

THREE INTERESTING BRACHYTHECIACEAE MOSSES FROM THE
BEARTOOTH PLATEAU (ROCKY MOUNTAINS, WYOMING, U.S.A.)

ТРИ ИНТЕРЕСНЫХ ТАКСОНА БРАЧУТНЕЦИАСЕАЕ С ПЛАТО
МЕДВЕЖИЙ ЗУБ (СКАЛИСТЫЕ ГОРЫ, ВАЙОМИНГ, США)

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Abstract

Sciuro-hypnum glaciale (Bruch, Schimp. & Gumbel) Ignatov & Huttunen, *Brachythecium brandegei* (Austin) H. Rob. and *B. erythrorrhizon* var. *alpinum* Kosovich-Anderson & Ignatov var. nov. (Brachytheciaceae) are reported from the upper elevations of Wyoming's Beartooth Plateau, Rocky Mountains, U.S.A. All three are rare in North America and are restricted to the most northern and/or alpine habitats. *Sciuro-hypnum glaciale* is a novelty for continental North America, with the nearest known localities being in Greenland, approximately 4400 kilometers from the Wyoming site. *Brachythecium brandegei* is a species formerly considered a highly localized endemic of mountainous Colorado. The Wyoming collections constitute the northernmost occurrence reported for North America and extend the known range northward by approximately 700 kilometers. *Brachythecium erythrorrhizon* var. *alpinum* is a new taxon described from alpine tundra of the Plateau. Taxonomic issues on the *B. erythrorrhizon* Bruch, Schimp. & Gumbel, *B. brandegei* and *B. coruscum* I. Hagen complex are discussed.

Резюме

Сообщается о трех редких для Северной Америки таксонах семейства Brachytheciaceae – *Sciuro-hypnum glaciale* (Bruch, Schimp. & Gumbel) Ignatov & Huttunen, *Brachythecium brandegei* (Austin) H. Rob. и *B. erythrorrhizon* var. *alpinum* Kosovich-Anderson & Ignatov var. nov., обнаруженных в высокогорьях Плато Медвежий Зуб (Скалистые Горы США, шт. Вайоминг). *Sciuro-hypnum glaciale* – новинка для североамериканского континента; вайомингская популяция вида находится примерно в 4400 км от ближайшего местонахождения в Гренландии. *Brachythecium brandegei* – вид, прежде считавшийся узколокальным эндемиком горного Колорадо; в Вайоминге зарегистрирован самый северный пункт его распространения в Северной Америке, расширивший известный ареал на 700 км. *Brachythecium erythrorrhizon* var. *alpinum* – новый таксон, описываемый из альпийской тундры плато. Обсуждаются таксономические проблемы комплекса *B. erythrorrhizon* Bruch, Schimp. & Gumbel – *B. brandegei* – *B. coruscum* I. Hagen.

KEYWORDS. Brachytheciaceae, North America, rare taxa, Rocky Mountains, Wyoming's Beartooth Plateau.

INTRODUCTION

This publication was made on the basis of specimens collected by Y. I. Kosovich-Anderson in the mountains of the Beartooth Plateau, Shoshone National Forest (SNF), Wyoming, U.S.A.

SNF is a unique nationally protected area located in the northwestern part of Wyoming, bordering the Yellowstone National Park. In 2008-2009, during bryophyte inventory projects on the SNF, the first author explored its northern territories, Wyo-

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Fig. 1a. Beartooth Plateau, Wyoming: view from Beartooth Scenic Byway, alt. 9,500–10,800 ft (2900–3300 m). Photo by Y.I. Kosovich-Anderson.



Fig. 1b. Unnamed alpine lake at 10,500 ft (3200 m). Only known locality of *Sciuro-hypnum glaciale* in continental North America and also the habitat of the new variety *Brachythecium erythrorrhizon* var. *alpinum*. Photo by R. D. Anderson.

ming's Beartooth Plateau. The alpine bryophyte flora was of special interest since it was the most poorly documented in the state and the least studied.

Beartooth Plateau is a part of the Beartooth-Absaroka Mountain complex in the Central Rocky Mountains, located in south-central Montana with a small portion in northwest Wyoming (within 44°50'–45°01' N & 109°24'–109°51' W). It represents an uplifted fault block of Precambrian granite and crystalline metamorphic rocks, which was eroded and partially blanketed with lava from Yellowstone's volcanoes (Lageson & Spearing, 1991). An extensive, gentle surface, partially dissected by canyons and glacial cirques, occupies most of the Plateau, a substantial part of which is above 3000 m; numerous alpine and subalpine lakes and persistent snowfields are the features of the area (Fig. 1). The growing season at high elevations may be as short as 45 days. Alpine meadows and tun-

dra are the characteristic vegetation. Of the primary vegetation types, Johnson & Billings (1962) describe *Geum rossii* (R. Br.) Ser. turfs on summits, ridges and upper slopes; *Deschampsia cespitosa* (L.) Beauv. meadows on lower mesic slopes and basins; *Carex scopulorum* Holm. fens on wet, mineral bog and peat soils; and *Salix planifolia* Pursh thickets along drainages. A variety of alpine habitats also includes talus slopes, outcrops of granite bedrock, boulder fields, late snow melt areas, and patterned ground. The plants and the soil are sensitive to trampling in this area, especially in the harsh conditions of wind-swept summits. However, the low level of anthropogenic disturbance allows many rare and relic species to survive here.

NEW REPORTS AND DISCUSSION

As a result of collecting in the upper subalpine and alpine elevations of Wyoming's Beartooth Plateau, the three interesting Brachytheciaceae taxa

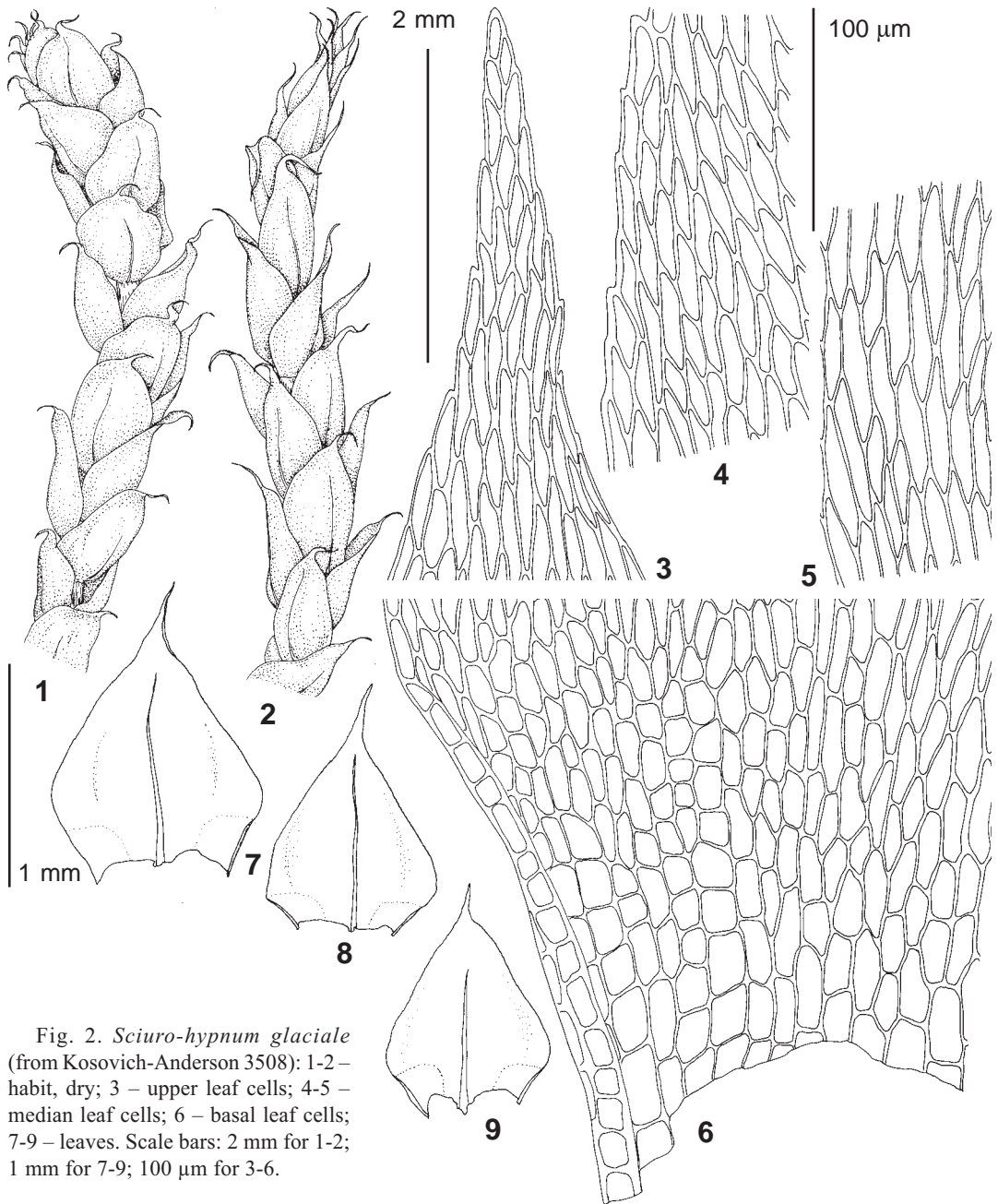


Fig. 2. *Sciuro-hypnum glaciale* (from Kosovich-Anderson 3508): 1-2 – habit, dry; 3 – upper leaf cells; 4-5 – median leaf cells; 6 – basal leaf cells; 7-9 – leaves. Scale bars: 2 mm for 1-2; 1 mm for 7-9; 100 µm for 3-6.

were discovered, none of which were previously known in Wyoming (Eckel, 2007). Their taxonomy, distribution and distinctions from closely related taxa are described, along with comments of morphological features of the Wyoming specimens. The earlier collections of W.A. Weber in 1973 (COLO) were also re-examined. Voucher specimens are deposited at RM.

Sciuro-hypnum glaciale (Bruch, Schimp. & GümbeI) Ignatov & Huttunen — *Brachythecium glaciale* Bruch, Schimp. & GümbeI. Fig. 2

Sciuro-hypnum glaciale is known as the most widely distributed species of the genus, having a bipolar arctic-alpine range. However, it appears to be common only in Northern Europe and at places in the Alps and Caucasian mountains, being known

by scattered collections from Asia and the Antarctic region. The collections of the species from North America were previously confined to Greenland. Several other records we were able to check were based on incorrect or unconfirmed identifications. Thus, the collection from Wyoming is the only one in continental North America. It extends the known range by no less than 4400 km representing an extraordinary arctic-alpine disjunction in the Rocky Mountains.

Sciuro-hypnum glaciale was thought to be closely related to *S. latifolium* (Kindb.) Ignatov & Huttunen, but differs in the serrulate leaf margins, gradually delimited alar cells and relatively short median laminal cells. Their status as distinct although related species was recently discovered by molecular studies (Draper & Hedenäs, 2009 a,b; Ignatov & Milyutina, 2007). The closely related *S. oedipodium* (Mitt.) Ignatov & Huttunen, a widespread western North American species, differs from *S. glaciale* by its larger sized plants and long, broad leaf decurrencies.

Judging from the most typical phenotype of the plants from Europe, the specimen from Wyoming differs by its abruptly acuminate leaves, so the maximally developed shoots have a somewhat squarrose aspect, which makes these plants somewhat similar to *Brachytheciastrum collinum* (Schleich. ex Müll. Hal.) Schimp. The latter species, however, has narrow and flexuose laminal cells, more strongly serrate leaf margins, a costa ending in a distinct tooth (often more than one) and small quadrate alar cells.

Specimen examined: U.S.A., Wyoming, Park County, SNF, Beartooth Plateau, alpine snow melt area, small lake in vast depression, ca. 100 m N of Beartooth Scenic Byway, boggy shore crossed by rills, *Carex* spp. - Bryidae wetlands, wet tussocks, on clay soil, associated with *Polytrichastrum alpinum* (Hedw.) G.L. Smith; N 44°58.510-515', W 109°27.165-170', alt. 10,500 ft (3200 m), 20 August 2008, *Kosovich-Anderson 3508* (MHA, MO, RM).

Brachythecium erythrorrhizon Bruch, Schimp. & Gümbel – ***B. brandegei*** (Austin) H. Rob. – ***B. coruscum*** I. Hagen complex

Among the collections made at the alpine elevations in Wyoming, there were a number of specimens of *Brachythecium* characterized by erect growth, ovate and abruptly acuminate leaves, relatively short laminal cells, numerous quadrate alar

cells, and subentire leaf margins. Almost all of them were sterile, or they rarely had only perichaetia, which may imply their dioicous sexuality.

This set of characters is known in *B. brandegei* and *B. coruscum*, both rare species; the former is known as a local endemic of high mountains in Colorado, the latter having an arctic distribution. These species are relatively poorly known and have never been compared with each other, so we are making the comparison here.

First, the Wyoming collections were sorted into two groups which are illustrated in Figs. 3 and 4. The former morphotype is characterized by relatively thin-walled cells, including the alar ones and usually non-plicate leaves, although some leaves exhibit plicae microscopically. The second morphotype differs from it in more numerous alar cells with thicker cell walls, as well as more thick-walled median laminal cells, and the leaves often have deep plicae. The former plants show very little difference from *B. brandegei*, a plant previously known only from the highlands of Colorado, although the Wyoming plants looked more strongly depressed by severe environments and their leaves were somewhat smaller.

Brachythecium brandegei (Austin) H. Rob. — *Cirriphyllum brandegei* (Austin) Grout. Fig. 3

A species previously considered a highly localized endemic of Colorado, where it was known from Park, Clear Creek, and Summit Counties. In those localities it was growing on wet soil in mountain tundra, rocks and wet cliffs, at 3570 to 3900 m, e.g. similar to Wyoming localities. Wyoming collections constitute the northernmost occurrence yet reported for North America and extend the known range northward by approximately 700 km.

Specimens examined: U.S.A., Wyoming, Park County, SNF, Beartooth Plateau: 1. Near Wyoming-Montana border, summits, wet alpine tundra, on humus beneath dwarf willow and at base of granite outcrop, associated with *Polytrichum juniperinum* Willd. ex Hedw.; N 45°00.065-75', W 109°25.275-285', alt. 10,250 ft (3125 m), 13 August 2008, *Kosovich-Anderson 2485* (MHA, MO, RM); 2. Unnamed tributary of Frozen Lake, seepage slope, on wet clay and peaty soil along streamlets in snow melt areas, abundant, in pure mats or associated with *Marchantia alpestris* Nees, *Polytrichastrum sexangulare* (Brid.) G. L. Smith, *Polytrichum juniperinum*, *Sanionia georgico-uncinata* (Müll. Hal.) R. Ochyra & L. Hedenäs (! – **a species new to Wyoming**); N 44°58.015-060', W 109°28.850-890', alt. 10,500-

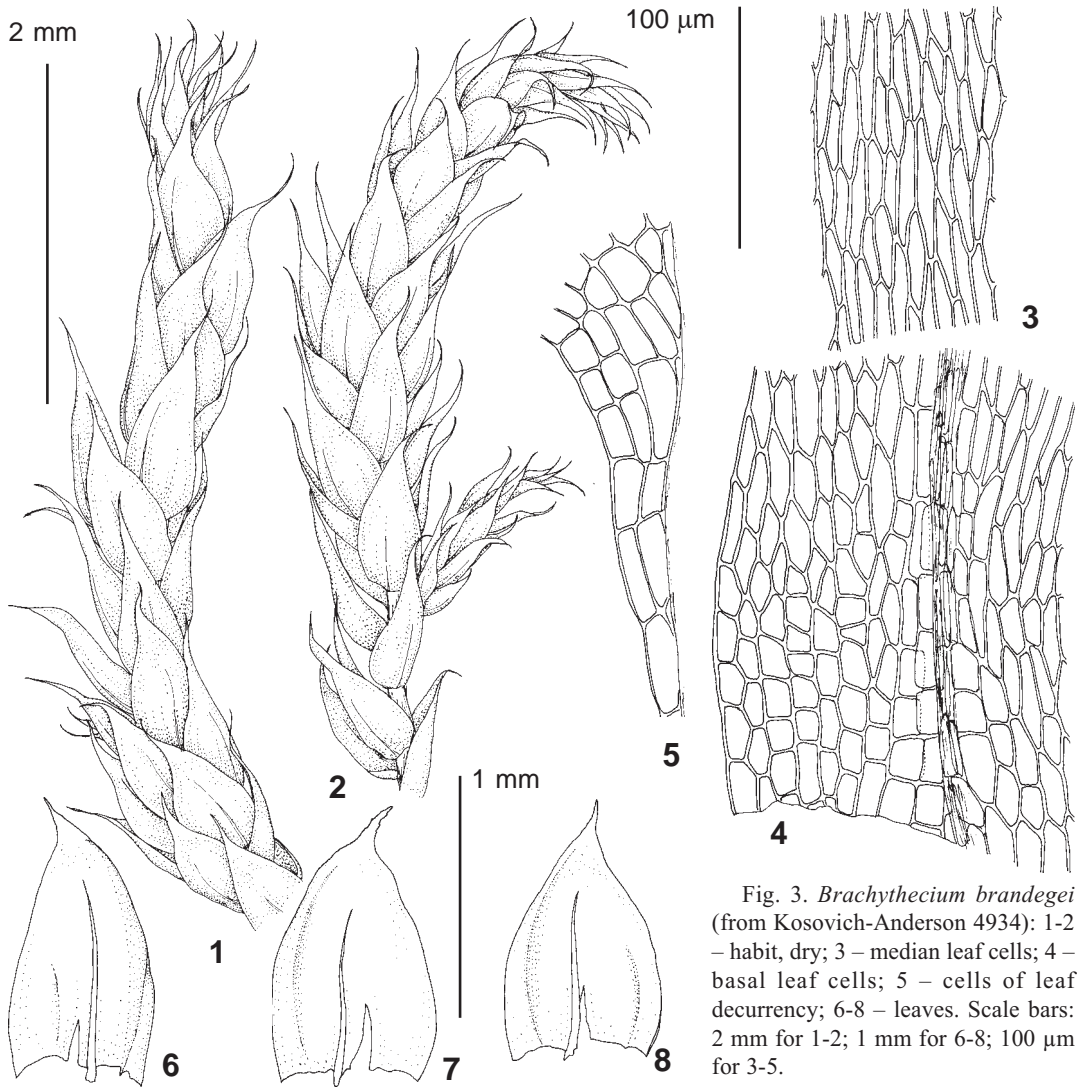


Fig. 3. *Brachythecium brandegei* (from Kosovich-Anderson 4934): 1-2 – habit, dry; 3 – median leaf cells; 4 – basal leaf cells; 5 – cells of leaf decurrency; 6-8 – leaves. Scale bars: 2 mm for 1-2; 1 mm for 6-8; 100 μ m for 3-5.

10,550 ft (3200-3215 m), 14 August 2008, *Kosovich-Anderson 2626, 2632* (both – MHA, MO, RM); 3. Clay Butte: slope facing to the west, grasslands below Rd 142, debris of limestone, on loamy soil at base of seabed rock; N 44°57.130', W 109°37.917', alt. 9,600 ft (2925 m), 19 August 2009, *Kosovich-Anderson 4934* (MHA, MO, RM).

Brachythecium brandegei is similar to *B. coruscum* in occurrence in cold environment, numerous alar cells, presumably dioicous sexual condition, as female plants are unknown in both species. However in *B. brandegei* the laminal and alar cells are thin-walled vs. thick-walled in *B. coruscum* (cf. Figs. 3 and 5).

The second morphotype (Fig. 4) fits *B. coru-*

scum by formal criteria; however, comparison with Arctic material of this species indicates a number of differences. Arctic plants have a more delicate texture (reminiscent of *B. albicans* (Hedw.) Schimp.), almost unbranched stems, the color of the plants is whitish to golden or rarely light green, whereas the Wyoming plants have a texture approaching the *B. salebrosum* (F. Weber & D. Mohr) Bruch, Schimp. & Gumbel and related species, characterized by rather numerous branches and green to yellowish or brownish green color of the plants.

A study of variation within these collections brought us to conclude that these plants should be interpreted not as *B. coruscum* (cf. Fig. 5),

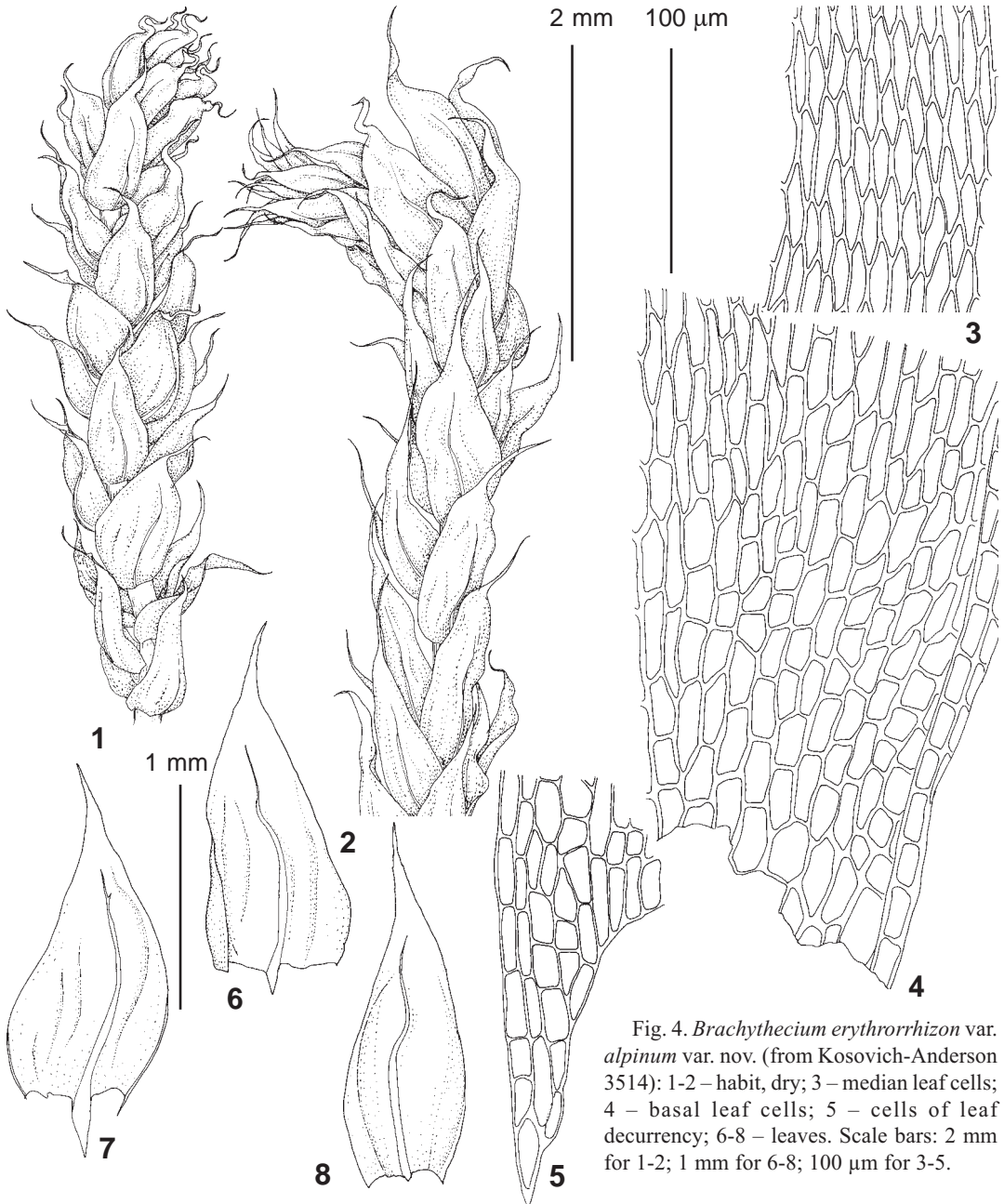


Fig. 4. *Brachythecium erythrorrhizon* var. *alpinum* var. nov. (from Kosovich-Anderson 3514): 1-2 – habit, dry; 3 – median leaf cells; 4 – basal leaf cells; 5 – cells of leaf decurrency; 6-8 – leaves. Scale bars: 2 mm for 1-2; 1 mm for 6-8; 100 µm for 3-5.

but as a specific alpine form of *B. erythrorrhizon*. The reasons for this are as follows: (1) in some collections we observed a tendency that the longer the leaf, the more falcate it is; (2) the cells in the leaf decurrencies in the larger leaves are larger and more or less transparent; (3) well developed plants exhibit rather regular pinnate branching; and (4) numerous alar cells, strong

plications, short cells and subtire leaves are characteristic of *B. erythrorrhizon*. The main differences from the most common phenotype of the latter species are the short and straight leaves.

This pattern of variation is known in other North American species, for example in *B. laetum* (Brid.) Bruch, Schimp. & Gumbel, which has depressed

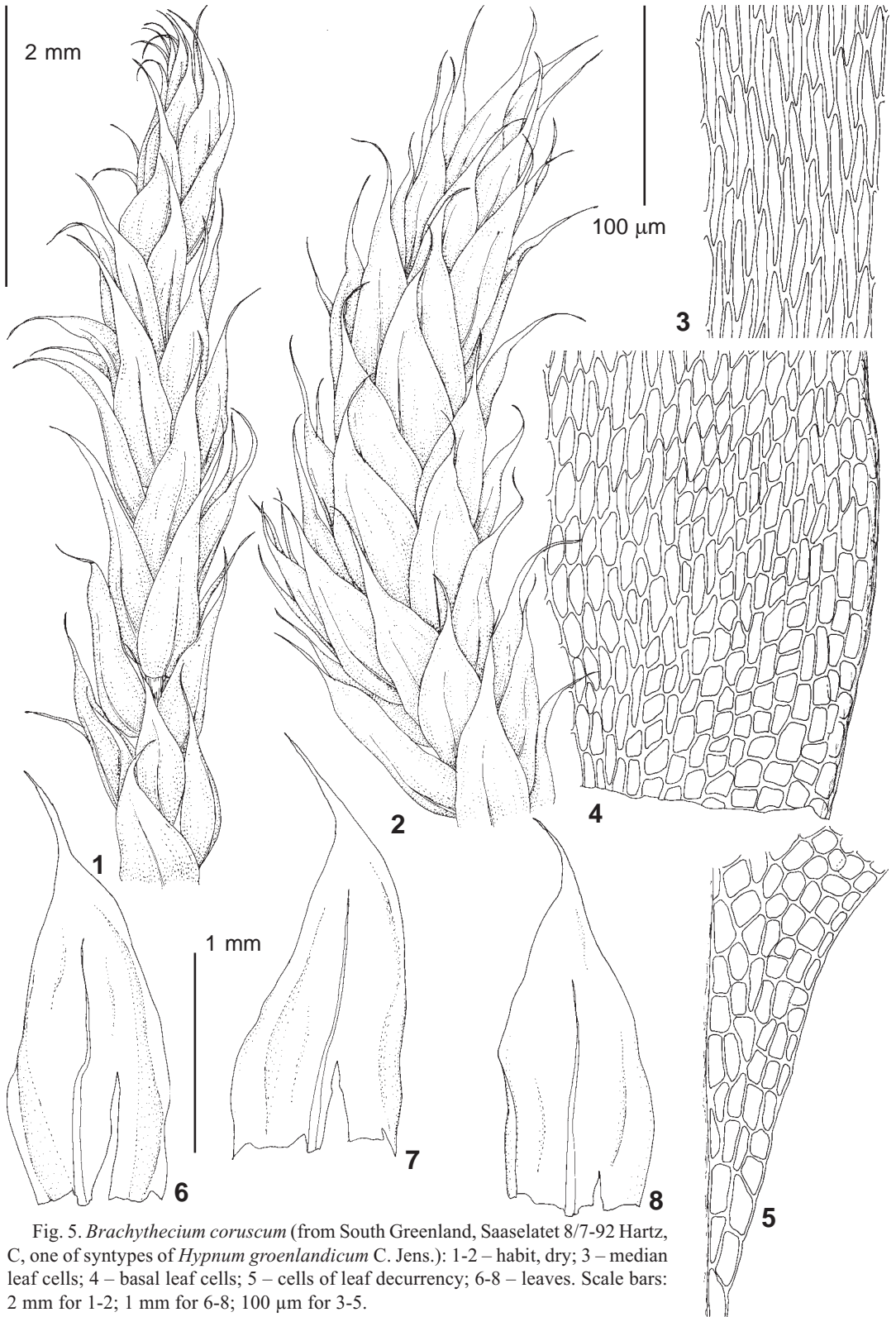


Fig. 5. *Brachythecium coruscum* (from South Greenland, Saaselatet 8/7-92 Hartz, C, one of syntypes of *Hypnum groenlandicum* C. Jens.): 1-2 – habit, dry; 3 – median leaf cells; 4 – basal leaf cells; 5 – cells of leaf decurrency; 6-8 – leaves. Scale bars: 2 mm for 1-2; 1 mm for 6-8; 100 μm for 3-5.

phenotypes that are much smaller, possessing perfectly straight leaves, making them difficult to distinguish from *B. acuminatum* (Hedw.) Austin.

However, in Asia, where *B. erythrorrhizon* occurs in high mountains, as well as in the Arctic, this species seems to never produce similar straight-leaved forms, and therefore these plants from the alpine zone of the Rocky Mountains can be interpreted as having a certain genetic basis and merit an infraspecific status of a separate variety, *B. erythrorrhizon* var. *alpinum*.

Brachythecium erythrorrhizon var. **alpinum**

Kosovich-Anderson & Ignatov, var. nov. Fig. 4

A var. *erythrorrhizon folia strictissima valde breviora differt.*

Type: U.S.A., Wyoming, Park County, SNF, Beartooth Plateau, alpine snow melt area, small lake in vast depression, ca. 100 m N of Beartooth Scenic Byway, boggy shore crossed by rills, *Carex* spp. – Bryidae wetlands, on wet clay and soaked peaty soil; N 44°58.510–515', W 109°27.165–170', alt. 10,500 ft (3200 m), 20 August 2008, *Kosovich-Anderson 3514* (holotype in RM; isotypes, MHA, MO).

Plants rather small, green. Stems to 4 cm, prostrate, regularly to irregularly pinnate, terete foliate. Stem leaves loosely imbricate, 1.2–1.7×0.5–0.7 mm, ovate-lanceolate, short acuminate, decurrent, plicate, margins entire to indistinctly serrulate; costa reaching 0.6–0.8 leaf length; laminal cells 30–50×8–11 µm, alar cells forming extensive group, subquadrate to short rectangular. Dioicous. Sporophytes unknown.

Other specimens: Colorado (King & Garvey B259 MO 5365410) and New Mexico (Buck 39746, MO 6001584), at least in part of the shoots.

Brachythecium coruscum (Fig. 5) is also a rather variable species and it is not easy to differentiate from *B. erythrorrhizon* var. *alpinum*. Important differences are the small cells in the decurrencies (same size as in the alar region), without any tendency to be larger (as in *B. erythrorrhizon* var. *alpinum*), stems never strongly branching, alar cells that are relatively smaller than in *B. erythrorrhizon* var. *alpinum*, while the median laminal cells are longer and somewhat porose. *Brachythecium erythrorrhizon* may also have long laminal cells but this correlates with the leaf length, and the long-leaved *B. erythror-*

rhizon invariably have distinctly falcate-second leaves, which never occurs in *B. coruscum*. Also, the plants of *B. coruscum* are usually larger than those of *B. erythrorrhizon* var. *alpinum*.

The new variety was found at the same site with the other rare Brachytheciaceae species reported here, i.e. *Sciuro-hypnum glaciale*, which implies a similarity of their ecological requirements. In the study area, both were discovered on wet soil in tundra-like communities around an alpine lake in the zone of persistent snowfields (Fig. 1b).

The populations of three rare Brachytheciaceae mosses were found on U.S. National Forest System lands; these taxa would likely meet the criteria for addition to the Forest Service sensitive species program, which would supplement long-term conservation and management of these mosses.

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