

Grimmia
(Grimmiaceae, Bryophyta)
in the Neotropics

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Instituto de Biología
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Hecho en México

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PREFACE

A conversation with S. R. Gradstein in 1993 concerning the distribution of bryophytes in the Neotropics resulted in my acceptance of the preparation of the present taxonomic revision. I was looking for a genus with a comparatively large number of species in search for clues about morphological changes that have occurred through time in the Neovolcanic Belt of central Mexico. The changes, if detected, would point toward migration trends along the mountains, or so it was hoped. Dr. Gradstein agreed with my plan to work on *Grimmia*, but said that since I expected to learn about the morphology and taxonomy of the group, the revision for the Neotropics would only take a small step forward. At the time he was bryophyte editor for the Flora Neotropica series.

The species names, their nomenclatural status, and synonymy were searched for in the literature for the region. It was soon evident that several individuals at other institutions were already well ahead in the study of this genus, but it was hoped that an independent effort would serve my floristic and phytogeographical inquiries. My results are not substantially different from those of others, but may have added precision to those already published. The nomenclature and descriptions were elaborated from personal observations and interpretation; thus, the selected synonymy given here.

Thanks are extended to Drs. Richard H. Zander and Bruce Allen for herbarium assistance and for requesting specimens for study at MO; Ángeles Cárdenas and Patricia Herrera tested the key and made useful suggestions. Paola Peña Retes assisted with the preparation of the illustrations. Special thanks are extended to Roxanne Hastings and Richard H. Zander for their critical reviews of the manuscript and their helpful suggestions for improvement; the curators of the following herbaria kindly arranged for the loan of specimens: BM, FH, GOET, H-BR, JE, KOCH, LIL, MEXU, MO, NY, and US.

Abstract. *Grimmia* is a genus of acrocarpic, rock-inhabiting mosses that are represented in the Neotropical region by about 26 species. In addition to habitat, they are usually recognized by stem leaves with a hyaline hair point, and frequently sinuous thick-walled cells in 1-3 layers. Gemmae are frequent in *G. austrofunalis*, *G. torquata*, and *G. trichophylla*. However, they were also observed in specimens of *G. pulla*.

In the Neotropical region, *Grimmia* grows at intermediate and high elevations, from 1000-5300 m, but lower altitudes are the rule at either end of the range. The higher elevations are part of the high sierras and mountain ranges that occupy the western areas of the continent. The genus is well-represented in tropical North America (18 species), South America (16 species), and Central America (6 species); in the West Indies the number of species is lower (2 species). *Grimmia austrofunalis* is newly reported for Costa Rica and Mexico.

The treatment includes a key, descriptions, illustrations, habitat information, distribution, and specimens examined. The introductory statements stress the composite structure of the hair point that, at least in certain species, is formed by costal and laminal cells; therefore, it may not be entirely homologous with the hair point in other mosses. In the taxonomic section, *Grimmia atrata* is maintained in its current generic position, not in *Streptocolea*, as proposed by Ochyra and Bednarek-Ochyra (2004); *G. herzogii* is distinct from *G. longirostris*; *G. fuliginosa* (= *G. elongata*) does not belong in *Schistidium* as proposed by Ochyra (1998), but its type is a mixture including a small form of *G. torquata*. *Grimmia bernoullii* and *G. involucrata* are not synonyms of *G. laevigata*, as proposed by Maier (2010); *G. mexicana* and *G. ochyriana* are considered different species; and *G. speirophylla* Herz. fo. *humilis* is regarded as a synonym of *G. navicularis*.

INTRODUCTION

Grimmia is a large genus of primarily rock inhabiting mosses widely distributed in the world. It was named in honor of the German physician and botanist J. F. K. Grimm (Greven, 2003) and was formally recognized by Hedwig in 1801. Many of the species in the genus are broadly distributed and show some degree of variation, often recognized under different names. Their taxonomic re-evaluation in recent years resulted in an extensive synonymy for several species, and differences of opinion among the leading specialists of worldwide treatments for the genus. In terms of numbers, Muñoz and Pando (2000) listed 71 species; Greven (2003) described 93 in his world monograph; Greven and Hastings (2007) mentioned 95, while Maier (2010) only recognized 51 species worldwide.

For Latin America, Muñoz (1999) recognized 31 species, most of which are also accepted for the Neotropical area. Although the present treatment is similar to Muñoz's (1999), it differs in details of synonymy, nomenclature, and in the interpretation of certain taxa. It also updates the geographical information with specimen data that was not given by Muñoz (1999). The circumscription of several species still remains uncertain because of morphological variation among populations and lack of collections from certain geographical areas. Some problems may be solved by detailed comparison of specimens, e.g., the identity and synonymy of *G. reflexidens* or its presumed situation in *Coscinodon* (Maier, 2002). Other problematic taxa are discussed elsewhere in the text.

Besides duplicates, more than 1490 specimens were studied for the revision of the Neotropical species of *Grimmia*. Loans were received from BM, FH, GOET, H-BR, JE, KOCH, LIL, MEXU, MO, NY, and US, but several species were only represented by a few specimens, notably *G. anodon*, *G. molesta*, *G. pseudoanodon*, and *G. tergestina*. As a whole, this revision recognizes 26 species for the Neotropical area, excluding *G. ochyriana*, *G. trinervis* Williams, and *G. ungeri* Jur. that are foreign to the region or are not part of the generic concept.

MORPHOLOGY AND ANATOMY

The morphological and anatomical features in *Grimmia* have been discussed by Muñoz (1999) for our area. It seems desirable, however, to put emphasis on certain gametophytic features that may be of taxonomic relevance or that are particularly variable in the Neotropical species. Although the reader may be referred to material illustrated by Maier (2010), because of her distinctly different taxonomic interpretations for several species, her drawings may not correspond to those of species recognized in the present treatment.

CENTRAL STRAND. It consists of small thin-walled cells with small trigons. Among the Neotropical *Grimmias*, it may be absent in sterile stems of *Grimmia austrofunalis* and *G. pilifera*; in *G. atrata* it may be present, indistinct or completely absent.

LAMINA AND LAMINAL CELLS. In addition to variation in leaf shape, the species of *Grimmia* are variable in leaf structure and anatomy. The leaf lamina is frequently lanceolate, ovate or ovate-lanceolate, ending in a hair point or awn; the leaf margins may be plane, but more frequently one or both are reflexed or revolute in part of their length. Also, the proximal cells at leaf margins may be thin-walled throughout as in *G. doniana*, *G. elongata*, and *G. fuscolutea*. In the last named species, cell shape is usually important as a taxonomic character because, in mid-leaf areas, the cells are long, narrow, strongly sinuous, and thick-walled; most other species have short rectangular to quadrate, scarcely sinuous mid leaf cells. In *G. laevigata* the proximal leaf cells are oblate. Cells in the alar region

may not be differentiated, but in some species, there may be a single row of slightly larger hyaline cells along the basal margin, as in *G. longirostris*. In *G. atrata*, the extreme alar cells are in two strata. The proximal mid-leaf cells are frequently thick-walled and elongated, but there is considerable variation even in the same species. With respect to the number of layers, a species or groups of species may have uni or bistratose leaf laminae, but neither condition is absolute. Bistratose patches, thus, may be present in an otherwise unistratose leaf. In such species as *G. longirostris*, *G. mexicana*, and *G. trichophylla* both conditions are present in different populations.

Leaves in Neotropical Grimmiids may be keeled or concave. Either condition is of taxonomic value to distinguish several species. Among the taxa with keeled laminae, *G. elongata*, *G. navicularis*, *G. pulla*, *G. trichophylla*, and *G. longirostris*, among others, show this condition in decreasing intensity. Species with concave leaves include *G. involucreta*, *G. laevigata*, and *G. ovalis*.

COSTA. In many mosses the hair point is an extension of the costa. However, in species of *Grimmia* in the Neotropics, the costa appears to have a dual composition. The lower part of the hair point may be partly made up of elongated apical laminal cells, thus forming a flattened structure. On the other hand, the long, narrow, thick-walled cells in the hair point appear to be an extension of the costal cells; observations of Hoyer mounts of *G. allionii* (= *G. longirostris*) and other species, show the elongated hair point cells penetrating the costa while the substereid cells that form the abaxial surface cease at leaf apex.

Understanding the composite nature of the costa is fundamental for morphological, taxonomic, and evolutionary reasons. Recent treatments of *Grimmia* (e.g., Cao & Vitt, 1986) describe *G. affinis* (= *G. longirostris*) as having percurrent costae. If other morphological observations and ontogenetic reconstructions demonstrate the continuity between costa and hair point, this and other species should be recognized as having excurrent costae. From the evolutionary point of view, the hair point of *Grimmia* and that in other mosses may not be completely homologous structures if the apical laminal cells are part of the hair point.

In section, the costa consists of ventral (guide) cells on the adaxial surface, one or two layers of stereid or substereid cells, and an abaxial epidermis. The ventral cells are usually recognized by their larger size, clear content and a thicker outer (adaxial) wall. Most of the species in this treatment exhibit two ventral cells that clearly distinguish them from others with a larger number of cells (*G. atrata*, *G. herzogii*, *G. lisae*, *G. longirostris*, and *G. mexicana*). The physiological significance of the ventral cells in *Grimmia* is unknown, but their position in the costa may be related to water transport. The name 'ventral cells' is retained here to distinguish them from the guide cells of other moss groups.

The outline of the costa in section may be elliptic or semicircular. In *G. longirostris* it may be reniform, but very often it is hardly distinct from the lamina. Both the lamina and the costa, in section, form a ventral sinus that is u- or v-shaped in the species with keeled leaves. A distinct v-shaped expression occurs in *G. elongata* and *G. navicularis*; *G. reflexidens*, as used in this treatment, shows a narrow channel because the leaf blade halves are parallel as they emerge from the costa, in cross section. Species with concave leaves may not have a distinct ventral sinus.

HAIR POINT. The hair point is usually a straight or flexuous structure. In *G. elongata* it is greatly reduced so that only the leaf tip appears whitish. In *G. pulla* it may be absent or very short and yellowish, but in some specimens it is long and hyaline. When evident, the awn in *G. pulla* is roughly dentate and sometimes has a zigzag twist.

The hair point in several Neotropical species is usually long, but variously dentate. *Grimmia involucrata*, *G. longirostris*, and *G. laevigata* have dentate hair points, but in *G. fuscolutea* and *G. trichophylla* hair points are usually long, flexuous and nearly smooth. In contrast, *G. austrofunalis* has hair points usually short and straight. Although extreme variations occur within the genus in the Neotropical area, the presence, length, ornamentation, and color of the hair point provide useful taxonomic characters.

GEMMAE. Gemmae are infrequent among the Neotropical species of *Grimmia*. However, they are well known in *G. austrofunalis*, *G. torquata*, and *G. trichophylla*, and recently were observed in several specimens of *G. pulla*. They are usually subspheric bodies formed by several brownish to reddish cells. According to Muñoz (1999), in *G. austrofunalis*, gemmae may arise on stalks on the proximal abaxial or adaxial cells on both sides of the costa while in *G. trichophylla* they are sessile on the lamina. However, in the course of this revision, stalked gemmae were also observed in *G. trichophylla* (e.g., Delgadillo 2202, MEXU; Standley 84451, NY) and in *G. pulla* (Cárdenas 5127, Delgadillo 5532, MEXU).

ECOLOGY

The Neotropical species of *Grimmia* are mainly rock inhabitants, and are frequent in sunny or exposed microhabitats. Sometimes they occupy other substrates, for instance, peat (*G. elongata*, Grubb & Guymmer B68, BM), soil (*G. longirostris*, Killip & Smith 17956, FH, NY), branches (*G. pulla*, Cárdenas 2813, MEXU) or stumps (*G. trichophylla*, Cárdenas 4771, MEXU). Frequently, plants of the genus grow on mixed substrates such as soil- or sand-covered rocks, and sometimes, on man-made substrates.

There is insufficient field information to determine precise fruiting times for most species. In the course of this revision, the author examined 498 specimens of *G. longirostris*; 380 of them bore sporophytes; similarly, of 311 specimens of *G. trichophylla* examined, 146 had sporophytes. Collecting data for either species indicate that mature sporophytes may be present at any time during the year and that latitude or altitude seem unrelated to the fertile condition of the plants. In *G. austrofunalis* 3/47 specimens had sporophytes; *G. elongata* 29/65; *G. fuscolutea* 62/75; and *G. involucrata* 31/35. Except for *G. austrofunalis*, all others have high fertile values, but fruiting times, as in *G. longirostris* and *G. trichophylla*, do not seem correlated with time of the year, latitude or altitude.

DISTRIBUTION

Except for localities at extreme high latitudes, species of *Grimmia* grow at intermediate to high altitudes. In Mexico, they are characteristic of the high mountains, between 1800 and 4600 m in elevation; in the Peninsula of Baja California and in Chihuahua, *Grimmia* is found between 40 and 1850 m in elevation. With regard to their ranges, four main areas of distribution can be distinguished in Mexico: a) Species restricted to the highlands of the Neovolcanic Belt in central Mexico, b) species with broad local distribution, c) species of the northwestern area, including the states of Baja California and Chihuahua, south to Durango, and d) species endemic to Mexico (Delgadillo *et al.*, 2012).

In Central America, six species of are known: *G. austrofunalis*, *G. elongata*, *G. longirostris*, *G. mexicana*, *G. ovalis*, and *G. trichophylla*. Their altitudinal distribution extends from 1800 m (*G. trichophylla* in Panama) to 4115 m (*G. elongata* and *G. mexicana*, both in Guatemala). However, the number of specimens representing each known species is rather small, partly due to a predominant lowland topography and also to the few bryologists that conduct bryological exploration in the Central American countries.

By comparison to the previous area, in South America, *Grimmia* is fairly common. Except for eight species (*G. involucrata*, *G. lisae*, *G. mexicana*, *G. montana*, *G. moxleyi*, *G. pilifera*, *G. pulla*, and *G. torquata*), the remaining sixteen Neotropical taxa are all known from western South America with several outlying stations in southern Brazil. Among them, *G. bicolor*, *G. herzogii*, *G. molesta*, *G. navicularis*, and *G. pseudoanodon* are South American endemics. The altitudinal range of *Grimmia* in tropical South America is broad, from ca. 1000 m (*G. trichophylla* in central Chile) to 5300 m (*G. navicularis* in Ecuador) because of its distribution along the Andean Cordillera; in Brazil it grows between 1800-2500 m in elevation.

The range of *Grimmia* in the Americas illustrates the distribution of many taxa that follow the higher mountains. Because of habitat and altitudinal preferences and the geographical position of the cordilleras, the age and continental patterns of distribution of *Grimmia* may be explained by geological events that gave rise to these mountains. However, other patterns require additional information as, for instance, the disjunct southeastern Brazilian populations of *G. elongata*, *G. longirostris*, and *G. navicularis* whose closest counterparts are in the Andes. Also, such species as *G. fuscolutea* show disjunct populations between North and South America with no known records from Central America to suggest a recently established continuous pattern. Both the Brazilian and the Central American disjunctions need careful consideration as there is still insufficient floristic data for an explanation.

SYSTEMATIC TREATMENT

Grimmia Hedw. Species Muscorum Frondosorum 75. 1801.

Stems in cushions or tufts, up to 4-50 mm tall, usually with a central strand surrounded by a cortex and 1-2 thin epidermal layers. *Leaves* entire, frequently ovate-lanceolate or lanceolate, occasionally ligulate, imbricate, flexuous, squarrose or contorted when dry, erect, erect-spreading to flexuous when wet; distally carinate or concave; lamina unistratose to bi- or partly multistratose in the distal half or two thirds; costa usually excurrent, indistinct from the lamina to semicircular in section, frequently with an u-shaped ventral sinus, 2-6 ventral cells, and 1-2 dorsal stereid or substereid layers, and a hydroid group. Hyaline *hair point* nearly smooth to serrulate, not decurrent to decurrent. Leaf cells in distal half or two thirds, prismatic-rounded, quadrate or short rectangular, with thick slightly sinuous walls; proximal marginal *cells* quadrate or rectangular, smooth, with thicker cross walls or thin-walled all around, frequently forming a slightly differentiated hyaline area; other proximal leaf cells usually parenchymatous, regularly thickened to nodulose, sometimes forming a distinctly differentiated juxtacostal area. *Multicellular gemmae* sometimes present, borne on filaments on costae and laminae. *Cladautoicous*, *goniouatoicous* or *dioicous*. *Perigonium* bud-like with short, convolute leaves 0.6-1.3 mm long, muticous. *Perichaetial leaves* similar or larger than vegetative leaves to convolute, with a well-developed hair point. Seta 0.2-4.4 mm long, straight, sigmoid or curved, twisted or not twisted. *Capsules* immersed, emergent or exserted, symmetric or asymmetric, cylindrical, ovoid- or oblong-cylindrical, sometimes ventricose; *peristome* usually present, with 16 deltoid or truncate,

cribrose teeth, with outer plate frequently smooth below, distally papillose and inner plate papillose throughout. *Annulus* simple and persistent to compound and revoluble; exothecial cells prismatic, quadrate-rounded to rectangular, thin- or thick-walled. Stomata few, basal, rarely lacking. *Operculum* conical to long rostrate, beak erect or inclined. *Calyptrae* mitrate or cucullate, smooth; columella persistent. *Spores* smooth to finely papillose.

The generic distinction between *Grimmia* and *Schistidium* is unsatisfactory. They have been distinguished mostly by the larger, strongly differentiated perichaetial leaves (Muñoz, 1999) and by the columella attached and deciduous with the operculum in *Schistidium* (Bremer, 1980; Deguchi, 1978; Flowers, 1973; Jones, 1933). Other differences cited by Hastings and Ochyra (2007) include, in *Schistidium*, a small calyptra, the immersed to emergent capsule and the straight seta; most of these characters are also represented in other genera and they are unreliable taxonomic characters at the generic level. Recently, Muñoz and Zippel (2006) indicated that *Schistidium* differs from *Grimmia* in having systylious capsules and usually homogeneous costal cells. The differences between *Grimmia* and *Coscinodon* are equally weak as they rely on the plicate campanulate calyptra that covers the capsule to the middle or below in the latter genus (Jones, 1933; Flowers, 1973; Hastings, 2007). According to Churchill (1981) three synapomorphies characterize the species of *Schistidium*: a columella that remains attached to the operculum, the loss of an annulus, and no air space between the capsule wall and the spore sac. He places *Coscinodon* in a different clade characterized by the perforated peristome and a plicate, campanulate calyptra. Additional cladistic and molecular analyses are necessary to further establish the distinctions and relationships among these genera. A recent molecular study (Hernández-Maqueda et al., 2007) showed *Coscinodon* and *Schistidium* nested within *Grimmia*. Since only the chloroplast gene *rps4* and the *trnL-F* region were used, a detailed study involving a broader species representation and other genes is desirable to clarify the systematic affinities of the genera in the Grimmiaceae.

1. Proximal marginal leaf cells uniformly thin-walled

2. Leaf margins recurved, at least on one side, for a portion of its length

3. Hair point long (>3 mm) and flexuous, mostly piliferous; mid-leaf cells long and narrow, very thick-walled, 3:1 or more; ventral sinus u-shaped; seta curved; gonioautoicous **7. *G. fuscolutea***

3. Hair point short (< 3 mm), straight, mostly muticous; mid-leaf cells short, thick-walled, 1-2:1; ventral sinus v-shaped distally; seta straight; dioicous **6. *G. elongata***

2. Leaf margins plane

5. *G. donniana*

1. Proximal marginal leaf cells with the transverse walls thicker than longitudinal ones

4. Distal half of leaf lamina mostly unistratose

5. Leaves lingulate, lanceolate to elliptic

6. Leaf apex muticous or very short awned; dioicous **21. *G. pulla***

6. Leaf apex muticous or with a well-developed hair point; autoicous

7. Proximal leaf cells quadrate to short rectangular; leaf apex keeled; distal margins 2-3 stratose; operculum crenulate-edged **22. G. pulvinata**
7. Proximal leaf cells rectangular; leaf apex subcucullate; distal margins 1-2 stratose; operculum smooth-edged **16. G. moxleyi**
5. Leaves ovate, ovate-lanceolate or ligulate
8. Glossy plants; central strand absent in sterile plants, epidermal layers of stem 2-3 of small, thick-walled cells **3. G. austrofunalis**
8. Dull plants; central strand usually present, epidermal layers of stem indistinct or 1-2 of smaller, thick-walled cells, the outer layer frequently collapsed
9. Costa in section reniform, with 2-6 ventral cells **11. G. lisae**
9. Costa in section semicircular, with 2 ventral cells
10. Leaf section with a narrow v-shaped ventral sinus **17. G. navicularis**
10. Leaf section with an u-shaped ventral sinus
11. Capsules immersed, without peristome; plants without gemmae
12. Seta curved, capsule ventricose, annulus small, of 1 cell layer, not revoluble, persistent **1. G. anodon**
12. Seta straight, capsule symmetric, annulus large, of several cell rows, revoluble, deciduous **20. G. pseudoanodon**
11. Capsules exserted, peristomate; plants with gemmae
13. Leaves strongly curled when dry; capsules smooth **25. G. torquata**
13. Leaves flexuous when dry; capsules ribbed **26. G. trichophylla (in part)**
4. Distal half of leaf lamina mostly bi- to multi-stratose.
14. Seta curved or slightly sinuose
15. Leaves imbricate when dry; mid-leaf costal section with 4 guide cells; hair point short **8. G. herzogii (in part)**
15. Leaves flexuous when dry; mid-leaf costal section with 2 guide cells; hair point long, sometimes absent
16. Leaves ovate-lanceolate or lanceolate, leaf apex channeled; gemmae often present at leaf base; capsules ribbed **26. G. trichophylla (in part)**

16. Leaves broadly ovate to ovate-lanceolate, leaf apex subcucullate; gemmae absent; capsules smooth

4. *G. bicolor*

14. Seta straight

17. Leaves concave or nearly flat in section, without a distinct ventral sinus

18. Inner perichaetial leaves strongly differentiated, hyaline, surrounding the immersed capsule

19. Capsule symmetric; dioicous; outer plate of the peristome papillose throughout

24. *G. tergestina*

19. Capsule ventricose; gonioautoicous; outer plate of the peristome smooth proximally

9. *G. involucrata*

18. Inner perichaetial leaves green, similar to vegetative leaves to convolute, capsule exerted

20. Proximal leaf cells oblate

10. *G. laevigata*

20. Proximal leaf cells quadrate to short rectangular

18. *G. ovalis*

17. Leaves keeled, costa evident abaxially, with a distinct ventral sinus

21. Capsules immersed or emergent

13. *G. mexicana*

21. Capsules exerted

22. Ventral sinus of costa narrow, linear in distal leaf sections; inner basal cells smooth and thin-walled; epidermal layer of stem undifferentiated; annulus small, 1 row of quadrate cells

3. *G. reflexidens*

22. Ventral sinus broad, u-shaped; inner basal cells sinuous and thick walled epidermal layer of stem of smaller cells with outer wall frequently collapsed; annulus prominent, 2 rows of rectangular cells

23. Small plants, leaves imbricate when dry, varying from ovate to ovate-lanceolate

8. *G. herzogii* (in part)

23. Robust plants, leaves erect, loosely appressed when dry, ovate-lanceolate

24. Costa reniform or nearly indistinct in section; ventral cells of costa 2-6

25. Hair point absent; leaf apex subcucullate, extreme alar cells bistratose **2. G. atrata**
25. Hair point well developed; leaf apex carinate; extreme alar cells unistratose **12. G. longirostris**
24. Costa semi-circular in section; ventral cells usually 2
26. Leaf base abruptly tapering, forming shoulders **19. G. pilifera**
26. Leaf base not abruptly tapering to the apex, not forming shoulders
27. Leaf margins plane, distally incurved; stomata lacking **15. G. montana**
27. Leaf margins recurved proximally, distally erect; stomata present **14. G. molesta**

1. *Grimmia anodon* Bruch & Schimp. in B.S.G., Bryol. Eur. 3: 110. 236. 1845.

Stem up to 10 mm tall, with central strand and an indistinct epidermal layer. *Leaves* 1.3-1.5 mm long, lanceolate, imbricate when dry, erect when wet, carinate, leaf apex obtuse; lamina unistratose, broadly reflexed on one side; margins plane, bistratose distally; costa excurrent, semicircular in section, with a ventral sinus broadly u-shaped, two ventral cells, a dorsal substereid layer and a hydroid group. *Hair point* 0.2-0.6 mm long, denticulate, non to slightly decurrent. Distal leaf cells 7-12 μm , quadrate to short rectangular, thick-walled, sinuose; proximal marginal cells 12-30 μm , quadrate to short rectangular, with thicker cross walls, indistinctly differentiated in several rows; other proximal leaf cells rectangular, thick-walled, shorter and sinuose upwards; juxtacostal basal cells rectangular, smooth, thick-walled, indistinctly differentiated. Gonioautoicous. *Perigonial leaves* 0.9 mm long, convolute, without a hair point. *Perichaetial leaves* 1.8-2.4 mm long, broadly lanceolate to convolute, with hair point 0.6-1.5 mm long. *Seta* 0.3 mm long, sigmoid, not twisted. *Capsule* 0.9 mm long, immersed, asymmetric, subspheric, ventricose; peristome absent. *Annulus* in one row of cells, indistinct; exothecial cells 40-75 μm , prismatic, longer than wide, thick-walled. Stomata basal, few. *Operculum* 0.2 mm long, mammillate. *Calyptra* 0.7 mm long, mitrate. *Spores* 8-12 μm , smooth.

Distribution and ecology. Chile (4200 m.a.s.l.), Mexico (1400-3800 m), and Peru. Also in Canada, U.S.A., Europe, northern Africa, and Asia. On calcareous boulders in open habitats in alpine and subalpine areas.

Illustrations. Figure 1. Deguchi (1984: fig. 1; 1987: pl. 1); Muñoz (1999: fig. 4); Greven (2003: fig. 4).

Specimens examined. CHILE. Prov. Antofagasta: Región de la Puna, Laguna Lejía, *Mahú* 6086 (US).

MEXICO. NUEVO LEÓN: Summit of Cerro Potosí, *Delgadillo* 2361, 2429 (MEXU). **Chihuahua:** Sierra de Samalayuca, *Lizárraga, Vargas & López* 587 (MEXU).

When fertile, *Grimmia anodon* is easily distinguished by the lanceolate unistratose leaves with bistratose margins distally, a gonioautoicous condition, and by its immersed ventricose capsule on a sigmoid seta, without peristome. At the same time, these features distinguish it from *G. pseudoanodon*. *Grimmia americana* E. B. Bartram, a species that may be found in northern Mexico, has bistratose leaves in the distal half, a well-developed peristome, and a large annulus of 2-3 rows of cells.

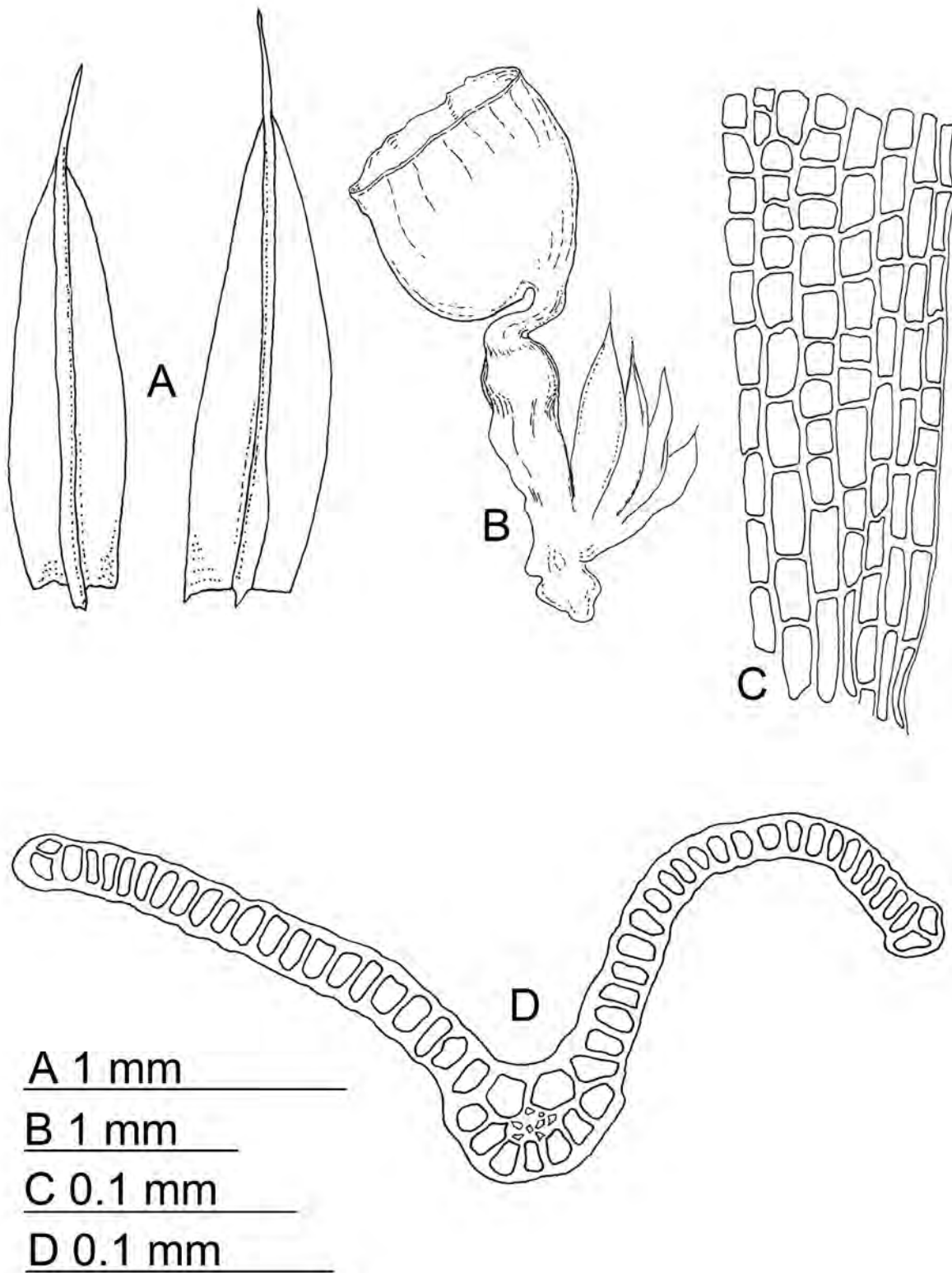


Fig. 1. *Grimmia anodon*. A. Leaves. B. Plant bearing sporophyte with no perichaetial leaves, but with perigonium in place. C. Proximal leaf cells. D. Mid-leaf section. (*Delgadillo 2429, MEXU*).

2. *Grimmia atrata* Miel. ex Hornsch., Flora 2: 85. 1819.

Grimmia tristicha Herz., Biblioth. Bot. 87: 58. 20. 1916, hom. *illeg.*, non *G. t.* (Brid.) Schwägr. Type: Bolivia. Hochtal von Viloco, *Herzog 3170* (Syntype, BM!, H-BR!, JE!), *Herzog 3152* (Lectotype, JE!, designated by Muñoz, 1999); Mine Chojñakota, *Herzog 2979* (Syntype, H-BR!, JE!).

G. tristicha var. *comosa* Herz., Biblioth. Bot. 87: 59. 1916. Type: Bolivia. Hochtal von Viloco, *Herzog 3188* (Lectotype, JE!, designated by Muñoz, 1999; isolectotype, H-BR).

Stem 10-30 mm tall, with central strand present, absent or indistinct, and an epidermal layer of smaller colored cells. *Leaves* 1.8-3.2 mm long, lanceolate to ligulate, slightly flexuose or contorted when dry, erect when wet, carinate, with and obtuse to acute, cucullate, muticous apex; lamina partly or irregularly bistratose in distal half; leaf margins one plane, sometimes both recurved, uni- or bistratose; costa percurrent to subpercurrent, in section reniform, with an u-shaped ventral sinus, four ventral cells, and one or two dorsal substereid or stereid layers. *Hair point* absent. Distal leaf cells 5-15 µm, rectangular, sinuose, thick-walled; proximal marginal leaf cells 12-55 µm, quadrate to rectangular, with a distinct bistratose alar group; other proximal leaf cells usually rectangular, strongly sinuose or nodulose, thick-walled; juxtacostal basal cells rectangular, smooth, thin- or thick-walled, forming an indistinct area. Dioicous. *Perigonium* terminal, *perigonal leaves* 0.9 mm long, convolute. *Perichaetial leaves* 2.8-3 mm long, oblong, without a hair point. *Seta* 2.7 mm long, straight, twisted counterclockwise when dry. *Capsule* 0.8-1.6 mm long, usually exserted, symmetric, oblong-cylindric; peristome teeth 187-275 µm long, 52-75 µm wide at base, stramineous, with outer plate smooth proximally, finely papillose elsewhere, somewhat cribose, strap-shaped. *Annulus* in 2-3 rows; exothecial cells 20-60 µm, prismatic, isodiametric, thick-walled. Stomata none. *Operculum* 0.6 mm long, conic to rostrate. *Calyptra* 2-2.1 mm long, cucullate, smooth. *Spores* 17-22 µm, finely papillose.

Distribution and ecology. Bolivia (4200-4800 m). Super-humid high Andean wet rock outcrops. Also known from Greenland, Canada, Europe and Asia.

Illustrations. Figure 2. Muñoz (1999: fig. 5); Greven (2003: fig. 10); Hastings & Greven (2007).

Specimens examined. BOLIVIA. La Paz: Prov. Bautista Saavedra, An Strasse nach Curva unterhalb der Passhöhe. Schlenke eines Distichia muscoides-Moores, *Feuerer 15253e* (NY). Prov. Inquisivi, Cordillera de Quimsa Cruz on east slope of pass through Cerro Colombia to Mina Huichincani (ex Mina Don Vicente), ca. 0.5 km NE of Represa Pacuni and 8.5 km NW of Quime, *Lewis 87398, 87398A* (MO); Mina Caracoles, sector Pacuni, between Represa Pacuni and the mouth of the Río Rebanca [sic], 11 km NW of Quime, *Lewis 87081* (MO).

Several Neotropical species have muticous leaves, but *Grimmia atrata* is unique in the bistratose alar region. It is similar to *G. mexicana* in general appearance and in the structure of the costa with several ventral cells, as seen in cross section, but the bistratose alar cells and the exserted sporophyte readily distinguish *G. atrata*. The proximal leaf cells in *G. atrata* are quadrate to long-rectangular while in *G. mexicana* the alar cells usually form a distinct group while those toward the costa are long and narrow.

Descriptions of *Grimmia atrata* in Deguchi (1978), Hastings and Greven (2007), and Muñoz (1999) cite the presence of stomata at the base of the urn. Maier (2010) gives them as present or absent, but her specific concept also includes *G. mexicana*. Sporophytes were uncommon in the specimens examined, but I failed to see any stomata in *Herzog 3188*, the lectotype of *G. tristicha* var. *comosa*, a specimen examined by Muñoz (1999).

Ochyra and Bednarek-Ochyra (2004) placed this species in the genus *Streptocolea*, on the basis of four characters: Torsion of the vaginula to the left, distinct convex bistratose auricles that are hyaline and thin-walled in young leaves and brownish and thicker-walled with age, systylious capsules, and an annulus composed of "...a single row of paradental cells at the insertion of the peristome". These observations cannot be fully supported in the present study. The vaginulae observed in wet or Hoyer mounts appear erect and straight, untwisted, and the capsules are deoperculated or unavailable for dissection in Neotropical material. Previous descriptions have referred to the systylious urn in *G. atrata* (cf. Ochyra & Bednarek-Ochyra, 2004), a condition that appears truly unique in *Grimmia*. The paradental cells are not part of the annulus, judging from the illustrations given by Mair (2002, 2010), and not unique to *G. atrata*, but shown in other species such as *G. lisae* or *G. ovalis*. The specimens examined are not distinctly auriculate, but only with a bistratose alar region. Thus, it seems that the generic position of *G. atrata* is still open to question and its uniqueness should be supported by further evidence from other studies.

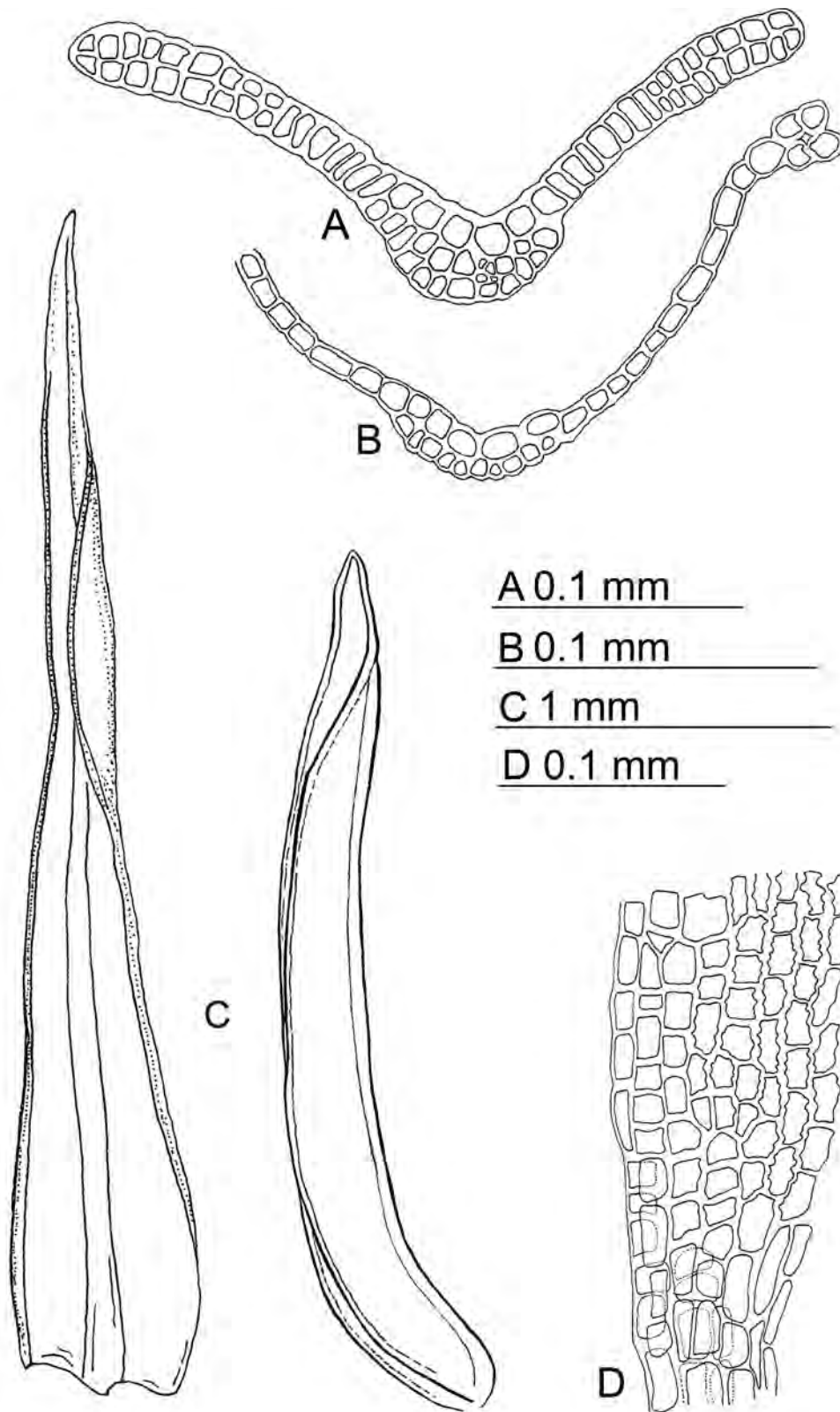


Fig. 2. *Grimmia atrata*. A. Mid-leaf section. B. Leaf section at extreme base. C. Leaves. D. Proximal leaf cells. (A, C, Herzog 3170, H-BR; B, Herzog 2979, H-BR; D, Herzog 3188, H-BR).

3. *Grimmia austrofunalis* Müll. Hal., Hedwigia 37: 165. 1898.

Grimmia pansa R. S. Williams, Bull. New York Bot. Gard. 3(9): 125. 1903. Type: Bolivia. [La Paz]: Pelechuco. [14° 48' S 69° 05' W], 3505 m, *Williams 2823* (Lectotype, NY!, designated by Muñoz, 1999; isolectotype, BM!).

Stem up to 50 mm tall, without central strand, and 2-3 layers of smaller thick-walled cells, the outer with the outer wall collapsed. *Leaves* 1.5-3 mm long, ovate-lanceolate, imbricate to slightly flexuous when dry, erect-spreading when wet, carinate, with an acute leaf apex; lamina usually unistratose, but with occasional bistratose patches; with both margins plane or one narrowly recurved proximally, unistratose throughout, rarely with bistratose patches distally; costa percurrent to excurrent, in section semicircular, with a broad u-shaped ventral sinus, two ventral cells and two dorsal substereid layers. *Hair point* 0.1-0.5-(0.9) mm long, smooth, non-decurrent, channeled proximally. Distal leaf cells 3-15 µm, quadrate, rectangular or oblate, thick-walled, slightly sinuose; proximal marginal cells 7-37 µm, quadrate to rectangular with thicker cross walls, in 1-2 distinct rows; other proximal leaf cells rectangular, thick-walled, sinuose or pitted; juxtacostal basal cells thick-walled, rectangular, smooth to nodulose, forming a distinct area. With multicellular gemmae on hyaline filaments developing from proximal abaxial side of leaves. Dioicous. *Perichaetial leaves* 2.8-3.3 mm oblong-lanceolate to convolute with hair point 0.1-0.5 mm long. Seta 3-4 mm, curved when wet, twisted counterclockwise distally when wet. *Capsule* 1.5-1.9 mm long, exserted, symmetric, oblong-cylindric; peristome teeth 437-540 µm long X 70-77 µm wide at base, deltoid, orange, smooth in basal part and outer and inner plates finely papillose, somewhat cribose. *Annulus* in 2-3 rows, revoluble; exothecial cells 20-40 µm, prismatic, isodiametric, thick-walled. Stomata few, basal. *Operculum* 0.7-0.9 mm long, short-rostrate. *Calyptra* 1.1 mm long, mitrate, smooth. Spores 12-15 µm, weakly papillose.

Distribution and ecology. Bolivia (3500-4890 m), Chile (5-1100 m), Colombia (3600-4285 m), Costa Rica (3400 m), Ecuador (3600-4200 m), Mexico (2500 m), Peru (4100 m), Venezuela (4050 m). Also in Argentina, Europe, and Australia. It grows in high altitude moist páramo or subalpine areas, on rocks.

Illustrations. Figure 3. Muñoz (1999: figs. 7-8); Greven (2003: fig. 12).

Specimens examined. BOLIVIA. COCHABAMBA: Prov. Quillacollo. Cordillera del Tunari, near summit of Cerro Tunari, Lewis 792568 (FH, GOET). Prov. Quillacollo/Chaparé/Ayopaya. Base of Serranías Tarucani, in area of Laguna Tarucani, Lewis 792398 B (NY). LA PAZ: Prov. Inquisivi. Hot springs between Mina Huichincani & Río Glorieta, ca. 1 km NE of lake locally called Laguna Huichincani and ca 8 km NW of Quime, Lewis 87479 (MO). Cumbre Sayaquira. Headwaters of Río Sayaquira, ca 2.5 km S of Estancia Huaña Hkota, Lewis 87321 p.p. (MO, NY), 87297 (MO). Along the Arco Pongo trail between Japo and Cargadero, SW slope of Cerro Ventanini, ca. 2 km N of Japo & 28 km NE of Inquisivi, Lewis 87750 (GOET, MO, US). Mina Chambillaya, ca. 1 km upriver from Mina Chambillaya and ca. 3 km S from Quime, Lewis 871008 d-1, 871023 d-1 (MO), d-3 (MEXU). 1 km SW of Planta Hidroeléctrica de Angostura #6. 6 km S of Choquetanga, Lewis 38139 d-3 (NY), 38139 d-1 (MO). Prov. Manco Kapac. Walk between potable water tank of Copacabana and the summit of “Horca de Inca” (Cerro Niño Calvario), Lewis 37290 d-3 (MO). Prov. Murillo. Head of Río Zongo at SW slope of Cerro Chekhara, N of La Paz, Lewis 791809 (MO, NY), 791814 A (FH, GOET, NY). Ca. 0.5 km E of the Cumbre de la Paz along the old Yungas Road, Lewis 88027 (MEXU). Prov. Nor Yungas. Along the road between the Cumbre de La Paz and Unduavi, between Laguna Kolini and Cuadrilla 35 and along the S facing slopes of Cerro Picacho Kasiri. Ca. 2-4 km NE of the Cumbre de La Paz,

Lewis 87767 d-4 (MO). Prov. Loayza. Viloco. Following the upper Rio Viloco between Viloco and its source at Nevado Salvador Apacheta, and along the slope of Nevado Tras Cuarenta, *Lewis* 871478 d-1 (MO). Prov. Camacho. 1 km below Escoma-Charasani road, about 3 km S of Amarete turnoff, NNW of Chuma, *Lewis* 79794 A (FH), 79803 (FH, GOET).

CHILE. ARAUCANIA: Prov. Cautín. Parque Nacional Conguillío, *Mahú* 23928 (MO). **LOS LAGOS.** Prov. Valdivia. Corra, La Aguada, *Mahú & Harnell* 12565 (MO).

COLOMBIA. ARAUCA: Sierra Nevada del Cocuy, Cabeceras de la Quebrada El Playón, Patio Bolos, 2 km ENE del Alto Cusirí, *Cleef* 8855 (GOET). **BOYACÁ:** Páramos al NW de Belén, cabeceras Quebrada Minas, Hoya Clla Larga, vertiente N del valle, *Cleef* 2115b (GOET). Páramo de La Rusia, NW-N de Duitama, Serranía Peña Negra, Hoya de la Laguna Agua Clara, *Cleef* 7019b (GOET). **SANTANDER:** Páramo de la Rusia, near km 24 of road between Quitama and Cañaverales, 60 km NE of Tunja, *Lewis* 881408 d-4 (MO).

COSTA RICA: Prov. San José. Cordillera Talamanca, Parque Nacional Chirripó, *Holz* CR 03-314, CR 03-334 (MO).

ECUADOR. W of Latacunga, Paramo of Yanaarcha, *McQueen* 7093 (MO). **AZUAY:** Páramo de Cajas, W of Cuenca, just E of highest pass, *Laegaard & Steere* 27732 (NY). **NAPO:** Road Olmedo-Laguna San Marcos, E of the pass, *Øllgaard et al.* 34463 (MO). **PICHINCHA:** Volcán Pichincha, N slope along trail in water catchment area (Yanacocha), *Buck* 9728 (NY).

MEXICO. STATE OF MÉXICO: Iztaccíhuatl, *Delgadillo* 2019 (MEXU); San Rafael Tlalmanalco, alrededores de la Cascada de los Diamantes, *Vivas* 199 (MEXU, NY). **VERACRUZ:** Cofre de Perote, *Cárdenas* 638 (GOET, MEXU).

PERU. Mountains of Peru W of Lima, *DeLillie s.n.*, 1917 (BM). **AYACUCHO:** An der Strasse Huauta-San Francisco; Pass zwischen Tambo und Quinos, *Frahm* 5069 (NY).

VENEZUELA. MÉRIDA: Sierra Nevada. Teleférico: Loma redonda y alrededores. Páramo pedregoso seco, *Cleef & Huber* 4807 (GOET).

Grimmia austrofunalis is one of the largest species in size in the area. The glossy ascending stems with imbricate leaves readily distinguish this species. The lack of a central strand, unistratose laminae with occasional bistratose patches at the margins, a semicircular costa in section with two ventral cells, a short hair point frequently appearing as a stiff smooth awn, occasional gemmae on the abaxial proximal side of the leaves, and the leaf areolation with narrow sinuous cells, also characterize this taxon. The specimens from Costa Rica, have exceptionally long hair points up to 0.9 mm. The species is newly reported from Costa Rica and Mexico.

A sterile specimen from Hawaii (*Hoe* 3467.0, MEXU) was tentatively identified as *G. austrofunalis*; the stems are long and glossy, the leaf border recurved on one or two sides in the lower third, a slightly rough awn, and a costa with substereid cells surrounding two large ventral cells. Similar forms were apparently referred to *G. trichophylla* by Hastings and Greven (2007), but they do not compare well with Neotropical materials. The latter have one revolute leaf border only, the costa includes a small stereid group, and the leaf awn is nearly smooth and usually sinuous when long.

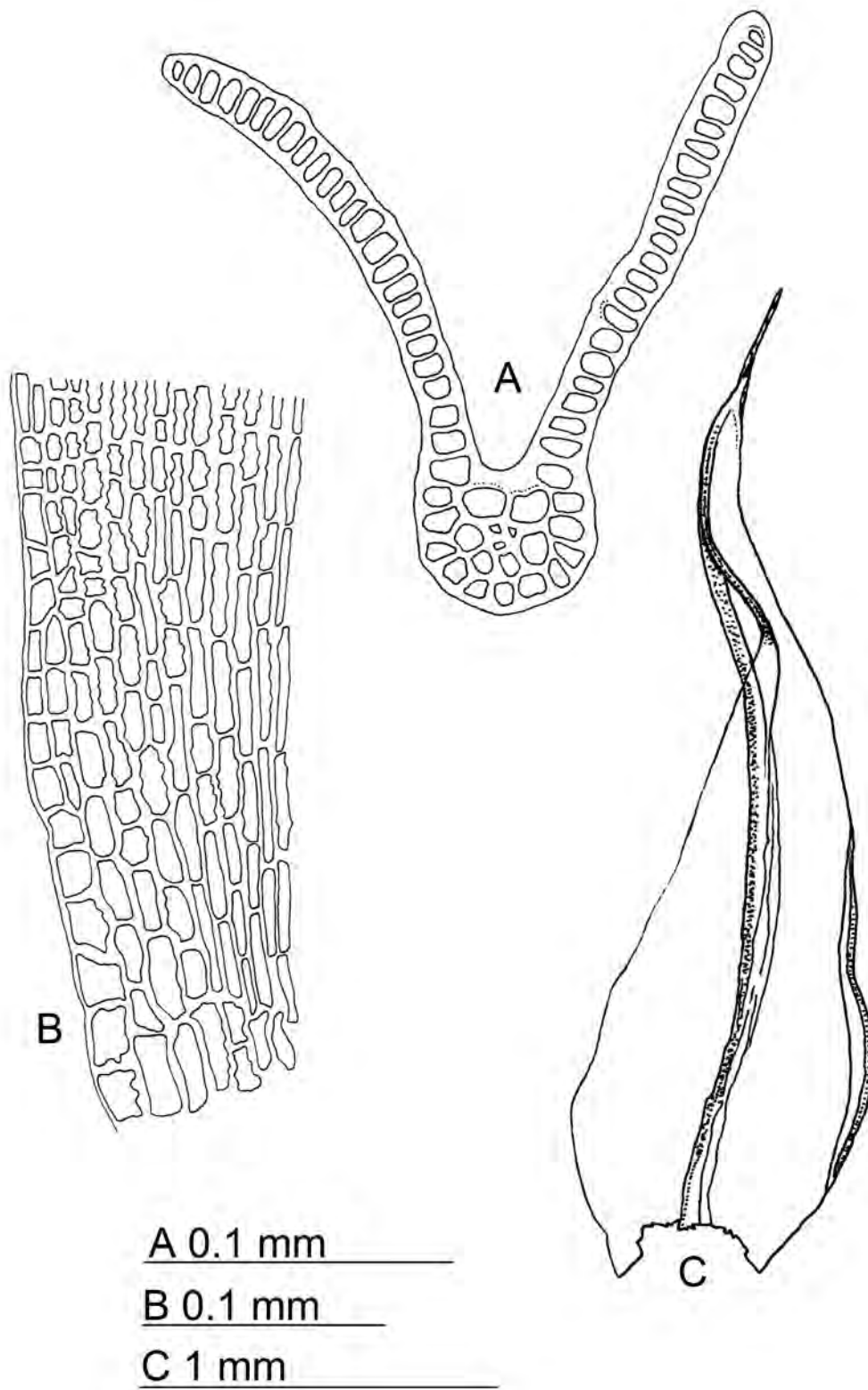


Fig. 3. *Grimmia austrofunalis*. A. Mid-leaf section. B. Proximal leaf cells. C. Leaf.
(Williams 2823, NY).

4. *Grimmia bicolor* Herz., Beih. Bot. Centralb. 26: 66. 1910. Type: Bolivia. Cochabamba. Im Llavetal, 3600 m, *Herzog* s.n., Jan. 1908 (Lectotype JE!, designated by Muñoz, 1999).

Grimmia subquatricruris Broth., in *Herzog*, Biblioth. Bot. 87: 57. 1916. Type: Bolivia. Huailattanisee, 4900 m, *Herzog* 2973 (Lectotype, H-BR!, designated by Muñoz, 1999; isolectotype JE!).

Stem 7-11 mm tall, central strand present or indistinct, with one indistinct epidermal layer. *Leaves* 1.3-1.7 mm long, broadly ovate to ovate-lanceolate, imbricate or flexuous when dry, erect when wet, broadly carinate, with an obtuse, subcucullate, mucicous or short piliferous apex; lamina bistratose but sometimes unistratose in distal half, with one margin plane, the other recurved proximally, narrowly involute apically, bistratose distally; costa percurrent or excurrent, in section semicircular, with an u-shaped ventral sinus, two ventral cells, two dorsal substereid layers and a central hydroid group. *Hair point* none to 0.9 mm long, smooth or denticulate, non- to slightly decurrent. Distal leaf cells 5-12 μm , irregularly quadrate, quadrate to hexagonal, thick-walled, slightly sinuose; proximal marginal cells 12-30 μm , quadrate to rectangular to transversely elongated, with thicker cross walls, undifferentiated; other proximal leaf cells quadrate to short rectangular, thin-walled; juxtacostal cells not forming a distinct area. Dioicous. *Perichaetial leaves* 2-2.4 mm long, ovate-lanceolate, with hair point points 0.6-1 mm long. Seta 1.4-2 mm long, curved, distally twisted counterclockwise. *Capsule* 0.9-1.2 mm long, exserted, symmetric, ovoid; peristome teeth 150 μm long X 62-75 μm wide at base, truncate, yellowish, outer plate smooth at base and inner plate papillose throughout. *Annulus* in 2-3 rows; exothecial cells 25-62 μm , prismatic, mostly longer than wide, thick-walled. Stomata few, basal. *Operculum* conic to mammillate. *Calyptra* not seen. *Spores* 12-17 μm , finely papillose.

Distribution and ecology. Bolivia (4300-5100 m). Reported from Colorado, U.S.A. (Maier, 2010)

Illustrations. Figure 4. (Muñoz 1999: fig. 9); Greven (2003: fig. 14); Maier (2010: fig. 8).

Specimens examined. BOLIVIA. Saittulaguna, *Herzog* 2680 (H-BR). Schneetalchen des Cerro Tunari, *Herzog* 4772 (GOET, JE). COCHABAMBA: Prov. Quillacollo, Cordillera del Tunari, near summit of Cerro Tunari, *Lewis* 792581 (MO, NY).

Although *Grimmia bicolor* is usually regarded as dioicous, at least one specimen (*Herzog* 2680) showed a gonioautoicous condition. The same specimen differed from others in having the leaf lamina unistratose and may be confused with *G. humilis* Mitt., but the latter has plane margins. The sexual condition in *G. bicolor* and other species, notably *G. donniana* and *G. reflexidens*, requires further analysis and evaluation as a taxonomic character. The occurrence of different sexual conditions in a single specimen may suggest a mixed sample or derived phenotypic expressions, as in the case where a cladoautoicous moss produces a “dioicous” colony if male and female branches separate with age. There seems to be no sex determination studies for *Grimmia*.

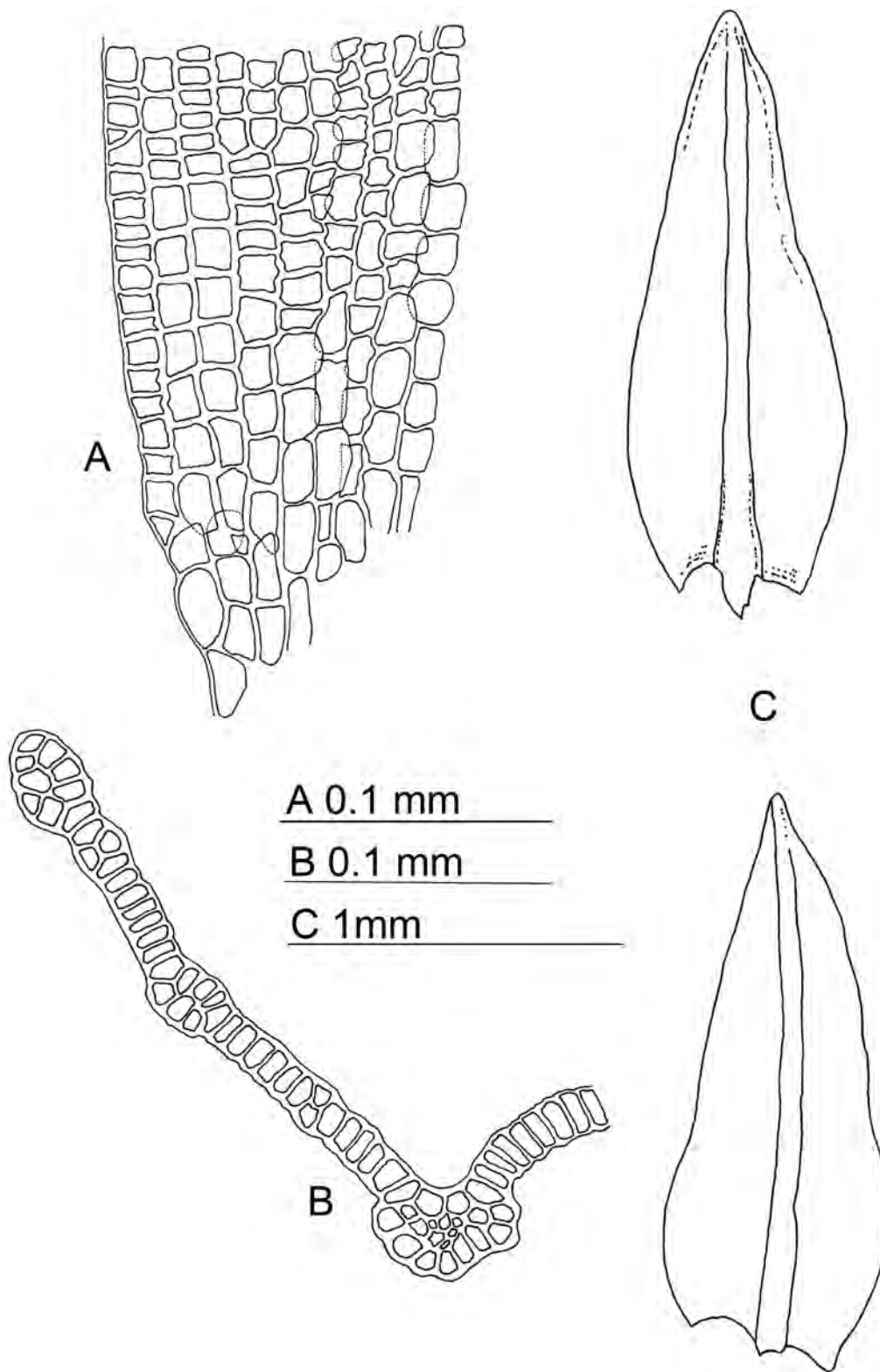


Fig. 4. *Grimmia bicolor*. A. Proximal leaf cells. B. Mid-leaf section. C. Leaves.
(A, C, Herzog s.n., 1908, JE; B, Herzog 4772, JE).

5. *Grimmia donniana* Sm., Engl. Bot. 18: 1259. 1804.

Stem 4-12 mm tall, with central strand, small and one indistinct epidermal layer or of smaller cells. *Leaves* 1.5-2.6 mm long, ovate-lanceolate, loosely imbricate or flexuous when dry, erect-spreading when wet, carinate, with an obtuse to acute leaf apex; lamina unistratose, with bistratose patches, margins plane, bistratose distally; costa excurrent, in section semicircular, with an u-shaped ventral sinus, two ventral cells, 1-2 dorsal substereid layer and a hydroid group. *Hair point* 0.3-1 mm long, nearly smooth, slightly decurrent. Distal leaf cells 7-12 μm , quadrate to short rectangular, thick-walled, slightly sinuose; proximal marginal cells 30-62 μm , rectangular, thin-walled throughout, in one to several rows of differentiated cells; other proximal leaf cells rectangular, shorter upwards, thin-walled, smooth, with sinuose walls upwards; juxtacostal basal cells rectangular, thin-walled, smooth, not forming a distinct area. Gonioautoicous or Cladautoicous. *Perichaetial leaves* 1.7-3 mm long, oblong-lanceolate with hair points 0.9-1.8 mm. Seta 0.7-0.9 mm long, straight, not twisted. *Capsule* 0.8-1 mm long, emergent to exserted, symmetric, oblong-cylindric; peristome teeth 250-272 μm long X 55-62 μm wide at base, deltoid, stramineous, with outer plate smooth at extreme base, papillose above, and inner plate papillose throughout. *Annulus* 1 -2 rows of cells; exothelial cells 17-57 μm , prismatic, mostly longer than wide, thin-walled. *Stomata* few, basal. *Operculum* 0.3 mm long, conic, short-rostrate. *Calyptra* 0.9-1 mm long, cucullate, smooth. *Spores* 7-10 μm , smooth [immature].

Distribution and ecology. Ecuador (3850 m), Mexico (3900-4267 m). Also in Bolivia. Europe, Asia, Greenland, Canada, U.S.A., Antarctica. At high elevation, in alpine areas, on rocks in exposed sites.

Illustrations. Figure 5. Muñoz (1999: fig. 11); Greven (2003: fig. 23); Maier (2010: fig. 14)

Specimens examined. ECUADOR. COTOPAXI: Parque Nacional Cotopaxi. Pampa de Limpios. 0° 40' S 78° 30' W, *Dávila & Balslev* 60 (NY).

MEXICO. STATE OF MÉXICO: Cráter del Nevado de Toluca, R. Cruz, 20/08/1962, (US). Ladera sur del Iztaccíhuatl, *Delgadillo* 1983 (MEXU). Volcán Popocatepetl, *Cleef & Delgadillo* 10247b (GOET). PUEBLA-VERACRUZ: Pico d'Orizaba, *Liebmann* 42 (BM).

Muñoz (1998a) reported setae straight, up to 3.5 mm long and an “anomalous specimen” with the “shortest setae” for *G. donniana* (*Sharp* 4761 p.p., TENN). Muñoz's seta measurements seem to include the vaginulae, but in this revision, seta length reflects only its visible portion, *i.e.*, without the vaginula. Thus, seta length here is smaller than 1 mm and the urn may be emergent to slightly exserted because the urn may turn away from the perichaetial leaves or may be hidden by them. The species is characterized and can be recognized by the plane margins and proximal thin-walled marginal cells.

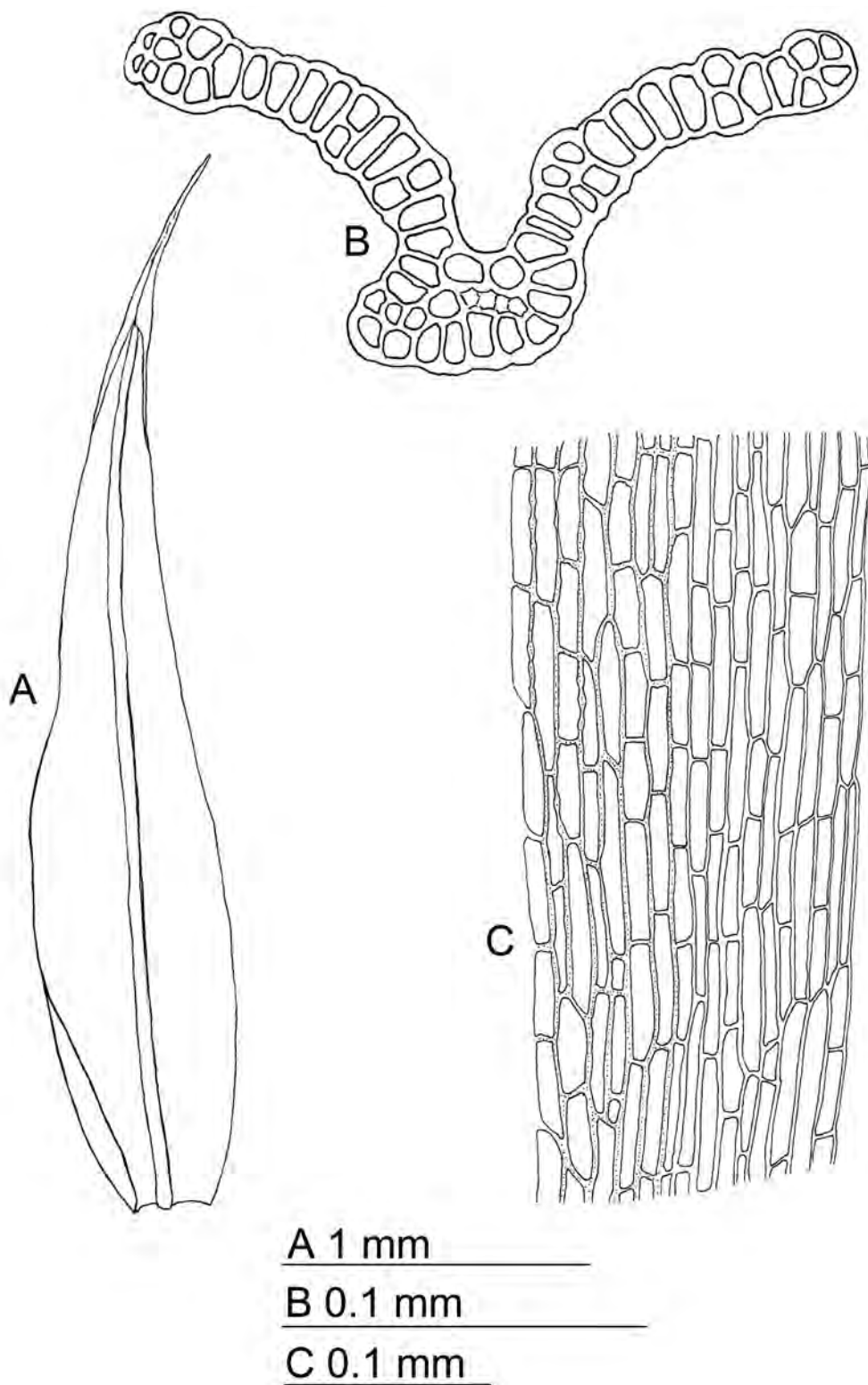


Fig. 5. *Grimmia doniana*. A. Leaf. B. Mid-leaf section. C. Proximal leaf cells.
(Cleef & Delgadillo 102476, GOET).

6. *Grimmia elongata* Kaulf., *Deutschl. Fl.* 2(15): 14.ic. 1816.

Grimmia fuliginosa Schimp. ex. C. Müll., *Syn. Musc. Frond.* 1: 778. 1849. Type: Mexico. Pic d' Orizaba, *Liebmann s.n.*, p.p. Feb 1844 (Lectotype, BM!, designated by Muñoz, 1999; NY!).

Grimmia toluensis Card., *Rev. Bryol.* 38: 1. 1911. Type: Mexico. State of México: Summit of the Volcano of Toluca, *Pringle 27a* (Isosyntype, BM!, FH!, JE!, H-BR!, MEXU!, NY!, US!).

Schistidium fuliginosum (Schimp.) Ochyra, *Fragm. Flor. Geobot.* 43: 105. 1998.

Stem 20-33 mm tall, with central strand small and 1-2 layers of smaller cells, sometimes forming an indistinct epidermis. *Leaves* 1.5-2.2 mm long, lanceolate, slightly contorted when dry, spreading, flexuose or erect-spreading when wet, carinate, with an acute apex; lamina unistratose, but irregularly bistratose at extreme apex; one margin plane, the other recurved, distally bistratose; costa percurrent, in section semicircular, with a v- to u-shaped ventral sinus, two ventral cells, two dorsal stereid or substereid layers and one hydroid group. *Hair point* absent to 0.1 mm long, smooth, non-decurrent. Distal leaf cells 5-12 μm , quadrate to short rectangular, smooth to slightly sinuose, thick-walled; proximal marginal cells 17-50 μm , rectangular, thin-walled, in 3-4 rows; other basal leaf cells rectangular, thin- to thick-walled and strongly sinuose; juxtacostal basal cells similar to other basal cells, thick-walled, long rectangular. Dioicous. *Perigonial leaves* 0.7 mm long, convolute, without hair point. *Perichaetial leaves* 1.9-3.7 mm long, oblong-lanceolate, or ovate lanceolate to convolute, with a hair point 0.1-0.4 mm long. *Seta* 0.5-2.3 mm long, straight to slightly curved, twisted counterclockwise when dry. *Capsule* 0.7-1.1 mm long, emergent to exserted, symmetric, oblong-cylindric; peristome teeth 137-225 μm long X 45-55 μm wide at base, deltoid, yellowish, with outer plate smooth below, papillose distally; inner papillose throughout. *Annulus* in 1-2 rows of cells; exothecial cells 20-47 μm , isodiametric, prismatic, thick-walled. Stomata few, basal. *Operculum* 0.3-0.5 mm long, conic, short-rostrate. *Calyptra* 1.4 mm long, mitrate, smooth. *Spores* 7-12 μm , weakly papillose.

Distribution and ecology. Brazil (2500 m), Colombia (4300 m), Guatemala (3800-4600 m), Mexico (2896-4572 m). Europe, Asia, Argentina. Growing on peat, sand, soil, gravel, rocks or cervices in rocks, in *Espeletia* zone, in alpine areas, *Juniperus monticola* rocky areas, in open *Pinus hartwegii* forest, or in fir woods.

Illustrations. Figure 6. Muñoz (1999: fig. 13); Greven (2003: fig. 25); Maier (2010: fig. 16).

Specimens examined. BOLIVIA. LA PAZ. Inquisivi, *Lewis 83-3306, 83-3317* (MO)

BRAZIL. Serra do Itatiaia. Dusén 611 (H-BR).

COLOMBIA. BOYACÁ: Sierra Nevada de Cocuy. 5 km E Farm Ritacuva, *Grubb & Guymmer B68, B73* (BM).

GUATEMALA. SAN MARCOS: Between San Sebastián and summit of Volcán Tajumulco. [15° 02' N 91° 55' W], *Steyermark* 35548 (NY). Near summit of Tajumulco, *Sharp* 5429 (MO).

MEXICO. JALISCO: Ladera N del Nevado de Colima, *Cárdenas* 2959, (GOET, MEXU), 2972 (MEXU), *Delgadillo* 4388, 4641 (MEXU). Nevado de Colima, ladera NE, *De Luna* G. 504, 515 (MEXU). Summit of Nevado de Colima, just below the radio station, *Whittemore, Matos & Rudolph* 3195 (MEXU, MO). **STATE OF MÉXICO:** On Route 15, “La Escondida”, 8 miles E of Lerma, *Hermann & Crum* 20886 (H). Road to Nevado de Toluca, *A.J. Sharp, E.B. Sharp, Clebsch & Thornburgh* 1506b (MEXU), Cráter del Nevado de Toluca, *Cárdenas* 3510, 3517 (MEXU), *Bro. Amable* 1797 p.p., 1899 p.p. (NY), *Tan* 95-134 (FH), *Duna, Torke & LeDoux* 21901 (MEXU), *Bowers, Delgadillo & Somers, s.n.*, 20 Dec 1973 (MEXU), *Balls* 4100 (US), *Buck* 28178 (NY). Ladera E del cráter, *Delgadillo* 1815 (MEXU), Ladera Norte del cráter, *Delgadillo* 1880 (MEXU), ladera que ve al S, *Delgadillo* 2243a, 2253 (MEXU), cerca de las lagunas del cráter, *Lowy, G. Guzmán & T. Herrera s.n.*, 19 Aug 1962 (MEXU), On shores of lake, 100 yards from edge of water, *Patrick* 289, 292, 293, 319c, 320 (MO). Ladera Norte del Popocatepetl, *Delgadillo* 2074, 2134a, (MEXU). Popocatepetl, *J.N. Rose s.n.*, 7 Aug 1901 (US), *Cleef & Delgadillo* 10247, 10252 (GOET). Ladera NW del Popocatepetl, *Delgadillo* 2160, 2162b, 2182 (MEXU). S end of Iztaccíhuatl, *Delgadillo* 2007 (MEXU). **PUEBLA:** Above las cuevas on Iztaccíhuatl above Hwy., *Sharp* 4280 p.p. (MEXU, MO), Ladera NW del Pico de Orizaba, *Delgadillo* 4081 (GOET, MEXU). **PUEBLA-VERACRUZ:** [Pic d'] Orizaba, *Liebmann* 67 (BM), *Liebmann s.n., p.p.*, 02/1844 (BM, NY). In monte Orizaba, *Deppe & Schiede* 1070a, p.p. (BM), Jalapasco. Orizaba, *J.G. Smith* 10d (NY). Orizaba, *J.G. Smith s.n.*, 25 Feb 1892 (NY). **VERACRUZ:** Road from Perote to Cofre, *Sharp, G. Juárez, M. Baez & B. Boom* 7174 b (MEXU).

Grimmia fuliginosa was originally described by Schimper (*Müller*, 1849) on the basis of a specimen collected on Pico de Orizaba in eastern Mexico. Little is known about it because the type collection is apparently the only material thus far available and its morphology and taxonomic position are still open to question. In recent years, *G. fuliginosa* was regarded as a synonym of *G. elongata* (Crum, 1994; Greven, 1999; Muñoz, 1999; Muñoz & Pando, 2000) or a species of *Schistidium* (Ochyra, 1998).

The type collection of *Grimmia fuliginosa* (*Liebmann s.n.*, 1844, BM, NY) contains two elements. The first corresponds to the concept of *G. elongata* Kaulf., a fact that explains its continued placement in the synonymy of this taxon. The second element belongs to a *Grimmia* with gemmiferous plants that is here referred to a small form of *G. torquata* Drum.

The original description of *G. fuliginosa* states that the upper leaves are flexuous, linear-lanceolate, with an incurved piliferous apex. These gametophytic features may be observed in plants of both elements, but the sporophytic characters describe those of *G. elongata* (‘pedunculo paullo longiore, recto v. curvulo, operc. conico acuto’). The gemmiferous plants bear no sporophytes. The question is whether Schimper used both elements in the specimen, but failed to observe gemmae because of the excessive soot (thus the name ‘fuliginosa’). It is interesting to note that recent workers also failed to observe the mixed condition of the sample. Because the sporophyte characters of the Orizaba collection are those of *G. elongata*, as given in the protologue, I conclude that *G. fuliginosa* is correctly placed here as a synonym.

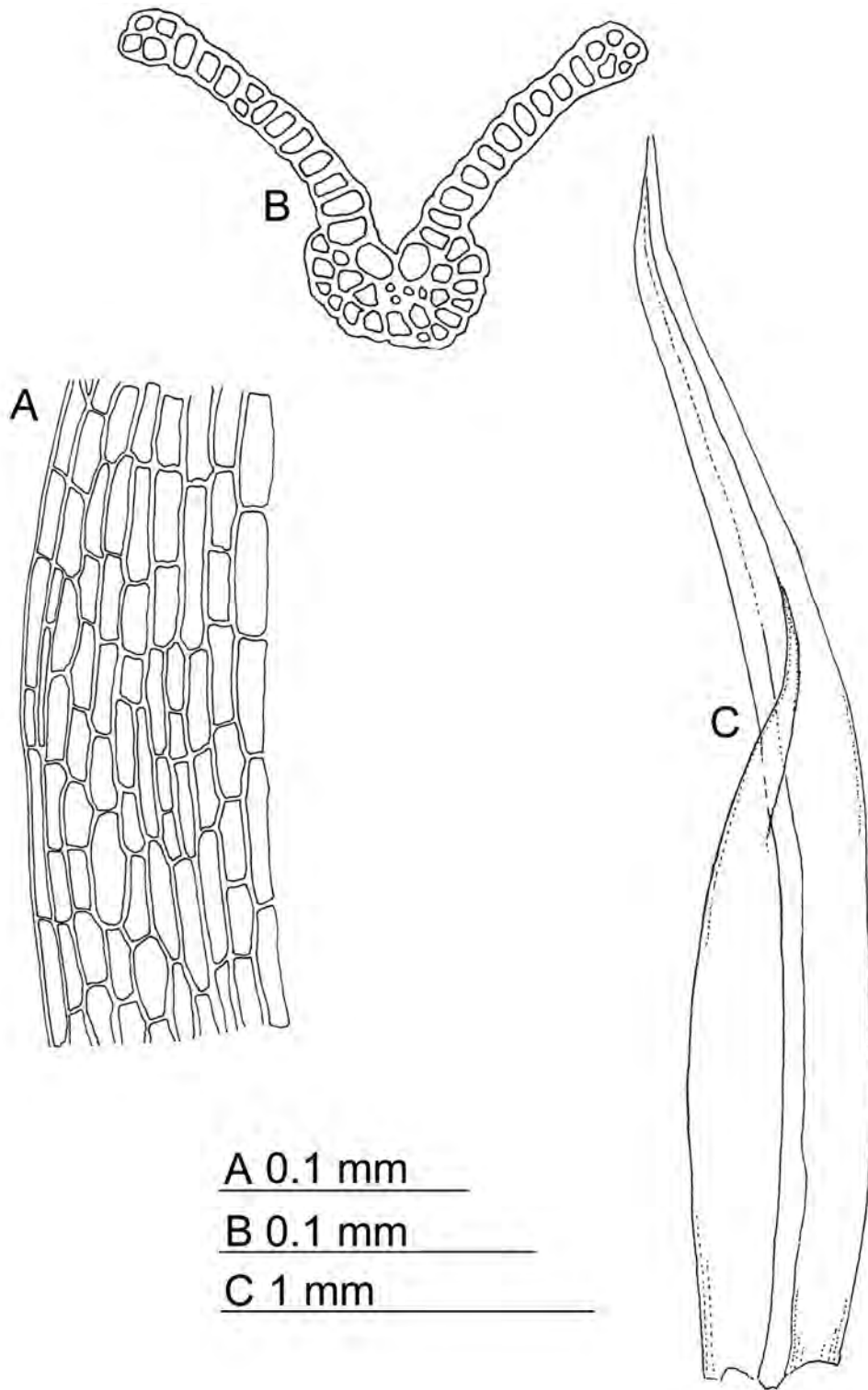


Fig. 6. *Grimmia elongata*. A. Proximal leaf cells. B. Mid-leaf section. C. Leaf. (Delgadillo 4081, MEXU).

7. *Grimmia fuscolutea* Hook., Musci Exot. 1: 63. 1818. Type: Mexico. State of México: In frigidis Tobeccae et Islahuacae, 2432 m, *Humboldt & Bonpland s.n.* (Isotype, NY!).

Grimmia unicruris Müll. Hal., Linnaea 43: 463. 1882. Type: Argentina. Cuesta de Pinos. 27 Mar 1873, (Lectotype, BM!, designated by Muñoz, 1999), Herb. E. Bescherele.

Grimmia quatricruris Müll. Hal., Linnaea 43: 462. 1882. Type: Argentina. Cuesta de Pinos, 1873 (Lectotype, BM!, designated by Muñoz, 1999), Herb. E. Bescherele.

Grimmia trichophylloidea Schimp. ex Müll. Hal., Nuov. Giorn. Bot. Ital. n. ser. 4: 127. 1897. Type: Bolivia. [Sorata, prope Vancuiri, in scopulosis, 4500 m], *Mandon 1633*, 04/1860 (Isolectotype, BM!, without locality data).

Stem 7-50 mm tall, with a small or indistinct central strand and an indistinct outer epidermal layer. *Leaves* 1.3-2.7 mm long, lanceolate or ovate-lanceolate, imbricate or loosely appressed when dry, erect-spreading when wet, carinate, with an acute leaf apex; lamina unistratose; margins one plane, the other recurved, bistratose distally; costa percurrent to excurrent, in section semicircular, with a v- to u-shaped ventral sinus, two ventral cells, an epidermal layer and a stereid group. *Hair point* 0-1 mm long, smooth, usually non-decurrent. Distal leaf cells 7-27 μm , quadrate to short rectangular, thick-walled, sinuose; proximal marginal cells 12-85 μm , quadrate to short rectangular, with thicker cross walls; other proximal leaf cells quadrate to rectangular, thick-walled, sinuose upwards; juxtacostal basal cells smooth, rectangular, thick-walled, longer toward costa, forming a distinct area. Gonioautoicous. *Perigonal leaves* 0.7-1 mm long, convolute, without hair point. *Perichaetial leaves* 1.7-3.3 mm long, oblong-lanceolate to convolute, with a hair point 0.4-2.5 mm long. *Seta* 1.5-2.8 mm long, curved when wet, twisted clockwise or counterclockwise. *Capsule* 1.1-1.7 mm long, exserted, symmetric, ellipsoid or oblong-cylindric, smooth; peristome teeth 150-262 μm long X 62-75 μm wide at base, truncate or deltoid, stramineous to orange, with outer plate smooth only at extreme base; inner plate papillose throughout. *Annulus* in 3 rows of cells; exothecial cells 22-70 μm long, prismatic, mostly longer than wide, thick-walled. Stomata few, basal. *Operculum* 0.3 mm long, convex, conic or short rostrate. *Calyptra* mitrate. Spores 10-20 μm , finely papillose.

Distribution and ecology. Bolivia (4300-4900 m), Colombia (4350-4400 m), Ecuador (4420-4572 m), Mexico (3353-4572 m), Peru (4724 m), Venezuela (4260 m). Europe, Asia, Africa. At high altitudes in alpine areas and superpáramo, on volcanic rocks.

Illustrations. Figure 7. Muñoz (1999: fig. 15); Greven (2003: fig 27); Maier (2010: fig. 18)

Specimens examined. **BOLIVIA.** Cordillera Real, Cumbre, Tate 6 (NY). Luipichi Pass, *Williams 1777* (BM, H-BR, NY). Oberen Chocayatal, *Herzog 3572* (BM, H-BR). Saittulaguna, *Herzog 2662* (H-BR, NY). **COCHABAMBA:** Prov. Quillacollo, Cordillera del Tunari, Cerro Huayna Tunari, above Laguna Macho, *Lewis 792539* (FH, GOET, MO, NY). Prov. Quillacollo/Chaparé/Ayopaya, Base of Serranías Tarucani in area of Laguna Tarucani, *Lewis 792429* (MO, NY), *792438 A* (FH, GOET), *792599* (NY). **LA PAZ:** Prov. Camacho, 1 km below Escoma-Charasani road, about 3 km S of Amarete turnoff, NNW of Chuma, *Lewis 79824* (FH, GOET, MO). Prov. Franz Tamayo, Fuss des Katantike am Pass zwischen Antaquilla und Pelechuco, *Feuerer & Preiss 15236 a* (NY). Prov. Inquisivi, Cumbre Sayaquira. Headwaters of Río Sayaquira, ca. 2.5 km S of Estancia Huaña Hkota, *Lewis 87314*, *87324*

(MO), 87329, 87620 A (MEXU, MO). Estancia Sayaquira, NE side of Rio Sayaquira between Jochara Punta and Cerro Saythokho Punta, ca. 2-4 km NW of Estancia Sayaquira, *Lewis* 87620 A (NY). Prov. Loayza, Viloco. Following the upper Río Viloco and its source at Nevado Salvador Apacheta, and along the slope of Nevado Tras Cuarenta, *Lewis* 871495 d-1 (MO). Prov. Murillo, Below Abra Zongo, N of La Paz, *Lewis* 791867 A (FH, GOET). First small creek ca. 0.5 km E of the Cumbre de La Paz along the old Yungas Road, *Lewis* 80037 d-6 (NY). Head of Río Zongo at SW slope of Cerro Chekhara, N of La Paz, *Lewis* 791824 (FH, GOET, MO, NY), 791825 A (NY), 791826 (MO).

COLOMBIA. ARAUCA: Sierra Nevada del Cocuy, Cabeceras de la Quebrada El Playón, Patio Bolos, 2.5 km S del Alto La Plaza, *Cleef* 8998, 8963a (GOET). Caldas: Nevado del Ruiz. Arenales 3 km SW del Refugio, Cabeceras Q Las Nereidas, *Cleef* 2449 (GOET).

ECUADOR. Pichincha, *Bell* 378, 409, 412 (BM).

MEXICO. STATE OF MÉXICO: Cráter del Nevado de Toluca, *Cárdenas* 3509, 3511, 3512 (MEXU), *Pringle* 26a, p.p. (NY), *Castilla* 1902a (MEXU), Ladera Sur del cráter del Nevado de Toluca, *Delgadillo* 2243b, 2310 (MEXU), Nevado de Toluca: East-facing slope of the crater, *Delgadillo* 1740 (MEXU), Nevado de Toluca: near highest point on outer W-facing slope, *Delgadillo* 1766 (MEXU), Nevado de Toluca; on inside south rim of crater, *Beaman* 3420, 3423 (US). **PUEBLA:** Ladera NW del Pico de Orizaba, *Cárdenas* 647 (MEXU, NY), 649, 651c (MEXU). **PUEBLA-VERACRUZ:** [Pico de] Orizaba. *Müller s.n.* (BM), *Liebmann s.n.*, p.p. 1841-43 (H, NY). **TLAXCALA:** Ladera norte de La Malinche, *Delgadillo* 2485 (MEXU). **VERACRUZ:** Road from Perote to Cofre, *Sharp et al.* 7497d. Cima del Cofre de Perote, *Delgadillo* 3057, 4064a (MEXU), Ladera NW del Pico de Orizaba, *Delgadillo* 4085 (MEXU), Mpio. La Perla, N side of Pico de Orizaba, above the Piedra Grande mountaineering shelter, *Nee et al.* 33194 p.p. (NY).

PERU. An der Lima-Orrya-Bahn, Hacienda Arana bei Yauli, *Weberbauer* 373 p.p. (H-BR).

VENEZUELA. MÉRIDA: Dist. Rangel, Páramo de Piedras Blancas, south slopes, *Griffin*, III 1499 (GOET, MEXU, MO, NY).

Grimmia fuscolutea is distinguished by flexuous or loosely appressed leaves, long (4:1 or longer) and narrow, thick-walled, strongly sinuous lower mid-leaf cells; thin-walled marginal cells, long perichaetial leaves, and a curved seta. The gonioautoicous condition is also a constant feature of this species.

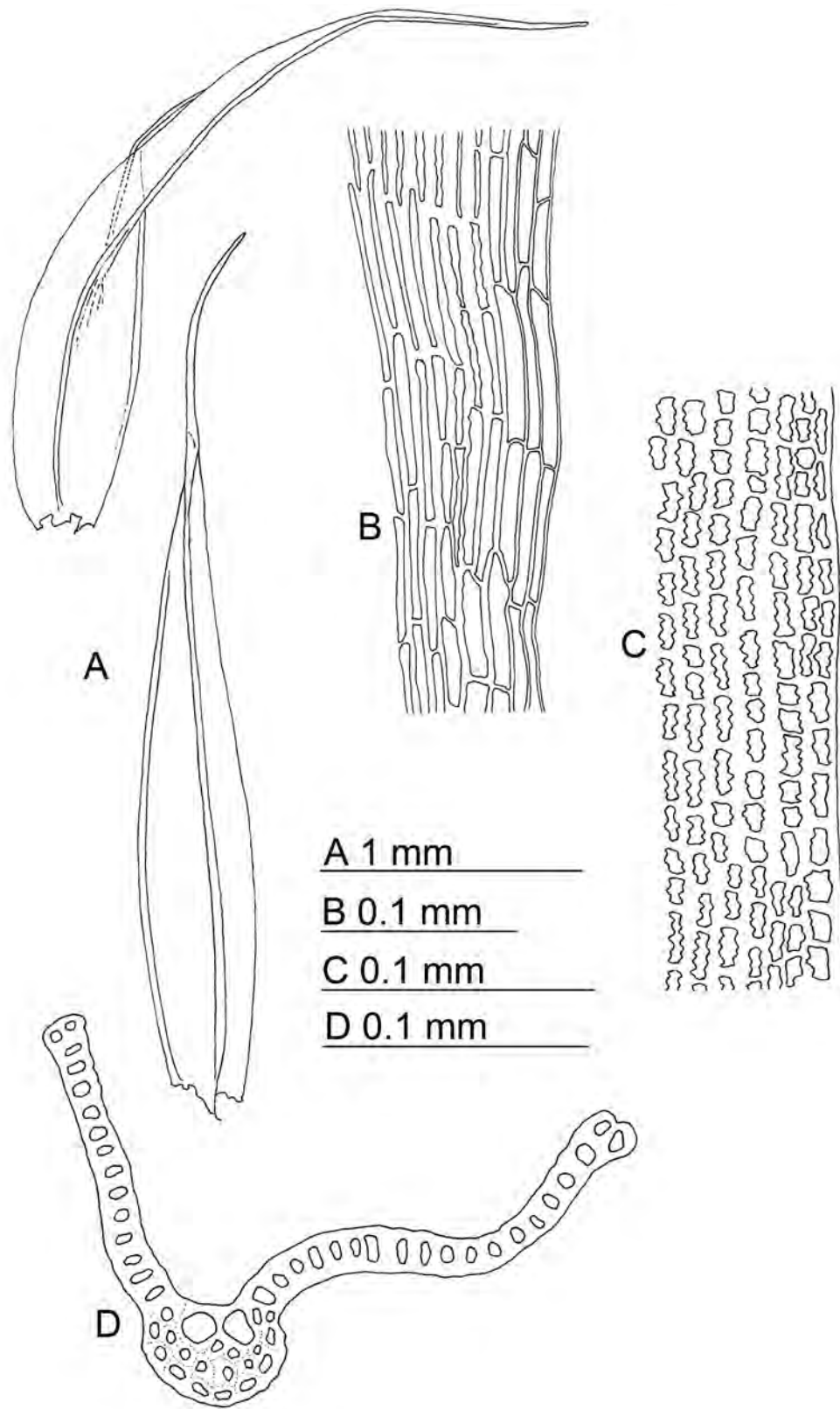


Fig. 7. *Grimmia fuscolutea*. A. Leaves. B. Proximal leaf cells. C. Mid-leaf cells. D. Mid-leaf section.
(Lewis 87329, MEXU, MO).

8. *Grimmia herzogii* Broth. in Herzog, Biblioth. Bot. 87: 55. 1916. Type: Bolivia. Yanakaka, 4500 m, Herzog 3826 (Lectotype designated by Deguchi, 1987; Isolectotype, H-BR!). Oberes Chocayatal, 4400 m, Herzog 3597 (Syntype, H-BR!).

Grimmia nigella Herz., Biblioth. Bot. 87: 55. 1916. Type: Bolivia. Im oberen Chocayatal, An Felsen, 4400 m, Herzog 3587a (Syntype, JE!).

Stem 11-13 mm tall, with central strand and one distinct epidermal layer of smaller thick-walled cells. *Leaves* 0.8-1.4 mm long, lanceolate to ovate-lanceolate, closely imbricate when dry, erect-spreading when wet, carinate, with an obtuse leaf apex; lamina uni- or bistratose distally; margins one erect, the other recurved, bistratose distally; costa excurrent, in section reniform, with a broad u-shaped ventral sinus, four ventral cells at mid leaf, one dorsal substereid layer and a hydroid group. Hair point 0.2-0.5 mm long, flexuous, nearly smooth, non-decurrent. Distal leaf cells 5-12 μm , quadrate, rectangular, thick-walled, slightly sinuose; proximal marginal cells 7-32 μm , short-rectangular to rectangular, with thicker cross walls, undifferentiated; other proximal leaf cells quadrate to rectangular, thick-walled, smooth to slightly sinuose; juxtacostal basal cells forming a distinct area, smooth or nodulose, larger than marginal cells. Cladautoicous. *Perigonial leaves* 0.6-0.8 mm long, convolute, without a hair point or mucronate. *Perichaetial leaves* 1.1-2.3 mm long, convolute with hair point 0.2-1 mm long. *Seta* 1.9-2.4 mm long, sinuose, slightly twisted counterclockwise. *Capsule* 1-1.4 mm long, exserted, symmetric, elliptical or cylindrical; peristome teeth 172-212 μm long X 65-75 μm wide at base, deltoid, stramineous, outer plate smooth proximally, distally papillose, inner plate finely papillose, somewhat cribose. *Annulus* 1-4 rows of cells, revoluble; exothecial cells 20-60 μm , prismatic, mostly longer than wide or isodiametric, firm-walled. Stomata several, basal. *Operculum* 0.3, short-rostrate, conic or mammillose. *Calyptra* mitrate. Spores 10-12 μm , finely papillose.

Distribution and ecology. Endemic. Bolivia (4000-4600 m). On granite rocks or wet crevices, in windswept high altitude ridges, or in overgrazed grassy sites.

Illustrations. Figure 8. Deguchi (1987: pl. 4, 5)

Specimens examined. BOLIVIA. Comanche, Rose 18882a (NY, US. LA PAZ: Prov. Aroma, 1 km S of Calamarca, Lewis 7926 (FH, GOET, MO, NY). Prov. Loayza, Slopes of Cerro Majthia Huata. W of and downslope from the Quime-Caxata road, ca. 5 km NE of Caxata, Lewis 871108 d-1 (MO). Prov. Murillo. 8 km towards La Mina San Francisco, from the road between Calacoto and Palca, Valley of Río Choquekkota, Solomon 6072 (MO). POTOSÍ: Tomás Frías, a 10 km sobre la carretera a Oruro, cañones de San Antonio, cerca de Miraflores, Linneo 337 (MO). Quijarro, Pueblo de Huari, Sanjines 4023 (MEXU). Sud López, 10 km de Villa Alota, Sanjines 4135B (MEXU).

Grimmia herzogii is similar to *G. longirostris* Hook. from which it is distinguished by densely foliated stems, short, appressed, ovate to ovate-lanceolate leaves, perichaetial leaves similar to the vegetative ones, a sinuous and slightly twisted seta, and the conic, mammillate operculum (Delgadillo & Villaseñor, 2002). Despite these differences there is some intergradation between both species, as shown by Lewis 7926 where the seta may be straight or sinuous and the operculum distinctly rostrate (although the urn was immature). In Solomon 6072, the leaves are similar in shape to those of *G. longirostris*, but the sporophytes are “typically” *G. herzogii*.

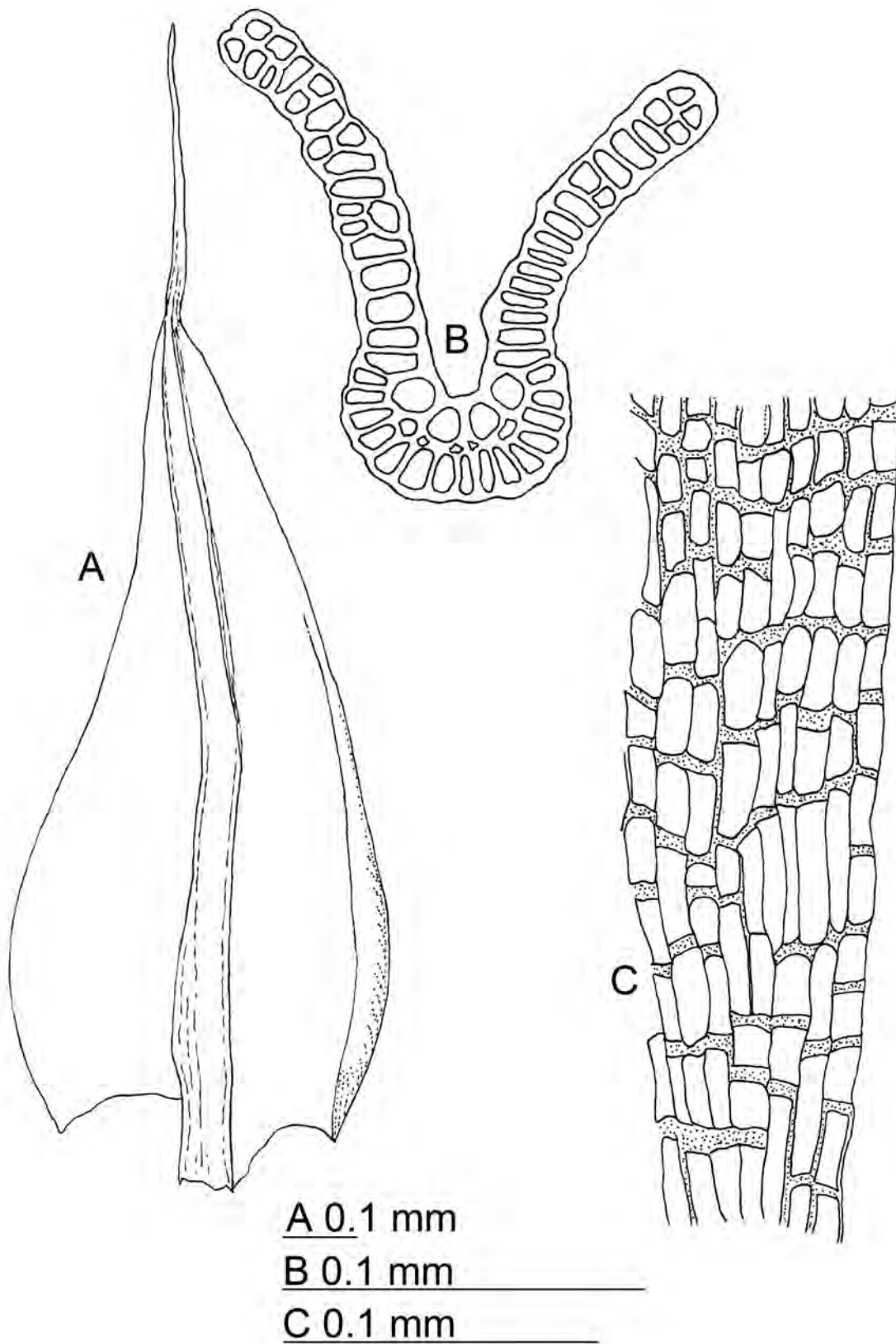


Fig. 8. *Grimmia herzogii*. A. Leaf. B. Mid-leaf section. C. Proximal leaf cells.
(Herzog 3826, H-BR).

9. *Grimmia involucrata* Card., Rev. Bryol. 36: 105. 1909. Type: Mexico. Hidalgo: Cuyamaloya, Pringle 10598 (Isolectotypes, FH!, H-BR!, US!; lectotype designated by Muñoz, 1999).

Stem up to 9 mm tall, with central strand and 1-2 epidermal layers of smaller thick-walled cells. *Leaves* 1.2-1.3 mm long, oblong-ovate, imbricate when dry, erect-spreading when wet, concave to slightly carinate distally, with an obtuse leaf apex; lamina bi- (or tri-stratose) in distal half; margins plane, bistratose distally; costa excurrent, ventral sinus none, ventral cells 2 and 4 large cells around a hydroid group, one dorsal substereid layer and one hydroid group. Hair point 0.6-1.2 mm long, denticulate, slightly decurrent. Distal leaf cells 5-12 μm , quadrate to short rectangular, thick-walled, slightly sinuose; proximal marginal cells 7-17 μm , quadrate to short rectangular to transversely elongated, with thicker cross walls, undifferentiated; other proximal leaf cells quadrate to rectangular, thick-walled, slightly sinuose upwards; juxtacostal basal cells not forming a distinct area; mostly quadrate and thin-walled. Gonioautoicous. *Perigonial leaves* 0.6 mm long, convolute, without hair point. *Perichaetial leaves* 1.4-1.9 mm long or slightly curved, oblong-ovate to convolute, usually with a well developed hyaline zone occupying most leaf area, hair point 0.9-1.6 mm long. Seta 0.5 mm long, straight to slightly curved, not twisted. *Capsule* 1.2-1.4 mm long, immersed, symmetric to slightly ventricose; peristome teeth 287-300 μm long X 62-75 μm wide at base, deltoid, stramineous, trabeculate; outer plate nearly smooth below, papillose distally; inner plate finely papillose, somewhat cribose distally. *Annulus* revoluble; exothecial cells 25-60 μm , prismatic, mostly longer than wide, thin-walled. Stomata several, basal. *Operculum* 0.7 mm long, conic, short-rostrate. *Calyptra* 1 mm long, mitrate, smooth. Spores 12-15 μm , smooth.

Distribution and ecology. Endemic. Mexico (2180-2900 m). On rocks, in *Pinus*, *Juniperus*, or *Quercus* forests; in *Quercus*, *Opuntia*, or *Ceanothus* thickets in dry areas.

Illustrations. Figure 9. Muñoz (1999: fig. 18); Delgadillo (1999: fig. 1); Greven (2003: fig. 37).

Specimens examined. MEXICO. DISTRITO FEDERAL: Tlalpan, *Amable 1448* (FH, MEXU), Zacatenco, *Amable 1352* (BM, MEXU). GUANAJUATO: Salto del Ahogado, *P. Herrera P. 1716* (MEXU). HIDALGO: 2 km NW de San Francisco Sarabia, 17 km NE de Tepeapulco, *Cárdenas 5635, 5639, 5642b, Delgadillo 6104* (MEXU), 6 km N de Tepeapulco, sobre la carretera a Epazoyucan, *Cárdenas 3835* (MEXU). Alrededores de Ciudad Sahagún, *Cárdenas 3107b, 3108* (MEXU). Cerro Alto, 2.5 km SE de Epazoyucan, *Cárdenas 3465, 3467, 3852, 3860* (MEXU). Cerro Xihuingo, 5 km NE de Tepeapulco, *Cárdenas 1710* (MEXU). Cuyamaloya, Sierra de Pachuca, *Pringle 10599 p.p.* (MEXU). Sierra de Tezontlalpan, 3 km NW de Tolcayucan. *Cárdenas 1780, 1783* (MEXU). Mpio. Pachuca, 5 km N de Huixmi, *Cárdenas 3176b* (MEXU). Mpio. Zempoala, Ladera N del Cerro de Santa María Tecajete, *Cárdenas 2847, 2852, 2863, 2864* (MEXU). Mpio. Temamatla, 3 km SW de San Pablo Atlazampan, *Cárdenas 3704a* (MEXU). STATE OF MÉXICO: Cima del Cerro Gordo, *Allen 12951* (MO), *Cárdenas 2903* (MEXU). Mpio. Tepotzotlán, Sierra de Alcaparrosa, 4 km NW de Tepotzotlán, *Cárdenas 3912, Delgadillo 7267* (MEXU). ZACATECAS: 1 km S de Troncoso, *Cárdenas 3092* (MEXU, NY). Mpio. Fresnillo, 2 km S de San Juan de los Hornillos, cerca de la Presa Hornos, *Cárdenas 752* (MEXU). Mpio. Luis Moya, Cerro Gordo, 3 km SE de la Colonia Hidalgo, *Cárdenas 736* (MEXU).

Grimmia involucrata was described on the basis of a single specimen (*Pringle 10598 p.p.*) as having a straight seta, with a symmetric capsule. Careful examination of capsules in the isotypes and other specimens cited above shows that the seta may be straight to slightly curved even when short, and the urn symmetric to inconspicuously ventricose so that the insertion of the seta may be central to slightly excentric (e.g., *Allen 12951, Cárdenas 3465*). The misunderstanding around the morphology of this species is perhaps due to the fact that the Pringle's specimen was pressed after collecting. Also,

there was a poor collecting record at the time of the description, and adequate characterization of the urn requires the dissection of a number of sporophytes per specimen.

Grimmia americana E. B. Bartram from Arizona and Texas, may be confused with *G. involucrata*, but the former is distinguished by its arcuate seta, a distinctly ventricose urn, and broad peristome teeth that are strongly cribose in the distal half. The perichaetial leaves of *G. americana* are not as conspicuously hyaline as in most specimens of *G. involucrata*.

Grimmia tergestina also seems to be related to *G. involucrata*. Morphologically, the former species can be distinguished by its dioicous sexual condition, and a straight seta centrally attached to the symmetric urn; the peristome teeth have few trabeculae. In *G. involucrata*, the gonioautoicous condition is consistent, but the seta may be slightly curved and may be centrally or excentrally attached to the urn; the peristome teeth are strongly trabeculate.

Grimmia involucrata (and *G. americana*) was placed in the synonymy of *G. laevigata* by Maier (2010). However, there are significant taxonomic differences, both in the gametophyte and the sporophyte, that easily distinguish them and that Maier (2010) did not account for. The leaves in *G. laevigata* have a broad subcordate clasping base and the oblate outer cells of the leaf base are very different from those in *G. americana* or *G. involucrata*. Furthermore, the dioicous sexual condition of *G. laevigata* and its exerted capsule readily distinguish it from *G. americana* and *G. involucrata* that exhibit a gonioautoicous condition and have immersed capsules.

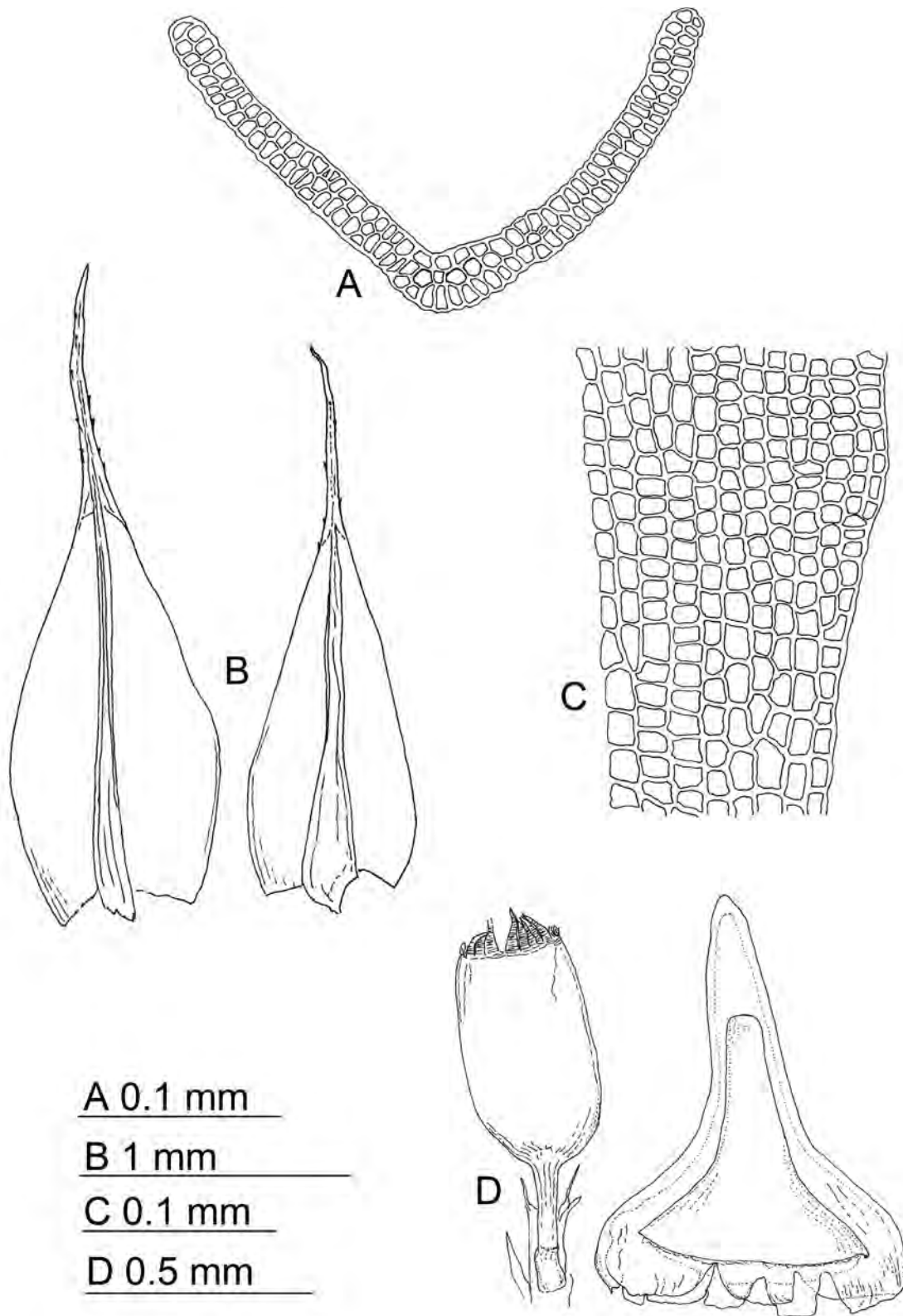


Fig. 9. *Grimmia involuocrata*. A. Mid-leaf section. B. Leaves. C. Proximal leaf cells. D. Sporophyte. E. Calyptra and operculum (A, B, C, Pringle 10598 p.p., H-BR; D, E, Cárdenas 5639, MEXU).

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

G. murina Müll. Hal., Hedwigia 36: 105. 1897. Type: Argentina. Sierra Ventana, Lorentz s.n., 27 Feb 1882 (Isolectotype, JE!).

Stem 8-10 mm tall, with central strand and 1-2 epidermal layers of smaller, thick-walled cells. *Leaves* 0.8-1.5 mm long, ovate to oblong-ovate with a subcordate clasping base, imbricate when dry, erect to spreading when wet, concave, with an obtuse or broadly obtuse leaf apex; lamina bi- (tri-)stratose in distal two thirds, with both margins plane to erect, uni- or bistratose in distal half; costa broad proximally, subpercurrent to excurrent, in section dorsally convex or indistinct, with or without a shallow ventral sinus, two ventral cells, 1-2 dorsal substereid layers, and a central hydroid group. *Hair point* 0.4-1.1 mm long, spinulose, non-decurrent to commonly decurrent at base. Distal leaf cells 5-15 µm, quadrate, short rectangular to hexagonal, smooth, thick-walled; proximal marginal cells 7-20 µm, quadrate, oblate to short rectangular, with thicker cross walls, undifferentiated; other proximal cells oblate to rectangular, smooth, thick-walled to colenchymatous; juxtacostal basal cells similar to other basal cells or forming a narrow area of rectangular cells. Dioicous. *Perigonial leaves* 0.6-1 mm long, terminal, broadly ovate, without a hair point. *Perichaetial leaves* 1.2-1.5 mm long, broadly ovate to convolute, with hair point ca. 0.8-1.2 mm. *Seta* 1-2 mm long, straight, twisted slightly counterclockwise. *Capsule* 1.2 mm long, exserted, symmetric, oblong-cylindric; peristome teeth 250 µm long X 67 µm wide at base, slightly cribose, stramineous to orange, with outer plate smooth below, distally papillose; inner plate papillose throughout. *Annulus* in 1-2 rows, revoluble; exothecial cells 17-50 µm long, prismatic, longer than wide or isodiametric, thin-walled. Stomata few, basal. *Operculum* 0.5 mm long, conic, short-rostrate, erect or slightly inclined. *Calyptra* mitrate. *Spores* 12-15 µm, weakly papillose.

Distribution and ecology. Argentina, Brazil, Chile (440-1110 m), Mexico (40-600 m), Uruguay. Canada, U.S.A.; Europe, Asia, Africa, Australia. On rocks or soil-covered rocks in sclerophyllous vegetation, scrubs, or in Pine-Oak forests.

Illustrations. Figure 10. Deguchi (1984: fig. 5); Muñoz (1999: fig. 20); Greven (2003: fig. 40).

Specimens examined. ARGENTINA. BUENOS AIRES: Sierra de la Ventana, ayo Osamentas, Kühnemann 4187 (MO).

BRAZIL. Rio Grande do Sul: Mpio. Lavras do Sul, Vital 9196 (NY).

CHILE. COQUIMBO: Prov. Choapa, Pichidangui, Cerro Santa Inés, ladera W, Mahú 20957 (MO). SANTIAGO: Prov. Santiago, El Canelo watershed, in the Cajón de Maipo Valley, ca. 17 km east of Puente Alto, Landrum 255 (MO). El Arrayán, Quebrada Pochoco, Mahú 13547 (MO). VALPARAÍSO: Prov. Petorca, Zapallar, cerro La Higuera, Mahú & Mahú 13272 (MO).

MEXICO. BAJA CALIFORNIA: 1 km oeste de Tijuana, Presa de Rodríguez, Meyer 32a (MEXU). 75 km S of Tijuana on Ensenada road, Sharp s.n., 6 Sept 1962 (MEXU, US), 9 km NW Rancho Santa Inez, Farley 17930, 17935 (MO). Arroyo 2 miles NW of Sta. Catarina near Rosario, Lightowers & Davis 672, 681, 683 (MEXU). Below Meling Ranch, E of Colenett, Sierra de San Pedro Mártir, Sharp et al. 6086 (MEXU), 6090 (MO). Between La Misión and Ensenada, Lightowers & Davis 650 (MEXU). Ca. 3.5 km Sur de Tecate, Meyer 34a (MEXU). Ca. 12 km Oeste de Tecate, Meyer 33c (MEXU). Ca. 16 km oeste Jct. Mex. 3, Meyer 36a (MEXU). Ca. 45 km southeast of El Mármol Jct., Meyer 28b (MEXU). Hills back Ensenada, Keever s.n., 26 Apr 1923 (US). Sonorabampo Canyon near La Misión, Mulroy, B, 28 Apr 1974 (MEXU).

URUGUAY. Montevideo, *Arechavaleta* 216, 2139, *Gibert* 1243 (NY).

This is a conspicuous species characterized by a robust habit, a broad clasping leaf base with proximal oblate cells, and an undifferentiated costa which is very broad at base. The calyptra is mitrate, but one specimen (*Lightowers & Davis* 681) includes two loose cucullate calyptras that may be part of it.

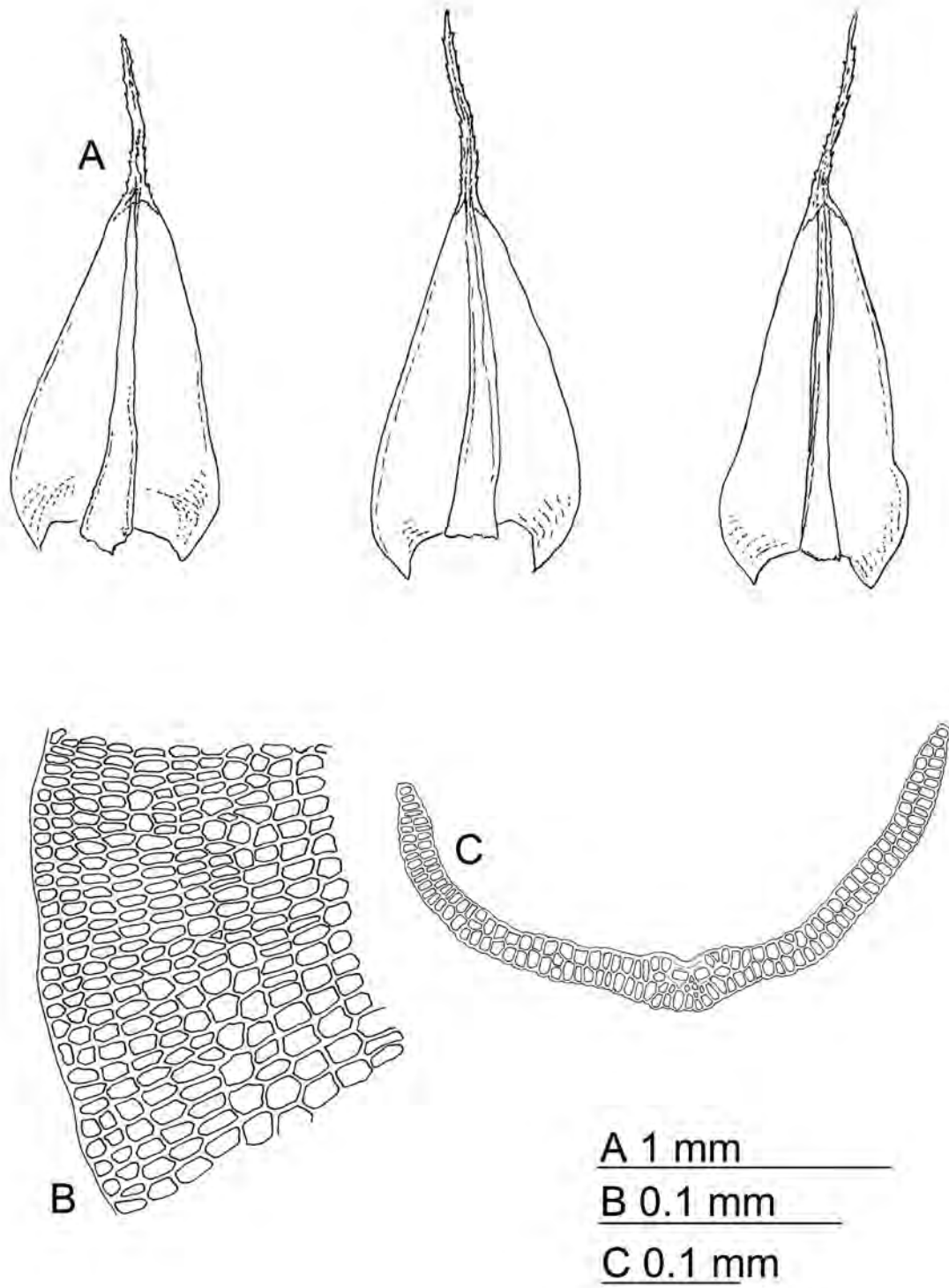


Fig. 10. *Grimmia laevigata*. A. Leaves. B. Proximal leaf cells. C. Mid-leaf section.
(Sharp et al. 6086, MEXU).

11. *Grimmia lisae* De Not., Muscol. Ital. Spic. 15. 1837.

Stem up to 15 mm tall, with central strand and two epidermal layers of smaller thick-walled cells. *Leaves* 2.4-2.7 mm long, ovate-lanceolate, imbricate when dry, squarrose when wet, carinate, with an obtuse leaf apex; lamina unistratose throughout, with one or both margins narrowly recurved to mid-leaf or beyond, bistratose in distal half; costa excurrent, reniform to rarely semi-circular, with a broad u-shaped ventral sinus, 2-6 ventral cells, and a dorsal substereid layer. *Hair point* 0.4-0.9 mm long, denticulate, slightly decurrent. Distal leaf cells 7-12 μm , quadrate to short rectangular, thick-walled, sinuose; proximal marginal cells 10-17 μm , quadrate to short rectangular, often with thicker cross walls, not differentiated; other proximal leaf cells quadrate to short rectangular, thick-walled, sinuose; juxtacostal basal cells rectangular, thick-walled, smooth, forming a small but distinct area. *Perichaetial leaves* 2.5-2.7 mm long, similar to vegetative leaves or convolute, with hair point 1.0-1.2 mm long. *Seta* 4 mm long, sinuous when dry, curved when wet. *Capsule* 1.3-1.5 mm long, exserted, weakly ribbed, ellipsoid; peristome teeth 187 μm long X 65 μm at base, cribose distally, papillose throughout. *Annulus* in about 2 rows of cells, revoluble. *Operculum* rostrate. Spores 12-15 μm , papillose.

Distribution and ecology. Mexico (0-300 m). On soil and rocks, in xeric coastal vegetation. In North America, from British Columbia to California; Europe, northern Africa. Reported from Hawaii (Hastings & Greven, 2007).

Illustrations. Figure 11. Muñoz (1999: fig. 21); Greven (2003: fig. 45).

Specimens examined. MEXICO. BAJA CALIFORNIA: Cedros Island. *Lindsay 17561* (NY), Punta Banda, near Los Arbolitos, *Mulroy 3* (MEXU), N facing slopes of Santo Tomás Valley, ca. 5 mi S of Santo Tomás, *Lightowers & Davis 718* p.p. (MEXU), 75 km S of Tijuana on Ensenada road, *Sharp s.n.*, 6 Sept 1962 (MEXU, MO, NY, US).

Grimmia lisae has a reniform to semi-circular costa in cross section, with 2-6 ventral cells; the proximal marginal leaf cells are quadrate, and the leaves unistratose squarrose when wet; both margins are narrowly recurved to revolute in the proximal or two-thirds of the lamina; the seta is sinuous when dry and curved when wet; and the urn is weakly ribbed. This combination of character states distinguishes *G. lisae* from *G. longirostris* and *G. trichophylla*. In *G. longirostris*, one leaf margin is broadly recurved, the seta is straight, and the urn is smooth; *G. trichophylla* may have partly bistratose leaves, and the costa shows two ventral cells in the distal half of the leaf.

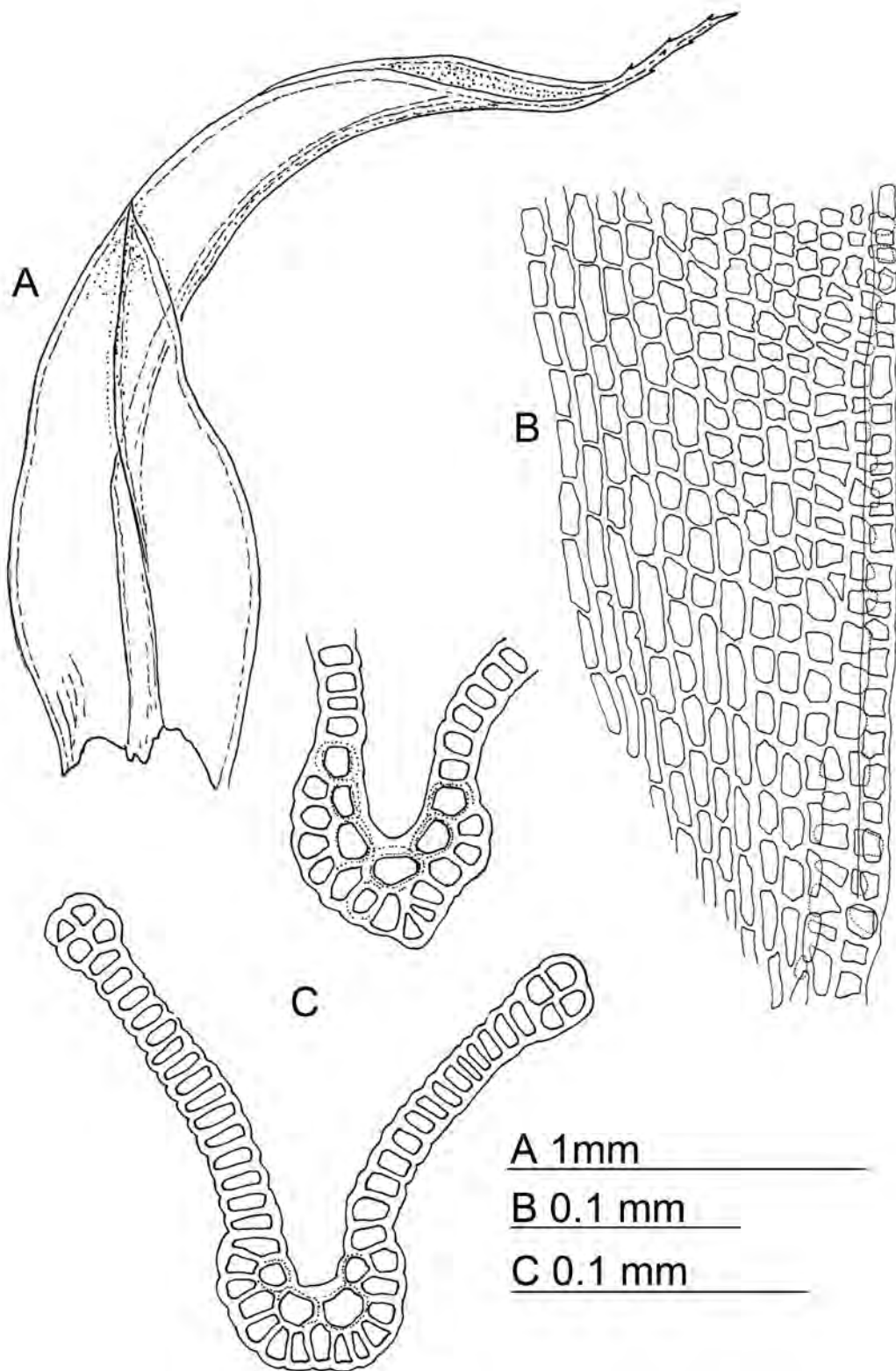


Fig. 11. *Grimmia lisae*. A. Leaf. B. Proximal leaf cells. C. Mid-leaf sections.
(Sharp s.n., 1962, MEXU).

12. *Grimmia longirostris* Hook., Musci Exot. 1: 62. 1818. Ecuador. [Chimborazo], *Humboldt* 76 (Isolectotype, BM!, lectotype designated by Deguchi, 1984), also marked with No. 2669 & 2670.

Guembelia bogotensis Hampe, Linnaea 32: 142. 1863. Colombia. Bogota, Los Laches, *Lindig* 2011 (Isolectotypes, BM!, GOET!, H-BR!, US!).

Grimmia itatiaiae Müll. Hal., Bull. Herb. Boiss. 6: 109. 1898. Brazil. Serra do Itatiaia. An Felsen der Aguhas Negras, *Ule* 1830 (Lectotype, H-BR!, designated by Muñoz, 1998b)

Grimmia itatiaiensis Broth., Bull. Herb. Boiss. 6: 108. 1898. Brazil. Serra do Itatiaia, *Ule* 1913 *Bryotheca Brasiliensis* 124 (Lectotype, H-BR!, designated by Muñoz, 1998b; isolectotypes BM, H-BR, JE).

Grimmia nigella Herz., Biblioth. Bot. 87: 55. 17. 1916. Type: Bolivia. Oberes Chocayatal, *Herzog* 3597 (Syntype, H-BR!, JE!), Saittulaguna, *Herzog* 2679 (lectotype, JE!, designated by Muñoz, 1998b; isolectotype, H-BR!)

Grimmia micro-ovata Müll. Hal., Nuov. Giorn. Bot. Ital. n. ser. 4: 128. 1897. Type: Bolivia. Cochabamba: Prope Choquecamata, *Germain* 1142 (Lectotype, JE!, designated by Muñoz, 1998b).

Grimmia praetermissa Card., Rev. Bryol. 36: 105. 1909. Type: Mexico. State of México, Pringle 26a (lectotype, NY!, designated by Muñoz 1998b; isolectotypes BM!, FH!, H-BR!, JE!, MEXU!, US!).

Grimmia speiophylla Herz., Biblioth. Bot. 87: 55. 1916. Type: Bolivia. Hochtal Viloco, *Herzog* 3148 (syntype, H-BR!, JE!), Cerro Tunari, *Herzog* 4871 (syntype, BM!, JE!), Yanakakabastion, *Herzog* 3745 (Syntype, JE!) 3827 (Lectotype, designated by Muñoz 1998b, JE!).

Grimmia nanoglobosa Müll. Hal., Bull. Torr. Bot. Cl. 23: 477. 1896. Bolivia. Mapiiri, *Rusby* 3195 (Isotype? BM?).

Grimmia allionii Broth. Rev. Bryol. 47: 9. 1920. Type: Ecuador. Azuay: Montis prope Cañar, *Allioni* 8095 (Lectotype, H-BR!, designated by Muñoz, 1998b).

Grimmia antillarum Thér., Rev. Bryol. Lichénol. 14: 13. 5. 1944. Type: Dominican Republic. Azua: Cordillera Central, Los Vallecitos de Yaque, *Ekman* 13630 (isolectotype, FH!).

Stem 7-36 mm tall, with central strand and 1-2 epidermal layers of small thick-walled cells. *Leaves* 0.9-2.9 mm long, ovate-lanceolate, imbricate when dry, erect-spreading when wet, sometimes spirally ranked, carinate, with an acute to obtuse leaf apex; lamina (1-)2- (-3)stratose in distal half; margins one plane, the other often broadly recurved, 2-(3-4-) stratose distally: costa percurrent to excurrent, in section indistinct from lamina, elliptical to reniform, with a broad u-shaped ventral sinus, (2-)4(-6) ventral cells, 1(-2) dorsal stereid or substereid layers and a hydroid group. *Hair point* absent or 0.2-2.6 mm long, nearly smooth to strongly denticulate, non-decurrent to slightly decurrent. Distal leaf cells 5-12 μm , quadrate, prismatic or short rectangular, thick-walled, slightly sinuose; proximal marginal cells 10-72 μm , quadrate to rectangular, with thicker cross walls, sometimes differentiated in 1-3 rows; other proximal leaf cells quadrate to rectangular, shorter upwards, thick-walled, smooth to nodulose; juxtacostal basal cells, rectangular, variously thickened or pitted, forming a small area. Cladautoicous or gonioautoicous. *Perigonial leaves* 0.7-0.9 mm long, convolute, without a hair point. *Perichaetial leaves* 1.2-4.3 mm long, oblong-lanceolate to convolute, with hair point 0.4-3.2 mm long. *Seta* 0.7-3 mm long, usually straight, not twisted or twisted counterclockwise when dry. *Capsule* 0.9-1.6 mm long, (immersed) emergent to exserted, symmetric, ovoid- to oblong-cylindric; peristome teeth 55-300 μm long X 35-75 μm wide at base, deltoid, stramineous to orange, with outer plate smooth proximally, papillose distally; inner plate papillose. *Annulus* in 2-4 rows of cells, revoluble; exothecial cells 15-77 μm , prismatic, isodiametric or longer than wide, thick-walled. Stomata few, basal. *Operculum* 0.3-0.7 mm long, conic, short to long rostrate. *Calyptra* 1.5 mm long, mitrate, smooth. *Spores* 7-15 μm , weakly papillose.

Distribution and ecology. Argentina (2000-4700 m), Bolivia (1524-5000 m), Brazil (1950-2500 m), Chile (3500-4300 m), Colombia (2750-4650 m), Dominican Republic (1800-3200 m), Ecuador (3100-4860 m), Guatemala (3200 m), Mexico (1829-4300 m), Peru (2200-4800 m), Venezuela (2850-4060 m). Also reported from Costa Rica and Honduras (Muñoz & Allen, 2002); Greenland, Canada, U.S.A. (Hastings & Greven, 2007); Europe, Africa, Asia, and Australasia. Growing on soil, sandstone, granite or volcanic rocks, and sometimes as epiphyte, in alpine areas, páramos and puna, in grasslands, coniferous or oak forests, and montane forests.

Illustrations. Figure 12. Deguchi (1984: fig. 6; 1987: pl. 7); Muñoz (1999: fig. 22); Greven (2003: fig. 46).

Selected specimens examined. ARGENTINA. CATAMARCA: Nevados de Aconquija (grupo austral), Cueva del Overo, *Lamb 5542* (LIL). Quebrada de los Cazadores (falda oriental del Nevado Pabellón de la Abra Grande), *Lamb 5558* (LIL). **CÓRDOBA:** Sierra Achala: Cuesta del Transito, *Kurtz 8904d* (H-BR). **TUCUMÁN:** Between Amaiche and Tafi del Valle, *Steere 60-119* (NY). Quebrada de los Alisos, above Tafi del Valle, *Steere 60-174, 60-183* (NY). Valle de Tafi, Carapunco-Infiernillo, *Lamb 5253* (LIL). Cima de Cumbre Potrerillo, *Lamb 5288* (LIL). Cerro Muñoz, Puesto Muñoz, *Halloy A-602* (LIL), Tafi del Valle, La Bolsa, *Schiavone & Biasuso 1435* (LIL).

BOLIVIA. COCHABAMBA: Abra de San Benito, Herzog s.n., *Jan 1908* (JE). Base of Serranías Tarucani in area of Laguna Tarucani, *Lewis 792434* (GOET). NW slope of Mt. Tunari, near Liriuni Aguas Termales Hotel, 28 km NW, *Hermann 25153* (US). Tunarisee, *Herzog s.n.*, Jan 1908 (JE). Tapacari, 2 km de Confital, en la carretera Cochobamba por La Paz, Churchill, *Magombo & Price 19947* (MEXU). **LA PAZ:** 21 km from Sorata on road to Achacachi, *Blaslev 1103* (NY). Prov. Inquisivi, along the Rio Santa Veracruz from ca. 1 km upstream from Estancia Huaña Kkota to the area between Cerro Chojña Kkota and Cerro Achachi Hkota, ca. 9 km SW of Quime, *Lewis 87164 p.p.* (MO). Prov. Loayza, Cerro Iru Khasa, along the road between Caxata and Koque where the road crosses a river 1 km E of Koque, ca. 3 km N of Caxata, *Lewis 871171 d-1* (MO). Prov. Murillo, Trail from Cota Cota to Muela del Diablo, *Solomon 7463* (MO). **ORURO:** Carangas, Cerro Sajama, *Asplund 75* (JE). Prov. Poopó, 56.4 km S of Machacamarca, near Pazña, S of Poopó, *Lewis 7970 A* (FH). **POTOSÍ:** Prov. Tomás Frías, Cerro Kari Kari, SE of Potosí, *Lewis 79214* (GOET, H).

BRAZIL. Ad confines Rio de Janeiro-Minas Geraes. In paludosis partis superioris montis Itatiaia, *Schiffner 461, 773* (BM, H-BR), *1920* (BM). Serra do Itatiaia, *Dusén 924* (H-BR), *Dusén s.n.*, May 1902 (JE), *Dusén s.n.*, June 1902 (NY). **MINAS GERAIS:** Serra do Itatiaia, Strasse zwischen Itamonte und Abrigo Reboucas, *Schäfer-Verwimp & Verwimp 9569* (MEXU).

CHILE. Chiloé, Zobb 8 (BM). Prov. Parinacota, Camino a Putre antes del km 135 al N de la biburcación Putre-Socoroma, *Moreno 12990* (US). Parque Nacional Lauca, al E del camino a Caquena y cruce con el Río Lauca, sur de Parinacota, *Moreno 12969 p.p.* (US).

COLOMBIA. ANTIOQUIA: Mpio. Urrao, Páramo de Frontino, ca. 17 km directamente N de Urrao. Churchill, *Sastre & Escobar 13335* (H, MEXU, NY, US), *13336* (GOET, MO, NY). **ARAUCA:** Sierra Nevada del Cocuy, Cabeceras de la Quebrada El Playón, Patio Bolos, 3 km S del Alto La Plaza. *Cleef 8941* (GOET). **BOYACÁ:** High pass north of Belén, Cordillera Oriental, *Steere 7276* (NY). Paramo de Guantiva, Alto de Toral, W de Belén, *Florschütz 4166* (GOET). Páramo de La Rusia, NW-N de Duitama, *Cleef 6771* (GOET). Páramos al NW de Belen, vereda S. José de la Montaña, Alto de las Cruces y alrededores, Cabeceras Q. El Toral, *Cleef 1798* (GOET). Sierra Nevada de Cocuy, Near Ritacuba Glacier, *Grubb & Guymer B210* (BM). **CUNDINAMARCA:** Represa de Neusa y alrededores,

Cleef 4186 (GOET). DEL VALLE: Mpio. El Cerrito, Páramo de Pan de Azúcar, Churchill, *N. & H. Hollaender* 15307 (NY). META: Páramo de Sumapaz, Cerro Nevado del Sumapaz, *Cleef* 7929, 8148 (GOET). SANTANDER: Eastern Cordillera. Páramo Rico, near Vetas, *Killip & Smith* 17688 (FH, NY) Páramo de Frailejonale, near Vetas, *Killip & Smith* 17985, 17987 (BM), 17629 (MO).

DOMINICAN REPUBLIC. LA VEGA: 20 km S of Constanza, on road to San José de Ocoa, *Steere* 23035, 23047 (NY), 47.5 km N of main town Plaza of San José de Ocoa at Pirámide location, *Zanoni* 16463 (MO, NY). Alto de la Bandera, 22 km S of Constanza, *Reese* 15863, 15874 (NY), *Steere* 23097 (GOET, NY), *Smith* 10337 (MO, NY). Vicinity of pyramids, 13.8 km S of Valle Nuevo, 44.7 km S of Constanza, *Steere* 22679 (NY). SAN JUAN: Pico Duarte, *Alain & Liogier* 25032 (NY). SAN JUAN-SANTIAGO: Parque Nacional J. Armando Bermúdez, en el “Vallecito de Lilis”, *Zanoni, Pimentel & Jiménez* 42061, 42063 (NY).

ECUADOR. AZUAY: Area Nacional de Recreación “Cajas”, in the small lakes N and W of the head of Río Maladero, 0-3 mi from the ranger station, WNW of Sayausí, *Lewis* 782338 (FH, NY). Nudo de Portete, W of Cuenca, Páramo de Soldados on road to Chaucha, *Laegaard* 53239D (NY). Páramo de Cajas, W of Cuenca, ca. 5 km W of pass, *Steere* 27708 (NY). CHIMBORAZO: Paramo-region, NW Seite, *Meyer* 5518 (H, JE). Refugio on Chimborazo, *Dorr & Valdespino* 6436 (NY). Summit of road from Riobamba to Guaranda, W of San Juan, *Lewis* 782560 (NY). COTOPAXI: W of Latacunga, on summit, *McQueen* 7096, 7100 (MO). Cordillera Oriental, just north of Volcán Cotopaxi, *Steere* E-23 (NY). N slopes of Mt. Cotopaxi, *Crosby* 10705 (MO, NY). Parque Nacional Cotopaxi, along road from Pampa de Limpios to summit of Cotopaxi, *Buck* 10066 (NY). IMBABURA: E side of Cerro Imbabura above La Esperanza, ENE of Otavalo, *Lewis* 782991 (NY). In páramo de Juanabuela, summit of Cordillera Occidental between Cahuasquí and Colonia Buenos Aires on Río Lita, *Steere* 9283 (NY). Lago Cuicocha, *Arts* 13/14 (MEXU). Laguna Cuicocha, crater lake 30 km W of Ibarra, *Holm-Nielsen, Jeppesen, Lojtnant & Ollgaard* 6292 (US). NAPO: SW slopes of Volcán Antisana, 2-3 km N of Hacienda El Hato and 5-6 km NNE of Laguna Micacocho, *Lojtnant & Molau* 15345 (NY). PICHINCHA: Pichincha, Jameson 10 (NY), *Bell* 154, 155 (BM)

GUATEMALA. HUEHUETENANGO: Near Paquix above Huehuetenango, *Sharp* 4777 (FH, US).

MEXICO. AGUASCALIENTES: Presa de los Serna, *Delgadillo* 7575, *Peña* 258 (MEXU); cerca del Cerro El Mirador, *Delgadillo* 7606 (MEXU); 6 km S de Tapas Viejas, *Delgadillo* 7566, *Peña* 256 (MEXU). BAJA CALIFORNIA: Lomas San Pedro Mártir, ca. 4 km southwest of observatory, *Meyer* 21a (MEXU). CHIHUAHUA: 21 mi N of San Juanito or 42 mi N of Creel, on the Creel to La Junta (Hwy. 16) road, *Bowers, Delgadillo, Somers, Jr.* 5403, 5405 (MEXU). Between Quirire and Basigoche, between drainages of Rio Batopilas and Rio Cobre, *Weber & Bye* 60304B (MEXU, NY). Ejido de Bocoyna, SW part of Creel Valley, *Bye* 7295 (MEXU). Parque Nacional Cascada de Basaseachic, *Whittemore et al.* 2845 (MEXU). Vicinity of Madera, *Palmer* 444 (NY, US). Mpio. Guachochic, Cusarare, near Km 28 of Creel-Guachochic road, *Bye* 6239a (MEXU). DISTRITO FEDERAL: 12 km W de San Miguel Ajusco, *Cárdenas* 4320, 4321, 4324 (MEXU, MO), 4323 (MEXU). Ajusco, *Orcutt* 5353 (FH). Cima, *Barnes & Land* 368 (JE, NY), *Pringle* 10539 (BM, FH, MEXU, MO, NY, US), *Trelease* 185, 186 p.p. (MO). Desierto de los Leones, hacia Cruz Blanca, *Delgadillo* 326 (MEXU). Delegación Tlalpan, Vertiente NW del Cerro Pelado, *Cárdenas* 2989 (MEXU). DURANGO: 30 km W of El Salto, *Sharp* 1848 (MEXU). Along Hwy. 40 about 9 miles west of La Ciudad, *Norris et al.* 20744 p.p. (H). GUANAJUATO: 13 km NE de Guanajuato, *Delgadillo* 5751 (MEXU). 4 km S de San José Iturbide, *Delgadillo* 5755, *Cárdenas* 5337, 5344 (MEXU). Cerro de la Vigilancia. 5 km NE de

la Ciudad de Guanajuato, *Cárdenas* 5269 (MEXU). **HIDALGO:** 10 km S de Singuilucan, *Delgadillo* 6122, 6132, *Cárdenas* 5668a (MEXU). 14 km E de Pachuquilla, *Cárdenas* 3378 (MEXU, NY). 2 km N de Presa Jaramillo, El Chico, *Alfaro & Castillo* 117 (MEXU). 2 km NW de San Francisco Sarabia, 17 km NE de Tepeapulco, *Cárdenas* 5633, *Delgadillo* 6112 (MEXU). 3 km N de Nopalillo, Epazoyucan, *Castillo* 92 (MEXU), 8 km SE de El Chico, *Cárdenas* 1610 (MEXU). Alrededores de Ciudad Sahagún, *Cárdenas* 3107a (MEXU). Cerro Xihuingo, 5 km NE de Tepeapulco, *Cárdenas* 1709, 1720 (MEXU). Cuyamaloya, Sierra de Pachuca, *Pringle* 10598 p.p. (H-BR, US), 10599 (BM, FH, H-BR, MEXU, MO, NY, US). Dublan, *Pringle* 15076 (H-BR, JE, MEXU, MO, NY). Near Hacienda Apulco, *Sharp* 4169 (MEXU). Peñas Largas, 6 km SE de Tezuantla, *Alfaro & Castillo* 189 (MEXU). **JALISCO:** Sierra Madre, west of Bolaños, *Rose s.n.*, Sept 1897 (NY). **STATE OF MÉXICO:** 1.5 km de la desviación al E de Techuchulco, *Castilla* 1983 (MEXU). 13 km E de Jiquipilco, *Cárdenas* 6274 (MEXU). 3 km N de Jocotitlán, *Delgadillo* 6780 (MEXU). 4 mi N of Atlacomulco, *Magill* 2463 p.p. (MO). Ca. 12 km NE de Texcoco, *Cárdenas* 4730 (MEXU). Cráter del Nevado de Toluca. Laguna del Sol, *Castilla* 1902b (MEXU). Cumbre del Cerro Gordo, cerca de San Martín de las Pirámides, *Rzedowski* 20056 (US). Extremo NW del Iztaccihuatl. 5 km S de Llano Grande, *Cárdenas* 3623 (MEXU). Presa Iturbide, 8 km SW de Tlazala, *Cárdenas* 4092, 4097 (MEXU). Río Frio, *Amable* 1401, 1681, 1697 (MEXU). Mpio. Naucalpan, Puerto El Guarda, 6 km W de San Francisco Chimalpa, *Cárdenas* 3720 (MEXU). Mpio. Tlalmanalco, Llano Grande, 14 km E de San Rafael, *Cárdenas* 3959 (MEXU). **MICHOACÁN:** 6 km NW de Tanaco, *Delgadillo* 5549, 5551 (MEXU). 7 km NE de Zinapécuaro, *Cárdenas* 4470 (MEXU, NY). **OAXACA:** Cima del Cerro Corral de Piedra, al N de la Ciudad de Oaxaca, *Cárdenas* 4294 (MEXU). **PUEBLA:** Above las cuevas on Iztaccihuatl above Huejotzingo, *Sharp* 4291 (MEXU). Along route 119, 15 miles S of Chignahuapan, *Hermann* 26444 p.p. (MEXU, NY, US). Ladera NW del Pico de Orizaba, *Delgadillo* 4082, 4083 (MEXU). **TLAXCALA:** 8 km W de Calpulalpan, *Cárdenas* 3674 (MEXU). Ladera norte de La Malinche, *Delgadillo* 2587b (MEXU). **VERACRUZ:** Ca. 17 mi NE of Jalapa along Mexico 140, *Pursell & Reese* 5028 (MO). Cima del Cofre de Perote, *Delgadillo* 3029 (MEXU). Escamela bei Orizaba, *Hahn s.n.*, 1870 (NY). Pedregal de las Vigas, above La Joya, *Rickett* 32 (MEXU, NY). **ZACATECAS:** Cerro de la Bufa, *Cárdenas* 357 (MEXU, MO). 53 mi N of Jalpa, *Mahler* 6135 (MO).

PERU. **Arequipa,** *Guenther & Buchtien* 1948, 1992 (H-BR). Cordillera Blanca Parrontel, *Lauterburg s.n.*, Sept 1948 (JE). Juliaca, *Williams* 2813 (BM, H-BR, NY). Ollantaytambo, *Cook & Gilbert* 609 (NY, US). Temple of Viracocha, near Tinta, *Cook & Gilbert* 206 (NY, US). **ANCASH:** Ca. 10 mi from Yungay, *Allen* 4323 (MO). Prov. Bolognesi, Ocos, *Cerrate* 5911 A (MO). Prov. Recuay, Arriba de la Laguna Querococha, López, *Sagástegui & Aldave* 7520 (MO, US). Distrito de Marca (Cuntu), Gómez 565 (US). **CAJAMARCA:** Contumazá, Alrededores del pozo Kuan, *Sagástegui et al.* 10082 (MO). Prov. Cajamarca, Laguna San Nicolás, *Hegewald* 6241 (MEXU). **CUZCO:** Calca, Pisac, *Vargas* 7099 (MO). Canchas, Ra'acchi; S. Pedro Cacha, *Vargas* 13127 (US). **HUANCAVELICA:** Prov. Huancavelica, Supay Mayo, Margen derecha del Río Ichu, *Dávila* 05 (MO). **HUANUCO:** Canyons above Mito, about 20 km N of Huanuco, *Bryan* 249 (MO). **JUNÍN:** Mount La Juntay, near Huancayo, *Killip* 22055 (NY). Orilla de laguna *Capillacocha*, [s.c.] 5197 (US). **LIMA:** Valley of Río Blanco, ENE of Matucana & Lima (about 100 km), *Bryan* 122 (MO). Vicinity of Matucana, 70 km ENE of Lima, *Bryan* 85 (MO). Prov. Yauyos. Cruz-pampa, encima de Tupe, *Cerrate* 1097 (US).

VENEZUELA. **Laguna Negra.** Páramo de Mucuchies, *Chardon* 24 (NY). San Rafael de Mucuchies, *Pittier* 13198 (US). **MÉRIDA:** Cañada Cerrada above Chachopo, *Pittier* 13183 (MO, US), 18124 (MO). Loma redonda (Pico Espejo), *Mägdefrau* 626b (GOET). Parque Nacional Sierra Nevada, region of Mucubaji and El Aguila, *Steyermark et al.* 106292 (US). Sierra Nevada. Teleférico: Loma Redonda, camino hacia Los Nevados, *Cleef* 4809 (GOET). Dist. Rivas Dávila, Páramo La Negra above

the town of Bailadores, *Griffin, III et al. 2047* (GOET, MEXU, MO). Distrito Libertador, Sierra Nevada de Mérida, near the Laguna de los Anteojos just below the Loma Redonda Station, *Griffin, III, López & Ruiz-Terán 398* (GOET, MEXU, MO).

Grimmia longirostris Hook. is an extremely variable taxon with nearly every taxonomic character showing a wide range of values that make specific limits difficult to establish. According to Muñoz (1998b) and my own observations, the sexual condition is almost always autoicous or cladautoicous. However, I have observed gonioautoicous plants in *Cárdenas 5668a* and in a specimen labeled *G. meridensis* Vareschi, nom. nud. (*Vareschi & Pannier 1274*, NY); the leaf lamina in the latter is mostly unistratose and the costa in section is distinct from the lamina. In *Delgadillo 4062* (MEXU) the perigonium is terminal (with innovations arising from below); the male plant was not attached to a female stem suggesting a dioicous condition or the separation of male and female branches by progressive decomposition of the lower parts of the stem.

Among other synonymous taxa, specimens of *G. micro-ovata* show comparatively small nearly lanceolate leaves, as in *Guenther & Buchtien 1992* and *Williams 2813* (H-BR), but at least some leaves show the trend toward the ovate-lanceolate condition that is characteristic of *G. longirostris*. In specimens originally labeled *G. integridens* (*Kurtz 8904 d* H-BR) and *G. subovata* (*Herzog 4938* H-BR), the seta is slightly curved.

Despite the variation, *G. longirostris* may be distinguished by the following character combination: ovate-lanceolate leaves with one margin plane, the other recurved; proximal marginal cells rectangular, with transverse walls thicker than the longitudinal ones, and in section, an indistinct to reniform costa with 2-6 ventral cells and an u-shaped ventral sinus; the perichaetial leaves are somewhat larger than the vegetative leaves and the seta straight, emergent to exerted.

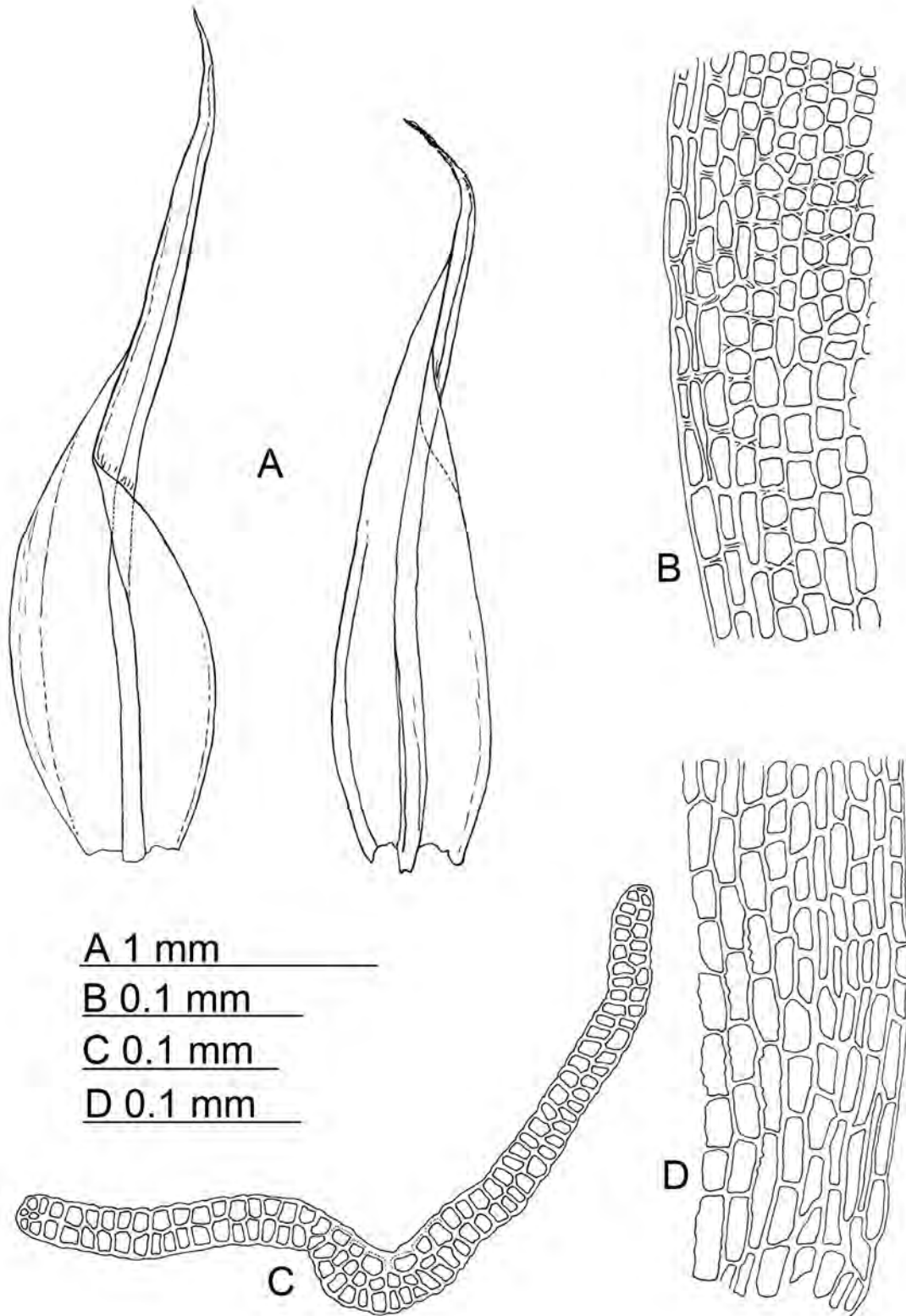


Fig. 12. *Grimmia longirostris*. A. Leaves. B, D. Proximal leaf cells. C. Mid-leaf section.
(A, C,D, Ule 1830, H-BR; B, *Delgadillo 4082*, MEXU).

13. *Grimmia mexicana* Greven, Bryologist 102: 432. 1999. Type: Mexico. Puebla: Pico de Orizaba, 2.5 km below Piedra Grande, 3870 m, *Greven M100* (Isotype, MEXU!).

Stem 25 mm tall, with central strand and 2-3 epidermal layers of smaller thick-walled cells. *Leaves* 1.5-2.6 mm long, lanceolate to ovate-lanceolate, laxly imbricate when dry, erect-spreading when wet, carinate, with an obtuse, subcucullate leaf apex; lamina uni- or (usually) bistratose in distal half, with one or both margins plane or one margin recurved, bi- or tri-stratose distally; costa percurrent, in section reniform, with a broad u-shaped ventral sinus, 4-6 ventral cells, one dorsal substereid layer and a hydroid group. *Hair point* none. Distal leaf cells 5-15 μm , quadrate to short rectangular thick-walled, smooth to slightly sinuose; proximal marginal cells 7-25 μm , rectangular, with thicker cross walls, not clearly differentiated; other proximal leaf cells rectangular, thick-walled, sinuose; juxtacostal cells rectangular, smooth or sinuose, thin- to thick-walled, forming a distinct area. Dioicous. *Perichaetial leaves* 1.3-4.3 mm long, oblong to broadly ovate, without hair point. *Seta* 0.4-1 mm long, straight, not twisted. *Capsule* 1.3-1.7 mm long, immersed to emergent, symmetric, ellipsoidal or oblong-cylindric; peristome teeth 150-195 μm long X 55-72 μm wide at base, strap-shaped, stramineous to orange, with outer plate smooth, inner plate papillose throughout. *Annulus* 2-4 rows of cells, exothecial cells 17-50 μm , prismatic, isodiametric, thin-walled. Stomata few, basal. *Operculum* 0.6 mm long, conic, obliquely rostrate. *Calyptra* cucullate. *Spores* 12-15 μm , finely papillose.

Distribution and ecology. Guatemala (4115 m), Mexico (3800-4400 m). Distributed in the alpine area of the high mountains of central Mexico and Guatemala, on rocks, in exposed sites or covered by *Juniperus monticola*.

Illustrations. Figure 13. Greven (1999: fig. 2; 2003: fig. 54)

Specimens examined. GUATEMALA. SAN MARCOS: Near summit of Tajumulco. *Sharp* 5428 (FH), 5429 (MEXU, US).

MEXICO. JALISCO: Ladera W del Nevado de Colima, *Cárdenas* 1230, 1240, 2955, *Delgadillo* 4365 (MEXU). **STATE OF MÉXICO:** Cerca Albergue Tlamacas, *Delgadillo* 1162 (MEXU). Cráter del Nevado de Toluca, *Delgadillo* 1741, 1803, 2734 (MEXU), *Amable* 1797 p.p., 1899 p.p. (NY). Falda SW del Iztaccíhuatl, *Delgadillo* 1720 (MEXU). Ladera Norte del Popocatepetl, *Delgadillo* 2059 (MEXU). Ladera NW del Popocatepetl, *Delgadillo* 2175, 2183 (MEXU). **PUEBLA:** Ladera NW del Pico de Orizaba, *Delgadillo* 4084 (MEXU). Las cuevas on Iztaccíhuatl above Huejotzingo, *Sharp* 4270, 4276 (MEXU). **TLAXCALA:** Ladera norte de La Malinche, *Delgadillo* 2587a (MEXU). **VERACRUZ:** Cofre de Perote, laderas NE, *De Luna* G. 338 p.p. (MEXU).

An isotype of *G. ochyriana* Muñoz received on loan from IBA, shows that the plants consistently have acute non-cucullate fragile apices with a subpercurrent costa (cf. Delgadillo, 2000). The sporophyte is immersed, with a cylindrical capsule; the operculum appears conic, nearly straight, short rostrate. By contrast, the type of *G. mexicana* has obtusely rounded sub-cucullate apices, also with a subpercurrent costa; its immersed sporophyte has oblong-cylindrical capsules with an inclined rostrate operculum. The proximal juxtacostal cells are variously described as rectangular to narrowly rectangular, with thick smooth walls (Muñoz 1998c), but random observations of different leaves also show nodulose or thin-walled cells in the isotype of *G. ochyriana* (IBA). The same variation has been observed in *G. mexicana* (Greven, 1999) so that the supposed taxonomic value of this character is negligible, except to say that there is a distinct juxtacostal area in both species.

Bednarek-Ochyra (2015) identified a specimen from Nevado de Toluca (Mexico) as *Streptocolea atrata*. A full taxonomic comparison between this and *Grimmia mexicana* is desirable.

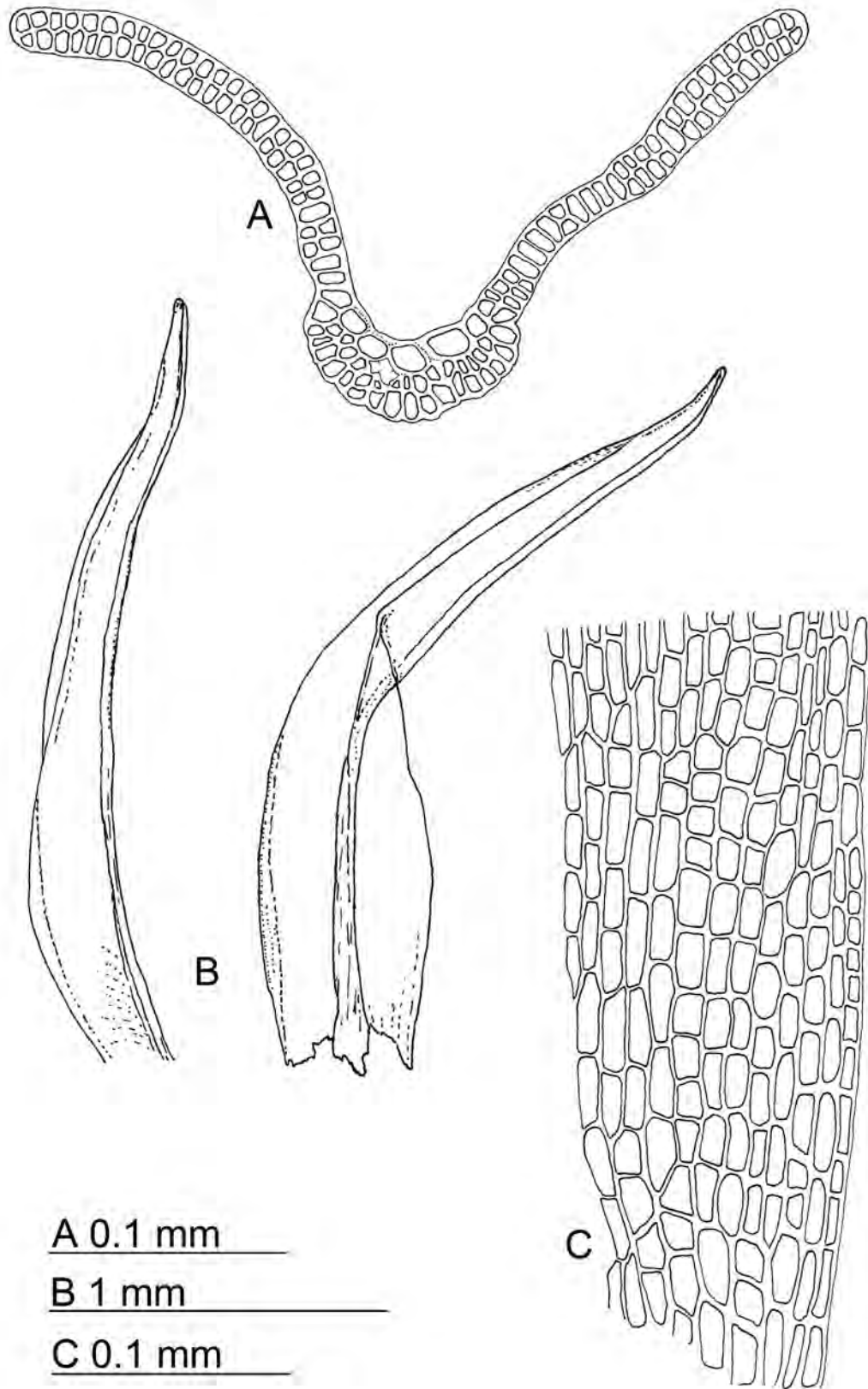


Fig. 13. *Grimmia mexicana*. A. Mid-leaf section. B. Leaves. C. Proximal leaf cells.
(A, Greven M100, MEXU; B, C, Delgadillo 1720, MEXU).

14. *Grimmia molesta* Muñoz, Ann. Missouri Bot. Gard. 86: 152. 1999. Type: Peru. Arequipa: Arequipa, Hegewald & Hegewald 5480 (Holotype, MO!).

Stem up to 20 mm tall, with central strand and one indistinct epidermal layer. *Leaves* 1.7-2 mm long, lanceolate, imbricate when dry, erect-spreading when wet, carinate, with an acute to obtuse leaf apex; lamina partly bistratose; margins plane or erect to narrowly recurved on one side, bistratose distally; costa excurrent, in section reniform, with an u-shaped ventral sinus, two ventral cells, a dorsal substereid layer and a hydroid group. *Hair point* 0.1-0.4 mm long, nearly smooth to denticulate, non-decurrent to slightly decurrent. Distal leaf cells 7-12 μm , quadrate to short rectangular, thick-walled, smooth; proximal marginal cells 12-50 μm , rectangular, with thicker cross walls, differentiated; other proximal leaf cells short rectangular, thick-walled, slightly sinuose; juxtacostal basal cells smooth, thick-walled, forming a distinct area. Cladautoicous, antheridia terminal on short lateral branches. *Perigonal leaves* 0.9-1.2 mm long, convolute, without hair point. *Perichaetial leaves* 2.4-3 mm long, lanceolate to oblong-lanceolate, hair point 0.8-1 mm. *Seta* 0.1 mm long, straight, not twisted. *Capsule* 1.6 mm long, immersed, symmetric, cylindrical; peristome teeth 295 μm long X 102 μm wide at base, lanceolate, stramineous, with outer plate smooth below, papillose throughout, strongly so distally, and inner plate finely papillose. *Annulus* in 2 rows of small cells; exothecial cells 30-87 μm , rectangular-rounded, thin-walled. Stomata few, basal. *Operculum* 0.4 mm long, convex, rostellate. *Calyptra* mitrate. *Spores* 10-13 μm , smooth.

Distribution and ecology. Peru (4000 m)

Illustrations. Figure 14. Muñoz (1999: fig. 24); Greven (2003: fig 55).

Specimens examined. PERU. AREQUIPA: Along road Arequipa-Ubinas, past Chiguata, van der Werff *et al.* 20815 (MO).

I have examined plants from van der Werff *et al.* 20815 where the leaf structure is similar to that depicted by Muñoz (1999) for *Grimmia pseudoanodon*, *i.e.* leaf laminae are unistratose, except at margins; the sporophytes, however, are peristomate as in *G. molesta*. Unless the van der Werff's specimen is a mixture, the gametophytic differences may not be reliable to distinguish between these two species.

Maier (2010) excluded *G. molesta* from *Grimmia* on the basis of peristome morphology, but she did not make a deposition in another taxon. I have been unable to confirm her claims.

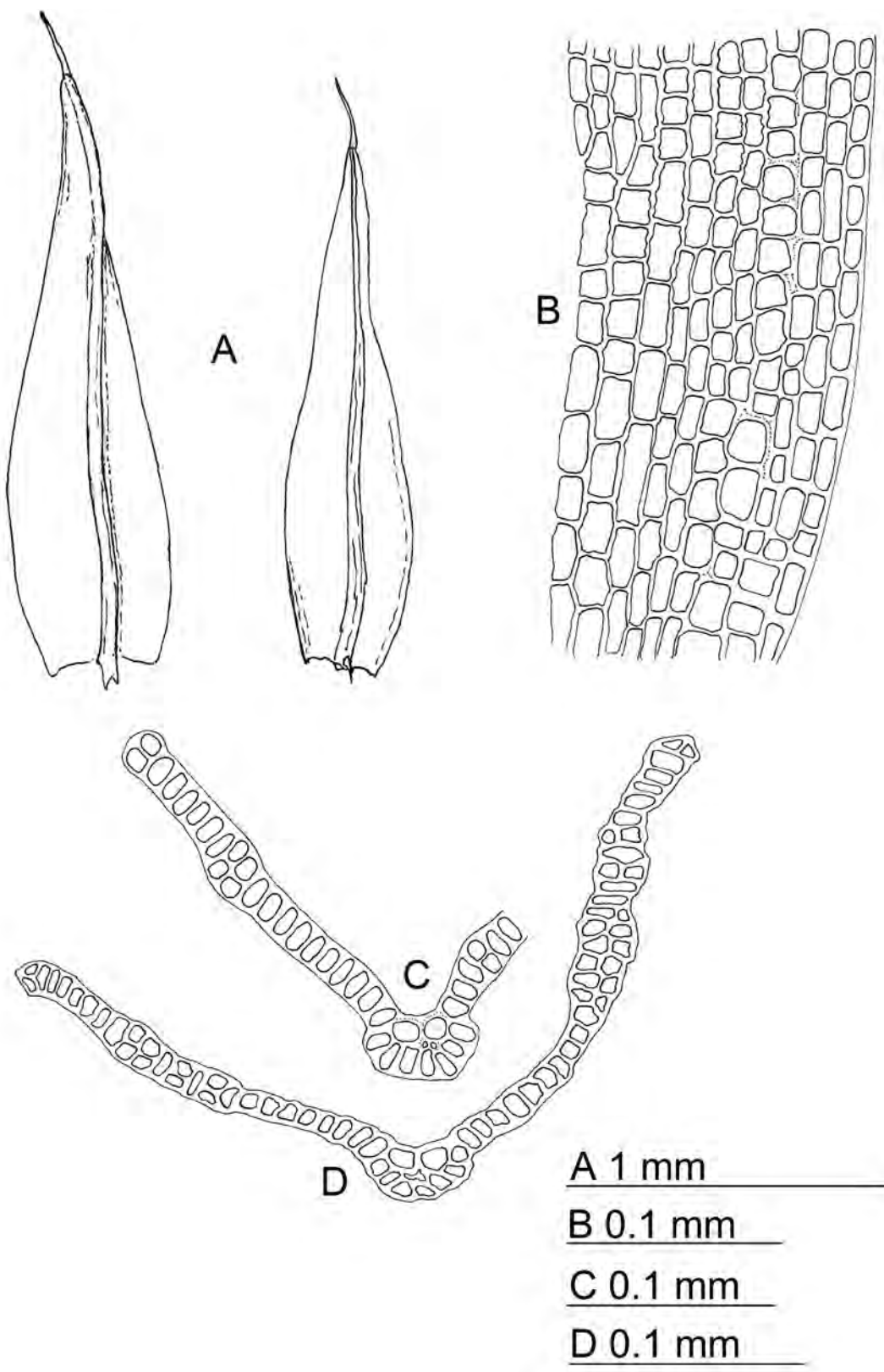


Fig. 14. *Grimmia molesta*. A. Leaves. B. Proximal leaf cells. C. Mid-leaf section. D. Lower mid-leaf section. (Hegewald & Hegewald 5480, MO).

15. *Grimmia montana* Bruch & Schimp., Bryol. Eur. 3: 128. 250. 1845 (fasc. 25-28 Mon. 26. 14).

Grimmia schiedeana Müll. Hal., Bot. Zeit. 13: 765. 1855. Type: Mexico. *Deppe & Schiede s.n., p.p.* (Lectotype designated by Muñoz 1999, BM!).

Stem 7-21 mm tall, with central strand, but no distinct epidermal layers. *Leaves* 1.2-1.8 mm long, ovate-lanceolate, imbricate when dry, erect when wet, concave, with an obtuse leaf apex; lamina bistratose in distal half; margins plane below, slightly incurved distally, bi- or tri-stratose distally; costa excurrent, in section elliptical, without or with a shallow u-shaped ventral sinus, two ventral cells, 1-2 dorsal substereid layers and a hydroid group. *Hair point* 0.2-1.6 mm long, smooth to denticulate, non-decurrent or decurrent. Distal leaf cells 5-12 μm , quadrate to short rectangular, thick-walled, slightly sinuose; proximal marginal cells 10-30 μm , rectangular, undifferentiated, other proximal leaf cells quadrate to rectangular, thick-walled, slightly sinuose upwards; juxtacostal cells rectangular, smooth, thick-walled, forming an indistinct area. Dioicous. *Perichaetial leaves* 2.4-2.9 mm long, broadly ovate-lanceolate, with hair point 1.1-1.5 mm long. *Seta* 0.8-1.2 mm long, straight, twisted counterclockwise. *Capsule* 0.9-1.2 mm long, exserted, symmetric, oblong-cylindric; peristome teeth 275 μm long X 67-87 μm wide at base, deltoid, stramineous, lower outer plate nearly smooth; papillose elsewhere. *Annulus* none; exothelial cells 25-62 μm , prismatic, mostly rectangular-rounded, thick-walled. Stomata none. *Operculum* 0.6 mm long, convex, with an oblique beak. *Calyptra* cucullate. *Spores* 10 μm , smooth (immature).

Distribution and ecology. Mexico (2286-4633 m); Greenland, Canada, U.S.A.; Europe; Africa. On granite and volcanic rocks, under *Juniperus monticola* or in alpine grasslands.

Illustrations. Figure 15. Muñoz (1999: fig. 25); Greven (2003: fig. 57).

Specimens examined. MEXICO. BAJA CALIFORNIA: Las Cuevitas, Sierra Juárez, S of Laguna Hanson, *Wiggins 9177* (FH). 18 km below observatory, (Cerro de La Encantada), Sierra San Pedro Mártir, *Sharp, Sharp & Radlow 5594* (MEXU, NY, US). Guadalupe Island, summit, *Moran 5664* (NY). STATE OF MÉXICO: Nevado de Toluca, *Froderstrom & Hulten 17a* (NY). Popocatepetl, *Kiener 18590, 18591* (FH). Northwestern portion of Popocatepetl, *Delgadillo 2181* (MEXU). South slope of Volcán Iztaccíhuatl, *Hermann 20845* (US). PUEBLA: Above las cuevas on Ixtaccíhuatl above Hwy., *Sharp 4280 p.p.* (MEXU, MO). Jalapasco, slope of Mt. Orizaba, *Smith 19* (NY). Ladera NW del Pico de Orizaba, *Delgadillo 4117* (MEXU). VERACRUZ: Cima del Cofre de Perote, *Delgadillo 4051* (MEXU). Road from Perote to Cofre. *Sharp, Juárez, Baez & Boom 7466c* (MEXU). Mt. Orizaba, *Purpus 4277* (FH, MO, NY, US).

Grimmia montana has leaf margins proximally plane and distally plane or slightly incurved; the elliptical section of the costa, the dioicous condition and the lack of stomata in the capsule further distinguish it from other Neotropical Grimmiads. According to Muñoz (1999), three specimens included here (*Wiggins 9177, Kiener 18590, 18591*) correspond to *G. ungeri* Jur. Since no perigonia were observed and all three specimens had capsules with rostrate opercula, they may be best regarded as *G. montana*. According to Muñoz (1999) *G. ungeri* is cladautoicous, but Greven (2003) illustrates it as gonioautoicous; Maier (2010) does not seem to consider the sexual condition relevant as she includes *G. ungeri* in the synonymy of *G. montana* whose gametophyte may be “dioicous, occasionally monoicous.”

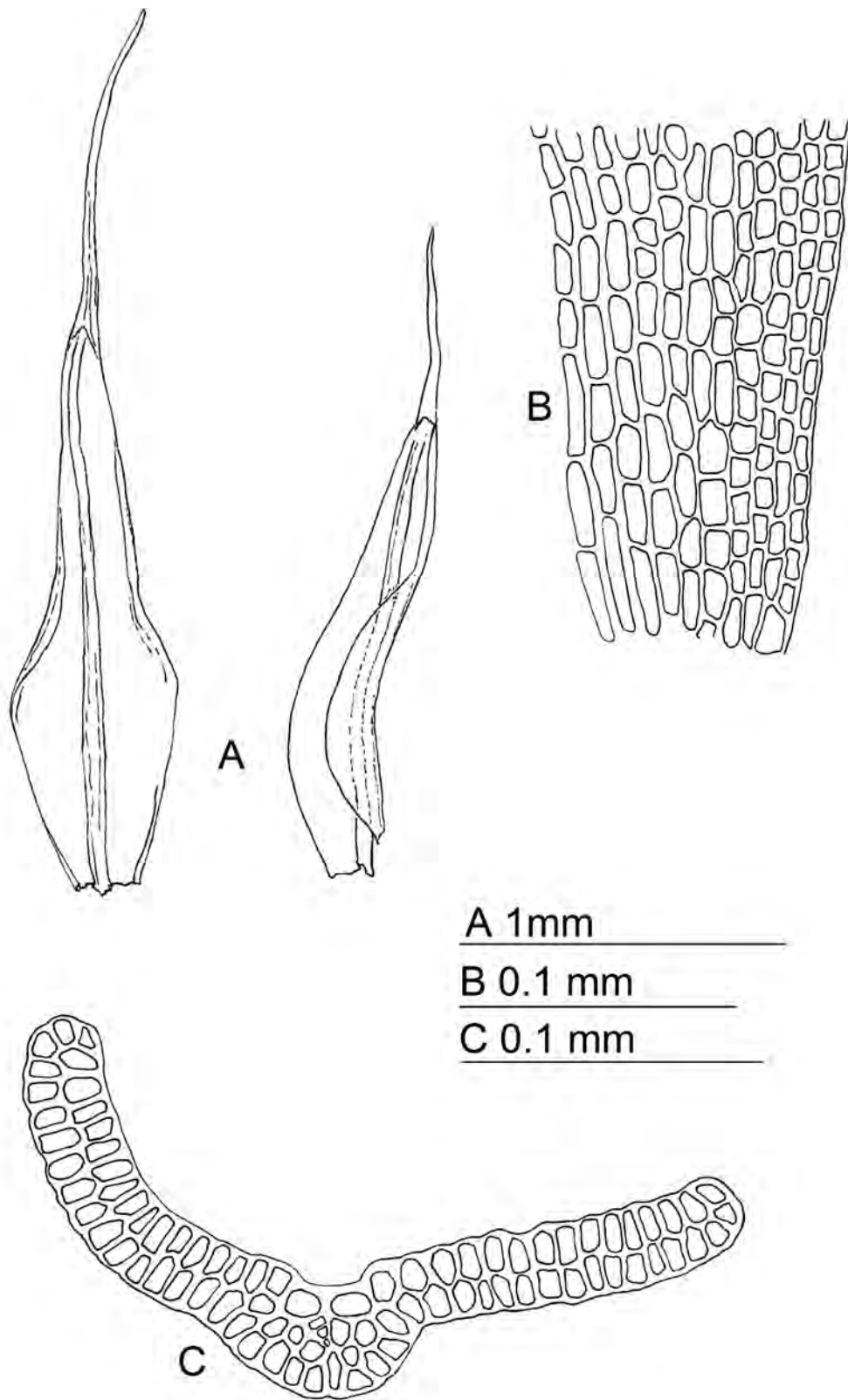


Fig. 15. *Grimmia montana*. A. Leaves. B. Proximal leaf cells. C. Mid-leaf section.
(A,C, Delgadillo 4117, MEXU; B, Kiener 18590, FH).

16. *Grimmia moxleyi* Williams, Musci Bor. Am. Eur. 24: n. 600. 1926. Type: U.S.A. California: Los Angeles Co., Sierra Madre Mts., between Big Rock Creek and Devil's Punch Bowl, *Moxley 1141* (Lectotype, NY!, designated by Muñoz, 2000).

Stem 12-18 mm tall, with central strand and 1-2 epidermal layers of slightly smaller thick-walled cells. *Leaves* 1-2 mm long, oblong, loosely imbricate when dry, erect when wet, carinate, with a rounded leaf apex; lamina unistratose, with occasional bistratose patches, margins plane or one narrowly recurved, bistratose in distal two thirds; costa percurrent to shortly excurrent, in section semicircular, with a broad u-shaped ventral sinus, two ventral cells, a dorsal substereid layer and a hydroid group. *Hair point* absent or 0.1-1.1 mm long, denticulate, non-decurrent to slightly so. Distal leaf cells 7-15 μm , rounded to quadrate or transversely elongated, smooth, thick-walled cells; proximal marginal cells 17-35 μm , rectangular, with thicker cross walls, undifferentiated; other proximal leaf cells rectangular to quadrate, firm-walled, smooth, occasionally sinuose; juxtacostal basal cells smooth, thick-walled, forming a small but distinct group. Gonioautoicous. *Perigonal leaves* 0.6-1 mm long, convolute, without hair point. *Perichaetial leaves* 1.5-2.2 mm long, oblong, with hair point 0.2-2.9 mm long. Seta 1.3-2.2 mm long, curved, not twisted or twisted counterclockwise distally. *Capsule* 1.1, exserted, symmetric, oblong-cylindric, irregularly wrinkled and ribbed; peristome teeth 150-250 μm long X 57-67 μm wide at base, deltoid-truncate, yellowish, papillose throughout, cribose. *Annulus* in 2-3 rows of cells, revoluble; exothecial cells 25-65 μm , prismatic, thick-walled. Stomata few, basal. *Operculum* 0.3 mm long, convex, not rostrate. *Calyptra* cucullate, smooth. *Spores* 10-15 μm , smooth.

Distribution and ecology. Mexico (550 m), U.S.A. On sandstone conglomerate.

Illustrations. Figure 17. Greven (2003: fig. 58); Hastings & Greven (2007).

Specimen examined. MEXICO. BAJA CALIFORNIA: Santa Inés Study Site, 9 km NW of Rancho Santa Inés, *Clark 3214* (MO).

Grimmia moxleyi is treated as a synonym of *G. orbicularis* Bruch in Wils. by Muñoz (2000) because he observed intermediate forms. Greven (1999) treated them as separate species. According to the latter author, *G. moxleyi* has plane margins, but my analysis of the type shows that leaf margins may be plane or recurved. Crum (1994) distinguished *G. orbicularis* by its unistratose margins and made reference to hair points in vegetative and in perichaetial leaves; in *G. moxleyi* hair points are present in the perichaetial leaves, but the vegetative leaf apices are rounded. Because of the number of specimens available of both species from the Neotropical region, it seems best to postpone judgment about their synonymy until additional material is examined.

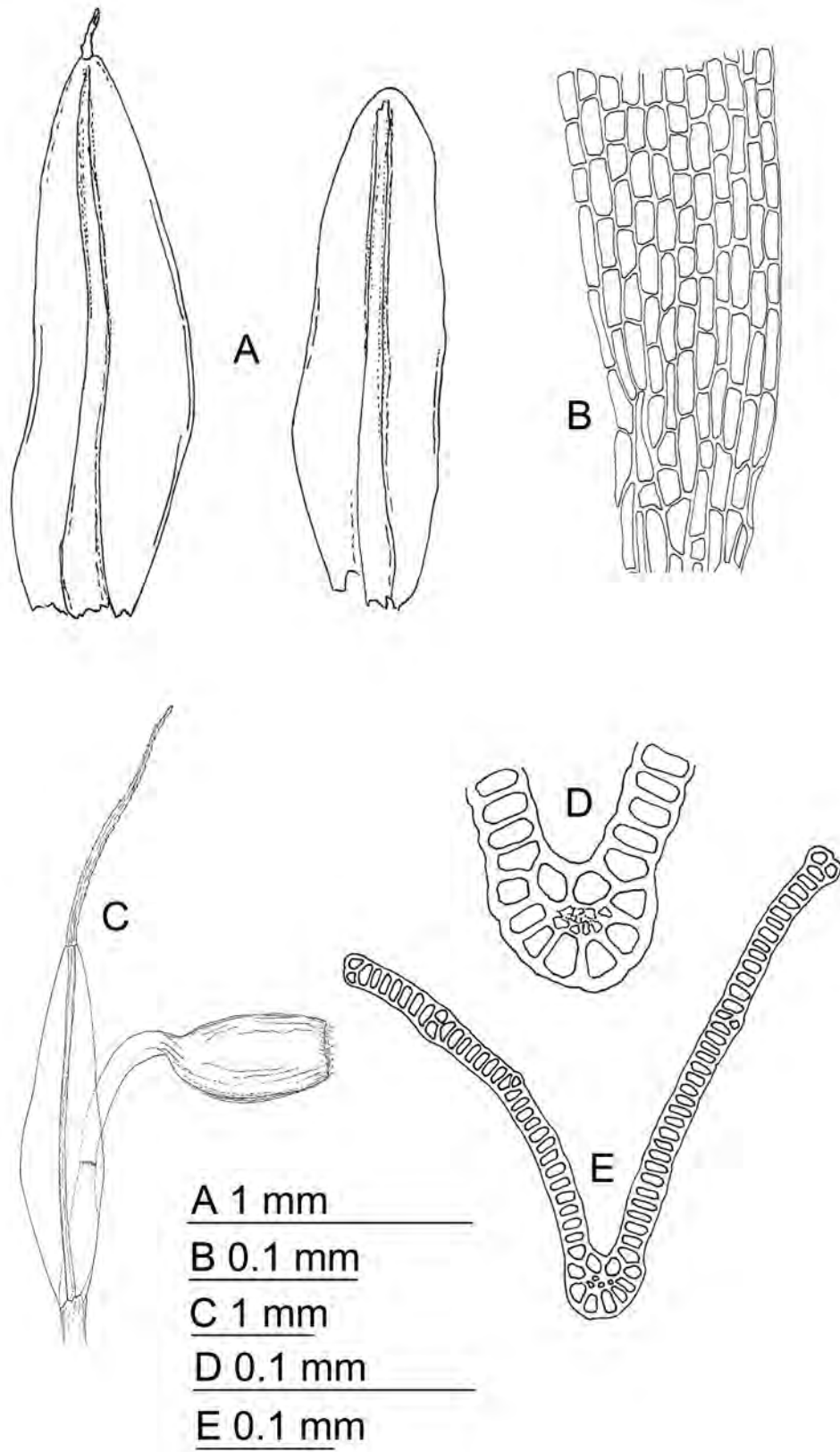


Fig. 16. *Grimmia moxleyi*. A. Leaves. B. Proximal leaf cells. C. Sporophyte and perichaetial leaf. D, E. Mid-leaf sections. (*Moxley 1141*, NY).

17. *Grimmia navicularis* Herz., Beih. Bot. Centralbl. 26(2): 65. 1910.

Grimmia speirophylla Herz. fo. *humilis* Herz. Biblioth. Bot. 87: 55. 1916. Type: Bolivia. Torreni-Janakaka, Herzog, Jul 1911 (Holotype, JE!).

Grimmia chilensis Thér., in Herzog, Darwiniana 11: 217. 1957.

Stem length 6-19 mm with central strand present, absent or indistinct, and an indistinct epidermal layer or 1-2 layers of small thick-walled cells, the outermost wall collapsed. *Leaves* 1 -1.8 mm long, lanceolate to ovate-lanceolate, imbricate when dry, erect-spreading when wet, carinate, with an acute channeled apex, lamina unistratose or bistratose in distal third; leaf margins bistratose distally, both plane and erect, or one plane and the other recurved; costa percurrent to excurrent, in section semicircular, with a ventral sinus v- or u-shaped, two ventral cells, a central hydroid group and 1-2 dorsal substeroid layers. *Hair point* 0-0.9 mm long, smooth, non-decurrent to slightly decurrent. Distal leaf cells 5-25 μ m, quadrate to short rectangular or transversely elongated, thick-walled, sinuose; proximal marginal cells 15-42 μ m, differentiated, quadrate to short rectangular, with thicker cross-walls; other proximal leaf cells rectangular, thick-walled, sinuose to nodulose; juxtacostal basal cells smooth, rectangular, thick-walled, forming a distinct area. Dioicous. *Perigonium* terminal, inner perigonial leaves 0.6-0.7 mm long, with no hair point, convolute. *Perichaetial leaves* 1.6-2.8 mm long, oblong-lanceolate to convolute, with hair point 0.4-0.7 mm long. *Seta* 1.1-3 mm long, curved, twisted counterclockwise when dry. *Capsule* 0.9-1.1 mm long, symmetric, exserted, oblong-cylindric; peristome teeth 150 X 60 μ m, straw-colored, with outer plate smooth only at extreme base and the inner plate papillose throughout. *Annulus* in 2-3 rows of cells; exothecial cells 22-47 μ m, prismatic, mostly longer than wide, thick-walled. Stomata few, basal. *Operculum* convex, short-rostrate. *Calyptra* cucullate. *Spores* 7-12 μ m, finely papillose.

Distribution and ecology. Bolivia (4000-4800 m), Brazil (2200-2450 m), Chile (1200-1600 m), Colombia (3870-4400 m), Ecuador (3600-5300 m), Venezuela (3500-4770 m). Grows on rock outcrops, in humid high Andean and more arid altiplano habitat, in barren or semi-arid areas, in alpine or superparamo areas.

Illustrations. Figure 16. Deguchi (1984: fig. 2, as *G. chilensis*; 1987: pl. 8, 9); Muñoz (1999: fig. 27); Greven (2003: fig. 60)

Specimens examined. **BOLIVIA.** Above Tolapampa, *Williams 1782* (BM, NY). Am Chacaltaya de La Paz, *Buchtien 31* (H). **COCHABAMBA:** Tunarisee, *Herzog 4913* (H-BR). Yanakakaberger, *Herzog s.n.*, Jul 1911 (BM). **LA PAZ:** Huallata Pass, *Williams 1781* (H-BR). Prov. Inquisivi, Along the Río Pacacha between ca 1 km NW of Estancia Huaña Hkota and Mina Veta Verde, ca 11 km SW of Quime, *Lewis 87235* (MO). Along the Rio Santa Veracruz from ca 1 km upstream from Estancia Huaña Hkota to the area between Cerro Chojña Kkota and Cerro Achachi Kkota, ca 9 km SW of Quime, *Lewis 87164 p.p.* (MO). Cumbre Sayaquira, ca. 2.5 km S of Estancia Huaña Hkota, *Lewis 87334, 87335* (MO). Small lake called locally Laguna Huichincani, ca. 1 km S of Río Glorietta along trail from Bicupaya and Mina Huichincani, ca. 8 km NW of Quime, *Lewis 87466* (MO). Prov. Loayza, W of and downslope from the Quime-Caxata road on the slopes of Cerro Majthia Huata and ca. 5 km NE of Caxata, *Lewis 871097 d-3* (MO).

BRAZIL. Serra do Itatiaia, *Dusén s.n.*, May 1902, (NY). **RIO DE JANEIRO:** Serra Mantiqueira, Agulhas Negras. *Lüth 3648* (MEXU).

CHILE. ARAUCANÍA: Prov. Cautín, Parque Nacional Conguillio, Captrén, *Mahú & Harnell 10800* (US). Prov. Valdivia, Immediately SW of Laguna Los Patos, SW slope of Volcán Quetrupillán, Forestal Trafún, *Crosby 11732* (MO).

COLOMBIA. BOYACÁ: Páramo de La Rusia, NWN de Duitama Alto de Avendaño, 2 km SE de la Laguna Negra, *Cleef 6965* (GOET, MO, NY). Sierra Nevada del Cocuy, Alto Valle Lagunillas, alrededores de Laguna Pintada, *Florschütz 3967* (GOET). Mpio. Güican, Sierra Nevada del Cucuy, sitio las cabañas por la carretera en construcción Guican-Cubará, *Escobar & Santa 403* (NY). **CALDAS:** Nevado del Ruíz. Arenales 3 km SW del Refugio, Cabeceras Q Las Nereidas. *Cleef & t Hart 2449b* (GOET).

ECUADOR. ANCASH: Cordillera Blanca, Parque Nacional Huascarán; Laguna Llanganuco, *Frahm 824071* (MEXU, MO). Cajamarca: Prov. Cajamarca, Cajabamba-Luchubamba, *Sagástegui et al. 11197* (MO, NY). **CHIMBORAZO:** N slopes of Mt. Chimborazo, along road 76, from Interamerican Highway toward El Corazón, *Crosby 10668* (MO). Paramo region, *Meyer 5500, 5510, 5511, 5512, 5513, 5514, 5516, 5517, 5522, 5531* (H). **COTOPAXI:** Paramo region, *Meyer 5478* (H). **NAPO:** Cordillera de los Llanganages, Páramo de Jaramillo, SE of Laguna Pisayambo. *Laegaard 53320 D* (NY). **PICHINCHA:** Base of Volcán Sincholhua, Holm-Nielsen, Jeppesen, *Lojnant & Ollgaard 6624* (US). Volcán Iliniza, NE slope below the refugio, Holm-Nielsen, *Ollgaard & Sperling 24920* (GOET, MO, NY).

VENEZUELA. MÉRIDA: Sierra de St. Domingo, Páramo de Mucuchies, flache Hänge nördlich des Passes El Aguila, gegen Chachopo, *Oberwinkler, Oberwinkler & Poelt s.n.*, Mar 1969 (US). Sierra Nevada, Pico Bolívar, Gipfelbereich des Pico Espejo über Merida, *Oberwinkler, Oberwinkler & Poelt s.n.*, Mar 1969 (US).

The inclusion of *Grimmia chilensis* Thér. in Herz. in the synonymy of *G. navicularis* by Deguchi (1987), modified the taxonomic concept of the latter. To be sure, two forms may be recognized under *G. navicularis*. The first is represented by the type of *G. navicularis*, as illustrated by *Deguchi* (1987, Fig. 8), and *Herzog 4913* (H-BR) that exhibit unistratose lanceolate laminae, strongly keeled at the apex and bistratose at margins; the proximal leaf cells tend to be long-rectangular with smooth walls and, in section, the lamina is mostly unistratose with bistratose margins. The second form is characterized by ovate-lanceolate leaves, strongly keeled, channeled and bistratose in the distal third; and short-rectangular proximal cells. This form is represented by a specimen labeled *G. paramophila* Broth., *nom. nud.* (*Meyer 5510*, H-BR) and other specimens from Ecuador (e.g., *Meyer 5522*, H-BR). Between these forms there are specimens with ovate-lanceolate leaves with partly bistratose laminae and long-rectangular proximal cells (e.g., *Meyer 5516*, H-BR). Their intermediate nature justifies the merge of *G. chilensis* and *G. navicularis*.

Muñoz (1998b) included *G. speirophylla* Herz. fo. *humilis* in the synonymy of *G. longirostris*. The holotype (*Herzog s.n.*, Jul 1911, JE) is sterile, but because of its gametophytic characteristics, it may be better placed in *G. navicularis*. The leaves are lanceolate, strongly keeled distally and only bistratose at the margins; the cross-section of the costa shows two ventral cells in the distal half of the leaf. By contrast, in *G. longirostris* the leaves are ovate-lanceolate, bistratose in the distal half, with a distinct ovate base; the costal section has 2-6 ventral cells at mid leaf.

Maier (2010) placed *G. navicularis* in the synonymy of *G. elongata* on the basis of correspondence in leaf shape, cells in leaf base and transitional part, and costal architecture, but did not elaborate on details. Undoubtedly, both species are morphologically similar, but the elongated thin-walled cells at the proximal leaf margin, the generally short hair point, and straight seta of *G. elongata* are distinguishing features.

The specimens cited from Brazil are apparently the first records for the country.

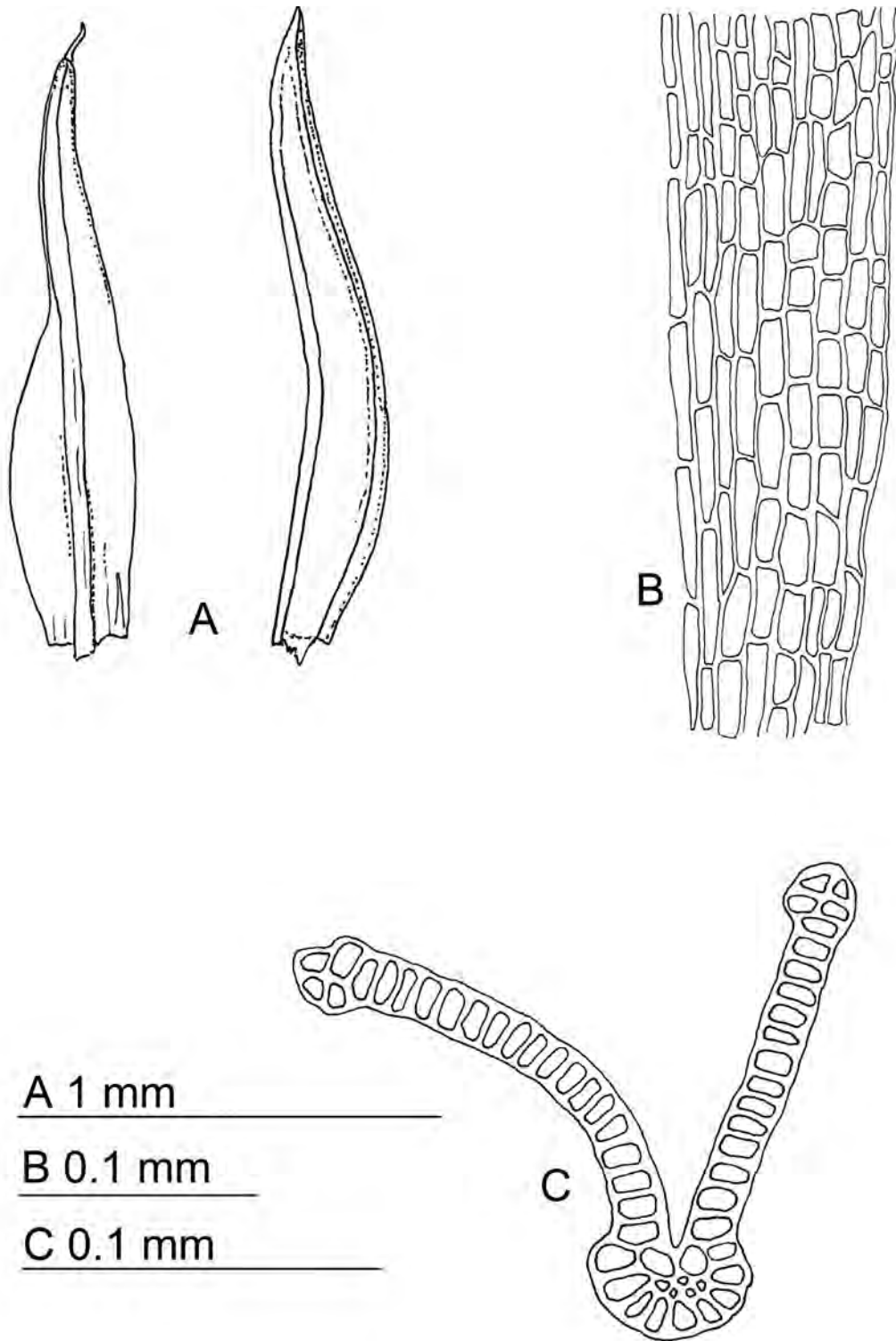


Fig. 17. *Grimmia navicularis*. A. Leaves. B. Proximal leaf cells. C. Mid-leaf section.
(Herzog 4913, H-BR).

18. *Grimmia ovalis* (Hedw.) Lindb., Act. Soc. Sc. Fenn. 10: 75. 1871.

Grimmia bernoullii Müll. Hal., Bull. Herb. Boissier 5: 200. 1897.

Stem 11-15 mm tall, with central strand and 1-2 epidermal layers of smaller thick-walled cells. *Leaves* 1.6-2 mm long, ovate-lanceolate, imbricate when dry, erect-spreading to wide-spreading when wet, concave, with an obtuse to rounded leaf apex; lamina bi- tri-stratose in two distal thirds; margins plane to erect, uni- to tri-stratose distally; costa excurrent, dorsally convex, distally indistinct, without a ventral sinus, 2(-3) ventral cells, a dorsal substereid layer and a hydroid group. *Hair point* 0.2-1 mm long, denticulate, decurrent or non-decurrent. Distal leaf cells 7-12 µm, quadrate, short rectangular, hexagonal to prismatic-rounded, smooth, thick-walled; proximal marginal cells 12-27 µm, rectangular, with thicker cross walls, not differentiated; other proximal leaf cells oblate, quadrate to short rectangular, thick-walled, smooth to slightly sinuose; juxtacostal cells smooth to nodulose, long rectangular, thick-walled, forming a distinct, often yellowish area. Dioicous. *Seta* straight 4-5 mm. *Operculum* obliquely rostrate, 0.8 mm; *calyptra* cucullate.

Distribution and ecology. Mexico (2000-3070 m), Peru (4000 m); also in Guatemala (Muñoz & Allen, 2002), Greenland, Canada, U.S.A. (Hastings & Greven, 2007); Europe, and Asia. Limestone cliffs in pine-oak forests, *Quercus* and *Juniperus* forests, open *Pinus* forests with *Nolina*, *Yucca* and *Opuntia*; dwarf *Quercus* communities with *Dasyllirion*, cacti and bunch grasses, and other scrubby communities.

Illustrations. Figure 18. Deguchi (1987: pl. 10); Muñoz (1999: fig. 30)

Specimens examined. MEXICO. BAJA CALIFORNIA: Ca. 8 1/2 km al Oeste de El Cóndor-La Rumorosa Jct., Sierra de Juárez, Meyer 44c (MEXU). CHIHUAHUA: Ejido de Bocoyna, SW part of Creel, Bye 7297 (MEXU). Valley of Basihuare, 21 km S of Cusarare, Weber & Bye 60309B (NY). Mpio. Bocoyna, Gongochic, E of Creel, Bye 6050 (MEXU, MO), 6153 (MEXU). Mpio. Guachochic, Valley E of Yahuiriachic, E of Cusarare, Bye 5461 (MEXU); SE of Cusarare, near km 30 of Creel-Guachochic road, Bye 6041 (MEXU). DURANGO: 34.5 mi E of El Salto on Rt. 40, Stuessy 408 (NY). GUANAJUATO: "La Rebusca", 2 km S de Ocampo, Herrera 1928, 1930 (MEXU). HIDALGO: Crucero Casas Quemadas, Alfaro & Castillo 271 (MEXU). Sierra de los Pitos, 1.5 km SE de Tlaquilpan, Cárdenas 1525a (MEXU). Mpio. El Chico, Alrededores del Cerro de las Ventanas, Cárdenas 3229, 3232, 3233, 3475a, 3538 (MEXU). Mpio. Real del Monte, 3 km NE de Pachuca, Cárdenas 3529 (MEXU). STATE OF MÉXICO: 4 mi N of Atlacomulco, Magill 2463 p.p. (MO). Hill NW of Toluca, Cerro Teresina, Clausen s.n. (MEXU). Toluca, Pringle 15173 (FH, US). Mpio. Tepetzotlán, Sierra de Alcaparrosa. 9 km N de la Presa de La Concepción, Cárdenas 1834 (MEXU). Mpio. Texcoco, La Purificación, Cárdenas 1888 (MEXU). MICHOACÁN: Campanario, vicinity of Morelia, Arsène 7449 (US). PUEBLA: Tlachichuca, El Cachón, western slope of Pico de Orizaba, Greven M144 (MEXU). QUERÉTARO: Peña de Bernal, Delgadillo 6646 (MEXU). TLAXCALA: 8 km W de Calpulalpan, Cárdenas 3675 (MEXU). ZACATECAS: 1 km S de Troncoso. Cárdenas 3094 (MEXU, NY). Cerro de la Bufo, Cárdenas 354 (MEXU). Near Plateado, Rose s.n., Sept 1897 (NY). Mpio. Fresnillo, 2 km S de San Juan de los Hornillos, cerca de la Presa Hornos, Cárdenas 781 (MEXU).

PERU. CUZCO: Marangani, R.R. southeast Sicuani, along Río Villcanota, Solomon 2928 (MO).

Greven (1999, 2003) states that *Grimmia bernoullii* differs from *G. ovalis* in its straight subulate operculum, mitrate calyptra, and ovate-imbricate leaves with plane margins. According to him, in *G. ovalis* the operculum is obliquely rostrate, the calyptra is cucullate, the ovate-lanceolate leaves are loosely appressed, and the margins are distally incurved. At least *Cárdenas 3233* (MEXU) has both types of opercula within the same sample.

Maier (2010) placed *G. bernoullii* in the synonymy of *G. laevigata* stating that there is "... correspondence in leaf shape, ... cells in leaf base ..., and costal architecture ... with the type specimen of *G. laevigata*". I follow the opinion of Muñoz (1999) who included it with *G. ovalis*.

The specimen from Peru is sterile and the proximal juxtacostal cells are not nodulose as described by Muñoz (1999). This is the first record of the species from that country.

Weber et al. (2003) recognized *G. bernoullii* from a station in Colorado, U.S.A. However, the generic treatment in the Flora of North America (*Hastings & Greven, 2007*) excluded it from that country.

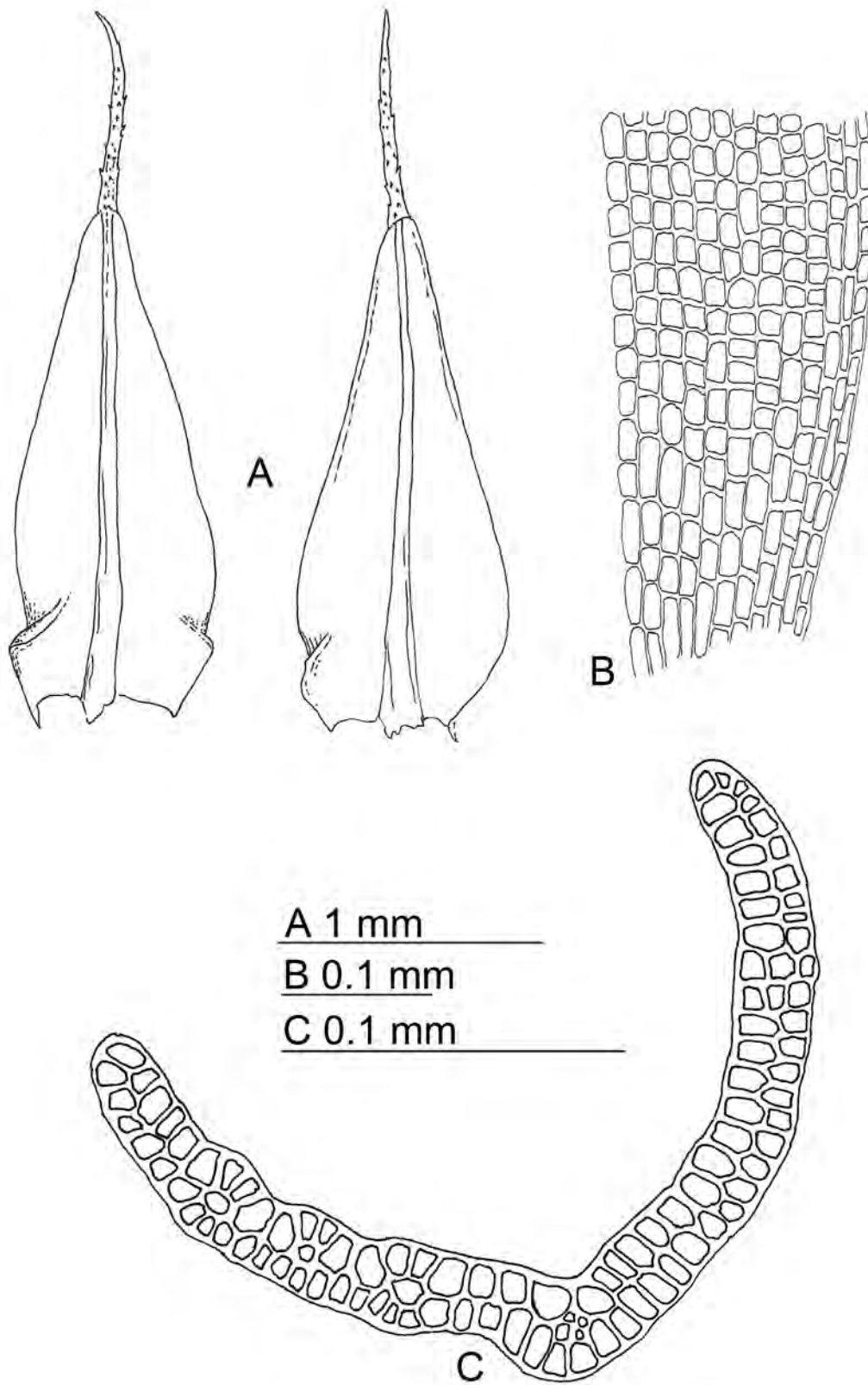


Fig. 18. *Grimmia ovalis*. A. Leaves. B. Proximal leaf cells. C. Mid-leaf section.
(A, B, Cárdenas 781, MEXU; Cárdenas 354, MEXU).

19. *Grimmia pilifera* P. Beauv., Prodr. 58. 1805.

Grimmia apocarpa var. *pilifera* (P. Beauv.) Brid. Musc. Recent. Suppl. 1: 97. 1806. Type: "America Borealis" Palisot de Beauvois (Herbarium Bridel, B 31 0130 01), lectotype designated by Muñoz & Zippel (2006).

Grimmia arsenei Card. Smiths. Misc. Coll. 81(1): 4. 2. 1928. Type: Mexico. Michoacán: Barranca near Morelia, wooded ravine, *Arsène s.n.*, Sep 1911 (Isotype, NY!), Vicinity of Morelia, 2000 m, *Arsène 7894* (Isolectotype, US!), designated by Muñoz, 1999).

Stem up to 35 mm tall, central strand absent or indistinct, with 2-3 epidermal layers of smaller thick-walled cells. *Leaves* 2.4-2.6 mm long, lanceolate from a broad, oblong clasping base, loosely imbricate when dry, wide-spreading when wet, carinate, with an obtuse leaf apex, bistratose in distal half; margins plane, erect or one or both recurved at base; lamina 2-4-stratose distally; costa excurrent, in section semicircular, with a broad u-shaped ventral sinus, two ventral cells, and 1(-2) dorsal substereid layers. *Hair point* 0.2 mm long, denticulate, non-decurrent. Distal leaf cells 5-10 µm, quadrate to short rectangular, thick-walled, slightly sinuose; proximal marginal cells 10-27 µm, quadrate to rectangular, smooth-walled, not differentiated; other proximal leaf cells rectangular, thick-walled, sinuose; juxtacostal basal cells longer than other basal cells. Dioicous. *Perigonial leaves* 0.7 mm long, convolute, without hair point. *Perichaetial leaves* 2.0-2.3 mm long, ovate-lanceolate. *Seta* 1.1 mm long, straight. *Capsule* 1 mm long, immersed, ellipsoid; peristome teeth 225 µm long X 70 µm wide at base, distally cribose, trabeculate, papillose throughout. *Annulus* in 3 rows of large cells, revolute. *Operculum* 0.4 mm long, rostrate. *Calyptra* mitrate. *Spores* 10 µm, nearly smooth.

Distribution and ecology. Mexico (1219-2420 m). Canada, U.S.A.; Asia. Growing in mixed *Pinus*, *Quercus*, *Pseudotsuga* forests, Pine-oak-juniper woodland, *Picea* forest, and in scrub with *Bursera*, *Erythrina*, and *Euphorbia*.

Illustrations. Figure 19. Muñoz (1999: fig. 32)

Specimens examined. MEXICO. Tenayuca, *Amable 1377* (MEXU). CHIHUAHUA: 30 millas N de San Juanito, *Delgadillo 3317* (MEXU). 15 miles WSW of Madera, *Nesom & Wells 51* (MO). Carretas, *White 983* (NY), *987* (MO). Cusarare, 20 km S of Creel; along trail up narrow and shaded rincon just behind mission church, *Weber & Bye 60292B* (NY). Mojarachic, *Knobloch s.n.*, Feb 1938, (US). Mpio. Batopilas, vicinity of La Bufa, Barranca de Batopilas, *Bye 5936* (MEXU). Mpio. Bocoyna, Río Oteros, west of Creel, *Bye 3680b* (MEXU). Mpio. Guachochic, between Cusarare and Bajichi, *Bye 7057* (MEXU). Mpio. Urique, S side of Río Urique, *Bye 6163* (MEXU). GUANAJUATO: 5 km SW de Acámbaro, *Delgadillo 4968* (MEXU). Sierra de Pénjamo, 24 km Swde Cuerámbaro, *Delgadillo 5824* (MEXU). JALISCO: Ca. 8 miles north of Los Volcanes, 3.1 miles south of El Jacal, on road from Ayutla to Talpa de Allende, *Whittemore, Scott & Ayers 2122* (MEXU). El Mirador on Hwy. 80, 9 mi. above San Martín Hidalgo, *Sharp et al. 3233* (MEXU). Sierra Madre, west of Bolaños, *Rose s.n.*, Sep 1897 (NY). STATE OF MÉXICO: Laderas orientales de la Sierra de Alcaparrosa. 5 km en línea recta al NW de Tepotzotlán, *Cárdenas 2399* (MEXU). MICHOACÁN: 11.5 km SW de Coeneo, *Delgadillo 5166* (MEXU). 19 km SSW de Jacona, *Delgadillo 5344* (MEXU). Cerro de la Campana, 4 km E de Tuxpan, *Delgadillo 4960* (MEXU, NY). Cerro Tonácuaro, 3 km SW de Villa Madero, *Cárdenas 4887*, *4889*, *Delgadillo 5286* (MEXU). Morelia, *Nicolas s.n.*, Jun 1912 (BM). Uripitío, 11 km NE de Maravatio, *Delgadillo 4906* (MEXU, NY). Vicinity of Morelia, *Arsène 7906* (US). OAXACA: 13 km (38 km above Oaxaca) east of the pass (La Cumbre) on the road between Oaxaca and Ixtlán de Juárez, *Sharp et al. 2608* (MEXU). QUERÉTARO: Mpio. Amealco, 1 km N de La Muralla, *Herrera 228* (MEXU). SAN

LUIS POTOSÍ: 44 mi W of Antiguo Morelos, on road to Huizache, *Pursell & Reese 5435* (MO).
SONORA: 11 miles northeast of Baviácora, Richards, *Drouet & Lockhart 675* (US). Cañon de Santa Rosa, E of El Tigre, NE Sonora, *White 547* (MO, NY). El Rancho del Roble, NE of El Tigre, *White 4210* (US). **ZACATECAS:** 7 km S de la Laguna Grande, al N de Monte Escobedo, *Cárdenas 3048* (GOET, MEXU, NY). Cerro del Moro, 29 km W de Jalpa, *Cárdenas 832* (NY). Mpio. Fresnillo, 2 km S de San Juan de los Hornillos, cerca de la Presa Hornos, *Cárdenas 767* (MEXU). Mpio. Jiménez de Teúl, Rancho El Madroño, 10 km W de Jiménez de Teúl, *Cárdenas 1097* (MEXU). Mpio. Valparaíso, 14 km N de Valparaíso, *Cárdenas 805* (MEXU).

According to descriptions from various geographical areas (Allen, 1993; Cao & Vitt 1986, Deguchi, 1978; Jones, 1933; Muñoz, 1999), *G. pilifera* is characterized by ovate-lanceolate leaves, abruptly narrowing to an acuminate lamina, with distinct shoulders and 1-2 recurved margins; the laminae are distally bistratose, with prominent costae that show two ventral cells in section, and a stem that frequently lacks a central strand.

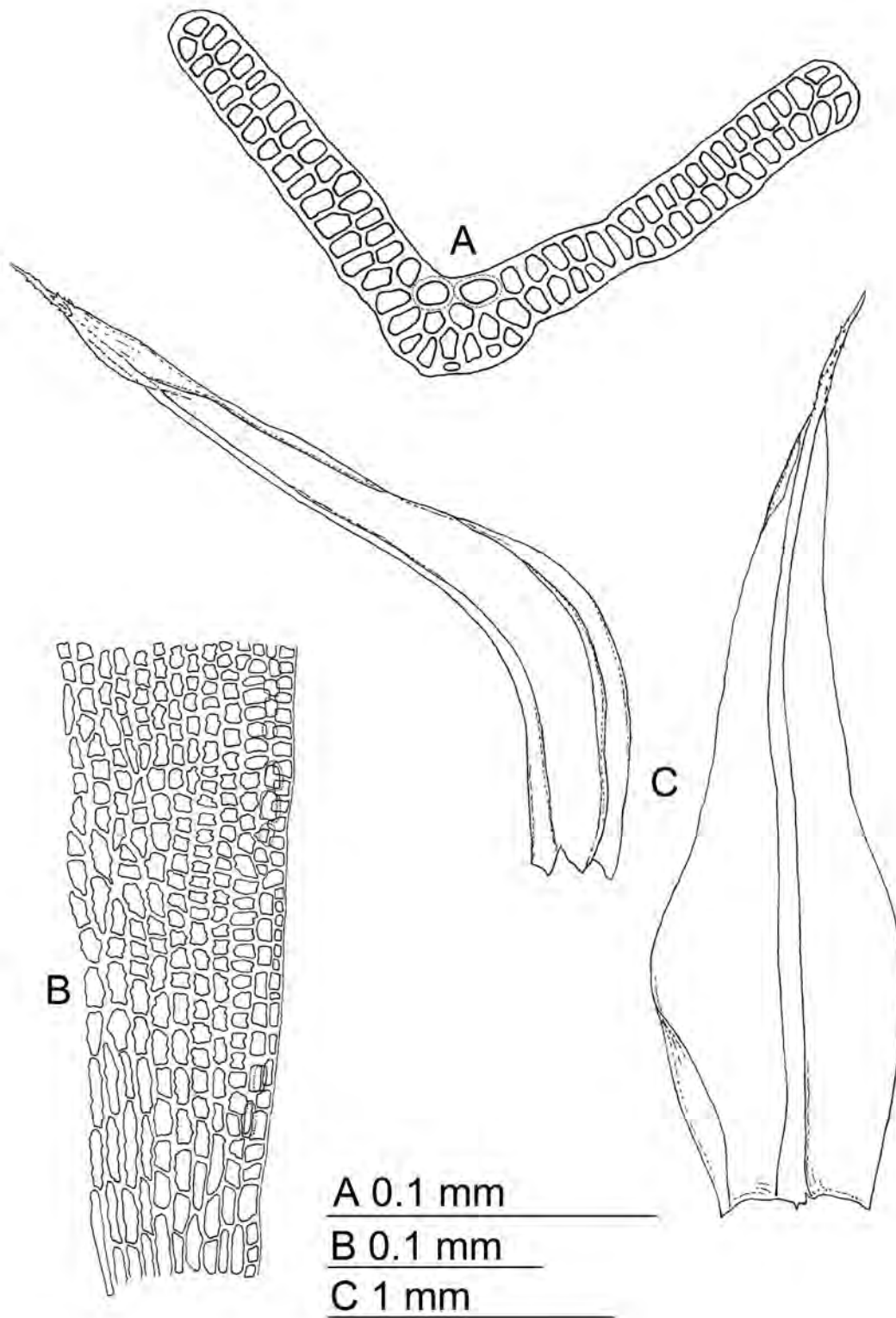


Fig. 19. *Grimmia pilifera*. A. Mid-leaf section. B. Proximal leaf cells. C. Leaves.
(Arsène s.n., 1911, NY).

20. *Grimmia pseudoanodon* Deguchi, Stud. Cryptog. S. Peru 29. pl. 11. 1987. Type: Peru. Puno: Prov. Puno, Chucuito, near Acora, in rocky meadow, 3900 m, *Deguchi 30008* (Isotype, KOCH!).

Stem up to 6 mm tall, with central strand, but without a distinct epidermal layer. *Leaves* 1.0-1.5 mm long, lanceolate, imbricate when dry, erect when wet, carinate, with an attenuate leaf apex; lamina unistratose, with occasional bistratose streaks; margins erect, bistratose distally; costa excurrent, in section semicircular, with an u- to v-shaped ventral sinus distally, two ventral cells throughout, a dorsal substereid layer and a central hydroid group. *Hair point* 0.45-0.7 mm long, smooth, slightly decurrent. Distal leaf cells 7-12 μm , transversely elongated to quadrate-round, smooth to slightly sinuose, thick-walled, with low papillae; proximal marginal cells 7-15 μm , transversely elongated to short-rectangular, undifferentiated; other proximal leaf cells quadrate to short-rectangular, smooth, with thicker cross walls; juxtacostal basal cells rectangular, smooth, thick-walled, similar to others or forming a small indistinct area. Autoicous. *Perigonial leaves* 0.6 mm long, convolute, without hair point. *Perichaetial leaves* 1.5 mm long, oblong, concave, hair point 0.5 mm long. *Seta* 0.2, straight, not twisted. *Capsule* 0.85-0.9 mm long, immersed, erect, symmetric, cylindrical to subglobose, without peristome. *Annulus* in two rows of cells; exothecial cells 25-55 μm , prismatic, mostly longer than wide, thin-walled. Stomata few, basal. Operculum 0.1 mm long, plane-convex. *Calyptra* [mitrate, irregularly lobed at base]. *Spores* 12-15 μm , weakly papillose.

Distribution and ecology. Bolivia (3925-4580 m), Peru (3900-4300 m). Also reported from Argentina (Muñoz, 1999). On rocks or soil protected by boulders.

Illustrations. Figura 20. Deguchi (1987: pl. 11); Muñoz (1999: fig. 37); Greven (2003: fig. 75)

Specimens examined. BOLIVIA. ORURO: Sajama, S-facing slopes of Nevado Sajama in areas of Cerro Jasasuni, Cerro Achuta and base of Cerro Tiraguagua, *Lewis 84266* (MO). Sajama, Wichu Khollu, senda hacia el Nevado Sajama, *Fuentes 5228, 5230* (MO). POTOSÍ: Nor Lípez. Valle de las Rocas, 21 km de Villa Alota, *Sanjines 4157* (MEXU, MO).

PERU. AREQUIPA: Prov. Arequipa, Laguna Las Salinas, *Hegewald & Hegewald 5483a* (MO).

According to Maier (2010), *Grimmia pseudoanodon* is a synonym of *G. andon*. She did not consider the goinioautoicous condition, ventricose capsules, and sigmoid seta with excentric insertion of the latter; in contrast, *G. pseudoanodon* is cladautoicous, and the straight seta is centrally attached to the symmetric urn. Maier's synonymy is not accepted here.

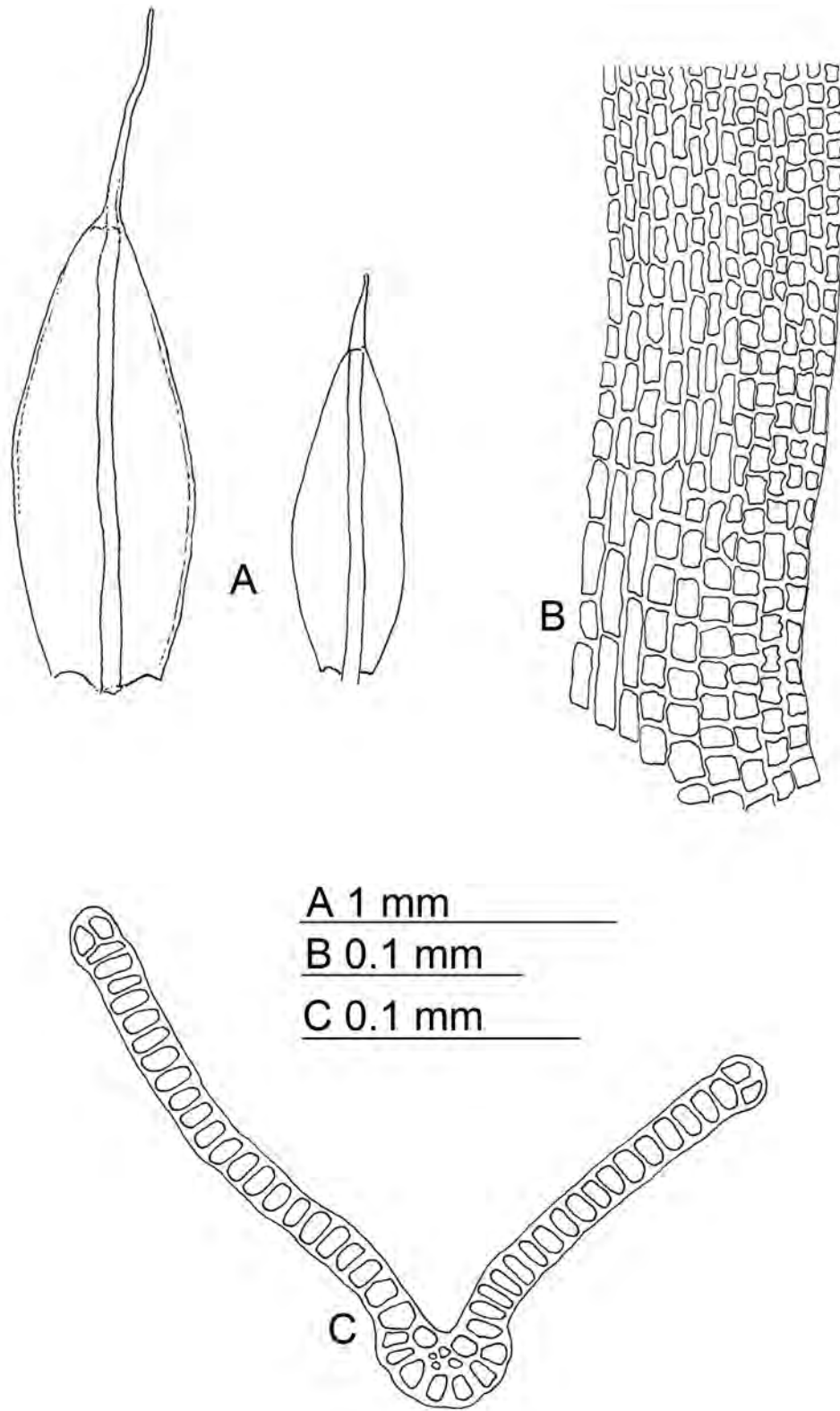


Fig. 20. *Grimmia pseudoanodon*. A. Leaves. B. Proximal leaf cells. C. Mid-leaf section.
(Deguchi 30008, KOCH).

21. *Grimmia pulla* Card., Rev. Bryol. 36: 106. 1909. Type: Hidalgo: Near Honey Station, *Pringle 10423* (Isolectotypes, BM!, FH!, H-BR!, JE!, MEXU!, MO!, NY!, US!).

Stem 5-14 mm tall, with central strand and 1-2 epidermal layers of small thick-walled cells. *Leaves* 1.4-2.3 mm long, oblong-lanceolate, slightly imbricate or flexuous when dry, squarrose when wet, carinate, with an obtuse leaf apex; lamina unistratose; margins one or both recurved, bistratose; costa percurrent to short-excurrent, in section semicircular, with a broad u-shaped ventral sinus, two ventral cells, a dorsal substereid layer, 3-4 stereid cells and a hydroid group. *Hair point* absent or up to 0.5 mm long, hyaline or yellowish, irregularly dentate, non-decurrent. Distal leaf cells 5-10 μm , quadrate to hexagonal, thick-walled, slightly sinuose; proximal leaf cells 10-37 μm , quadrate to rectangular with thicker cross walls, undifferentiated; other proximal leaf cells quadrate to rectangular, firm-walled, smooth to slightly sinuose; juxtacostal basal cells rectangular, smooth, long, firm- to thick-walled, not forming a distinct area. Multicellular gemmae occasionally present on short filaments developing from proximal abaxial leaf cells. Dioicous. *Perigonial leaves* 0.7-1.3 mm, convolute, the innermost ending in a rounded apex. *Perichaetial leaves* 1.8-2 mm long, oblong-lanceolate to convolute, hair point absent to 0.6 mm long. *Seta* 2-2.5 mm long, curved, flexuous, not twisted. *Capsule* 1.3 mm long, exserted, symmetric, ellipsoid, ribbed; peristome teeth 200-225 μm long X 50-65 μm wide at base, deltoid, orange, with outer plate smooth proximally, spiculose-papillose distally and on the inner face, trabeculae strong, numerous. *Annulus* in 2-3 rows of cells, dehiscent; exothecial cells 12-35 μm , prismatic, mostly quadrate, thin-walled. Stomata few, basal. *Operculum* 0.5 mm long, conic. *Calyptra* mitrate. *Spores* 10-15 μm , weakly papillose.

Distribution and ecology. Endemic. Mexico (2030-3500 m). Growing in Pine, Pine-oak, oak, or *Abies* forests. Occasionally found in open fields, on rocks, soil-covered rocks, and as an epiphyte.

Illustrations. Figure 21. Muñoz (1999: fig. 38); Greven (2003: fig. 76)

Specimens examined. MEXICO. AGUASCALIENTES: 1 km W de la cascada El Garruño, *Delgadillo 7590* (MEXU). DISTRITO FEDERAL: Delegación Alvaro Obregón, Santa Rosa, *Cárdenas 1502b* (MEXU). Delegación Tlalpan, Bosque de Tlalpan, *Cárdenas 2813* (MEXU). Delegación Contreras, Ladera norte del Cerro del Judío, *Cárdenas 1461, 1463* (MEXU). Contreras, *Amable 1475* (BM, MEXU). Delegación Milpa Alta, Alrededores de Santa Ana, hacia El Mirador, *Cárdenas 1437* (MEXU). Milpa Alta, alrededores del cerro Tláloc, *Vivas 366, 373* (MEXU). Delegación Cuajimalpa, Desierto de los Leones, *Vivas 342* (MEXU). GUANAJUATO: Sierra de Pénjamo, 24 km SW de Cuerámaro, *Delgadillo 5829* (MEXU). HIDALGO: Parque Nacional El Chico, *Vivas 7* (MEXU). Mpio. El Chico, Alrededores del Cerro de las Ventanas, *Cárdenas 3245* (MEXU). STATE OF MÉXICO: 9 km E de Amecameca, *Cárdenas 3614* (MEXU). Cima de la Sierra de Alcaparrosa. 7 km en línea recta hacia el NW de Tepotzotlán, *Cárdenas 2337* (GOET, MEXU), *2401a* (MEXU, MO). On Route 15, 'La Escondida', 8 miles E of Lerma, *Hermann & H. Crum 20884 p.p.* (US). 2 mi south of Hwy. 15 on road to Valle de Bravo, *Sharp & Cárdenas 8716* (MEXU). Cañada al W de Jiquipilco, *Delgadillo 6758* (MEXU). Mpio. Atizapán de Zaragoza, Parque Ecológico 'Los Ciervos'. Ciudad López Mateos, *Delgadillo 6055* (MEXU). Mpio. Texcoco, San Camilo, ca. 6.5 km E de Coatlinchán, *Cárdenas 1939* (MEXU). Mpio. Tlalmanalco, 3 km E de San Rafael, *Cárdenas 45 p.p.* (MEXU). San Rafael, *Amable 1860* (NY). Mpio. Iztapaluca, Llano Aculco, ca. 10 km S de Llano Grande, *Cárdenas 2948* (MEXU). Mpio. Naucalpan, Puerto El Guarda. 6 km W de San Francisco Chimalpa, *Cárdenas 2452* (MEXU). MICHOACÁN: 27 km SE de Zacapú, cerca de Lago de Pátzcuaro, *Delgadillo 2753* (MEXU). 9 km S de Pátzcuaro, *Cárdenas 4831* (MEXU). 20 km N de Cherán, *Cárdenas 5124, 5127, Delgadillo 5532* (MEXU). 2 km N de Cuanajo, *Cárdenas 5082* (MEXU). MORELOS: Lagunas de Zempoala, *Cárdenas*

6149 (MEXU). Cerro del Tepozteco, *Delgadillo* 6729 (MEXU). QUERÉTARO: Mpio. Colón, Cerro Zamorano, *Cárdenas* 6062 (MEXU). Mpio. Amealco, Cerro de la Cruz, *Herrera* 190, 191 (MEXU). VERACRUZ: Cofre de Perote, laderas NW, cerca del rancho Dos Aguas, *De Luna* G. 824 (MEXU).

Grimmia pulla is a distinct species that is distinguished by the unistratose oblong-lanceolate leaf lamina, bistratose at margins, bearing a sharply dentate awn. Contrary to what Muñoz (1999) states, it is a very variable taxon. The leaves may vary from lingulate to elliptic and the awn is frequently absent; specimens with lingulate leaves and no awn may be similar in appearance to *G. mexicana*, but the cross section of the costa distinguishes them. The awn may be short, consisting of several cells, or long and yellowish or hyaline, and rough. Gemmae have been observed in three specimens (*Cárdenas* 5127, *Delgadillo* 5532, 7410, MEXU) on the abaxial surface of the leaf cells rising from short filaments; several subspherical cells make up each gemma.

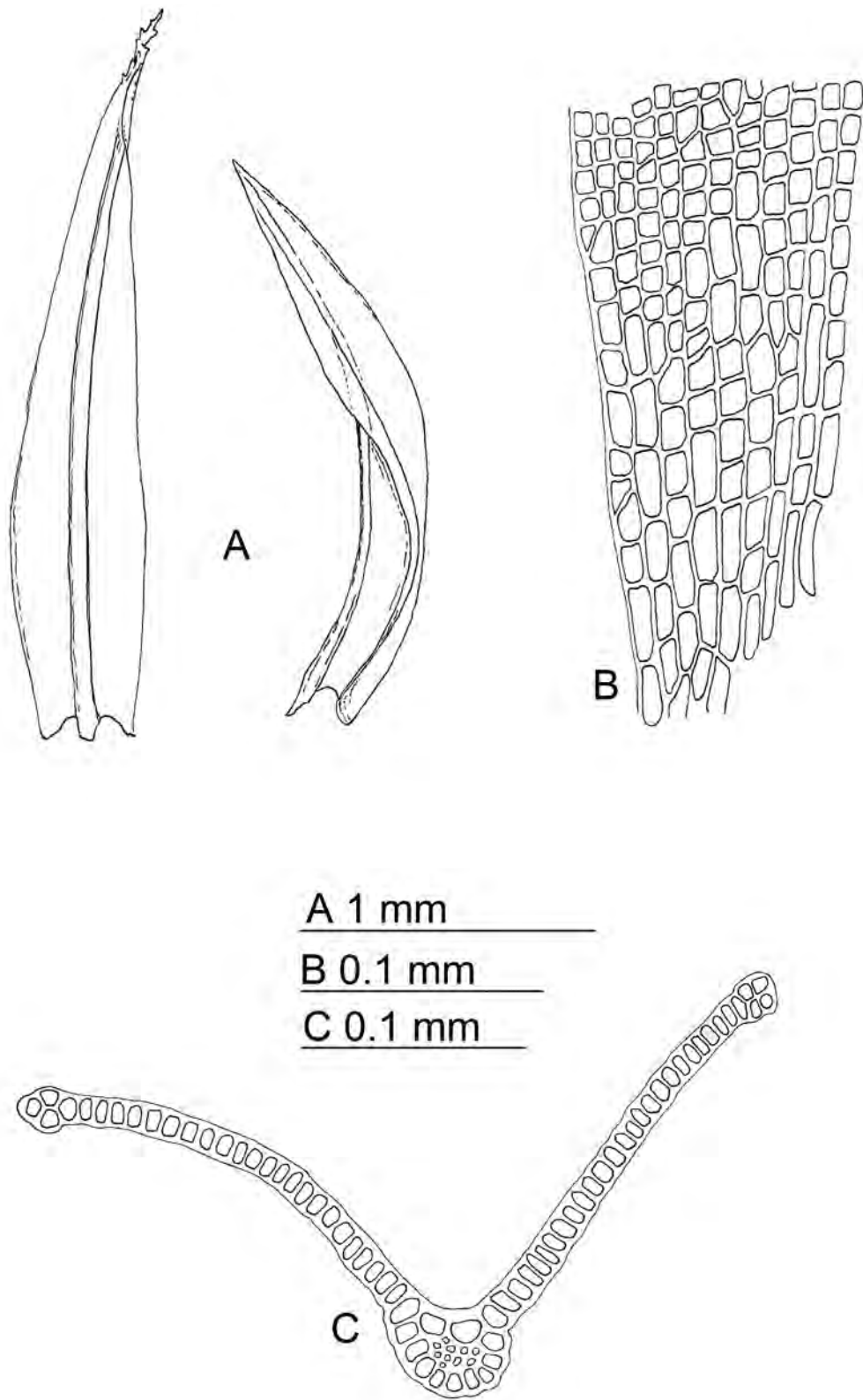


Fig. 21. *Grimmia pulla*. A. Leaves. B. Proximal leaf cells. C. Mid-leaf section.
(A, C, Pringle 10423, MEXU; B, Cárdenas 2452, MEXU).

22. *Grimmia pulvinata* (Hedw.) Sm., Engl. Bot. 24: 1728. 1867 (IV).

Grimmia gibertii Mitt., J. Linn. Soc. Bot. 12: 100. 1869. Type: Uruguay. Montevideo, *Gibert* 729 (Lectotype, NY!, designated by Muñoz, 1999).

Stem 5-9 mm tall, with central strand and no distinct epidermal layer. *Leaves* 1.1-1.8 mm long, lanceolate to oblong-lanceolate, imbricate to somewhat flexuous when dry, erect-spreading when wet, carinate, with an obtuse leaf apex; lamina unistratose; margins plane to narrowly recurved, uni- or bistratose in patches distally; costa excurrent, in section semicircular, with or without an u-shaped ventral sinus, two ventral cells, a dorsal substereid layer and a hydroid group. *Hair point* 0.1-1.2 mm long, smooth to denticulate, decurrent to non-decurrent. Distal leaf cells 5-15 μm , quadrate to short rectangular, thick-walled, slightly sinuose; proximal marginal cells 12-35 μm , rectangular, with slightly thicker cross walls, undifferentiated; other proximal leaf cells quadrate to rectangular, thin-walled, thicker and slightly sinuose upwards; juxtacostal basal cells smooth, rectangular to thick walled, not forming a conspicuously distinct area. Gonioautoicous or rarely dioicous. *Perigonial leaves* 0.7-0.9 mm long, broadly ovate to convolute, without hair point. *Perichaetial leaves* 1.3-1.9 mm long, oblong-lanceolate, hair point 0.6-1.5 mm long. *Seta* 1.9-4.4 mm long, curved when wet, slightly twisted counterclockwise. *Capsule* 1-1.2 mm long, exserted, symmetric, ellipsoid, ribbed; peristome teeth 200-235 μm long X 50 μm wide at base, deltoid, distally cribose, stramineous, with outer plate smooth proximally, papillose distally; inner plate papillose throughout. *Annulus* in 2-3 rows of cells, revoluble; exothecial cells 25-62 μm , prismatic, long rectangular, mostly longer than wide, thin- to thick-walled. Stomata basal. *Operculum* 0.3-0.5 mm long, conic, short-rostrate, crenulate. *Calyptra* 0.9-1.1 mm long, mitrate, smooth. *Spores* 10-20 μm , nearly smooth.

Distribution and ecology. Mexico (2286 m), Uruguay (20-50 m). U.S.A.; Europe, Asia, Africa, Australia; southern South America. Partial shade, dry, granite boulder crevice.

Illustrations. Figure 22. Deguchi (1984: figs. 8, 9); Muñoz (1999: fig. 39); Greven (2003: fig. 77)

Specimens examined. BRAZIL. RIO GRANDE DO SUL: Mpio. Pinheiro Machado, Próximo do arroio Candiota, *Vital* 9155 (NY).

CHILE. JUAN FERNÁNDEZ IS.: Masafuera, Quebrada Mono, *Hacher & Engel* 470 (US).

MEXICO. BAJA CALIFORNIA: Guadalupe Island, *Palmer* 113 (FH, NY). Ca. 18 km suroeste El Cóndor en Sierra de Juárez, *Meyer* 43b (MEXU). 2 miles NW of Catarina near Rosario, *Lightowlers & Davis* 684 (MEXU). Pass below observatory, Cerro de la Encantada, Sierra San Pedro Mártir, *Sharp, Sharp & Radlow* 5663 (MEXU). N facing slopes of Santo Tomás Valley, ca. 5 mi S of Santo Tomás, *Lightowlers & Davis* 718 p.p. (MEXU). 18 km below observatory, Cerro de la Encantada, Sierra San Pedro Mártir, *Sharp, Sharp & Radlow* 5596 (MEXU). 17 mi SE of Meling Ranch, 26 km below observatory, Sierra San Pedro Mártir, *Sharp, Sharp & Radlow* 6974 (MEXU). Below Meling Ranch, E of Colenett, Sierra de San Pedro Mártir, *Sharp, Sharp & Radlow* 6099 (MEXU, MO). Chihuahua: Sierra de Samalayuca, *Lizárraga, Vargas & López* 524 (MEXU).

URUGUAY. MONTEVIDEO: Montevideo. *Felippone s.n.*, Mar 1913 (H-BR), *Gibert 1262* (NY), *Arechavaleta 12* (JE). Arroyo Piedras, *Herter 1267* (GOET, MO, NY, US). Buceo, *Felippone 1338* (H). CANELONES: La Paz, *Felippone 720* (H), Las Prechas, *Felippone 651* (H). COLONIA: Estanzuela, *Herter 83574* (JE).

The leaves of *Grimmia pulvinata* are somewhat similar to those of *G. pulla*, particularly in cross section. Although the latter may lack a hair point, it is usually strong, rigid, dentate, and yellowish at base; the plants are dioicous. In contrast, the hair point in *G. pulvinata* is usually completely hyaline, nearly smooth, and longer than in *G. pulla*; the plants in *G. pulvinata* are usually gonioautoicous.

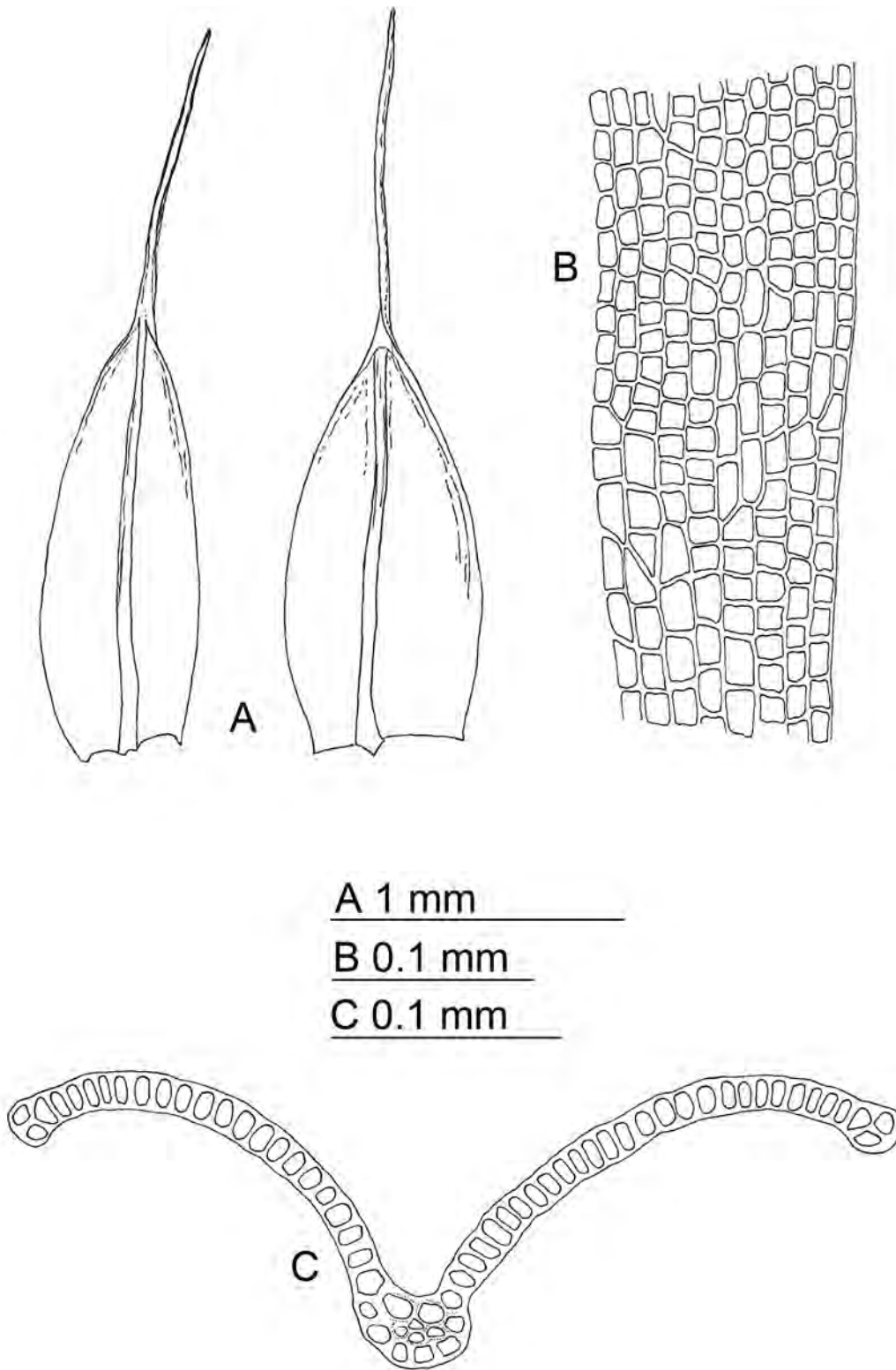


Fig. 22. *Grimmia pulvinata*. A. Leaves. B. Proximal leaf cells. C. Mid-leaf section.
(A, B, Sharp et al. 5596, MEXU; C, Felippone 1338, H).

23. *Grimmia reflexidens* Müll. Hal., Syn. Musc. Frond. 1: 795. 1849.

Stem 4-15 mm tall, with central strand, but no differentiated epidermal layer. *Leaves* 1-1.5 mm long ovate-lanceolate, imbricate when dry, erect-spreading when wet, carinate, with an obtuse to rounded leaf apex, lamina bistratose in distal half; leaf margins plane, distally incurved or one narrowly recurved, bi- to 4-stratose distally; costa excurrent, semicircular in section, with a ventral sinus narrow and deeply canaliculated distally, two ventral cells, two dorsal substereid layers, and a central hydroid group. *Hair point* 1.2-2.1 mm long, nearly smooth, decurrent to non-decurrent. Distal leaf cells 5-15 μm , quadrate, short-rectangular, prismatic-rounded, thick-walled, smooth; proximal marginal leaf cells 15-42 μm , rectangular, with thicker cross walls, undifferentiated; other proximal leaf cells quadrate, short rectangular, thin- to thick-walled, slightly sinuose; juxtacostal basal cells rectangular, thin-walled, smooth, not forming a distinct area. Dioicous. *Perichaetial leaves* 2.1-2.5 mm long, broadly ovate-lanceolate to oblong-lanceolate with hair point 1.2-1.9 mm long. *Seta* 0.4 mm long, straight, not twisted. *Capsule* 1.1 mm long, exserted, symmetric, cylindrical; peristome teeth 225 μm long X 82 μm wide at base, deltoid [broken], yellow, with outer plate smooth below, distally papillose and inner plate smooth. *Annulus* in one row of cells, persistent; exothecial cells 37-70 μm , prismatic, longer than wide, thick-walled. Stomata few, basal. *Operculum* mammillate. *Calyptra* cucullate. *Spores* 7-12 μm , weakly papillose.

Distribution and ecology. Chile (1360-2840 m), Colombia (4200-4300 m). Also reported from Argentina, Bolivia; Europe, Asia, Australasia, Antarctic; on rocks.

Illustrations. Figure 23. Muñoz (1999: fig. 41)

Selected specimens examined. CHILE. O'Higgins: Prov. Colchagua, antes de Las Tercuas del Flaco, lado N del camino, *Mahú* 9685 (MO). Vega del Flaco, al N del Sanatorio, *Mahú* 9686 (MO). SANTIAGO: Prov. Chacabuco, Cerro El Roble, al W de la estación de micro-ondas, *Mahú* 20487 (MO). Prov. Cordillera, Embalse El Yeso, *Mahú* 5981 (MO, US). Prov. Santiago, Arrayán above Las Condes, *Landrum* 179 (MO). Baños Morales, *Mahú* & *Harnell* 13523 (MO). Cajón del Río Maipo, San Gabriel, cerros al N del camino, *Mahú* 9551 (MO). Cajón del Río Maipo, San José de Maipo a Lagunillas, *Mahú* 10362 (MO). Cajón del Río Maipo. El Volcán, Quebrada San Antonio, *Mahú* 11250 (MO). La Parva, *Mahú* 12234, 20741 (MO). Laguna Negra, *Mulhausen* 20140 (MO). San José de Maipo, ca 27 km E of Puente Alto, *Landrum* 180 (MO). VALPARAÍSO: Prov. Los Andes, Portillo, al S de los Refugios, *Mahú* 5292, 13476 (MO).

COLOMBIA. MAGDALENA: Sierra Nevada de Santa Marta, valley descending southwestern from Picos Reina and Ojeda: rocky and meadowy paramos around Laguna Naboba, Laguna Mamito and Laguna Mamo, *Cuatrecasas* & *Romero* 24603 (US).

The taxonomic situation of this species is still uncertain. Muñoz (1999) describes it as an autoicous species, but I have been unable to confirm this as no isoelectotypes have been available for study. Further difficulties arise from the fact that Maier (2002, 2010) indicates that the type specimen belongs in *Coscinodon*. An alternate name seems to be *G. sessitana* De Not., but Muñoz (1998a, 2000) regards that as a synonym of *G. reflexidens*. According to Hastings and Greven (2007), the latter species has enlarged perichaetial leaves, decurrent awns, non-bulging laminal cells, and a dioicous condition. These are not characteristics present in *G. sessitana*.

The type specimen of *G. tenerrima* Renauld & Cardot – a name also placed in the synonymy of *G. reflexidens* by Muñoz (1998a, 1999) – is morphologically distinct from the South American specimens listed above. According to Maier (2010), *G. tenerrima* is a synonym of *G. alpestris* (F. Weber & D. Mohr) Schleich.

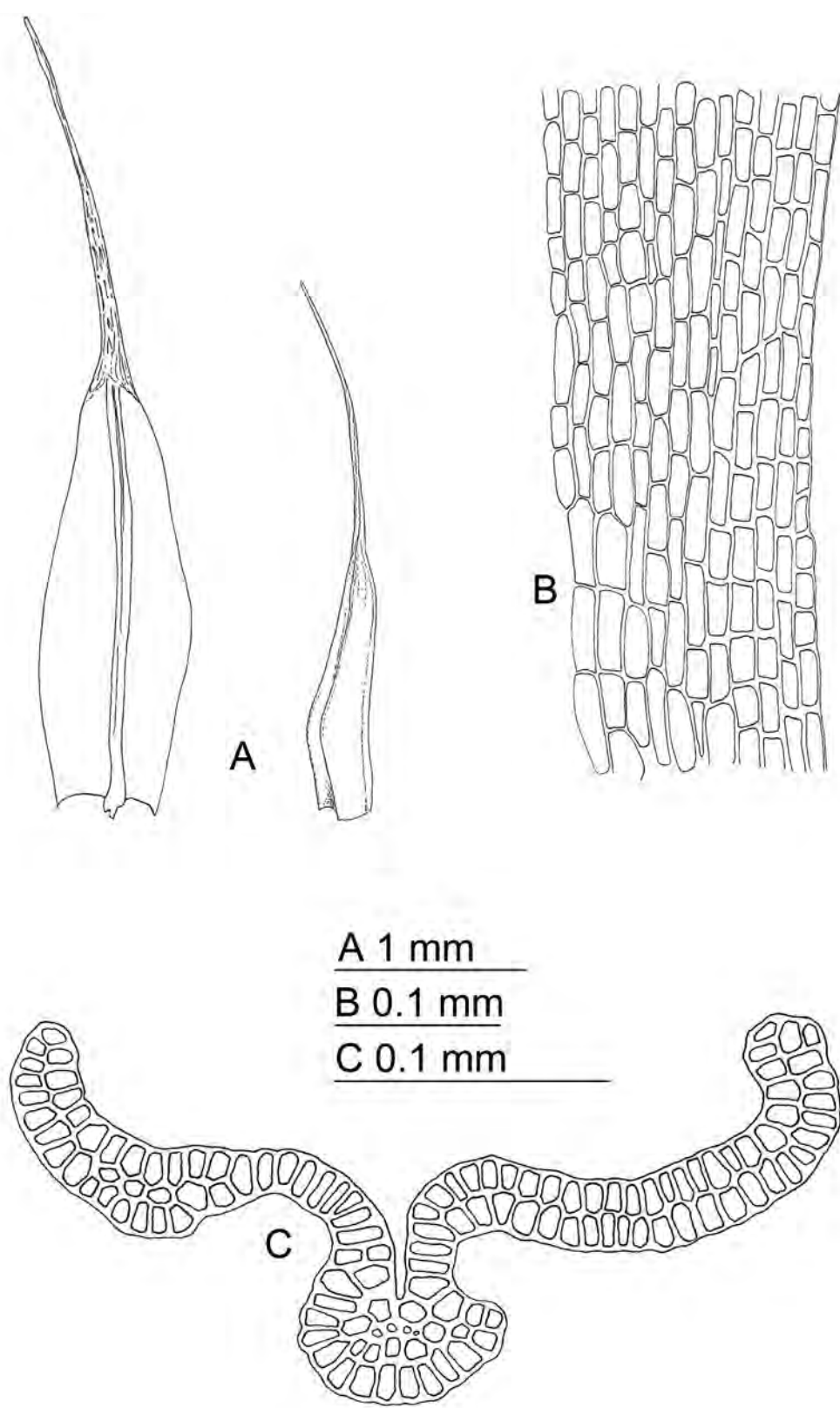


Fig. 23. *Grimmia reflexidens*. A. Leaves. B. Proximal leaf cells. C. Mid-leaf section.
(Mahú 9686, MO).

24. *Grimmia tergestina* Tomm., Bryol. Eur. 3: 126. 258. 1845. Type: Italia. Bosco di Melara prope Tergestum [Trieste], Rupibus umbrosis (isolectotypes, BM!, NY!).

Stem up to 12 mm tall, with a central strand and 1 (-2) layers of smaller thick-walled epidermal cells. *Leaves* 1.4-1.6, oblong-ovate, imbricate when dry, erect-spreading when wet, concave, with an obtuse leaf apex; lamina bistratose, with margins plane, erect, bistratose; costa excurrent, dorsally convex in section, without a ventral sinus, two ventral and 3-4 large cells around the hydroid group, and a dorsal substereid layer. *Hair point* 0.9-1.7 mm long, smooth to denticulate, broadly decurrent. Distal leaf cells 5-10 μm , quadrate, rounded, smooth, thick-walled; proximal marginal leaf cells 12-22 μm rectangular, with thicker cross walls, not differentiated; other proximal leaf cells quadrate to short-rectangular, thick-walled, smooth; juxtacostal cells long, thick-walled, forming a distinct area. Dioicous. *Perigonial leaves* 0.8, convolute, without hair point. *Perichaetial leaves* 2.1-2.7 mm long, convolute; hair point 2-2.3 μm long. *Seta* 0.4 mm long, straight, not twisted. *Capsule* 1.7 mm long, immersed, symmetric, oblong-cylindric; peristome 275 μm long X 70 μm wide at base, deltoid, bifid, slightly perforated, orange, nearly strongly papillose throughout; somewhat cribose distally. *Annulus* in about three rows of cells; exothecial cells 20-42 μm , prismatic, mostly longer than wide, thin-walled few. Stomata few, basal. *Operculum* 0.6 mm long, conic, rostrate. *Calyptra* 1 mm long, mitrate, smooth. *Spores* immature.

Distribution and ecology. Peru (3450-3700 m). Europe, Asia; Bolivia in South America; Dominican Republic.

Illustrations. Figure 24. Muñoz (1999: fig. 42); Greven (2003: fig. 86)

Specimens examined. PERU. JUNÍN: Prov. Jauja, Südlich Canchaylo, *Hegewald & Hegewald* 5848a (MO). Prov. Tarma. Cerro Quinchomachay bei Tarma, vor Pueblo Coches Bajo, *Hegewald & Hegewald* 6262 (MO).

Grimmia tergestina is morphologically close to *G. involucrata*. The differences between them include the dioicous condition and the strongly papillose peristome teeth in the former species while *G. involucrata* is consistently gonioautoicous and the peristome is finely papillose with numerous trabeculae. The present description of *G. tergestina* is mainly based on the type specimen as the two Peruvian specimens are sterile.

Muñoz and Pando (2000) and Norris and Shevock (2004) cited the United States in the distribution of *G. tergestina*. However, Hastings and Greven (2007) referred all their supporting specimens to *G. crinitoleucophaea* Cardot or *G. ovalis* noting the close gametophytic similarity between *G. crinitoleucophaea* and *G. tergestina*.

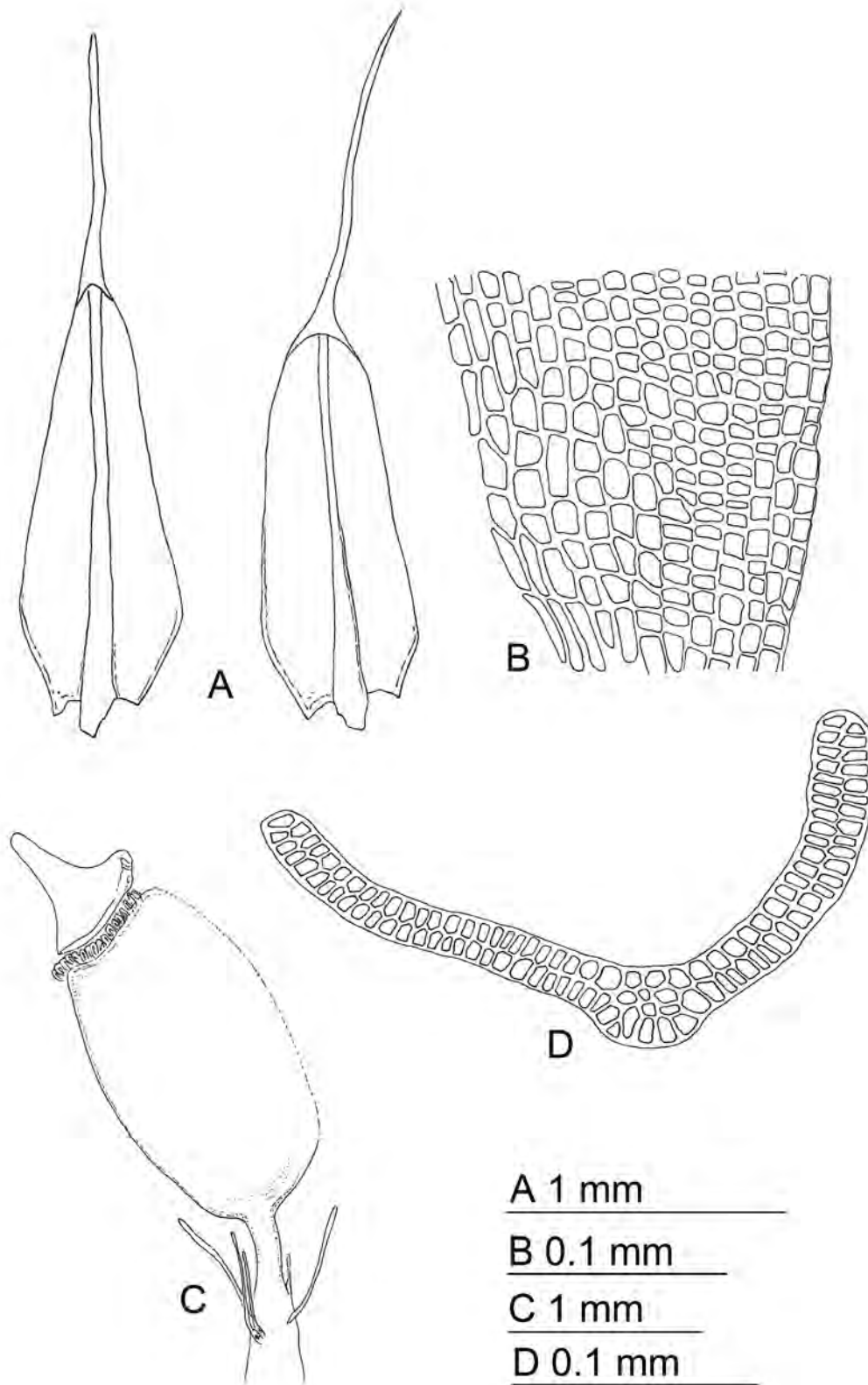


Fig. 24. *Grimmia tergestina*. A. Leaves. B. Proximal leaf cells. C. Sporophyte. D. Mid-leaf section.
(Type, s. col., NY).

25. *Grimmia torquata* Hornsch., Scott. Crypt. Fl. 4: 199. 1826.

Stem 24-28 mm tall, with or without a central strand, 1-2 layers of smaller thick-walled epidermal cells. *Leaves* 1-1.6 mm long, narrowly lanceolate or ovate-lanceolate, loosely imbricate or flexuous to contorted when dry, erect or erect-spreading when wet, carinate, with an obtuse to acute leaf apex; lamina unistratose, with margins plane or erect or one narrowly reflexed, distally bistratose; costa excurrent, in section semicircular, with an u-shaped ventral sinus, two ventral cells, and 1-2 dorsal substereid layers. *Hair point* 0.1-0.2 mm long, smooth, not or slightly decurrent. Distal leaf cells 10-15 μm , quadrate to short rectangular, smooth, thick-walled; proximal marginal leaf cells 12-37 μm , rectangular, thick-walled, 1-2 rows differentiated; other proximal leaf cells rectangular, sinuose upwards; juxtacostal basal cells usually indistinct. Multi-cellular gemmae on branched filaments from the basal abaxial cells of the costa and laminal cells. Sterile.

Distribution and ecology. Mexico (3750-4267 m). Greenland, Canada, U.S.A. (Hastings & Greven, 2007); Europe, Asia, Africa.

Illustrations. Figure 25. Greven (2003: fig. 87)

Specimens examined. MEXICO. In monte Orizaba, *Deppe & Schiede 1070a, p.p.* (BM). Pic d' Orizaba, *Liebmann s.n., p.p.* (BM, NY, Part of the type of *G. fuliginosa* = *G. elongata*). STATE OF MÉXICO: Iztaccíhuatl, above La Joya, *Greven M165* (MEXU). VERACRUZ: Road from Perote to Cofre, *Sharp et al. 7492a* (MEXU).

Most of the specimens listed above are mixed samples involving more conspicuous plants of other Grimmiads. This may be the reason why the species was not detected in Mexico before 1999 (Greven, 1999). When fully grown, the comparatively narrow unistratose leaves are spirally rolled around the stem, the leaf cell walls are very thick, and there are abundant gemmae borne on abaxial filaments at leaf base.

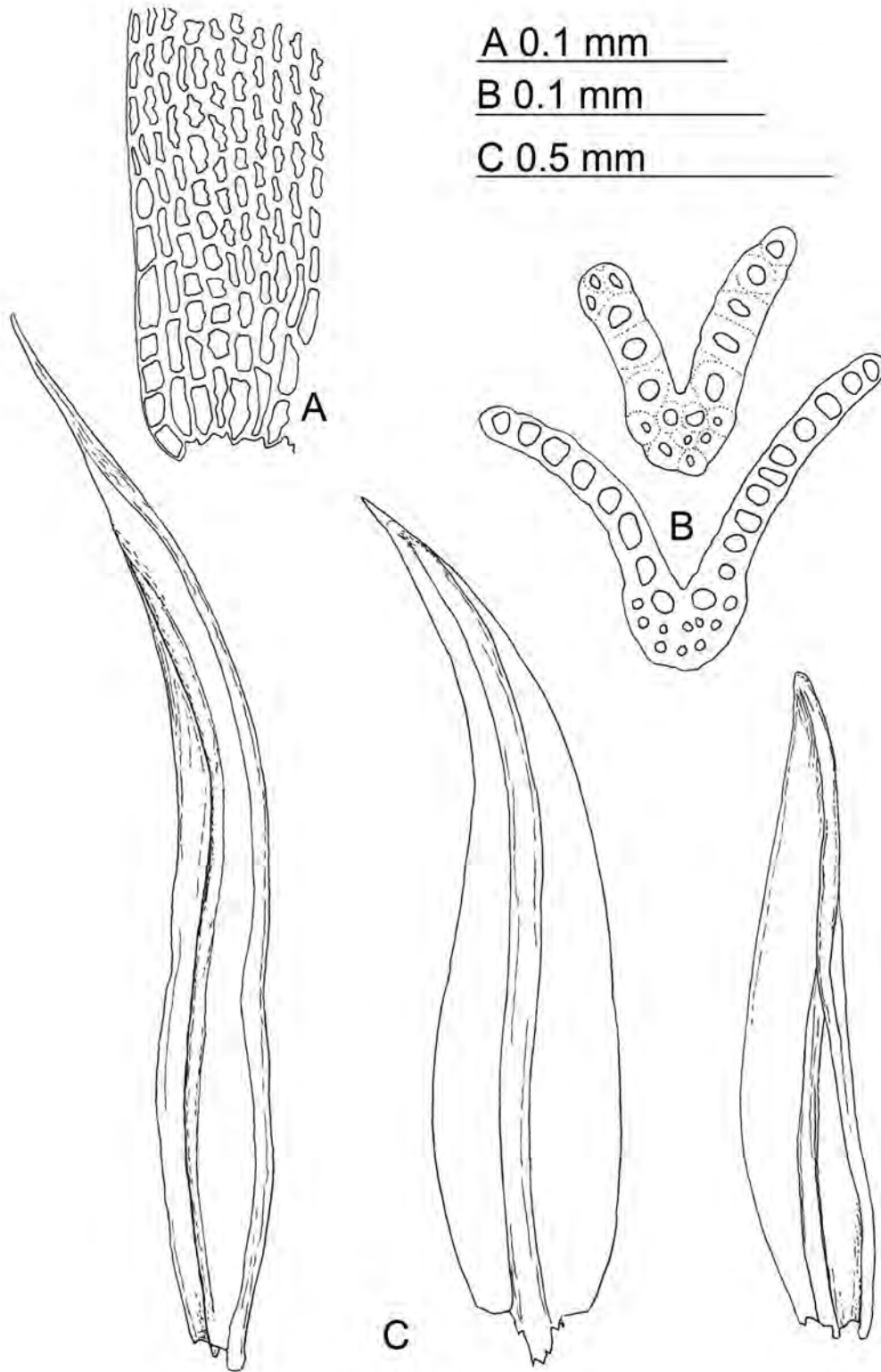


Fig. 25. *Grimmia torquata*. A. Proximal leaf cells. B. Distal and mid-leaf sections. C. Leaves.
(Greven M165, MEXU).

26. *Grimmia trichophylla* Grev., Fl. Edinensis 235. 1824.

Grimmia flexicaulis var. *dicksonii* Dusén, Bot. Not. 1905: 303. 1905. Type: Chile. Aisén: Patagonia, in valle flum. *Dusén s.n.* (Isolectotype, NY!; lectotype designated by Deguchi, 1984).

Stem 8-27 mm tall, with central strand and one epidermal layer of smaller thick-walled cells. *Leaves* 1.6-2.4 mm, ovate-lanceolate or lanceolate, flexuous when dry to flexuous or erect-spreading when wet, carinate, with an obtuse to acute leaf apex; lamina unistratose, but frequently irregularly bistratose in distal half, with one margin plane, the other recurved, bi-tri-stratose distally; costa percurrent to excurrent, in section semicircular, with an u-shaped ventral sinus, two ventral cells, two dorsal stereid layers, and one hydroid group. *Hair point* absent to 1 mm long, stiff or flexuous, nearly smooth, non-decurrent. Distal leaf cells 7-12 μm , quadrate to short rectangular, thick-walled, sinuose; proximal marginal cells 7-52 μm , rectangular, frequently differentiated in 2-4 rows; other proximal leaf cells rectangular, thick-walled, sinuose; juxtacostal leaf cells rectangular, with slightly undulate to nodulose walls, forming an indistinct area. Multicellular gemmae frequently borne on hyaline filaments on the proximal abaxial surface of leaves. Dioicous. *Perichaetial leaves* 2.7-3.2 mm long, ovate-lanceolate to convolute, with hair point 0.1-0.7 mm long. *Seta* 1.7-2.5 mm long, curved when wet, twisted counterclockwise when dry. *Capsule* 1.4 mm long, exserted, symmetric, ellipsoid, ribbed; peristome teeth 237 μm long X 62 μm wide at base, deltoid, orange, outer plate smooth, finely papillose elsewhere, somewhat cribose. *Annulus* in 2-3 rows of cells, revolvable; exothecial cells 20-55 μm , isodiametric to rectangular rounded, thin-walled. Stomata basal, few. *Operculum* 0.4-0.6 μm , mammillate to rostrate. *Calyptra* mitrate. *Spores* 10-15 μm , weakly papillose.

Distribution and ecology. Argentina (3900-4500 m), Bolivia (4600 m), Brazil (1780 m), Chile (10-2130 m), Colombia (3500 m), Costa Rica (3333 m), Ecuador (3658-4496 m), Guatemala (2896-4115 m), Honduras (2700-2849 m), Mexico (610-4350 m), Panama (1800-3400 m), Peru (3000-4050 m). Europe, Asia, Africa, Australia; North, Central and South America. On rocks, concrete, soil, or as epiphyte; in *Nothofagus* forests, sclerophyllous vegetation, or in *Pinus*, *Abies religiosa*, or oak-pine forests, or in alpine areas.

Illustrations. Figure 26. Deguchi (1984: fig. 11-13; 1987: pl. 12-14); Muñoz (1999: fig. 44); Greven (2003: fig. 89)

Selected specimens examined. ARGENTINA. CATAMARCA: Nevados de Aconquija (grupo austral), Quebrada de los Cazadores (falda oriental del Nevado Pabellón de la Abra Grande), *Lamb* 5566 (LIL). Andalgalá, Ascenso al Cerro Yutuyaco, *Sleumer* 2658 (LIL).

BOLIVIA. LA PAZ: Prov. Loayza, W of and downslope from the Quime-Caxata road on the slopes of Cerro Majthia Huata and ca. 5 km NE of Caxata, *Lewis* 871111 d-3 (MO).

BRAZIL. ST. CATARINA: Uribici, Morro de Igreja, *Lüth* 3597 (MEXU).

CHILE. ARAUCANIA: Prov. Cautín, Melipeuco, *Mahú* 11269 (MO). Parque Nacional Conguillío, roquerío al N de las Cabañas, *Mahú* 23927 (MO). Pucón, La Península, *Mahú* 11606, 11636 (MO). Pucón, lado E del Lago Villarrica, *Mahú* 11617 (MO, US). Prov. Malleco/Prov. Arauco, Araucaria forest in Parque Nacional Nahuelbuta, 10 km W of park entrance and 48 km by road W of Angol, Cordillera Nahuelbuta, *Crosby* 13071, 13076 (MO). **BIOBIO:** Prov. Nuble, San Carlos, San Fabián, *Queirolo* 9294 (MO). San Fabián, ca. 60 km east of San Carlos. About 2-5 km from San Fabián

along trail to Lago Valiente, *Landrum 1504b* (MO). Prov. Biobío, Salto del Laja, entre la entrada y el canal que cruza el sendero, *Mahú & Harnell 11072* (MO). **COQUIMBO:** Prov. Choapa, Cerro Imán, *Moreno 13827* (MO). Prov. Limari, Parque Nacional Fray Jorge, Potada C Skottsberg, *Mahú 23127* (MO). **LOS LAGOS:** Prov. Valdivia, Amargos, *Mahú & Harnell 12072* (MO). Isla Mancera, Casa del Gobernador, *Mahú 24128* (MO). Isla Teja, Parque de la universidad, *Mahú 12315* (MO). South facing slopes of Cerro Tralcan, west of western end of Lago Riñihue, *Crosby 11577* (MO). **MAULE:** Prov. Curicó, La Montaña Asentamiento, La Basílica, *Mahú 8635, 10654* (MO). La Montaña, Cajón del Río Teno, *Landrum 5119* (MO). Los Queñes, *Mahú 5549* (MO, US). Prov. Linares, East and a little south of Linares along the Río Ancoa, along the road to Melado and Medina, 38.2 km upstream from the intersection with the road to Peñasco, *Taylor & Gereau 11016* (MO). Prov. Maule, 'Bosque Fisco' between Quirihue and Cobquecura. *Landrum 1547a* (MO). **O'HIGGINS:** Prov. Cachapoal, Las Balsas, *Mahú 24028* (MO). Prov. Cardenal, Caro, Quebrada El Roble, al N de Pichilemu, *Mahú 13429* (MO). Prov. Colchagua, Ad Hacienda Cauquenes, *Dusén 145* (US). Prov. Colchagua, Yaquil, ca 20 km west of San Fernando, *Landrum 1554, 1555* (MO). **SANTIAGO:** Prov. Chacabuco, Cerro El Roble, *Mahú 20492, 21117, 22627* (MO). Cuesta La Dormida, *Mahú 20828* (MO). Prov. Cordillera, Cajón del Río Maipo, Puente El Almendro, entre la carretera y el río, *Mahú 22887* (MO). El Ingenio, *Mahú 22076* (MO). El Manzano, W del Estero El Manzano, *Mahú & Harnell 20341* (MO). Reserva Nacional Río Clarillo, sector de camping, orilla E del brazo S del Río Clarillo, *Mahú 22602* (MO). San Gabriel, cerros N del camino, *Mahú 9552* (MO). Prov. Maipú, Laguna de Aculeo, cerros NE de la laguna, *Mahú 22128* (MO). Prov. Santiago, El Canelo watershed, in the Cajón de Maipo valley, ca 17 km east of Puente Alto, *Landrum 257* (MO). Baños Morales, *Mahú 13522* (MO). Cajón del Río Maipo, entre San Gabriel y Puente El Volcán, *Mahú 11248* (MO). Camino a Farellones, Curva 12. *Mahú 23988* (MO). Cerro Manquehue, *Mahú 9521* (MO). Cerro San Ignacio, *Mahú 23350* (MO). Quebrada de Peñalalolén, *Mahú 10904* (MO). Prov. Talagante, Mallarauco, *Mahú 10575* (MO). **VALPARAÍSO:** Prov. Petorca, Cachagua, Quebrada El Tigre, *Mahú & Mahú 13247* (MO). Zapallar, cerro La Higuera, *Mahú & Mahú 13217* (MO). Prov. San Antonio, El Quisco Punta de Tralca, Quebrada Guallilemu, frente a la Cooperativa de Empleados Particulares, *Mahú 13562* (MO). Prov. Quillota, Fundo Santa Laura, *Moreno 20549* (MO). Parque Nacional La Campana (granizo) Sendero El Andinista, *Tapia 21134* (MO).

COLOMBIA. ANTIOQUIA: Mpio. Urrao, Páramo de Frontino, ca. 17 km directamente N de Urrao, *Churchill, Sastre & Escobar 13329, 13334* (NY).

COSTA RICA. SAN JOSÉ: Summit of Pan American Hwy at Cerro de la Muerte, *Crosby 3888A* (MO).

ECUADOR. COTOPAXI: Avenida volcánica del Cotopaxi, *Espinosa 19* (JE). Cordillera Oriental; in cold, dry páramo (arenal) just north of Volcán Cotopaxi, *Steere E-22 p.p.* (NY). **IMBABURA:** E side of Cerro Cotacachi, NW of Cotacachi, *Lewis 782769* (GOET, NY). E side of Cerro Imbabura above La Esperanza, ENE of Otavalo, *Lewis 782982* (NY). **PICHINCHA:** Pichincha, *Bell 153, 395* (BM).

GUATEMALA. QUETZALTENANGO: Getena area north of Sija, *Sharp 2211* (MEXU). **SAN MARCOS:** Near summit of Tajumulco, *Sharp 5434* (FH, US). On slope of Tajumulco, *Sharp 5441* (FH). **TOTONICAPÁN:** Region of Chiu Jolóm, above Totonicapán, on road to Desconsuelo, *Standley 84451, 84474* (NY).

HONDURAS. LEMPIRA: Montaña de Celaque, Filo Seco, 13 km SW of Gracias, *Allen* 12133, 12144, 12260 (MO), 12262 (MO, NY).

MEXICO. BAJA CALIFORNIA: 75 km S of Tijuana on Ensenada road, *Sharp s.n.*, *Sep* 1962 (MO). Below Meling Ranch, E of Colenett, Sierra San Pedro Mártir, *Sharp* 6097 (MEXU). Cedros Island, *Moran* 17557 (NY). Isla de Guadalupe, *Pimentel s.n.* (MEXU). Sierra San Pedro Mártir, Cerro de la Encantada, pass below observatory, *Sharp, Sharp & Radlow* 5664, 6058 (MEXU). **CHIAPAS:** Cima del Cerro Mozotal, 30 km NW de Motozintla, *Cárdenas* 4238, *Delgadillo* 4779, 4782 (MEXU, NY). **DISTRITO FEDERAL:** 12 km W de San Miguel Ajusco, *Cárdenas* 4413b (MEXU). Contreras, *Amable* 1475 p.p. (US). Cañada de Contreras, *Madrigal* 1397a (US). Contreras, 4° Dinamo, *Vivas* 283 (MEXU). Milpa Alta, alrededores del cerro Tláloc, *Vivas* 389 (MEXU). Sierra del Ajusco, alrededores del centro de convivencia del Pentatlón, *Vivas* 237 (MEXU). Slopes of the ridge San Miguel, *Antipovitch* 80 (MO). **DURANGO:** Along Hwy. 40 about 9 miles west of La Ciudad, *Bowers, Delgadillo & Somers, Jr.* 5061 (MEXU). **HIDALGO:** 10 km S de Singuilucan, *Cárdenas* 5667 (MEXU). 4.5 km NE de Nopalillo, Sierra de las Navajas, *Castillo* 252 (MEXU). Below Las Ventanas near Mineral del Chico, *Sharp et al.* 1686 (MEXU). Cerro Xihuingo, 5 km NE de Tepeapulco, *Cárdenas* 1749, 3434, 3437 (MEXU). Mineral del Chico, *Orcutt* 6708 (FH). Mpio. Epazoyucan, Peñas Largas, *Cárdenas* 1684 (MEXU). **JALISCO:** Nevado de Colima, Laderas NE, cerros al S de La Joya, *De Luna* 554, 556 (MEXU). **STATE OF MÉXICO:** 14 km E of San Pedro Nexapa, *Delgadillo* 1148, 1151 (MEXU). 3 km N de Jocotitlán, *Cárdenas* 6290 (MEXU). Along road to Texcaltitlán, 12 mi SW of Toluca, *Hermann & Crum* 20914 (NY). Cañada de los Diamantes, vertiente NW del Iztaccíhuatl, *Cárdenas* 2716 (MEXU). Extremo NW del Iztaccíhuatl, 5 km S de Llano Grande, *Cárdenas* 3624 (MEXU). Canoas Altas, ladera W de la Sierra Tlaloc, *Cárdenas* 4766, *Delgadillo* 5165 (MEXU). Gap at Nevado de Toluca through which the foot trail passes, *Sharp et al.* 1528 (MEXU). Ladera NW del Nevado de Toluca, *Delgadillo* 6165a (MEXU). Paraje Las Palomas. 16.5 km de Tlazala, *Cárdenas* 4395 (MEXU). Salazar, *Amable* 1293 (FH, MEXU). West slope of Popocatepetl, Sierra Nevada, *Hermann* 20822 (BM, FH, NY, US). Mpio. Donato Guerra, 4 km S de San Martín, *Delgadillo* 6753 (MEXU). Mpio. Ixtapaluca, Lado sur del Cerro Telapón, *Flores* 308 (MEXU). Mpio. Naucalpan, Puerto El Guarda, 6 km W de San Francisco Chimalpa, *Cárdenas* 3721 (MEXU). **MICHOACÁN:** Cerro del Águila, 15 km N de Capácuaro, *Cárdenas* 5498a, 5499, *Delgadillo* 5963 (MEXU). **OAXACA:** Cima del Cerro Corral de Piedra, al norte de Oaxaca, *Delgadillo* 4853 (MEXU). **PUEBLA:** Along route 119, 15 miles S of Chignahuapan, *Hermann* 26444 p.p. (MEXU, NY). Below las cuevas on Iztaccíhuatl, above Huejotzingo, *Sharp* 4296 (MEXU, US). **QUERÉTARO:** Mpio. Colón, Cerro Zamorano, *Cárdenas* 6056, *Delgadillo* 6543 (MEXU). **TLAXCALA:** Ladera norte de La Malinche, *Delgadillo* 2490, 2557 (MEXU). **VERACRUZ:** Camino a Las Minas. 2 km N de la desviación con la carretera Méx. 140, *Mojica & Johansen* 15-82 (MEXU). Cima del Cofre de Perote, *Delgadillo* 4053 (MEXU). Pic d' Orizaba, *Liebmman* 63 (NY). **ZACATECAS:** Cerro de la Bufa, *Cárdenas* 343, 347 (MEXU).

PANAMA. CHIRIQUÍ: Along road from gatehouse to summit of Volcán Baru, *Allen* 9089, 9093 (MO).

PERÚ. Ancash: Quebrada Pucavado, *Hegewald & Hegewald* 7729 (MO). Arequipa: Arequipa, *Hegewald & Hegewald* 5467 (MO). La Libertad: Prov. Stgo. de Chuco, Pampas de la Julia, Jalca, *Sagástegui* 11138 et al. (NY).

Specimens from Honduras have comparatively narrow leaves, a short hair-point, and sometimes are spirally arranged around the stem. However, the leaves retain the flexuous condition observed elsewhere. Because of the waxy sheen of their leaves, some specimens may be confused with *G. austrofunalis*, but the flexuous condition, thicker bistratose margin, and 1-2 rows of outer thick-walled cells in the stem, seem sufficient to distinguish them as *G. trichophylla*. The former has imbricate leaves on long stems, the leaf margins are unistratose or bistratose in patches, but the combined diameter of the marginal cells is the same as that of the lamina; in addition the layers of thick-walled cells in the stem section form a distinct area.

Specimens from Baja California may have quadrate to short rectangular proximal cells across the width of the leaf, and the leaves may be imbricate, not flexuous.

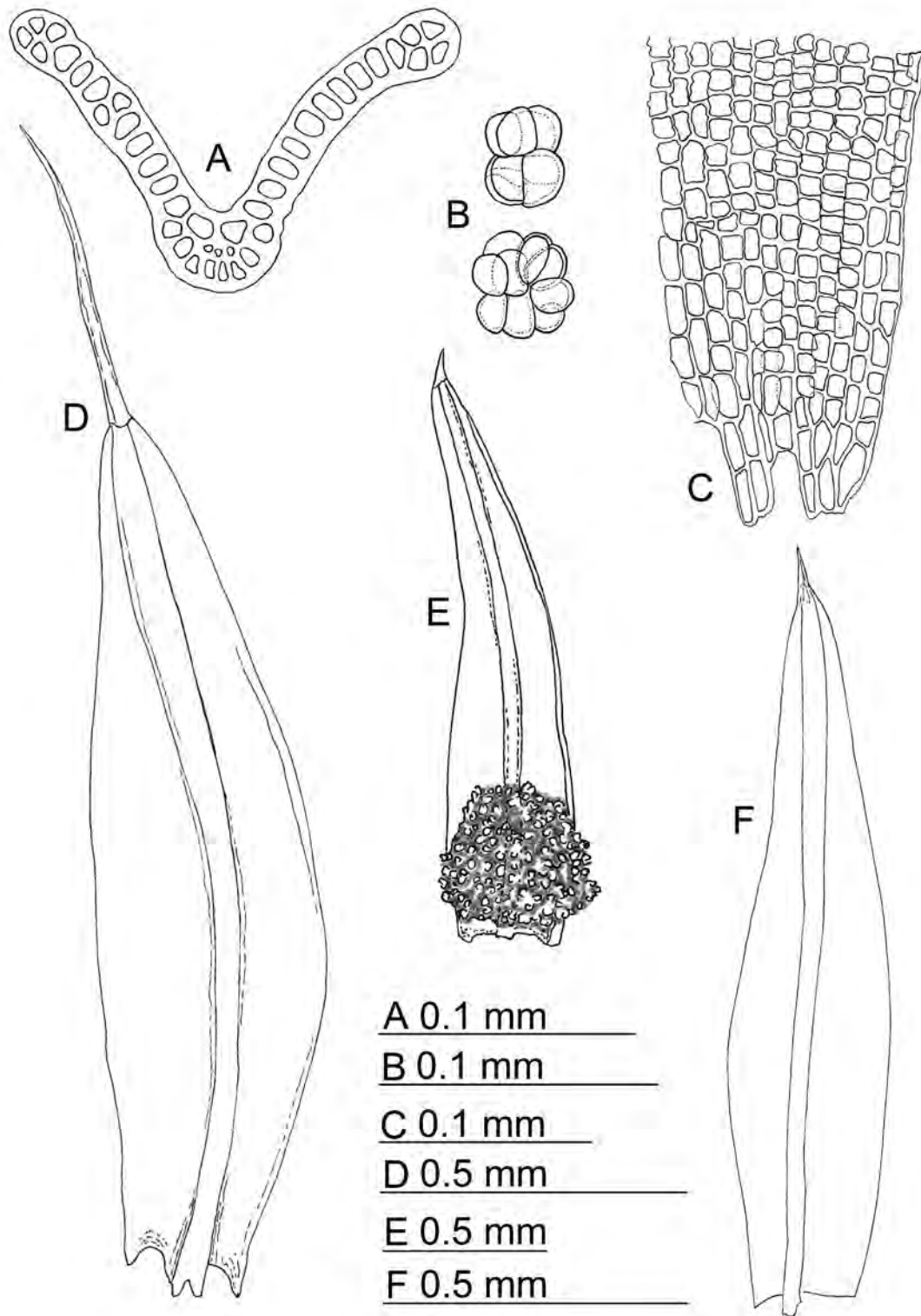


Fig. 26. *Grimmia trichophylla*. A. Mid-leaf section. B. Gemmae. C. Proximal leaf cells. D, E, F. Leaves, one with abaxial gemmae. A, B, E, Orcutt 6708, FH; C, F, Cárdenas 347, MEXU; D, Delgadillo 2490, MEXU).

Excluded taxa

Grimmia trinervis Williams. Hastings (1996) and Muñoz (1999) have opposing views concerning the generic placement of this taxon. Hastings (1996) has argued against placing it within *Grimmia* subgenus *Gasterogrimmia*, as originally proposed by Deguchi (1987), but her arguments in favor of *Coscinodon* were said to be unreliable by Muñoz (1999). With no new information, and, in fact, with the view that the generic segregation of *Coscinodon* is still open to debate, I favor the treatment of this taxon in *Coscinodon* as *C. trinervis*, following Hastings (1996) and Maier (2010).

Grimmia plagiopodia Hedw. Brazil. Brasilien: Arro Pelque. P. Dusén s.n. 16/01/1905 (NY) Sterile specimen. Herb. bryol. C. Alb. Tarnlund. Muñoz (1999) cites the locality as being in Argentina; Deguchi (1984) indicates that it is in Chile, but the specimen studied here was given as collected in Brazil. Since the locality cannot be established with accuracy or may be outside the Neotropical region, and the specimen is sterile, the species is not considered part of the Neotropical flora. Several specimens from Pueblo de Huari, Potosí, Bolivia may belong in *G. plagiopodia*, but confirmation requires further study.

Grimmia ungeri Jur. Muñoz (1999) cited this species from Mexico on the basis of three specimens, one from Baja California, the other from Popocatépetl in central Mexico. I have examined all three specimens (*Wiggins 9177*, *Kiener 18590*, 18591) deposited at FH, but find no grounds to consider them distinct from *G. montana*. According to Muñoz (1999), *G. ungeri* has conical to rostellate opercula and is autoicous, but, in my analysis, I found rostrate opercula in all three Mexican specimens, but failed to observe perigonia. The cladautoicous condition associated with the concept of *G. ungeri* may appear dioicous if the male branches separate from the parent plant in older gametophytes. Greven (2003) indicated that *G. ungeri* is a taxon restricted to Europe (*Cyprus*) and stated that the synonyms listed by Muñoz and Pando (2000) "... can be reduced to forms of *G. montana* or *G. alpestris*".

Grimmia consobrina Kunze ex Müll. Hal. was listed as a valid species occurring in Mexico (Maier 2010), but Muñoz (1999, 2000) regarded it as a synonym of *G. trichophylla*.

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