Arctoa (2001) **10**: *189-200*

ON THE AXILLARY HAIRS OF LEPTOBRYUM (MEESIACEAE, MUSCI) AND SOME OTHER ACROCARPOUS MOSSES

О ПАЗУШНЫХ ВОЛОСКАХ LEPTOBRYUM (MEESIACEAE, MUSCI) И НЕКОТОРЫХ ДРУГИХ ВЕРХОПЛОДНЫХ МХОВ

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Abstract

Axillary hairs of 55 species of genera *Amblyodon, Aplodon, Aulacomnium, Brachymitrion, Breutelia, Bryobrittonia, Bryum, Catoscopium, Encalypta, Funaria, Leptobryum, Meesia, Mnium, Orthodontium, Orthotrichum, Paludella, Philonotis, Plagiomnium, Plagiopus, Pohlia, Pyrrobryum, Rhodobryum, Rhizomnium, Splachnum, Tayloria, Tetraplodon, Timmia, Ulota, Voitia, Zygodon* are described (and illustrated for most of genera). Axillary hair morphology is in agreement with the placement of *Leptobryum* in Meesiaceae, a family close to Splachnaceae. Similarity of axillary hairs in Encalyptaceae and Timmiaceae, as well as in *Mnium* and *Rhizomnium* is outlined.

Резюме

Пазушные волоски 55 видов из родов *Amblyodon, Aplodon, Aulacomnium, Brachymitrion, Breutelia, Bryobrittonia, Bryum, Catoscopium, Encalypta, Funaria, Leptobryum, Meesia, Mnium, Orthodontium, Orthotrichum, Paludells, Philonotis, Plagiomnium, Plagiopus, Pohlia, Pyrrobryum, Rhodobryum, Rhizomnium, Splachnum, Tayloria, Tetraplodon, Timmia, Ulota, Voitia, Zygodon* описаны (и для большинства родов также проиллюстрированы). Строение пазушных волосков свидетельствует в пользу помещения *Leptobryum* в Meesiaceae, которое рассматривается как родственное Splachnaceae. Отмечено сходство пазушных волосков Encalyptaceae и Timmiaceae, а также *Mnium* и *Rhizomnium*.

Recent advances in the analysis of DNA sequence data of mosses brought the evidences that both morphological and molecular data lead to the generally identical classification, at least at the level of families and genera. However, some results of sequence analysis appeared to be unexpected, contradicting the traditional ideas of the relationships of this or that group. Among them the case of *Leptobryum pyriforme* (Hedw.) Wils. is probably the most interesting.

Leptobryum pyriforme is the type species of the the genus, and the only widespread and well-known species of the genus of 2(-6?) species (Crosby, 1999). This species was invariably placed in *Bryum* or *Pohlia* (Hedwig, 1801, and other authors of the first half of XIX centure), later, after segregation in separate genus – near *Bryum* or *Pohlia*, and then within the family Bryaceae (Brotherus, 1924, and all regional floras). Molecular data removed *Leptobryum* from Bryaceae, and put it very definitely in proximity to Meesiaceae, in a rather isolated clade, which includes also Splachnaceae (Hedderson & al., 2000; Cox & al., 2000; Newton & al., 2000; Goffinet & Cox, 2000). Buck & Goffinet (2000) recognized order Splachnales with 3 families: Splachnaceae, Meesiaceae and Catascopiaceae (however without explanation of reasons for the latter family).

Despite of a rather small volume, Meesiaceae are very poor in synapomorphic characters, and comparing its desription (for example, in Crum & Andreson, 1981) with those of Bryaceae, one would hardly find any formal key character for their separation: *Meesia* and *Paludella* have rather thick-walled leaf cells, but in *Amblyodon* cells are thin-walled; *Meesia* and *Amblyodon* exhibit the tendency to reduction of exostome and lack of ciliae, but *Paludella* has rather normal exos-

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tome. *Leptobryum* has rather thin-walled laminal cells and perfect peristome with 3-4 appendiculate ciliae.

So, neither peristome, nor leaf (two main sources of morphological characters in many groups of mosses) are useful to evaluate this new placement of *Leptobryum* from the morphological point of view. In this situation all other characters become more important, even if they are rarely useful at familial level. One of them, the axillary hair' structure, appears to be a good support of relation of *Leptobryum* with both Meesiaceae and Splachnaceae.

Axillary hairs were first used in taxonomy of the generic level by Saito (1975), for classification in Pottiaceae. Buck (1987) found them useful in familial classification of Hookeriales. One of the biggest overviews (200 species) of axillary hair morphology has been done by Hedenaes (1990) for northern (mostly European) pleurocarps. Hedenaes concluded that in taxa he studied the axilary hairs (a) are usually not family-specific; (b) rather homogeneous within one genus, and if not so – might be because of unnaturalness of that genus; (c) the fact of similarity in axillary hairs does not mean that taxa can not be quite unrelated; (d) some species have peculiar axillary hairs highly diagnostic at the species level. No one similar overview has been done for acrocarps. The only family where axillary hairs are useful for intrafamilial classification appear to be Bartramiaceae (Griffin, 1991, 1998; Griffin & Buck, 1989). Discussing Bartramiaceae, Griffin & Buck (1989) overviewed also axillary hairs of Aulacomniaceae, Meesiaceae and Timmiaceae (neighbors of Bartramiaceae in Fleischer-Brotherus' family arrangement). Their comparison revealed (1) Bartramiaceae have 3 main types of axillary hairs, well correlated with other characters of plants and therefore taxonomically useful; (2) Aulacomniaceae have rather generalized pattern of axillary hairs; (3) axillary hairs in Meesiaceae are very peculiar in having only one very long upper hyaline cell, and deeply brick-red other cells; this peculiar pattern allowed to suggest no close relationships between Meesiaceae and Bartramiaceae; (4) Timmiaceae were found very odd in having very long (to 700 μm) filiform axillary hairs, hyaline throughout, a case known in *Bartramia* (thus considered allied with the Timmiaceae).

In the last decade, axillary hairs became one of a standart items of morphological descriptions (at least in special monographic studies), but were not specially reviewed throughout acrocarps. By this reason we added to this study some related or otherwise nearby placed groups of acrocarps with double peristomes, despite the primary aim of this paper was just to point out the similarity of axillary hairs in *Leptobryum* and Meesiaceae.

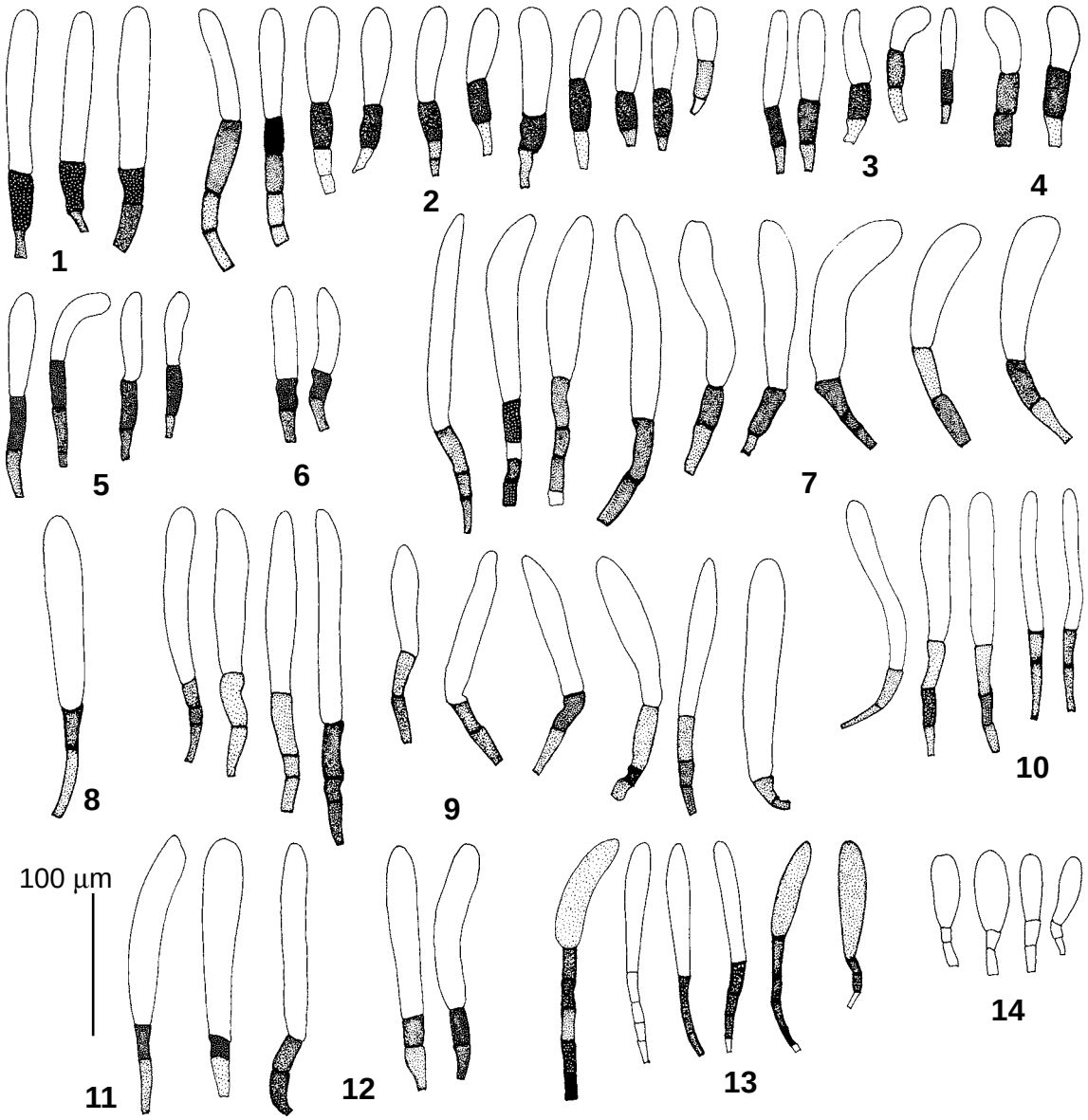
MATERAL AND METHOD

Species, number of studied specimens and of axillary hairs, and character states of the latter are given in the Table 1, and illustrated in Figs. 1-67. The color formula of axillary hairs (in Table 1) is introduced here for the description of color pattern. The deepness of pigmentation is evaluated for each cell in 1 to 6 scale (1 – hyaline; 2 – very light; 3 – light; 4 – moderate; 5 – deep; 6 – very deep), from base to top. List of specimens used for this study is in the Appendix 1.

RESULTS AND DISCUSSION

1. The structure of the axillary hairs described for Meesiaceae by Griffin & Buck (1989) is found also in *Leptobryum*. Their axillary hairs are peculiar in two respects: (1) only one upper cell is hyaline; other cells are colored, and the intensity of pigmentation is commonly increasing upwards, so the second cell from the top is the deepest in color; (2) upper cell is large and slightly to moderately inflated, so the axillary hair has club-like shape. Both these features are observed in *Leptobryum, Meesia, Amblyodon* and *Paludella*, at least in some hairs (Figs. 1-13). Club-like shape is very distinct in Splachnaceae (Figs. 15-28), and in this family *Leptobryum*-like color pattern (second upper cell having deepest pigmentation) is observed in some species of *Tayloria*, *Brachymitrion* and in *Aplodon*; in *Splachnum*, *Tetraplodon* and *Voitia* this pattern is inapparent. Thus, the placement of *Leptobryum* in Meesiaceae is supported by axillary hair morphology; Splachnaceae (at least some genera) also share this pattern of pigmentation of axillary hairs, which support its close to Meesiaceae.

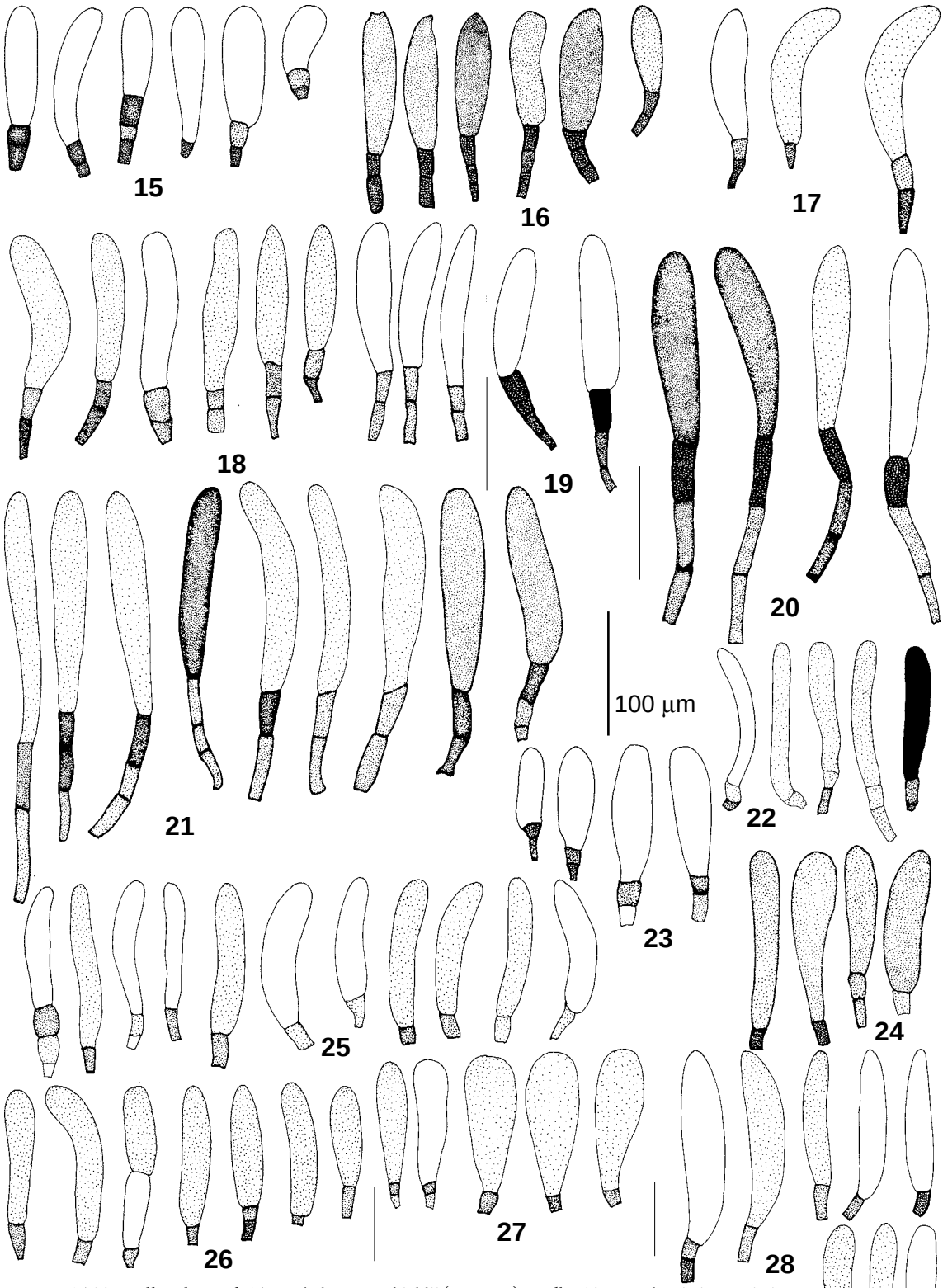
Besides these families, club-like axillary hairs have been observed in *Catascopium* (Fig. 14) and *Funaria* (Figs. 47-48). Few club-like hairs were seen in genera with commonly not club-



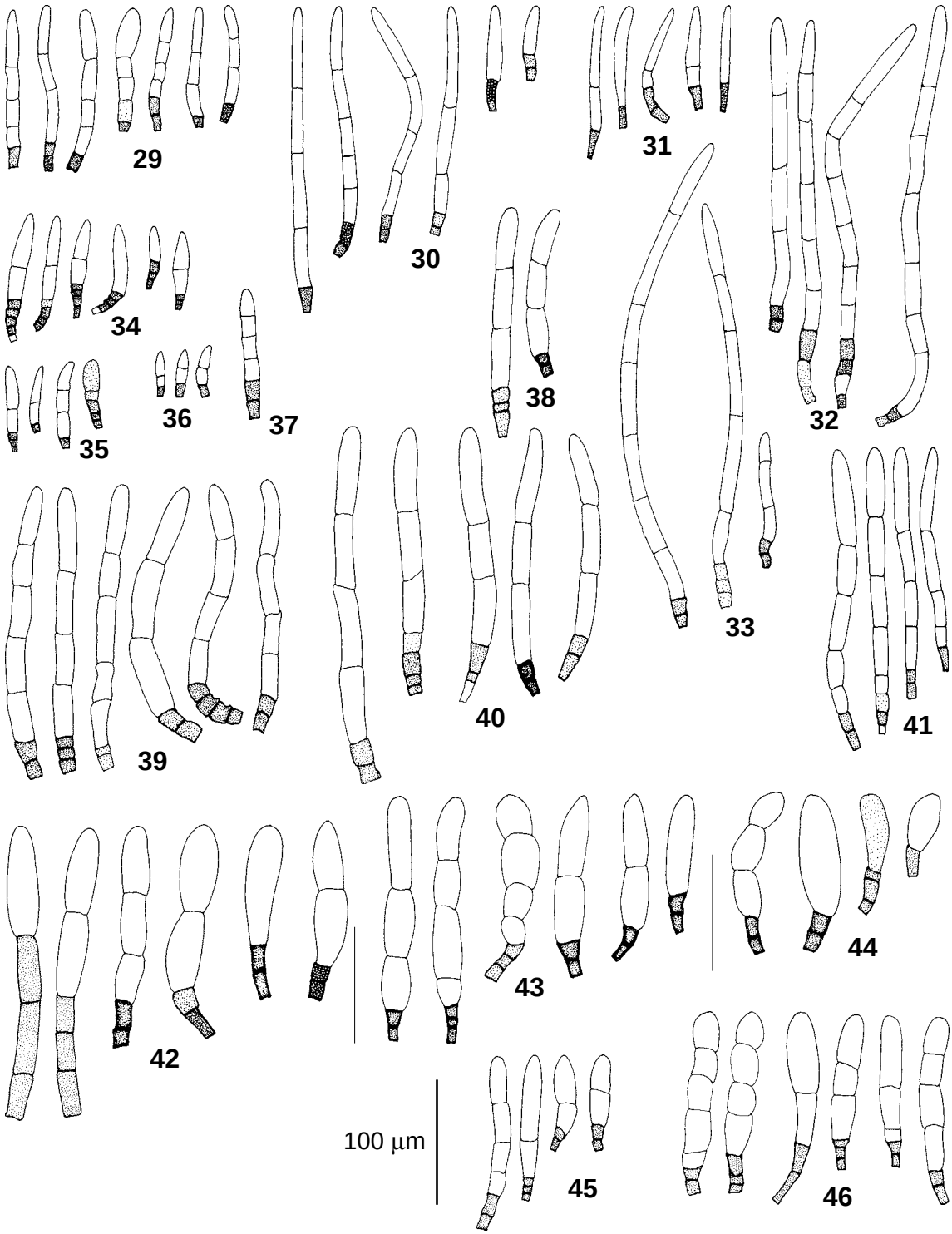
Figs. 1-14: Axillary hairs of: 1-6 – *Leptobryum pyriforme* (Hedw.) Wils.; 7-8 – *Meesia longiseta* Hedw.; 9 – *M. muelleri* C. Muell. et Hampe; 10 – *M. triquetra* (Richter) Aongst.; 11-12 – *Amblyodon dealbatus* (Hedw.) B.S.G.; 13 – *Paludella squarrosa* (Hedw.)Brid.; 14 – *Catascopium nigritum* (Hedw.)Brid.

like hairs: *Rhizomnium* (Figs. 42, 44) and *Mnium* (Fig. 46). The distant position of at least Funariaceae was demonstrated recently in most of studies (Newton & al., 2000; Goffinet & Cox, 2000; Cox & al., 2000). Therefore, we can just conclude, that the club-like shape alone is not a very specific character. Therefore we hesitate to comment the placement of Catoscopiaceae in proximity to Meesiaceae and Splachnaceae (Buck & Goffinet, 2000).

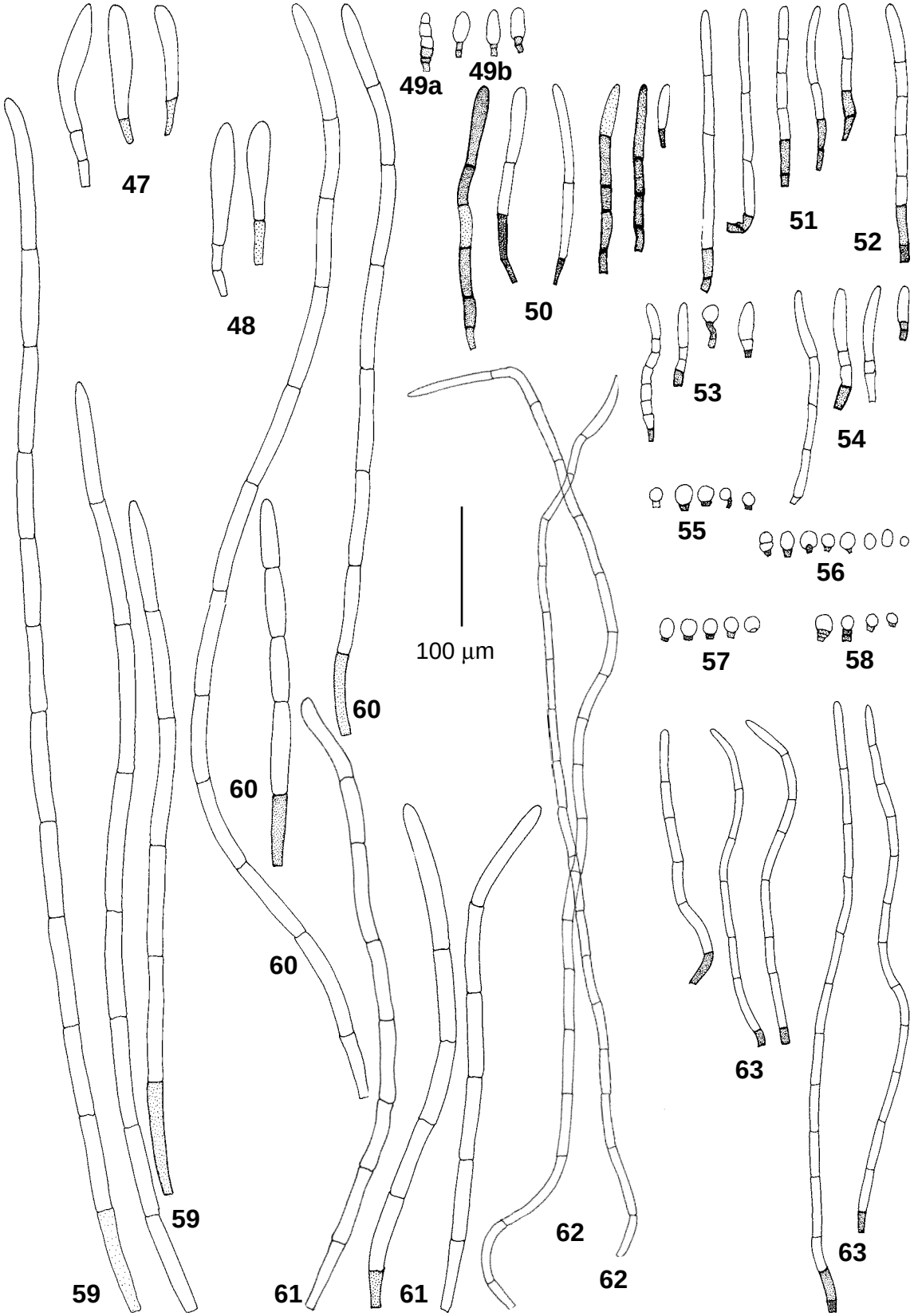
2. In many groups axillary hairs are rather "average", without any sound peculiarities, consisted of 1-2(-3) short colored basal cells and (1-)2-5(-8) longer hyaline cells. This case is known in most of pleurocarps (cf. Hedenaes, 1990). In this study it was observed in *Bryum, Pohlia, Rhodobryum, Pyrrobryum, Plagiomnium, Bartramia, Aulacomnium, Orthotrichum,* and *Ulota*. This character state is obviously plesiomorphic and can be used *pro* or *contra* in tax-



Figs. 15-28: Axillary hairs of: 15 – *Aplodon wormskjoldii* (Hornem.) Kindb.; 16 – *Brachymitrion moritzianum* (C. Muell.) A. Kop.; 17-18 – *Tayloria acuminata* Hornsch.; 19-20 – *T. lingulata* (Dicks.)Lindb.; 21 – *T. froelichiana* (Hedw.) Mitt. ex Broth.; 22 – *Splachnum ampullaceum* Hedw.; 23-24 – *S. luteum* Hedw.; 25 – *Tetraplodon angustatus* (Hedw.) B.S.G.; 26-27 – *T. mnioides* (Hedw.) B.S.G.; 28 – *Voitia nivalis* Hornsch.



Figs. 29-46: Axillary hairs of: 29 – *Bryum cryophilum* O. Mart.; 30 – *B. elegans* Nees ex Brid.; 31 – *B. pallens* Sw.; 32 – *Rhodobryum roseum* (Hedw.) Limpr.; 33 – *Rhodobryum ontariense* (Kindb.) Kindb.; 34 – *Pohlia bulbifera* (Warnst.) Warnst.; 35 – *Pohlia cruda* (Hedw.) Lindb.; 36-37 – *Pohlia melanodon* (Brid.) Shaw; 38 – *Plagiomnium ellipticum* (Brid.) T. Kop.; 39 – *Plagiomnium affine* (Bland.) T. Kop.; 40 – *Plagiomnium cuspidatum* (Hedw.) T. Kop.; 41 – *Pyrrobryum mnioides* (Hook.)Manuel; 42-43 – *Rhizomnium pseudopunctatum* (Bruch et Schimp.) T. Kop.; 44 – *Rhizomnium punctatum* (Hedw.) T. Kop.; 45 – *Mnium stellare* Hedw.; 46 – *Mnium spinulosum* B.S.G.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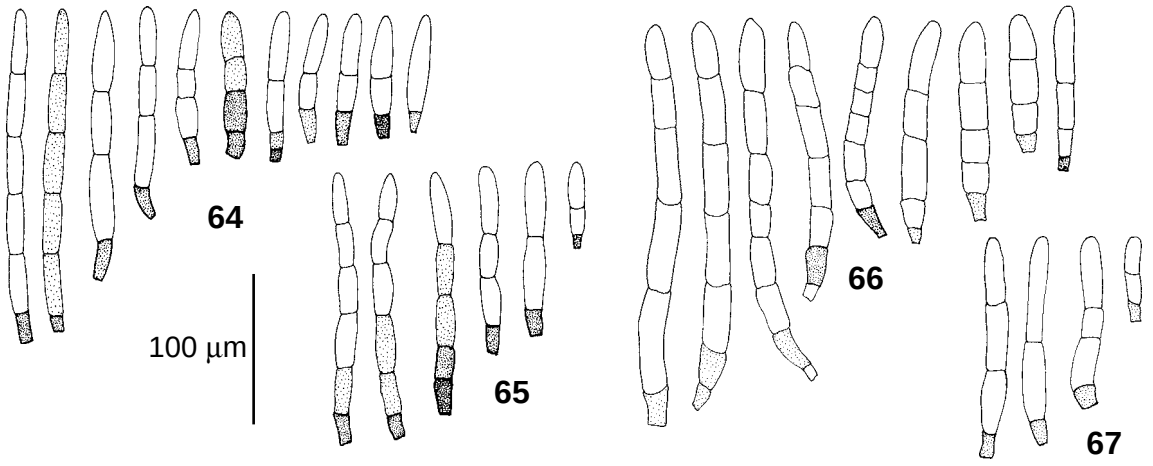

Figs. 64-67: Axillary hairs of: 64 – *Ulota crispa* (Hedw.)Brid.; 65 – *U. curvifolia* (Wahlenb.) Lilj.; 66 – *Orthotrichum speciosum* Nees; 67 – *O. pallens* Bruch ex Brid.

←Figs. 47-63: Axillary hairs of: 47-48 – *Funaria hygrometrica* Hedw.; 49 – *Aulacomnium palustre* (Hedw.) Schwaegr.; 50 – *Plagiopus oederiana* (Sw.) Crum et Anderson; 51-52 – *Bartramia papillata* Hook. f. & Wils.; 53-54 – *B. ithyphylla* Brid.; 55 – *Philonotis fontana* (Hedw.) Brid.; 56 – *P. fontana* (Hedw.)Brid. var. *caespitosa* (Jur.) Schimp.; 57 – *Breutelia affinis* (Hook.) Mitt.; 58 – *B. pendulata* (Sm.) Mitt.; 59 – *Encalypta rhaptocarpa* Schwaegr.; 60 – *E. brevicollis* (B.S.G.) Bruch ex Aongstr.; 61 – *Bryobrittonia longipes* (Mitt.) Horton; 62 – *Timmia bavarica* Hessl.; 63 – *T. austriaca* Hedw.

onomic hypotheses just when it is contrasting with other states of the character.

3. Mniaceae s. l. This family was for a long time very constant in volume, until Koponen (1988) tought its relationships with mostly tropical and subtropical Rhizogoniaceae, concluding that *Mnium* and *Pyrrhobryum* are more close to each other than (1) *Mnium* to *Plagiomnium* and *Rhizomnium*; (2) *Pyrrhobryum* to *Rhizogonium*. This situation was resolved by Koponen (l. c.) in resurrecting of the family Cinclidiaceae Kindb. (for *Cinclidium, Rhizomnium* and *Cyrtomnium*) and in description of a new family Plagiomniaceae (for *Plagiomnium*, *Orthomnium* and *Pseudobryum*). In this study we found that upper hyaline cells are unusually short and broad in *Rhizomnium* ssp. and some species of *Mnium* (*M. spinulosum* and *M. marginatum,* cf. Figs. 43-44, 46), so they are more similar to each other, than to *Plagiomnium* and *Pyrrobryum* (which have unspecialized type of axillary hairs). It is probable, that the study of axillary hairs in all species of this group could be helpful for its taxonomy.

4. Bartramiaceae exhibits a great variety in axillary hair structure, and this study can just support the conclusions of Griffin (1991, 1998) and Griffin & Buck (1989) about the importance of their usage in infrafamiliar classification of this family.

5. Timmiaceae and Encalyptaceae are very unusual in having very long axillary hairs, 6-19 cells long (Figs. 59-63), exceeding 1 mm. Horton (1982) reported axillary hairs to 2 mm long in *Bryobrittonia longipes* (Mitt.) Horton and *Encalypta affinis* Hedw. f.

Recent studies changed the position of Timmiaceae greatly, placing this familiy to basal position, in proximity to Funariacaeae and Encalyptaceae, but the more close similarity was found between Timmiaceae and Funariaceae (Newton & al., 2000; Cox & al., 2000), than to Encalyptaceae, or between Funariceae and Encalyptaceae (Goffinet & Cox, 2000), than to Timmiaceae. According to axillary hair morphology, Timmiaceae is much more similar to Encalyptaceae. Note also that *Bryobrittonia,* the second genus of the Encalyptaceae, is quite similar to species of *Timmia* in leaf morphology, as well as in habitat preferences.

AKNOWLEDGEMENTS

This study was partly suported by Russian Foundation of Basic Reseraches, 99-04-48194 and 01-04-06395.

Table. 1. Characteristics of axillary hairs of some acrocarpous species with double peristome

Species	number of hairs/specimens studied	number of cells per hair	axillary hair length, µm	upper cell length, µm	width of upper cell, µm	width of second cell µm	Color pattern (see text for explanation) in parenthesis – number of hair with this pattern
MEESIACEAE							
Amblyodon dealbatus	21/2	(2)3-4(5)	163-238	(108)125-138(175)	16-25	(9)11(13)	44441(2), 5442(1), 4441(1), 552(3), 452(3), 442(1), 551(7), 441(1), 541(1), 51(1)
Leptobryum pyriforme	76/12	3-4(5)	(83)100-125(176)	(33)50-63(105)	15-25	7-13(15)	33461(1), 3351(1), 2251(1), 3341(1), 3451(1), 2351(1), 2451(1), 4541(1), 4451(3), 4551(1), 1341(1), 2341(3), 351(31), 341(3), 131(1), 251(10), 451(10), 551(1), 331(1), 441(1), 241(1), 141(1)
Meesia longiseta	17/2	3(4)(5)	160-200	87-125	(18)23-28	13(15)	54151(1), 4441(1), 341(10), 441(3), 431(2)
Meesia muelleri	7/1	3(4)	175	100-125	15-23(25)	10-13(15)	3431(1), 331(5), 341(1)
Meesia triquetra	19/2	3(4)(5)	(138)162-193	(88)100-125	10-18	10-13(15)	34431(1), 3341(1), 3331(1), 341(6), 331(7), 351(1), 421(1), 441(1), 666661(1),
Paludella squarrosa	41/2	(3)4-5(6)	(113)138-175(225)	(70)75-100(168)	11-19	8-11(13)	164443(3), 15551(2), 55543(1), 16543(1), 65443(1), 16443(1), 14542(1), 15442(1), 55551(1), 65551(1), 66551(1), 66662(2), 64432(1), 44541(1), 6663(2), 6643(1), 6642(2), 5542(1), 5442(1), 1643(1), 1454(1), 4446(1), 6542(1), 5552(1), 5664(1), 4442(1), 554(1), 6661(6), 662(1)
SPLACHNACEAE							
Aplodon wormskjoldii	37/2	2-3(5)	(75)100-150(170)	55-133	23-35	10-23	44441(2), 4441(2), 4341(1), 441(15), 41(14), 31(3)
Brachymitrion moritiana	20/1	(2)3-4(5)	100-138(150)	63-113	25-38	(8)11(14)	34443(1), 5554(1), 4353(1), 4443(1), 554(6), 454(4), 444(2), 443(2),54(1), 44(1)
Splachnum ampullaceum	15/2	2(3)	(115)118-150(175)	88-125(135)	13-20	10-13(18)	221(1), 431(1), 31(2), 32(2), 11(1), 12(2), 21(3), 41(3)
Splachnum luteum	15/2	2-3	(38)125(150)	(26)68(125)	(20)25-33	(10)13-15	333(1), 333(1), 432(1), 341(1), 231(1), 43(2), 34(1), 23(2), 32(5)
Tayloria acuminata	28/2	2-3	(125)162-175(225)	(75)100-125(205)	23-30	(8)10-15	342(1), 442(1), 322(4), 432(3), 232(2), 332(6), 331(3), 333(1), 32(4), 42(3)
Tayloria froelichiana	39/2	(2)3-4(5)	(168)218-275(295)	120-143(205)	20-30(35)	10-15	33334(1), 43332(1), 3342(5), 3334(5), 5332(1), 3332(1), 4332(2), 4343(1), 3343(1), 233(2), 442(1), 232(4), 332(1), 334(1), 343(2), 342(10)
Tayloria lingulata	25/2	3-4	(200)-250-(263)	112-150-(160)	(26)30(36)	11-14(18)	4454(1), 3351(5), 3451(1), 3341(2), 4452(4), 4451(1), 4461(1), 454(6), 441(1), 331(1), 351(1), 455(1)
Tetraplodon angustatum	13/2	2(3)	100-112(175)	(68)88-98(135)	(13)19-29	10-13	121(1), 331(1), 341(1), 332(1), 22(2), 11(1), 21(2), 31(4)
Tetraplodon mnioides	25/2	2(3)	(95)100-128(138)	(68)88-112(120)	21-=15(43)	10-13	232(1), 231(1), 432(1), 121(1), 32(17), 31(4)
Voitia nivalis	29/2	2-3	112-183	75-150	20-23(33)	10(13)	431(2), 331(4), 322(1), 232(7), 332(3), 21(4), 31(5), 22(1), 32(2)
FUNARIACEAE							
Funaria hygrometrica	15/2	2(3)	95-125	(35)75-93(98)	13-20	6-9	111(1), 11(7), 22(7)
CATASCOPIACEAE							
Catascopium nigritum	19/2	(2)3	63-88	38-55	16-25	7-8(9)	111(15), 11(4)
BRYACEAE							
Bryum argenteum	11/2	2/3	(38)50-65(95)	(23)38-45(68)	6-8(9)	(6)8(10)	221(2), 121(1), 211(2), 311(1), 21(4),31(1)
Bryum cryophilum	19/2	3-7	(75)100-125	(25)38-43(75)	8-11(16)	(6)10-13	3311111(1), 331111(3), 431111(1), 33111(5), 31111(2), 3211(1), 3111(3), 2111(1), 111(1), 221(1)

Table. 1. Characteristics of axillary hairs of some acrocarpous species with double peristome (continue)

Bryum elegans	30/2	(2)4-7	(58)125-188(250)	25-50	(6)10(13)	(9)10-16	3311111(1), 331111(5), 31111(5), 33111(1), 23111(1), 3111(11), 3321(1), 4111(1), 3311(1), 331(3)
Bryum pallens	20/2	2-3(4)	75-138	(38)50-75	6-11	(6)8-9(10)	2311(1), 211(1), 311(8), 231(1), 321(1), 31(6), 41(2)
Bryum pseudotriquetrum	15/2	4-6	(88)113-150(163)	25-50(68)	8-9(10)	(8)9-10(11)	331111(3); 31111(1), 33111(6),43111(1), 33311(1), 3311(2), 3111(1)
Orthodontium gracile	1/1	3	100	33	25	11	311(1)
Orthodontium lineare	1/1	4	163	88	23	10	3211(1)
Pohlia bulbifera	13/2	(3)4-6(7)	(28)63-75(93)	(15)30-43(45)	9-11(13)	(5)8(10)	4333311(1), 133311(1), 333311(3), 13331(1), 33331(1), 33111(1), 3331(3), 3311(1), 331(1)
Pohlia cruda	12/2	(3)4-5	(38)50-63	18-28	6-13	(8)10(11)	33311(3), 1311(1), 2211(1), 3311(4), 3331(1), 4411(1), 131(1)
Pohlia melanodon	12/2	2-5(6)	(18)30-75	(10)18-25(35)	8-10	(6)8-10	331111(1), 31111(1), 33311(1), 3211(1), 2211(1), 331(4), 31(1), 11(2)
Rhodobryum ontariense	9/2	(5)6-8(12)	163-230	(28)38-58(65)	8-13	(8)10-13	333311111111(1), 33311111(2), 3311111(2), 1221111(1), 221111(1), 311111(1), 11111(1)
Rhodobryum roseum	13/2	6-10	225-343	50-55(75)	11-13	9-10	4143111111(1), 231111111(1), 331111111(2), 33111111(2), 3311111(3), 311111(1), 331111(3)
MNIACEAE							
Plagiomnium affine	19/2	5-7(8)	(163)175-263	50-75	13-18	13-20	33311111(1), 3331111(1), 3311111(1), 1331111(1), 311111(1), 333111(6), 331111(2), 321111(1), 33111(5)
Plagiomnium cuspidatum	16/	5-6(7)	175-225	38-75	15-20	(13)15-20	2331111(1), 3311111(1), 333111(3), 243111(1), 331111(1), 33111(9)
Plagiomnium ellipticum	14/2	5-6	175-200	38-55(65)	15-20	(15)18-20	331111(2), 333111(2), 33111(10)
Rhizomnium punctatum	9/2	3-6	55-185	(35)50-75(92)	20-33	(6)10(20)	222111(1), 44111(1), 3331(1), 3311(1), 331(2), 431(1), 441(1), 21(1)
R. pseudopunctatum	21/2	(3)4-5(6)	(113)125-188	(43)45-93	(18)21-29	(10)18-25	444411(1), 44111(2), 33311(1), 3311(2), 5511(8), 4111(2), 4411(4), 331(1)
Mnium lycopodioides	11/2	(4)5-7(8)	(108)150-200	(15)25-50(65)	10-23	(10)14-24	33321111(1), 2221111(1), 3111111(1), 311111(2), 33111(4), 44111(1), 3311(1)
Mnium marginatum	11/2	(4)5-7(8)	163-233	25-50(60)	11-16	11-13(19)	3311111111(1), 33111111(1), 3311111(2), 331111(3), 211111(1), 33111(1), 3322291), 3311(1)
Mnium spinulosum	33/2	(4)5-7(12)	(100)125-175(225)	25-50(63)	18-24	15-18(25)	333111111111(1), 33333111111(3), 4444411111(1), 331111111(2), 33311111(2), 4444111(1), 3331111(2), 3333111(1), 3311111(4), 331111(8), 343111(1), 333111(1), 33111(5), 3311(1)
Mnium stellare	15/2	(5)6-7(9)	(1000)125-150(163)	(18)20-35(38)	13-18	11-13	4441111111(1), 332211111(1), 33311111(1), 4441111(1), 3311111(3)
Pyrrobryum mnioides	32/2	(4)5-7(10)	(68)125-250(300)	25-50(70)	11-15	(8)9-11	3222111111(1), 2111111(2), 3311111(2), 1321111(1), 211111(2), 221111(3), 332111(1), 321111(1), 231111(1), 11111(2), 31111(3), 21111(4), 22111(4), 32111(2),33111(1),2211(1),3111(1),3321111(1), 331111(4), 431111(1), 33111(2)
AULACOMNIACEAE							
Aulacomnium palustre	7/2	(2)3-4	35-50	(13)20-23(25)	(6)10-13	6-8	3111(2), 331(3), 311(1), 31(1)

Table. 1. Characteristics of axillary hairs of some acrocarpous species with double peristome (end)

BARTRAMIACEAE							
Bartramia ithyphylla	19/2	(2)3-7	(53)70-158(175)	(20)43-63(83)	8-11(13)	5-10(11)	1111111(1), 4311111(1), 311111(1), 111111(1), 11111(2), 34111(1), 1111(2), 3111(5), 111(3), 311(1), 31(1)
Bartramia papillata	12/2	(3)4-6(11)	100-225(308)	(43)50(60)	8-9(10)	5-8(15)	33311111111(1), 33111111(2), 3331111(1), 331111(1), 333111(1), 33111(2), 3311(3), 321(1)
Breutelia affinis	22/2	1-2(3)	(8)13-15(25)	10-13(15)	13	5-8	321(1), 31(3), 21(2), 41(2), 11(2), 4(2), 1(11)
Breutelia pendulata	18/2	1-3	10-15(25)	8-13	9-15	5-8	331(1), 311(2), 221(3), 111(1), 121(1), 31(1), 21(4), 11(2), 1(3)
Philonotis fontana	26/	1-2	10-15(18)	10-13(15)	8-15	5-8	31(6), 41(11), 1(9)
P. fontana var. *caespitosa*	22/2	1-2	13-15(25)	(8)10-13(15)	9-15	5-8(10)	22(1), 42(1), 41(1), 31(4), 11(1), 1(14)
Plagiopus oederiana	18/2	2-6	(20)100-163(263)	(20)63(108)	8-13	(5)8-13(20)	333332(1), 33111(1), 3211(1), 3232(1), 3333(1), 3311(3), 111(1) 411(3), 211(2), 441(1), 41(3)
ORTHOTRICHACEAE							
Orthotrichum pallens	18/2	3-4(7)	(68)75-150(225)	28-63	10-13	(8)9-15	3311111(1), 331111(1), 31111(3), 3111(4), 2111(1), 3311(2), 3331(1), 311(5)
Orthotrichum speciosum	33/2	(3)4-7(8)	(88)100-250	25-50(68)	13-18	10-15(20)	31111111(1), 1211111(2), 1111111(4), 2111111(1), 321111(1), 221111(2), 431111(1), 111111(1), 311111(2), 22111(3), 31111(1), 41111(3), 1111(2), 2111(5), 2211(2), 111(1)
Ulota crispa	25/2	2-6	50-193	(18)25-55(70)	8-13(15)	8-13	321111(1), 311111(1), 322222(1), 3211(2), 3111(3), 3221(2), 3322(1), 2111(1), 311(3), 431(2), 321(1), 21(1), 43(2), 31(4)
Ulota curvifolia	17/2	2-6	38-200	(18)25-63	8-13	8-13	311111(1), 431111(1), 32211(1), 33311(1), 31111(5), 43333(1) 31131(1), 4111(1), 3111(1), 3211(1), 331(1), 321(1), 21(1)
Zygodon sibiricus	9/3	2-3	40-125	25-63	8-13	8-13	311(5), 31(4)
Zygodon viridissimus	1/1	2	55	38	8	9	31(1)
ENCALYPTACEAE							
Bryobrittonia longipes	19/2	5-11(12)	(275)400-750(900)	(50)75-100(125)	14-16	11-16(20)	31111111111(1), 11111111111(3), 31111111111(1), 22111111111(1), 11111111111(1), 211111111(1), 3311111(1), 1111111(2), 3111111(1), 1111111(1), 311111(1), 111111(2), 211111(1), 11111(2)
Encalypta brevicollis	16/2	(5)8-12(18)	(300)600-900	(45)100-110	13-14	10-15	1111111111111111111(1), 111111111111(1), 11111111111(3), 1111111111(1), 31111111111(1), 1111111111(1), 111111111(1), 11111111(2), 31111111(1), 1111111(1), 211111(1), 41111(1), 31111(1)
Encalypta rhaptocarpa	15/2	(6)11-12	(560)800(1150)	(70)80-130	13-14	15	11111111111(3), 21111111111(1), 2111111111(1), 1111111111(3), 111111111(1), 11111111(1), 1111111(2), 111111(1), 311111(1)
TIMMIACEAE							
Timmia austriaca	18/2	5-13	225-625	(38)50-93	5-10	8-10	3211133333311(1), 3311111111111(2), 221112211(1), 322222211(1), 33222222(1), 32111111(1), 31111111(2), 1114311(1), 311112(1), 221111(1), 333333(1), 333222(1), 311111(1), 32111(2), 21111(1)
Timmia bavarica	22/2	9-21	468-1008	(43)50-103	8-10	(8)9-11	11111111111111111111(1), 111111111111111111(2), 11111111111111111(1), 3111111111111111(1), 1111111111111111(4), 222222222222222222(1), 222222222(1) 111111111111111(3), 31111111111111(2), 1111111111111(1), 3111111111111111(1), 222222222222222(1), 1111111111111(1), 11111111111111(1), 22222222222222(1)

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APPENDIX

(number in parenthesis correspond to figure number; all specimens in MHA)

Amblyodon dealbatus (Hedw.) B.S.G. – (12) Arkhangelsk Prov., Ignatov, 4.VIII.1988; (11) Altai, Ignatov, #33/19.

Aplodon wormskjoldii (Hornem.) Kindb. – (15) Taimyr, Bardunov & Ververchyuk, 3.VIII.1988; West Spitsbergen, Godzik & Grodzinska, 2.VI.1985.

Aulacomnium palustre (Hedw.) Schwaegr. – (49a) S-W Yakutiya, Krivoshapkin, 22.VII.1995; (49b) Moscow Prov., Ignatov, 22.IX.1987.

Bartramia ityphylla Brid. – (53) Khabarovsk Prov., Ignatov #97-1050; (54) N. Caucasus, Ignatova, 8.VIII.1986.

Bartramia papillata Hook. f. & Wils. – (51) Victoria, Streimann 53377; (52) New South Weles, Streimann 51005;

Brachymitrion moritziannum (C. Muell.) A. Kop. – (16) Costa Rica, Crosby, 25.IV.1975.

Breutelia affinis (Hook.) Mitt. – (57) New South Weles, Streimann 61580; New South Weles, Streimann 37862.

Breutelia pendulata (Sm.) Mitt. – (58) Tasmania, Streimann 59515; Tasmania, Streimann 47700.

Bryobrittonia longipes (Mitt.) Horton – (61) Komi, Korchagin, 2.IX.1934; Altai, Ignatov #18/30;

Bryum argenteum Hedw. – Moscow Prov., Ignatov, 18.VI.1996; Moscow Prov., Ignatov, 4.VI.1986;

Bryum cryophilum O. Mart. – (29) Khabarovsk Prov., Iwatsuki 60505; West Spitzbergen, Godzik & Grodzinska, 28.VI.1985.

Bryum elegans Nees ex Brid – (30) Nizhnij Novgorod Prov., Popov, 31.V.1998; Altai, Ignatov #8/148.

Bryum pallens Sw. – (31) Altai, Ignatov #0/85; Moscow Prov., Ignatov, 3.VIII.1996.

Bryum pseudotriquetrum (Hedw.) Gaertn. et al. – Moscow Prov., Ignatov, 15.VI.1984; Moscow Prov., Ignatov, 23.VI.1987.

Catascopium nigritum (Hedw.) Brid. – (14) Arkhangelsk Prov., Ignatov, 5.VIII.1988; Yakutiya, Ivanova, 28.VII.1991;

Encalypta brevicollis (B.S.G.) Bruch ex Aongstr. – (60) Khabarovsk Prov., Ignatov #97-1230; Altai, Ignatov #32/22.

Encalypta rhaptocarpa Schwaegr. – (59) Estonia, Kannukene #19705; Taimyr, Matveeva #321;

Funaria hygrometrica Hedw. – (47) Khabarovsk Prov., Ignatov #97-930; (48) Nizhnij Novgorod Prov., Ignatov, 15.IX.1999;

Leptobryum pyriforme (Hedw.) Wils. – (1) Moscow Prov., Ignatov, 7.VII.1998; Kursk Prov, Ignatov, 20.V.1999; (2) Murmansk Prov., Lihachyov, 23.VIII.1994; (3) Xinijang Prov., Tan 93-1132; South Australia, Streimann 54871; (4) British Columbia, Vitt 35951; (5) Taimyr, Kannukene #4499; (6) Altai, Ignatov #36/163; Moscow Prov., Ignatov, 7.VII.1998; Moscow Prov., Ignatov, 8.VII.1996; Moscow Prov., Ignatov, 26.V.1982; Moscow Prov., Ignatov, 9.VI.1986.

Meesia longiseta Hedw. – (7) Georgia, Abramov & Abramova, 14.IX.1956; (8) Colombia, Aguirre & Gradstein 6567.

Meesia muelleri C. Muell. et Hampe – (9) Australia, Streimann 53241.

Meesia triquetra (Richter) Aongstr. – (10) Yakutija, Protopopov & Ivanova, 2.VII.1991; Altai, Ignatov #36/130.

Mnium lucopodioides Schwaegr. – North Caucasus, Ignatova, 12.VIII.1986; Yakutiya, Ivanova, 24.VII.1995.

Mnium marginatum (With.) P. Beauv. – Yakutiya, Ivanova & Stepanova, 25.VI.1993; Bashkortostan, Solometch, 23.VIII.1988.

Mnium spinulosum B.S.G. – (46) Perm Prov., Bezgodov #527; Caucasus, Onipchenko, 1.VII.1998.

Mnium stellare Hedw. – (45) Altai, Ignatov #24/113; Moscow Prov., Ignatov, 16.VI.1988.

Orthodontium gracile Schwaegr. ex B.S.G. – Tanzania, Pocs, Ochyra & Bednarek-Ochyra 88150/13.

Orthodontium lineare Schwaegr. – West Pomerania, Piotrowska, 25.VI.1987.

Orthotrichum pallens Bruch ex Brid. – (67) Kursk Prov., Zolotov, 23.VI.1999; Volgograd Prov., Suragina & Tsibina, 6.VI.1992.

Orthotrichum speciosum Nees – Kursk Prov, Ignatov, 13.VIII.1996; (66) Pskov Prov., Zolotov, 10.IX.2000.

Paludella squarrosa (Hedw.)Brid. – (13) Murmansk Prov., Ignatov, 4.VIII.1998; Tyumen Prov., Onipchenco, 24.VII.1987.

Philonotis fontana (Hedw.)Brid. – (55) Stavropol Prov., Onipchenko #359; Khabarovsk Prov., Ignatov #97-799.

Philonotis fontana (Hedw.)Brid. var. *caespitosa* (Jur.) Schimp. – (56) Bashkortostan, Grigor`jev, 6.VIII.1989; Stavropol Prov., Ignatova, 10.VIII.1986.

Plagiomnium affine (Bland.) T. Kop. – (39) Moscow Prov., Ignatov, 3.VIII.1996; Nizhnij Novgorod Prov., Ignatov, 18.IX.1999.

Plagiomnium cuspidatum (Hedw.) T. Kop. – (40) Altai, Ignatov #9/90; Altai, Ignatov #25/14.

Plagiomnium ellipticum (Brid.) T. Kop. – Arkhaggelsk Prov., Ignatov, 4.VIII.1988; (38) Moscow Prov., Ignatov, 16.VI.1986.

Plagiopus oederiana (Sw.) Crum et Anderson – (50) Khabarovsk Prov., Ignatov #97-727; Perm Prov., Bezgodov #158.

Pohlia bulbifera (Warnst.) Warnst. – (34) Tyumen Prov. Bezgodov. #87; Nizhnij Novgorod Prov., Ignatov, 14.IX.1999.

Pohlia cruda (Hedw.) Lindb. – (35) Khabarovsk Prov., Ignatov #97-596; Karelia, Bakalin & Bakalina, 18.IV.1997.

Pohlia melanodon (Brid.) Shaw – (36) Estonia, Kannukene #20401; (37) Altai, Ignatov #0/1304.

Pyrrobryum mnioides (Hook.)Manuel – (41) Victoria, Streimann 58591; South Island, Streimann 51372.

Rhizomnium pseudopunctatum (Bruch et Schimp.) T. Kop. – (42) Altai, Ignatov #0/171; (43)Arkhangelsk Prov., Ignatov, 8.VIII.1988.

Rhizomnium punctatum (Hedw.) T. Kop. – (44) Altai, Ignatov #17/107; Kaluga Prov., Bochkin, 17.IX.1987.

Rhodobryum ontariense (Kindb.) Kindb. – Bashkortostan, Shevyrjova & Konovalova, 10.VIII.1994; (33) Altai, Ignatov & Ignatova #34/183.

Rhodobryum roseum (Hedw.) Limpr. (32) – Ryazan Prov., Ignatov, 29.IX.1999; Khabarovsk Prov., Ignatov #97-509.

Splachnum ampullaceum Hedw. – Basegi, Bezgodov, 6.VI.1994; (22) Chita Prov., Blohina, 5.VI.1958.

Splachnum luteum Hedw. – (23) Magadan Prov., Vaculenko #96; (24) Altai, Ignatov #36/91.

Tayloria acuminata Hornsch. – (18) Altai, Ignatov #31/107; (17) Altai, Ignatov #31/106.

Tayloria froelichiana (Hedw.) Mitt. ex Broth. – (21) Altai, Ignatov #31/111; Altai, Ignatov #31/113.

Tayloria lingulata (Dicks.)Lindb. – (20) Altai, Ignatov #0/1174; (19) Murmansk Prov., 11.VIII.1991.

Tetraplodon angustatus (Hedw.) B.S.G. – Murmansk, Ignatov, 5.VIII.1998; Altai, Ignatov #0/1169; (25) Bashkortostan, Ignatova #2/122.

Tetraplodon mnioides (Hedw.) B.S.G. – (27) Khabarovsk Prov., Ignatov #97-903; (26) Arkhangelsk Prov., Ignatov, 8.IX.1988.

Timmia austriaca Hedw. – Altai, Ignatov, 21.VII.1993; (63) Tajmyr, Pospelova, 25,VIII.1988.

Timmia megapolitana var. *bavarica* (Hessl.) Brid. – (62) Adzharia, Abramov, 16.IX.1961; Altai, Ignatov & Ignatova #28/98.

Ulota crispa (Hedw.) Brid. – (64) Moscow Prov., Ignatov, 7.VII.1998; Altai, Ignatov #18/38.

Ulota curvifolia (Wahlenb.) Lilj. – (65) Khabarovsk Prov., Ignatov #97-20; Magadan Prov., Blagodatskih, 24.VIII.1976.

Voitia nivalis Hornsch. – (28) Altai, Ignatov #30/35; Altai, Ignatov #0/2088.

Zygodon sibiricus Ignatov & al. – Khabarovsk Prov., Ignatov #97-1270; Khabarovsk Prov., Ignatov #97-1258; Altai, Ignatov #1/82.

Zygodon viridissimus (Dicks.) Brid. – Hohduras, Allen 12280.