

# A taxonomic revision of *Ulota* Mohr (Orthotrichaceae) in South and Central America



Qinghua Wang, Yu Jia\*

State Key Laboratory of Systematic and Evolutionary Botany, Institute of Botany, The Chinese Academy of Sciences, Beijing, 100093, China

## ARTICLE INFO

### Article history:

Received 1 February 2016

Received in revised form

9 March 2016

Accepted 9 March 2016

Available online 24 May 2016

### Keywords:

Taxonomy

Moss

Orthotrichaceae

*Ulota*

South and Central America

## ABSTRACT

Twenty-three species of *Ulota* from South and Central America have previously been reported. A revision of the species suggests that number should be reduced to thirteen (*Ulota billbuckii*, *Ulota fuegiana*, *Ulota germana*, *Ulota larrainii*, *Ulota luteola*, *Ulota macrocalycina*, *Ulota macrodontia*, *Ulota magellanica*, *Ulota phyllantha*, *Ulota pusilla*, *Ulota pycnophylla*, *Ulota rhytiore* and *Ulota streptodon*) with eight names (*Ulota aurantiaca* = *U. pycnophylla*, *Ulota carinata* = *U. fuegiana*, *Ulota fernandeziana* = *U. fuegiana*, *Ulota glabella* = *U. fuegiana*, *Ulota lativentrosa* = *U. pusilla*, *Ulota lobbiana* = *U. germana*, *Ulota pygmaeothecia* = *U. luteola* and *Ulota rufula* = *U. germana*) reduced to synonyms, as well as three varieties (*U. fuegiana* var. *crispata* = *U. fuegiana*, *U. rufula* var. *fagicola* = *U. germana* and *U. rufula* var. *patagonica* = *U. fuegiana*). The taxonomic status of two names (*Ulota angustissima* and *Ulota ventricosa*) remains ambiguous. The typification of five names (*U. macrodontia*, *U. magellanica*, *Ulota nothofagi*, *Ulota persubulata* and *U. pygmaeothecia*) is proposed here. With the first report of *Ulota crispa* for South America, the total number of species accepted here for this region is fourteen. Two species (i.e. *U. phyllantha* and *U. crispa*) occur in both Hemispheres, one species (i.e. *U. rhytiore*) is only present in the Northern Hemisphere, whereas the remaining eleven species are all restricted to the Southern Hemisphere. Among them, nine (*U. billbuckii*, *U. fuegiana*, *U. larrainii*, *U. macrocalycina*, *U. macrodontia*, *U. magellanica*, *U. pusilla*, *U. pycnophylla* and *U. streptodon*) are restricted to South America, and two (*U. germana* and *U. luteola*) are distributed in South America and Oceania. The peristomes and spores of seven accepted species are illustrated in SEM micrographs. A key to all accepted species as well as descriptions, illustrations, synonyms, ecological and geographic distributions, and discussions are provided.

Copyright © 2016 Kunming Institute of Botany, Chinese Academy of Sciences. Publishing services by Elsevier B.V. on behalf of KeAi Communications Co., Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## 1. Introduction

*Ulota* Mohr (Orthotrichaceae) is a genus of mostly epiphytic mosses. The plants typically have crisped leaves, hyaline basal marginal leaf cells, and a diplolepidous peristome consisting of 16 exostome teeth and eight endostome segments. The stomata are superficial and the calyptra is hairy or naked. *Ulota* occurs mainly in temperate areas, with few taxa extending into the tropics or

subantarctic/subarctic regions (Albertos et al., 2008; Seppelt, 1978; Vitt, 2003).

Twenty-three species of *Ulota* from South America were cited by Wijk et al. (1969). Four of them were excluded from the genus or reduced to synonyms, making the remaining number of species 19 (Crosby et al., 2000). Subsequently, one species from Central America was transferred from *Orthotrichum* to *Ulota* (Albertos et al., 2008) and three new species were added (Garilleti et al., 2012, 2015). After those additions the total number of *Ulota* species in South and Central America was 23, which is more than in Africa (5), Asia (18), Europe (9), Oceania (14) or North America (9). Most of these species occur only in southern South America.

\* Corresponding author.

E-mail address: [yjia@ibcas.ac.cn](mailto:yjia@ibcas.ac.cn) (Y. Jia).

Peer review under responsibility of Editorial Office of Plant Diversity.

The genus *Ulot* has existed for more than two centuries (Mohr, 1806). Mohr's separation of *Ulot* from *Orthotrichum* was not generally accepted for a long time (Hooker and Greville, 1824; Kindberg, 1897; Malta, 1933; Mitten, 1869) because the morphological differences between the two genera were not clear. With the increasing number of species under *Ulot*, from three at that time to almost seventy (Albertos et al., 2008; Crosby et al., 2000; Garilletei et al., 2015) today, it has been accepted by modern bryologists. The genus *Ulot* is gametophytically distinguished from *Orthotrichum* by the often crisped leaves when dry, which are usually erect in the latter. Moreover, there are several rows of hyaline cells at the leaf base in most *Ulot* species. Sporophytically, capsules in *Ulot* are always exserted (and generally long) except *Ulot rhytiore* in Central America, and never smooth when dry and with superficial stomata. Using these characters, we can easily discriminate *Ulot* from *Orthotrichum* in most cases.

The first species of *Ulot* reported from South and Central America was *Ulot magellanica* (Mont.) A. Jaeger, described as *Orthotrichum magellanicum* by Montagne (1843). Soon thereafter, Montagne (1845) described another species, *Orthotrichum germanum* Mont. ( $\equiv$  *Ulot germana* (Mont.) Mitt.) from Chile, while Müller (1845) almost simultaneously reported a new taxon, *Zygodon ventricosus* ( $\equiv$  *Ulot ventricosa* (Müll. Hal.) Malta). The fourth species, *Orthotrichum luteolum* Hook. f. & Wilson, was published by Hooker (1847) from Chile. More than ten years later, when Mitten (1860, 1869) published his new species from the Southern Hemisphere, six taxa were reported from South America. During the next 30 years, another two species were described (Müller, 1885; 1897). *Ulot phyllantha* was added to the South American flora by Brotherus (1925). Malta (1927) revised the genus *Ulot* for South America and this is the only treatment of *Ulot* for this area so far. He accepted 17 names of which seven were new to science. The only taxon known from Central America, *U. rhytiore*, was described as *Orthotrichum rhytiore* (Allen, 2002) and transferred to *Ulot* by Albertos et al. (2008). *Ulot billbuckii*, *Ulot larrainii* and *Ulot streptodon* are the most recently published species from this area (Garilletei et al., 2012, 2015). All of the above 23 alleged species are re-evaluated in the present taxonomic revision and the species number is reduced to 13. With the new addition of *Ulot crista*, the number of species of *Ulot* recognized in Central and South America is 14.

Several reasons led us to undertake a revision of *Ulot* for South and Central America. Firstly, the southern part of South America harbors the highest species number and would thus be central to our understanding of the evolution of the genus. Secondly, twenty of the 23 species are regarded as endemics, which may reflect extremely narrow species concepts or simply a lack of comparative studies. Furthermore, half of the species have almost never been treated in any studies and have not been collected since their original descriptions, which may also point to ambiguities in taxon differentiation. Finally, the one revision done (Malta, 1927) is over eighty years old, and its descriptions and illustrations are incomplete.

## 2. Material and methods

The present study is based on herbarium specimens from B, BM, DUKE, E, H, JE, M, MICH, NY, PC and S. Seven type specimens were not available to us, either because they could not be located (i.e. *U. ventricosa*), were too old to be lent (i.e. *U. crista*), have been lost in the mail (i.e. *Ulot luteola*), were under study by

other bryologists (i.e. *U. billbuckii* and *U. streptodon*), were too fragmentary for scrutiny (i.e. *Ulot angustissima*) or cannot be obtained by loan in a short time (i.e. *U. larrainii*). Four species lack non-type specimens, most probably due to their rareness in the field. All specimens listed here with underline were cited by Malta (1927).

Specimens were observed using an Olympus CX31 light microscope after soaking them with water. Only the species with sufficient material were examined using Scanning Electron Microscopy (SEM) to observe their peristome and spore ornamentation; the protocol was given in Wang and Jia (2012a).

## 3. Taxonomy

### 3.1. *Ulot* D. Mohr. Ann. Bot. 2: 540. 1806.

Type: *U. crista* (Hedw.) Brid., (lectotype, designated by Vitt, 1970).

$\equiv$  *Orthotrichum* sect. *Ulot* (D. Mohr) Müll. Hal., Syn. Musc. Frond. 1: 711. 1849.

$\equiv$  *Orthotrichum* subgen. *Ulot* (D. Mohr) Boulay, Musc. France, Mousses 342. 1884.

*Weissia* Ehrh. ex G. Gaertn., B. Mey. & Scherb., Oekon. Fl. Wetterau 3(2): 94. 1802. *Illegitimate, later homonym.*

*Bryodixonia* Sainsbury, Trans. & Proc. Roy. Soc. New Zealand 75: 177. 1945.

**Description:** Plants green to dark, 0.5–3 cm high, rarely up to 9.0 cm, in tufts or cushions. Leaves usually crisped when dry, sometimes erect to flexuose, patent when moist, lanceolate from a broader base, acuminate. Costa single and strong, ending near the apex. Upper and middle laminal cells irregularly rounded, thick-walled, mostly with short or high papillae; basal inner cells rhomboidal to elongate-rectangular or vermiculate, smooth, thick-walled; basal margin differentiated in (1) 3–10 (x) rows hyaline cells, quadrate to rectangular, with thickened transverse walls.

Autoicous, rarely dioicous. Perichaetial leaves often slightly differentiated, rarely remarkably longer. Capsules short or long exserted, usually cylindrical, mostly 8-ribbed and constricted when dry. Stomata superficial, confined to the urn or the junction between urn and neck. Peristome often double, rarely single or none; exostome teeth 16, often united into 8 pairs, lanceolate, usually recurved when dry, papillose or striate; endostome segments 8, rarely 16 or none, filiform to lanceolate, hyaline or pale yellow, smooth outside, slightly to strongly coarse inside. Opercula with a short or long rostrum. Calyptra campanulate, hairy, seldom naked. Spores unicellular, rarely multicellular, globose, finely papillose to verrucose, 18–40  $\mu$ m, sometimes more than 100  $\mu$ m in diameter.

**Discussion:** All species of *Ulot* reported from Central and South America are included in this work and 13 of them are accepted by us, as well as one new report for this region. One difference between these *Ulot* species and those in other parts of the world is the smaller plant size. They are usually less than 2 cm, while outside Central and South America often reach up to 3 cm high, rarely to 9 cm, i.e. *Ulot splendida* from Papua New Guinea. Another peculiarity of *Ulot* in this area is the high percentage of species with stomata restricted to the urn. Six out of 14 species belong to this category, but in other continents there are only two such species, i.e. *Ulot cochleata* from Oceania and *Ulot ecklonii* from Africa.

#### 4. Key to the taxa of *Ulota* in South and Central America

1. Plants dioicous; many cylindrical gemmae often at the tips of leaves; capsules hardly present; only occur in coastal habitats.....10. *U. phyllantha*
1. Plants autoicous; never producing gemmae; capsules usually present; occur in both inland and coastal habitats.....2
  2. Peristome apparently absent; capsules emergent and fusiform.....13. *U. rhytiore*
  2. Peristome present; capsules exerted and cylindrical.....3
3. Capsules constricted strongly near the mouth when dry, forming puckered mouth; endostome absent or rudimentary.....14. *U. streptodon*
3. Capsules constricted through entire length when dry, never puckered mouth; endostome always well-developed.....4
  4. Endostome segments 16.....5
  4. Endostome segments 8.....9
5. Leaves often falcate when dry; endostome segments very broad, as wide as exostome; stomata at the lower part of urn or the transition between urn and neck; spores very large, mostly >40  $\mu\text{m}$ , even more than 100  $\mu\text{m}$ .....6
5. Leaves never falcate when dry; endostome always narrower than exostome; stomata at the urn; spores mostly 20–40  $\mu\text{m}$ .....8
  6. Spores unicellular; capsules cylindrical; vaginula hairs long.....9. *U. magellanica*
  6. Spores multicellular; capsules short cylindrical; vaginula hairs short.....7
7. Endostome segments connected by high basal membrane, as 1/2 high as exostome.....1. *U. billbuckii*
7. Endostome segments free or connected by short basal membrane, never more than 1/4 high of exostome.....5. *U. larrainii*
  8. Stems somewhat slender; leaves flexuose, non-crisped when dry; exostome quite coarse; endostome yellowish, densely and finely papillose.....11. *U. pusilla*
  8. Stems usually not slender; leaves flexuose to strongly crisped when dry; exostome generally coarse; endostome hyaline or pale yellow, slightly papillose.....8. *U. macrodontia*
9. Leaf basal margin always less than 3 rows of hyaline cells.....6. *U. luteola*
9. Leaf basal margin usually more than 3 rows of hyaline cells.....10
  10. Leaves erect and appressed when dry, smaller, 1.0–2.4 mm, with hyaline cells with thin wall.....11
  10. Leaves flexuose to crisped when dry, 1.3–3.2 mm, with hyaline cells with thickened transverse wall.....12
11. Stomata at the urn; calyptra naked.....7. *U. macrocalycina*
11. Stomata at the junction between urn and neck; calyptra densely hairy.....12. *U. pycnophylla*
  12. Endostome filiform, slender; stomata on the urn.....3. *U. fuegiana*
  12. Endostome linear, well-developed; stomata at the junction between urn and neck.....13
13. Plant smaller, often less than 1 cm; Perichaetial leaves markedly longer; capsules often short exerted.....4. *U. germana*
13. Plants larger, often at least 1 cm; Perichaetial leaves little differentiated; capsules long exerted.....2. *U. crispa*

#### 5. The species description

5.1. *Ulota billbuckii* Garilleti, Mazimpaka & F. Lara, *Bryologist* 115: 587. 2012.

Type: CHILE. Región de Magallanes y de La Antártica Chilena. Provincia Antártica Chilena, Comuna de Cabo de Hornos. Parque Nacional Alberto de Agostini, north-central west of Isla Hoste, ca. 5 km W of the eastern tip of Isla Gordon along SW arm of

Beagle Channel in unnamed sound, 55°00'22" S, 69°12'11" W, 2 m a.s.l., branches of *Nothofagus antarctica*, *R. Garilleti s.n.*, 19 Jan. 2012 (holotype NY; isotype VAL).

**Description:** Plants green above, brown below, less than 2 cm tall. Leaves erect, sinuose at upper part and mostly falcate when dry, patent when moist, 0.8–2.1 mm long, lanceolate with a broad rounded base, acuminate. Costa strong, ending just below the apex. Upper and middle laminal cells irregularly rounded, thick-walled,

with low papillae; basal inner cells linear, rhomboidal, elongate rectangular with thickened wall, smooth; basal marginal cells often differentiated in 1–3 rows, hyaline, quadrate to rectangular, with only transversely thickened walls.

Autoicous. Perichaetial leaves slightly differentiated. Capsules long exserted, cylindrical when moist, strongly constricted when dry, with 8 furrows along the entire length; exothecial cells distinctly differentiated into eight bands. Stomata superficial, on the lower part of urn or the transition between urn and neck. Peristome double; exostome teeth 16, united into 8 pairs, lanceolate, densely and finely papillose on the outside, striate on the inside, often recurved when dry; endostome segments 16, broad, lanceolate, as wide as exostome, basal membrane often 1/2 as high as exostome, hyaline, smooth outside, finely striate inside. Opercula with a short beak. Calyptra campanulate, with few or many hairs. Spores globose or ellipsoid, slightly papillose to almost smooth, very large, 70–123 µm in diameter, multicellular.

**Illustration:** see Garilletei et al., 2012, peristome and spore also shown in figures of *U. magellanica*.

**Habitat and distribution:** Epiphytic, reported from Chile and Argentina.

**Discussion:** *U. billbuckii* is a distinct species due to the large multicellular spores and the endostome with a high basal membrane (Fig. 12 t–u). We only found three specimens of this species and their stomata location is not strictly consistent with the description of Garilletei et al. (2012), according to which stomata are located in the upper half of capsule, mostly in the central part of urn. Based on our observations, they are present at the lower part of capsule, and even in the transition between urn and neck. We cannot make firm conclusions before seeing the type. *U. magellanica* is very similar to *U. billbuckii* in some characters, including the non-cripsed leaves, few rows of hyaline cells at the basal leaf margin, 16 broad endostome segments and large spores. But *U. magellanica* is different in the completely free endostome segments, unicellular spores and stomata always at the junction between urn and neck. A detailed description and comparison was given by Garilletei et al. (2012).

**Additional specimens examined:** ARGENTINA. Tierra del Fuego: Ushuaia, D. H. Norris 98079 (H3211982). CHILE. Osorno: Refugio Marc Blancpain, C. J. Cox 595/00 (DUKE0189156); Tierra del Fuego: Isla Navarino, C. J. Cox 198/00(2) (DUKE0188804).

5.2. *Uloa crispa* (Hedw.) Brid. *Muscol. Recent. Suppl.* 4: 112. 1819. (Fig. 1)

≡ *Orthotrichum crispum* Hedw., Sp. Musc. Frond.: 162. 1801. Type: “In saxis, arborum truncis per omnem Europam.” (lectotype G, designated by Vitt, 1970).

**Description:** Plants green to dark, 1–2 cm high. Leaves moderately to strongly crisped when dry, patent when moist, 1.7–3.0 mm long, lanceolate from a broader base, acuminate. Costa strong, percurrent or ending near the apex. Upper and middle laminal cells irregularly rounded, thick-walled, with short papillae on both surfaces; basal inner cells rhomboidal, linear, elongate-rectangular or vermiculate, smooth, thick-walled; basal marginal cells often differentiated in 4–10 rows of hyaline cells, quadrate to rectangular, with thickened transverse walls.

Autoicous. Perichaetial leaves hardly differentiated. Capsules long exserted, cylindrical, constricted when dry, 8-ribbed along entire length of capsules, often constricted when empty and dry, with an indistinct neck; exothecial cells differentiated in eight bands. Stomata superficial, at the junction of urn and neck. Peristome double; exostome teeth 16, united into 8 pairs, lanceolate, densely papillose, usually reflexed when dry; endostome segments

usually 8, linear, hyaline or pale yellow, smooth outside, slightly coarse inside. Calyptra campanulate, densely hairy. Spores globose, finely papillose, 20–47 µm in diameter.

**Habitat and distribution:** common in both temperate and boreal zones except Africa, only known from Chile in Central and South America, grows on trees.

**Discussion:** The known geographic distribution of *U. crispa* is increasing. The species was known only from the Northern Hemisphere until it was reported from Australia and Africa by Wang and Jia (2012b). Here the species is newly reported from South America.

*U. crispa* has the typical morphology of the genus, including crisped leaves, markedly differentiated basal marginal leaf cells, cylindrical capsules, eight narrow-lanceolate endostome segments, stomata in the transitional zone between urn and neck, and hairy calyptra. *U. germana* and *Uloa macrodonta* are similar to *U. crispa* in their usually crisped leaves, but *U. germana* differs in the remarkably longer perichaetial leaves, and *U. macrodonta* has sixteen endostome segments and stomata distributed in the wall of the urn. There is no noteworthy variation of *U. crispa* between South America and other continents.

**Additional specimens examined:** CHILE. Chiloe Island: Aucud, Carl O. Enla...son 97 (MICH, no barcode); Valdivia: no detailed locality, W. Lechler s.n. (H3150823).

5.3. *Uloa fuegiana* Mitt., J. Proc. Linn. Soc. 4: 76. 1860. (Figs. 2 and 3).

Type: CHILE. Tierra del Fuego, “Hermite island, Cape Horn”, J. D. Hooker 141b, 1839–1843 (holotype NY; isotype BM00919961! BM000976120! E00052653–54! PC0108132!).

*Uloa carinata* Mitt., J. Proc. Linn. Soc. 4: 75. 1860. **syn. nov.** Type: CHILE. Mr. Lobb 35 (holotype NY; isotype MICH526538! BM000825444!). ≡ *Orthotrichum carinatum* (Mitt.) Mitt., J. Linn. Soc., Bot. 12: 190. 1869.

*Uloa darwinii* Mitt., J. Proc. Linn. Soc. 4: 77. 1860. Type: ARGENTINA. Terra del Fuego, C. Darwin, 1833 (holotype NY; isotype BM, PC00100148!). Proposed by Malta (1927) as a synonym of *U. fuegiana*.

*Uloa eremitensis* Mitt., J. Proc. Linn. Soc. 4: 76. 1860, ≡ *Orthotrichum eremitense* (Mitt.) Mitt., J. Linn. Soc., Bot. 12: 189. 1869. Type: CHILE. Tierra del Fuego, “Hermite Island, Cape Horn”, J. D. Hooker s.n. (holotype NY). Proposed by Malta (1927) as a synonym of *Uloa glabella*.

*U. glabella* Mitt., J. Proc. Linn. Soc. 4: 76. 1860. **syn. nov.** Type: CHILE. Tierra del Fuego, “Hermite island, Cape Horn”, J. D. Hooker 141a, 1839–1843 (holotype NY; isotype BM000919960! E00052655! E00052673! PC0101534! PC0108133!).

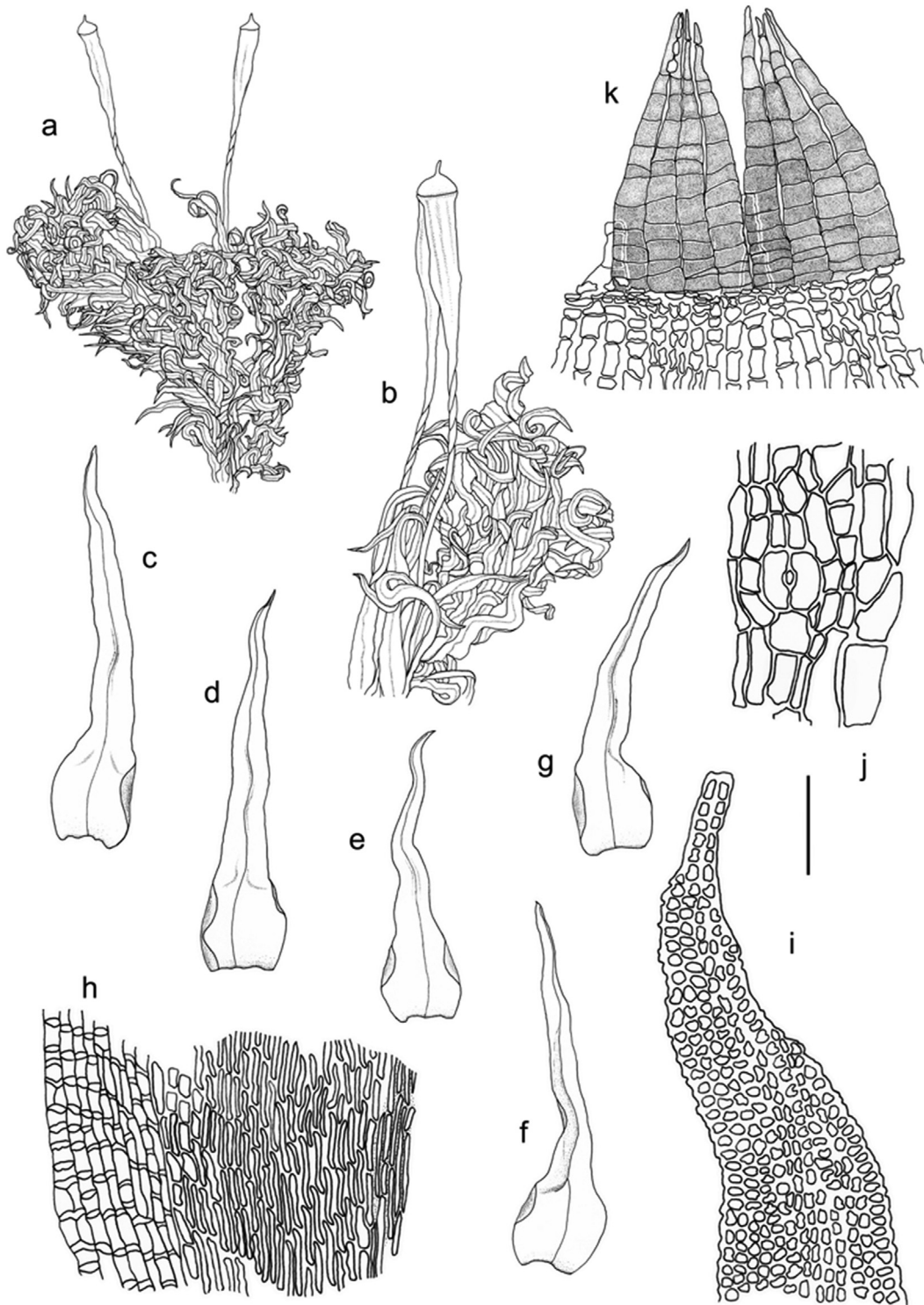
*Uloa fernandeziana* Malta, Acta Horti Bot. Univ. Latv. 2: 202. f. 20. 1927. **syn. nov.** Type: CHILE. Juan Fernandez: Masafuera, Cordon de Borril, an Drimys, C. et I. Skottsberg sub n.165, 1 Mar. 1917 (holotype H4334033! isotype S-B127726!).

*U. fuegiana* var. *crispata* Malta, Acta Horti Bot. Univ. Latv. 2: 188. 1927. **syn. nov.** Type: CHILE. Valdivia, H. Hahn, 1888 (holotype H4334032!).

*Uloa hermitei* Besch., Miss. Sci. Cape Horn, Bot. 5 (Bot.): 274. 1889. Type: CHILE. Baie Orange (île Hoste) Terre de Feu, P.A. Hariot 150, 25 July 1883 (holotype PC0703858–61!). Proposed by Malta (1927) as a synonym of *U. glabella*.

*Uloa rufula* var. *patagonica* Malta, Acta Horti Bot. Univ. Latv. 2: 188. 1927. **syn. nov.** Type: CHILE. “Río Aysen, in ramulis.” P. Dusén 516, Jan. 1897 (holotype H4334002! isotype PC! no barcode).

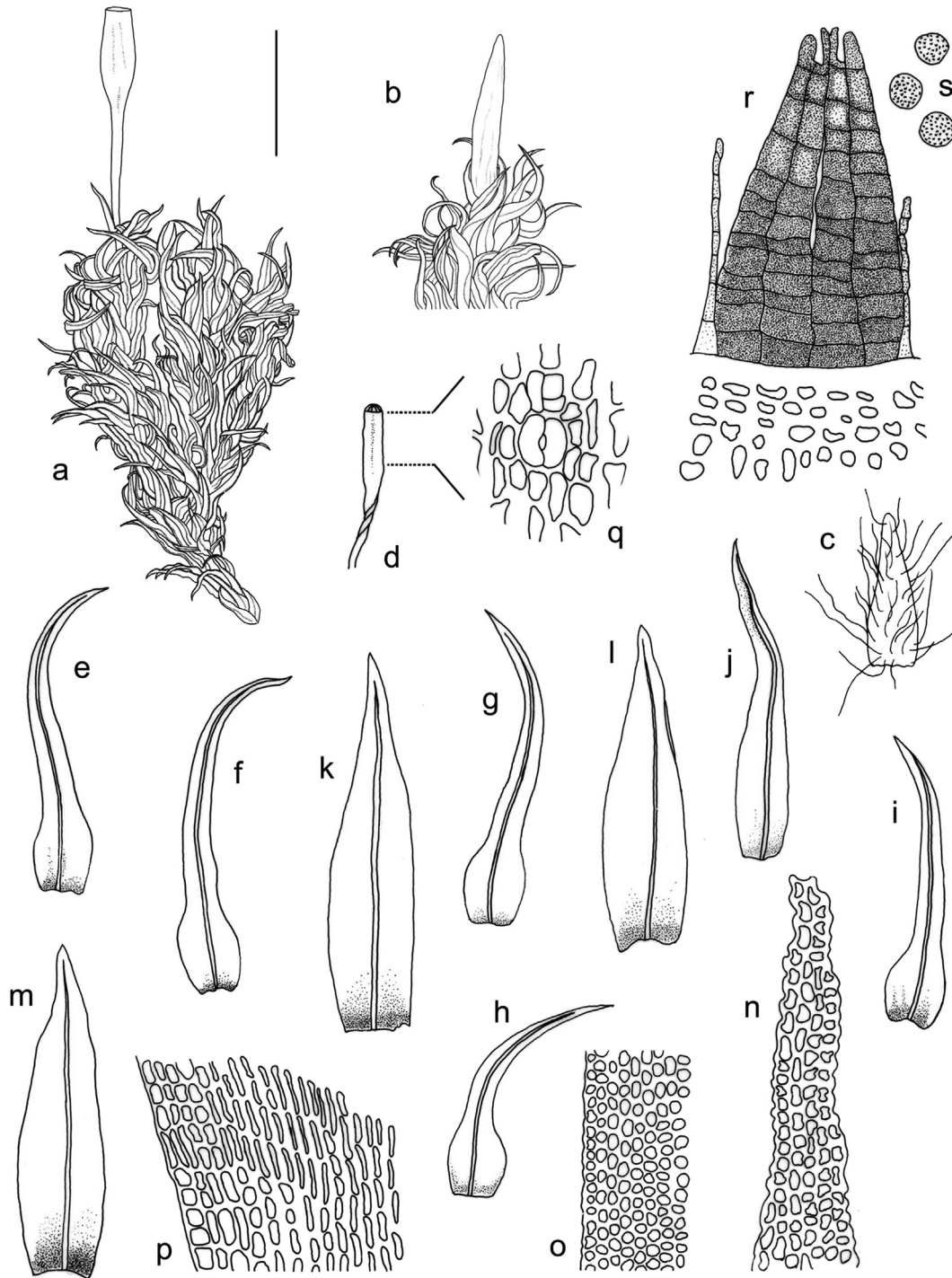
**Description:** Plants green above, gradually brown below, 0.5–2.5 cm tall. Leaves often flexuose when dry, sometimes weakly to strongly crisped, patent when moist, 1.3–3.2 mm long,



**Fig. 1.** *Ulota crisa* (Hedw.) Brid. **a–b.** Plants. **c–g.** Leaves. **h.** Basal cells. **i.** Top laminal cells. **j.** Stoma. **k.** Portion of peristome (with fragmentary endostome segments). (scale bar: a = 2 mm; b = 1 mm; c–g = 1 mm; h–j = 127  $\mu$ m; k = 203  $\mu$ m; a–p were drawn from W. Lechler s.n. [H3150823]).

lanceolate from a broad rounded base, long acuminate. Costa strong, ending shortly below the apex. Upper and middle laminal cells irregularly rounded, thick-walled, with 1 or 2 low papillae per cell; basal inner cells linear, elongate rectangular, vermicular, smooth, thick-walled; basal marginal cells often differentiated in 5–11 rows, hyaline, quadrate to rectangular, with thin walls or only transversely thickened walls.

Autoicous. Perichaetial leaves somewhat differentiated, lanceolate with shorter acumination and longer broad base. Capsules long exserted, cylindrical when moist, weakly to strongly constricted when dry, 8 furrows along the entire length; exothelial cells clearly differentiated into eight bands. Stomata superficial, present on the urn. Peristome double; exostome teeth 16, united into 8 pairs, lanceolate, densely papillose on both surfaces, often

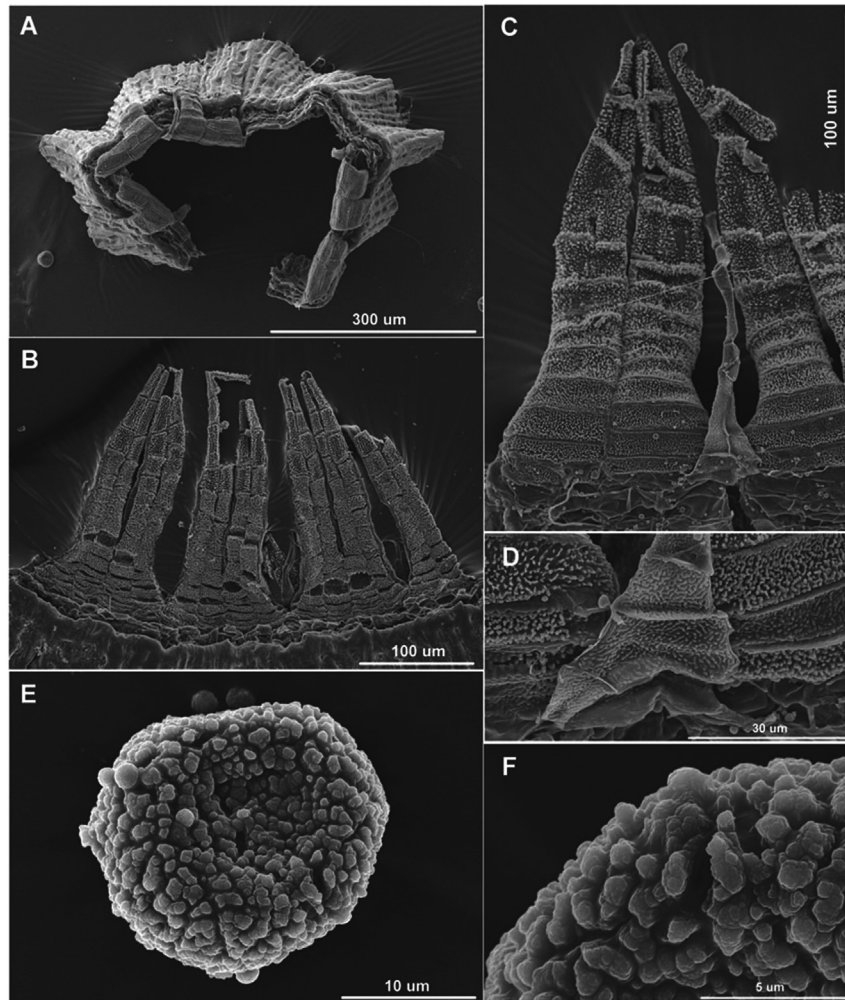


**Fig. 2.** *Uloa fuegiana* Mitt. **a.** Plant. **b–c.** Calyptra. **d.** Capsule. **e–i.** Leaves. **j–m.** Perichaetial leaves. **n.** Top laminal cells. **o.** Median marginal cells. **p.** Basal cells. **q.** Stoma. **r.** Portion of peristome. **s.** Spores. (scale bar: a = 2 mm; b = 1.2 mm; c = 1.4 mm; d = 1.5 mm; e–m = 1 mm & n–s = 0.1 mm; a–p were drawn from the isotype [E00052653] while q–s from *H. Roivainen* s.n. [H3150819]).

reflexed when dry; endostome segments usually 8, filiform, slender, almost as tall as the exostome, hyaline or pale yellow, smooth on the outside, and with scattered papillae on the inside. Opercula with a short beak. Calyptra campanulate, densely hairy, sometimes naked. Spores spherical, brownish, finely papillose, 23–43  $\mu\text{m}$  in diameter.

**Habitat and distribution:** Epiphytic, endemic to Chile and Argentina.

**Discussion:** *U. glabella* was different from other taxa in this genus in its non-crisped leaves and naked calyptra as indicated in Mitten's (1860) protologue. But Malta (1927) emphasized its naked calyptra and serrated leaf margin in his revision. Examination of the type materials shows that the leaves of *U. glabella* are more or less crisped, the calyptra are naked and the leaf margin is entire. Mitten's two characters fell within the variation of *U. fuegiana*, whose leaves flexuose to crisped when dry and calyptra vary from



**Fig. 3.** SEM of *Ulota fuegiana* Mitt. **A.** capsule mouth. **B.** outside surface of exostome. **C.** inside surface of exostome and endostome. **D.** inside ornamentation of endostome. **E.** spore. **F.** ornamentation of spores. (material from *T. Seki s.n.* [H3151107]).

naked to hairy. Moreover, [Malta \(1927\)](#) found a specimen of *U. glabella* with hairy calyptra (Patagonia acid., Isla Werthoff, *P. Dusén s.n.*, 28 April 1897 in S but no barcode). We have fortunately seen this specimen and confirmed his result. We did not find the serrated leaf margin mentioned by [Malta \(1927\)](#) in the type material and this so-called “serration” is probably the papilla on the surface of marginal leaf cells according to his line drawing. There is hitherto no other authors reported serration on leaf margin in *Ulota*. Besides, [Malta \(1927\)](#) characterized the endostome in *U. glabella* as comprising of eight or sixteen segments, but examination of three capsules from the type material revealed endostome of only eight segments. Furthermore, *U. glabella* is also consistent with *U. fuegiana* in stomata position, occurring on the urn. To sum up, *U. glabella* is virtually identical with *U. fuegiana* in terms of leaf crisping, peristome structure, stomata position and calyptra hairiness and thus here regarded as a synonym of *U. fuegiana*. Notably, the type informations for *U. glabella* and *U. fuegiana* in [Mitten's protologue \(1860\)](#) are the same, i.e. “Hermit Island, Cape Horn, *Dr. J. D. Hooker*”. Subsequently, [Malta \(1927\)](#) cited the type material of *U. glabella* as *J. D. Hooker 141a*, the one of *U. fuegiana* as *J. D. Hooker 141b*. The type information of E00052673 we studied here is completely identical with Malta's citation, as well as the isotype in PC. Consequently, this material should be isotype, not “isosyntype” as wrote on its package.

In the protologue, [Mitten \(1860\)](#) compared *U. carinata* with *Ulota fulvella* and considered them different in the crispness and size of the leaves and shape of the capsules. [Malta \(1927\)](#) emphasized the leaf shape, peristome structure and calyptra hairiness of *U. carinata* as distinguishing characters. Our examination has shown that *U. carinata* has somewhat crisped leaves, a broad band of hyaline cells at leaf base, cylindrical capsules, filiform endostome segments, stomata restricted to the urn and hairy calyptra, and all these characters matched the type of *U. fuegiana*. [Malta \(1927\)](#) also stated that *U. fernandeziana* was similar to *U. fuegiana* in the leaf shape, peristome structure and resembled *U. rufula* (= *U. germana*) in capsule shape. Actually, *U. germana* differs from *U. fuegiana* by the always crisped leaves, remarkably differentiated perichaetial leaves, stomata occurring in the transitional zone between urn and neck, and linear but not slender endostome segments. Features of the type material of *Ulota fernandeziana* are generally consistent with those of *U. fuegiana*. Consequently, *U. carinata* and *U. fernandeziana* could not be clearly distinguished from *U. fuegiana* and thus they are reduced as synonyms here.

Similarly, we examined the types of *U. rufula* var. *patagonica* and *U. fuegiana* var. *crispata* and they both have crisped leaves, differentiated basal marginal leaf cells, filiform segments and stomata on the urn, thus they are actually consistent with *U. fuegiana* and therefore synonymized here.

**Malta's treatment (1927)** for *U. Darwinii* was self-contradictory. On the one hand, he listed *U. darwinii* as a synonym of *U. fuegiana*, on the other hand, he put it under *U. fuegiana* as a subspecies. Recently, we obtained and observed its isotype in PC, but the material is very scanty. Despite no sporophyte, its leaf is well consistent with *U. fuegiana*'s. The type materials of *U. darwinii* cited in **Malta (1927)** deposit in BM. Eight possible type specimens from BM were found in Global Plants database (<http://plants.jstor.org/specimen/ny01244149?s=t>). All these types are noted as *O. luteolum*, with only one simultaneously noted as *U. darwinii*, but their morphology is all apparently consistent with *U. fuegiana*. **Malta (1927)** with some hesitation reduced *U. darwinii* as a subspecies of *U. fuegiana*, and our result did not support this treatment either. Thus, we accepted his another suggestion (**1927**), that reducing *U. darwinii* in the synonymy of *U. fuegiana*.

The main diagnostic characters of *U. fuegiana* are the flexuose or slightly crisped leaves, markedly differentiated basal marginal leaf cells, stomata restricted to the urn, eight slender endostome segments, and hairy calyptra. This species is very similar to *U. germana* and their difference has been mentioned above.

**Selected additional specimens examined:** ARGENTINA. Buenos Aires: Villarino, *J. B. Hatcher E.99* (S, no barcode); Río Negro: Puerto Blest, *P. Dusén 830* (S-B11829). Tierra del Fuego: Ushuaia, *J. B. Hatcher E.3*, (S, no barcode). CHILE. Aisén: Ventisquero San Rafael, *T. Seki s.n.* (H3151107); Estancia Río Circo, *T. Seki 3/2-20* (H3151089); Chiloé: Aucud, *Carl O. Enla.son 126* (MICH, no barcode); Magallanes: Borja Bay, *Cunningham 50* (BM000852214 & H4334030); Puerto Cutter, *J. F. Engel s.n.* (H3150821); Desolacion Island, *P. Dusén 284* (H4334018 & S, no barcode); Port Angosto, *Cunningham 149* (H4334022), *160* (BM000852216); Port Gallant, *Cunningham 253* (BM000852215 & H4334031), *156* (H4334019 & MICH, no barcode), *s.n.* (MICH, no barcode); Talca: San Rafael, *M. Gusinde s.n.* (S-B177757 & S-B177759); Fjardo Martinez, *H. Roivainen s.n.* (H3150818–19); Tierra del Fuego: Bahía Tekenika, *C. Skottsberg 90* (S, no barcode); Port Barrow, *C. Skottsberg 450* (S, no barcode); Puerto Tempanos, *C. Skottsberg 457* (BM, no barcode, PC, no barcode & S, no barcode); Río Azopardo, *P. Dusén 264* (H4334020 & S, no barcode); Valparaíso: Isla Alejandro Selkirk, *C. Skottsberg M124(2)* (S-B177719). Total number of specimens studied is 43.

#### 5.4. *Ulota germana* (Mont.) Mitt., J. Proc. Linn. Soc. 12: 190. 1869. (Figs. 4 and 5)

≡*O. germanum* Mont., Ann. Sci. Nat.; Bot., sér. 3 4: 121. 1845. Type: CHILE. "in corticibus arborum reipublicae chilensis a cl. Claude Gay. lectum" (holotype PC0100700–01! PC0108137! isotype BM000873134–35!).

*Ulota lobbiana* Mitt., J. Linn. Soc., Bot. 75. 1860. **syn. nov.** Type: CHILE. Patagonia, *Mr. Lobb 35b* (holotype NY; isotype BM000825445! MICH526540!). ≡*Orthotrichum lobbianum* (Mitt.) Mitt., J. Linn. Soc., Bot. 12: 192. 1869.

*Ulota brevicollis* (Mitt.) A.Jaeger, Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1872–73: 164. 1874. ≡*Orthotrichum brevicolle* Mitt., J. Linn. Soc., Bot. 12: 192. 1869. Type: CHILE. prope urbem Valdivia, *Lechler 527*, 1850, ex parte (holotype NY; isotype S-B172018! PC0099361!). Proposed by **Malta (1927)** as a synonym of *U. rufula*.

*Ulota chilensis* (Mitt.) A.Jaeger, Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1872–73: 164. 1874. ≡*Orthotrichum chilense* Mitt., J. Linn. Soc., Bot. 12: 193. 1869. Type: CHILE. prope urbem Valdivia, *W. Lechler 527*, 1850 (holotype NY). Proposed by **Malta (1927)** as a synonym of *U. rufula*.

*Ulota persubulata* Dusén, Rep. Princeton Univ. Exp. Patagonia, Botany 8(3): 122. 1903. *invalid, no description*. Type: ARGENTINA. Nahuelhuapi (=Nahuel Huapi National Park) in truncis arborum,

*P. Dusén 791*, 7 July 1897 (lectotype S-B181245! designated here; isolectotype BM000879989–90! H4334001! PC! no barcode). Proposed by **Malta (1927)** as a synonym of *U. rufula*.

*U. rufula* (Mitt.) A.Jaeger, Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1872–73: 164. 1874. **syn. nov.** ≡*Orthotrichum rufulum* Mitt., J. Linn. Soc., Bot. 12: 191. 1869. Type: CHILE. prope urbem Valdivia, *W. Lechler 527*, 1850, ex parte (holotype NY; isotype S! no barcode, PC0099347!).

*U. rufula* var. *fagicola* Dusén ex Malta, Acta Horti Bot. Univ. Latv. 2: 200. 1927. **syn. nov.** Type: CHILE. in monte "Cordillera de la Costa" supra Angol app., in truncis arborm, *P. Dusén 346a*, 4 Nov. 1896 (holotype H4334023!).

**Description:** Plants green above, brown to black below, 0.5–1.0 cm tall. Leaves strongly crisped, sometimes flexuose when dry, erect-spreading to patent when moist, 1.4–2.6 mm long, lanceolate from a broad rounded base, long acuminate. Costa strong, ending shortly below the apex. Upper and middle laminal cells irregularly rounded, thick-walled, with 1 or 2 low papillae per cell; basal inner cells linear, elongate rectangular, vermicular, with thick wall, smooth; basal marginal cells often differentiated in 4–14 rows, hyaline, quadrate to rectangular, with only thickened transverse walls.

Autoicous. Perichaetial leaves much longer. Capsules often short exerted, cylindrical when moist, strongly constricted when dry, 8 furrows along the entire length; exothelial cells distinctly differentiated into eight bands. Stomata superficial, at the lower part of urn or junction between urn and neck. Peristome double; exostome teeth 16, united into 8 pairs, lanceolate, densely papillose on the outside, striate and papillose on the inside, often revolute when dry; endostome segments usually 8, linear, yellowish or hyaline, smooth on the outside, finely papillose on the inside. Opercula with a medium long beak. Calyptra campanulate, densely hairy. Spores spherical, finely papillose, 29–33 µm in diameter.

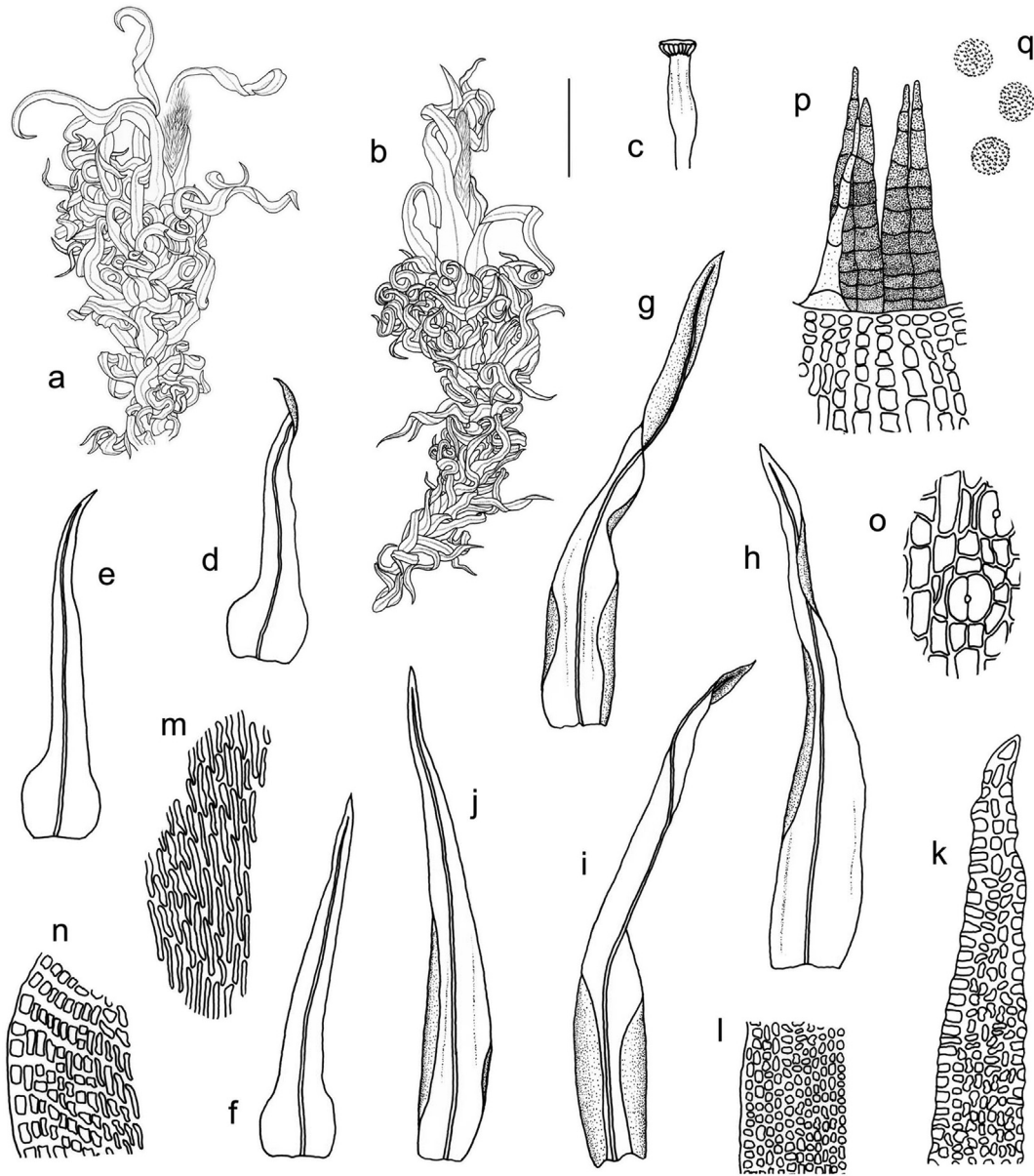
**Habitat and distribution:** Epiphytic, reported from Chile, Argentina and New Zealand (**Sainsbury, 1945, 1955**).

**Discussion:** The only specimen of *U. germana* cited by **Montagne (1845)** in the protologue is a mixture with *U. fuegiana*. He emphasized that this species is very similar to *Ulota crispulum* Bruch (= *U. crispa*). Later, **Mitten (1869)** described it as having crisped leaves when dry. Concerning this, we know that the material with strongly crisped leaves in the type specimens is *U. germana* and the other material with flexuose leaves is *U. fuegiana*. **Mitten (1869)** described *U. germana* as having eight endostome segments, while **Malta (1927)** found that there were 16. After examining the types, we found that *U. germana* has only eight endostome segments. Like *U. germana*, the type specimen of *U. rufula* is also a mixture with *U. fuegiana* and the isotype in S agrees with the original description while the one in PC seems to be only *U. fuegiana*.

*U. persubulata* is first published by **Dusén (1903)** without morphological description. **Malta (1927)** reduced it to *U. germana* as a synonym without any comments. After examining the original material, we found it resembles *U. germana* in the conspicuous hyaline cells at the marginal leaf base, long perichaetial leaves, short exerted capsules, well-developed double peristome and densely hairy calyptra. We therefore confirmed Malta's treatment here.

*U. germana* is a very distinctive species easily recognized by the long perichaetial leaves, also mentioned by **Robinson (1975)**. But we cannot find it from **Malta's illustration (1927)** which most likely results from the impurity of the type specimens. Based on the crisped leaves, many rows of hyaline leaf alar cells, distinctly differentiated perichaetial leaves, stomata over the urn to neck transition and eight well-developed endostome segments, *U. lobbiana* and *U. rufula* var. *fagicola* are regarded as synonyms of *U. germana* here. According to **Malta's protologue (1927)**, especially





**Fig. 4.** *Ulota germana* (Mont.) Mitt. **a–b.** Plant. **c.** Capsule. **d–f.** Leaves. **g–j.** Perichaetial leaves. **k.** Top laminal cells. **l.** Median marginal cells. **m.** Basal laminal cells. **n.** Basal marginal cells. **o.** Stoma. **p.** Portion of peristome. **q.** Spores. (scale bar: a–b = 1.35 mm; c = 1 mm; d–j = 0.67 mm & k–q = 0.07 mm; a–b, k, n & o–p drawn from *T. Seki* 2/32-61 [H3151091] and the remainings from the isotype [S-B172301] of *U. rufula*).

his illustrations, *U. germana* var. *brevisetata* is similar to *U. germana* in the long perichaetial leaves. But we can't make a decision before examining its type specimen.

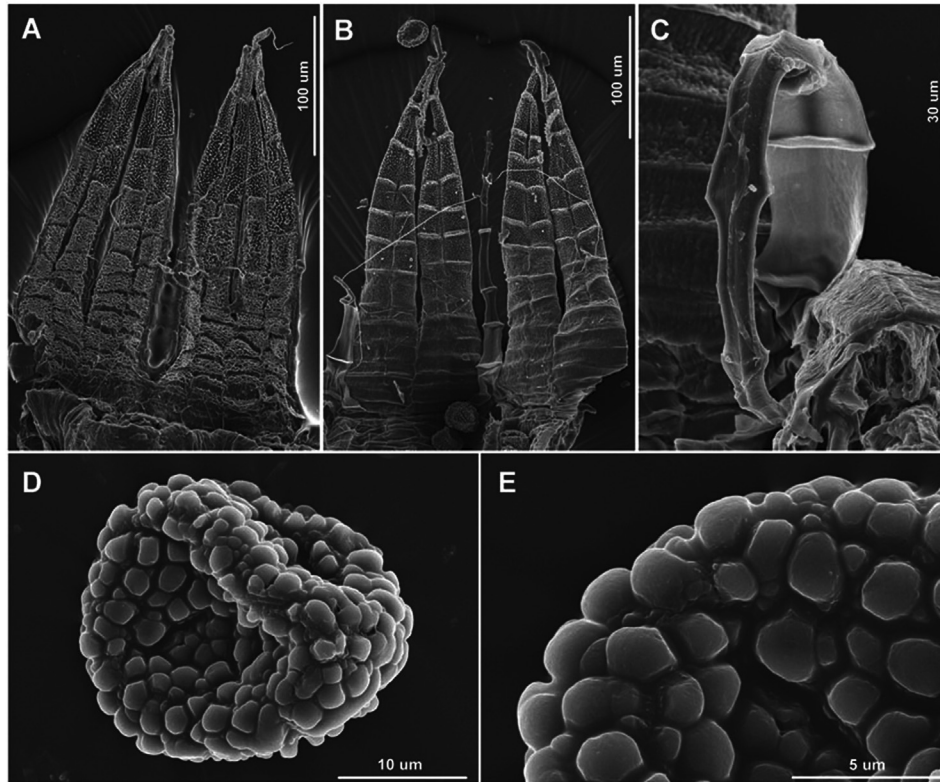
*U. germana* is distinguished from all congeners by the following combination of characters: strongly crisped leaves, much longer perichaetial leaves, stomata (almost) over the urn to neck transition, eight linear endostome segments and densely hairy calyptra. *U. germana* resembles *U. fuegiana* in the flexuose or crisped leaves, conspicuously differentiated basal marginal leaf cells and eight endostome segments, but the latter has stomata restricted to the urn region, hardly differentiated perichaetial leaves, a longer seta and filiform, slender endostome segments. Besides that, *U. germana* also shares many characters with *U. crispa* but the latter is different in the hardly differentiated perichaetial leaves and longer seta.

Both holotypes of *U. rufula* var. *fagicola* and *Ulota pycnophylla* have identical collection information and we thus named them here as *a* and *b*, respectively.

**Selected additional specimens examined:** ARGENTINA. Chubut: Lago Menéndez, *A. Kalela* B248j(3) (H3150919). CHILE. Aisén: Río Exploradores, *T. Seki* 2/32-61 (H3151091–92); Chiloé: Aucud, *Carl O. Enla.* son 126 (MICH); Llanquihue: Río Puelo, *B. Sparre* 4318 (S-B177718); Talca: San Rafael, *M. Gusinde* s.n. (S-B177758–62); Valdivia: no detail locality, *Hahn* s.n. (S-B177720), *Hahn* 41 (S-B177721); Valparaíso: Masafuera, *C. Skottsberg* M124(1) (S-B177719). Total number of specimens studied is 32.

**5.5. *Ulota larrainii*** Garilleti, Mazimpaka & F. Lara, *Phytotaxa* 217 (2): 133. 2015.

Type: CHILE. Prov. Capitan Prat: Caleta Tortel, comienzo de “ruta turística”, en tundras de *Donatia*, *Astelia* y *Lepidothamnus fonkii*, 47°47'32" S, 73°31'48" W, alt. ca. 90 m, epifito en *Nothofagus dombeyi*, *J. Larrain* 26884A, con *R. Vargas*, 20 Ene[ro] 2007 (holotype VAL-Briof; isotype CONC).



**Fig. 5.** SEM of *Ulota germana* (Mont.) Mitt. **A.** outside surface of exostome. **B.** inside surface of exostome. **C.** endostome. **D.** spore. **E.** ornamentation of spores. (all material from *T. Seki* 2/32-61 [H3151091]).

**Illustration:** see [Garilletei et al., 2015](#).

**Description, habitat and distribution:** see [Garilletei et al., 2015](#).

**Discussion:** *U. larrainii* was published during the review period of this manuscript, we therefore have not enough time to obtain the type specimen by loan. In the description of [Garilletei et al. \(2015\)](#), this species is morphologically very close to *U. billbuckii* and *U. magellanica*, especially the former. *U. larrainii* and *U. billbuckii* both have multicellular spores, short seta and short cylindrical capsules. But the basal membrane of endostome segments is short (only 1–2 cells high, never more than 1/4 high of exostome) in *U. larrainii* and high in *U. billbuckii* (often as 1/2 high as exostome). [Garilletei et al. \(2015\)](#) also mentioned the difference of spore shape between the two species. According to our study, however, unicellular spores in *Ulota* are generally irregularly spherical, multicellular spores vary to some extent in shape, from oblate, elliptic to spherical. Actually, the spore shape is usually correlated with the freshness of material, that the spores are often irregular in shape when the material is old, on the contrary, mostly spherical when the material is fresh. Our study has shown irregular variation in this character, which consequently has no taxonomic value. Additionally, the other morphological distinctions referred by [Garilletei et al. \(2015\)](#) for *U. larrainii* and *U. billbuckii* are weak, for example, spore size and seta length. It is notable that the description of *U. larrainii* in [Garilletei et al. \(2015\)](#) is most likely based on only the type collection. Although neither type nor non-type specimens were available for us, we still accepted it here due to the fairly detailed description and comparison in the protologue.

**Additional specimens examined:** None.

5.6. *Ulota luteola* (Hook.f. & Wilson) Wijk & Margad., *Taxon* 10: 26. 1961. (Figs. 6 & 7)

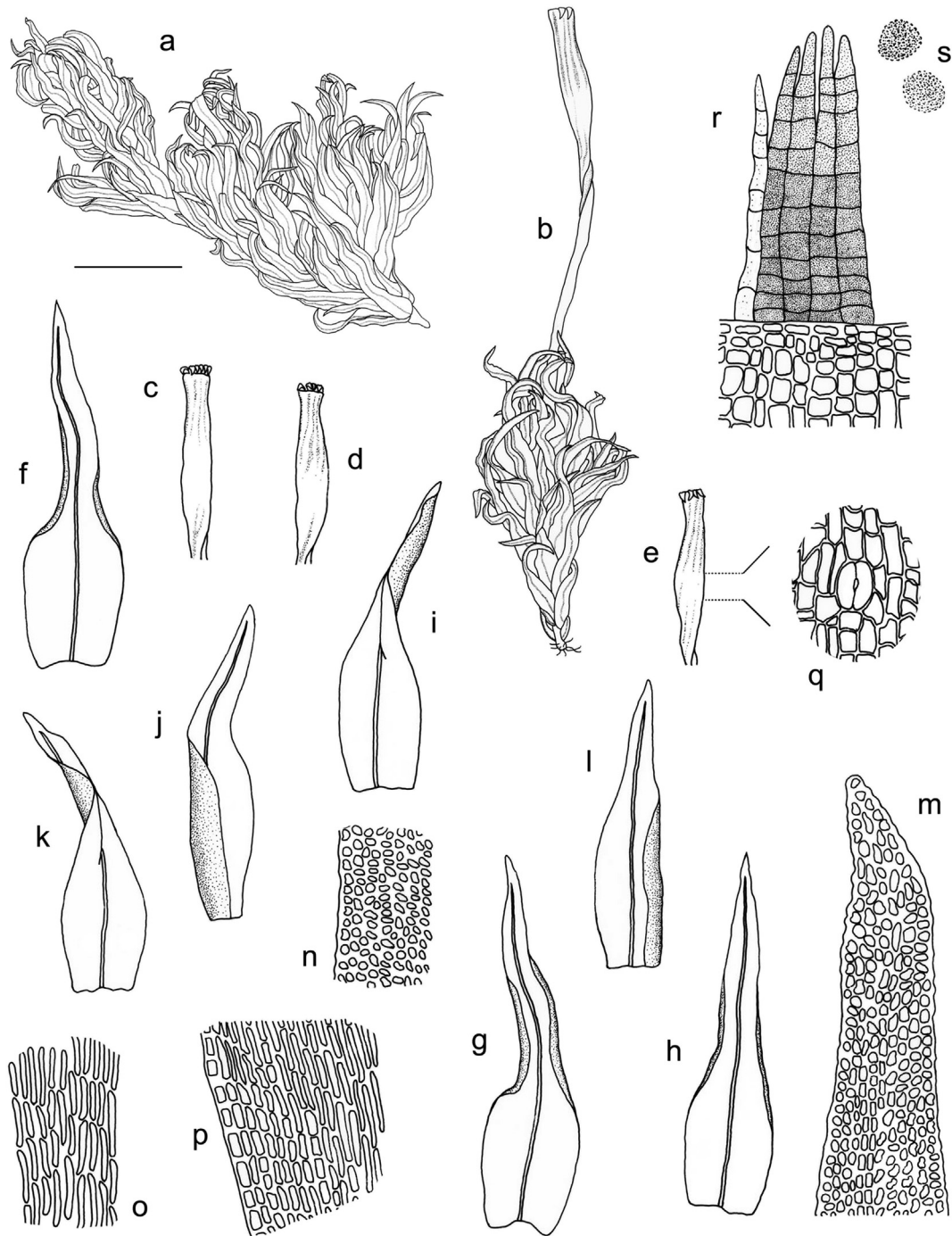
≡ *O. luteolum* Hook.f. & Wilson, *Fl. Antarctica* 2: 403. 1847. Type: CHILE. Tierra del Fuego, “Hermite Island, Cape Horn.”, *J. D. Hooker s.n.*, 1839–1843 (holotype NY; isotype H2057001!). [≡ *U. fulvella* Mitt., *J. Proc. Linn. Soc.* 4: 75. 1860. ≡ *Orthotrichum fulvellum* (Mitt.) Mitt., *J. Linn. Soc., Bot.* 12: 191. 1869. *Illegitimate, type of earlier name included.*]

*Ulota immarginata* Cardot, *Bull. Herb. Boissier, sér. 2, 5*: 1004. 1905. Type: ARGENTINA. “Terre-de-Feu: Ushuaia, ad trunc. *Nothofagi antarcticae*, C. Skottsberg 91, 25 Sep. 1902” (holotype PC0703850! isotype S-B158028!). Proposed by [Malta \(1927\)](#) as a synonym of *Ulota pygmaeothecia*.

*U. pygmaeothecia* (Müll. Hal.) Kindb., *Enum. Bryin. Exot.* 79. 1888. **syn. nov.** ≡ *Orthotrichum pygmaeothecium* Müll. Hal., *Flora* 68: 418. 1885. Type: CHILE. Fuegia, ad ramos *Maytheni magellanicae* montls Darwin 1882, *Spegazzini* (lectotype H4334012! designated here; isolectotype PC0101543!).

*Ulota savatieri* Besch., *Bull. Soc. Bot. France* 32: LXII. 1885. Type: “Patagonie occidentale, ile Wellington: Port-Eden (*Dr. Savatier*, 24 février 1877)” (holotype PC0108134! PC0099349–50! isotype BM000879988! NY). Proposed by [Malta \(1927\)](#) as a synonym of *U. fulvella*.

**Description:** Plants dark green above, brown to black below, ca. 1 cm tall. Leaves erect or flexuose, rarely crisped when dry, erect-spreading when moist, 1.2–1.9 mm long, lanceolate from a broad oval, sometimes rounded base, acuminate. Costa strong, ending



**Fig. 6.** *Ulota luteola* (Hook.f. & Wilson) Wijk & Margad. **a–b.** Plant. **c–e.** Capsules. **f–h.** Leaves. **i–l.** Perichaetial leaves. **m.** Top laminal cells. **n.** Median marginal cells. **o.** Basal laminal cells. **p.** Basal marginal cells. **q.** Stoma. **r.** Portion of peristome. **s.** Spores. (scale bar: a–e = 1 mm; f–h = 0.48 mm; i–l = 0.6 mm & m–s = 0.08 mm; a–p drawn from the isolectotype [PC0101543] of *U. pygmaeothecia* and q–s from M. S. Pennington 349 [S-B157955]).

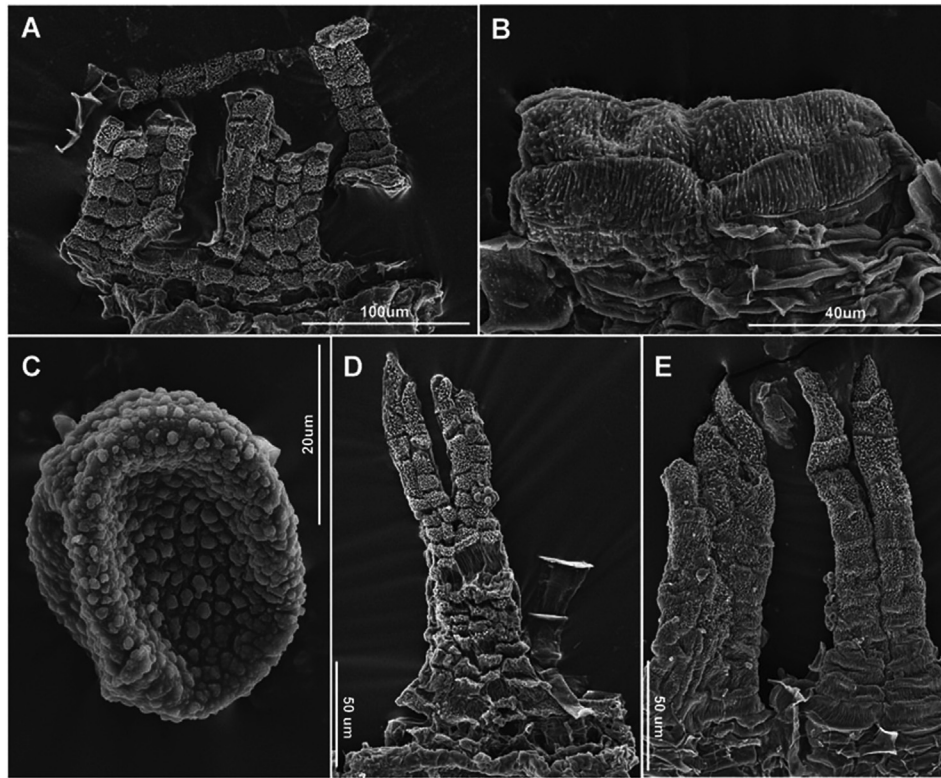
shortly below the apex. Upper and middle laminal cells irregularly rounded, thick-walled, with 1 or 2 low papillae per cell; basal inner cells linear, elongate rectangular, vermicular with thickened wall, smooth; basal marginal cells often differentiated in 1–3 rows, hyaline, quadrate to rectangular, with thin walls.

Autoicous. Perichaetial leaves not markedly differentiated. Capsules long exserted, cylindrical when moist, weakly to strongly constricted when dry, 8 furrows along the entire length; exothelial cells clearly differentiated into eight bands. Stomata superficial, at the junction between urn and neck. Peristome double; exostome

teeth 16, united into 8 pairs, lanceolate, densely papillose on the outside, striate and papillose on the inside, often revolute when dry; endostome segments 8, linear, yellowish or hyaline, smooth outside, slightly papillose on the inside. Opercula with a short beak. Calyptra campanulate, with many hairs. Spores spherical, finely papillose, 29–34  $\mu\text{m}$  in diameter.

**Habitat and distribution:** Epiphytic, reported from Chile, Argentina and New Zealand (Sainsbury, 1945, 1955).

**Discussion:** *U. luteola* and *U. fulvella* are homotypic and the latter is illegitimate based on Wijk et al. (1969). Malta (1927) placed



**Fig. 7.** SEM of *Uloa luteola* (Hook.f. & Wilson) Wijk & Margad. **A & D.** outside surface of exostome. **B.** basal inside surface of exostome. **C.** spore. **E.** inside surface of exostome. (material: A–C from isolecotype [PC0101543] of *U. pygmaeothecia* and D–E from *P. Dusén s.n.* [H4334024]).

*U. luteola* in synonymy of *U. fulvella* but did not mention their homotypic relationship. Both type specimens of *U. luteola* in NY and H are named as *U. fulvella*.

The type specimen of *U. luteola* in H is a mixed collection with *U. fuegiana*. *U. luteola* is easily distinguished from *U. fuegiana* by the usually erect or flexuose leaves, weakly differentiated basal marginal leaf cells, well-developed linear endostome segments and stomata occurring at the junction between urn and neck. The protologue of *U. luteola* is close to *U. pygmaeothecia* and as the earlier published name, *U. luteola* has priority and is retained here. This treatment is confirmed by previous descriptions for *U. fulvella*; for example, Mitten, in his protologue (1860), emphasized that the leaves in *U. fulvella* are not crisped when dry and Malta (1927) also stated that *U. fulvella* has only one, rarely two rows of hyaline cells at leaf base.

The diagnostic characters for *U. luteola* are flexuose leaves, a few rows of hyaline basal marginal leaf cells, stomata located at the junction between urn and neck, eight endostome segments and somewhat larger spores. It resembles *U. pycnophylla*, which can be separated by the usually erect leaves, more differentiated leaf basal marginal cells, narrowly lanceolate endostome segments and smaller spores. *U. luteola* is also closely related to *U. crispa*. Their sporophytes are quite similar, having cylindrical capsules, stomata confined to the junction between urn and neck, eight linear endostome segments, and a hairy calyptra. However, they have different gametophytes, for example *U. crispa* can be distinguished by the strongly crisped leaves and more than three rows of hyaline cells at basal leaf margin.

**Selected additional specimens examined:** ARGENTINA. Tierra del Fuego: Ushuaia, *M. S. Pennington* 349 (S-B157955). CHILE. Aisén: no detail locality, *P. Dusén* 605(1) (H4334011); Magallanes: Canal Jeronimo, *Halle & Skottsberg* 458 (S-B177711 & H4334005); Port

Famine, *N. J. Andersson s.n.* (S-B158024); Punta Arenas, *P. Dusén s.n.* (H4334024); Tierra del Fuego: no detail locality, *T. Halle* 459 (BM, no barcode & S-B158027). Total number of specimens studied is 15.

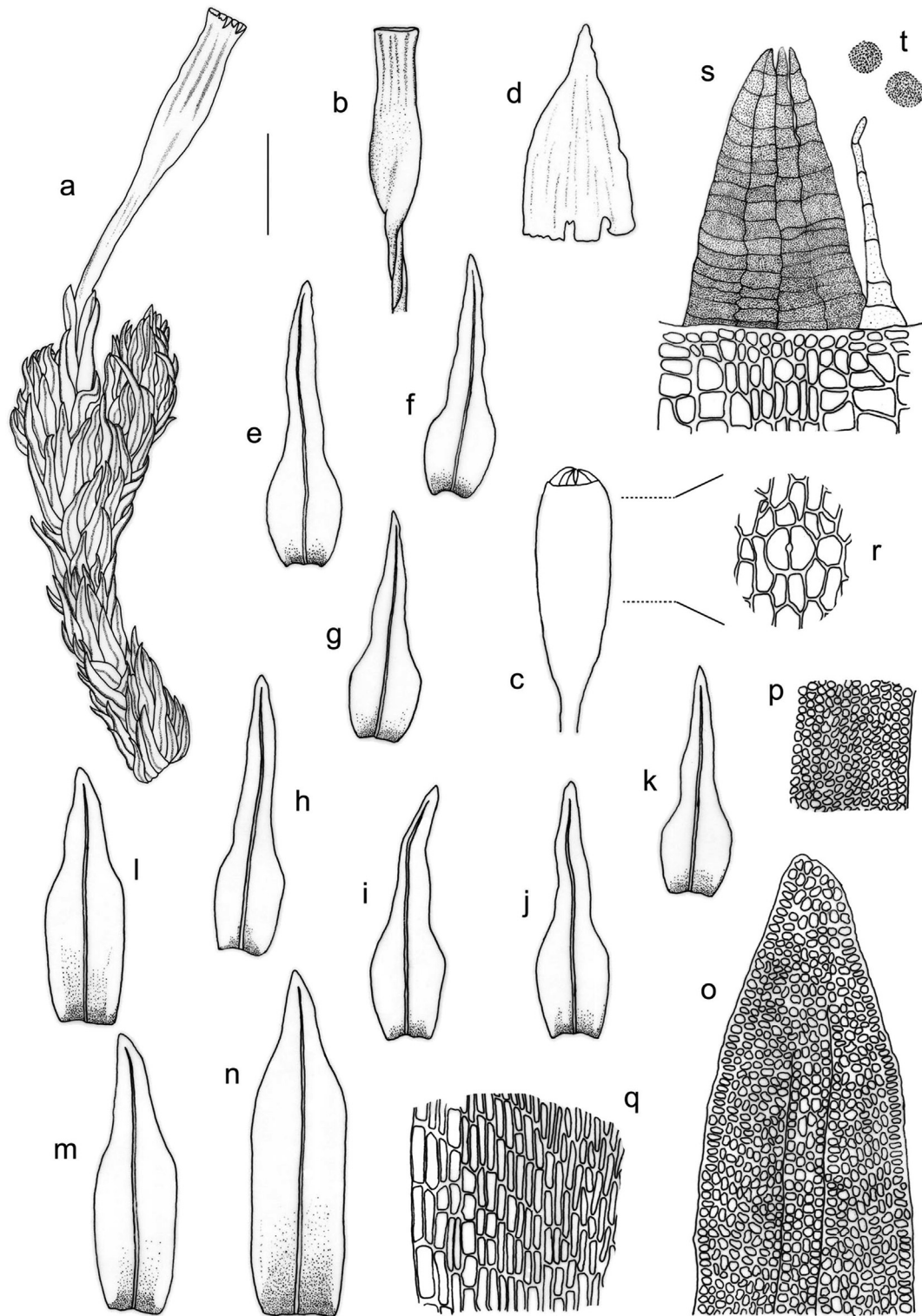
#### 5.7. *Uloa macrocalycina* Mitt., *J. Proc. Linn. Soc.* 4: 75. 1860. (Figs. 8 and 9).

Type: CHILE. Straits of Magellan, on trunks of trees, Port Famine, *Dr. Lyall*, Sep. 1851 (holotype NY; isotype BM000879991! BM000879992! PC00993361).  $\equiv$  *Orthotrichum macrocalycinum* (Mitt.) Mitt., *J. Linn. Soc., Bot.* 12: 190. 1869.

*Uloa marginata* (Ångström) A. Jaeger, *Ber. Thätigk. St. Gallischen Naturwiss. Ges.* 1877–78: 427. 1879.  $\equiv$  *Skottsbergia marginata* Ångström, *Öfvers. Förh. Kongl. Svenska Vetensk.-Akad.* 29(4): 4. 1872. Type: CHILE. Port Famine, *J. Andressaw* (holotype S-B172163!). Proposed by Malta (1927) as a synonym of *U. macrocalycina*.

*Uloa nothofagi* Cardot, *Bull. Herb. Boissier, sér. 2, 5:* 1005. 1905. Type: ARGENTINA. “Terre-de-Feu: Ushuaia, troncs de *Nothofagus antartica* et *betuloides*.”, *C. Skottsberg* 85, 25 Sep. 1902 (lectotype PC0703855! designated here); *C. Skottsberg* 84 (paratype PC0703857! isoparatype S-B157887! H4334015!); *C. Skottsberg* 86 (paratype PC0703856!). Proposed by Malta (1927) as a synonym of *U. macrocalycina*.

**Description:** Plants dark green above, brownish below, less than 1 cm tall. Leaves erect and appressed when dry, erect-spreading to patent when moist, 1.0–2.0 mm long, lanceolate from a broad oval base, acute. Costa strong, ending shortly below the apex. Upper and middle laminal cells irregularly rounded, thick-walled, with low papillae; basal inner cells linear, elongate rectangular, vermicular,

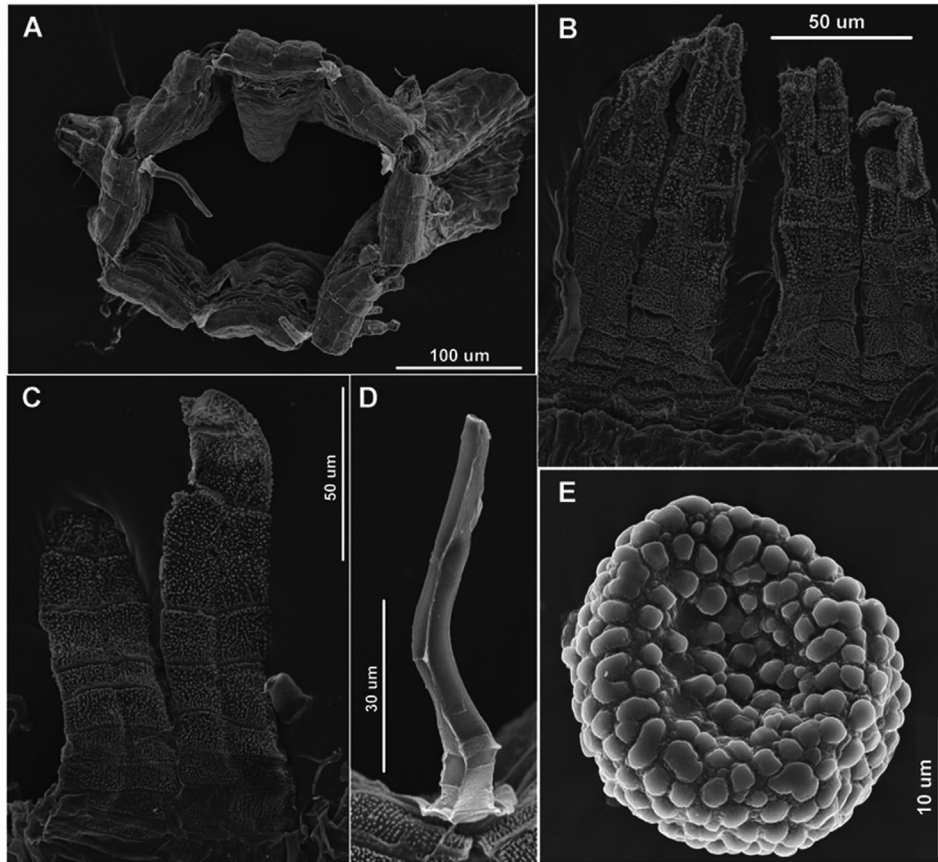


**Fig. 8.** *Ulota macrocalycina* Mitt. **a.** Plant. **b.** dry capsule. **c.** moist capsule. **d.** Calytra. **e–k.** Leaves. **l–m.** Perichaetial leaves. **n.** Basal cells. **r.** Stoma. **s.** Portion of peristome. **t.** Spores. (scale bar: a = 1 mm; b–d = 0.8 mm; e–k = 0.47 mm; l–n = 0.56 mm & o–t = 0.08 mm; a–q were drawn from the isotypes [BM000879991–93] while r–t from Townsend 97/229 [MO5628775].

smooth, thick-walled; basal marginal cells often differentiated in 3–10 rows, hyaline, quadrate to rectangular, mostly thin-walled.

Autoicous. Perichaetial leaves more or less differentiated. Capsules long exserted, cylindrical when moist, strongly constricted when dry, 8 furrows along the entire length; exothelial cells distinctly differentiated into eight bands. Stomata superficial, occur

on the urn. Peristome double; exostome teeth 16, united into 8 pairs, lanceolate, densely and finely papillose on both surfaces, often revolute when dry; endostome segments usually 8, linear, hyaline or pale yellow, smooth on the outside, slightly papillose on the inside. Opercula with a short beak. Calytra campanulate, naked. Spores spherical, brownish, finely papillose, 20–40  $\mu\text{m}$  in diameter.



**Fig. 9.** SEM of *Ulota macrocalycina* Mitt. **A.** capsule mouth. **B.** outside surface of exostome. **C.** inside surface of peristome. **D.** outside surface of endostome. **E.** spore. (material from C. J. Cox 319/00 [DUKE0188833]).

**Habitat and distribution:** Epiphytic, Chile and Argentina.

**Discussion:** *U. macrocalycina* is an easily identified species based on the following combination of characters: erect and appressed leaves, stomata located on the urn, often eight linear endostome segments and always naked calyptra. This species often grows with *U. magellanica* and resembles the latter in the non-crisped leaves and constricted capsules. However, *U. magellanica* has hardly differentiated basal marginal leaf cells, sixteen very wide endostome segments, stomata located at the transition between urn and neck, and sparsely hairy calyptra.

**Selected additional specimens examined:** ARGENTINA. Neuquén: Lago Quillén, A. *Kalela B179b* (H3151123); Parque Nacional de Nahuel Huapi, A. *Donat s.n.* (S, no barcode); Tierra del Fuego: Canal Beagle, M. *Gusinde s.n.* (S-B157883 & H4334027–28); Ushuaia, P. *Dusén 366(2)* (S-B158007, S-B157962, H4334013 & H4334025). CHILE. Antártica Chilena: Isla Navarino, C. J. Cox 319/00 (DUKE188833), C. J. Cox 198/00(1) (DUKE0188804); Magallanes: Lago del Toro, R. *Santesson M788* (S-B157881); Laguna Parrillar, J. *Engel 2074(1)* (H3150927); Punta Arenas, A. *Kalela B304d* (H3151124), P. *Dusén 15b(2)* (S-B158009), 88 (S-B157882), C. J. Cox 14/00(1) (DUKE0021245); Malleco: Nahuelbuta National Park, B. *Goffinet 5487a* (DUKE0000829); Tierra del Fuego: Estancia Basmen, H. *Roivainen s.n.* (H3150926); Estancia Vicuna, H. *Roivainen s.n.* (H3150925). Total number of specimens studied is 32.

5.8. *Ulota macrodontia* Dusén & Malta, *Acta Horti Bot. Univ. Latv.* 2: 202. 1927. (Figs. 10 and 11).

Type: CHILE. Río Aysén, in ramulis, *Dusén 434*, 14 Jan. 1897 (lectotype S-B157813! designated here; isoelectotype

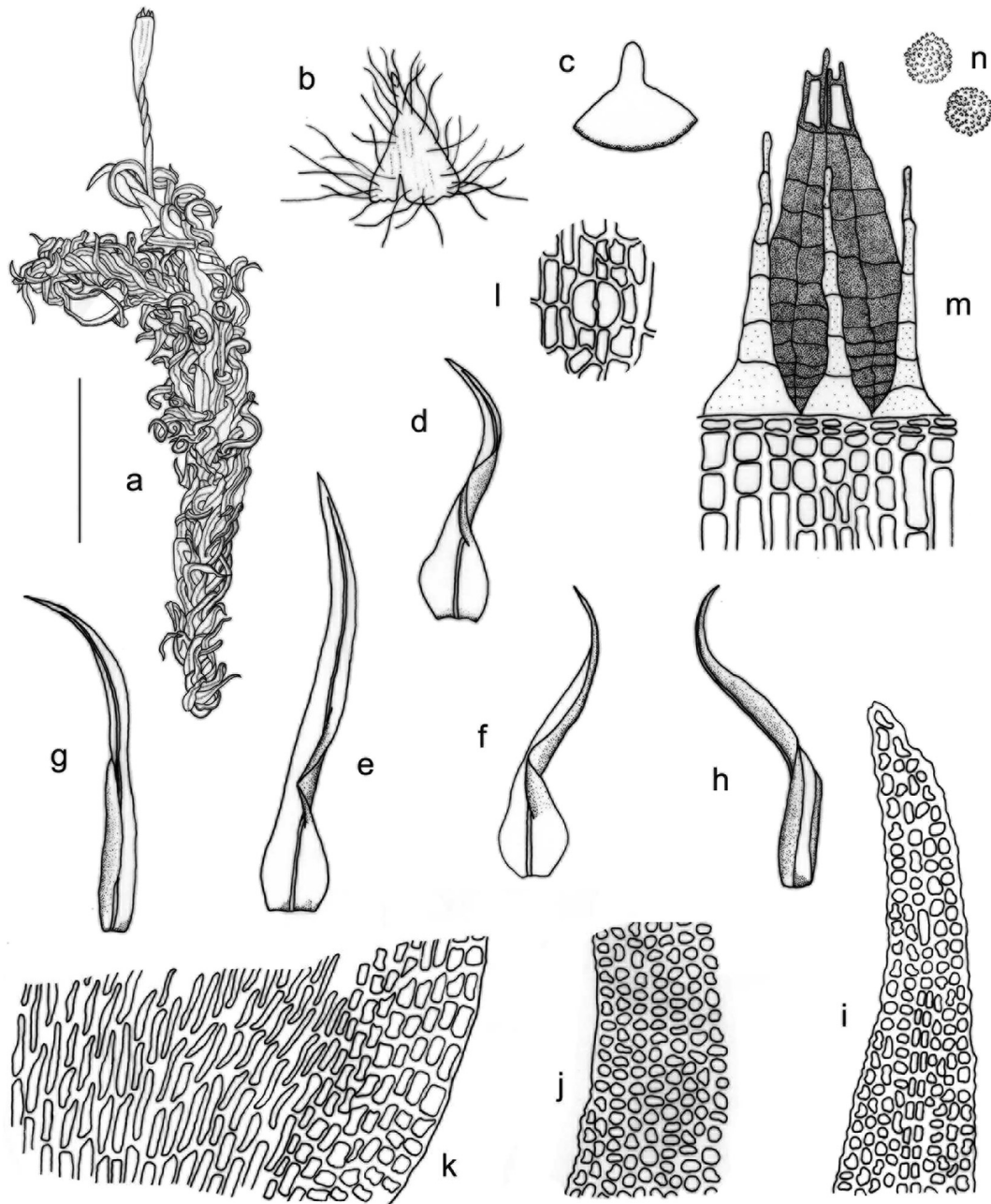
H4334009!); *Dusén 516*, 4 Feb. 1897 (paratype S-B181248!); *Dusén s.n.*, 1897 (paratype S-B157812!).

**Description:** Plants green above, gradually brownish below, 0.5–1.0 cm tall. Leaves strongly crisped, sometimes flexuose when dry, patent to wide-spreading when moist, 1.2–3.0 mm long, lanceolate from a broader rounded base, acuminate. Costa strong, ending just below the apex. Upper and middle laminal cells irregularly rounded, thick-walled, with ca. 2 low papillae per cell; basal inner cells linear, elongate rectangular, vermicular, smooth, thick-walled; basal marginal cells often differentiated in 4–9 rows, hyaline, quadrate to rectangular, with only thickened transverse walls.

Autoicous. Perichaetial leaves somewhat differentiated. Capsules long exserted, cylindrical when moist, weakly constricted when dry, 8 furrows along the entire length; exothelial cells distinctly differentiated into eight bands. Stomata superficial, on the urn. Peristome double; exostome teeth 16, united into 8 pairs, lanceolate, densely and finely papillose on the outside, striate and papillose on the inside, often revolute when dry; endostome segments 16, narrow lanceolate, almost as tall as exostome, hyaline or pale yellow, smooth on the outside, slightly papillose on the inside. Opercula with a short beak. Calyptra campanulate, densely hairy. Spores spherical, brownish, finely papillose, 30–43 µm in diameter.

**Habitat and distribution:** Epiphytic, endemic to Chile.

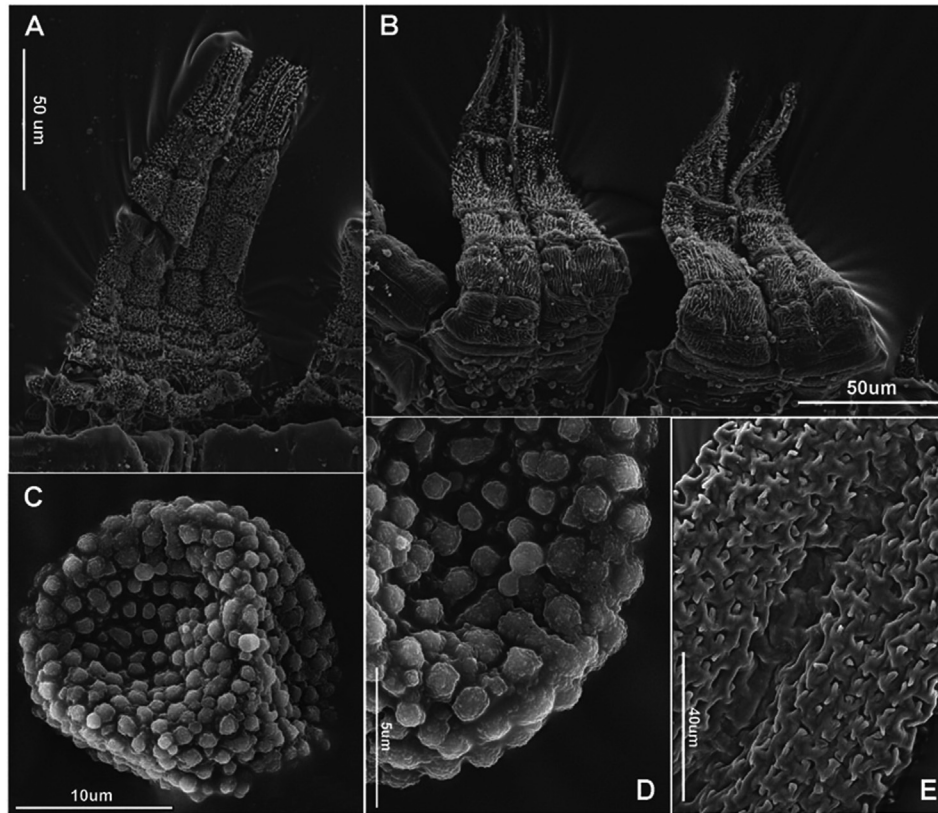
**Discussion:** *U. macrodontia* has been infrequently reported since its original description. Malta (1927) in his protologue recognized this species as crisped leaves, many rows of hyaline cells at basal leaf margin, longer perichaetial leaves, eight endostome segments and densely hairy calyptra. Three specimens were cited by him (1927), including *Dusén s.n.* (in B herbarium), *Dusén 434* (S),



**Fig. 10.** *Uloa macrodontia* Dixon & Malta. **a.** Plant. **b.** Calyptra. **c.** Operculum. **d–f.** Leaves. **g–h.** Perichaetial leaves. **i.** Top laminal cells. **j.** Median marginal cells. **k.** Basal cells. **l.** Stoma. **m.** Portion of peristome. **n.** Spores. (scale bar: a = 2 mm; b = 2.03 mm; c = 0.47 mm; d–f = 0.89 mm; g–h = 1.8 mm & i–n = 0.12 mm; all drawn from the isotype [H4334009]).

*Dusén 516* (herbarium unknown). We found four specimens referred to these three Dusén's collections but no one from B in which it may be destroyed during the war. Among the four specimens, three of them are from S, including B157812, B157813 and B181248, one from H, i.e. H4334009. Now we found three problems about these syntypes: 1. Type collection information is not strictly identical with Malta's citation. For example, the collection date of H4334009 is Jan. 11, different from Malta's citation of Jan. 14. Also, only the collection year "1897" was present in S-B157812, but [Malta \(1927\)](#) clearly indicated it as "Jan. 11, 1897". The collection information of S-B157813 and S-B181248 is well consistent with the protologue. 2. Type materials are mixture of three species. Two of them belong to *Uloa*, one belongs to *Orthotrichum*. 3.

Morphological characters in Malta's illustration are based on different species. As mentioned above, there are two *Uloa* species mixed together in the type materials and both are very similar with Malta's protologue (1927), except segment number of endostome, that one has eight segments, the other has 16 segments, and the former matches well with Malta's description (1927). But at the same time, we found a well-kept picture of *U. macrodontia* in the package of H4334009 and the capsules and peristome in this picture are completely identical with those of Malta's drawings in the protologue. And there was also a densely hairy calyptra in the herbarium picture but absent in Malta's original publication. He indicated that all the characters in herbarium picture are based on the collection of *Dusén 434*, namely S-B157813 and H4334009.



**Fig. 11.** SEM of *Ulota macrodontia* Dixon & Malta. **A.** outside surface of exostome. **B.** inside surface of exostome. **C.** spore. **D.** ornamentation of spores. **E.** surface of leaf cells. (material from isolectotype [H4334009]).

There are two *Ulota* species mixed together in these two types, one possesses long cylindrical capsules and densely hairy calyptra, but 16 endostome segments; another has cylindrical capsules, but eight endostome segments and calyptra hairiness unknown. Confused illustration raise doubt more or less upon the accuracy of Malta's description. According to our observation, the material in the type with eight endostome segments has much longer perichaetial leaves and stomata confined to the transition zone between urn and neck, and thus it should be *U. germana*; while another material with 16 endostome segments bears hardly differentiated perichaetial leaves and stomata restricted to the urn, is different from any other species in *Ulota*. Considering this, we therefore defined the latter as *U. macrodontia*.

The most prominent characters of *U. macrodontia* are the crisped leaves and 16 endostome segments. It is closely related to *U. crispa* in the crisped leaves, remarkably differentiated basal leaf margin and double peristomes. However, *U. crispa* is different in the stomata confined to the transitional zone between urn and neck, and usually eight endostome segments.

**Additional specimens examined:** None.

5.9. *Ulota magellanica* (Mont.) A.Jaeger, Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1872–73: 164. 1874. (Figs. 12 and 13).

≡ *O. magellanicum* Mont., Ann. Sci. Nat., Bot., sér. 2, 19: 242. 1843. Type: CHILE. Magellan, Port Famine, *M. Jaequinot* (lectotype PC0094404! designated here).

*Ulota hamata* Dusén, Rep. Princeton Univ. Exp. Patagonia, Botany 8(3): 82. 1903. Type: CHILE. "Patagonia australis in truncis arborum", *J. B. Hatcher* 67, 1897 (holotype S-B157810! isotype

PC! no barcode; NY). Proposed by Wijk et al. (1969) as a synonym of *U. magellanica*.

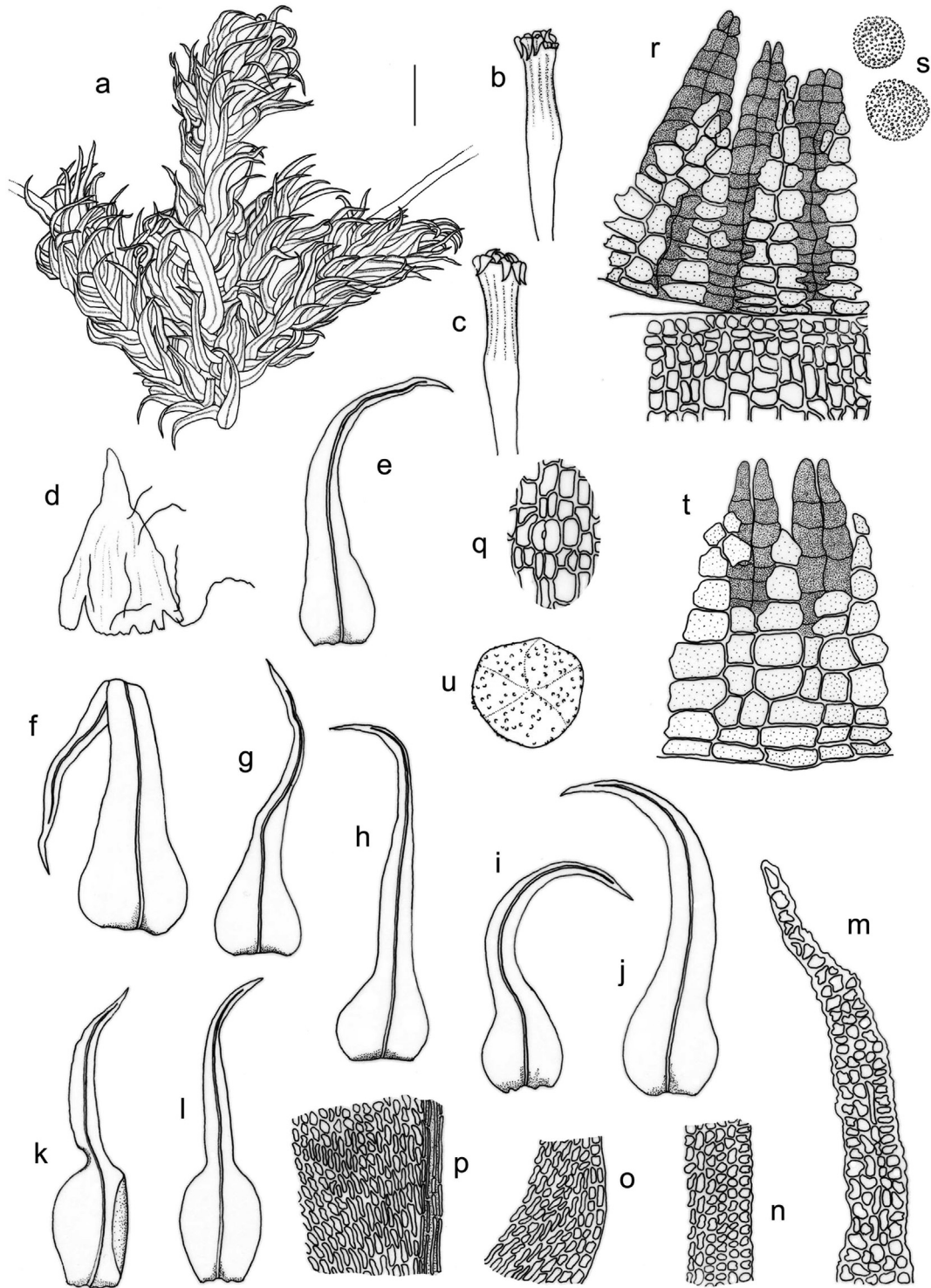
**Description:** Plants green above, brown to black below, less than 1 cm tall. Leaves erect, sinuose at upper part and mostly falcate when dry, patent when moist, 0.8–2.3 mm long, lanceolate with a broad rounded base, acuminate. Costa strong, ending just below the apex. Upper and middle laminal cells irregularly rounded, thick-walled, with low papillae; basal inner cells linear, rhomboidal, elongate rectangular with thickened wall, smooth; basal marginal cells often differentiated in 1–3, rarely 5 rows, hyaline, quadrate to rectangular, with thin or only transversely thickened walls.

Autoicous. Perichaetial leaves not markedly differentiated. Capsules long exserted, cylindrical when moist, strongly constricted when dry, with 8 furrows along the entire length; exothecial cells distinctly differentiated into eight bands. Stomata superficial, at the junction between urn and neck. Peristome double; exostome teeth 16, united into 8 pairs, lanceolate, densely and finely papillose on the outside, striate and papillose on the inside, often revolute when dry; endostome segments 16, broad, lanceolate, as wide as exostome, hyaline, smooth outside, finely striate and papillose inside. Opercula with a short beak. Calyptra campanulate, with few hairs. Spores irregularly spherical, finely papillose, very large, 40–103 μm in diameter, unicellular.

**Habitat and distribution:** Epiphytic, reported from Chile and Argentina.

**Discussion:** *U. magellanica* has been a quite remarkable species until two new species described recently (Garilleti et al., 2012, 2015), i.e. *U. billbuckii* and *U. larrainii*. They are closely related to *U. magellanica* in morphology, including non-crisped leaves,

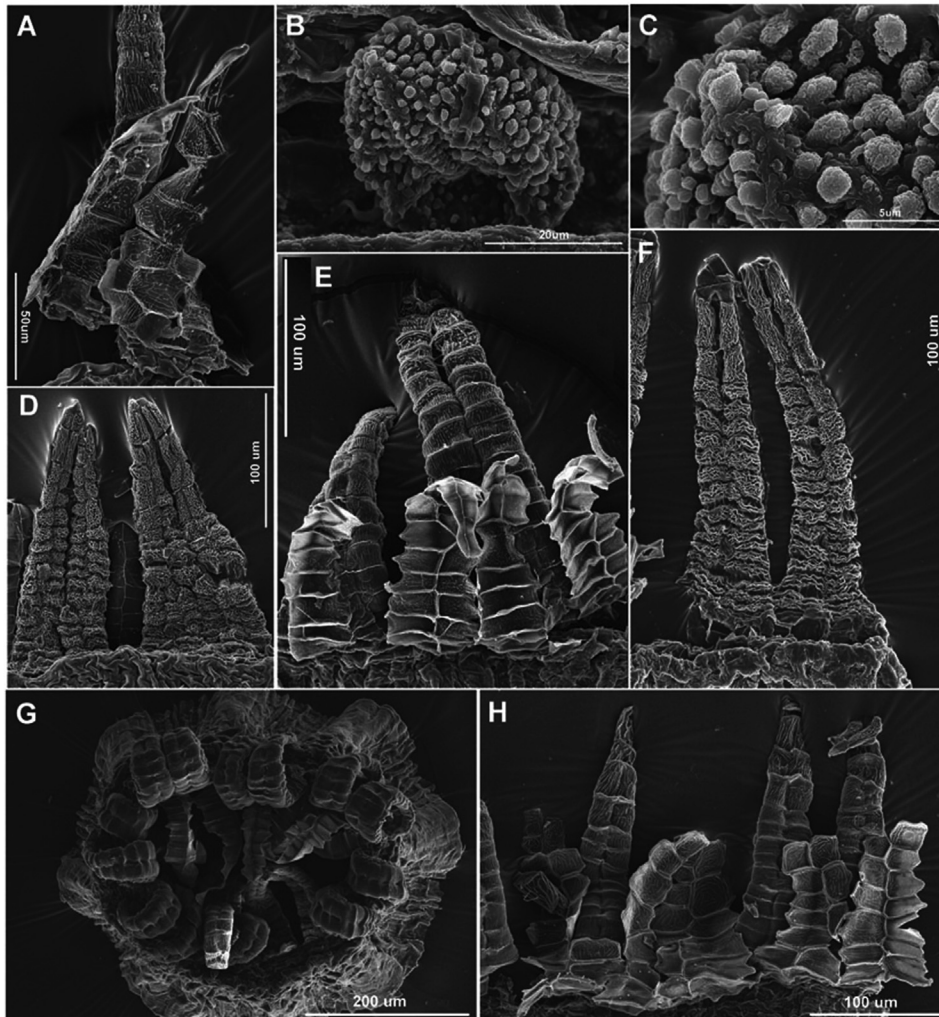




**Fig. 12.** A–S. *Ulota magellanica* (Mont.) A. Jaeger. T–U. *U. billbuckii* Garilieti, Mazimpaka & F. Lara. **a.** Plant. **b–c.** Capsules. **d.** Calyptra. **e–j.** Leaves. **k–l.** Perichaetial leaves. **m.** Top laminal cells. **n.** Median marginal cells. **o.** Basal marginal cells. **p.** Basal laminal cells. **q.** Stoma. **r & t.** Portion of peristome. **s.** Unicellular spore. **u.** multicellular spore. (scale bar: a = 1 mm; b–d = 0.47 mm; e–j = 0.3 mm; k–l = 0.37 mm & m–u = 0.05 mm; a–p & s drawn from the lectotype [PC0094404], r from A. Kalela B296a [H3150817], q from B. Goffinet 5648 [DUKE0000830] and t–u from C. J. Cox 595/00 [DUKE0189156]).

scarcely differentiated basal marginal leaf cells, 16 broad endostome segments and rather large spores. According to their prototypes, *U. magellanica* is different from *U. billbuckii* by the low basal membrane (only 1–2 cell high and sometimes completely absent) and unicellular spores, from *U. larrainii* by the long vaginula hairs,

cylindrical capsules and unicellular spores. We have not seen the type specimens of *U. billbuckii* and *U. larrainii*, and only three non-type collections of *U. billbuckii* were examined, and thus comments here are mostly based on the descriptions of Garilieti et al. (2012, 2015).



**Fig. 13.** SEM. A–E. *Uloa magellanica* (Mont.) A. Jaeger. F–H. *Uloa billbuckii* Garilleti, Mazimpaka & F. Lara. **A, E & H.** inside surface of peristome. **B.** spore. **C.** ornamentation of spores. **D & F.** outside surface of exostome. **G.** capsule mouth. (material: A–C from lectotype [PC0094404], D–E from *N. J. Andersson s.n.* [S-B157957] and F–H from *D. H. Norris 98079* [H3211982]).

**Selected additional specimens examined:** ARGENTINA. Tierra del Fuego: Ushuaia, *P. Dusén 366(1)* (S-B158007, S-B158011, S-B157962 & H4334025), *C. Skottsberg 88* (S-B157960 & PC, no barcode), *89* (S-B157958–59 & PC, no barcode). CHILE. Aisén: Estancia Río Romero, *T. Seki 4/14-28* (H3151090); Antártica Chilena: Isla Navarino, *C. J. Cox 351a/00* (DUKE0188834); Magallanes: Laguna Parrillar, *J. Engel 2074(2)* (H3150927); Otway Water, *C. Skottsberg 454* (S-B157879); Punta Arenas, *P. Dusén 15(1)* (S-B158009 & H4334016), *A. Kalela B287c* (H3150816); Port Famine, *N. J. Andersson s.n.* (S-B157957); Tierra del Fuego: Almirantazgo, *T. Halle & C. Skottsberg 460b* (S-B158026). Total number of specimens studied is 47.

**5.10. *Uloa phyllantha* Brid.** *Muscol. Recent. Suppl. 4:* 113. 1819. (Fig. 14).

Type: DENMARK. “E Danice maritimus. Ludwigius. 1811” (holotype B31024101!).

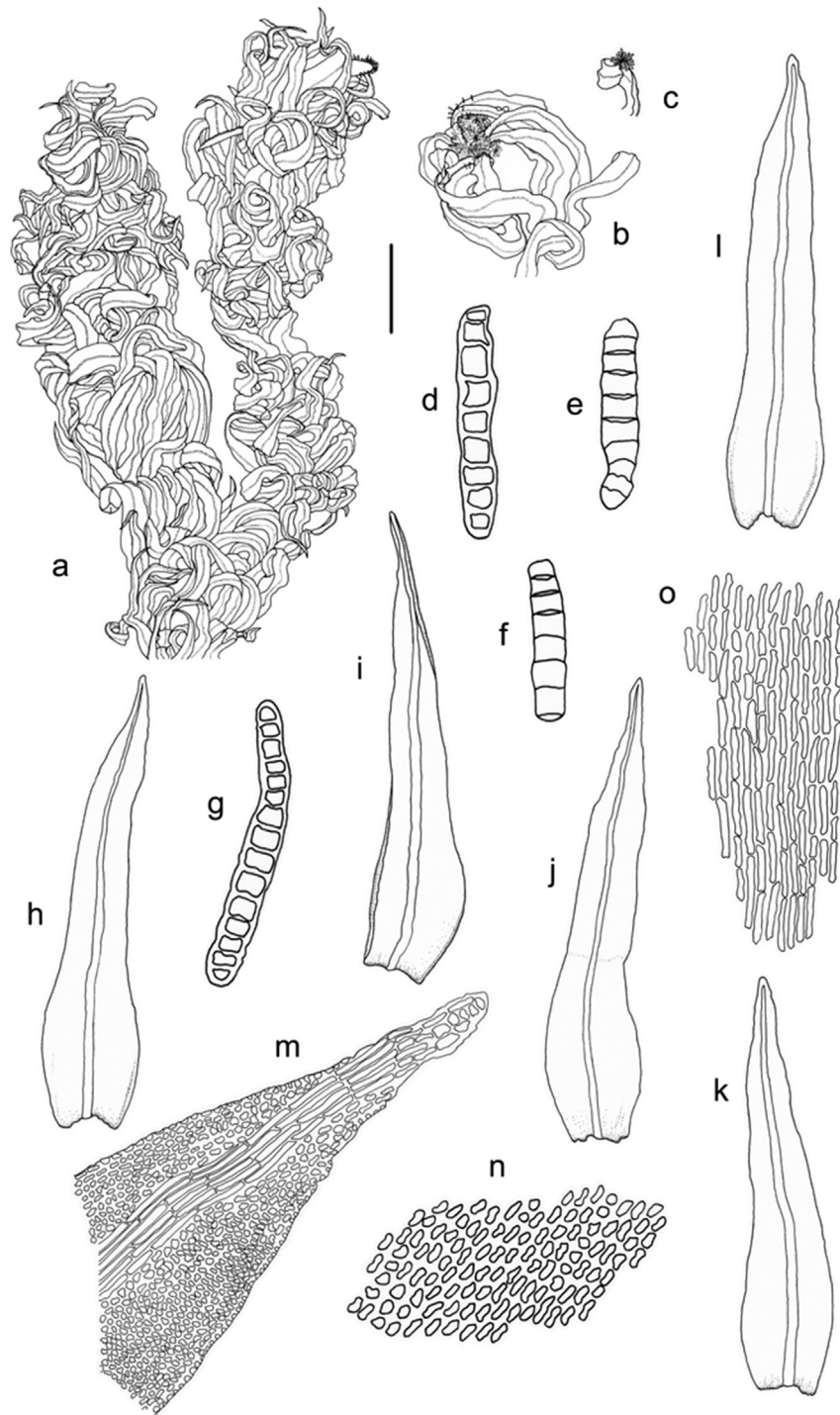
**Description:** Plants green above, gradually brown below, 1.0–2.0 cm tall. Leaves strongly crisped when dry, patent to spreading when moist, 2.8–4.7 mm long, lanceolate to obovate lanceolate, long acuminate. Costa strong, ending just below the apex, sometimes shortly excurrent with many gemmae on it. Upper

and middle laminal cells irregularly rounded, thick-walled, with 1 or 3 low papillae per cell; basal inner cells linear, elongate rectangular, vermicular, smooth, thick-walled; basal marginal cells not differentiated. Gemmae cylindrical or club-shaped, usually abundant on the leaf apex. No sporophyte seen.

**Habitat and distribution:** Epiphytic, known from Chile and Argentina.

**Discussion:** *U. phyllantha* is the most widespread species within *Uloa*, and also one of the most easily diagnosable taxa in the genus. It is dioicous, produces abundant gemmae at the tip of the leaves, which are strongly crisped, and the basal marginal leaf cells are hardly differentiated. Unlike other *Uloa* spp., *U. phyllantha* rarely produces capsules and is exclusively restricted to coastal habitats. Most recently, this species was erected as a new genus (Plasek et al., 2015), i.e. *Plenogemma* Plasek, Sawicki & Ochyra, but we considered that this still needs more strong molecular evidences and thus view this taxon as a member of *Uloa* here.

**Additional specimens examined:** ARGENTINA. Tierra del Fuego: Cabo san Pablo, *H. Roivainen s.n.* (H3150969); Estancia Moat, *D. H. Norris 97062* (H3212002); Bahía Lapataia, *H. Roivainen s.n.* (H3150971–72), *H. Roivainen 1908* (MICH, no barcode). CHILE. Antártica Chilena: Wollaston Islands, *B. Allen 26689* (MO5648821), *B. Allen 26713* (MO5648820); Tierra del Fuego: Fjardo Martinez, *H. Roivainen s.n.* (H3150970).



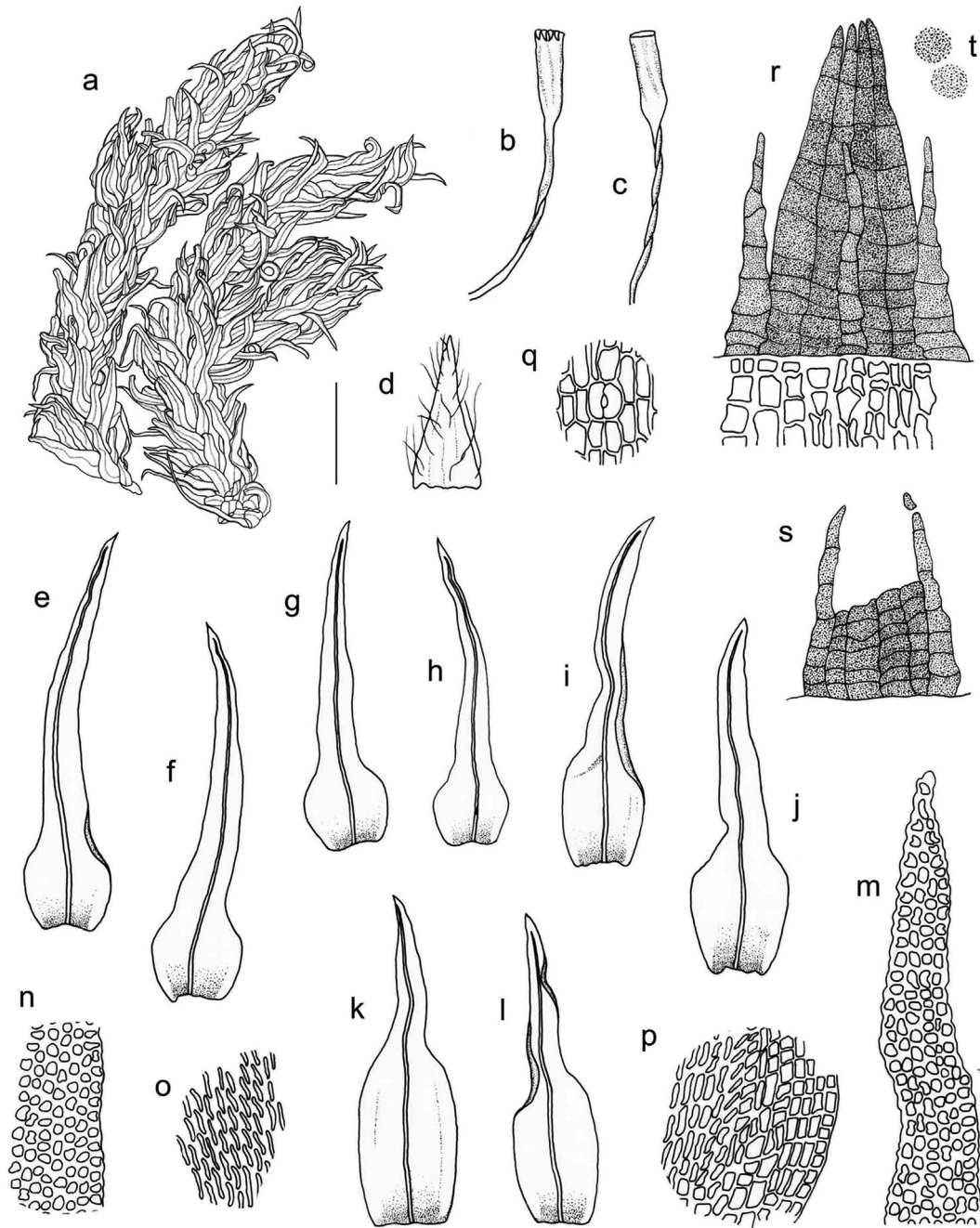
**Fig. 14.** *Ulota phyllantha* Brid. **a.** Plant. **b–c.** Leaves with gemmae. **d–g.** Gemmae. **h–l.** Leaves. **m.** Top laminal cells. **n.** Median marginal cells. **o.** Basal laminal cells. (scale bar: a = 1 mm; b–c = 759  $\mu$ m; d–g = 73  $\mu$ m; h–l = 526  $\mu$ m; m = 111  $\mu$ m; n–o = 55  $\mu$ m; a–c drawn from *H. Roivainen s.n.* [H3150971], d–o from *H. Roivainen 1908* [MICH, no barcode].

5.11. *Ulota pusilla* Malta, *Acta Horti Bot. Univ. Latv.* 2: 193. 1927. (Figs. 15 and 16).

Type: CHILE. Tierra del Fuego, Almirantazgo, *Halle & Skottsberg* 460a, 1908 (holotype H4334003! isotype PC0099346!).

*Ulota lativentrosa* Müll. Hal. ex Malta, *Acta Horti Bot. Univ. Latv.* 2: 194. 1927. **syn. nov.** Type: CHILE. Valdivia, Anden von Villarica, *D. Neger*, 1897 (holotype B; isotype M0155421!).

**Description:** Plants green above, gradually brownish below, less than 1 cm tall. Stems somewhat slender. Leaves erect or flexuose when dry, erect-spreading to patent when moist, 1.3–2.1 mm long, lanceolate with a broader rounded base, acuminate. Costa strong, ending just below the apex. Upper and middle laminal cells irregularly rounded, thick-walled, with 1 or 2 low papillae per cell; basal inner cells linear, elongate rectangular with thickened wall, smooth; basal marginal cells differentiated in 6–9 rows, hyaline,



**Fig. 15.** *Ulota pusilla* Malta. **a.** Plant. **b–c.** Capsules. **d.** Calyptra. **e–h.** Leaves. **i–l.** Perichaetial leaves. **m.** Top laminal cells. **n.** Median marginal cells. **o.** Basal laminal cells. **p.** Basal marginal cells. **q.** Stoma. **r & s.** Portion of peristome. **t.** Spores. (scale bar: **a–c** = 1 mm; **d** = 0.91 mm; **e–h** = 0.45 mm; **i–l** = 0.55 mm & **m–t** = 0.07 mm; **a** & **r** drawn from *B. Ruthsatz s.n.* [H3150924], **q** & **s–t** from *B. Ruthsatz s.n.* [H3150923] and the remainings from the holotype [H4334003]).

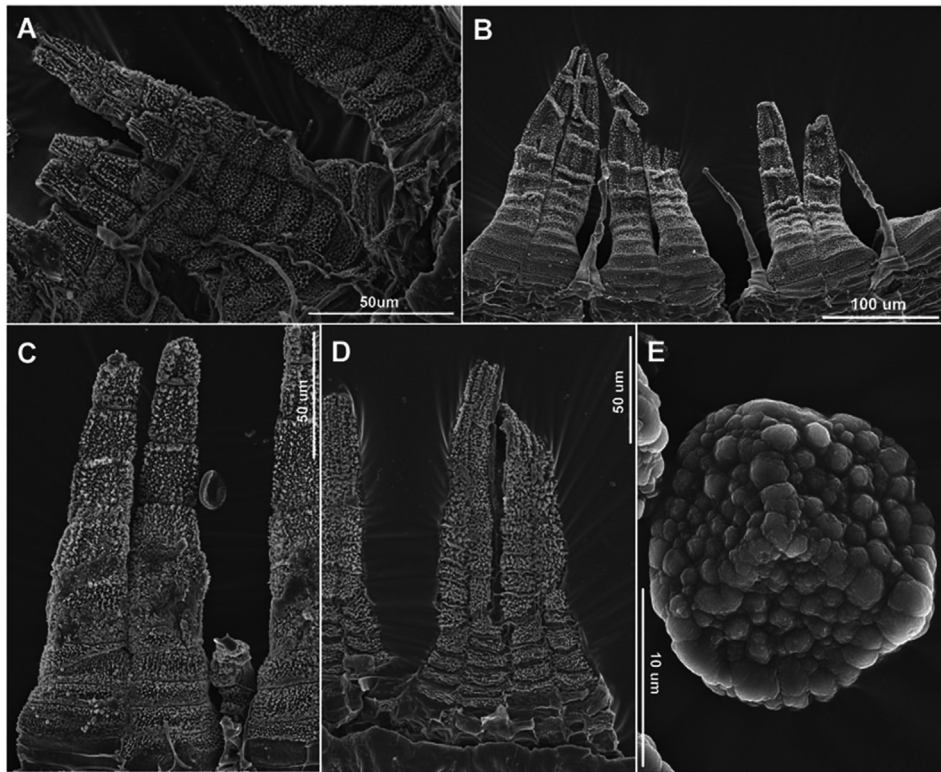
quadrate to rectangular, with thin or only transversely thickened walls.

Autoicous. Perichaetial leaves not markedly differentiated. Capsules long exserted, cylindrical when moist, weakly constricted when dry, 8 furrows along the entire length; exothecial cells clearly differentiated into eight bands. Stomata superficial, on the urn. Peristome double; exostome teeth 16, united into 8 pairs, lanceolate, densely and strongly papillose on the outside, striate on the inside, often revolute when dry; endostome segments 16, as tall as the teeth, sometimes alternatively 8 long 8 short and the short ones occasionally fugacious, lanceolate to linear, yellowish, smooth outside, densely and finely papillose on the inside. Opercula with a

medium long beak. Calyptra campanulate, with few or many hairs. Spores spherical, finely papillose, 25–43  $\mu\text{m}$  in diameter.

**Habitat and distribution:** Epiphytic, known from Chile and Argentina.

**Discussion:** Malta stated in his protologue (1927) that *U. lativentrosa* resembled *U. pusilla* in the basal leaf margin, papillae on leaf cells, capsule neck and peristome, but differed in the cylindrical capsule and much smaller spores. We failed to find any obvious difference in the capsule shape and spore size between these two species after examining their type materials and thus reduced *U. lativentrosa* to a synonym. The main diagnostic characters of *U. pusilla* are non-cripsed leaves, distinctly differentiated



**Fig. 16.** SEM of *Ulota pusilla* Malta. **A & D.** outside surface of exostome. **B & C.** inside surface of peristome. **E.** spore. (all material from *B. Ruthsatz s.n.* [H3150923] except A, which from the holotype [H4334003]).

basal marginal leaf cells, stomata located over the urn and 16 endostome segments with strongly papillose. *U. pusilla* is very similar to *U. macrodontia*, but the latter has crisped leaves and much weaker peristome ornamentation.

Malta (1927) mentioned a non-type specimen of *U. magellanica* (Halle & Skottsberg 460, S-B158026) whose collection information is the same as the type of *U. pusilla*. We cited them respectively as *a* and *b* at this work.

**Additional specimens examined:** ARGENTINA. Chubut: Lago Menéndez, *A. Kalela B248j(1)* (H3150919). CHILE. Cautín: Volcán Villarrica, *B. Ruthsatz s.n.* (H3150923–24); Tierra del Fuego: Canal Whiteside, *R. Santesson M519(2)* (S-B158025); Almirantazgo, *T. Halle & C. Skottsberg* (S-B158029).

**5.12. *Ulota pycnophylla* Dusén ex Malta, Acta Horti Bot. Univ. Latv. 2: 183. f. 6. 1927. (Fig. 17)**

Type: CHILE. Cordillera de la Costa, Angol, an Stämmen, elev. 700 m, *P. Dusén 346b*, 4 Nov. 1896 (holotype S-B115596!).

*Ulota aurantiaca* Dusén ex Malta, Acta Horti Bot. Univ. Latv. 2: 184. f. 7. 1927. **syn. nov.** Type: CHILE. Patagonia, *P. Dusén 15a*, 21 Nov. 1895 (holotype S-B88537!).

**Description:** Plants green above, brownish below, less than 1 cm tall. Leaves erect or slightly flexuose, appressed or slightly open when dry, erect-spreading when moist, 1.0–2.4 mm long, lanceolate from a broad oval base, acute. Costa strong, ending just below the apex. Upper and middle laminal cells irregularly rounded, thick-walled, almost smooth or with short papillae; basal inner cells linear, elongate rectangular, smooth, thick-walled; basal marginal cells differentiated in 5–10 rows, hyaline, quadrate to rectangular, with thin, sometimes slightly thickened walls.

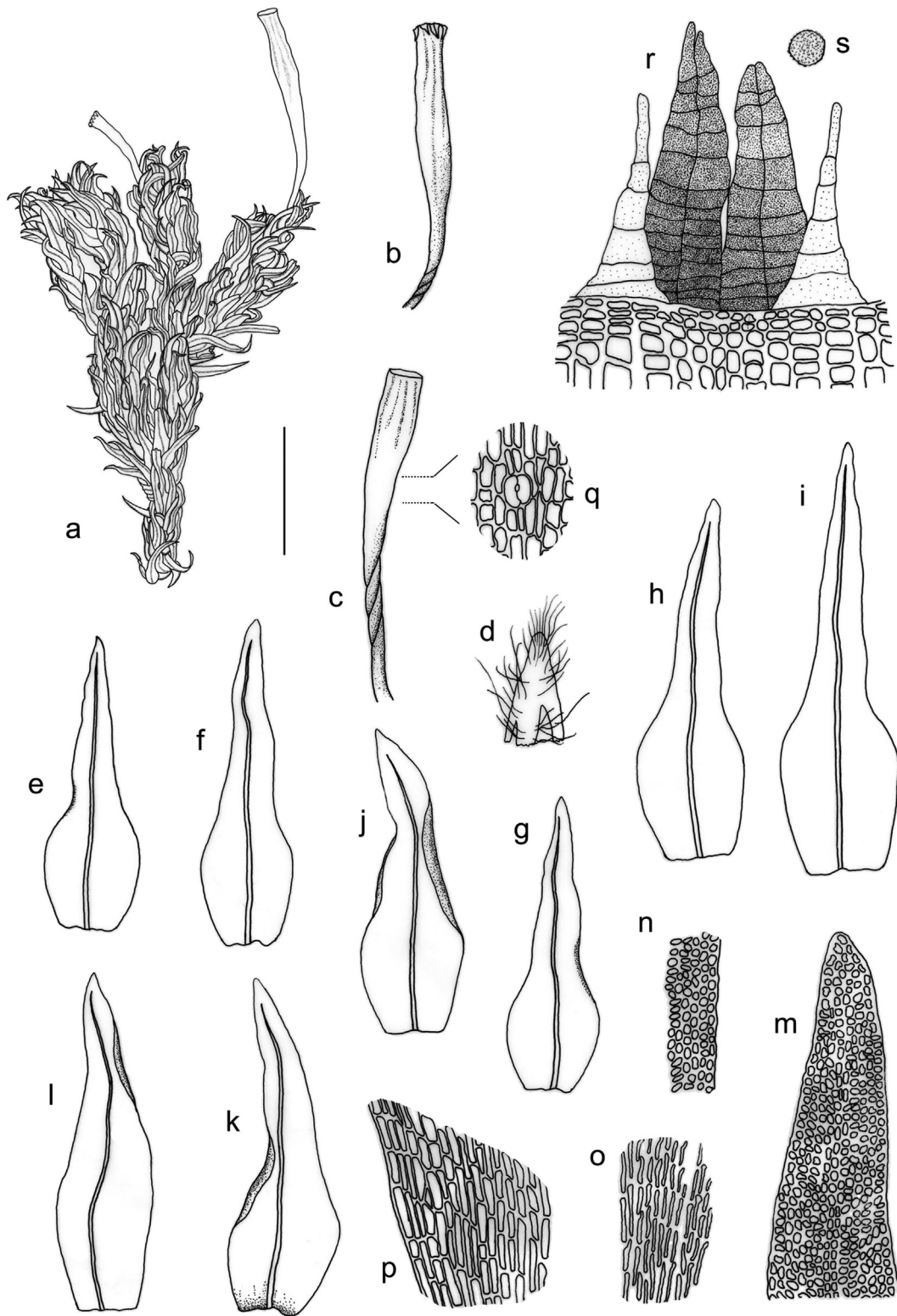
Autoicous. Perichaetial leaves somewhat differentiated. Capsules long exserted, cylindrical when moist, moderately to strongly constricted when dry, 8 furrows along the entire length; exothelial cells clearly differentiated into eight bands. Stomata superficial, at the junction between neck and urn. Peristome double; exostome teeth 16, united into 8 pairs, lanceolate, densely papillose on the outer surface, which fuse into papillose ridges differently orientated on the inner surface, usually revolute when dry; endostome segments usually 8, narrow lanceolate, hyaline or pale yellow, smooth outside, slightly coarse inside. Opercula with a short beak. Calyptra campanulate, densely hairy. Spores spherical, brownish, finely papillose, 18–30 µm in diameter.

**Habitat and distribution:** Only known from Chile where it grows on trees.

**Discussion:** *U. pycnophylla* has been rarely mentioned in previous studies. The dissection of an operculate capsule from the type of *U. pycnophylla* revealed that the endostome is composed of eight segments, but Malta's (1927) found some specimens had more segments. In the protologue, Malta (1927) stated that he did not find calyptra in the type of *U. aurantiaca*. Nevertheless, we saw one in the type, and it is campanulate and hairy. *U. aurantiaca* is similar to *U. pycnophylla* in leaf shape, stomata position, peristome structure and calyptra hairiness, and they are therefore considered conspecific.

*U. pycnophylla* resembles *U. macrocalycina* by its leaves, which are small, erect when dry, have an oval base and many rows of hyaline cells with thin walls. However, the latter is distinguished by the stomata that are formed above the neck in the region of the urn, the exostome teeth not fusing into papillose ridges on the inner surface, and the naked calyptra.

There is a non-type specimen (*P. Dusén 15*, S-B158009) cited by Malta (1927) in *U. macrocalycina*. Its collection information is the



**Fig. 17.** *Ulota pycnophylla* Dusén ex Malta. **a.** Plant. **b–c.** Capsules. **d.** Calyptra. **e–i.** Leaves. **j–l.** Perichaetial leaves. **m.** Top laminal cells. **n.** Median marginal cells. **o.** Basal laminal cells. **p.** Basal marginal cells. **q.** Stoma. **r.** Portion of peristome. **s.** Spores. (scale bar: a = 2 mm; b–c = 1 mm; d = 2.3 mm; e–i = 0.4 mm; j–l = 0.74 mm & n–s = 0.1 mm; all drawn from the holotype [S-B88537] of *U. aurantiaca* except peristome which is from the holotype of *U. pycnophylla* [S-B115596]).

same as the holotype of *U. aurantiaca* and thus we also named them *a* and *b*, respectively.

**Additional specimens examined:** None

5.13. *Uloa rhytiore* (B.H.Allen) F. Lara, Garilleti, Albertos & Mazimpaka, *Bryologist* 111: 323. 2008

≡*O. rhytiore* B.H.Allen, Monogr. Syst. Bot. Missouri Bot. Gard. 90: 639. f. 261. 2002. Type: EL SALVADOR. Chalatenango, Mun. Ignacio, Cantón Río Chiquito, Cerro Pital, finca de los Sres. Portillo, cima de Cerro Pital, elev. 2730 m, 14°23' N, 89°08' W, exposed mountain top, disturbed low mossy forest, *Sipman* 37626A, 21 Nov. 1993 (holotype NY00799474!).

**Description:** Plants green above, brown to black below, ca. 1.6 cm tall. Leaves flexuose, spiral, rarely crisped when dry, patent to spreading when moist, 4.5–5.4 mm long, lanceolate with a broad rounded base, acuminate. Costa strong, ending just below the apex. Upper and middle laminal cells irregularly rounded, thick-walled, with low papillae; basal inner cells linear, elongate rectangular with thickened wall, smooth; basal marginal cells often differentiated in 1–8 rows, hyaline, quadrate to rectangular, with transversely thickened walls.

Autoicous. Perichaetial leaves slightly differentiated. Capsules emergent, fusiform, 8 furrows only near the mouth, strongly constricted when dry. Stomata superficial, at the urn. Peristome apparently absent. Opercula with a long beak. Calyptra campanulate, with many hairs. Spores unknown.

**Illustration:** see Albertos et al., 2008.

**Habitat and distribution:** Habitat unknown, only reported from El Salvador.

**Discussion:** *U. rhytiore* is the only species in Central American within *Uloa* so far and all the available studies are based on the type material, which was scanty when we obtained it. In this case, we did not dissect any capsule from the holotype, and the sporophyte is described based on our observation under stereomicroscope and a previous study (Albertos et al., 2008). It is a very distinct species with apparently no peristome, strongly flexuose leaves, fusiform capsules and stomata present only on the urn. The Chinese species, *Uloa gymnostoma* (Guo et al., 2004), is very similar to *U. rhytiore* in capsule shape, lack of peristome and calyptra hairiness, but differs in the strongly crisped leaves, those being flexuose or spirally twisted in *U. rhytiore*. Additionally, *U. gymnostoma* has short exserted capsules and stomata located at the transition between urn and neck, whereas *U. rhytiore* has emergent capsules and stomata distributed over the urn.

Additional specimens examined: None

5.14. *Uloa streptodon* Garilleti, Mazimpaka & F. Lara, *Bryologist* 115: 594. 2012.

Type: CHILE. Región de Magallanes Y de La Antártica Chilena. Provincia Antártica Chilena. Comuna de Cabo de Hornos. Parque Nacional Alberto de Agostini, south-central coast of Isla Gordon, Caleta Caracoles, NW of Estero Fouqué along SW arm of Beagle Channel, 55°01'57" S, 69°36'41" W, 5 m a.s.l., patches of tundra and disperse small areas of shrubby *Nothofagus betuloides*, horizontal branches of *N. betuloides* close to the shoreline, *R. Garilleti s.n.*, 20 Jan. 2012 (holotype NY; isotype VAL).

**Description:** Plants green above, brownish below, ca. 0.5 cm tall. Leaves strongly flexuose when dry, lanceolate from a broad oval base, acuminate. Costa strong, ending just below the apex. Upper and middle laminal cells irregularly rounded, thick-walled, with short papillae; basal inner cells linear, elongate rectangular,

smooth, thick-walled; basal marginal cells differentiated only one row, hyaline, quadrate to rectangular, with thin or slightly thickened walls.

Autoicous. Perichaetial leaves somewhat differentiated. Capsules short to long exserted, cylindrical when moist, moderately constricted when dry, somewhat puckered at mouth, 8 furrows along the entire length; exothelial cells clearly differentiated into eight bands. Stomata superficial, on the urn. Peristome double; exostome teeth 16, united into 8 pairs, lanceolate, densely and finely papillose, usually recurved when dry; endostome not seen. Opercula not seen. Calyptra campanulate, densely hairy. Spores not seen.

**Illustration:** see Garilleti et al., 2012.

**Habitat and distribution:** endemic to Chile, grow on trees (Garilleti et al., 2012).

**Discussion:** *U. streptodon* is one of three species (including *U. billbuckii* and *U. larrainii*) with multicellular spores in South America. Besides that, it also can be distinguished by the erect leaves, only 1–2 rows of hyaline basal marginal leaf cells, puckered capsule mouth and rudimentary or sometimes absent endostome segments. *U. streptodon* resembles *U. billbuckii* and *U. larrainii* in the non-crisped leaves and the giant multicellular spores, however, the latter two species have well-developed endostome segments and capsules without a puckered mouth. We have seen only one collection referred to *U. streptodon* during this work and a more complete description and detailed discussion were provided by Garilleti et al. (2012).

**Additional specimens examined:** CHILE. Ranco: Cordillera Pelada, *G. Hollermagor s.n.* (S, no barcode).

## 6. Doubtful Taxa

6.1. *Uloa angustissima* Müll. Hal., *Hedwigia* 36: 104. 1897.

Type: CHILE. Valdivia, *Dr. H. Hahn*, 1888 (holotype G; isotype S-B88536! NY).

*U. angustissima* has been ignored by bryologists for a long time. Müller (1897) in the protologue stated that the spirally twisted leaves distinguish it from all other species in *Uloa* and this character made us think of the suggestions of Brotherus (1925) and Malta (1927) that this taxon probably belongs to *Macromitrium*. The type specimen from S is very poor, consisting only of several stems and a fragmentary capsule. We could only observe that the species has flexuose to moderately crisped, lanceolate leaves with a rounded base, 4–5 rows of hyaline cells at the basal leaf margin with only thickened transverse walls, and stomata located at the middle of capsule. The type specimens in NY and G are not available for us, but we obtained their photos from the website of Global Plants. The morphology of these three types is generally consistent. The material from NY is also fragmentary according to the photos but that in G is much better, especially we can see the “spirally twisted leaves” and a complete long-exserted capsule in the latter. Therefore, considering all hitherto known characters, including flexuose to crisped leaves, several rows of hyaline cells at leaf base, long seta, stomata confined to the urn, *U. angustissima* has much in common with *U. fuegiana*. Although these features mostly also occur in *U. macrocalycina*, *U. macrodontia* and *U. pusilla*, but the leaves are erect and appressed in *U. macrocalycina*, strongly crisped in *U. macrodontia* and erect to flexuose in *U. pusilla*. We have not observed the peristome of *U. angustissima* and thus cannot reduce it as a synonym of *U. fuegiana* at present work, but we can be sure that this species definitely belongs to *Uloa*, rather than *Macromitrium* as suggested by Brotherus (1925) and Malta (1927).

Moreover, we found two specimens (H4334010 & S-B177720) which have the same collection information with the type of *U. angustissima*, but there were written as “*U. rufula*” on their packages, not *U. angustissima*, and thus they should not be type specimens. Our observation confirmed the previous determination of these two specimens, but some *U. fuegiana* were mixed in H4334010.

6.2. *Ulota ventricosa* (Müll. Hal.) Malta, *Acta Horti Bot. Univ. Latv.* 2: 180. 1927.

≡*Z. ventricosus* Müll. Hal., *Linnaea* 18: 668. 1845. Type: “in agro Chilensi, ubi legit Philippi”.

*U. ventricosa* has rarely, if ever, been mentioned in the literature. Malta (1927) cited only two specimens of *U. ventricosa* in his protologue (*Philippi s.n.* & *P. Dusén s.n.*) and both deposited in B herbarium. But we have not obtained any information about them by requesting loan or searching in the herbarium database, neither in any other herbaria consulted. Only a non-type specimen as *U. ventricosa* (Fuegia, Beagle Canal, leg. M. Günsede 357, Mar. 1922) was found in S (no barcode) so far, but the material is little, consisting of three incomplete branches, and its morphology agrees well with *Orthotrichum bicolor* Thér., rather than *Ulota* species. But this is not type and thus cannot be used to define *U. ventricosa*. In fact, *U. ventricosa*, in Malta's protologue (1927), has undifferentiated basal leaf margin, eight pairs of exostome teeth and sixteen endostome segments. It was considered by Malta (1927) to be related to *U. magellanica*, but *U. ventricosa* differs in the wide-spreading leaves and naked calyptra. These distinctions, however, are obviously weak and thus it is most likely to be a synonym of *U. magellanica*. Although Malta (1927) gave detailed description and illustration of *U. ventricosa*, considering it has not been reported for a quite long time, it is not possible for us to settle the taxonomic position of this taxon only from the protologue.

## Acknowledgments

This work is supported by the National Nature Science Foundation of China (No.31400188). Some important work in this paper was carried out while the first author was a visiting researcher at Botanical Museum (H), Finnish Museum of Natural History in 2014. She is most grateful to the directors, Marko Hyvärinen, and the Senior Curator of Bryophytes, Sinikka Piippo, for giving her this opportunity. Xiaolan He and Yu Sun are gratefully acknowledged for their help in solving many problems in her life and work during this year. All staff members at the Botanical Museum are thanked for their help and friendliness during her stay. Special thanks to Timo Koponen for the scholarship from Finnish Bryological Society, and Teuvo Ahti for translating the handwritten collection information on historical specimens.

The first author also thanks the Curator of Bryophytes in BM (Len Ellis), the director (Arne Anderberg) of Botany and Collections Manager (Jens Klackenborg) in S, and the Curator (Catherine Rausch) of Bryology and Lionel Kervran in PC for their support and cooperation during her short work at these three herbaria.

We thank the curators at B, BM, DUKE, E, H, JE, M, MICH, NY, PC and S for the loans of specimens that made this work possible. Also we are very grateful to Bernard Goffinet and Johannes Enroth for

helpful comments and careful English correction on the manuscript. We thank Mei-Zhi Wang and Ning-Ning Yu for SEM technical assistance. The stipend to live abroad was supplied by the China Scholarship Council.

## References

- Albertos, B., Garilletei, R., Mazimpaka, V., Lara, F., 2008. Reevaluation of *Orthotrichum rhytiore* (Orthotrichaceae). *Bryologist* 111, 323–327.
- Allen, B., 2002. Moss flora of Central America, Part 2. Encalyptaceae – Orthotrichaceae. Missouri Botanical Garden, St. Louis.
- Brotherus, V.F., 1925. *Ulota*. In: Engler, A., Prantl, K. (Eds.), *Die Natürlichen Pflanzenfamilien, Musci*. Wilhelm Engelmann Press, Leipzig, pp. 24–25.
- Crosby, M.R., Magill, R.E., Allen, B., He, S., 2000. A Checklist of the Mosses. Missouri Botanical Garden, St. Louis.
- Dusén, P.K.H., 1903. Patagonian and Fuegian mosses. *Rep. Princet. Univ. Exped. Patagonia, Bot.* 8 (3), 63–104.
- Garilletei, R., Mazimpaka, V., Lara, F., 2012. New *Ulota* species with multicellular mosses, belonging to southern South America. *Bryologist* 115, 585–600.
- Garilletei, R., Mazimpaka, V., Lara, F., 2015. *Ulota larrainii* (Orthotrichoideae, Orthotrichaceae, Bryophyta) a new species from Chile, with comments on the worldwide diversification of the genus. *Phytotaxa* 217, 133–144.
- Guo, S.L., Enroth, J., Virtanen, V., 2004. Bryophyte flora of Hunan province, China. 10. *Ulota gymnostoma* sp. nova (Orthotrichaceae). *Ann. Bot. Fenn.* 41, 459–463.
- Hooker, J.D., 1847. Botany of Fuegia, the Falklands, Kerguelen's Land etc. *Flora Antarct.* 2, 209–574.
- Hooker, W.J., Greville, R.K., 1824. Art. XXIII. Sketch of the characters of the species of mosses, belonging to the genera *Orthotrichum* (including *Schlotheimia*, *Micromitrium* and *Ulota*), *Glyphomitrium*, and *Zygodon*. *Edinb. J. Sci.* 1, 110–133.
- Kindberg, N.C., 1897. Species of European and Northamerican Bryineae (Mosses). Part 2, pp. 153–420.
- Malta, N., 1927. Die *Ulota*-Arten Süd-Amerikas. *Acta Horti Bot. Univ. Latv.* 2, 165–208.
- Malta, N., 1933. A survey of the Australasian species of *Ulota*. *Acta Horti Bot. Univ. Latv.* 7, 1–24.
- Mitten, W., 1860. Descriptions of some new species of Musci from New Zealand and other parts of the Southern Hemisphere, together with an enumeration of the species collected in Tasmania by William Archer, arranged upon the plan proposed in the Musci Indiae Orientalis. *J. Proc. Linn. Soc. Bot.* 4, 64–100.
- Mitten, W., 1869. Musci Austro-Americani. *J. Linn. Soc. Lond. Bot.* 12, 1–632.
- Mohr, D.M.H., 1806. Observations on *Orthotrichum* and *Neckera*, together with some other genera of mosses. *Ann. Bot.* 2, 532–547.
- Montagne, C., 1843. Quatrième centurie de plantes cellulaires exotiques nouvelles. *Ann. des Sci. Nat. Bot. sér 2* (19), 238–266.
- Montagne, C., 1845. Cinquième centurie de plantes cellulaires exotiques nouvelles. Décades I a VI. *Ann. des Sci. Nat. Bot. sér 3* (4), 86–123.
- Müller, C., 1845. Beiträge zu einer Flora der Aequinoctial-Gegenden. *Laubmoose*. *Linnaea* 18, 667–709.
- Müller, C., 1885. *Bryologia Fuegiana*. *Flora* 68, 391–429.
- Müller, C., 1897. *Prodrum bryologiae Argentinae atque regionum vicinarum III*. *Hedwigia* 36, 84–144.
- Plasek, V., Sawicki, J., Ochyra, R., Szczecinska, M., Kulik, T., 2015. New taxonomical arrangement of the traditionally conceived genera *Orthotrichum* and *Ulota* (Orthotrichaceae, Bryophyta). *Acta Musei Silesiae, Sci. Nat.* 64, 169–174.
- Robinson, H., 1975. The mosses of Juan Fernandez Islands. *Smithson. Contributions Bot.* 27, 1–88.
- Sainsbury, G.O.K., 1945. New and critical species of New Zealand mosses. *Trans. Proc. R. Soc. N. Z.* 75, 169–186.
- Sainsbury, G.O.K., 1955. A handbook of the New Zealand mosses. *R. Soc. N. Z. Bull.* 5, 217–226.
- Seppelt, R.D., 1978. Studies on the bryoflora of Macquarie Island II. *Ulota phyllantha* Brid. *N. Z. J. Bot.* 16, 21–23.
- Vitt, D.H., 1970. The Family Orthotrichaceae (Musci) in North America, North of Mexico. PhD thesis. University of Michigan.
- Vitt, D.H., 2003. *Ulota*. In: *Bryophyte Flora of North America. Provisional Publication* [accessed 25.09.14.]. available at: <http://www.mobot.org/plantscience/bfna/V2/OrthUlota.htm>.
- Wang, Q.H., Jia, Y., 2012a. A taxonomic revision of the Asian species of *Ulota* Mohr (Orthotrichaceae). *Bryologist* 115, 412–443.
- Wang, Q.H., Jia, Y., 2012b. Three new synonyms of *Ulota crispa* (Hedw.) Brid. (Orthotrichaceae, Bryopsida). *J. Bryology* 34, 303–306.
- Wijk, R van der, Margadant, W.D., Florschütz, P.A., 1969. Index Muscorum. In: *Regnum Vegetabile* 65, Vol. V, pp. 164–170.