BRYOPHYTES OF ALTAI MOUNTAINS. IV.
THE FAMILY GRIMMIACEAE (MUSCI)
МОХООБРАЗНЫЕ АЛТАЙ. IV.
СЕМЕЙСТВО GRIMMIACEAE (MUSCI)

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Abstract

Fifteen species of Grimma, 5 of Schistidium, 5 of Racomitrium, and 1 of Coscinodon, Hydrogrimmia, Indusiella, and Jaffueliobryum are reported for Altai. Brief descriptions, illustration, keys for identification, distinguishing characters and comments on species distribution are provided for all species. Seven species and two genera, Hydrogrimmia and Indusiella, are reported as new for Altai.

Резюме

Пятнадцать видов рода Grimma, 5 Schistidium, 5 Racomitrium и по одному из родов Coscinodon, Hydrogrimmia, Indusiella и Jaffueliobryum выявлены в бриофлоре Алтая. Для всех видов приведены краткие описания, иллюстрации, ключи для определения, диагностические признаки и заметки об их распространении и экологической приуроченности. Семь видов и два рода, Hydrogrimmia и Indusiella указываются для Алтая впервые.

INTRODUCTION

This article belongs to a series of treatments of the bryoflora of Altai which started in this issue of Arctoa. As we intend, the series will describe, illustrate and discuss all the bryophyte groups present in the study area. For detailed information about the natural history of Altai, the history of its bryological investigation, as well as for an explanation of the specimen citation, please see the introductory part by Ignatov in this issue.

B. A. Keller (1914) reported 2 species of Grimma in Altai Mts., P. N. Krylov (1925) - 17 species, now referable to the genera Grimma, Schistidium, Racomitrium, Coscinodon, Jaffueliobryum, and L. V. Bardunov (1974) - 22 species of the same genera.

Between 1989 - 1993 the senior author collected in Altai a lot of specimens. In addition, he received abundant collections of bryophytes from the Altaian State Reserve, made mostly by N. I. Zolotukhin. These materials and also a revision of other collections in herbariums allow the present additions of two genera, Hydrogrimmia and Indusiella, and 7 species of Grimmiaceae new to Altai.

In recent years both Grimma and Schistidium (Deguchi, 1979a; Cao Tong & Vitt, 1986), Jaffueliobryum (Churchill, 1987) and Racomitrium (Frisvoll, 1983, 1988) were carefully taxonomically revised. The purpose of this paper is to concentrate mainly on the variability of some species observed in Altai, to provide data on their ecology and distribution in Altai, as well as to discuss some neglected and underestimated taxonomic characters.

GRIMMIACEAE (description based on Altaian representatives)

Plants small to robust, in dull, dark cushions, tufts or mats, typically becoming black with age, especially in lower parts of plants. Stems erect to ascending, rare prostrate, forked or fasciculately branched, with rhizoids mostly only at base. Leaves spirally arranged, more or less erect when dry, rarely crisped, fastly reflexing when wetting, but soon afterward becoming less reflexed, spreading, lanceolate, rare to ovate, usually entire, with plane or recurved, rare incurved margins, keeled or rarer concave, with more or less developed hyaline hair-point. Costa
Plants, growing in cold to temperate climates. Many are well adapted to xeric conditions. Most of Altaian species have wide Holarctic or nearly worldwide distribution.

Key to the Altaian genera of Grimmiaceae

1. Plants very small, rigid, dull-brown; leaves with sheathing base and strongly inrolled upper margins, muticous; capsule exserted
   ....... Indusiella (p. 68)  

   1. Plants otherwise

2. Calyptra large, campanulate to mitriform, longitudinally plicate; capsule deeply immersed; peristome cribrose to strongly cribrose; small plants

3. Plants in dense whitish cushions; leaves broadly ovate to suborbicular, with a hyaline margin of several rows of thin-walled cells in upper part; calyptrae covering most of the urn
   ....... Jaffueliobryum (p. 70)  

4. Plants soft, leaf laxly areolated, upper leaf cells ca.20 μm

5. Basal cells long linear with nodulose lateral walls; usually robust plants with numerous abbreviated branches

6. Opercula falling with the attached columella; calyptra covering only a part of operculum; capsule immersed, rare emergent (S. agassizii); leaves mostly ovate to ovate-lanceolate, with quadrate cells reaching the base along leaf margins

Indusiella Broth. et C. Muell. in Broth.

Indusiella thianschanica Broth. et C. Muell. in Broth., Bot. Centralbl. 75: 322. 1898. Fig. 1.  
Stem up to 5 mm high, with a sharply differentiated cortical region of 2 layers of transversely rectangular cells. Leaves 1.0 mm long. Upper lamina cells dimorphous: cells on abaxial (dorsal) side 10-12 μm, while those on adaxial (ventral) side larger, 18 μm wide in median part, ca. 12 μm towards the margin. Basal cells at margin quadrate to very short-rectangular (1.5:1). Cells in paracostal area wider but of the same length and therefore, transversely rectangular. In uppermost and perichaetial leaves basal cells short-rectangular (2.1). Autoicous. Seta straight, ca.
Fig. 1. *Indusella thianschanica* Broth. et C. Muell. in Broth. (from Tabozhok Creek, 8 km upstream 2100 m Ignatov 30/24): 1 - peristome teeth; 2 - capsules; 3 - archegonia; 4 - leaf cross sections; 5 - leaves; 6 - cells of leaf base. Scale bars: 2 mm - for 2; 1 mm - for 5; 100 μm - for 1, 4, 6; 30 μm - for 3.
1 mm long. Capsula 0.7 mm long, exothecial cells below the mouth transversely elongated, variously irregular below. Peristome teeth reddish, lanceolate, 0.15 mm tall. Spores 9-12 μm, yellow-brown, more or less granulate.

The peculiar inrolled leaves make *Indusiella thianschanica* an unmistakable moss. Other useful recognizing features in the field include: 1) very small plants in dense dull-brown tufts; 2) calyptra totally covering the capsules, deeply plicate; 3) sporogones (both calyptra and capsule) are very small (smaller, probably, than in any other Altaian mosses), slightly exerted from the perichaetia. An interesting feature which we never observe in the other mosses is the funnel-like and sharply toothed mouth of arhaeogonium in the present species.

**Distribution**: The world distribution of *Indusiella thianschanica* is discussed and mapped by Murray (1984). It includes Alaska and xeric regions of Southern Siberia (at 1200 - 2100 m), Mongolia (including Mongolian Altai), China (Nei Monggol, Xinjiang, Tibet), Tian-Shan Mountains in Middle Asia, Dagestan (the only locality in Caucasus), and Chad in Africa. Probably, South Siberia with neighboring Mongolia and North-West China represent the territory where *Indusiella* occurs rather regularly in all appropriate habitats. The distribution within the former USSR was mapped by Mamatkulov (1988), and in Mongolia by Abramov & Abramova (1983).

In Altai *Indusiella* was found only once from Kuraiskij Mt. Range, growing on shaded rocks (red-brown clayish schists) in a narrow canyon of a small dry stream in the steppe/semi-desert zone.

*Specimens examined*: Tabozhok Creek, 8 km upstream 2100 m (30/24).

**Jaffueliobryum Thér.**

Plants small, in dense cushions. Stem with well defined central strand, julaceous foliated. Leaves broadly ovate to obovate, concave, with differentiated base consisting of thin-walled cells; margins entire or eroso-serrate in upper lamina. Costa narrow, percurrent. Hyaline hairpoint smooth, long (1/2 to 2 lamina length), slightly flexuose. Upper lamina cells quadrate or shortly rhombic, with the cell walls especially thick on the abaxial surface. Marginal leaf cells elongate, sometimes hyaline, forming more or less distinct border. Basal cells shortly rectangular. Autoicous. Perichaetal leaves more or less enlarged, with longer hairpoint. Seta in most species shorter than urn. Capsula broadly ovoid. Peristome teeth highly perforate, papillose. Annulus of 2-3 rows of cells. Operculum conic, with short obtuse beak. Calyptra large, campanulate, plicate, flanked by the deep, broad lobes at base. Spores 7-9 μm, finely papillose.

Once seen, this species is impossible to be confused with any species of mosses. Even in the field it is easily recognized by the very small plants forming dense cushions and with numerous large golden calyptras. Superficially, it somewhat resembles *Bryum argenteum* which grows in the same habitat, sometimes even intermixed with it. The always present sporogones distinguish *Jaffueliobryum* at once from the *Bryum*.

The genus *Jaffueliobryum* has been given five species by Thériot (1928). Only *J. austinii* from Mexico is well differentiated by an exserted capsule. The status of the other four species remains more or less disputable. They are the...
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North American *J. wrightii* and *J. rauii*, the Bolivian *J. marginatum*, the South Siberian+Mongolian+Chinese *J. latifolium*. In Russian bryological literature this latter species was reported as *Coscinodon latifolium* (Lindberg & Arnell, 1890; Krylov, 1925) or *Jaffueliobryum latifolium* (Savicz-Ljubitskaya & Smirnova, 1970; Bardunov, 1969, etc.). Also this name was used for the Mongolian materials (Abramov & Abramova, 1983). In China, Cao & Gao (1985) at first identified the Tibetan plants as *J. marginatum*, but later Cao & Gao (in press), following Churchill (1987) revision, attributed all Asian collections of *Jaffueliobryum* to *J. wrightii*. In his revision, Churchill (1987) had synonymized *J. latifolium* and *J. marginatum* with *J. wrightii*. Recently Murray (1992) studied again the taxonomy of *Jaffueliobryum*. She disagreed with the synonymization of *J. latifolium* and *J. marginatum* with *J. wrightii*, but admitted the identity of the two former species. However, *J. marginatum* of Bolivia known so far only from too small specimen (Murray, pers. corr). Murray (1992) also reported a new undescribed species from Alaska. Based on the collection of Weber & Krasnoborov (B-65165), Murray (l.c.) re-
ported *J. wrightii* as a second species for the Altai. Authors of this paper are not in full agreement about the status of *J. latifolium*. The first author accepted its specific rank, while the second agree with Churchill (1987). Below discussion on this species reflect the former point of view.

In his study, Churchill (1987) saw only 9 Asian specimens. He stated that they are different from the North American plants in being smaller, with shorter hairpoints, more developed hyaline margins and a strongly demarcated leaf.
base. Since in some North American collections could be found similar forms, Churchill concluded that these are not enough differences for a separate specific recognition. We have seen about 70 herbarium collections of Asian Jaffueliobryum and also field observations were made in Altai where this species is locally fairly common. Admittedly, we have not examined numerous North American collections, but what we saw originated from different states (Arizona, Texas, and Minnesota, specimens in MHA, LE). These specimens agree well with the description of American materials in the literature (Churchill, 1987; Crum & Anderson, 1981; Lawton, 1971; Flowers, 1983). We concluded that nothing similar to North American materials was observed in Asian Jaffueliobryum. To the characters mentioned by Churchill should be added some differences in the growth habit. In J. latifolium, the very dense cushions appear in herbarium packet as a number of soil pieces from which solitary shoots do not break off. In contrast, in all American materials numerous separated shoots were seen in most collections. Such character is due to the more abundant rhizoids at base of J. latifolium than in J. wrightii and also due to more extensive branching. The cushions consist of mostly very small sterile shoots among which are scattered conspicuous rosettes of perichaetial leaves which are three times bigger than stem leaves and are hyaline in upper quarter (or sometimes in upper half). In J. wrightii, the proportion of fertile/sterile shoots is higher and the perichaetial leaves are separated shoots in most collections. Hairpoints on sterile shoots are also longer, making the cushions look homogenous and without at once seeing the sporogones.

Jaffueliobryum latifolium is morphologically fairly uniform in Altai and Sayan mountains, and agrees completely with the original material (Sahlberg, Krasnojarsk, 56° N, H. W. Arnell, lectotype H, not seen, isotypes LE!, NY!). Specimens of Weber & Krasnobarov B-65165 (cited by Churchill as Elias & al. B-65165) has a little longer hairpoints, but does not exceed the variation of Altaian populations. However, collections from Baikal area, Transbaikalia, and especially from the Eastern part of Mongolia, look different. They have rather short hairpoints and a more inflated (tumid) appearance of foliated stem, due to more concave leaves (better seen in wet condition, but hard to observe in two-dimensional geometry on a slide, Fig. 4). Other differences include: (1) cells of the costa in the uppermost part of the abaxial surface (in specimens from western end of the range, these leaf cells are short-rectangular, while those in the eastern end of the range are elongate; (2) hairpoint seen in western populations is longer and more widened toward the base than their eastern counterparts; (3) abaxial surface of leaf costa forming more sharp angle among individuals of western populations. However, all these differences between the two forms are connected by intermediate forms.

Distribution: The range of Jaffueliobryum latifolium includes China, Mongolia, and the south facing mega-slopes of mountains in Southern Siberia and extends eastward to Transbaikalia to about 120°E (map of Mongolian distribution is in Abramova & Abramov, 1983; for Siberian distribution in Bardunov, 1992). In Mongolia, J. latifolium occurs in most part of the country, eastward to “External Mongolia” (115°E, Gubanov’s collections in MHA), reaching mountains at 3000 m alt. In China J. latifolium is known from Xizang (Tibet), Xinjiang and Inner Mongolia (Cao & Gao, in press). In Altai it is very frequent in xeric parts of Central Altai and South-East Altai (450 to 2450 m). It is totally absent in the basin of Biya River. Along Katun River it reaches the mouth of Aedigan Creek, being absent further downstream where climate becoming wetter. Only one isolated population in very small quantity was found on the south-facing rock outcrops near Gorno-Altaisk. The distribution of this species could be interpreted as being restricted to the areas with annual precipitation lower than 300 mm. In wetter areas it is nearly totally absent, while very nearby is very common across a wide range of habitats (rocks outcrops, soil among rocks, and alone boulders) and always with numerous sporogones.

Specimens examined: Aedigan 600 m (34/134); Aedigan Creek, 5 km upstream 600 m (34/26); Bijka Creek, 2 km upstream along Katun 450 m (34/33); Chagan-Uzun Creek 1700 m (Bardunov 23.VII.1966 IRK!); Chuya River, lower course 800 m (Weber & Krasnobarov B-65165 MO!), Gorno-Altaisk (SE edge) 550 m (23/10); Malyi Yaloman 700 m (25/127); Malyi Yaloman Creek, 2 km upstream 850 m (25/43); 950 m (25/173); Malyi Yaloman Creek, 8 km upstream 1100 m (25/107); Tabozhok Creek, 8 km upstream 2000 m (30/21; 30/23; 2250 m (30/22); Toshak Creek 1980 m (36/114).

Coscinodon Spreng.
Plants small, in dense hoary cushions. Stem with central strand. Leaves lanceolate, keeled, strongly
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Fig. 5. *Coscinodon cribrosus* (Hedw.) Spruce (from Kobiguayuk Creek 2050 m Ignatov 0/474): 1 - peristome tooth; 2, 4 - habitus; 3 - upper lamina cells; 5 - basal cells of upper leaf; 6 - perichaetial leaf; 7 - stem leaf. Scale bars: 2 mm - for 2, 4; 1 mm - for 6, 7; 100 μm - for 1, 3, 5.

Plicate, the plicae bistratose. Costa percurrent. Hyaline hairpoint long, narrow, smooth, somewhat flexuose. Upper lamina cells small, isodiametric. Basal cells at margin short rectangular, with incrassate transverse walls, becoming longer in paracostal area. Dioicous. Perichaetial leaves much larger, not plicate, with basal half consisting of thin-walled, rectangular cells throughout. Seta 0.5-1 mm long, straight. Capsula immersed or emergent. Peristome teeth more or less perforated. Annulus absent. Operculum rostrate. Calyptra mitrate, covered about a half of capsules, longitudinally plicate. Spore smooth.
*Grimmia cribrosa* Hedw. Sp. Musc. Frond. 76. 1801

Plants in dense cushions, bluish-green above, blackish below. Stem 0.5-1 cm. Leaves 1.0-1.5 mm long. Hyaline hairpoint in middle leaves about 1/4-1/2 of their length, in upper leaves nearly as long as the lamina. Upper lamina cells isodiametric, 6-9 μm, basal cells rectangular at paracostal position, quadratic in several rows along the margins; at the ultimate margin of larger leaves, there is 2-3 rows of elongated cells. Perichaetial leaves up to 3-4 times larger than stem leaves. Seta 0.5-1 mm long. Capsula ca. 1 mm. Peristome teeth papillose, reddish brown. Spores 12-15 μm.

The distinguishing characters of *Coscinodon cribrosus* include the specific bluish, color, strongly plicate leaves on both sides of costa, rather small plant size with immersed capsules, more or less cribrose peristome, and obviously plicate calyptra. Despite its dioicous condition, most of Altaian collections are with sporogones. Young cushion of this species, however, can be confused with *Grimmia caespiticia* which also have small plants with strongly plicate leaves. However, the latter species have quadrate lamina cells reaching the base in stem leaves; the perichaetial leaves have several rows of rectangular and rather thin-walled cells at the base, but this area is much smaller than in perichaetial leaves of *C. cribrosus*. Another difference between *C. cribrosus* and *G. caespiticia* is the cortical layer of the stem (of 1-2 row in *C. cribrosus*; undifferentiated in *G. caespiticia*).

**Distribution:** Despite its wide distribution throughout the Holarctic, this species is probably nowhere common. A beautiful illustration of this was given by Steere (1978) who had shown on the map of North America only few dots representing the exceedingly random distribution of *C. cribrosus*. In Western Europe *C. cribrosus* is known in many countries where it is confined mostly to mountain areas. In former USSR, it was found in most mountain systems: Carpathians, Khibiny (on Kola Peninsula), Polar Urals, Caucasus, Krym (Crimea), mountains of Middle Asia, Altai, near Krasnoyarsk in Upper Yenissei, mountains of Baikal Area and also from the Beringian and Siberian (Yakutian) Arctics and mountains of Russian Far East. Also *C. cribrosus* is known from Mongolia (including the Mongolian Altai), China (Taiwan), Japan, Himalayas, and northern Africa. In Altai *C. cribrosus* was reported by Krylov from Manzherok at about 300 m alt. It was collected tree times by the senior author from subalpine zone near the tree line on highly acidic, often wet (after everyday rains) rocks in association with *Grimmia donniana*, *G. affinis*, *G. elatior*, *G. funalis*.

**Specimens examined:** Bogoyash Creek 2400 m (36/444), Kayakkatuyarykksig Creek 2100 m (7/109), Kobiguayuk Creek 2050 m (0/474).

**Grimmia** Hedw., Spec. Musc. Frond. 76. 1801.

Plants small to robust, green to yellowish-green above, dark-brown to black below, in dense or loose cushions or tufts. Stem with or without central strand, moderately irregularly branched. Leaves imbricate to contorted when dry, erect-spreading when moist, ovate, lanceolate to narrow-lanceolate, keeled or concave, with hyaline hairpoint or, rarer, muticous; leaf margin recurves, plane or incurved. Costa strong, percurrent, terete or at times, flattened, in cross section consisting of nearly homogeneous cells. Upper lamina cells bi- or unistratose, small, isodiametric, with more or less incrassate walls; middle leaf cells also isodiametric, with variously incrassate walls; basal cells larger, quadrate and short-rectangular with straight wall to long rectangular and narrow linear with straight or sinusose (rarely to nodulose in paracostal area) walls. Autoicous or dioicous. Perichaetial leaves more or less enlarged, with basal margins often composed of relatively thin-walled cells. Seta straight or geniculate, in latter case turning capsule to horizontal or pendent when moist and young. Capsula ovoid, exserted, emergent or immersed, with persistent columella. Annulus developed, consisting of thick-walled cells in several rows, or undeveloped. Operculum rostrate, beaked or convex. Calyptra cucullate to mitrate. Peristome teeth 16, well-developed, red-brown, bright-red, or yellowish-red, erect or reflexed backward when dry, entire or imperfectly perforated above, papillose on both surfaces, especially in upper part, to nearly smooth below, outer plates thicker than inner ones. Spores small, 7-16 μm, smooth to granulose or finely papillose.

**Key to Altaian species of Grimmia**

1. Capsula immersed in perichaetial leaves, seta shorter than urn ........................................ 2
2. Leaves narrowly lanceolate, 4 or more times longer than its width, gradually tapered, keeled above, with recurved margins ........................................ *G. pilifera* (p. 78)  
3. Robust plant of 2-4 cm high; leaves obviously concave, at apex more or less obtuse,
most of leaves with long, nearly smooth, hyaline hairpoint; perichaetial leaves with a broad hyaline border ... *G. tergestina* (p. 96)

3. Plants low, rarely taller than 1 cm; leaves in upper part obviously keeled, at apex broadly triangular, only upper leaves with developed hyaline hairpoint which is markedly widened toward the base; middle stem leaves much smaller than perichaetial leaves and often muticous ........................................ 4

4. Peristome present, leaf margin unistratose ............ *G. plagiopodia* (p. 93)

4. Peristome absent, leaf margin bistratose .................. *G. anodon* (p. 95)

5. Leaves muticous, cucullate at apex .................. *G. unicolor* (p. 103)

5. Leaves with hyaline hairpoint; some species (especially *G. incurva*) have also muticous forms under unfavorable conditions, but in these forms, the apex is filled by the broadened costa and is not obviously cucullate .6

6. Leaves strongly longitudinally plicate, small alpine plants ........ *G. caespiticia* (p. 85)

6. Leaves plane or slightly plicate above .......... 7

7. Leaves broad, length to width ratio less than 4:1, margins plane or incurved ......................... 8

7. Leaves lanceolate, length to width ratio more than 4:1, margins recurved or rarely, plane to incurved (*G. ovalis, G. montana* and *G. donniana*) ........................................... 11

8. Lamina bistratose and not transparent above, leaves broadly rounded at apex with long hairpoint ........................................... 9

8. Leaves unistratose and transparent above or bistratose only at margin, leaves obtuse to broadly acute, keeled above ................ 10

9. Perichaetial and uppermost stem leaves with thick-walled cells reaching the margin at base, awn coarsely serrate; julaceous innovations with small, rounded leaves often present; sporogones exerted ..... *G. laevigata* (p. 90)

9. Perichaetial and uppermost stem leaves with broad pale margin at base, composed of thin-walled hyaline cells; sporogones immersed .............. *G. tergestina* (p. 92)

10. Leaf margin bistratose .... *G. anodon* (p. 95)

10. Leaf margin unistratose .......................... *G. plagiopodia* (p. 93)

11. Plants with thread-like young slender shoots, bearing small cymbiform and carinally muticous leaves; leaves more or less spirally twisted, often with long hairpoint .............. *G. funalis* (p. 101)

11. Plants otherwise ........................................... 12

12. Robust plants, with typically arcuate stem of 2-6 cm high, and leaves 3-4 mm long, bistratose in upper lamina with a 3-5-stratose margin; costa at back and cells of upper lamina more or less papillose; seta geniculate; capsule horizontal to pendent, ribbed ............ *G. elatior* (p. 97)

12. Less robust plants, upper lamina at the margin 1-2-stratose, cells smooth .......... 13

13. Leaves with plane margins (rarely slightly incurved) at upper part of leaf; quadrate cells of lamina reaching nearly the leaf base along the margin (or submarginal zone) ........ 14

13. Leaves with obviously recurved margin on one or both sides, or rarely, with plane margins, but then basal cells rectangular (*G. donniana*) ........................................... 17

14. Robust to medium sized plants, 1-3 cm high, central strand is well-developed; capsule well exerted, operculum long-rosтрат; widespread in all vegetational zones .......... *G. ovalis* (p. 89)

14. Small plants, 0.5-1 cm high; capsule emer­gent to slightly exerted, operculum with short beak ........................................ 15

15. Leaves linear-lanceolate, costa fills up most of the upper lamina, muticous or with very short hyaline hairpoint

.... *G. incurva* (forma) (p. 97)

15. Leaves lanceolate to ovate-lanceolate, costa does not fill up upper lamina ............ 16

16. Basal cells quadrate at margin and elongate in paracostal area; stem without or with a weak central strand; dioicus .. *G. montana* (p. 88)

16. Basal cells quadrate to short rectangular, but practically uniform all across the leaf base; central strand well-developed; autocious, often with emergent brownish capsule with obtuse beak; alpine plant ......... *G. alpestris* (p. 85)

17. Plants up to 4 cm high, with linear-lan­ceolate leaves, crisped and contorted when dry; cells at leaf base near the costa narrow-linear, with nodulate longitudinal walls; capsule on arcuate-geniculate setae which are shorter than perichaetial leaves, ribbed ......... *G. incurva* (p. 97)
17. Leaves straight; basal cells rectangular to linear, with walls straight to sinuose; setae shorter or longer, but always straight ... 18
18. Rather robust plants with stems 2-4 cm high, leaves ca. 3 mm long .......................... 19
18. Small, alpine plants, with stems 0.5-1 cm high, leaves ca. 2 mm long .......................... 20
19. Stem without central strand; dioicus; capsule immersed, seta shorter than urn

............ G. pilifera (p. 78)
19. Stem with a well-developed central strand; autoicus plants, often bearing capsule exserted on long setae .... G. affinis (p. 78)
20. Plants usually of medium size, with stem longer than 1 cm; capsules well exserted; operculae with long beak; leaves usually recurved at margin on both sides

............ G. affinis (form) (p. 78)
20. Plants usually small, with stem shorter than 1 cm; capsules emergent to shortly exserted; operculae conic-convex, sometimes with short beak; leaves with plane margin or recurved on one side ... G. donniana (p. 81)


Fig. 6.

Plants robust, in rather loose tufts, dark-green above, blackish below. Stem erect, up to 3 cm high, without central strand. Leaves narrowly lanceolate, 2.5-3.5 mm long, keeled, with recurved margins on both sides. Hyaline hairpoints rather short, 1/8-1/4 of lamina length. Upper lamina bistratose, 7-9 μm. Basal cells at margin slightly enlarged, with thin walls; in paracostal area cells elongate with sinuose longitudinal walls. Dioicus. Seta 0.6-1.0 mm, shorter than urn. Capsula immersed, ovoid, 1.5-2 mm long. Peris­ tome teeth erect, lanceolate, reddish-brown, irregularly cleft and perforated above, densely papillose above, sparsely papillose below. Annu­ lus of 2-3 rows of short, thick-walled cells. Operculum with straight or slightly oblique beak. Calyptra mitriform. Spores about 9 μm, granulate.

When it is fertile, the rather robust plant with immersed capsule allows the recognition of G. pilifera at once. However, under sterile condition, it can be confused with G. affinis. Because of the enormous polymorphism of the latter species in Altai, probably the only reliable difference between the two taxa is the absence of central strand in G. pilifera, while it is always readily seen in G. affinis. In the field the robust plants with narrowly acute leaves are usually helpful in recognizing G. pilifera.

Distribution: This species represents an example of classical disjunction between East Asia and Eastern North America (maps: Iwatsuki, 1972; Ignatov, 1992; for China - Cao Tong & Vitt, 1986). Recently Iwatsuki (1992) excluded it from this pattern group because the species has been found in Western North America in British Columbia. However, the distributional pattern of G. pilifera could still be referred to this group in a broader sense as suggested by Ignatov (1993). Asian range of this species lies mostly in eastern China (especially east of hundred meridian), Japan, Korea, and southern part of Russian Far East. In other countries G. pilifera is rather rare. It is reported from 1 locality in India (Assam), Pakistan, two places in Mongolia (Abramov & Abramova, 1983) and several localities in Transbaikal Area of Southern Siberia (Bardunov, 1992). In Eastern North America G. pilifera is known from many states (southward to Texas), and in Canada, from Ontario. In Altai G. pilifera is rare and found so far only in two areas: (1) in high mountains of South-Eastern Altai, in tundra-steppe landscape at 2190-2300 m alt., and (2) in the middle range of Katun River, at 450-500 m alt.

Specimens examined: Bogoyash Creek, upper course 2300 m (36/341); Chemal 450 m (34/217); Chemal, 10 km upstream along Katun 450 m (34/215; 34/97); Dzhulukul Lake 2190 m (Zolotukhin 1.VIII.1989); Kokkul Lake 2300 m (33/11); Kuba Creek 500 m (Makarov 3.VI.1972).


Fig. 7.

Plants in dense tufts, yellowish-green above, brown to dark brown below. High alpine forms are totally black. Stem (0.5)-1.3 cm high, with central strand. Leaves lanceolate, up to 3-3.5 mm long. Hyaline hairpoint 1/6-1/3 of lamina length. Upper lamina cells bistratose, 7-9 μm. Basal cells at margin rectangular, hyaline, with thin longitudinal and somewhat thicker transverse walls, becoming linear at paracostal area, with sinuose walls. Autoicus, with perigonia on separate branches. Seta erect, 2.5 mm long, yellow. Capsula ovoid to cylindric. Peristome teeth yellow-brown to red-brown, somewhat cleft above. An­ nulus well-developed. Operculum with long to short beak. Calyptra mitriform. Spores 9-12 μm, granulate.

Grimmia affinis in its typical expression is a medium-size plant of dull-green or yellowish-green color. Leaves in dry conditions are somewhat curved with the hairpoints differently oriented. Despite the hairpoints are of average length in the genus, cushions of G. affinis do not seem hoary. This character is useful to de-
limit this species from *G. ovalis* which has leaves closely adpressed with straight, upward orientation in dry condition, making the cushions appear hoary. Leaves of *G. affinis* are sharply keeled in the upper part and recurved usually on both sides at about the middle of the leaf, becoming reflexing when wet. Microscopically *G. affinis* is characterized by a rather prominent narrow area at basal margin where cells are much longer and have thinner walls. Some-
Fig. 7. Grimmia affinis Hoppe et Hornsch. ex Hornsch. (from Kukol 1750 m Ignatov 0/922): 1, 2 - peristome; 3 - basal leaf cells; 4 - leaf; 5 - capsule; 6 - habitus. Scale bars: 2 mm - for 5, 6; 1 mm - for 4; 100 μm - for 1, 2, 3.

Sometimes this area is just of one row of cells, but still it is distinct because of larger cells with relatively thin and straight cell walls. Farther from the margin there is a zone of rectangular to linear cells with thick and more or less sinuous walls which gradually merges into the paracostal zone of elongate-rectangular cells with straight walls.

Grimmia affinis is autoicous and most collection of it are with sporogones, even under
very unfavourable conditions. In alpine zone, capsules remain juvenile until the end of summer and therefore only in rare seasons can they become ripen. Perigonias are situated on branches which are long and have the same appearance as the female axes (stems and some branches). In alpine conditions, however, many junctions of male and female parts of plants are buried and become decomposed, so that plants may seem like dioicous.

The variation of G. affinis is rather moderate in the forest and taiga zones, but become considerable above the tree line. Alpine plants are often totally black, sometimes brownish, forming very dense tufts (becoming difficult to pick up from rocks by hands) and showing a reduction of hairpoint to nearly almost muticous condition. Leaves also become smaller and with less recurved margins (the smallest plant could have plane leaf margins). Sporogones are oblong and therefore only in rare seasons can they be observed in plants growing even on exposed rocks at high elevations (up to 2800 m alt.) where fruting cushions become far less common than the sterile cushions - the latter, upon examination, consist of only female plants. The distinction of such expression from the G. elongata Kaulf., which is so far not seen in Altai, needs further observation. At the same time on less exposed rocks (especially when growing among rocks), G. affinis maintains its normal appearance up to nearly its upper distributional limit.

Distribution: Very widespread species, Grimmia affinis is known from most regions of the Holarctic. It is present in practically all of the boreal and temperate regions of the former USSR, except the flat lowlands of the Eastern Europe and Western Siberia. It is rather common in Mongolia, in many provinces of China (southward to Yunnan), Japan, New Guinea, Himalayas, Ceylon, Philippines. In North America the species is also widespread, penetrating southward to Guatemala, Costa Rica and Bolivia. In tropical high mountains it is known from Africa too. In Altai and other mountains in Southern Siberia, G. affinis is one of the most common species on granites, schists and other rocks in open places and in not very dense forests. It occurs at all altitudes, becoming somewhatrarer only in more xeric areas where G. ovata becomes more common.

Specimens examined: Arsoek Creek (Koroleva 16.VI.1988); Anyshu Creek 600 m (Zolotukhin 20.IX.1989); Askat 1000 m (Zerov 15.VIII.1940 LB); Bardaly Creek 2100 m (11/8); Bele 550 m (0/926); Berekhtryagyr 1600 m (0/473; 0/731; 0/920); Bogoyash Creek, at mouth 2100 m (Zolotukhin 17.VI.1986); Bogoyash Creek, upper course 2350 m (36/330); Bogoyash Lake 2965 m (Zolotukhin 18.VI.1986); Bugazun Creek, at mouth of Saigujev Cr. 2100 m (Pavlov V.N. 19.VIII.1993); Chaitary Creek, upper course 1800 m (34/218); Chulcha River, in middle course 1000 m (9/11; 9/30); 1100 m (9/166); Kairu Creek, 8 km upstream 1000 m (15/36); Kairu Creek, lower course 500 m (Zolotukhin 11.IX.1987); Kairu-Bele Peak 2100 m (13/32; 13/61); 2300 m (13/122; 13/79; 13/96); Kamga Creek, 11 km upstream 580 m (0/933); Karama Creek, 8 km upstream 1600 m (0/923); Kava-kattayaryskiy Creek 1760 m (8/18), 1800 m (8/178), 1860 m (8/275), 1900 m (8/147; 8/153; 8/284; 8/328; 8/96), 1920 m (3/273; 8/48), 1930 m (3/181; 3/182; 3/247; 3/274; 3/275; 3/290; 7/152), 1950 m (3/111; 8/154), 2000 m (3/132; 3/183; 3/39; 6/7; 13/81), 2050 m (3/100; 3/102; 3/103, 5/14; 7/32; 7/33), 2100 m (4/7; 8/66), 2150 m (4/27), 2200 m (6/15), 2250 m (6/36), 2400 m (7/82), 2450 m (7/80), 2550 m (7/79), 2750 m (7/66), 2965 m (7/55); Kobigaran Creek 2150 m (0/477), 2200 m (0/728), 2220 m (0/730), 2300 m (0/732), 2350 m (0/948), 2500 m (0/729; 0/924), 2908 m (0/186); Kookhtushka 440 m (0/475); Kokorya Creek 2100 m (32/5), 2200 m (32/4); Kolyshta River 2050 m (Zolotukhin 27.VII.1982); Kukol 1750 m (0/472; 0/922; 0/928), 1850 m (0/931), 1900 m (0/921), 2440 m (Zolotukhin 23.VI.1989); Kurmin 450 m (20/11), Malchj Yaloman 1100 m (25/129; 25/8; 25/86); Malchj Yaloman Creek, 4 km upstream 900 m (25/71); Malchj Yaloman Creek, 5 km upstream 900 m (25/59); Omok 1100 m (Zolotukin 8.IX.1987); Ok-Porok Creek, at mouth 450 m (Zolotukhina 30.III.1988); Seminskij Pass 1850 m (s.m.); Vysokaya LB); Tabozhok Creek, 12 km upstream, 2200 m (30/43); Tabozhok Creek, 8 km upstream, 2500 m (30/9); Tabozhok Creek, upper course 2400 m (30/8); Tabozhok Peak 2200 m (31/8), 2550 m (31/6; 31/7), 2750 m (31/11), 2780 m (31/10); Tamanel Peak 1800 m (34/190); Tokpak Creek, in middle course 1950 m (36/275); Toshalkalyapa Creek 2600 m (Zolotukhin 14.VII.1990); Tura Creek, in middle course 1300 m (28/12; 28/52), 1650 m (28/11); Ulagan Pass 2000 m (Vysokaya 10.VII.1977 LB); Uzennyuy Creek, upper course 2400 m (Zolotukhin 9.VII.1990); Uzunyuy Creek, upper course 2400 m (36/350); Yatilu 440 m (0/923), 450 m (1/43), 460 m (0/929); Yazul 400 m (Zolotukhin 26.VI.1990), 2000 m (Zolotuktin 26.6.1990), Yazula 1600 m (0/925).

Figs. 8-10.

Plants in grayish-green, dense hoary cushions. Stem up to 1 cm high, with central strand. Leaves lanceolate, 1.5-2 mm long, distinctly keeled, with plane or, rarer, recurved margins. Hyaline hair point well developed, between 1/5 to 4/3 of the lamina length, decurrenting to the lamina forming a hyaline margin in the upper leaf. Upper lamina cells ca. 10 μm, rounded to quadrate, partly bistratose. Basal cells at margins rectangular (3:1), with thin walls, both transverse and longitudinal. Cells at paracostal area rectangular, with thin transverse and thicker and straight longitudinal walls. Aparicous. Seta yellow-brown 1.6-1.8 mm long. Capsule emergent, ovate to elliptic, yellow-brown. Peristome teeth brownish, papillose throughout, nearly entire to hardly eroded above. Annulus of quadrate, thick-walled cells. Operculum convex, shortly beaked. Calyptra mitriform, Spores 10 μm, finely granulose.
The conception of *G. donniana* is sufficiently broadened here, since its enormous variability. Plants with relatively narrow leaves, plane margins, highly sinuose cells in middle zone of leaf (as in syntype specimen of *G. donniana*: “Beddgelart, North Wales, col. Turner, BM!”) are rare in Altai. Only few specimens, i.e. Ignatov 4/26 (Fig. 8) almost totally agree with the type. Most of specimens from Altai have less sinuose to nearly straight cell walls in middle of leaf, slightly recurved margins and very variable areolation of leaf base. In smaller stem leaves cells along leaf margin are short rectangular, with thicker transversal cell walls. However in larger upper leaves cells along leaf margin are pellucid forming a transparent area of cells with very thin walls; this area contrasting with paracostal cells, also rectangular, but with thicker longitudinal walls. In smaller leaves hair-point is rather short, in upper leaves longer, in ultimate case (Fig. 10) longer than lamina and decurrenting on leaf forming a border in upper lamina.

Some specimens with shorter basal cells and narrow lanceolate leaves (Fig. 9) agree with *G. sessitana*, but this species is described as having no annulus. Also all these modifications are connected by numerous transitional forms, making impossible any natural segregation.

*G. donniana* is growing in alpine zone, where it could be mistaken with the other species of *Grimmia*. The close relatives, *G. montana* and *G. alpestris* are differing from *G. donniana* by the areolation of the leaf base - in *G. donniana* cells along the margin at least in upper leaves are elongate without transverse thickness. Also in basal paracostal group longitudinal cell walls are thickened. Forms with shorter basal cells differ from *G. alpestris* by more narrow leaves with usually recurved margin and autoicous sexual conditions. From the *G. affinis* *G. donniana* differs by the emergent capsules with very short beak or without it, smaller size of plants, thickened longitudinal cell walls in base along the costa and extensive hyaline area at margin of upper leaves.

In 3 collections were observed the setae arcuate when young and moist in part of plants, while in others - straight. By this feature these

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**Fig. 8. Grimmia donniana Sm.** (from Kayakkatuyaryk ski Creek 2250 m Ignatov 4/26). 1 - cells of leaf base; 2 - leaf. Scale bars: 1 mm - for 2; 100 μm - for 1.
The family Grimmiaceae in Altai

Fig. 9. Grimmia donniana Sm. (from Kobiguayuk Creek 2200 m Ignatov 0/944): 1 - peristome teeth; 2, 6 - leaves; 3 - habitus; 4 - cells of leaf base; 5 - basal cells at margin. Scale bars: 2 mm - for 3; 1 mm - for 2, 6; 100 µm - for 1, 4, 5.

Plants could be referred to *G. apiculata* Hornsch., but the inflorescences of them are autoicous or female, not paroicous as in true *G. apiculata* and also cell walls in middle leaf are nearly straight, not strongly sinuose, as *G. apiculata*.

**Distribution:** This species has a very wide distribution in both hemispheres at low latitudes and in high mountains. In Western Europe, *G. donniana* is known from Scotland, Portugal, Norway, Sweden, Finland, Poland, and reported also from France, Brit-
Grimmia alpestris (Web. et Mohr) Schleich. ex Nees, Bryol. Germ. 2(1): 139. 1827. Fig. 11.

Trichostomum pulvinatum var. alpestris Web. & Mohr, Bot. Taschenb. 110. 1807.

Plants small, in greenish-gray hoary cushions. Stem ca. 0.5 mm high, with central strand. Leaves lanceolate to broadly lanceolate, ca. 1.5 mm long, margins plane. Hyaline hairpoint 1/4-2/3 of lamina length. Upper lamina cells 8-10 μm, partly bistratose, with longitudinal rows of bistratose cells. Basal cells at margin and in paracostal area homogeneous, quadrate to short rectangular in stem leaves, and rectangular with a ratio of 1.5-2:1 in upper and perichaetial leaves, ca. 40 x 25 μm. Dioicous. Seta ca. 2 mm long, straight. Capsule emergent, broadly ovoid to broadly cylindrical, dark-brown. Peristome teeth red-orange, entire or eroded above. Annuulus not differentiated. Operculum shortly and obtusely beaked. Spores ca. 8 μm, smooth.

Among small species of Grimmia, superficially similar to G. alpestris, there are G. caespiticia, G. montana and G. donniana. G. caespiticia is easily distinguished by its strongly plicate leaves, G. montana - by quadrate cells at basal margin and rectangular paracostal cells, G. donniana in typical expression - by long-rectangular basal cells; however some forms with short basal cells is more difficult to delimit from G. alpestris; the following characters are useful:

- leaves ovate-lanceolate, rigid, straight; margin plane; cells quadrate or short rectangular (1.5-2:1) to the base; dioicous, capsule dark-brown; peristome papillate above - G. alpestris;
- leaves lanceolate, flexuose; margin typically recurved on one side; basal cells rectangular (2-3:1); dioicous, capsule yellowish; peristome papillate throughout on inner surface - G. donniana (small forms).

The character of sexuality needs comments. In alpine plants in most of collections are observed only archegoniae, even in such normally autoicous species, as G. affinis. So, if a collection is not very extensive (and it is usually so for small alpine species), the decision about dioicus condition is unreliable.

Distribution: The distribution of Grimmia alpestris needs additional verification. Plants almost identical with the Altaian G. alpestris have been seen from Central Europe, Caucasus, North America (California). Japanese plants referred by Deguchi (1979a) to G. subsulcata Limpr. (G. alpestris var. subsulcata (Limpr.) Loeske) probably are also very close to the Altaian specimens studied. In Altaic, G. alpestris is a rather rare moss, occurring on lithosol in lower alpine zone.

Specimens examined: Bayas Lake 2200 m (0/477); Tuguryuk Creek 2200 m (Bardunov 23.VI.1966 IRK!).

Grimmia caespiticia (Brid.) Jur., Laubm.-Fl. Oesterr.-Ung. 172. 1882. Fig. 12.

Campylopus caespiticus Brid., Muscol. Recent. Suppl. 4: 77. 1819.

Plants in dense grayish hoary cushions. Stem low, 0.3-0.5 cm high, with indistinct central strand. Leaves on male plants 0.7-1 mm long, on female - up to 1.5 mm. Hyaline hairpoint 1/3-1/2 of lamina length. Upper lamina cells bistratose, 6-8 μm, with incrassate walls, toward the base in male plants the cells become quadrate at margins and short-rectangular in paracostal area; in female plants the cells at leaf base are rectangular, 40 x 15 μm. Dioicous. Sporogones unknown in Altaian collections.

This species is readily distinguished from all other Grimmia by the small plants with deeply sulcate leaves and very long hairpoint. Its stout plicae on both sides of the costa seem unlikely.
Fig. 11. *Grimmia alpestris* (Web. et Mohr) Schleich. ex Nees (from Bayas Lake 2000 m Ignatov 0/477): 1 - peristome teeth; 2 - habitus; 3 - cells of leaf base; 4 - leaves. Scale bars: 2 mm - for 2; 1 mm - for 4; 100 μm - for 1, 3.
to be mistaken even under the stereo-microscope. In male plants it is important to note that there is a very slight differentiation of cells at the leaf base where they are almost all quadrangular. The latter character readily discriminates *G. caespiticia* from *Coscinodendron cribrosus* which have also sulcate leaves. In female plants of *G. caespiticia*, however, in the upper and especially perichaetal leaves there are several rows of rectangular, thin-walled cells at the leaf base, but this feature is never so developed as in the case of *Coscinodendron.*

**Distribution:** The species is restricted to the Holarctic where it is scattered in high mountain areas of
Central Europe, Scandinavia, Caucasus, South and East Siberia, Middle Asia, China (Shanxi only) and Greenland. In Altai \textit{G. caespiticia} was found in lower alpine, subalpine and upper taiga zones, on relatively xeric S-facing slopes, on rocks or lithosol, always in restricted quantity.

\textbf{Specimens examined}: Abyntash Creek 2150 m (Zolotukhin 16.VI.1989); Bogoyash Creek, in middle course 2400 m (36/334; 36/355); Bogoyash Creek, upper course 2350 m (36/328); Bolshoye Kurkure Creek, upper course 2300 m (Galanin 9.VIII.1976); Chulyshman against Uandu Creek mouth 1950 m (36/300); Kayakhataygyskiy Creek 1940 m (3/282; 3/286), 2100 m (7/112a; 7/112); Kobiguayuk Creek 2200 m (0/947); Trekhglavaya Peak 2200 m (Zolotukhin 18.VII.1990); Yagusa 1600 m (0/946).

\textbf{Grimmia montana} Bruch et Schimp. in B.S.G., Bryol. Eur. 3: 128. pl. 250. 1845. Fig. 13.

Plants small, in dense, dark-green tufts or cushions. Stem up to 1 cm, without a central strand. Leaves lanceolate, 1.5-2.0 mm long, keeled above. Hyaline hairpoint 1/5-1/3(1/2) of lamina length. Upper lamina totally or partially bistratose, cells about 7 μm. Basal cells at margin are quadrate to short-rectangular, with transverse walls thicker than longitudinal ones; in paracostal area, cells are rectangular up to 2:1. Dioicous. Sporogones unknown in Altaian plants.

\textbf{Grimmia montana} is a small-sized species, superficially similar to \textit{G. donniana} (among Altaian representatives). The diagnostic character of \textit{G. montana} is the peculiarities of leaf base areolation, including quadrate or short-rectangular cells at the basal margin and more elongated paracostal cells (in \textit{G. donniana} marginal cells are typically thin and much elongated, or
in its forms with short basal cells there is no or only slight differences between marginal and para-costal cells). Also *G. donnniana* grows in Altai only in alpine zone. In leaf areolation patterns *G. montana* seems to be similar with *G. ovalis*, but the leaf of *G. montana* is keeled (cf. Figs. 13, 14), the plants in *G. ovalis* is much larger and usually have in upper leaves a differentiated zone at leaf margin, composed of more thin-walled cells.

**Distribution:** *Grimmia montana* has a scattered Holarctic distribution in Central Europe, Great Britain and Iceland. In the former USSR it is present in mountains of Kola Peninsula, Carpathians, South Ural Mts., Caucasus, Altai, and mountains of Middle Asia. Known also from China, western North America, and Morocco. In Altai it is known from a single collection from the steppe zone of Central Altai.

*Specimens examined.* Chuya River, lower course 800 m (Bardunov 16.VI.1966 IKR!)

**Grimmia ovalis** (Hedw.) Lindb., Acta Soc. Sci. Fenn. 10: 75. 1872. Fig. 14.

**Dicranum ovale** Hedw., Sp. Musc. Frond. 140. 1801.


Plants in loose tufts, dark-green above and ferruginaceous brown below, often hoary. Stem up to 3 cm high, with central strand, sparsely branched. Leaves rigid, directed upward when dry, with hyaline hairpoints crowded at stem top. Lamina lanceolate with ovate base and more narrow upper part, 2.5-3.2 mm long, margins plane to slightly incurved or rarely recurved. Hyaline hairpoint 1/5-1/2 of lamina length. Upper lamina cells bistratose, opaque, about 7 μm. Median leaf cells 2:1, with sinuose walls. Basal cells at leaf margin in middle stem leaves quadrate to short-rectangular, with thick walls. However, there are several rows of cells with thinner walls along basal margins of larger upper leaves. In perichaetial leaves all the bases are composed of thin-walled cells whereas the paracostal cells are rectangular, up to 3(4):1. Dioecious. Seta erect 4-6 mm long, yellowish. Capsula well exserted, ovoid, about 2 mm long, smooth when dry. Peristome teeth erect, lanceolate, 2-3 cleft or somewhat perforate above, papillose above and nearly smooth below. Annulus of 3-4 rows of elongate, thick-walled cells with small lumina. Oerculum longly rostrate with oblique beak. Calyptra cucullate. Spores 12-14 μm, granulose.

Typical expression of *Grimmia ovalis* is easily recognized in the field by its (1) large plant size for the genus; (2) loose tufts with long hair points which are usually straight upward (as compared to *G. affinis* which has somewhat flexuose leaves in dry condition and therefore with the hairpoints differently orientated resulted in a quite different appearance); (3) the characteristic ferruginaceous brownish color below. Often *G. ovalis* is described as having concave and unkeeled leaves. Although this is true, this character is not always easy to decide (cf. the series of cross sections of concave leaf of *G. ovalis* and the keeled leaf of *G. montana*, Figs. 13, 14). In some leaves of *G. ovalis*, margin in the middle can become recurved on one side. In *G. affinis* and other species with typically recurved margins, the "keelness" of leaves is not apparent when growing in unfavoured conditions. Microscopically, *G. ovalis* is characterized by (1) the shape of leaf which is distinctly consticted above the broadly ovate base, with lanceolate upper part, while in *G. affinis* it is gradually, narrow-triangularly tapering towards the apex, and (2) the pattern of leaf base areolation, with a broad zone of quadrate cells along the leaf base margin, or in larger leaves, along the submarginal area. For its differentiation from *G. montana*, see discussion under that species.

**Distribution:** *Grimmia ovalis* is a very widespread species in most of the European countries and in nearly all the regions of the former USSR (except some northern areas). It is known also from China, Mongolia, Indonesia, India, Sikkim, Nepal, Pakistan, Iraq, Middle East, Canary Isls., North America, North and South Africa, South America, Australia. In Altai *G. ovalis* grows on exposed rocks and is especially abundant in forest-steppe districts of Central Altai. Also it is not rare in open xeric places in forest areas and at higher elevations in steppe/semi-desert areas. It does not penetrate into alpine zone in wetter areas. In the most xeric areas of South-Eastern Altai, some rather poor and ill-developed plants of *G. ovalis* were found up to 2700 m alt.

**Specimens examined**. Aedigan Creek 650 m (34/126); Artyshku Creek 650 m (Zolotukhin 20.IX.1989); Bijka Creek, 2 km upstream along Katun 450 m (34/52); Bijka Creek, 4 km upstream along Katun 450 m (34/219); Chemal 450 m (29/68); Chemal, 10 km upstream along Katun 450 m (34/12); Chemal, 4 km upstream along Katun 450 m (34/212); Chiri 450 m (0/950; 17/43; 17/48; 17/54); Chodro 800 m (0/935); Chulcha River, in middle course 1000 m (9/37; 9/48); Chulysman River (Shishkin 4.IX.1931); Edikhta Creek 1100 m (34/161); Kairu-Bazhi Peak 2050 m (13/170); Kayakhatuyarykskij Creek 1850 m (8/149); 2000 m (8/279);
Fig. 14. Grimmia ovalis (Hedw.) Lindb. (from Yailyu 440 m Ignatov 0/918): 1 - leaf cross sections; 2 - basal leaf cells; 3 - leaf. Scale bars: 1 mm - for 3; 100 μm - for 1, 2.

Grimmia laevigata (Brid.) Brid., Bryol. Univ. 1: 183. 1826.

Campylopus laevigatus Brid., Muscol. Recent. Suppl. 4: 76. 1819 [1818].

Plants in moderately dense, rigid cushions, dark-green to black. Stem 1-2 cm high, with central strand, sparsely branched, the innovations at proximal posi-
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Fig. 15. Grimmia laevigata (Brid.) Brid. (from Kobukhta 550 m Ignatov 0/462): 1 - habitus; 2 - leaf; 3 - basal leaf cells; 4 - basal cells at margin of perichaetial leaf. Scale bars: 2 mm - for 1; 1 mm - for 2; 100 μm - for 3, 4.

tion julaceouslly foliated with small, concave, and strongly appressed leaves. Stem leaves broadly ovate to broadly lanceolate, 1.5-2.5 mm long, concave, with flattened costa. Hyaline hairpoint short in lower leaves, becoming longer upward, to as long as the lamina, finely serrulate all along. Upper lamina cells opaque, bistratose, small, 5-7 μm. Basal cells at margins quadrate to short rectangular, with thick walls, or in upper leaves with 1-2 row of relatively thin-walled cells. In paracostal area at basal leaf cells are rectangular, up to 3:1. Dioicous. Perichaetial leaves larger, similar to stem leaves. Seta up to 2 mm long,
yellow. Capsula shortly exerted or emergent. Peristome teeth erect, lanceolate, variously split or perforated above, red-brown, papillose throughout (densely above). Annulus of 2-3 row of elongated cells. Operculum with short beak. Calyptra mitrate. Spores 7-9 \( \mu m \) smooth. (Since only juvenile and old capsule were found in only one collection from Altai, the description of peristome is borrowed from Chinese collections).

**Grimmia laevigata** is distinguished by ovate to oblong leaves, concave, with flattened costa. Being dioicus, it rarely bears sporogones in the Altai region. By gametophyte alone the species can be mistaken for **G. tergestina**. The important difference between these two species lies in the development of a zone of very thin-walled cells along the basal leaf margin in **G. tergestina** and this character is well seen in perichaetal and upper stem leaves. In **G. laevigata** thick walled cells reach the leaf base, and only rarely in larger upper leaves one sees 1-2 rows of cells with moderately thick walls. The second species which can be confused with **G. laevigata** is **G. ovalis**. In their typical expressions, leaf shape is distinctive enough to separate the two taxa (cf. Figs. 14, 15), but forms that are difficult to interpret sometimes occur. To summarize the delimitation of the two species, the following characters can be used:

- plants usually 1.0-1.5 cm high; leaves without constriction above the base, if with constriction, then the upper portion of lamina is shorter than the basal part ........ **G. laevigata**
- plants usually 2-3 cm high; leaves with a constriction above the base; upper portion of the lamina is longer than the basal part ................ **G. ovalis**

**Grimmia ovalis** sometimes produces small forms in alpine zone, but within forest and steppe zones of Altai it is uniform and always markedly larger than **G. laevigata**.

**Distribution:** **Grimmia laevigata** is known from many xeric parts of the world. In Europe it occurs mostly in the south, penetrating northward to Scandinavia where it is rare. In the former USSR it is known from the southern half of European part, Caucasus, Middle Asia, and South Siberia. Also it occurs in Mongolia, China (except the most oceanic regions), India, Sri Lanka, Pakistan, many countries of Middle East, North and South Africa, arid zone of North America (from Georgia to California), Hawaii, Australia, Tasmania and New Zealand. In Altai **G. laevigata** is scattered all over xeric rock faces from 350 to 1400 m alt.

**Specimens examined:** Chulcha River, in middle course 1100 m (9/163); Gorno-Altaisk 400 m (35/11); Gorno-Altaisk (SEDGE) 550 m (23/13; 23/14); Kobukhta 550 m (0/462), 600 m (0/229); Maley Yaloman 550 m (25/145); Saratan 1400 m (36/349); Usr-Sema 350 m (24/151); Yaikyu 800 m (0/945).

**Grimmia tergestina** Tomm. ex B.S.G., Bryol. Eur. 3: 126. pl. 258. 1845. Fig. 16.

Plants rough, in dense, rigid tufts, green to pale-green above and black below. Stem up to 2.5 cm, with central strand. Leaves broadly-ovate to oblong-ovate, 2.0-2.5 mm long, concave, with flattened costa. Hyaline hairpoints short in lower leaves, as long as the lamina in upper leaves. Upper lamina cells bistratose, opaque, small, 5-7 \( \mu m \). In upper stem and perichaetal leaves, the marginal basal cells in few to many rows, rectangular, about 25-40 x 10 \( \mu m \), with very thin, hyaline walls; in paracostal area cells rectangular, up to 5.1, with straight walls. Dioicus. Seta shorter than urn, about 0.3 mm long. Calyptra mitriform. Mature capsule unknown in Altai.

When sporogones are present **Grimmia tergestina** is easily distinguished by the immersed capsule on a rather robust plant and the unkeeled, ovate to oblong-ovate, leaves with long awns. In sterile condition it much resembles **G. laevigata**. Their difference in gametophyte includes, in the case of **G. tergestina**, the extensive hyaline "alars" of the perichaetal or upper leaf bases where cells are strikingly thin-walled and are well contrasting with the zone of thick-walled cells in leaf base (this character is often seen in upper leaves of plants even without archegoniae). In **G. laevigata**, the zone of thick-walled cells extends up along the margin or forms 1-2 rows of marginal cells having only slightly thinner walls. Other differences include the nearly smooth hairpoint in **G. tergestina** (distinctly serrate in **G. laevigata**), and the presence of julaceously foliated innovations in **G. laevigata**. Though in many cases juvenile sporogones are present, we have never seen mature or old capsules in our Altaian collections.

**Distribution:** The distribution of **G. tergestina** definitely corresponds with the xeric range of the Old World. It is known from Central (very rare) and South Europe, Northern Africa (Morocco) and Macaronesia, the former USSR - in Krym, Caucasus, East Siberia (tundro-steppe regions of Yakutia) and South Siberia, southern part of Russian Far East, Middle Asia, in Asia also in Middle East, Iraq, Afghanistan, China, and Mongolia. In Altai **G. tegestina**
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Fig. 16. Grimmia tergestina Tomm. ex B.S.G. (from Derbogach 440 m Ignatov 0/897): 1 - habitus; 2 - basal leaf cells; 3 - leaves. Scale bars: 2 mm - for 1; 1 mm - for 3; 100 µm - for 2.

Grimmia tergestina is very common in forest-steppe areas of the Central Altai, in regions where *G. ovalis* and *Jaffueliobryum latifolium* are common. The species occurs also in steppe areas of South-East Altai and rare in forested part of Northern Altai. It strictly avoids the alpine zone (though in Mongolia it is reported from 2600-3100 m alt.).

Specimens examined: Aedigan 600 m (34/168); Bjiha Creek, 2 km upstream along Katun 450 m (34/120); Chagan-Uzun Creek 1700 m (Bardunov 23.VII.1966 IRK!); Chemal, 4 km upstream along Katun 450 m (34/213); Derbogach 440 m (0/897); Inya 800 m (Melnichuk 19.VIII.1959 LWS! 3584); Kokkul Lake 2200 m (33/1), 2300 m (33/2); Kokorya Creek 2100 m (32/7); Malgi Yaloman 800 m (25/128), 950 m (25/160; 25/89); Malgi Yaloman Creek, 2 km upstream 850 m (25/42), 950 m (25/178; 25/181); Malgi Yaloman Creek, 7 km upstream 1050 m (25/26); Tabozhok Creek, 12 km upstream 2200 m (30/18); Tabozhok Creek, 8 km upstream 2000 m (30/16), 2050 m (30/15), 2250 m (30/17).


Fig. 17. Grimmia plagiopodia. Plants small, dark-green, in dense cushions. Stem
Fig. 17. Grimmia plagiopodia Hedw. (from: Kobiguayuk Creek 2200 m Ignatov 0/884): 1 - upper lamina cells; 2, 4 - peristome; 3 - basal leaf cells; 5 - leaf; 6 - habitus. Scale bars: 2 mm - for 6; 1 mm - for 4, 5; 100 μm - for 1, 2, 3.
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0.5-1.0 cm high, with central strand. Leaves broadly ovate, up to 1.5 mm long, acute, keeled above. Costa thin, ending below the apex. Lower leaves muticous or with a hyaline apical cell; in upper and perichaetial leaves, hyaline hairpoints are well developed, but short, to 0.1 mm long. Upper lamina cells ca. 10 μm, unistratose, transparent, strongly and irregularly rounded. Cells at basal margin and in paracostal area of the leaf uniformly rectangular, 3-4:1, thin-walled. Autoicous. Seta shorter than urn, 0.2-0.8 mm long, curved, excentrically attached to the capsule. Capsula deeply immersed in perichaetial leaves, 1.0-1.5 mm long, broadly ovoid or nearly hemisphaeric, not contracted below the mouth. Peristome teeth spreading when dry, reddish, much eroded and also moderately perforate, finely papillose above, nearly smooth below. Annulus absent. Operculum nearly plane, bluntly mucronate. Calyptra nitrate. Spores about 11 μm, smooth.

**Grimmia plagiopodia** is a small moss with immersed capsule. Superficially it is much similar to the submuticous expression of *G. anodon*, but since it is usually found with sporogones, it is easy to identify this species by the presence of a peristome. In sterile condition the most important diagnostic character is the unistratose margins of *G. plagiopodia* and the bistratose leaf margins of *G. anodon*. From *Schistidium* species, both *G. anodon* and *G. plagiopodia* are easily distinguished by the much enlarged area of thin-walled cells at the leaf base, an area about a quarter to a half in upper leaves.

**Distribution:** *Grimmia plagiopodia* has a scattered Holarctic range. It is known from southern Europe and Middle East. In the former USSR - it is reported from Ukraine, Cis-Caspean territory, South Ural, Caucasus, Middle Asia, Altai. Also it is known from Mongolia (specimen of *Grimmia elenkiniae* Broth. sp. nov., nom ined.; Mongolia, lac. Kossogol. 31.VII.1902. A. A. Elenkin, LE!), and from the xeric territories of western North America where it reaches its northern range limit at 65°N. In Altai *G. plagiopodia* occurs on xeric rocks in subalpine/steppe zone of South-Eastern Altai.

**Specimens examined:** Kobiguayuk Creek 2200 m (0/884); Yustyd 2250 m (Vereshchagin 3.VII.1907 LE!).

**Grimmia anodon** Bruch et Schimp. in B.S.G., Bryol. Eur. 3: 110. f. 236 1845. Fig. 18.

Plants in dense dark-green to nearly black cushions. Stem 0.3-1.5 cm high, with central strand, more or less branched. Leaves of lower stem and branches small, less than 1 mm long, strongly concave, muticous, or similar with the upper stem leaves, larger (to 1.5 mm long) and hairpointed. Costa percurrent or ending below the apex. Hyaline hairpoint in upper leaves up to 1/3 of leaf length, but often shorter, towards its base broader and flattened, and irregularly serrate. Upper lamina cells unistratose except along the bistratose margins, 7-10 μm, with incrassate cell walls. Basal cells rectangular, up to 60 x 15-20 μm, with thin, straight walls. Autoicous. Seta 0.2-0.3 mm, curved. Capsula deeply immersed, subglobose, 0.6-0.8 mm long. Peristome and annulus absent. Operculum nearly plane, bluntly mucronate. Calyptra mitriform. Spores 8-11 μm, granulate.

**Grimmia anodon** is easily distinguished from all other *Grimmia* species by the absence of a peristome and the subglobose, ventricose capsule borne on distinctly curved and very short seta. These characters are practically always useful, since capsules are present in nearly all the cushions. Sterile materials can be identified by the ovate leaves, with the hairpoint becoming broader ("decurrenting") on lamina. The only similar species is *G. plagiopodia*, which, however, differs in the lamina being unistratose throughout, while in *G. anodon*, the margins are bistratose.

The range of development of hairpoint in *G. anodon* varies greatly. Some cushions look very hoary, but some consist mostly of stems and branches with muticous leaves, with the hairpointed leaves present in the uppermost portion of fertile shoots. When totally sterile, such expressions look much alike some species of Pottiaceae.

**Distribution:** The species is known from many countries in Western Europe from Pyrenees to Scandinavia. In the European part of the former USSR, it occurs in Kola Peninsula and also to the south - Ukraine (both mainland and Krym) and South-East. Also it is known from Caucasus, South Siberia, Middle Asia, Chukotka Peninsula, Mongolia, Tibet in China, India, South-West Asia, Northern Africa (Algeria, Morocco), Western North America (from California to Alaska) and Greenland. Reported also from the Great Antilles Is. The general distribution obviously seems related to more or less xeric territories, avoiding the humid East Asia and Eastern North America. In Altai *G. anodon* is not rare. Its typical habitat in the most part of Altai is dry rock outcrops where it grows in the distal corner of an overhanging cliff. The difference is, however, in xeric areas of South-Eastern Altai at the Kuraiskij Mt. Range - here *G. anodon* occurs everywhere, often forming extensive tufts on the upper surface of rocks. It probably is the most abundant epilithic moss here at 2000-2300 m alt.
Specimens examined: Ak-Turu Creek 2600 m (Bardunov 19.VII.1966); Berektuyuyryk 1600 m (0/478); Bogoyash Creek, upper course 2350 m (36/340), 2400 m (36/329), 2500 m (36/333), 2550 m (36/250); Chulyshman against Uandu Creek mouth 1950 m (36/301); Kauru-bazi Peak 2100 m (13/31; 13/50); Kayakkatuyarykskij Creek 2150 m (7/113); Kobiguayuk Creek 2240 m (0/724), 2300 m (0/480); Kokorya Creek 2100 m (32/2; 32/6), 2200 m (32/17), 2400 m (32/1; 32/3); Kukol 1800 m (0/721), 1900 m (0/479; 0/722; 0/726; 0/727), 2000 m (0/723); Tabozhok Creek, 12 km upstream 2200 m (30/12; 30/13; 30/14; 30/2); Tabozhok Creek, 8 km upstream 2050 m (30/4), 2100 m (30/3; 30/5), 2200 m (30/6), 2250 m (30/1; 30/11; 30/7), 2500 m (30/10); Tabozhok Peak 2100 m (31/2), 2350 m (31/4), 2380 m (31/264), 2500 m (31/1; 31/3); Tokpak Creek, upper course 2400 m (36/359); Tutuoyuk Creek 2500 m (Zolotukhin & 15.VII.1990);

Plants robust, in loose rigid, green to yellow-green tufts. Stem up to 6 cm long, ascending, moderately branched, with central strand. Leaves imbricate when dry, reflexed soon after wetting, but then spreading, 3-4 mm long, keeled, margins recurved on both sides. Hyaline hairpoint relatively short, 1/7-1/3 of lamina length. Upper lamina cells bistratose with a 3-5-stratose margin, irregularly papillose, 8-12 μm, with incrasate walls. Basal cells at margin rectangular, in paracostal area longer, with sinuose longitudinal walls and thin transverse walls. Incrassate walls. Basal cells at margin rectangular, with straight walls, in paracostal area longer, with stratose margin, irregularly papillose, 8-12 μm, with incrassate walls. Operculum convex with long conic beak. Capsula horizontal to pendent, doesn’t exceed perichaetial leaves, 1.5 mm long, elliptic, ribbed. Peristome teeth erect, linear-lanceolate, cribrose or irregularly 2-3-cleft above, red-brown and smooth below. Seta arcuate when wet, 2-3 mm long. Capsula horizontal to pendent, doesn’t exceed perichaetial leaves, horizontal to pendent, Dioicus. Seta arcuate when wet, 2-3 mm long. Peristome teeth lanceolate, cribrose or irregularly 2-3-cleft above, red-brown and smooth below. Yailyu River, in middle course 1100 m (9/104); Inya River, in middle course 1100 m (9/104); bayas Lake 1750 m (0/467); Bogypash Creek, upper course 2400 m (36/331, 36/98); Chamanj Creek, upper course 1800 m (34/102, 34/139, 34/201); Chemal 450 m (29/6); Chukha River, in middle course 1100 m (9/104); Inya 800 m (Melnichuk 19.VIII.1953 LWS! 3446; Melnichuk 20.VIII.1953 LWS! 3447; Melnichuk 19.VIII.1953 LWS! 3452; Melnichuk 20.VIII.1953 LWS! 3455); Kairu-bazhi Peak 2100 m (13/37); Karagat 500 m (Zolotukhin 10.VIII.1988); Kayak Lake 2280 m (7/187); Kayakatuyaryksij Creek 1850 m (8/170, 8/331; 8/82), 1900 m (8/169), 2000 m (3/200, 8/324), 2050 m (3/13, 3/46, 5/17, 7/17), 2100 m (7/106), 2200 m (4/11, 7/97), 2250 m (6/25, 7/102, 7/102b), 2300 m (7/6), 2650 m (7/42); Kobuganuk Creek 2150 m (4/460), 2300 m (2/904); Kokorya Creek 2100 m (32/38); Malak Yalom 1000 m (25/7); Seminskij Pass 1750 m (Makarov 15.VI.1972); Srednij Shaltan Creek 1000 m (9/905); Tabozhok Creek, uppermost right branch 2700 m (36/363); Tabozhok Peak 2350 m (31/5), 2500 m (31/16), 2700 m (31/17); ust-nezya 800 m (Melnichuk 22.VIII.1953 LWS! 3448); Yailust 450 m (9/903).


Plants green to dark green above, brown to black below, in loose tufts or rather dense cushions. Stem up to 2-3 cm high, with poorly developed central strand. Leaves flexuose-contorted when dry, narrowly lanceolate (length:width ratio about 6:1), up to 3 mm long. Hyaline hairpoint short, usually less than 1/5 of lamina length. Upper lamina cells bistratose, 3-5-stratose leaf margin and the obviously papillose cells. The distinctively ribbed capsules on a curved seta is also diagnostic for G. elatior.

Grimmia incurva is constant in its vegetative characters. We have seen one unusual collection (8/169) of robust plants to about 10 cm high with submuticous leaves and very-high papillae. It was found in abundance on a rather xeric and shrubby rock-field in subalpine zone.

Distribution: Grimmia elatior is known from many countries in Northern Atlantic and Central Europe; in the former USSR - in mountains of European part (Carpathians, Knibiny, Ural, rarely in lowland, and in Baltia), Caucasus, mountains of Middle Asia and throughout the Siberia and Far East, and also in the Siberian and Beringian Arctics. It is reported from Mongolia, China (southward to Fujian Province), North America (boreal mountains southward to Colorado), and Greenland. In Altai it is one of the most common epithitic mosses, occurring in all altitudes and in nearly all the climatic zones, except the most xeric zone. In forest zone it occurs in more or less open places on rocks and boulders, often covering the latter all around. Above the tree line G. elatior survives on open rock surfaces only in permanently wet habitats (near waterfalls, etc.). It however is one of the most common species in alpine zone, growing in the well-sheltered rocks or deep crevices between rocks up to the "depth of arm" and more. In the latter habitat, it was found with sporogones probably more often than in any other types of habitats.

Specimens examined: Altynish Creek 2050 m (Zolotukhin 7.VI.1982); Astystu Creek 1100 m (Zolotukhin 8.IX.1987); Aylyushnak Creek 2500 m (0/468); Bayas Lake 1750 m (0/467); Bogypash Creek, upper course 2400 m (36/331, 36/98); Chamanj Creek, upper course 1800 m (34/102, 34/139, 34/201); Chemal 450 m (29/6); Chukha River, in middle course 1100 m (9/104); Inya 800 m (Melnichuk 19.VIII.1953 LWS! 3446; Melnichuk 20.VIII.1953 LWS! 3447; Melnichuk 19.VIII.1953 LWS! 3452; Melnichuk 20.VIII.1953 LWS! 3455); Kairu-bazhi Peak 2100 m (13/37); Karagat 500 m (Zolotukhin 10.VIII.1988); Kayak Lake 2280 m (7/187); Kayakatuyaryksij Creek 1850 m (8/170, 8/331; 8/82), 1900 m (8/169), 2000 m (3/200, 8/324), 2050 m (3/13, 3/46, 5/17, 7/17), 2100 m (7/106), 2200 m (4/11, 7/97), 2250 m (6/25, 7/102, 7/102b), 2300 m (7/6), 2650 m (7/42); Kobuganuk Creek 2150 m (4/460), 2300 m (2/904); Kokorya Creek 2100 m (32/38); Malak Yalom 1000 m (25/7); Seminskij Pass 1750 m (Makarov 15.VI.1972); Srednij Shaltan Creek 1000 m (9/905); Tabozhok Creek, uppermost right branch 2700 m (36/363); Tabozhok Peak 2350 m (31/5), 2500 m (31/16), 2700 m (31/17); ust-nezya 800 m (Melnichuk 22.VIII.1953 LWS! 3448); Yailust 450 m (9/903).
Fig. 19. Grimmia elatior Bruch ex Bals. et De Not. (from Kobiguayuk Creek 2150 m Ignatov 0/469): 1 - peristome tooth; 2 - basal leaf cells; 3 - habitus; 4 - leaf. Scale bars: 2 mm - for 3; 1 mm - for 4; 100 μm - for 1, 2.
Fig. 20. Grimmia incurva Schwaegr. (from Kobiguayuk Creek 2700 m 0/902): 1 - middle leaf cells; 2 - habitus; 3 - basal leaf cells; 4 - leaf; 5 - peristome teeth. Scale bars: 2 mm - for 2; 1 mm - for 4; 100 µm - for 1, 3, 5.
easy recognizable in the field. The variation in *G. incurva* mostly concerns the degree of development of hairpoint. In “difficult” habitats the hairpoints can become reduced, so that only upper leaves are shortly hairpointed. Further reduction of leaf hairpoint is observed in several places in the upper alpine zone where *G. incurva* grows on soil: plants are much smaller; leaf is to only 1.5 mm long, perfectly straight, more or less fragile, muticous, costa filling the whole upper half of the leaf. The leaf basal area has the strongly elongate cells reduced to just several rows of rectangular cells (Fig. 21). This expression may become difficult to determine as *G. incurva* (or even to the family Grimmia-ceae), if transitional forms with hairpoint are not present.

**Distribution:** The species is known from the mountains of Europe, from Pyrenees to Scandinavia and Iceland. In the former USSR, it is known from the Arctic (Novaya Zemlya, Chukotka), Kola Peninsula, Baltia, Carpathians in Ukraine, South Ural Mts., Caucasus, Mountains of South Siberia, northern part of the Russian Far East. Present also in Mongolia, China (Tibet and East China), North America (in mountains southward to California) and Greenland. In Altai *G. incurva* is a common species in subalpine and alpine zones. It is distributed from about the timber line to the highest altitudes investigated. Habitat preferences of *G. incurva* are similar to that of *G. elatior*, since both have robust plant body which
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enables them to exist without more or less frequent moisturising. As a result, *G. incurva* grows between rocks in rock-field, inside cliff crevices and other sheltered places, usually avoiding exposed surfaces. However, in upper alpine zone *G. incurva* grows sometimes on exposed rocks and soil, forming the unusual expressions discussed above.

Specimens examined: Ayulyuyuzyuk Creek 2500 m (0/927); Bogogay Creek, upper course 2600 m (36/99); Booshkon Pass 2600 m (Zolotukhin 1.VII.1990), 2700 m (Zolotukhin 5.VII.1990); Karakol Lakes 1950 m (28/111); Kayakkatu-garyskij Creek 1900 m (6/23), 1930 m (3/139; 3/260), 1950 m (8/336), 2000 m (3/264; 3/270; 3/72), 2050 m (7/38), 2350 m (7/168; 7/171; 7/4), 2600 m (7/50), 2650 m (7/78), 2850 m (7/57), 2966 m (7/56); Kobguayuk Creek 2500 m (0/471), 2700 m (0/901; 0/902; 0/907), 2750 m (0/934), 2830 m (0/906), 2900 m (0/883), 2908 m (0/187; 0/361; 0/421; 0/930); Pass between Bashkauas & Prayoi Bogogyay 2900 m (36/346); Pass between Kolbakaya and Saluiru Creeks 2400 m (36/71); Tabozhok Peak 2750 m (31/13; 31/14), 2780 m (31/12; 31/8); Tamanel Peak 2150 m (34/87; 34/88); Trekhglavaya Peak 3151 m (Zolotukhin 19.VII.1990); Uzunkul Lake 2050 m (Zolotukhin 23.VI.1990); Uzunoyuk Creek, upper course 2400 m (Zolotukhin 9.VII.1990).


Dioicous plants with sexual dimorphism, forming loose tuft, up to 2-3 cm high. Male cushions golden-yellow above and dark-brown to black below. Female cushions blackish and hoary. Stem straight, but slender, with central strand, producing thread-like young slender shoots, bearing small cymbiform and carinate, muticous leaves. Leaves lanceolate, keeled, appressed, spirally twisted on male stems, with approximately 3-4 perigonia. The neighbouring "internodes" have 1-2 rows of more elongated cells. In paracostal area cells are elongate. Perichaetial leaves are somewhat larger. Seta arcuate when wet in premature capsula, but only slightly curved when wet in collection with old empty capsules. Capsulae are small (for a *Grimmia* of such height) and slightly ribbed.

As described above, male cushions are greyish above and contrastingly black below. Stem leaves are small, with hair points, and obviously twisted. Usually 3-4 perigonia are found on each stem, with approximately the same distance between them and with a geniculate curvature of stem at those places with perigonia. The neighbouring "internodes" have the different direction of twisting, clockwise/counter-clockwise. The length of hairpoint varies from moderate (in unfavoured conditions) to long. Female plants are considered conspecific with the male plants on the basis of similarity in the leaf areolation pattern and presence of thread-like shoots. Female plants form more robust cushions, because of longer leaves which are only slightly twisted. A rather constant character of female plants is the very long hairpoint which easily distinguishes *G. funalis* from *G. affinis*, a species of about the same size. Sporogones were seen only in 2 collections from Altai: seta is short (hairpoints of perichaetial leaves exceed the capsule), rather stout, arcuate when wet in premature capsula, but only slightly curved when wet in collection with old empty capsules. Capsulae are small (for a *Grimmia* of such height) and slightly ribbed.
Fig. 22. Grimmia funalis (Schwaegr.) Bruch et Schimp in B.S.G. (from Kobiguayuk Creek 2150 m Ignatov 0/908): 1 - peristome; 2, 5, 8 - female plants; 9-10 - male plants; 3 - capsule; 4 - upper leaf cells; 6 - basal leaf cells; 7 - leaf. Scale bars: 2 mm - for 2, 3, 5, 8, 9, 10; 1 mm - for 7; 100 μm - for 1, 4, 6.

Distribution: The species is present in the mountains of Northern and Central Europe and reported from Canaries, Algeria, Greenland and East Nepal. In the territory of the former USSR - in Kola Peninsula (rather common there), Carpathians, Caucasus, mountains of Middle Asia and South Siberia, and also in Siberian Arctic. In Japan, it is known from only 1 locality. In the Altai, G. funalis is a rather common species throughout the subalpine and lower part of alpine zone, especially in more wet areas. In more xeric part of Altai, G. funalis usually occurs only at very high elevations where the influence of surrounding steppe and semi-deserts is minimized.

Specimens examined: Bayas Lake 1750 m (0/913); Bogoyash Creek, upper course 2300 m (36/135), 2400 m (36/335); Dvukhkarovaya Creek 2450 m (36/179); Karabazhi Peak 2100 m (13/38; 13/45), 2300 m (13/133; 13/30); Karakol Lakes 1900 m (28/121); Kayakhatuyaryksky Creek 1750 m (8/10), 1950 m (3/112), 2000 m (3/165), 2050 m (3/107; 3/33; 3/52; 3/69; 7/35), 2200 m (6/182), 2350 m (7/5; 7/7); Kobiguayuk Creek 2150 m (0/469; 0/470; 0/908; 0/910), 2200 m (0/911), 2220 m (0/914), 2350 m (0/912), 2370 m (0/2350; 0/297), 2500 m (0/916).

Plants medium in size, rather dense dark-green to dark-brown tufts. Stem ascending, up to 3 cm high, with central strand. Leaves lanceolate, muticous, concave, with incurved margins and narrowly obtuse cucullate apex, 2.0-2.5 mm long. Costa ends below the apex. Upper lamina cells bistratose, not translucent, rounded, ca. 6 μm. Basal cells at margin thick-walled, quadrate to short-rectangular; in larger leaves concave, with quadrate to margin thick-walled, cells. Operculum with short obtuse beak. Calyptra below. Annulus of 3 rows of subquadrate, thick-walled, perforated, densely papillose above, less papillose teeth erect, rigid, dark-red, nearly entire, slightly the seta attaching to urn in a depression. Peristome curved, yellow-brown. Capsula exserted, yellow-brown longitudinal walls. Dioicous. Seta 2-3 mm long, 3:1. Laminal cells in paracostal area linear, with thick-walled; basal cells shortly rectangular. Dioicous. Spores 8-12 μm, nearly smooth.

Muticous leaves with a rather cucullate apex allow an easy distinction of Grimmia unicolor from all other Altaian Grimmia. Some expressions of G. affinis and G. incurva, growing in unfavourable conditions, can produce muticous forms, but the two taxa never have cucullate apex, and also they form usually small and dense cushions, while under normal condition, G. unicolor is a rather robust plant. Contrary to the widespread report that the seta of G. unicolor is straight when wet, we found geniculate or curve setae in some cushions with numerous sporogones. At the same time the seta is not hygroscopic and the changing moisture does not affect the characteristics of curvation. Capsula is usually somewhat ribbed, though not always, and definitely constricted both below the mouth and at base as in G. pulvinata, G. elatior, and other members of the subgenus Rhabdogrimmia.

Distribution: The species is widely distributed in Northern Hemisphere, known from Northern Europe and mountains of Atlantic and Central Europe. In the former USSR, it is known from Kola Peninsula, Polar Urals, Caucasus, mountains of Middle Asia and South Siberia. Also present in Mongolia (Khangai Mts.), China (Tibet, Shanxi, Jilin) and has been reported from India and North America (scattered in boreo-temperate regions). In Altaï G. unicolor is not common, occurring usually on wet and relatively basic rocks (schists) mostly in subalpine zone, rarely in forest and alpine zones.

Specimens examined: Ak-Turu Creek 2600 m (Bardunov 18.VII.1966 IRK!); Artystash 450 m (Melnichuk 3589 LWSI); Kauru-Bazhi Peak 2100 m (13/162; 13/21; 13/41; 13/49); Kayakatuzyanskij Creek 1900 m (3/268; 8/158; 8/163), 1920 m (3/147), 2050 m (3/12; 3/32; 3/61; 3/84), 2280 m (7/11); Kobiguayuk Creek 2220 m (0/464); Pass between Kolbakaya and Salauri Creeks 2400 m (36/347); Tabozhok Creek, uppermost right branch 2700 m (36/363).

Hydrogrimmia Loeske


. Stem 1-2 cm high. Leaves 1.5-2.5 cm long, costa narrow, ca. 0.01 mm. Upper lamina cells ca. 20 μm; basal cells at margin and in paracostal area similar, 30-40 μm long, 20-25 μm wide. Altaian plants sterile.

As a member of Grimmiaeae, there is no problem in determining a specimen of Hydrogrimmia mollis because of its unusually large quadrate cells and large leaves which are broadly rounded at the apex.

Distribution: Hydrogrimmia mollis has a Holarctic range which was discussed in details by H. Bednarek-Ochyra & al. (1990). Probably the only region where it is common is the Northern Europe, including Scandinavia and Kola Peninsula. In Central Europe it is a rare montane moss. Specimens from the former USSR were seen from Kola Peninsula, Polar Ural, Caucasus, Chukotka, northern part of Russian Far East and Altai. Recently it was reported for Japan from a single locality (Iwatsuki & al., 1986). Also it is known from North America (rare in Yukon, Rocky Mountains, Labrador, Greenland). In Altaï H. mollis was found well above the tree line on rocks in dry brook bed, in seepy lithosol from melting water of snow bed, and among big rocks in the rock-field.

Specimens examined: Ayulguyuyuk Creek 2500 m (0/466); Pass between Bashkaus & Pratyg Bogoyash 2600 m
Fig. 23. Grimmia unicolor Hook. ex Grev. (from Kayakkataryksij Creek 2050 m 3/84): 1 - capsula; 2 - peristome teeth; 3 - habitus; 4 - basal leaf cells; 5 - leaf. Scale bars: 2 mm - for 1, 3; 1 mm - for 5; 100 µm - for 2, 4.
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Fig. 24. *Hydrogrimmia mollis* (Bruch et Schimp. in B.S.G.) Loeske (from Ayuluguyuk Creek 2500 m Ignatov 0/466): 1 - cells of leaf tip; 2 - basal cells; 3 - leaf. Scale bars: 1 mm - for 3; 100 μm - for 1, 2.
Schistidium Brid.

Plants slender to robust, yellowish-green, green, reddish-brown or blackish-green tufts. Stem erect to ascending, frequently branched, with or without central strand. Leaves erect when dry and spreading when moist, lanceolate to ovate, keeled to obtusely keeled, muticous or ending in hyaline hairpoint. Margins recurved on one or both sides, uni- or bistratose, entire, or in S. strictum, slightly toothed above. Costa stout, terete, percurrent or subcurrent, smooth or papillose on abaxial surface. Upper lamina cells quadrate or almost so, with thick walls. Basal cells at margins quadrate to short rectangular, in paracostal area, rectangular, with straight or slightly sinuose margins quadrate to short rectangular, in paracostal area, rectangular, with straight or slightly sinuose walls. Parichaeiata leaves of the same shape, but larger and with extensive zone of thin-walled rectangular cells in its lower half. Autoicous (Altaian species). Seta straight, shorter than urn (except G. agassizii). Capsula erect, immersed, oblong-cylindric to hemispheric. Peristome teeth 16, well-developed (in Altaian species), bright-red to red-brown, lanceolate, entire, or in S. strictum, (36/79); Uzunoyuk Creek, upper course 2400 m (Zolotukhin 9 VII.1990).

KEY TO THE ALTAIAN SPECIES OF SCHISTIDIUM

1. Leaves totally muticous, capsule broadly hemispheric, spores 12-19 μm

2. Leaves with hairpoint or submuticous, at least with hyaline apical cells in upper leaves, capsule oblong-cylindric, spores 9-13 μm

3. Leaves broadly ovate, bi- to tristratose along the margins, seta shorter than urn

4. Abaxial cells of costa distinctly papillose, plants typically in rather loose, red-brown tufts

SCHISTIDIUM AGASSIZII Óull. et Lesq. in Sull., Musci Hep. U.S. (repr.) 104. 1856. Fig. 25.

Plants in dark green to nearly black tuft. Stem up to 5 cm long, ascending, or prostrate in frequently submerged populations, with central strand. Leaves lanceolate, 1-3 mm long (perichaetial leaves up to 4.5 mm), obtuse or obtusely acute, concave, muticous. Costa percurrent or ending a little below the apex. Upper lamina cells unistratose, including margins, quadrate-rounded, 9-11 μm. At leaf bases are a small groups of short-rectangular cells. Autoicous. Seta up to 1 mm long, about as long as urn. Capsula submersed, obconic, with broad mouth. Peristome teeth big, up to 0.6 mm long, narrow-triangular, red, papillose, more or less cribose, irregularly cleft above, especially along median line. Operculum with oblique beak. Calyptra cucullate. Spores smooth, ca. 15 μm.

Deguchi (1979b) clarified the typification of Grimmia alpicola. Bremer (1980) proposed that the names G. alpicola and Schistidium alpicola be placed on the list of rejected names. In this case, the species with narrow leaves will then be named Schistidium agassizii or Grimmia agassizii (Cao & Vitt, 1986).

Schistidium agassizii is easy to recognize by its very narrow and long leaves with unistratose margins. When growing submerged, the leaves of S. agassizii often become decomposed and only the costae remain persistent, except in a few uppermost leaves.

Distribution: For a long time this species was known under the name Schistidium alpicola var. alpicola, while S. rivulare was named S. alpicola var. rivulare or S. alpicola var. latifolia. Since many publications referred only to S. alpicola, the actual range of S. agassizii is still little known. In Europe, S. agassizii is known in many countries from Lusitania, Spain, Italy, Bulgaria to Iceland and Scandinavia. In the former USSR, it is known from Siberian and Beringian Arctic, northern part of European Russia, penetrating southward along the coast to Baltic countries, Caucasus, mountain areas of South and East Siberia, Far East and Middle Asia. In North America S. agassizii is bicentric, being widespread in mountains in the West from Alaska, Yukon to California and Colorado, and in the East from Newfoundland to New York. S. agassizii has not been reported so far from China and Mongolia. In Altai S. agassizii is known only from a single creek basin, where, however, it is frequent in a number of creek tributaries in alpine and subalpine zones. Populations grow on rocks along streams and beside waterfalls occurring constantly for kilometers along banks.
Fig. 25. Schistidium agassizii Sull. et Lesq. in Sull. (from Kayakkatsarykskiy Creek 2050 m Ignatov 7/139): 1 - habitus; 2 - peristome teeth; 3 - leaf; 4 - basal cells. Scale bars: 2 mm - for 1; 1 mm - for 3; 100 μm - for 2, 4.
*Grimmia rivularis* Brid., J. Bot. (Schrader) 1(2): 276. 1801.

*Grimmia alpicina* Hedw. var. *rivularis* (Brid.) Wahlenb., Fl. Lapp. 32. 1812.

Plants medium to robust, in loose, large tufts, dark-green above, black below. Stem up to 4 cm high, with central strand. Leaves 1.5-3.0 mm long, ovate-lanceolate to ovate and nearly triangular, acute, with broadly recurved margins, muticous. Costa thick, percurrent. Upper lamina cells rounded, ca. 10 μm in diameter, slightly mamilllose, so that the margin looks denticulate. Basal cells at margin quadrate or very shortly rectangular, up to 1:5; in paracostal area, rectangular, up to 2.5:1. Autoicous. Seta shorter than urn, ca. 0.3 mm long. Capsula immersed, dark-diametric, slightly mamillose, so that the margin looks percurrent. Upper lamina cells rounded, ca. 10 μm broad. Operculum convex, with oblique beak. Calyptra cucullate. Spores 13-17 μm.

**Schistidium rivulare** is a robust plant with broad muticous leaves and nearly always present hemispherical capsules with massive bright-red peristome teeth. In some ambiguous cases it can be distinguished from *S. agassizii*, by the unistratose margins of the latter.

**Distribution:** *Schistidium rivulare* is distributed throughout the Holarctic, being however rarer or absent in the lowland. In the territory of former USSR, it occurs in nearly all regions. Outside Holarctic, it was reported from the Himalayas, Central Africa, Central America (Ecuador) and Australia. In Altai this species is distributed mostly in alpine zone, typically on wet, sometimes over-flooded rocks, rarer in other habitats on rocks (in alpine and forest zones), or on soil (in alpine zone).

*Specimens examined:* Ayulyuyuzyuk Creek 2500 m (8/15); Bardak Lake 1950 m (0/900); Inya 800 m (Vysozkaya 15 VII 1977 LB! 9217); Karakol Lakes 1900 m (28/139); Kayakkatuyarykskij Creek 1750 m (8/15); 1700 m (8/235); 1830 m (8/58); 2050 m (7/139; 7/15).


Plants in more or less dense tufts, green or dark-green above, black below. Stems (1)1.5-3 cm high, with central strand. Leaves lanceolate from an ovate base, 1.5-2.5 mm long (perichaetial leaves up to 3.5 mm long), keeled above, with variously developed hairpoints from only a few hyaline cells in uppermost leaves (lower leaves muticous) to about 1/5-1/3 of the entire laminal length. Upper lamina cells irregularly isodiametric to subquadrate, barely papillose hairs. Operculum with short straight beak. Calyptra small, cucullate. Spores 7-12 μm, smooth.

Most treatments describe *Schistidium apocarpum* as a very variable species. Altaian materials can confirm this statement. The most common expression in Altai has medium to robust plants (for the genus) forming dull-green or blackish-green tufts, with weekly developed hairpoints (sometimes present only in perichaetial leaves), and triangular (not attenuated) peristome teeth. Such plants were observed on calcareous rocks (often covered by alluvium) along Katun River and in the region of Teletzkoye Lake at lower altitudes. Other plants, especially that on xeric rocks, have a more slender appearance, almost black in its tuft coloration during mid- to late summer, and with rather developed hairpoints. This form could become very similar to the weakly papillose form of *S. strictum*. Under the circumstance, the different sizes of cells at leaf base can be used for their respective identification, since this character seems to be constant in these two species. In alpine zone, *S. apocarpa* is rare and more or less uniform in morphology, forming more lowly and denser tufts.

**Distribution:** *Schistidium apocarpum* s.l. is a species of world-wide distribution from polar to temperate zones of both hemispheres, occurring also in high mountains in low latitudes. In Europe it is known from all the countries and in the former USSR, from all regions. It is especially common in lowlands, probably because of its preference of calcareous rocks. On acidic rocks *S. apocarpum* is less common, while

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Fig. 26. *Schistidium rivulare* (Brid.) Podp. (from Ayulyuyuzyuk Creek 2500 m Ignatov 0/430): 1 - peristome teeth; 2 - habitus; 3 - capsule; 4 - cells of leaf tip; 5 - leaf; 6 - cells of leaf base. Scale bars: 2 mm - for 2, 3; 1 mm - for 5; 100 μm - for 1, 4, 6.
Fig. 27. *Schistidium apocarpum* (Hedw.) Bruch et Schimp. in B.S.G. (from Kobiguayuk Creek 2750 m Ignatov 0/885): 1, 8 - leaves; 2, 7 - cells of leaf tip; 3 - upper lamina cells; 4 - middle lamina cells; 5 - habitus; 6 - parts of peristome; 9 - cells of leaf base. Scale bars: 2 mm - for 5; 1 mm - for 1, 8; 100 μm - for 2, 3, 4, 6, 7, 9.
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S. strictum become more frequent. Consequently, in Altai S. apocarpum is rather rare, especially in comparison with the very abundant S. strictum (the same situation is also true in China and Japan). In the study area, most of its localities are situated in the valley of Katun River, from the Chuya mouth and downstream, at 1000 - 300 m alt. Only a few other collections are known from the northern shore of Teletzkoye Lake in the alpine zone.

Specimens examined: Bogoyash Creek, upper course 2350 m (36/370), 2400 m (36/373); Chemal 400 m (29/66), 420 m (29/17, 29/54); Chuke-Taman Pass (Vysozkaia 12.VII.1977 LB!) 1600 m (Vysozkaia 12.VII.1977 LB!); Kobogayak Creek 2750 m (0/885); Matyi Yaloman 800 m (25/31), 950 m (25/163); Taldura 2200 m (Krylov 18.VII.1903 LE); Ust-Sema 400 m (Vysozkaia 14.VII.1977 LB! 57.77); Yailyu 450 m (1/75).

In one collection from subalpine zone (Bayas Lake 1950 m 0/936) we have found a form which was preliminary identified as *Schistidium helveticum* (Schkuhr) Deguchi, Rev. Bryol. Lichenol. 45: 434. 1979 - *Grimmia helvetica* Schkuhr, Deutschl. Krypt. Ges. 2(2): 48. pl.21. 1811. (Fig. 28). This is not enough clear species for us, so it is discussed briefly.

Plants in compact brownish-green tufts. Stem 2 cm high, with central strand. Leaves lanceolate, up to 2 mm long, muticous, obtusely keeled, with recurved margins. Costa percurrent. Upper lamina cells rounded, ca. 10 mm in diameter. Basal cells at margin quadrate, becoming short-rectangular in paracostal area. Autoicous. Seta ca. 0.3 mm long. Capsula immersed, oblong-cylindric. Peristome teeth lanceolate, rather short, 0.25 mm long, papillose, yellowish above, red below. Operculum obtusely beaked, cucullate, ca 12 mm, nearly smooth.

From *S. agassizii* and *S. rivulare*, this species differs in having oblong-cylindric capsules, a
much less massive peristome, and smaller spore size. From *S. apocarpum* it differs in having totally muticous leaves, smaller leaf size, shape of cells at leaf base, and by the rounded, somewhat mamilllose, cells of the upper lamina. This species is intermediate in many ways between *S. rivulare* and *S. apocarpum*.


Fig. 29. *Schistidium strictum* (Turn.) Loeske ex Maort. (from Kukol 1800 m Ignatov 0/432): 1 - peristome teeth; 2 - cells of leaf tips; 3 - leaves; 4 - cells of leaf base. Scale bars: 1 mm - for 3; 100 μm - for 1, 2, 4.
Grimmia stricta Turn., Musc. Hibern. Spic. 20, pl. 2: f. 1. 1804

Plants rather slender, in loose tufts, green above and red-brown or ferruginaceous below. Stems up to 5 cm high, with distinct or often indistinct central strand. Leaves ovate-lanceolate to lanceolate, up to 3 mm long, keeled above, with recurved margins which are often obtusely serrate above, and sometimes reaching mid-leaf level. Costa moderately thick, papillose at back in upper half. Hyaline hairpoints developed in many leaves, 1/7-1/3 of the lamina length. Upper lamina cells 5-7 µm wide; basal leaf cells at margins especially when being flooded or growing in snow and largely beaked. Calyptra small, cucullate. Spores ca. 10 µm, smooth.

Schistidium strictum is a rather uniform in Altai. Rather slender plants constitute variously variegated tufts. Upper leaves are often green, but becoming ferruginaceous (reddish-brown) soon with age, so that a large part of the tuft (and sometimes the whole tuft) is of this color. Such change in coloration was never observed in S. apocarpum. In some alpine situations, especially when being flooded or growing in snow melt near temporary snow bed, S. strictum could loose this specific color, becoming darker, up to totally black; but this is a rare phenomenon. The most important character for distinguishing of S. strictum is its papillosity on the abaxial surface of costa in the upper portion of leaf (easily observed under the stereo-microscope).

However, degree of papillosity varies considerably and in some (few) collections costa was nearly smooth. However, the combination of other characters such as slender appearance, variegated coloration of tufts, with or without a poorly developed central strand, long hairpoints on most of the leaves, and the somewhat attenuate peristome teeth, allow the attribution of such forms to S. strictum. Leaf hairpoint is usually present on stem leaves, without a sharp difference in perichaetial leaves. Peristome teeth are uniformly attenuate, unlike the mostly triangular teeth of S. apocarpum (although in some of the Altaian specimens attributed to S. apocarpum, their peristome teeth are also attenuate).

Distribution: Schistidium strictum have been reported from many European countries. We saw materials from Great Britain (including the type specimen), Belgium, Hungary, Estonia, Ukrainian Carpathians, most regions of Asiatic Russia, Caucasus, mountains of Middle Asia, Mongolia, China, Japan, India and from temperate to arctic North America. The species is also reported from Mexico, Guatemala and Hawaii. In most regions in Europe, S. strictum is much less frequent than S. apocarpum. The situation is reverse in the Asian parts of the former USSR (including the Altai) and in China and Japan where S. strictum is common and abundant in all zones (in Mongolia, however, S. strictum was reported to be rarer than S. apocarpum). In Altai S. strictum is fairly common in all altitudes. It grows on rocks in wide range of habitats. Occasionally (several observations), it grows also on tree trunks (especially on inclined trunks of Betula alba) and rotten logs (leafy trees and conifers), among other mosses, in rather sunny places, in lower forest and taiga zones.

Specimens examined: Artbyash 450 m (22/2); Artbyshai Creek 600 m (Zolotukhin 20.IX.1983); Ayukol 1000 m (0/896); Ayuljapuzyuy Creek 2100 m (0/133); Bajguzan 450 m (19/1); Bayas Creek 850 m (16/39); Berekhtuyaryk 1600 m (0/433); Bolshoi Shaltan Creek 530 m (0/886); Bolshoye Isyube Creek 470 m (18/122; 18/51; 18/96); Buzguzan Creek, at mouth of Salyugem Cr. 2100 m (Pavlov V.N. 19.VIII.1993); Chema 400 m (29/30), 500 m (Makarov 27.VI.1972); Chemal Creek, 3 km upstream 450 m (34/211); Chirl 450 m (17/51; 17/93); Chukha River, in middle course 1100 m (9/162); Derbogach 450 m (0/34); Kairu Creek, 8 km upstream 1000 m (15/108; 15/129); Kairu-Bazhi Peak 2100 m (13/27; 13/82) 2150 m (13/154); 2300 m (13/1; 13/117); Kamga Bay 450 m (Zolotukhin 20.X.1988); Kamga Creek, 12 km upstream 550 m (0/102); Karagat 440 m (0/274; 0/285; 0/894), 450 m (Zolotukhin 11.VIII.1988; 0/892), 500 m (Zolotukhin 10.VIII.1988); Kayakhatuyaryk Creek 1850 m (8/53), 1900 m (8/273); 1920 m (3/134), 1940 m (3/281), 1950 m (3/113), 2000 m (3/241), 2050 m (3/109; 3/19), 2280 m (7/8); Kishte 440 m (Zolotukhin 11.VIII.1988); Kobuguyak Creek 2000 m (0/734), 2150 m (0/887), 2300 m (0/733), 2400 m (0/327), 2800 m (0/890); Koubukhtuska 440 m (Zolotukhin 28.III.1988); Kukul 1750 m (0/895), 1800 m (0/432); Kumiz 450 m (20/26); Kuga River, 2 km upstream 300 m (0/434); Malji Yakoman 950 m (25/140); Malji Yakoman Creek, 2 km upstream 950 m (25/179); Malji Yakoman Creek, 7 km upstream 1000 m (25/65); Ok-Porok Creek, at mouth 440 m (Zolotukhina 30.III.1988) 470 m (2/15; 2/24; 2/45); Tabozechok Creek, 12 km upstream 2200 m (30/19); Tabozechok Peak 2100 m (31/278); Tura Creek, in middle course 1300 m (28/24); Ust-Sema 580 m (24/20; 24/90); Yailiyu 450 m (0/888; 1/19), 470 m (0/889), 550 m (0/891); Yakhanorsu Lake 1870 m (Zolotukhin 28.VI.1990); Yazzula 1520 m (0/893).


Plants small, forming dense, reddish-brown to green cushions. Stem 0.5-1.0 cm high, without cen-
Fig. 30. *Schistidium hiliputanum* (C. Muell.) Deguchi (from Kobiguayuk Creek 2000 m Ignatov 0/953): 1 - peristome teeth; 2 - cells of leaf tip; 3 - habitus; 4 - cells of leaf base; 5, 6 - leaves. Scale bars: 2 mm - for 3; 1 mm - for 5, 6; 100 μm - for 1, 2, 4.
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Schistidium liliputanum differs from S. apocar-pum in having very small stem leaves that are markedly contrasting with the much larger perichaetial leaves. In S. apocarpum, stem leaves gradually change into the size of perichaetial leaves. Also, leaf basal cells are much smaller in S. liliputanum than in S. apocarpum, and have a much more thickened and somewhat sinuose cell walls, while in S. apocarpum, the latter has thin and straight cell walls. The differences between S. liliputanum and S. strictum include the smooth abaxial surface of costa and a much smaller plant size. We have not seen small form of S. strictum from Altai as well as from other regions.

The differences between S. liliputanum and European forms described as S. confertum need further observations. The usually mentioned diagnostic features of S. confertum are almost the same as those of S. liliputanum. Some European collections of S. confertum that we examined have plants with small leaf cells just like those seen in S. liliputanum, although the cells have less sinuose walls. In S. confertum, the plants are of different sizes, varying from very small to the average size of S. apocarpum. In addition, there is no obvious size difference between its perichaetial and stem leaves. This last mentioned feature was shown in the drawing of Bremer (1981) for the lectotype of S. confertum. However, the color of peristome in S. confertum and its cribrosity seem too variable to be of use for a delimitation of this species. The same conclusion was reached by Bremer (1981) who was unable to correlate one character with the other. In conclusion, we prefer to keep S. liliputanum as a species apart from S. confertum, even though the only constant difference between these two taxa is the proportion between the stem leaves and perichaetial leaves. The difference in their leaf cell wall thickness at basal margin, mentioned by Deguchi (1979a), appears to be unstable, even with the lectotype of S. liliputanum. The other difference suggested by Deguchi, that of obtusely/sharply keeled leaf, again, seems too arbitrary to call it for a certainty. Judging from his illustrations, we can suppose that Japanese materials of S. confertum probably belong to S. liliputanum.

Distribution: Schistidium liliputanum was described originally from Central China and then found subsequently in North-East China and Mongolia (Mongolia, Darchan, lac. Kossogol. 14.VII.1902. A. A. Elenkin, LE!, sub. S. confertum). In Japan, it is rather widespread in mountains exceeding 3000 m from Hokkaido to Kyushu. In Altai, it was found on rocks in several localities on rather xeric, S-facing slopes and at about tree line elevation, or rarer in forest zone.

Specimens examined: Chulcha River in middle course 1100 m (9/77), Kayakkatugaryksky Creek 1900 m (8/269; 8/274); 2000 m (8/323); 2100 m (7/107), Kobiguayuk Creek 2000 m (0/953).

Racomitrium Brid.

Plants usually robust, in dull extensive mats. Stems creeping to ascending, irregularly to nearly pinnate branching, with central strand. Leaves erect to spreading, lanceolate, acute or acuminate, piliferous in Altaian species, hairpoint papillose or smooth, often more or less serrate or serrulate. Costa single, strong, percurrent to excurrent. Lamina mostly unistratose, often bistratose in upper margins. Upper leaf cells short-rectangular to rectangular, with strongly sinuose walls; lower cells linear, with nodulose walls; basal cells at margin larger, typically short-rectangular, transparent, with straight walls. Dioicus. Archegonia lateral. Seta longer than urn, straight when moist. Capsule symmetric, oblong-ovoid, more or less smooth. Annulus well-differentiated. Peristome teeth erect, fused at the insertion forming basal membrane and split above into 2-3 narrow or filiform divisions. Preperistome present, consisting of hyaline membrane adhering to the base of teeth. Operculum long-rostrate. Calyptra mitrate. Spores spherical.

Key to the Altaian species of Racomitrium
1. Leaves ending in papillose hairpoint ..... 2
1. Leaves ending in smooth hairpoint ..... 4
2. Plants regularly and pinnately branched; leaf cells smooth, hairpoint strongly erose-dentate at margin, costa apparent from base to apex. ... *R. lanuginosum* (p. 119)

2. Plants sparsely and irregularly branched; leaf cells papillose, costa apparent below, in upper half of leaf becoming indistinct from the lamina. 

3. Hyaline hairpoint rather densely papillose; basal leaf cells papillose. *R. canescens* (p. 117)

3. Hyaline hairpoint weakly papillose at most of its length; basal leaf cells smooth. 

4. Plants with numerous short branches, leaf with long and flexuose hairpoint, at base bordered with 10-20 thin-walled cells; upper lamina cells linear or long-rectangular 

4. Plants rare branching, with few short branches, leaf with short hyaline hairpoint, at base unbordered or bordered with 4-8 thin-walled cells; upper lamina cells short-rectangular to quadrate. 

**Racomitrium microcarpon** (Hedw.) Brid., Muscol. Recent. Suppl. 4: 79. 1819[1818].

*Fig. 31.*


Plants in moderately dense mats or cushions, yellowish-green above, blackish below, often grayish due to long hairpoints. Stem up to 4 cm high, with numerous, subpinnately short branches (some long branches also are subpinnately branched with short secondary branches). Leaves lanceolate, often secund, 2-3 mm long, with recurved margins. Costa percurrent, strongly convex, at middle leaf position usually bistratose. Hyaline hairpoint about 1/7-1/4 of lamina length, typically flexuose. Upper lamina cells rectangular (ca 3:4:1) with sinuose walls, basal and middle cells longer (4-6:1); at basal margin cells larger with straight thin walls forming a distinct border of 15-20 cells. Dioicous. Seta ca. 5 mm long. Capsula ovoid, up to 1.5 mm long. Peristome teeth ca. 0.25 mm long, nearly smooth. Anulus persistent. Operculum with long straight beak. Calyptra mitrate. Spores 12-14 μm.

The *Racomitrium heterostichum*-group is represented in Altai by two species, *R. microcarpon* and *R. sudeticum*. From the latter *R. microcarpon* differs well in: 1) a border of 10-20 thin-walled cells along the leaf base (in *R. sudeticum* - 4-8, if present); 2) long-rectangular laminal cells near the apex (in *R. sudeticum*, they are mostly short-rectangular (1.5-2:1) or quadrate near the apex); 3) 3-4 ventral cells of the costa in the mid-leaf (4-6 in *R. sudeticum*); 4) costa bistratose (in *R. sudeticum* tristratose); 5) long and flexuose hairpoint (short and straight in *R. sudeticum*); 6) numerous short branches throughout the stem (rarely branching in *R. sudeticum*).

**Distribution:** The distribution of *Racomitrium microcarpon* was discussed and mapped by Frisvoll (1988) and also by Bednarek-Ochyra et al. (1990). This species is common in Northern and Central Europe, especially in the mountains, but avoiding territories with more warm, temperate climate. In lowland there are only scattered relictual localities (Poland, Baltic Region, Vologda Province in Central Russia). *R. microcarpon* is known further from Polar to Southern Ural Mts., Putorana Plateau in Northern Siberia, mountains of South Siberia, and mountain in Amur River Basin (in these regions in all well-explored areas it appears to be common). In addition, *R. microcarpon* is known from the northern part of Russian Far East, Chukotka Peninsula, Arctic and boreal mountains of North America and Greenland. In Altai it is common in alpine and sub-alpine zone in rather humid areas, while absent in more xeric highlands. Some collections were made on fell fields in taiga and forest zone.

*Specimens examined:* Aguluyayuy Creek 2500 m (0/395); Bardaky Lake 2100 m (11/1); Bolshoye Kurkure Creek, upper course 2300 m (Galanin 8.VIII.1976); Chiik (Altai State Reserve) (M.Schmidt 9.VIII.1935 LE!); Kairu Creek, 16 km upstream 1400 m (14/56); Karakol Lakes 1900 m (28/128); Kayakatkuyaryksky Creek 1850 m (8/111); 1950 m (3/20), 2000 m (3/45); Kobiguyuk Creek 2250 m (0/426); Sostuyuyuk Creek, upper course 2600 m (Zolotukhin 19.VI.1990); Tamanay Peak 2150 m (34/41); Uedinomnoye Lake 880 m (0/938).


*Fig. 31.*

**Trichostomum sudeticum** Funck, Deutschl. Moose 26. f. 18. 1820.

Plants in moderately dense tufts, dark-green above, blackish below. Stem 2-4 cm high, irregularly and dichotomously branched. Leaves erect to secund, 1.8-3.0 mm long, margins recurved, bistratose in upper part. Hyaline hairpoint rather short, typically about 1/10 of laminal length, spinulose. Costa convex, in middle leaf position mostly bistratose. Upper lamina cells short rectangular or subquadrate; basal cells rectangular, up to 4:1, with nodulose walls, at margin forming 5-15 slightly differentiated subquadrate to short rectangular cells. Dioicous. Seta ca. 3 mm long. Capsula ovoid, ca 1.5 mm long. Peristome teeth up to 0.2 mm high, finely papillose. An-
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Fig. 31. *Racomitrium sudeticum* (Funek) Bruch et Schimp. in B.S.G. (1-6) and *R. microcarpon* (Hedw.) Brid. (7-12). *R. sudeticum* (from Karakol Lakes 1950 m Ignatov 26/121): 1 - leaf tips; 2 - upper lamina cells; 3 - habitus; 4 - leaf sections; 5 - peristome teeth; 6 - marginal basal cells. *R. microcarpon* (from Kayakkutuqaryksky Creek 1850 m Ignatov 8/111): 7 - upper lamina cells; 8 - leaf tip hairs; 9 - habitus; 10 - leaf sections; 11 - marginal basal cells; 12 - peristome teeth. Scale bars: 3 mm - for 3, 9; 1 mm - for 1, 8; 100 μm - for 2, 4, 5, 6, 7, 10, 11, 12.

*Figillus* well developed, persistent. Spores 13-15 μm.

The differences of this species from *Racomitrium microcarpon*, the most closely related species, are summarized under that species.

Distribution: The distribution of *Racomitrium sudeticum* was discussed and mapped by Frisvoll (1988) and also by Bednarek-Ochyra & al. (1990). In Europe it is mostly restricted to mountain areas and is very rare in lowlands. It penetrates southward along high mountains to Caucasus, Krym, Pyrenees and Corsica; in Asia - to Japan. The species is also known from the Southern Hemisphere in Patagonia, Terra del Fuego, Australian Alps and Antarctic Islands. In Altai *R. sudeticum* occurs in subalpine and in lower part of alpine zones in relatively wet areas.

Specimens examined: Ayulyuyuzyuk Creek 2450 m (0/937) 2500 m (0/428); Bayas Lake 2000 m (0/429); Chuk (Aksai State Reserve) (M.Schmidt 2.VIII.1935 LE!); Inskye Belki (2106 Kuznetsov 16.VII.1913 LE!); Kairu-bazhi Peak 2050 m (13/64); Karakol Lakes (Zerov 22.VIII.1940 LVOV!), 1900 m (28/55, 28/66, 28/79) 1950 m (26/121, 28/85); Kayakkutuqaryksky Creek 2350 m (7/169); Lesnot Creek 1860 m (Zolotukhin 2.VII.1990).

*Racomitrium canescens* (Hedw.) Brid., Muscol. Recent. Suppl. 4: 78. 1819[1818].

Fig. 32.

*Trichostomum canescens* Hedw., Sp. Musc. Frond. 111. 1801

Plants in loose to moderately dense, yellow-green to greenish-gray mats. Stem ascending, up to 6 cm
Fig. 32. Racomitrium canescens (Hedw.) Brid. (1-4) and R. panschii (C. Muell.) Kindb. (5-7). R. canescens (from Bolshoi Shaltan Creek 520 m Ignatov 0/753): 1 - basal leaf cells; 2 - leaves; 3 - papillae of hair-point; 4 - hair-point. R. panschii (from Trekhglavaya Peak 3150 m Zolotukhin 19 VII 1990): 5 - leaves; 6 - basal cells; 7 - cells of leaf tips. Scale bars: 1 mm for 2, 5; 0.5 mm for 4; 100 μm for 1, 3, 6, 7.

tall, sparsely fasciculately branched. Leaves broadly lanceolate to ovate, 2-3 mm long, acute to acuminate, sometimes obtuse, margins unistratose, revolute below. Costa percurrent, convex, broad, in upper part indistinct from the lamina. Hyaline hairpoint well-developed, more or less serrulate, densely papillose throughout most of its length, or sometimes absent. Lamina cells, including the basal cells, papillose with large papillae, 1-3(5) per cell. Upper cells short rectangular, 1.5-2.5:1; middle and lower cells rectangular up to 4-6:1, with nodulose walls. Alar group triangular with large, subquadrate cells with straight walls. Dioicous. Seta about 20 mm, straight. Capsula ca 2 mm long, oblong-ovoid, pale-brown. Peristome teeth divided on long filiform divisions, papillose. Annulus deciduous. Operculum with long straight beak. Calyptra mitrate. Spores 7-10 μm.

The strongly papillose leaf cells with strongly
sinuos to nodulose walls distinguish *Racomitrium canescens* s.l. from all other mosses. However, further division of this strongly polymorphic complex is a problem. Frisvoll (1983) has recognized within this group two species - *R. canescens* and *R. panschii*. Here we follow his treatment, although the variability of characters in separating these two taxa, probably, admits only an infraspecific rank for the latter. The differences of these taxa are discussed under *R. panschii*.

**Distribution:** *Racomitrium canescens* s.l. is a very common moss in Arctic and boreal-montanes of Holarctic region, somewhat less frequent in boreal lowlands. Frisvoll (1983) demonstrated that in Arctic occurs only *R. canescens* ssp. latifolius, while *R. canescens* ssp. canescens occurs across the wide range of boreal and montane regions of Holarctic. In Altai *R. canescens* is very common above the tree line where it grows in a wide range of epilitic and epigeic habitats. In the taiga and forest zones it is rarer and grows usually on sandy to gravelly bars of creeks, usually in rather humid climates.

*Specimens examined: Bayas Creek 500 m (Zolotukhin 28.VII.1982); Bolshoi Shaltan Creek 520 m (0/753); Chemal Creek, 3 km upstream 450 m (34/57); Kairu-bazhi Peak 2200 m (13/9); Kayakhatuyarykky Creek 2650 m (7/46); Kobiguayuk Creek 2220 m (0/750), 2600 m (0/188), 2650 m (0/197), 2800 m (0/751), 2890 m (0/752); Talizkiye Belki (Pobedimova 6.VIII.1929); Tamanel Peak 2150 m (34/40); Yazula 1800 m (Zolotukhin 21.VII.1979).

*Racomitrium panschii* (C.Muell.) Kindb., Eur. N. Amer. Bryin. 2: 236. 1897. Fig. 32.

*Grimmia panschii* C. Muell., Koldevey's Nord Pole Exped. 72. 1873.

Plants in rather dense, green to greenish-gray mats. Stem ascending, up to 5 cm tall, sparsely fasciculated branches. Leaves broadly lanceolate to ovate, 2-3 mm long, acute to acuminate, margins revolute below. Costa percurrent, convex, broad, in upper part indistinct from the lamina. Hyaline hairpoint well-developed, serrulate to serrate, weakly papillose below, nearly smooth above. Lamina cells papillose, basal cells smooth. Upper cells short rectangular, 1.5-2.5:1; middle and lower cells rectangular up to 4:6, with nodulose walls. Alar group consists of large, subquadrate cells with straight walls. Altaian plants sterile.

In many treatments *Racomitrium panschii* was not separated from *R. canescens* at all or it merited only a varietal rank as var. *robustum* (Lindb. et H. Arnell in H. Arnell) Par. Frisvoll (1983) brought evidence to maintain it as a species. The differences of this species from *R. canescens* include: (1) smooth basal cells, and (2) slightly or non-papillose upper part of hairpoint. Frisvoll also mentioned that leaves of *R. panschii* are principally acute, while in *R. canescens* s. str. they are acuminate; but this latter character seems not correlate with the two former features. In Altaian the papillosity of hairpoint changes more or less gradually among populations from lower elevations to high mountains. The papillosity of leaf base, however, is more uniform and is absent only in a few collections, all of which have also very weakly papillose hairpoint. Such forms are referred here as *R. panschii*. The status of this taxon, however, needs additional supportive study.

**Distribution:** According to Frisvoll (1983) and some of his identifications at LE, *Racomitrium panschii* has a circumpolar, mainly arctic distribution, occurring in Europe only in Svalbard, and in Asia, in Siberian and Beringian Arctic, Yakutia, Transbaikalia, Amurskaya Province, Khabarovsk Territory, Khamar-Daban Range in Baikal Area and Altai Mts. In America it is known from Alaska and the nearby parts of Yukon and Northwest Territories, Arctic Archipelago, Greenland (all around) and Labrador. From Altai, Frisvoll cited two specimens: 1) *Dschankantae in den Tschuja Alpen, 20.VIII.1915, Granro (H); 2) Terekta-Jugum, 2.VIII.1909, Kursky (H). According to our observations, *R. panschii* occurs mostly in upper alpine zone, with occasional penetration into the taiga zone.

*Specimens examined: Iyul Lake 1665 m (Zolotukhin 22.VI.1990); Kairu-Bazhi Peak 2300 m (13/98); Kobiguayuk Creek 2850 m (0/400); Sat-Khomas 2720 m (Zolotukhin 9.VII.1990); Trekhglavaya Peak 3150 m (Zolotukhin 19.VII.1990).

*Racomitrium lanuginosum* (Hedw.) Brid., Musc. Recent. Suppl. 4: 79. 1819. Fig. 33.


Coarse, robust plants forming moderately dense, grayish, hoary mats. Stem erect, up to 10 cm high, pinnately branched with short lateral branches. Leaves up to 5 mm long, narrow lanceolate, keeled, gradually narrowing to a long hyaline hairpoint. Hyaline cells of hairpoint and its decurrent bases densely papillose; otherwise, leaf cells smooth. Upper lamina cells rectangular, ca. 3-4:1, with sinuose to nodulose walls; cells at marginal and basal decurrent parts longer and with straight, thin walls. Middle and basal cells about 5:1, with thick nodulose walls, at margin forming one row of elongate to quadrate cells with straight walls. Dioecious. Altaian plants sterile.

*Racomitrium lanuginosum* is a distinctive moss having a coarse and robust plant size with regu-
Racomitrium lanuginosum (Hedw.) Brid.
(Booshkon Pass 2700 m Zolotukhin 5.VII.1990): 1 - cells of hair-point; 2 - leaf; 3 - upper leaf cells; 4 - marginal cells at leaf base. Scale bars: 1 mm - for 2; 100 μm - for 1, 3, 4.

Fig. 33. 

Racomitrium lanuginosum (Hedw.) Brid. (Booshkon Pass 2700 m Zolotukhin 5.VII.1990): 1 - cells of hair-point; 2 - leaf; 3 - upper leaf cells; 4 - marginal cells at leaf base. Scale bars: 1 mm - for 2; 100 μm - for 1, 3, 4.

Pinnately pinnate branches. Leaves are long, narrowly tapering, with long and broad hairpoint which extends decurrently to the lamina. Microscopically, it is impossible to confuse this species with other taxa because of its papillose and eroso-dentate hairpoint coupled with smooth leaf cells.

Distribution: The most widespread species of the genus, it is known in nearly all European countries, from Arctic islands (Svalbard, etc.), through the mountains of Central Europe, to Mediterranean countries, Azores, Canaries and Madeira, Middle East and Caucasus. In territories of the former USSR, it is known from all arctic and mountain regions, while in the lowland it is rather rare in the oceanic region (Baltics). Racomitrium lanuginosum is known further from Japan, China (southward to Taiwan), Mongolia, Himalayas, Indonesia, Philippines, New Guinea, Australia, New Zealand, Hawaii, Antarctic Islands and even from mainland Antarctic. In Pacific side of America, the species is reported from Alaska to Terra del Fuego (including the Andes in tropical latitudes); and in other arctic and eastern boreal regions of North America, it ranges southward to Maine (for details see Vitt & Marsh, 1988; Ochyra & al., 1990). In Altai R. lanuginosum is not very common. It has been observed in several places of subalpine and, especially, the alpine zone, reaching the upper limits of vegetation. It grows on rock and lithosol in alpine zone, often in open, windy places, preferring the most “lifeless” situations.

Specimens examined: Ayulyuyuzyuk Creek 2450 m (0/131); Booshkon Pass 2700 m (Zolotukhin 5.VII.1990); Karakol Mt. Range 2000 m (Zerov 22.VIII.1940 LBI); Kayaktau-yaryskij Creek 1920 m (3/263), 2150 m (4/5), 2200 m (6/1); Kobiguazuk Creek 2450 m (0/417), 2700 m (0/118); Kurkure Creek, upper course 2500 m (Galanin 9.VII.1976); Kurkurebaazhi Peak 3100 m (Zolotukhin 13.VII.1976); Merok Peak 2630 m (Zolotukhin & al. 24.VII.1980); Ozernaya Creek 2190 m (Zolotukhin & al. 9.VIII.1978); Tamanel Peak 2150 m (34/39).

UNCONFIRMED AND ERRONEOUS RECORDS

Dryptodon patens (Hedw.) Brid.
This was reported for Altai by Krylov (1925) from a locality in the Katunskije Belki Mt. Range near Multinskoye Lake. There is, however, no specimens of this species in the herbarium of Tomsk University.

Grimmia pulvinata (Hedw.) Sm.
Having been reported from Chike-Taman Pass by Bardunov (1974), no specimen of this species was available for confirmation. Although G. pulvinata is principally a western species in Eurasia, it does penetrate eastward to Tibet in China, reaching some of the mountains of Middle Asia (Pamir, Kopet-Dag) and also was reported from Mongolian Altai. It certainly can be expected in the Altai. G. pulvinata can be recognized by the broad leaves which is distinctly keeled, the long and slightly serrate hairpoint, the nearly unistratose lamina except at the margins, the almost straight cell walls, paroicous sexual condition (sporogones usually present), the distinctly curved seta, and a strongly ribbed capsula.

Schistidium confertum (Funck) Bruch et Schimp. in B.S.G.
The species was mentioned for Altai and Sayan mountains by Bardunov (1974) who, however, referred the same species later as a synonym of S. apocarpum in his list of Siberian mosses (Bardunov, 1992). We have studied Bardunov's specimens from Altai (Tyudraly and Ak-Tura) at IRK and found them to be S. liliputanum, while so-named specimens from Sayan Mts. and Baikal area appeared to be just a small expressions of S. apocarpum.

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**LITERATURE CITED**


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