rhizoids brown to red, very coarsely papillose, papillae tall, up to 5 μm wide. **Leaves** evenly arranged, imbricate, moist plants budlike or julaceous, leaves little altered when dry, not or only very slightly twisted, obovate, strongly concave, suddenly narrowed at apex to small, mostly reflexed apiculus, reddish at base; margin plane or slightly recurved at leaf base, entire or weakly denticulate near apex, not decurrent; costa excurrent in entire apiculus or ending below leaf apex, in that case the apiculus is formed by upper laminal cells and confluent marginal cells. **Laminal cells** *ca* 40–50 × (13–)15–20(–28) μm, slightly porose, border of elongate cells indistinct, often consisting of one cell row only or lacking. **Seta** 1–2 cm. **Capsule** cernuous, cylindrical, brown, large-mouthed. **Endostome** basal membrane reaching 1/3 of peristome length, cilia appendiculate. **Spores** 12–15 μm, finely papillose.

According to Crundwell in Hill *et al.* (1994): 100, brown rhizoidal tubers rarely occur on the rhizoids.

Similar species: *B. capillare*: to 4 cm tall; when dry, leaves distinctly twisted spirally around stem; marginal border distinct; costa excurrent as long apiculus, plants growing on diverse substrates (*B. elegans*: plants bud-like or julaceous, leaves imbricate, not twisted; marginal border indistinct; costa shortly excurrent and reflexed, plants growing on limestone rocks).

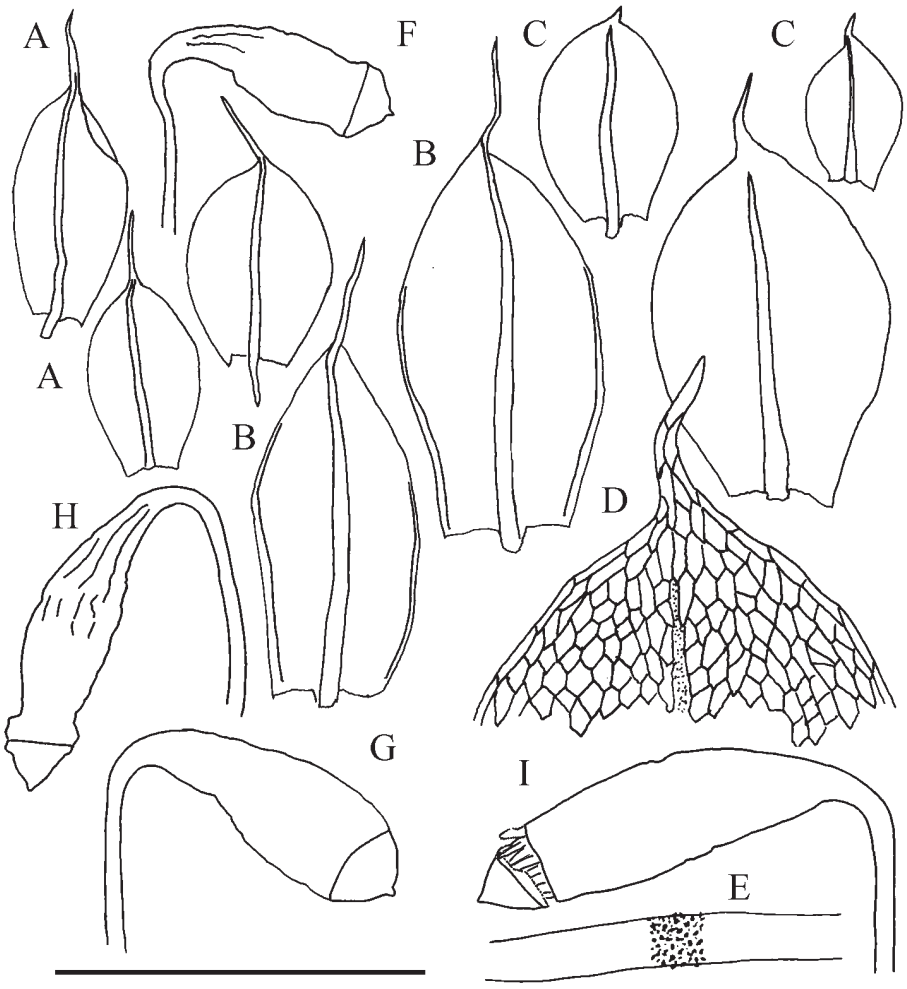

Fig. 28. *Bryum elegans*. A, C = leaves; B = external perichaetial leaves; D = leaf apex (costa stippled); E = rhizoid (ornamentation shown in part); F–I = capsules (F, H dry/G, I moist). Scale bar: A–C: – 2 mm; D: – 400 μm; E: – 200 μm; F–I: – 4 mm. [A, B, F–I: BP 118435, C–E: BP 73363, del. Erzberger].

For the differences between *B. elegans* and *B. funckii*, *B. kunzei* and *B. stirtonii*, see the notes under the latter species.

References: Syed (1973): 277–282, Demaret (1993): 180–181, 233–234, Nyholm (1993): 185–186, Ahrens (2001): 68–69, Guerra *et al.* (2010): 125–126.

Habitat: shaded calcareous or other base-rich rock.

Substrate: limestone, rarely dolomite rock crevices, sometimes on diabase and basaltic rock.

Associated bryophytes: *Anomodon attenuatus*, *A. viticulosus*, *Barbilophozia barbata*, *Brachythecium velutinum*, *Bryoerythrophyllum recurvirostrum*, *Bryum argenteum*, *B. capillare*, *Ctenidium molluscum*, *Didymodon vinealis*, *Ditrichum flexicaule*, *Encalypta streptocarpa*, *E. vulgaris*, *Eurhynchium crassinervium*, *E. striatulum*, *Fissidens dubius*, *Homalothecium sericeum*, *Hypnum cupressiforme*, *Myurella julacea*, *Neckera crispa*, *Plagiochila porelloides*, *Porella platyphylla*, *Tortella tortuosa*.

Vertical distribution: 300–700 (mean 393) m a.s.l.

Distribution in Hungary (16 specimens, 11 grid cells, of which 2 represent recent finds): **Bükk Mts** (7989.2): Borsod-Abaúj-Zemplén County, Bükk Mts, limestone rocks opposite to Kerek-hegy hill at Lillafüred above the Szinva spring water catchment area, N 48° 5' 8.9", E 20° 36' 55.8", 375 m, 11.07.2005 leg. B. Papp BP 172969; **Pilis Mts** (8379.1): Comit. Pest. In rupibus calcar. umbrosis sept. montis Vaskapu-hegy supra vallem Vaskapu-völgy prope Pilisszentkereszt,

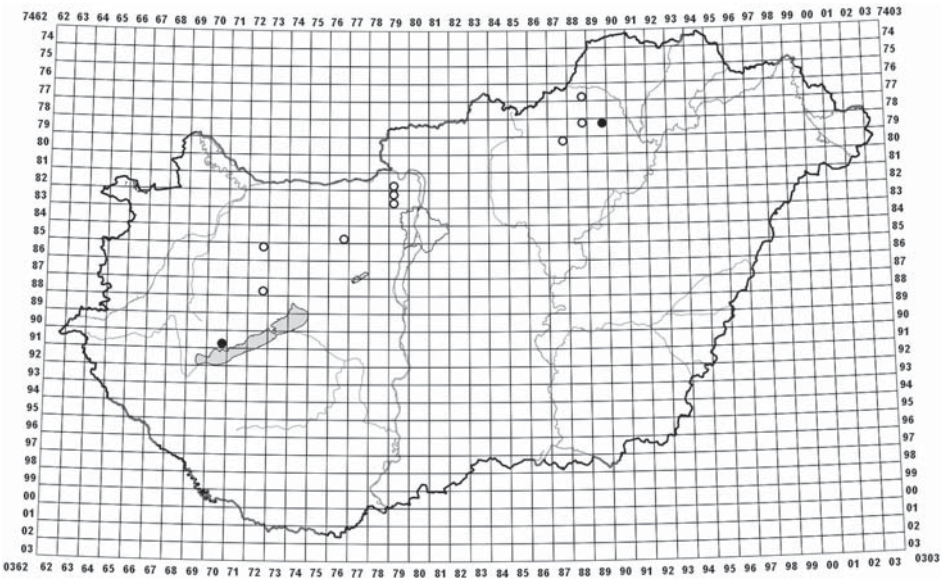

Fig. 29. Distribution of *Bryum elegans*.

550–600 m, 04.04.1946 leg. Á. Boros BP 118425; **Buda Mts** (8379.3): Comit. Pest. In declivibus umbrosis supra Pilis-Szentiván, 26.04.1916 leg. Á. de Degen BP 46890; **Vértes Mts** (8576.2–8576.4): Comit. Fejér. In rupestribus dumetosis vallis Svábrőzse-völgy pr. Vérteskozma, 340 m, 07.04.1935 leg. Á. Boros BP 118416; **Bakony Mts** (8872.4): Comit. Veszprém. In rupibus dolomiticis vallis Csordás-árok, prope pag. Markó, montes Bakony, 21.04.1967 leg. L. Vajda BP 73363; **Balaton Uplands** (9170.4): Com. Veszprém, Balatonoberland, Szent György-hegy, Basaltfelsrasen am Pyramidula-Standort, 300 m, 29.03.2002 leg. P. Erzberger B (Erzberger 7955).

Although this species is one of the rarer members of sect. Trichophylla, it could perhaps be recorded in more locations, since its typical habitat (shaded base-rich rocks) can be found in many of the hills and mountains in the northern or southern parts of Hungary. Although this could mean that *B. elegans* is still under-recorded, with only 2 recent finds out of a total of 11 the red list status LC-att (Papp *et al.* 2010) should be changed to NT; in comparison with other types of habitat, shaded base-rich rocks have been relatively well explored in the last decades (Papp 2008).

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB, UA.

Literature: Regions listed in Boros (1953, 1968) and Orbán and Vajda (1983) not supported by confirmed specimens include Börzsöny Mts (BP 47182: Rózsáspatak; BP 60061: Nagyvasfazék-patak – were revised to *B. capillare*), Visegrád Mts (Fekete-kő: BP 7744 – was revised to *B. capillare*; BP 118333 – was revised to *B. moravicum*), Mecsek Mts (Pécs: 118420 – was revised to *B. capillare*; BP 118421: could not be named with certainty), Kőszeg Mts, Vas, Tiszántúl (szarvasi Pepi-kert) (no specimens seen). Additional region: Balaton Uplands.

Syed (1973) in his revision of the *B. capillare* group confirms a specimen collected by Boros from the Uppony Mts (7788.4: BP 118434, BP 162373, both also confirmed in our revision).

Zanten (1999) reports on two collections from loess cliffs that might be *B. elegans*. No corresponding specimens were obtained from EGR upon request.

Bryum funckii Schwaegr.
(Figs 30, 31)

Dioicous, sporophytes rare (seen in 1 out of 4 specimens). **Plants** 0.5–1(–2) cm tall, whitish green, very slightly glossy, golden green or reddish, growing in groups or as solitary plants; old rhizoids brown, strongly and coarsely papillose, young rhizoids pale brown, finely papillose. **Leaves** erectopatent when moist, appressed when dry, sterile shoots julaceous, male shoots resembling miniature artichokes, leaves broadly ovate, strongly concave, keeled, reddish at base; margin

entire, sometimes weakly recurved below, not decurrent; costa very stout (to 100 μm thick at insertion), red below, excurrent as short, stout apiculus. **Laminal cells** slightly porose, wide and lax, 20–35 × 15 μm, in perichaetial leaves sometimes to 20–25 μm wide, hardly narrower at margin, with slightly incrassate walls, not forming distinct border. **Seta** 1.5–2(–3.5) cm, flexuose, brownish. **Capsule** cernuous, 2–3.5 mm long, ventricose, rather narrow-mouthed, several rows of rounded cells below capsule mouth, capsule therefore turbinate when dry. **Endostome** cilia appendiculate. **Spores** 16–20 μm, smooth or finely papillose.

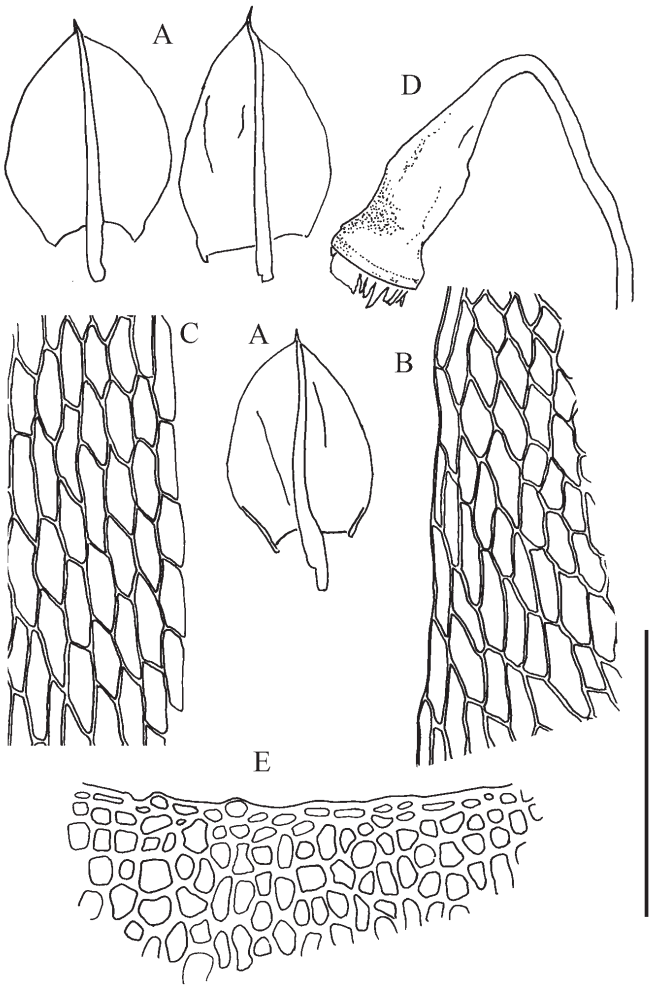

Fig. 30. *Bryum funckii*. A = leaves; B = laminal and marginal cells; C = median laminal cells; D = capsule (dry); E = exothecial cells at capsule mouth. Scale bar: A, D: – 2 mm; B, C, E: – 200 μm. [EGR Károlyi 1951 (Nagykapornak), del. Erzberger].

Similar species: *B. elegans*: plants taller, to 3 cm tall; leaves with reflexed apiculus; costa less stout, excurrent or often ending below leaf apex (*B. funckii*: plants to 1 cm tall, costa very stout, shortly excurrent to percurrent).

B. argenteum: plants silvery-bluish green, upper part of leaf without chlorophyll, costa usually vanishing far below leaf apex; often with sporophytes; foliated stems 0.6–0.8 mm wide (*B. funckii*: golden-greenish to reddish, upper part of leaf chlorophyllose, costa percurrent to shortly excurrent; very rarely with sporophytes; foliated stems 1.0–1.2 mm wide).

For the differences between *B. funckii* and *B. blindii* and *B. kunzei*, see the notes under the latter species.

References: Limpricht (1895): 411–413, Demaret (1993): 218–220, Nyholm (1993): 203–204, Ahrens (2001): 70–71, Guerra *et al.* (2010): 147–148.

Habitat: in open situations in a quarry, at a roadside, in sand and loess hills, at a loess cliff.

Substrate: phyllite, sand and loess.

Associated bryophytes: *Didymodon fallax*, *D. vinealis*.

Vertical distribution: 110–200 (mean 170) m a.s.l.

Distribution in Hungary (4 specimens, 4 grid cells, of which 1 represents a recent find): **Gerecse Mts** (8276.3): Komárom County, Gerecse Mts. Loess cliff on the W edge of Pap Hill, with rich steppe on the hilltop, at 200 m alt., E from Neszmély village, on sandy soil, N 47° 43', E 18° 21.5', coll. nr. 96111/M,

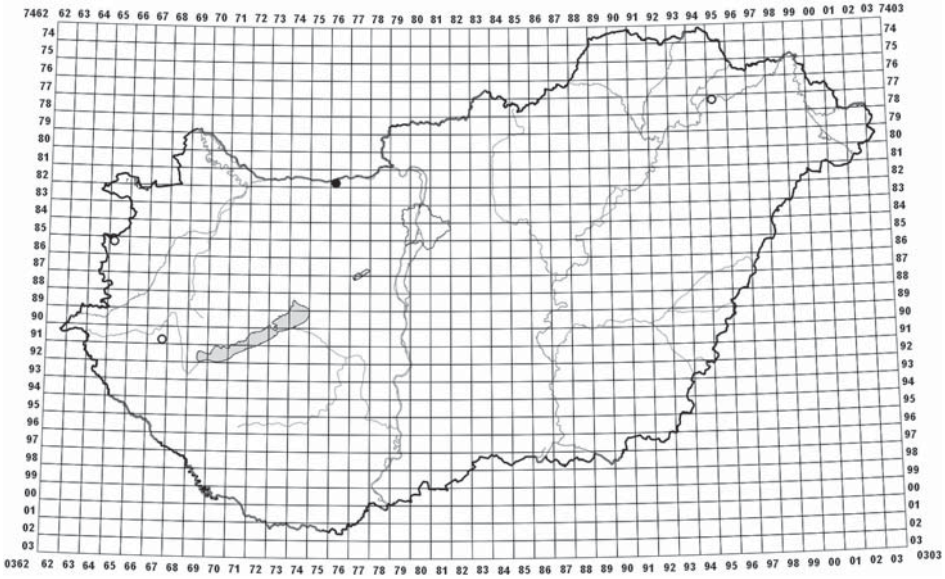

Fig. 31. Distribution of *Bryum funckii.*

05.11.1996 leg. T. Pócs, B. van Zanten, G. Kis, A. Szabó EGR sub *B. bicolor*; **Kőszeg Mts** (8665.1): A meszesvölgy kőfejtőben. Phylliton. Kőszeg, 13.5.1905 leg. A. Latzel BP 169883 (Dupl. in SZO acc. Erzberger and Papp (2004), not seen); **Zala** (9167.4): Flora hungarica, Comitat Zala. Secus vias pr. pag. Nagykapornak, 200 m, 12.05.1951 leg. Á. Károlyi EGR sub *B.* sp.; **Tiszántúl** (7895.1): Comit. Szabolcs. In collibus arenoso-loessaceis inter Balsa et Szabolcs, 110 m, 24.10.1943 leg. Á. Boros BP 118174 sub *B. bicolor*.

B. funckii is a rare species in Hungary that can easily be confused with other imbricately foliated species. Since its habitat is in danger of being overgrown during succession, it is very doubtful whether the populations still exist at the old growth sites. Red list status: DD (Papp *et al.* 2010). According to the updated state of knowledge, CR (criterion B, 1 recent locality, high risk of extinction) would appear appropriate.

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB, UA.

Literature: Boros (1953, 1968), Orbán and Vajda (1983) report Latzel's Kőszeg record; in Boros (1953) *B. bohemicum* (Óbuda, Aquincum: BP 117382, revised to *B. caespiticium*) is also placed here, but this taxon is referred to *B. bicolor* in later publications (see under *B. dichotomum*).

Three new localities in the Gerecse Mts, Zala and Tiszántúl regions are added in the present revision; in particular the Zala material is in excellent condition and very typical! Nevertheless, Boros only wrote "*Bryum* sp." on the convolute that had been submitted to him by the collector for determination.

Bryum gemmiferum R. Wilczek et Demaret
(Figs 32, 33)

Dioicous, occasionally with sporophytes (not seen in Hungarian material). **Plants** 0.5–1 cm tall, growing solitary or in lax tufts, light yellowish green, golden green or reddish; stem red; rhizoids pale brown, finely papillose. Numerous (up to 30 per leaf axil) small **bulbils** (50–)75–150(–550) μm long, with finger-like leaf primordia (hook-like, incurved or straight), nearly always present in the upper leaf axils of sterile plants or innovations, often also found in the substrate. **Leaves** patent when moist, often near horizontal, appressed and imbricate when dry; concave, broadly ovate to triangular lanceolate; margin entire, recurved mostly to apex, not or hardly decurrent; costa red, shortly excurrent in sterile plants, excurrent in a faintly denticulate apiculus 200–300 μm long in fruiting plants. **Laminal cells** 30–40(–65) × 6–10(–16) μm, moderately incrassate, somewhat narrower towards margin, but not forming distinct border. **Seta** 0.5–1.5 cm, red-brown. **Capsule** pendulous, 1.5–2.5 mm long, ovate to broadly pyriform, contracted below mouth, capsule suddenly narrowed to seta, red when ripe.

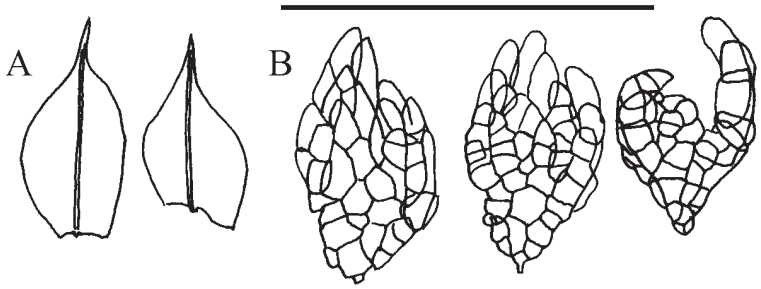

Fig. 32. *Bryum gemmiferum*. A = leaves; B = bulbils. Scale bar: A: – 2 mm; B: – 200 μm. [EGR Pócs et al. 1997 (Csóka-h./Báta, coll. no. 97186/D), del. Erzberger].

Exostome with yellow teeth. **Endostome** segments with narrow perforations, cilia appendiculate. **Spores** (13–)18 μm smooth or nearly so.

Similar species: *Bryum dichotomum*: plants mostly green, bulbils 1–5 in leaf axils, plants often with sporophytes (*B. gemmiferum*: plants yellow-green, up to 30 small yellowish green bulbils per axil, leaf primordia very narrow, plants rarely with sporophytes).

For the differences between *B. gemmiferum* and *B. barnesii*, see the note under the latter species.

References: Demaret (1993): 207–209, Ahrens (2001): 71–72, Guerra *et al.* (2010): 167–168.

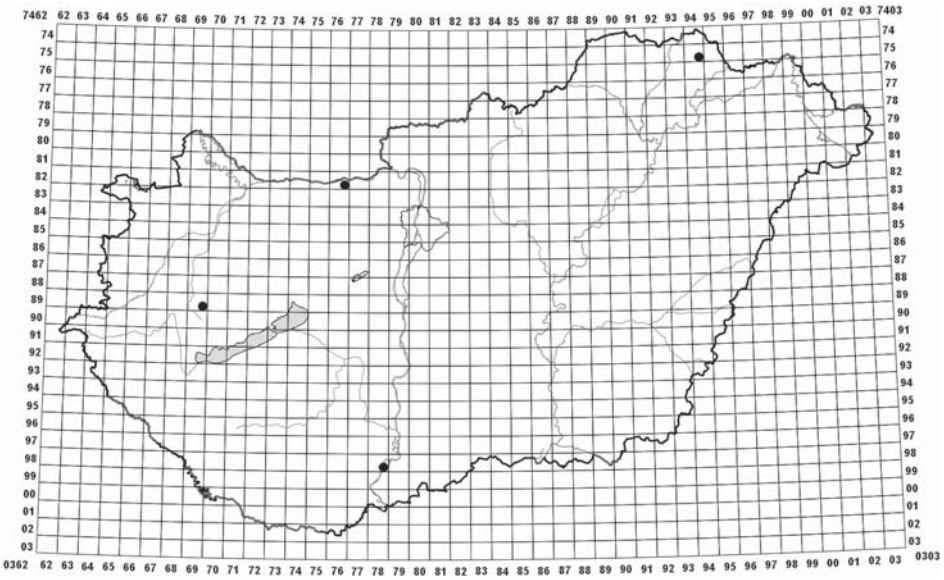

Fig. 33. Distribution of *Bryum gemmiferum*.

Habitat: at shallow river and stream banks, in old sand pits, in loess cliffs.

Substrate: moist calcareous soil, sand or gravel, loess.

Associated bryophytes: *Barbula unguiculata*, *Bryum argenteum*, *B. klinggraeffii*, *Hilpertia velenovskyi*, *Pterygoneurum ovatum*.

Vertical distribution: 150–350 (mean 222) m a.s.l.

Distribution in Hungary (6 specimens, 4 grid cells, of which all represent recent finds): **Zemplén Mts** (7594.4): Borsod-Abaúj-Zemplén County, Zemplén Mts, Kőkapu, Rostalló at Pálháza, N 48° 25.618', E 21° 25.864', 350 m, 05.04.2004 leg. B. Papp BP 171542; **Gerecse Mts** (8276.4): Komárom county, Gerecse Mts, 4 km S of Süttő village. Loess cliff under dry oak forest, at 180 m alt., near Bikol. no gemmae, tubers, N 47° 43', E 18° 27', coll. nr. 96119/E, 07.11.1996 leg. T. Pócs, B. van Zanten, A. Szabó EGR; **Bakony Mts** (8969.4): Veszprém County. On rock at Meleg-víz river at Gyepűkaján, N 47° 2.409', E 17° 17.524', 150 m, 31.03.2002 leg. B. Papp BP 168534; Dupl. leg. P. Erzberger B (Erzberger 7966); **Sopron Mts** (8365.1–8365.3): Comit. Győr-Sopron, ad latera rivulorum vallis Ördög-árok supra opp. Sopron, 350 m, 29.10.1977 leg. I. Galambos BP 162166 sub *B. bicolor*; **Mecsek Mts** (9878.4): Tolna County, Baranyai dombság. E end of Báta village. N facing natural cliff of Csóka Hegy, at 150 m alt., N 46° 7', E 18° 47.5', coll. nr. 97186/D, 19.10.1997 leg. T. and S. Pócs, van Zanten, Szabó EGR.

This species obviously is very much undercollected, and its precise distribution remains to be established. It is listed as European endemic in the Red data book of European bryophytes (ECCB 1995). Red list status: NT (Papp *et al.* 2010).

Distribution in adjacent countries: A, RO, SRB.

Literature: Zanten (1999), who first reported this species from Hungary, lists 4 localities from loess cliffs. Although in his paper Zanten claims that a "complete set of specimens is deposited in the herbarium of Eszterházy K. College in Eger (EGR)", only for two of the published records specimens were obtained upon request from EGR. These could be confirmed in our revision (see above). The other 2 published localities, for which no specimens were seen, are: Kisalföld (8472.3): Győr-Moson-Sopron County, Sokoró Hills, Bácsi Horog, W of Ravazd village, 230 m; eroded gully in loess plateau; Mecsek Mts (9878.3): Baranya County [recte Tolna County], Baranya Hills, Báta Furkótelep; artificial ENE facing loess cliff in the terraced vineyard "Lánka", 140 m.

Bryum gemmilucens R. Wilczek et Demaret
(Figs 34, 35)

Dioicous, sphorophytes very rare in Europe: only found once in Spain (Guerra *et al.* 2010: 170). **Plants** 1–8 mm tall, in small, but dense tufts, light green, stem orange-red; rhizoids light brown, nearly smooth. Many spherical or

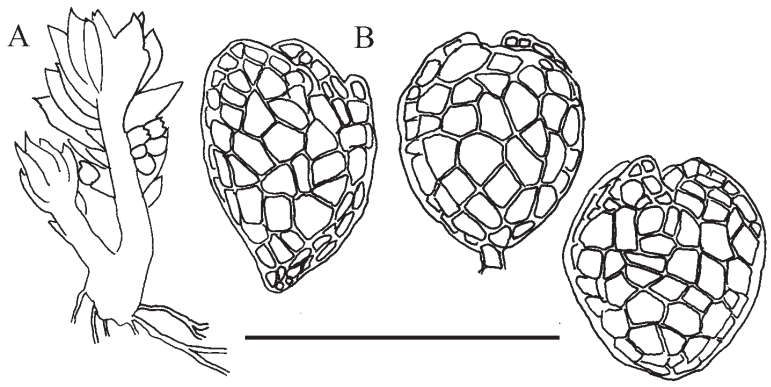

Fig. 34. *Bryum gemmilucens*. A = plantlet with axillary bulbils; B = bulbils. Scale bar: A: – 2 mm; B: – 200 μm. [Erzberger 9196, del. Erzberger].

irregularly oval, 100–200(–300) μm large **bulbils** without or with indistinct leaf primordia, crowded in leaf axils (mostly 5 per axil), rather resembling tubers, bulbils shining yellow, rarely light brown or reddish. **Leaves** evenly arranged along stem, erectopatent when moist, appressed to stem when dry, orbiculate-ovate or ovate-lanceolate, concave; margin entire, plane or recurved below, not decurrent; costa ending in or below apex. **Laminal cells** 30–40 × 8–12(–16) μm, hardly more elongate towards unistratose margin, not forming distinct border.

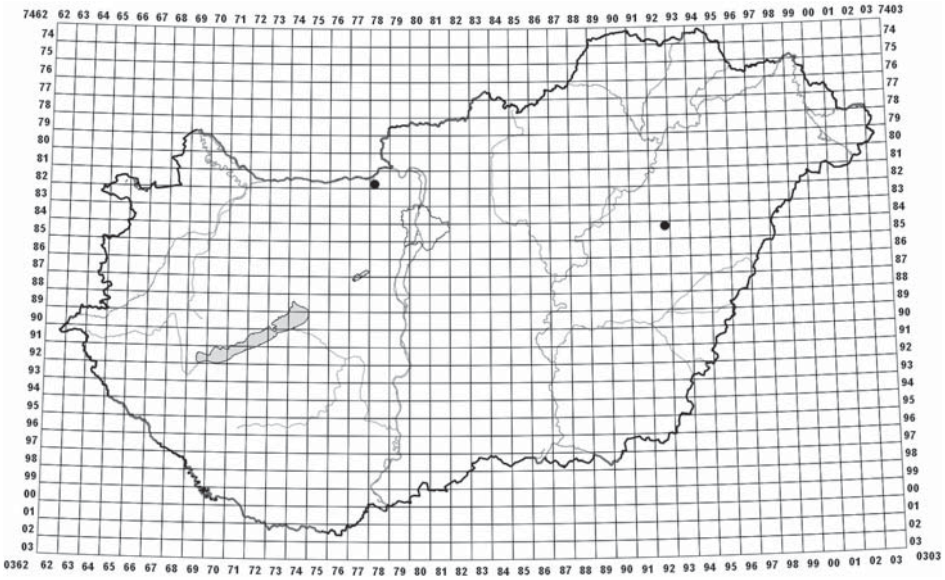

Fig. 35. Distribution of *Bryum gemmilucens*.

Similar species: Among the species of the *B. dichotomum* group (plants with leafy bulbils in leaf axils) *B. gemmilucens* is singular by the shiningly yellow bulbils that more resemble tubers and ± lack leaf primordia. The species can be confused with *B. tenuisetum*: light yellow rhizoidal tubers, never axillary (*B. gemmilucens*: shining yellow spherical or irregularly shaped bulbils in leaf axils).

For the differences between *B. gemmilucens* and *B. dichotomum*, see the note under the latter species.

References: Demaret (1993): 212–214, Ahrens (2001): 72–73, Guerra *et al.* (2010): 168–170.

Habitat: on a sandstone outcrop in calcareous rock grassland, on soil in saline grassland.

Substrate: sand, saline soil: moderately halotolerant.

Vertical distribution: 95–280 (mean 188) m a.s.l.

Distribution in Hungary (2 specimens, 2 grid cells representing 2 recent finds): **Gerecse Mts** (8278.3): Komárom-Esztergom County, Gerecse Mts, foot of Gete hill at Tokod, on a sandstone outcrop, N 47° 42' 50.0", E 18° 39' 53.8", 280 m, 20.03.2008 leg. B. Papp BP 177729 sub *B. gemmiferum*; **Tiszántúl** (8592.2): Com. Hajdú-Bihar, Hortobágy National Park, Angyalháza, Nádudvar, *Artemisia* and *Achillea* salt steppe, N 47° 29' 23.8", E 21° 9' 37.0", 95 m, 24.04.2003 leg. P. Erzberger B (Erzberger 9196).

This species obviously is much rarer than *B. gemmiferum*. The distributional record is probably still very incomplete. Red list status: DD (Papp *et al.* 2010). According to the present state of knowledge, EN seems appropriate (criterion B, 2 recent localities, high risk of extinction).

Distribution in adjacent countries: UA (Crimea).

Literature: The first Hungarian records were published in Appendix of Orbán and Vajda (1983): Velence Mts, and the Great Hungarian Plain: Méhkerék. However, no specimens labelled *B. gemmilucens* were located. Therefore, these published chorological data should be considered with reservation until appropriate material turns up.

Bryum gemmiparum De Not.
(Fig. 36)

Dioicous, sporophytes very rare (Guerra *et al.* 2010). **Plants** 1–3 cm tall, in yellowish to brownish-greenish turf; rhizoids brown, very finely papillose. Vegetative propagation by foliate **bulbils** solitary in leaf axils, to 700 μm long and often found in the substrate only, but leaving distinct scars on the stem; rarely with spherical red rhizoidal **tubers**, to *ca* 100–150 μm long. **Leaves** evenly and densely arranged along stem, erectopatent when moist, imbricate, appressed to

stem when dry; elongate ovate-lanceolate, taut, leaf margins parallel in lower half or often more, entire, sometimes narrowly recurved in basal part of leaf; costa stout, 80–100 μm wide at leaf base, ending in leaf apex or shortly excurrent. **Laminal cells** 60–100 × 16–18 μm; several rows of cells at margin narrower and longer, moderately incrassate, but not forming distinct border; cells at leaf base quadrate and rectangular. **Seta** 1–1.5 cm, reddish brown. **Capsule** horizontal to pendulous, 2–3 mm long, ovate, lid mamillate. **Endostome** free, basal membrane 2/3 length of endostome, cilia long, hardly appendiculate. **Spores** 12–14 μm, smooth or sparsely papillose.

Similar species: *B. mildeanum*: forming green or rarely dirty-brown turf; foliated bulbils lacking; costa in lower part of leaf to 60 μm wide; leaves triangular-lanceolate with recurved margin (*B. gemmiparum*: forming yellowish or brownish green turf; foliate bulbils present, very large; costa to 100 μm wide at leaf base; leaves elongate-lanceolate, margins parallel in lower part of leaf, margin recurved at most in basal part).

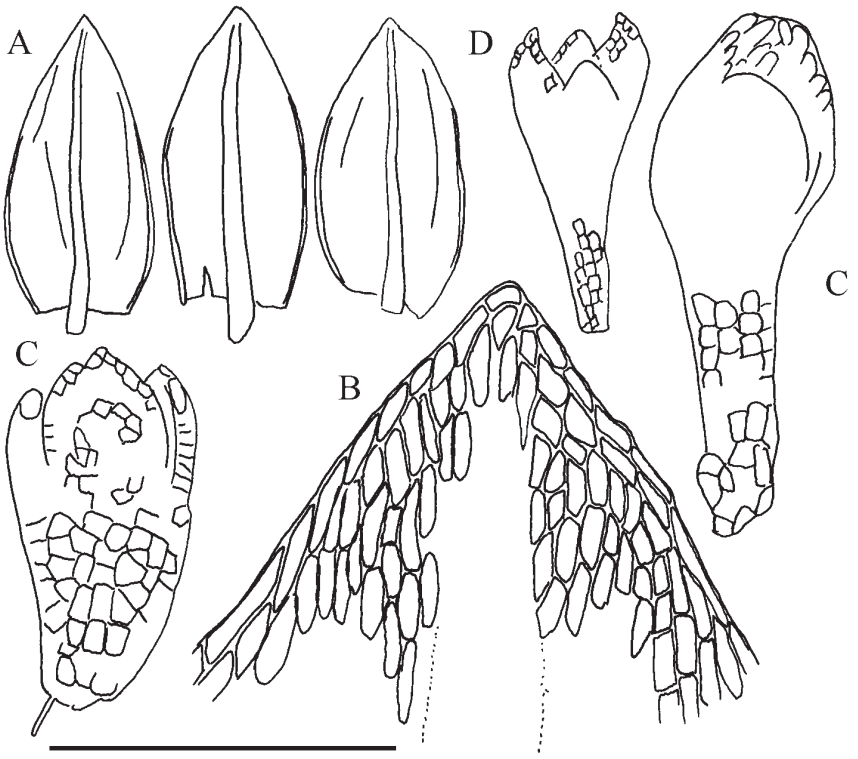

Fig. 36. *Bryum gemmiparum*. A = leaves, B = leaf apex; C, D = bulbils. Scale bar: A: – 2 mm; B: – 200 μm; C: – 400 μm; D: – 800 μm. [Erzberger s.n. (Albania, leg. J. Marka), del. Erzberger].

B. dichotomum: margins not parallel in lower part, bulbils smaller, never attaining 700 μm (*B. gemmiparum*: margins parallel in lower part of leaf, bulbils to 700 μm long).

For the differences between *B. gemmiparum* and *B. alpinum*, see the note under the latter species.

References: Demaret (1993): 214–215, Ahrens (2001): 73–74, Guerra *et al.* (2010): 169–171.

Habitat: thermophilic species at river and stream banks, on rock or walls.

Substrate: on moist basic rock or silt.

Distribution in Hungary: not known from Hungary.

Distribution in adjacent countries: UA.

Bryum intermedium (Brid.) Blandow
(Figs 37, 38)

Synoicous, always with sporophytes (in all specimens seen), mostly 2–3 generations can be found in one turf, but sometimes also purely male plants in the same turf. **Plants** 1–1.5 cm tall, with comal tuft, solitary or in lax turf; rhizoids red-brown, finely papillose. **Leaves** erect when moist, faintly twisted when dry, elongate lanceolate, acuminate, leaf base red; margin recurved, finely denticulate above, not decurrent; costa longly or sometimes shortly excurrent in smooth or faintly denticulate apiculus. **Laminal cells** 40–70 × 12–18(–20) μm; border indistinct, unistratose, made up of 2–3 rows of narrower cells. **Seta** up to 3 cm long, reddish. **Capsule** pendulous, cernuous or horizontal, to 5 mm long, narrowly pyriform and narrow-mouthed, mostly somewhat curved, asymmetric, gibbous, red brown to blackish when ripe, lid conical. **Exostome** teeth with conspicuous incrassate cell wall remnants in upper part. **Endostome** not attached to exostome, with oval perforations, cilia (2–3) shorter than segments, often variable in length, nodose or with short appendages. **Spores** 18–25 μm, green, faintly papillose.

Similar species: *B. archangelicum*: capsule ovate-pyriform, brown when ripe; endostome cilia lacking (*B. intermedium*: capsule narrowly pyriform, dark red to blackish when ripe; endostome with nodose cilia). Both species have incrassate cell wall remnants in the upper part of the exostome, but exostome teeth are more slender in *B. intermedium*.

For the difference between *B. intermedium* and *B. algovicum*, see the note under the latter species.

References: Limpricht (1895): 349–351, Demaret (1993): 253–254, Nyholm (1993): 194–195, Ahrens (2001): 76–77, Guerra *et al.* (2010): 137–138.

Habitat: pioneer in old quarries, sand pits, road cuttings, in open or half shaded situations.

Substrate: prefers temporarily moist calcareous or base-rich soils, more acidic substrates are avoided.

Vertical distribution: 180–200 (mean 190) m a.s.l.

Distribution in Hungary (6 specimens, 2 grid cells, of which 0 represent recent finds): **Vértes Mts** (8476.1): Comit. Komárom. In arenosis foveae inter Bánhida et Újtelep, 200 m, 08.08.1937 leg. Á. Boros BP 117178 (inmixed *B. pallens* var. *fallax*) sub *B. pallens* var. *fallax* (Milde) Jur., Dupl.: BP 117192 (inmixed *B. pallens* var. *fallax*); further duplicates: BP 117191 sub *B. pallens* subvar. *gracile* Podp. and BP 118256; (8476.3): Comit. Komárom. In foveis arenosis Nagy-irtás

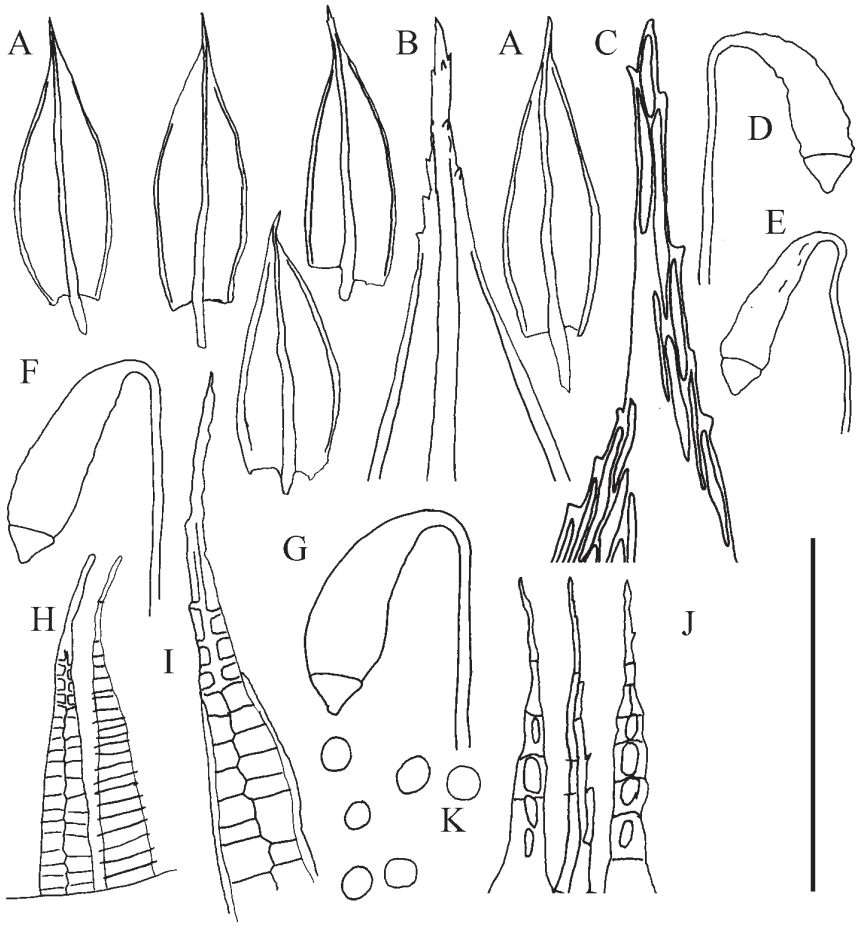

Fig. 37. *Bryum intermedium*. A = leaves; B, C = leaf apices; D–G = capsules (D, E dry/F, G moist); H = exostome teeth (outer/inner face); I = apical part of exostome tooth, outer face; J = detail of endostome (processes, cilia); K = spores. Scale bar: A: – 2 mm; B, H: – 400 μm; C, I–K – 200 μm, D–G: – 4 mm. [BP 118256, del. Erzberger].

ad Sikvölgy prope Bánhida, 180 m, 28.10.1934 leg. Á. Boros BP 116885 sub *B. lacustre* Bland.; Comit. Komárom. In arenosis humidis foveae Nagy-irtás prope Bánhida, 200 m, 08.08.1937 leg. Á. Boros BP 117193 (inmixed *B. pseudotriquetrum*) sub *B. pallens* subvar. *gracile* Podp.

These specimens from two adjoining sites represent the only collections of *B. intermedium* in Hungary. It is interesting to compare the specimen data with the notes in the field book of Boros (1915–1971). We find a precise description of the localities at the southern border of Tatabánya, and their conditions: both sites in long abandoned sand pits with moist sand near water tables and different stages of succession with growth of grass and scrub. The second locality is also the only growth site of *B. warneum* (see below). As with nearly all *Bryum* collections of Boros, the original determinations are by Podpera. The localities lie in the depression between the Gerecse Mts and the northern foothills of the Vértes Mts and are here somewhat arbitrarily assigned to the latter.

This species has probably vanished from the sites where it was found in 1937, since, due to rapid succession, ecological conditions surely must have changed in the 75 years elapsed. According to the details in Boros's field book (Boros 1915–1971) the site was a particularly deep sand pit from which sand had been formerly removed in large quantity to fill abandoned coal mines, and the bottom obviously touched the ground water table, thus giving rise to springs. Also, in sand deposits at comparable depth mineral bases have been protected from being

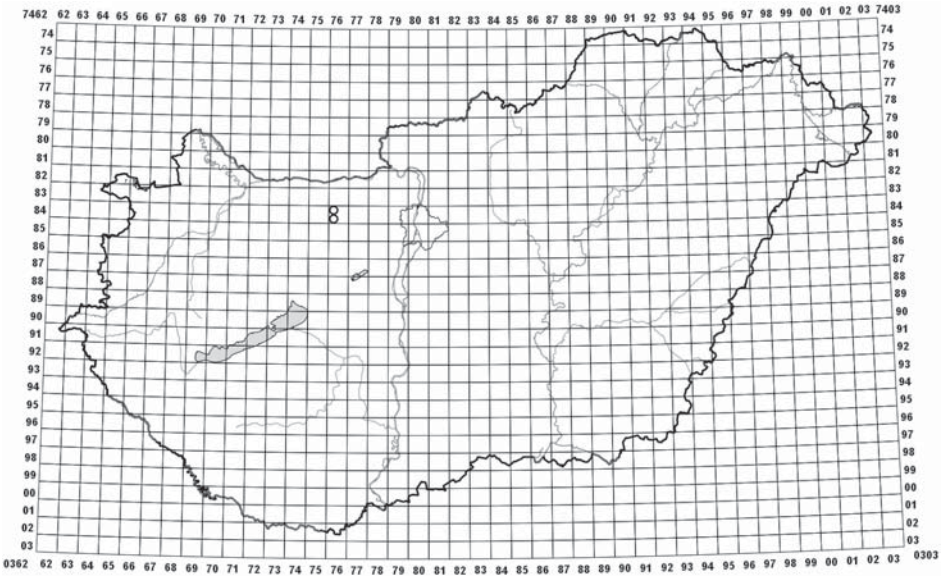

Fig. 38. Distribution of *Bryum intermedium*.

washed out and are still available. It remains to be established whether potential growth sites still exist for this definitely infrequent species. Red list status: DD (Papp *et al*. 2010). See also the note added in proof (p. 192).

Distribution in adjacent countries: A, RO, SK, SLO, SRB, UA.

Literature: Apart from the above site, Boros (1953, 1968), Orbán and Vajda (1983) enumerate Buda Mts, Bakony Mts, Balaton Uplands, Keszthely Mts, Kőszeg Mts, Mecsek, Danube–Tisza Interfluve, Tiszántúl, and Nyírség as area of *B. intermedium*. However, there are no confirmed specimens for these regions. Where specimens originally labelled *B. intermedium* were located, they were revised to other species or could not be definitely named: Buda Mts (8379.3): Comit. Pest. In decliv. dolomiticis montis Kisszénás-hegy prope pagum Pilisszentiván, 300–400 m, 09.05.1948 leg. Á. Boros BP 118255 sub *B. intermedium* f. *brachycarpum* Warnst. c.sporog. det. Podpera; revision: not *B. intermedium*, cannot be determined with certainty; Bakony Mts (8672.2): Montes Bakony, Vallis Cuha prope Sándormajor, 13.05.1937 leg. S. Polgár BP 118257 sub *B. intermedium* "capsulis subregularibus" det. Podpera; revision: not *B. intermedium*, material too scarce; Balaton Uplands (9170.4): Comit. Zala. In petrosis basalticis pedis bor. montis Szentgyörgyhegy prope Tapolca, 200 m, 03.04.1926 leg. Á. Boros BP 118258 sub *B. intermedium* det. Podpera; revision: cannot be determined with certainty; Mecsek Mts (9875.3): Pécs, Tubes, a János-kilátó oldalfalán (in pencil: Triaskalkmauer, sonnig, trocken), 613 m, 25.07.1937 leg. A. Visnya BP 118259 sub *B. intermedium* det. Latzel; was revised to *B. creberrimum*; Danube–Tisza Interfluve (9184.1): Kecskemét Szikra 03.06.1895 leg. L. Hollós BP 82531 sub *B. intermedium* det. Schilberszky with the additional note: "összehasonlítandó!" (must be compared); revised to *B. caespiticium*.

No specimens were found for Keszthely Mts, Kőszeg Mts, Tiszántúl, and Nyírség.

Boros (1953) gives two sites for the closely related *B. fuscum* (now considered a synonym of *B. intermedium*): Szentendre Island and Pusztavacs. Two specimens were located: Pest Plain (8380.2): Comit. Pest. Insula Szentendrei-sziget. In arenosis dumetosis ad Horányi-csárda pr. Szigetmonostor, 100 m, 15.04.1926 leg. Á. Boros BP 118238 sub *B. fuscum* det. Podpera; was revised to *B. caespiticium*; Danube–Tisza Interfluve (8883.1): Comit. Pest. In silva Nagyerdő ad Puszta Vacs prope Örkény, 100 m, 05.07.1919 leg. Á. Boros BP 118239 sub *B. fuscum* det. Podpera with the additional note "inveni solum ǫ?"; revised as *B.* cf. *intermedium*.

Papp and Rajczy (1999) publish two records from the Danube–Tisza Interfluve, one based on a literature report by Hollós (1896) – compare the specimen from Kecskemét BP 82531 revised to *B. caespiticium*; the other one based on BP 118239, revised as *B.* cf. *intermedium*.

Bryum klinggraeffii Schimp.
(Figs 39, 40)

Dioicous, sporophytes occasional (in 3.8% of specimens seen). **Plants** very small, 0.2–0.5 cm tall, green or mostly with a reddish hue; rhizoids pale yellowish to brownish, only slightly papillose. **Rhizoidal tubers** to 100 μm large, irregular in shape, consisting of relatively few cells with distinctly protuberant walls, red. **Leaves** arranged evenly along stem, erectopatent when moist, slightly flexuose when dry, elongate-ovate, leaf base red; margin plane or recurved, faintly denticulate above, unistratose; costa only shortly excurrent or ending in leaf apex. **Laminal cells** *ca* 50–70 × 12–15 μm, narrower at margin, not forming distinct border. **Seta** 1–2 cm, red-brown. **Capsule** pendulous, small, 1–1.5 mm long (note the different scale of capsules in Figure 39 than in other figures!), wine-red

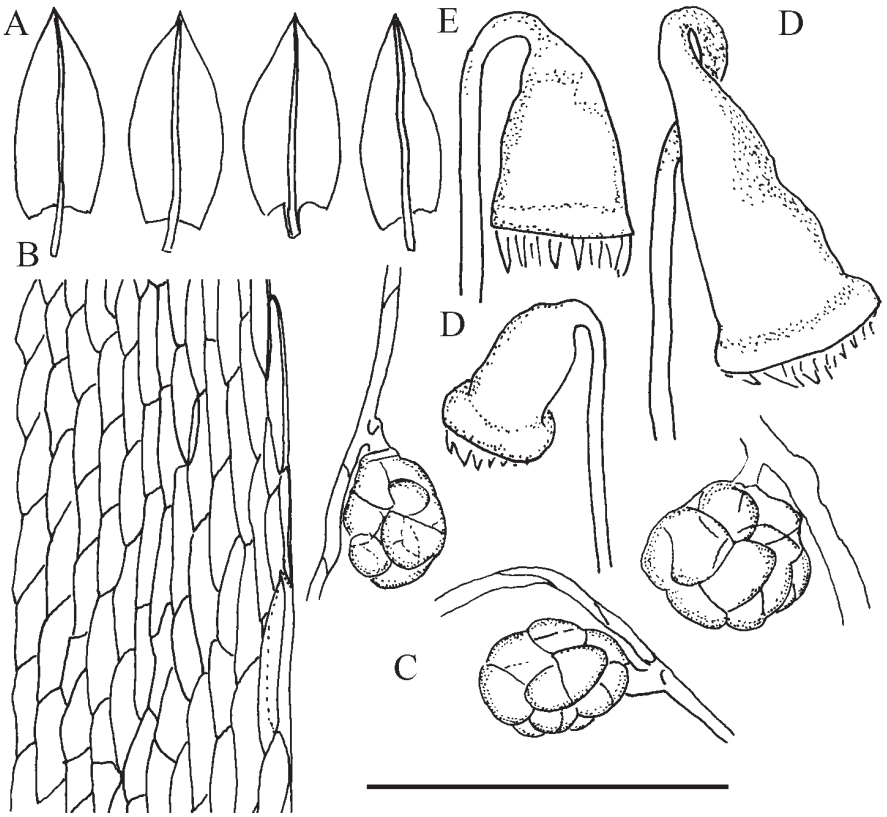

Fig. 39. *Bryum klinggraeffii*. A = leaves; B = marginal and median leaf cells; C = rhizoidal tubers; D, E = capsules (dry/moist). Scale bar: A, D, E: – 2 mm; B, C: – 200 μm. [A–C: Erzberger 244, D, E: Schröder s.n. 1995 (Germany: Bavaria 8338.4 Gießenbachtal), del. Erzberger].

when ripe, in shape resembling the capsules of *B. turbinatum*, but smaller, with 6–7 rows of very small red-walled cells below mouth, causing strong contraction below mouth in dry capsule. **Endostome** cilia longly appendiculate. **Spores** (8–)10–12 µm, smooth or finely papillose.

Similar species: *B. ruderale*: rhizoids deep violet, tubers to 200 µm, spherical (*B. klinggraeffii*: rhizoids yellowish brown, tubers in large numbers, irregular in shape, less than 100 µm).

B. violaceum: rhizoids pale violet, tubers ± spherical, yellow to orange (*B. klinggraeffii*: rhizoids pale yellowish, tubers irregular in shape with protuberant cells, red).

This species often grows together with *Dicranella staphylina*, which also produces rhizoidal tubers that bear a superficial resemblance to those of *B. klinggraeffii*, having approximately the same size and also distinctly bulging cells. However, they are brownish (and not red as in *B. klinggraeffii*) and more irregular in shape (see illustration in Smith 2004: 191).

References: Demaret (1993): 168–170, Nyholm (1993): 208, Ahrens (2001): 77–78, Guerra *et al.* (2010): 159–160, 163.

Habitat: pioneer on sandy, mostly calcareous to slightly acidic soil, in fields, at river banks, along paths (at a forest path, in arable fields, in saline meadows, at the moist bank of a stream, on moist calcareous rocks near a stream, on moist walls near a watermill, on the wall of a well, in loess cliffs, at riverbanks and lake shores).

Substrate: mostly calcareous sand, clay, loess, soil, mud.

Associated bryophytes: *Barbula unguiculata*, *Bryum argenteum*, *B. dichotomum*, *B. gemmiferum*, *B. rubens*, *B. subapiculatum*, *Dicranella staphylina*, *Ditrichum cylindricum*, *Entosthodon longicolle*, *Funaria hygrometrica*, *Phascum cuspidatum*, *Physcomitrium pyriforme*, *Pottia intermedia*, *Riccia bifurca*, *R. sorocarpa*.

Vertical distribution: 95–750 (mean 215) m a.s.l.

Distribution in Hungary (31 specimens, 26 grid cells, of which 15 represent recent finds): **Zemplén Mts** (7594.2): Comit. Abauj-Torna. Ad vias sylvarum vallis Senyővölgy prope pag. Nagybozsva, montes Sátorhegység, 01.09.1956 leg. L. Vajda BP 49109 sub *Mniobryum carneum*? revised to cf. *Bryum klinggraeffii* by G. Nordhorn-Richter 1980; **Aggtelek Karst** (7589.1): Comit. Borsod-Abaúj-Zemplén. In terra in valle rivi Tohonya-patak, Aggteleki-karszt, Jósvafő, 240 m, 24.06.1987 leg. M. Rajczy BP 165517; **Bükk Mts** (7990.2): Comit. Borsod. In rupibus irrigatis rivi Héjő-patak in Görömböly-Tapolca, montes Bükk, 14.09.1949 leg. L. Vajda EGR; **Mátra Mts** (8186.1): on a loamy bank just below Kékes in the Mátra Hills, Hungary, 750 m, 01.09.1971 leg. M. O. Hill BP 162747; **Börzsöny Mts** (8079.2): Com. Pest, Börzsöny-Geb., oberes Bachtal des Baches Kemence-patak, 500 m, 15.03.1997 leg. P. Erzberger B (Erzberger 3043); **Pilis Mts** (8380.3): Com. Pest, Pilis-Geb., Berg Ezüst-Kevély bei Üröm, 270 m, 01.04.1996 leg. P. Erzberger

B (Erzberger 2250); **Buda Mts** (8480.3): Budapest. In agris argillosis, inter segetes Medicaginis Törökvész, 250 m, 15.04.1945 leg. Á. Boros BP 7711; **Vértes Mts** (8575.2): Comit. Komárom. In muris irrigatis calc. molae Bokodi-malom pr. pag. Bokod, 160 m, 05.10.1948 leg. Á. Boros BP 118135 sub *B. erythrocarpum* var. *rubens*; **Sopron Mts** (8365.1): Comit. Győr-Sopron, ad latera rivulorum vallis Ördög-árok supra opp. Sopron, 350 m, 29.10.1977 leg. I. Galambos BP 162166 sub *B. bicolor*; **Mecsek Mts** (9975.1): Comit. Baranya. Ad parietem latericium putei publici intra urbem Pécs, 120 m, 23.07.1932 leg. A. Visnya BP 23038; **Villány Mts** (0175.2): Comit. Baranya. In abrupte loessacea Macskalyuk in decl. merid. montis prope pag. Máriagyüd, 200–250 m, 08.08.1999 leg. B. Papp BP 166706; **Kisalföld** (8272.3): Comit. Győr, Bácsai-sziget ad ripam argillosam Danubii, 10.10.1940 leg. S. Polgár BP 118131 sub *B. erythrocarpum*; **Danube–Tisza Interfluve** (9181.1): Comit. Bács-Kiskun, in natronatis ad viam ferream ad margines lacu Kisrét prope pag. Szabadszállás, 100 m, 15.04.1978 leg. M. Rajczy BP 164594; **Tiszántúl** (9293.4): Békés County. Riverline forests along the Fekete-Körös. On soil in the forest Sarkad-Remetei-erdő at Sarkad, 20.05.1998 leg. B. Papp BP 168036; **Észak-Alföld** (8002.3): Szabolcs-Szatmár-Bereg County, Majtisi-erdő forest at Jánkmajtis, on soil, N 47° 56’ 17.0”, E 22° 40’ 18.2”, 119 m, 05.08.2004 leg. B. Papp BP 171340; **Pest Plain** (8380.1): Com. Pest, Donauaue, Szentendre, Pap-sziget, auf feuchtem im Abtrocknen begriffenem Donau-Schlamm, N 47° 40’ 50”, E 19° 04’ 53”, 110 m, 02.04.2007 leg. P. Erzberger B (Erzberger 12054).

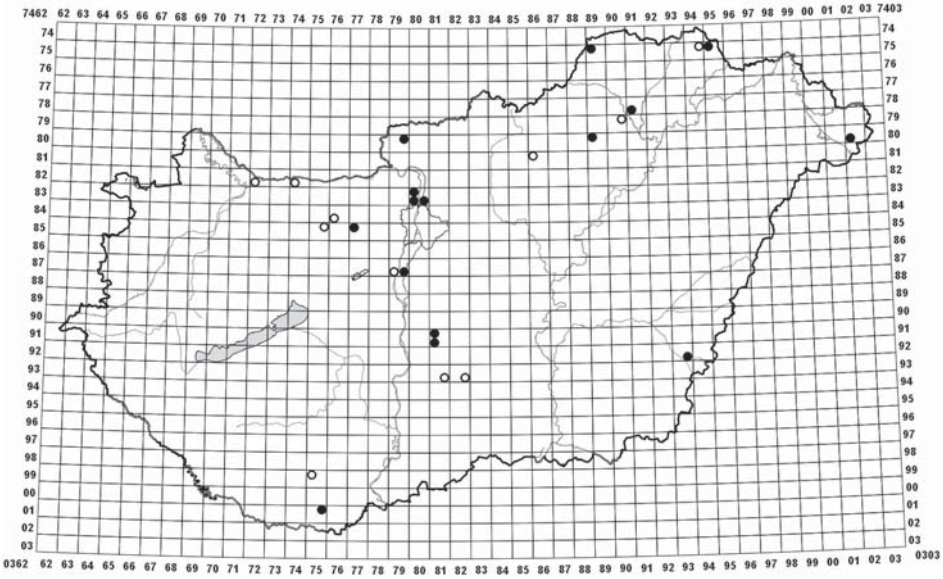

Fig. 40. Distribution of *Bryum klinggraeffii*.

B. klinggraeffii is most likely under-recorded, suitable habitats can presumably be found all over the country. The red list status: LC-att (Papp *et al*. 2010) should be changed to LC in view of the moderately high number of records.

Distribution in adjacent countries: A, RO, SK, SLO, UA.

Literature: Düll (1985: p. 128) seems to be the first report of this species from Hungary. His record is possibly based on the specimen from the Zemplén Mts revised by G. Nordhorn-Richter, since she worked in Düll's group at Duisburg.

In Papp and Rajczy (1999) three collections from the Kiskunság National Park are published that are based on specimens confirmed during our revision.

In Papp and Erzberger (2000) the confirmed specimen from Villány Mts (see above) is published.

Bryum knowltonii Barnes
[= *B. lacustre* (F. Weber et D. Mohr) Blandow non Brid.]
(Figs 41, 42)

Synoicous (or polyoicous). Sporophytes probably frequent (seen in Hungarian specimen). **Plants** 0.5–1.5(–2.5) cm tall, growing in compact tufts; rhizoids red-brown, strongly papillose. **Leaves** ± crowded in comal tuft, erecto-patent when moist, slightly spirally twisted when dry, broadly ovate, shortly acuminate with small point, concave, often ± keeled; margin entire or weakly denticulate above, recurved to revolute almost to apex, leaf base reddish; costa stout, at base red or brown-red, percurrent to nearly excurrent. **Laminal cells** 36–60(–70) × 12–18(–24) μm, marginal cells narrow and elongate in 3–4(–6) rows, walls not thickened, unistratose, forming ill-defined border. **Seta** 1.5–4.5 cm long, thin, ± flexuose. **Capsule** cernuous or pendulous, small, 1.5–2.5(–3.5) mm long, small-mouthed (but moderately wide-mouthed when dry and empty), short rounded pyriform or ovate, brown, neck distinct, often longer than half the length of the urn, lid small, shortly conical. **Exostome** rarely with few cross-walls between lamellae. **Endostome** basal membrane shorter than 1/2 (*ca* 1/3) of exostome length, cilia short to rudimentary. **Spores** (15–)18–25(–30) μm, finely papillose.

Note: This species can usually be recognised in the field by its shortly pointed, broadly ovate leaves and the small brown capsules on a long, thin, ± flexuose seta.

Similar species: *B. archangelicum* has similar peristomial characters, but differs in capsule shape and size as well as in habit of gametophyte: costa longly excurrent, marginal border of very long and narrow, incrassate cells 2–8 rows wide, very distinct, capsule to 4 mm long, obovate or pyriform (*B. knowltonii*: costa percurrent to nearly excurrent, not forming long apiculus, marginal border

indistinct, formed by 3–4(–6) rows of thin-walled cells, capsule short, 1.5–2.5 (–3.5) mm long, rounded pyriform or ovate).

References: Limpricht (1895): 315–317, Demaret (1993): 217–218, Nyholm (1993): 190, Zolotov (2000): 176–179, Smith (2004): 557–558.

Habitat: sand pits moistened by basic water, beside lakes and rivers.

Substrate: basic moist sand.

Vertical distribution: 110 m a.s.l.

Distribution in Hungary: doubtfully recorded from Hungary. **Danube–Tisza Interfluve** (9880.1): Bajaszőlők vasút-mente, 16.05.1959 leg. L. Balanyi EGR sub *B. pendulum*.

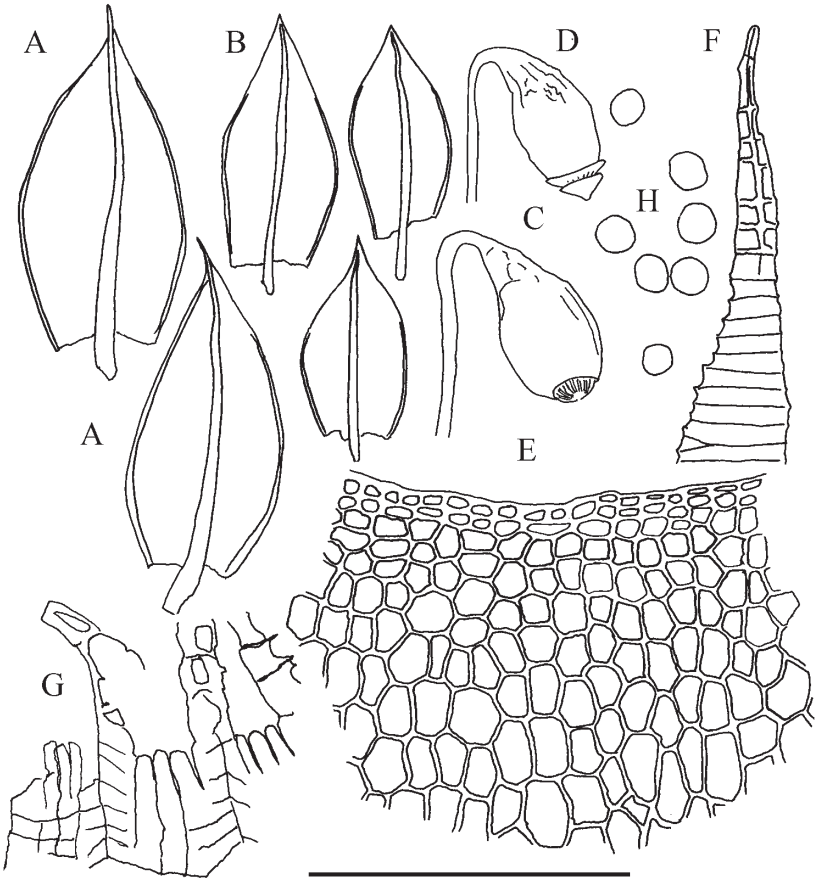

Fig. 41. *Bryum knowltonii*. A, B = leaves; C, D = capsules (moist); E = exothecial cells at capsule mouth; F = apical part of exostome tooth; G = detail of endostome with reduced cilia; H = spores. Scale bar: A, B: – 2 mm; C, D: – 4 mm; E–H: – 200 μm. [A, C, E–H: EGR Balanyi 1959 (Bajaszőlő), B, D: Meinunger and Schröder s.n. 2004 (Germany: Thuringia 5433.4 Neuhaus), del. Erzberger].

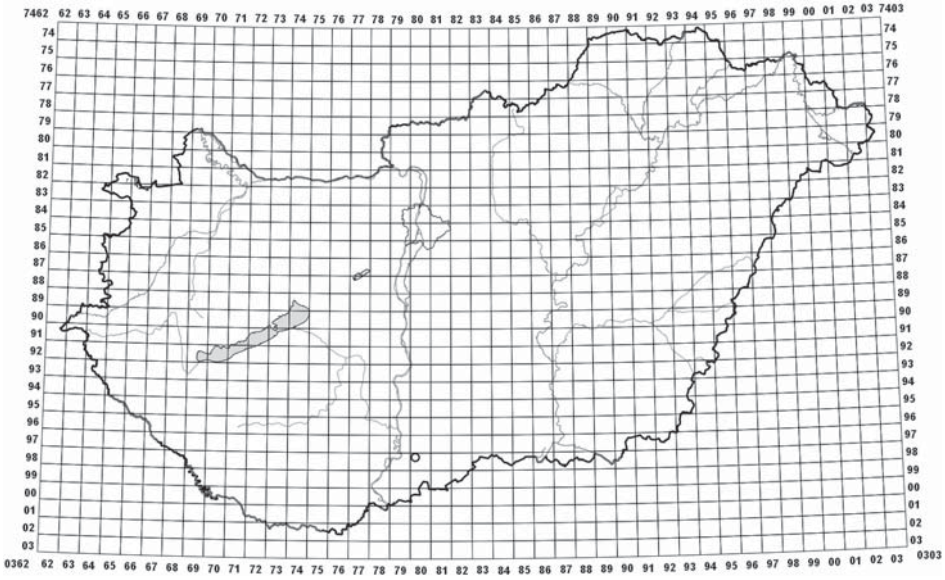

Fig. 42. Distribution of *Bryum knowltonii.*

The plants of this specimen show the typical capsule form, peristomial characters and spore size of *B. knowltonii*, however the costa is slightly longer excurrent than usual. Therefore some doubts concerning the occurrence of this species in Hungary remain.

A specimen in BP that Podpera had determined as *Bryum lacustre* Bland. (= *B. knowltonii*) has been revised to *B. intermedium*: Vértes Mts (8476.3): Comit. Komárom. In foveis arenosis Nagy-irtás ad Síkvölgy prope Bánhida, 180 m, 28.10.1934 leg. Á. Boros BP 116885.

As Red list category DD seems appropriate.

Distribution in adjacent countries: A, RO, SLO, UA.

Literature: To our knowledge, this species has not been mentioned in the bryological literature of Hungary.

Bryum kunzei Hornsch.

[*B. caespiticium* var. *imbricatum* Bruch et Schimp., *B. caespiticium* subsp. *kunzei* (Hornsch.) Podp.]

(Figs 43, 44)

Dioicous, usually without sporophytes (not seen in Hungarian material). **Plants** 0.5–1(–2) cm tall, growing in dense, green or yellowish tufts; rhizoids reddish brown, strongly papillose. **Leaves** forming comal tuft, erectopatent when

moist, imbricate when dry, ovate-triangular to broadly ovate, slightly to strongly concave, margins entire, plane, unistratose, border not differentiated, not decurrent; costa 45–60 μm wide at leaf base, excurrent in awn 120–400 μm long, smooth or faintly denticulate. **Laminal cells** 25–40(–60) × (8–)12–16(–20) μm, moderately incrassate, not porose, towards margin slightly longer (to 60 μm); basal paracostal cells quadrate to short-rectangular. **Seta** 1.5–2.5 cm long. **Capsule** cernuous, 1.5–3 mm long, pyriform, lid conical. **Endostome** cilia appendiculate. **Spores** 12–15 μm.

Similar species: *B. caespiticium*: leaves triangular, plane, slightly flexuose and less imbricate when dry; margins recurved and with indistinct border; basal paracostal cells rectangular (*B. kunzei*: leaves triangular to ovate-triangular, slightly concave, strongly imbricate when dry; margins plane, border lacking; basal paracostal cells quadrate to short-rectangular).

B. funckii: leaves broadly ovate, strongly concave, keeled; costa very stout, 75–130 μm wide at leaf base, excurrent in short mucro or an awn < 200 μm long; plants growing in loose patches or scattered (*B. kunzei*: leaves triangular to ovate-triangular, slightly concave, not keeled; costa 45–60 μm wide at leaf base, excurrent in an awn 100–400(–600) μm long; plants growing in dense tufts).

B. elegans: piliferous acumen reflexed from appressed leaves, laminal cells porose, slightly wider (*B. kunzei*: upper part of leaf including piliferous acumen reflexed from basal part of appressed leaf, laminal cells not porose).

B. dichotomum: axillary bulbils usually present; plants not growing in dense tufts (*B. kunzei*: axillary bulbils lacking; plants growing in dense tufts).

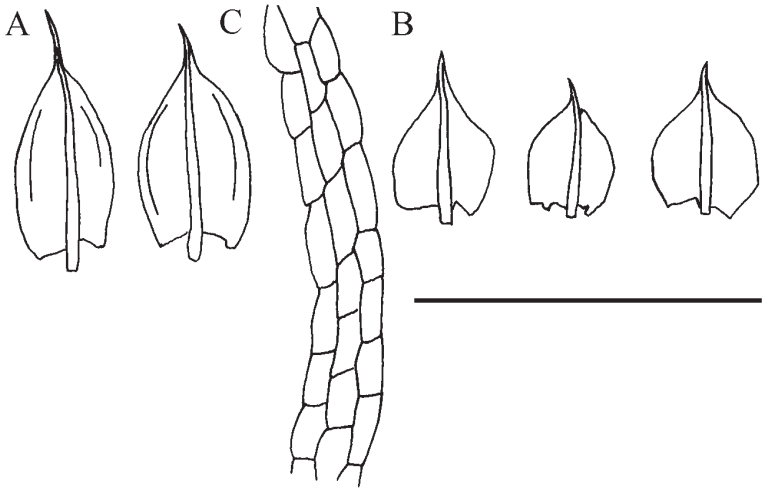

Fig. 43. *Bryum kunzei*. A, B = leaves; C = cells at leaf margin (to the right). Scale bar: A, B: – 2 mm; C: – 200 μm. [A: BP 117689; B, C: BP 117687, del. Erzberger].

References: Demaret (1993): 226–227, Zolotov (2000): 192–193, Holyoak (2004): 257–258, Meinunger and Schröder (2007): 50–51, 53–54, Hallingbäck (2008): 366–367, Guerra *et al.* (2010): 147–150.

Note on taxonomic status: The difficulties encountered in separating *B. kunzei* from *B. caespiticium* have prompted many authors to include the former as variety, subspecies or even synonym in the latter (Boros 1953, 1968, Orbán and Vajda 1983, Demaret 1993, Ahrens 2001, Köckinger *et al.* 2008).

Habitat: limestone grassland, tiled roof.

Substrate: calcareous soil, plastered wall, concrete, roof tiles.

Associated bryophytes: *Bryum argenteum*, *B. moravicum*, *Grimmia pulvinata*, *Pottia mutica*, *Schistidium crassipilum*, *Tortula muralis*.

Vertical distribution: 88–190 (mean 140) m a.s.l.

Distribution in Hungary (2 specimens, 2 grid cells, of which 0 represent recent finds): **Vértes Mts** (8577.2): Comit. Fejér, in robinietis prope Bicske, versus Felcsut, 190 m, 12.02.1936 leg. Á. Boros BP 117684 (originally determined by Podpera as *B. caespiticium* var. *kunzei* (Hornsch.) Warnst. "immixtum *B. capillare* foliis latioribus"); **Tiszántúl** (9187.4): Comit. Jász-Nagykun-Szolnok. Ad tegulis in oppido Kunszentmárton, 88 m, 12.05.1936 leg. Á. Boros BP 117687.

No conclusions about the actual distribution of this taxon in Hungary can be drawn at present. No red list status has been assigned, due to inclusion in *B. caespiticium*; DD would be appropriate.

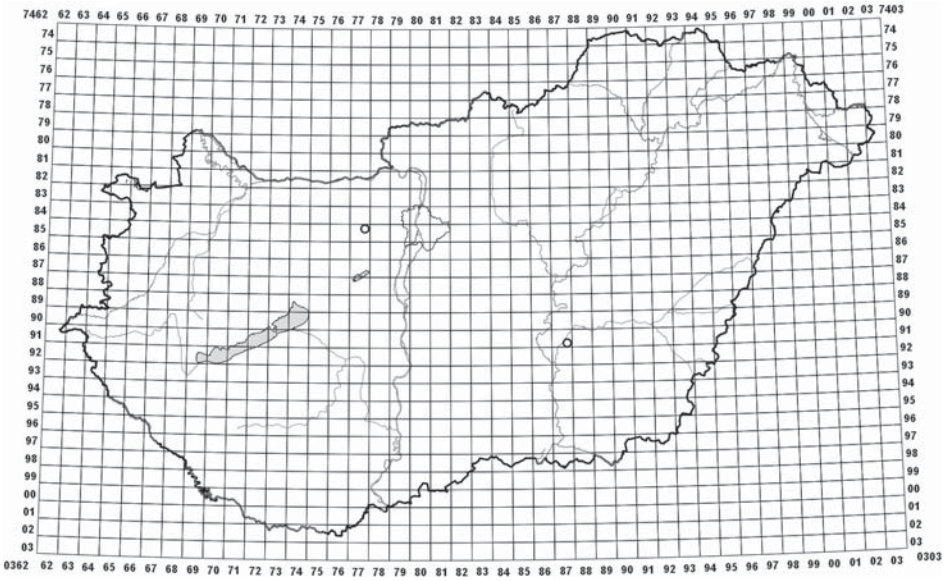

Fig. 44. Distribution of *Bryum kunzei.*

Distribution in adjacent countries: A, HR, RO, SK, SLO, UA.

Literature: Boros (1953, 1968), Orbán and Vajda (1983) enumerate several regions: Gerecse Mts, Vértes Mts, Kisalföld, Danube–Tisza Interfluve, Tiszántúl. Some are, however, not supported by confirmed specimens. As with other critical species, we here give a complete list of all unconfirmed specimens originally under *B. kunzei* with the result of our revision: Gerecse Mts (8277.3): Comit. Esztergom. In rupibus calcareis montis Öreg-kő prope Bajót, 300–375 m, 05.04.1936 leg. Á. Boros BP 117683 (originally determined by Podpera as *B. caespiticium* var. *kunzei* (Hornsch.) Warnst. ♂; revision: not *B. kunzei*, see note under *B. capillare*); Kisalföld (8371.2): Győr, ad tectum cavae, 09.11.1940 leg. S. Polgár BP 117682 (original label "*B. kunzei* v. *pulvinatum* Roth teste Podpera"; revision: not determinable); Danube–Tisza Interfluve (9181.1): Comit. Pest. In natronatis ad viam ferream prope Szabadszállás, 100 m, 20.05.1928 leg. Á. Boros BP 117686 (originally determined by Podpera as *B. caespiticium* var. *kunzei* (Hornsch.) Warnst. f. *revolutum* Podp.; revision: not determinable); Tiszántúl (8194.4): In pascuo natronato apud *Phragmitetum* Dávidka prope Hajdúnánás, com.: Hajdú, 21.09.1938 leg. J. Igmándy BP 117689 (originally determined by Podpera as *B. caespiticium* var. *kunzei* (Hornsch.) Warnst., revision: *B. caespiticium*); (8495.4): Locus natalis: Debrecen, com. Hajdú, 26.04.1913 leg. M. Péterfi BP 117688 (*B. caespiticium* var. *kunzei* (Hornsch.) Warnst.; revision: cannot be determined with certainty).

Bryum lonchocaulon Müll. Hal.
[= *B. cirrhatum* Hoppe et Hornsch., *B. cirratum* auct. hung.]
(Figs 45, 46)

Polyoicous, i.e. stem ends in synoicous inflorescence and subterminal shoots nearly always male (Zolotov 2000) (sporophytes present in all specimens seen). **Plants** 1–3 cm tall, growing solitary or in turf; rhizoids red-brown, coarsely or finely papillose. **Leaves** crowded in comal tuft, patent when moist, appressed and slightly twisted when dry, ovate-lanceolate, taut and stout, longly acuminate, leaf base red; margin entire or denticulate, recurved; costa longly excurrent in ± flexuose, often denticulate awn (250–)400–650(–800) μm long. **Laminal cells** 50 × 15–18 μm, at margin 6(–7) rows of narrow, incrassate cells forming broad, distinct unistratose border. **Seta** 3–4 cm, reddish. **Capsule** cernuous, large-mouthed, brown, lid convex. **Exostome** and endostome not connected. **Endostome** cilia longly appendiculate. **Spores** (12–)15–20(–24) μm, light yellowish, often spores of different size in one capsule, often malformed, shrunk or deformed, papillose.

Similar species: *B. lonchocaulon* cannot be identified with certainty without ripe sporophytes. The separation from the other species of the *B. pallescens* group is critical, see also Table 4 (p. 132).

B. pallescens: autoicous, plants to 5 cm tall, growing also on slightly acidic subtrates; spores 18–22 μm, mostly slightly papillose, olive green to yellowish brown, perfectly spherical (*B. lonchocaulon*: polyoicous, plants to 3 cm tall, on calcareous substrates, spores (12–)15–20(–24) μm, light yellowish, often spores of different size in one capsule, often malformed, shrunk or deformed, papillose).

B. creberrimum: synoicous, also subterminal inflorescences, leaf border consisting of 2–3(–4) rows of narrow incrassate cells, costa shortly excurrent, awn 200–400(–650) μm long (*B. lonchocaulon*: polyoicous, i.e. terminal inflorescence synoicous, subterminal inflorescences male, leaf border consisting of 6(–7) rows of narrow incrassate cells, costa longly excurrent, awn (250–)400–650(–800) μm long) (Zolotov 2000).

B. archangelicum: capsules narrow-mouthed, endostome lacking cilia (*B. lonchocaulon*: capsules large-mouthed, straight; endostome with long cilia).

For the differences between *B. lonchocaulon* and *B. algovicum* and *B. caespiticium*, see the notes under the latter species.

References: Limpricht (1895): 352–353, Zolotov (2000): 196–198, 200–202, Meinunger and Schröder (2007): 43–46.

Note on taxonomic status: Although known as a separate taxon in the older literature (*B. cirrhatum*), within the last decades it has been included in *B. pallescens* (Meinunger and Schröder 2007).

Habitat: pioneer in old quarries, in road embankments, in wall fissures, always in open situations (on moist stone wall of thermal piscine, on tree trunks in a lake, in sand pits, in sandy hills, in tall sedge vegetation).

Substrate: on moist sand, soil, calcareous rocks, mortar.

Associated bryophyte: *Fissidens dubius*.

Vertical distribution: 100–250 (mean 155) m a.s.l.

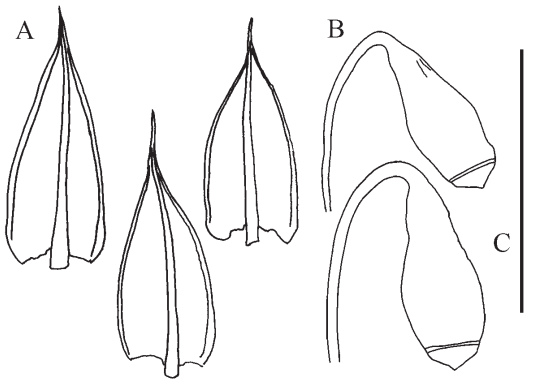

Fig. 45. *Bryum lonchocaulon*. A = leaves; B, C = capsules. Scale bar: A: – 2 mm; B, C: – 4 mm. [BP 117773; del. Erzberger].

Distribution in Hungary (6 specimens, 6 grid cells, of which 0 represent recent finds): **Bükk Mts** (8188.1): Comit. Heves. In muris humidis "Uszoda" ad font. therm. oppidi Eger. Eger (Heves m.). Uszoda nedves kőmedencéjén, 150 m, 21.08.1929 leg. A. Bartha BP 117661; **Vértes Mts** (8476.3): Comit. Komárom. In arenosis foveae silvae Nagy-erdő prope Felsőgalla, 250 m, 08.08.1937 leg. Á. Boros BP 117663; **Zala** (9567.2): Flora hungarica, Comitat Zala. In arenosis humidis inter opp. Nagykanizsa et pag. Sormás, 150 m, 05.06.1948 leg. Á. Károlyi EGR sub *B.* sp.; **Danube–Tisza Interfluve** (8782.): Comit. Pest. In magnocaridetis Vajkó ad Pusztapótharaszt prope Nyáregyháza, 125 m, 14.06.1932 leg. Á. Boros BP 116840 sub *B. Hagenii*; (8982.3): Comit. Pest. In collibus arenosis ad Tatárszentgyörgy, versus pag. Ladánybene, 100 m, 04.06.1920 leg. Á. Boros BP 117773 sub *B. caespiticium*; Lake Balaton (9073.1): Comit. Veszprém. In truncos in lacu Balaton pr. pag. Balatonfüred, 10.05.1956 leg. L. Vajda BP 4783.

The distributional record is probably still very incomplete. Since this taxon was included in *B. pallescens* in Erzberger and Papp (2004) and Papp *et al.* (2010), no red list status has been assigned. DD would be appropriate.

Distribution in adjacent countries: UA only. But this may not reflect the actual distribution, due to the controversial taxonomic status (often included in *B. pallescens*).

Literature: This taxon was formerly treated under the name *B. cirrhatum* Hoppe et Hornsch. (Meinunger and Schröder 2007), therefore we consider

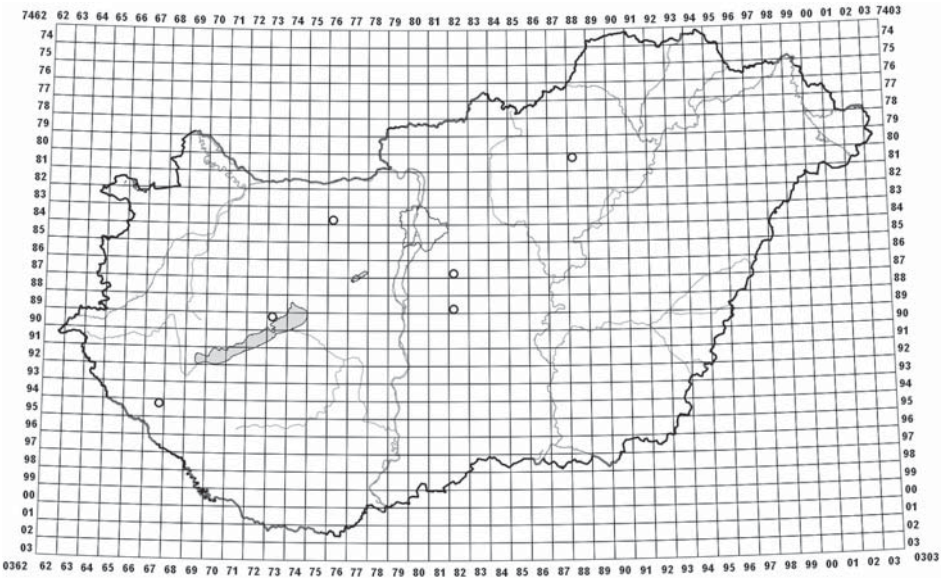

Fig. 46. Distribution of *Bryum lonchocaulon*.

the data under this name in Boros (1953, 1968) and Orbán and Vajda (1983). Several recent check-lists, however, include *B. cirrhatum* in *B. pallescens* (Corley *et al.* 1981, Koperski *et al*. 2000, Erzberger and Papp 2004, Hill *et al.* 2006). To avoid future confusion, apart from the complete list of specimens of *B. lonchocaulon* (see above), we here also give a list of all specimens originally under the name of *B. cirrhatum* or *B. cirratum*, and the result of our revision.

Zemplén Mts (7494.4): Com. Abaúj-Torna. In rupestribus montis Füzéri várhegy prope Füzér, 09.09.1955 leg. L. Vajda EGR (revised to *B. creberrimum*); (7594.3): Comit. Abaúj-Torna. In abietis montis Dorgóhegy prope pag. Telkibánya, montes Sátorhegység, 14.09.1960 leg. L. Vajda BP 62803 (revised to *B. algovicum*), EGR (revised to *B. archangelicum* + *B. pallescens*); Pilis Mts (8378.2): Hungaria centr., com. Esztergom. Ad margines rivulorum prope pag. Csév, 01.05.1946 leg. L. Vajda BP 117672, EGR (both revised to *B. algovicum*); Vértes Mts (8476.3): Comit. Komárom. In arenosis foveae silvae Nagy-erdő prope Felsőgalla, 250 m, 08.08.1937 leg. Á. Boros BP 117664 (rev. *pallescens* group), BP 117665 (revised to *B. pallescens*); (8576.2): Comit. Fejér. In argillosis silvaticis vallis Holdvilág-árok montis Tamás-hegy prope Szár, 350–400 m, 22.04.1935 leg. Á. Boros BP 117666 (revised to *B. caespiticium*), EGR (revised to *B.* cf. *caespiticium* + *B. dichotomum*); Kisalföld (8272.3): Győrszentiván, Utkaparóház kútjának belső peremén, 29.05.1940 leg. S. Polgár BP 117660 (revised to *B. creberrimum*); Balaton Uplands (9073.1): Comit. Veszprém. In truncos in lacu Balaton pr. pag. Balatonfüred, 10.05.1956 leg. L. Vajda EGR (material too scarce for safe determination); Danube–Tisza Interfluve (8682.4): Comit. Pest. In pascuis arenosis ad viam ferream prope Monor, 140 m, 26.04.1932 leg. Á. Boros BP 117658 (revised to *B. algovicum*); (9181.3): Comit. Bács-Kiskun. Solo arenario in umbrosis. Prope pag. Fülöpháza, 06.04.1977 leg. M. Rajczy BP 159449 (dioicous, indeterminable without ripe sporophytes); (8685.4): Com. Pest. A vasút mellett szikes helyen Tápiógyörgye és Újszász közt, 100 m, 07.09.1917 leg. Á. Boros BP 117659 (not determinable with certainty); Tiszántúl (8391.4): Comit. Hajdú. In silva Ohati-erdő prope Ohat, 95 m, 25.05.1938 leg. Á. Boros BP 117656 (not determinable with certainty); (8496.4): Locus natalis: Debrecen, com. Hajdú. Haláp, in arenosis, 29.05.1934 leg. Ujvárossy BP 117655 (revised to *B. caespiticium*).

For Kőszeg Mts and Nyírség no specimen was seen. Additional region: Zala.

Note: Compare also the account on the collective *B. pallescens* group.

Bryum longisetum Blandow ex Schwägr.

Synoicous or polyoicous, mostly with sporophytes. **Plants** 1–2 cm tall, with comal tuft, growing solitary or in lax turf; rhizoids red-brown, coarsely papillose. **Leaves** elongate-lanceolate; leaf base red; margin denticulate above, recurved to

apex; costa shortly excurrent as weakly denticulate awn. **Laminal cells** 40–50 × (12–)14–16(–18) μm, rather incrassate, porose; marginal border to 6 cells wide, formed of narrow, to 90 μm long cells. **Seta** 6–10 cm long. **Capsule** cernuous, to 4 mm long, ventricose-pyriform, narrow-mouthed, brown when ripe, lid conical with acute mamilla. **Exostome** and endostome of equal length, connected at base only, free above. **Endostome** processes with oval perforations, cilia (2) rudimentary. **Spores** 40–50 μm, green, papillose.

Similar species: *B. longisetum* cannot be named without capsules. However, due to the setae up to 10 cm long, even in the field, the plants cannot be mistaken for any other species. The form of the capsule is similar to that of *B. algovicum*. The spore size of up to 50 μm is not reached by any other species in Central Europe.

References: Limpricht (1895): 320–322, Nyholm (1993): 190–191, Ahrens (2001): 78–79.

Habitat: swampy meadows, fens, lake shores, also in temporarily inundated areas, always in open situations.

Substrate: wet base-rich soil, preferably calcareous.

Distribution in Hungary: not recorded from Hungary.

Distribution in adjacent countries: –.

Bryum mildeanum Jur.
(Figs 47, 48)

Dioicous, sporophytes very rare (not seen in Hungarian material). **Plants** 1–3 cm tall, growing in shining green to brownish, easily disintegrating tufts; rhizoids sparse, light orange-red, finely papillose. Tubers, bulbils lacking, but vegetative dispersal by erect **fragile shoots (cladia)** in the leaf axils, which can be found in the substrate after breaking off, gradually becoming rounded and swollen turnip-like at the base. **Leaves** evenly arranged along stem, erectopatent when moist, hardly altered when dry, taut, triangular-lanceolate, slightly concave; margin entire, recurved often to apex; costa shortly excurrent, green or red, *ca* 60 μm wide at insertion, at times slightly denticulate in excurrent apiculus. **Laminal cells** 50–60 × 12, walls hardly thickened, cells narrower towards margin, but border indistinct; at leaf base a larger group of quadrate to rectangular cells that may exhibit a reddish colour. **Seta** 2–2.5 cm, brown. **Capsule** cernuous, 2–3 mm long, broadly ovate or pyriform, brown. **Endostome** cilia appendiculate (Limpricht 1895) or rudimentary (Guerra *et al.* 2010: 175, description based on type material). **Spores** 15 μm, smooth or slightly papillose.

Similar species: *B. mildeanum* is an inconspicuous species that in the past has been frequently confused with *B. alpinum* and with luxuriant forms of *B. dichotomum*: leaves ovate-lanceolate, costa shortly or longly excurrent, with bul-

bils of various shape in the leaf axils (*B. mildeanum*: leaves triangular-lanceolate, costa shortly excurrent, fragile shoots, not bulbils, in leaf axils).

For the differences between *B. mildeanum* and *B. alpinum* and *B. gemmiparum*, see the notes under the latter species.

References: Limpricht (1895), Demaret (1993): 239–241, Nyholm (1993): 201–203, Ahrens (2001): 80–81, Meinunger and Schröder (2007): 54, 63–64, Guerra *et al.* (2010): 173–175.

Habitat: on andesitic rocks, in saline grasslands.

Substrate: dry andesitic rocks, soil.

Associated bryophytes: *Barbula unguiculata*, *Campylium chrysophyllum*, *Ceratodon purpureus*.

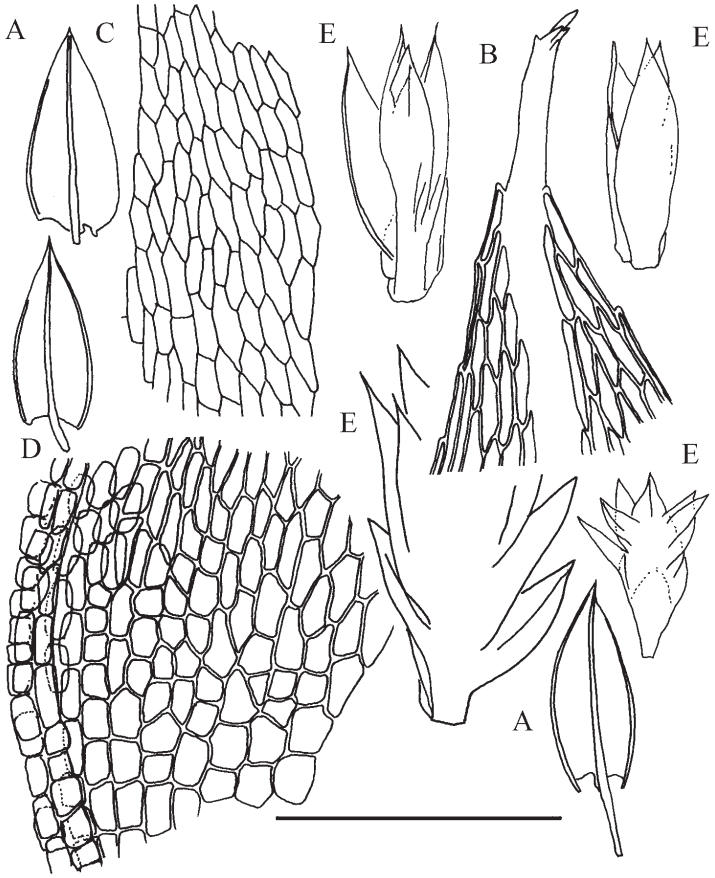

Fig. 47. *Bryum mildeanum*. A = leaves; B = leaf apex; C = mid-leaf cells; D = basal cells; E = cladia (brood branches). Scale bar: A, E: – 2 mm; B–D: – 200 μm. [A–D: BP 118264, E: Schröder s.n. 1996 (Germany: Bavaria 8256.3 Sibgratsgfäll), del. Erzberger].

Vertical distribution: 90–750 (mean 310) m a.s.l.

Distribution in Hungary (9 specimens, 8 grid cells, of which 2 represent recent finds): **Zemplén Mts** (7594.4): Comit. Abaúj-Torna. In rupibus andesiticis siccis supra pag. Kishuta, montes Sátorhegység, 26.06.1954 leg. L. Vajda BP 27847, BP 118264; **Mátra Mts** (8185.2): Comit. Heves. In fruticetis ad margines vivarum in decl. Erős-oldal supra vall. rivi Nagy-patak prope Mátraháza, 29.10.1952 leg. L. Vajda BP 7730 sub *B. alpinum* (rev. L. Meinunger and W. S.); **Vas** (8668.3): Comit. Vas. Ostffyasszonyfa, ad viam ferream, 180 m, 29.09.1922 leg. Á. Boros BP 118039 sub *B. alpinum*; **Danube–Tisza Interfluve** (8985.2): Comit. Pest. In natronatis Pusztajenő prope Jászkarajenő, 90 m, 24.04.1938 leg. Á. Boros 118027 sub *B. alpinum*; **Tiszántúl** (8292.4): Comit. Hajdu-Bihar. In pascuis salsis Cserepespuszta prope pag. Ujszentmargita, 11.03.1975 leg. S. Orbán BP 156918 sub *B. alpinum*; (8591.2): Comit. Szolnok. In pascuis salsis prope pag. Nagyiván, 13.11.1975 leg. S Orbán BP 156912 sub *B. alpinum*.

This species has been confused with other species in the past, mainly with (green forms of) *B. alpinum*, with which it also shares some habitat preferences. It is definitely less frequent and perhaps more vulnerable. It is endangered in many Central European countries. Red list status: DD (Papp *et al.* 2010). According to the information now available, EN appears appropriate (criterion B, 2 "recent" (from 1975!) localities, high risk of extinction). See also the note added in proof (p. 192).

Distribution in adjacent countries: A, HR, RO, SK, SLO, UA.

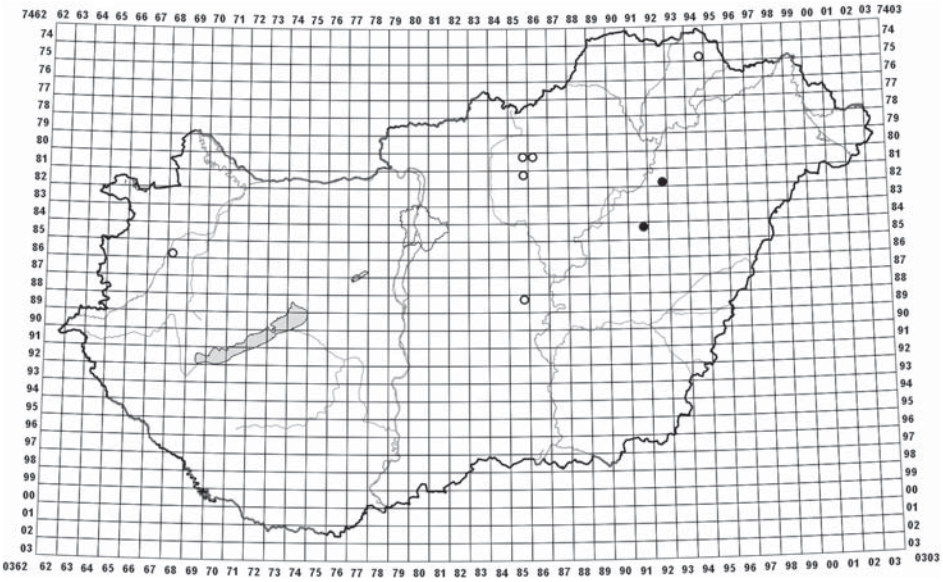

Fig. 48. Distribution of *Bryum mildeanum*.

Literature: The chorological data in Boros (1953, 1968) and Orbán and Vajda (1983) should be treated with reservation, since no specimens could be located to support them except the report from Zemplén Mts, which is obviously based on the confirmed specimens quoted above. (Visegrád Mts: BP 118271 revised to *B. alpinum*; according to Szepesfalvi (1941), a record for the Visegrád Mts dates from Förster, but no specimen seen; Vértes Mts: BP 118266, BP 118263 indeterminable); Kőszeg, Makó: no specimens seen; Tiszántúl: Mezőberény BP 118265: indeterminable).

Bryum moravicum Podp.
[= *B. flaccidum* auct. non Brid., *B. subelegans* auct. non Kindb., *B. laevifilum* Syed]
(Figs 49, 50)

Dioicous, occasionally with sporophytes (in 21% of specimens seen). **Plants** 1–2(–4) cm tall, growing in very lax tufts; rhizoids brown-red, finely papillose, sometimes forming tomentum. Brownish, very finely papillose **filiform gemmae** always present in leaf axils, sparse in fruiting plants; globular tubers are reported to occur on the rhizoids (Crundwell in Hill *et al.* 1994: 102). **Leaves** erectopatent when moist, flexuose and spirally twisted (mostly around their own longitudinal axis, to a lesser degree around the stem) when dry, elongate obovate, margin entire or weakly denticulate in upper third, producing a wavy outline, plane or recurved in lower part; costa vanishing below apex or confluent in apex with marginal border forming smooth apiculus 200–650 μm long. **Laminal cells** *ca* 40–60 × 20–25 μm, marginal cells up to 160 × 10 μm, forming distinct unistratose border 1–3 cells wide. **Seta** 1–2 cm, brownish. **Capsule** cernuous to pendulous, *ca* 5 mm long, straight or slightly curved, brown. **Endostome** cilia appendiculate. **Spores** 12–15 μm, smooth or nearly so.

Similar species: *B. capillare*: without filiform propagules in leaf axils; to 4 cm tall, leaves spirally twisted around stem when dry, growing also on soil (*B. moravicum*: always with filiform propagules in leaf axils, 2–3 cm tall, leaves twisted mainly around their own axes when dry, mostly growing on deciduous trees).

For the differences between *B. moravicum* and *B. donianum*, see the note under the latter species.

References: Demaret (1993): 194–196, Nyholm (1993): 183–184, Ahrens (2001): 69–70, Smith (2004): 551–553.

Note on taxonomic status and nomenclatural history: Boros (1953, 1968) like many other authors in the 20th century treated this taxon as variety (var. *flaccidum*) or form (f. *flaccidum*), respectively, of *B. capillare*. The basionym of this combination is *B. flaccidum* Brid. Syed (1973) distinguished three

European species with filamentous axillary gemmae: (i) *B. subelegans* Kindb. with gemmae coarsely papillose, (ii) the newly described *B. laevifilum* Syed (type: collected by Boros from the Bükk Mts, housed in S; collections from the same locality and the same day in EGR and BP (118436), determined originally by Podpera as *B. elegans* c.fr., were revised to *B. capillare*), allegedly differing by its smooth filiform gemmae from (iii) *B. flaccidum* with "finely papillose" filamentous gemmae. Accordingly, Orbán and Vajda (1983) treated *B. flaccidum* (the widespread taxon) and *B. laevifilum* (reported only from the type locality) as separate species. Corley *et al.* (1981) synonymised *B. laevifilum* and *B. subelegans* under *B. flaccidum*, partly following Smith (1978), who argued that *B. laevifilum* cannot be maintained because it intergraded with *B. flaccidum*. Later, Corley and Crundwell (1991) followed the argument of Wilczek and Demaret (1982) that the name *B. flaccidum* is illegitimate and must be replaced. But since *B. subelegans* is an earlier name, Corley and Crundwell (1991) proposed this name, with *B. flaccidum* and *B. laevifilum* as synonyms. Hodgetts (2001) re-established *B. subelegans* as a rare British species based on a Scottish collection, differing among others, in coarsely papillose filamentous gemmae. Therefore, the common taxon was listed under *B. laevifilum* in Erzberger and Papp (2004). Holyoak (2004) showed that *B. subelegans* is conspecific with *B. oeneum* and what European authors called *B. rutilans*, which is in fact a form of *B. pallens* with filiform axillary gemmae. He also studied type material of *B. moravicum* Podp. and proved that it is the oldest name available for the taxon with axillary filamentous gemmae related to *B. capillare*.

Habitat: on the bark of deciduous trees, also on coarse concrete, always in sheltered sites with moist air (at the entrance of caves, on the bark of trees and on roots in oak forests on sand and poplar-juniper sand dune forests, ash-elm forests (*Fraxino pannonicae-Ulmetum*), willow-poplar gallery forests (*Salicetum albae-fragilis*) and other forests, rarely in basaltic grasslands).

Substrate: base-rich bark, shaded rock (shaded limestone rock, shaded dolomite rock, shaded basaltic rock, shaded andesite rock, moist shaded sandstone rocks, stone walls, moist concrete walls, decaying wood, on thatched roofs, rarely on fungus, in particular on the bark of *Acer* sp., *A. campestre*, *A. negundo*, *Alnus glutinosa*, *Carpinus betulus*, *Fagus sylvatica*, *Fraxinus* sp., *Ginkgo biloba*, *Maclura pomifera*, *Picea abies* (tree base), *Populus alba*, *P. italica*, *Quercus* sp. *Q. pubescens*, *Robinia pseudacacia*, *Sambucus nigra*, *Tilia* sp., rarely on sandy soil and soil in basaltic grasslands).

Associated bryophytes: *Amblystegium serpens*, *A. varium*, *Anomodon attenuatus*, *A. viticulosus*, *Apometzgeria pubescens*, *Atrichum angustatum*, *Barbilophozia barbata*, *Bartramia pomiformis*, *Brachythecium populeum*, *B. velutinum*, *Bryoerythrophyllum recurvirostrum*, *Bryum caespiticium*, *B. capillare*, *Campylium*

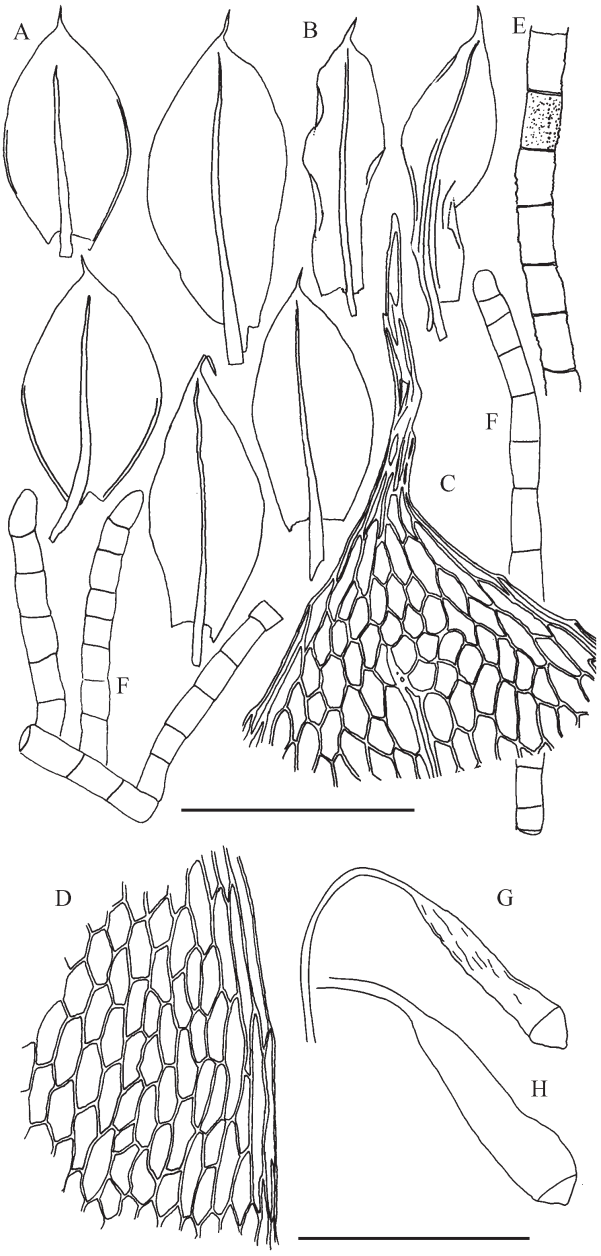

Fig. 49. *Bryum moravicum*. A, B = leaves (B only partially remoistened); C = leaf apex; D = leaf margin; E = part of filiform gemma, showing ornamentation in one cell; F = filiform gemmae; G, H = capsules (dry/moist). Scale bar: A, B: – 2 mm; C–F: – 200 μm; G, H: – 4 mm. [A–E, G–H: EGR Orbán 1978 (Pazsag/Bükk), F: Erzberger 237, del. Erzberger].

calcareum, *Ceratodon purpureus*, *Chiloscyphus polyanthos*, *Ctenidium molluscum*, *Dichodontium pellucidum*, *Dicranum scoparium*, *Didymodon insulanus*, *D. rigidulus*, *D. sinuosus*, *Encalypta ciliata*, *E. streptocarpa*, *E. vulgaris*, *Eurhynchium flotowianum*, *E. striatulum*, *Fissidens bryoides*, *Grimmia* cf. *hartmanii*, *Hedwigia ciliata* var. *ciliata*, *Homalia besseri*, *H. trichomanoides*, *Homalothecium philippeanum*, *H. sericeum*, *Hypnum cupressiforme*, *Isothecium alopecuroides*, *Leptodictyum riparium*, *Leucodon sciuroides*, *Lophocolea bidentata*, *L. heterophylla*, *L. minor*, *Metzgeria furcata*, *Mnium stellare*, *Orthotrichum affine*, *Paraleucobryum longifolium*, *Plagiomnium cuspidatum*, *P. rostratum*, *Plagiothecium cavifolium*, *P. denticulatum*, *P. succulentum*, *Pleurochaete squarrosa*, *Pohlia nutans*, *Polytrichum formosum*, *Pseudoleskeella nervosa*, *Pterigynandrum filiforme*, *Radula complanata*, *Rhizomnium punctatum*, *Rhynchostegium murale*, *Schistidium lancifolium*, *Syntrichia montana*, *S. ruralis*, *Tortella tortuosa*, *T. aestiva*, *Tortula schimperi*, *T. subulata*, *Weissia brachycarpa* var. *obliqua*, *W. controversa*.

Vertical distribution: 90–1010 (mean 360) m a.s.l.

Distribution in Hungary (462 specimens, 177 grid cells, of which 109 represent recent finds):

This species most likely occurs in the majority of grid cells. A detailed list of specimens appears unnecessary. There are specimens from nearly all floristical regions (Zemplén Mts, Aggtelek Karst, Bükk Mts, Mátra Mts, Karancs-Medves Mts, Cserhát Hills, Gödöllő Hills, Börzsöny Mts, Visegrád Mts, Naszály, Pilis Mts,

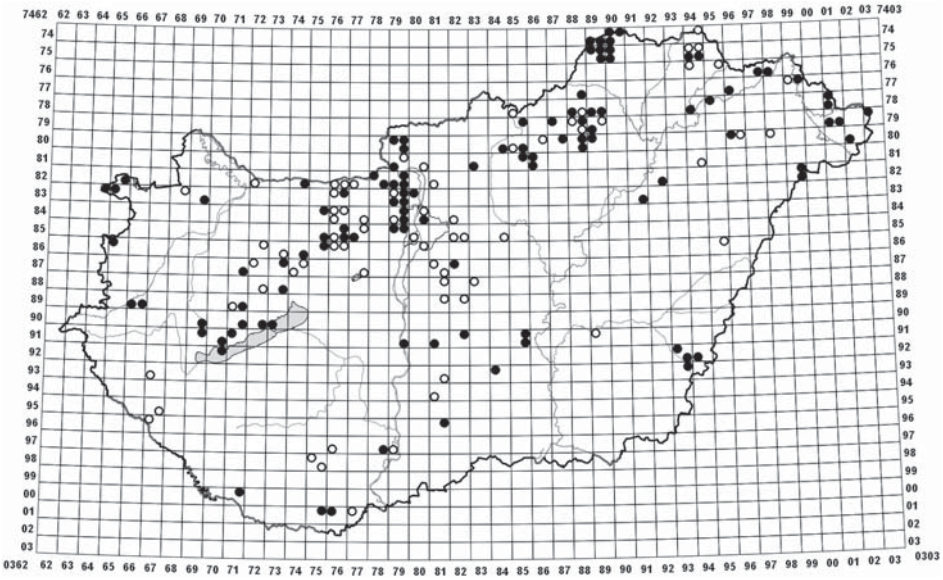

Fig. 50. Distribution of *Bryum moravicum*.

Buda Mts, Gerecse Mts, Vértes Mts, Velence Mts, Bakony Mts, Balaton Uplands, Keszthely Mts, Sopron Mts, Kőszeg Mts, Vas, Zala, Mecsek Mts, Villány Mts, Kisalföld, Hanság, Danube–Tisza Interfluve, Tiszántúl, Nyírség, Észak-Alföld, Dráva-vidék, Pest Plain). No specimens were seen from Cserehát, Aggtelek-kavicshát, Putnok Hills, Fertő Hills, Vendvidék, Őrség, Hetés, Göcsej, Belső-Somogy, Zselic, Külső-Somogy, but it is probably not difficult to observe the species in these as well.

Red list status: LC (Papp *et al.* 2010).

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB, UA.

Literature: No specific chorological information.

Bryum neodamense Itzigs.
[= *B. pseudotriquetrum* var. *neodamense* (Itzigs. ex Müll. Hal.) Büse]
(Figs 51, 52)

Dioicous, sporophytes not seen in Hungarian material. **Plants** to 10 cm tall, slender and flaccid, evenly and ± distantly foliated, light to brownish green, often blackish when old; rhizoids red, finely papillose. **Leaves** ovate oblong, shortly acute or obtuse, mostly spoon-like concave and cucullate (hooded) at apex; weakly decurrent; often leaves of different shape at the same stem; margin entire to faintly denticulate near apex, not recurved; costa and leaf base often red; costa ending below or in leaf apex, rarely slightly excurrent in upper leaves. **Laminal cells** *ca* 50 × 25 μm; unistratose border of elongate, narrow, incrassate cells distinct. **Seta** 3–4 cm, reddish. **Capsule** pendulous, 3–4 mm long, obovate-pyriform. **Endostome** cilia appendiculate. **Spores** (12–)14–16(–20) μm, smooth.

Similar species: *B. pseudotriquetrum*: leaves distinctly decurrent, acuminate, elongate-lanceolate; costa ending in leaf apex or excurrent (*B. neodamense*: leaves weakly decurrent, leaves ovate, costa usually ending in or below leaf apex, rarely excurrent in upper leaves).

For the differences between *B. neodamense* and *B. cyclophyllum*, see the note under the latter species.

References: Demaret (1993): 216–217, Nyholm (1993): 200–201, Ahrens (2001): 81–83, Guerra *et al.* (2010): 142–144.

Note on taxonomic status: Many recent authors (but not all: see references above) consider *B. neodamense* to be conspecific with *B. pseudotriquetrum* following Holyoak and Hedenäs (2006).

Habitat: *B. neodamense* is a species of rich fens with intact hydrology, but can occur also in man-made habitats.

Substrate: calcareous soil in fens and swamps.

Associated bryophyte: *Drepanocladus aduncus*.

Vertical distribution: 110–150 (mean 128) m a.s.l.

Distribution in Hungary (8 specimens, 3 grid cells, of which 0 represent recent finds): **Zala** (8969.4): Comit. Zala. In pratis turfosis ad rivum Marcal infra Gyepűkaján, 11.06.1962 leg. Á. Boros BP 73364; (9068.2): Comit. Zala. In pratis uliginosis Batyki-rét prope pag. Türje, 19.09.1953 leg. L. Vajda BP 26748; Dupl.: Comit. Zala. In turfosis versus Batyk prope Türje, 125 m, 19.09.1953 leg. Á. Boros BP 117076, 117078, 117079; Comit. Zala. In paludosis (Batyki berek) prope Türje, 04.06.1954 leg. É. Nagy BP 117081; **Kisalföld** (8271.4–8371.2): Győr, ad marginem arundineti territorii "Pataháza" dicti, 16.10.1938 leg. S. Polgár BP 82216; Dupl. BP 117077.

In ECCB (1995), *B. neodamense* is listed as vulnerable. According to Papp *et al.* (2010) the populations are no longer existent (DD-va).

Distribution in adjacent countries: A, HR, RO, SK, SRB, UA.

Literature: In Boros (1953) only the growth site in Győr Pataháza "in a swamp that formed in an artificial pit" is mentioned; Boros (1968) lists and

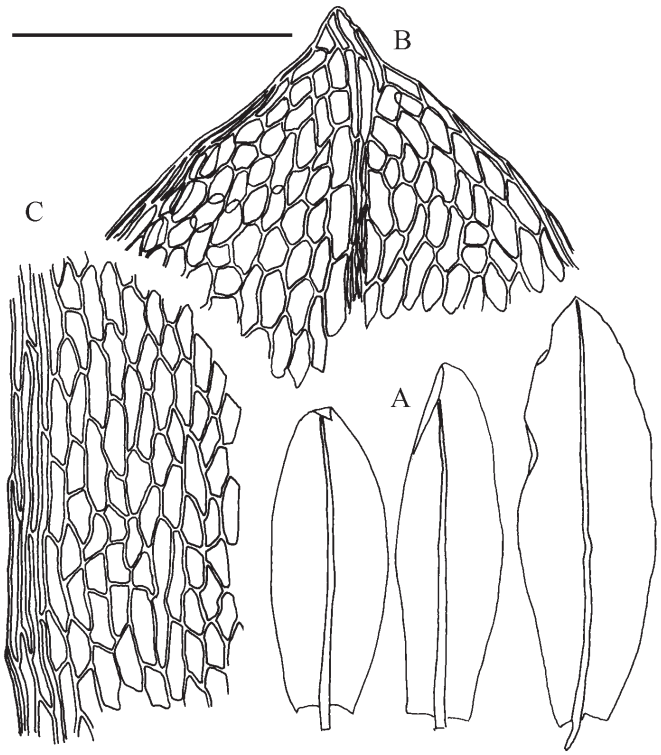

Fig. 51. *Bryum neodamense*. A = leaves; B = leaf apex; C = leaf margin. Scale bar: A: – 2 mm; B, C: – 200 μm. [BP 117076, del. Erzberger].

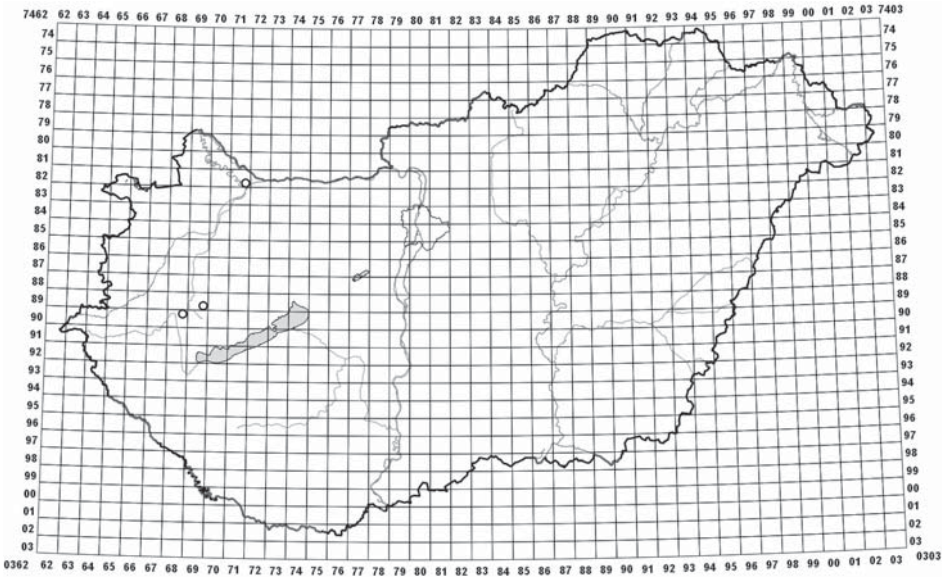

Fig. 52. Distribution of *Bryum neodamense*.

characterises the additional two sites from Zala discovered in between: in depressions in *Carex*-meadows, especially with *Menyanthes trifoliata* (Magnocaricion). Domokos-Nagy (1955) gives a detailed description of the vegetation at the Türje site and a map showing the distribution of *B. neodamense*, *Drepanocladus lycopodioides* and *Meesia triquetra* in Europe (according to this paper these species and *Drepanocladus sendtneri* grew together with *B. neodamense*).

Bryum pallens Sw. ex anon.
[= *B. fallax* Milde, *B. rutilans* auct. eur. non Brid., *B. oeneum* Blytt ex Bruch et Schimp. emend. Wijk *et al.*, *B. subelegans* Kindb.]
(Figs 53, 54)

Dioicous, sporophytes occasional (in 42% of specimens seen). **Plants** 0.5–3 cm tall, growing in soft, lax turf, pink or wine-red, also greenish with reddish hue; rhizoids brown, finely papillose (verrucose). Sterile plants often with **filiform gemmae** in leaf axils (f. *rutilans*, f. *oeneum*). **Leaves** distantly arranged along stem, erectopatent when moist, flexuose when dry, ovate-lanceolate, widest at middle, leaves uniformly green, pink or reddish, leaf base concolorous; margin entire or slightly denticulate at apex, narrowly recurved mostly to apex, narrowly decurrent along stem; costa stout, ending shortly below apex or shortly (in some populations longly) excurrent. **Laminal cells** 40–60 × 18–25 μm, marginal cells

longer, narrower and more incrassate, forming distinct, frequently locally bistratose (at times unistratose) border up to 3 cells wide. **Seta** 1.5–4 cm, reddish. **Capsule** cernuous to pendulous, 2–4 mm long, ovate-pyriform, narrow-mouthed, with long, curved, wrinkled neck, lid convex with acute mamilla; ripe capsules frequently glossy (as if covered by varnish), not or only slightly contracted below mouth after the lid has fallen. **Endostome** cilia polymorphic, appendiculate or only nodose (= *B. fallax*), rarely rudimentary; segments with narrow perforations. **Spores** 16–25 μm, papillose.

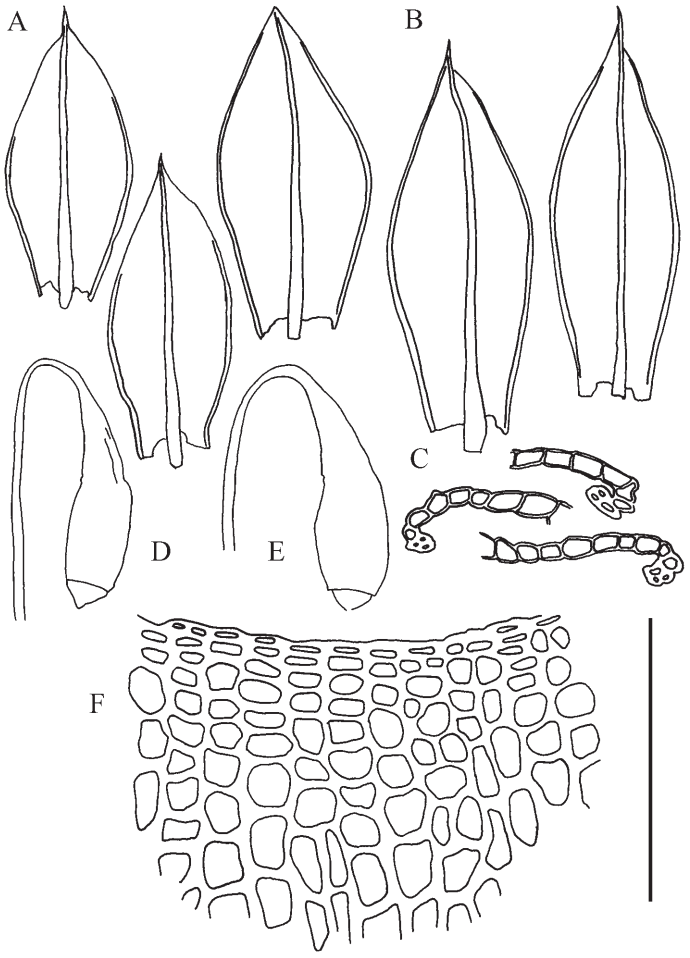

Fig. 53. *Bryum pallens*. A = leaves of sterile plant; B = comal leaves; C = cross sections of leaf margin; D, E = capsules (dry/moist); F = exothecial cells at capsule mouth. Scale bar: A, B: – 2 mm; C, F: – 200 μm; D–E: – 4 mm. [A, C: EGR Vajda 1947 (Kőkapu/Zemplén); B: BP 117196; D–F: BP 117185, del. Erzberger].

Similar species: *B. pallens* is very variable, especially the sporophytes vary in shape as well as in peristome structure. Different forms and varieties were distinguished earlier. In lax sterile tufts (frequent, e.g. on forest roads covered with calcareous material in Germany) the distinct leaf border is lacking, these plants can only be recognised by their pale red colour and the lax areolation.

Sterile plants can be mistaken for *B. turbinatum*: This species can produce the same wine-red coloration when sterile, but is distinguished by slightly smaller laminal cells (to 20 μm wide), rectangular below mid-leaf, an inconspicuous, ± unistratose border mostly only 1 cell row wide and plane margin; costa 100–120 μm thick at leaf base; leaves triangular-lanceolate; capsules turbinate when dry (*B. pallens*: laminal cells wider (to 25 μm) and areolation more lax, only basal cells rectangular, leaves with conspicuous, often bistratose border, margin strongly recurved; costa 80–90 μm thick at leaf base, leaves ovate-lanceolate; capsules pyriform with curved neck, not turbinate).

For the differences between *B. pallens* and *B. uliginosum* and *B. weigelii*, see the notes under the latter species.

References: Limpricht (1895): 433–435, Demaret (1993): 241–243, Nyholm (1993): 177–179, Ahrens (2001): 83–84, Dolnik (2001), Guerra *et al.* (2010): 110–113.

Habitat: *B. pallens* is a calciphilic species that grows in swampy meadows, along streams and other waters, and there occasionally produces sporophytes. In Germany, lax sterile turfs are frequent on forest roads that have been filled with calcareous material (e.g. Ahrens 2001); however, these forms mostly lack the distinct leaf border, and can only be recognised by their pale red colour and the lax areolation (on roadsides, banks of streams and rivers, swampy meadows, sand pits, at a thermal spring).

Substrate: on calcareous and siliceous rocks, calcareous soil, moist sand.

Associated bryophytes: *Bryum intermedium*, *Cratoneuron filicinum*, *Eurynchium hians*, *Funaria hygrometrica*, *Jungermannia gracillima*, *Leptodictyum riparium*, *Palustriella commutata*, *Pohlia annotina*, *Preissia quadrata*, *Rhizomnium punctatum*, *Scapania irrigua*.

Vertical distribution: 100–350 (mean 257) m a.s.l.

Distribution in Hungary (19 specimens, 13 grid cells, of which 3 represent recent finds): **Zemplén Mts** (7594.4): Hungaria bor., comit. Abaúj-Torna. In rupestribus vallis Szárazkút-völgy ad Kőkapu, montium Sátorhegység, prope Pálháza, 26.05.1947 leg. L. Vajda BP 117196; 2 Dupl. in EGR; **Aggtelek Karst** (7590.3): Comit. Borsod-Abaúj-Zemplén. In rupibus calc. ad rivum in valle Telekes-völgy prope pag. Varbóc, 200 m, 02.05.1993 leg. M. Rajczy BP 166389 (f. *oeneum*); **Bükk Mts** (7889.3): Comit. Borsod. In rupestribus calcareis vallis Garadna-völgy prope pag. Ómassa, montes Bükk, 16.10.1959 leg. L. Vajda

BP 63472; **Mátra Mts** (8086.3): Comit. Heves. In vias sylvarum humidis vallis Fülemülevölgy prope pag. Parádfürdő, montes Mátra, 29.09.1956 leg. L. Vajda EGR; **Börzsöny Mts** (8179.4): Comit. Hont. In ripa rivi vallis Malom-völgy versus Kóspallag prope pagum Nagymaros (with a note "Piros" – red), 220 m, 30.06.1947 leg. Á. Boros BP 117203 (f. *oeneum*); **Visegrád Mts** (8379.2): Comit. Pest. In rupibus andesit. alvei rivi Holdvilág-árok ad Margitliget prope Pomáz (with a note "Piros" – red), 250–350 m, 30.04.1944 leg. Á. Boros BP 117186; **Pilis Mts** (8378.2): Comit. Esztergom. In uliginosis ripae rivi versus viam ferream prope Csév (with a note "Piros" – red), 170 m, 14.04.1946 leg. Á. Boros BP 117187 (f. *oeneum*); **Vértes Mts** (8476.1): Comit. Komárom. In arenosis foveae inter Bánhida et Újtelep, 200 m, 08.08.1937 leg. Á. Boros BP 117178, Dupl. BP 117192 (var. *fallax*, inmixed *B. intermedium*; compare note under that species); **Bakony Mts** (8771.1): Comit. Veszprém. Ad fontem therm. ad Tapolcafő (with a note "Piros" – red), 200 m, 06.03.1966 leg. Á. Boros BP 117183; **Pest Plain** (8380.4): Comit. Pest. In locis humidis irrigatis calcareis in ripae Danubii supra pagum Dunakeszi, 100 m, 15.06.1924 leg. Á. Boros BP 117182.

The distributional record of this species appears rather incomplete, there are presumably more suitable habitats; however, the populations are often small and may easily be overlooked. Red list status: VU (Papp *et al.* 2010).

Distribution in adjacent countries: A, RO, SK, SLO, SRB, UA.

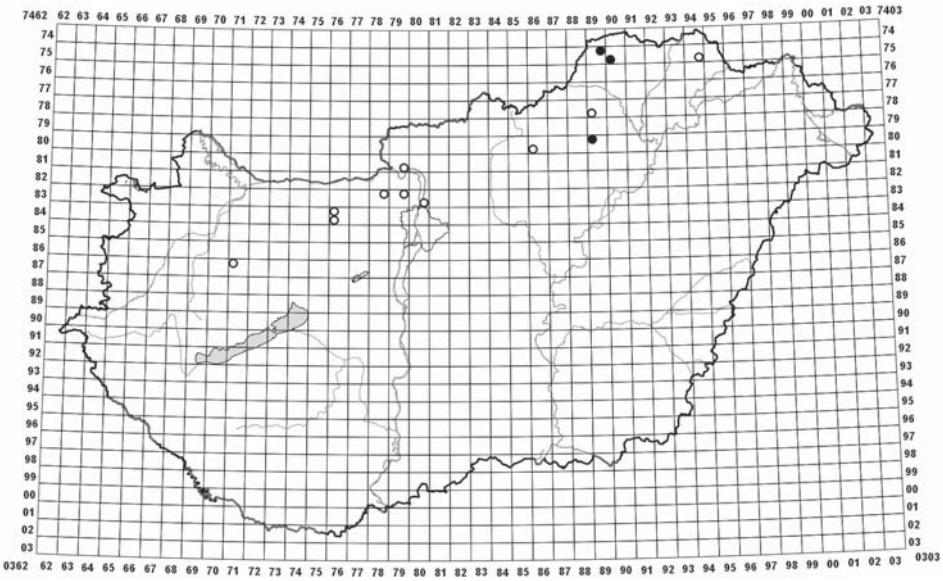

Fig. 54. Distribution of *Bryum pallens*.

Literature: Most regions listed in Boros (1953, 1968) are supported by correctly determined specimens, but some have to be deleted: the specimen from Zala – BP 117184 – has been revised to *B. turbinatum*; the specimen from the Gerecse Mts – BP 117189 – has not been confirmed (poor material); the specimen from the Mecsek Mts – BP 117180 – was *Pohlia melanodon*; no specimen was found to support the Kőszeg Mts; Pest Plain, considered doubtful in Boros (1968): the specimen from springs near Göd, Lórév – BP 117177 – was revised to *B. pseudotriquetrum*; but there is a good specimen from that region (see enumeration above). In Boros (1968) the Bükk Mts was also considered doubtful, but there are some good specimens, while others were revised to other species or could not be safely named. It is peculiar that all regions enumerated in Orbán and Vajda (1983) have to be deleted because they are based on erroneously named or lacking specimens.

Bryum pallescens Schleich. ex Schwaegr.
(Figs 55, 56)

Autoicous, i.e. male and female inflorescences are found on the same plant, occasionally some synoicous inflorescences can also occur (sporophytes seen in all specimens). **Plants** 1–5 cm tall, growing solitary or in lax turf, branched several times, with comal tuft, taut; rhizoids red-brown, coarsely to finely papillose. **Leaves** ovate-lanceolate, stiff and stout, longly acuminate, erectopatent when wet, appressed to stem and slightly twisted when dry; leaf base red, not decurrent; margin sometimes slightly denticulate above, recurved, costa longly excurrent, often denticulate. **Laminal cells** 50 × 15–18 μm, areolation uniformly mesh-like, at margin several rows of narrow, elongate, incrassate cells forming distinct border. **Seta** 1–3.5 cm, reddish. **Capsule** cernuous or pendulous, to 5 mm long, straight or slightly curved, often by a twist of the seta pointing upward like a trumpet when ripe (= inclined), large-mouthed, brown, lid convex. **Exostome** and **endostome** not connected, cilia nodulose or appendiculate. **Spores** 18–22 μm, olive green to yellowish brown, perfectly spherical, mostly slightly papillose.

Similar species: *B. pallescens* cannot be named with certainty when ripe capsules are absent. For the critical differentiation within the *B. pallescens* group, see also Table 4 (p. 132).

B. creberrimum: plants to 2 cm tall; synoicous; capsule pendulous; cilia longly appendiculate; spores 12–16 μm, smooth; prefers calcareous substrates at low altitudes (*B. pallescens*: to 5 cm tall; autoicous; capsules often inclined; cilia nodulose or appendiculate; spores 18–22 μm, papillose; growing in montane habitats, but in Hungary also at low altitudes).

B. lonchocaulon: plants to 3 cm tall, polyoicous; capsules pendulous; cilia longly appendiculate; prefers calcareous substrates and low elevations (*B. pallescens*: to 5 cm tall; autoicous; capsules often inclined; cilia nodulose or appendiculate; growing in montane habitats, but in Hungary also at low altitudes).

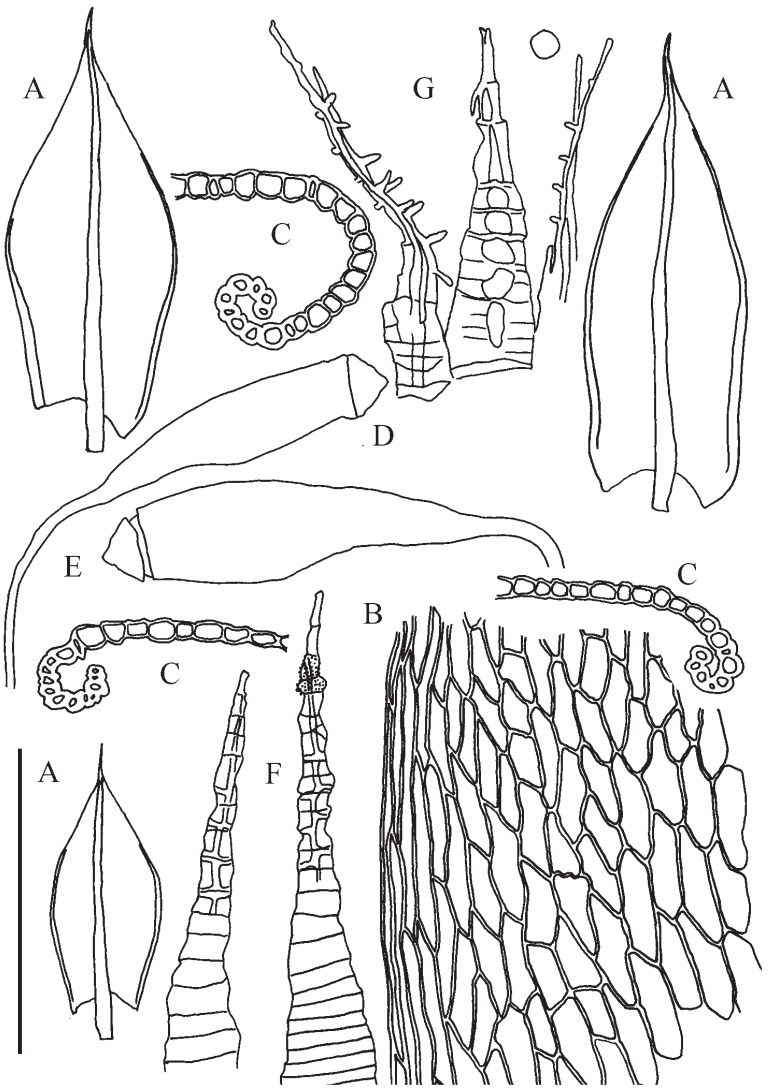

Fig. 55. *Bryum pallescens*. A = leaves; B = leaf margin; C = cross sections of leaf margin; D, E = capsules (dry/moist); F = exostome teeth (ornamentation shown in small part); G = details of endostome (cilia, process) and spore. Scale bar: A: – 2 mm; B, C, F, G: – 200 μm; D, E: – 4 mm. [BP 117798, del. Erzberger].

B. algovicum: plants to 2 cm tall, synoicous; capsules narrow-mouthed, exostome with oblique cross-walls, attached to endostome, appearing opaque (*B. pallescens*: to 5 cm tall; autoicous; capsules large-mouthed; exostome and endostome not connected, exostome cross-walls lacking).

B. archangelicum: plants to 2 cm tall; capsules narrow-mouthed; endostome cilia lacking (*B. pallescens*: to 5 cm tall; capsules large-mouthed; endostome with long cilia).

For the differences between *B. pallescens* and *B. caespiticium*, see the note under the latter species.

References: Limpricht (1895): 368–370, Demaret (1993): 250–252, Nyholm (1993): 196–197, Ahrens (2001): 84–86, Zolotov (2000): 196–200.

Habitat: (soil in) rock fissures, on walls, road embankments; mostly in partly shaded situations (in calcareous grassland, in forests in the plain, in conifer forest, beside ditches, in a deep pit in volcanic area, at railroad embankments, on walls, in sand pits).

Substrate: weakly calcareous or basic rock, also on slightly acidic substrates, coarse gravel (moist sand, andesite rock, diabase rock).

Associated bryophytes: *Bartramia pomiformis*, *Bryum archangelicum*, *Didymodon insulanus*, *Fissidens bryoides*, *F. taxifolius*, *Plagiopus oederianus*.

Vertical distribution: 100–900 (mean 281) m a.s.l.

Distribution in Hungary (18 specimens, 12 grid cells, of which 0 represent recent finds): **Zemplén Mts** (7494.4): Comit. Abaúj-Torna. In rupibus andesit. montis Vár-hegy prope pag. Füzér, 400–500 m, 07.09.1947 leg. Á. Boros BP 7690; **Bükk Mts** (8087.2): Comit. Heves. In rupestribus diabas. ad Szarvaskő, 300 m, 11.08.1924 leg. Á. Boros BP 117371; **Mátra Mts** (8186.1): Comit. Heves. In rupibus andesit. bor. silvat. montis Saskő prope Parád, 800–900 m, 04.07.1931 leg. Á. Boros BP 183648; **Börzsöny Mts** (8179.2): Comit. Nógrád. Ad margines rivi Szárazpatak prope Királyrét, montes Börzsöny, 19.08.1958 leg. L. Vajda BP 59727/b (sub *B. capillare*); **Buda Mts** (8379.3): Comit. Pest. In calcareis montis Kisszénáshegy prope Pilisszentiván, 200–400 m, 08.05.1927 leg. Á. Boros BP 117380; **Vértes Mts** (8476.3): Comit. Komárom. In arenosis foveae silvae Nagyerdő prope Felsőgalla, 250 m, 08.08.1937 leg. Á. Boros BP 117665 (concerning the site – see note under *B. intermedium*); **Zala** (9567.2): Flora hungarica, mer.-occ. Com. Zala. In locis arenosis humidis inter Nagykanizsa et Sormás, 150 m, 07.02.1948 leg. Á. Károlyi EGR (sub *B.* sp.); **Danube–Tisza Interfluve** (8780.3): Comit. Pest. Ad aggerem viae ferreae prope Kiskunlacháza, 100 m, 27.06.1926 leg. Á. Boros BP 117347; **Tiszántúl** (8495.4): Comit. Hajdu. In umbrosis ad murum in via lateralia Hadházi-út 34 ad Debrecen, 100 m, 16.06.1945 leg. L. Felföldy (sub *B. caespiticium*) BP 117795, Dupl. 117796, 117798; **Nyírség** (8395.2–8396.1):

Nyírség, pr. pg. Hajdúhadház. In silv., 15.07.1945 leg. L. Felföldy BP 58519 (sub *B. capillare*).

Only specimens that could be identified unambiguously as *B. pallescens* s. str. are shown in the map, which therefore is very incomplete (compare also the following account on *B. pallescens* agg.). The closely related *B. lonchocaulon* has fewer records, although e.g. in Germany *B. pallescens* is much rarer than *B. lonchocaulon* (Meinunger and Schröder 2007), but not much can be concluded from so little data. Red list status: DD (Papp *et al.* 2010).

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB, UA.

Literature: Boros (1953, 1968), Orbán and Vajda (1983) report *B. pallescens* from the following additional regions: Gödöllő Hills (Isaszeg), Bakony Mts, Balaton Uplands, Mecsek Mts, Kisalföld. However, the corresponding specimens were revised to other species or could not be safely named, therefore these regions are not supported by confirmed specimens. In some cases, specimens were revised to closely related species like *B. creberrimum*, or the species could not be named with certainty within the *B. pallescens* group (*B.* cf. *lonchocaulon*). To avoid confusion in the future, as in the case of *B. lonchocaulon*, we give a complete list of all revised specimens, including also those that were already considered doubtful by Podpera and had been omitted in the above-mentioned publications.

The records published in Papp and Rajczy (1999) from the Danube–Tisza Interfluve are erroneous except the confirmed specimen quoted above for that

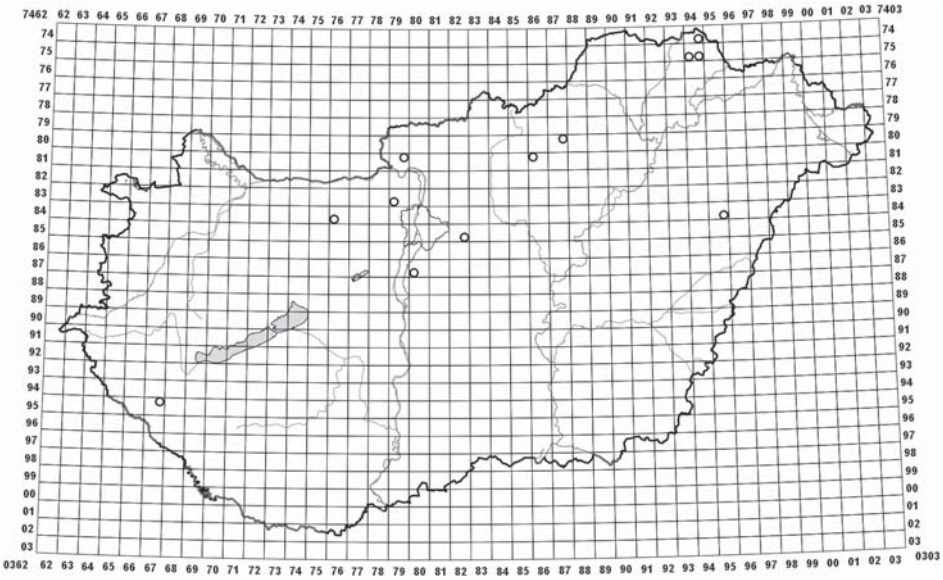

Fig. 56. Distribution of *Bryum pallescens*.

region. Many of the data in that paper are without revision based on specimens that had already been considered indeterminable by Podpera.

Revised specimens: Zemplén Mts (7494.4): Comit. Abaúj-Torna. In rupibus andesit. montis Vár-hegy prope pag. Füzér, 400–500 m, 07.09.1947 leg. Á. Boros BP 7688 (revised to *B. algovicum*); BP 117367 (revised to *B. caespiticium*); BP 117365 (revised to *B. creberrimum*); (7695.3): Comit. Zemplén. In muris ad viam ferream ad Sárospatak, 119 m, 09.11.1936 leg. Á. Boros BP 117366 (revised to *B. caespiticium*); EGR (could not be named with certainty); Bükk Mts (7988.2): Comit. Borsod. In petrosis calc. sub monte Vörössár prope Szilvásvárad, 840 m, 10.07.1934 leg. Á. Boros BP 117368 (revised to *B. creberrimum*); (7988.4): Comit. Borsod. In petrosis calcar. silvat. decliv. sept. montis Peskő prope Szilvásvárad, 800–840 m, 19.09.1937 leg. Á. Boros BP 117369 (revised to *B. moravicum*); BP 163327 (revised to *B. caespiticium*); (8089.2): Comit. Borsod. In muris humidis alvei uszoda fontis therm. ad Kácsfürdő, 200 m, 15.06.1933 leg. Á. Boros BP 117370 (*B.* cf. *pallescens*); Mátra Mts (8085.4): Comit. Heves. In monte Nagygalya prope Gyöngyössolymos, 25.09.1926 leg. Z. Zsák BP 117372 (revised to *B. pseudotriquetrum*); Börzsöny Mts (8080.3): Comit. Nógrád. Diósjenő, a tótól D-re szikár lejtőkön, 240 m, 08.06.1911 leg. Á. Boros BP 117374 (revised to *B. caespiticium*); (8279.1): Comit. Hont. In rupibus andesit. silvat. mer.-occ. montis Szentmihály-hegy prope pag. Zebegény, 350 m, 03.10.1948 leg. Á. Boros BP 117373 (*B. pallescens* group); Gödöllő Hills (8482.3): Comit. Pest. Sub Pinus silv. in silva Fenyves-dűlő pr. pag. Isaszeg, 200 m, 24.02.1920 leg. Á. Boros BP 117375 (revised to *B. moravicum*); Buda Mts (8479.4): Budapest, Lipótmező, árnyas helyen a Kondor út felsőbb részének fasorjában, 250 m, 29.11.1917 leg. Á. Boros BP 117379 (revised to *B. caespiticum*); Gerecse Mts (8277.3): Comit. Esztergom. In rupibus calcareis montis Öreg-kő prope Bajót, 300–375 m, 05.04.1936 leg. Á. Boros BP 117358 (revised to *B.* cf. *caespiticium*); (8377.1): Comit. Esztergom. In saxis calc. lias. montis Kisgerecse prope Süttő, 450 m, 22.05.1932 leg. Á. Boros BP 117357 (revised to *B.* cf. *lonchocaulon*); (8475.4): Comit. Komárom. In locis irrigatis ad molam "Uj-malom" prope Kecskéd, 160 m, 08.09.1937 leg. Á. Boros BP 7685 (could not be named with certainty); BP 117356 (revised to *B. caespiticium*); Vértes Mts (8476.3): Comit. Komárom. In arenosis humidis ripae rivi Száraz-ér pr. Környe, vers. Vértessomló, 160 m, 14.04.1935 leg. Á. Boros BP 117359 (revised to *B.* cf. *caespiticium* + *B. dichotomum*); (8575.3): Comit. Fejér. In locis irrigatis ad molam rivi Szép-víz prope Pusztavám, 190 m, 05.09.1937 leg. Á. Boros BP 7684, BP 117360 (both revised to *B. pseudotriquetrum*); Balaton Uplands (9170.1): Hungaria occ., com. Zala. In rivulo prope pag. Lesence Istvánd, 17.05.1949 leg. L. Vajda BP 117361, EGR (both revised to *B. pseudotriquetrum*); (9170.2): Comit. Zala. In muris ripae lacus therm. Malom-tó opp. Tapolca, 120 m, 03.04.1926 leg. Á. Boros BP 117364 (revised to *B. algovicum*);

Zala (9166.4?): Comit. Zala. In muris az opp. Zalaegerszeg (Erzsébet-u. 22 ház kőkerítésén, cementen), 23.05.1940 leg. A. Visnya BP 117344 (revised to *B.* cf. *caespiticium*); Mecsek Mts (9875.4): Pécs, a Bertalan-hegytől délre húzódó gerincen, mészkősziklák közt (in pencil: autöc!), 11.08.1931 leg. A. Visnya BP 117346, BP 117352 (both revised to *B. capillare*); 21.07.1932 leg. A. Visnya BP 117349 (could not be named with certainty); Kisalföld (8271.4): Comit. Győr, Bácsa in arenoso, 12.05.1935 leg. S. Polgár BP 117355 (revised to *B.* cf. *caespiticium*); (8272.3): Győrszentiván, Utkaparóház kutjának belső felületén, 18.05.1940 leg. S. Polgár BP 117353 (revised to *B. caespiticium*); (8471.1): Győrszemere Kisszentpál-p. in populito arenoso, 24.06.1937 leg. S. Polgár BP 117354 (*B.* cf. *pallescens*); Vértes Mts (8675.3): Comit. Fejér. In muris ripae lacus therm. pagi Bodajk, 150 m, 03.04.1927 leg. Á. Boros BP 117362 (*B. pallescens* group, synoicous, i.e. either *B. lonchocaulon* or *B. creberrimum*); Danube–Tisza Interfluve (8582.4): Comit. Pest. In foveis arenosis ad Gyömrő, 170 m, 12.04.1935 leg. Á. Boros BP 7683; BP 117376 (cannot be named with certainty); (8685.1): Comit. Pest. In natronatis ad Nagynádas prope Farmos, 100 m, 31.05.1925 leg. Á. Boros BP 117348 (*B. pallescens* group, synoicous, i.e. either *B. lonchocaulon* or *B. creberrimum*); (8682.4): Comit. Pest. In muris ad viam ferream prope Monor, 130 m, 23.04.1936 leg. Á. Boros BP 117350 (revised to *B. caespiticium*); (8582.3): Comit. Pest. Ad corticem Populi inter pag. Maglód et Gyömrő, 170 m, 12.04.1935 leg. Á. Boros BP 117377 (could not be determined with certainty); (8582.4): Comit. Pest. In silva versus Mende prope Péteri, 200 m, 20.10.1931 leg. Á. Boros BP 117378 (*B. pallescens* group); (9386.2): Comit. Csongrád. In argillosis secus vias ad Vidra-ér prope Csongrád, 90 m, 03.05.1937 leg. Á. Boros BP 117345 (could not be named with certainty); Pest Plain (8380.4): Comit. Pest. In pratis turfosis Nádas prope Dunakeszi, 100 m, 30.04.1938 leg. Á. Boros BP 117351 (revised to *B. algovicum*, autoicous form).

***Bryum pallescens* agg.**
[= *B. creberrimum*, *B. lonchocaulon*, *B. pallescens*]
(Fig. 57)

The difficulties encountered within this group are detailed above under the individual species accounts (Table 4). These often result in unsatisfactory determinations of specimens, especially if these are suboptimal. Therefore, we here add data on the collective group.

Habitat: the collective species occurs also in saline grasslands.

Associated bryophytes: *Barbula convoluta*, *Bartramia pomiformis*, *Brachythecium rutabulum*, *Bryum algovicum*, *B. archangelicum*, *Ceratodon purpureus*, *Didymodon insulanus*, *Fissidens bryoides*, *F. dubius*, *F. taxifolius*, *Funaria hygro-*

Table 4. Differentiation within the *B. pallescens* group (Meinunger and Schröder 2007, Zolotov 2000).

Character	*B. creberrimum*	*B. pallescens*	*B. lonchocaulon*
sexual condition	synoicous	autoicous	polyoicous
spore size	12–16 µm	18–22 µm	(12–)15–20(–24) µm
other spore characters	smooth, colourless to yellowish, of equal size within 1 capsule	mostly slightly papillose, olive green to yellowish brown, perfectly spherical	slightly papillose, light yellowish, spores of different size within 1 capsule, often deformed, shrunk or otherwise malformed
excurrent costa	awn short, 200–400 (–650) µm long	awn short, 200–400(–650) µm, straight, weakly serrulate	awn long, (250–)400–650 (–800) µm, ± flexuose, serrulate
leaf border	narrow, (1–)2–3(–4) rows	narrow, 2–3(–4) rows	broad, 6(–7) rows

metrica, *Plagiopus oederianus*, *Schistidium* sp., *Thuidium abietinum*, *T. delicatulum*, *Tortula subulata*.

Vertical distribution: 90–900 m a.s.l.

Distribution of the *B. pallescens* group in Hungary (55 specimens, 36 grid cells, of which 4 represent recent finds) (Specimen data already listed in the individual accounts are not repeated):

Zemplén Mts: *B. creberrimum*, *B. pallescens*; **Bükk Mts:** *B. creberrimum*, *B. pallescens*; (8089.2): Comit. Borsod. In muris humidis alvei uszoda fontis therm. ad Kácsfürdő, 200 m, 15.06.1933 leg. Á. Boros BP 117370 sub *B. pallescens* (rev.: *B.* cf. *pallescens*); **Mátra Mts:** *B. creberrimum*, *B. pallescens*; **Gödöllő Hills** (8684.3): Pest County, Gödöllői-dombság. 10 m high seminatural cliffs at the SW side of Tápióbicske, N 47° 21', E 19° 41', 120 m, 12.10.1997 leg. T. Pócs and B. van Zanten BP 176964 sub *B. caespiticium* (rev.: juv. *B. pallescens* group); **Börzsöny Mts:** *B. pallescens*; (8279.1): Comit. Hont. In rupibus andesit. silvat. mer.-occ. montis Szentmihály-hegy prope pag. Zebegény, 350 m, 03.10.1948 leg. Á. Boros BP 117373 (rev.: *B. pallescens* group); **Buda Mts:** *B. pallescens*; (8479.2): Hungaria centr., com. Pest. In rupestribus vallis Farkasvölgy, Budapest, 28.11.1937 leg. L. Vajda EGR sub *B.* sp. (rev.: *B.* cf. *pallescens*); **Gerecse Mts** (8377.1): Comit. Esztergom. In saxis calc. lias. montis Kisgerecse prope Süttő, 450 m, 22.05.1932 leg. Á. Boros BP 117357 (rev.: *B.* cf. *lonchocaulon*); **Vértes Mts:** *B. lonchocaulon*, *B. pallescens*; **Balaton Uplands** (9170.4): Hungaria occ., com Zala. In rupestribus montis Szentgyörgyhegy prope pag. Tapolca, 19.05.1949 leg. L. Vajda EGR sub

B. pseudotriquetrum (rev.: *B.* cf. *lonchocaulon*); **Zala:** *B. creberrimum*, *B. lonchocaulon*, *B. pallescens*; **Külső-Somogy** (9372.1): Com. Somogy, Gyugy, Petőfi-u. 18, Garten, auf Erde über Ziegel, N 46° 41' 31.5", E 17° 41' 4.8", 140 m, 20.07.2011 leg. P. Erzberger B (Erzberger 14949) sub *B.* cf. *caespiticium* (rev.: *B. pallescens* group); **Mecsek Mts:** *B. creberrimum*; **Kisalföld:** *B. creberrimum*; **Danube–Tisza Interfluve:** *B. lonchocaulon*, *B. pallescens*; (8582.4): Comit. Pest. In silva versus Mende prope Péteri, 200 m, 20.10.1931 leg. Á. Boros BP 117378 sub *B. pallescens* (rev.: *B. pallescens* group); (8675.3): Comit. Fejér. In muris ripae lacus therm. pagi Bodajk, 150 m, 03.04.1927 leg. Á. Boros BP 117362 sub *B. pallescens* (rev.: synoicous, *B. lonchocaulon* or *B. creberrimum*); (8685.1): Comit. Pest. In natronatis ad Nagynádas prope Farmos, 100 m, 31.05.1925 leg. Á. Boros BP 117348 sub *B. pallescens* (rev.: synoicous, *B. lonchocaulon* or *B. creberrimum*); (8685.4): Com. Pest. A vasút mellett szikes helyen Tápiógyörgye és Újszász közt, 100 m, 07.09.1917 leg. Á. Boros BP 117659 sub *B. cirratum* (rev.: *B. pallescens* group); (8982.3): Comit. Pest. In collibus arenosis fruticetis Borovicska-erdő ad Sarlósár prope Tatárszentgyörgy, 100 m, 25.06.1919 leg. Á. Boros BP 116870 sub. *B. inclinatum* (rev.: *B.* cf. *pallescens*); (9280.2): Com. Bács-Kiskun, Kiskunsági N.P., Böddi-szék bei Fülöpszállás, 90 m, 16.04.1998 leg. P. Erzberger B (Erzberger 4317) sub *B.* sp. (rev.: *B. pallescens* group, probably *B. pallescens* s. str.); (9280.4): Com. Bács-Kiskun, Große Tiefebene, Donau–Theiß-Interfluvium, sw Solt, zwischen

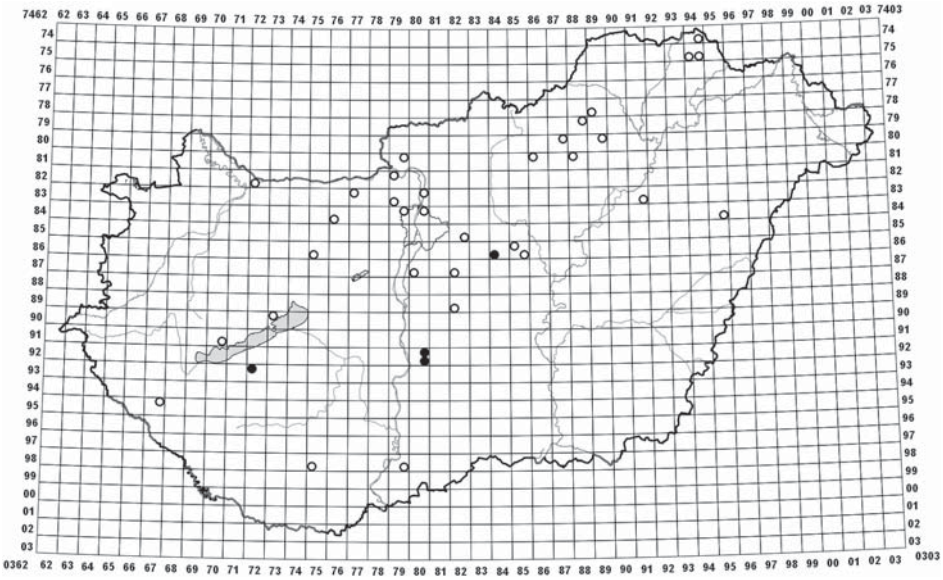

Fig. 57. Distribution of the *Bryum pallescens* group (*B. creberrimum*, *B. lonchocaulon*, *B. pallescens* s. l.).

Harta und Kiskőrös, Miklapuszta bei Állampuszta (Gefängnis), Natronsteppe, 100 m, 27.04.1995 leg. P. Erzberger B (Erzberger 1924) sub *B.* cf. *capillare* (rev.: *B. pallescens* group, polyoicous); Com. Bács-Kiskun, Große Tiefebene, Donau–Theiß-Interfluvium, sw Solt, zwischen Harta und Kiskőrös, Miklapuszta bei Állampuszta (Gefängnis), "Halastavak", 100 m, 16.03.1997 leg. P. Erzberger B (Erzberger 3074) sub *B.* sp. (rev.: *B. pallescens* group, possibly autoicous); (9879.4): Baja, Vaskuti gyakorlótér, 04.05.1959 leg. L. Balanyi EGR sub *B. pendulum* (rev.: *B.* cf. *pallescens*); **Tiszántúl:** *B. creberrimum*, *B. pallescens*; **Tiszántúl:** *B. pallescens*; (8391.4): Comit. Hajdú. In silva Ohati-erdő prope Ohat, 95 m, 25.05.1938 leg. Á. Boros BP 117656 sub *B. cirratum* (rev.: *B. pallescens* group); **Nyírség:** *B. pallescens*; **Balaton:** *B. lonchocaulon*; **Pest Plain:** *B. creberrimum*.

Bryum pseudotriquetrum (Hedw.) P. Gaertn., E. Mey. et Scherb.
[= *B. ventricosum* Dicks.]
(Figs 58, 59)

Dioicous, occasionally with sporophytes when growing in very moist places (in 10.5% of specimens seen). **Plants** growing in 3–10 cm tall turf or as solitary plants, green, often tinged red; rhizoids red, finely to strongly papillose, tomentum of rhizoids reaching to the uppermost leaves; occasionally with **filiform gemmae** in leaf axils when growing in dry places (f. *propagulifera*). **Leaves** evenly arranged along stem, erectopatent when moist, flexuose, curved, often spirally twisted when dry, very stout and robust, taut, ovate-lanceolate, leaf base red; leaf margin entire below, mostly denticulate at apex, ± recurved; costa red, ending in leaf apex or shortly excurrent, mostly denticulate (when plants grow in dry places, the costa can be more longly excurrent, leaves are then elongate-lanceolate). **Laminal cells** forming very regular reticulate areolation, 40–50 × 20 μm; unistratose marginal border of 3–8 rows of elongate, incrassate, narrow cells, distinctly and usually longly decurrent along stem. **Seta** 1.5–6 (–8) cm, red brown. **Capsule** cernuous, 3–5 mm long, elongate claviform, large-mouthed, brownish. **Exostome** and endostome of equal length. **Endostome** cilia longly appendiculate. **Spores** (12–)15–18 μm, very finely papillose.

Similar species: This species can be recognised in the field by the mostly red-tinged, to 10 cm tall plants and the leaves with only shortly excurrent costa. Confusion is possible with *B. schleicheri*: plants yellowish green, leaves ovate, marginal border of narrow cells ends above leaf base and is replaced by rectangular to quadrate cells; border not or indistinctly decurrent along stem; rhizoids orange-brown, capsule turbinate (*B. pseudotriquetrum*: leaves ovate-lanceolate; marginal border distinctly and broadly decurrent; rhizoids red, capsule not turbinate).

For the differences between *B. pseudotriquetrum* and *B. alpinum*, *B. bimum*, *B. neodamense*, *B. turbinatum* and *B. weigelii*, see the notes under the latter species.

References: Limpricht (1895): 440–442, Demaret (1993): 190–192, Nyholm (1993): 199–201, Ahrens (2001): 86–87, Guerra *et al.* (2010): 142–144.

Habitat: in all kind of moist or wet habitats like wet meadows, swamps, fens, springs, banks of streams, rivers and shore of lakes, also on wet rocks (in wetlands, particularly over lime, but also in peat wetlands, in bog woodland, in swamp forests with *Alnus glutinosa* and/or *Fraxinus angustifolia*, in acidic bogs, in (spring) mires, swamps, mountain meadows near springs, streams and flushes over andesite, granite, and limestone as bedrock, in floating fens, in and near ditches, in reed and tall-sedge beds, on moist sand in sand pits, in mesotrophic wet meadows, in rich fens, in riverine oak-hornbeam forest, at the bank of rivers; on moist andesite rock near stream, at the shore of a lake, on wet walls at lakes, watermills, thermal springs; on limestone rock in cave, on wet limestone rock near lakes and springs, on wet calcareous tufa, on concrete in a stream, on concrete at a bridge, at the bottom of a dried lake, rarely in saline grassland.

Substrate: on wet, weakly acidic to calcareous soil and in rock fissures (over andesite bedrock as well as limestone, on tree bark, at the trunk and base of trees, on rotting wood in river flood zone, on limestone at river embankment, on a brick stone wall).

Associated bryophytes: *Amblystegium serpens*, *Barbula convoluta*, *Brachythecium velutinum*, *Bryum alpinum*, *B. intermedium*, *Calliergon giganteum*, *Calliergonella cuspidata*, *Campylium polygamum*, *C. stellatum*, *Chiloscyphus pallescens*, *C. polyanthos*, *Cratoneuron filicinum*, *Dichodontium pellucidum*, *Didymodon fallax*, *D. spadiceus*, *D. tophaceus*, *Drepanocladus aduncus*, *D. cossonii*, *Eurhynchium hians*, *Fissidens adianthoides*, *F. taxifolius*, *Grimmia hartmanii*, *Hedwigia ciliata* var. *ciliata*, *Marchantia polymorpha* subsp. *polymorpha*, *Palustriella commutata*, *Paraleucobryum longifolium*, *Pellia endiviifolia*, *Philonotis calcarea*, *P. fontana*, *P. tomentella*, *Plagiomnium cuspidatum*, *P. elatum*, *P. ellipticum*, *P. rostratum*, *P. undulatum*, *Platyhypnidium riparioides*, *Pohlia melanodon*, *P. wahlenbergii*, *Racomitrium canescens*, *Scleropodium purum*, *Syntrichia ruralis*, *Thuidium abietinum*, *T. delicatulum*, *T. philibertii*, *Tomentypnum nitens*.

Vertical distribution: 100–700 (mean 221) m a.s.l.

Distribution in Hungary (333 specimens, 132 grid cells, of which 29 represent recent finds): **Zemplén Mts** (7594.3): Comit. Abaúj-Torna. In pratis montanis Hidlásfeji-rét ad fontem rivi Köves-patak prope Telkibánya, 600 m, 09.07.1949 leg. Á. Boros BP 117062; **Aggtelek Karst** (7589.1): Jósva-völgyi forráslápban a falu alatt kb 600 m, 20.08.1955 leg. P. Jakucs BP 44688; **Putnok Hills** (7688.4): Kelemér, Nagy Mohos tó, 300 m, 07.04.1992 leg. P. Erzberger B (Erzberger 167); **Bükk Mts** (7889.1): Comit. Borsod. Ad fontes prope Jávorkút, 680 m, 25.09.1952

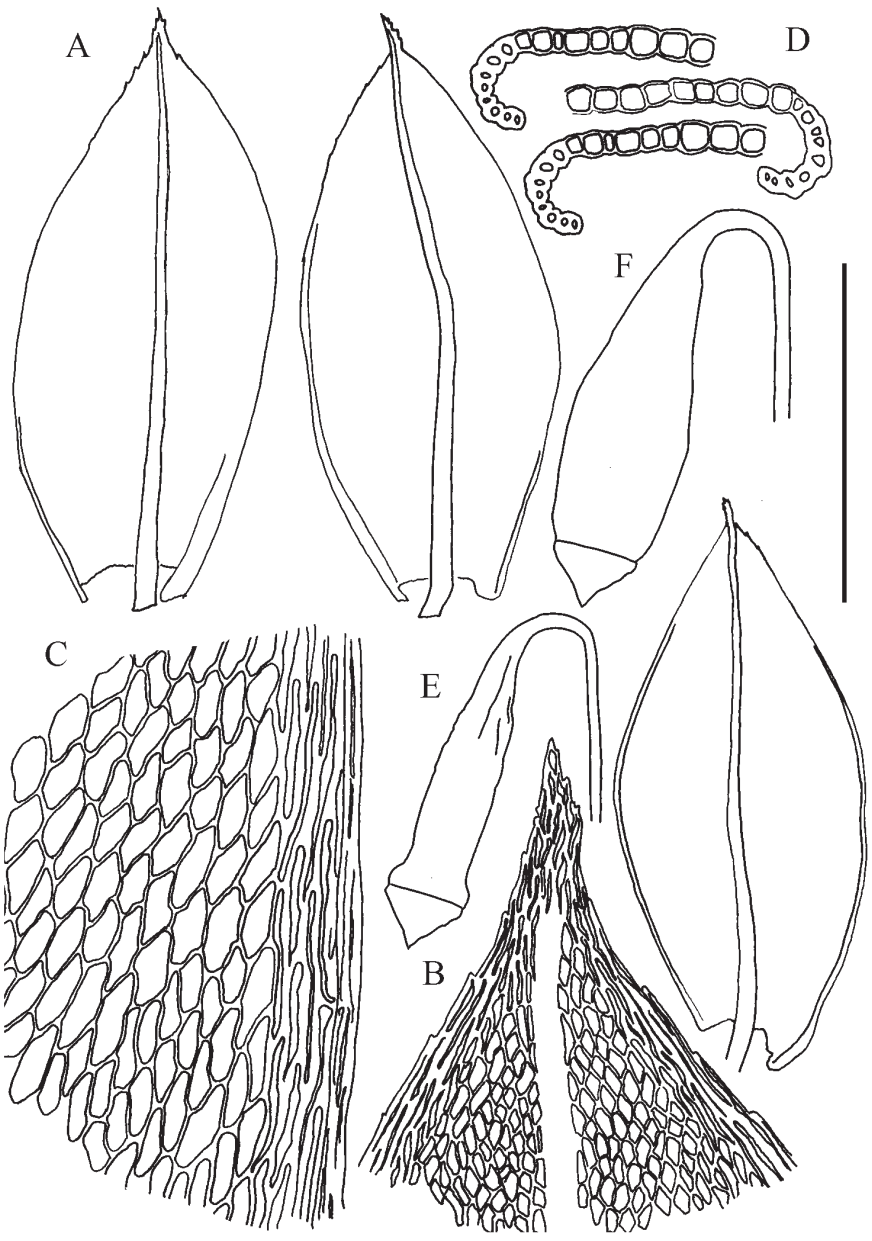

Fig. 58. *Bryum pseudotriquetrum*. A = leaves; B = leaf apex; C = marginal and median laminal cells; D = cross sections of leaf margin; E, F = capsules (dry/moist); G, H = exostome tooth (basal/apical part, ornamentation shown in small part); I = detail of endostome (process, appendiculate cilia) and spores. Scale bar: A: – 2 mm; B: – 400 μm; C, D, G–I: – 200 μm; E, F: – 4 mm. [A–D: Erzberger 2552; E–I: BP 117599, del. Erzberger].

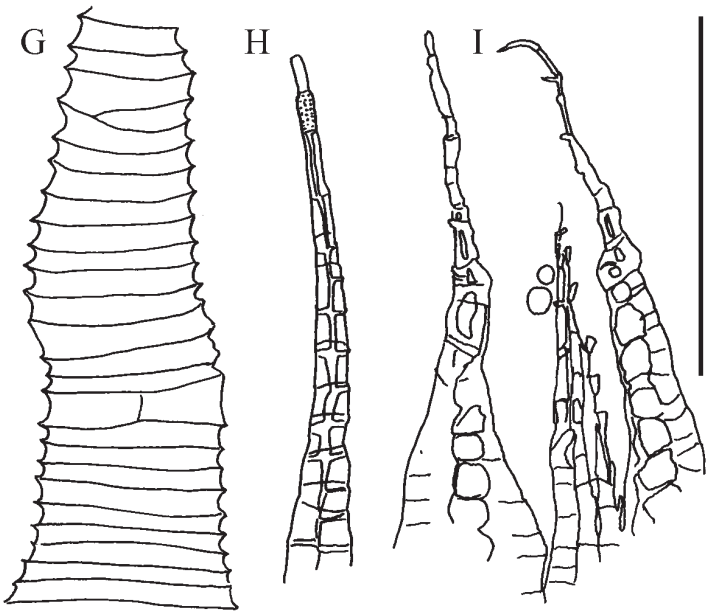

Fig. 58. (continued)

leg. Á. Boros BP 82254; **Mátra Mts** (8185.2): Com. Heves. In fontibus in pratis Tetvesrét prope Mátraháza, 600 m, 30.10.1952 leg. L. Vajda EGR sub *B.* sp.; **Ózd Hills** (7886.2): Comit. Borsod. Ózdi-dombvidék. In pratis limosis (Magnoc.) ad Palina-puszta prope pag. Domaháza, 31.03.1967 leg. T. Pócs BP 156611; **Gödöllő Hills** (8281.3): Comit. Pest. In locis spongiosis ad fontem Vácrátót et Sződ, 130 m, 01.10.1949 leg. Á. Boros BP 117619; **Börzsöny Mts** (8079.2): Comit. Nógrád. In pratis spongiosis ad Királykút vallis rivi Kemence-patak pr. Diósjenő, 400 m, 17.05.1931 leg. Á. Boros BP 117027; **Visegrád Mts** (8280.3): Comit. Pest. In pratis montanis Városi-rét inter Szentendre et Pilisszentlászló, 445 m, 26.08.1945 leg. Á. Boros BP 117028; **Pilis Mts** (8379.3): Comit. Pest. Piliscsaba, a vasút csabai tábori kanyarodójában lévő mocsárban, 250 m, 01.05.1918 leg. Á. Boros BP 117019; **Buda Mts** (8379.3): Comit. Pest. In paludibus rivi Vadászrét-árok sub monte Kisszénás prope pag. Pilisszentiván, 250 m, 09.05.1948 leg. Á. Boros BP 7657; **Gerecse Mts** (8375.2): Comit. Komárom. In paludosis fontis Fényes-forrás prope opp. Tata et Tóváros, 100 m, 19.10.1924 leg. Á. Boros BP 117021; **Vértes Mts** (8575.2): Comit. Komárom. In pratis spongiosis Labanc-berek prope Oroszlány, 200 m, 22.03.1936 leg. Á. Boros BP 7663; **Velence Mts** (8777.1): Comit. Fejér. In locis humidis, ad fontes supra vallem Csöpögő-völgy prope Sukoró, sol. granit., 250 m, 03.04.1938 leg. Á. Boros BP 117577; **Bakony Mts** (8772.3): Comit. Veszprém.

In limosis supra vall. rivi Tisztavíz prope pag. Bakonybél, 16.05.1954 leg. L. Vajda BP 27612; **Balaton Uplands** (9071.4): Veszprém County, Szentbékkálla, Feketehegy, Vaskapu-árok, on soil, N 46° 54' 9.74", E 17° 35' 42.43", 350 m, 27.06.2009 leg. B. Papp BP 178540; **Keszthely Mts** (9170.1): Comit. Zala. In pratis turfosis Sörény ad Billege-puszta prope Lesenceistvánd, 120 m, 17.05.1949 leg. Á. Boros BP 117540; **Sopron Mts** (8265.4): Győr-Sopron-Moson County, Kis-Tómalom wet meadow at Sopron, N 47° 42' 31.7", E 16° 37' 17.7", 150 m, 05.05.2006 leg. B. Papp B 173016; **Kőszeg Mts** (8664.4): Comit. Vas. In pratis humidis ad rivum Bozsoki-patak prope Bozsok, 300 m, 12.06.1970 leg. Á. Boros BP 117558; **Vendvidék** (9163.2?): Comit. Vas. In turfoso Ördög-tó prope Farkasfa, 300 m, 18.10.1960 leg. Á. Boros BP 162753; **Őrség** (9163.2): Vas County, Őrség, meadow at Orfalu, N 46° 52' 58.7", E 16° 15' 57.29", 290 m, 10.10.2009 leg. B. Papp BP 180622; **Vas** (8967.1): Comit. Vas. Ad margines rivi Koponyáspatak prope pag. Kám, 05.09.1958 leg. L. Vajda BP 117552; **Göcsej** (9066.4): Praenoricum: Göcsej, in uliginosis vallis riv. Sárvíz, pr. pg. Telekes, 22.06.1954 leg. T. Pócs et I. Gelencsér BP 58514; **Zala** (8969.4): Comit. Zala. In pratis turfosis ad rivum Marcal infra Gyepükaján, 170 m, 11.06.1962 leg. Á. Boros BP 117084 sub *B. neodamense*; **Belső-Somogy** (9869.1): Comit. Somogy. Ad stirpes arborum in locis paludosis ad Csatártó inter pagos Berzencze et Tarany, 150 m, 25.09.1922 leg. Á. Boros BP 117536; **Mecsek Mts** (9775.4): Hosszúhetény, Hidasi völgy Csurgó

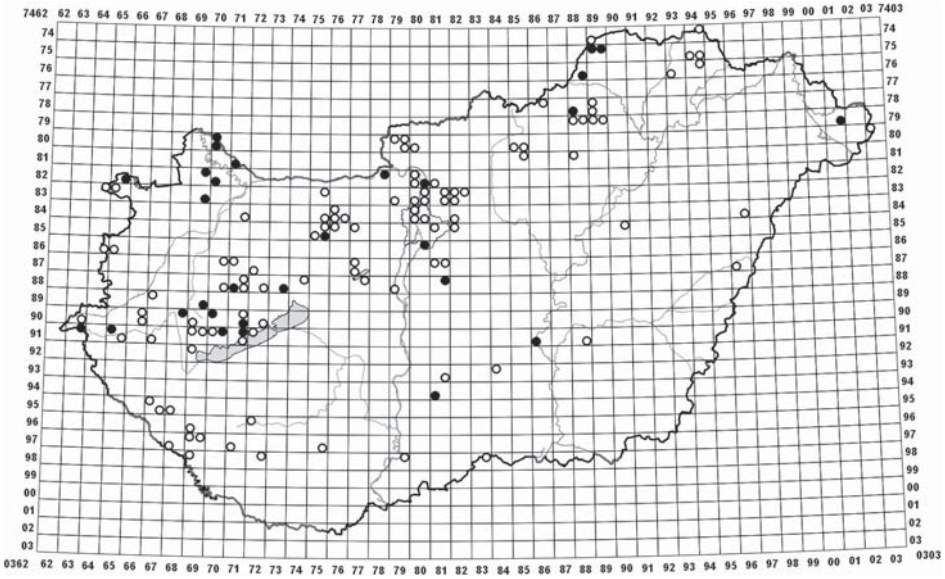

Fig. 59. Distribution of *Bryum pseudotriquetrum*.

szikla, mésztuffán (in pencil: Kalktuff, nass), 320 m, 23.07.1934 leg. A. Visnya BP 117537; **Kisalföld** (8471.4): Locus natalis: Arrabonicum, in pratis uliginosis (*Caricetum davallianae*) pr. pagum Felpéc, 27.05.1955 leg. M. Kovács EGR; **Hanság** (8269.2): Győr-Sopron-Moson County, Tárnokréti, wetlands beside Úrhanya-canal, N 47° 45' 8.5", E 17° 19' 15.5", 110 m, 23.06.2012 obs. P. Erzberger (Dupl. leg. B. Papp BP); **Danube–Tisza Interfluve** (8781.2): Comit. Pest. In pratis paludosis pr. Ócsa, versus stationem Inárcsi-szőllők, 100 m, 30.09.1928 leg. Á. Boros BP 117608; **Tiszántúl** (8496.4): Locus natalis: cott. Hajdú, in pratis uliginosis praed. Haláp pr. opp. Debrecen (in ass. *Caricetum goodenovii*), 26.04.1934 leg. I. Máthé BP 117570; (8796.3): Comit. Bihar. In natronatis ad marg. silvae Csere-erdő inter pag. Hencida et Gáborján, 100 m, 03.05.1948 leg. Á. Boros BP 117990 sub *B. alpinum*. **Nyírség** (9188.4): Comit. Szabolcs. In pratis humidis ad viam ferream prope Nyírbátor, 150 m, 25.09.1926 leg. Á. Boros BP 117565; **Észak-Alföld** (7901.4): Szabolcs-Szatmár-Bereg County, water mill at Túristvándi, N 48° 2' 51.8", E 22° 38' 30.5", 120 m, 06.08.2004 leg. B. Papp BP 171384; **Pest Plain** (8280.4): Kom. Pest, Sződliget, Donauufer-Altarm, Auwald, auf Totholz, 110 m, 09.08.2012 leg. P. Erzberger B (Erzberger 15685).

A superficial glance at the distribution map, which is probably still quite incomplete, reveals a concentration of records in the hill and mountain regions of the northern part of the country and much fewer records from the lowlands. This is in obvious relation to the availability of suitable wetland habitats. Many of the lowland records are old. This could be related either to a possible loss of habitats due to intensification of agriculture or other environmental changes, or to a shift in focus of recent collecting activity from the lowlands to mountain regions (compare Fig. 88). Red list status: LC-att (Papp *et al.* 2010).

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB, UA.

Literature: Boros (1953): in *Carex* meadows, near springs, streams, in peat wetlands, mainly in valleys; distributed all over the country, but in the lowlands in some areas missing, especially where clean water streams are scarce. Cardamineto-Montion, Molinion coeruleae, Caricion fuscae.

Boros (1968) lists practically all regions that are compiled in the above selection of specimens; in his list not mentioned are: Putnok Hills, Ózd Hills. Additional remarks concerning the ecological needs of this species: occurrence near mountain springs, in places rich in lime, even rarely on tufa. Molinio-Juncetea species.

Interestingly, Boros (1953) states that *B. pseudotriquetrum* is missing from saline areas. However, one specimen from the Tiszántúl (see above) was in fact collected by him in a saline meadow – but mistaken for *B. alpinum*. But certainly, *B. pseudotriquetrum* is very rare in saline grasslands.

Bryum radiculosum Brid.
[= *B. murale* Wils. ex Hunt.]
(Figs 60, 61)

Dioicous, rarely producing sporophytes (in 7% of specimens seen). **Plants** growing in very dense cushions to 1.5 cm tall, woven together by red-brown, finely to strongly papillose rhizoids. Brown-reddish **rhizoidal tubers**, 150–200 μm, always present among the rhizoids. **Leaves** evenly arranged along stem, erecto-patent when dry and moist, taut, lanceolate; leaf margin denticulate near apex, narrowly recurved, at times to apex; costa often red, excurrent as 100–250 μm long denticulate apiculus. **Laminal cells** 50–60 × 12 μm, basal paracostal cells quadrate to short-rectangular, cells hardly narrower at margins and hardly forming indistinct border. **Seta** 1–2.5 cm, reddish. **Capsule** cernuous, 2–4 mm long, often curved, elongate pyriform, narrow-mouthed, dark red when old, with very thick exothecium; exothecial cells below mouth rounded-quadrate, in the middle part of the capsule oblong with wavy, very strongly thickened walls. **Endostome** cilia appendiculate. **Spores** 10–12 μm, smooth.

Note: In the rare event when sporophytes are produced, rhizoidal tubers may sometimes be very hard to find.

Similar species: *B. subapiculatum*: plants growing solitary between other mosses or in lax tufts; basal paracostal cells elongate, laminal cells slightly wider, to 15–16 μm (*B. radiculosum*: growing in compact tufts; basal paracostal cells quadrate to short-rectangular, laminal cells to 12 μm). *B. caespiticium*: this species can also grow in dense patches, but usually lacks rhizoidal tubers; besides, sporophytes are normally produced, capsules brown when ripe (*B. radiculosum*: always with brownish rhizoidal tubers, rarely with sporophytes; capsules red).

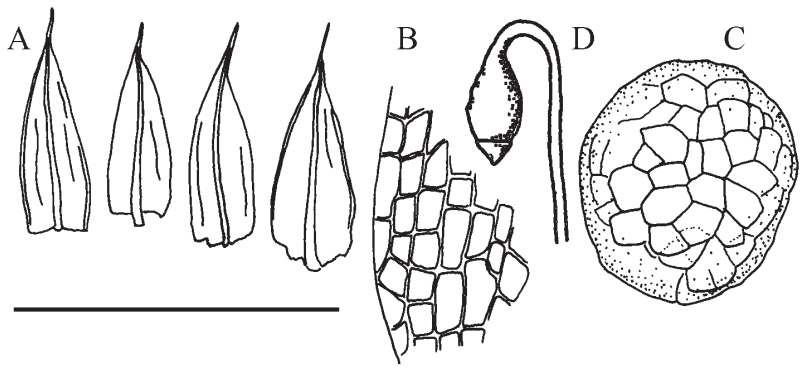

Fig. 60. *Bryum radiculosum*. A = leaves; B = basal leaf cells near costa (to the left); C = rhizoidal tuber; D = capsule (moist). Scale bar: A: – 2 mm; B, C: – 200 μm; D: – 4 mm. [BP 118222, del. Erzberger].

References: Crundwell and Nyholm (1964): 603–605, Demaret (1993): 173–175, Nyholm (1993): 213–215, Ahrens (2001): 87–88, Guerra *et al.* (2010): 151–153, 163.

Habitat: calciphilic, growing preferably in warm regions, in vineyards, at embankments (in open and closed calcareous grasslands, on moist limestone and dolomite rock, on irrigated walls near mills, near thermal springs, in saline grasslands, near saline lakes).

Substrate: on walls, calcareous rocks, calcareous soil, alkaline soil.

Associated bryophytes: *Bryum argenteum*, *B. dichotomum*, *B. rubens*, *Didymodon vinealis*, *Drepanocladus aduncus*, *Pterygoneurum ovatum*, *Tortula muralis*.

Vertical distribution: 82–400 (mean 177) m a.s.l.

Distribution in Hungary (32 specimens, 21 grid cells, of which 12 represent recent finds): **Gödöllő Hills** (8281.3): Com. Pest. In rupibus andesiticis in horto Vácrátót, 24.03.1952 leg. L. Vajda EGR (sub *B. caespiticium* var. *kunzei*); **Pilis Mts** (8379.4): Pest County, Pilisborosjenő, south-west face of Nagy Kevély, open calcareous grassland, 400 m, 24.04.1992 leg. P. Erzberger B (Erzberger 294); **Buda Mts** (8580.1): Budapest County, Mt. Sas-hegy in Budapest, forest on the western part, on soil, N 47° 28' 53.2", E 19° 0' 55.3", 245 m, 30.05.2008 leg. B. Papp BP 176326; **Gerecse Mts** (8276.3): Comit. Komárom. In rupibus calcareis humidis montis Nagysomló prope Dunaszentmiklós, 400 m, 04.06.1942 leg. Á. Boros BP 118117; **Vértes Mts** (8575.2): Comit. Komárom. In locis irrigatis

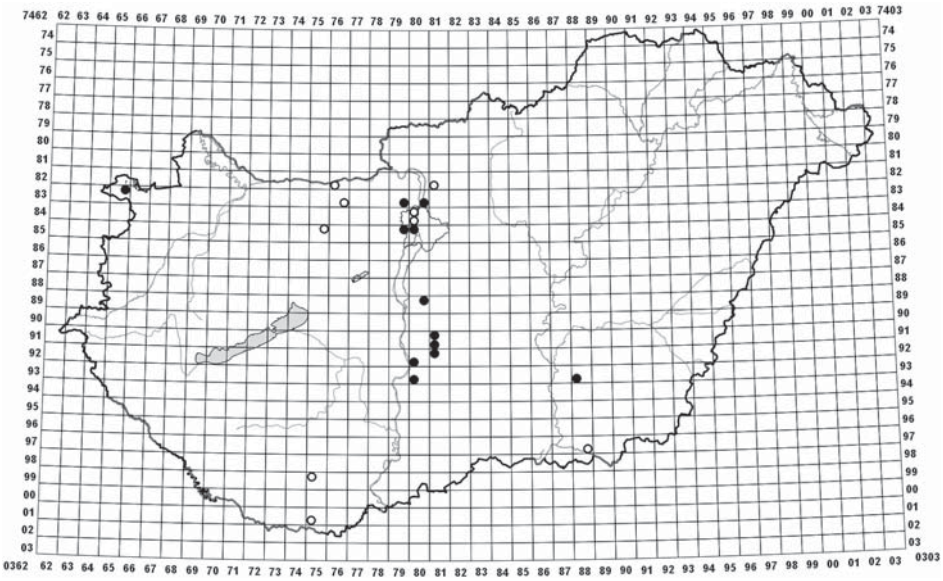

Fig. 61. Distribution of *Bryum radiculosum*.

ad molam Miska-malom prope Oroszlány, 175 m, 08.09.1937 leg. Á. Boros BP 118120; **Sopron Mts** (8365.2): Comit. Győr-Sopron, in rupibus glareosis collis Bécsi-domb prope opp. Sopron, 270 m, 08.11.1984 leg. I. Galambos BP 162165; **Mecsek Mts** (9975.1): Pécs, Bálics-völgy, Sipőcz felé szöllő kőfalán. Wand aus Kalkst. schattig, 200 m, 17.07.1932 leg. A. Visnya BP 118109; **Dráva-vidék** (0175.3): Comit. Baranya. ad fontem therm. Hárkányfürdő, 100 m, 20.08.1927 leg. Á. Boros BP 118108; **Danube–Tisza Interfluve** (9281.1): Com. Bács-Kiskun, Kiskunsági N.P., Umgebung des Kelemenszék bei Fülöpszállás, Bordatanya, 90 m, 16.04.1998 leg. P. Erzberger B (Erzberger 4308); **Tiszántúl** (9388.3): Csongrád county, near Szentes, at Lapistó lake, on alkali soil, 82 m, 04.03.2000 leg. B. Papp 169713; **Pest Plain** (8380.4): Pest County, Dunakeszi, waste pit near new buildings, 100 m, 02.02.1994 leg. P. Erzberger B (Erzberger 706).

This species is probably under-recorded. Its occurrence in the limestone and dolomite mountain regions (Pilis Mts, Buda Mts, Gerecse Mts, Vértes Mts, Mecsek Mts, Villány Mts) and the calcareous sand areas between the Danube and Tisza reflects its ecological needs as a calciphilic species. Since it is also thermophytic, its lack of occurrences in the northern mountains (e.g. Bükk Mts) might depend on climatic conditions. Red list status: LC (Papp *et al.* 2010).

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB.

Literature: Of the regions listed in Boros (1953, 1968), some have to be deleted, since the corresponding specimens were not confirmed: Kisalföld (Győr: BP 118102 is indeterminable); Vas (Tömörd: BP 118103 est: *B. rubens*), but most are supported by confirmed specimens.

Papp and Rajczy (1999) report several sites from the Kiskunság National Park (Danube–Tisza Interfluve) mostly based on specimens confirmed in our revision.

Bryum rubens Mitt.
(Figs 62, 63)

Dioicous, sporophytes occasional (in 2% of specimens seen). **Plants** 0.5–1.5 cm tall, growing in lax turf, frequently in large patches, light green or with a light red tinge; rhizoids brown to reddish, finely papillose. This species can often be recognised in the field by its spherical **rhizoidal tubers**, to 250 μm large, with protuberant cells (can be seen with a hand lens) that are rather thick-walled; these tubers are light pale green in spring, become orange later and are ruby when ripe. They are found close to the stem, especially in spring; in autumn, they can be found mostly at the rhizoids or in the soil. **Leaves** evenly arranged along stem in non-fruiting plants, forming comal tuft in plants with sporophytes, erectopatent when moist, slightly flexuose when dry, ovate-lanceolate; leaf margin denticulate

at apex, entire and somewhat recurved below; costa ending in leaf apex or shortly excurrent. **Laminal cells** 60–80 × 15–20 μm, at margin 1–2 rows narrower cells, forming a distinct border. **Seta** 1–3 cm, flexuose, red. **Capsule** cernuous, mostly slightly curved, large-mouthed, red-brown when young. **Endostome** cilia appendiculate. **Spores** 10 μm, finely papillose.

Similar species: *B. bornholmense*: very close in appearance to *B. rubens*, has been often mistaken for that species in the past. However, *B. bornholmense* grows always on lime-free soil, in forests (spruce forest); it has never tubers close to the stem, only at the rhizoids; tubers up to 400 μm, orange to light brownish, with larger, thin-walled, non-protuberant to very slightly protuberant cells (*B. rubens*: calciphilic, mostly in arable fields; tubers up to 260 μm, often crowded immediately at stem, ruby, with distinctly protuberant, thick-walled cells). It is advisable to examine the structure of the tuber cells in the compound microscope. The difference in wall thickness is best seen in profile, i.e. observe the cells near the perimeter. When treated with 2% KOH solution for 20–30 minutes, the tubers of *B. rubens* turn very dark, nearly black, whereas the tubers of *B. bornholmense* remain essentially unchanged in colour and are still orange-red or turn a darker shade of red.

B. subapiculatum: leaves without distinct border of elongate, narrow cells; tuber cells not protruding, tubers occasionally ± irregular in shape, sometimes oblong, on non-calcareous soils (*B. rubens*: leaves bordered, tuber cells strongly protuberant, incrassate; on calcareous to slightly acidic soil).

B. caespiticium: slightly taller (to 3 cm), costa longly excurrent, laminal cells 12–15 μm, capsules frequent, brown; usually without rhizoidal tubers, if tubers are present, they have non-protuberant cells (*B. rubens*: to 1.5 cm tall, costa percurrent or shortly excurrent, laminal cells 16–20 μm, capsules infrequent; always with rhizoidal tubers with protuberant cells).

For the differences between *B. rubens* and *B. ruderale*, see the note under the latter species.

References: Crundwell and Nyholm (1964): 629–635, Demaret (1993): 175–178, Nyholm (1993): 212–213, Ahrens (2001): 88–90, Crundwell and Whitehouse (2001), Guerra *et al.* (2010): 153–154, 163.

Habitat: frequent in arable fields (often building up mass populations), in forest paths, calciphilic, but also on neutral soil (in arable fields, fallow fields, forest clearings, meadows, pastures, at railroads, roadsides, roadside ditches, on ant hills in meadows, loamy banks (in forest), in open dolomite grassland, limestone grassland, open basaltic grassland, forest steppe, wet meadows, swamps, at a cave entrance, in saline grassland, at river embankments).

Substrate: loamy or sandy soil, clay, loess, dried-up mud.

Associated bryophytes: *Atrichum undulatum*, *Barbula convoluta*, *Brachythecium albicans*, *B. velutinum*, *Bryum alpinum*, *B. argenteum*, *B. caespiticium*, *B. capillare*, *B. dichotomum*, *B. klinggraeffii*, *B. radiculosum*, *B. ruderale*, *B. violaceum*, *Ceratodon purpureus*, *Ditrichum cylindricum*, *Entosthodon longicolle*, *Ephemerum minutissimum*, *Eurhynchium hians*, *Fissidens dubius*, *F. taxifolius*, *Phascum cuspidatum* var. *cuspidatum*, *Pleuridium subulatum*, *Pleurochaete squarrosa*, *Pottia bryoides*, *P. truncata*, *Pterygoneurum ovatum*, *Riccia glauca*, *Weissia longifolia*.

Vertical distribution: 82–750 (mean 255) m a.s.l.

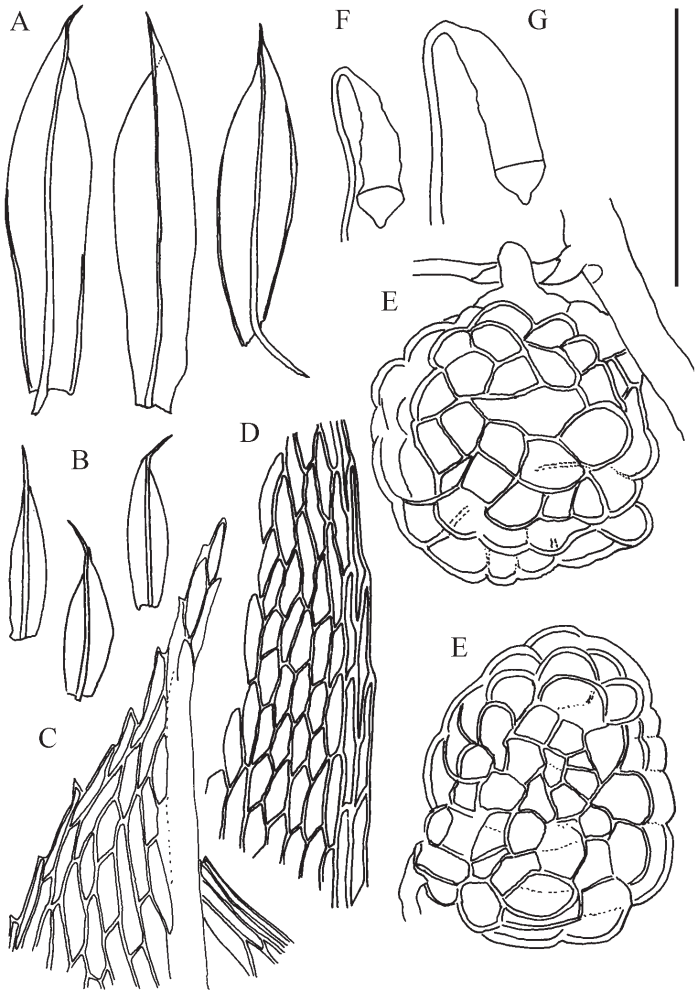

Fig. 62. *Bryum rubens*. A = comal leaves of non-fruiting plants; B = external perichaetial leaves; C = leaf apex; D = leaf margin; E = rhizoidal tubers; F, G = capsules (dry/moist). Scale bar: A, B: – 2 mm; C–E: – 200 μm, F, G: – 4 mm. [A, C: Erzberger 3045; B, D–G: BP 118138, del. Erzberger].

Distribution in Hungary (70 specimens, 49 grid cells, of which 35 represent recent finds): **Zemplén Mts** (7594.2): Comit. Abaúj-Torna. In argillosis subhum. in apertis silv. supra vallem Senyő prope Nagybózsva, 500 m, 06.10.1954 leg. Á. Boros 116636 sub *Pohlia*; **Aggtelek Karst** (7489.4): Comit. Borsod-Abaúj-Zemplén. In terra in valle Szelce-völgy ad Szelcepuszta prope pag. Jósvafő, 400–440 m, 05.05.1987 leg. M. Rajczy BP 165265; **Bükk Mts** (8089.1): Borsod-Abaúj-Zemplén County, Bükk Mts, Hidegkút laposa at Cserépfalu, meadow, N 47° 57' 55.5", E 20° 33' 35.4", 250 m, 15.04.2010 leg. B. Papp, BP 180852; **Mátra Mts** (8186.1): on a loamy bank just below Kékes in the Mátra Hills. Hungary, 750 m, 01.09.1971 leg. M. O. Hill BP 162758; **Gödöllő Hills** (8281.3): Com. Pest. In pomariis in horto Vácrátót, 19.03.1952 leg. L. Vajda EGR; **Börzsöny Mts** (8079.2): Com. Pest, Börzsöny-Geb., Tal Bacsina-völgy bei Királyháza, Wiese mit Ameisenhügeln, 380 m, 04.04.1994 leg. P. Erzberger B (Erzberger 1096); **Naszály** (8180.4): Szendehely-Katalinpuszta, Gyadai rét Maulwurfshügel, N 47° 50' 58", E 19° 7' 22", 210 m, 09.04.2007 leg. P. Erzberger and P. Szűcs B (Erzberger 12170); **Buda Mts** (8580.1): Budapest County, Mt. Sas-hegy in Budapest, open dolomite grassland, on soil, N 47° 28' 56.1", E 19° 1' 6.8", 250 m, 28.03.2008 leg. B. Papp 176239; **Gerecse Mts** (8376.2): Komárom-Esztergom County, Gerecse Mts, Nagy-Teke hill at Süttő, limestone grassland, N 47° 41' 58.3", E 18° 26' 41.2", 250 m, 29.04.2007 leg. B. Papp BP 174783; **Vértes Mts** (8576.4): Comit. Fejér. In argillosis apert. silvarum sub monte Kistábor-hegy pr. Csákvár, 230 m,

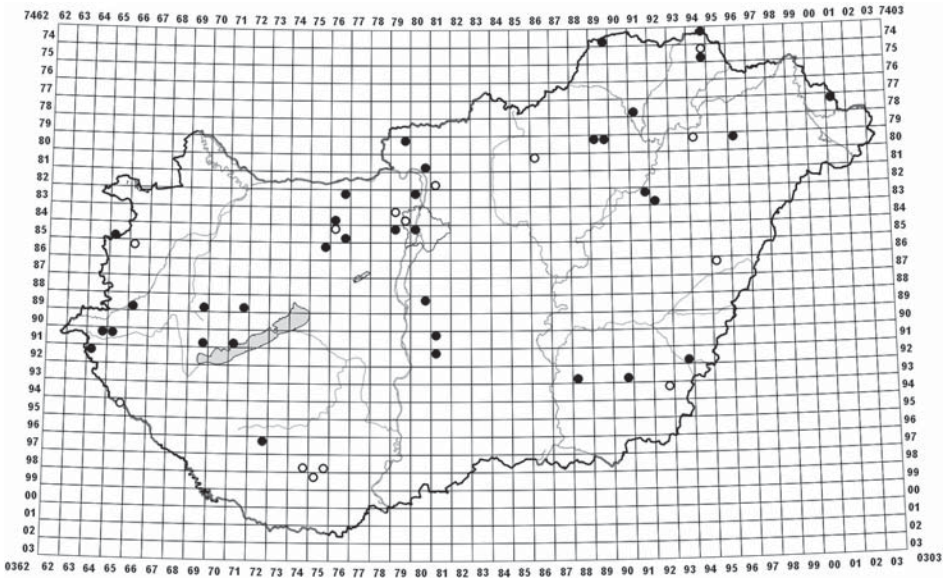

Fig. 63. Distribution of *Bryum rubens.*

07.04.1935 leg. Á. Boros BP 118137; **Bakony Mts** (8969.4): Veszprém County, wet meadow between Gyepűkaján and Szentimrefa, N 47° 2' 29.3", E 17° 17' 14.1", 150 m, 12.05.2009 leg. B. Papp BP 180740; **Balaton Uplands** (9171.3): Veszprém County, Balaton-felvidék region, Gulács hill at Nemesgulács, southeast facing open basalt rock grassland, 360 m, 29.04.2000 leg. B. Papp BP 172957; **Keszthely Mts** (9169.4): County Veszprém. Keszthelyi Mts. On soil near Vadvízárok in SW and NW direction, in forest at Vállus, 300 m, 18.10.1999 leg. B. Papp BP 166774; **Kőszeg Mts** (8565.3): Kőszeg, im Graben der Landstrasse nach Olmód, 19.01.1978 leg. A. Visnya BP 118187; **Őrség** (9264.1): County Vas. Őrség. In wet meadows in the valley Szentgyörgy-völgy at Magyarszombatfa, 20.04.2000 leg. B. Papp BP 167359; **Vas** (8966.3): Vas County, Nagymákfa at Vasvár, meadow at Csörnöc stream, N 47° 2' 17.47", E 16° 44' 44.33", 175 m, 05.06.2010 leg. B. Papp BP 180492; **Zala** (9565.2): Flora hungarica, Comitat Zala. In paludosis pr. pag. Muraszemenye, 150 m, 02.05.1948 leg. Á. Károlyi EGR sub *B.* sp.; **Zselic** (9772.2): Somogy County, Zselic, Ropolyi Forest Reserve at Bözsénfa, south of Kaposvár, on soil, 300 m, 27.08.2004 leg. B. Papp BP 171528; **Mecsek Mts** (9874.4): Comit. Baranya. In caverna Cseppkő-barlang ad Abaliget, 200 m, 15.09.1929 leg. Á. Boros BP 118141; **Danube–Tisza Interfluve** (9281.1): Comit. Bács-Kiskun, in natronatis ad marginem lacu Kelemenszék prope pag. Fülöpszállás, 100 m, 24.03.1977 leg. M. Rajczy BP 164671; **Tiszántúl** (8392.3): Hajdú-Bihar County, at Hortobágyi halastó lake near Hortobágy village, on soil, N 47° 36' 34.1", E 21° 4' 9.55", 85 m, 12.04.2010 leg. B. Papp BP 180367; **Nyírség** (7801.1): Szabolcs-Szatmár-Bereg County, Csere-erdő forest at Beregdaróc, on soil, N 48° 11' 43.6", E 22° 33' 44.0", 122 m, 04.08.2004 leg. B. Papp BP 171284; **Pest Plain** (8380.1): Com. Pest, Donauaue, Szentendre, Pap-sziget, trockener Donau-Schlamm am oberen Deichrand, N 47° 40' 50", E 19° 4' 53", 110 m, 02.04.2007 leg. P. Erzberger B (Erzberger 12053).

B. rubens is the most frequent species of the *B. erythrocarpum* group. Suitable habitats (disturbed ground) are found throughout the country, from the lowlands to the highest elevations, therefore many more records can be expected from continued exploration. Red list status: LC (Papp *et al.* 2010).

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB, UA.

Literature: Probably most of the records of *B. erythrocarpum* in Boros (1953, 1968) correspond to *B. rubens*, but after the revision of Crundwell and Nyholm (1964), *B. ruderale* and *B. bornholmense* were recognised, though only the reports of that paper are quoted in Boros (1968) and Orbán and Vajda (1983); the new concept was not applied by Hungarian bryologists until the 1990s. Compare also the note under *B. ruderale*. Papp and Rajczy (1999) publish two records of *B. rubens* from Kiskunság National Park based on specimens confirmed by our revision.

Bryum ruderale Crundw. et Nyh.
(Figs 64, 65)

Dioicous, very rarely yet occasionally producing sporophytes (not seen in Hungarian material). **Plants** 0.5–1 cm tall, green or with a reddish tinge, when dry with a slight golden sheen; old rhizoids dark red or red-violet, distinctly papillose, young rhizoids pale reddish and only weakly papillose. **Rhizoidal tubers** to 200 μm, (yellowish orange to reddish or) red, their cells not (to scarcely) protuberant. **Leaves** evenly arranged along stem below comal tuft, erecto-patent when moist and dry, taut, slender ovate-lanceolate, margin entire, weakly denticulate near apex only, narrowly recurved especially in lower half of leaf; costa only shortly excurrent in non-fruiting plants, longly excurrent in comal leaves, excurrent part distinctly denticulate. **Laminal cells** rather incrassate, 60–70 × 10 μm, narrower at margins but hardly forming border. **Seta** 1–2 cm. **Capsule** pendulous, 2 mm long. **Endostome** cilia appendiculate. **Spores** 8–10 μm, very finely papillose.

Similar species: *B. ruderale* grows in similar places as *B. rubens*, but differs by its smaller size and especially by the rhizoids and rhizoidal tubers.

B. rubens: rhizoids reddish to brown-red; tubers to 250 μm, ruby with strongly protuberant incrassate cells (*B. ruderale*: rhizoids conspicuously dark red to red-violet; tubers mostly less than 200 μm, yellowish to orange, cells not (to scarcely) protuberant).

B. subapiculatum: rhizoids red, tubers > 200 μm, red to brown-red (*B. ruderale*: rhizoids conspicuously dark red to red-violet; tubers mostly less than 200 μm, red or yellowish to orange).

For the differences between *B. ruderale* and *B. klinggraeffii*, see the note under the latter species.

References: Crundwell and Nyholm (1964): 605–609, Demaret (1993): 171–173, Nyholm (1993): 206–207, Guerra *et al.* (2010): 163.

Habitat: in arable fields, along paths, on open soil in meadows, at river banks (at roadsides, in open limestone grassland, in fallow fields, in saline grassland).

Substrate: on ± calcareous soil.

Associated bryophytes: *Bryum rubens*, *Entosthodon longicolle*, *Phascum cuspidatum* var. *cuspidatum*, *P. cuspidatum* var. *piliferum*, *Riccia sorocarpa*.

Vertical distribution: 90–450 (mean 250) m a.s.l.

Distribution in Hungary (8 specimens, 8 grid cells, of which 6 represent recent finds): **Zemplén Mts** (7494.2): Borsod-Abaúj-Zemplén County. On abandoned field at Felsőmalom erdészház at Füzér in Zemplén Mts, 450 m, 27.09.2001 leg. B. Papp BP 168493; **Gödöllő Hills** (8183.3): Com. Pest, Gödöllőer Hügelland, Fóti-somlyó, offener Trockenrasen, 250 m, 29.03.1994 leg. P. Erzberger B

(Erzberger 958); **Gerecse Mts** (8376.2): Komárom-Esztergom County, Gerecse Mts, Nagy-Teke hill at Süttő, limestone grassland, N 47° 41' 58.3", E 18° 26' 41.2", 250 m, 29.04.2007 leg. B. Papp BP 174784; **Vértes Mts** (8577.3): Fejér County, Vértes Mts, Somos-gödör at Vértesboglár village, N 47° 24' 45.1", E 18° 31' 41.4", 170 m, 18.04.2010 leg. B. Papp BP 180394; (8675.2): Kom. Fejér, Csákberény, nördl. Ortsrand, am Friedhof, N 47° 21' 22.7", E 18° 19' 24.1", 240 m, 13.04.2012 leg. P. Erzberger and Cs. Németh B (Erzberger 15143); **Bakony Mts** (8971.4): Com. Veszprém, Bakony Mts, Kab-hegy, on forest path, N 47° 2' 34.7", E 17° 36' 12.2", 400 m, 13.07.2012 leg. B. Papp and P. Erzberger B (Erzberger 15503); **Tiszántúl** (8696.3): Comit. Bihar. In natronatis ad Fehér-tó prope Konyári-Sóstó, 100 m, 11.05.1937 leg. Á. Boros BP 6791, as admixture to *Entosthodon longicolle*; (9492.2): Comit. Békés. In planitie Hungariae magna. Rarissima in natronatis parum-graminosis inter pagum Kétegyháza et stationem viae ferreae Újkígyós dict., 90 m, 23.05.1924 leg. Á. Boros, as admixture to *Entosthodon longicolle*, associated with *B. rubens*, in herb. A. C. Crundwell E00619986.

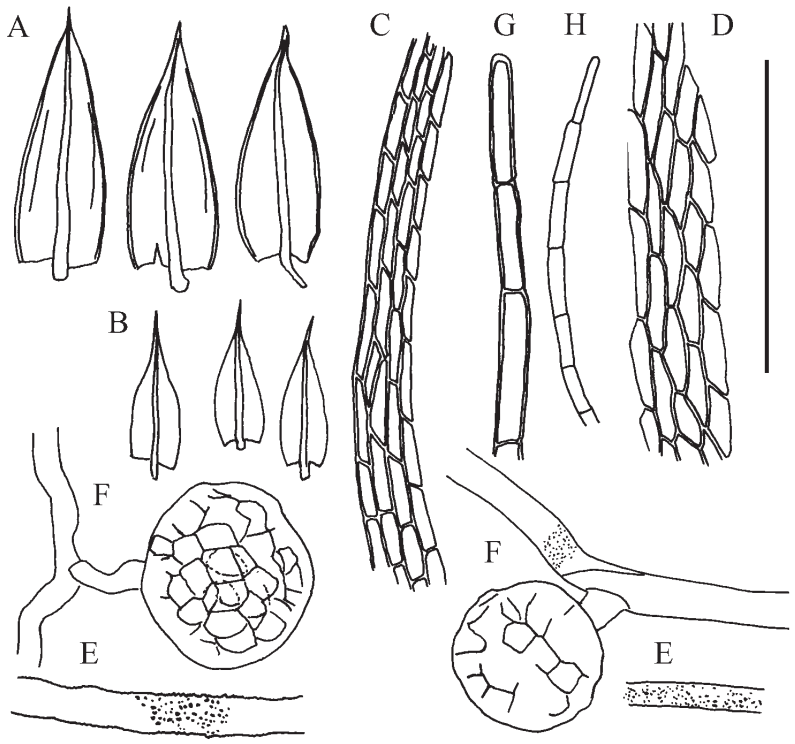

Fig. 64. *Bryum ruderale*. A = comal leaves; B = stem leaves; C = marginal cells; D = mid-leaf cells; E = rhizoid details (ornamentation shown in part); F = rhizoidal tubers; G, H = male paraphyses, apical part. Scale bar: A, B: – 2 mm; C–G: – 200 μm; H: – 400 μm. [Erzberger 15143, del. Erzberger].

The small number of records shown in the distribution map can only be considered as the starting point for further exploration. As a calciphilic species of disturbed ground, *B. ruderale* can probably be found in many more suitable regions, e.g. the Danube–Tisza Interfluve with its calcareous sands. Red list status: LC (Papp *et al*. 2010).

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB, UA.

Literature: Boros (1968) quotes the record reported in Crundwell and Nyholm (1964): "Bihar: in natronatis ad 'Fehértó' prope Konyári-Sóstó, alt. c. 100 m, May 1937 Á. Boros (in *Funaria hungarica*)". Interestingly, in the specimen from A. C. Crundwell's herbarium at E we could not find *B. ruderale*, but we did in a duplicate at BP (see specimens above). The regions listed in Orbán and Vajda (1983) obviously are not based on revised specimens and therefore should not be accepted, they are exactly those enumerated under *B. erythrocarpum* in Boros (1968). Since *B. erythrocarpum* is an aggregate, the records cannot be referred to a single species without revision of specimens.

The record published in Papp and Rajczy (1999) from the Kiskunság National Park is based on a specimen (BP 164411) that could not be determined unambiguously.

Revised specimens (inserted in "*B. erythrocarpum*"): Buda Mts (8479.2): Budapest. Ad fontem Csúcshegyi dűlő sub monte Csúcs-hegy ad Óbuda, 129 m, 23.03.1948 leg. Á. Boros BP 118134 est: *Pohlia* sp.; Vértes Mts (8575.3):

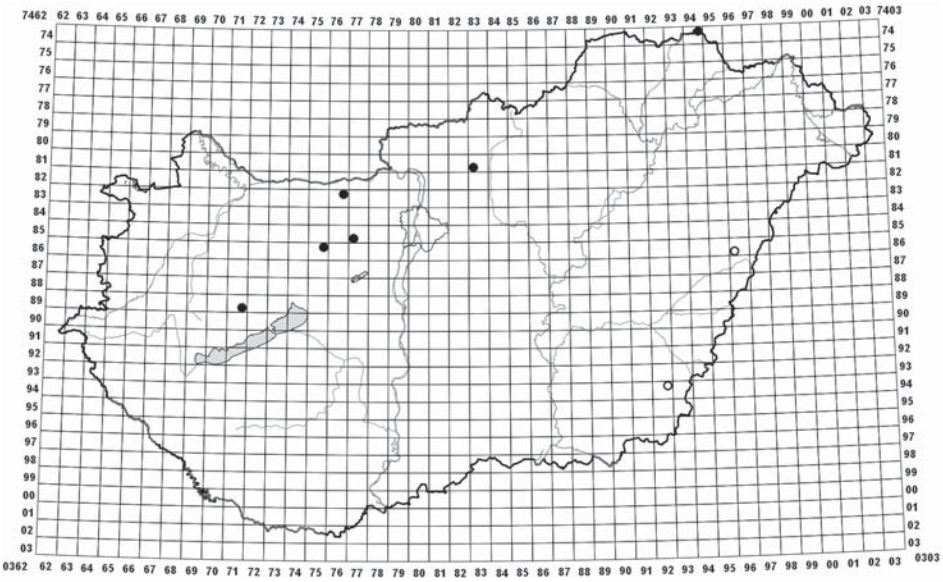

Fig. 65. Distribution of *Bryum ruderale.*

Comit. Fejér. Ad domos pagi Pusztavám, 190 m, 05.09.1937 leg. Á. Boros BP 118136 est: *B. subapiculatum*; (8576.1): Comit. Komárom. In argillosis silvaticis Cseresznyefa-hajtás pr. Várgesztes, 350–400 m, 29.04.1935 leg. Á. Boros BP 118138 est: *B. rubens*; (8576.4): Comit. Fejér. In argillosis apert. silvarum sub monte Kistábor-hegy pr. Csákvár, 230 m, 07.04.1935 leg. Á. Boros BP 118137 est: *B. rubens*; Austria (Burgenland), near Kőszeg: (8663.1): Comit. Vas. Ad ripas aquarum stagnantium infra Alsólő, 300 m, 08.08.1920 leg. Á. Boros BP 118130, est: *B. klinggraeffii*; Mecsek Mts (9874.4): Comit. Baranya. In caverna Cseppkő-barlang ad Abaliget, 200 m, 15.09.1929 leg. Á. Boros BP 118141 est: *B. rubens*; (9875.4): Pécs, Árpádi-rét, 120 m, 08.04.1934 leg. A. Visnya BP 118140 est: *B. rubens*; Kisalföld (8272.3): Comit. Győr, Bácsai-sziget ad ripam argillosam Danubii, 10.10.1940 leg. S. Polgár BP 118131 est: *B. klinggraeffii*. Tiszántúl (8589.2): Comit. Jász-Nagykun-Szolnok. In argillosis ripae brachii mortui Tibisci ad Abádszalók, 90 m, 30.07.1934 leg. Á. Boros BP 118132 est *Pohlia* sp.

Bryum schleicheri DC.
(Fig. 66)

Dioicous, male and female plants in separate turfs, occasionally with sporophytes**. Plant** 3–5 cm tall, the var. *latifolium* to 10 cm tall, in lax, light green turf; rhizoids orange-brown, finely verrucose-papillose. **Leaves** erectopatent when moist, flexuose and often slightly twisted apically when dry, of different shape and size, small and orbicular in the lower part of the stem, ovate-elongate in the upper part, concave, margin entire, plane or narrowly recurved, leaf base longly and narrowly decurrent along stem; costa green or brownish, percurrent or shortly excurrent, in some forms excurrent as smooth or slightly denticulate apiculus. **Laminal cells** 50–80 × 18–25 μm, rhombic in upper part of leaf, ± rectangular in lower part, *ca* 100–120 × 40(–56) μm at leaf base; distinct border of 2–3 rows of elongate, narrow, only slightly incrassate cells, usually unistratose, sometimes bistratose, vanishing towards leaf base, where rectangular to quadrate cells replace the narrow cells. In some forms the leaf base is widened in an auricle-like form, with reddish to brownish coloration. **Seta** (2–)4–6 cm. **Capsule** pendulous or cernuous, 3.5–5 mm long, broadly pyriform when moist, turbinate when dry, light yellow to light brown; exothecial cells horizontally rectangular in 2 rows of narrow cells below mouth, followed by 6–8 rows of small roundish exothecial cells, and only below these the turbinate capsule is constricted when dry. **Exostome** and endostome not connected, of equal height; exostome teeth sometimes with oblique cross-walls between lamellae. **Endostome** with oval perforations, cilia nodulose or sometimes longly appendiculate. **Spores** 18–20 μm, finely papillose.

Note: *B. schleicheri* is very polymorphic. The var. *latifolium* is very conspicuous and can usually be recognised in the field by the tumid light green tufts to 10 cm tall; less vigorous forms may be recognised by their light green colour without distinct red coloration, only close to the stem cells may be pinkish; the turbinate capsules are also characteristic.

Similar species: *B. pseudotriquetrum*: rhizoids red, rhizoid tomentum reaching up high; leaves distinctly decurrent in several cell rows, marginal cells decurrent without interruption; leaf areolation regularly reticulate; leaves green, with red tinge, leaf base red; capsule not conspicuously constricted below mouth when dry (*B. schleicheri*: rhizoids orange-brown, rhizoids only sparsely present high up stem; leaves narrowly decurrent, the long marginal border cells are replaced by rectangular cells at leaf base, these may occasionally form small auricles; leaf areolation less regular, cells in lower part of leaf appearing more rectangular; leaves light green, occasional with pinkish leaf base; capsule turbinate, distinctly constricted below mouth when dry).

B. turbinatum: plants reddish, to 2 cm tall; leaves oblong-triangular (*B. schleicheri*: plants light green, to 5 cm high, var. *latifolium* to 10 cm high; leaves orbicular to ovate).

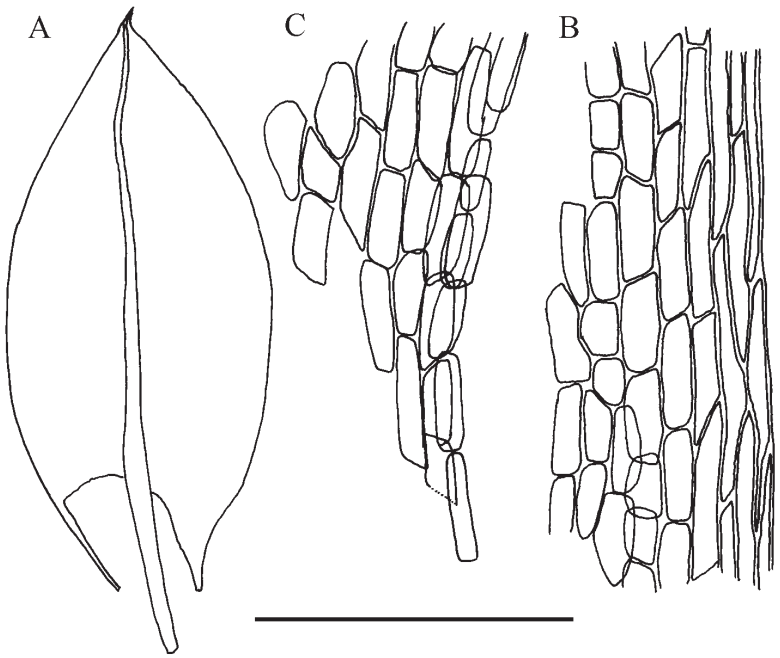

Fig. 66. *Bryum schleicheri*. A = leaf; B = margin near leaf base; C = decurrency. Scale bar: A: – 2 mm; B, C: – 200 μm. [Erzberger 6382 (Switzerland), del. Erzberger].

For the differences between *B. schleicheri* and *B. weigelii*, see the note under the latter species.

References: Limpricht (1895): 438–440, Nyholm (1993): 180–181, Ahrens (2001): 92–94, Meinunger and Schröder (2007): 32–34, Guerra *et al.* (2010): 113–115.

Habitat: near springs, stream banks and swamps in the mountains.

Substrate: wet soil over calcareous layers.

Distribution in Hungary: excluded from Hungary.

Distribution in adjacent countries: A, RO, SK, SLO, SRB, UA.

Literature: All specimens originally labelled *B. schleicheri* were revised to *B. pseudotriquetrum*. Therefore the corresponding passages in Boros (1953, 1968), Szepesfalvi (1941), Orbán and Vajda (1983), Papp and Rajczy (1996) and in particular Pócs *et al.* (1958): 27 with description of *Bryetum schleicheri* from Szőce are erroneous.

Specimens revised: Bükk Mts (7889.1): Com. Borsod. In turfosis rivi Disznós-patak prope Jávorkút, 630 m, 05.10.1952 leg. Á. Boros BP 117254 (revised to *B. pseudotriquetrum* form by L. Meinunger and W. Schöder); Comit. Borsod. In rivulo Disznóspatak prope Jávorkút, montes Bükk, 06.10.1952 leg. L. Vajda BP 29353 (earlier revised to *B. pseudotriquetrum* by B. Papp); Őrség (9165.1): Praenoricum: Őrség, in font. ulig. vallis sub pg. Szőce, in sol. glareos., 220 m, 06.07.1954 leg. T. Pócs and I. Gelencsér BP 58516 (earlier revised to *B. pseudotriquetrum* by B. Papp); Vasi-Hegyhát, in font. ulig. vallis sub pg. Szőce, sol. glareos., 220 m, 06.07.1954 leg. T. Pócs and I. Gelencsér BP 117255 (first revised to *B. ventricosum* by Boros, then confirmed as *B. schleicheri* 30.1.1955 also by Boros, but now definitely revised to *B. pseudotriquetrum*); Comit. Vas. In fontibus vallis rivi Szőcepatak prope pag. Szőce, 05.08.1954 leg. L. Vajda BP 117256, BP 28016 (both earlier revised to *B. pseudotriquetrum* by B. Papp); Comit. Vas. In turfosis vallis rivi Szőce-patak ad Szőce, 200 m, 15.08.1954 leg. Á. Boros BP 117257 (earlier revised to *B. pseudotriquetrum* by B. Papp); Comit. Vas. In turfosis vallis rivi Szőce-patak ad Szőce, 200 m, 16.08.1954 leg. Á. Boros BP 117258, BP 117260 (both earlier revised to *B. pseudotriquetrum* by B. Papp); Pest Plain (8480.3): Budapest. Óbuda. In locis irrigatis calc. fontis therm. ad Árpádmalom, 100 m, 23.07.1926 leg. Á. Boros BP 117252 (original determination by Podpera, earlier revised to *B. pseudotriquetrum* by B. Papp).

Bryum schleicheri var. *latifolium* (Schwägr.) Schimp.
(Fig. 67)

Differs from the typical variety in the following characters. **Plants** to 10 cm tall, in very conspicuous, tumid yellowish green lax tufts. **Leaves** broadly ovate;

costa percurrent or very shortly excurrent. **Laminal cells** 40–60 × 40 μm, with thin, light green walls; at leaf base 4–5 rows of up to 100 μm long cells with red walls, sometimes formed as laterally protruding auricles; marginal border distinct, partially bistratose, formed of up to 5 rows of long, narrow cells. Sporophytes unknown.

Similar species: this taxon is very tall and can hardly be mistaken for any other species.

Habitat, substrate: as in the typical var.

Distribution in Hungary: excluded from Hungary.

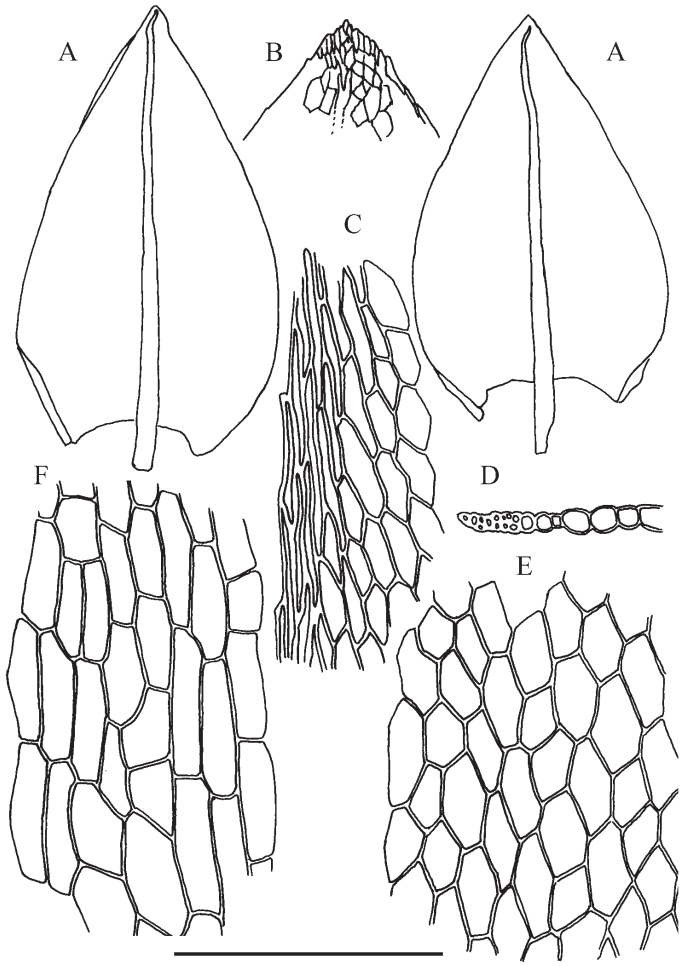

Fig. 67. *Bryum schleicheri* var. *latifolium*. A = leaves; B = leaf apex; C = leaf margin near apex; D = cross section of leaf margin; E, F = laminal cells (upper/lower). Scale bar: A: – 2 mm; B: – 400 μm; C–F: – 200 μm. [Erzberger 14109 (Greece), del. Erzberger].

Bryum stirtonii Schimp.
[= *B. elegans* var. *carinthiacum* (Bruch et Schimp.) Breidl.]
(Figs 68, 69)

Dioicous, sporophytes rare (not seen in Hungarian material). **Plants** growing in 0.5–2 cm high, dense green turf; brown-red, finely papillose rhizoids far up stem, older rhizoids coarsely and densely papillose. **Leaves** evenly arranged along elongate stem, erectopatent when moist, not or only very loosely twisted when dry, broadly ovate, margin entire, slightly recurved or plane; costa stout, sometimes > 100 μm wide at leaf base, ending below apex or shortly excurrent. **Laminal cells** 40–60 × 16–23(–30) μm, at margin 1–2 rows narrow cells forming indistinctly delimited border, decurrent along stem and confluent at apex to a mostly reflexed apiculus.

Capsule cernuous, subcylindrical, symmetrical, not contracted below mouth when dry. **Spores** 12–14(–19) μm.

Similar species: *B. elegans*: plants often bud-like, julaceous with evenly arranged imbricate leaves; leaves not decurrent; laminal cells 15–20 μm wide; rhizoids very coarsely papillose, papillae reaching 5 μm (*B. stirtonii*: leaves evenly arranged along elongate stem, leaves decurrent; laminal cells slightly wider; rhizoids less coarsely, but densely papillose).

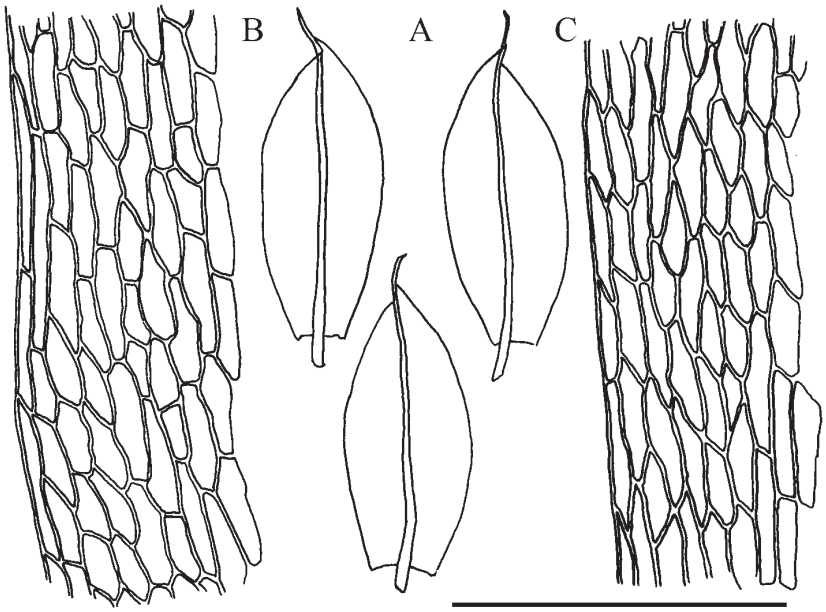

Fig. 68. *Bryum stirtonii*. A = external perichaetial leaves; B, C = leaf margin. Scale bar: A: – 2 mm; B, C: – 200 μm. [EGR Vajda 1956 (Nagyhideg-hegy/Börzsöny), del. Erzberger].

B. capillare: plants to 4 cm tall, leaves spirally twisted around stem; border of several rows of elongate cells distinct (*B. stirtonii*: plants to 2 cm tall, leaves not or only very loosely twisted, marginal border indistinct, formed by 1–2 rows of narrow cells).

References: Syed (1973): 282–286, Demaret (1993): 254–256, Nyholm (1993): 185–186, Smith (2004): 551–552.

Note on taxonomic status: Some authors include *B. stirtonii* in the synonymy of *B. elegans* (e.g. Holyoak 2004, Hallingbäck 2008).

Habitat: shaded andesitic rocks, shaded calcareous rocks.

Substrate: base-rich siliceous and calcareous rock.

Associated bryophytes: none.

Vertical distribution: 350–800 (mean 575) m a.s.l.

Distribution in Hungary (3 specimens, 2 grid cells, of which 1 represents a recent find): **Börzsöny Mts** (8079.4): Comit. Nógrád. In rupibus andesiticis umbrosis in cacumine montis Nagyhideghegy, montes Börzsöny, 22.04.1956 leg. L. Vajda EGR sub *B. capillare*; Comit. Nógrád. In rupestribus montis Nagyhideghegy, supra Királyrét, montes Börzsöny, 25.07.1966 leg. L. Vajda BP 71545; **Vértes Mts** (8675.2): Kom. Fejér, nördl. Csákberény, schatt. Kalkfelsen, N 47° 21' 45.1", E 18° 18' 28.3", 340 m, 13.04.2012 leg. P. Erzberger and Cs. Németh B (Erzberger 15177).

As with *B. elegans*, to which *B. stirtonii* is closely related, many more potential habitats (shaded calcareous rock, preferably at higher elevations) are prob-

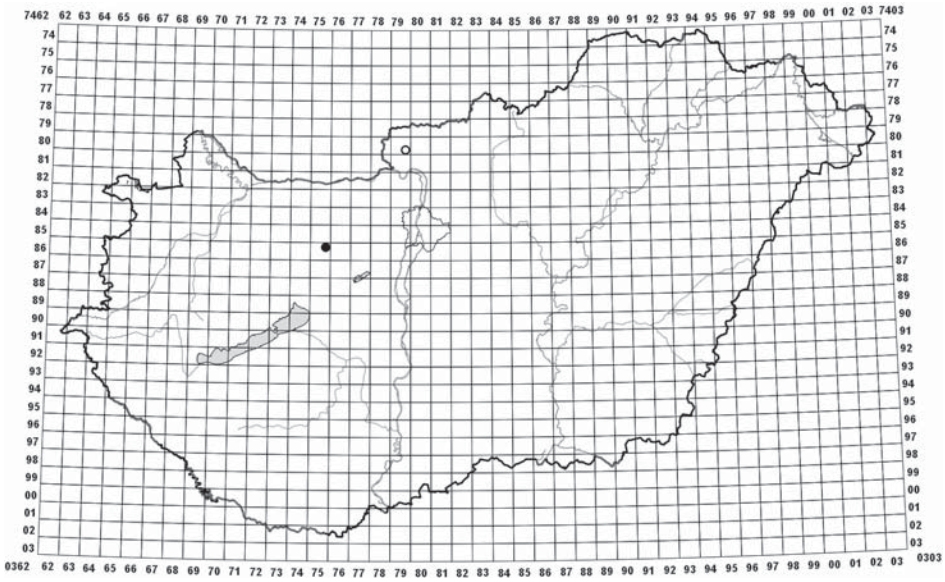

Fig. 69. Distribution of *Bryum stirtonii*.

ably available, but *B. stirtonii* appears to be much rarer than its relative. The near lack of recent finds is aggravated by the fact that habitats of this species have been rather well explored in the last decades. In Hungary, *B. elegans* and *B. stirtonii* are the species with the highest altitudinal average (393 and 575 m a.s.l., respectively), apart from *B. weigelii* (625 m a.s.l.). In the Red data book of European bryophytes, *B. stirtonii* is listed as insufficiently known (K) (ECCB 1995). Red list status: NT (Papp *et al*. 2010). According to the updated information, VU seems appropriate. See also the note added in proof (p. 192).

Distribution in adjacent countries: A, SLO, SK. This may not reflect the true distribution, but be due to controversial taxonomic treatment (as synonym or subspecific taxon of *B. elegans*).

Literature: First reported from Hungary in Orbán and Vajda (1983) Appendix: Bükk Mts, Mátra Mts. However, from these regions no specimen could be located. Therefore these chorological data should be considered with reservation until appropriate material turns up. Pénzes-Kónya and Orbán (2000) publish a record from Bükk Mts, but no specimen was obtained from EGR.

Bryum subapiculatum Hampe
[= *B. microerythrocarpum* Müll. Hal. et Kindb.]
(Figs 70, 71)

Dioicous, rarely with sporophytes (seen in 1 specimen of Hungarian material). **Plants** 0.5–1 cm tall, in lax groups, green, often tinged red, sometimes strongly red; rhizoids pale brown, very finely papillose. **Rhizoidal tubers** numerous, red or brown-red, spherical or somewhat irregular in shape, often differing in size, 150–250(–300) μm, cells not protuberant. **Leaves** taut, erectopatent when moist and dry, glossy, narrowly lanceolate, leaf margin plane and indistinctly denticulate above, from mid-leaf downward mostly recurved and entire; fruiting plants often have the leaf margin recurved to apex; leaf base red, costa stout, often red, shortly excurrent as slightly denticulate apiculus. **Laminal cells** 50–60 × 10–12(–16) μm; marginal cells elongate, occasionally 100–150 μm, but not forming distinct border. **Seta** 1.5–2(–4) cm, red brown. **Capsule** pendulous, 1.5–2.5 (–4) mm long, narrowly pyriform, red when ripe. **Endostome** cilia appendiculate. **Spores** 10–12 μm ± papillose.

Notes: Among the species of the *B. erythrocarpum* group *B. subapiculatum* is relatively robust and can be recognised in the field by its dark red/green colour, similar to *B. alpinum*, but that species is considerably larger. Occurrence in non-calcareous habitats is also a good pointer.

Similar species: *B. rubens*: plants pale green to pink, leaves flexuose when dry; leaves broadly ovate-lanceolate; ruby-coloured rhizoidal tubers with pro-

tuberant, thick-walled cells (raspberry-like) (*B. subapiculatum*: plants dark red-green, glossy, taut; leaves narrowly ovate-lanceolate; rhizoidal tubers brown-red, sometimes irregular in shape, with non-protuberant cells).

For the differences between *B. subapiculatum* and *B. alpinum*, *B. bornholmense*, *B. radiculosum*, *B. ruderale* and *B. tenuisetum*, see the notes under the latter species.

References: Crundwell and Nyholm (1964): 622–626, Nyholm (1993): 210–211, Demaret (1993): 186–188, Ahrens (2001): 79–80, Guerra *et al.* (2010): 161–164.

Habitat: beside paths, in arable fields, also in forest clearings and at embankments (crevices of andesitic rocks, in loess cliffs, arable fields, near thermal springs, near houses, at cemeteries, along paths, in saline meadows).

Substrate: lime-free soil, sand, clay, humus (clay, moist sand, soil over concrete, soil in andesitic rock crevices, gravel at river bank, alkaline soil).

Associated bryophytes: *Acaulon triquetrum*, *Barbula convoluta*, *B. unguiculata*, *Brachythecium albicans*, *Bryum argenteum*, *B. dichotomum*, *B. klinggraeffii*, *B. violaceum*, *Dicranella varia*, *Encalypta vulgaris*, *Entosthodon longicolle*, *Ephemerum minutissimum*, *Phascum cuspidatum*, *Pleuridium acuminatum*, *Pottia intermedia*, *Pterygoneurum ovatum*.

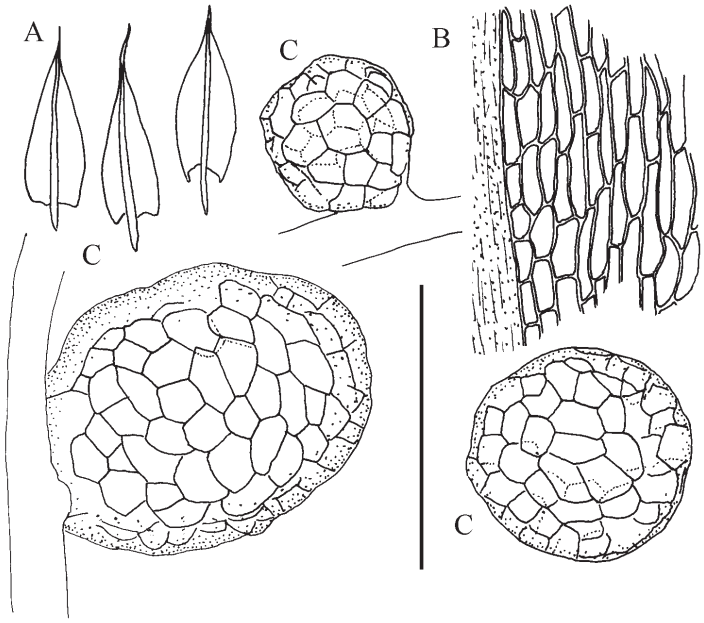

Fig. 70. *Bryum subapiculatum*. A = leaves; B = basal leaf cells near costa (to the left); C = rhizoidal tubers. Scale bar: A: – 2 mm; B, C: – 200 μm. [Erzberger 3352a, del. Erzberger].

Vertical distribution: 82–750 (mean 170) m a.s.l.

Distribution in Hungary (33 specimens, 20 grid cells, of which 12 represent recent finds): **Zemplén Mts** (7594.4): Borsod-Abaúj-Zemplén County, Zemplén Mts, Komlóska valley at Pálháza, *Callunetum* with *Lycopodium*, on bare soil, N 48° 25' 19.3", E 21° 28' 7.1", 225 m, 15.04.2006 leg. B. Papp BP 175198 sub *B. rubens*; **Mátra Mts** (8186.1): Com. Heves, Mátra-Geb., Disznókő, sonnige Felsspalte, 750 m, 04.08.2000 leg. P. Erzberger B (Erzberger 6290a); **Buda Mts** (8480.3): Budapest. In agris argillosis, inter segetes Medicaginis Törökvész, 250 m, 15.04.1945 leg. Á. Boros BP 7711 sub *B. bicolor*; **Gerecse Mts** (8476.2): Com. Komárom. In argillosis Irtásföldek prope pag. Alsógalla, 220 m, 25.04.1948 leg. Á. Boros BP 118210 sub *B. bicolor*; **Vértes Mts** (8476.3): Comit. Komárom. In arenosis humidis ripae rivi Száraz-ér pr. Környe, vers. Vértessomló, 160 m, 14.04.1935 leg. Á. Boros BP 118212 sub *B. bicolor*; **Bakony Mts** (8674.4): Kom. Fejér, Bakonycsernye, Friedhof, auf Erde 210 m, 22.07.2012 leg. Cs. Németh and P. Erzberger B (Erzberger 15586); **Balaton Uplands** (9072.4): Kom. Veszprém, Balatonoberland, Pécsely, Weg zwischen Kemencekút und Zádor-kút, Beton, Wegrand, N 46° 58' 10.0", E 17° 46' 44.4", 240 m, 12.07.2012 leg. B. Papp and P. Erzberger B (Erzberger 15490); **Sopron Mts** (8265.4–8365.2): Comit. Győr-Sopron, ad margines fossarum concreto firmatium inter vineas in declivibus orientalibus silvae Szárhalmi erdő, 200 m, 25.10.1978 leg. I. Galambos EGR sub *B. argenteum*; **Villány Mts** (0176.1): Comit. Baranya. In monte Harsányhegy prope Villány, 26.02.1927 leg. L. Vajda BP 42398 sub *B.*

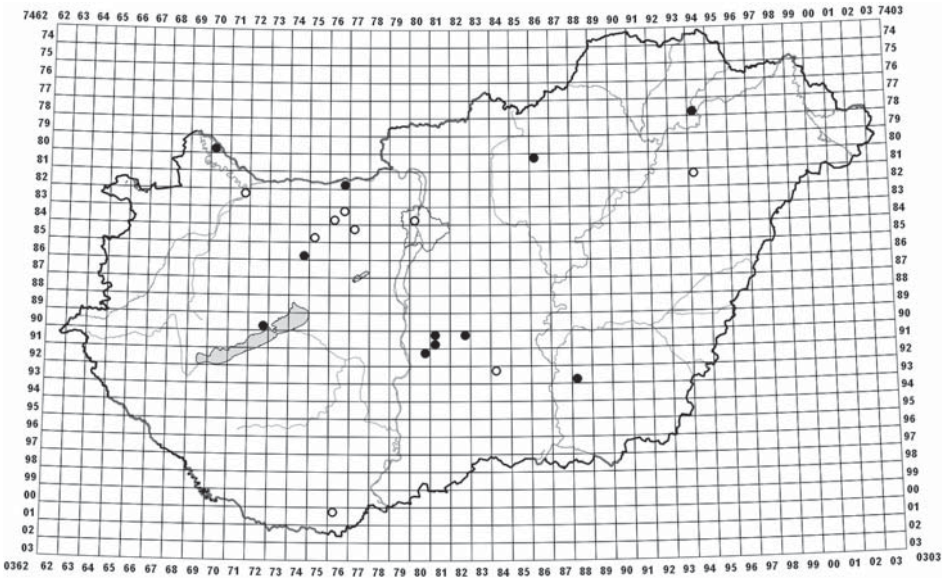

Fig. 71. Distribution of *Bryum subapiculatum*.

bicolor; **Kisalföld** (8371.2): Győr in incultis ad cimentum centrale, 22.04.1937 leg. S. Polgár BP 118211 sub *B. bicolor*; **Szigetköz** (8070.3): Com. Győr-Moson-Sopron, Szigetköz, Cikola, Görbe-Duna, kiesiges Ufer eines Donauarmes, 115 m, 27.06.1997 leg. P. Erzberger B (Erzberger 3352a); **Danube–Tisza Interfluve** (9181.3): Comit. Bács-Kiskun, in *Festucetum vaginatae* prope pag. Fülöpháza, 100 m, 18.07.1977 leg. M. Rajczy BP 164677 sub *B.* cf. *bornholmense*; **Tiszántúl** (9388.3): Csongrád county, near Szentes, at Lapistó lake, on alkali soil, 82 m, 04.03.2000 leg. B. Papp BP 169717 sub *B. ruderale*.

The presence of this species in Hungary was recognised only at the beginning of our revision (Schröder and Erzberger 2012). It is definitely still under-recorded. No red list status has been assigned, but LC appears appropriate.

Distribution in adjacent countries: A, RO, SLO, SRB, UA (reported from mainland Ukraine and Crimea, but not from the Carpathian part).

Literature: Apart from Schröder and Erzberger (2012), no other literature reports are known to us.

Bryum tenuisetum Limpr.
(Figs 72, 73)

Dioicous or synoicous, sporophytes not infrequent (not seen in Hungarian material). **Plants** to 1 cm tall, greenish or pale reddish, growing in lax turf or as solitary plants, deep red; rhizoids red-brown, weakly papillose, young rhizoids pinkish or pale yellow**. Rhizoidal tubers** yellowish to orange, spherical or irregular in shape, sometimes oblong, 100–200 μm long; tubers often sparse in fruiting plants. **Leaves** evenly arranged along stem, but young plants with comal tuft, leaves elongate lanceolate, taut, gradually acuminate; margin distinctly denticulate in upper third of leaf, (similar to a *Pohlia*, but distinguished by excurrent costa), margin plane or weakly recurved; costa red, sometimes very wide, to 100 μm at leaf base, excurrent as sharply dentate apiculus. **Laminal cells** 60–80(–120) × 12–15 μm, often rather incrassate; margin with few rows of more elongate cells, not forming distinct border. **Seta** 2–2.5 cm, dark red. **Capsule** pendulous, 1.2–2 mm long, ovate cylindrical, contracted below mouth when dry, red or red-brown when ripe. **Endostome** cilia appendiculate. **Spores** 12 μm, smooth.

Similar species: *B. demaretianum*: rhizoidal tubers in clusters, numerous, small (*ca* 100 μm), pyriform, few-celled; laminal cells to 80 μm long, plants to 0.5 cm tall, dioicous, sporophytes unknown (*B. tenuisetum*: gemmae spherical not in clusters, to 200 μm, laminal cells to 120 μm long, plants to 1 cm tall, often synoicous and therefore with sporophytes; leaves taut due to the very strong costa).

Since *B. demaretianum* and *B. tenuisetum* often grow in close association and their leaf shape is hardly different, further research is necessary.

B. subapiculatum: leaf margin weakly denticulate above, awn weakly denticulate or smooth; tubers red to red-brown (*B. tenuisetum*: leaf margin sharply denticulate above; tubers yellowish).

For the differences between *B. tenuisetum* and *B. gemmilucens*, see the note under the latter species.

References: Demaret (1993): 163–165, Nyholm (1993): 209–210, Ahrens (2001): 94–95, Guerra *et al.* (2010): 155–157, 163.

Habitat: margin of ditches, wet places in arable fields or meadows.

Substrate: moist base-rich soil, wet sand poor in lime, clay.

Vertical distribution: 240 m a.s.l.

Distribution in Hungary: doubtfully recorded from Hungary. **Őrség** (8666.1): [Comit. Vas] Tömörd: Kis tónál lévő fenyves előtt vízlevezető árok fenekén (with a hand-written note inside: A *Riccia* bizonyára *glauca*, Boros [The *Riccia* probably is *glauca*, Boros]), 15.10.1930 leg. A. Visnya BP 118104 sub *B. murale*.

This collection contains mainly *B. dichotomum* and some other bryophytes (*Riccia glauca*, *Pottia truncata* c. spg., *B. argenteum*), but there are a few reddish

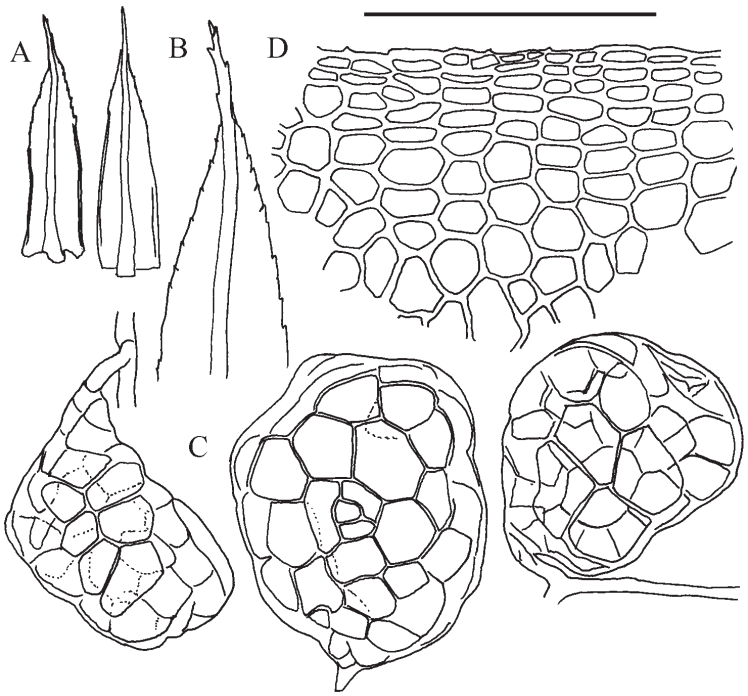

Fig. 72. *Bryum tenuisetum*. A = leaves; B =leaf apex; C = rhizoidal tubers; D = exothecial cells at capsule mouth. Scale bar: A: – 2 mm; B: – 800 μm; C, D: – 200 μm. [Schröder s.n. (Germany: Alstätte 3807.1), del. Erzberger].

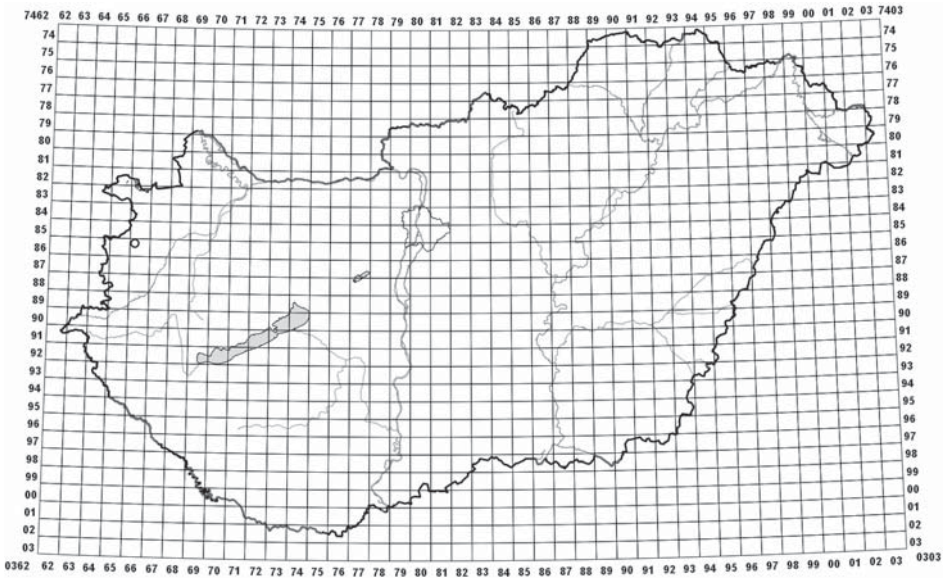

Fig. 73. Distribution of *Bryum tenuisetum*.

(typical colour!) plants of a *Bryum* that could well be *B. tenuisetum*, and there are yellow rhizoidal tubers in the substrate. The growth site ("on the bottom of the ditch in front of the pine forest at the Small Lake") seems to fit well the ecological needs of *B. tenuisetum*. This would qualify for a first record of *B. tenuisetum* in Hungary, if only the material was not so very sparse. In the Red data book of European bryophytes, the species is listed as insufficiently known (K) (ECCB 1995). No red list status in Papp *et al.* (2010), but DD would appear correct.

Distribution in adjacent countries: A, SK, UA (only mainland, not Carpathian part).

Literature: To our knowledge, this species has hitherto not been mentioned in the bryological literature of Hungary.

Bryum torquescens Bruch et Schimp.
(Figs 74, 75)

Synoicous, mostly with sporophytes (in 40% of specimens seen). **Plants** 1–2 cm tall, growing in dense, green, red-tinged turf; rhizoids light brown, finely to coarsely papillose. Brown-red spherical **rhizoidal tubers**, *ca* 200 μm, with non-protuberant cells, usually present. **Leaves** erectopatent when moist, slightly spirally twisted when dry, elongate-ovate, often concave, evenly tapering, denticulate at apex; margin plane or recurved; costa excurrent as curved apiculus.

Laminal cells 60 × 20 μm, unistratose border of 2–4 rows of elongate, narrow, slightly incrassate marginal cells distinct, yellowish. **Seta** 2–4 cm long. **Capsule** cernuous, to 5 mm long, dark red when ripe. **Endostome** cilia appendiculate. **Spores** 12–15 μm, smooth.

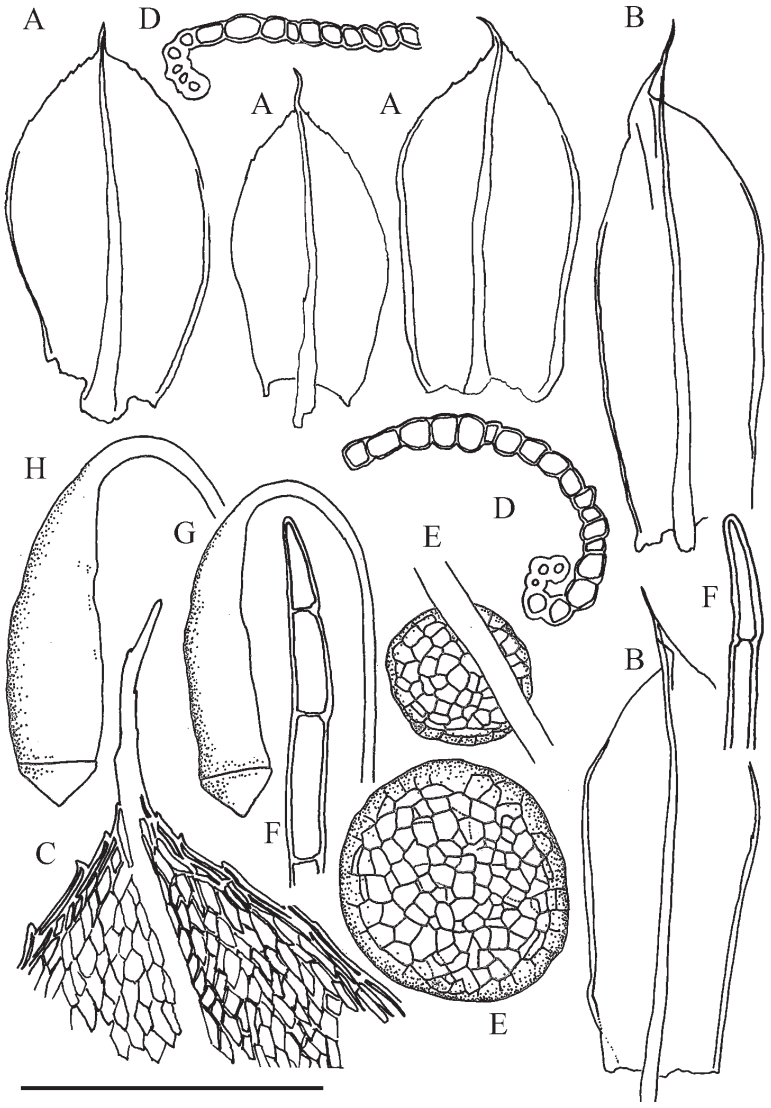

Fig. 74. *Bryum torquescens*. A = leaves; B = comal leaves; C = leaf apex; D = cross sections of leaf margin; E = rhizoidal tubers; F = paraphyses near antheridia (in synoicous inflorescence), apical part; G, H = capsules (dry/ moist). Scale bar: A, B: – 2 mm; C, E: – 400 μm; D, F: – 200 μm; G, H: – 4 mm. [A, C, D: Erzberger 396; B, F: BP 117893; E, G, H: BP 88604, del. Erzberger].

Note: The end cell of paraphyses of *B. torquescens* is described and illustrated as sharply pointed in some floras (Nyholm 1993, Guerra *et al.* 2010), as opposed to the usually truncate or rounded end cells in other species. However, also in *B. capillare* the end cell of male paraphyses is pointed to some extent, and the difference to *B. torquescens* is very slight. (See also the note under *B. capillare*).

Similar species: *B. capillare*: capsules brown, often slightly curved and weakly gibbous; plants dioicous (*B. torquescens*: capsules dark red when ripe, straight; plants synoicous). Dark red rhizoidal tubers occur in both species, but more frequently in *B. torquescens*.

For the differences between *B. torquescens* and *B. donianum*, see the note under the latter species.

References: Demaret (1993): 181–183, Nyholm (1993): 186–187, Ahrens (2001): 95–97, Guerra *et al.* (2010): 130–133.

Habitat: saline pastures, calcareous grasslands, grasslands over volcanic bedrock.

Substrate: sand, soil in saline pastures, calcareous soil.

Associated bryophytes: none.

Vertical distribution: 90–300 (mean 187) m a.s.l.

Distribution in Hungary (10 specimens, 10 grid cells, of which 3 represent recent finds): **Börzsöny Mts** (8279.2): Com. Pest, Nagymaros, Templomvölgy, 230 m, 07.04.1993 leg. P. Erzberger B (Erzberger 396); **Balaton Uplands**

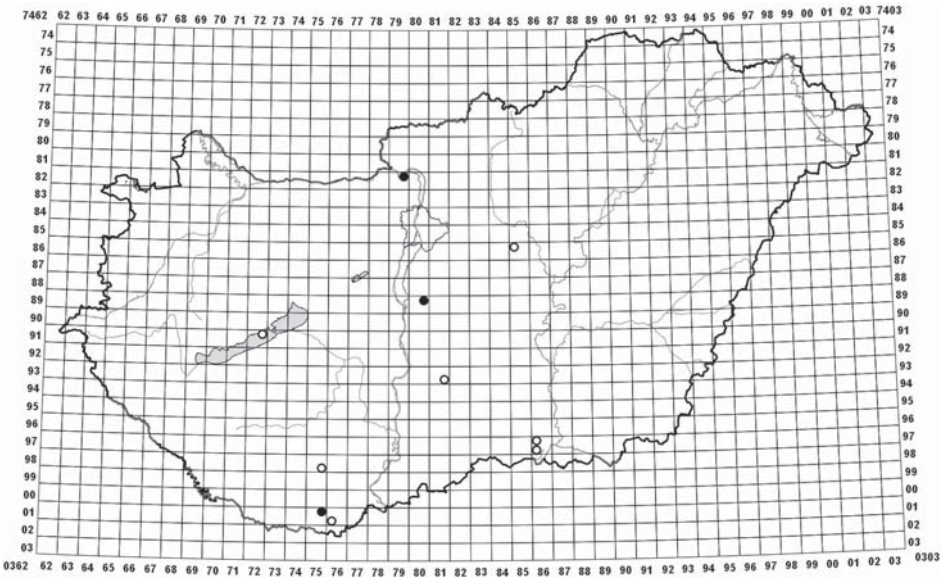

Fig. 75. Distribution of *Bryum torquescens*.

(9172.2): Comit. Veszprém (olim Zala), in graminosis saxosis ad viam publicam pr. stat. ferroviae Kiliántelep (olim Antaltelep), 06.05.1952 leg. L. Felföldy BP 117893 sub *B. caespiticium*; **Mecsek Mts** (9875.4): Pécs, a Bertalan-hegytől délre húzódó gerincen, mészkőn, 11.08.1931 leg. A. Visnya BP 118458; **Villány Mts** (0175.2): Comit. Baranya. In rupestribus in decl. merid. montis Tenkes ad Kövesmáj prope pag. Máriagyüd, 300 m, 02.05.1999 leg. B. Papp BP 166640; **Danube–Tisza Interfluve** (8980.2): Comit. Bács-Kiskun, in natronatis ad Apajpuszta prope pag. Dömsöd, 100 m, 13.04.1982 leg. M. Rajczy BP 164840.

The apparent rarity of *B. torquescens* in Hungary is not well understood, since the calciphilic and thermophytic species can colonise also disturbed habitats. Its occurrence in saline grasslands is remarkable and suggests some kind of halotolerance. The species is redlisted in most Central European countries. Red list status: VU (Papp *et al.* 2010). See also the note added in proof (p. 192).

Distribution in adjacent countries: HR, RO, SLO, SRB.

Literature: The localities enumerated in Boros (1953, 1968) and Orbán and Vajda (1983) are confirmed; additional regions (see above enumeration): Börzsöny Mts and Balaton Uplands.

Three records out of four published in Papp and Rajczy (1999) are based on specimens confirmed by our revision (no specimen was located for Dunatetétlen: Böddiszék).

Bryum turbinatum (Hedw.) Turner
(Figs 76, 77)

Dioicous, occasionally with sporophytes (seen in nearly 50% of specimens). **Plants** 1–2 cm tall, dirty green or dirty red, but mostly red or reddish tinged, especially young plants; growing solitary or in lax turf; rhizoids pale brown, weakly to strongly papillose-verrucose, papillae 1–2 μm in diameter. **Leaves** erectopatent to horizontal when moist, erect and slightly flexuose when dry, narrow, from ovate base triangular tapering to acute apex, taut, keeled; leaf base lacking red (concolorous); margin sometimes denticulate above, not recurved; costa very stout, brownish to red-brown, percurrent or shortly excurrent. **Laminal cells** lax, thin-walled, 40–50 × 16–20 μm; margin with 1–2 rows of more narrow cells that form a somewhat inconspicuous unistratose or towards middle of leaf bistratose border; cells at leaf base quadrate to rectangular, not or very narrowly decurrent. **Seta** 1.5–4 cm long, reddish brown. **Capsule** cernuous or pendulous, 2–3 mm long, pyriform, pale yellow when young, light to dark brown when ripe, strongly turbinate when dry and empty; exothecial cells below capsule mouth in 2 rows very narrow horizontally rectangular, followed by 5–8 rows of isodiametric incrassate cells. **Exostome** yellowish, **endostome** segments above with narrow per-

forations, with ovate perforations below; cilia appendiculate. **Spores** 15–20 μm, finely papillose.

Note: *B. turbinatum* can be recognised by its small size, the red-brownish coloration of the plants, and, when present, the turbinate capsules. The contraction of the capsule below the mouth is not developed until the capsules are ripe or have shed their lid, but even earlier the diagnostic isodiametric incrassate cell rows below the capsule mouth can be seen.

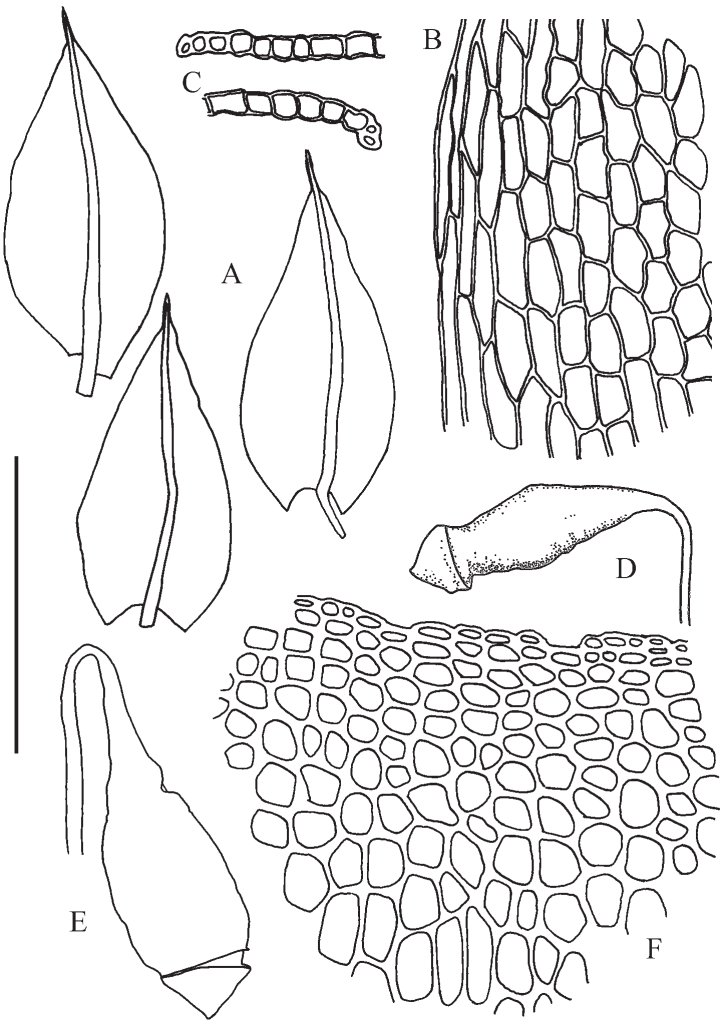

Fig. 76. *Bryum turbinatum*. A = leaves; B = leaf margin; C = cross sections of leaf margin; D, E = capsules (dry/moist); F = exothecial cells at capsule mouth. Scale bar: A: – 2 mm; B, C, F: – 200 μm; D, E: – 4 mm. [EGR Vajda 1938 (Kallók völgye/Mátra), del. Erzberger].

Similar species: Non-fruiting plants of *B. turbinatum* are similar to *B. pallens* due to their reddish colour. Leaf shape, marginal border, areolation, and costa thickness, however, are different: *B. pallens*: leaves ovate-lanceolate; margin strongly recurved from base to apex; marginal border of elongate cells distinct, often bistratose; laminal cells wider (to 25 μm) and areolation more lax; costa less stout, 80–90 μm thick at leaf base (*B. turbinatum*: leaves triangular-lanceolate; margin plane; marginal border indistinct, mostly unistratose, mostly only one row of elongate cells; laminal cells to 20 μm, rectangular below mid-leaf; costa stouter, 100–120 μm thick at leaf base).

B. schleicheri: plants always yellowish green, var. *latifolium* to 10 cm tall; leaves broadly ovate, concave; laminal cells 50–80 × 18–22 μm (*B. turbinatum*: plants reddish, to 2 cm tall; leaves lanceolate acuminate; laminal cells 40–50 × 16–20 μm).

B. pseudotriquetrum: leaves with border of up to 5 rows of narrow cells; border distinctly decurrent; laminal cells rhombic, areolation reticulate; capsule hardly contracted below mouth (*B. turbinatum*: border of narrow cells often very narrow, hardly decurrent; laminal cells near rectangular below mid-leaf, areolation lax; capsule turbinate, distinctly contracted below mouth).

References: Limpricht (1895): 436–437, Demaret (1993): 234–236, Nyholm (1993): 179–180, Ahrens (2001): 97–98, Guerra *et al.* (2010): 115–117.

Habitat: in moist meadows, at ditches and streams, in abandoned quarries and sand pits (beside streams, on moist walls at mills, moist andesitic rocks at streams, moist meadows beside streams, swamps, on pieces of concrete in a river, on moist calcareous soil in car tracks in a road).

Substrate: moist, mostly calcareous soil, wet sand and gravel.

Associated bryophytes: *Brachythecium populeum*, *B. rutabulum*, *B. velutinum*, *Cratoneuron filicinum*, *Dicranella varia*, *Didymodon spadiceus*, *Hypnum cupressiforme*, *Pellia endiviifolia*, *Philonotis tomentella*, *Pohlia melanodon*.

Vertical distribution: 140–450 (mean 270) m a.s.l.

Distribution in Hungary (18 specimens, 13 grid cells, of which 2 represents recent finds): **Mátra Mts** (8084.4): Comit. Heves. In petrosis alvei rivi Csevicepatak prope pagum Tar, 220 m, 06.05.1928 leg. Á. Boros BP 117295; **Gödöllő Hills** (8381.2): Comit. Pest. In muris irrigatis calcar. molae "Középső-malom" prope Veresegyház, 160 m, 02.10.1949, leg. Á. Boros BP 7650; **Börzsöny Mts** (8079.2): Comit. Nógrád. In rupibus irrigatis rivi Rózsáspatak prope Királyháza, montes Börzsöny, 03.06.1957 leg. L. Vajda BP 57570; **Visegrád Mts** (8279.2–4 or 8280.1–3): Comit. Pest. In rupibus andesit. silvat. vallis Apátkúti-völgy prope Visegrád [with a note reading "Piros" = red], 250 m, 10.06.1946 leg. Á. Boros BP 117296; **Buda Mts** (8379.3): Com. Pest. Pilisszentiván, az Egyeskő alatti patak mocsaraiban, 200 m, 30.09.1917 leg. Á. Boros BP 117298; **Gerecse**

Mts (8476.1): Comit. Komárom. In locis irrigatis ad molam Lapatár-malom prope pagum Bánhida, 140 m, 10.05.1942 leg. Á. Boros BP 117302; **Vértes Mts** (8576.2): Comit. Komárom. Ad ripas rivulorum Mocsár-rét versus Kapberek-puszta pr. Vértessomló, 310–320 m, 19.05.1935 leg. Á. Boros BP 117300; **Bakony Mts** (8872.4): Comit. Veszprém. In muris irrigatis calc. molae Eklézsia-malom ad Herend, 350 m, 23.10.1949 leg. Á. Boros BP 117288; (8873.4): Veszprém-Gyulafirátót, am Rand der Fischteiche, 190 m, 14.07.2012 leg. P. Erzberger, Cs. Németh and B. Papp, B (Erzberger 15545) sub *B. pallens*; **Balaton Uplands** (9170.2): Veszprém County. On rock at Malom-tó lake at Tapolca, 100 m, 13.10.2001 leg. B. Papp BP 168515 sub *B. pallens*; **Zala** (9167.3): Zalaegerszeg, az 1949 évszámot viselő áteresz előtt az 1945-ben felrobbantott vasut-áteresz vízben heverő betondarabján, 150 m, 23.04.1953 leg. F. Czeglédi BP 117184 sub *B. pallens*; **Mecsek Mts** (9875.2): Budafa, Rákósi-völgy, elárasztott kocsiúton (in pencil: Kalk, zeitweise überschwemmt), 26.07.1932 leg. A. Visnya BP 117291.

Frequency and distribution in Hungary of *B. turbinatum* at first glance appear similar to those of *B. pallens*, which is remarkable, since in other Central and even more so in Western European countries, *B. turbinatum* is much rarer than *B. pallens* and seems to be also more endangered (Lockhart *et al.* 2012, Crundwell in Hill *et al.* 1994: 88–89, Meinunger and Schröder 2007). However, this may not completely reflect the true frequency of *B. turbinatum*, since it has been often misidentified. Only by continuing exploration of the Hungarian bryoflora

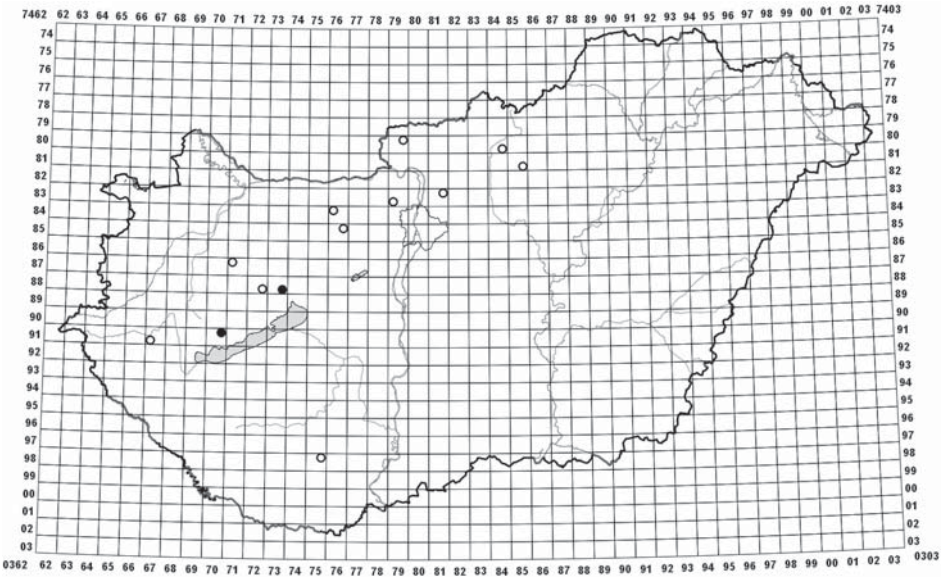

Fig. 77. Distribution of *Bryum turbinatum*.

this issue may be resolved. Red list status: DD (Papp *et al.* 2010), suggested status: at least VU (compare *B. pallens*).

Distribution in adjacent countries: A, HR, RO, SK, SLO, SRB, UA.

Literature: For three of the nine regions listed in Boros (1953) there are no supporting specimens: Bükk Mts (BP 117294 Szalajka spring: revised to *B. pseudotriquetrum*), Kőszeg Mts (no specimen found), and Danube–Tisza Interfluve (BP 117289 on alkali soil at Kunszentmiklós, questioned already by Podpera, cannot be named with certainty since only juvenile sporophytes are present). These reports should therefore be treated with reservation until appropriate material turns up. In Boros (1968) the Bükk Mts and the Danube–Tisza Interfluve are considered doubtful. These areas are omitted in Orbán and Vajda (1983). In addition to the regions correctly listed in the above works, we now report *B. turbinatum* also from the Gödöllő Hills, Gerecse Mts, Balaton Uplands, and Zala.

In Papp and Rajczy (1999) two records are reported for the Danube–Tisza Interfluve. However, one of them (Kunszentmiklós BP 117289) could not be confirmed in our revision (see above), and for the other one (Szeged, Ruzsaszék) no specimen could be located. Therefore the presence of *B. turbinatum* in the Danube–Tisza Interfluve remains yet to be established.

Bryum uliginosum (Brid.) Bruch et Schimp.
[= *B. cernuum* (Hedw.) Bruch et Schimp.]
(Figs 78, 79)

Autoicous, usually with sporophytes (seen in the Hungarian specimen). **Plants** 0.5–2(–3) cm tall, growing in lax patches, green to brown-green, without red coloration; rhizoids light brown, finely verrucose-papillose. **Leaves** ovate-lanceolate, acuminate, plane, leaf base concolorous (not red); margin entire and recurved only below, ± denticulate above, not decurrent; costa red-brown, excurrent in a short apiculus. **Laminal cells** 60–80 × 20–25 μm, marginal cells very long, narrow and incrassate, forming yellowish distinct, often bistratose border. **Seta** conspicuously long (to 5 cm). **Capsule** cernuous to inclined, *ca* 6 mm long, narrowly ellipsoid, slightly curved, gibbous, narrow-mouthed, brown when ripe. **Endostome** with oval perforations; cilia rudimentary. **Spores** 24–28(–32) μm, finely papillose.

Similar species: *B. pallens* and *B. uliginosum* are closely related; however, *B. pallens* is much more frequent. *B. pallens*: dioicous, seta 2–3 cm long, capsule broadly pyriform (*B. uliginosum*: autoicous; seta to 5 cm long; capsule narrowly ellipsoid).

For the differences between *B. uliginosum* and *B. archangelicum*, see the note under the latter species.

References: Limpricht (1895): 323–325, Demaret (1993): 231–233, Nyholm (1993): 178, Ahrens (2001): 98–99, Meinunger and Schröder (2007) 3: 29–30, Guerra *et al.* (2010): 117–119.

Habitat: *B. uliginosum* is a calciphilic species that usually grows in fens, old quarries and beside ditches. In Hungary, it was found near a spring in a moist forest valley (Boros 1915–1971).

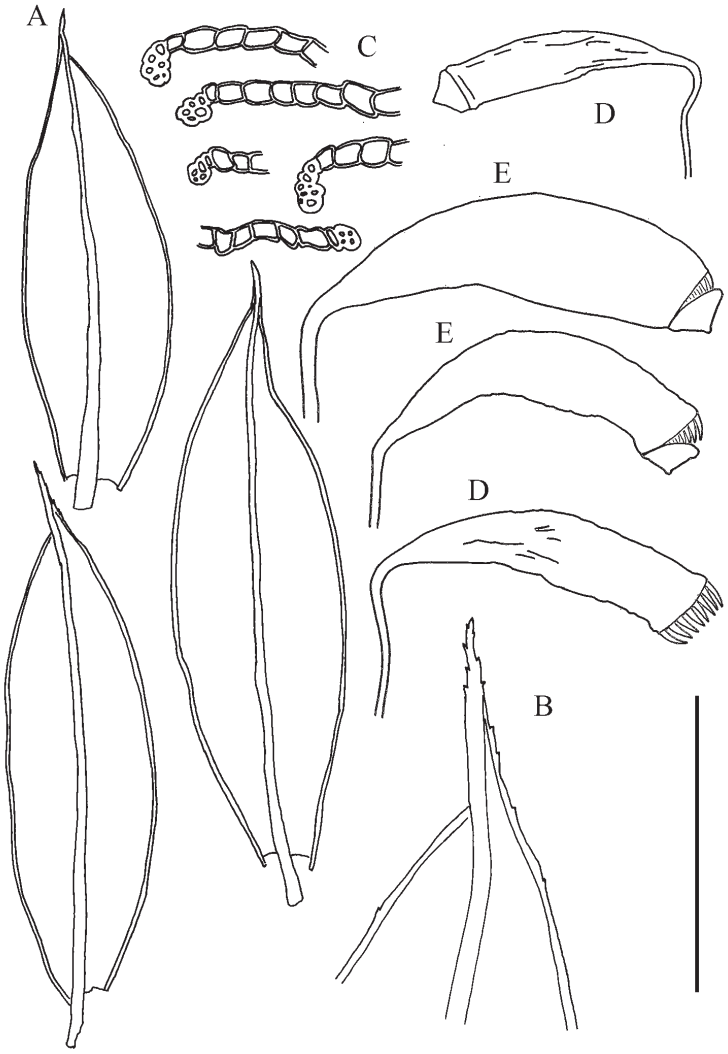

Fig. 78. *Bryum uliginosum*. A = leaves; B = leaf apex; C = cross sections of leaf margin; D, E = capsules (dry/moist). Scale bar: A: – 2 mm; B: – 800 μm; C: – 200 μm; D, E: – 4 mm. [BP 116864, del. Erzberger].

Substrate: loamy soil.

Associated bryophytes: none.

Vertical distribution: 200 m a.s.l.

Distribution in Hungary (1 specimen, 1 grid cell, representing an old find): **Vértes Mts** (8576.1): Comit. Komárom. In locis humidis silvat. ripae rivi vallis Bodony-völgy prope Oroszlány, versus fontem Buger-kút, 200 m, 21.06.1937 leg. Á. Boros BP 116864 sub *B. inclinatum* var. *laubacense* Roth det. Podpera.

The population of *B. uliginosum* is most likely extinct at the only confirmed site in Hungary. Since the time of collection of the specimen in 1937, important habitat qualities have probably undergone severe changes. The species requires open vegetation on moist, calcareous substrates, therefore progress in succession possibly has rendered the habitat unsuitable by shading. Drainage and eutrophication, generally observed in the landscape, could also have led to habitat deterioration. The species has a widespread, but scattered distribution in Europe, and during the past 100 years there has been a dramatic decline in many countries (Crundwell in Hill *et al.* 1994: 87, Church *et al.* 2001, Lockhart *et al.* 2012). It is therefore redlisted in most European countries, and mostly in the most endangered categories, if not extinct. It is listed as RT (regionally threatened) in the Red data book of European bryophytes (ECCB 1995). Red list status in Hungary: DD (Papp *et al.* 2010).

Distribution in adjacent countries: A, RO, SK, SLO, SRB, UA.

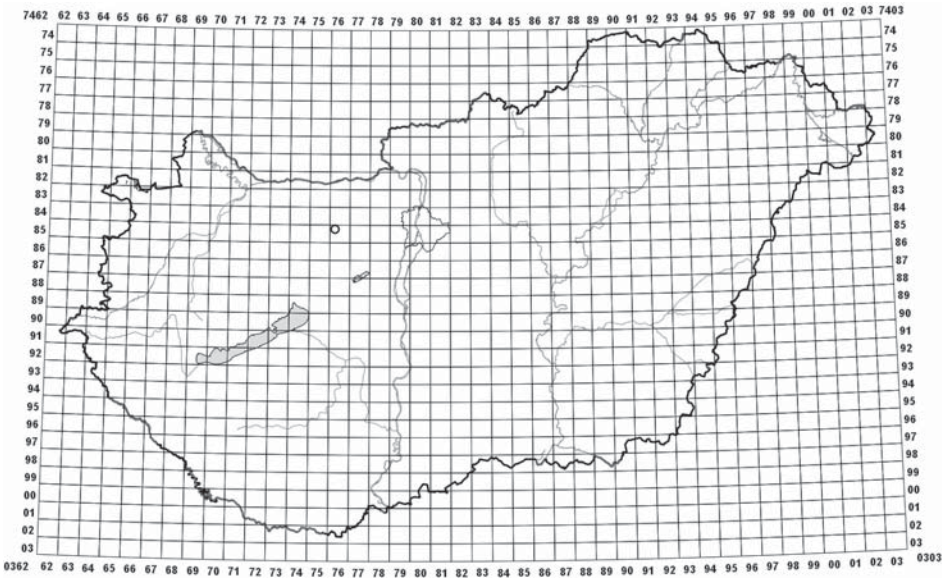

Fig. 79. Distribution of *Bryum uliginosum*.

Literature: Szepesfalvi (1941), Boros (1953, 1968), Orbán and Vajda (1983) report a single occurrence (Pest Plain: Szigetszentmiklós) based on a report by Förster (Szepesfalvi 1941: "Spärlich bei Szigetszentmiklós, 102 m, Först."), for which no specimen could be traced and that must therefore be considered doubtful.

The only confirmed locality of *B. uliginosum* (see specimen above) is in the west of the Vértes Mts, where many streams originating in the underground of the dolomitic hills flow through areas covered by sand (Boros 1968). In this area, some of the richest calcareous fens of Hungary were in good condition during the first half of the 20th century with *Tomentypnum nitens*, *Palustriella commutata*, *Campylium stellatum*, as is seen in many specimens in the Hungarian bryophyte collections. From the same area (Mocsár-berek near Oroszlány) Boros (1968: 133) mentions a *Bryum* closely related to *B. uliginosum* that Podpera had at some time thought to be a new species ("*B. danubiale*"), for which, however, no specimen could be traced.

Bryum veronense De Not.
[= *B. argenteum* subsp. *veronense* (De Not.) J. J. Amann, *B. argenteum* var. *veronense* (De Not.) Molendo]

References: Limpricht (1895): 418–419, Nyholm (1993): 218–219, Hill *et al.* (2006): 217, 238, Meinunger and Schröder (2007) 3: 52.

Note on taxonomic status: The identity of *B. veronense* is unclear. Nyholm (1993) treats it as a taxon closely related to *B. argenteum*. According to Hill *et al.* (2006: Note 279), some of the material placed under the name *B. veronense* in herbaria consists of plants that intergrade with *B. argenteum* (e.g. with respect to the chlorophyllose leaf tips). Other specimens could be depauperate forms of other species, e.g. *B. pallens*.

For this reason we refrain from giving a description.

Distribution in Hungary: excluded from Hungary.

Distribution in adjacent countries: A, SK. This may not reflect the real distribution, since in some checklists the taxon is included in *B. argenteum*.

Literature: *B. veronense* is reported from one site in the Börzsöny Mts in Boros (1968) (as subsp. of *B. argenteum*) and in Orbán and Vajda (1983). The two specimens in BP (BP 57956 and BP 118573) were already revised to *B. argenteum* by B. Papp (see Erzberger and Papp 2004). A third specimen in EGR was also revised to *B. argenteum*: Börzsöny Mts (8079.2): Comit. Nógrád. In rupibus irrigatis rivi Rózsapatak prope Királyháza, montes Börzsöny, 03.06.1957 leg. L. Vajda EGR sub *B. veronense*. Therefore, *B. veronense* is excluded from the Hungarian bryoflora, as it had been already in Erzberger and Papp (2004).

Bryum versicolor A. Braun ex Bruch et Schimp.
[= *B. excurrens* Lindb.]
(Fig. 80)

Dioicous, but often with sporophytes. **Plants** 0.5–1 cm tall, growing solitary or in lax turf, greenish to dark red; rhizoids light brown, finely papillose. **Leaves:** very taut and straight, from ovate base longly and evenly acuminate, leaf base red; leaf margin entire, recurved to apex; costa red, excurrent as 200–300 mm long, denticulate apiculus. **Laminal cells** 50–60 × 10–14 μm, hardly narrower at margin. Very large solitary foliate **bulbils** in leaf axils, to 500(–600) μm long, easily detached and often only found in the substrate, leaf primordia very well developed, with visible costa, in upper half or upper two thirds of bulbil, lower, turnip-like part of bulbil half as wide as upper half with patent leaf primordia. **Seta** 1–2.5 cm, brown. **Capsule** pendulous, short, thick, abruptly narrowed to seta, firmly appressed to seta, not contracted below wide mouth when empty, light brown when ripe. **Endostome** yellow, cilia appendiculate. **Spores** 10–12 μm, smooth or nearly so.

This species belongs to the *B. dichotomum* complex; it is easily recognised in the field by its capsules appressed to the seta and by the very large bulbils.

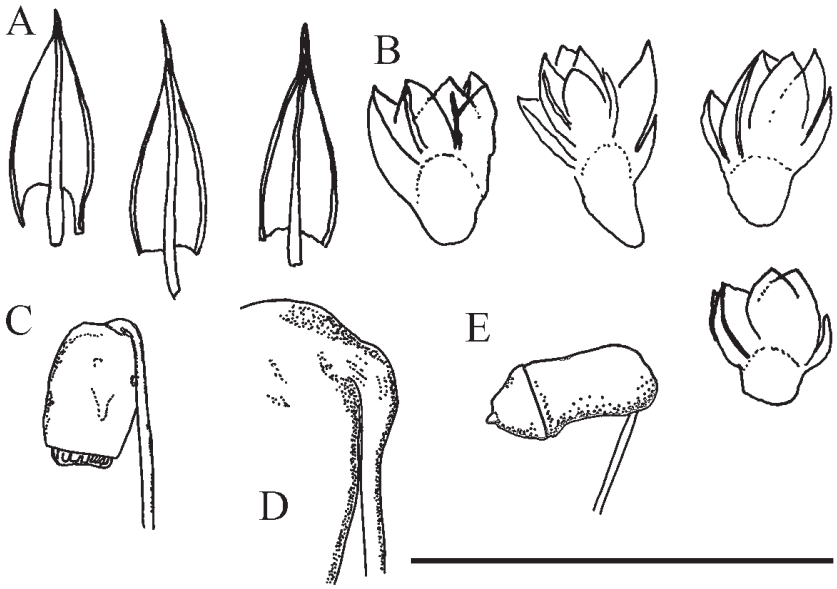

Fig. 80. *Bryum versicolor*. A = leaves; B = bulbils; C, E = capsules (dry); D = part of capsule with attachment of seta. Scale bar: A: – 2 mm, B: – 800 μm, C, E: – 4 mm, D: – 1.6 mm. [A, B: BP 117293 (Croatia), C: Meinunger s.n. (Germany: 8335.3), D: Lotto s.n. (Germany: 8432.4), E: Schröder s.n. (Germany: 8627.2 Oberstdorf leg. M. Reimann), del. Erzberger].

Similar species: *B. dichotomum*: capsule cernuous or pendulous; bulbils in leaf axils 1–3, usually < 500 μm (*B. versicolor*: capsule appressed to seta, only very old capsules may be cernuous; bulbils very large, solitary, easily detached).

References: Limpricht (1895): 403–405, Demaret (1993): 205–207, Nyholm (1993): 216–217, Ahrens (2010): 99–100.

Note on taxonomic status: Holyoak (2003) synonymised *B. versicolor* with *B. dichotomum*. However, we consider it as a taxon in its own right, with characteristic features of the sporophyte (seta appressed to capsule) and a particular ecological profile and habitat (Meinunger and Schröder 2007).

Habitat: on sandy flat river banks, occasionally on frequently inundated sites in the mountains; calciphilic.

Substrate: moist, coarse calcareous sand or riparian gravel.

Distribution in Hungary: excluded from Hungary.

Distribution in adjacent countries: A, HR (Erzberger and Schröder 2013), SLO.

Literature: Szepesfalvi (1941) quotes an old literature report: Schilberszky (1889) "Zwischen Schotter neben dem Izbéger Bach" (Szentendre), which, however, without specimen, must be considered at least doubtful. This report is repeated in Boros (1953, 1968), but the species is missing in Orbán and Vajda (1983), Erzberger and Papp (2004), and Papp *et al.* (2010).

As in similar cases (*B. barnesii*, *B. cyclophyllum*), until appropriate material turns up, we consider this species as not recorded from Hungary.

Since *B. versicolor* has been collected in Croatia close to the Hungarian border [(9664.3): Comit. Zala. In arenosis humidis ripae fluvii Dráva ad Zrínyifalva, adv. Varasd 160 m, 13.08.1943 leg. Á. Boros BP 117293 sub *B. turbinatum* (original determination by Podpera "stat. juven.? ♀") – in fact the growth site belonged to Hungary at the time of collection] it seems possible that it could be found also within the present borders of Hungary.

Bryum violaceum Crundw. et Nyholm
(Figs 81, 82)

Dioicous, sporophytes rare (not seen in Hungarian material). **Plants** 0.5–1 cm tall, female plants with comal tuft, taut, to 1 cm tall, sterile plants very delicate, flaccid, to 0.5 cm tall, light green, in lax turf or solitary among other mosses; older rhizoids reddish, young rhizoids pale violet, finely papillose. **Rhizoidal tubers** always numerous, 70–80 μm, spherical, yellowish or orange, with non-protuberant cells. **Leaves** evenly arranged along stem, crowded in comal tuft (in female plants), erectopatent when moist, flexuose when dry, elongate lanceolate, margin slightly denticulate at apex, widely recurved; costa very stout, to 100 μm

wide at leaf base, excurrent as ± long apiculus. **Laminal cells** 40–50 × 8–12 μm, somewhat more elongate at margin, forming indistinct unistratose (or partly bistratose) border, shortly decurrent along stem. Sterile plants have ovate lanceolate leaves and margins plane or recurved below, costa vanishing in apex to shortly excurrent. **Seta** 1–2 cm long, reddish brown. **Capsule** pendulous, *ca* 2 mm long, obovate-elongate, red-brown. **Endostome** cilia appendiculate. **Spores** 9–11 μm, nearly smooth.

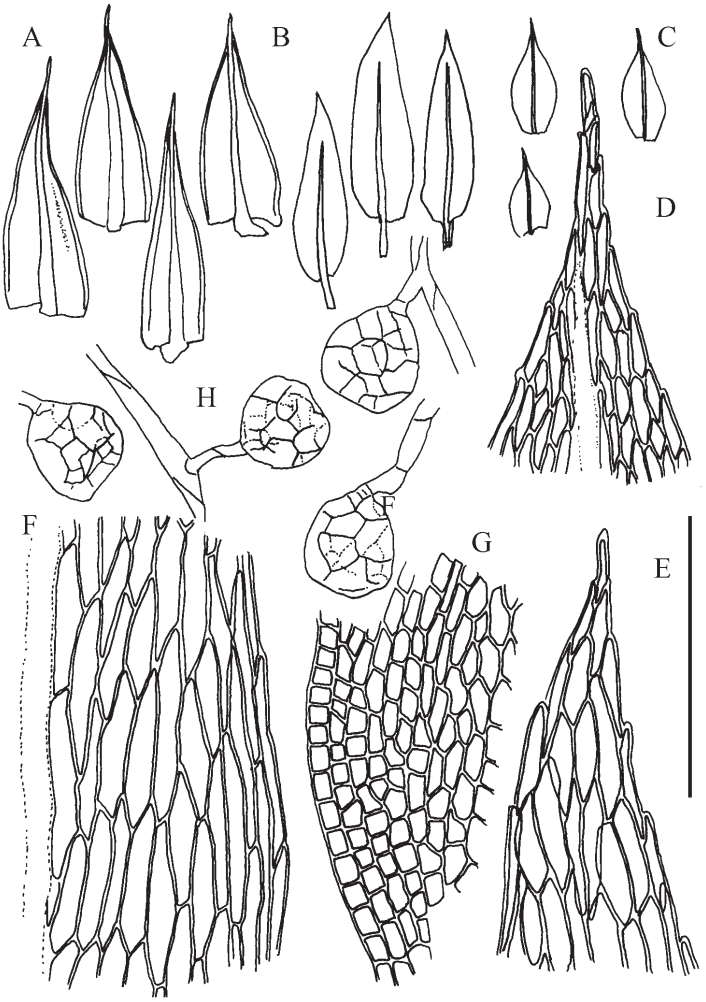

Fig. 81. *Bryum violaceum*. A = leaves of comal tuft; B, C = leaves of sterile plants; D, E = leaf apices; F = laminal and marginal cells; G = basal cells; H = rhizoidal tubers. Scale bar: A–C: – 2 mm; D–H: – 200 μm. [A: BP 114491, B, E, F, H: Erzberger 3043; C, D, G: Erzberger 15500, del. Erzberger].

Similar species: *B. klinggraeffii*: rhizoidal tubers intensely red, irregular in shape, with protuberant cells; rhizoids yellowish to brownish (*B. violaceum*: rhizoidal tubers regularly spherical, pale reddish or yellowish, cells not protuberant, rhizoids ± violet).

References: Crundwell and Nyholm (1964): 609–612, Demaret (1993): 165–168, Nyholm (1993): 207, Ahrens (2001): 100–101.

Habitat: in arable fields, on recently disturbed, weakly calcareous or neutral soil (in fallow fields, saline grassland, saline meadows at shore of alkaline lake, sandy loamy fields, forest road, near stream).

Substrate: sand, loose soil.

Associated bryophytes: *Bryum argenteum*, *B. dichotomum*, *B. rubens*, *B. subapiculatum*, *Entosthodon longicolle*, *Phascum cuspidatum* var. *piliferum*.

Vertical distribution: 95–500 (mean 168) m a.s.l.

Distribution in Hungary (14 specimens, 9 grid cells, of which 4 represent recent finds): **Börzsöny Mts** (8079.2): Com. Pest, Börzsöny-Geb., oberes Bachtal des Baches Kemence-patak, 500 m, 15.03.1997 leg. P. Erzberger and B. Papp B (Erzberger 3043); **Pilis Mts** (8380.3): Com. Pest. In agris argillosis meridie supra pago Pomáz, 180 m, 30.03.1947 leg. Á. Boros BP 118219 with *B. bicolor*; **Gerecse Mts** (8476.2): Com. Komárom. In argillosis Irtásföldek prope pag. Alsógalla, 220 m, 25.04.1948 leg. Á. Boros BP 118210 sub *B. bicolor*; **Bakony Mts** (8971.4): Kom. Veszprém, Bakony-Geb., Kab-hegy bei Nagyvázsony, Forstweg, N 47° 2' 47.7",

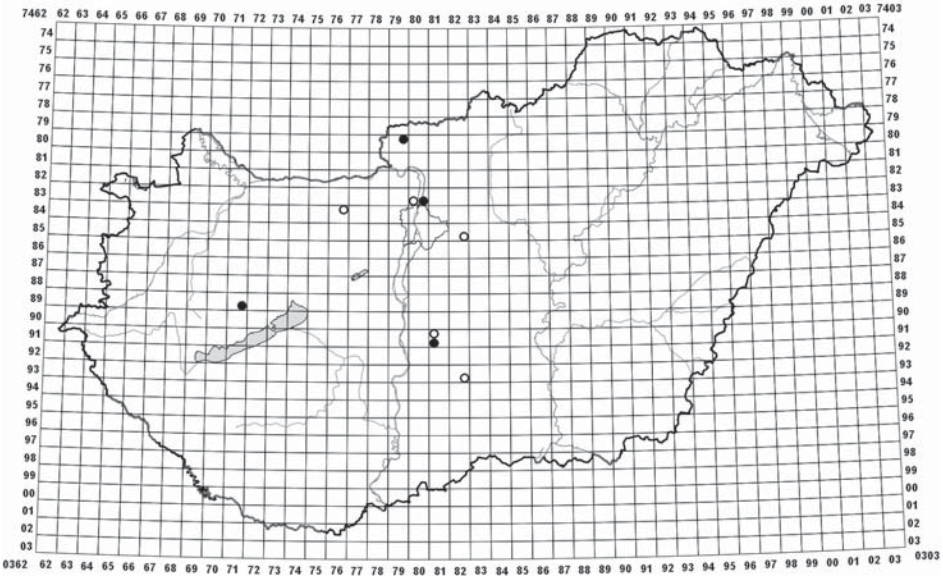

Fig. 82. Distribution of *Bryum violaceum*.

E 18° 36' 12.2", 400 m, 13.07.2012 leg. B. Papp and P. Erzberger B (Erzberger 15500); **Danube–Tisza Interfluve** (8582.4): Comit. Pest. In agris argillosoarenosis ad Gyömrő, 150 m, 22.03.1935 leg. Á. Boros BP 118215 sub *B. bicolor*; **Pest Plain** (8380.4): Com. Pest, Dunakeszi, fallow field, 100 m, 06.04.1993 leg. P. Erzberger B (Erzberger 385).

B. violaceum is probably much under-recorded. Red list status: LC-att (Papp *et al*. 2010).

Distribution in adjacent countries: A, SK, SRB, UA (mainland).

Literature: Zanten (1999) was the first to publish records of *B. violaceum* in Hungary. However, already in 1976 Demaret recognised the species as an admixture with *B. dichotomum* according to his annotation of the specimen (BP 118219: Pomáz). The record published in Papp and Rajczy (1999) is based on a confirmed specimen (BP 164607 Zabszék). For the records in Zanten (1999) no specimens were obtained upon request from EGR.

Bryum warneum (Röhl.) Brid.
(Figs 83, 84)

Autoicous (sporophytes seen in both specimens examined). **Plants** growing in short (0.5–1 cm tall) lax or dense, sometimes pale reddish tufts; rhizoids brown or grey-brown, coarsely papillose. **Leaves** crowded at stem apex in comal tuft, loosely imbricate when dry, slightly flexuose when moist, rounded ovate or ovate-lanceolate, shortly acuminate into fine, short or elongate, denticulate or smooth apiculus, leaf base not red, concolorous; margin entire or denticulate at apex, plane or recurved below; costa green to brownish, stout, ending in leaf apex or shortly (to 250 μm at most) excurrent. **Laminal cells** ± 20 μm wide, thin-walled, border of 2–3 rows of narrow, elongate cells only slightly more incrassate than laminal cells, narrow, locally bistratose, yellowish, distinct. **Seta** stout, usually long, 3–6 cm. **Capsule** pendulous or cernuous, 2.5–4 mm long, broadly pyriform, narrow-mouthed, yellowish to dark brown; lid high, conical. **Exostome** with oblique cross-walls between lamellae, partly joined to endostome, hyaline apical part of exostome often conspicuously coarsely papillose, appearing pebbly, with hemispherical to conical papillae 2–3 μm wide at their base. **Endostome** yellowish, segments with very narrow slit-like perforations, cilia short or sometimes longer, slightly nodose. **Spores** usually 30–45 μm, finely papillose.

Similar species: *B. algovicum* also has oblique cross-walls between lamellae of exostome teeth, however in that species the endostome is adherent to the exostome in its total length, the perforations of the endostome processes are wide, ovate, not slit-like; spores normally 35 μm at most; plants usually synoicous; costa excurrent in apiculus often > 300 μm, margin unistratose, recurved nearly from

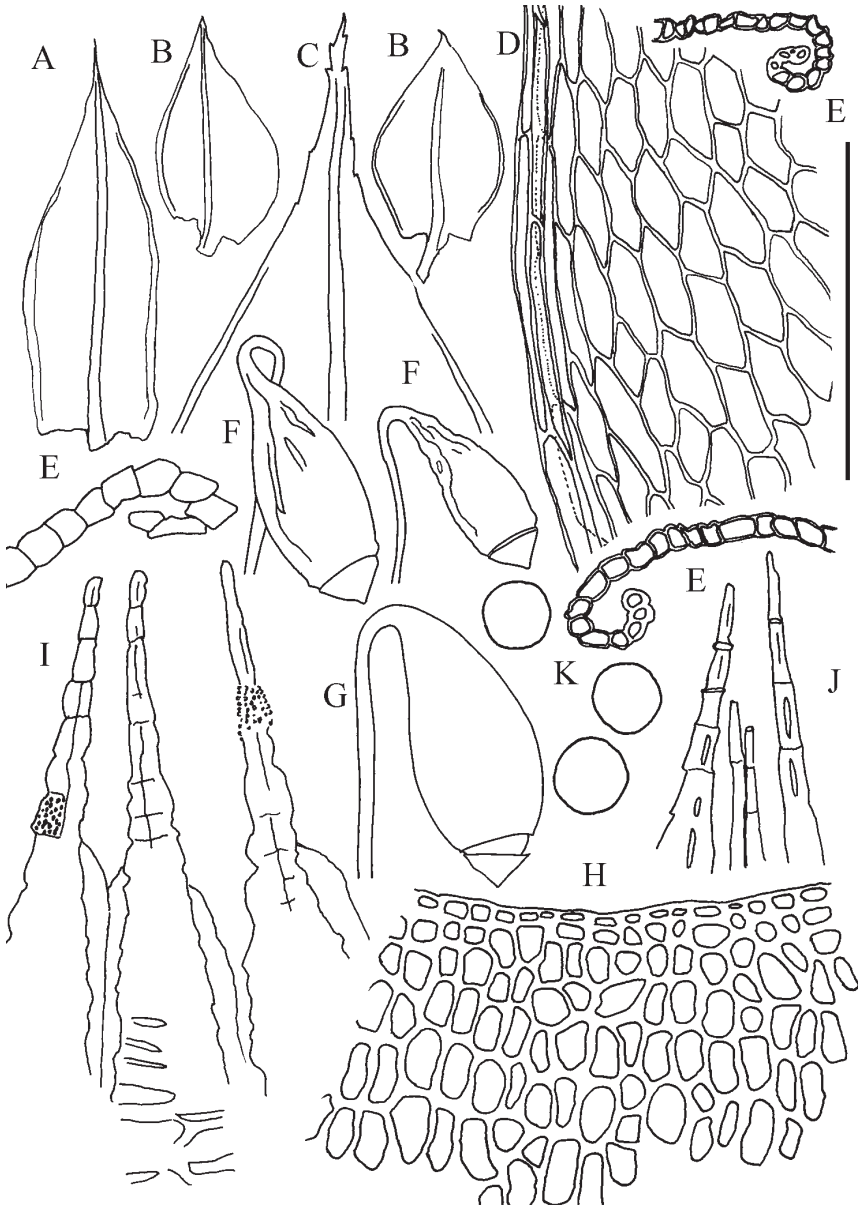

Fig. 83. *Bryum warneum*. A = comal leaf; B = cauline leaves; C = leaf apex; D = leaf margin; E = cross sections of leaf margin; F, G = capsules (dry/moist); H = exothecial cells at capsule mouth; I = detail of exostome (apical part of teeth with ornamentation shown in small portion and cross-walls between lamellae below); J = detail of endostome (process, short cilia); K = spores. Scale bar: A, B: – 2 mm; C: – 400 μm; D, E, H–K: – 200 μm; F, G: – 4 mm. [A–G, I, J: BP 117193; H, K: BP 117001, del. Erzberger].

base to apex, border composed of 3–6 rows of narrow and elongate, incrassate cells, leaf base red, discolorous (*B. warneum*: endostome only partially attached to exostome, segments with very narrow, slit-like perforations, spores 30–45 µm, plants autoicous, costa only shortly (to 250 µm) excurrent, margin locally bistratose, partly recurved below, border formed of 2–3 rows of narrow, elongate cells only slightly more incrassate than laminal cells, leaf base not red, concolorous)

B. uliginosum: spores 24–32 µm; cilia rudimentary; capsule elongate pyriform; exostome without cross-walls (*B. warneum*: spores 30–45 µm, cilia short or sometimes longer; capsule short, broadly pyriform; exostome with cross-walls).

B. longisetum: spores (35–)40–50 µm, lamellae of exostome teeth not joined by oblique cross-walls (*B. warneum*: spores 30–45 µm, exostome with oblique cross-walls between lamellae).

References: Limpricht (1895): 290–293, Demaret (1993): 237–239, Nyholm (1993): 174.

Habitat: sand pits with water-filled depressions.

Substrate: base-rich sandy or gravelly soil.

Associated bryophytes: *Bryum pseudotriquetrum*, *Didymodon tophaceus*.

Vertical distribution: 200 m a.s.l.

Distribution in Hungary (2 specimens, 1 grid cell representing a single old find): **Vértes Mts** (8476.3): Comit. Komárom. In arenosis humidis foveae Nagy-irtás prope Bánhida, 200 m, 08.08.1937 leg. Á. Boros BP 117001, BP 117193 sub *B. pallens*.

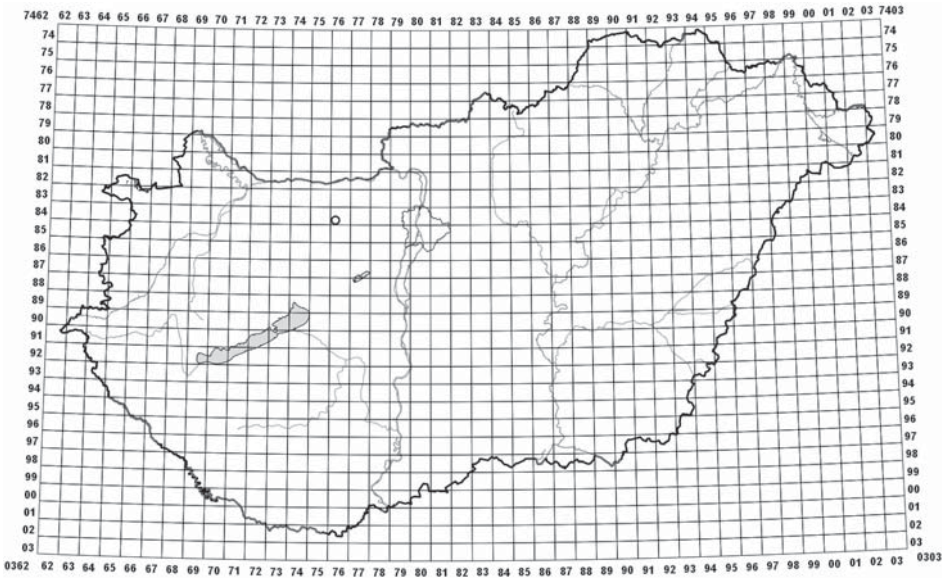

Fig. 84. Distribution of *Bryum warneum*.

This is the only collection of *B. warneum* in Hungary. The growth site is also one of two adjoining localities of *B. intermedium* (compare the note under that species). The populations of *B. warneum* most likely do no longer exist at their only site in Hungary. Since the species is restricted to early successional stages of vegetation colonising damp sand, the habitat has probably long ago been lost to shading as succession proceeded. There is a general decline in inland Central European populations of *B. warneum* that are found mainly in man-made habitats like sand pits, and even at coastal sites in western and northern Europe (Meinunger and Schröder 2007, Lockhart *et al*. 2012). In these countries, *B. warneum* is either extinct or redlisted in high categories. In Hungary, it is at the south-eastern border of its area. It is in the R (rare) category in the Red data book of European bryophytes (ECCB 1995). Red list status in Hungary: DD (Papp *et al.* 2010).

Distribution in adjacent countries: A, SK.

Literature: In Boros (1953, 1968), Orbán and Vajda (1983) two sites are reported for *B. warneum*, apart from the confirmed locality (see specimen above) also Zamárdi at Lake Balaton. However, the corresponding specimen (BP 117005, collected by Z. Zsák 03.07.1940, det. as *B. warneum* by Podpera) represents *B. algovicum*, as was already published in Erzberger and Papp (2004) based on a revision by B. Papp.

Bryum weigelii Spreng.
[= *B. duvalii* Voit]
(Figs 85, 86)

Dioicous, sporophytes very rare (not seen in Hungarian material). **Plants** growing in 2–8 cm tall, very lax tufts or solitary between other mosses of meadows, brown-green to flesh-coloured; rhizoids red-brown, smaller ones light brown, finely papillose. **Leaves** distantly and evenly arranged along unbranched stem, leaves erectopatent when moist, flexuose to curled when dry, broadly ovate, widest at middle, broadly acute to obtuse or rounded above, leaf base not red, concolorous, conspicuously widely decurrent along stem, decurrency about as wide as half the leaf, making the free leaf blade appear nearly triangular; margin entire or very slightly denticulate at apex, plane or slightly recurved; costa yellowish, ending in leaf apex or shortly below. **Laminal cells** at leaf base quadrate or rectangular, upper cells rhombic, 30–50 × 20–25 μm, thin-walled; at margin 1–2 rows of narrow cells, forming locally bistratose border. **Seta** 2–6 cm. **Capsule** pendulous, 3–4 mm long, pyriform, contracted below mouth, pale brown, almost blackish when dry. **Exostome** teeth lamellae occasionally united by sparse cross-walls. **Endostome** cilia long, appendiculate. **Spores** 12–15 μm, papillose.

Similar species: *B. pallens* (as f. *rutilans*): non-fruiting plants pink to wine-red; leaves not or only narrowly decurrent (*B. weigelii*: plants flesh-coloured; leaves very widely and conspicuously decurrent).

B. schleicheri: leaf margin longly and narrowly decurrent along stem; plants light green (*B. weigelii*: leaf margin broadly decurrent, plants flesh-coloured).

B. pseudotriquetrum: leaves ovate lanceolate, leaf base red; leaf margin recurved from base to apex, narrowly, but distinctly decurrent in several cell rows; plants green to reddish (*B. weigelii*: leaves ovate, appearing triangular due to the very wide decurrencies; leaf base not red; margin plane or slightly recurved; plants flesh-coloured).

References: Limpricht (1895): 429–431, Demaret (1993): 160–161, Nyholm (1993): 181–183, Ahrens (2001): 101–103, Guerra *et al.* (2010): 119–120.

Habitat: *B. weigelii* is a plant of base-rich open habitats in wet meadows, near springs, streams or at lake shores. In Hungary it was found in a moist mountain meadow adjoining *Salicetum cinereae*, and in a moist mountain meadow near a stream.

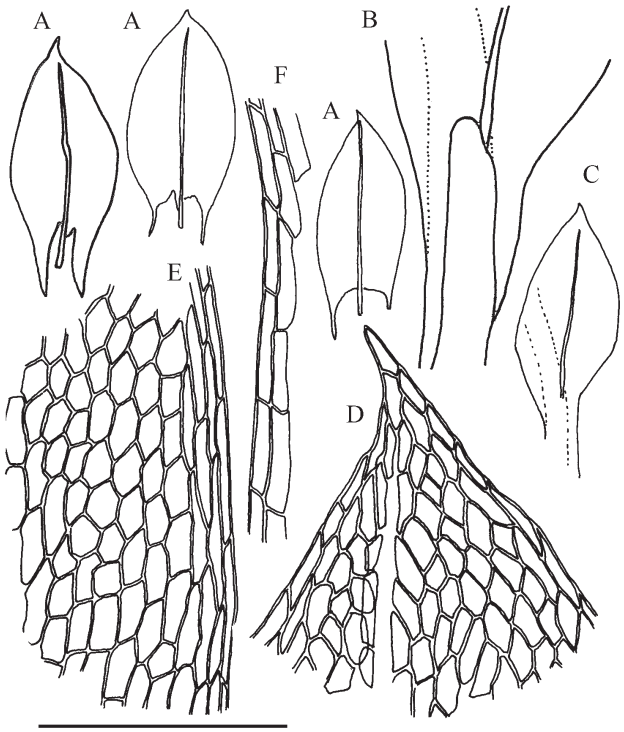

Fig. 85. *Bryum weigelii*. A = leaves; B, C = leaves in situ at stem; D = leaf apex; E = leaf margin; F decurrency. Scale bar: A, C: – 2 mm; B: – 800 μm; D–F: – 200 μm. [BP 116790, del. Erzberger].

Substrate: moist, weakly calcareous soil, also in weakly acidic sites. In Hungary, its growth sites are over volcanic bedrock (Zemplén Mts) and limestone (Bükk Mts).

Associated bryophytes: *Aulacomnium palustre*, *Calliergonella cuspidata*, *Climacium dendroides*, *Marchantia polymorpha* subsp. *polymorpha*, *Plagiomnium ellipticum*.

Vertical distribution: 600–650 (mean 625) m a.s.l.

Distribution in Hungary (5 specimens, 2 grid cells, of which 0 represent recent finds): **Zemplén Mts** (7594.3): Comit. Abaúj-Torna. Ad margines Salicetosum ciner. pratis montanis Bohó-rét montis Hosszúkő prope Telkibánya, 600 m, 19.10.1959 leg. Á. Boros BP 116791; **Bükk Mts** (7989.1): Comit. Borsod. Ad margines rivulorum in pratis montanis ad Jávorkút prope Felsőhámor, 650 m, 18.05.1923 leg. Á. Boros BP 116789.

The population at the Bükk growth site probably was already extinct in 1953 (Boros 1953: "Jávorkút, kipusztult?"), it is marked as extinct in Boros (1968). Concerning the site in the Zemplén Mts we have no specific information, but due to general change of habitat conditions, especially reduction of water supply and drought, the population is probably extinct as well (B. Papp, pers. comm.). Red list status: DD (Papp *et al.* 2010).

Distribution in adjacent countries: A, RO, SK, SLO, SRB, UA.

Literature: (Boros 1953, 1968) – see above.

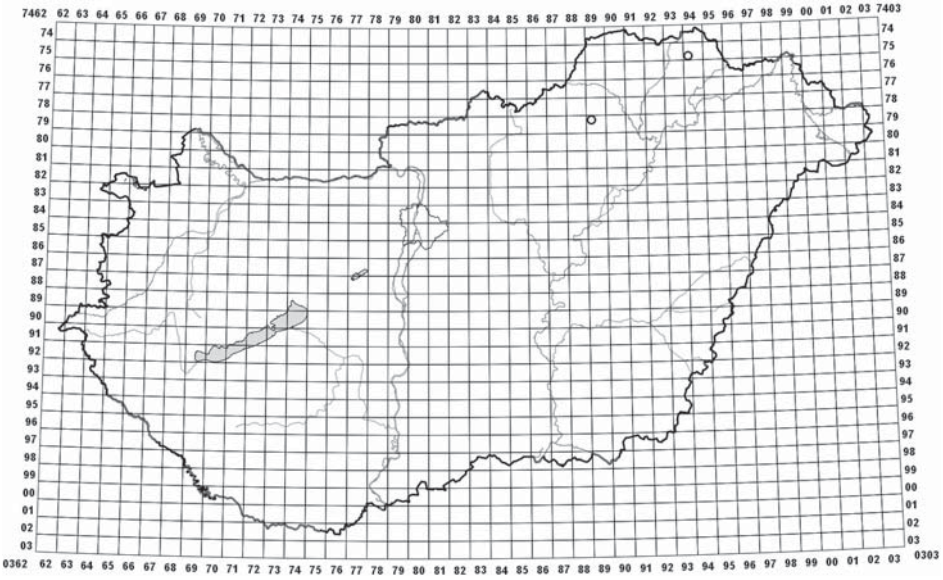

Fig. 86. Distribution of *Bryum weigelii*.

Frequency and updated red list status of *Bryum* taxa in Hungary (Fig. 87)

Based on our revision, the red list status of *Bryum* species may be estimated more accurately, although in many cases field studies with a special focus on the members of the genus will prove necessary to achieve this goal. For many species the distributional pattern needs additional, and in particular recent data to become more clear-cut. Some unresolved issues have already been mentioned in the individual species accounts. However, some general shortcomings of herbarium data should be noted:

The specimens collected are not random probes. To obtain representative frequency data would require the collection and determination of all *Bryum* taxa present in representative areas of Hungary. Since some species can only be determined when ripe capsules are present, this would necessitate visiting the study sites at the right season (for most species April–June). Due to the difficulties in naming collections, there would still be a bias in favour of species that can be identified by gametophytic characters. There are also inherent difficulties when the determination relies on the study of subterranean structures like rhizoids and tubers, because these are not easily detected in the field, and were neglected in former decades, before the epochal work of Crundwell and Nyholm (1964).

Nevertheless, the lifelong collecting activity of Ádám Boros and his contemporaries has resulted in a remarkable treasure of specimens that approaches the ideal sample to an extent not easily matched. Keeping in mind the inevitable deficiencies outlined above, some indirect evidence on the frequency of taxa in Hungary can be obtained from our study (Fig. 87, Table 5).

We evaluate the number of grid cells in which a species has been collected, since the number of specimens is not suited for estimating frequency due to numerous duplicates present in the herbaria. For frequent species, this will underestimate their frequency since there is probably often more than one population in a grid cell. However, our concern is rather with rare species. For these, the number of grid cells is in most cases close to the number of growth sites.

Bryum species in Hungary may be grouped according to frequency into three classes: frequent, moderately frequent and rare (or perhaps strongly underrecorded) species. The nine most frequent species (*B. moravicum*, *B. argenteum*, *B. caespiticium*, *B. pseudotriquetrum*, *B. capillare*, *B. dichotomum*, *B. alpinum*, *B. algovicum*, and *B. rubens*) together cover more than 80% of all grid cell data. The group of moderately frequent species consists of eleven species (*B. klinggraeffii*, *B. radiculosum*, *B. subapiculatum*, *B. pallens*, *B. turbinatum*, *B. pallescens*, *B. bimum*, *B. creberrimum*, *B. elegans*, *B. torquescens*, *B. violaceum*) with between 26 and 9 grid cells per species. In the third group (8 or less grid cells per species)

(Table 5) species are either rare (R) or probably substantially under-collected (U): *B. archangelicum* (U), *B. mildeanum* (R), *B. ruderale* (U), *B. lonchocaulon* (U), *B. funckii* (R), *B. gemmiferum* (U), *B. neodamense* (R), *B. badium* (U), *B. gemmilucens* (R), *B. intermedium* (R or U), *B. kunzei* (U), *B. stirtonii* (R), *B. weigelii* (R), *B. knowltonii* (R), *B. tenuisetum* (R), *B. uliginosum* (R), *B. warneum* (R). The decision between R and U has been made taking into account the history of the distributional record in Hungary and the status of the species in other European countries (for details see the individual species accounts).

As has been pointed out already, the apparent frequency of a taxon will also depend on the ease or difficulty of its recognition. It is therefore not astonishing that the nine most frequent *Bryum* species in Hungary can be identified in most cases without difficulties, perhaps except *B. caespiticium* and *B. dichotomum*. Those species that require ripe sporophytes for identification, on the other hand, are expected to have been collected from far less grid cells, even if they are moderately frequent. This might apply for *B. pallens*, *B. pallescens*, *B. creberrimum*, *B.*

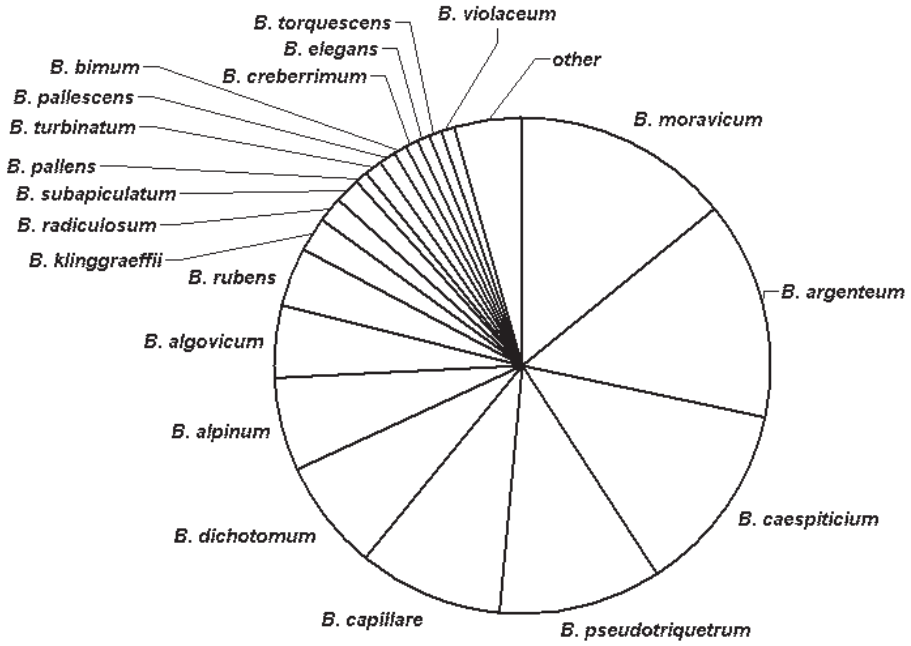

Fig. 87. Frequency of *Bryum* taxa in Hungary (no of grid cells). Others (in brackets: no of grid cells): *B. archangelicum* (8), *B. mildeanum* (8), *B. ruderale* (8), *B. lonchocaulon* (6), *B. funckii* (4), *B. gemmiferum* (4), *B. neodamense* (3), *B. badium* (2), *B. gemmilucens* (2), *B. intermedium* (2), *B. kunzei* (2), *B. stirtonii* (2), *B. weigelii* (2), *B. knowltonii* (1), *B. tenuisetum* (1), *B. uliginosum* (1), *B. warneum* (1).

Table 5. Frequency and red list categories of *Bryum* taxa in Hungary. (Abbreviations of red list categories (Papp *et al.* 2010): DD = data-deficient; DD-va = data-deficient vanished; CR = critically endangered; EN = endangered; VU = vulnerable; NT = near threatened; LC = least concern; LC-att = least concern attention).

Taxon	Number of grid cells		Red List status (Papp *et al.* 2010)	Red List category proposed
	total	recent (after 1973)		
B. algovicum	60	7	LC	LC-att
B. alpinum	77	15	LC-att	LC-att
B. archangelicum	8	0	DD	DD
B. argenteum	175	90	LC	LC
B. badium	2	1		DD
B. bimum	11	1		LC-att
B. caespiticium	159	56	LC	LC
B. capillare	115	47	LC	LC
B. creberrimum	11	0	DD	DD
B. dichotomum	90	55	LC	LC
B. elegans	11	2	LC-att	NT
B. funckii	4	1	DD	CR
B. gemmiferum	4	4	NT	NT
B. gemmilucens	2	2	DD	EN
B. intermedium	2	0	DD	DD-va?
B. klinggraeffii	26	15	LC-att	LC
B. knowltonii	1	0		DD
B. kunzei	2	0		DD
B. lonchocaulon	6	0		DD
B. mildeanum	8	2	DD	EN
B. moravicum	177	109	LC	LC
B. neodamense	3	0	DD-va	DD-va
B. pallens	13	3	VU	VU
B. pallescens	12	0	DD	DD
B. pseudotriquetrum	132	29	LC-att	LC-att
B. radiculosum	21	12	LC	LC
B. rubens	49	35	LC	LC
B. ruderale	8	6	LC	LC
B. stirtonii	2	1	NT	VU
B. subapiculatum	20	12		LC
B. tenuisetum	1	0		DD
B. torquescens	10	3	VU	VU
B. turbinatum	13	2	DD	VU
B. uliginosum	1	0	DD	DD-va?
B. violaceum	9	4	LC-att	LC-att
B. warneum	1	0	DD	DD-va?
B. weigelii	2	0	DD	DD-va?

archangelicum and many others with less than 9 grid cells per species that are rare or significantly under-recorded.

The number of grid cells with recent finds in relation to the total number of grid cells needs to be interpreted with caution. While in our study "recent" refers to specimens after 1973, in discussions of conservational aspects, "recent records" usually are from within the last decade. Most species of *Bryum* in Hungary are colonists of bare soil in need of new growth sites after some time, since the progress of vegetational succession inevitably entails a loss of habitat quality, mostly due to over-growth and shading. This must inevitably lead to a preponderance of old over recent records. On average, 40% of grid cell data represent recent collections. The number of species in stable habitats – mainly rock dwellers like *B. elegans* and *B. stirtonii*, in part also *B. alpinum*, and wetland inhabitants like *B. bimum*, *B. pseudotriquetrum*, *B. neodamense*, *B. pallens*, *B. turbinatum*, *B. weigelii* – is small in comparison to the number of colonists of bare soil.

If for a given species the fraction of recent grid cell data is considerably lower than 40%, we might assume some negative development, e.g. a decline in populations or numbers of suitable habitats. This is observed in *B. pseudotriquetrum* (21% recent), *B. alpinum* (20%), and *B. algovicum* (11%) among frequent species. In the case of *B. pseudotriquetrum*, it is tempting to attribute this low percentage of recent data to the generally observed decrease in habitat quality for wetland species (Papp 2008). However, there are possible alternative explanations. A smaller number of recent finds could also be caused by a shift in collecting activity since the time of Boros from the lowlands to hill and mountain regions (compare Fig. 88). No bryologist since Boros has collected from such a wide range of lowland sites. Also, during monitoring activities (Papp *et al.* 2006), which represent an important part of the field studies carried out nowadays in Hungary, specimens are collected from the same grid cell in different years, leaving the number of grid cells with recent finds essentially unchanged.

On the other hand, the fact that most species of *Bryum* in Hungary are pioneer species also means that many of them can colonise man-made habitats or habitats close to human settlements or even in urban environments. These species are under less pressure from human impact and expanding civilisation than oligohemerobic species, like *B. elegans*, *B. knowltonii*, *B. mildeanum*, *B. neodamense*, *B. pseudotriquetrum*, *B. stirtonii*, *B. turbinatum* and *B. weigelii*.

The results of our revision may contribute to an improved assessment of red list categories for some species of *Bryum* in Hungary. According to the actual red list (Papp *et al.* 2010), *B. pallens* and *B. torquescens* are in the highest red list category applied to species of *Bryum*, VU (vulnerable). 11 species are DD (data deficient), *B. neodamense* is DD-va (vanished), *B. gemmiferum* and *B. stirtonii* are NT (near threatened), 5 species are LC-att (least concern-attention) and 9 species

are LC (least concern) (Table 5). 7 taxa represented in our revision have not been evaluated since they were not known from Hungary at that time (*B. knowltonii*, *B. subapiculatum*, *B. tenuisetum*) or had been included in other species (*B. badium*, *B. bimum*, *B. lonchocaulon*, *B. kunzei*). According to our improved knowledge, for some DD species now specific threat categories can be proposed, and some other categories should be modified too according to the information now available: *B. funckii* is considered CR (critically endangered), 2 species are estimated EN (*B. gemmilucens*, *B. mildeanum*), 4 species are listed as VU (*B. pallens*, *B. stirtonii*, *B. torquescens*, *B. turbinatum*), 2 species are NT (*B. elegans*, *B. gemmiferum)*, 13 species are DD, of them probably 4 more can be considered DD-va in addition to *B. neodamense* (*B. intermedium*, *B. uliginosum*, *B. warneum*, *B. weigelii* – but this is definite only after the corresponding localities have been searched for the species without success –), 5 species are LC-att, and 10 species are LC (Table 6).

In making decisions about threat status, some general ecological facts about the species of *Bryum* have to be taken into account, as was already pointed out with respect to the frequency of recent versus old records, where species of stable habitats have to be treated differently from those with a colonist strategy. Since the bryological exploration of Hungary during the last decades has focused on fewer, mostly mountains and hill regions, this implies that the state of knowledge is different between e.g. rock inhabitants and pioneers of the lowlands. The latter could have been under-explored, and lack of recent collections is less aggravating

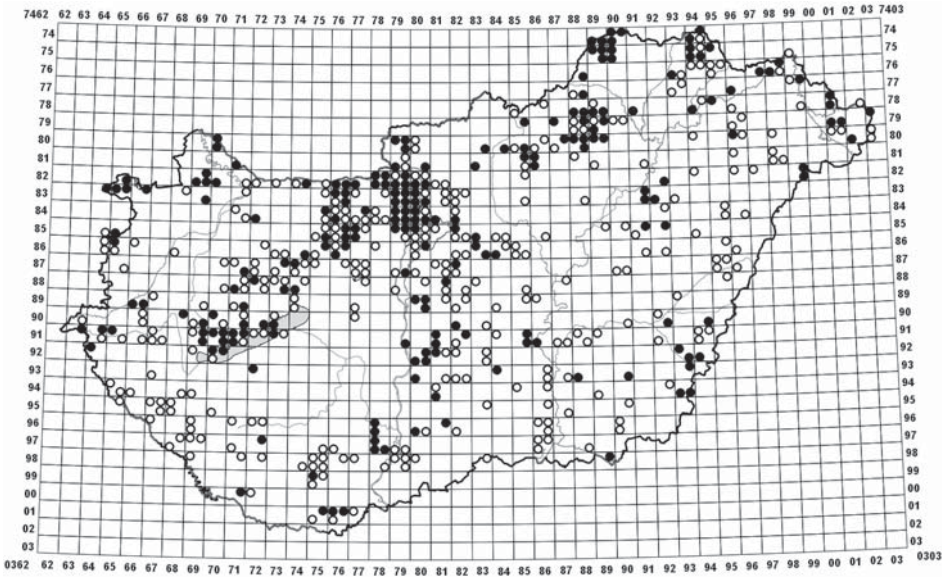

Fig. 88. Cumulative representation of grid cell data of all *Bryum* species.

than in the case of *B. elegans* and *B. stirtonii*, which grow in shaded rock habitats that are relatively well surveyed. On the other hand, in particular rural and urban environments were less intensively studied (but see Szűcs 2007, Szűcs and Lóth 2008), and many species that can grow in such habitats certainly are under-collected. All the species of the *B. erythrocarpum* complex (except the newly and doubtfully recorded *B. tenuisetum*) are unthreatened, only *B. violaceum* is LC-att. This is certainly owed to the effectiveness of rhizoidal tubers as their means of vegetative propagation.

Grasslands on saline soils are of particular interest in Hungary, since they are the westernmost representative of this Eurasian steppe zone habitat (Papp and Rajczy 2000). Hungary has a high responsibility for the conservation of this type of habitat, covering the largest among comparable areas in Eastern Central Europe. Several *Bryum* species can be found in alkaline grasslands, and some even have major populations there: *B. algovicum*, *B. alpinum*, *B. dichotomum*, *B. argenteum* have numerous collections from the saline grasslands of the Danube–Tisza Interfluve or the Tiszántúl; the species of the *B. erythrocarpum* group (*B. klinggraeffii*, *B. radiculosum*, *B. rubens*, *B. ruderale*, *B. subapiculatum*, *B. violaceum*) are frequently found in this habitat, and several others occasionally: *B. caespiticium*, *B. capillare*, *B. gemmilucens*, *B. mildeanum*, *B. pseudotriquetrum*, *B. torquescens* (and some at present indeterminable taxa of the *B. pallescens* agg.). *B. ruderale*, *B. radiculosum*, and *B. torquescens* can grow on base-rich soil as found particularly in the Danube–Tisza Interfluve. Many of these species require moist substrates that can dry out for some time, but at other times are thoroughly wetted, conditions met, e.g. in the vicinity of permanent shallow lakes, or in areas that are often temporarily under water during winter and spring, as are many saline areas in the Hungarian plain (Papp and Rajczy 2000).

The results presented here should be seen as a starting point for further research, in particular field studies. Many species are still under-recorded, their true ecological relations in Hungary will become evident only if their distributional record is improved. For some probably extinct species there is the challenge of finding potentially suitable habitats and perhaps even new populations.

Table 6. Proposed changes in red list status compared to Papp *et al.* (2010).

Category	CR	EN	VU	NT	DD	DD-va (+ DD-va?)	LC-att	LC	sum
Red list status (Papp *et al.* 2010)			2	2	11	1	5	9	30
Red list category proposed	1	2	4	2	8	1 + (4)	5	10	37

* * *

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After the completion of the manuscript, the first author collected specimens of *Bryum* in Hungary, which entrails some important modifications (notes added in proof)

Bryum intermedium: **Danube–Tisza Interfluve** (9182.2): Bács-Kiskun County, Fülöpháza, on sand near dried-up saline lake Szappanszék, N 46° 53' 9.1", E 19° 25' 40.8", 110 m, 30.05.2013 leg. P. Erzberger det. W. Schröder (B Erzberger 16277). – The first confirmed record after 1937, new to the region Danube–Tisza Interfluve, and the third site in Hungary.

Bryum creberrimum: **Danube–Tisza Interfluve** (8782.1): Pest County, Csévharaszt, on calcareous sand in open *Juniperus communis* vegetation, N 47° 17' 27.0", E 19° 23' 16.8", 134 m, 23.05.2013 leg. et det. P. Erzberger, conf. W. Schröder (B Erzberger 16194). – The first record after 1955, first confirmed specimen for the region Danube–Tisza Interfluve.

Bryum mildeanum: **Visegrád Mts** (8379.2): Pest County, Pomáz, on soil between siliceous outcrops on the SW-slope of the hill Kis-Csikóvár, N 47° 40' 3.4", E 18° 59' 18.5", *ca* 300 m, 16.05.2013 leg. et det. P. Erzberger, conf. W. Schröder (B Erzberger 16088). – First confirmed specimen for the Visegrád Mts and third "recent" record.

Bryum stirtonii: **Danube–Tisza Interfluve** (8782.1): Pest County, Csévharaszt, on calcareous sand in open *Juniperus communis* vegetation, N 47° 17' 27.0", E 19° 23' 16.8", 134 m, 23.05.2013 leg. et det. P. Erzberger, conf. W. Schröder (B Erzberger 16184). – Third record for Hungary. The species was not expected in this kind of habitat!

Bryum torquescens: **Danube–Tisza Interfluve** (9181.3): Bács-Kiskun County, Fülöpszállás, small saline pasture near the road No 52, on soil, N 46° 49' 32.8", E 19° 13' 13.5", *ca* 100 m, 30.05.2013 leg. et det. P. Erzberger conf. W. Schröder (B Erzberger 16284). – This is the fourth recent record, and the 11th for Hungary.