

Meteoridium and *Zelometeorium* in Bolivia

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Abstract. The genera *Meteoridium* and *Zelometeorium* are described and illustrated from 73 collections made by the author in Bolivia. *Barbella tenuissima* (Hook. & Wils.) Fleisch. is transferred to the genus *Meteoridium* as *Meteoridium tenuissimum* (Hook. & Wils.) M. Lewis comb. nov. Due to its hypnobryoid peristome and other characters, the genus *Meteoridium* is placed in the Brachytheciaceae. *Meteoridium remotifolium* (C. Müll.) Manuel shows marked variation over its altitudinal range and four ecoforms are recognized. Distribution records show that the species of these two genera have distinct ranges, with only *Meteoridium remotifolium* overlapping the ranges of the other species. Habitat data shows that none of the species treated are obligate epiphytes, and that they grow equally well in terrestrial habitats.

The genus *Meteoriopsis* was revised by Manuel (1977a, 1977b) and the South American species were divided amongst two genera: *Meteoridium* and *Zelometeorium*. In Manuel's revision, few localities were given for Bolivia, and the habitat information proved scanty. I had noticed during rough sorting of my specimens that the species seemed to have distinct ranges in Bolivia and that many populations were not epiphytic, but were found on loose sticks and twigs, the sides of cliffs, and even over humus covered boulders. I also noticed that some species varied considerably over their range.

In order to document these phenomena, I examined 73 collections of the genus *Meteoriopsis* sensu lato that I made over the years in Bolivia. For each collection, the following data were recorded: collection number, locality, altitude, habitat, substrate, leaf shape and insertion, leaf width and length; shape, length and width of

alar, basal, mid and apical leaf cells; form of cell walls of alar, basal, mid and apical leaf cells; costa length - leaf length ratio, widest point of leaf - leaf length ratio; flagelliform branch presence or absence, and costal anatomy. Measurements were made averaging 25 leaves, or 5 cells each from 5 leaves for each collection number. This information was placed in tabular form to see what, if any, variation occurred. Sporophytes of these genera are exceedingly rare, and were examined when available. Illustrations were made using a Leitz Mikro Promar microprojector and descriptions were then written using the data from the tables. Identification using Manuel's revisions were then made, and confirmed by comparison with specimens at the New York Botanical Garden. The results are presented below. Collection numbers are those of the author unless otherwise noted, and all specimens are deposited in LPB with some duplicates at F and MO.



Plate I. Distribution of *Meteoridium* and *Zelometeorium* in Bolivia. Solid triangles = *Meteoridium remotifolium*, hollow circles = *Meteoridium tenuissimum*; solid square = *Zelometeorium patulum*; solid circle = *Zelometeorium patens*; hollow triangle = *Zelometeorium ambiguum*.

KEY TO METEORIDIUM AND ZELOMETEORIDIUM IN BOLIVIA

1. Branch leaves loosely arranged, barely to not at all clasping, apices twisted. Exostome teeth striate proximally, papillose distally. Plants abundant in montane forests of La Paz and Cochabamba, rare farther south.....*Meteoridium*

2. Habit gossimeriform (formed like a cobweb), stems and branches filiform-flagelliform. Leaves lanceolate to ovate lanceolate, very sparsely arranged along the stem and not covering it.....*Meteoridium tenuissimum*

2. Plants often pendent, or in coarse mats over various terrestrial habitats, stems and branches soft and thin, but not filiform-flagelliform (some specimens from ceja de montaña woodlands often have some flagelliform branching, but never entirely so). Leaves widely ovate to cordate with acuminate apices, loosely arranged around the stem and mostly covering it.....*Meteoridium remotifolium*

1. Branch leaves crowded, sub-clasping to clasping, without twisted apices. Exostome teeth smooth, or papillose distally. Plants of lowland or low-montane forests of Beni, Santa Cruz and Tarija.....*Zelometeorium*

3. Stem leaves orbicular with very short, corkscrew-like acumina. Leaf cells thick-walled and somewhat pitted throughout. Plants of lower montane habitats of Cochabamba and Santa Cruz.....*Zelometeorium patens*

3. Stem leaves with cordate to reniform bases and untwisted, abruptly narrowed, long acuminate apices. Cells at mid leaf neither thick-walled nor pitted. Plants of lowland forests, or if lower montane, known only from Tarija.

4. Stem and branch leaves differentiated, stem leaves appressed from a clasping subcordate to reniform base, apices of stem leaves often long and capillary; branch leaves ovate to cordate, barely acuminate; leaf cells 10:1, alar cells not at all to obscurely differentiated. Plants of lowland habitats in Beni, Cochabamba, Santa Cruz

and Pando.....*Zelometeorium patulum*

4. Stem and branch leaves not differentiated; all leaves acuminate from erect, orbicular or reniform bases, cathedraform (shaped like a chair, squarrose at mid-leaf with apices decurved) with acute, never capillary apices; alar cells usually differentiated in a round, concave group. Plants of lower montane forests*Zelometeorium ambiguum*

METEORIDIUM (C. Müll.) Manuel

1. *Meteoridium remotifolium* (C. Müll.) Manuel
(Plates III, V, VI figs. 1-4)
Leskea remotifolium C. Müll.

Plants pendent or in loosely interwoven mats, soft, yellow-green to golden brown. Primary stems elongate, to 15 cm or longer, often with elongated secondary stems, ultimate branches shorter. Central strand indistinct or absent. Foliation lax and subcomplanate, to semi-dense and evenly spaced all around. Primary and secondary stem leaves erect-spreading from insertion, often subcomplanate, or with the base squarrose and the apical portion erect, ovate from a sub-cordate base, gradually acuminate, the apex acute to piliferous, twisted, (1.3)-1.8-(2.0) mm long, (.6)-.9-(1.2) mm wide, (1.5)-2-(2.5) longer than wide. Costa thin, extending 1/2 to 2/3 from base to apex, with a rudimentary spine at its apex on at least some leaves from all populations. Leaf margins plain, serrate from near base to apex. Branch leaves differentiated, ovate and gradually acuminate near the base of the stem, becoming narrowly lanceolate at the stem near apex; the margins sharply serrate, and the apices strongly twisted. Alar cells little differentiated, often a few thicker walled, short rectangular cells in the angles. Cells at the leaf insertion mostly thick-walled and somewhat pitted, the walls often femur-like. Mid-leaf cells linear and sub-flexuose with thin to firm walls; (59)-71-(87) μm long, (4.1)-4.8-(6.0) μm wide, (11)-15-(20) longer than wide. Acumen cells somewhat shorter and broader, (45)-61-(72) μm long, (4.5)-5.3-(6.8) μm wide, (6.8)-11.4-(14.4) longer than wide. Asexual reproduction by soft, fragile stems which cling to hair, fur, feathers and

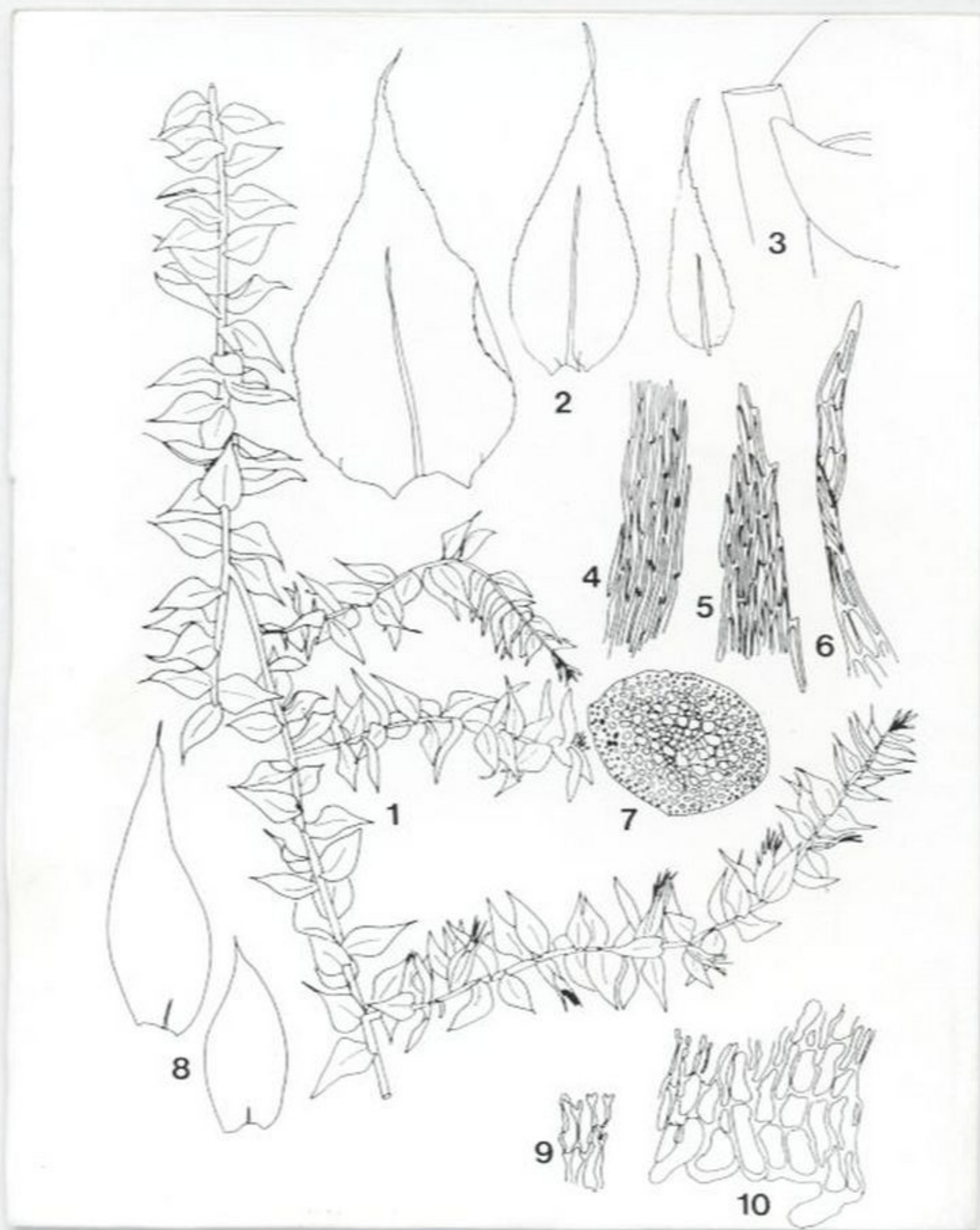


Plate III. *Meteoridium remotifolium* (C. Müll.) Manuel. 1. Habit. -- 2. Stem leaf, branch leaf and leaf from apex of branch. -- 3. Base of leaf showing insertion. -- 4. Mid-leaf cells. -- 5. Marginal cells from upper mid-leaf. -- 6. Leaf apex. -- 7. Cross section of stem. -- 8. Perigonal bracts. -- 9. Basal juxracostal cells. -- 10. Alar cells. -- From M. Lewis #86-2031. -- (fig. 1= scale b; figs. 2 & 8= scale e; fig. 3= scale f; figs. 4, 5, 6, 9 & 10= scale k; fig. 7= scale h).

longer than wide. Asexual reproduction by soft, fragile stems which cling to hair, fur, feathers and is also easily transported by wind. **Dioicous.** Sporophytes unknown from Bolivia. Perigonia in leaf axils. Perigonal bracts ovate to lanceolate, gradually narrowed to the acumen, with margins entire to serrulate, and the costa confined to lower 1/10 of the lamina. Perichaeta unknown from Bolivia.

Variation. Marked variation is found between plants from different altitudes in the Depto. La Paz. Plants from lower montane forest, below 2500 m, are laxly foliate and the branch leaves are complanate with non-clasping leaf bases (ecoforma "*complanata*") In forests between 2500-3000 m, the stems are more densely leaves, non-complanate and with sub-clasping bases (ecoforma "*regularis*"). In the upper part of its range, the branches may produce flagelliform shoots. Near tree line in the seasonally super humid cloud forests of the "ceja de montaña", the branches commonly end in long flagelliform shoots (ecoforma "*flagelliforma*"), the morphology of which are similar to *Meteoridium tenuissimum*. Populations of *M. remotifolium* isolated in the southern part of their range in Depto. Tarija have considerably broader leaves than populations from northern Bolivia, and have an aspect similar to those of *Zelometeorium ambiguum*. I have had to invent a word to describe the aspect of the leaves of these Tarija plants, "cathedraform", which means "shaped like a throne or chair". Many of the leaves of southern *M. remotifolium* have capillary leaf apices similar to those commonly found on leaves of *Zelometeorium patulum*. These variations may be a result of a drier, more strongly seasonal climate. I have not found *M. remotifolium* in the intervening Depto. Chuquisaca and cannot decide whether the Tarija plants deserve a varietal rank. Herzog(1916) has designated this ecoform as var. *latifolia* which was later included as a synonym of *M. remotifolium* by Manuel (1977a). For the time being, I prefer to call the typical Tarija plants with broad, cathedraform leaves as ecoforma "*tarijensis*". Leaf shape in *M. remotifolium* was not correlated with altitude (see Plates III, IV figs. 1-4).

Distribution in Bolivia. *Meteoridium remotifolium* is abundant on the east slopes of the Andes in Deptos. La Paz and Cochabamba, and uncommon further south in Deptos. Santa Cruz and Tarija. It is confined to montane forests, and is absent from lowland Amazonian habitats. It ranges in altitude from 860-3440 m.

Habitat in Bolivia. This species prefers semi-shady to shady habitats in the understory, and is equally at home in primary or secondary forests. Plants found below 1500 m prefer terrestrial habitats, especially humus and loose sticks (5 collections), and cliffs (3 collections), but are occasionally found on tree trunks (2 collections) or pendent from twigs (1 collection) Plants found above 1500 m are usually found festooning twigs (14 collections), or on tree trunks (5 collections), but are occasionally found on soil, rotten logs, boulders or road cuts (1 collection each).

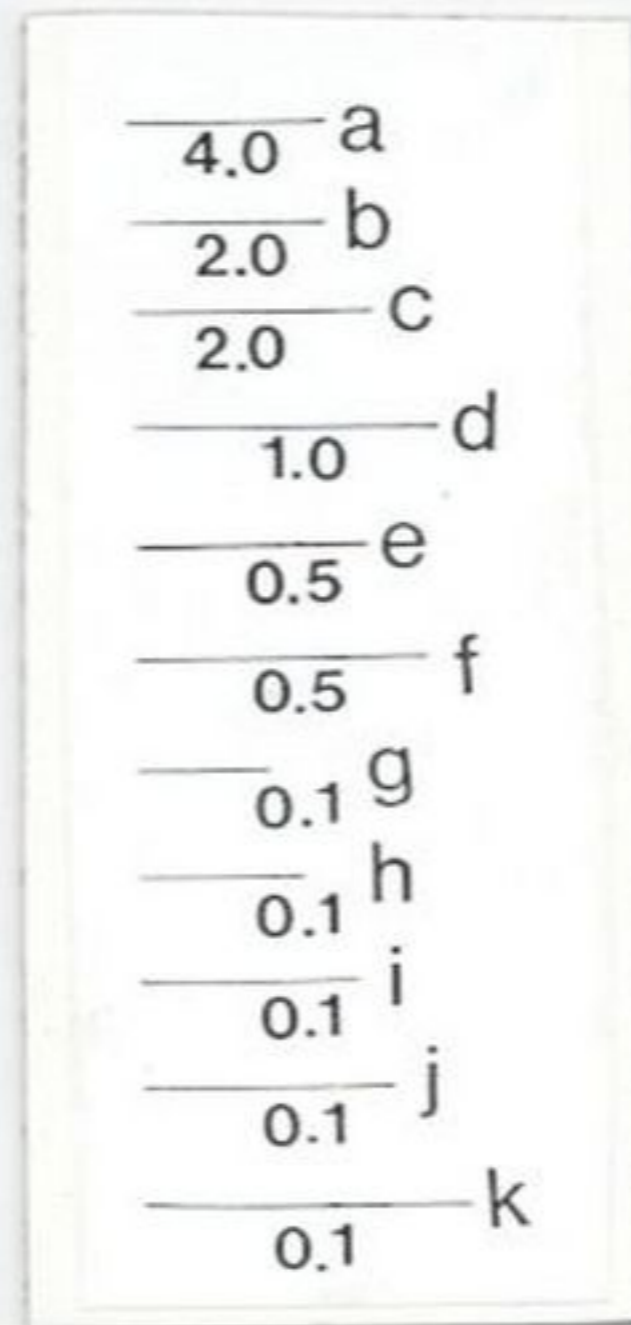


Plate II. Scales for Plates III-XII, at the end of the caption for each plate, information is given as to which scale is used with each figure.

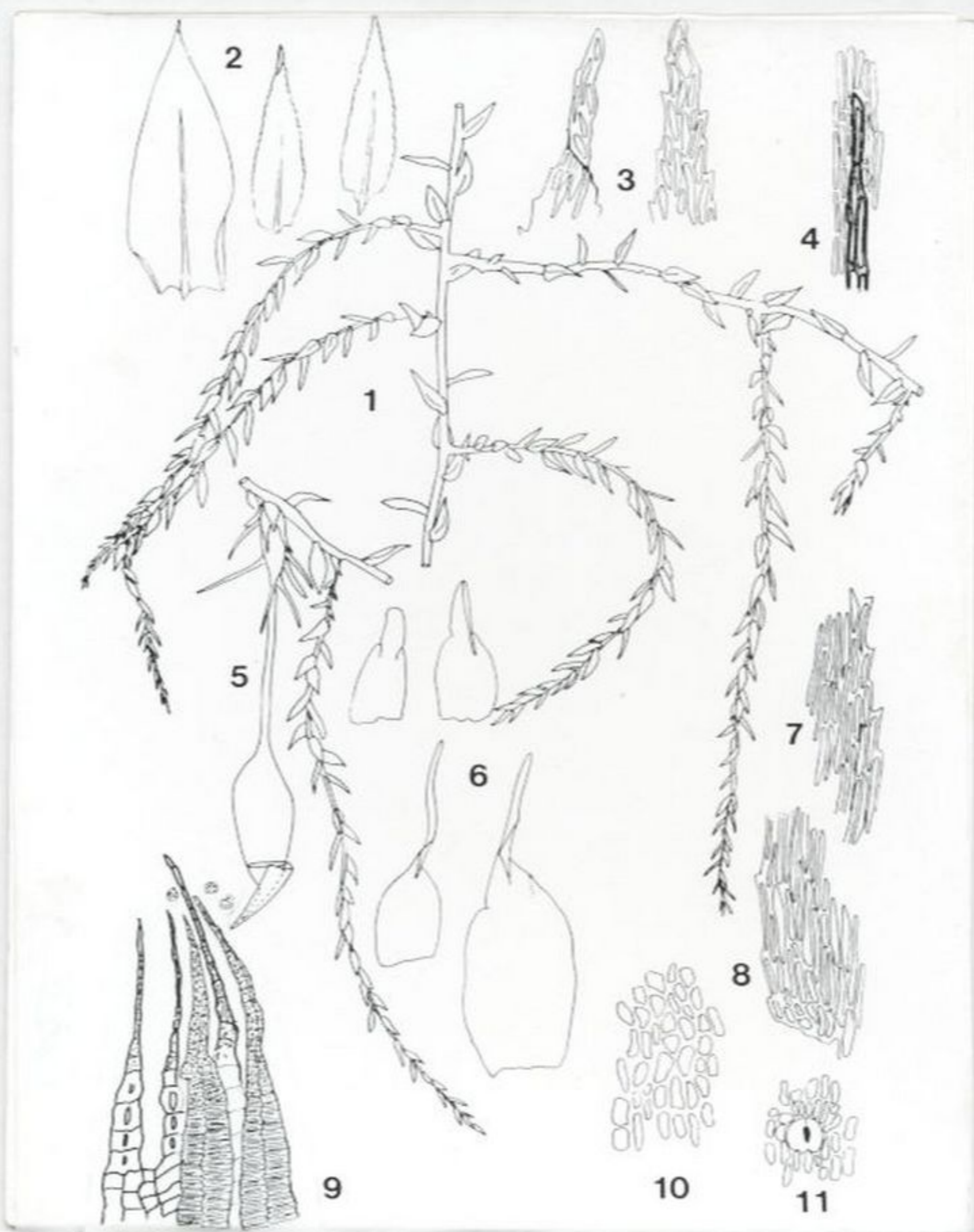


Plate IV. *Meteoridium tenuissimum* (Hook. & Wils.) M. Lewis. 1. Habit. -- 2. Stem and branch leaves. -- 3. Two leaf apices. -- 4. Apex of costa showing rudimentary spine. -- 5. Branch with sporophyte. -- 6. Perichaetal leaves. -- 7. Marginal cells from upper mid-leaf. -- 8. Alar cells. -- 9. Peristome. -- 10. Exothecial cells. -- 11. Stomate. -- From M. Lewis #88-1840, sporophyte characters from Hegewald #8703. -- (fig. 1= scale b; fig. 2= scale e; figs. 3, 4, 7 & 8= k; fig. 6= scale d; figs. 9 & 10= scale g; fig. 11= scale i).

(38816), Cuchiwasi 3200-3300 m (38764, 38744), Chojña Kkota 3000 m (89-823, 89-841), Boca de Río Milla Milla 2200 m (89-894), Abra de Alto Polea 2750 m (83-3889, 83-3863, 83-3894); **Prov. Larecaja:** Consata Trail 1 1450 m (83-372, 83-373), Consata Trail 2 1450 m (83-423); **Prov. Murillo:** Río Tilia 1070 m (86-1847), Río Tilia 1100 m (86-1847), Río Zongo 1400 m (79-1768), Río Cedru Mayu 1720 m (86-1796), Zongo-Cambaya 2570 m (82-596); **Prov. Nor Yungas:** Río Suapi 1330m (86-1711, 86-1721, 86-1741), Abra de Bella Vista 1650 m (86-2031); Abra de Cerro Uchumani 2420 m (83-609), Río Quita Calzón 860 m (86-1924), Unduavi Transito 3440 m (83-826); **Prov. Sur Yungas:** Río Perkha Pampa 3010 m (83-1062, 83-1086). **DEPTO. COCHABAMBA.** **Prov. Chaparé:** Cerro Limbo 2420 m (85-1714), Río Vinto 2450 m (83-1522, 83-1523, 83-1539). **DEPTO. TARIJA, Prov. Arce:** Puñalada 1300 m (84-2293), Sidras 970 m (84-2317, 84-2322), Túnel 1150 (84-2349). **DEPTO. SANTA CRUZ, Prov. Ichilo:** Summit of Cérro Amboró, 1500 m (37882).

2. *Meteoridium tenuissimum* (Hook. & Wils.) M. Lewis comb. nov.

(Plates IV & VI figs. 5-10)

Cryphaea tenuissima Hook. f. et Wils. London J. Bot. 5: 453. 15 e. 1846.

Meteorium tenuissimum (Hook. & Wils.) Mitt.

Barbella tenuissimum (Hook. & Wils.) Fleisch.

Plants golden, gossameriform (with cobweb-like life form) with soft, tangled, thin stems and branches. Primary stems and branches elongate, with small, widely separated leaves. Primary stem leaves ovate-lanceolate. Branch leaves narrowly lanceolate to lanceolate, (0.9)-1.2-(1.6) mm long, (0.3)-0.4-(0.5) mm wide. Leaf margins strongly serrate from base to apex. Leaf apices strongly once twisted. Costa reaching 1/2 to 2/3 from base to apex, occasionally with a rudimentary spine. Leaf cells, at the insertion, short rectangular in two rows, with thin to medium non-pitted walls. Mid cells long, narrow, vermicular (4.0)-4.6-(5.4) μm wide, (60)-74-(96) μm long, 16:1 length to width ratio. Apical cells shorter and wider, (4.6)-5.2-(5.8) μm wide, 11:1 length to width ratio. Asexual reproduction by fragile stem which cling to feathers, fur and hair. **Sporophytes** unknown from Bolivia. The following description is from Hegewald & Hegewald #8703 (Bryo.

Neotrop. Exsic. Fasc. I. #2). Dioicous. Perichaetia bud-like in leaf axils, the perichaetal leaves elliptic, acuminate, without a costa, the margins plane and entire. Seta 3 mm long, smooth. Capsules ovoid, erect, 1.1 mm wide, 2.2 mm long, brown. Annulus of two rows of incrassate cells. Operculum long rostrate. Peristome with outer teeth narrow, 550 μm long, with outer surface proximally horizontally striate with papillae superimposed upon the ridges of the striae, distally papillose. Endostome from a low basal membrane, proximally smooth, distally papillose, somewhat papillose in mid-line, cilia none or very rudimentary. Spores 18-20 μm , green, papillose. Calyptra cucullate.

Variation. Little variation seen. The branch leaves are remarkably similar in aspect to those of *Meteoridium remotifolium*.

Distribution in Bolivia. *Meteoridium tenuissimum* is found on the east slope of the Andes in Deptos. La Paz and Cochabamba as far south as the Chaparé region. It is confined to high cloud forests between 2400-3500 m.

Habitat in Bolivia. This species is usually found festooning bark and loose dead branches at the base of trees, over loose decayed sticks on ravine banks, and over loose twigs and humus on the ground. In the Choquetanga area it is associated with such trees as *Weinmannia pinnata*, *Hesperomeles lanuginosa*, *Clusia salvinii* and *Myrsine pearcei*, and associated with *Meteoridium remotifolium*, *Lepidopilum muelleri*, and *Squamidium nigricans*. It prefers cold, semi-shady, very humid habitats.

Specimens examined. BOLIVIA, DEPTO. LA PAZ, Prov. Franz Tamayo: Pelechuco 2900 m (88-1840); **Prov. Inquisivi:** Valle de Chimu 3100 m (38818), Río Mina Jahuira 3550 m (39225); **Prov. Nor Yungas:** Chuspipata 2950 m (83-678), Unduavi Tránsito 3400 m (83-799), 3440 m (83-815); **Prov. Sur Yungas:** Río Perkha Pampa 3010 m (83-1060) **DEPTO. COCHABAMBA, Prov. Chaparé:** Río Vinto 2450 m (83-1472), Cerro Chua Laguna 3350 m (79-2233A). **ECUADOR, Quito:** in sylvia Llalla (9000 ped) Jameson. **PERU, Depto. Cuzco:** near Macchu Picchu 2100 m - Hegewald and Hegewald 8703

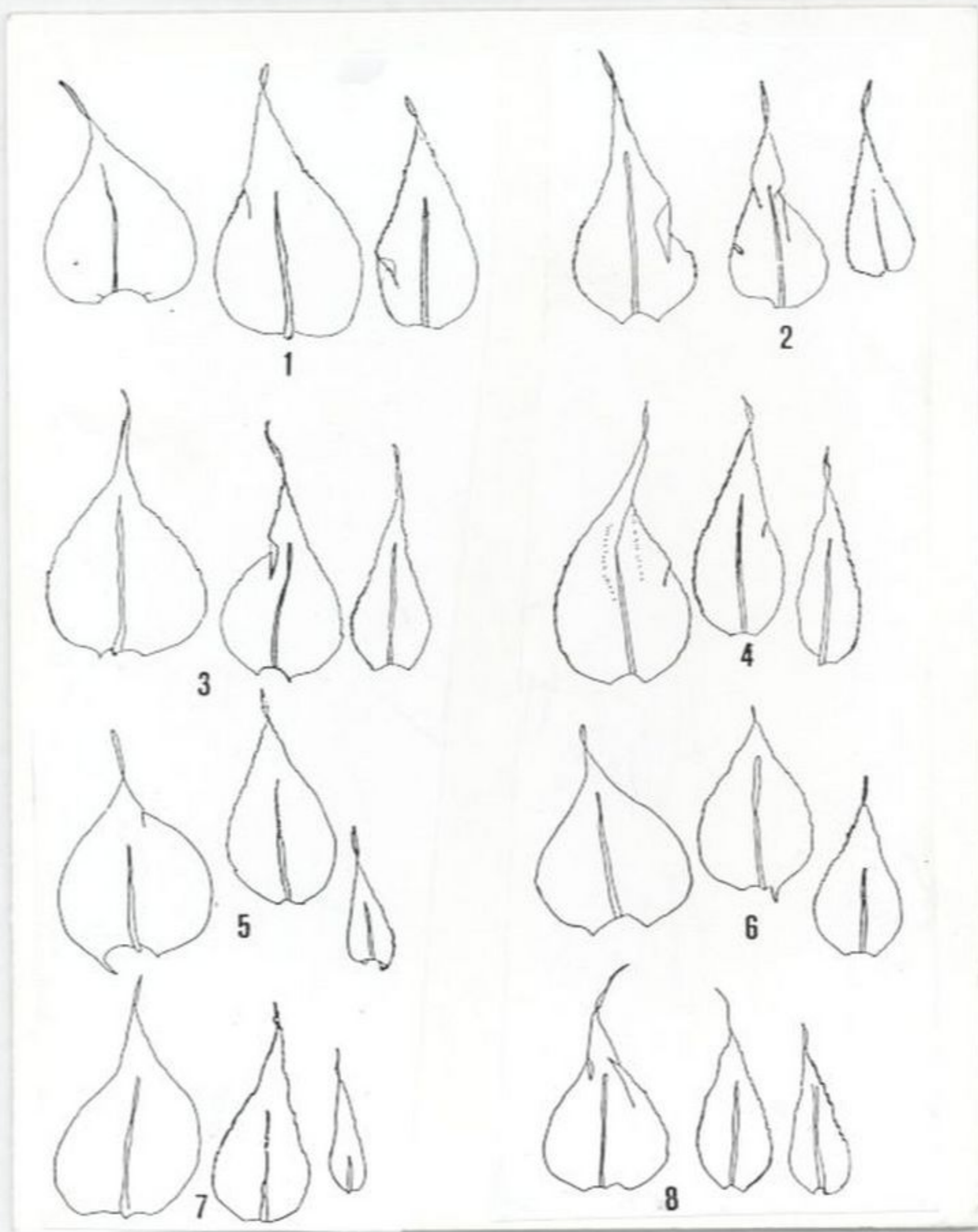


Plate V. *Meteoridium remotifolium* (C. Müll.) Manuel. Stem, branch and apical branch leaves sorted in altitudinal order. Widest leaves are from stem, narrowest from branch apices. 1. From Río Quita Calzón, 860 m. -- 2. From Río Consata, 1040 m. -- 3. From Río Suapi, 1300 m. -- 4. From Consata Trail, 1400 m. -- 5. From Bella Vista, 1650 m. -- 6. From Río Chekha, 1950 m. -- 7. From Río Monte Puncu, 1950 m. -- 8. From Yungas de Espíritu, 2420 m. -- (all figures= scale d).

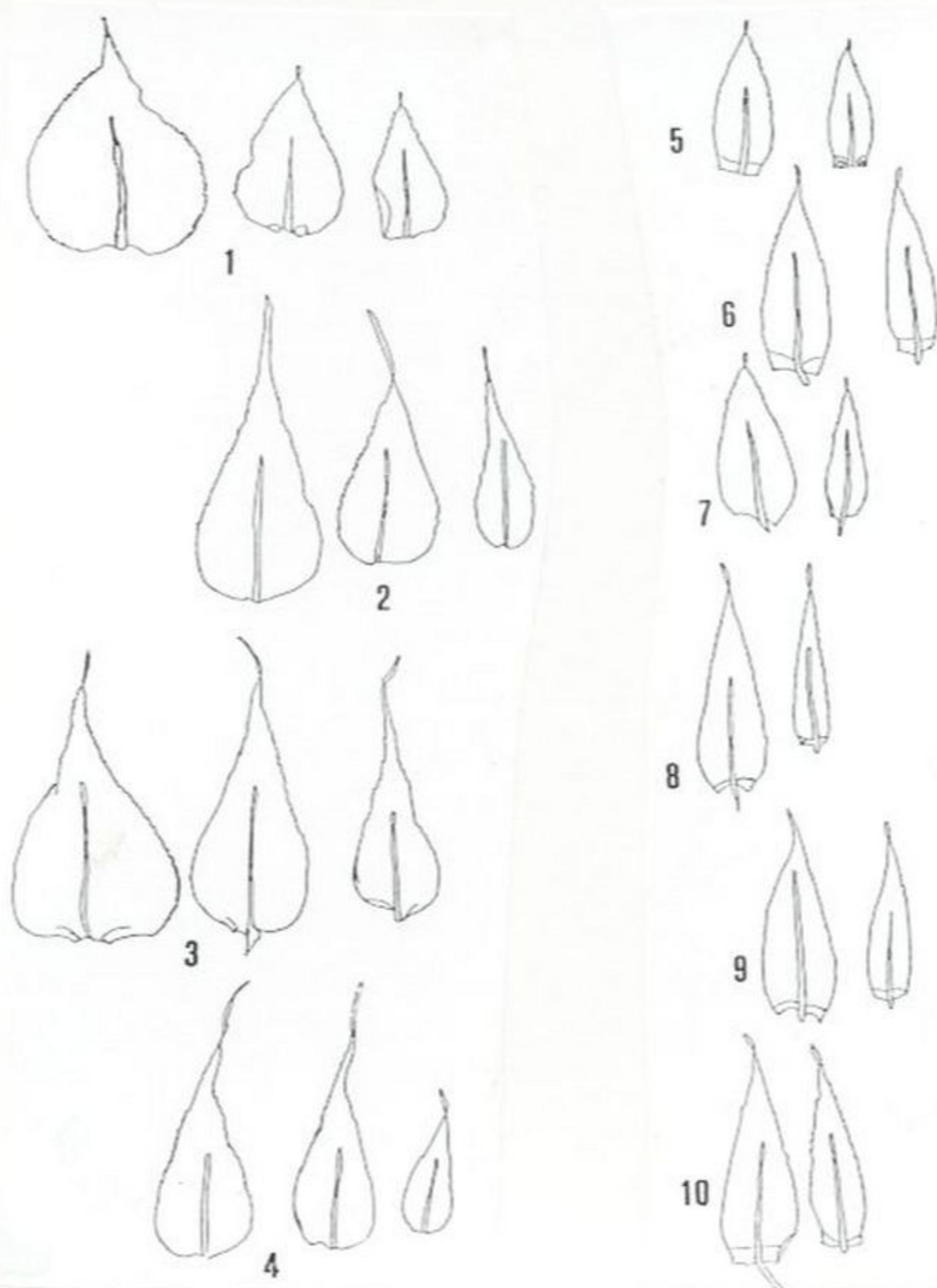


Plate VI. 1-4: *Meteoridium remotifolium* (C. Müll.) Manuel. Stem, branch and apical branch leaves sorted in altitudinal order. Widest leaves are from stems, narrowest from apices of branches. 1. From Pelechuco, 2580 m. -- 2. From Alto Polea, 2700 m. -- 3. From Río Perha Pampa, 3010 m. -- 4. From Unduavi, 3440 m. -- 5-10: *Meteoridium tenuissimum* (Hook. & Wils.) M. Lewis. Stem and branch leaves sorted in altitudinal order, the widest leaves are from the stems. -- 5. From Macchu Pichu, Peru, 2100 m. -- 6. From Río Vinto, 2450 m. -- 7. From Pelechuco, 2900 m. -- 8. From Chuspipata, 2950 m. -- 9. From Río Perkha Pampa, 3010 m. -- 10. From Unduavi Tránsito, 3400 m. -- (all figures= scale d).

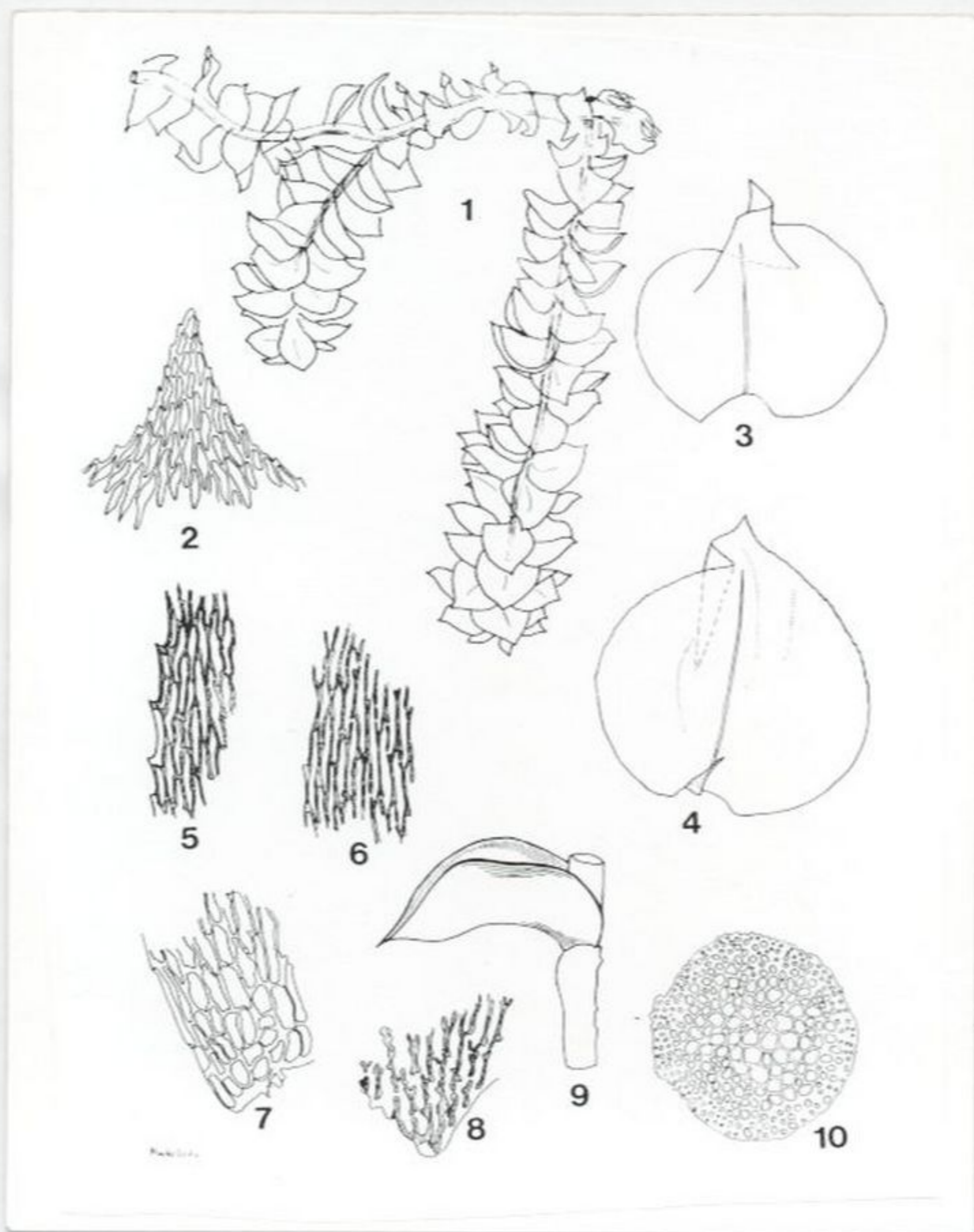


Plate VII. *Zelometeorium patens* (Hook.) Manuel 1. Habit. -- 2. Habit with sporophytes. -- 3. Stem leaf. -- 4. Branch leaf. -- 5. Cells of upper mid-leaf at margins. -- 6. Mid-leaf cells. -- 7. Alar cells. -- 8. Juxtacostal cells. -- 9. Leaf with stem denuded to show insertion. -- 10. Stem cross-section. -- From M. Lewis #1483. -- (fig. 1= scale b; figs. 2, 5, 6, 7 & 8= scale k; figs. 3 & 4= scale e; fig. 9= scale d; fig. 10= scale k).

Taxonomic discussion. I have examined the type of *Cryphaea tenuissima* Hook. & Wils. collected by Jameson. This species was later transferred to *Barbella* by Fleischer. The only other South American species of *Barbella*, *B. cubensis*, is a moss of Caribbean distribution. This species has ecostate leaves with entire margins, and untwisted leaf apices with elongate cells. I have not been able to find either fertile specimens, or a description of the peristome of *B. cubensis*, but Noguchi (1976) states in his description of the genus that the exostome teeth are "papillose throughout, the papillae sometimes arranged in diverse rows at the base." In addition, most species of *Barbella* have leaf cells with a single papilla over each lumen. The exostome of *Cryphaea tenuissima* is clearly striate at the base, the striae being secondarily papillose over their ridges. The leaves are costate, serrate, the cells are smooth, have the apical cells shorter than those of the lamina, and the apices twisted. These considerable differences, in my opinion, exclude *Cryphaea tenuissima* from *Barbella*.

On the other hand, this species shares many important characters with *Meteoridium*. In the higher reaches of the range of *Meteoridium remotifolium*, flagelliform branches are formed. The morphology of the leaves of these branches, and those of *Cryphaea tenuissima* are similar, both have at least some leaves with twisted leaf apices, and the costa produces rudimentary spines at its apex. The areolation and dentation of the margins is similar. In fact, leaves from the apices of the branches of *Meteoridium remotifolium* when placed side by side with those of the stems of *Cryphaea tenuissima*, cannot be separated. More importantly, both species share a hypnobryalean peristome with reduction of the endostomial cilia. The exostome of both species are deeply horizontally striate at the base, and papillose distally. The transversal ridges of the exostome of both species are both somewhat to strongly papillose. The endostome of each species shows 2-3 plates between each segments. In *Cryphaea tenuissima*, rudimentary (one plate high) cilia are sometime produced. From these shared characters, it is clear that *Cryphaea tenuissima* should be included in the genus *Meteoridium*.

dium.

I can discern no difference in the peristome of *Aerolindigia capillacea* (Hornsch.) Menzel and those of *Meteoridium*. Because of the hypnobryalean peristome, in combination with the twisted leaf apices of the leaves, and rudimentary costal spine, Menzel (1991) and Visnaldi & Allen (1991) have placed the former taxon in the Brachytheciaceae, although *Aerolindigia capillacea* may be separated from *Meteoridium* by its autoicous condition and papillose setae. The presence of all these characters in *Meteoridium* show that this genus should be placed in the Brachytheciaceae.

Excluded species. *Meteorium reflectomucronata* C. Müll. ex Broth. Bull. Torr. Bot. Club 23:496 (1896). Manuel (1977a) was unable to locate the type. During my visit to NYI was also unable to find it. It is therefore excluded from the Bolivian flora.

ZELOMETEORIUM Manuel

- 1. *Zelometeorium patens*** (Hook.) Manuel
(Plates VII & X figs. 6-7)
Hypnum patens Hook.

Plants green, pendent or in loosely interwoven mats. Stems and branches elongate, soft, without a central strand. Stems sparsely foliate, branches densely foliate. Stem and branch leaves differentiated: stem leaves orbicular with a strongly corkscrew twisted upper lamina and apex, the margins denticulate. Branch leaves orbicular-concave, squarrose- recurved from a clasping base, short acuminate, 1 - 1.4 mm long, 1 - 1.4 mm wide, with denticulate margins. Costa thin, reaching 2/3 - 7/8 the way from base to apex. Basal and alar cells somewhat differentiated, square to rectangular, thick-walled and pitted, especially in the alar region. Mid-cells thick walled and somewhat pitted, (6.3)-6.6-(7.0) μm wide, (55)-60-(66) μm long, 10 times longer than wide. Upper cells fusiform, considerably shorter and broader than those below, 7 μm wide, 45 μm long, 7 times longer than wide. **Sporophytes** not seen in Bolivia.

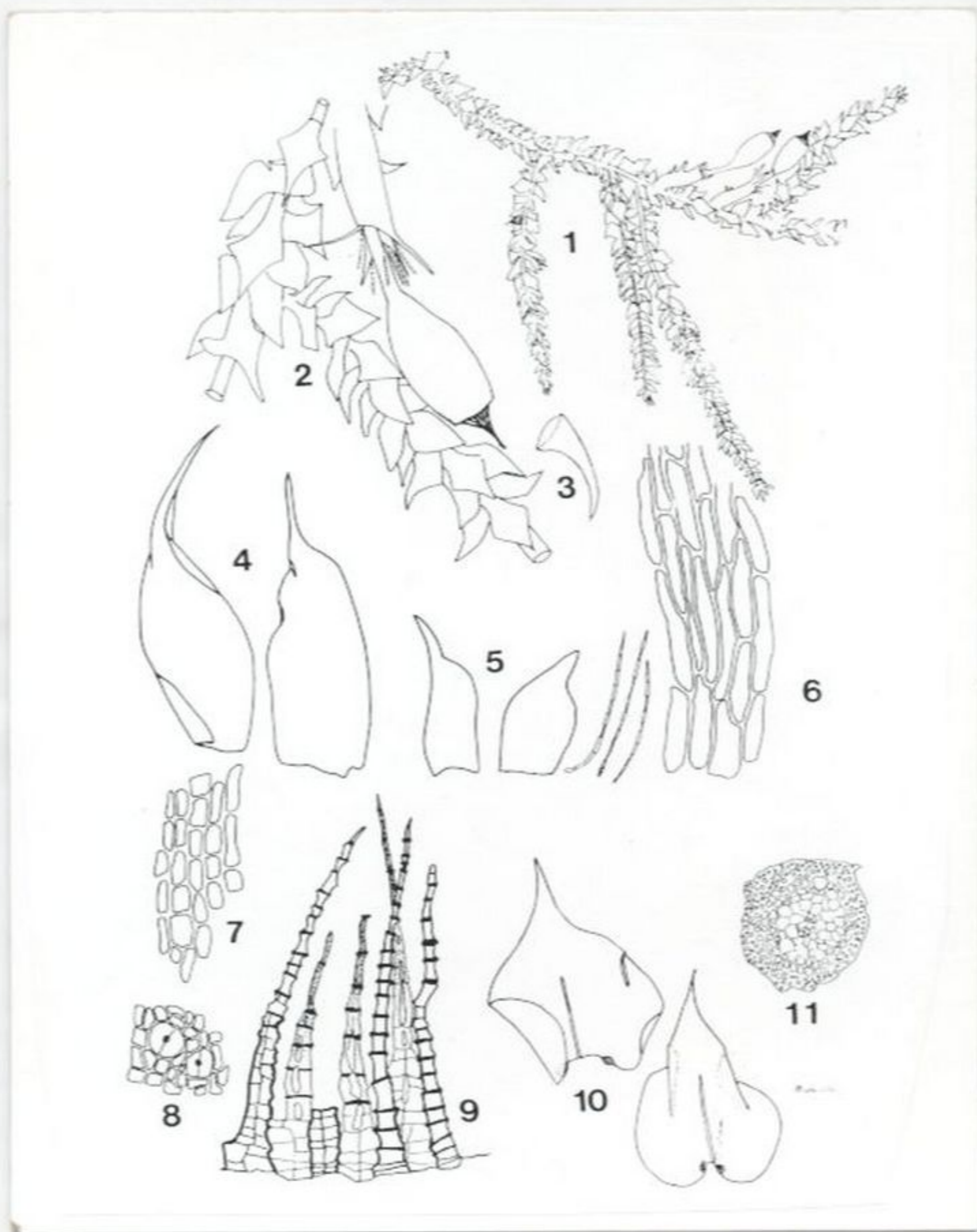


Plate VIII. *Zelometeorium ambiguum* (Hornsch.) Manuel. 1. Habit. -- 2. Habit with sporophyte.-- 3. Calyptra. -- 4. Outer perichaetal leaves. -- 5. Inner perichaetal leaves and paraphyses. -- 6. Cells at base of inner perichaetal leaves. -- 7. Exothecial cells. -- 8. Stomata. -- 9. Peristome. -- 10. Stem and branch leaves. 11. Stem cross-section. -- (fig. 1= scale a; fig. 2= scale c; figs. 4, 5 & 10= scale d; fig. 6= scale h; figs. 7 & 8= scale j; figs. 9 & 11= scale h).

Variation. No variation was seen in the two specimens examined from Bolivia. Manuel (1977b) does not mention either the corkscrew spiralled apices of the stem leaves, or the apical cells being shorter than those of the mid lamina. *Z. patens* var. *recurvifolium* (Hornsch.) Menzel (= *Z. recurvifolium* (Hornsch.) Manuel) have been reported from Bolivia by Herzog (1910) and Williams (1910). I have not revised these collections, or collected any specimens of this variety.

Distribution in Bolivia. Apparently quite rare, collected only twice by the author in the sandstone foothills of the Andes west of Santa Cruz de la Sierra. The known altitude range is between 1000-2350 m.

Habitat in Bolivia. Found on bark, and growing over a dead log in the understory of submontane forests in deeply shaded situations.

Specimens examined. DEPTO. SANTA CRUZ, Prov. Florida: Cerro Volcán 1060 m (85-1483); Prov. Vallegrande: Río Aguita Helada 2350 m (85-765).

2. *Zelometeorium ambiguum* (Hornsch.) Manuel (Plates VIII, IX & X figs. 1-5)
Pilotrichum ambiguum Hornsch.

Plants in tangled mats over boulders or rotten logs, or festooning trees. Stems long and soft, to 30 cm or longer, subpinnately branched with shorter branches. Leaves densely arranged all around the stem, occasionally in spiral rows. Stem and branch leaves little differentiated. Leaves cathedraform, with bases clasping the stem, mid lamina squarrose, and apices decurved upwards. Stem leaves with bases rotundate to reniform, contracted to a blunt to acute apex, generally with apices more sharply acute than those of the branch leaves. Branch leaves similar, generally with blunter apices and occasionally widely ovate or cordate and somewhat acuminate. Leaves (0.7)-1.0-(1.5)mm wide, (1.0)-1.4-(1.8)mm long. Leaf margins serrulate from widest part of base upwards. Costa reaching 12 - 2/3 way from base to apex. Leaf apices plain, never twisted. Basal juxtacostal cells thin-walled, barely, if at all, pitted. Alar cells differentiated, mostly thick-walled and quadrate

in rounded, concave groups surrounded by smaller round to oval cells. Mid-cells linear-sigmoid-fusiform, (5.8)-7.0-(8.6) μm wide, (41)-52-(64) μm long, (6)-7-(9) times longer than wide, the walls non-pitted. Apical cells somewhat shorter, (5.8)-7.2-(8.7) μm wide, (33)-46-(56) μm long, (4)-6-(9) times longer than wide. **Dioicous.** Only one fertile specimen seen. Perichaetal leaves ecostate, outer leaves bluntly acuminate from an oblong base; inner leaves narrowly acuminate from an oblong to elliptic base. Paraphyses exerted. Setae 1 - 1.5mm long, smooth. Capsules ovoid, 0.8mm wide, 1.8mm long, brown. Stomata exerted. Annulus not seen. Operculum long rostrate. Exostome teeth long and narrow, averaging 0.42mm long, orange-brown, entirely smooth. Endostome from a low basal membrane, perforate along center line, smooth proximally and papillose distally, cilia none. Spores 20 μm green, densely papillose. Calyptra not seen.

Distribution in Bolivia. *Zelometeorium ambiguum* is known from Depto. Tarija where it is confined to Tucumán montane forests. Its altitude range is between 610-2280 m. It is an abundant species in this area. Manuel reports that Herzog #3566 from “Cordillere von Santa Cruz, Cuesta de la Piedra Borracha” is this species. I have not seen this specimens or been able to locate “Piedra Borracha”.

Habitat in Bolivia. This species is a dominant moss in many humid forests in the mountains east and southeast of Tarija, thickly festooning trees or covering boulders. Once I found a bat sleeping in one of the festoons. The species has been collected 6 times from boulders, as a pendent from branches and twigs 5 times, on tree trunks 4 times, on rotten logs twice, and over humus once.

Variation. On an altitudinal transect (plates VII & VIII figs. 1-5) leaf shape shows only random variation, with stem leaf bases varying from cordate-ovate to reniform, and leaf apices bluntly to sharply acute. Branch leaves are variable within these confines as well, but are normally blunter at the apex, and widely ovate to rotundate at the base. One specimen (84.-2056) was found with attenuate branches. Leaves arranged spirally around the stems are sporadically seen and have

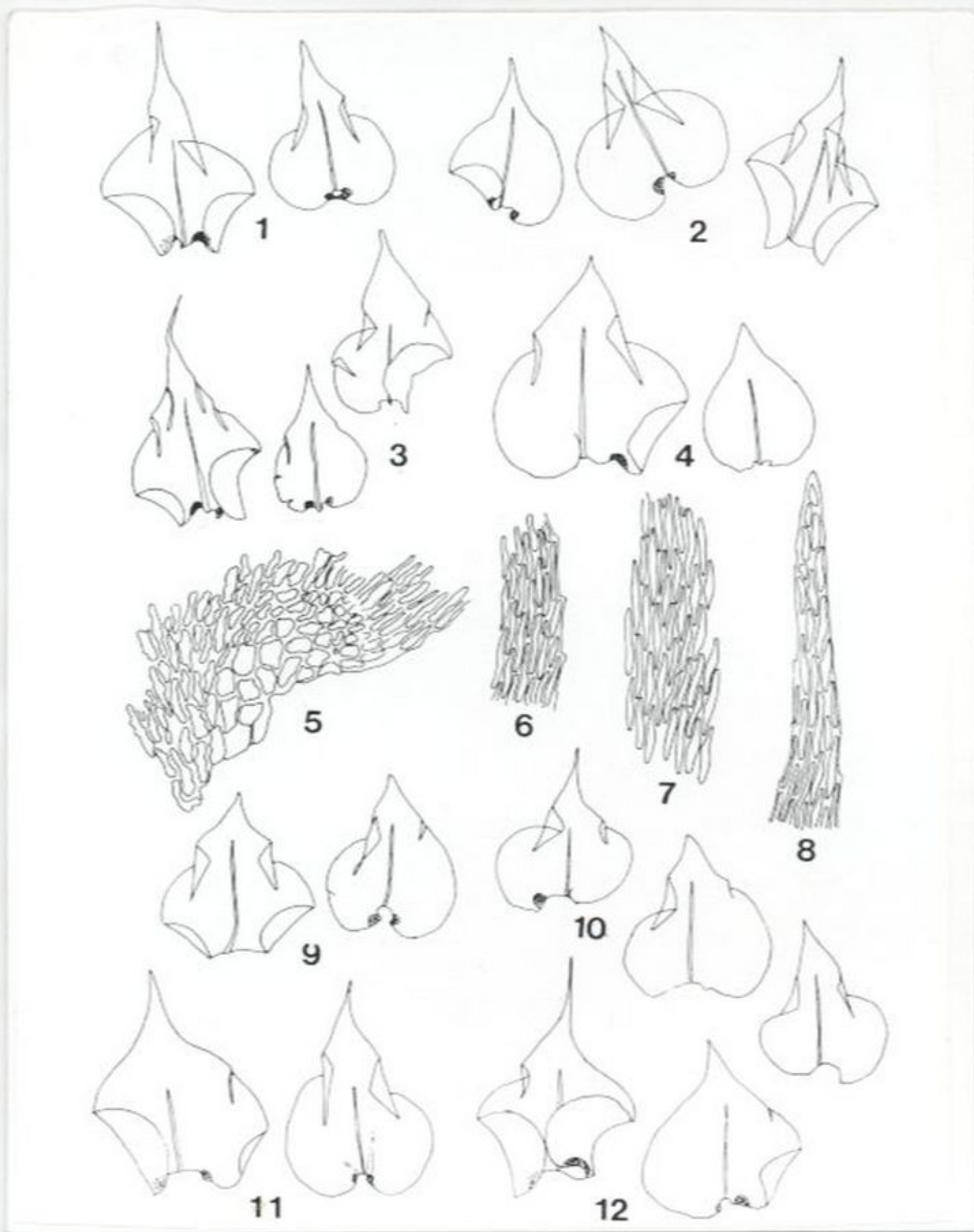


Plate IX. *Zelometeorium ambiguum* (Hornsch.) Manuel. Stem and branch leaves sorted in altitudinal order. Branch leaves to right of stem leaves. 1. From Toro, 610 m. -- 2. From Conchas, 900 m. -- 3. From Puñalada, 1100 m. -- 4. From Nogal, 1300 m. -- 5. Alar cells. -- 6. Marginal cells from upper mid-leaf. -- 7. Mid-leaf cells. -- 8. Apical leaf cells. -- 9. From Nogal,

not been described for the species. The smooth exostome that I have described from my one fertile specimen differs from that described by Manuel (1977b) in his generic analysis of *Zelometeorium*. He did not describe the exostome of *Z. ambiguum* except to give its size.

Specimens examined. **DEPTO. TARIJA, Prov. Arce:** Toro 610 m (84-2425), Conchas 900 m (84-2435), Puñalada 1100 m (84-2248), Nogal 1300-1410 m (84-2175, 84-2200), Cruz Grande 1910-1970 m (84-2107, 84-2131, 84-2125, 84-2140), Rumi Cancha 2200-2280 m (84-2056, 84-2064, 84-2103A); **Prov. O'Connor:** Abra San Simón 1480 m (84-2830), Narvaez 1620-1630 m (84-2726, 84-2720, 84-2743), Rancho Tambo 2150 m (84-2616).

3. *Zelometeorium patulum* (Hedw.) Manuel (Plates XI & XII)

Hypnum patulum Hedw.

Plants pendent or in thin mats over humus, golden green. Stems to over 20 cm long, often appearing denuded due to the appressed stem leaves, with numerous short, blunt branches densely leaved with squarrosely spreading leaves. Stem and branch leaves differentiated. Stem leaves appressed or erect from clasping subcordate to cordate, rarely reniform bases, gradually narrowed to ovate or lanceolate, sharply acute to capillary acuminate, (0.8)-1.0-(1.2)mm wide, (1.2)-1.6-(2.1)mm long, (1.2)-1.6-(2) times longer than wide. Branch leaves ovate-cordate to cordate, somewhat acuminate, squarrose to recurved from a sub-clasping base, the apex acute, (0.7)-0.9-(1.0)mm wide, (1.2)-1.4-(1.9)mm long, (1.5)-1.6-(2.0) times longer than wide. Margins of all leaves denticulate from widest part of base to apex. Costa reaching 1/2 to 2/3 from base to apex. Juxtacostal cells thin walled or thick walled and pitted. Alar cells infrequently somewhat shorter, rectangular and blending into mid-cells or not at all differentiated. Midleaf cells linear and narrowly fusiform, with non-pitted walls, (5.1)-6.1-(6.9) μm wide, (55)-67-(74) μm long, 8-(11)-(14) times longer than wide. Apical cells the same as midleaf cells. **Fertile** specimens not collected in Bolivia.

Distribution in Bolivia. *Zelometeorium pa-*

tulum is found in the lowlands of Deptos. Beni, Cochabamba and Santa Cruz where it is widely distributed. It is absent from montane areas and has an altitude range of 250-570 m.

Habitat in Bolivia. This species is found in a variety of lowland habitats. It is common on bark of *Citrus* trees in the Chaparé region. It has been collected twice in two widely separated localities at the base of giant trees in primary Amazonian forests. Only once, in Depto. Beni has it been found as a pendent plant, and this was in a chaparral-like habitat. It has been found on a rotten log in secondary forest near Puerto San Francisco in the Chaparé, on boulders in the dry Mato Grosso type forest of the Cordillera Sunsas near the Bolivian-Brazilian border, and over loose sticks and humus of the forest floor near Río Guarayos in NE Santa Cruz.

Variation. Stem leaves in *Zelometeorium patulum* vary from ovate-acuminate to reniform-apiculate in a continuous series. The perimeters of altitude and geographical location form a random series when compared with stem leaf shape (see Plate XII). Branch leaf variation shows a continuous series from ovate-lanceolate to widely ovate and is not correlated with shape of the acumina.

Specimens examined. **DEPTO. BENI, Prov. Ballivian:** Estación Biológica del Beni 250 m (89-031); **DEPTO. COCHABAMBA, Prov. Chaparé:** Puerto San Francisco 350 m (83-1356), Villa Tunari 450-500 m (83-1330, 83-1332, 83-1335, 83-1364); **DEPTO. SANTA CRUZ, Prov. Angel Sandoval:** Serranía Sunsas-Murciélago 470 m (85-1351); **Prov. Velasco:** Río Guarayos 350 m (85-994).

Excluded species. *Meteorium stramineum* C. Müll. (hom. illeg.) was reported by Hermann (1976) in his checklist under the name *Meteoropsis pseudo-stramineum*. Manuel (1977b) was unable to locate the TYPE and it is therefore excluded from the Bolivian flora.

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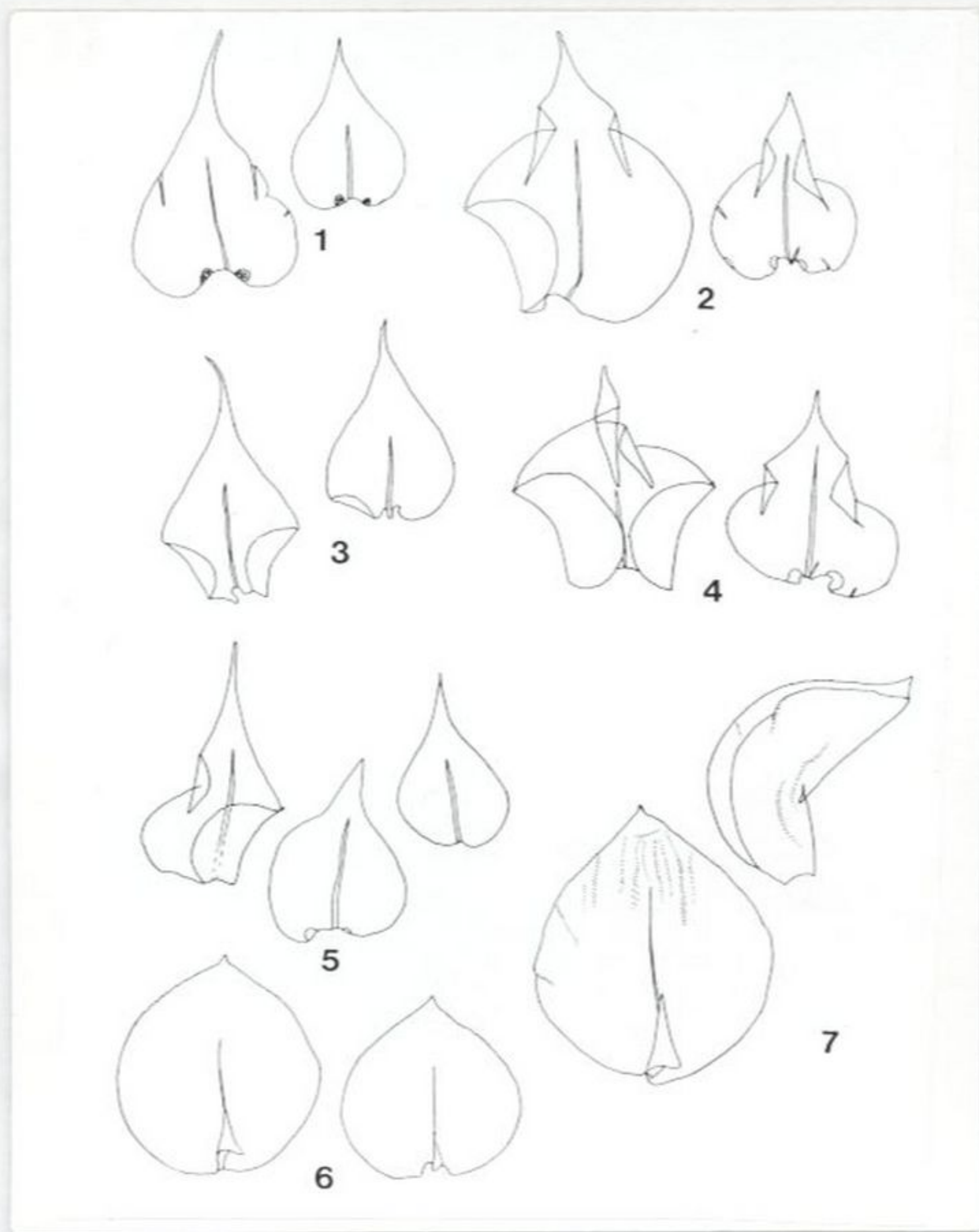


Plate X. 1-5: *Zelometeorium ambiguum* (Hornsch.) Manuel. Stem and branch leaves in altitudinal order. Branch leaves to right of stem leaves. 1. From Cruz Grande, 1910 m. -- 2. From Cruz Grande, 1970 m. -- 3. From Rancho Tambo, 2150 m. -- 4. From Rumi Cancha, 2200 m -- 5. From Rumi Cancha, 2280 m -- 6-7: *Zelometeorium patens* (Hook.) Manuel. 6. Stem and branch leaves. -- 7. Stem and branch leaves. -- (all figures= scale d).

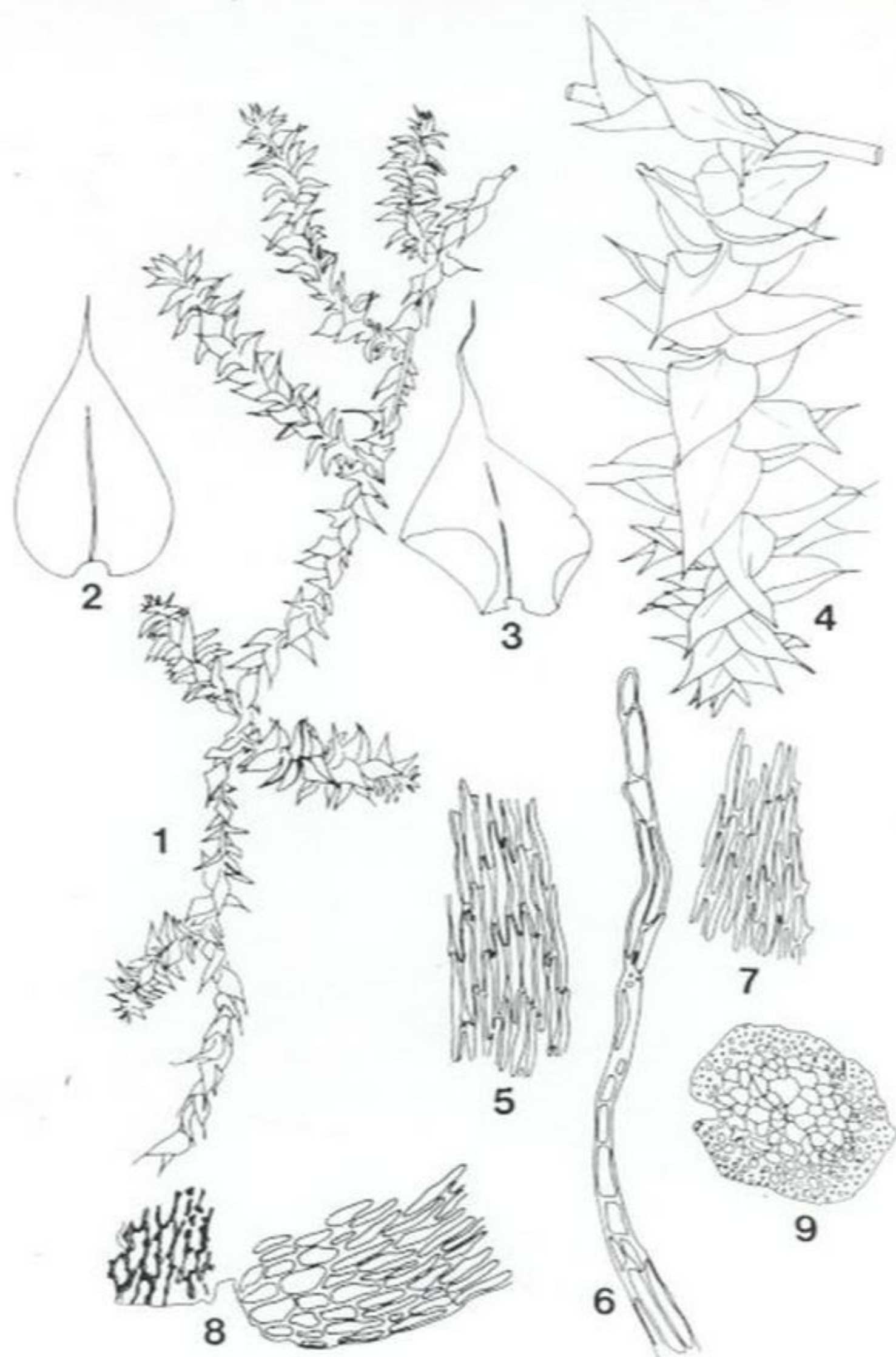


Plate XI. *Zelometeorium patulum* (Hedw.) Manuel. 1. Habit. -- 2. Branch leaf. -- 3. Stem leaf. -- 4. Branch attached to stem. -- 5. Mid-leaf cells. -- 6. Stem leaf apex. -- 7. Marginal cells from upper mid-leaf. -- 8. Juxtacostal and alar cells. -- 9. Stem cross-section. -- (fig. 1= scale a; figs. 2 & 3= scale d; fig. 4= scale c; figs. 5, 6, 7 & 8= scale k; fig. 9= scale h).

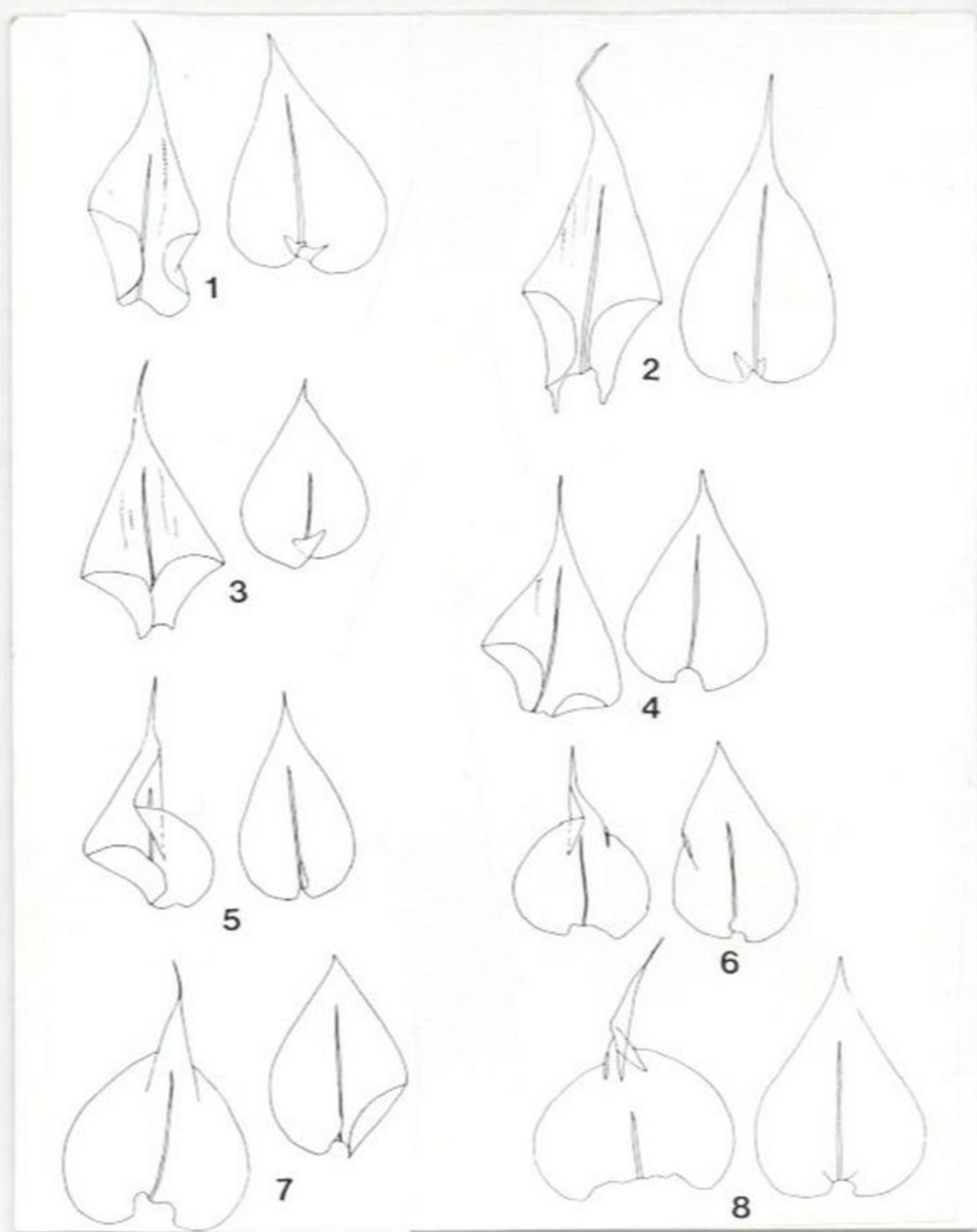


Plate XII. *Zelometeorium patulum* (Hedw.) Manuel. Stem and branch leaves arranged to show variation of stem leaves from narrowest to broadest. 1. From Puerto San Francisco, 450 m. -- 2. From Villa Tunari, 460 m. -- 3. From Doloresa, 570 m. -- 4. From Villa Tunari, 460 m. -- 5. From Estación Biológica del Beni, 250 m. -- 6. From Villa tunari, 500 m. -- 7. From Río Guarayos, 350 m. -- 8. From Serranía Sunsas-Murcielego, 470 m. -- (all figures = scale d).

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