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Author(s): Iván A. Valdespino

Source: Novon: A Journal for Botanical Nomenclature, 24(1):96-105.

Published By: Missouri Botanical Garden

DOI: <http://dx.doi.org/10.3417/2011022>

URL: <http://www.bioone.org/doi/full/10.3417/2011022>

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Two New Species and a New Record of *Selaginella* (Selaginellaceae) from Bolivia

Iván A. Valdespino

Departamento de Botánica, Facultad de Ciencias Naturales, Exactas y Tecnología, Universidad de Panamá, Apartado Postal 0824-00073, Panama, Panama. iavaldespino@gmail.com

ABSTRACT. Two new species of *Selaginella* P. Beauv., *S. angustifolia* Valdespino and *S. solomonii* Valdespino, from the department of La Paz in Bolivia are described, and *S. minima* Spring is reported as new to the country. *Selaginella angustifolia* may be confused with *S. chionoloma* Alston ex Crabbe & Jermy from which it differs by the lamina shape and apex type of the median leaves. *Selaginella solomonii* differs from *S. cavifolia* A. Braun, a species with similar median leaves, by its habit, rhizophore distribution on stem, lateral leaf marginal projections, and lack of a laminal flap on sporophylls. This account brings the known number of *Selaginella* species recorded for Bolivia to 37.

RESUMEN. Dos nuevas especies de *Selaginella* P. Beauv., *S. angustifolia* Valdespino y *S. solomonii* Valdespino, recolectadas en el departamento de La Paz en Bolivia son descritas, mientras que *S. minima* Spring se registra por primera vez para este país. *Selaginella angustifolia* puede ser confundida con *S. chionoloma* Alston ex Crabbe & Jermy pero se diferencia de ésta por la forma de la lámina y el tipo de ápice de la hoja medial. *Selaginella solomonii* difiere de *S. cavifolia* A. Braun, una especie con hojas mediales similares, por su hábito, la distribución de los rizóforos en el tallo, las proyecciones marginales de la hoja lateral y por la ausencia de un ala laminar en los esporofilos. Estos nuevos reportes contribuyen al registro de 37 especies de *Selaginella* en Bolivia.

Key words: Bolivia, IUCN Red List, megaspores, Neotropics, *Selaginella*, Selaginellaceae, South America.

The monilophyte and lycophyte flora of Bolivia is still poorly known botanically (Smith et al., 1999) and this assertion certainly applies to *Selaginella* P. Beauv., a heterosporic lycophyte. In the last treatment of *Selaginella* for South America, 26 species were reported to occur in Bolivia (Alston et al., 1981). However, Kessler et al. (2006) noted that two of the species included in that treatment were misidentified taxa not occurring in Bolivia and further

described four new species for this country, one of which, *S. chiquitana* M. Kessler, A. R. Sm. & M. Lehnert, was subsumed under *S. arroyoana* M. Kessler & A. R. Sm. by Huaylla et al. (2010). My preliminary studies on *S. arroyoana* (Valdespino, unpublished), however, suggest this species is not different from *S. cabrerensis* Hieron. In turn and contrary to Kessler et al. (2006), I consider *S. cabrerensis* a distinct species and not a synonym of *S. xiphophylla* Baker.

A checklist of *Selaginella* included in *The Catalogue of the Vascular Plants of Bolivia* (Tropicos®, 2014) listed 36 species occurring in this country. Within this, *S. arenaria* Underw., nom. illeg. (= *S. arenicola* Underw., nom. nov., 1898), a species endemic to the southern United States (Valdespino, 1993a), is reported as also occurring in Bolivia. This is most likely an oversight and surely the intended taxon is the South American *S. arenaria* Baker, which I consider conspecific with, and a synonym of, *S. brevifolia* Baker.

In this paper, *Selaginella angustifolia* Valdespino and *S. solomonii* Valdespino from Bolivia are described as new species and *S. minima* Spring is recorded as new to this country, as previously noted by Valdespino (1995). Based on the literature discussed, together with specimens seen and the work in progress by the author, the number of known *Selaginella* reported from Bolivia is 37 species.

The two new species were collected in upper montane cloud forest at high elevations (2950–3000 m) in the Yungas region on the eastern slopes of the Andes in Bolivia, which is identified as a biodiversity hotspot (Foster et al., 1994; Kitching et al., 2001; Soria-Auza & Kessler, 2007; Gerold et al., 2008). Small trees forming an open canopy, abundant light, and a rich number of epiphytes, mainly mosses and monilophytes, characterize this forest type (Bach et al., 2003). Nevertheless, both new species are epipetric growing in shaded and moist rocks and cliff faces.

A description of the new taxa follows the pattern utilized by Valdespino (1995) and, to allow for a straightforward comparison of the surfaces (e.g., cell

morphology) of the leaves, regardless of leaf type and position on dorsiventral shoots, they are termed upper and lower, following Mital (1969) and Valdespino (1995), as discussed by Valdespino et al. (2014).

1. *Selaginella angustifolia* Valdespino, sp. nov.
TYPE: Bolivia. La Paz: Murillo, Valle del Río Zongo, 2.3 km al N de la cumbre, 16°09'S, 68°07'W, 3000 m, 8 Jan. 1988, J. C. Solomon 17455 (holotype, UC; isotypes, F, LPB not seen, MO, NY, PMA). Figures 1–3.

Diagnosis. *Selaginella angustifolia* differs from *S. chionoloma* Alston ex Crabbe & Jermy by having median leaves narrowly lanceolate (vs. obovate-elliptic to narrowly elliptic) with apices gradually tapering into an acumen 0.14–0.2 mm long (vs. abruptly ending in an arista 0.5–0.7 mm long).

Plants epipetric; stems ascending to suberect, stramineous to chlorophyllous, 4–10 cm, 0.2–0.4 mm diam., inarticulate, not flagelliform, stoloniferous, 2-branched; rhizophores axillary, restricted to the basal one third of the stem, filiform, 0.08–0.16 mm diam. Leaves dimorphic throughout, thin-membranous, both surfaces glabrous, upper surface green, lower surface silvery-green; lateral leaves distant, perpendicular to the stem or slightly ascending, ovate to oblong, 1.8–2.3 × 0.5–0.8 mm; base rounded, acroscopic base slightly to strongly overlapping the stem, basiscopic base not overlapping the stem; margins conspicuously hyaline in a band 2 to 4 cells wide with cells elongate and papillate parallel to margin, papillae in 1 or 2 rows over cell lumen, acroscopic margin short-ciliate along basal half, serrulate along apical half, basiscopic margin entire to minutely serrulate apically; apex shortly acuminate, tipped by 1 to 3 teeth; upper surface consisting of rounded to quadrangular, sinuate-walled cells, some of these cells covered with many (8 to 15) papillae, without idioblasts or stomata, lower surface consisting of elongate, slightly sinuate-walled cells, with conspicuous, papillate (1 or 2 rows) idioblasts and stomata along midrib; median leaves distant, ascending, narrowly lanceolate, 1.8–2 × 0.5–0.6 mm; base rounded; margins conspicuously hyaline in a band 2 to 4 cells wide with cells elongate and papillate parallel to margin, papillae in 1 or 2 rows over cell lumen, sparsely ciliate; apex gradually tapering into a long acumen, acumen 0.14–0.2 mm ending in 1 to 3 teeth; both surfaces without conspicuous idioblasts, upper surface consisting of quadrangular, slightly sinuate-walled cells, some of these cells covered with many (8 to 15) papillae, with stomata

along midrib and outer base, lower surface consisting of elongate, slightly sinuate-walled cells, without stomata; axillary leaves similar to lateral leaves. Strobili terminal on branch tips, lax, slightly flattened, not strongly dorsiventral, 2 or 3 mm; sporophylls monomorphic to subdimorphic, without a distinct laminal flap, ovate-lanceolate to lanceolate, 1.2–1.5 × 0.4–0.6 mm, with a slightly developed, glabrous keel along the midrib; base rounded; margins conspicuously hyaline, shortly ciliate to serrate; apex gradually tapering into a long acumen, acumen ending in 1 to 3 teeth and with both surfaces lacking idioblasts; dorsal sporophylls upper surface green with cells as in median leaves, except for the half that is overlapping the ventral sporophylls where it is hyaline and has elongate, sinuate-walled cells, lower surface greenish hyaline consisting of elongate, sinuate-walled cells, ventral sporophylls with both surfaces hyaline to greenish hyaline, consisting of elongate, sinuate-walled cells. Megasporangia in 2 ventral rows; megaspores orange, tuberculate on proximal and distal faces, the microstructure micro-echinulate and micro-foveolate, 300–330 μm diam. Microsporangia in 2 dorsal rows; microspores flame-scarlet (i.e., deep orange), not measured.

Distribution and habitat. *Selaginella angustifolia* is epipetric on shaded rocks in moist montane forest; the type and one of the paratypes were collected at 3000 m. The new species is known from the Murillo and Sud Yungas provinces of the Yungas region of La Paz, Bolivia.

IUCN Red List category. There are insufficient data to ascertain the complete distributional range, abundance, and possible threats to this species, thus, only a conservation assessment of Data Deficient (DD) can be made at this time, according to IUCN Red List criteria (IUCN, 2012).

Etymology. The epithet of the new species refers to the narrow median leaves.

Discussion. Among Neotropical species of *Selaginella*, *S. angustifolia* may be confused with *S. chionoloma* because of its hyaline leaf margins, but the two species can be separated by the characters of leaf shape and apex as given in the diagnosis. *Selaginella angustifolia* differs further from *S. chionoloma* by having non-flagelliform apices of stem and branches (vs. occasionally flagelliform) and with tuberculate megaspores on proximal and distal faces (vs. the megaspores rugulate or seemingly smooth on proximal face and reticulate

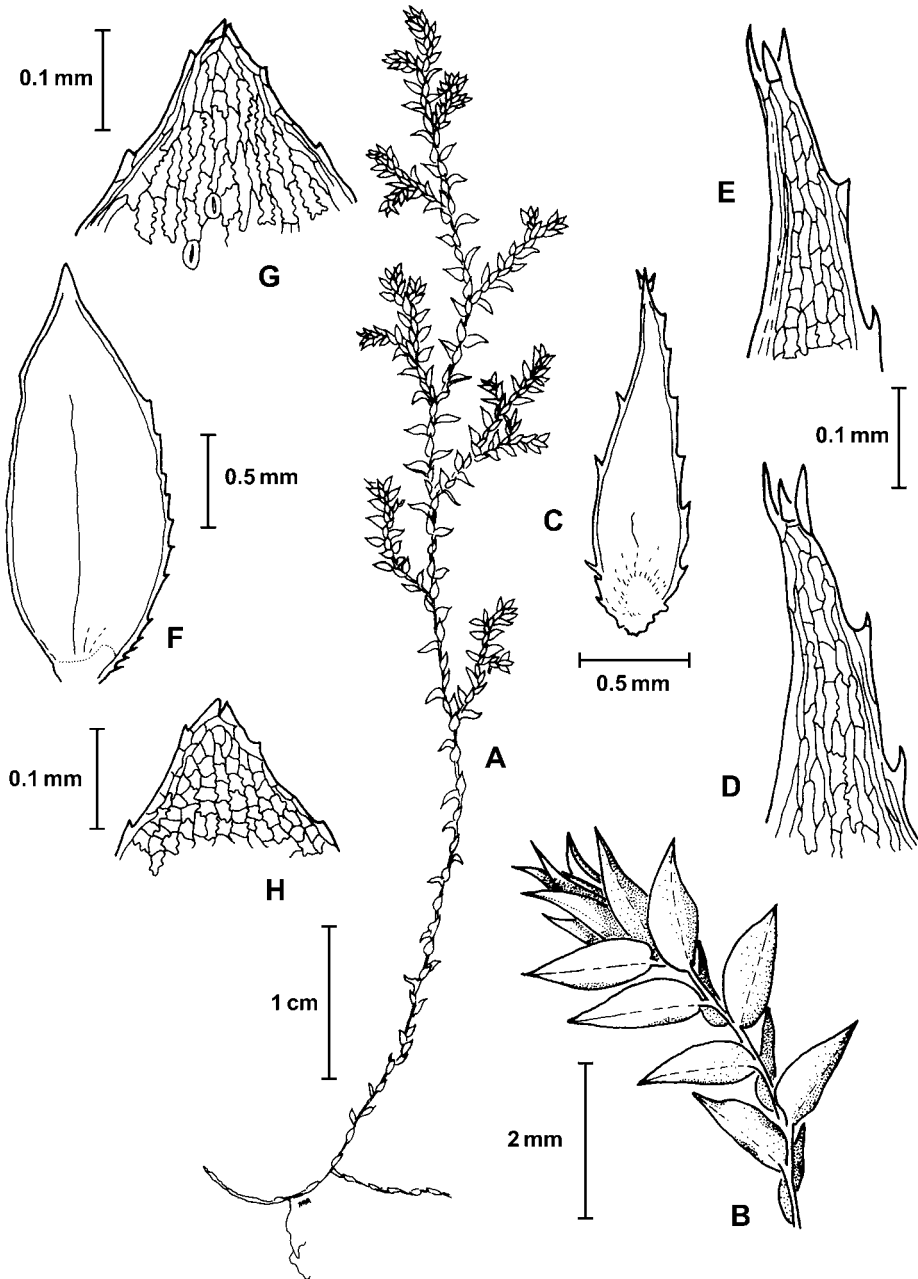


Figure 1. *Selaginella angustifolia* Valdespino. —A. Habit. —B. Branch tip showing juvenile strobilus. —C. Median leaf. —D. Lower surface of median leaf apex. —E. Upper surface of median leaf apex. —F. Lateral leaf. —G. Lower surface of lateral leaf apex. —H. Upper surface of lateral leaf apex. A–H drawn from the holotype *J. C. Solomon 17455* (UC) by A. Arbeláez.

with open reticulum of moderately high ridges on distal face) that are 300–330 μm diam. (vs. 220–240 μm diam. in *S. chionoloma*). *Selaginella novae-hollandiae* (Sw.) Spring is another species with ascending to suberect stems that has been collected (e.g., *Solomon 18825*, MO) around the same general area as *S. angustifolia*, but this species has a more

robust habit, coarser leaf texture, and median leaves broadly ovate to ovate-elliptic with a conspicuous outer auricle and an abruptly aristate apex. *Selaginella angustifolia* and the second species described herein, *S. solomonii*, have similar megaspore sizes and sculpturing patterns, but differ by the characters discussed later.

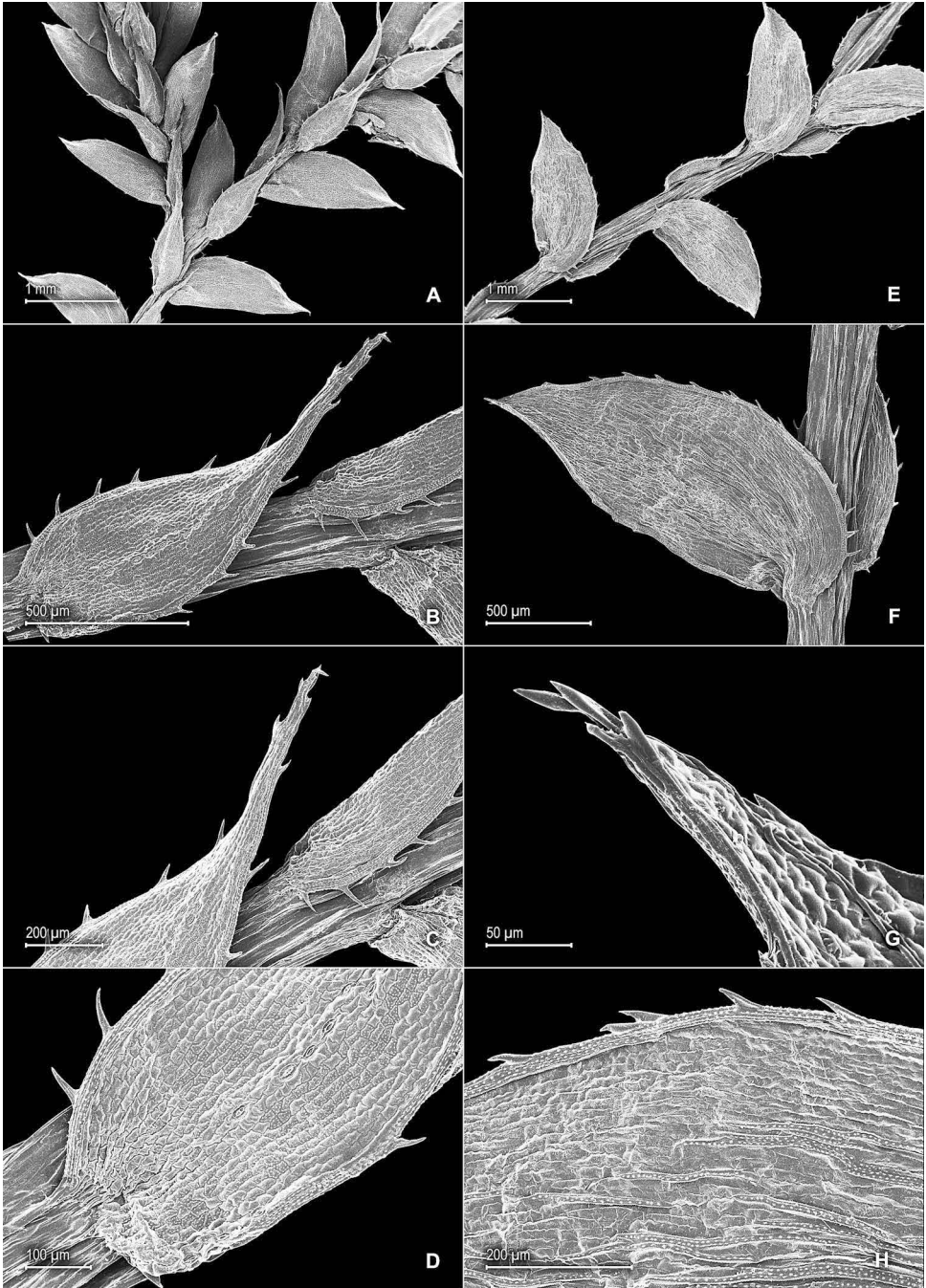


Figure 2. SEM micrographs of *Selaginella angustifolia* Valdespino. —A. Section of upper surface of stem. —B. Upper surface of median leaf. —C. Detail of median leaf apex (upper surface). —D. Detail of basal region of upper surface of median leaf. —E. Section of lower surface of stem. —F. Lower surface of lateral leaf. —G. Detail of lateral leaf apex (lower surface). —H. Detail of lower surface of lateral leaf. A–H taken from the isotype *J. C. Solomon 17455* (MO).

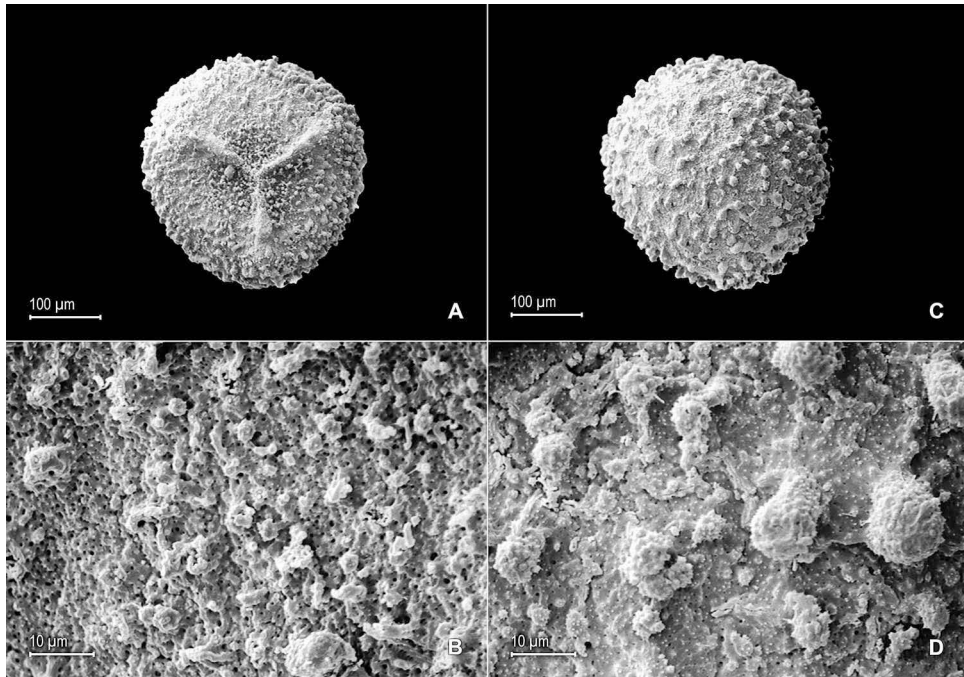


Figure 3. SEM micrographs of *Selaginella angustifolia* Valdespino. —A. Megaspore proximal face. —B. Detail of proximal face, megaspore microstructure. —C. Megaspore distal face. —D. Detail of distal face, megaspore microstructure. A–D taken from paratype *J. C. Solomon 16288* (MO).

Paratypes. BOLIVIA. **La Paz:** Murillo, Valle del Río Zongo, 22.9 km al N de la cumbre, 16°09'S, 68°07'W, 3000 m, 8 Mar. 1987, *J. C. Solomon 16288* (LPB not seen, MO); [Sud Yungas], vic. Yungas & La Paz, Yanacachi, [16°23'0"S, 67°44'0"W], July 1893, *Jay s.n.* (NY).

2. *Selaginella solomonii* Valdespino, sp. nov. TYPE: Bolivia. La Paz: Nor Yungas, 2.4 km below Chuspipata on rd. to Chulumani, 16°19'S, 67°49'W, 2950 m, 4 Mar. 1983, *J. C. Solomon 9676* (holotype, NY; isotypes, LPB not seen, MO, PMA, UC). Figures 4–6.

Diagnosis. *Selaginella solomonii* differs from *S. cavifolia* A. Braun by its ascending to suberect (vs. creeping) stems, rhizophores restricted to the basal one third of (vs. throughout) the stem, acroscopic margin of lateral leaves shortly ciliate along basal half and serrate to serrulate along apical half (vs. serrate to serrulate throughout), and sporophylls monomorphic to subdimorphic (vs. dimorphic) without a laminal flap (vs. with laminal flap slightly or strongly developed).

Plants epipetric; stems ascending to suberect, stramineous to chlorophyllous, 4.5–13 cm, 0.2–0.5 mm diam., inarticulate, not flagelliform, obscurely stoloniferous, 2- or 3-branched; rhizophores axillary, restricted to the basal one third of the stem, filiform, 0.06–0.12 mm diam. Leaves dimorphic throughout,

thin-membranous, both surfaces glabrous, upper surface green, lower surface silvery-green; lateral leaves distant, ascending to slightly perpendicular to the stem, ovate to ovate-lanceolate, 1–1.8 × 0.4–0.8 mm; base rounded, acroscopic base strongly overlapping the stem, basiscopic base not overlapping the stem; acroscopic margin on upper surface chlorophyllous to greenish hyaline, on lower surface hyaline in a band 2 to 4 cells wide with cells elongate and papillate parallel to margin, papillae in 1 or 2 rows over cell lumen, shortly ciliate along basal half, serrate to serrulate along apical half, basiscopic margin greenish, entire along basal half, serrate to serrulate along apical half; apex acute, tipped by 1 to 3 teeth; upper surface consisting of rounded to quadrangular, slightly sinuate-walled cells, some of these cells covered with many (7 to 15) papillae, without idioblasts or stomata, lower surface consisting of elongate, slightly sinuate-walled cells, with conspicuous, straight-walled and papillate (in 2 rows) idioblasts, some of which fuse to form a continuous hyaline band along both sides of midrib, and stomata along midrib; median leaves distant, ascending, ovate-lanceolate, 1–1.3 × 0.4–0.6 mm; base rounded; margins hyaline in a band 2 to 4 cells wide with cells elongate and papillate parallel to margin, papillae in 1 or 2 rows over cell

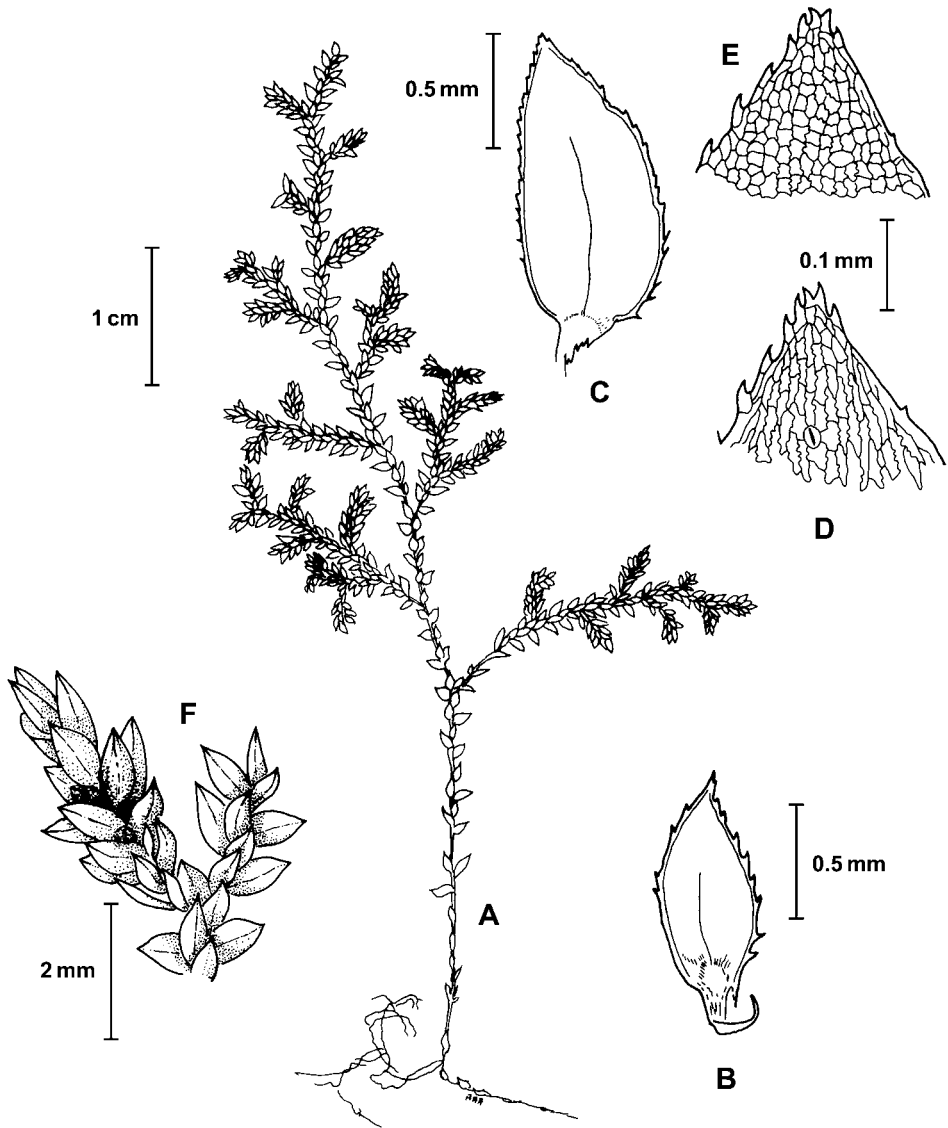


Figure 4. *Selaginella solomonii* Valdespino. —A. Habit. —B. Median leaf. —C. Lateral leaf. —D. Lower surface of lateral leaf apex. —E. Upper surface of lateral leaf apex. —F. Lateral branch tip, showing juvenile strobilus. A–F drawn from the holotype *J. C. Solomon 9676* (NY) by A. Arbeláez.

lumen, sparsely short-ciliate; apex acute to short-acuminate, acumen, if present, 0.1–0.2 mm ending in 1 to 3 teeth; both surfaces without conspicuous idioblasts, upper surface consisting of quadrangular, straight to slightly sinuate-walled cells, some of these cells covered with many (7 to 15) papillae, with stomata along midrib and outer base, lower surface consisting of elongate, slightly sinuate-walled cells, without stomata; axillary leaves similar to lateral leaves or more oblong. Strobili terminal on branch tips, lax, slightly flattened, not strongly dorsiventral, 1.5–2.5 mm; sporophylls monomorphic

to subdimorphic, without a distinct laminal flap, ovate to ovate-deltate, 0.8–1.2 × 0.4–0.6 mm, with a slightly developed, glabrous keel at least along the apical half of the midrib; base rounded; margins greenish to greenish hyaline, shortly ciliate to serrate; apex acute, tipped by teeth; dorsal sporophylls with both surfaces lacking idioblasts, upper surface green with cells as in median leaves, except for the half that is overlapping the ventral sporophylls where it is hyaline and has elongate, sinuate-walled cells, lower surface silvery-green, as in median leaves; ventral sporophylls with obscure

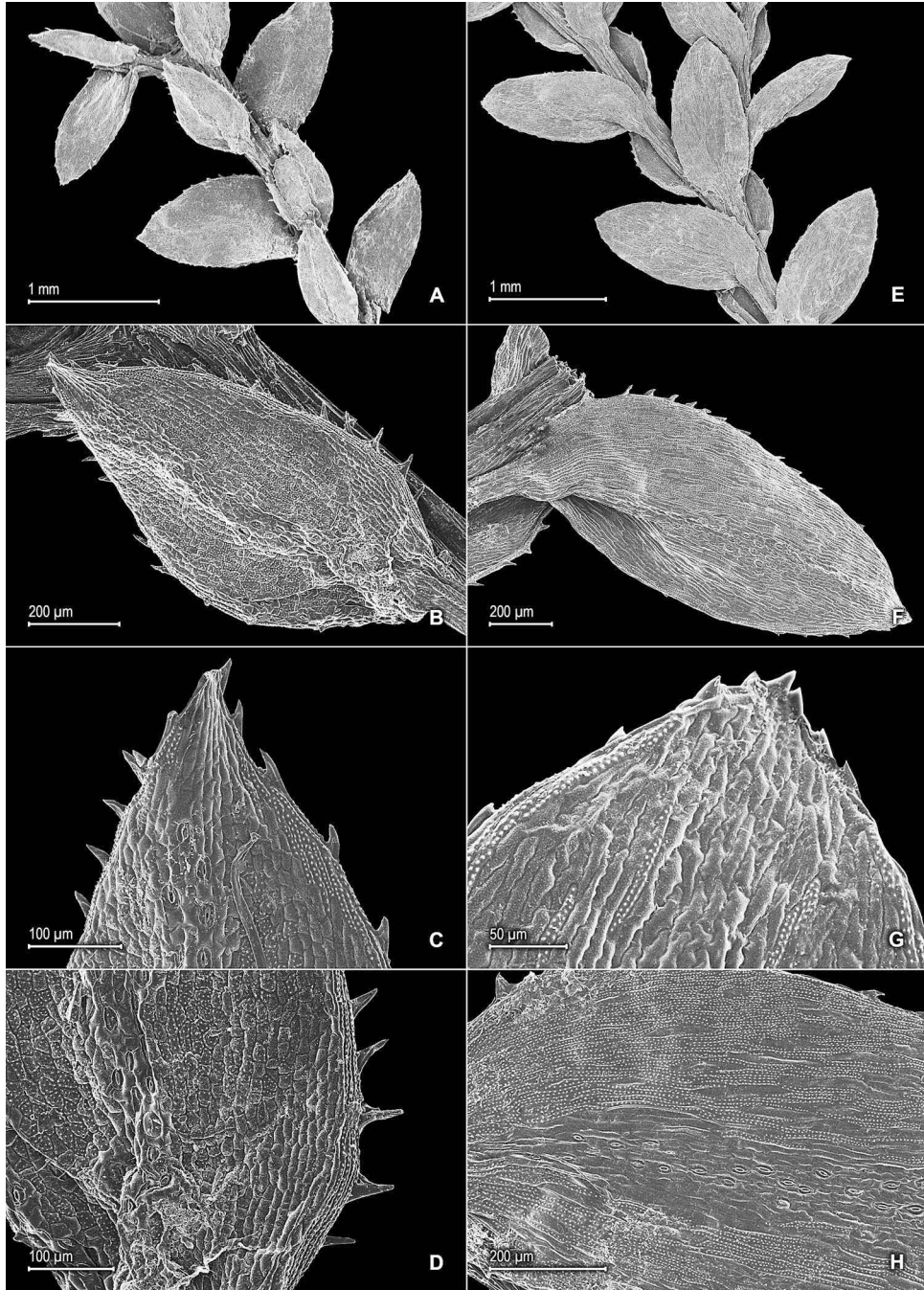


Figure 5. SEM micrographs of *Selaginella solomonii* Valdespino. —A. Section of upper surface of stem. —B. Upper surface of median leaf. —C. Detail of median leaf apex (upper surface). —D. Detail of basal region of median leaf (upper surface). —E. Section of lower surface of stem. —F. Lower surface of lateral leaf. —G. Detail of lateral leaf apex (lower surface). —H. Detail of lower surface of lateral leaf. A–H taken from the isotype *J. C. Solomon 9676* (MO).

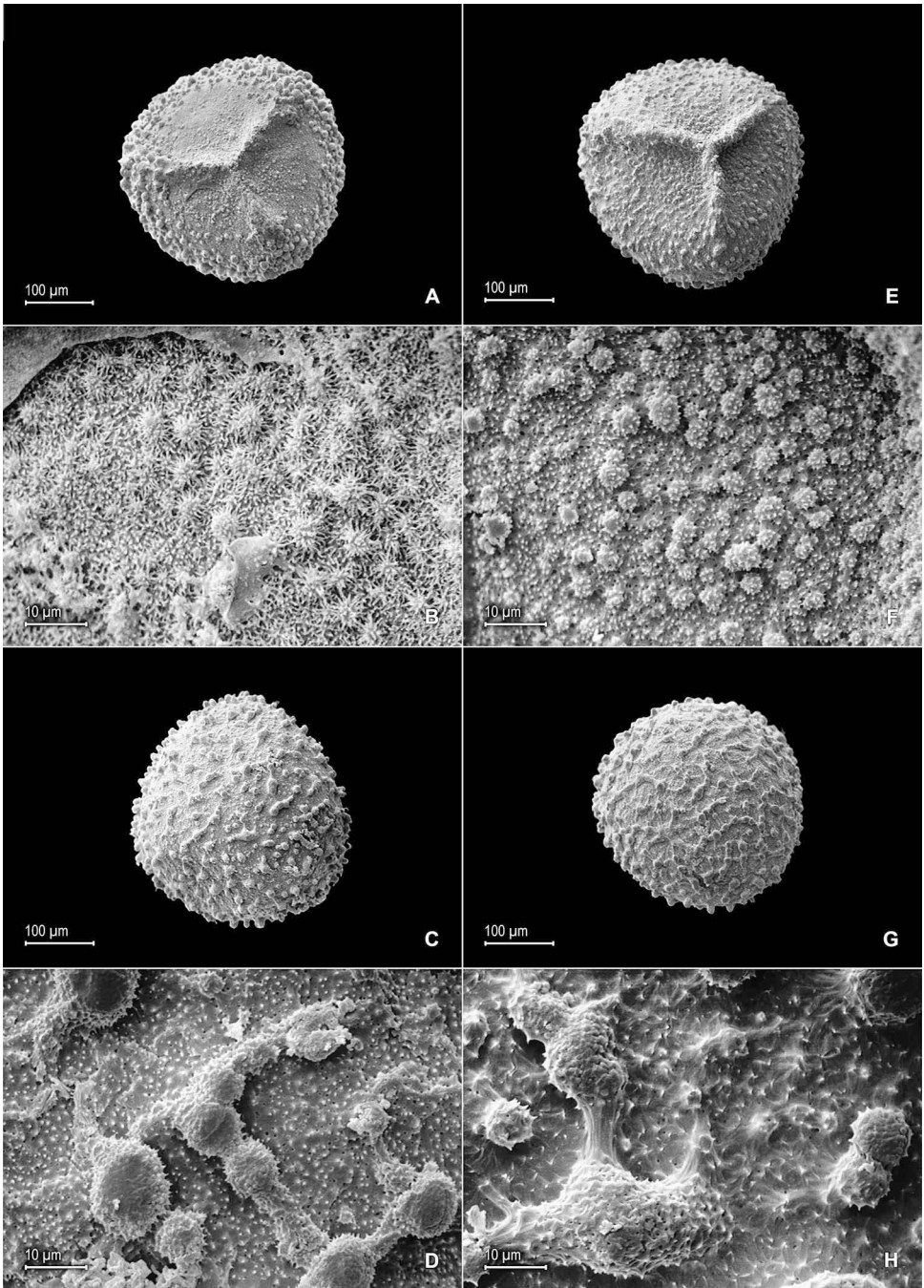


Figure 6. SEM micrographs of *Selaginella solomonii* Valdespino. —A, E. Megaspore proximal faces. —B, F. Detail of proximal face, megaspore microstructure. —C, G. Megaspore distal faces. —D, H. Detail of distal face, megaspore microstructure. A–H from the holotype *J. C. Solomon 9676* (NY).

idioblasts only on the upper surface, both surfaces hyaline to greenish hyaline, made up of elongate, sinuate-walled cells. Megasporangia in 2 ventral rows; megaspores orange, granulate-tuberculate on

proximal face, tuberculate-reticulate on distal face, the microstructure on both proximal and distal faces micro-echinate to micro-verrucate and micro-foveolate, 300–330 μm diam. Microsporangia in 2 dorsal

rows; microspores grenadine red to flame-scarlet (i.e., deep orange), not measured.

Distribution and habitat. *Selaginella solomonii* is epipetric, on a moist cliff face; the type was collected at 2950 m. The new species is known only from the type collection in La Paz, Bolivia.

IUCN Red List category. There are insufficient data to ascertain the complete distribution range, abundance, and possible threats to this species, therefore, only a conservation assessment of Data Deficient (DD) can be made at this time, according to IUCN Red List criteria (IUCN, 2012).

Etymology. *Selaginella solomonii* is named after Dr. James C. Solomon (1952–) a prolific plant collector who has collected the type specimens of the two taxa newly described in this paper and who has tirelessly worked to understand the Bolivian flora, becoming in the process one of the foremost experts in this field.

Discussion. *Selaginella solomonii* shows some variation in the microstructure pattern of the proximal and distal faces of the megaspores. The microechinae on granulate-tuberculae projections of the proximal face may be long (Fig. 6B) or short and look more verrucae-like (Fig. 6F), while the tuberculae projections of the distal face may occur singly (Fig. 6C, D) or become fused to form open to closed reticulae (Fig. 6G, H).

Selaginella solomonii may be confused with *S. cavifolia* because of their similar median leaves and occurrence in Bolivia at the same elevation; however, the characters given in the diagnosis separate them. Furthermore, *S. solomonii* is distinguished from the latter by having megaspores with proximal face granulate-tuberculate (vs. striate-reticulate to reticulate) and distal face tuberculate-reticulate (vs. reticulate in *S. cavifolia*). *Selaginella leucoloma* Alston ex Crabbe & Jermy, another Bolivian species, slightly resembles *S. solomonii*, but differs from it by having median leaves with the base tufted with long cilia and margins hyaline in a band more than four elongated cells wide and fimbriate lateral leaves with short hairs along basiscopic submarginal region, and yellow megaspores.

The color and sculpturing pattern of the megaspores, the ascending to suberect habit, and the minute plant size may relate *Selaginella solomonii* to *S. angustifolia*. Furthermore, specimens examined for both newly described species were gathered in the same department of Bolivia (La Paz). They can be distinguished, however, by *S. solomonii* having wider

median leaves ovate-lanceolate (vs. narrowly lanceolate), with acute to short-acuminate apices (vs. apices gradually tapering into a long acumen), lateral leaves ovate to ovate-lanceolate (vs. ovate-oblong) with acrosopic margin greenish to weakly hyaline (vs. conspicuously hyaline) and acute apices (vs. acuminate), and sporophylls with acute apices (vs. apices gradually tapering into a long acumen).

3. *Selaginella minima* Spring, Bull. Acad. Roy. Sci. Bruxelles 10: 139. 1843. TYPE. French Guiana: *Leprieur s.n.* (lectotype, designated by Mickel et al., in Mickel & Smith [2004]. Mem. New York Bot. Gard. 88: 581, LG; isolectotype, P).

Selaginella minima is rather amply distributed throughout the Neotropics and is known from southern Mexico, Honduras, Nicaragua, Panama, Venezuela, Trinidad, French Guiana, Brazil, and Bolivia (Valdespino, 1995). Here, the species is vouchered for the first time for Bolivia. It is usually found in tropical rainforests to tropical mountain forests from 100 to 1000 m, and on dry and open wooded areas and shaded stream banks. In Bolivia, *S. minima* has also been collected on sandy soil in thin woodland with rock outcrops near the border with Mato Grosso, as previously recorded from Brazil (Valdespino, 1993b).

Selaginella minima is often confused with *S. simplex* Baker, which is also found in Bolivia, because of their similar plant size and general morphology (Valdespino, 1993b; Valdespino, 1995; Mickel et al., 2004). *Selaginella minima* is easily distinguished from *S. simplex* by having leaves and sporophylls with margins hyaline (vs. greenish), median leaves ovate (vs. lanceolate to lance-ovate), and megaspores white (vs. yellow).

Specimen examined. BOLIVIA. **Santa Cruz:** Velasco, camp. Las Torres, margen del Río Iténez (Guaporé), frontera con Mato Grosso, NE Serranía Huanchaca, 24 km S de Flor de Oro, ca. 50 km N del Río Verde, 13°39'S, 60°48'W, 200–400 m, 24 May 1991, *Peña & Foster 210* (F).

Acknowledgments. I am indebted to Alba Luz Arbeláez for kindly rendering the line drawings and to Pedro Argudo for helping to prepare SEM plates. Thanks are due to the curators of F, MO, NY, PMA, and UC who made their collections available, as well as to Mónica Moraes who confirmed the existence of type material at LPB. This paper was written, in part, while I conducted research at the Botany Department of the California Academy of Sciences as a Tilton Postdoctoral Fellow, and as research associate of the Smithsonian Tropical Research Institute in Panama (STRI). The staff of the Botany Department of the California Academy of Sciences deserve my warmest

thanks for their support and also Jorge Ceballos at STRI for his help with SEM work. Additional logistical and institutional support was provided by the dean's office of the Faculty of Natural and Exact Sciences and Technology of the University of Panama, the New York Botanical Garden, and the Autoridad Nacional del Ambiente (ANAM) of Panama. Michael Kessler and John Pruski reviewed earlier versions of the manuscript and made helpful comments. I am grateful to *Novon* reviewers, Steve Churchill and John Wood, who made useful suggestions to improve the manuscript.

Literature Cited

- Alston, A. H. G., A. C. Jermy & R. M. Rankin. 1981. The genus *Selaginella* in tropical South America. *Bull. Brit. Mus. (Nat. Hist.), Bot.* 9: 233–330.
- Bach, K., M. Schawe, S. Beck, G. Gerold, S. R. Gradstein & M. Moraes. 2003. Vegetación, suelos y clima en los diferentes pisos altitudinales de un bosque montano de Yungas, Bolivia: Primeros resultados. *Ecol. Bolivia* 38: 3–14.
- Foster, R. B., T. A. Parker III, A. H. Gentry, L. H. Emmons, A. Chicchon, T. Schulenberg, L. Rodriguez, G. Lamas, H. Ortega, J. Icochea, W. Wust, M. Romo, J. A. Castillo, O. Phillips, C. Reynel, A. Kratter, P. K. Donahue & L. J. Barkley. 1994. The Tambopata-Candamo Reserved Zone of southeastern Peru: A biological assessment. *Rapid Assessment Program Working Papers* 6. Conservation International, Washington, DC.
- Gerold, G., M. Schawe & K. Bach. 2008. Hydrometeorologic, pedologic and vegetation patterns along an elevational transect in the montane forest of the Bolivian Yungas. *Die Erde* 139: 141–168.
- Huaylla, H., R. W. Scotland & J. R. I. Wood. 2010. Further notes on a rare species of *Selaginella* (Pteridophyta – Selaginellaceae) from the Cerrados of eastern Bolivia. *Edinburgh J. Bot.* 67: 69–73.
- IUCN. 2012. IUCN Red List Categories and Criteria, Version 3.1. Second edition. Prepared by the IUCN Species Survival Commission. IUCN, Gland, Switzerland, and Cambridge, United Kingdom.
- Kessler, M., A. R. Smith & M. Lehnert. 2006. Four new species of *Selaginella* (Pteridophyta – Selaginellaceae) from Bolivia. *Edinburgh J. Bot.* 63: 85–93.
- Kitching, I. J., J. Ledezma & J. Baixeras. 2001. An annotated checklist of the Sphingidae of Bolivia (Insecta: Lepidoptera). *Gayana* 65: 79–111.
- Mickel, J. T., A. R. Smith & I. A. Valdespino. 2004. *Selaginella*. Pp. 550–602 in J. T. Mickel & A. R. Smith. *The Pteridophytes of Mexico*. *Mem. New York Bot. Gard.* 88.
- Mital, P. L. 1969. Epidermal studies in the genus *Selaginella*. *Bull. Bot. Surv. India* 11: 150–160.
- Smith, A. R., M. Kessler & J. Gonzales. 1999. New records of pteridophytes from Bolivia. *Amer. Fern J.* 89: 244–266.
- Soria-Auza, R. & M. Kessler. 2007. Estado del conocimiento y conservación de los helechos y plantas afines en Bolivia. *Ecol. Bolivia* 42: 136–147.
- Tropicos®. 2014. The catalogue of the vascular plants of Bolivia. *Tropicos.org*. Missouri Botanical Garden. <<http://www.tropicos.org/Name/40034882>>, accessed 5 September 2014.
- Valdespino, I. A. 1993a. Selaginellaceae. Pp. 38–63 in *Flora of North America* Editorial Committee (editors). *Flora of North America North of Mexico*. Vol. 2. Pteridophytes and Gymnosperms. Oxford University Press, New York.
- Valdespino, I. A. 1993b. Notes on neotropical *Selaginella* (Selaginellaceae), including new species from Panama. *Brittonia* 45: 315–327.
- Valdespino, I. A. 1995. A Monographic Revision of *Selaginella* P. Beauv. subgenus *Heterostachys* Baker in Central and South America. Ph.D. Thesis, The City University of New York, New York.
- Valdespino, I. A., C. López & L. A. Góes-Neto. 2014. Additions to Cuban *Selaginella* (Selaginellaceae). *Phytotaxa* 184: 235–244.