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THE GENUS BRYUM (BRYACEAE, MUSCI) IN MIDDLE EUROPEAN RUSSIA

РОД BRYUM (BRYACEAE, MUSCI) В СРЕДНЕЙ ЧАСТИ ЕВРОПЕЙСКОЙ РОССИИ

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Abstract

A revision of the genus *Bryum* in Middle European Russia (= European Russia, excluding the Caucasus, the Kola Peninsula and Karelia, and northern Arkhangelsk Province and the Komi Republic, and including the Ural Mountains to the northern border of Perm and Sverdlovsk/Ekaterinburg Provinces) documents the occurrence of twenty-nine species, including *B. algovicum, B. amblyodon, B. alpinum, B. arcticum, B. argenteum, B. bicolor, B. bimum, B. caespiticium, B. capillare, B. creberrimum, B. cyclophyllum, B. elegans, B. funkii, B. intermedium, B. klingraeffii, B. knowltonii, B. kunzei, B. laevifilum, B. lonchocaulon, B. pallens, B. pallescens, B. pseudotriquetrum, B. rubens, B. schleicheri, B. subapiculatum, B. turbinatum, B. uliginosum, B. violaceum, B. weigelii*. All species are described and illustrated, selected specimens are cited (at least one for each province/republic), and a key is provided. *Bryum bimum* is treated as distinct from *B. pseudotriquetrum,* as is *B. kunzei* from *B. caespiticium,* and *B. lonchocaulon* (*B. cirrhatum* auct.) from *B. pallescens.*

Резюме

Проведена ревизия гербариных материалов по роду *Bryum* с территории средней части Европейской России (=Европейской части без Северного Кавказа, Кольского полуострова и Карелии, севера Архангельской области и Республики Коми). Подтверждено присутствие здесь 29 видов: *B. algovicum, B. amblyodon, B. alpinum, B. arcticum, B. argenteum, B. bicolor, B. bimum, B. caespiticium, B. capillare, B. creberrimum, B. cyclophyllum, B. elegans, B. funkii, B. intermedium, B. klingraeffii, B. knowltonii, B. kunzei, B. laevifilum, B. lonchocaulon, B. pallens, B. pallescens, B. pseudotriquetrum, B. rubens, B. schleicheri, B. subapiculatum, B. turbinatum, B. uliginosum, B. violaceum, B. weigelii*. Приводится ключ для определения видов, и для каждого из них даны описания, иллюстрации, перечислены изученные образцы (по крайней мере один для каждой из областей/республик). Приводятся данные в пользу видовой самостоятельности *B. bimum* и *B. kunzei*, которые в ряде последних публикаций относили в синонимы к *B. pseudotriquetrum* и *B. caespiticium* соответственно. Также, *B. lonchocaulon* (*B. cirrhatum* auct.) и *B. pallescens* принимаются как самостоятельные виды.

INTRODUCTION

The genus *Bryum* has a reputation as one of the systematically most difficult genera of mosses. It is challenging to attempt identification of vast numbers of specimens because of considerable intraspecific polymorphism; lack of, or imperfect preservation of, sporophytes; and insufficient material for certainty regarding sexual condition. Also, the genus is one of the largest in the boreal and temperate bryofloras. These difficulties generally result in a number of erroneous identifications. The main goal of the present study is to revise the collections from Middle European Russia in order to determine how many species occur in this region and to identify their distinguishing characteristics. Species concepts are based on the publications of Limpricht (1895), Podpera (1959, 1962), Savicz-Ljubitskaya (1954), Savicz-Ljubitskaya & Smirnova (1970), Melnichuk, (1970), Nyholm (1993), Syed (1973), Crundwell & Nyholm (1964), Demaret (1986a, b), Smith (1978) and Smith & Whitehouse (1978), among others, as well as on collections identified by Podpera, Warnstorf and other authorities on European bryophytes (specimens in MW, LE).

MATERIAL AND METHODS

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The study area includes Middle European Russia (i.e., European Russia, excluding the Caucasus and northern territories: the Kola Peninsula, Karelia, Northern half of Leningrad/St.-Petersburg Province, and northern Arkhangelsk Province and the Komi Republic, and including the Ural Mountains up to the northern border of Perm and Sverdlovsk/Ekaterinburg Provinces).

All *Bryum* collections from the study area in MW, MHA, LE and VOR have been examined, as well as some from H and local Russian herbaria, including Tver State University, Ekaterinburg Pedagogical University, Institute of Ecology (Ekaterinburg), and Volgograd Pedagogical University. Altogether, approximately 700 specimens were studied. Several species cited in publications pertaining to Middle European Russia were not available for study, and these are cited in the section "unconfirmed records".

Measurements in species descriptions are based on ten specimens from different parts of the territory, if this number was available. The number of specimens studied is indicated in parentheses after "specimens studied". Species known only from sterile plants are supplemented with descriptions of sporophytes (and sometimes perigonia and perichaetia) based on other, mostly European collections, which are listed in Appendix 1. All data from outside of our area are in square brackets. The SEM analyses of peristome and spores include several species from outside of the study area, and a number of these are used to illustrate particular character states.

ANALYSES OF CHARACTER STATES

Sexual condition traditionally has been considered one of the important characters in *Bryum* taxonomy, because most species are invariable in this respect. In some groups, the differences in sexual condition were treated as an important basis for species segregation, e.g., with *Bryum pseudotriquetrum–B. bimum*, *B. pallescens–B. lonchocaulon–B.creberrimum*, and *B. capillare–B. torquescens*. However, recent authors have expressed doubts about the significance of this character, which (along with other evidence) has led some to reduce the status of *B. bimum* to a variety or a synonym with *B. pseudotriquetrum,* and to treat *B. lonchocaulon* (as *B. cirrhatum*) as synonymous with *B. pallescens*. Sexual condition was found, in the present study, to be fairly stable. The most puzzling case is the group, *B. pallescens–B. lonchocaulon–B. creberrimum;* it is discussed in detail under the first species.

Male and female plants of dioicous species are often in separate tufts, but in some species both sexes can be often found in the same tuft (for example, in *B. pseudotriquetrum)*, at least if the collection is large. Male plants are usually slender, more loosely foliate (*B. pallens, B. caespiticium*), or almost identical with female plants (*B. schleicheri*). Perigonia are usually about as long as wide, and have a ± capitate shape, but in some species (*B. schleicheri*, *B. pseudotriquetum*) with especially numerous antheridia, perigonia are wide, i.e., noticeably wider than long.

Plants grow as separate individuals scattered on the substrate (often in *B. funkii*, sometimes in *B. argenteum*), or form loose (*B. weigelii*), compact (*B. bimum*), or dense tufts (*B. caespiticium*). I call a tuft 'compact' if a complete shoot can be pulled off the tuft from above, whether dry or wet. Correspondingly, I call a tuft 'dense' if a shoot usually breaks in attempts to pull it from above, and the separation of a single shoot requires first a splitting of a tuft and then the careful removal of a plant from the opening. The compact or dense states are generally dependent on the density of rhizoidal tomentum, but they are not correlated in all cases. Therefore, tuft density can be treated as a separate character.

The height of tufts is a complex parameter resulting from the length of female shoots, the length of subterminal shoots, and the mode of growth (shoots are mostly straight, or sometimes ascendant, as in *B. rubens, B. laevifilum*, or shady phenotypes of *B. capillare*, and includes both living and dead, partly decayed parts). Tufts vary from low (less than 0.5 mm, as in *B. violaceum*) to tall (10-12 cm, as in *B. pseudotriquetrum, B. schleicheri, B. weigelii*).

Tuft color can be pure green (*B. capillare*), light green (*B. rubens*), dirty green (often in *B. turbinatum*), pale green (often in *B. weigelii*), yellow-green (*B.cirrhatum*), brownish-green (sometimes in *B. bimum*), brownish-yellow (sometimes in *B. elegans*), pinkish to vine-red (often in *B. pallens*), glaucous (sometimes in *B. laevifilum* and *B. turbinatum*), whitish (*B. funkii*), silvery (*B. argenteum*), or variegated with a mixture of green, yellow-brownish and purplish (*B. alpinum*). Tufts can be dull (*B. weigelii*) or glossy (*B. alpinum*).

Most *Bryum* species have leaves ± evenly arranged along the stem, except the leaves around gametangia are larger and more densely crowded, or comose (from the Latin adjective *comosus,* which is used sometimes as a species epithet in vascular plants to describe characteristically crowded upper flowers). The largest comose leaves (Fig. 69, p. 168) are most characteristic for individual species, and they are used in the descriptions and measurements of "upper leaves". Leaves from the lower part of stems are described additionally for species where they are numerous. Inner comose leaves become smaller and narrower as the margins are more recurved, and often form a gradual transition to outer perichaetial leaves.

The thickness and porosity of laminal cell walls were evaluated in median cells between the costa and leaf border. Closer to the acumen, border and costa, cells usually have thicker walls. Cell wall thickness was used for to discriminate between *B. pseudotriquetrum* and *B. bimum* by Limpricht (1895) and Savich-Ljubitskaya & Smirnova (1970), and I can confirm their opinion – see discussion under *B. bimum*.

Outer perichaetial leaves are narrowly lanceolate in most species, differing from the inner comose leaves mainly in narrowly (vs. broadly) recurved margins. Inner perichaetial leaves are shorter than outer ones, and small, often with plane margins and a weaker costa. In species descriptions "perichaetial leaves" refers to the inner ones.

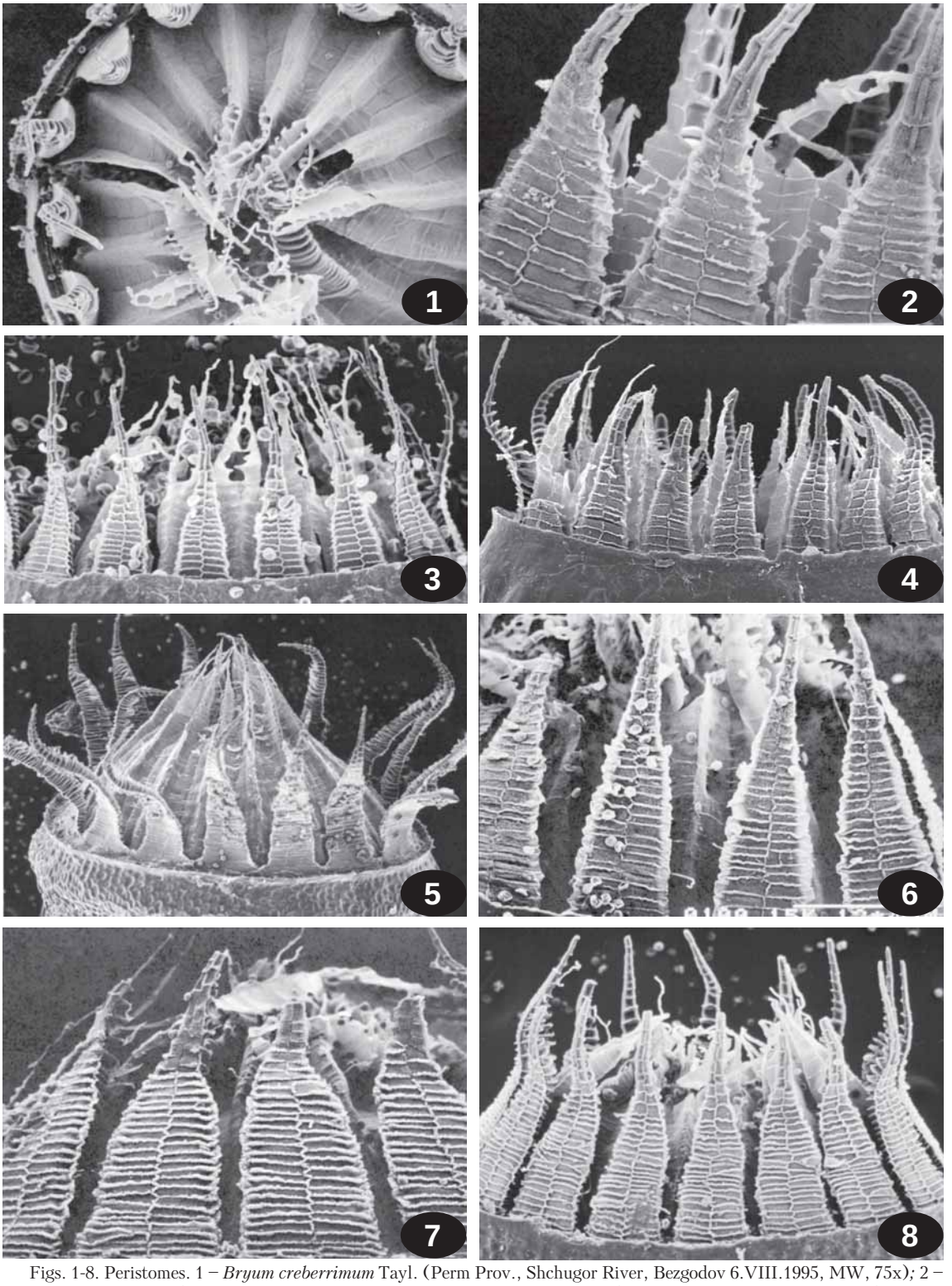
The capsule wall is thick in most species, but some have remarkably thin-walled capsules that look very delicate (*B. cyclophyllym, B. knowltonii, B. weigelii, B. turbinatum*). The states of this character were evaluated visually based on open capsules.

The peristome is invariably double, inserted at the urn mouth, or more rarely markedly below the mouth (*B. uliginosum, B. pallens*). There are 16 exostome teeth; in the dry state, almost erect (often in the *B. erythrocarpum*-group, cf. Figs. 6, 13-14) or erect-reflexed in most species (Fig. 5, 9-12), or rarely curved-arcuate, with the tips inserted between the endostome segments (*B. pallens, B. uliginosum, B. calophyllum* R. Br., Figs. 15-16). Teeth of *Bryum* often are classified as holodontous, not perforate along the median line, and aulacodontous. In the latter, the outer peristomial layer is split along the median line through 1-2(-3) plates (Figs. 16, 28); However, this is a relatively rare character state, known in certain species groups not represented in our study area (e.g., *B. calophyllum*), and occasionally in species with normally holodontous peristomes (e.g., *B. creberrimum*). In most species, the teeth are gradually tapered in the transition zone, rarely more abruply tapered (*B. bicolor,* Fig. 7), and pale-yellow to brownish, reddish and orangish.

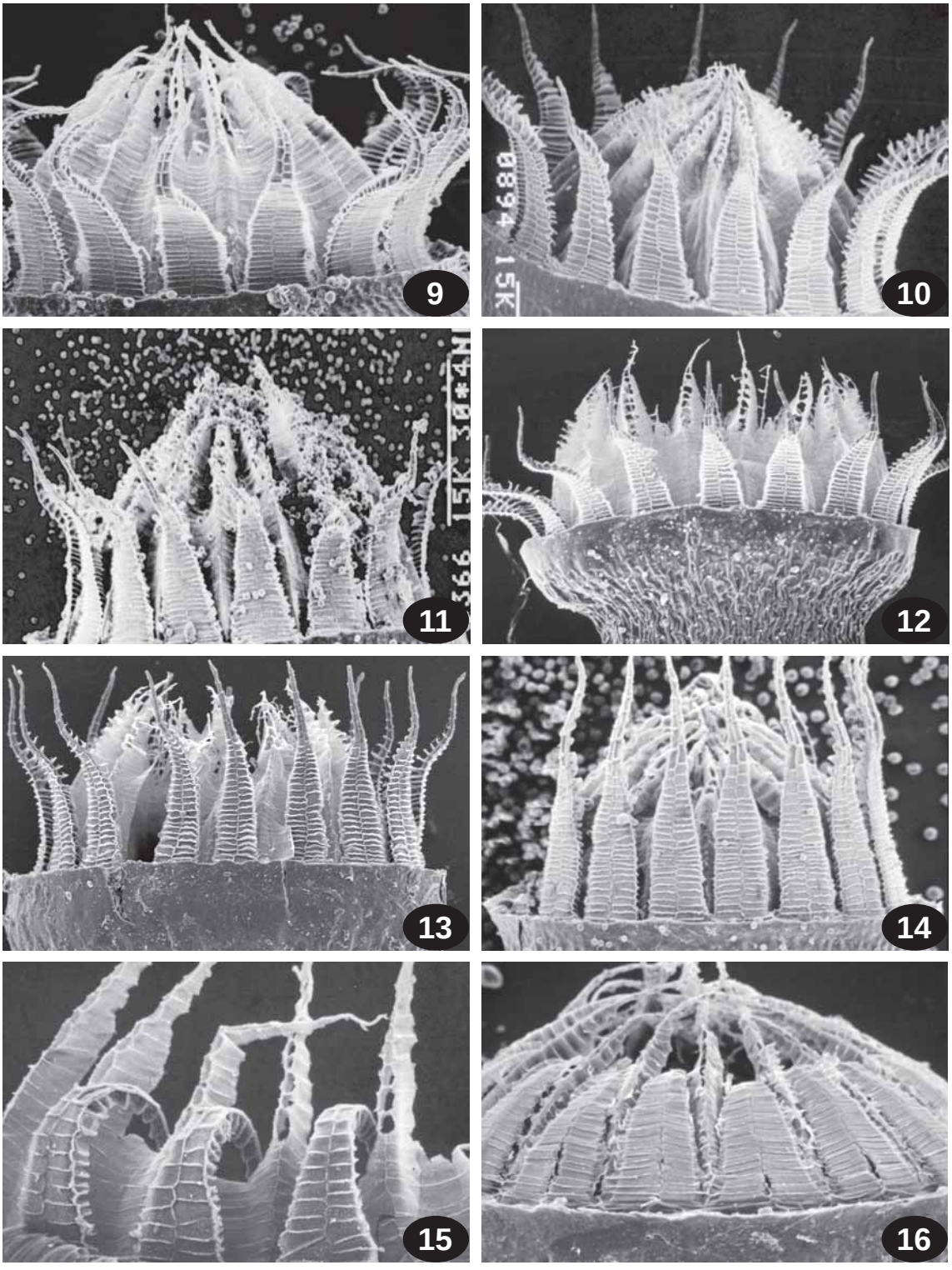
An important diagnostic character of tooth is the number of ventral trabeculae: they were count up to the upper well-developed one (i. e. uppermost non-projecting PPL transversal cells walls were not included).

The part of an exostome tooth below the lowermost ventral trabeculae is referred to as the 'fundus', and usually is considered important in the taxonomy of *Bryum*. The fundus can be broadened, i.e. markedly broader than the plates above, so the teeth are not attached to each other basally and appear distant from one from another (cf. Figs. 3, 5-6, 8). In other species, the fundus is not broadened, and the lower portions of the teeth are immediately adjacent to each other (Fig. 2, 16). The color of the fundus often differs from that of basal portions of the teeth; it can be paler or brighter, and usually has more intense orange or red pigmentation.

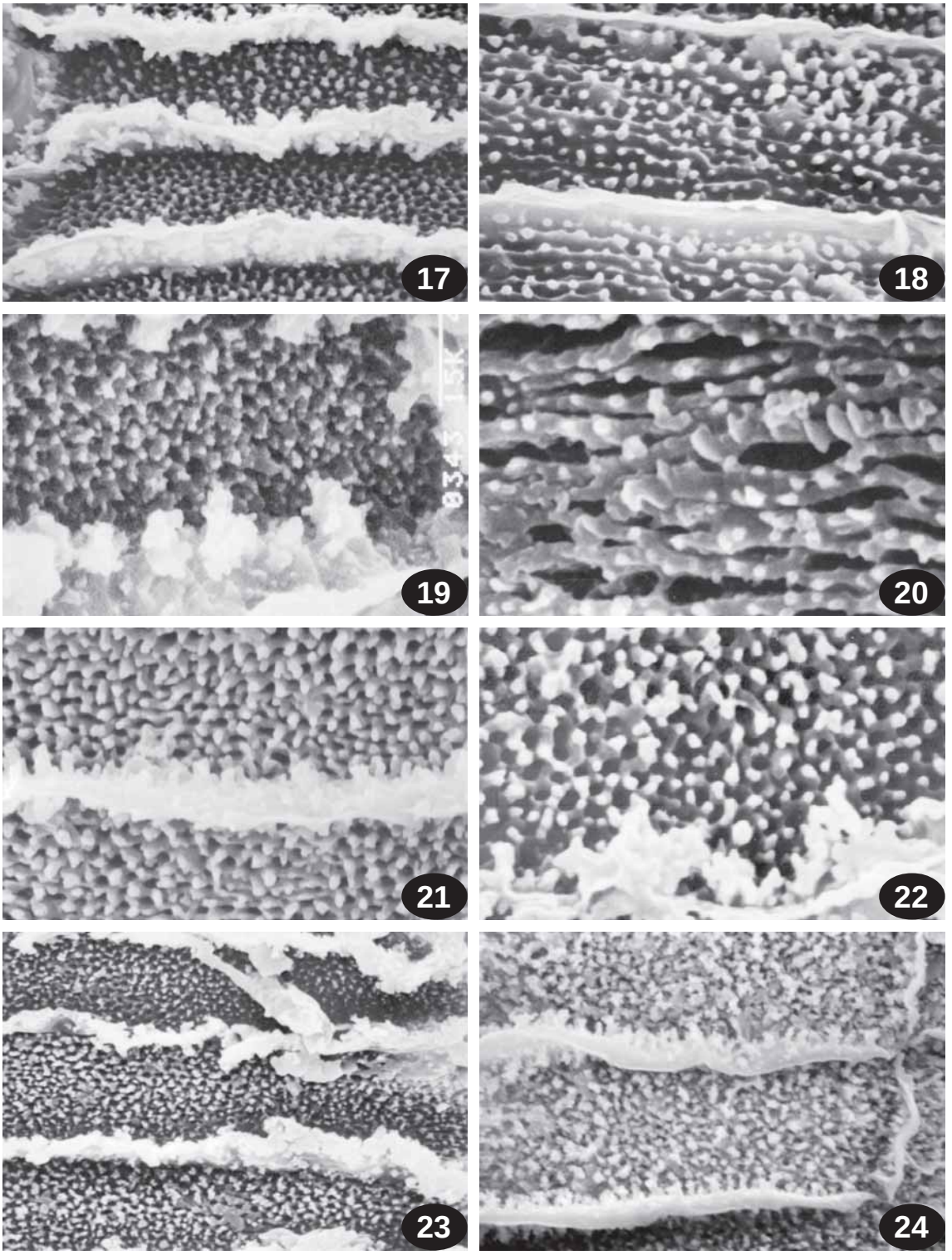
The outer surface of the lower part of the peristome appears papillose under the light microscope, while several states can be recognized under SEM. Distinct reticulate ornamentation (Fig. 27-30) is not a very common character state among the species examined. More often, the corners of the reticulum loops have papillae, which can be more or less dense and sometimes almost mask the reticulum (Figs. 17-19, 21-24). In a very few species (all from outside of our territory) the outer surface of the plates is striolate, and the striolae always are covered by small papillae (Figs. 18, 20: *B. purpurascens* (R. Br.) B. S. G., *B. muehlenbeckii* B. S. G.). The transition zone usually includes few plates (Fig. 33-35) with denser papillae that mask the reticulum, even in those species that have an obvious reticulum in lower portions of the teeth. Higher up, these densely papillose plates grade (usually very abruptly) into sparsely papillose, or sometimes totally smooth plates (Figs. 2, 35: *B. knowltonii, B. wrigtii* Sull. et Lesq., Figs. 2, 35). The uppermost part usually is colorless, hyaline, and variously papillose (Figs. 36-41), with papillae arranged in rows or not. The inner surface and ventral trabeculae of the segments in middle tooth are almost smooth in most species (Figs. 48-55). It is



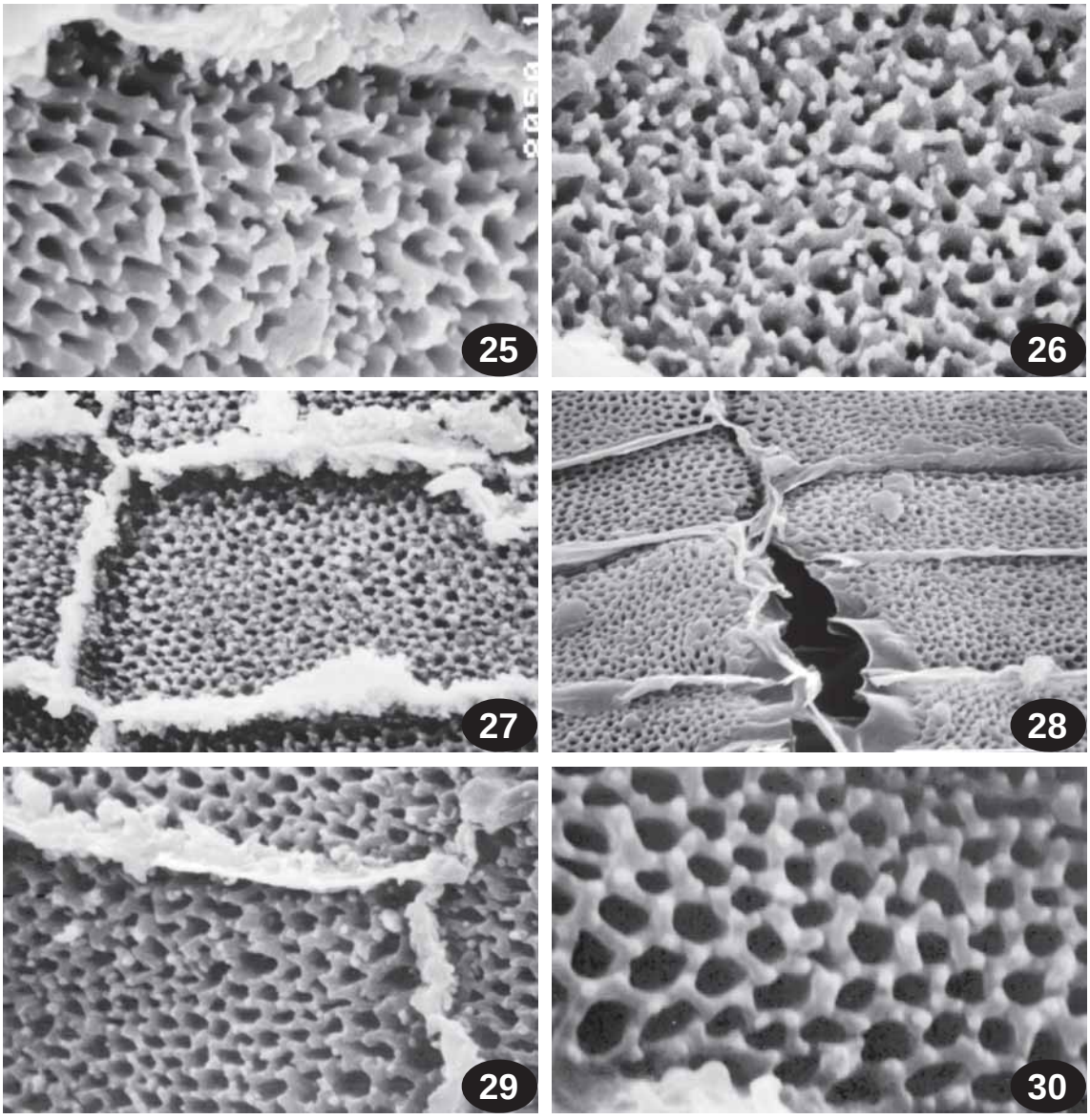
Figs. 1-8. Peristomes. 1 – *Bryum creberrimum* Tayl. (Perm Prov., Shchugor River, Bezgodov 6.VIII.1995, MW, 75x); 2 – *B. knowltonii* Barnes (Finland, Brotherus: Bryotheca Fennica 137, MW, 350x); 3 – *B. amblyodon* C. Muell. (Finland, Brotherus: Bryotheca fennica 136, MW, 110x); 4 – *B. arcticum* (R. Br.) B. S. G.(Komi Republic, Ukhta [Archangelsk Prov.], Zickendrath 3.VII.1895,H,105x); 5 – *B. schleicheri* Schwaegr.(Caucasus,Teberda Reserve,Onipchenko 121/94,MW,52x); 6 – *B. alpinum* Huds. ex With. (Schweiz, Bauer: Musci Eur. Exs. 331, MW, 180x); 7 – *B. bicolor* Dicks. (Istrien, Bauer: Musci Eur. Exs. 338, MW, 180x); 8 – *B. argenteum* Hedw. (Moscow, Filin 19811103-1, MW, 125x).



Figs. 9-16. Peristomes. 9 – *Bryum caespiticium* Hedw. (Moscow Prov., Dzerzhinsky, Ignatov,1996, MHA, 105x); 10 – *Bryum creberrimum* Tayl. (Perm Prov., Shchugor River, Bezgodov 6.VIII.1995, MW, 85x); 11 – *B. pseudotriquetrum* (Hedw.) Gaertn. & al., (Moscow Prov., Dzerzhinsky, Ignatov VI.1996, MHA, 87x); 12 – *B. lonchocaulon* C. Muell. (Karelia, Brotherus: Bryotheca Fennica 239, MW, 71x); 13 – *B. subapiculatum* Hampe (Novgorod Prov., Ulanova, 1999, MW, 105x); 14 – *B. sauteri* B. S. G. (Tirol; Fl. Exs. Austro-Hung. 2318, MW, 115x); 15 – *B. pallens* (Brid.) Sw. ex Roehl. (Tver Prov., Central Forest Reserve, Ignatov 5.VIII.1994, MHA, 220x); 16 – *B. calophyllum* R. Br. (Taimyr, Pospelova, VIII.1994, MW, 155x).



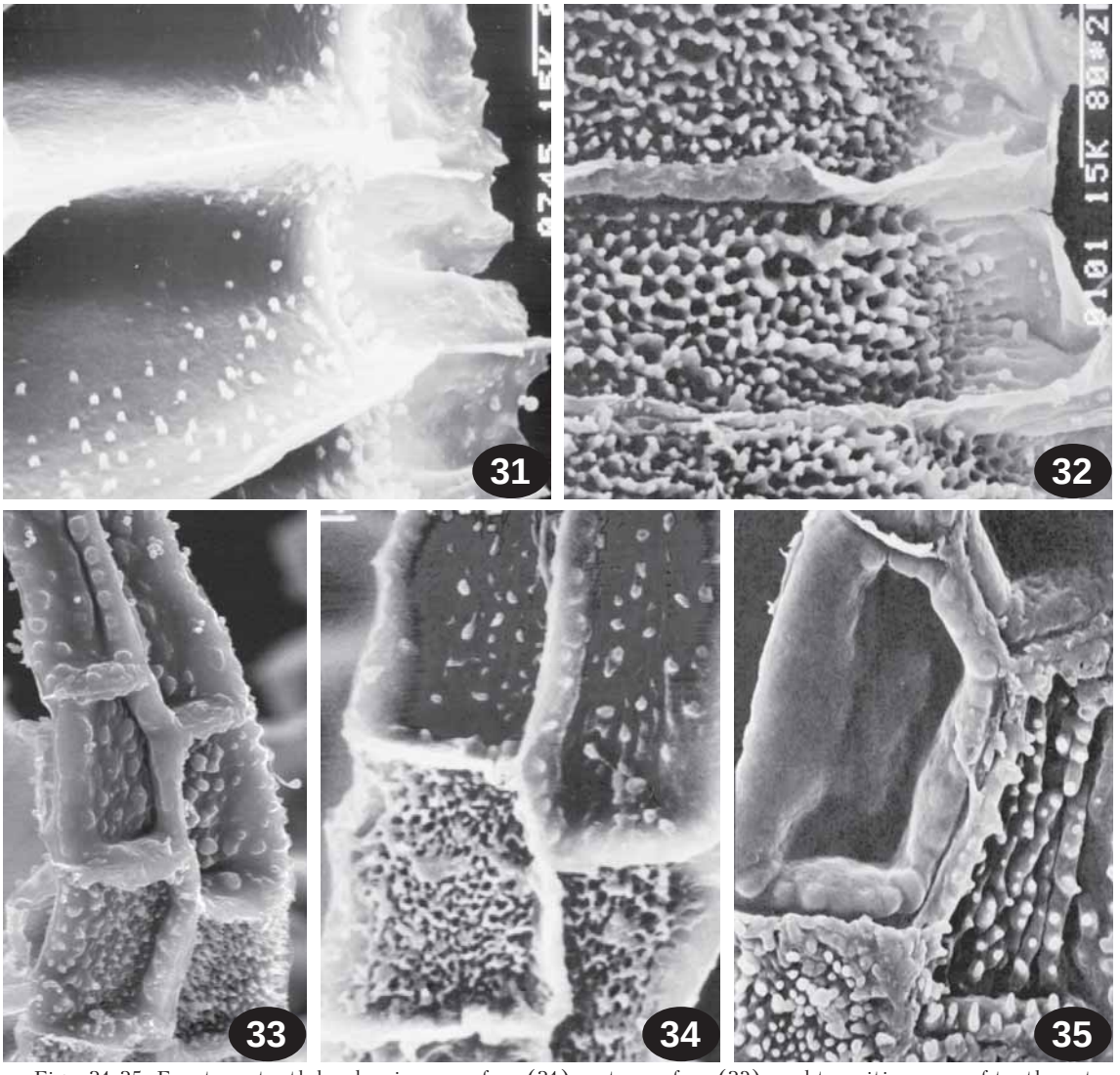
Figs. 17-24. Outer surface of lower exostome teeth. 17 – *Bryum argenteum* Hedw. (Moscow, Filin 19811103-1, MW, 1050x); 18 – *B. purpurascens* (R. Br.) B. S. G. (Finland, Brotherus: Bryotheca Fennica 235, MW, 3500x); 19 – *B. radiculosum* Brid. (Migula: Crypt. Germ. Austr. & Helv. Exs. 59, MW, 6530x); 20 – *B. muehlenbeckii* B. S. G. (Kola Peninsula, Schljakov, 2132, MW, 6850x); 21 – *B. weigelii* Spreng. (Europe [Germany?], Paul & Ruoff, 30.IV.1916, MW, 4630x); 22 – *B. algovicum* Sendtn. ex C. Muell. (Finland, Brotherus: Bryotheca Fennica 132, MW, 7160x); 23 – *B. subapiculatum* Hampe ([Europe], Breutel, 6437, MW, 2360x); 24 – *B. laevifilum* Syed (Czechia, Dombrovskaya, 28.IX.1957, MW, 2100x).



Figs. 25-30. Outer surface of lower exostome teeth. 25 – *Bryum cyclophyllum* (Schwaegr.) B. S. G. (Yaroslavl Prov., Meshcheryakov 1924, LE, 6990x); 26 – *B. caespiticium* Hedw. (Moscow Prov., Dzerzhinsky, Ignatov, VI.1996. MHA, 5000x); 27 – *B. lapponicum* Kaur. (Finland, Bauer: Musci Eur. Exs. 369, MW, 2860x); 28 – *B. calophyllum* R. Br. (Taimyr, Pospelova, VIII.1994, MW, 4000x); 29 – *B. pallens* (Brid.) Sw. ex Roehl. (Tver Province, Central Forest Reserve, Ignatov 5.VIII.1994, MHA, 5870x); 30 – *B. pallescens* Scleich. ex Schwaegr. (Finland, Brotherus: Bryotheca Fennica 148, MW, 10300x).

worthwhile to note two peculiarities: (1) In some species, the marginal part of the ventral surface in the transition to the tooth border has a distinct strip of fine papillae (Fig. 52); this pattern, however, was found to be variable, and lacking obvious taxonomic significance. (2) The inner surface of the upper part of the tooth is smooth in most species, but is rather densely papillose in *B. pallens*.

Another important character of the inner surface of exostome teeth is the presence of longitudinal and oblique septae between ventral trabeculae (Figs. 53-55). Their presence often is considered highly diagnostic and taxonomically important. My study confirms the importance of the regular presence of numerous septae in *B. algovicum* and *B. arcticum*, but such septae also occur rarely in many other species (for example, *B. caespiticium* and *B. schleicheri*, Figs. 53-54). However, rather firm septae, almost perpendicular to the ventral trabeculae, were found only in *B. algovicum* and

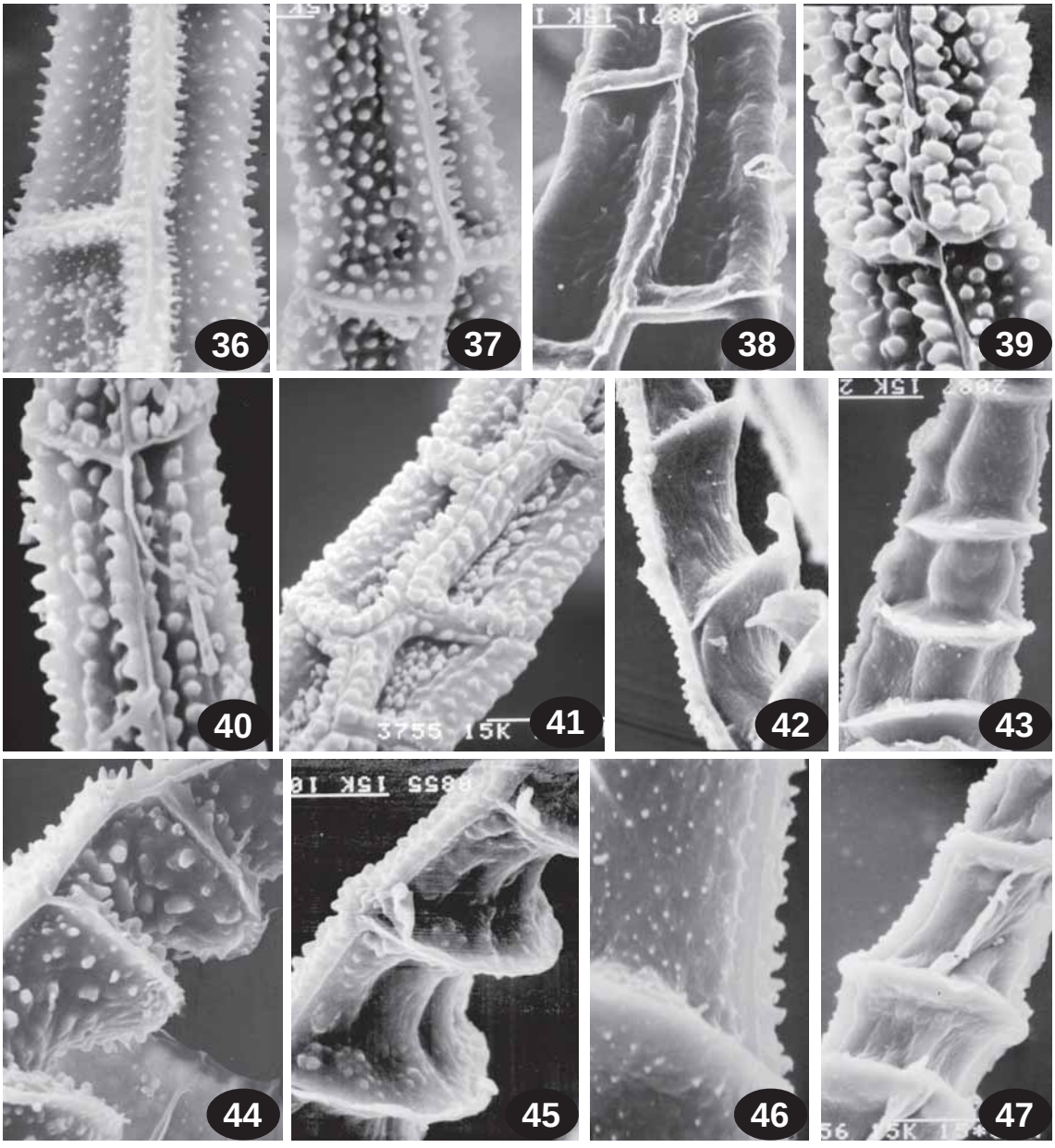


Figs. 31-35. Exostome tooth border: inner surface (31), outer surface (32), and transition zone of tooth, outer surface (33-35). 31 – *B. caespiticium* Hedw. (Moscow Prov., Pushchino, Ignatov, 18.VI.1996, MHA, 3400x); 32 – *B. wrigtii* Sull. et Lesq. (Chukotka, Afonina: Bryophyta Rossica et Civ. Coll Near. Exs., 54, MW, 1740x); 33 – *B. arcticum* (R. Br.) B. S. G. (Komi Republic, Ukhta [Archangelsk Prov.], Zickendrath 3.VII.1895, H, 1450x); 34 – *B. capillare* Hedw. (Switzerland, K. Korotkov, 1992, MW, 2230x); 35 – *B. wrigtii* (Chukotka, Afonina: Bryophyta Rossica et Civ. Coll Near. Exs., 54, MW, 2100x).

related species (Fig. 55).

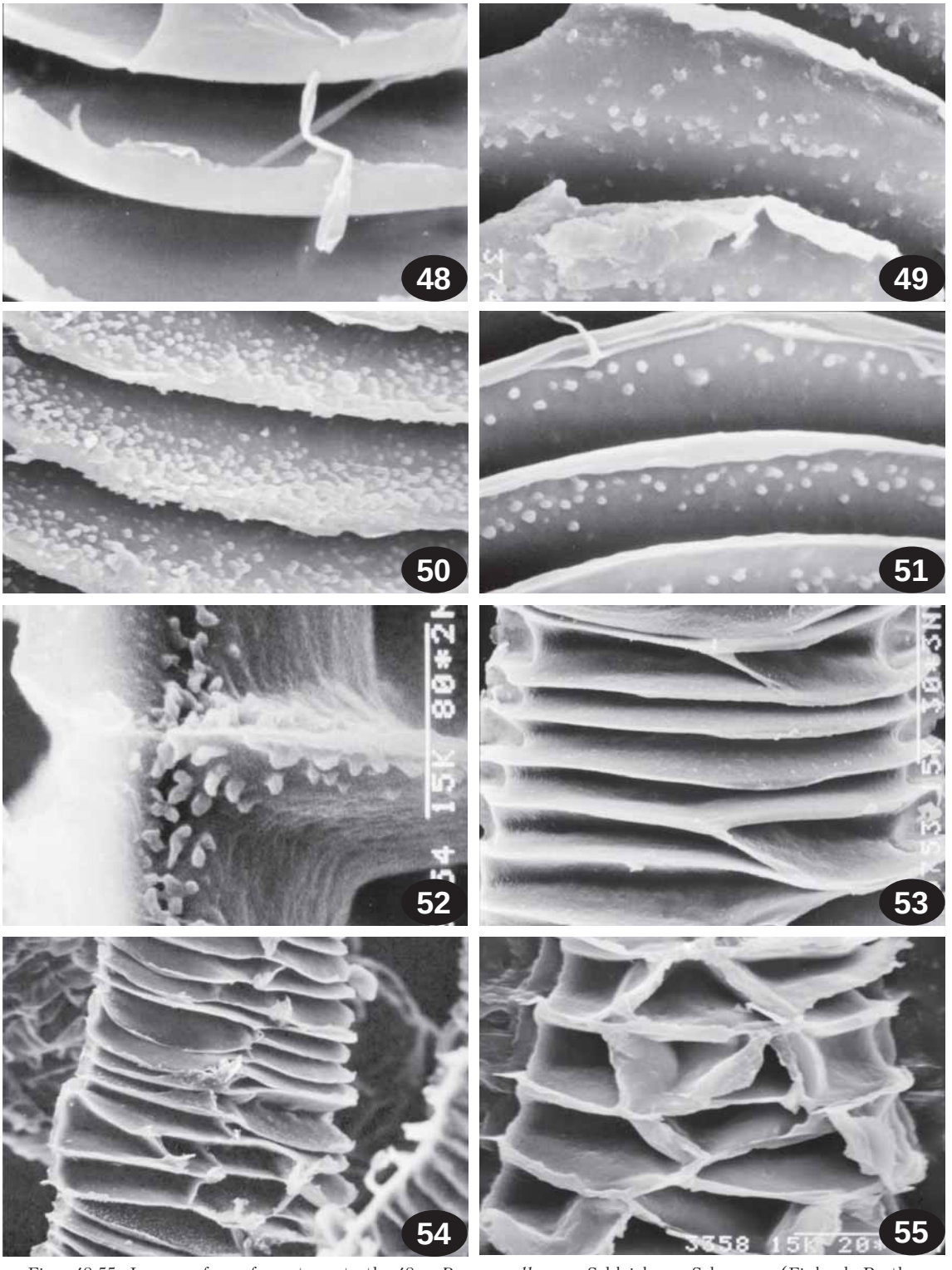
Lower and middle portions of the exostome teeth have a border. This zone is 4-12 mkm wide and appears pellucid under the light microscope. Under SEM, it is defined as a marginal area that is: (1) much thinner than the central part of the plate; and (2) lackingthe ornamentation developed in the central part of the plate. The tooth border often is considered as being composed only from the OPL, without PPL material; however, at least at the inner trabeculae, the PPL contributes some material to its formation (Figs. 31-32). The width of the tooth border is a useful character for some sections of the genus; for example, species with a ± reduced peristome (*B. knowltonii, B. arcticum*) usually have a narrower border. The tooth border also is relatively narrow in species of the *B. erythrocarpum* complex.

The endostome of *Bryum* has a more variable structure than the exostome. The most highly developed, or perfect, endostome hasa high basal membrane (about 1/2 the endostome length), broad segments, and 2-3(-4) cilia with long appendiculae. In this case, the endostome leaves only a small

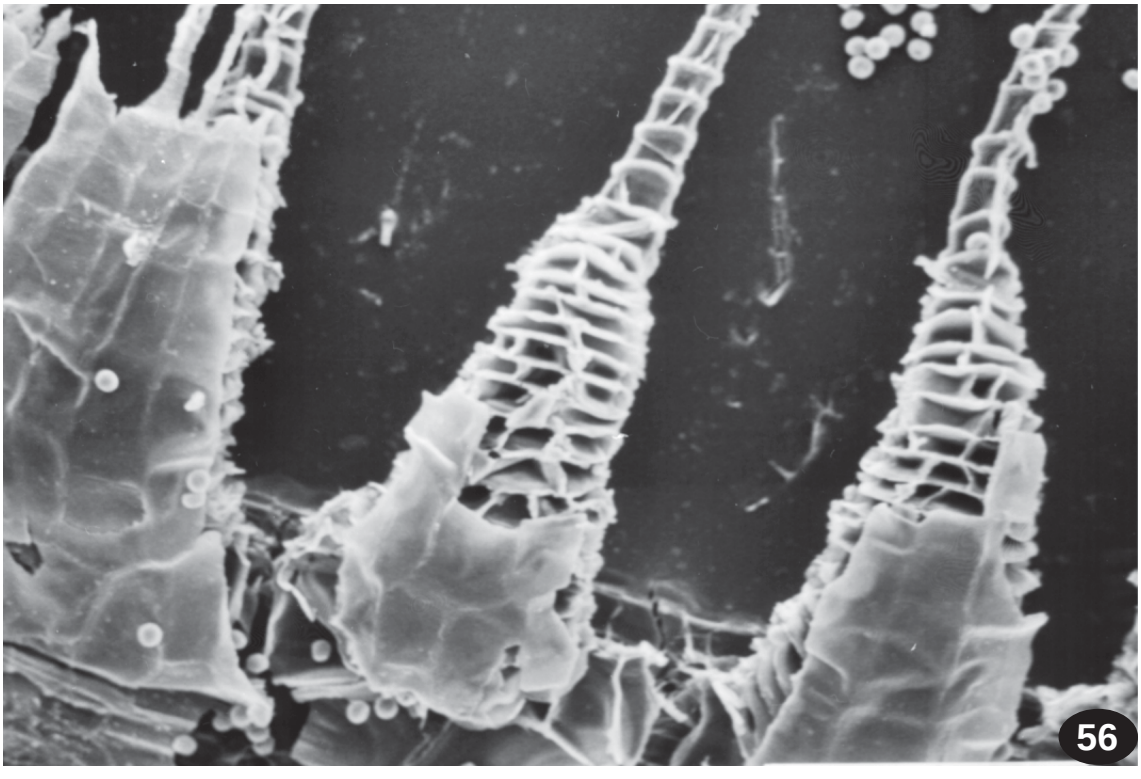


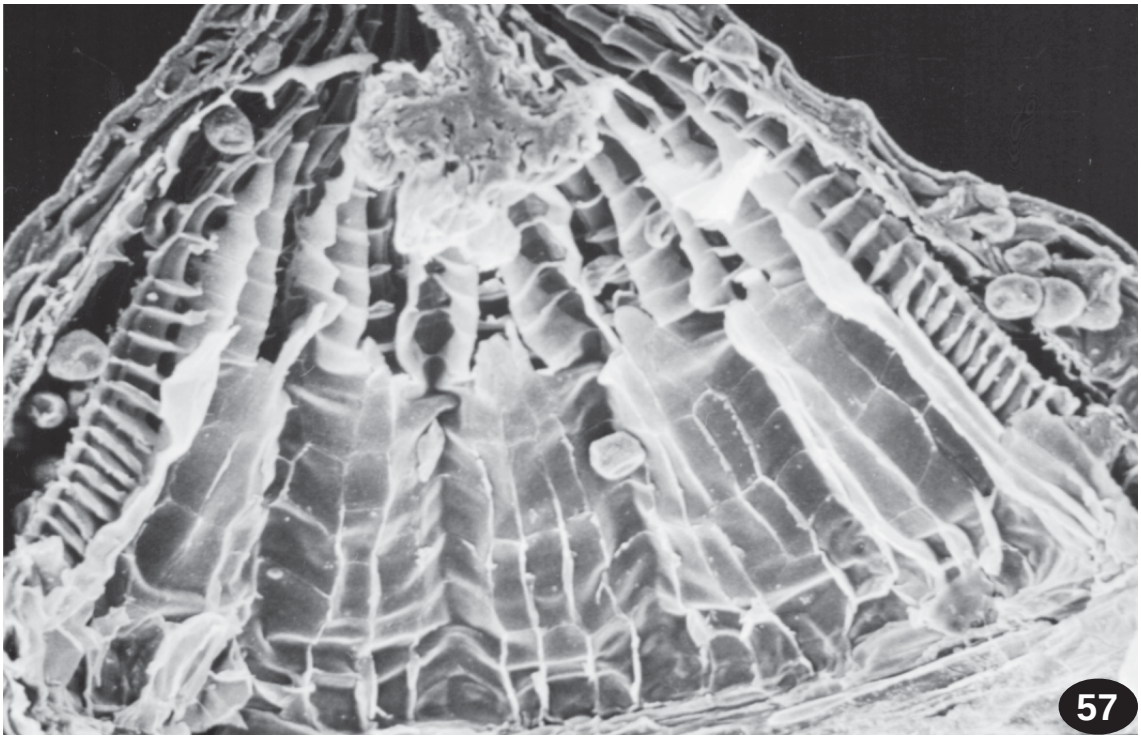
Figs. 36-47. Upper exostome teeth: outer surface (36-41) and inner surface (42-47). 36 – *Bryum archangelicum* B. S. G. (Murmansk Prov., Schljakov, 30.VII.1948, LE, 2050x); 37 – *B. laevifilum* Syed (Czechia, Dombrovskaya, 28.IX.1957, MW, 3340x), 38 – *B. purpurascens* (R. Br.) B. S. G. (Finland, Brotherus: Bryotheca Fennica 25, MW, 1270x), 39 – *B. blindii* B. S. G. ([Europe] #6447 [Muell. n. 59], MW, 2530x); 40 – *B. weigelii* Spreng. (Europe [Germany?], Paul & Ruoff, 30.IV.1916, MW, 2120x); 41 – *B. torquescens* B. S. G. ([Europe] #6425 [Muell. n. 32], 1910x); 42 – *B. pseudotriquetrum* (Hedw.) Gaertn. & al., (Moscow Prov., Dzerzhinsky, VI.1996, MHA, 1250x); 43 – *B. schleicheri* Schwaegr. (Caucasus, Teberda Reserve, Onipczenko 121/94, MW, 950x); 44 – *B. pallens* (Brid.) Sw. ex Roehl. (Tver Prov., Central Forest Reserve, Ignatov 5.VIII.1994, MHA, 2000x); 45 – *B. intermedium* (Brid.) Bland. (Finland, Bryotheca Fennica 147, MW, 1910x); 46 – *B. umbratum* Hag. (Murmansk Prov., Schljakov 8.IX.1948, MW, 2650x); 47 – *B. algovicum* Sendtn. ex C. Muell. (Finland, Brotherus: Bryotheca Fennica, 132b, MW, 1270x).

window for spores to disperse (Fig. 1), which seems very adaptive for species with principally pendulous capsules. Modified endostomes, often termed "reduced", have: (1) a lower basal membrane (to 1/3 of the endostome height in our species); (2) narrower segments; (3) shorter and fewer, (1-)2, cilia; and (4) cilia appendiculae exhibit a reduction series (long appendiculate - short appendiculate - nodose - flat and short – almost none). Species with reduced peristomes often have larger

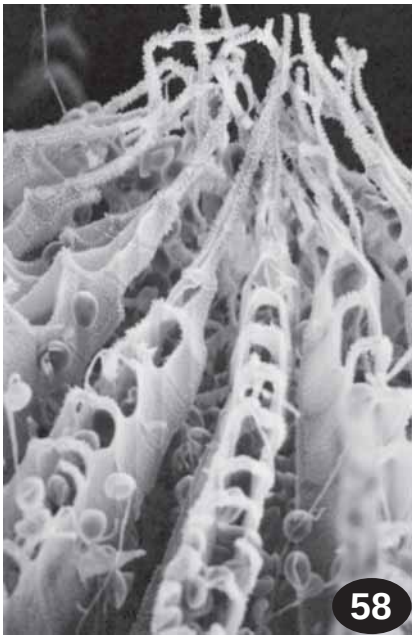


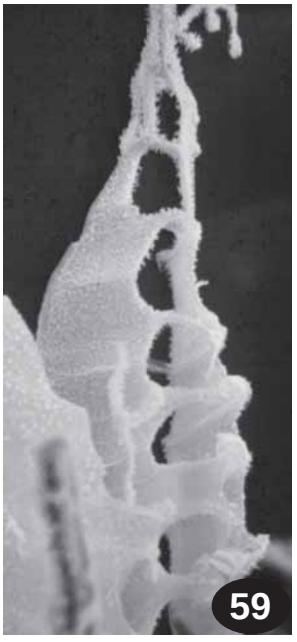
Figs. 48-55. Inner surface of exostome teeth. 48 – *Bryum pallescens* Schleich. ex Schwaegr. (Finland, Brotherus: Bryotheca Fennica 148, MW, 1270x); 49 – *B. pallens* (Brid.) Sw. ex Roehl. (Bashkortostan, Nosov, AH-91605, MW, 2170x); 50 – *B. sauteri* B. S. G. (Tirol, Fl. Exs. Aust.-Hung. 2318, MW, 1810x); 51 & 53 – *B. caespiticium* Hedw. (Moscow Prov., Pushchino, Ignatov, 18.VI.1996, MHA, 2660x, & 865x); 52 – *B. caespiticium* (Moscow Prov., Dzerzhinsky, Ignatov, VI.1996, MHA, 3880x); 54 – *B. schleicheri* Schwaegr. (Caucasus, Teberda Reserve, Onipchenko 121/94, MW, 530x); 55 – *B. algovicum* Sendtn. ex C. Muell. (Finland, Brotherus: Bryotheca Fennica 132b, MW, 1050x).

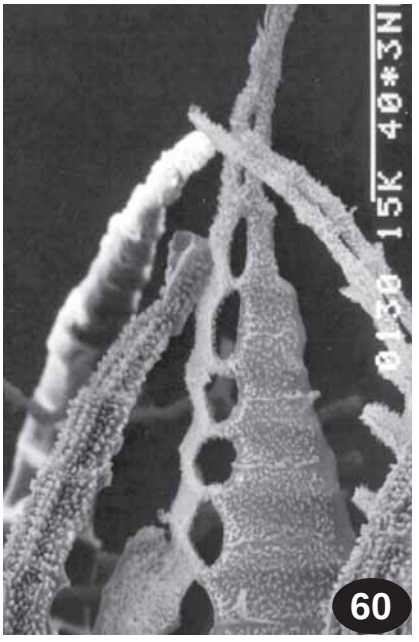


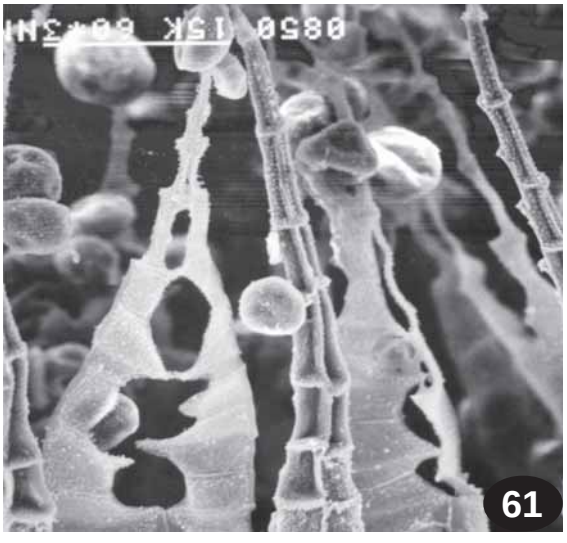


Figs 56-57. Peristomes from inside. 56 – *Bryum algovicum* Sendnt. ex C. Muell. (Finland, Brotherus: Bryotheca Fennica,132b,MW,356x); 57 – *B. amblyodon* C.Muell.(Caucasus; Teberda Reserve,Onipczenko 110/95,MW,283x).



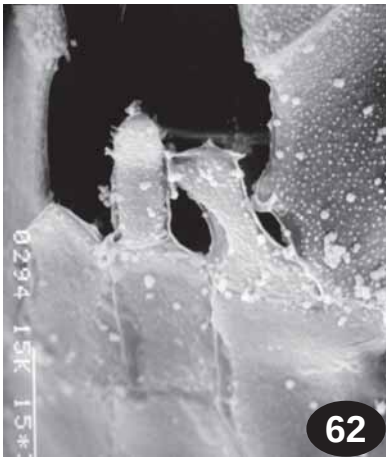


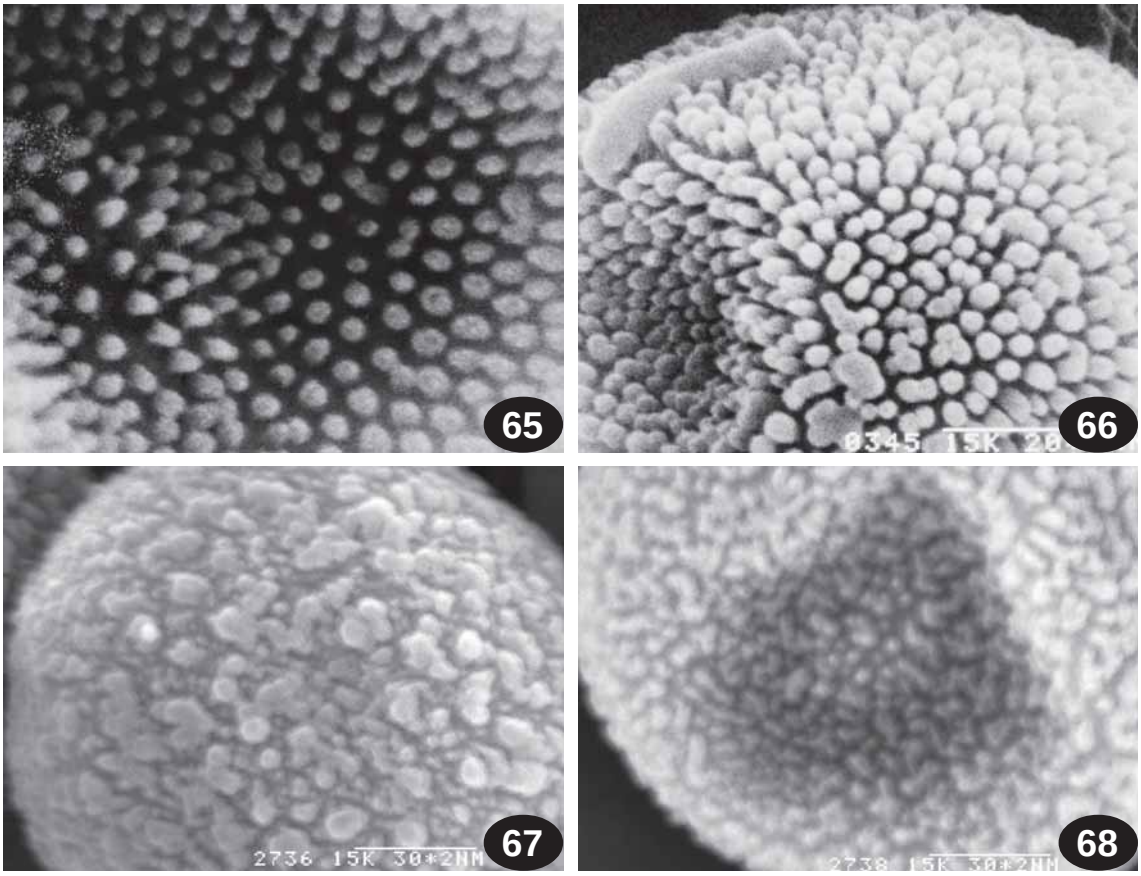




Figs. 58-61. Endostome segments. 58 – *Bryum creberrimum* Tayl. (Perm Prov., Shchugor River, Bezgodov, 6.VIII.1995,MW,420x); 59 – *B. funckii* Schwaegr.(Lipezk Prov., Samsel, 82, MW, 6450x); 60 – *B. klinggraeffii* Schimp. ex Klinggr. (Austria, Fl. Exs. Aust.-Hung. 2317, MW, 680x), 61 – *B. amblyodon* C. Muell. (Finland, Brotherus: Bryotheca Fennica 136, MW; 410x).

Figs. 62-64. Cilia (62) and upper parts of ciliae. 62 – *Bryum amblyodon* (Caucasus,Teberda Reserve,Onipczenko 110/95, MW, 1270x); 63 – *B. argenteum* Hedw. (Moscow, Filin 19811103-1, MW, 7500x); 64 – *B. caespiticium* Hedw. (Moscow Prov., Dzerzhinsky, Ignatov, VI.1996, MHA, 1900x).





Figs. 65-68. Spores. 65 – *Bryum algovicum* Sendtn. ex C. Muell. (Orel, Rostovtsev, 1098, MW, 13400x); 66 – *B. radiculosum* Brid. (Migula: Crypt. Germ., Austr. & Helv. 59, MW, 10000x); 67 – *B. uliginosum* (Brid.) B. S. G. (Moscow, Zickendrath 402, LE, 5300x); 68 – *B. intermedium* (Brid.) Bland. (Lipezk Prov., Argamal-Palshe, coll. Popova 23VII.1994, VOR, 5300x).

spores and the endostome adheres to the exostome. The manner of adherence is an important character in the classification of *Bryum*. The most adherent endostome, often called "tightly adherent", is represented in *B. algovicum;* it can be separated from the exostome only with great difficulty. I was able to get an SEM picture of the inner surface of the lower exostome of this speces (Fig. 56) only after a part of the endosome was stripped off with a piece of sticky tape. Otherwise,the endostome is tightly attached throughout the lower half of the teeth. Therefore, I call this state "adherent throughout the basal membrane". In the group of species close to *B. amblyodon,* the endostome often is described as "attached" or "loosely adherent". It usually is positioned close to the teeth (Fig. 57), but its large fragments, consisting of segments with basal membrane, can be removed with fine forceps. However, I was unable to remove any large fragment of endostome with an entire basal portion, where it probably adheres to the teeth. Thus, I call this endostome state "adherent at the base". In species with the most highly developed endostomes, the endostome is free and readily detachable with the spore sac.

Endostome segments are broadly perforated along the keel in the lower part in most species (Figs. 58-59); perforations frequently are fused forming irregular gaps (Fig. 61). Narrow segments usually have narrower perforations (*B. uliginosum,* sometimes in *B. amblyodon*, Fig. 60), but this correlation is, to some extent, relative. Perforations were not a subject for measurements because of their complex three-dimensional structure, which was affected considerably by the type of preparation. Similarly, the width of segments depends on how much they have been flattened on a slide. To avoid this problem, I separated segments in two halves and then measured them in the lowermost part. This measurement is given in the species descriptions as 'width of half of the segment'.

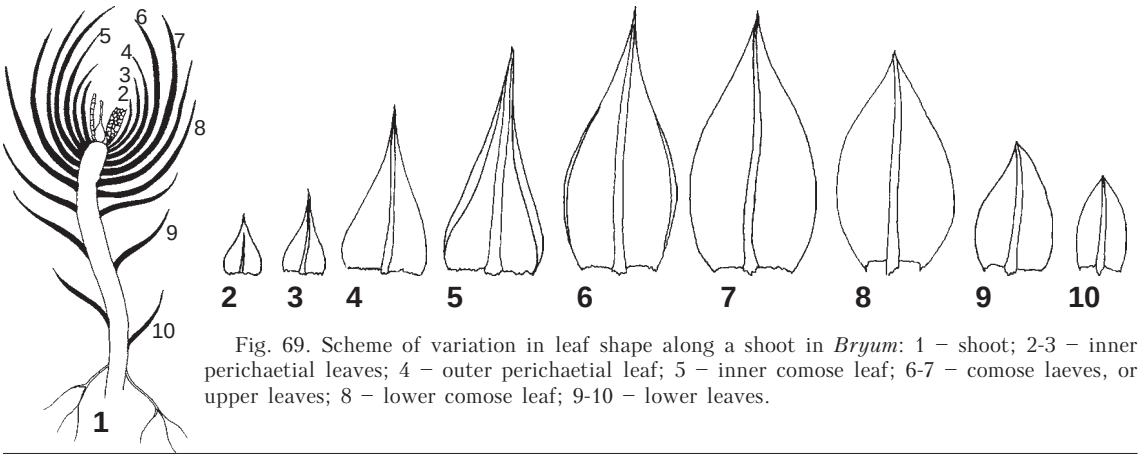


Fig. 69. Scheme of variation in leaf shape along a shoot in *Bryum*: 1 – shoot; 2-3 – inner perichaetial leaves; 4 – outer perichaetial leaf; 5 – inner comose leaf; 6-7 – comose laeves, or upper leaves; 8 – lower comose leaf; 9-10 – lower leaves.

Cilia in most species about as long as segments, and called in this case 'long'; rarer they are short (Fig. 62). Upper parts of ciliae are often papillose, with high, thin papillae (Fig. 64); rarely do they have low papillae (cf. *B. argenteum*, Fig. 63).

Spores appear finely papillose to smooth under the light microscope, but analyses with SEM reveal that the surface is always papillose. Papillae usually are quite dense and blunt (Fig. 66), rarely ±tapered apically (in *B. algovicum*, Fig. 65). In two species, some peculiarities were noted: (1) in *B. uliginosum,* the papillae are dimorphous, with a few large papillae among small, low and dense ones (Fig. 67); and (2) in *B. intermedium,* the distibution of papillae over the spore surface is not even, but rather brain-like (Fig. 68). However, these data must be considered preliminary, because they are based on the observation of single specimens of each species.

Bryum Hedw.

Plants dioicous, autoicous, synoicous, or polyoicous (partly synoicous, partly male, partly female). Male and female plants of dioicous species in mixed or in separate tufts; male plants more slender and more loosely foliate than or similar to female plants. *Perigonium* terminal, capitate to wide; perigonial leaves short, broad, sometimes more intensively colored than stem leaves (yellowish, brownish, pinkish to reddish); antheridia pale-pinkish to purple; paraphyses pale yellow to brownish and reddish, as long as antheridia to twice as long, usually only slightly longer; in autoicous species subterminal shoots long to short, inserted below perichaetium or within it.

Plants in loose, compact or dense tufts, or as separate individuals scattered on substrate; individuals separating from tuft readily or difficult due to close rhizoid interweave. *Tufts* from less than 0.5 mm to 10-12 cm; green or yellow-green to brownish, pinkish, vine-red, glaucous, whitish, argentate, or variegate by mixture of green, yellow-brownish and purplish; dull to glossy. *Stem* usually red, more rarely pale, firm and rigid to thin and slender, with 1-3(-5) subterminal shoots. *Rhizoids* axillary, usually at stem base, rare to the tip of stem, fuscous to dark-brown, red-brown, deep-violet; nearly smooth to warty papillose. *Foliage* comose (upper leaves enlarged and crowded) or homogeneous; loosely imbricate, distinctly julaceous, or leaves remotely arranged. *Leaves* usually ovate to ovate-lanceolate, broader basally; comose ones usually largest, 0.5-6.0 mm long, 0.5-2.5 mm wide; inner comose ones smaller and narrower, with more strongly recurved margins, closer to perichaetium leaves small, oblong-obovate, spathulate, narrow-lanceolate, triangular, cordate, obcordate, orbicular; acute to acuminate, rarely rounded, or roundly contracted into piliferous acumen; decurrent or not, sometimes longly so; plane, concave, or carinate; margin plane, recurved to reflexed and revolute; border distinctly differentiated or transition between lamina and border rather gradual, of the same color as lamina, or yellowish to brownish, 1- to 6-7-rowed, unistratose or partly bistratose; costa single, ending below apex, or more frequently percurent to longly excurrent; leaf base with red pigmentetion or not. *Laminal cells* in mid-leaf rhombic, rhomboid, hexagonal, partly rectangular, towards the apex cells

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
B. algovicum	0	0	0	0	0	1	**0**	0	2	0	**1**	**2**	3	1	0	0	0
B. alpinum	0	**3**	**1**	**1**	0	0	0	0	1	0	0	0	0	0	0	0	1
B. arcticum	0	1	0	0	0	1	**1**	0	0	0	**1**	**2**	3	1	0	0	0
B. argenteum	0	**2**	**1**	**2**	0	2	0	0	1	0	0	0	0	0	0	0	0
B. amblyodon	0	0	**0**	0	0	1	0	0	2	0	0	**1**	**3**	1	0	0	0
B. bicolor	0	0	**1**	0	0	2	0	0	1	0	0	0	0	0	0	**1**	0
B. bimum	0	0	0	0	0	1	0	**1**	**0**	0	0	0	0	0	0	0	0
B. caespiticium	0	0	0	0	0	**0**	0	0	**1**	0	0	0	0	0	0	0	2
B. capillare	0	0	0	**2**	0	**1**	0	0	1	0	0	0	0	0	**0**	0	2
B. creberrimum	0	0	0	0	0	1	0	0	**0**	0	0	0	0	0	0	0	0
B. cyclophyllum	**1**	**1**	0	**1**	0	**2**	0	0	1	0	0	0	0	0	2	0	0
B. elegans	0	0	**1**	2	0	**2**	0	0	1	0	0	0	0	0	**0**	0	2?
B. funkii	0	**2**	**1**	**0**	0	2	0	0	1	0	0	0	0	0	0	0	0
B. intermedium	0	0	0	0	0	1	0	0	**0**	**1**	0	0	**1**	**1**	0	0	0
B. klingraeffii	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
B. knowlonii	0	0	**1**	0	0	0	0	0	**2**	0	0	**1**	**3**	1	0	0	0
B. kunzei	0	0	**1**	0	0	**2**	0	0	1	0	0	0	0	?	0	0	0
B. laevifilum	0	0	0	**2**	0	1	0	0	1	0	0	0	0	0	**1**	0	2?
B. lonchocaulon	0	0	0	0	0	1	0	0	**2**	0	0	0	**0**	0	0	0	0
B. pallens	0	**1**	0	0	0	**1**	1	0	**1**	1	0	0	**2**	0	2	0	0
B. pallescens	0	0	0	0	0	1	0	0	**3**	0	0	0	**0**	0	0	0	0
B. pseudotriquetrum	**1**	0	0	0	0	**1**	0	0	**1**	0	0	0	0	0	2	0	0
B. rubens	0	0	0	0	0	**1**	0	0	1	0	0	0	0	0	0	0	**1**
B. schleicheri	**1**	0	**1**	**1**	0	**0**	0	0	1	0	0	0	0	0	0	0	0
B. subapiculatum	0	0	0	0	0	**0**	0	0	1	0	0	0	0	0	0	0	**1**
B. turbinatum	0	**1**	0	0	0	**0**	0	0	**1**	0	0	0	0	0	0	0	0
B. uliginosum	0	0	0	0	0	1	1	0	**3**	**1**	0	1	0	1	0	0	0
B. violaceum	0	**4**	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
B. weigelii	**1**	1	0	0	**1**	2	0	0	1	0	0	0	0	0	0	0	0

Tabl. 1. The important diagnostic characters of *Bryum* species; boldfaced are characters usually allowing to recognize species in our area by their combinations: **1**: Tufts 0 – <4 cm; 1 – often > 4 cm; **2**: Tuft color: 0 – ±yellow-green; 1 – pinkish to red; 2 – whitish to silvery; 3 – variegate (green, golden to red); 4 – purple to violet; **3**: Leaves (when dry): 0 – not closely imbricate; 1 – closely imbricate; **4**: Leaf: 0 – acute to acuminate; 1 – bluntly acute to rounded; 2 – abruptly contracted into piliform acumen; **5**: Decurrency: 0 – none to ±short; 1 – about as long as leaf; **6**: Leaf border: 0 – indistinctl delimited; 1 – distinctly delimited; 2 – absent; **7**: Leaf border: 0 – unistratose; 1 – bistratose; **8**: Laminal cells: 0 – ±thin-walled; 1 – thick-walled; **9**: Sexual condition: 0 – synoicous; 1 – dioicous; 2 – polyoicous; 3 – autoicous; **10**: Capsule: 0 – ±symmetric; 1 – curved; **11**: Longitudinal septae between ventral trabeculae of exostome teeth: 0 – absent or few; 1 – regularly present; **12**: Edostome: 0 – free; 1 – adherent at base; 2 – adherent throughout basal membrane; **13**: Ciliae: 0 – long, appendiculate; 1 – long, nodose; 2 – short and appendiculate; 3 – short to rudimental; **14**: Spores: 0 – mostly 10-20 mkm; 1 – mostly >22 mkm; **15**: Brood filaments; 0 – absent; 1 – usually present; 2 – occasionally present; **16**: Axillary gemmae: 0 – absent; 1 – present; **17**: Rhizoid gemmae: 0 – absent; 1 – usually present; 2 – occasionally present.

narrower, towards base larger and usually rectangular, in leaf corners subquadrate, sometimes inflated; cell walls thin-walled to somewhat incrassate, porose or not, in upper cells thicker than in mid-leaf.

Inner perichaetial leaves small, ovate to lanceolate. *Seta* 1 to 6 cm long, pale-brownish to deep purple, chestnut, or blackish, rigid to slender, straight or twisted when dry, below capsule arcuate to abruptly hooked (affecting capsule orientation). *Capsule* 1.5-6 mm long, 0.5-2.5 mm thick, usually obovate to pyriform, sometimes shortly obovate to clavate or cylindric, mostly symmetric, sometimes curved and somewhat gibbosus; constriction below mouth indistinct to strong; neck usually twice as long as urn, sometimes as long or slightly longer or quite short; capsule color fuscous to brown, purple, deep violet, or blackish. *Operculum* small, in diameter from much smaller to nearly as large as urn diameter, convex or conic, low or high, with small acute or blunt apiculus or small beak; operculum color similar to capsule, brighter or darker, glossy or dull. *An-*

nulus 1-2- to 3-4-rowed, deciduous. *Peristome* double, inserted at urn mouth or markedly below, holodontous or rarely aulacodontous. *Exostome* teeth 16, when dry mostly erect or erect-reflexing,rarely curved-arcuate,with tips inserted in between endostome segments; teeth gradually tapered in transition zone in most of species, rarely more abruply tapered, pale-yellow to brownish, reddish, or orangish; uppermost part usually hyaline, variously papillose; fundus broadened or not broadened, pale to bright orange to red; median line zig-zag-shaped to almost straight; ventral trabeculae 9-40, rarely with longitudinal septae; inner surface and ventral trabeculae smooth to finely papillose, rarely regularly papillose above. *Endostome* pale to yellowish, rarely orangish, as long as exostome or somewhat shorter, free and easily separated with the spore sac, or rarely tightly adherent to exostome all along the basal membrane, or weakly adherent in basal portion only; basal membrane usually ca. 1/2 of its heigth, rarely higher; segments narrow to broad, keeled, split above and perforate below, perforations usually broad, often fused, forming irregular gaps, rarely perforations narrow; ciliae well developed, appendiculate, rarely nodose to short and broad, highly (most of species) to lowly papillose. *Spores* yellowish, brownish, olive-green, or greenish.

KEY TO *BRYUM* SPECIES IN THE MIDDLE EUROPEAN RUSSIA

(In addition to the key, identification is possible by Tabl. 1, p. 169, where the combinations of important diagnostic characters are given).

1. Endostome adherent to exostome throughout basal membrane; teeth with numerous septae in between ventral trabeculae, usually from tooth base to its upper part; synoicous, rarely polyoicous 2
– Endostome adherent to exostome at base or free; septae absent or few and scattered; sexual condition variable 3
2. Septae between ventral trabeculae in lower tooth rather numerous, forming brick-wall pattern; leaf border unistratose . . . . . *B. algovicum* (p. 172)
– Septae between ventral trabeculae mostly along median tooth; leaf border bistratose . . . . . *B. arcticum* (p. 174)
3. Endostome adherent to exostome at base; cilia always short, non-appendiculate, or absent 4
– Endostome free, cilia as long as or at least half as long as segments, nodose to appendiculate 6
4. Autoicous; ventral trabeculae 25-30; cilia none to very short, rather narrow; capsule curved, with narrow oblique mouth . . . . . *B. uliginosum* (p. 178)
– Synoicous; ventral trabeculae 14-20(-25); cilia short, broad; capsule symmetric 5
5. Stem comosely foliate; costa longly excurrent; basal membrane 1/3-1/2 of endostome length . . . . . *B. amblyodon* (p. 174)
– Stem evenly foliate on most of its length; costa percurrent or shortly excurrent; basal membrane 1/3 of endostome length . . . . . *B. knowlonii* (p. 176)
6. Cilia long, rigid, thin, nodose, rarely with short appendicules; capsule curved, somewhat gibbosus; operculum persistent long after maturation; synoicous . . . . . *B. intermedium* (p. 194)
– Cilia appendiculate; capsule symmetric or curved; operculum readily falling off after maturation; sexual condition variable . . 7
7. Cilia 1/2-3/4 of segments length; capsule curved, with broad mouth; leaf border bistratose at places; plants green to vine-red; dioicous species, growing in moist to wet places . . . . . *B. pallens* (p. 179)
– Ciliae slightly shorter than segmens; capsule ±symmetric; leaf border unistratore, rarely bistratose; plants color, sexual condition and habitats variable 8
8. Autoicous, synoicous or polyoicous; leaf border present 9
– Dioicous; leaf border present or absent . . 12
9. Plants regularly autoicous, with both male and female inflorescences on every plant; shoots ±long, rather evenly and densely foliate below comose leaves . . . . . *B. pallescens* (p. 196)
– Synoicous or polyoicous (mostly synoicous with numerous male and occasionally female inflorescences); shoots relatively short, rather loosely foliate, with leaves markedly descreasing downwards 10

10. Leaves shortly acuminate to acute, decurrent, costa excurrent in stout short awn; laminal cells thick-walled, tuft to 2-6 cm high . . . . . *B. bimum* (p. 202)
– Leaves ±longly acuminate, not or shortly decurrent, costa excurrent in long awn; laminal cells thin-walled, tuft to 1-3 cm high . . 11
11. Synoicous; subterminal shoots bearing synoicous inflorescences; border (1-)2-3(-4)-rowed, narrow, yellowish . . . . . *B. creberrimum* (p. 202)
– Polyoicous; subterminal shoots bearing male inflorescences; border (4-)6(-7)-rowed, broad, similar in color to lamina . . . . . *B. lonchocaulon* (p. 200)
12. Brood bodies common 13
– Brood bodies absent to occasionally present (*B. pallens, B. pseudotriquetrum* might have short axillary brood filaments; *B. argenteum* – short brood branches; *B. elegans, B. caespiticium* – fragile branches and rhizoid gemmae) 19
13. Brood bulbs in leaf axils, fuscous to reddish, with minute leaves in upper part; tufts dense, green to brownish-green; female plants with numerous julaceous subterminal shoots . . . . . *B. bicolor* (p. 226)
– Axillary bulbs absent 14
14. Plants with rhizoid gemmae . . . . . *B. erythrocarpum*-complex[1] 15
– Plants with axillary brood filaments . . 18
15. Gemmae 60-110 µm in diameter . . . 16
– Gemmae usually larger than 150 µm in diameter 17
16. Gemmae light-brownish, red, or rich violet, round to irregularly globose; surface cells not projecting . . . . . *B. violaceum* (p. 221)
– Gemmae red to purple; round to pyriform; surface cells convex . . *B. klingraeffii* (p. 222)
17. Gemmae on long rhizoids within and on soil surface, bright-red to orangish-red; surface cells of gemmae non-projecting; leaves indistinctly bordered . . . . . *B. subapiculatum* (p. 220)
– Gemmae on short rhizoids within and above soil surface, ruby-red to cherry-red; surface cells of gemmae angulose-projecting; leaves clearly bordered . . . . . *B. rubens* (p. 218)
18. Leaves obtuse to rounded, with narrow, 1-rowed border, narrowly decurrent, crisped when dry; brood filaments few, short, sometimes branched . . . *B. cyclophyllum* (p. 182)
– Leaves acute to acuminate, often piliferous, non-decurrent, with distinct (1-)2-3(-4)-rowed border, when dry spirally twisted to contorted, patent to subimbricate; brood filaments numerous, in leaf axils all along the stem . . . . . *B. laevifilum* (p. 216)
19. Leaves concave, ±closely imbricate 20
– Leaves not concave; not closely imbricate . . 25
20. Plants variegate (green, yellow-green, fuscous, red, or purple, especially in upper part), glossy; leaves blunt, 2-3 times longer than wide; costa percurrent to shortly excurrent . . . . . *B. alpinum* (p. 228)
– Plants almost of one color: green, whitish, argentate, rarely brownish; leaves acute, apiculate, rarely nearly blunt, as long as to 2.5 longer than wide; costa excurrent, percurrent,or ending far below leaf tip .. 21
21. Leaves in upper part often hyaline; costa ending below leaf apex . . . *B. argenteum* (p. 225)
– Costa excurrent or percurrent . . . 22
22. Tufts to 10 cm high . . *B. schleicheri* (p. 188)
– Plants usually to 1-2 cm high . . . 23
23. Plants whitish, usually in scattered groups of individuals; female plants bud-like, sterile ones julaceous; leaves roundly acute, costa stout, excurrent in thick short awn . . . . . *B. funkii* (p. 193)
– Plants ±green, usually in compact to dense tufts; leaves suddenly contracted into piliferous acumen, costa filling acumen to excurrent 24
24. Plants white-green; leaves 0.5-1.0 mm long; acumen straight to recurved . . . . . *B. kunzei* (p. 192)
– Plants pure green to brownish;leaves 1.0-2.0 mm long; acumen recurved to reflexed . . . . . *B. elegans* (p. 212)
25. Tufts low, dense; leaves ±bordered, transition between border and laminal cells very gradual . . . . . *B. caespiticium* (p. 190)
– Tufts ±high or low, loose to compact; bor-

[1] – This complex includes in Europe 9 species; for keys to their identification see also Nyholm (1993); Smith (1978); Virchenko (1989).

der if present with relatively sudden transition to laminal cells 26

26. Leaves distinctly bordered; leaf base red . . 27
– Leaves not or indistinctly bordered; at base without red color, but sometimes pinkish throughout 28

27. Plants of wet habitats; tufts to 5(-12) cm high; leaves widest below the leaf middle, gradually acuminate, decurrent, border distinct, 4-6-rowed; margin broadly revolute . . . . . *B. pseudotriquetrum* (p. 208)
– Plants on soil and tree trunks; tufts up to 2.5-3 cm; leaves widest at or above the leaf middle, contracted into piliferous acumen, non-decurrent; margin narrowly recurved . . . . . *B. capillare* (p. 208)

28. Leaves very longly and broadly decurrent . . . . . *B. weigelii* (p. 185)
– Leaves slightly decurrent . . . . . *B. turbinatum* (p. 186)

SPECIES DESCRIPTIONS

Bryum algovicum Sendtn. ex C. Muell., Syn. Musc. Frond. 2: 569. 1851. Fig. 70

B. angustirete Kindb., Bull. Torrey Bot. Club 16: 94. 1889.

B. pendulum (Hornsch.) Schimp., Coroll. Bryol. Eur.: 70. 1855. hom. illeg.

Synoicous, rarely some plants within same tuft male or female. In synoicous inflorescences antheridia few, perigonia with numerous red antheridia and paraphyses; paraphyses pale, about as long as antheridia.

Plants in compact to dense tufts 0.5-1.0 cm high, yellow-green to brown-green, densely tomentose; rhizoides orangish-fuscous to red-brown, ±papillose. Stem light to dark red, ca. 0.5 cm long, comose; subterminal shoots 2-4, comose. Lower leaves ca. 1.5 mm long, 0.5 mm wide, ovate-lanceolate. Upper leaves erect when wet, appressed to flexuose or slightly twisted when dry, (1.8-)2.2-2.5(-2.7) mm long, (0.5-)0.8(-0.9) mm wide; oblong-ovate to lanceolate, acuminate, widest at 1/4–1/3 of leaf length, carinate, non-decurrent, red at base; margin revolute nearly to apex, entire; border (2-)4-5(-6)-rowed, indistinctly or distinctly delimited from lamina; costa stout, red below, brown-yellow above, excurrent into long smooth or indistinclty serrulate awn. Laminal cells with incrassate and slightly porose cell walls; in upper leaf rhomboid-hexagonal, 40-60(-64) x 16 μm; in mid-leaf (35-)44-56(-70) x (12-)16(-20) μm; towards base larger, rectangular, (40-)50-60(-70) x (16-)20-24(-28) μm, in leaf corners subquadrate, 32-36 μm, somewhat inflated.

Perichaetial leaves lanceolate, longly acuminate, margin plane, costa percurrent to shortly excurrent. Seta 1.5-2.0(-3.0) cm long, brownish to red, rigid, not twisted when dry, abruptly curved below capsule. Capsule inclined to pendulous, brownish to brown or reddish-brown, below mouth orange to red, 2.5-3(-4) mm long, 1.0-1.5 mm thick, obovate or ellipsoid, not constricted below a narrow mouth, neck short, slightly curved. Operculum small, low-conic to conic, acutely apiculate, brownish, darker than urn, slightly glossy; often persistent. Annulus 2-4-rowed. Peristome inserted far below mouth, 360-460 μm high. Exostome teeth 100 μm wide below, tapered from middle into subulate apex, in lower part reddish- or brownish-yellow, above yellow and in upormost part hyaline; border narrow; median line zig-zag-shaped in lower 1/3, straight above; fundus red-orange, 60-70 μm high broadened; ventral lamellae 15-17, with longitudinal septae at base or nearly throughout, numerous or few, incrassate or thin. Endostome adherent to exostome throughout basal membrane, yellowish; basal membrane 1/3 to 1/2 of endostome heigth; segments narrow, half-segment at base 6 to 20 μm wide, narrowly split along keel; cilia 2-3, reduced or occasionally better developed and rarely even shortly appendiculate, densely papillose, papillae ±large. Spores (24-)28(-36) μm, greenish-yellow.

Differentiation and variation: Certain identification of sterile plants is impossible. The peristome of this species is one of the most peculiar; the exostome is adherent to the endostome throughout the basal membrane (Fig. 000), and there are numerous longitudinal septae between the ventral trabeculae. These septae are scattered from the tooth base upwards, often reaching its uppermost part. In the lower part of the tooth, several septae are found between the trabeculae, creating the appearance of a brick wall. The septae are usually thick, but in some specimens they aresparse and rather narrow. Cilia usually are absent, but exceptionally well-developed and even shortly appendiculate cilia were found in one capsule (Tula, Zinger).

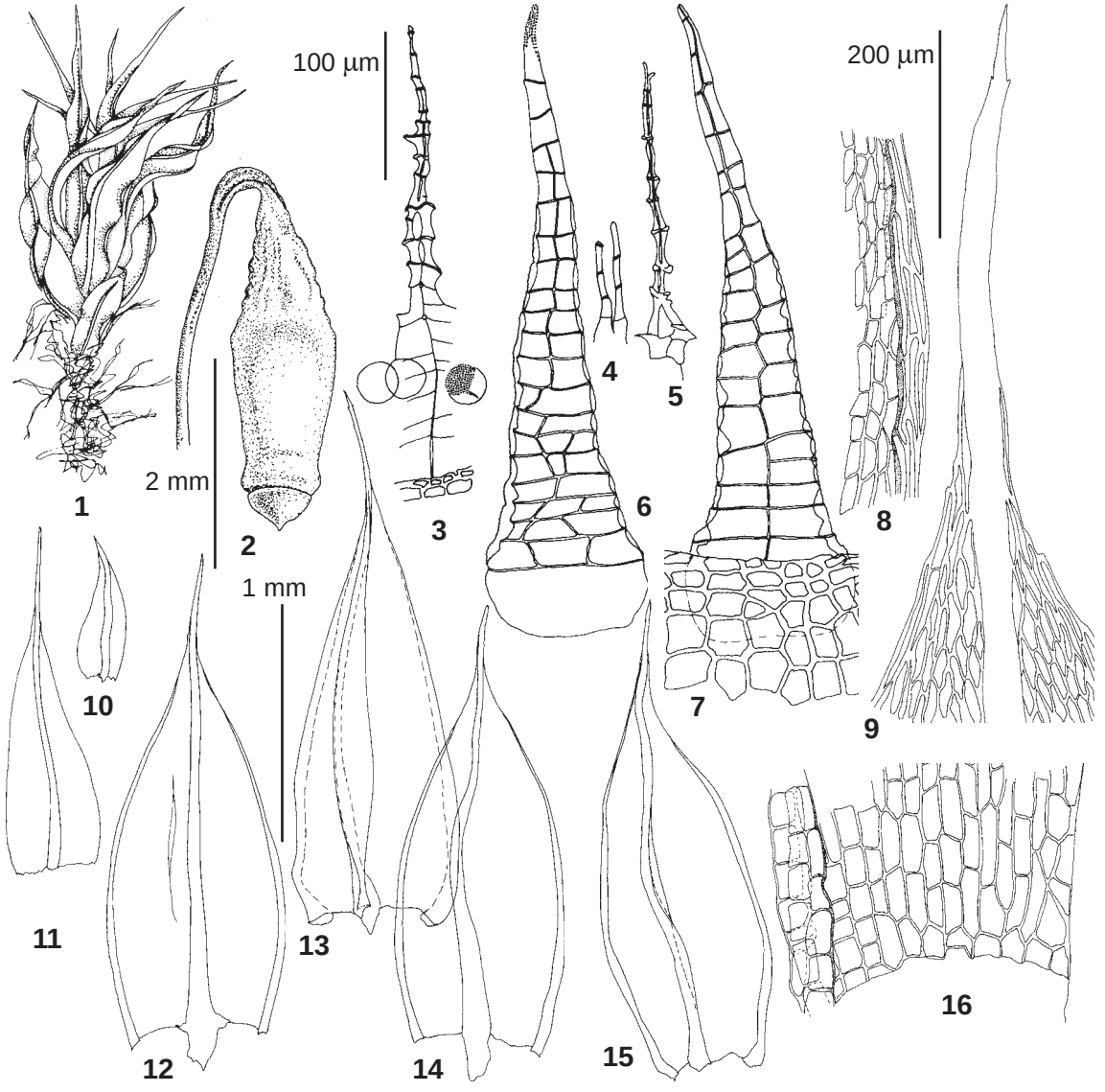


Fig. 70. *Bryum algovicum* Sendtn ex C. Muell. (from Orel, Rostovtsev 1098, LE): 1 – habit; 2 – capsule; 3-5 – segments; 4 – ciliae; 6 – inner surface of exostome tooth; 7 – outer surface of exostome tooth; 8 – mid-leaf cells; 9 – upper laminal cells; 10-11 – perichaetial leaves; 12-15 – leaves; 16 – basal cells. Scale bars: 2 mm for 1-2; 1 mm – 10-15; 200 µm – 8-9, 16; 100 µm – 3-7.

Habitat: Scattered in steppe zone on North-facing slopes, and in forest zone in open habitats; on wet sandy, clayish, or peaty soils, and fine soil above rocks (limestones, sandstones) in slopes, pits, etc.

Selected specimens examined (9): Bashkortostan, Selivanova-Gorodkova #23, LE; Moscow Prov., Zickendrath #413, LE; Ignatov 20.VI.1986, 14.VII.1996, MHA; Orel Prov., Rostovzev 9.VII.1888, LE; Penza Prov., Sarygina 25.V.1904, LE; Pskov Prov., anonymous 16.VI.1979, MHA; Tula Prov., Zinger 10.VI.1898, LE; Vologda Prov., Kolesnikov #1055, LE; Voronezh Prov., Popova #1823, VOR.

Bryum arcticum (R. Br.) B. S. G., Bryol. Eur. 4: 154. 1846. – *Pohlia arctica* R. Br., Suppl. App. Parry's Voy.: 296. 1823. Fig. 71

Synoicous. Antheridia few, reddish; paraphyses numerous, yellow-green, longer than antheridia.

Plants in low, dense tufts to 0.5 cm high, brownish- or yellowish-green, sometimes slightly reddish; not tomentose; rhizoids only at stem bases, fuscous to red-fuscous, ±papillose. Stem red-brown, 4-5 mm long, evenly foliate below, comose above; subterminal shoots 1-2, evenly

foliate. Lower leaves broadly lanceolate, 1.5-1.7 mm long, 0.6-0.8 mm wide. Upper leaves erect when wet, ±appressed, flexuose to slightly twisted when dry, 2.2-3.0 mm long, 0.8-1.0 mm wide, ovate-lanceolate to oblong-ovate, widest at 1/4-1/3 of leaf length, non or weakly decurrent, without red color at base, but old leaves reddish throughout; margin narrowly recurved from base to apex, entire to weakly serrulate above; border orangish- to fuscous-yellow, 1-3-rowed, at places bistratos; costa stout, orangish to fuscous-red, at base always reddish to red, shortly excurrent. Laminal cells thin-walled, slightly or non-porose; in upper leaf cells rhomboid-hexagonal, 60-80 x 16-28 μm; mid-leaf cells rhomboid-hexagonal to rhomboid, 60-100(-120) x 20-28 μm; basal cells rhomboid and rhomboid-hexagonal to rectangular, 40-80 x (12-)16-20(-24) μm, in leaf corners ±quadrate, 32-40 μm.

Perichaetial leaves triangular-lanceolate, margin plane, border narrow, indistinct, costa weak, ending below leaf apex to shortly excurrent. Seta 1.5-3.0 cm long, reddish-fuscous or reddish-orange, thin, rigid, non twisted when dry, arcuate below capsule. Capsule pendulous, fuscous to yellow-fuscous, reddish below mouth, 2.5-3.0 mm long, ca. 1.5 mm thick, pyriform to clavate, not contracted below narrow oblique mouth, neck about as long as urn, slightly curved, collapsed when dry. Operculum small, low-conic, with acute apiculus, orange-red. Annulus 2-rowed, cell subquadrate. Peristome inserted at urn mouth, ca. 400 μm long. Exsostome teets 80 μm wide at base, gradually tapered; below orange-yellow; in uppermost part hyalyne; border to 8 μm; median line zig-zag shaped to nearly straight throughout; fundus broadened, orange, 40-50 μm high; ventral trabeculae 15-18, septae in lower part of tooth, oblique or longutudinal, mostly in the middle of tooth. Endostome adherent to exostome in lower part, yellow; basal membrane ca. 1/3-1/4 of endostome height; segments narrow, half-segment at base 16-20 μm wide, narrowlty perforate throughout; cilia 2-3, very short, slightly papillose. Spores 32-40 μm, yellow.

Differentiation: The following combination of character states is important for differentiation of *B. arcticum*: (1) numerous ventral trabeculae; (2) septae between ventral trabeculae nearly throughout the tooth; (3) bistratose leaf margins; (4) synoicous sexual condition; and (5) leaf base of the same color as lamina above.

Habitat: limestones at river bank.

Specimens examined (2): Arkhangelsk Prov., Zickendrath 2.VII.1895, H3019231 (H); Zickendrath #1173; H3019242 (H).

This species has been reported by Zickendrath (1900) from Wologda Province, Velikij Ustyug, and Komi Republic, Ukhta River (formerly belonging to Arkhangelsk Province). No specimens from the former locality were found, so the descri ption is based on plants from the latter locality only, which is situated at the border of the study area.

Bryum amblyodon C. Muell., Linnaea 42: 293. 1879. Fig. 72

B. inclinatum (Brid.) Bland., Uebers Mecklenb. Moss. 6: 1809, hom. illeg.

B. imbricatum (Schwaegr.) B. S. G., Bryol. Eur. 4:: 99. 1846, hom. illeg.

Synoicous, rarely polyoicous. Antheridia reddish; paraphyses pale to orangish or reddish, longer than antheridia.

Plants in low dense tufts 0.5-1.5(-2.5) cm high, brownish- or yellow-green; densely tomentose; rhizoids fuscous to fuscous-brown, papillose or finely papillose. Stem red, 0.5-1.0(-1.5) cm long, comose, subterminal shoots 1-3, more homogeneous foliate, ±comosely crowded above. Lower leaves small, ca. 1.5 mm long, 0.7 mm wide, ovate-lanceolate. Upper leaves erect when wet, appressed when dry, 2.7-3.0(-3.5) mm long, (0.9-)1.0-1.1(-1.5) mm wide, lanceolate to oblong-lanceolate, widest at 1/3-1/2 of leaf length, carinate, longly acuminate, non-decurrent, at base red or purple; margin revolute nearly to the apex, entire; border distinct, yellow, 2-6-rowed, unistratose, formed by thick-walled very narrow linear cells; costa stout, red below, green above, excurrent in ±smooth awn. Laminal cells rather thick-walled, but not porose, in upper leaf rhomboid-hexagonal, 50-60 x 16-20 μm; in mid-leaf rhombic to rhomboid, 52-60 x 12-16(-20) μm; towards base rectangular, 40-60(-80) x 20-25 μm, in leaf corners quadrate to 32(-40) μm wide.

Perichaetial leaves ovate-lanceolate, margin plane, costa excurrent. Seta (2.0-)3.5-3.0(-4.0) cm long, brownish-orange, non-twisted when dry, suddenly curved below the capsule. Capsule inclined, rarely penulous, orange-brown to brownish, below mouth more dark up to brown, (2.5-)4.5(-5.0) mm long and 1.0 mm thick, elon-

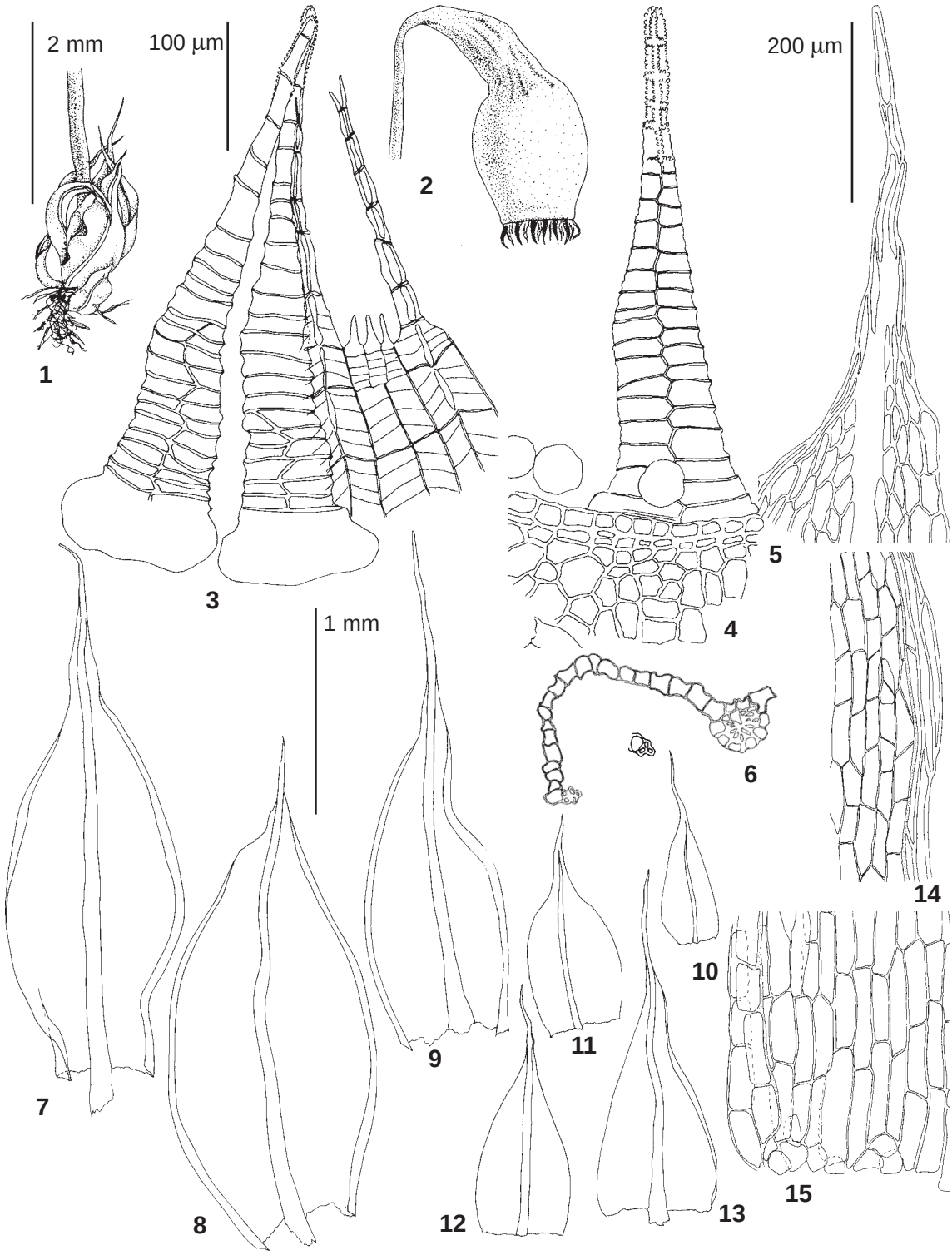


Fig. 71. *Bryum arcticum* (R. Br.) B. S. G. (Komi Republic, Ukhta [Archangelsk Prov.] Zickendrath 2.VII.1895, H): 1 – habit; 2 – capsule; 3 – inner surface of exostome teeth and part of endostome; 4 – outer surface of exostome tooth; 5 – upper laminal cells; 6 – transversal leaf section; 7-9 – leaves; 10-13 – perichaetial leaves; 14 – mid-leaf cells; 15 – basal cells. Scale bars: 2 mm for 1-2; 1 mm – 7-13; 200 µm – 5-6, 14-15; 100 µm – 3-4.

gate-pyriform or elongate-obovate, rarely subcylindric, symmetric, somewhat contracted below narrow mouth when open; neck about a half of urn length. Operculum small, high-conic, with small red apiculus, reddish-orange, glossy, easily deciduous. Annulus 1-2-rowed. Peristome attached to urn close to mouth, 350-400 μm high. Exostome teeth 80 μm wide below, finely pointed, below pale-yellow to orangish-yellow; in uppermost part to hyaline; narrowly bordered; median line indistinctly zig-zag-shaped; fundus 50-60 μm high, red-orange or red, broadened; ventral trabeculae (9-)14-20, without longitudinal septae, or rarely with very few thin septae in different parts of teeth. Endostome adherent to exostome at base, ±attached throughout basal membrane, pale to yellowish; basal membrane 1/2-1/3 of peristome length; segments moderately narrow, half-segment at base 20-40 μm wide, remotely arranged, broadly perforate below and narrowly split above (some relatively broad segments not split); cilia 2-3, often broad, short, finely papillose, without appendicules and nodules; rarely single cilia narrower and longer (to 1/4-1/3 of segment length), but never appendiculate. Spores 18-24(-34) μm, greenish-yellow to greenish-brown.

Differentiation: Certain identification of sterile plants is impossible. The most important diagnostic character state is that the endostome is adherent to the exostome base and has short, broad cilia. In addition: (1) exostome teeth with none or few, narrow septae; (2) capsule almost symmetric; (3) plants synoicous; and (4) leaves with a broad, 2-6 row, border.

The nomenclature of this species is after Demaret & Geissler (1990).

Habitat: On moist and wet peaty and clayish soil; in pits and wet to swampy meadows; in broad-leaved forests on soil near trunks.

Selected specimens examined (4): Bashkortostan, Selivanova-Gorodkova, #2, LE, Pskov Prov., Malta 22.VI.1916, LE; Moscow Prov., Zikendrath, 221, H; Ufa, Podpera, 10.8.1917, LE.

Bryum knowltonii Barnes, Bot. Gaz. 14: 44. 1889. Fig. 73

B. lacustre (Web. et Mohr) Bland. in Sturm, Deut. Fl. (ed. 2) 2(10): 13. 1809, hom. illeg.

Synoicous or polyoicous, with perigonia on subterminal shoots; paraphyses longer than antheridia.

Plants in dense tufts, 1-2.5 cm high, yellow-green; tomentose; rhizoids red-brown, finely densely papillose. Stem red, 0.5-0.7 cm long, comose, subterminal shoots 1-2, 1.0-2.0 cm long, rather evenly, imbricately foliate, with few larger leaves comosely crowded above. Lower leaves 0.7-0.8 mm long, 0.5 mm wide, ovate-lanceolate to ovate, acuminate, concave, non-decurrent, red at base; margin narrowly recurved at base, weakly serrulate above; border 1-rowed; costa stout, red at base, yellow-green to brownish above, percurrent. Upper leaves erect when wet, appressed when dry, 1.2-2.5 mm long, 0.6-1.4 mm wide, ovate-lanceolate to ovate, widest at 1/4-1/3 of leaf length, concave, not or very shortly decurrent, without red color at base; margin plane to broadly reflexed from base to acumen, entire to weakly serrulate above; border narrow and indistinctly delimited from lamina; costa stout, at base red, above yellow-green to brownish-green, percurrent to shortly excurrent. Laminal cells thin-walled, not porose, in upper leaf rhomboid-hexagonal to rhombic, 40-50(-60) x 12-20(-24) μm; in mid-leaf rhomboid-hexagonal to rhomboid (to rectangular in juxtacostal area), (40-)50-60(-64) x (16-)20(-38)mkm; basal cells rectangular, 48-60(-80) x (16-)20-24(-32) μm; in leaf corners to quadrate, 24-28 μm, sometimes inflated.

Perichaetial leaves ovate-lanceolate to lanceolate, margins recurved from base to apex to plane in innermost leaves, costa ending below leaf tip. Seta 1.5-2.5 cm, fuscous to reddish-fuscous thin, twisted when dry, abruptly hooked below capsule. Capsule pendulous, fuscous, 2.5-3.5 mm long, ca. 1.5 mm thick, shortly pyriform, not contracted below narrow mouth; neck as long as half urn, sligthly curved. Operculum small, conic, apiculate, brighter than urn to red-fuscous. Annulus very broad, to 100 μm high, 2-3-rowed. Peristome inserted at urn mouth, to 400 μm high. Exostome teeth at base to 100 μm wide, narrow, tapered more abruptly at 1/3-1/2 of tooth length, below fuscous-yellow; above hyaline; border very narrow to absent; median line nearly straight througout; fundus fuscous-orange-red, 60-80 μm high; ventral trabeculae 18-20(-25); longitudinal septae absent. Endostome yellowish, shorter than exostome; basal membrane ca. 1/3 of endostome length; segments narrow, half-segment at base 12-16 μm

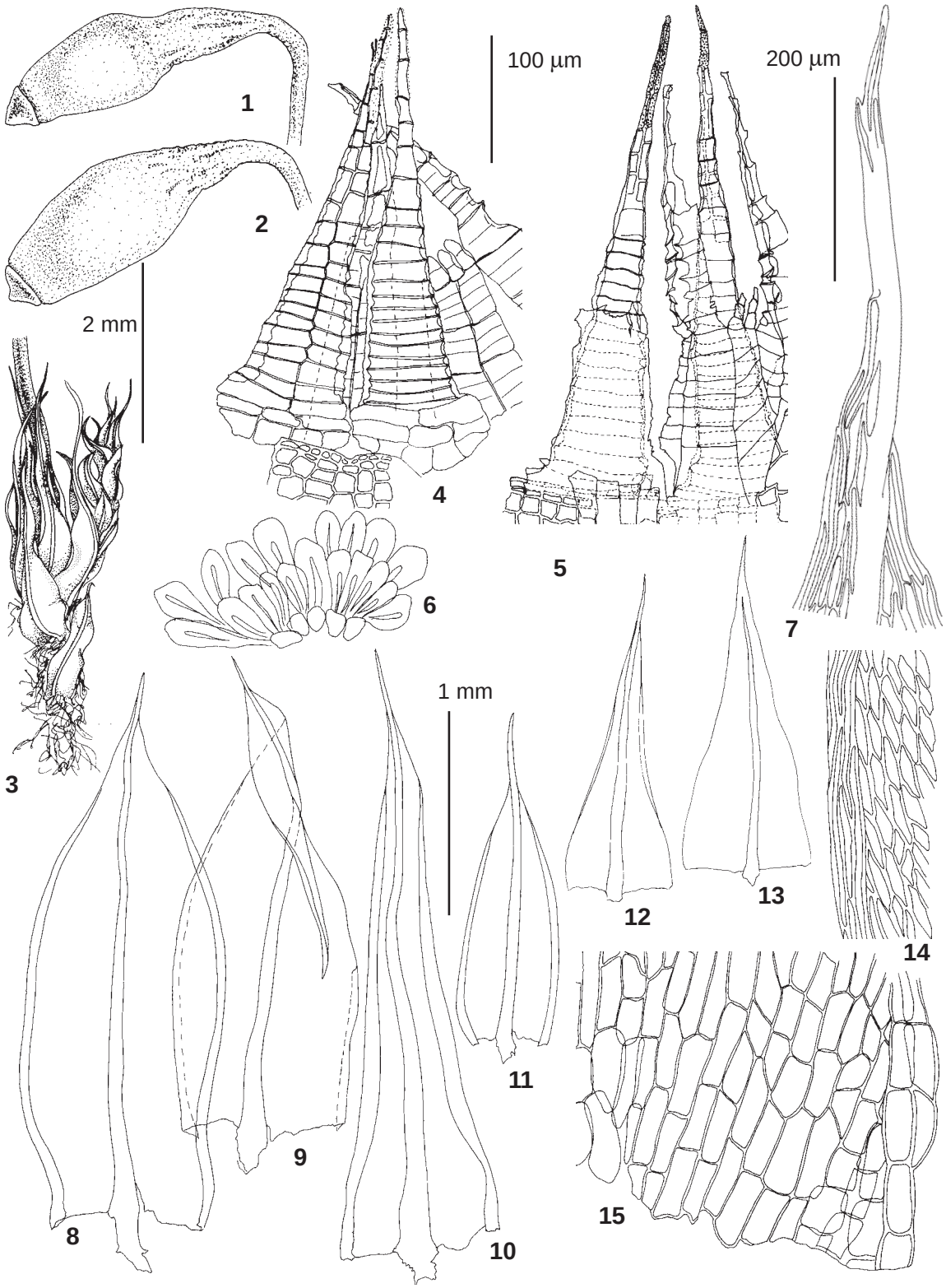


Fig. 72. *Bryum amblyodon* C. Muell. (1-7 – Pskov, Malta 22.VI.1916, H; 8-15 from Ufa, Podpera s.n. LE): 1-2 – capsules; 3 – habit; 4-5 – parts of peristomes; 6 – annulus; 7 – upper laminal cells; 8-11 – leaves; 12-13 – perichaetial leaves; 14 – mid-leaf cells; 15 – basal cells. Scale bars: 2 mm for 1-3; 1 mm – 8-13; 200 µm – 6-7-14-15; 100 µm – 4-5.

wide, with ovate perforations along keel, below often fused and forming irregular gaps; cilia 2-3, short, without appendicules, slightly finely papillose. Spores 20-28 μm, brownish.

Differentiation: *Bryum knowltonii* resembles *B. amblyodon* in peristome characters, but has a peculiar appearance due to closely imbricate, concave leaves, and a percurrent or shortly excurrent costa. Also, *B. knowltonii* differs from other species in having an exceptionally low basal membrane.

Habitat: no data.

Specimen examined (2): Leningrad Prov., Schlisselburg, [collector?] 8.VI.1875, H301911 (H); Novgorod Prov., Andreev & Pigurnova #8, 8.V.1977 (MHA).

Bryum uliginosum (Brid.) B. S. G., Bryol. Eur. 4: 88 (fasc. 6-9. Monogr. 18). 1839. – *Cladodium uliginosum* Brid., Bryol. Univ. 1: 841. 1827. Fig. 74

Bryum cernuum (Hedw.) B. S. G., Bryol. Eur. 4: 84. 1839. hom. illeg.

Autoicous; antheridial shoots very short, with 1-2 antheridia, arranged very close to perichaetium within the same group of comosely crowded and enlarged upper leaves; perigonial leaves ovate, margin plane, costa ending below leaf apex.

Plants always in rather loose tufts 1.5(-2.0) cm high, green to olive-green or brownish-green, with dense tomentum, rhizoids brown or dark-brown, rather densely and finely papillose. Stem dirty-red, to 1 cm long, loosely foliate, comose, subterminal shoots 1-3, comose. Lower leaves ovate-lanceolate, 1.2-2.0 mm long, 0.5-0.7 mm wide; costa shortly excurent or percurrent. Upper leaves spreading when wet, curved to contorted when dry, (3.0-)4.0-5.0(-6.0) mm long, 1.0(-1.5) mm wide, oblong-lanceolate to narrow-elliptic,widest at ca.1/2 of leaf length,longly acuminate, narrowed towards insertion, non-decurrent; margin narrowly recurved to nearly plane, entire or above weakly serrulate; border distinctly delimited from lamina, 2-3-rowed, unistratose to bistratose at places, yellow to brown-yellow, formed by long, thick-walled cells; costa stout, red below, greenish-brown to reddish-brown above, percurrent to shortly excurrent. Laminal cells thin-walled, not porose, in upper leaf narrow, 70-80(-100) x 20 μm, in mid-leaf rhomboid-hexagonal to rhomboid, ca. 100 x 30 μm, towards leaf base larger, 80-200 x 20-36 μm, variable in size from ±rectangular to irregularly tetra-, penta- and hexagonal, green.

Perichaetial leaves oblong to lanceolate, with plane margin, non-bordered. Seta 3-5 cm high, orange-brownish to red-brownish, not twisted when dry, below capsule arcuate. Capsule horizontal to pendulous, pale brownish to brownish or brown when open, 5.0-6.0 mm long, 1.5-2.0 mm thick, clavate-pyriform to oblong-obovate, somewhat gibbosus, not or only slightly contracted below small oblique mouth when dry; neck longer than urn, curved, collapsed when dry. Operculum small, short conic, with short small beak, orange-brownish, glossy. Annulus 2-3-rowed. Peristome inserted at urn mouth, 500(-550) μm high. Exostome teeth curved in dry condition with upper teeth inserted in between endostome segments, at base 140(-150) μm wide, linear-lanceolate, from middle tapered into thin subulate upper part; at base brownish- to brownish-yellow; above hyaline; border 10-12 μm; median line zig-zag-shaped; fundus orange or not differing in color from teeth, 60-70 mm high, not broadened; ventral trabeculae 25-30, without longitudinal septae or with very few septae in different parts of tooth. Endostome loosely adherent to exostome below, as long as exostome or slightly shorter, yellowish to yellow; basal membrane 1/2-4/4 of endostome length; segments broad, half-segment at base to 60 μm wide, ±broadly perforate below (sometimes perforations fusing and forming big gaps), split along keel above; cilia 3, very short to nearly absent, finely papillose. Spores 28-32 μm, brownish-olive.

Differentiation: When sporophytes are present, *B. uliginosum* is peculiar in having: (1) a long curved capsule with a narrow oblique mouth; (2) the endostome weakly adherent to the based of the exostome; (3) short, narrow cilia; and (4) narrowly perforate segments. Sterile plants of *B. uliginosum* are similar to those of *B. pallens* without red pigmentation; however, differentiating features of the former are large upper leaves, to 5-6 mm long, and very long basal leaf cells.

The type of *B. uliginosum* was described by Demaret & Wilczek (1983).

Habitat: Both collections are from wet clayish soil, one from springy place with *Marchantia*.

Specimens examined (2): Moscow Prov. Zickendrath #402 & #988, LE.

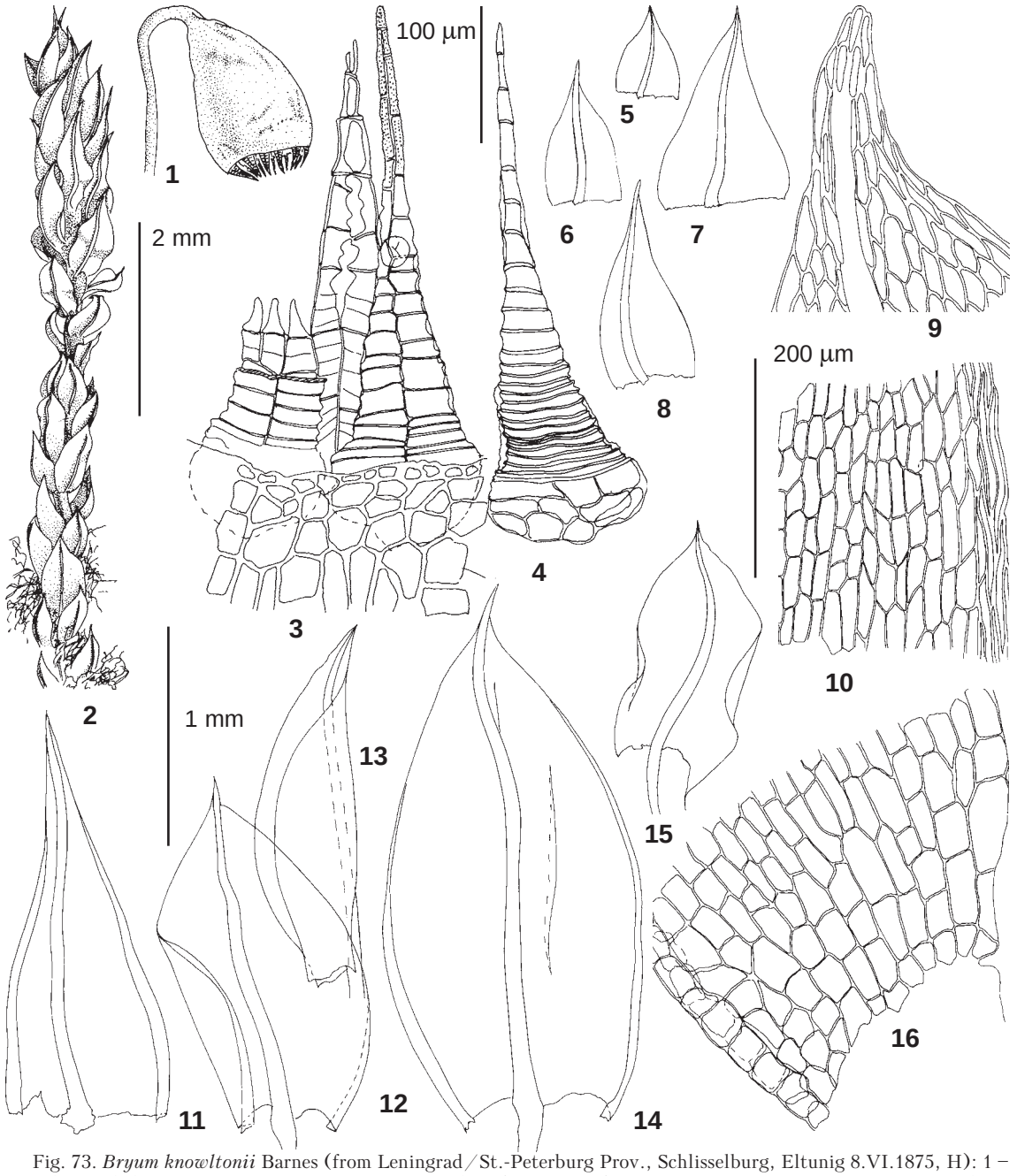
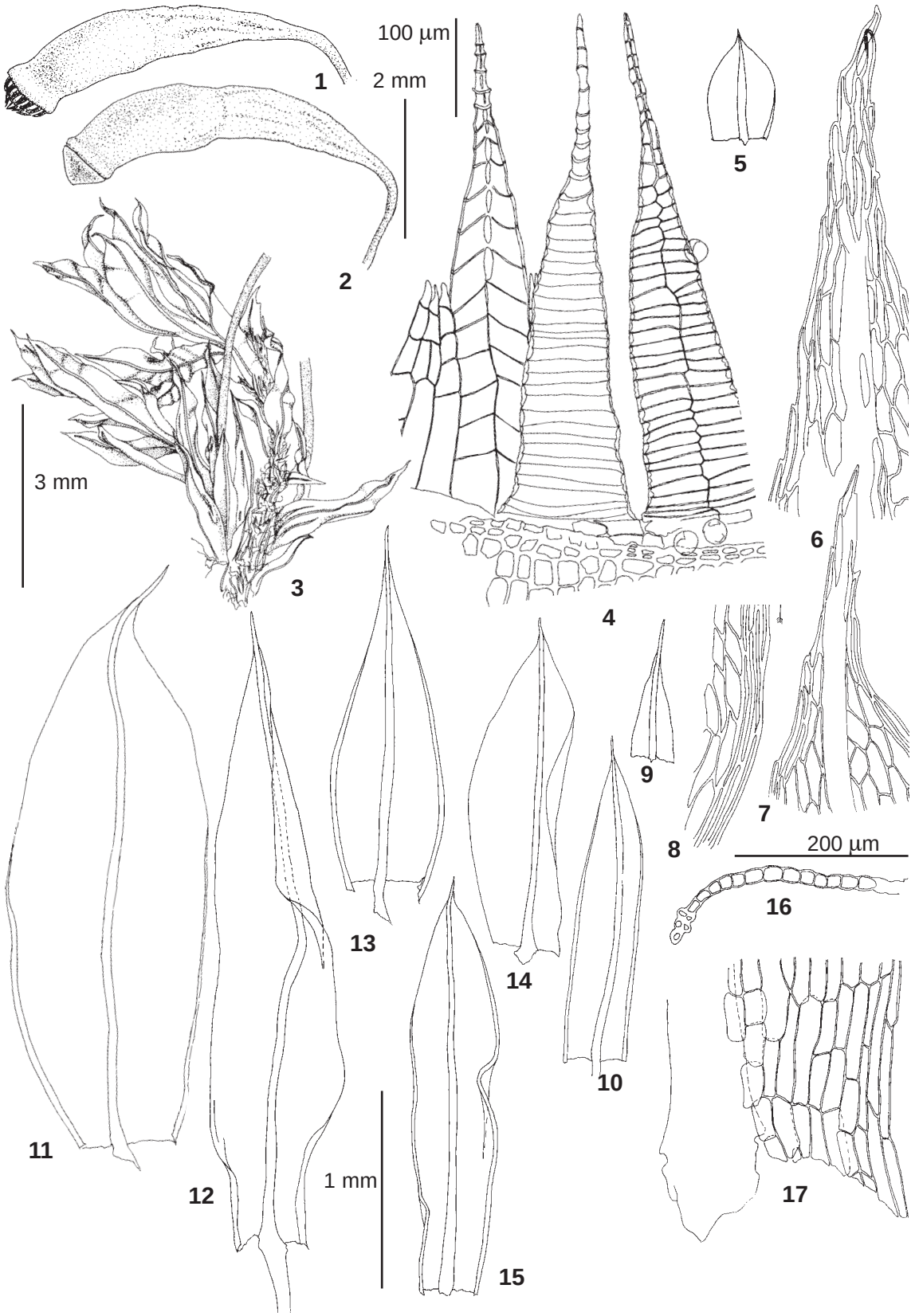


Fig. 73. *Bryum knowltonii* Barnes (from Leningrad / St.-Peterburg Prov., Schlisselburg, Eltunig 8.VI.1875, H): 1 – capsule; 2 – habit; 3 – outer surface of exostome tooth and part of endostome; 4 – inner surface of exostome tooth; 5-8 – perigonial leaves; 9 – upper laminal cells; 10 – mid-leaf cells; 11 – perichaetial leaf; 12-15 – leaves; 16 – basal cells. Scale bars: 2 mm for 1-2; 1 mm – 5-8, 11-15; 200 µm – 9-10, 16; 100 µm – 3-4.

Bryum pallens (Brid.) Sw. ex Roehl., Monthly Rev. 34: 538. 1801. – *Pohlia pallens* Brid., Muscol. Recent., 2(3): 145. 1803. Fig. 75

Dioicous; male and female plants in the same tuft; male plants gracile, loosely foliate; perigonia capitate with numerous thick anteridia and paraphyses; paraphyses yellowish-reddish, longer than anteridia; perigonial leaves small; upper comosely crowded leaves few, appressed to perigonium, from broad concave clasping base, lanceolate, acuminate, with somewhat reglexed lead tip.

Plants in loose to moderately dense tufts, low or rarely to 3-4 cm high, olive-green to brownish and brown, sometimes purplish to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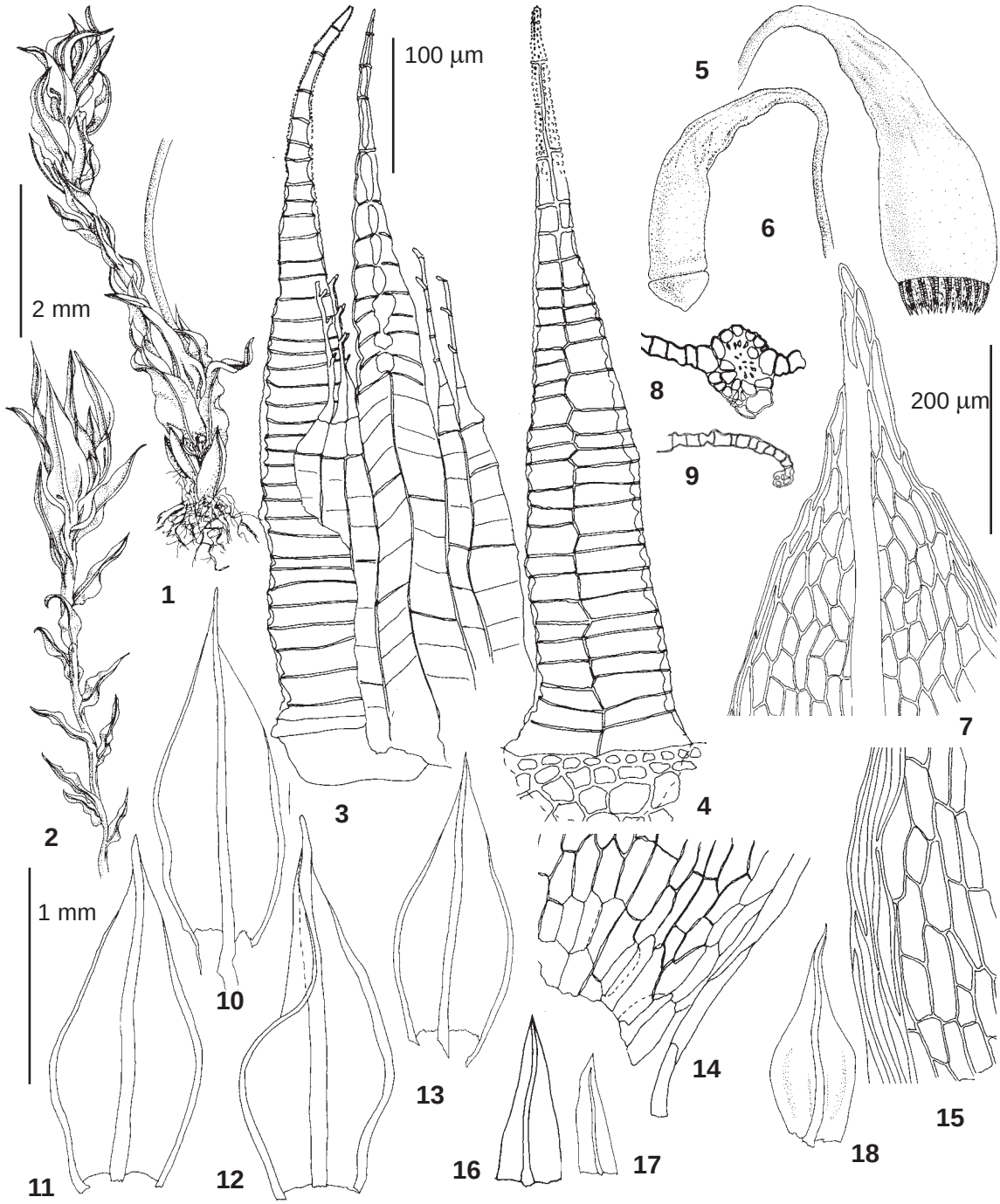


Fig. 75. *Bryum pallens* (Brid.) Sw. ex Roehl. (Moscow Prov., Lytkarino, Zolotov 27.VI.1997, MHA): 1-2 – habit; 3 – part of endostome and inner surface of exostome tooth; 4 – outer surface of exostome tooth; 5-6 – capsules; 7 – upper laminal cells; 8-9 – leaf transverse section, showing costa and border respectively; 10-13 – leaves; 14 – basal cells; 15 – mid-leaf cells; 16-17 – perigonial leaves; 18 – perichaetial leaf. Scale bars: 2 mm for 1-2, 5-6; 1 mm – 10-13, 16-18; 200 µm – 7-9, 14-15; 100 µm – 3-4.

← Fig. 74. *Bryum uliginosum* (Brid.) B. S. G. (Moscow, Zickendtrath 26.IX.1891, LE): 1-2 – capsule; 3 – habit; 4 – part of perisome, showing endostome, inner and outer surface of exostome tooth; 5 – perigonial leaf; 6-7 – upper laminal cells; 8 – mid-leaf cells; 9-10 – perichaetial leaves; 11-15 – leaves; 16 – transversal leaf section; 17 – basal cells. Scale bars: 3 mm for 3; 2 mm– 1-2; 1 mm – 5, 9-15; 200 µm – 6-8, 16-17; 100 µm – 4.

vine-red; not tomentose; rhizoids brown or brownish, finely papillose. Stem deep red, 1 cm long, rarely higher, evenly foliate along most of stem, few leaves comosely crowded above, subterminal shoots 1-3(-4), to 1.0-1.5 cm long, ±evenly foliate and comose above. Leaves of subterminal shoots and leaves from sterile shoots 2.0-2.4 mm long and 0.7-0.9 mm wide. Upper leaves erect to spreading when wet, loosely appressed and moderately curved when dry, delicate, to 3.0-3.1 mm long, 0.8-1.0 mm wide, obovate to oblong-obovate, widest at 1/3-1/2 of leaf length, acuminate to longly acuminate, rather longly decurrent, without red color at base but sometimes pinkish throughout; margin recurved to reflexed from base to acumen or to mid-leaf, entire or weakly serrulate above; border inflated, 2-3-rowed, 1-2-stratose, yellow to brownish, composed by long thick-walled cells; costa always very stout, fuscous to reddish, later brown, ending in leaf tip or excurrent in very short awn. Laminal cells thin-walled, not porose, in upper leaf rhomboid-hexagonal, 40-60 x 16-24 μm; in mid-leaf rhombic to rhombic-hexagonal, (40-)60(-80) x 16-24 μm, at base rectangular and rhomboid-hexagonal, 60-80 x (20-)28-32(-36) μm.

Perichaetial leaves lanceolate, acute, margin plane, costa percurrent to shortly excurrent. Seta (2.0-)2.5-3.5(-5.0) cm, fuscous to reddish-brown, not twisted when dry, arcuate below capsule. Capsule horizontal, inclined to pendulous, pale, brownish to yellowish-brownish, 4.0-5.0 mm long, 1.5-2.0 thick, oblong-pyriform, with broad mouth, not or slightly contracted below mouth when dry; with narrow ±curved neck to twice as long as urn. Operculum large, conic or conic-convex, with small acute apiculus, orangish, slightly glossy. Annulus 4-5-rowed. Peristome inserted at mouth, ca. 560 μm high. Exostome teeth curved in dry condition with upper teeth inserted in between endostome segments; at base ca. 100 μm wide, gradually tapered, below light-yellow, in uppermost part hyaline; narrowly bordered, median line zig-zag-shaped; fundus yellow to orange, 60-70 μm high, broadened; ventral trabeculae 26-27(-30), longitudinal sepatae absent. Endostome free, yellowish to yellow; basal membrane ca. 1/2 of endostome height; segments narrow, half-segment at base 40-50 μm wide, broadly perforate below (sometimes perforations fusing in large irregular gaps) and narrowly split above; cilia 2-3, 1/2-7/8 of segments length, densely papillose, appendiculate to nodose. Spores 16-20 μm, yellow-green.

Axillary brood filaments sometimes present, nearly translucent to pale-fuscous or pale-pinkish, finely papillose to nearly smooth.

Differentiation: *Bryum pallens* usually can be recognized in the field by its vine-red to dirty-pinkish color, better expressed in sunny places. In shady places, this species is olive-green; in this case, the following combination of character states can serve for its identification: (1) dioicous sexual condition; (2) a long curved capsule (similar to that of *B. uliginosum*, but with a broader mouth); and (3) free endostome and little reduced, nodose to shortly appendiculate cilia.

Habitat: Common on wet and moist sandy, clayish, muddy, or peaty soil, bare or with scattered herbs, forming pure stands or often intermixed with other species; on lake and pond shores, swampy places, along streams and creeks, on damp places in wet meadows, pits, along cuvettes and trails. Usually on non-calcareous soils.

Selected specimens examined (60): Arkhangelsk Prov., Ignatov 30.VII.1988, MHA; Bashkortostan, Ignatova #2/50, MHA; Kaluga Prov., Boczkin 5.VIII.1989, MHA; Kostroma Prov., Ignatov 18.IX.1990, MHA; Kursk Prov., Ignatov 13.VIII.1996, MHA; Moscow Prov., Ignatov 22.VIII.1985, MHA; Nizhnij Novgorod Prov., Shvezov 17.VII.1913, LE; Pskov Prov., Zolotov 18.VIII.1998, MHA; Ryazan Prov., Ignatov 1.X.1999, MHA; Tatarstan, Krylov 13.VI.1983, LE; Tver Prov., Gordeeva 14.VIII.1984, MHA; Vladimir Prov., Nazarov 19.IV.1913, LE; Voronezh Prov., Popova 638, 12.VI.1981, VOR; Yaroslavl Prov., Kostyleva 25.V.1984, MHA.

Bryum cyclophyllum (Schwaegr.) B.S.G., Bryol. Eur. 4: 133. 1839. – *Mnium cyclophyllum* Schwaegr., Sp. Musc. Frond., Suppl. 2 2(2): 160. pl. 194. 1827. Fig. 76-77

Dioicous; male and female plants in the same tuft, but often whole tuft having only male plants; perigonia capitate, with numerous purplish antheridia and yellow paraphyses; paraphyses slightly longer than antheridia; perigonial brackts orangish, to 1 mm long, ovate to broadly ovate, concave, acuminate, plane margin, with short weak costa; perigonia surrounded by 5-7 broadly oblong leaves, crowded terminally and forming cup-like structure.

Plants in very loose, soft tufts 1.5-2.5(-8) cm long or scattered among other mosses; high

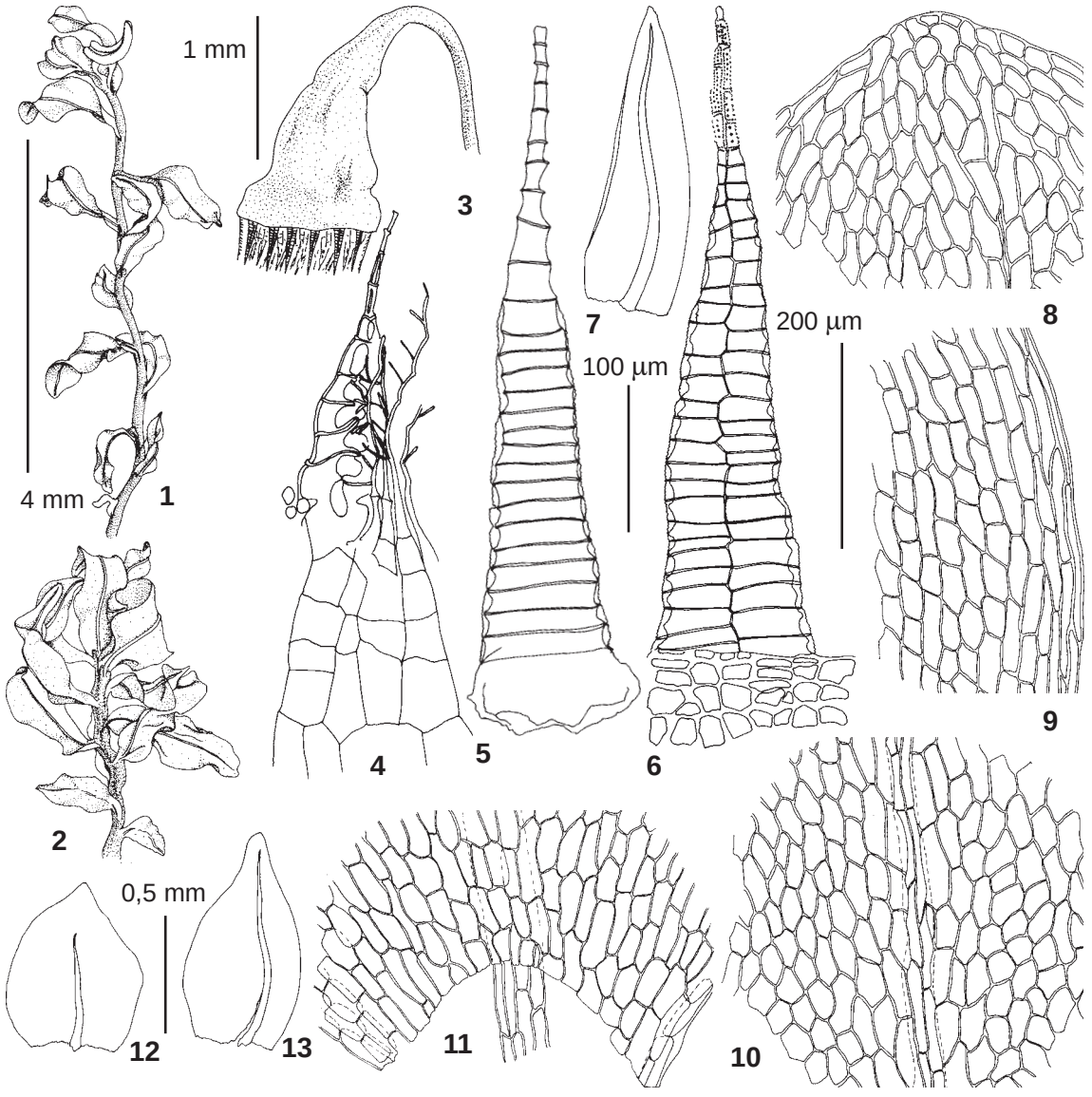


Fig. 76. *Bryum cyclophyllum* (Schwaegr.) B. S. G. (1-2 & 8-11 from Moscow Prov., Lytkarino, Ignatov 9.VII.1988, MHA; 3-7 & 12-13 from Yaroslavl prov., Meshcheryakov, 7.VII.1924, LE): 1-2 – habit; 3 – capsule; 4 – part of endostome; 5 – inner surface of exostome tooth; 6 – outer surface of exostome tooth; 7 – perigonial leaf; 8 – upper laminal cells; 9-10 – mid-leaf cells; 11 – basal cells; 12-13 – perichaetial leaves. Scale bars: 4 mm for 1-2; 1 mm – for 3; 0.5 mm – 7, 12-13; 200 µm – 8-11; 100 µm – 4-6.

tuft often with only upper 0.8-1.0 cm green, semidecayed below; pure rich green, glaucous-green to dirty-green, rarely pinkish, blackish inside; not tomentose, rhizoids in lower part of plant, brown, ±papillose. Stem pale greenish-brownish to pale reddish, sterile and subterminal shoots to 5(-8) cm long, slender, loosely and evenly foliate; female shoot short, ca. 1 cm long, few upper leaves enlarged and comosely crowded. Lower stem leaves, leaves of subterminal and sterile shoots remotely arranged, ovate to broadly ovate-elliptic or sometimes orbicular, 1.2-1.5 mm long, 0.8-1.2 mm wide, narrowed toward base, narrowly (in 1-2 rows) and shortly decurrent. Upper leaves widely spreading when wet, crisped and somewhat contorted when dry, 2.0-2.5 mm long,1.2-1.3mm wide,elliptic,broadly elliptic to broadly ovate,widest at 1/5-3/5 of leaf length, slightly concave, broadly acute to rounded at apex; shortly decurrent; margin plane or narrowly recurved at base, entire; border indistinct to ±distinct, 1-3-rowed, yellow or

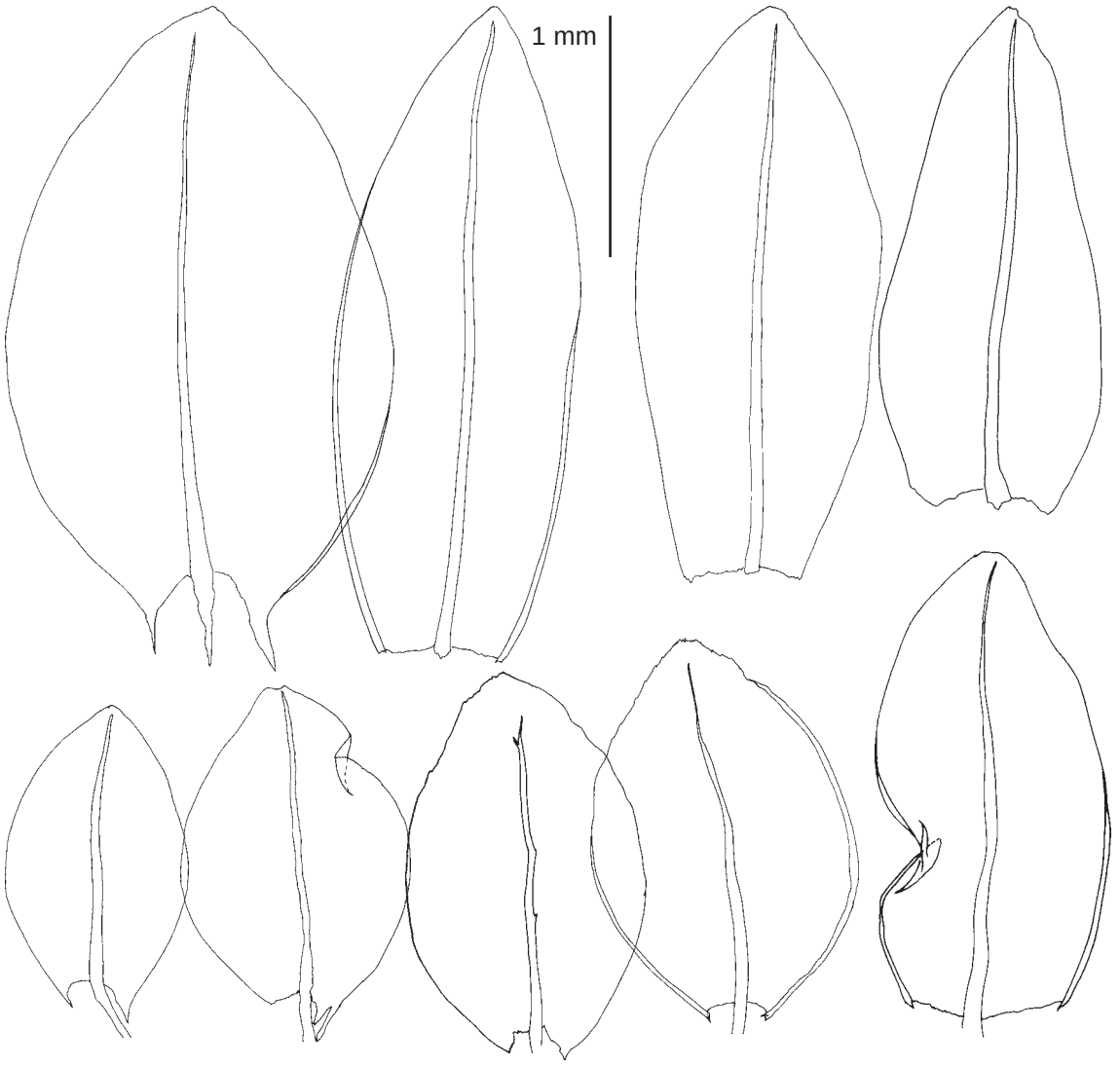


Fig. 77. *Bryum cyclophyllum* (Schwaegr.) B. S. G. (from Yaroslavl prov., Meshcheryakov, 7.VII.1924, LE): leaves. Scale bar: 1 mm for all.

translucent, formed by thin-walled elongate cells; costa thin, weak, green or yellowish-green, ending in leaf apex or below. Laminal cells thin-walled, not porose, in upper leaf rhomboid-hexagonal to rhombic, 32-56 x 16-24 μm, in mid-leaf lax, rhomboid to regularly hexagonal, 48(-80) x 16-28 μm, above smaller and shorter, at base rectangular to elongate-rectangular, 60-160 x 16-28 μm, green; basal marginal cells longer than juxta-costal ones.

Perichaetial leaves lanceolate, acuminate, concave, margin plane, costa ending below leaf apex. Seta 2-3 cm long, fuscous to red, thin, rigid, twisted when dry, abruptly curved below capsule. Capsule pendulous, light brown, dull, ca. 2 mm long, 0.8-0.9 mm thick, shortly pyriform, symmetric, contracted below rather broad mouth when dry, neck broad, nearly as long as urn. Operculum large, low-conic to highly conic-convex, with short apiculus, brownish-yellow, slightly glossy. Annulus 3-rowed. Peristome inserted at urn mouth, 420-440(-450) μm high. Exostome teeth narrow, gradually acuminate, at base ca. 100 μm wide, below fuscous-yellow to pale, above hyaline; border rather broad, 12-14 μm wide; median line zig-zag-shaped; fundus of same color as teeth or brighter, 60-70 μm high, broadened; ventral trabeculae 19-22. Endostome free, translucent to pale yellowish; basal membrane to 1/2 of endostome length; seg-

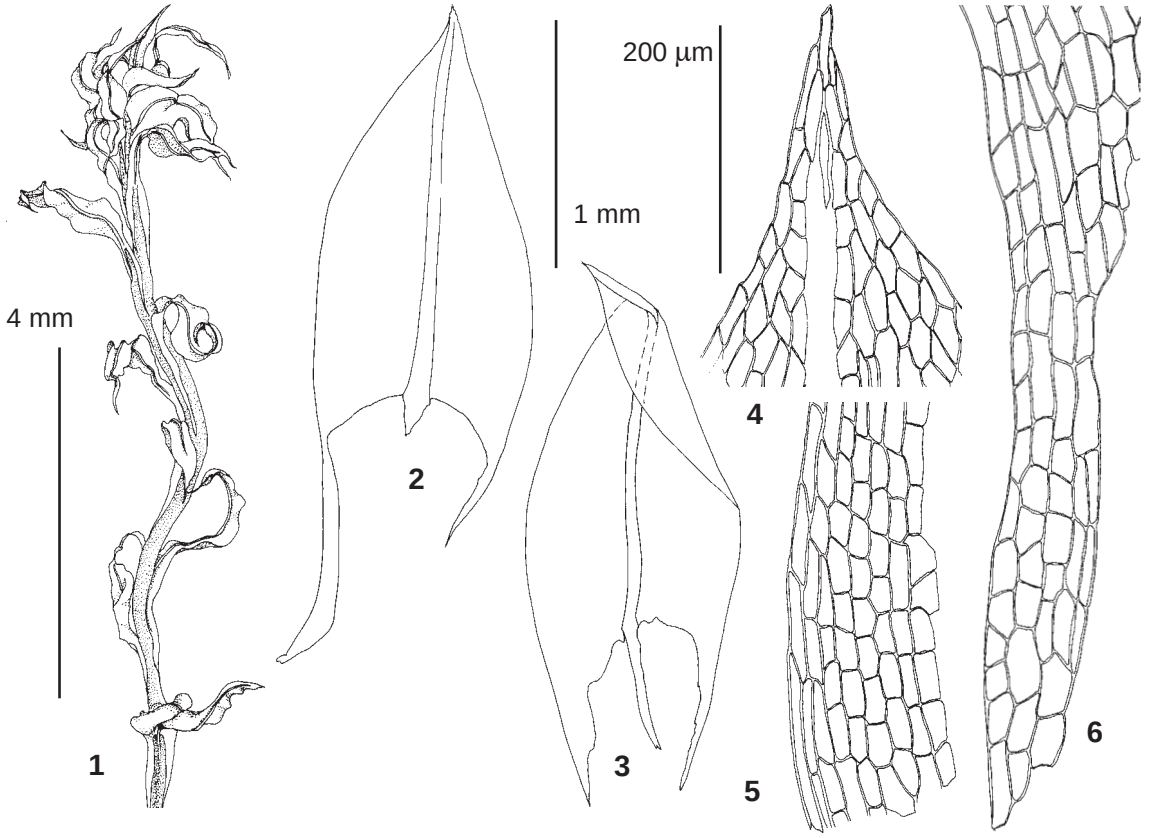


Fig. 78. *Bryum weigelii* Spregn. (from Vladimir Prov.,Nazarov 160, MW): 1 – habit; 2-3 – leaves; 4 – upper laminal cells; 5 – mid-leaf cells; 6 – basal cells. Scale bars: 4 mm for 1; 1 mm – 2-3; 200 µm – 4-6.

ments broad at base, half-segment at base 44-50 µm wide, broadly perforate below, narrowly split above; cilia 1-3, long, finely and densely papillose, longly appendiculate. Spores 10-14 µm, yellow to yellow-green.

Brood filaments rarely present in axils of upper leaves of sterile shoots, branched, greenish to brownish, finely and moderately densely papillose.

Differentiation and variation: This species is easy to recognize by its roundly obtuse to orbicular leaves that are crisped when dry, plane margins and an indistinct, 1-3 row33 , border, and a costa that ends below the leaf apex. Plants from the Yaroslavl Province differ in being taller and sometimes having a pinkish color.

Habitat: On wet and moist muddy soil; at banks of lakes, ponds, or in pits (often with *B. pallens)*. All collections are from the forest zone.

Selected specimens examined (5): Moscow Prov., Ignatov 4.VII.1988, MHA; Perm Prov., Bezgodov #153, #39, MW; Yaroslavl Prov., Meshcheryakov 7.VII.1924 & .1924 LE.

Bryum weigelii Spreng. in Biehler, Mant. Prim. Fl. Hal. 55. 1807. Fig. 78

B. duvalii Voit in Sturm, Deut. Fl. (ed. 2) 2(12): 10, ill. 1812.

Dioicous; male plants sometimes in separate tufts; perigonium wide, with numerous antheridia and paraphyses; paraphyses equal to or slightly longer than antheridia; perigonial leaves small, obovate, bluntly acute, costa ending below apex; comose leaves around perigonia loose.

Plants in extensive, soft, loose to compact tufts 2.5-4(-10) cm high, pale green to pale yellow-green, pinkish to reddish; moderately tomentose; rhizoids in axils of lower leaves, fuscous to red-fuscous, densely papillose with medium-size papillae. Stem pale, yellowish to reddish, 1.5-10 cm long, straight, evenly distantly foliate, upper leaves loosely comose; subterminal shoots 1-3, straight, loosely comose. Upper leaves soft, spreading when wet, crisped to contorted when dry, 1.2-2.0(-2.2) mm long, 0.8-1.6 mm wide, broadly ovate to ovate-lanceolate, widest at 1/4-3/5 of leaf length, shortly to bluntly acuminate, broadly and

longly decurrent, decurrencies 2.2-2.7(-3.5) mm; without red pigmentation at base but sometimes pinkish throughout; margin narrowly recurved in lower third of leaf or plane, entire; border indistinct, narrow; costa thin, green, decurrent, ending below apex to percurrent. Laminal cells thin-walled, not porose, in upper leaf rhomboid-hexagonal, 40-52 x 18-22(-30) μm, in mid-leaf rhomboid-hexagonal and partly rectangular, 48-56(-60) x 16-20(-24) μm, towards margin longer and narrower, at base elongate-rhomboid, elongate-rectangular, more rarely elongate-hexagonal, 60-80 μm long and (20-)24(-28) μm wide, in decurrencies elongate-rhomboid, 60-80 x 18-20(-24) μm; border cells with more thicker cell walls than in laminal cells.

[Perichaetial leaves lanceolate, margin plane, costa ending below apex. Seta 2-4(-6) cm, reddish to red, thin, twisted when dry, abruptly curved below capsule. Capsule pendulous, brownish, to 4 mm long, 0.8-1.0 mm thick, oblong-pyriform, symmetric, strongly contracted below broad mouth when dry, neck narrow, shorter than or as long as urn. Operculum large, convex, with acute conic apiculus, light-brown, dull. Annulus broad, 3-4-rowed. Peristome inserted at urn mouth, 600(-700) μm high. Exostome teeth at base ca. 100 μm wide, gradually tapered above, below yellow, in uppermost part hyaline; border narrow, to 4-8(-12) μm; median line zig-zag-shaped to straight; fundus dark-yellow, 40-60(-70) μm high, broadened; ventral trabeculae 25-30(-36). Endostome free, yellowish; basal membrane 1/2-4/7 of endostome length; segments rather broad, half-segment at base 50-55 μm wide, broadly perforate below, narrowly split above; cilia 2-3, long, densely and finely papillose, appendiculate. Spores 12-16(-20) μm, yellowish to greenish.]

Differentiation: This species is easy to identify by its unbordered leaves with very elongate and broad decurrencies.

Habitat: On muddy and peat soil in swampy meadows and eutrophic swamps, banks of irrigative channels, near springs, along streams in forests.

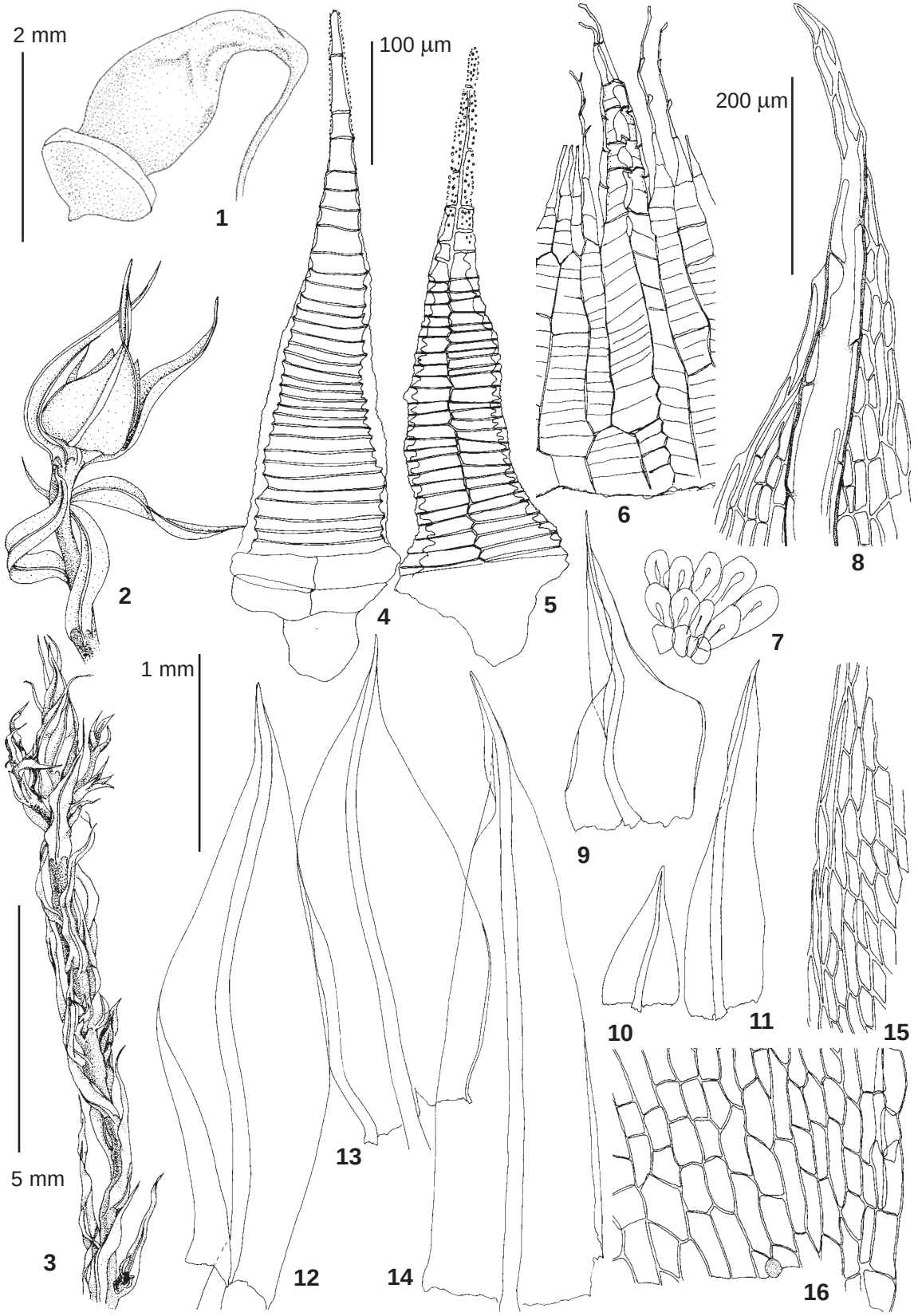
Selected specimens examined (50): Bashkortostan, Grigor'ev 10.VIII.1989, MW; Leningrad Prov., Korchagin 8.VII.1924, MW; Moscow Prov., Trofimov 10.IX.1948, MW; Nizhnij Novgorod Prov., Shvezov 11.VI.1915, MW; Perm Prov., Bezgodov #5766, MW; Vladimir Prov., Nazarov #160, MW; Voronezh Prov., Popova #4391, VOR.

Bryum turbinatum (Hedw.) Turn., Muscol. Hibern. Spic. 127. 1804. – *Mnium turbinatum* Hedw., Sp. Musc. Frond. 191. 1801. Fig. 79

Dioicous; male and female plants in mixed or separate tufts; male plants delicate, loosely foliate; perigonia with numerous red-orange antheridia and yellow paraphyses; paraphyses somewhat (to 1/3) longer than antheridia; outer perigonial leaves slightly concave, lanceolate, inner perigonial leaves smaller, rounder and ecostae. Upper leaves of male plants with more distinct leaf border of more thick-walled cells than in females, and costa thin, yellowish below, brownish above, excurrent in thin and long awn.

Plants in soft, loose to rather compact tufts 1-4 cm high, green, dirty-green, yellow-green to reddish-brown, densely tomentose, rhizoids ferrugineous-brown, papillose. Stem pale greenish-fuscous to red or red-brown, 1.0-2.5 cm long, evenly moderately densely foliate along most of its length, comose above, subterminal shoots 1-2(-3), short, evenly loosely foliate except comosely crowded uppermost leaves. Sterile shoots straight, tall, loosely foliate. Lower leaves, leaves of subterminal and sterile shoots small, gradually enlarged upwards, ovate, acuminate, weakly decurrent, with plane and entire margin, 1.0-1.5 mm long, 0.5 mm wide. Upper leaves ±rigid, erect when wet, losely appressed when dry, 2.2-2.8 mm long, 0.7-0.9 mm wide, ovate-lanceolate to oblong, widest at ca. 1/3 of leaf length, carinate, narrowly acuminate, slightly narrowed toward the base, non-decurrent, without red pigmentation at base, but sometimes reddish throughout; leaf margin broadly to narrowly recurved from base to 2/3-3/4 of leaf length, entire or weakly serrulate above; border distinct to indistinct, yellowish to yellow, sometimes inflated, composed of 2-3 rows of elongate cells with thin or slightly thickened cell walls, uni- or partly bistratose; costa stout, brownish-green, above brown to fuscous, shortly excurrent in smooth awn. Laminal cells lax, with thin or slightly thickened walls, not po-

Fig. 79. *Bryum turbinatum* (Schwaegr.) B. S. G. (from Tula Prov., Barkov 1302, LE): 1 – capsule; 2-3 – habit; 4 – inner surface of exostome tooth; 5 – outer surface of exostome tooth; 6 – part of endostome; 7 – annulus; 8 – upper laminal cells; 9 – perigonial leaf; 10-11 – perichaetial leaves; 12-14 – leaves;15 – mid-leaf cells; 16 – basal cells. Scale bars: 5 mm for 3; 2 mm – 1-2; 1 mm – 9-14; 200 μm – 7-8, 15-16; 100 μm – 4-6.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rose, in upper leaf longly rhomboid-hexagonal to longly rhomboid, 40-60 x 12-16 μm, in mid-leaf rhomboid, elongate-rhomboid, elongate-hexagonal, more rarely rectangular, 40-60 x 16-24 μm, towards margin narrower, more elongate, below rectangular, to 100 x 25 μm.

Perichaetial leaves triangular-lanceolate, margin plane, costa ending below leaf apex to shortly excurrent. Seta (1-)2(-4) cm, reddish, rigid, not or waekly twisted when dry, below capsule shortly and strongly curved. Capsule inclined to pendulous, light-fuscous to brown, before dehiscence to 3.0 mm long, 1.5 mm thick, broadly pyriform, symmetric, strongly contracted below broad mouth when dry; neck as long as urn or shorter, collapsing when dry. Operculum convex, with small beak, brown, slightly glossy. Annulus 3-4-rowed. Peristome attached at mouth, 440-600 μm long. Exostome teeth at base 100-140 μm wide, gradually acuminate, below brownish-yellow, uppermost part stout, hyaline; border 4-8 μm wide; median line zigzag-shaped; fundus of the same color as teeth or brighter, 50-70 μm high; ventral trabeculae to 30. Endostome free, yellowish, basal membrane ca. 1/2 of endostome length; segments broad, half-segment at base 40-52 μm wide, broadly perforate below, narrowly split above; cilia 2-3, long, densely papillose, appendiculate. Spores (14-)16-20 μm, fuscous-yellow.

Differentiation: This species is polymorphous and most collections consist of sterile plants. When growing in sunny habitats, *B. turbinatum* is low, 1-2 cm high, and forms dirty-olive-green to pinkish tufts, similar in color to *B. pallens*, but the former is immediately differentiated by unbordered leaves (in *B. pallens,* the border is always clear and bistratose). Plants of *B. turbinatum* from shady habitats are taller, 2-3(-4) cm high, pale, and resemble weak phenotypes of *B. pseudotriquetrum*. Such plants of *B. turbinatum* can be recognized by non-decurrent leaves and a 2-3-row border (vs. a 3-5(-6) row border in *B. pseudotriquetrum*). When sporophytes are present, the shape of the capsule is distinct; strongly contracted below the mouth, and relatively short.

Habitat: On wet and moist, sandy to clayish soil, sometimes among loose herbaceous vegetation; in wet meadows, river banks, along streams, edges of mires, at springs, on partly submerged sandstones.

Selected specimens examined (20): Bashkortostan, Selivanova-Gorodkova # 231, LE; Lipezk Prov., Popova 7.VI.1986, VOR; Nizhnij Novgorod Prov., Shvezov #157, LE; Tula Prov., Barkov 3.VI.1897, LE; Voronezh Prov., Popova 5.VI.1981, LE.

Bryum schleicheri Schwaegr., Sp. Musc. Frond., Suppl. 1, 2: 113. pl. 73. 1816. Fig. 80

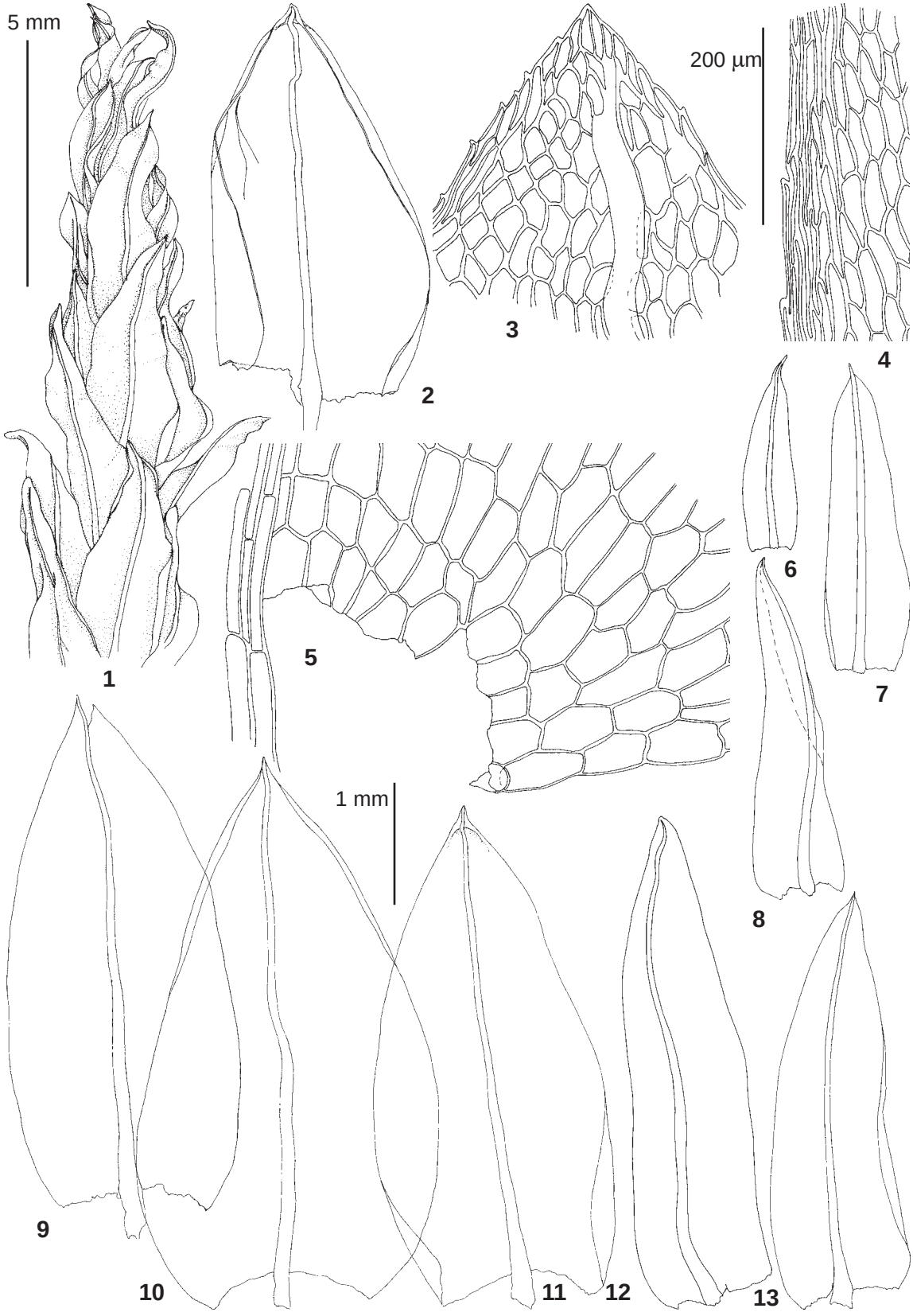
Bryum latifolium (Schwaegr.) Brid., Musc. Recent. Suppl. 4: 120. 1819(1818). – *Mnium latifolium* Schwaegr., Sp. Musc. Frond. Suppl. 1, 2: 138. 1816. – *B. schleicheri* var. *latifolium* (Schwaegr.) Schimp., Syn. Musc. Eur. (ed.2) 463. 1876.

Dioicous; only female plants found in the study area; [perigonia wide, with numerous purple anteridia and fuscous paraphyses; paraphyses twice as long as antheridia; perigonial leaves cordate, with brownish costa and plane margin].

Plants in compact, easily separating tufts to 3.5-6.0 cm high, greenish-stramineous; rhizoid tomentum weak, rhizoids fuscous, finely papillose. Stem stout, light-brownish, yellowish to orangish, 2.0-6.0 cm long, evenly densely foliate, not comose; subterminal shoots absent or 1, foliage pattern similar to that of stem. Leaves of sterile shoots 2.5-3.5 mm long, 1.3-1.7(-2.5) mm wide. Stem leaves appresed to erect when wet, flexuose to slightly contorted when dry, 3.0-4.0(-4.5) mm long, 2.0-2.5 mm wide, broadly ovate to cordate, widest at 1/4-5/7 of leaf length, shortly acute, ±cucullate, carinate, nondecurrent, at base green to brownish; margin plane, weakly serrulate above; border 4-5-rowed, unistratose; costa stout, decurrent, at base brownish, above yellow-green, percurrent to shortly excurrent. Laminal cells with slightly incrassate cell-walls, in upper leaf rhombic, 44-60 x 24-36 μm, in mid-leaf rhomboid-hexagonal, 80-92 x 28-32(-40) μm, at base rectangular, large, to 40 μm wide, in leaf corners subquadrate, ca. 40 μm wide.

[Perichaetial leaves oblong-lanceolate, margin plane, costa strong, percurrent. Seta to 3-4 cm long, red, slender, slightly twisted when dry, abruptly curved below capsule. Capsule inclined, yellowish-fuscous, orange below mouth, 3.5 mm long, 1.5 mm thick, broadly pyriform, symmetric, strongly contracted below broad mouth when

Fig. 80. *Bryum schleicheri* Schwaegr. (2-5 from Komi Republic, Abramova 412, LE; 1 & 6-13 from Tver province, Notov, MW): 1 – habit; 2, 9-13 – leaves; 3 – upper laminal cells; 4 – mid-leaf cells; 5 – basal cells; 6-8 – leaves from upper stem. Scale bars: 5 mm for 1; 1 mm – 2, 6-13; 200 μm – 3-5.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dry; neck 1/2-3/4 of urn length, collapsed when dry. Operculum large, high-conic, bluntly acute, orange, slightly glossy. Annulus broad, to 120 μm, 3-rowed. Peristome to 840 μm high, inserted at urn mouth. Exostome teeth at base to 180 μm wide, gradually acuminate, below yellow, above hyaline; non-bordered; median line zig-zag-shaped; fundus pale, 30-40 μm high, broadened; ventral trabeculae 38-42, some with longitudinal septae. Endostome free, orange; basal membrane slightly 1/2-2/3 of endostome length; segments broad, half-segment at base to 55 μm wide, gradually tapered above, with narrow ovate perforations, sometimes fused by 2 in lower part; cilia 3-4, long, ±densely papillose, with numerous appendicules. Spores ca. 20 μm, orange-green.]

Differentiation and variation: *Bryum schleicheri* has large, tumid shoots that readily distinguish it from all other species in Middle European Russia. If sporophytes are present, the large thick capsule, long exostome teeth (with ca. 40 ventral trabeculae) and orange endostome are highly diagnostic.

Schljakov (1995) suggested that *B. latifolium* is distinct from *B. schleicheri*; however, the characters he used to delimit the two (width of the leaf base, cells of the leaf corners, length of decurrencies, and shape of the acumen) were found not to correlate sufficiently for two entities to be segregated.

Habitat: On rocks near springs.

Specimens examined (2): Tver Province, Notov, 1999, MW; Republic Komi, Abramova #412, 13.IX.1941, LE.

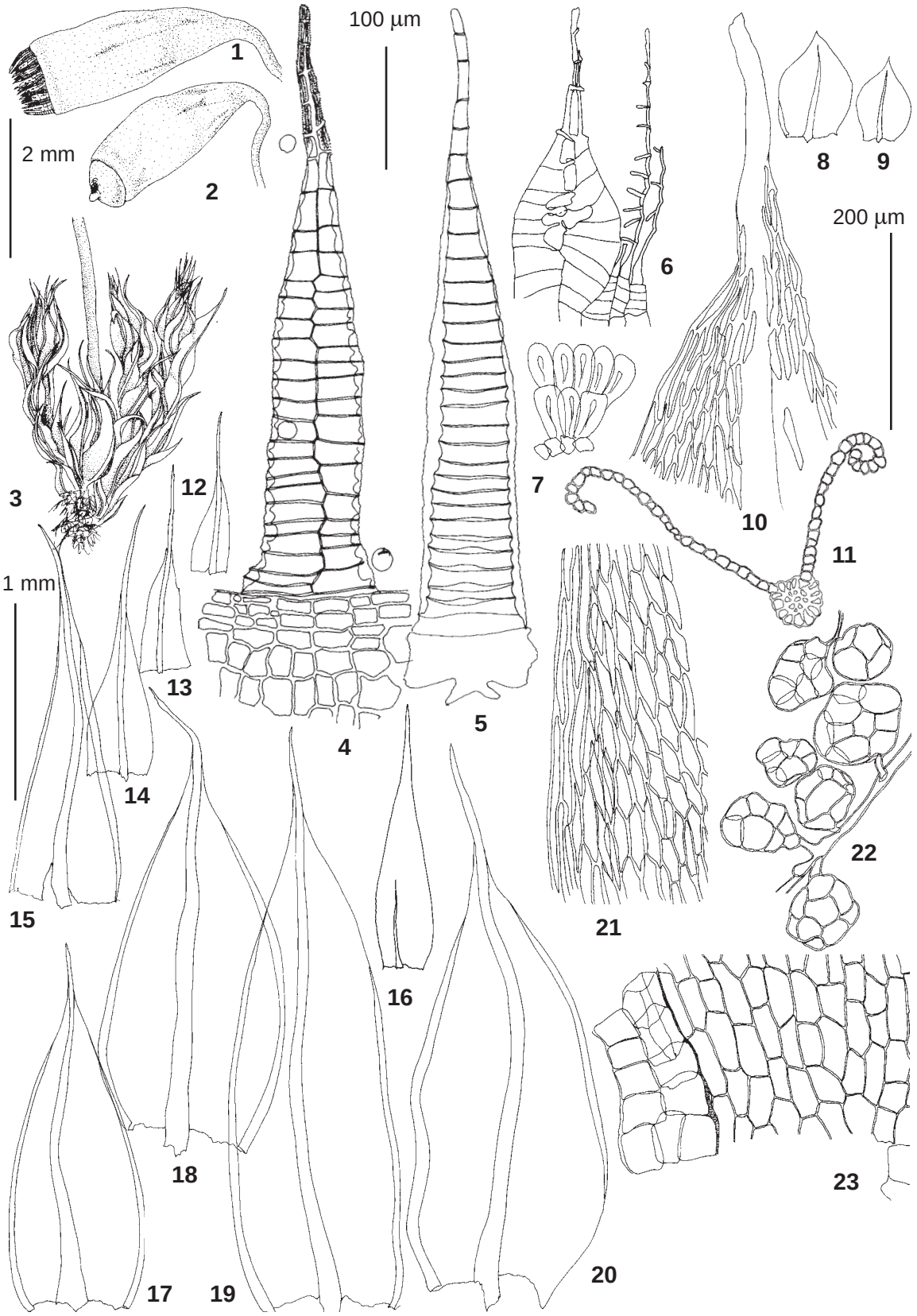
Bryum caespiticium Hedw., Sp. Musc. Frond. 180. 1801. Fig. 81

Dioicous; male plants often in separate tuft 0.5-1.0 cm high, delicate, branched; upper leaves comosely crowded, ovate-lanceolate to lanceolate; perigonial leaves broadly obovate, with plane entire margin and costa ending below short acumen; perigonium with numerous orange anteridia and orange paraphyses; paraphyses longer than antheridia.

Plants in dense tufts 1.0-1.5(-2.0) cm high; green, dirty-green to yellow-green; densely tomentose, rhizoids ferrugineous-brown to ferrugineous-red, densely and finely papillose. Stem of female shoot short, ca. 1 cm long, comose; subterminal shoots 1-4, 0.5-1.0 cm long, rather evenly imbricate to comose. Lower leaves remotely arranged, small, 1.2-1.4 mm long, 0.4-0.5 mm wide, lanceolate, with narrowly recurved margins. Upper leaves erect-spreading when wet, loosely appressed when dry, markedly larger than lower ones, to 2.4(-2.7) mm long, 0.8-1.2 mm wide, oblong-lanceolate, widest 1/5-1/3 of leaf length, longly acuminate, non-decurrent, red at base; margin broadly reflexed to strongly revolute from base to acumen, entire to weakly serrulate above; border narrow or broad, indistinctly delimited from lamina; costa stout, at base red, above yellow-green to yellow, excurrent in smooth to weakly serrulate, short to long awn. Laminal cells with slightly incrassate cell-walls, not porose; in upper leaf and downward along margins (sometimes to the base) linear, (60-)80(-120) x (7-)8(-12) μm, but in contrast with border cells chlorophyllose and thin-walled; in upper third cells elongate-rhomboid to rhomboid, 60-80(-100) x 12-14(-16) μm; in mid-leaf cells rhomboid to subrectangular, 52-60(-80) x 16(-20) μm, narrower and longer towards margin; at base cell rectangular, to (60-)80-100 x 24-28(-32) μm, in leaf corners subquadrate, somewhat inflated, 28-30 μm wide.

Perichaetial leaves lanceolate, longly acuminate, margin plane, costa excurrent to ending below leaf apex. Seta 2-3(-4) cm, fuscous to red, rigid, not twisted when dry, shortly arcuate below capsule. Capsule pendulous, fuscous to light-reddish-brown and dark-chestnut, 3.0-4.0 mm long, 0.8-1.2 mm thick, oblong-clavate to cylindric, when dry narrower and contracted below rather broad mouth; neck half as long as urn. Operculum large, shortly conic to conic-convex, with acute beak, orange to brown, glossy. Annulus 2-3-rowed. Peristome 480-520(-600) μm high, inserted at urn mouth. Exostome teeth at base 100-120(-140) μm wide, abruptly tapered in transition zone, below yellow to yellow-brown; above hyaline to yellowish; border narrow to ±broad; median line zig-zag-shaped; fundus red-orange, (40-)60-80(-90) μm high, broadened; ven-

Fig. 81. *Bryum caespiticium* Hedw. (1-21 & 23 from Voronezh Prov., Popova 10.VI.1983 VOR; 22 from Tula Prov., Popova 24.VIII.1996 VOR): 1-2 – capsules; 3 – habit; 4 – outer surface of exostome tooth; 5 – inner surface of exostome tooth; 6 – part of endosotme; 7 – annulus; 8-9 – perigonial leaves; 10 – upper laminal cells; 11 – transversal leaf seccion; 12-16 – perichaetial leaves (12-15 from one perichaetium, 16 – from another one); 17-20 – leaves; 21 – mid-leaf cells; 22 – rhizoid gemmae; 23 – basal cells. Scale bars: 2 mm for 1-3; 1 mm – 8-9, 12-20; 200 μm – 10-11, 21-23; 100 μm – 4-6.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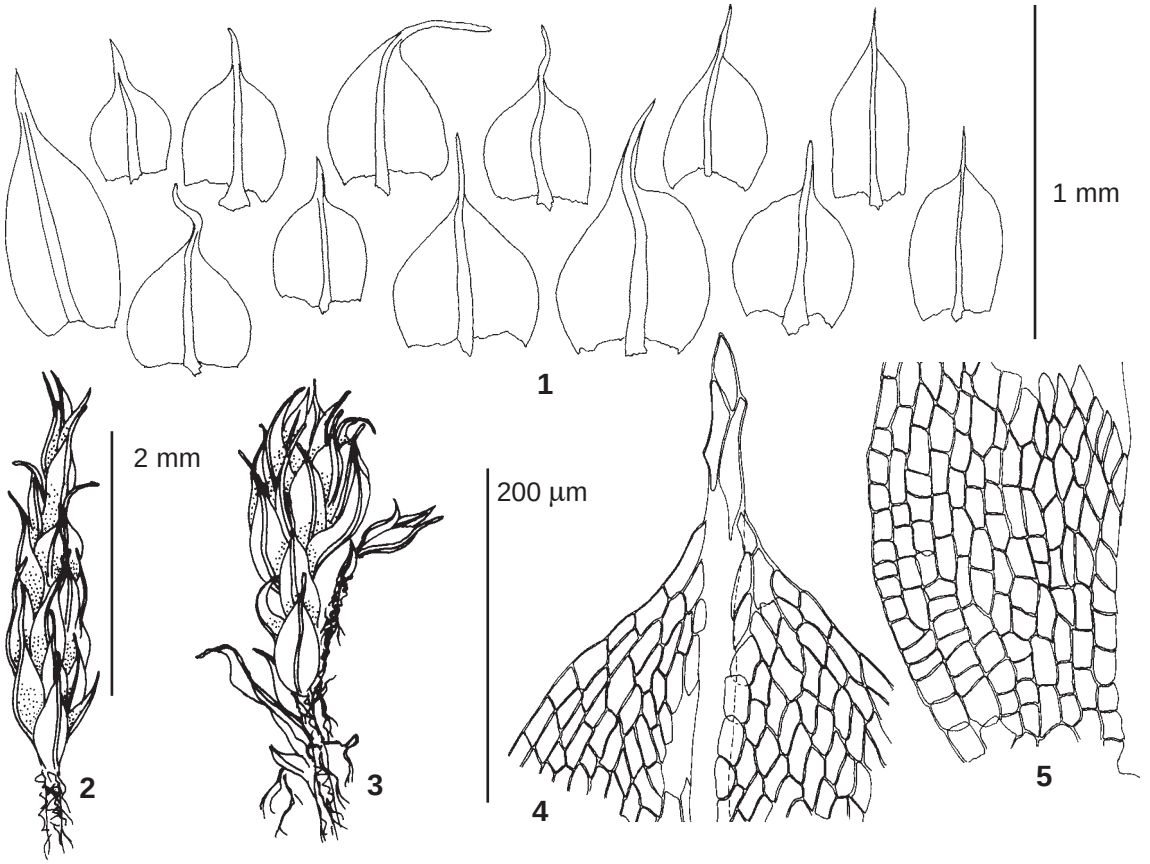


Fig. 82. *Bryum kunzei* Hoppe et Hornsch. (from Pskov Prov., Zolotov, 13.IX.1999, MHA): 1 – leaves; 2-3 – habit; 4 – upper laminal cells; 5 – basal cells. Scale bars: 2 mm for 2-3; 1 mm – 1; 200 µm – 4-5.

tral trabeculae 25-28(-36). Endostome free, yellowish; basal membrane ca. 1/2 of endostome length; segments broad, half-segment at base 40-60 µm wide, broadly perforate below, narrowly split above; cilia (2-)3(-4), long, moderately papillose, longly appendiculate. Spores 9-16 µm, yellow.

Rhizoid gemmae rarely present in sterile plants, numerous, red, round, pyriform or irregularly-shaped , 60-80 µm in diameter, with slightly convex, rather thick-walled cells.

Differentiation: This species usually has sporophytes, but sterile plants can be distinguished by: (1) dense tufts; (2) dioicous sexual condition; and (3) the gradual transition from laminal to border cells.

Habitat: *Bryum caespiticium* occurs in both forest and steppe zones in different open and dry habitats on soil (sand, clay, humus) and rocks: in grasslands, eroded slopes, steppes, various synantropic habitats, including concrete and brick surfaces.

Selected specimens examined (80): Arkhangelsk Prov., Ignatov 8.VIII.1988, MHA; Bashkortostan, Schljakov #230, LE; Tatarstan, Vereteinov 30.VIII.1909, LE; Belgorod Prov., Shishkova 27.VI.1958, LE; Kaluga Prov., Boczkin 5.IV.1986, MHA; Kursk Prov., Ignatov 15.VIII.1996, MHA; Moscow Prov., Ignatov 8.VII.1996, MHA; Nizhnij Novgorod Prov., Shvezov #89, LE; Orel Prov., Rostovzev #1099, LE; Perm Prov., Ignatov 23.IX.1988, MHA; Pskov Prov., Zolotov 18.VIII.1998, MHA; Rostov-na-Donu Prov., Babenko 25.VII.1992, MHA; Saratov Prov., Czerepanova #756, LE; Tver Prov., Minaeva 12.VIII.1986, MHA; Volgograd Prov., Belyanina 5.IX.1985, MHA; Voronezh Prov., Popova 10.VI.1983, LE.

Bryum kunzei Hoppe et Hornsch., Flora 2(1): 90. 1819. – *B. caespiticium* var. *kunzei* (Hoppe et Hornsch.) Warnst. – *B. caespiticium* ssp. *kunzei* (Hornsch.) Podpera, Rozpr. Ceske Akad. Ved. Tr. 2. Vedy Mat. Prir. 10(2): 55. 1901. Fig. 82

No gametangia and sporophyte found in study area.

Plants in dense, easily separating tufts, 0.5-2.0(-2.5) cm high, light-green, ±tomentose; rhizoid light fuscous to light brownish, finely papil-

lose. Stem red, 0.5-1.0(-2.0) cm long, narrow, julaceous or almost so, no subterminal shoots were seen in sterile shoots. Leaves small, 0.45-1.0 mm long, 0.45-0.50 mm wide, broadly ovate, obtusely acute with abruptly piliferous acumen to ±lanceolate or elongate to ovate-lanceolate, widest at 1/3-1/2 of leaf length; with narrower and more longely piliferous acumen; concave, non-decurrent, without red color at base; margin plane or in largest leaves narrowly recurved at base; border not differentiated; costa thin to rather stout, red at base, ending below apex to percurrent or filling piliferous acumen in largest leaves. Laminal cells thin-walled, not porose, in upper part to 40(-60) x 12-16(-20) µm, hexagonal, in lower half smaller, at base rectangular, in leaf corners ±quadrate, 16-20 µm wide.

Differentiation and variation: *Bryum kunzei* grows in low tufts or clusters and is characterized by closely imbricate leaves. The tufts are characteristically whitish due to numerous hyaline awns; however, the lamina is green, unlike the partially colorless lamina of *B. funkii* and *B. argenteum*. The leaves of *B. kunzei* are rigid and concave with a stout, shortly excurrent costa, and plane to narrowly recurved and indistinctly bordered margins. Small plants of *B. elegans*, growing in the same habitats, differ in the green to brown-green color of tufts and the orientation of the piliferous acumen. In *B. elegans,* the acumen is reflexed to recurved from an appressed leaf, so that the subterminal shoots are clearly julaceous; in *B. kunzei* the entire upper leaf is reflexed, following the curvature of the piliferous acumen, resulting in a characteristic julaceous appearance. Small, sterile specimens of *B. bicolor* from chalk areas differ from *B. kunzei* in: (1) the presence of axillary buds (not always!); (2) the absence of small-leaved lower parts of shoots, which thus look sessile; (3) the rather fragile upper part of leaves; (4) subdichotomous branching; and (5) less dense tufts. *Bryum funkii* usually has a looser growth form, and never forms dense tufts.

Habitat: On sandy and rocky open slopes, both on sandstones and limestones; scattered in the steppe and forest zones, and in the lowlands and South Urals.

Selected specimens examined (15): Bashkortostan, Selivanova-Gorodkova #33, LE; Pskov Prov., Zolotov 13.IX.1999, MHA; Volgograd Prov., Ignatov 7.VIII.1999, MHA.

Bryum funkii Schwaegr., Sp. Musc. Frond. 1(2): 89, fig. 69. 1816. Fig. 83

Dioicous; male plants often in separate tufts; perigonia open due to numerous antheridia and paraphyses; paraphyses somewhat longer than antheridia; perigonial leaves obovate, with excurrent costa.

Plants growing as separate individuals or in loose to somewhat dense tufts to 1(2) cm high, yellowish-green, whitish, somewhat glossy, inside tomentose, rhizoids red, red-brown to red-fuscous, densely papillose. Stem red, 0.5 cm long, remotely foliate below, densely bud-like foliate above; subterminal shoots 2-3, julaceous, to 0.5 cm long; proximal leaves of subterminal shoots larger than distal ones, making shoots acute; All leaves closely imbricate when both wet and dry. Lower leaves of female shoots and leaves of subterminal and sterile shoots small, to 1.5 mm long and 0.8 mm wide, concave to carinate, ovate, shortly acuminate. Upper leaves to 2.2 mm long, 1.1 mm wide, ovate-lanceolate, widest at 1/4-1/3 of leaf length, ±shortly acuminate, carinate, non-decurrent, red at base; margin in lower leaves plane, in upper leaves ±reflexed; entire; border weakly differentiated, 1-rowed, unistratose; costa in all leaves very stout, at base red, above yellow-green, becoming red with age, shortly to longly excurrent as a stout awn. Laminal cells with slightly to moderately incrassate walls, less thick towards leaf base, in upper leaf rhombic to rhomboid, (35-)40(-50) x (14-)18(-20) µm, in mid-leaf ca. 60(-130) x 20 µm, at base elongate rectangular, 130(-160) µm long and 24-40 µm wide, red, in leaf corners rectangular, to 80 µm long and 40(-50) µm wide.

Perichaetial leaves oblong-ovate, gradually acuminate, inwards smaller and narrower to lanceolate; margin plane, costa percurrent to shortly excurrent. Seta (1.5-)2-3(-3.5) cm, fuscous-orange to red, thin, not or slightly twisted when dry, suddenly curved below capsule. Capsule inclined to pendulous, orange-fuscous, dull, 2.5-3.5 mm long, 1.0-1.5 mm thick, broadly pyriform to oblong pyriform, symmetric, slightly contracted below broad mouth when open; neck half as long as urn, collapsed when dry. Operculum small, high-conic or conic-convex, with acute beak, similar in color to urn, dull. Annulus 3-rowed. Peristome 500 µm high, inserted at urn mouth. Exostome teeth at base ca. 95 µm wide, suddenly contracted in transition-

al zone, below pale-yellow; in uppermost part hyaline; border to 8 μm wide; median line zigzag-shaped; fundus orange, 70-80 μm high, broadened; ventral trabeculae 25-30. Endostome free, pale-yellowish, as long as teeth; basal membrane to 3/5 of endostome length; segments broad below, half-segment at base 40-48 μm wide, abruptly contracted into thin to spinulose uppermost part, broadly perforate below, narrowly split above; segments rather remotely arranged; cilia (2-)3(-4), long, ±papillose, appendiculate. Spores 16(-20) μm, fuscous-yellow.

Differentiation: The loose growth form and the bud-like appearance of plants generally facilitate immediate recognition of *B. funkii*. In more difficult cases, *B. funkii* can be distinguished from *B. argenteum* by the stout, excurrent and often red costa; from *B. elegans* by the absence of pure green color, and the straight and stout leaf awn (vs. the recurved and slender, piliferous acumen in *B. elegans*). *Bryum bicolor* resembles *B. funkii* in short, concave leaves and a stout excurrent costa, but its leaves are never so tightly appressed and subterminal shoots are not julaceous at all.

Habitat: Scattered in limestone and chalk areas. Growing on ±solid rocks, as well as on soft calcareous material, which often covered solid limestones, or on fine humus layer.

Selected specimens examined (15): Arkhangelsk Prov., Ignatov 3.VIII.1988, MHA; Bashkortostan, Podpera 28.VIII.1917, LE; Belgorod Prov., Popova 20.VII.1993, LE; Moscow Prov., Zickendrath #1447, LE; Tula Prov., Zinger 22.V.1898, LE; Volgograd Prov., Ignatov 2.VIII.1999, MHA.

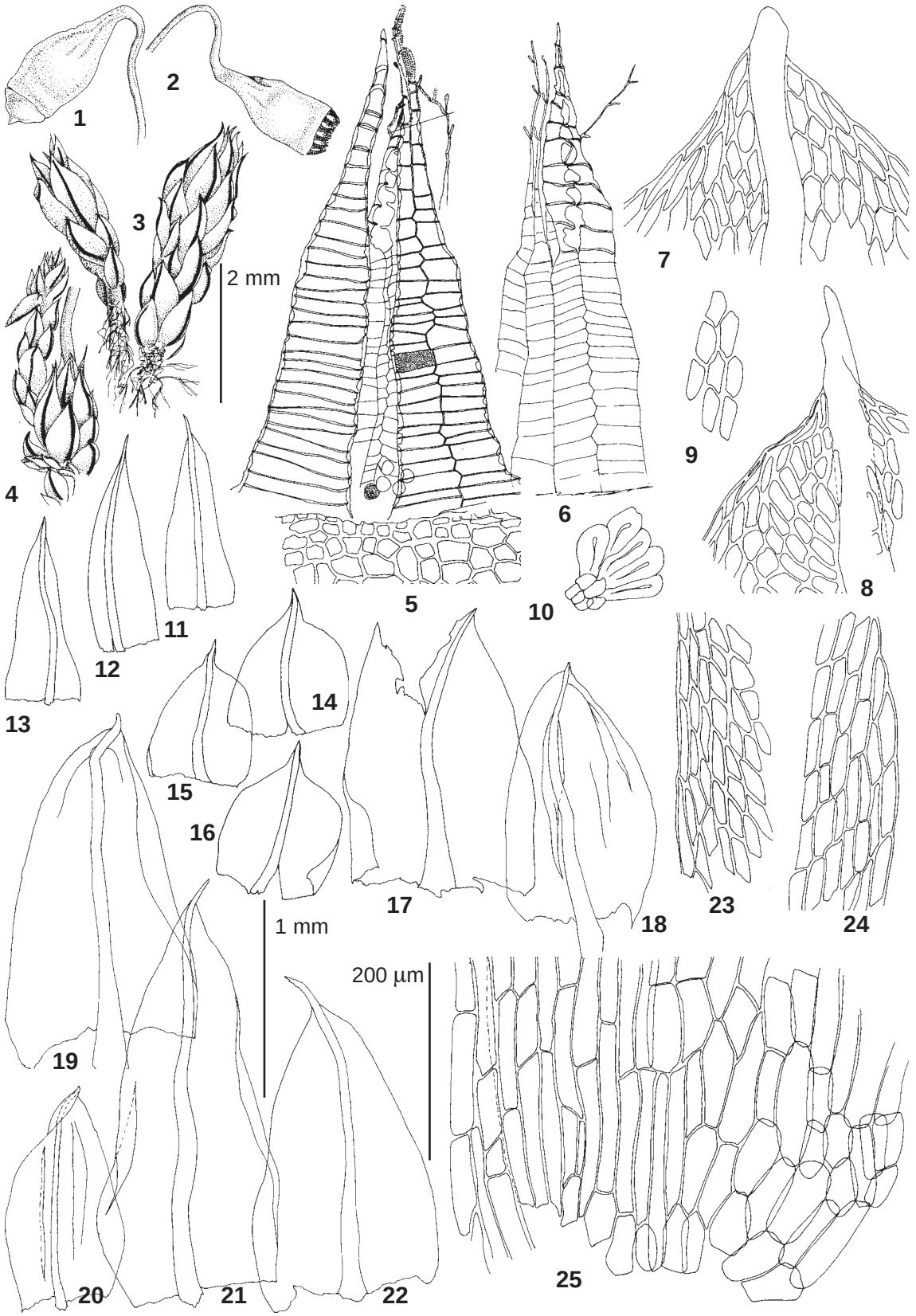
Bryum intermedium (Brid.) Bland., Ueber. Mecklenb. Moose 6. 1809. – *Pohlia intermedia* Brid., Muscol. Recent. 2(3): 144. 2 f. 12. 1803. Fig. 84

Synoicous; antheridia and paraphyses numerous, reddish; paraphyses somewhat longer to twice as long as antheridia.

Plants in extensive, dense, low tufts to 1(-2) cm high, green, bright-green to yellow-green, inside densely tomentose, rhizoids brown to fuscous, papillose. Stem red, 0.8-1.0 cm long, comose, subterminal fertile shoots short, comose; sterile shoots straight, evenly foliate. Lower leaves ovate-lanceolate, erect, remote, 2.0 mm long, 0.8 mm wide, costa ending below apex to percurrent. Upper leaves erect when wet, appressed when dry, 2.4-2.8(-3.5) mm long, 1.0-1.1(-1.2) mm wide, broadly-lanceolate to ovate-lanceolate, widest at 1/4-1/3 of leaf length, acuminate, nondecurrent, at base red; margin revolute from base to acumen, entire or weakly serrulate above; border 2-3(-4)-rowed, distinct due to thick-walled border cells, which however weakly differentiated from laminal cells in shape; costa stout, at base red, above brownish, becoming black with age, shortly to longly excurrent in smooth or weakly serrulate awn. Laminal cells with slightly incrassate cell-walls, not porose, in upper leaf rhombic or rhomboid, 35-50 x 18-20 μm, with thicker walls than median ones; in mid-leaf rhomboid to rhomboid-hexagonal, partly rectangular, 40-60 x 12-16 μm; marginal cells elongate-rhomboid; basal cells more thin-walled, larger, rectangular to very shortly rectangular, 28-40 x 12-24 μm, in leaf corners lax, subquadrate, to 40 μm.

Perichaetial leaves lanceolate, margins narrowly recurved, costa longly excurrent. Seta 2 cm long, red, rigid, not twisted when dry, abruptly curved below capsule. Capsule horizontal, inclined to pendulous, fuscous to dark-brown, chestnut to blackish, to 3.0 mm long and 1.0 mm thick, oblong-pyriform to pyriform, slightly curved, slightly contracted below mouth when dry; neck as long as urn. Operculum small to large, conic-convex, with acute beak, similar in color to urn to somewhat darker, glossy, longly persistent after maturation. Annulus broad, 3-rowed. Peristome inserted at mouth, to 450-500 μm high. Exostome teeth at base 100-110 μm wide, gradually narrowed upwards, below yellow to rich-yellow, uppermost part hyalyne, massive; border broad, 12-16 μm wide; median line nearly straight; fundus orange or orange-red, 70-75 μm high, broadened; ventral trabeculae 25-30, longitudinal septae absent. Endostome free, pale-yellow, as high as exostome; basal membrane 1/3-1/2 of endostome length; segments suddenly tapered at ca. 2/3 of their length, broad, half-segment at base 80 μm wide, broadly perforate below, narrowly split above; cilia 3-4, equal to 3/4 of segment length, densely papillose, nodose or shortly appendicules. Spores 24-28(-32) μm, olive-green.

Fig. 83. *Bryum funkii* Schwaegr. (from Tula Prov., Zinger 22.V.1898, LE): 1-2 – capsules; 3-4 – habit; 5 – outer and inner surfaces of exostome teeth; 6 – part of endosotme; 7-9 – upper laminal cells; 10 – annulus; 11–13 – perichaetial leaves; 14-16 – perigonial leaves; 17-22 – leaves; 23-24 – mid-leaf cells; 25 – basal cells. Scale bars: 2 mm for 1-4; 1 mm – 11-22; 200 μm – 5-10, 23-25.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Differentiation: Sterile plants cannot be identified with certainty. The following sporophytic characters are important in distinguishing this species: (1) curved capsule with long-persistent operculum; (2) long nodose to very shortly appendiculate cilia; (3) a free endostome; and (4) large spores, mostly ca. 25 μm. In addition, this species has a synoicous inflorescence and an indistinct leaf border.

Habitat: On gypsum, limestone and sandstone outcrops, on fine soil layer above rocks.

Selected specimens examined (4): Arkhangelsk Prov., Ignatov 28.VII.1988, MHA; Bashkortostan, Selivanova-Gorodkova #202, LE; Lipezk Prov., Popova 23.VII.1994, VOR; Lipezk Prov., Galichya Gora, anonymous, VOR.

Bryum pallescens Schleich. ex Schwaegr., Sp. Musc. Frond., Suppl. 1(2): 107. pl. 75. 1816.

Fig. 85-86

Autoicous; perigonium ±compact, with numerous antheridia and golden paraphyses; paraphyses longer than antheridia; perigonial leaves lanceolate, with plane to narrowly recurved margins, indistinct border and excurrent costa; inner perigonial leaves obcordate, abruptly rounded into acute acumen, with costa ending below mid-leaf.

Plants in dense, easily separated tufts, 1.5-2.0 cm high, bright green, tomentose inside, rhizoids dark red-brown, ±coarsely and densely papillose. Stem red, 0.5-1.0 cm long, comose, subterminal male shoots 1-4, 1.0-1.5 cm long, comose. Lower leaves brownish-green, 1.7-2.2 mm long, 0.6-0.7 mm wide, ovate to ovate-lanceolate, non-decurrent, red at base, with reflexed margin; border indistinctly delimited, (3-)4-rowed, yellowish or brownish; costa in lower leaves stout, at base red, above yellow, fuscous with age, percurrent to shortly excurrent in smooth to weakly serrulate yellow awn. Upper leaves erect when wet, appressed when dry, straight to slightly twisted, 2.4-2.6(-3.0) x 0.8-0.9(-1.0) mm, ovate-lanceolate to lanceolate,widest at 1/3-1/2 of leaf length, longly acuminate, concave, non-decurrent, red at base; margin reflexed to revolute, entire to weakly serrulate above; border broad, (3-)4-5(-6)-rowed, indistinctly delimited, yellowish-green; border cells long and thick-walled, transition to laminal cells gradual; costa stout, at base thick and red, yellow above, excurrent in smooth to weakly serrulate long awn. Laminal cells with slightly incrassate cell-walls, above rhomboid-hexagonal, 35-40(-50) x 12-16(-18) μm, in mid-leaf rectangular to rhomboid-hexagonal, 40-50(-60) x 12-20(-22) μm, at base rectangular, 80-100(-120) x (16-)20-24(-28) μm, in leaf corner shortly rectangular, lax, to 32 μm wide.

Perichaetial leaves lanceolate to triangular, longly acuminate, margin plane, costa percurrent to shortly excurrent. Seta to 2.5 cm, brown, fuscous to red-fuscous, thin, rigid, not twisted when dry, below capsule arcuate or more abruptly curved. Capsule horizontal or inclined to pendulous, fuscous to brown, dull, 3-4 mm long, ca. 1 mm thick, elongate-clavate-pyriform, symmetric, not contracted below mouth when dry; neck as long as urn. Operculum large, convex-conic to highly convex, with broadly acute apiculus, similar in color to urn, dull. Annulus 2-3-rowed. Peristome inserted at mouth, 450-500 μm high. Exostome teeth at base 60(-70) μm wide, gradually acuminate, below pale yellow, in uppermost part hyaline; border 4-8 μm wide; median line zig-zag-shaped; fundus orange, 80-85 μm high, broadened; ventral trabeculae to 30. Endostome free, yellow; basal membrane 1/2 of endostome length; segments broad, half-segment at base 40-50 μm, narrow above, broadly perforate below (sometimes perforations fusing in big gaps), narrowly split above; cilia (2-)3(-4), long, moderately papillose, with broad and long appendicules. Spores 16-18 μm, olive-green.

Differentiation and species concept: The most important character states of this species are the autoicous sexual condition and the broad, (3-)4-5(-6) row, indistinct leaf border of the same color as the lamina. Podpera (1959) noted a similarity between *B. pallescens* and *B. intermedium*, but the differences between this pair of species are numerous: autoicous vs. synoicous; cilia long appendiculate vs. nodose to short appendiculate; capsule symmetric vs. curved; spores 16-18 μm vs. 24-28(-32) μm; operculum easily deciduous vs. long persistent.

Bryum pallescens frequently is reported in the literature from many parts of Middle European Russia; however, only one specimen has been verified for this region. Most collections identified as this species actually represent *B. lonchocaulon.*

The group of species with autoicous, synoicous and polyoicous inflorescences, i.e., *B. pallescens, B. creberrimum,* and *B. lonchocaulon,* has a puz-

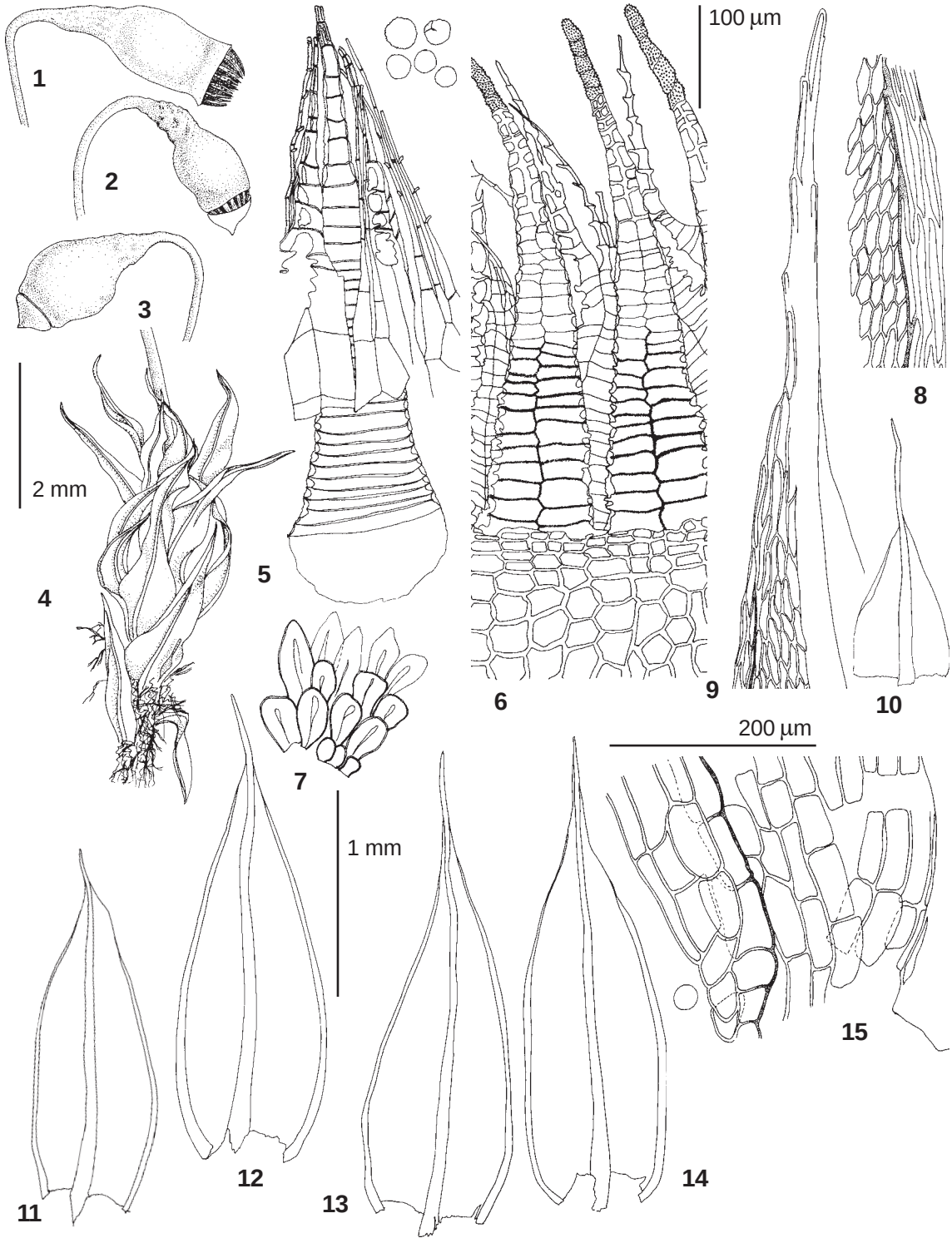


Fig. 84. *Bryum intermedium* (Brid.) Bland. (from Arkhangelsk Prov., Ignatov, 28.VII.1988, MHA): 1-3 – capsules; 4 – habit; 5 – inner surface of exostome teeth and part of endostome; 6 – outer surface of exostome tooth; 7 – annulus; 8 – mid-leaf cells; 9 – upper laminal cells; 10 – perichaetial leaf; 11-14 – leaves; 15 – basal cells. Scale bars: 2 mm for 1-4; 1 mm – 10-14; 200 µm – 5-9, 15.

zling history of studies and a number of contradictory species concepts. The authors of Bryologia Europaea (Bruch & al., 1846), Warnstorf (1906), and Podpera (1952) recognized two species in this complex: autoicous *B. pallescens* and synoicous *B. cirrhatum* (corresponding to *B. lonchocaulon* in the present study). Nyholm (1958) suggested that autoicous *B. pallescens* and *B. cirrhatum* should be treated as synonymous, because she considered the autoicous and the synoicous + male sexual conditions not readily distinct. She separated *B. creberrimum* from *B. pallescens* relying mostly on spore size. Smith (1973, 1978) followed Nyholm in including *B. cirrhatum* in the synonymy of *B. pallescens*, and tried to find reliable characters for separating it from *B. creberrimum*. He measured/evaluated 11 characters in 54 specimens and found that two are reliable: spore size, and width of endostome segment perforations. Crum & Anderson (1981) did not find these two characters useful for North American material. Instead, they used laminal cell shape as a key character; 2:1 in *B. pallescens* and 3:1 in *B. creberrimum.* Ochi (1959, 1985) distinguished *B. pallescens* and *B. cirrhatum*, using a single character, autoicous vs. synoicous sexual condition. Savicz-Ljubitskaya (1954) and Savicz-Ljubitskaya & Smirnova (1970), in their treatments of *Bryum* for the bryoflora of the USSR, accepted 3 species: *B. pallescens* (autoicous); *B. cirrhatum* (polyoicous), and *B. creberrimum* (synoicous).

My observations are as follows. First, I found only one truly autoicous collection: in ca. 30 inflorescences studied I found either numerous antheridia, or numerous archaegonia. This plant is rather tall with evenly arranged leaves below comose leaves, a relatively short excurrent costa, broad leaf border, and short laminal cells. Almost identical plants were seen from western Europe and the Caucasus, but they were rare in both these regions (listed below). These autoicous collections are referred here to *B. pallescens*. Other specimens are divided into two groups: (1) stem ends in synoicous inflorescence (in exceptional cases inflorescences has only archaegonia); subterminal shoots nearly always male; leaves ±long acuminate with a long excurrent costa; awn (0.25-)0.4-0.65(-0.8) mm long, narrow, ±flexuose and serrulate; leaf border relatively broad, 6(-7) rows; and (2) inflorescence synoicous, and subterminal shoots have also synoicous inflorescences (very rarely unsexual inflorescences were observed); leaves ±shortly acuminate with a short excurrent costa; awn 0.2-0.4(-0.65) mm long, stout, straight and smooth or weakly serrulate; leaf border relatively narrow, 2-3(-4)-rows. I was able to sort 110 specimens of this group into two groups (50 and 60 specimens respectively), without significant difficulty, though poor specimens without developed subterminal shoots can be identified not so certainly. These two groups I refer to *B. lonchocaulon* and *B. creberrimum* respectively. An example of distribution of gametangia in 3 populations of *B. lonchocaulon* and 3 populations of *B. creberrimum* is presented in Fig. 87. In each population (2-)4-6 samples ca. 2 cm in diameter were taken, and in each sample 5 randomly selected shoots were studied. The proportion of gametangia was found to be rather stable (Fig. 87), which agree with my observation in other specimens.

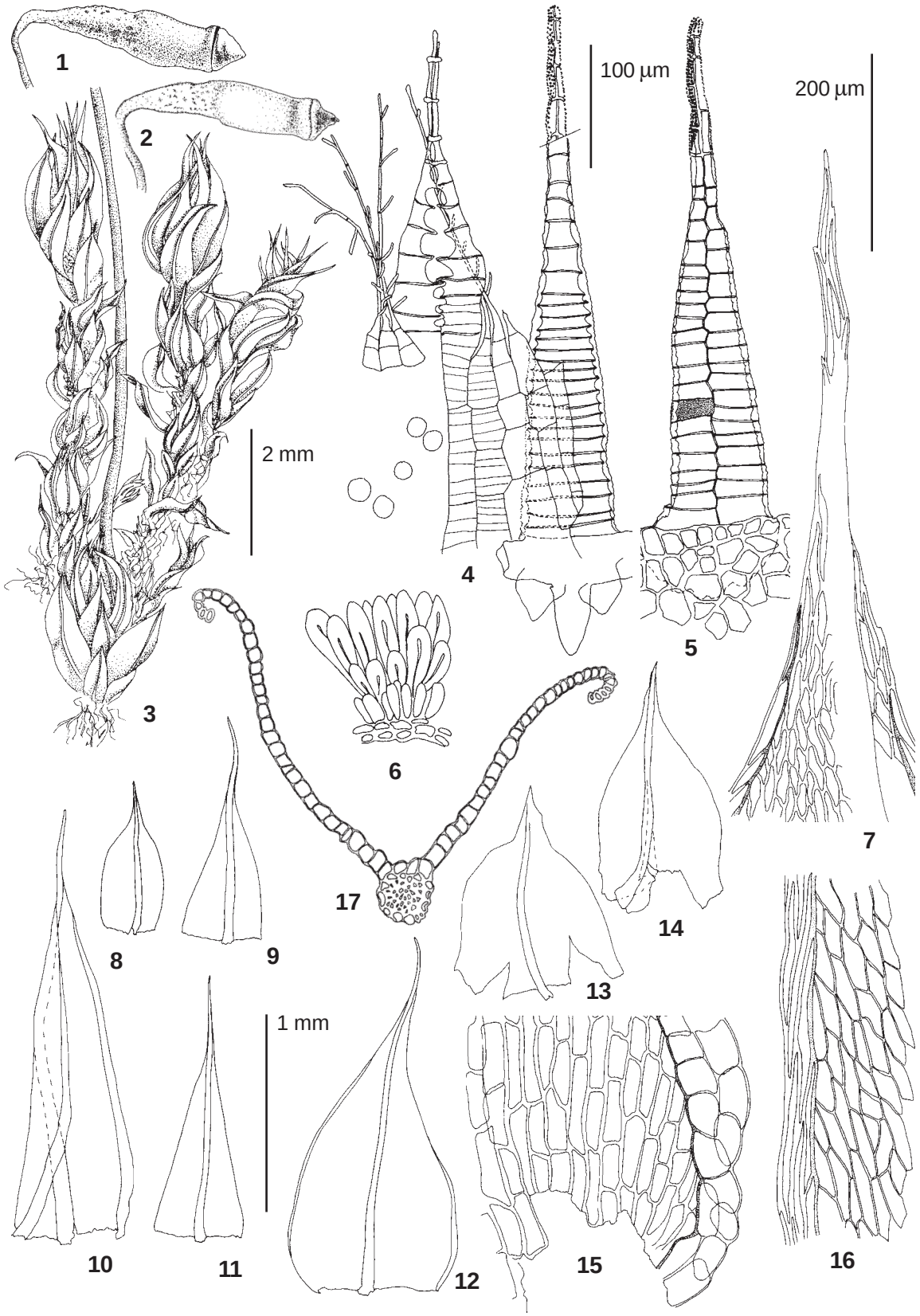
Since this concept is almost in agreement with the concept of *B. cirrhatum* and *B. creberrimum* of Savicz-Ljubitskaya (1954), I accept the names used by her, with the necessary nomenclatural corrections. Both these names must be considered as preliminary, and may not be appropriate for the following reasons. *Bryum cirrhatum* was found to be an illegitimate name and was replaced by *B. lonchocaulon* (Ochi, 1980), but Ochi (1959) considered *B. cirrhatum* as a synoicous species. Demaret (1986) described the type of *B. creberrimum*, and it does not correlate very well with the present concept, but falls better within the range of variability of *B. lonchocaulon*. A search for correct names (or verification of those used here) is needed, but it is a special task beyond the limits of the present study.

Habitat: Found once, on a limestone outcrop.

Specimen examined: Perm Prov., Bezgodov & Selivanov #228, 20.VI.1995, MW.

Studied specimens of B. pallescens from other areas: 1) Finland, Brotherus VII.1913, MW; 2) Brotherus:

Fig. 85. *Bryum pallescens* Schleich. *ex* Schwaegr. (from Perm Prov., Bezgodov & Selivanov, 228, MW): 1-2 – capsules; 3 – habit; 4 – part of endostome and inner surface of exostome tooth; 5 – outer surface of exostome tooth; 7 – upper laminal cells; 8-11 – perichaetial leaves; 12-14 – perigonial leaves; 15 – basal cells; 16 – mid-leaf cells (border recurved); 17 – transverse leaf section. Scale bars: 2 mm for 1-3; 1 mm – 8-14; 200 μm – 7, 15-17; 100 μm – 4-6.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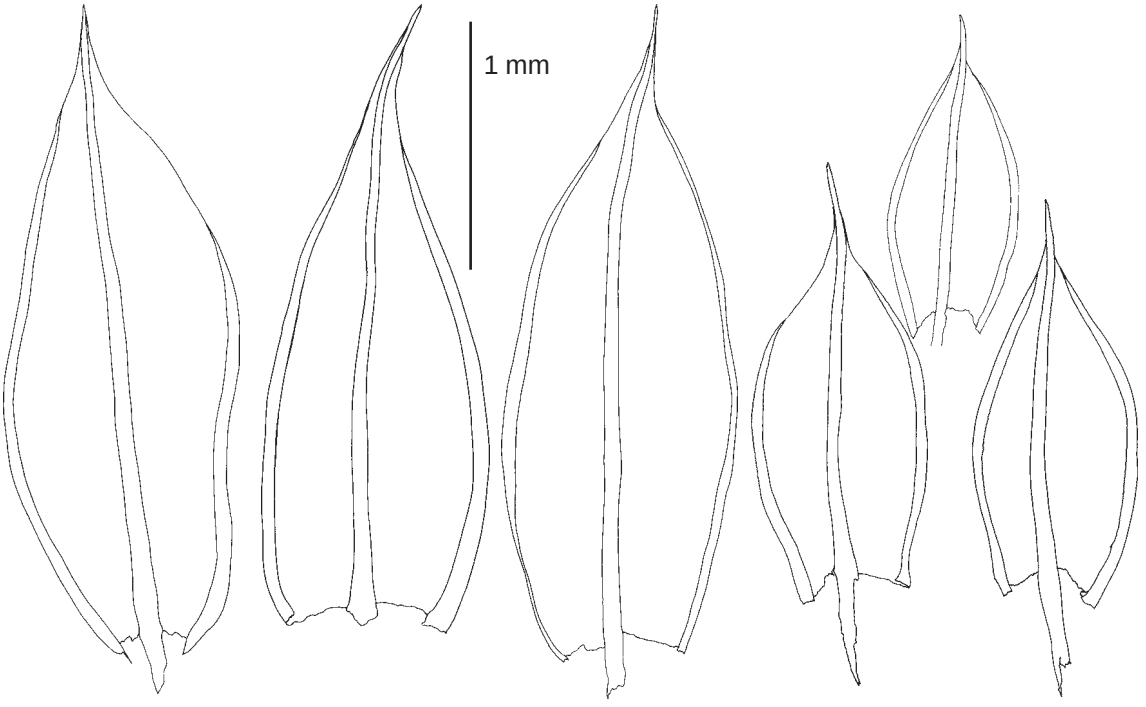


Fig. 86. *Bryum pallescens* Schleich. ex Schwaegr. (from Perm Prov., Bezgodov & Selivanov, 228, MW): leaves. Scale bar 1 mm for all.

Bryotheca Fennica 148 (.1908), MW; 3-4) [Central Europe], anonymous, MW; 5) Caucasus, Teberda Reserve, 2050 m elev., Ignatova 2.VIII.1986, MHA; 6) same, 1300 m, 1.VIII.1986, MHA.

Bryum lonchocaulon C. Muell.,
?Bryum cirrhatum Hoppe et Hornsch., Flora 2(6): 90. 1819. Fig. 87-88

Polyoicous: shoots partly synoicous, partly male and rarely female in the same tuft; in synoicous plants anteridia few, (1-)2-7, red; paraphyses yellow to orangish, longer than antheridia.

Plants in wide, compact or dense tufts, 1.0-2.5 cm high, green, yellowish or brownish-green, slightly glossy, tomentose, rhizoids ferrugineous, ±papillose. Stem puprle, 1.0-1.5 cm long, densely foliate, comose, subterminal shoots 1-3, to 0.5-1.5 cm long, more loosely foliate, comose. Lower leaves loosely arranged, ovate-lanceolate to ovate, to 2.0 mm long, 0.6 mm wide. Upper leaves spreading when wet, densely imbricate and slightly spirally twisted around stem when dry, 2.0-3.0(-3.8) mm long, 0.7-0.9(-1.2) mm wide, widest at 1/5-1/3 of leaf length, lanceolate or broadly lanceolate, longly and gradually acuminate, non-decurrent, red at base; margin recurved or revolute from base to acumen, entire or serrulate; border distinct, (4-)6(-7)-rowed, composed of thick-walled linear cells, not differentiated in color; costa stout, red at base, yellow above, brownish in acumen, excurrent in long, (0.24-)0.4-0.65(-0.8) mm, straight or slightly flexuose, serrulate or rarely smooth, rather thick awn. Laminal cells with sligthly incrassate cell walls, slightly porose, in acumen narrow, to 70(-80) x 8-10 μm, in upper leaf rhombic-hexagonal to rombic, (50-)60(-80) x (12-)16(-18) μm, in midleaf (40-)50-60(-70) x(12-)16-20(-22) μm, at base rectangular, to 70 x 36(-40) μm, in leaf corners subquadrate, to 50 μm wide.

Perichaetial leaves ovate-lanceolate, margin narrowly recurved to plane in innermost leaves; costa excurrent to percurrent and ending below leaf apex in innermost leaves. Seta (2.5-)3.5-4(-6) cm, cupper-reddish to fuscous-red, thin, slightly twisted when dry, arcuate below capsule. Capsule pendulous, light-fuscous to brown, 2.0-3.0(-4.5) mm long, 1.0-1.5 mm thick; cylindric, symmetric and contracted below mouth to obovate or pyriform and not contracted below mouth, neck as long as urn or shorter. Operculum small, slightly to highly convex, shortly beaked, brown to dark red-brown, glossy. Annulus broad, to 140 μm, 2-3-rowed. Peristome inserted at urn mouth, 500 μm high. Exostome teeth at base 120 μm wide, gradually tapered, below yellow, in uppermost part hyaline; border 12-18 μm wide; median line zig-zag-

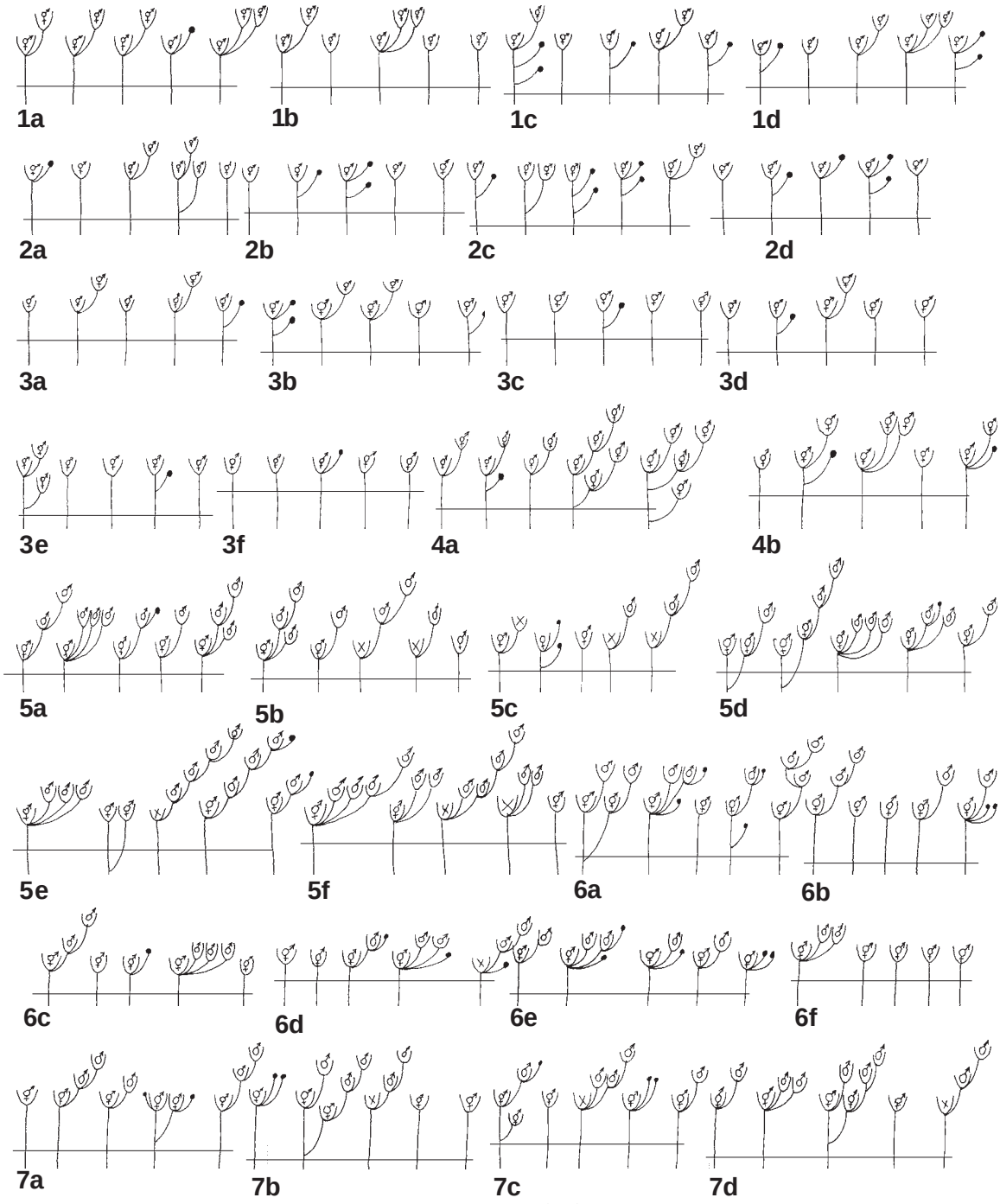


Fig. 87. Distribution of gametangia in *Bryum creberrimum* (1-4) [1-3: from Moscow, Zolotov 10.VI. 2000, MHA; 4 – Moscow, Zolotov 1.VI.2000, MHA] and *Bryum lonchocaulon* (5-7) [from Moscow, Zolotov 1.VI.2000, MHA].

shaped below, straigth above; fundus orange, 80 μm high, broadened; ventral trabeculae 28-30(-35). Endostome free, basal membrane 1/2-2/3 of endostome length; segments broad, half-segment at base 40-50 μm wide, with narrow uppermost part, broadly perforate below and narrowly split above; cilia 2-3, long, moderately to densely and highly papillose, appendicules well developed. Spores (12-)16-20(-24) μm, olive-green.

Differentiation: The differences from *B. pallescens* and *B. creberrimum* are discussed under the former.

Habitat: In forest and steppe zones, on soil (sand, clay, peat), rocks, and old brick walls; often on dry slopes, in synantropic vegetation, sometimes in wet swamping and flooded meadows.

Selected specimens examined (50): Arkhangelsk Prov., Zickendrath 27.VII.1895, LE; Arkhangelsk Prov., Ignatov 27.VIII.1988, MHA; Bashkortostan, Selivanova-Gorodkova, 24.VII.1946, LE; Kaluga Prov., Nikolskij 28.VII.1911, LE; Moscow Prov., Ignatov 16.VII.1987, MHA; Nizhnij Novgorod Prov., Shvezov #81, LE; Tatarstan, Vereteinov 6.V.1911, LE; Volgograd Prov., Ignatov 6.VIII.1999, MHA.

Bryum creberrimum Tayl., London J. Bot. 5: 54. 1846. Fig. 87,89

Bryum affine Lindb. et H. Arnell, Kongl. Sv. Vet. Acad. Handl. 23(10): 43. 1890.

Synoicous; antheridia large, purple, terminal and sometimes single antheridia in axils of upper leaves; antheridia and paraphyses numerous, paraphyses yellow to red, to twice as long as antheridia.

Plants in low, rather dense tuft 1-2 cm high, green, densely tomentose, rhizoids ferrugineous-brown, papillose. Stem red, to 1 cm long, comose, subterminal shoots (1-)2-4(-6), to 0.5 cm long, comose. Lower leaves 2.0-2.2 mm long, 0.8-1.0 wide, ovate, shortly acuminate to ovate-lanceolate and longly acuminate; costa percurrent to excurrent. Upper leaves spreading when wet, imbricate when dry, sometimes slightly twisted around stem and curved, 3.0-3.9 mm long, 1.0-1.4 mm wide, ovate-lanceolate, broadest at 1/5-1/3 of leaf length, gradually longly acuminate, ±shortly decurrent, red at base; leaf margin reflexed to revolute from base to acumen, entire to weakly serrulate above; border narrow, (1-)2-3(-4)-rowed, unistratose, yellow, distincly delimited; costa rather stout, at base red to bright-red, usually longly decurent, above yellow-green, in acumen to brownish, excurrent in smooth or weakly serrulate stout 0.20-0.40(-0.65) mm long awn. Laminal cells thin-walled, slightly porose, in upper leaf rhomboid-hexagonal and rhomboid, 50-60(-70) x 12-16(-20) μm, in mid-leaf (24-)48-52(-60) x (12-)16-20(-24) μm, at base long rectangular (64-)88(-92) x (20-)24(-28) μm, in leaf corners long rectangular to 80 μm long and 20 μm wide in distinctly decurrent leaves or shorter and slightly inflated, to 44 μm wide in slightly decurrent leaves.

Perichaetial leaves ovate, with long piliferous acumen and costa ending in acumen, margin plane. Seta (1.5-)2-3(-6) cm, orange-red, red or fuscous, rigid, not twisted when dry, below capsule abruptly hooked. Capsule horizontal, inclined to pendulous, brown to fuscous, 2.0-4.0(-4.5) mm long, 1.0-1.5 mm thick, narrow-cylindric to cylindric, oblong clavate or kegel-shaped, symmetric, slightly contracted below mouth when dry; neck as long or somewhat shorter than urn, collapsed when dry or not. Operculum large, plane-convex to convex, with short acute apiculus, of the same color as capsule or brighter, glossy. Annulus to 120 μm broad, 2-3-rowed. Peristome inserted at urn mouth, 450-700 μm high. Exostome teeth holodontous, rarely aulacodontous, at base 100-140 μm wide, below yellow, in uppermost part hyaline; border broad 16-20 μm; median line often nearly straight; fundus orange, 72-84 μm high, broadened; ventral trabeculae 27-30. Endostome free, yellowish, basal membrane 1/2 of endostome length; segments broad, half-segnment at base 52-60 μm wide, broadly perforate below, narrowly split above; cilia (2-)3(-4), long, papillose, longly appendiculate. Spores 12-16(-22) μm, yellow.

Differentiation: The differences from *B. lonchocaulon* and *B. bimum* are discussed under both.

Habitat: On wet and moist soil, peat, eroded chalk and limestome mixed with humus, rarely on rotten wood; in swamps, meadows, meadow-steppes, and secondary vegetation.

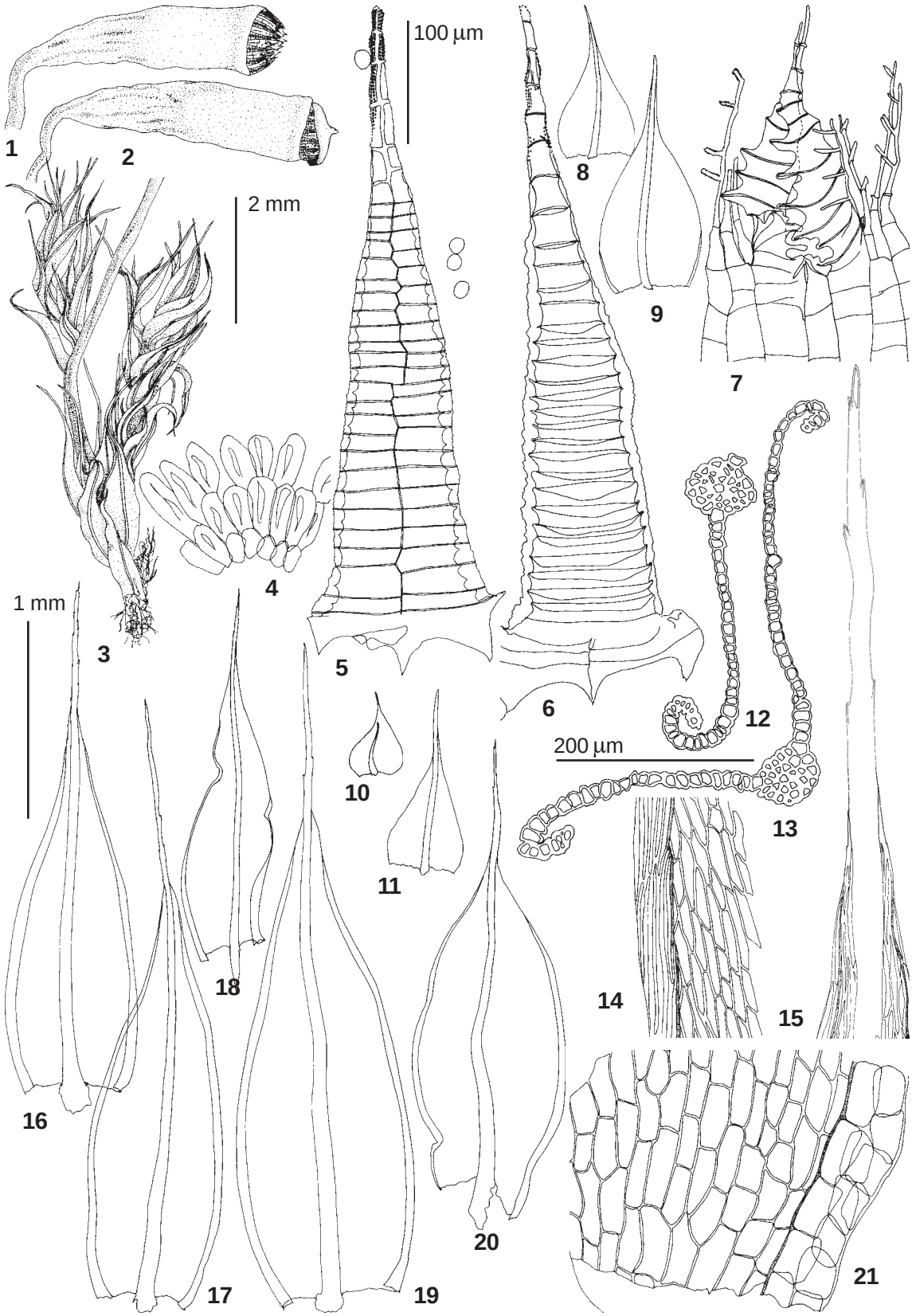
Selected specimens examined (60): Arkhangelsk Prov., Zickendrath #1179, LE; Bashkortostan, Selivanova-Gorodkova #68, LE; Belgorod Prov., Popova 17.VIII.1994, VOR; Kaluga Prov., Nikolskiy 29.VII.1911, LE; Moscow Prov., Zickendrath # 463, LE; Nizhnij Novgorod Prov., Shvezov #109, LE; Voronezh Prov., Popova 3.IX.1982, VOR; Yaroslavl Prov., Zickendrath 31.V.1891, LE.

Bryum bimum (Schreb.) Turn., Muscol. Hibern. Spic. 127. 1804. – *Mnium bimum* Schreb., Bot. Zeitung 1: 79. 1802. – *Bryum pseudotriquetrum* var. *bimum* (Schreb.) Lilj., Utkast Sv. Fl. 3: 553. 1816. Figs. 90-91

Synoicous; antheridia and paraphyses numerous, red, longer than antheridia.

Plants in wide, compact to dense tufts 2-3(-6) cm high, green, fuscous-green, brownish-green, and ±red inside, densely tomentose, rhizoids red-

Fig. 88. *Bryum lonchocaulon* C. Muell. (from Ufa, Podpera, 10.VIII.1917, LE): 1-2 – capsules; 3 – habit; 4 – annulus; 5 – outer surface of exostome tooth; 6 – inner surface of exostome tooth; 7 – part of endostome; 8-9 – perigonial leaves; 10-11 – perichaetial leaves; 12-13 – transverse leaf section; 14 – mid-leaf cells; 15 – upper laminal cells; 16-20 – leaves; 21 – basal cells. Scale bars: 2 mm for 1-3; 1 mm – 8-11, 16-20; 200 μm – 4, 12-15; 100 μm – 5-7.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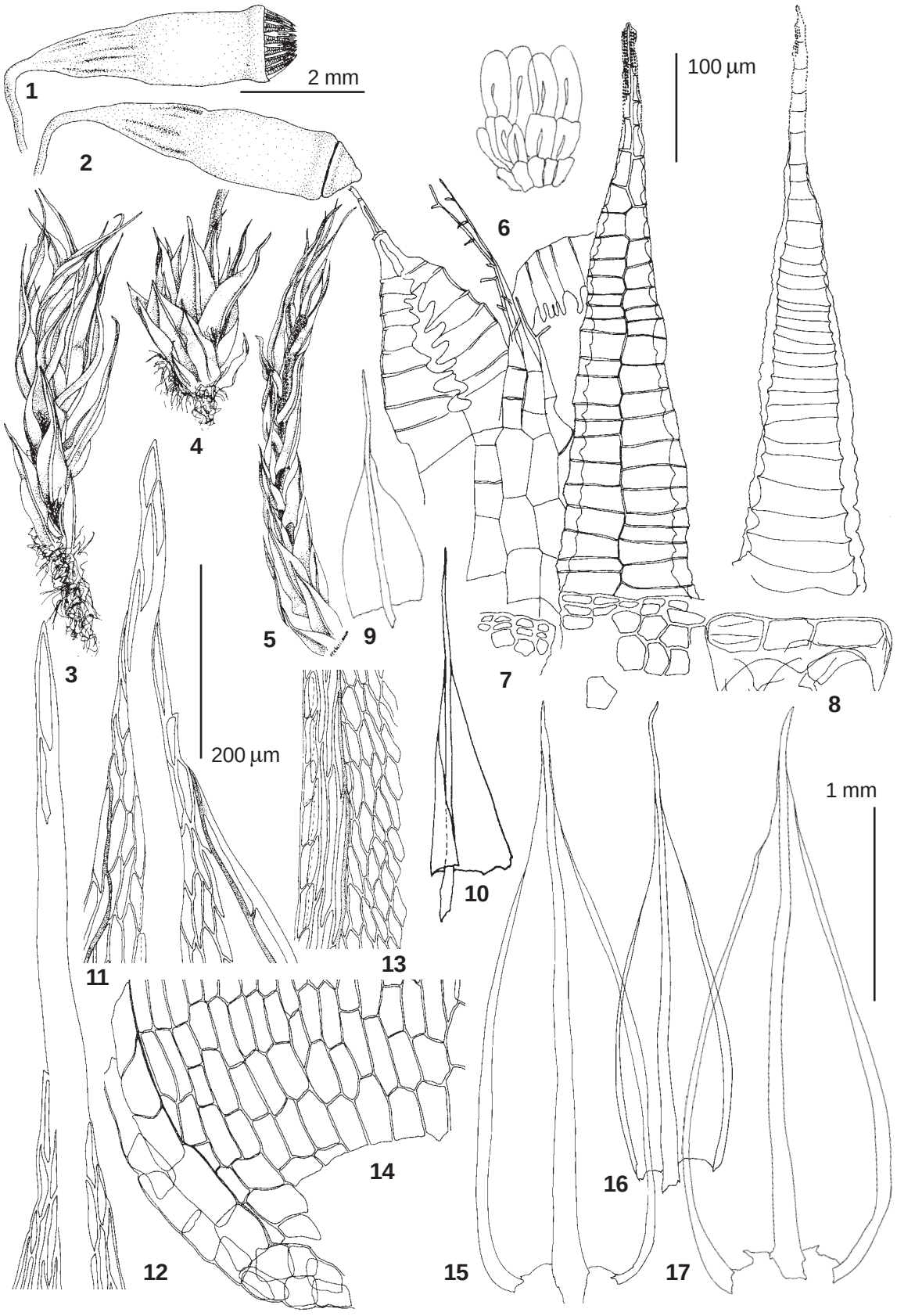
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dish-brown to ferrugineous-brown or dark-brown, moderately densely and finely papillose, often up to upper leaves. Stem deep red, stout, 0.4-1.0(-2.5) cm high, rather densely and comosely foliate, subterminal shoots 1-3, comose. Lower leaves densely imbricate, rather rigid, decurrent. Upper leaves widely spreading when wet, curved to twisted when dry, densely crowded, (2.5-)3-4(-4.5) mm long, (0.9-)1.1-1.4(-1.5) mm wide, ovate, widest at ca. 1/3, shortly acuminate to acute, usually distinctly narrowly and shortly decurrent, at base red to 0.4-0.6 mm from base; margin reflexed to revolute, entire or ±serrulate above; border 4-6-rowed, unistratose, yellowish-brownish, composed of long thick-walled cells; costa stout, at base red, above brownish to brown, percurrent or excurrent in rather stout serrulate awn. Laminal cells rather thick-walled, slightly porose at leaf base, rhombic above, 35-50 μm long and 14-18 μm wide, in mid-leaf rhombic to rhomboid, partly rhomboid-hexagonal and rectangular, (36-)40-60(-64) x (12-)16-20(-24) μm, near costa in oblique rows, at base rectangular to elongate-rectangular, 60-80(-120) x 20-24(-28) μm, in leaf corners with thinner walls, short-rectangular to subquadrate, 28-32 μm wide.

Perichaetial leaves triangular-lanceolate, margin plane, costa ending below apex. Seta 3-4(-6) cm, orange-fuscous to purple, relatively thin to rather thick, rigid, not twisted, arctuate below capsule. Capsule inclined to pendulous, yellowish-fuscous when just ripe,later chestnut, red below mouth, 3.5-5 mm long, ca. 1.5(-2.0) mm thick, oblong-pyriform to oblong-clavate or subcylindric when dry, symmetric, contracted below broad mouth; neck as long as urn, collapsed when dry. Operculum large, highly conic to nearly hemispheric, acutely apiculate, similar in color to urn, glossy. Annulus broad, to 140 μm, 3-4-rowed, cells relatively short. Peristome inserted at urn mouth, 560-750 μm high. Exostome teeth at base 100-140 μm wide, gradually acuminate, below pale yellow to yellow and olive-yellow, in uppermost part hyaline; border broad, to 12-16 μm wide; median line zig-zag-shaped to nearly straight; fundus orange-red, 56-65(-90) μm high, broadened; ventral trabeculae 20-30(-37). Endostome as long as exostome, free, translucent to yellowish, basal membrane 1/2-4/7 of endostome length; segments broad, half-segment at base (40-)60-80 μm wide, broadly perforate below, perforation often fused to one big gap, narrowly split above; cilia 2-4, about as long as segments, densely, spinulosely papillose, longly appendiculate. Spores (10-)14-18(-20) μm, yellow and yellow-green.

Differentiation: *Bryum bimum* can be confused with *B. creberrimum*. These species grow in similar habitats, but *B. creberrimum* has a wider habitat tolerance, and is more common in mesic communities, whereas *B. bimum* is a hygrophyte. Growing in similar mesic habitats, *B. bimum* forms relatively taller tufts and has leaves with relatively longer decurrencies than those of *B. creberrimum*. *Bryum bimum* also differs from *B. creberrimum* in: (1) thicker laminal cell walls (2-2.5 μm vs. ca. 1.5); (2) a broader, 4-6 row, leaf border, vs. (1-)2-3(-4)rows; (3) a percurrent to shortly excurrent costa vs. a shortly to moderately excurrent one. For differentiation from *B. pseudotriquetrum,* see the latter species.

On the basis of relatively robust plants and decurrent leaves, *B. bimum* has been treated either as a variety of *B. pseudotriquetrum* (e.g., Smith, 1978) or as synonymous with the latter (Crum & Anderson, 1981). Demaret & Empain (1985) found that the proportions of laminal cells correlate well with synoicous/dioicous sexual condition in this group, so these taxa can be accepted as good varieties. However, the authors hesitated to recognize *B. bimum* as a species, because they considered that two characters are not sufficient for species recognition. Another character treated as diagnostic for *B. bimum* is thick-walled laminal cells (Limpricht, 1895; Savicz-Ljubitskaya & Smirnova, 1970).

We compared *B. bimium* and *B. pseudotriquetrum* using the following method. Ten cell walls were measured at half of the leaf length, in the middle between the costa and the leaf margin on one side of the leaf. These measurements were taken on five well-developed leaves from the upper part of one stem on 20 synoicous and 20 dioicous collections. The leaves

Fig. 89. *Bryum creberrimum* Tayl. (from Yaroslavl Prov., Meshcheryakov, 1924, LE): 1-2 – capsules; 3-5 – habit; 6 – annulus; 7 – part of endostome and outer surface of exostome tooth; 8 – inner surface of exostome tooth; 9-10 – perichaetial leaves; 11-12 – upper laminal cells; 13 – mid-leaf cells; 14 – basal cells; 15-17 – leaves. Scale bars: 2 mm for 1-5; 1 mm – 9-10, 15-17; 200 μm –11-14; 100 μm – 6-8.

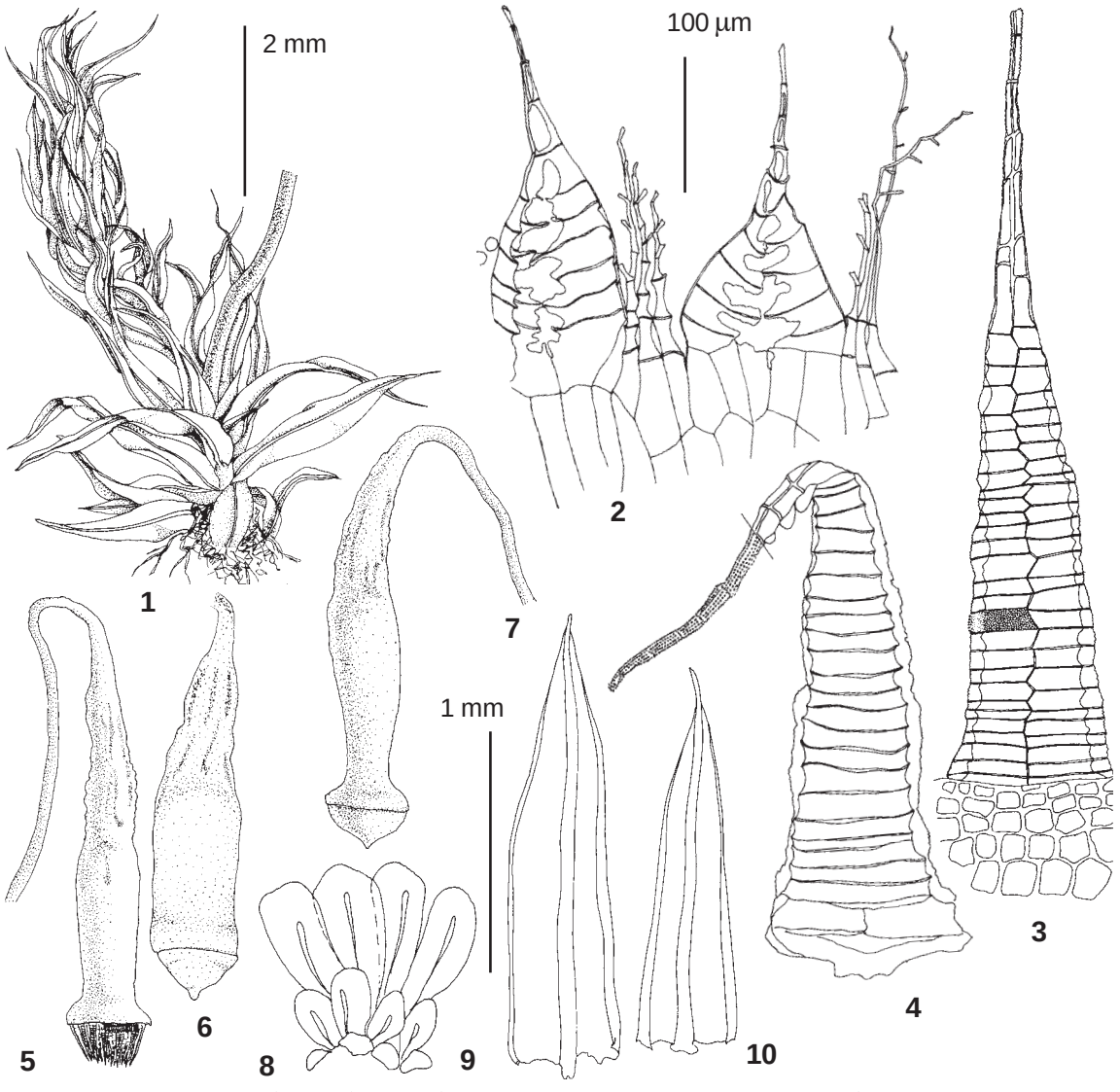


Fig. 90. *Bryum bimum* (Schreb.) Turn. (from Voronezh, Popova 20.IV.1982, VOR): 1 – habit; 2 – part of endostome; 3 – outer surface of exostome tooth; 4 – inner surface of exostome tooth; 5-7 – capsules; 8 – annulus; 9-10 – perichaetial leaves. Scale bars: 2 mm for 1-3; 1 mm – 8-14; 100 μm – 2-4, 8.

were mounted in water, and the measurements were made on a light microscope with a 100x objective,and an ocular micrometer with a scale of 0.98 μm. Measurements were precise to 0.5 μm. The results of these anaylses are in Tabl. 2. With the exception of two abnormal specimens of *B. bimum* with thin-walled laminal cells, this character provides one more basis for recognition of *B. bimum* as a separate species. The utility of this character is confused by the fact that Demaret & Empain (1985) described the type of *B. pseudotriquetrum* as having cell walls 3 μm thick and those of *B. bimum* as 2 μm, i.e., totally contradicting my results. However their values are at odds with the drawings in the same paper, especially those of transverse leaf sections. Possibly the measurements were taken in a different part of the leaf than we used in the present study.

Habitat: Common in ±calcaroeus, mesic to hygric habitats. It occurs in wet meadows, on the edges of swamps, inundated bogs, peaty sides of channels, or muddy banks of creeks; sometimes on old brick walls and in greenhouses; in steppe zone on chalk slopes (probably rather wet).

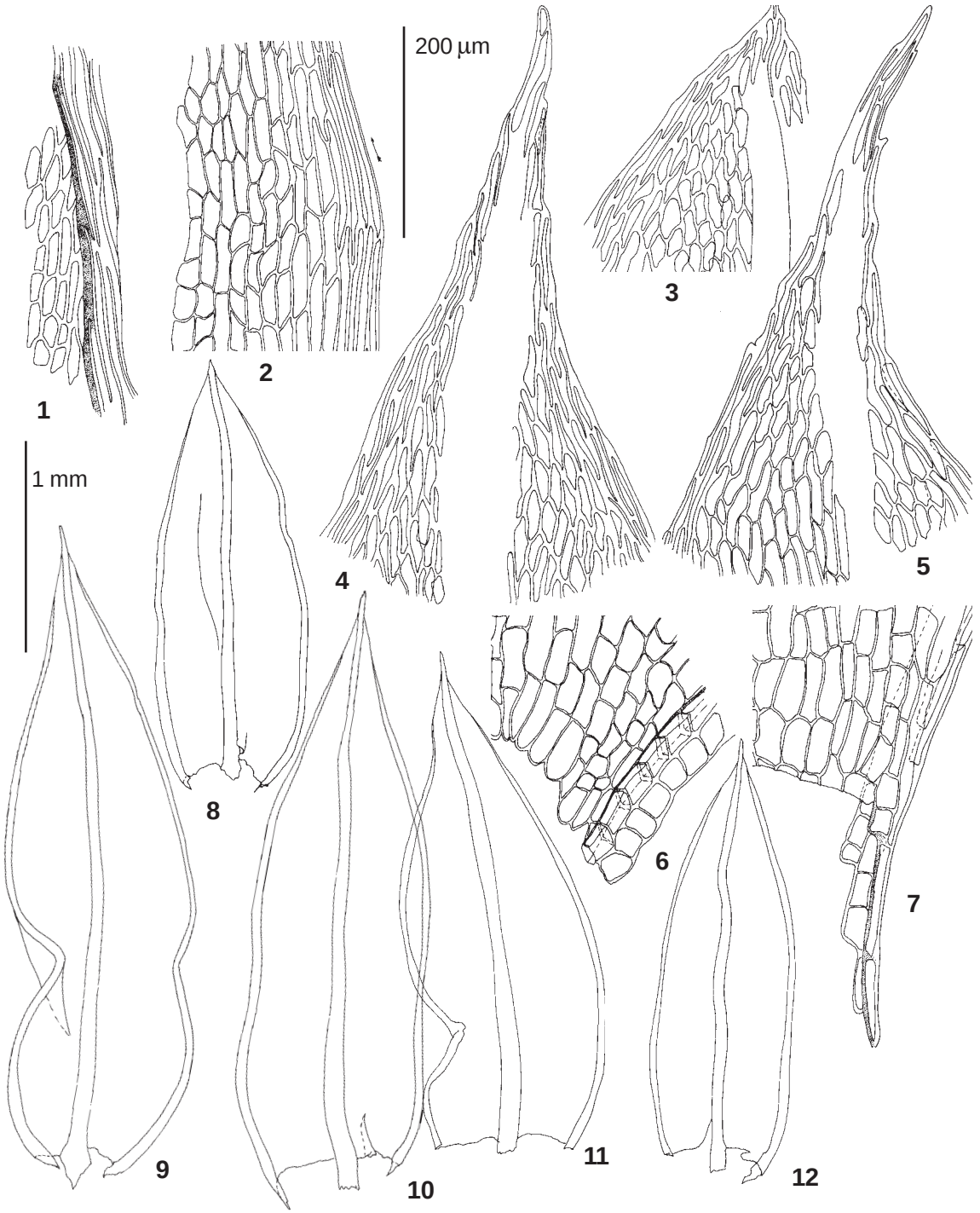


Fig. 91. *Bryum bimum* (Schreb.) Turn. (1-8 & 11-12 from Ufa, Podpera 10.VIII.1917, LE; 9-10 from Voronezh, Popova 20.IV.1982, VOR): 1-2 – mid-lead cells; 3-5 – upper laminal cells; 6-7 – basal cells; 8-12 – leaves. Scale bars: 1 mm for 8-12; 200 µm – 1-7.

Selected specimens examined (60): Bashkortostan, Podpera 1.VIII.1917, LE; Bashkortostan, Solometch 4.VIII.1988, MHA; Belgorod Prov., Popova 20.VII.1993, VOR; Kaluga Prov., Nikolskiy 29.VII.1911, LE; Kursk Prov., Popova 7.VII.1984, VOR; Lipezk Prov., Vyshegorodskikh 6.VII.1987, LE; Moscow Prov., Ignatov 16.VI.1986, LE; Perm Prov., Bezgodov #503, MW; Rostov-na-Donu Prov., Babenko 28.VII.1992 MHA; Ryazan Prov., Volosnova, Sept. 1996, MW; Saratov Prov., Zickendrath #605, LE; Tver Prov., Ignatov 3.VIII.1994, MW; Voronezh Prov., Popova 4.VI.1982, LE.

Bryum pseudotriquetrum (Hedw.) Gaertn. et al., Oekon. Fl. Wetterau 3(2): 102. 1802. – *Mnium pseudotriquetrum* Hedw., Sp. Musc. Frond. 190. 1801. Fig. 92-93

Bryum ventricosum auct.

Dioicous; male and female plants usually in mixed, rarer in separate tufts; perigonium wide, with numerous thick anteridia and paraphyses; paraphyses ca. 1.5 as long as antheridia; perigonial leaves obcordate, attenuately acuminate, margin plane and entire, bordered undifferentiated, non-decurrent, costa percurrent, inner small, ecostate, obcordate.

Plants in compact to dense or loose tufts 1-10(-12) cm high; olive- to yellow- or fuscous-green, reddish inside, densely tomentose, rhizoids brown, finely papillose to nearly smooth. Stem red, stout, rigid, straight, 1-10 cm high, ±homogeneous along stem, gradually larger upward and largest at ca. 5 mm below shoot tip in non-fruiting shoots, or seveal upper leaves enlarged and loosely comosely crowded in fruiting shoots; subterminal shoots absent or 1-3, 1.0-1.5(-2.0) cm long, foliage similar to stem. Lower leaves broadly ovate-lanceolate. Middle stem leaves erect when wet, loosely appressed when dry, curved to slightly twisted, 4.5(-5) mm long, 1.4-1.6(-2.0) mm wide, oblong-ovate to oblong-lanceolate, widest at 1/3-1/2 of leaf length, gradually acuminate, slightly narrowed toward base, decurrent, red at base; margin broadly reflexed to nearly apex or rarely only in lower part, entire to weakly serrulate above; border distinct, 3-5(-6)-rowed, composed by thick-walled linear cells, slightly yellowish to brownish; costa stout, red nearly throughout or above green to fuscous, percurrent to ±longly excurrent in serrulate awn. Laminal cells moderately or slightly thick-walled, weakely porose, in upper leaf rhomboid-hexagonal, partly rhombic, (40-)60(-80) x (18-)20(-24) µm, in mid-leaf rhomboid-hexagonal, partly rhomboid, 40-60 x 20-24 µm, below rectangular 60-80(-100) x 24-28(-32) µm, in leaf corners somewhat smaller. Comose leaves around perichaetia larger than lower leaves of fertile shoots, (3.0-)3.5(-4.5) mm long, (1.2-)1.5(-2.0) mm wide, ovate-lanceolate, gradually acuminate.

Perichaetial leaves narrowly lanceolate to narrowly triangular, longly acuminate, non-decurrent, margin recurved to plane in innermost leaves; border 1-2-rowed; costa excurrent in smooth awn to ending below leaf apex in innermost leaves. Seta 2-6 cm, reddish-fuscous to purple, thin to rather thick, but rather slender, slightly twisted when dry or not, arcuate to abruptly hooked below capsule. Capsule pendulous, brown, 4-6 mm long, ca. 1.5(-2.0) mm thick, oblong-clavate, symmetric or sometimes slightly curved, ventricose, contracted below mouth when dry; neck as long as urn, narrowed when dry. Operculum large, highly convex, acutely apiculate, brown, slightly glossy. Annulus 3-4(-5)-rowed. Peristome inserted at urn mouth, 700-720 µm high. Exostome teeth at base 100-110 µm wide, gradually acuminate, below yellow; in uppermost part hyaline; border broad, 8-12(-20) µm wide; median line zig-zag-shaped to nearly straight; fundus orange to red, ca. 100 µm high, broadened; ventral trabeculae ca. 30. Endostome free, yellow; basal membrane 1/2-2/3 of endostome length; segments broad, half-segment at base to 80 µm wide, tapered in upper 1/3-1/4, broadly perforate below, narrowly split above; cilia 2-4, long, finely and moderately densely papillose, longly appendiculate. Spores 12-14(-20) µm, yellow-green.

Brood filaments sometimes present in sterile plants, few, usually in axils of lower leaves, short, pale, non-branched.

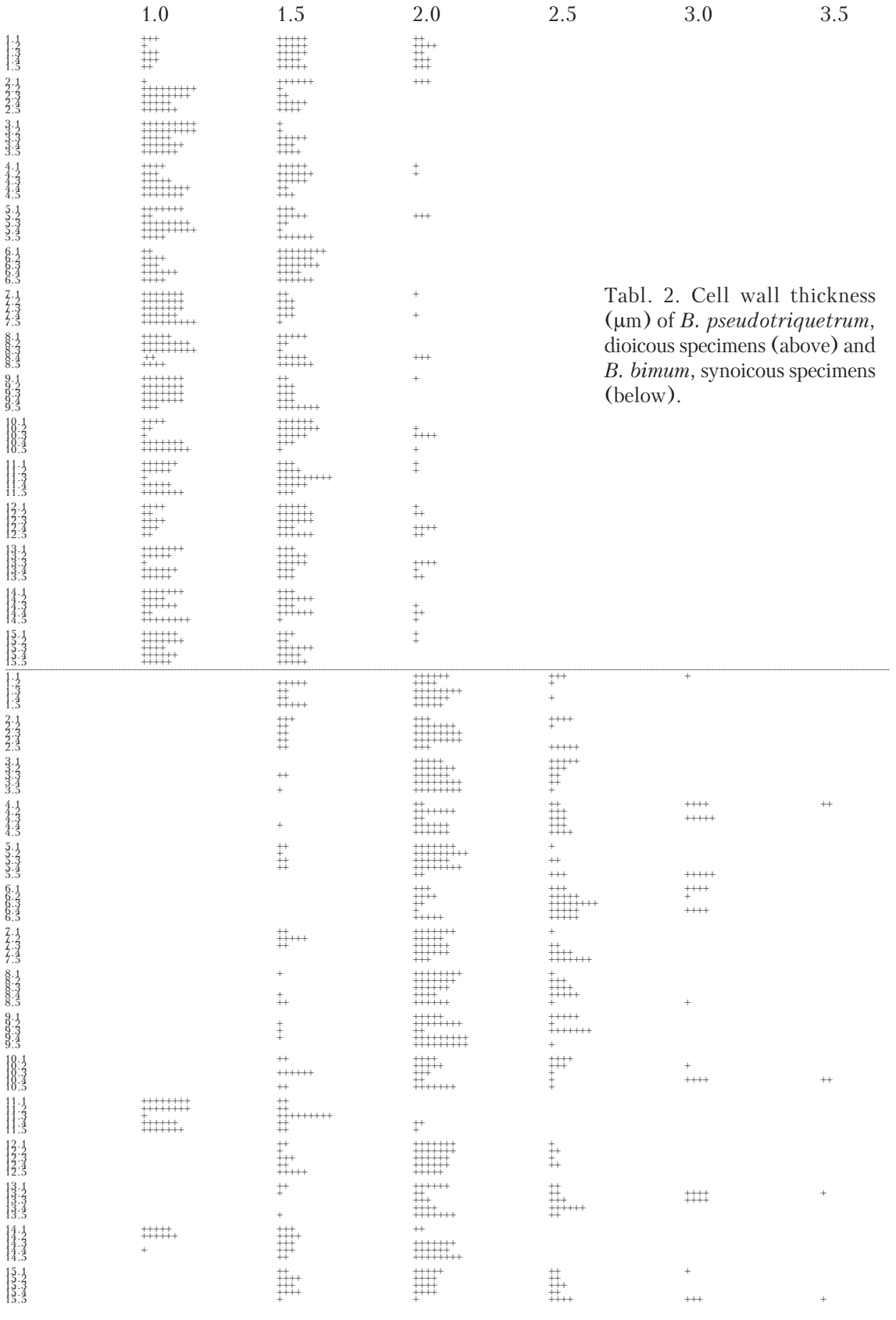
Differentiation: *Bryum pseudotriquetrum* is usually easy to recognize by tall plants, long decurrent leaves and a firm, broad leaf margin. The differences from *B. bimum* are discussed under that species.

Habitat: Calciphilous hygrophyte; very common in boggy vegetation, secondary successions in sandy and peaty pits, at springs, along banks of rivers, creeks, streams, lakes.

Selected specimens examined (160): Arkhangelsk Prov., Sokolov #210, 11.VIII.1996, MHA; Bashkortostan, Ignatova #9/9, MHA; Bryansk Prov., Abramova 9.VIII.1958, LE; Kaluga Prov., Peshkova #277, MW; Moscow Prov., Ignatov 15.VI.1984, MHA; Perm Prov., Bezgodov #308, MW; Pskov Prov., Zolotov 18.VIII.1998, MHA; Ryazan Prov., Bogdanova 30.VI.1966, LE; Tver Prov., Istomina 12.IX.1928, MHA; Vladimir Prov., Ovsyannikova 13.VI.1930, MW; Volgograd Prov., Sobaeva & Mukhamedzhanov, #20a, MHA; Vologda Prov., Ignatov 22.IX.90, MHA; Voronezh Prov., Popova #1281, VOR.

Bryum capillare Hedw., Sp. Musc. Frond. 182. 1801. Fig. 94

Dioicous, male and female plants in mixed tufts; male plants comosely foliate; antheridia and paraphyses rather few to numerous, para-



Tabl. 2. Cell wall thickness (μm) of *B. pseudotriquetrum*, dioicous specimens (above) and *B. bimum*, synoicous specimens (below).

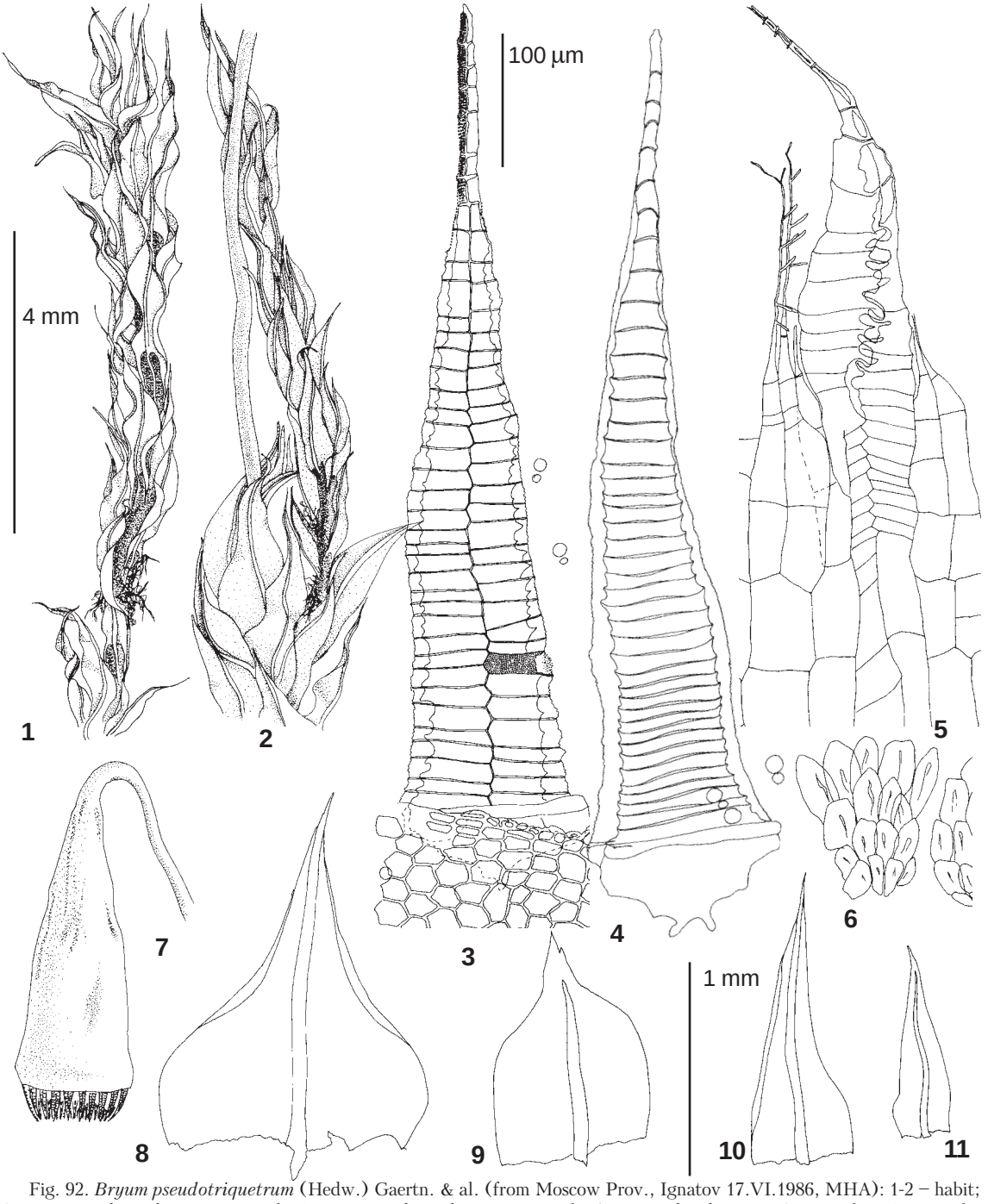


Fig. 92. *Bryum pseudotriquetrum* (Hedw.) Gaertn. & al. (from Moscow Prov., Ignatov 17.VI.1986, MHA): 1-2 – habit; 3 – outer surface of exostome tooth; 4 – inner surface of exostome tooth; 5 – part of endostome; 6 – annulus; 7 – capsule; 8-9 – perigonial leaves; 10-11 – perichaetial leaves. Scale bars: 4 mm for 1-2, 7; 1 mm – 8-11; 100 µm – 3-6.

physes slightly longer than to twice as long as antheridia, outer perigonial leaves ovate to elongate-triangular, green to pinkish, costa stout, ending below apex to percurrent or excurrent, margin narrowly recurved; inner perigonial leaves small, ovate, pinkish.

Plants in dense to rather loose, soft tufts 1.0-3.0 cm high, green, glaucous-green to dirty-green, rarely pale-green; tomentum loose to rather dense, rhizoids reddish-brown, papillose. Stem reddish-fuscous to red, 0.5-2.0 cm long, straight, upper leaves comosely crowded or nearly forming a

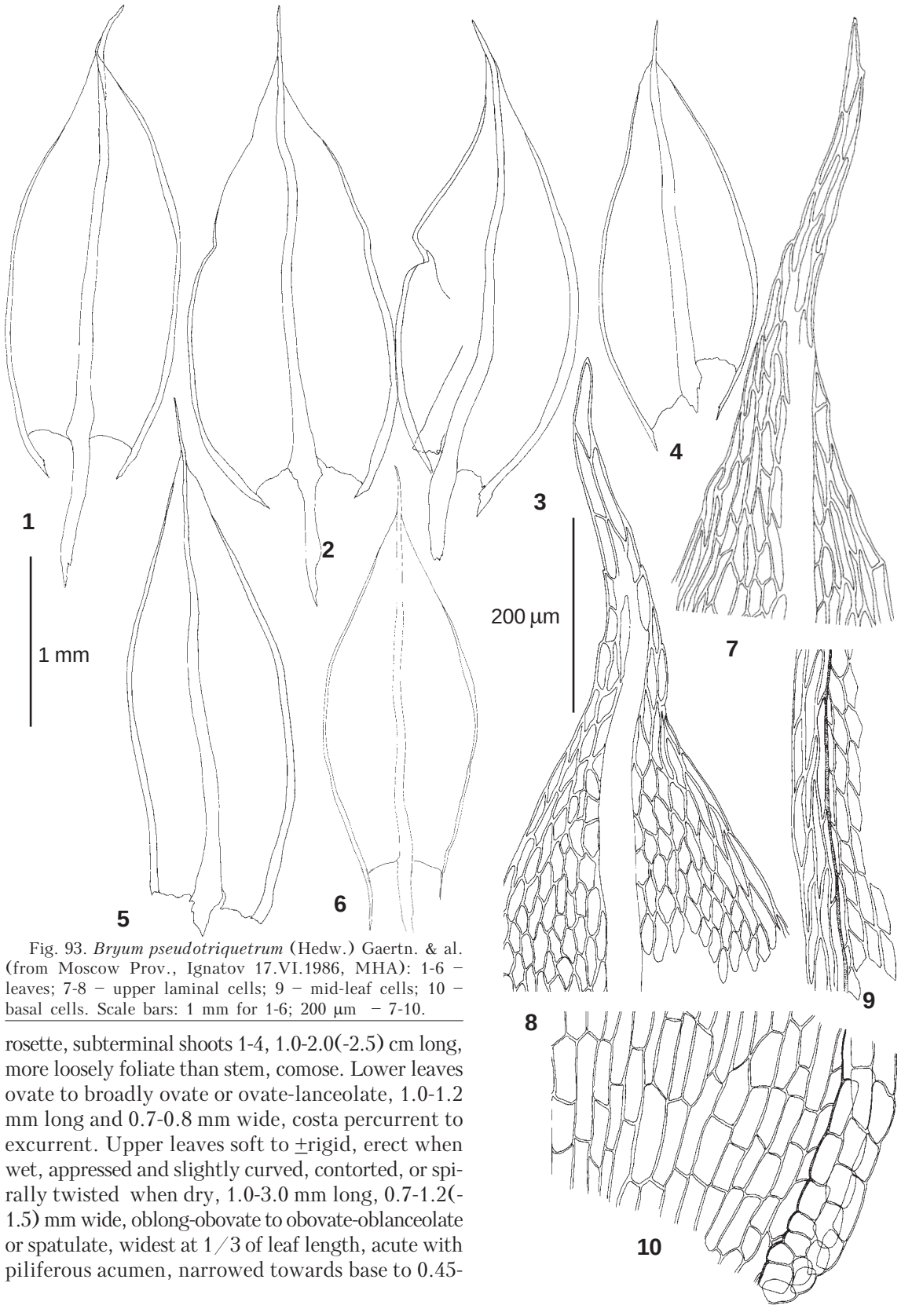


Fig. 93. *Bryum pseudotriquetrum* (Hedw.) Gaertn. & al. (from Moscow Prov., Ignatov 17.VI.1986, MHA): 1-6 – leaves; 7-8 – upper laminal cells; 9 – mid-leaf cells; 10 – basal cells. Scale bars: 1 mm for 1-6; 200 µm – 7-10.

rosette, subterminal shoots 1-4, 1.0-2.0(-2.5) cm long, more loosely foliate than stem, comose. Lower leaves ovate to broadly ovate or ovate-lanceolate, 1.0-1.2 mm long and 0.7-0.8 mm wide, costa percurrent to excurrent. Upper leaves soft to ±rigid, erect when wet, appressed and slightly curved, contorted, or spirally twisted when dry, 1.0-3.0 mm long, 0.7-1.2(-1.5) mm wide, oblong-obovate to obovate-oblanceolate or spatulate, widest at 1/3 of leaf length, acute with piliferous acumen, narrowed towards base to 0.45-

0.50 mm wide, not to weakly decurrent, with reddish pigmantation at base or not; margin narrowly recurved to plane, entire to weakly serrulate above; border (1-)3(-4)-rowed, unistratose, green to brownish, composed of elongate to linear, thick-walled cells; costa at base red, above green, becoming red throughtout with age, ending below pilifeous acumen, rarer in acumen (in latter case acumen serrulate). Laminal cells rich in chloroplasts, lax, moderately thick-walled to thin-walled, not porose, in upper part shortly rhombic-hexagonal, 40-50(-60) x 16-24 μm, in mid-leaf rhomboid-hexagonal and rhomboid (40-)50-60(-80) x (16-)20-24(-32) μm, at base rectangular, to 80(-100) x (20-)24-32(-40) μm.

Perichaetial leaves narrowly lanceolate or narrowly elongate, margin narrowly recurved to broadly reflexed or revolute; costa excurrent. Seta (1-)2-4 cm high, rarely higher, red, fuscous-red or yellowish-fuscous, not twisted, arcuate below capsule. Capsule horizontal to pendulous, yellowish-fuscous, brownish to reddish-brown, 2.0-4.5(-5.0) mm long, ca. 1.0(-1.5) mm thick, oblong-clavate to subcylindric, slightly curved, slightly to abruptly contracted below mouth when dry; neck 1/2-1/3 of urn length, collapsed when dry or not. Operculum large, convex, with short acute beak, more richly colored than capsule to richly brown-red, glossy. Annulus broad, 3-rowed. Peristome inserted at urn mouth, 450(-700) μm high. Exostome teeth at base 110-120 μm wide, below brownish-yellow, in uppermost part hyaline; border 8-12 μm wide; median line zig-zag-shaped to nearly straight; fundus broadened, 40-50(-80) μm high, orange; ventral trabeculae ca. 25-30. Endostome free, yellowish; basal membrane 1/2-2/3 of endostome length; segments broad, half-segment at base 50-60(-80) μm wide, gradully tapered upward, broadly perforate below, narrowly split above; cilia (2-)3(-4), long, densely papillose, longly appendiculate. Spores variable in size within capsule, (10-)12-16(-18) μm, greenish-yellow.

Rhizoidal gemmae rarely present, reddish-brown, globose or almost so, ca. 60-120 μm in diameter, with slightly convex surface cells.

Variation and differentiation: *Bryum capillare* is a variable species. The phenotype from sandy soils in pine forests is characterized by loose, soft, dark-green tufts. The fertile shoots are ca. 1 cm high, while the longer sterile shoots, ca. 1.5-2 cm, have looser foliage. These plants have leaves curved to twisted and a long capsule, ca. 4 mm long, with the neck indistinctly differentiated from the urn. For the differences between this species, and *B. elegans* and *B. laevifilum,* see Tabl. 3.

Habitat: On bare soil and rocks, covered by soil, rarer on rotten wood; in forests, forest edges, more rarely on open places.

Selected specimens examined (15): Arkhangelsk Prov., Ignatov 9.VIII.1988, MHA; Bashkortostan, Ignatova #9/16, MHA; Moscow Prov., Ignatov 23.V.1988, MHA; Orel Prov., Radygina 27.IV.1986, VOR; Perm Prov., Ignatov 23.IX.88, MHA; Rostov-na-Donu Prov., Babenko #1195, MHA; Vladimir Prov., Nazarov 1913, LE; Volgograd Prov., Ignatov 8.VIII.1999, MHA; Voronezh Prov., Popova #2047, VOR.

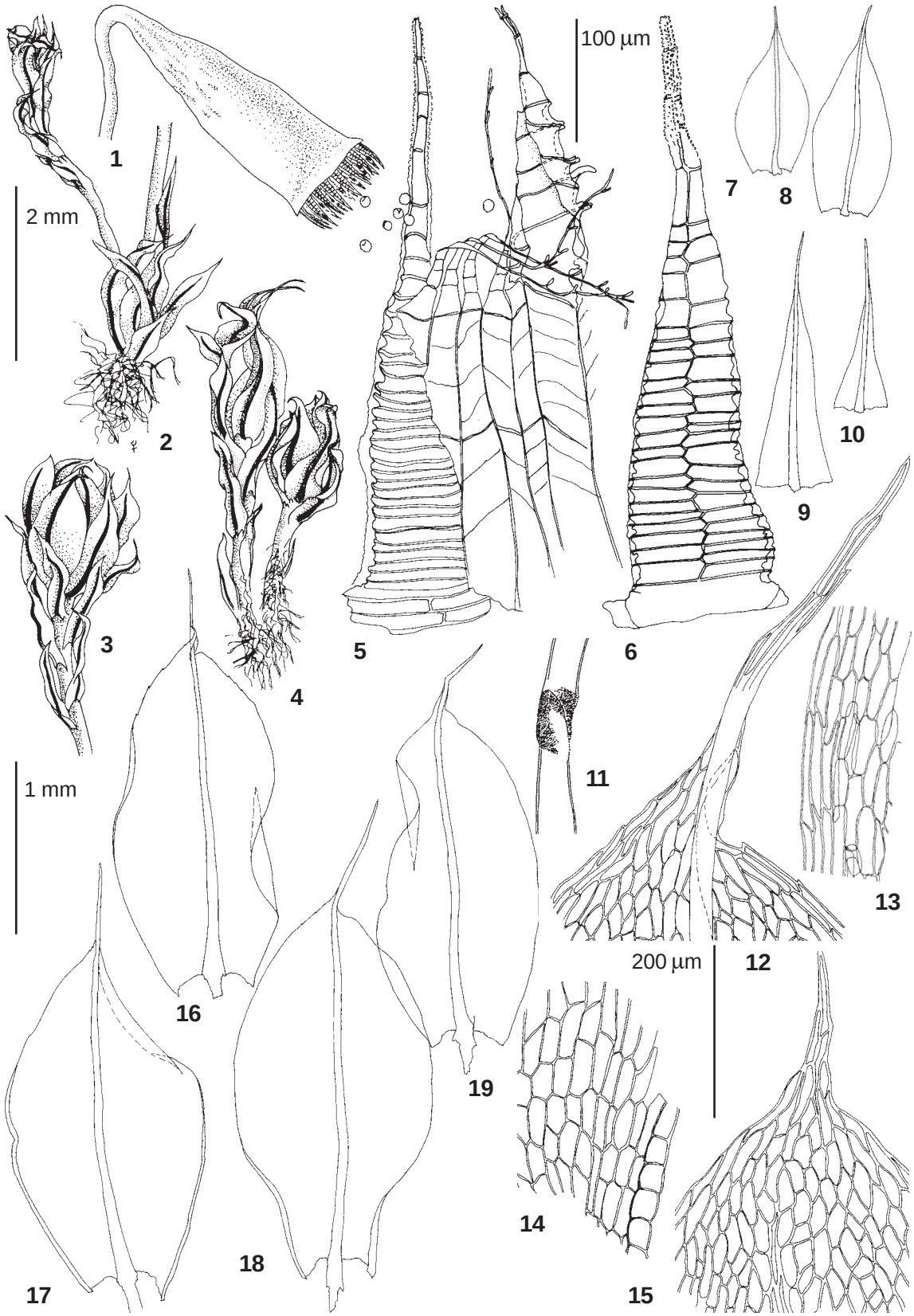
Bryum elegans Nees ex Brid., Bryol. Univ. 1: 849. 1827. – *Bryum capillare* var. *elegans* (Nees ex Brid.) Husn., Muscol. Gall. 241. 1889. Fig. 95-96

Bryum stirtonii Schimp., Syn. Musc. Eur. (ed. 2) 470, figs. 8-9. 1876.

Dioicous, male plants similar to female ones. Perigonia capitate, anteridiae numerous, paraphyses somewhat longer than antheridia, orangish. Perigonial leaves orangish, broadly-ovate, concave, with long and straight piliferous acumen, margin narrowly recurved to plane, costa filling acumen.

Plants in compact to very dense, soft tufts 1-4(-5) cm high, pure-green to brown-green (but always bright), slightly glossy or dull, inside densely tomentose, rhizoids reddish-brownish, coarsely and densely papillose. Stem reddish to dark red or brown-red, 0.5-1.5 cm long, straight, evenly foliate or upper leaves comosely crowded, subterminal shoots usually 3-4(-5), rarely absent, ±evenly foliate or upper leaves comose. Lower leaves and branch leaves obovate to oblong-ovate, small, 1-2 mm long, 0.5-1.0 mm wide, spoon-like, concave; margin plane or narrowly recurved at base, border indistinct, 1-rowed. Upper leaves closely imbricate, appressed when wet, erect to

Fig. 94. *Bryum capillare* Hedw. (1-4, 7-10 – Voronezh Prov., Popova 2047, VOR; 5-6, 11-15 – Vladimir Prov., Nazarov .1913, LE): 1 – capsule; 2 – female plant; 3-4 – male plants; 5 – inner surface of exostome tooth and part of endostome; 6 – outer surface of exostome tooth; 7-8 – perigonial leaves; 9-10 – perichaetial leaves; 11 – rhizoids; 12, 15 – upper laminal cells; 13 – mid-leaf cells; 14 – basal cells; 16-19 – leaves. Scale bars: 2 mm for 1-4; 1 mm – 7-10, 16-19; 200 μm – 12-15; 100 μm – 5-6.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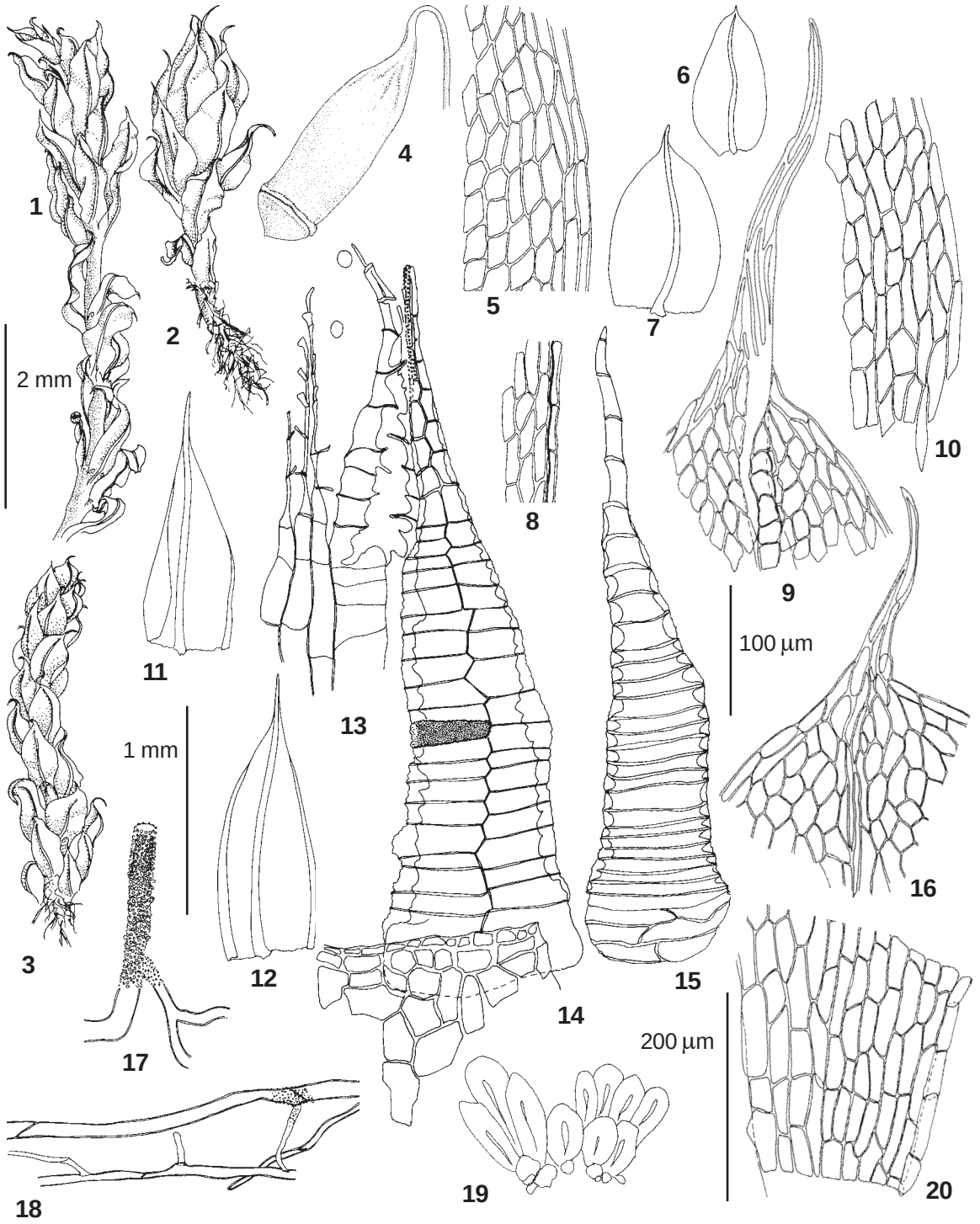


Fig. 95. *Bryum elegans* Nees ex Brid. (1, 5, 8-10, 16-18, 20 – Voronezh Prov., Popova 294, LE; 2-3 – Nizhnij Novgorod Prov., Ignatov, 15.IX.1999, MHA; 4, 6-7, 11-15, 19 – Moscow Prov., Petrov 27.V.1908, MW): 1-3 – habit; 4 – capsule, 5, 8, 10 – mid-leaf cells; 6-7 – perigonial leaves; 9, 16 – upper laminal cells; 11-12 – perichaetial leaves; 13 – part of endostome; 14 – outer surface of exostome tooth; 15 – inner surface of exostome tooth; 17, 18 – rhizoids; 19 – annulus; 20 – basal cells. Scale bars: 2 mm for 1-4; 1 mm – 6-7, 11-12; 200 µm – 5, 8-10,16-18, 20; 100 µm – 13-15, 19.

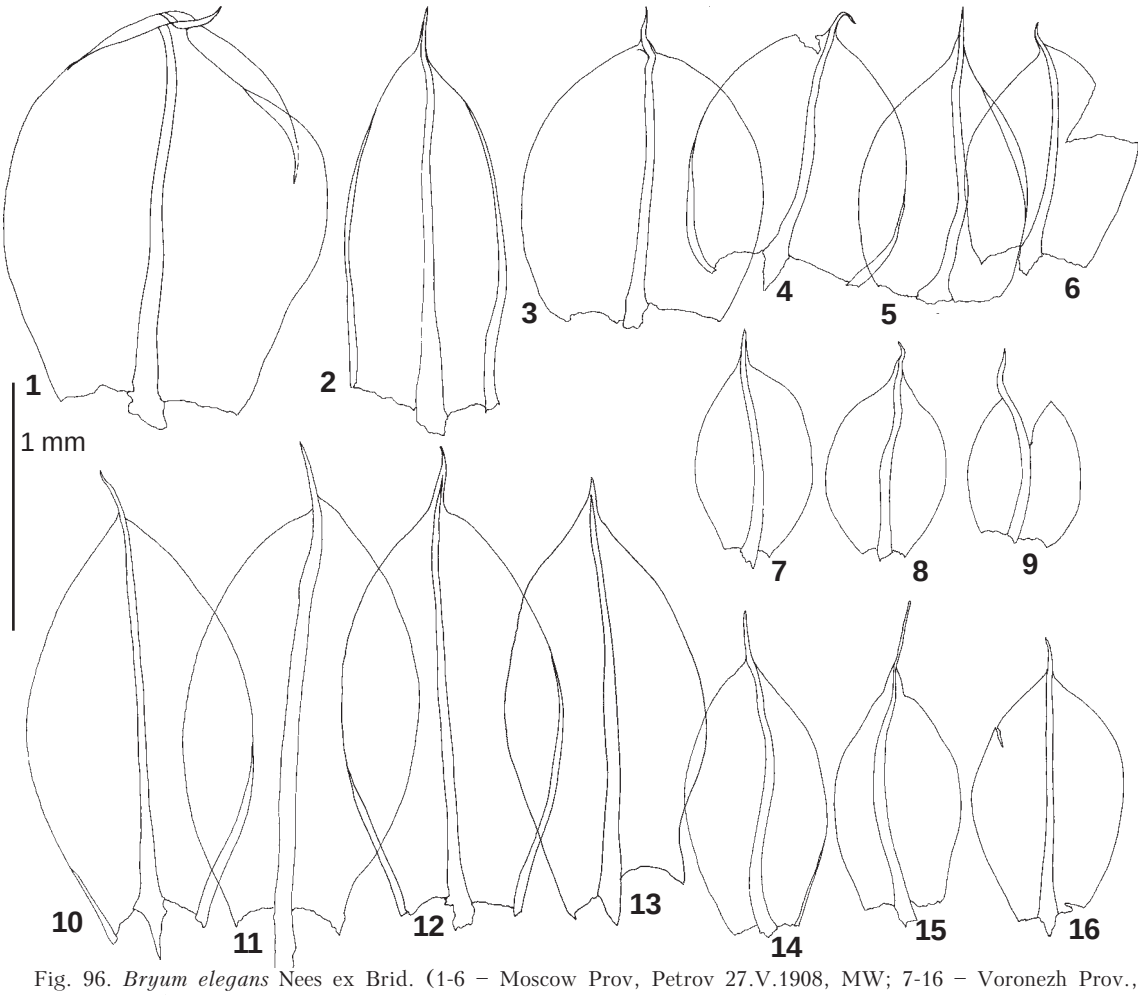


Fig. 96. *Bryum elegans* Nees ex Brid. (1-6 – Moscow Prov, Petrov 27.V.1908, MW; 7-16 – Voronezh Prov., Popova 294, LE): 1-2 – upper leaves from female plant; 3-6 – upper leaves from male plant; 7-16 – leaves from sterile plants (from different shoots).

sometimes slightly spirally twisted when dry, 0.9-2.0 mm long, 0.6-1.3 mm wide, oblong-obovate to broadly obovate, widest at ca. 1/2 of leaf length; acute to cucullately rounded at apex and suddenly tapered into narrow acumen, narrowed towards base to 0.5 mm wide, non-decurrent, green or slightly reddish at base; margin plane or narrowly recurved at base, entire or above remotely and weakly serrulate; border distinct, rarely indistinct, 1-2(-3)-rowed, green or yellowish-brownish, composed of somewhat longer and narrower cells; costa moderately stout, at base red, above yellow, reddish to brownish with age, tapered in upper leaf and ending below acumen, or in acumen, or shortly to longly (to 0.3-0.4 mm) excurrent into smooth, reflexed to recurved awn. Laminal cells lax, rich in chloroplasts, moderately incrassate to thin-walled, in upper leaf rhombic to shortly rhomboid-hexagonal, (20-)24-40(-50) x ((16-)20-24(-28) μm, in mid-leaf rhombic-hexagonal to rhombic, (26-)40-52(-58) x (16-)20-24(-28) μm, at base thin-walled, red to reddish, rectangular to shortly rectangular, partly elongate-hexagonal, (28-)50(-100) μm long and (16-)28 μm wide.

Perichaetial leaves lanceolate, margin plane, costa percurrent. Seta 1-2(-3) cm, red, not twisted, arcuate below capsule. Capsule horizontal to pendulous, light brown, red below mouth, 2.5-3 mm long, 0.5-0.7(-1.0) mm thick, oblong to subcylindric, contracted below broad mouth when dry; neck short to nearly as long as urn, collapsed when dry. Operculum nearly hemispheric, shortly acutely apiculate, fuscous-orange to nearly orange, slightly glossy. Annulus 3-4-rowed. Peristome inserted at mouth, 500 μm

Table 3. A comparison of *Bryum capillare, B. laevifilum,* and *B. elegans.*

Character	*Bryum capillare*	*Bryum laevifilum*	*Bryum elegans*
Foliage	comose	±evenly loose, comose above	evenly imbricate
Leaves when dry	spirally twisted	twisted to contorted	closely appressed
Leaf length, mm	1-3	1.5-3.5	1-2
Leaf shape	±plane	±plane	concave
Leaf border	1-3(-4)-rowed	1-3(-4)-rowed	1-rowed
Brood filaments	absent	present	absent
Rhizoids	papillose	finely papillose	coarsely papillose

high. Exostome teeth at base ca. 100 μm wide, below yellow to brownish-yellow, in uppermost part hyaline; border narrow, 8(-10) μm; median line zig-zag-shaped to nearly straight; fundus red, ca. 80 μm high, broadened; ventral trabeculae 23-25. Endostome free, pale yellowish; basal membrane 1/3-1/2 of endostome length; segments broad, half-segment at base 50-60 μm wide, abruptly tapered above, broadly and irregularly perforate below, narrowly split above; cilia (2-)3-4, long, delicate, densely papillose, shortly to longly appendiculate. Spores (11-)12(-14) μm, pure-yellow.

Variation and differentiation: Fragile subterminal shoots occur in some populations from calcareous substrates in Volgograd and Pskov Provinces. It is probable these represent an environmental response.

Syed (1973) suggested that *B. stirtonii* can be segregated from *B. elegans* by the following combination of character states: (1) leaves decurrent; (2) rhizoids more finely papillose; (3) a shorter capsule neck; and (4) lack of rhizoid gemmae. However, Nyholm (1993) noted that the leaf decurrencies are variable in *B. elegans* and much dependent on habitat, and my studies confirm this. Rhizoidal papillae are very variable, even within a single specimen, which also was noted by Nyholm (l. c.). Capsules were not found in our territory, as with rhizoid gemmae. Thus, *B. stirtonii* cannot be recognized; at least, not by using the character states discussed here.

For differences between this species and *B. capillare* and *B. laevifilum,* see Tabl. 3.

Habitat: On soil (often rather pure sand), limestone, and chalk on open places.

Selected specimens examined (15): Bashkortostan, Ignatova #6/43, MHA; Moscow Prov., Zickendrath #1724, LE; Nizhnij Novgorod Prov., 16.X.1998, Popov, MHA; Ryazan Prov., Volosnova 4.IV.1997, MHA; Smolensk Prov., Rostovzev #1091, LE; Volgograd Prov., Ignatov 10.VIII.1999, MHA; Voronezh Prov., Popova 21.VII.1981, LE.

Bryum laevifilum Syed, J. Bryol. 7: 293, f. 13-14. 1973. Fig. 97

Bryum flaccidum auct. Fl. Eur. non Brid., Bryol. Univ. 1: 667. 1826.

Bryum capillare var. *flaccidum* (Brid.) B. S. G., Bryol. Eur. 4: 130. 1859.

Dioicous; perigonia with numerous yellow to orange antheridia and paraphyses; paraphyses longer than antheridia; perigonial leaves ovate to elliptic,narrow and longly acuminate; margin recurved, costa percurrent to excurrent; innermost leaves small orangish, ovate, acuminate; with short thin costa and plane margins, carinate; subterminal shoots in male plants 1-2(-3).

Plants in loose, rarely compact, soft tufts 1-3(-4) cm high, green or glaucous, yellowish-green to brown-green, densely tomentose, rhizoids brown, finely to coarsely and densely papillose or nearly smooth. Stem pale yellowish-green to dark-red or brown-red, ascending, 1.0-1.5 cm long, homogeneously foliate, with upper leaves slightly comosely crowded; subterminal shoots 1-2, rarely more, more loosely foliate than stem. Lower leaves 1.4-2.0 mm long and 0.7-1.0 mm wide, elongate-lanceolate, to elongate-obovate, acuminate, narrowed toward base; margin plane and entire or weakly serrulate above; border (1-)3(-4)-rowed, yellowish; costa percurrent. Upper leaves soft, erect to streading when wet, crisped and patent, rarely loosely appressed and spirally twisted when dry, 1.5-3.5(-4) mm long, 0.5-1.2(-1.5) mm wide, oblong to obovate-lanceolate, obovate-oblanceolate to spatulate, widest at about 1/2-2/3 of leaf length, abruptly contracted to piliferous acumen, non-decurrent to distinctly narrowly and longly decurrent, at base red or not; margin plane to narrowly recurved from base to 1/3-1/2 of leaf length, entire to weakly or distinctly serrulate above; border distinctly delimited, 1-3(-4)-rowed, yellowish to yellowish-brownish, composed of long and thick-walled cells; costa stout, at base red-brown, above brownish to

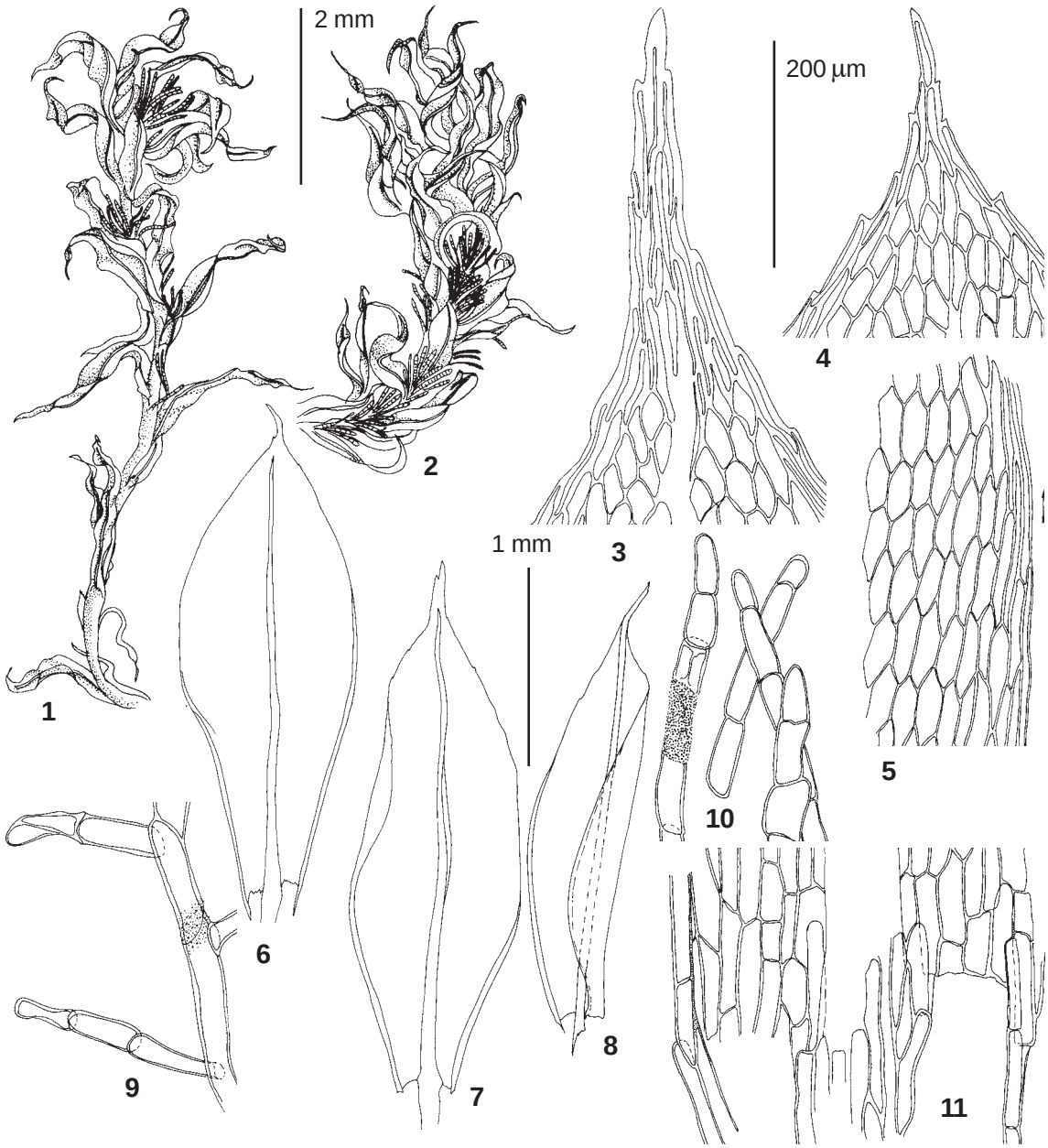


Fig. 97. *Bryum laevifilum* Syed (Pskov Prov., Zolotov 19.VIII.1998, MHA): 1-2 – habit; 3-4 – upper leminal cells; 5 – mid-leaf cells; 6-8 –leaves; 9 – rhizoids; 10 – brood filaments; 11 – basal cells. Scale bars: 2 mm for 1-2; 1 mm – 6-8, 200 µm – 3-5, 9-11.

fuscous, thinning upward and disappearing below apex to shortly excurrent. Laminal cells lax, thin-walled, not or slightly porose, in upper leaf rhomboid-hexagonal, 40-60(-80) x 24-28 µm, in mid-leaf rhomboid-hexagonal to rhomboid, (40-)60-70(-90) x (18-)20-24(-28) µm, at base elongate-rectangular, to 120 x 20-24 µm.

Perichaetial lanceolate to triangular, margin plane, costa ending in piliferous acumen or below. Seta 2.0-2.5 cm, red-fuscous, fuscous to brown-fuscous, rigid, not twisted when dry, arcuate below capsulae. Capsule inclined to pendulous, orange-fuscous to brown, mouth red-fuscous to brownish, 2.0-3.5 mm long, 1.0-1.5 mm thick, broadly cylindric, symmetric to slightly curved, contracted below broad mouth when dry; neck as long as urn. Operculum conic-convex to nearly hemispheric, medium-sized, bluntly apiculate,

fuscous, ±glossy. Annulus broad, to 150 μm, 3-rowed. Peristome inserted at mouth, 400-450 μm high. Exostome teeth at base 80-100 μm wide, gradually tapered, below yellow, in uppermost part hyaline; border 8-12 μm wide; median line zig-zag-shaped; fundus orange, 40-56 μm high, broadened; ventral trabeculae 18-20. Endostome free, yellow, as long as exostome or somewhat shorter; basal membrane 1/2-4/7 of endostome length; segments broad, half-segment at base 50-60 μm wide, abruptly narrowed upward, broadly perforate below, narrowly split above; cilia 2-3, long, papillose, appendiculate. Spores 12-14 μm, yellow.

Brood filaments common and numerous in leaf axils throughout both sterile and fruting shoots, upwards to perigonial leaves, brown, finely papillose, thin-walled.

Differentiation and species concept: *Bryum laevifilum* is easy to recognize by its patent leaves and numerous axillary brood filaments. Other differences between this species, *B. capillare,* and *B. elegans* are presented in Tabl. 3.

For a long time this species was treated as *B. flaccidum*, or *B. capillare* var. *flaccidum*. Syed (1973) suggested that in Europe, two related species, *B. laevifilum* and *B. subelegans*, should be recognized in addition to *B. flaccidum*. The former was described as different from *B. flaccidum* in smooth brood filaments, a shorter costa and non-decurrent leaves. In our collections, brood filaments are both finely papillose and smooth, but these character states are not correlated with those of the other two characters. Thus, I agree with Smith (1978), and Wilczek & Demaret (1982) that *B. flaccidum sensu* Syed and *B. laevifilum* are synonymous. An additional consideration is that Wilczek & Demaret (1982) found that the true *B. flaccidum* is a Central American species, different from European '*B. flaccidum*', so the latter must be called *B. laevifilum*.

Another opinion was expressed by Corley & Crundwell (1991), and Duell (1992), who considered *B. flaccidum* to be identical not only with *B. laevifilum*, but also with *B. subelegans* Kindb. In this case, European '*B. flaccidum*' must be treated as synonymous with *B. subelegans,* as well as *B. laevifilum*. This position was accepted in some recent check-lists (*cf*. Ignatov & Afonina, 1992; Blockeel & Long, 1998, etc.), though other authors left *B. subelegans* as a separate species with a more oceanic distribution (cf. Soederstroem, 1996). According to Syed (1973), *B. subelegans* has porose laminal cells, non-decurrent appressed leaves, and a costa that is broad to the apex. No plants with such a combination of character states were found in our territory. Also, *B. subelegans* was reported as growing on calcareous rocks, where *B. flaccidum* is quite rare. Therefore, the identity of *B. laevifilum* and *B. subelegans* is not apparent for me, and thus I accept *B. laevifilum* following the suggestion of Wilczek & Demaret (1982).

Habitat: In forests on tree trunks (usually of broad-leaves trees), sometimes on rocks.

Selected specimens examined (40): Arkhangelsk Prov., Ignatov 10.VIII.1988, MHA; Bashkortostan, Selivanova-Gorodkova #4759, LE; Kursk Prov., Ignatov 16.VIII.1996, MHA; Moscow Prov., Ignatov 4.VI.1986, MHA; Pskov Prov., Zolotov 19.IX.1998, MHA; Saratov Prov., Czerepanova 8.VII.1969, LE; Tambov Prov., Makarov 10.IX.1966, MHA; Volgograd Prov., Suragina & Zybina #256, MHA.

Bryum rubens Mitt., Hooker's J. Bot. Kew Gard. Misc. 8: 232. 1856. Fig. 98

Dioicous. [No mature perigonia seen in Russian collections].

Plants in dense or loose tufts 1.0-1.5 cm high, or separate plants intermixed with other mosses, light-green or dull-green; loosely tomentose, rhizoids light- to dirty fuscous, moderately largely and ±densely papillose. Stem red to raspberry-purplish, 0.5-2.5 cm long, homogemeously loosely foliate and somewhat comosely crowded above, subterminal shoots 1-2, otherwise unbranched. Lower leaves 0.9-1.0 mm long, 0.2-0.3 mm lide. Upper leaves spreading when wet, erect-spreading and slightly curved when dry, pellucid, 2.0-2.5 mm long, 0.4-0.6 mm wide, oblong-ovate to elliptic, widest at 1/2 to 2/3 of leaf length, acute, narrowly and shortly decurrent, green or red at base; margin plane or narrowly recurved in lower half, distinctly serrulate above; border distinct, yellowish or not differentiated in color or pellucid, 2-3-rowed, composed of thick-walled, narrow cells; costa thin, but rather stout, green, later red, shortly to ±longly excurrent. Laminal cells thin-walled or slightly thick-walled, in upper leaf rhomboid-hexagonal to rhombic, 50-70 x 16-20 μm, in mid-leaf rhombic-hexagonal, 64-88 x 16-24 μm, towards margin longer and narrower, at base 80-100 x 20-30 μm and in leaf corners elongate-rectangular.

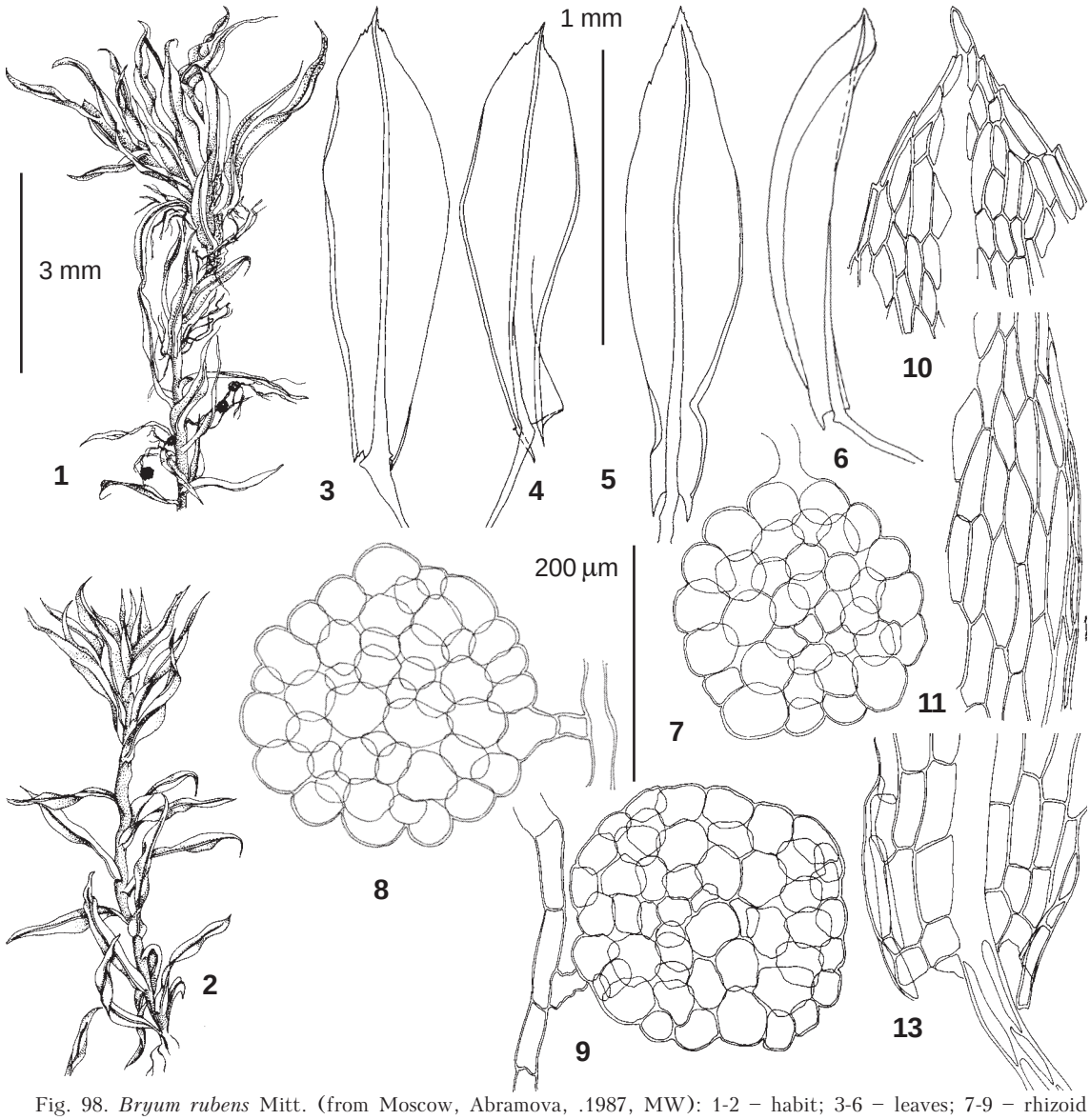


Fig. 98. *Bryum rubens* Mitt. (from Moscow, Abramova, .1987, MW): 1-2 – habit; 3-6 – leaves; 7-9 – rhizoid gemmae; 10 – upper leaf cells; 11 – mid-leaf cells; 12 – cells of upper urn; 13 – lower leaf cells. Scale bars: 3 mm for 1-2; 1 mm for 8-9, 14-17; 200 µm for 10-11, 13, 18.

[Perichaetial leaves narrowly lanceolate to longly triangular, margin plane, costa ending below leaf apex. Seta 1-2 cm, reddish-brownish, rigid, not twisted, shortly arcuate below capsule. Capsule inclined, dirty-dark-red, 2.0-3.0 mm long, 0.6-1.0 mm wide, subcylindric or elongate-clavate, slightly constricted below mouth when dry; neck shorter than urn. Operculum rather large, massive, convex-conic, with stout obtuse beak, similar in color to urn, ±glossy. Annulus 3-4-rowed. Peristome inserted at urn mouth, 400-450 µm high. Exostome teeth at base ca. 50 µm wide, gradually acuminate, below dark-yellow to fuscous, in uppermost part hyaline; border narrow, 4(-6) µm wide; median line almost straight; fundus orange, 40 µm high, broadened; ventral trabeculae 20-24. Endostome free, yellowish, densely papillose; basal membrane 1/2-2/3 of endostome length; segments broad, half-segment at base 40-48 µm wide, suddenly tapered upwards, with moderately big, round perforations along lower keel, narrowly split above. Cilia (2-)3-4, as long as segments or somewhat longer, lowly and moderately densely papillose, appendiculate. Spores 8-12 µm, pale-yellow].

Rhizoid gemmae always present, on rhizoids of lower stem both within and above soil; usually close to base of rhizoid, so looking axillary; ruby-red, (170-)250(-280) μm wide, with projecting surface cells,

Differentiation: The rhizoidal gemmae of *B. rubens* are larger than those of *B. subapiculatum,* (170-)250-280 μm vs. 200-240 μm, are darker in color (ruby-red to cherry-red vs. bright-red to orangish-red), and have distinctly projecting vs. almost smooth surface cells. In addition, the gemmae in *B. rubens* are scattered high up along the stem, whereas in *B. subapiculatum* they are restricted to the base and found on rhizoids within the soil. Virchenko (1989) provided nice SEM illustrations of the gemmae of these two species.

Virchenko (1989) provided a nice SEM illustrations of the gemmae of these two species.

Habitats: On clayish and sandy bare soil; in open places within forest and on forest edge.

Specimens examined (3): Moscow, Abramova, .1987, MW; Volgograd Prov, Zemlyanskaya 6.V.1999, MHA; Voronezh Prov., Popova 6.X.1982, VOR.

Bryum subapiculatum Hampe, Vidensk. Meddel. Dansk Naturhist. Foren. Kjobenhavn, ser. 3, 4: 51. 1872. Fig. 99

Bryum microerythrocarpum C. Muell. et Kindb. in Macoun et Kindb., Cat. Canad. Pl. 6: 124. 1892.

Bryum erythrocarpum auct.

Dioicous; male and female plants in mixed tuft; perigonia with numerous antheridia and paraphyses; paraphyses slightly longer than antheridia; perigonial leaves obovate, contracted into long piliferous acumen; margin plane, costa rather stout, ending in acumen.

Plants in low, loose tufts 0.5-1.0 cm high, green, light-green to slightly reddish, not or slightly tomentose, rhizoids brownish to orange-brown, papillose. Stem short, ca. 0.5 cm long, loosely foliate, comose, subterminal shoots 1-3, loosely foliate, comose. Lower leaves, branch leaves and leaves of sterile shoots 1.0 mm long, 0.4-0.5 mm wide, lanceolate, with plane or narrowly recurved margin, indistinctly bordered. Upper leaves soft, spreading when wet, variously curved when dry, loosely imbricate, comosely crowded, 1.9-2.2(-2.7) mm long, 0.6(-0.8) mm wide, oblong-lanceolate, widest at 1/3 to 1/2 of leaf length acuminate, non-decurrent, red at base; margin recurved from base to mid-leaf or higher, in upper 1/3 remotely serrulate; leaf border indistinct, not differentiated in color, 1-2-rowed, composed of longer, ±broad cells; costa rigid, yellow-green, excurrent in short, smooth or serrulate awn, rarely ending below apex. Laminal cells lax, thin-walled, not porose, in upper part rhomboid-hexagonal to rhombic, (40-)50-90(-100) x 20-24 μm, in mid-leaf rhombic-hexagonal, irregularly elongate, partly rectangular, 50-100 μm x 20-24 μm, at base elongate-rectangular, 40-60(-80) x 20-24 μm.

Perichaetial leaves triangular-lanceolate, margin plane, costa strong, excurrent to percurrent. Seta 2-3 cm, fuscous to red, thin, rigid, not twisted when dry, arcuate below capsule. Capsule inclined to horizontal, dark-red, below mouth dark, 2-3 cm long, 0.5-0.8(-1.0) mm thick, oblong-pyriform, symmetric or indistinctly curved, contracted below mouth when dry; neck about as long as half urn, collapsed when dry. Operculum large, highly conic-convex, with short acute apiculus, purple, glossy. Annulus 3-rowed. Peristome inserted at urn mouth, 440-500 μm high. Exostome teeth at base 60-80 μm wide, gradually acuminate, below reddish or pale, from outside, in uppermost part hyaline; border broad, 8-12 μm wide; median line zig-zag-shaped to nearly straight; fundus red, ca. 40 μm high, broadened; ventral trabeculae 25-30. Endostome free, pale yellow; basal membrane 1/2-4/7 of endostome length; segments broad, half-segment at base 40-50 μm wide, narrow above, broadly perforate below, with perforations irregularly fused, narrowly split above; cilia 3-4, long, thin, papillose, longly appendiculate. Spores ca. 12 μm, greenish-yellow.

Rhizoid gemmae always present, on rhizoids within and on soil, round, red, 150-200 μm in diameter; surface cells smooth.

Differentiation: The differences from *B. rubens* are discussed under the latter species. *Bryum violaceum* and *B. klingraeffii* have much smaller gemmae, less than 120 μm in diameter.

Habitat: On bare soil in clear cutting (in forest zone) and in oak forest in ravine (in steppe zone).

Specimens examined (4): Leningrad Prov., Aver'yanova, 8.VIII.1992, MHA; Novgorod Prov., 1999, Ulanova, MW; Voronezh Prov, Popova #2672, VOR.

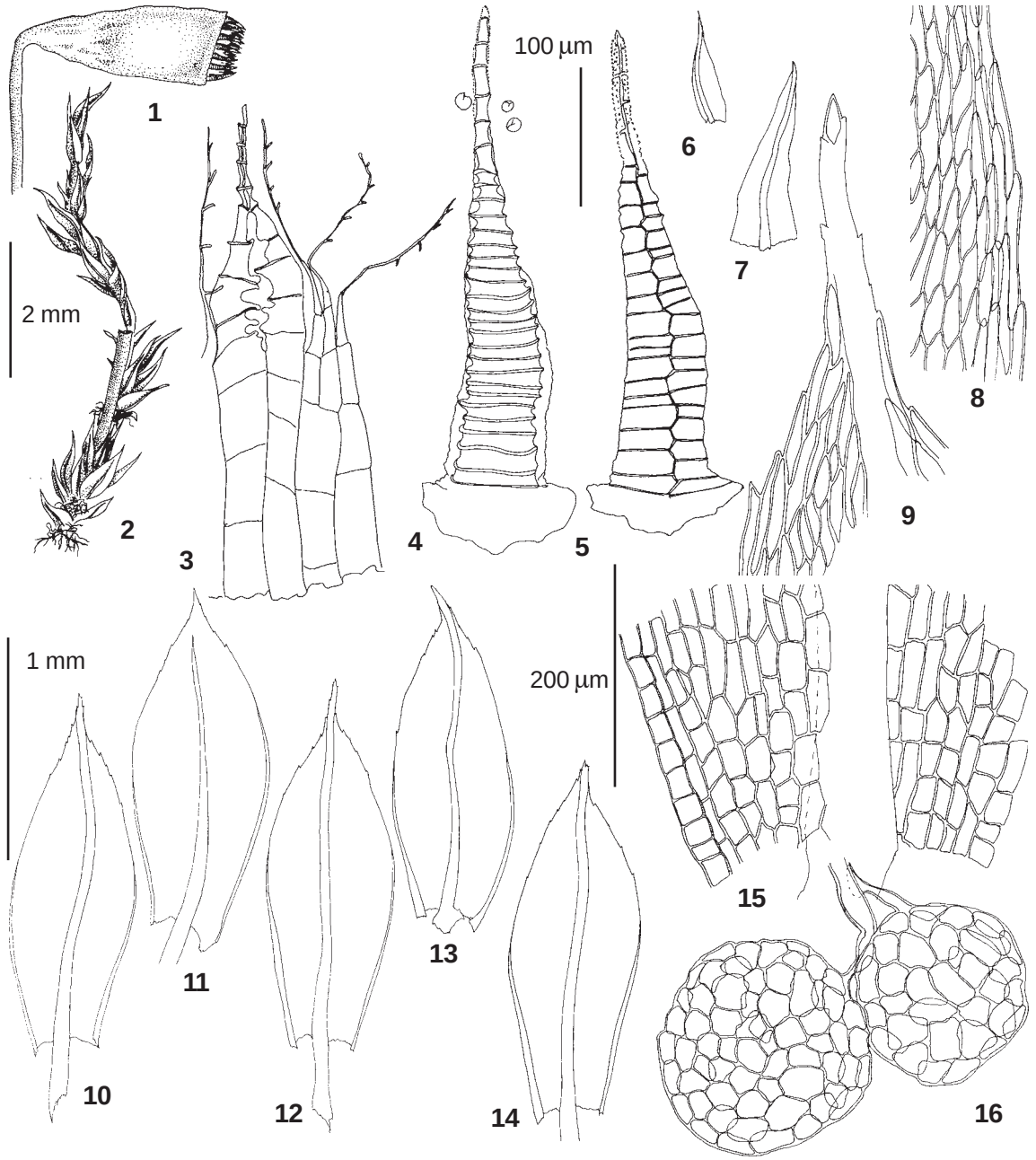


Fig. 99. *Bryum subapiculatum* Hampe (1-7 – from Novgorod Prov., Ulanova .1999, MW; 8-16 – Voronezh Prov., Popova 27.IX.1982, VOR): 1 – capsule; 2 – habit; 3 – part of endostome; 4 – inner surface of exostome tooth; 5 – outer surface of exostome tooth; 6-7 – perichaetial leaves; 8 – mid-leaf cells; 9 – upper laminal cells; 10-14 – leaves; 15 – lower leaf cells; 16 – rhizoid gemmae. Scale bars: 2 mm for 1-2; 1 mm – 6-7, 10-14; 200 µm – 8-9, 15-16; 100 µm – 3-5, 12.

Bryum violaceum Crundw. et Nyh., Bot. Not. 116: 94. 1963. Fig. 100

Dioicous; male and female plants similar in leaf shape, occurring in mixed tufts; antheridia numerous, fuscous, paraphyses twice as long as antheridia, fuscous.

Plants in low, open and often partly buried tufts ca. 0.5 cm high, dirty-yellow-green, brownish-green to violet-red; rhizoids in lower (buried) part of stem, long, fuscous to red-brown, papillose. Stem red, 0.5 cm long, comose, subterminal shoots 1-3, comose. Lower leaves 0.7 mm

long, 0.3 mm wide, lanceolate, non-decurrent, with plane non-bordered entire margin and short stout costa. Upper leaves 1.5-2.0 mm long, 0.5-0.6 mm wide, ovate-lanceolate to triangular, widest at 1/3 to 2/5 of leaf length, gradually acuminate, non-decurrent, without red color at base; margin plane to reflexed from base to acumen, entire to weakly serrulate above; border not differentiated; costa stout, at base yellowish-green, fuscous above, dark- or violet-red, excurrent in stout, long, smooth to serrulate awn. Laminal cells with ±incrassate cell walls, not porose, in upper leaf rhomboid-hexagonal to rhomboid, 40-80 x 14-16 μm, in mid-leaf elongate-hexagonal, ca. 60 x 20 μm, towards margin cells narrower and longer, more diverse in shape, at base rectangular or short-rectangular, to 60-80 x 24 μm, in leaf corners subquadrate.

Perichaetial leaves narrowly triangular, margin plane, costa stout, percurrent. Seta 1-2 cm long, dark-red, red-violet to blackish, thin, rigid, not twisted when dry, abruptly curved below capsule. Capsule inclined to pendulous, dark-red to rich red-violet, ca. 2 mm long and 1 mm wide, oblong-obovate, symmetric, contracted below mouth when dry; neck twice shorter than urn. Operculum large, conic to conic-convex, apiculus bluntly acute, of same color as capsule, glossy. Annulus 3-rowed. Peristome inserted at urn mouth, ca. 400 μm high. Exostome teeth at base ca. 60 μm wide, narrow, straight, gradually acuminate, below fuscous-yellow, from outside, in uppermost part hyaline; border ca. 8 μm wide; median line zig-zag-shaped; fundus orange-red, 40-60 μm high, broadened; ventral trabeculae 15-20. Endostome free, yellowish; basal membrane ca. 4/7 of endostome length; segments broad, half-segment at base ca. 40 μm, narrow above, broadly perforate below, narrowly split above. Cilia 2-3, long, finely papillose, longly appendiculate. Spores ca. 10 μm, yellow.

Rhizoid gemmae on rhizoids within soil, pale-fuscous, round to irregularly rounded, with non-projecting to slightly angulose-projecting surface cells, 60-110 μm in diameter.

Differentiation: *Bryum violaceum* differs from *B. subapiculatum* and *B. rubens* in having smaller gemmae, and from *B. klingraeffii* in brownish (not bright red) gemmae, and the presence of purple to violet pigmentation in the seta and capsule. Rhizoids and gemmae in our specimen lack violet pigmentation, an important diagnostic character of this species; however, the fact that rhizoids in some specimens are much paler was noted already in the original description (Crundwell & Nyholm (1963). Contrary to the descriptions of Crundwell & Nyholm (1963, 1964), Smith (1978), Savich-Ljubitskaya & Smirnova (1970), and Virchenko (1987, 1989), some gemmae are not perfectly globose and have slightly projecting surface cells. The latter character state has been observed in *B. ruderale* Crundw. et Nyh., a species closely related to *B. violaceum*, but differing in larger gemmae, 125-180(-200) μm. I refer the only specimen from European Russia to *B. violaceum,* relying mostly on size of the gemmae. Moreover, illustrations of Crundwell & Nyholm (1964) and Virchenko (1987) also show a somewhat angular surface on the gemmae.

Habitat: The only specimen from the area was collected on bare peat in peat bog.

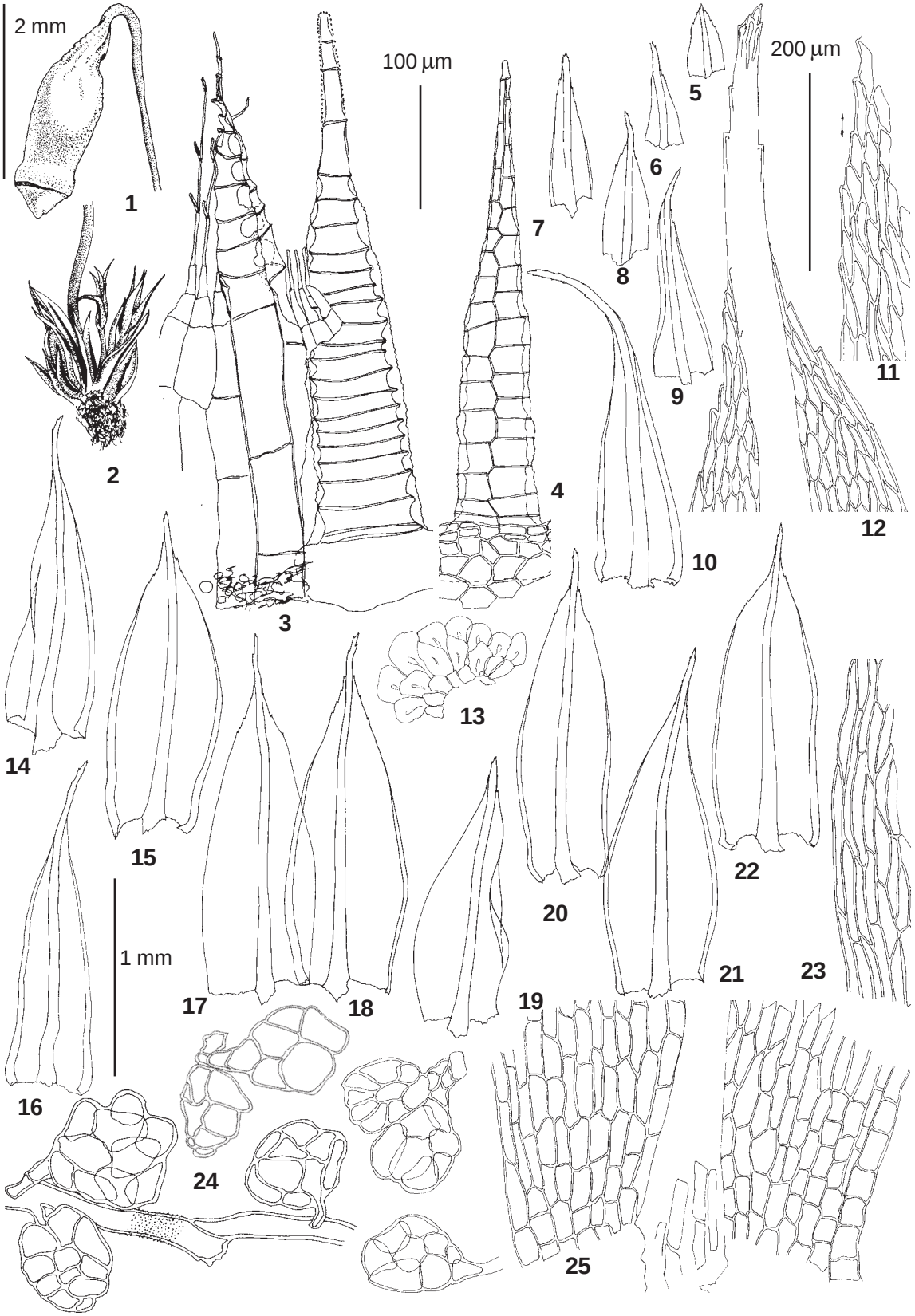
Specimen examined (1): Orel Prov., Popova 16.VI.1985, VOR, dupl. MHA.

Bryum klinggraeffii Schimp. ex Klinggr., Hoh. Crypt. Preuss 81. 1859. Fig. 101

Dioicous. Male plants not seen.

Plants in low, loose tuft ca. 2 mm high, brownish-green, rhizoids only at stem base, fuscous, slightly papillose. Stem red, ca. 2 mm long, evenly foliate, without subterminal shoots. Lower leaves 0.4-0.6 mm long, 0.2-0.4 mm wide, ovate-lanceolate, unbordered or with indistinctly delimited border of one row of longer cells. Upper leaves erect when wet, appressed when dry, 1.0-1.5 mm long, 0.4-0.5 mm wide, lanceolate, widest at 1/4 of leaf length, gradually acuminate, non-decurrent, red at base; margin recurved from base nearly to apex, entire, serrulate above; border indistinct, 1-2-rowed, or undifferentiated; costa stout, red at base, fuscous above, percurrent to shortly excurrent. Laminal cells moderately thick-

Fig. 100. *Bryum violaceum* Crundw. et Nyh. (from Orel Prov., Popova 16.VI.1985, VOR)): 1 – capsule; 2 – habit; 3 – part of endostome and inner surface of exostome tooth; 4 – outer surface of exostome tooth; 5-10 – perichaetial leaves; 11 – mid-leaf cells; 12 – upper leaf cells; 13 – annulus; 14-19 – upper leaves of female plant; 20-22 – upper leaves of male plant; 23 – mid-leaf cells; 24 – rhizoid gemmae; 25 – lower leaf cells. Scale bars: 2 mm for 1-2; 1 mm – 5-10, 14-22; 200 μm – 11-13, 23-25; 100 μm – 3-4.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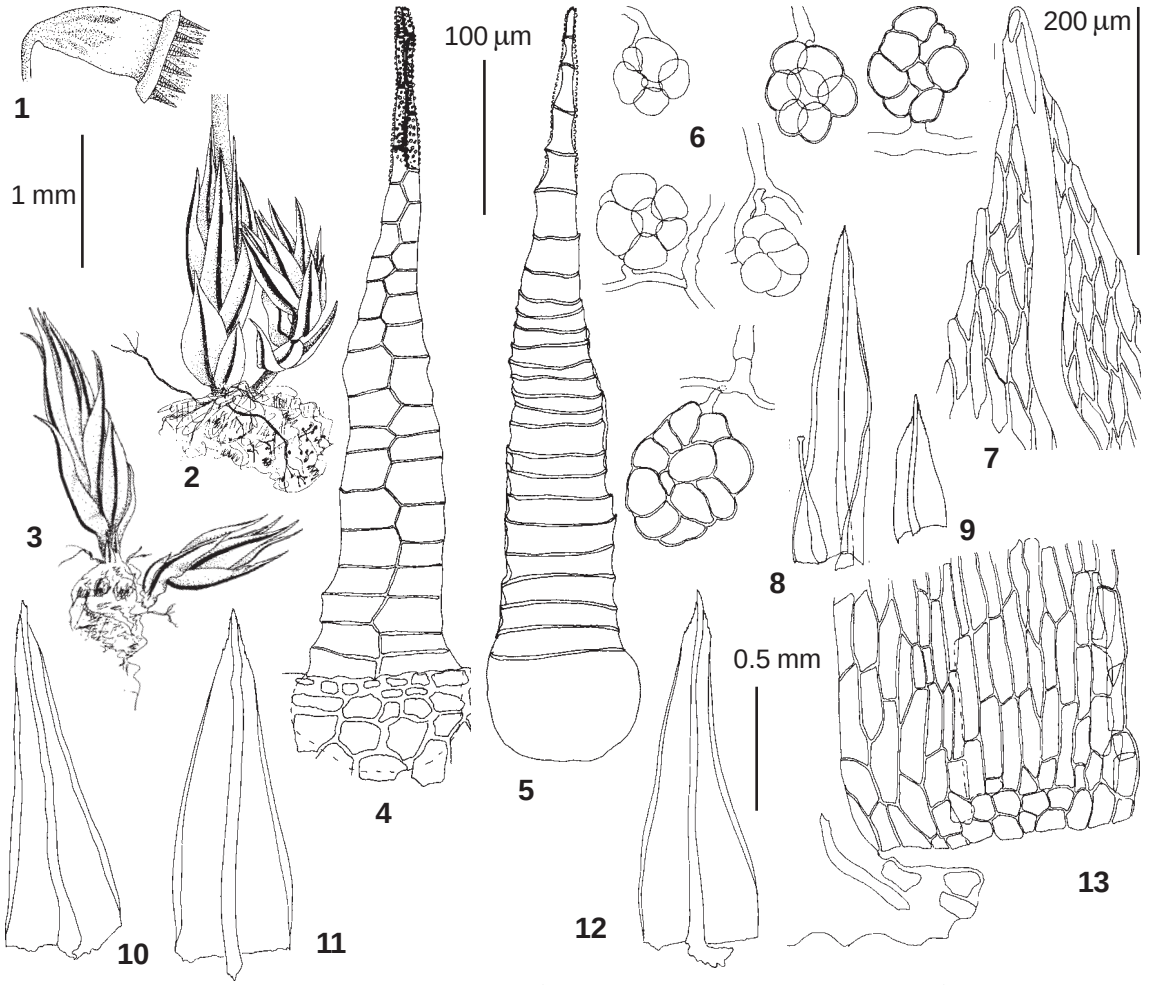

Fig. 101. *Bryum klinggraeffii* Schimp. ex Klinggr. (from Pskov Prov., Malta 31.VII.1917, H): 1 – capsule; 2-3 – habit; 4 – inner surface of exostome tooth; 5 – outer surface of exostome tooth; 6 – rhizoid gemmae; 7 – upper leaf cells; 8-9 – perichaetial leaves; 10-12 – leaves; 13 – lower leaf cells. Scale bars: 1 mm for 1-3; 0.5 mm for 8-12; 200 µm – 6-7, 13; 100 µm – 4-5.

walled, not porose, in upper leaf rhomboid-hexagonal, 40-60 x 12-16 µm, in mid-leaf rhomboid-hexagonal, 60-70 x 16-20 µm, at base rectangular, to 80-120 x 16-20 µm, in leaf corner short-rectangular to quadrate, 12-16 µm wide.

Perichaetial leaves elongate-triangular, margins plane unbordered, costa percurrent or ending below leaf apex. Seta 1.0-1.2 cm, reddish-fuscous, thin, slender, slightly twisted when dry, abruptly hooked below capsule. Capsule pendulous, reddish-fuscous, to 1.5 mm long, 0.8 mm thick, narrowly scyatiform when open, slightly contracted below broad dark-red mouth, neck as long as urn, slightly curved, collapsed when dry. Operculum and annulus not seen. Peristome inserted at urn mouth, 400-420 µm high. Exsostome teets 85-90 µm at base, ±abruptly tapered at 1/3 of tooth length, below olive-yellow, in uppermost part hyaline; border narrow, 4-8 µm wide; median line zig-zag-shaped, fundus dark-orange, to 100 µm high, somewhat braodened; ventral trabeculae 20-25. Endostome free, yellowish; basal membrane ca. 1/2 of endostome length; segments broad, half-segment at base ca. 40 µm wide, broadly perforate below with some preforations fused into irregular gaps, narrowly split above; cilia 3, as long as segments, finely papillose, appendiculate. Spores ca. 8 µm, yellow.

Rhizoid gemmae within soil level, globose to pyriform, red to purple, 60-100 µm, with projecting surface cells.

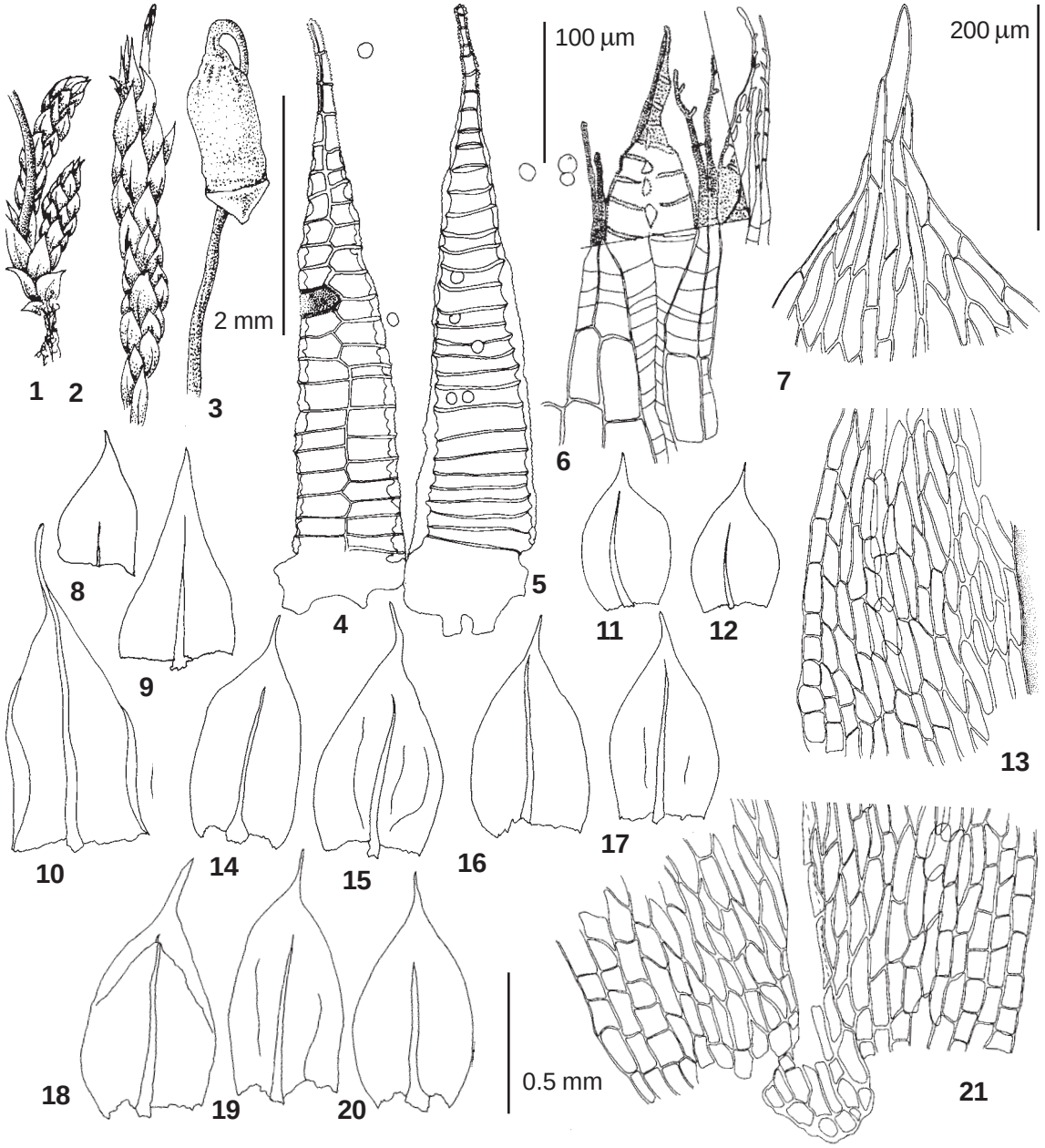

Fig. 102. *Bryum argenteum* Hedw. (from Pskov Prov., Zolotov 18.VIII.1998, MHA): 1-2 – habit; 3 – capsule; 4 – outer surface of exostome tooth; 5 – inner surface of exostome tooth; 6 – part of endostome; 7 – upper leaf cells; 8-9 – inner perichaetial leaves; 10 – outer perichaetial leaf; 11-12 – perigonial leaves; 14-20 – leaves; 21 – lower leaf cells. Scale bars: 2 mm for 1-3; 0.5 mm – 8-20; 200 µm – 7, 13, 21; 100 µm – 4-6.

Differentiation: *Bryum klingraeffii* can be recognized by rhizoid gemmae, which are small, light red, globose to pyriform, and composed of irregularly aggregated cells, such that the exposed surfaces of the cells are convex. Overall, the gemmae resemble small, imperfect raspberries.

Habitat: limestones.

Specimen examined (1): Pskov Prov., Malta 31.VII.1917, H3021869 (H).

Bryum argenteum Hedw., Sp. Musc. Frond. 181. 1801. Fig. 102

Bryum argenteum var. *lanatum* (P. Beauv.) Hampe, Linnaea 13: 44. 1839. – *Mnium lanatum* P. Beauv., Prodr. Aetheol. 75. 1805.

Dioicous; male and female plants in mixed

tuft, perigonia with numerous antheridia; paraphyses as long as antheridia; perigonial leaves from broad base broadly ovate-lanceolate, yellowish-brownish.

Plants in extensive, rather compact, but easily separating tufts 1(-2) cm high, rarely higher; green, whitish-green to argentate, silky glossy; rhizoids abundant, light fuscous, finely papillose. Stem red, ca. 1 cm high, straight, slender, regularly julaceous, with upper leaves comosely crowded; subterminal shoots 1-3(-4), julaceous. Middle stem leaves closely imbricate, concave, ovate, acuminate or abruptly tapered to narrow colorless acumen, 0.5-0.9 mm long and 0.3-0.6 mm wide, non-decurrent, margin plane. Upper leaves to 1.1(-1.2) mm long, 0.6(-0.7) mm wide, ovate to oblong-ovate, widest at 1/4-1/2 of leaf length, gradually acuminate, non-decurrent, red at base; margin plane or narrowly recurved at base (in largest leaves), entire; border not differentiated; costa weak, at base red, above greenish, ending in mid-leaf or in upper half, rarely shortly excurrent. Laminal cells thin-walled, not porose, in upper part translucent, elongate, (60-)70-80(-90) x (12-)16-20 μm, in mid-leaf rhomboid, rhomboid-hexagonal, partly rectangular, 40-60(-70) x 15-20(-25) μm, at base shortly rectangular to quadrate, 18-22 μm wide.

Perichaetial leaves longly triangular, margin plane, costa short. Seta 1-2 cm (varying within the same tuft), red to blackish, thin, twisted when dry, abruptly hooked above. Capsule inclined to pendulous, deep-red to lily-red and blackish-red, below mouth orange to red, glossy or not, 2.0-2.5 mm long, 0.7-1.0 mm thick, oblong- to broadly obovate, symmetric, contracted below broad mouth when dry, neck 1/3-1/4 of urn length. Operculum lowly conic to highly conic-convex, bluntly acute, glossy, longly persistent on capsule. Annulus 3-rowed. Peristome inserted below mouth, 400-450 μm high. Exostome teeth at base 100 μm wide, below orange; in uppermost part hyaline; border broad, 8-12 μm wide; median line zig-zag-shaped to nearly straight; fundus orange, 50-80 μm high, broadened; ventral trabeculae ca. 25. Endostome free, as long as exostome, yellowish; basal membrane 1/2-4/7 of endostome length; segments broad, half-segment at base ca. 40 μm wide, subulate above; narrowly perforate below, narrowly split above; cilia 2-3, long, coarsely and densely papillose, appendiculate. Spores 10-15 μm, yellowish.

Brood branches sometimes present in leaf axils.

Differentiation and variation: *Bryum argenteum* is easily distinguishable, even when sterile, by its silver color and clearly julaceous, small plants. The leaves are short, concave, usually colorless in their upper part, and the costa often ends below the leaf apex.

Plants from more xeric habitats have leaves with a more extensive hyaline upper part, a longer piliferous acumen, and the costa often filling the acumen to excurrent. These phenotypes are segregated as the var. *lanatum* by some authors; however, they occur throughout the study territory and hardly warrant taxonomic recognition.

Habitat: Very common in secondary habitats at early stages of successions, steppes, meadows, old brick and concrete walls, etc.

Selected specimens examined (40): Bashkortostan, Ignatova, 28.VIII.1990, MHA; Kaluga Prov., Boczkin 20.IV.1986, MHA; Lipezk Prov., Samsel 152, MW; Moscow Prov., Ignatov 15.VI.1984, MHA; Nizhnij Novgorod Prov., Shvezov 16.VIII.1914, MW; Novgorod Prov., Morozov & Morozova, 27.VIII.1980, MHA; Perm Prov., Ovesnov, 16.VII.1994, MW; Pskov Prov., Zolotov 18.VIII.1998, MHA; Volgograd Prov., Zybina 11.V.1992, MHA; Voronezh Prov., Popova 27.IX.1982, VOR; Yaroslavl Prov., G. Merril #13961, MHA.

Bryum bicolor Dicks., Pl. Crypt. Brot. 4: 16. 1801. Fig. 103

?Bryum dichotomum Hedw., Pl.Sp. Musc. Frond. 183. t. 42. 1801.

Dioicous; female and male plants in separate tufts [in European collections often in mixed tufts; male plants not found in Middle European Russia; perigonia dense, with numerous antheridia and reddish paraphyses; paraphyses 1.5-2 times longer than antheridia; perigonial leaves small. Male plants often subdichotomously branched above].

Plants in rather dense, low tufts 0.5-1.0 mm high, light-green, silky glossy, tomentose, rhizoid fuscous or orange-fuscous, ±papillose. Stem of fruiting shoot short, 0.3-0.5 cm long, very loosely foliate below, comose; subterminal shoots 1-3, more loosely foliate; sterile shoots 0.5-1.0 cm, rarely longer, more loosely subjulaceously foliate. Leaves of sterile shoot ca. 0.9 mm long, 0.5 mm wide, ovate-lanceolate, acuminate, concave, with rather stout, shortly excurrent costa. Lower leaves loosely arranged, to 0.7 mm long, 0.5 mm wide, broadly lanceolate to ovate-lanceolate, carinate, with plane margin, border narrow, costa narrow, ending below

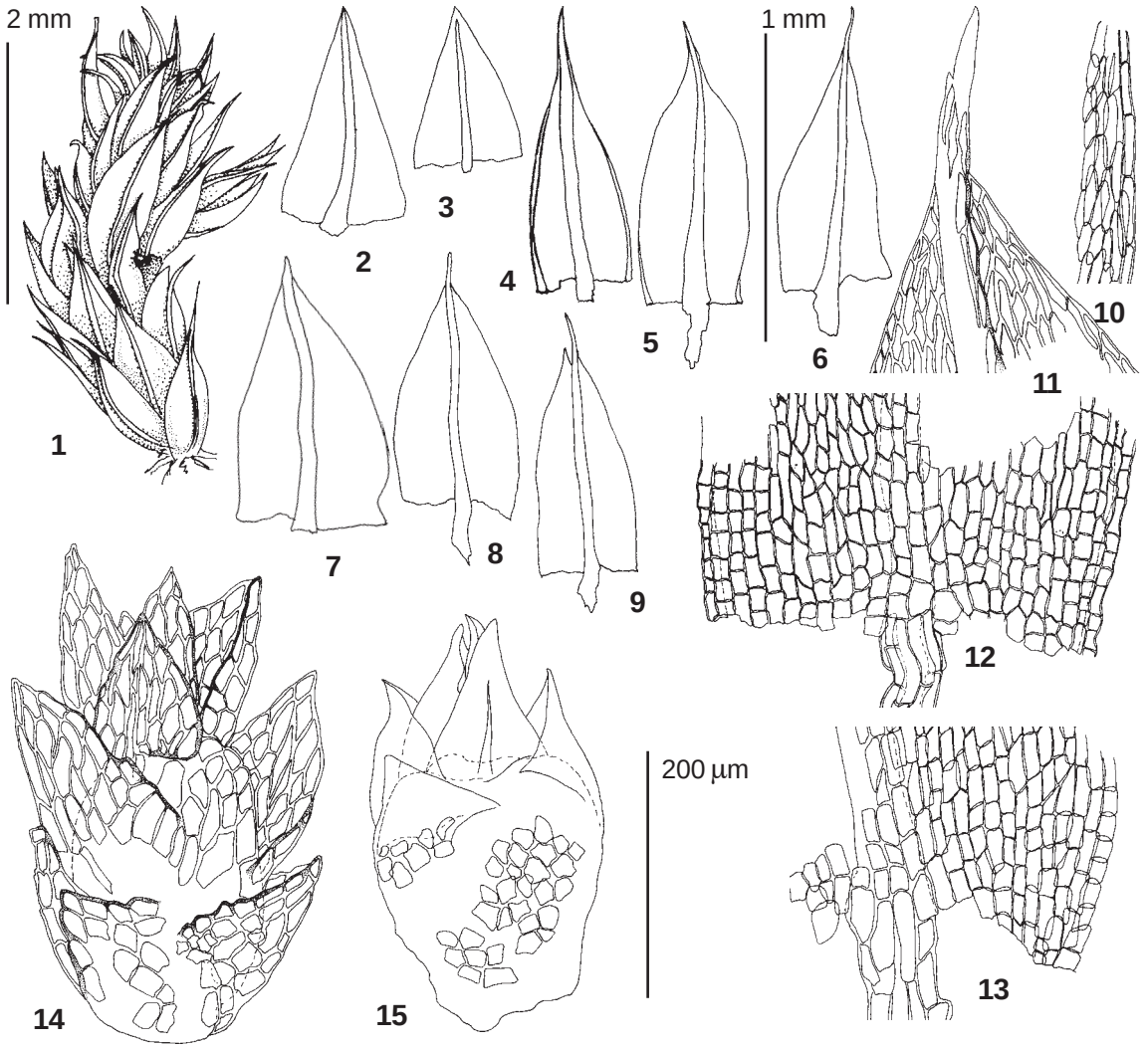

Fig. 103. *Bryum bicolor* Dicks. (from Voronezh Prov., Popova #1822, VOR): 1 – habit; 2-3 – perichaetial leaves; 4-9 – leaves; 10 – mid-leaf leaf cells; 11 – upper leaf cells; 12-13 – lower leaf cells; 14-15 – axillary brood buds. Scale bars: 2 mm for 1; 1 mm for 2-9; 200 µm for 10-15.

apex to percurrent. Upper leaves erect when wet, appressed when dry, 1.0(-1.2) mm long and 0.6(-0.7) mm wide, ovate-lanceolate,widest at 2/7-1/3 of leaf length acuminate, carinate, non decurrent, at base and often up to half-leaf red or green nearly throughout; margin recurved to reflexed, entire or weakly serrulate above; border indistinct or undifferentiated; costa stout, greenish-yellow, fuscous-brown with age, shortly excurrent in stout smooth awn. Laminal cells with moderately incrassate cell-walls, not porose in upper leaf rhombic, 35-50 x 12-16 µm, in mid-leaf narrowly rhombic and rhomboid-hexagonal, 40-52 x 12(-16) µm, at base shortly rectangular, in leaf corners to quadrate, ca. 18-20 µm wide, not inflated.

[Perichaetial leaves triangular, margin plane, costa short. Seta 1.0-1.5(-2.5) cm, red to dark-red, twisted when dry, arcuate below capsule. Capsule pendulous, deep-red to blackish, ca. 2 mm long, 1 mm thick, broadly obovate, short, symmetric, not contracted below mouth; neck broad, as long as urn or shorter. Operculum large, high conic, with short and blunt beak, purple, glossy. Annulus 2-3-rowed. Peristome inserted at urn mouth, 500-550 µm high. Exostome teeth at base 120-140(-150) µm wide, below deep-yellow to reddish, in uppermost part hyaline; border broad, 12(-16) µm wide; median line zig-zag-shaped; fundus red, 50 µm high, broadened; ventral trabeculae to 30. Endostome free, pale yel-

low; basal membrane 1/3-1/2 of endostome length; segments broad, half-segment at base 56-60 μm, abruptly contracted near middle, broadly perforate below, narrowly split above; cilia 2-3, slightly shorter than segments, papillose, longly appendiculate. Spores 8-11 μm, light yellow.]

Brood buds often present, in axils of lower leaves, light orange to red, 300-500 μm long (including leaves); with minute triangular leaves, sometimes with discernable greenish costa.

Differentiation and variation: *Bryum bicolor* has julaceous shoots somewhat resembling those of *B. kunzei*, *B. elegans*, and *B. funkii*. However, the latter have no axillary brood buds, whereas these are present in most of collections of *B. bicolor*. Several specimens from the steppe zone in Kursk and Voronezh Provinces (Popova, VOR) have no axillary buds and thus cannot be identified with certainty, although in other characters they agree with *B. bicolor*.

Ochi (1972) found that *B. dichotomum* Schwaegr., described from New Zealand, is identical with *B. bicolor*, described from the Europe, and the former name is earlier. However, in Europe, recent studies revealed that *B. bicolor* in the sense of authors of XIX century is an aggregate, including as many as five species with small, but stable differences, primarily in the shape and size of brood buds (Smith & Whitehouse, 1978; Smith 1978). Demaret & Wilczek (1980) studied types of both *B. bicolor* and *B. dichotomum,* and found that they have some differences in brood bud shape and position on the stem, so the two taxa might be considered separate species. However, further studies on the variability of species of the *B. bicolor* complex in the Southern Hemisphere are needed for a conclusive decision. The shape of buds of specimens from European Russia fit well within the range of variability of *B. bicolor s. str.*

Habitat: In forest zone (Moscow Prov.), *Bryum bicolor* was collected on wet soil with *B. pallens*; collections from steppe zone are from solid chalk outcrops.

Specimens examined (4): Bashkortostan, Ignatova, #11/159, MW; Kursk Prov., Popova 1995, VOR; Moscow Prov., Zickendrath #338, LE; Voronezh Prov., Popova #1822, VOR.

Bryum alpinum Huds. ex With., Syst. Arr. Brit. Pl., ed. 4, 3: 824. 1801. Fig. 104

Dioicous; male and female plants similar; antheridia and paraphyses numerous, paraphyses longer than antheridia; perigonial leaves ovate to ovate-lanceolate, small, costa ending below leaf apex.

Plants often in extensive tufts 1.5-2.5 cm high; green below, golden-green, ochra, brownish, or purple above; tomentose, rhizoids brown to red-brown, finely and densely papillose. Stem stout dark red-brown, 1.5-2.5(-3.0) mm long, straight or ascending, foliage homogeneous; subterminal shoots 1-3, evenly foliate, with densely imbricate leaves. Leaves rigid, erect when wet, appressed when dry, 2.2-2.5(-3) mm long, 0.4-0.6 mm wide, lanceolate to broadly-lanceolate, widest at 1/3 to 1/2 of leaf length, carinate to concave, sometimes longitudinally plicate, bluntly acuminate, slightly narrowed towards base, non-decurrent, not or slightly red; leaf margin recurved, or more rarely revolute from base to 3/4 of leaf length, or nearly to the apex, entire or weakly serrulate above; border not differentiated; costa stout, especially below, fuscous-green, becoming red with age, ending abruptly below apex to percurrent, rarely shortly excurrent. Laminal cells thick-walled, not porose, in upper leaf rhomboid, (40-)50-60(-80) x 12-16 μm, in mid-leaf narrowly rhomboid and rhomboid-hexagonal, 60-80 x 16-20 μm, at base shortly rectangular to quadrate, to 28 μm wide.

[Perichaetial leaves lanceolate, margin plane, costa ending below leaf apex. Seta to 2 cm high, purple, rigid, not or slightly twisted when dry, shortly arcuate below capsule. Capsule cernuous to pendulous, deep-red to blacky-purple, 2.5-3.0 mm long, 0.7-0.9 mm thick, oblong-obovate to pyriform, symmetric, strongly contracted below mouth when dry; neck narrow, straight, half as long as urn. Operculum high-convex, with acute apiculus, orange to red, glossy. Annulus 3-4-rowed. Peristome inserted at urn mouth, 500-600 μm high. Exostome teeth at base 120-130 μm wide, below yellow, in uppermost part pale; border broad, to 12-16 μm wide; median line zig-zag-shaped; fundus red, to 30-40 μm high, broadened; ventral trabeculae 30-35. Endostome free, yellow; basal membrane 1/2-4/7 of endostome length; segments broad, half-segment at base ca. 60 μm, broadly perforate below, narrowly split above; cilia 3-4, long, densely papillose, with very broad appendicules. Spores 12-18 μm, greenish-yellow.]

Rhizoid gemmae on long and short rhizoids, fuscous or reddish, globose to ovoid, 60-100 μm wide, surface cell slightly convex.

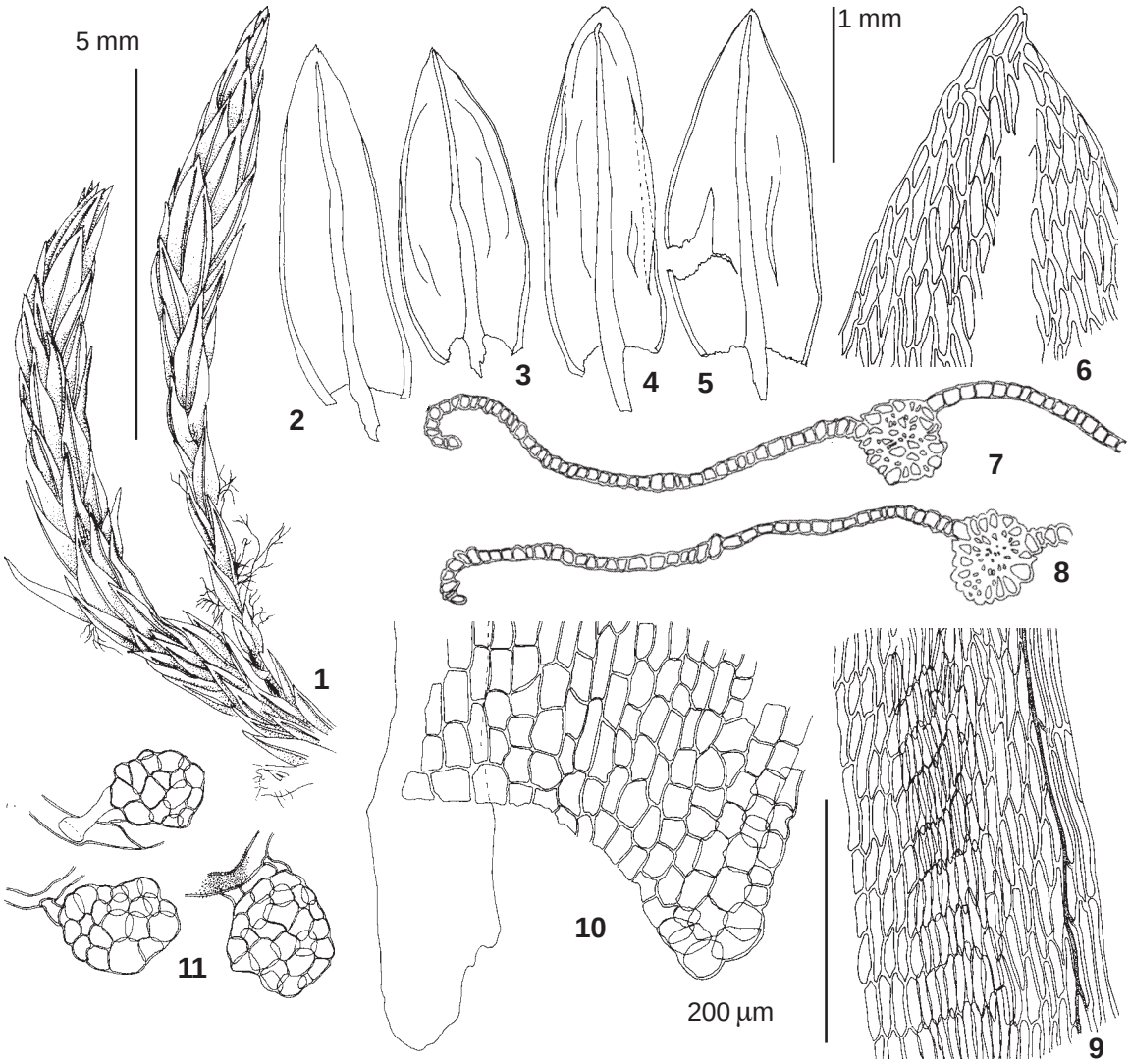

Fig. 104. *Bryum alpinum* Huds. ex With. (from Rostov-na-Donu Prov., Babenko, 18.VI.1993, MHA): 1 – habit; 2-5 – leaves; 6 – upper leaf cells; 7-8 – transversal leaf section; 9 – lower leaf cells; 10 – mid-leaf leaf cells; 11 – rhizoid gemmae. Scale bars: 5 mm for 1; 1 mm for 2-5; 200 µm for 6-11.

Differentiation: *Bryum alpinum* is easy to recognize by its variegated glossy tufts, closely imbricate foliage when dry, and broadly lanceolate, blunt leaves.

Habitat: The only specimen from our territory was collected in a rocky steppe, within a lichen community.

Specimen examined: (1) Rostov-na-Donu Prov., Babenko 18.VI.1993, MHA.

NON-CONFIRMED RECORDS

Bryum androgynum Warnst. in Malta, Beitr. Mossfl. Gouv. Pleskau: 58. 1919. Described from Novgorod Prov., Solzy. No type material was studied yet. Podpera (1959) considered this taxon as a variety of *Bryum cirrhatum.* According to the original description this species belongs to the *B. lonchocaulon–B. creberrimum* complex.

Bryum mosquense Warnst., Hedwigia 54: 52, fig. 12b. 1913. – *B. caespiticium* ssp. *mosquense* (Warnst.) Podpera, Prace Brenenske Zakl. Ceskolov. Akad. Vet. 29: 142. 1957. – *B. caespiticium* var. *mosquense* (Warnst.) Podpera, Consp. Musc. Eur. 385. 1954. This taxon was segregated by Warnstorf (1914) mainly because of larger spore size, 16-20 µm vs. 10-16 in typical expressions of *B. caespiticium*. No type material, nor plants with so large spores were studied.

Bryum purpurascens (R. Br.) B. S. G. More northern species, once reported from the southern part of Komi republic (Zheleznova, 1994). The specimen has not been studied yet.

Bryum sauteri B. S. G. Reported by Dyachenko (1988) from the Middle Urals. No specimens were available for study.

Bryum warneum Bland. Reported for Pskov Province by Malta (1919). This speices occurs in Baltic countries and certainly can be found in North-Western Russia. No collections in LE and H were found.

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APPENDIX 1. Specimens from outside ot the study area used for additions in descri ptions.

Bryum weigelii: Angml. [Angermanland?] Sabra, VIII.1871, Arnell., H.

Bryum schleicheri: Caucasus, Kharachaevo-Cherkessiya, Oni pchenko, 121/94, MW.

Bryum laevifilum: Caucasus, Caucasian Reserve, Artamonova, 23.VII.1960, MW.

Bryum rubens: [Latvia & Estonia] Musci Hep. et Frond. Rus. Balt. Exs., 186, LE.

Bryum bicolor: Istrien, E.Bauer, Mus. Eur. Exs. 338, MW.

Bryum alpinum: Kazakhstan, Talasskii Ala-Tau, Reserve "Aksu-Dzhabagly, Nenasheva, 20.IV.1979, MHA.

INDEX TO NAMES OF BRYUM SPEICES (for species descriptions)
(in bold – page of species description; in bold-italic – illustration)