

## **Review of hairy species of Selaginella (Selaginellaceae) of the West Indies, with description of two new species from Cuba**

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Review of hairy species of *Selaginella* (*Selaginellaceae*) of the West Indies, with description of two new species from Cuba

Abstract

Caluff M. G. & Shelton G.: Review of hairy species of *Selaginella* (*Selaginellaceae*) of the West Indies, with description of two new species from Cuba [Novitiae florae cubensis 30]. – Willdenowia 39: 107-119. – Online ISSN 1868-6397; © 2009 BGBM Berlin-Dahlem. doi:10.3372/wi.39.39113 (available via <http://dx.doi.org/>)

Five species of *Selaginella* growing in the West Indies present hairs on their leaves. They are here revised, with full descriptions, illustrations, specimen citations and an identification key. Two of them, both endemic to Cuba, are described as new to science: *S. epipubens*, an acidophilous species from W Cuba (Pinar del Río province and Isla de la Juventud), and *S. urquiolae*, a calcicolous species from W Cuba (Pinar del Río province).

Additional key words: *Pteridophyta*, *Selaginella* subg. *Stachygynandrum*, Greater Antilles, taxonomy, endemism

Introduction

Hairy leaf surfaces are uncommon in *Selaginella* (Crabbe & Jermy 1973). Of the 39 species recorded for Chiapas, Mexico, by Mickel & Beitel (1998), only six possess hairs in some of their parts, as do eight (two of them only on the stem) of the 72 species known from Mesoamerica (Fraile & al. 1995), and only two of 27 species recognised by Alston (1952) in the treatment of *Selaginellaceae* for the West Indies: *S. hispida*, endemic of Jamaica, and *S. plagiochila* of Cuba and Hispaniola.

In this paper two new hairy species are described from Cuba: *Selaginella epipubens* and *S. urquiolae*. To these and the two species recognised as hairy by Alston (1952), we add *S. leonardii*, from Jamaica and Hispaniola, because it presents scarce but evident hairs at the base of the upper face of median leaf auricles. In view of the fact that neither the original nor any subsequent descriptions of this and the other hairy species mention their morphological details in full, we include detailed descriptions not only of the new species but of the previously recognised hairy ones as well. All five species here treated belong to *S.* subg. *Stachygynandrum* (P. Beauv.) Baker.

Key to the species

- 1. Lateral leaves hairy on both faces; median leaves hairy adaxially (NE Cuba and Hispaniola) . . . 1. *S. plagiochila*
- Median or lateral leaves hairy only adaxially . . . 2
- 2. Median leaves hairy only at the lower end of the auricle; lateral leaves glabrous (Hispaniola and Jamaica) . . . 2. *S. leonardii*
- Median leaves glabrous; lateral leaves hairy . . . 3
- 3. Lateral leaves with the basiscopic margin revolute, with only a thin submarginal band of hairs (W Cuba) . . . 3. *S. urquiolae*
- Lateral leaves flat, hairy on almost the whole adaxial face . . . 4
- 4. Median leaves auriculate (Jamaica) . . . 4. *S. hispida*
- Median leaves exauriculate (W Cuba) . . . 5. *S. epipubens*

Revision of the species

The placement of the rhizophores can be (1) dorsal, lowering along one of the sides of the main stem; (2) axillary-dorsal, emerging from the upper part of the

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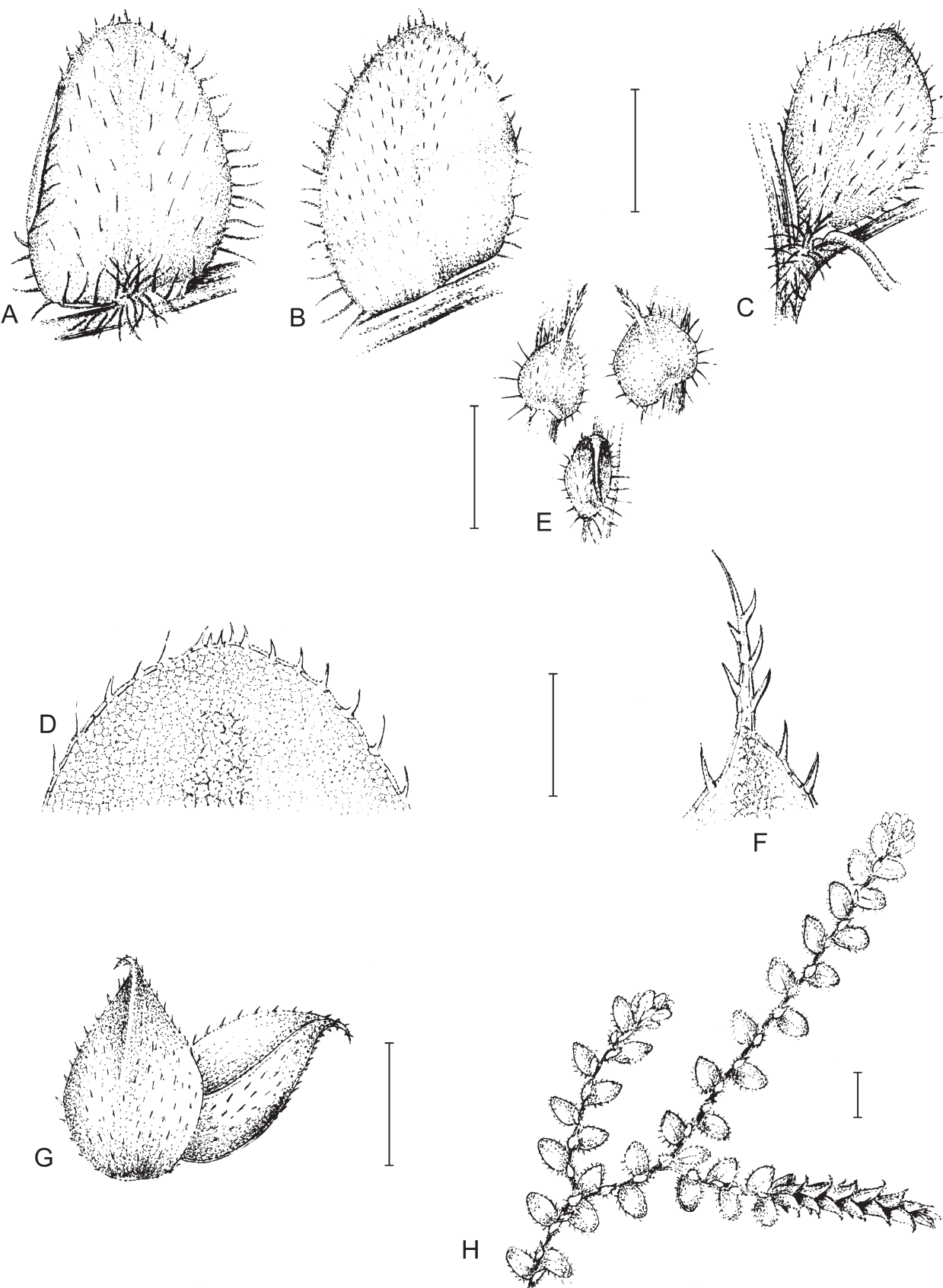


Fig. 1. *Selaginella plagiochila* – A-B: lateral leaves, abaxial side (A), adaxial side (B); C: axillary leaf; D: apex of a lateral leaf; E: median leaves; F: apex of a median leaf; G: sporophylls; H: habit. – Scale bar: A-C, E = 1 mm, D-F = 0.5 mm, G = 1 mm, H = 3 mm. – Drawn by M. G. Caluff from *Caluff 4344* (BSC).

axilla and lowering among two secondary branches; (3) axillary, emerging from the middle of the axilla; or (4) axillary-ventral, emerging from the lower part of the axilla; in the last two cases lowering among the branches of the bifurcation.

The terminology of Lellinger & Taylor (1997) is used to describe spore ornamentation.

**1. *Selaginella plagiochila*** Baker in J. Bot. 21: 212. 1883  $\equiv$  *Lycopodioides plagiochilum* (Baker) Kuntze, Revis. Gen. Pl. 1-2: 827. 1891. – Fig. 1.

– *Selaginella confusa* sensu Griseb., Cat. Pl. Cub.: 271. 1866, non Spring 1838.

– *Selaginella flexuosa* sensu Griseb., Cat. Pl. Cub.: 271. 1866, non Spring 1838.

– *Selaginella lasiophylla* sensu Maxon in J. Wash. Acad. Sci. 14: 199. 1924.

Plants prostrate, musciform, forming intricate mats. *Stem* 6-19 cm long and 0.3-0.5 mm in diameter, monostelic, striate on drying, straw-coloured, neither stoloniferous nor flagelliform nor articulate, pinnately branched, the branches alternate, of irregular length, the largest to 9 cm long, these, in turn, 1-2 times unequally branched. *Rhizophores* filiform, 0.2-0.3 mm in diameter, all along the stem, axillary, axillary-dorsal or dorsal; frequently in a bifurcation, one dorsal, lowering by one side of the principal stem, and another axillary, lowering among the 2 secondary branches. *Leaves* dimorphic, herbaceous, pale to reddish adaxially, slightly paler and somewhat brilliant abaxially, frequently somewhat iridescent, the margins differentiated, of one row of elongate, non-papillate cells. *Lateral leaves* 1.3-2  $\times$  0.8-1.5 mm, approximate to apart 1.5 mm, occasionally imbricate, slightly oblique, ovate, broadly ovate to obovate, equilateral, apex rounded, obtuse to subacute, rarely apiculate, base truncate, sometimes subequilateral, the acroscopic side more pronounced, margins frequently somewhat recurved, long-ciliate at the proximal two thirds, ciliate to ciliolate toward the distal third, long-ciliate at the base, the cilia 0.15-0.3 mm, subopaque, forming a tuft on the leaf insertion area on the abaxial side and frequently borne on the proper stem, the midvein inconspicuous, the adaxial face hairy, the hairs erect, 0.1-0.15 mm and abaxially up to 1.5-0.25 mm long, rarely glabrous or glabrescent, without idioblasts, the cells rectangular, the stomata more copious on both sides of the midvein. *Median leaves* 0.6-0.9  $\times$  0.4-0.6 mm long, apart up to 0.5 mm to occasionally imbricate, lanceolate, ovate-lanceolate, ovate to nearly orbicular, equilateral, acuminate to aristate, the arista less or longer than the half of the laminae, rigidly ciliate, distal part of the leaf frequently incurved, the base straight to oblique, cuneiform, rounded to cordiform, the outer side more pronounced, ciliate, the cilia similar of those of the lateral leaves, usually hairy on the whole adaxial face, the hairs 0.15-0.2 mm, the

surface without idioblasts, the midvein generally prominent. *Axillary leaves* 1.2-1.5  $\times$  0.6-0.9 mm, obovate, equilateral, apex rounded to subacute, base cuneiform to truncate, long-ciliate as in the lateral leaves, the margins somewhat reflexed, ciliate to ciliolate, both faces hairy. *Strobili* terminal on the lateral branches, somewhat compact and quadrangular, 3-11  $\times$  0.9-1.3 mm. *Sporophylls* 0.8-1.2  $\times$  0.6-0.8 mm, uniform, ovoid-attenuate, concolorous, short-aristate, the arista frequently incurved, usually hairy, keel and margins ciliolate to denticulate. *Megaspores* pale orange, 300-400  $\mu$ m in diameter, the exine very slightly verrucose, the verugae more pronounced in the equatorial band. *Microspores* orange, the exine clavate, 20-35  $\mu$ m.

**Specimens seen** — CUBA: SINE LOCO: 1863, *Fraser* 25 (B); 1865, *Fraser* 942 (B); 1865, *Wright* 1825 (S). — PROV. GUANTÁNAMO: Abra del Yumurí, Baracoa, 13.1.1956, *Hno. Alain & C. V. Morton* 5072 (HAC); El Yunque Mountain, Baracoa, 3.1903, *Berkeley* 676 (B), 906 (B, BM); Baracoa, slopes of the Río Báez, near camp Los Naranjos, 1.8.1975, *J. Bisse, L. González & F. K. Meyer* 26854 (HAJB, JE); Imías, Sierra de Imías, La Yamagua, Loma Maestra de Yamagua, 750-850 m, 14.4.1984, *I. Arias* 52859 (HAJB); headwaters of Río De Mola, Cupeyal del Norte, 400-600 m, 28.8.1986, *Caluff* 2188 (BSC), *Caluff & J. Fagilde* 2190 (BSC); western side of Meseta Altos de Iberia, Baracoa, 250 m, 27.2.1998, *Caluff* 4474 (BSC), 4475 (BSC); Río Santa María, Baracoa, 80-100 m, 3.3.1998, *Caluff* 4484 (BSC); Tabajó, Baracoa, 100-200 m, 30.3.1988, *Caluff & J. Reyes* 2659 (BSC); Viento Frío, 550 m, 21.4.1992, *Caluff & Shelton* 3172 (BSC); prope Bayate, Sabana Resuena, 18.7.1914, *E. L. Ekman* 2009 (S); El Manguito Camp, Los Cedrones, near Río Duaba, west side of Río Duaba, 250-300 m, 5.5.1998, *C. Sánchez* 77071 (HAJB); Yunque de Baracoa, Parque Nacional Alejandro de Humboldt, 22.1.2002, *C. Sánchez & al.* 79452 (HAJB); Yunque de Baracoa, 100-500 m, 22.5.2000, *Shelton & Caluff* 4489 (BSC), 4495 (BSC); Arroyo Manglarito, Bahía de Taco, 10-30 m, 25.5.2000, *Shelton & Caluff* 4499 (BSC); Arroyo de Cheíto, Hoyos de Sabanilla, 80-100 m, 7.3.2001, *Shelton & Caluff* 4503 (BSC), 4504 (BSC); prope villam Monteverde, 1865, *Wright* 942 (type, B, BREM, E, HAC [2], GOET, P, K). — PROV. HOLGUÍN: Cliffs of Moa River, Moa, 15.11.1945, *J. Acuña* 12961 (HAC, ULV); Moa, cliffs of Jaragua rivulet, near mine Jaragua, 200 m, 3.5.1980, *A. Álvarez & al.* 42675 (HAJB, JE); southwestern side of Loma El Mirador, 500 m, 9.8.1975, *A. Areces & al.* 27335 (HAJB, JE); La Veguita, Monte de Breña, way to Río Yagrumaje, 300 m, 17.4.1981, *J. Bisse & al.* 44279 (HAJB, JE); rivulet near Alto de La Melba, Moa, 400-460 m, 23.9.1997, *Caluff* 4335 (BSC); surroundings ancient Mina La Melba, Moa, 600-700 m, 24.9.1997, *Caluff* 4336 (BSC), 4337 (BSC); surroundings Mina Mercedita, slopes of Río Jaragua, Moa, 250 m, 25.9.

1997, *Caluff* 4343, 4344, 4346 (BSC); Dos Comadres, La Melba, Moa, 500 m, 26.9.1997, *Caluff* 4348 (BSC); surrounding ancient Aserrío La Melba, Moa, 500 m, 26.9.1997, *Caluff* 4352, 4353 (BSC); Río Cromita, Cayoguan, Moa, 25.7. 1944, *Hnos. Clemente & Alain* 4094 (HAC); slopes of Río Jaragua, near the confluence with the Río Cayoguan, 7.1949, *Clemente & al.* 7113 (HAC); valley of Río Cayoguan, Moa, 30.3.1942, *Hno. León & al.* 20885 (HAC), 20923 (HAC); way from Moa to La Melba, km 10, 30.1.1969, *H. Lippold* 12297 (HAJB, JE).

HISPANIOLA, DOMINICAN REPUBLIC: PROV. SAMANÁ: Summit of Loma Atravezada, 600 m, 14.12.1923, *W. L. Abott* 2941 (US); Península de Samaná, Pan de Azúcar, shaded rocks, 510 m, 4.5.1930, *E. L. Ekman* 14886 (B, S); Península de Samaná, trail Laguna to Rincón de los Naranjos, shaded rocks, 250 m, 20.5.1930, *E. L. Ekman* 15020 (BM, K, S).

**Distribution and habitat** — Northeastern Cuba and Hispaniola. In Cuba serpentinicolous, growing on the ground, on humus or leaf litter, moist or dripping rocks and cliffs, usually along rivers and on ravine slopes, forming extensive patches usually in shaded places, living together with bryophytes, in gallery forest of submontane rainforests, or rarely in mogote vegetation, at 10-850 m; locally frequent.

**Notes** — *Selaginella plagiochila* is remarkable for the extreme variability of the pubescence of its median leaves, even in one and the same plant. In some specimens many leaves are glabrous, which hampers identification, but even in such plants it is possible to spot scattered hairs and seemingly glabrous plants often have a few pubescent leaves.

Plants growing in intense light or on vertical cliff faces develop an extreme habit, having densely crowded and even tightly imbricate leaves with a firmer texture and a darker, reddish shade; also they are less densely pubescent, with smaller hairs and cilia. These plants also present a high fertility, producing numerous strobili of quadrangular shape, with tightly overlapping sporophylls.

*Selaginella plagiochila* is the only species in the West Indies that is hairy on both leaf faces. *S. pubens* A. R. Smith, from northern South America, has the same characteristic (Smith 1990; Valdespino 1992). It differs mainly in its coriaceous leaf texture, not herbaceous as in *S. plagiochila*, the leaf margins being serrate to shortly ciliate, as opposed to long-ciliate to ciliolate in *S. plagiochila*; the lateral leaves are oblong-ovate, with the basiscopic margin reflexed, those of *S. plagiochila* being  $\pm$  broadly ovate, with flat margins; and its median leaves bear a tuft of long hairs in the lower part of the adaxial face, which are absent in *S. plagiochila*.

**2. *Selaginella leonardii*** O. C. Schmidt in Repert. Spec. Nov. Regni Veg. 20: 155. 1924. — Fig. 2.

Plants prostrate, caespitose. *Stem* up to 40 cm long and 0.4-0.6 mm in diameter, monostelic, cylindrical on drying, straw-coloured, neither stoloniferous nor flagelliform nor articulate, pinnately branched, the branches alternate and distant, up to 5 cm long, those in time once branched. *Rhizophores* axillary, filiform, 0.15-0.25 mm in diameter, absent in many bifurcations. *Leaves* nearly uniform, coriaceous, dark greyish green on the upper face, pale green and somewhat lustrous on the lower face, margins of 3-5 rows of cells. *Lateral leaves* 1.5-2.5  $\times$  1-1.5 mm, in the main stem up to 1 mm apart, approximate to imbricate in the branches, strongly ascending, ovate-attenuate, slightly inequilateral, the acroscopic half somewhat wider, apex acuminate to cuspidate, ending in two cilia, base cordiform, with a prominence in the implantation point on the abaxial side, the acroscopic half wider and overlapping the stem, the margins somewhat reflexed, rigidly ciliate, the cilia nearly translucent, numerous, approximate, at the acroscopic margin up to 0.2 mm, the midvein nearly indiscernible, the laminar surfaces glabrous, without idioblasts, the cells rectangular, stomata scarce, disposed at the sides of the midvein. *Median leaves* 1.5-2  $\times$  0.7-1.2 mm, approximate to imbricate, very similar to the lateral ones, white-marginate, auriculate outwardly, auricle lowering and curved inward, hairy on the adaxial face very near the lower edge, the hairs less than 0.1 mm. *Axillary leaves* similar to the lateral ones. *Strobili* ending in the lateral branches, compact, tetragonous, up to 17  $\times$  2.5 mm. *Sporophylls* 1.4-2  $\times$  1.5-2.2 mm, uniform, concolorous, ovoid-attenuate, acuminate, glabrous, keel inconspicuous, glabrous to slightly denticulate toward the apex, margins rigidly ciliate to ciliolate. *Megaspores* cream to pale orange, 300-600  $\mu$ m in diameter, exine finely cristate-verrucate. *Microspores* orange, thin and sparsely tuberculate, 10-20  $\mu$ m.

**Specimens seen** — HISPANIOLA: HAITI: Morne la Visite, 2050 m, 9.8.1924, *E. L. Ekman* 1408 (B); Massif de la Selle, 1250 m, 2.3.1927, *E. L. Ekman* 7754 (B); east side Morne de la Selle, 1650 m, 16.11.1944, *L. R. Holridge* 1989 (BM [2], GH [2], P, S); Massif de la Selle, Parc National Morne la Visite, ravine of Riviera Blanche, 1700-1800 m, 10.5.1984, *W. S. Judd* 4467 (S); vicinity of Missions, Frons Varettes, 1000 m, 17.3. 1920, *E. C. Leonard* 3757 (isotypes: BM, GH). — DOMINICAN REPUBLIC: Vicinity of San Fco. de Macorís, Prov. Pacificador, 400-1000 m, 5.4.1922, *W. L. Abott* 2137 (BM); Barahona, trail between Pedernales and Aceital, 1200 m, 8.8.1946, *E. S. Howard* 8173 (BM, S). — JAMAICA: Near Troy, 2000 ft., 4.1916, *W. N. Clute* 909 (B), 23.3.1917, *W. N. Clute* 1370 (B).



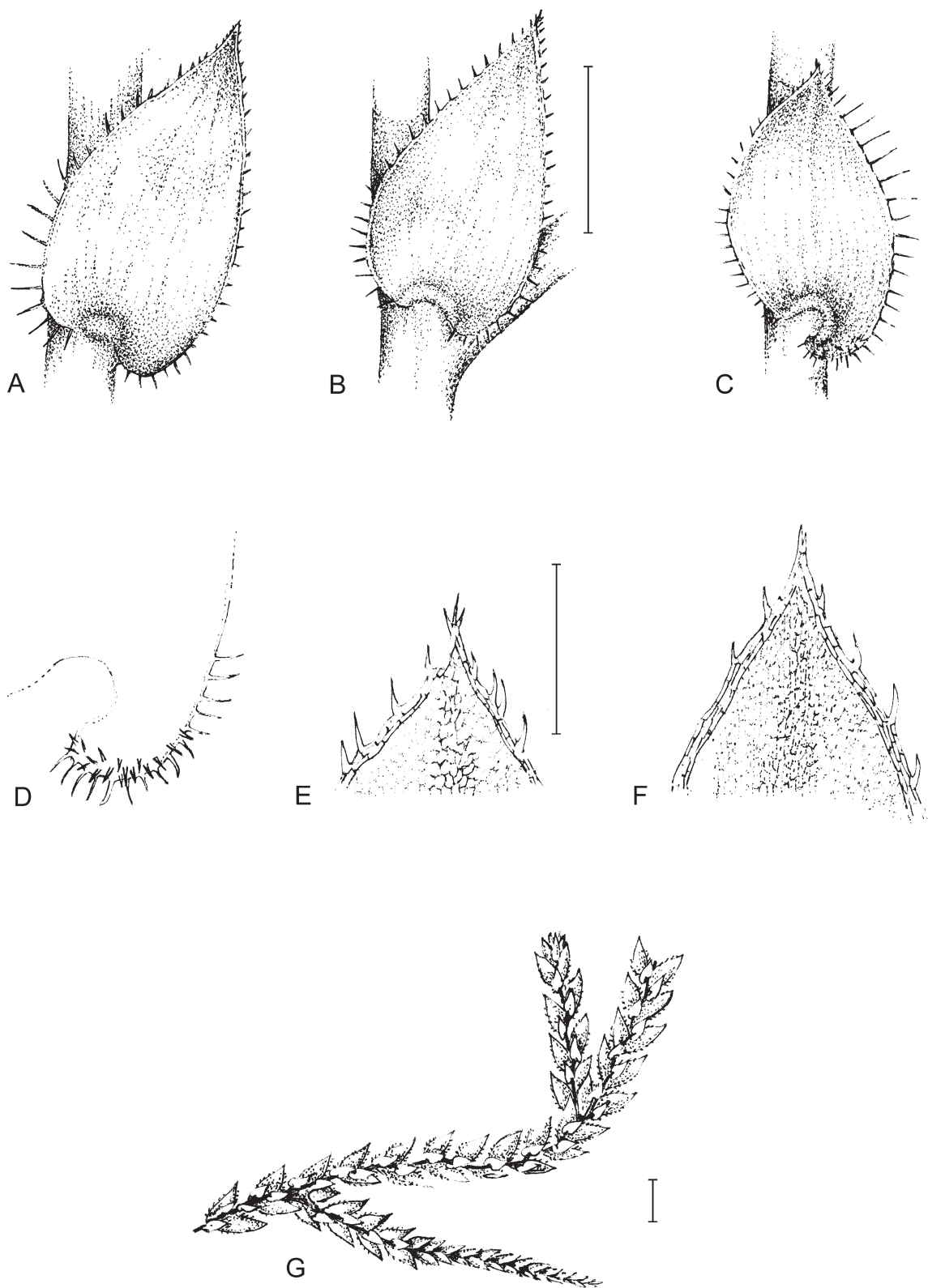


Fig. 2. *Selaginella leonardii* – A: lateral leaf; B: axillary leaf; C: median leaf; D: median leaf auricle; E: apex of a median leaf; F: apex of a lateral leaf; G: habit. – Scale bars: A-C = 1 mm, D-F = 0.5 mm, G = 3 mm. – Drawn by M. G. Caluff from Holdridge 1989 (S).

**Distribution and habitat** — Hispaniola and Jamaica, in mogote vegetation, gallery forest and pine forest, on calcareous and moist rocks and cliffs, at medium to high altitudes, 400-2050 m; very rare in Jamaica (Proctor 1985). *Selaginella leonardii* is here recorded for the first time from the Dominican Republic.

**3. *Selaginella urquiolae* Caluff & Shelton, sp. nov.** — Holotype: Caluff 6261 (BSC; isotypes: B, HAC, HAJB). — Fig. 3.

*Selaginellae revolutae*, *S. bernoullii*, *S. chiapensi*, *S. distichae* et *S. porphyrospora* affinis, differt a priore foliorum margine basiscopico tantum revoluta, foliis mediis lanceolatis vel ellipticis, in facie superiore ideoblastis conspicuis instructis, nec non colore albo megasporarum; a *S. bernoullii* & *S. porphyrospora* caulibus procumbentibus, per cunctam longitudinem rhizophoros gerentibus; a *S. chiapensi* foliis lateralibus late rotundatis, deltoideo-ovatis vel ovato-oblongis, mediis aristatis idioblastis conspicuis instructis, nec non strobilis semper viridibus; a *S. disticha* marginibus foliorum lateralium mediorumque ciliatis, ciliolatis vel in tertia parte distali denticulatis, foliis mediis aristatis, sporophyllis uniformibus et colore albo megasporarum.

Plants prostrate, caespitose. *Stem* up to 6-34.4 cm long and 0.6-1.2 mm in diameter, monostelic, striate on drying, straw-coloured, neither stoloniferous nor flagelliform nor articulate, pinnately branched, the branches alternate, of irregular length, up to 13.7 cm long, in turn 1-2 times ramified. *Rhizophores* axillary-dorsal, filiform, 0.2 mm in diameter, all along the stem. *Leaves* dimorphic, papery, olive-green on the upper face, slightly paler and somewhat lustrous on the lower one, margins of 2-3 rows of papillous cells. *Lateral leaves* of the branches 2.6-3.5 × 0.9-2 mm, approximate, perpendicular to slightly ascending, deltoid-ovate to ovate-oblong, inequilateral, the acroscopic half wider and curved, apex acute, acuminate to apiculate, base rounded, the acroscopic side wider and overlapping the stem, the basiscopic side reflexed, ciliate on the proximal side of the acroscopic margin and denticulate to the apex, basiscopic margin entire to ciliolate toward the proximal third and then denticulate toward the apex, the cilia nearly translucent, spaced, up to 0.15-0.2 mm, the midvein strong and somewhat prominent abaxially, reaching the leaf apex. *Lateral leaves* of the principal stem apart up to 1.2 mm, very inequilateral, the acroscopic side nearly twice as wide as the basiscopic one, broadly rounded, nearly forming a great auricle then overlapping the stem, laminar surface on the adaxial side denticulate to hairy in a thin band adjacent to the margin on the basiscopic side where it incurves, the hairs 0.05-0.15 mm, frequently only seen on the abaxial side, with numerous spicular idioblasts, little and inconspicuous, the cells rounded, stomata scarce, on both sides of the

midvein. *Median leaves* 1.6-2.5 × 0.6-1.1 mm, spaced, lanceolate, broadly lanceolate, ovate-lanceolate to elliptic, slightly inequilateral, the inner side somewhat wider than the outer, aristate, arista as long as half of the lamina or longer, minutely denticulate, exauriculate, ciliate, cilia similar to those of the lateral leaves, glabrous, with conspicuous idioblasts on the adaxial face, the midvein prominent. *Axillary leaves* 2-2.9 × 1.1-2.4 mm, ovate, slightly inequilateral, acute, the base rounded to subcordiform, the margins flat or reflexed on one side or on both sides, ciliate in the proximal third and then denticulate to the apex, glabrous, midvein prominent. *Strobili* ending in the lateral branches, neither compact nor quadrangular, 3-8 × 2-3.5 mm. *Sporophylls* 1.7-1.8 × 1.1-1.3 mm, uniform, concolorous, ovoid-attenuate, acuminate, glabrous, the keel denticulate toward the apex, the margins rigidly ciliolate to denticulate. *Megaspores* white, 200-300 µm in diameter, the exine cristate. *Microspores* orange, long-echinate-clavate, 20-35 µm.

**Specimens seen** — CUBA: SINE LOCO: 29.1.1910, *J. A. Shafer 12017* (B); 9.1870, *Hno. Fortún & Arias* (K); 1865, *Fraser 11, 13, 14, 15, 940 p.p., 942 p.p., 1824 p.p.* (B). — PINAR DEL RÍO: Pan de Guajaibón, La Mulata, 16.5.1953, *Acuña & Alain 18525* (BSC, HAC); Fuente del Azufre, Rangel, Sierra del Rosario, 450 m, 4.1946, *Hno. Alain 510* (HAC); falda norte del Pan de Guajaibón, La Palma, 300-400, 12.1967, *J. Bisse & L. Rojas 4785* (HAJB, JE); summit of Pan de Guajaibón, La Palma, 720 m, 28.12. 1970, *J. Bisse 15604* (HAJB, JE); Bahía Honda, Pan de Guajaibón, 200-670 m, 14.10.1976, *A. Areces & al. 32525* (B, HAJB, JE); Mina Dora, 21.4.1984, *J. Bisse & al. 51533, 51534* (HAJB); Candelaria, Las Terrazas, Lomas Peladas de Cayajabos, 300-400 m, 18.3.1984, *J. Bisse & al. 51968* (B, HAJB, JE); headwaters of Río San Juan, base of Lomas Peladas, Sierra del Rosario, 250 m, 28.2.2007, *Caluff 6257* (BSC), 6258 (BSC), 6259 A/B (BSC), 6261 (BSC); Río San Juan, from Las Terrazas to Los Vertedores, Sierra del Rosario, 220 m, 28.2.2007, *Caluff 6276* (BSC); surroundings of Arroyo Seguí, Mil Cumbres, Sierra del Rosario, 250 m, 3.3.2007, *Caluff 6335* (BSC); Cayo Ratones, Alturas de Pizarras del Sur, 300 m, 20.1.2007, *Caluff & Urquiola 6276* (BSC); Cayo Ratones, Alturas de Pizarras del Sur, San Juan y Martínez, 300 m, 4.2. 1990, *Caluff & al. 2859* (BSC); Sierra de los Organos, San Diego de Tapia, 3.4.1920, *E. Ekman 10626* (S, B); Sierra de los Organos, San Diego de Tapia, Grupo del Rosario, 400-500 m, 21.12.1920, *E. Ekman 12676* (S, B); between Bahía Honda and El Rosario, 29.1.1912, *J. A. Shafer & al. 12017* (B, BM); Baños de San Vicente, 12./16.9.1910, *O. E. Jennings 7341* (B); slopes of upper Río Taco Taco, Rangel, 8.1926, *Hno. León 12683* (HAC); Sierra del Rosario, Loma Pelada, Las Terrazas, 23.2.1982, *Niteibanitzkaja 38 (40228)* (BSC, HAC); vicinity of Sumidero, Pinar del Río, 6.8.1912, *J. R.*

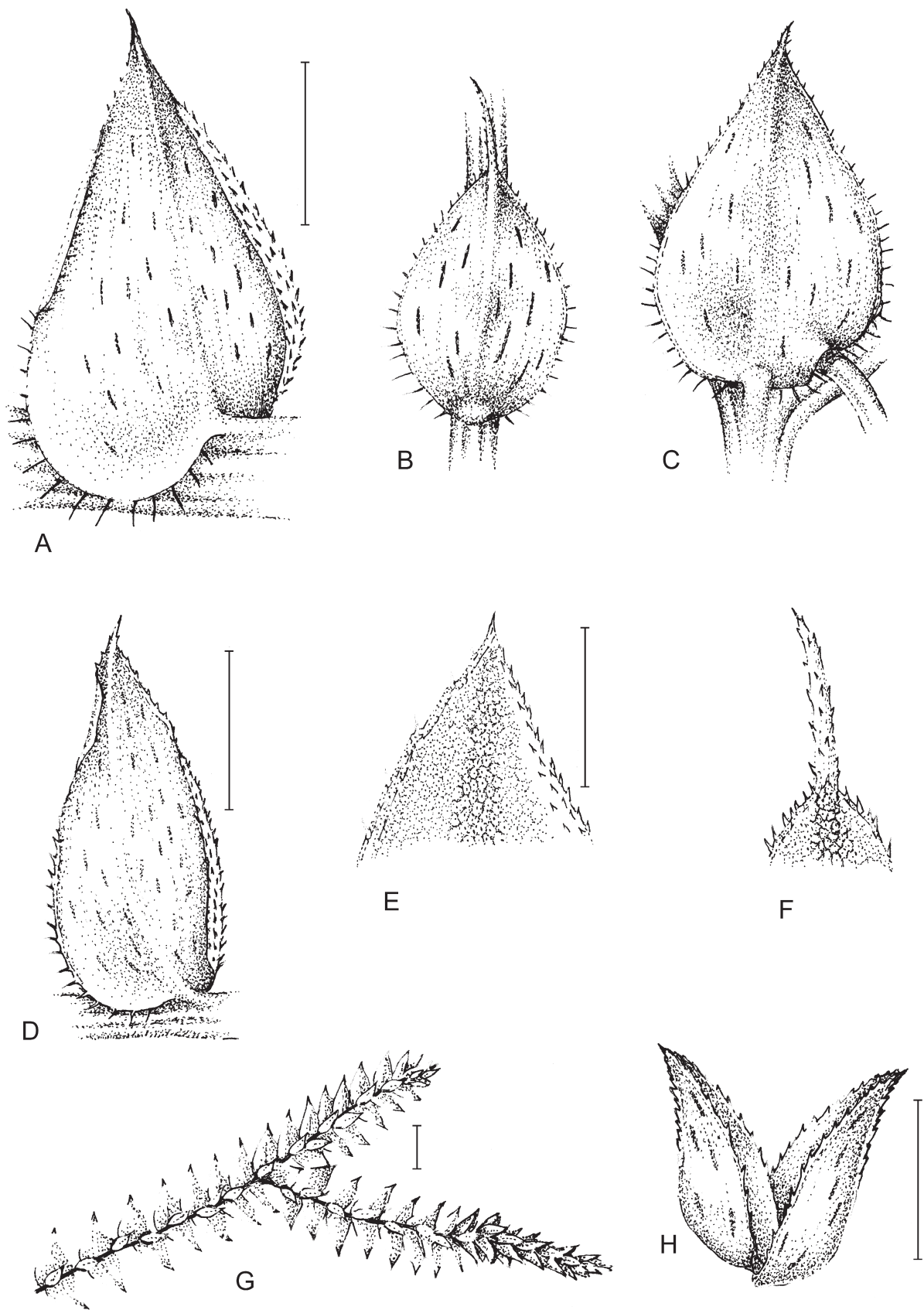


Fig. 3. *Selaginella urquiolae* – A: lateral leaf of the main stem; B: median leaf; C: axillary leaf; D: lateral leaf of a branch; E: apex of a lateral leaf; F: apex of a median leaf; G: habit; H: sporophylls. – Scale bars: A-D, H = 1 mm, E-F = 0.5 mm, G = 3 mm. – Drawn by M. G. Caluff from *Caluff 6261 A/B* (BSC).



*Perkins 13646, 13668* (B); Bahía Honda, camino de Los Mulos, side of Pan de Guajibón, 200-620 m, 26.4.1990, *C. Sánchez 69124* (HAJB); Minas de Matahambre, Sumidero, banks of arroyo Sumidero, near Sumidero town, 20.1.1984, *C. Sánchez & al. 51501* (HAJB); Sierra Guayaba, S of Sumidero, 28.8.1912, *J. A. Shafer 13853* (B); Río Bayate, Soroa, 100-200 m, 22.10.1997, *Shelton & Caluff 4366* (BSC), *4369* (BSC); banks of Río Taco Taco, El Rangel, 300 m, 29.10.1997, *Shelton & Caluff 4387, 4388, 4389, 4390* (BSC); near Las Terrazas, Sierra del Rosario, 500 m, 12.10.1999, *Shelton & Caluff 4444* (BSC); La Palma, mountainous region of Rangel, 12.1865, *Wright 1824* (2902) (HAC); Río San Miguel, from Volador to Mal Paso, 17.12.1910, *T. Zanoni & al. 9375* (B).

**Distribution and habitat** — Endemic to W Cuba, Pinar del Río province, locally copious, on river and rivulet banks, on rocks and cliffs, or on the ground, on sand, humus and leaf litter, in gallery forests, evergreen forests, mogote vegetation and secondary forests, sometimes on waysides among grasses, at 100-720 m, usually in moist to wet places, in the shade or with filtered sun, rarely in full sun, forming large patches on the ground or hanging from moist rocks and cliffs, on limestone.

**Eponymy** — This species is dedicated to Dr Armando Urquiola, eminent Cuban botanist and Director of Pinar del Río Botanic Garden, who promoted and facilitated us many collecting travels in western Cuba. His sudden and premature death in January 2009 is a sad loss for Cuban botany.

**Notes** — *Selaginella urquiolae* is related to a group of species from southern Mexico and Mesoamerica of which the lateral leaves have a reflexed and hairy basiscopic margin (Fraile & al. 1995; Mickel & Beitel 1998). Its main affinity is with *S. revoluta* Baker, recorded from Costa Rica to Brazil, which has leaves with both margins revolute whereas only the basiscopic one is revolute in *S. urquiolae*; in *S. revoluta* the median leaves are ovate to suborbicular, without spicular idioblasts, while in *S. urquiolae* they are lanceolate to elliptic and with conspicuous idioblasts on the upper face; also, the megaspores are pale yellow in *S. revoluta* but white in *S. urquiolae*. *S. bernoullii* Hieron. differs from *S. urquiolae* in is suberect, stoloniferous stem, with rhizophores mostly restricted to the proximal third, *S. urquiolae* being prostrate, non-stoloniferous and with rhizophores all along the stem; in the strobili of *S. bernoullii* the two ventral rows of sporophylls are colourless, but in *S. bernoullii* they are uniformly green; the megaspores of *S. bernoullii* are cream coloured but those of *S. urquiolae*, white. *S. chiapensis* A. R. Smith can be distinguished from *S. urquiolae* by its obliquely oblong lateral leaves, those of *S. urquiolae* being

broadly rounded, deltoid-ovate to ovate-oblong; in *S. chiapensis* the median leaves are acuminate, without spicular idioblasts, but they are aristate and show conspicuous idioblasts in *S. urquiolae*; the strobili of *S. chiapensis* have two silvery ventral rows of sporophylls, but in *S. urquiolae* the sporophylls are uniformly green. *S. disticha* Mickel & Beitel differs in the entire to minutely denticulate margins of its lateral and median leaves, those of *S. urquiolae* being ciliate to ciliolate, denticulate in the distal third; the median leaves of *S. disticha* are acuminate but those of *S. urquiolae* aristate; *S. disticha* has dimorphic, bicolorous sporophylls, whereas they are uniform, concolorous in *S. urquiolae*; the megaspores of *S. disticha* are orange, those of *S. urquiolae* white. *S. porphyrospora* A. Braun has flagelliform, stoloniferous, sometimes suberect stems, with rhizophores borne in the lower third only, whereas in *S. urquiolae*, with a different habit, the rhizophores are spaced all along the stem; the leaves of *S. porphyrospora* are denticulate and characterised by two false veins, those of *S. urquiolae* are ciliate to ciliolate, denticulate toward the apex, and lack false vein.

**4. *Selaginella hispida*** (Willd.) A. Br. ex Urb., Symb. Antill. 9: 394. 1925 ≡ *Lycopodium hispidum* Willd., Sp. Pl. 5: 35. 1810. – Fig. 4.

= *Selaginella swartzii* Spring in Bull. Acad. Roy. Sci. Bruxelles 10: 140. 1843.

= *Selaginella lasiophylla* A. Br. in Sitzungsber. Ges. Naturf. Freunde Berlin 1863: 8. 1863.

= *Selaginella pilosiuscula* Kuhn ex Krug in Bot. Jahrb. Syst. 24: 151. 1897.

Plants prostrate, musciform, forming intricate mats. *Stem* 15-30 cm long and 0.4-0.6 mm in diameter, monostelic, striate on drying, somewhat flattish, straw-coloured, neither stoloniferous nor flagelliform nor articulate, irregularly branched. *Rhizophores* filiform, 0.2-0.3 mm in diameter, all along the stem, axillary, axillary-dorsal to dorsal, occasionally two in a bifurcation, one dorsal, lowering by one side of the principal stem or branch, and another axillary, lowering among the two secondary branches. *Leaves* dimorphic, herbaceous, somewhat translucent, green and dull adaxially, paler and brilliant abaxially, margins greenish to whitish, of one row of cells, sometimes recurved. *Lateral leaves* 1.5-1.7 × 0.1-1.6 mm, very approximate to imbricate, ascending, ovate to ovate-oblong, nearly equilateral, the apex obtuse, subacute to cuspidate, the base subcordiform, the acroscopic margin ciliate to ciliolate, the basiscopic one ciliate in the proximal third and denticulate to ciliolate toward the apex, the cilia 0.1-0.2 mm, approximate, the midvein inconspicuous, the adaxial face hairy, the hairs up to 0.1 mm, rarely glabrous or glabrescent, without idioblasts, the cells rounded to pentagonal, with stomata principally on both sides of the midvein. *Median leaves* 0.6-0.9 × 0.4-

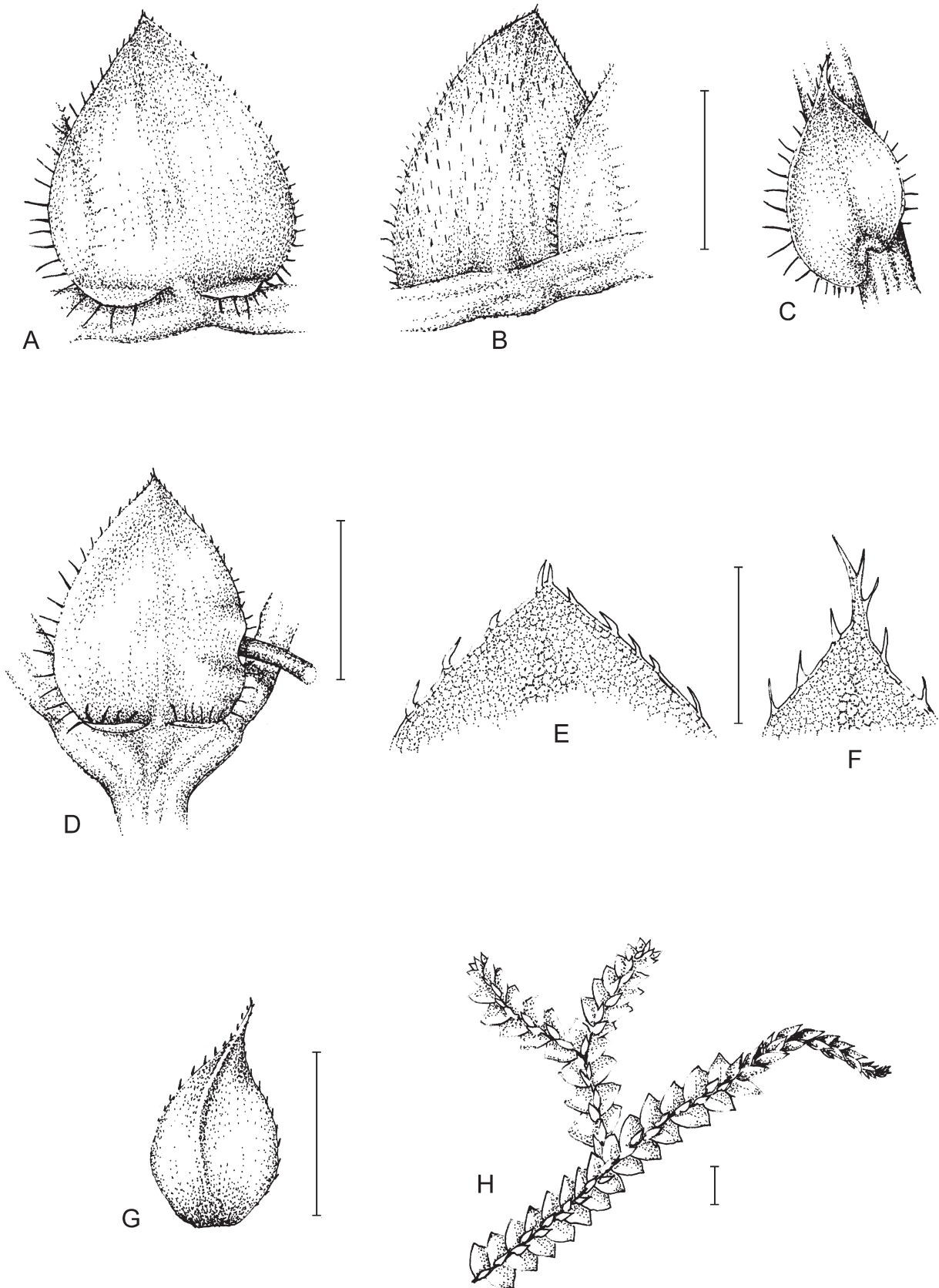


Fig. 4. *Selaginella hispida* – A-B: lateral leaves, abaxial side (A), adaxial side (B); C: median leaf; D: axillary leaf; E: apex of a lateral leaf; F: apex of a median leaf; G: sporophyll; H: habit. – Scale bars: A-D = 1 mm, E-F = 0.5 mm, G = 1 mm, H = 3 mm. – Drawn by M. G. Caluff from *Maxon & Killip*1465 (HAC).

0.6 mm, ovate to broadly elliptic or obovate, approximate to imbricate, appressed, acuminate to short-aristate, ciliate all around including the arista, the cilia up to 0.15 mm, longer at the outer margin, glabrous, without idioblasts, midvein inconspicuous, auriculate outwardly, the auricle broad and rounded. *Axillary leaves* 0.8-1.2 × 0.6-1 mm, similar to the lateral ones. *Strobili* ending in the lateral branches, compact, quadrangular, flexuous, 3-10 × 2-3 mm. *Sporophylls* 1-1.3 × 0.8-1 mm, uniform, ovoid-acuminate, concolorous, glabrous, the keel strong, denticulate toward the distal third, the margins rigidly ciliate. *Megaspores* cream-coloured, 300-400 µm in diameter, the exine nearly smooth to low-verrucate. *Microspores* pale orange 30-40 µm.

**Specimens seen** — JAMAICA: Parish of Bandeaba, 21.9.1908, *N. L. Britton* (BM [2]); near Ipswich, St Elizabeth, 200-300 m, 1.3.1920, *A. M. Evans 1508* (B); Trelawny, end of the Crown lands road in the Cockpit country, 29.9.1954, *R. A. Howard 14169* (GH); St Ann, limestone cliff in forested area 2 miles W of Albion, 18.9.1956, *R. A. Howard & G. R. Proctor 14885* (GH); Swallemburg estate, northeastern slopes of Mt Diabolo, 200-2300 feet, 21.1.1958, *R. A. Howard & G. R. Proctor 15173* (BM, GH); lower eastern slopes of Mount Diabolo, 350 m, 29.2.1920, *W. Maxon & P. Killip 554* (GH); Cooks Bottom, north of Ipswich, St Elizabeth, 400-450 m, 31.3.1920, *W. Maxon & P. Killip 1465* (BM, GH, HAC); near Ipswich, St Elizabeth, 200-300 m, 1.4.1920, *W. Maxon & P. Killip 1508* (B, BM, GH); near Troy, 2000 ft, 23.3.1917, *J. R. Perkins 1370* (GH); Hannover, Schepers Hall, 1 mile E of Great Valley, 1100 ft, 28.10.1952, *G. R. Proctor 7248* (GH); Somerset, 5 miles NW of Mandeville, shaded limestone ledges, 2300 ft, 7.1.1961, *G. R. Proctor 21879* (BM, GH); St Elizabeth, Ipswich, hill south of the village, 8.9.1976, *C. Whightfoord 1487* (BM).

**Distribution and habitat** — Western Jamaica, endemic, present in the parishes of Hanover, Westmoreland, St James, St Elizabeth, Trelawney, Manchester, Clarendon, St Ann and St Catherine, in shaded limestone ledges and cliffs at lower to middle elevations (183-762 m), widespread and frequent (Proctor 1985).

*Selaginella hispida* differs from the other hairy West Indian species by its auriculate median leaves.

**5. *Selaginella epipubens* Caluff & Shelton, sp. nov.** — Holotype: Caluff & Shelton 4565 (BSC; isotypes: B, HAC, HAJB). — Fig. 5.

*Selaginellae lindenii*, *S. correae* et *S. smithiorum* affinis, differt a priore foliis lateralibus acutis, ideoblastis conspicuis carentibus, foliis mediis exauriculatis et colore citrino macrosporum; ab altera habitu non musciformi et caulibus ad 21 cm longis, ternatim ramosis; ab ultima autem foliis lateralibus glabris.

Plants prostrate. *Stem* up to 21 cm long and 0.3-0.4 mm in diameter, monostelic, striate on drying, straw-coloured, neither stoloniferous nor flagelliform nor articulate, pinnately branched, the branches alternate, up to 9 cm long, these in turn one or two times branched. *Rhizophores* axillary, filiform, 0.15-0.2 mm in diameter, all along the stem. *Leaves* dimorphic, finely herbaceous, somewhat translucent, adaxially olive-green and dull, paler and lustrous abaxially, the margins only seen by the abaxial side, greenish, of 3-6 rows of cells, slightly recurved. *Lateral leaves* 0.9-1.5 × 0.6-1.3 mm, 0.8-1 mm apart, gradually approximate and finally imbricate toward the distal branches, slightly oblique, ovate to nearly orbicular, rarely ovate-oblong, attenuate, asymmetric, the acroscopic margin wider and curve, the apex acute to apiculate, the base truncate to rounded or subcordiform, strongly ciliate in the proximal  $\frac{3}{4}$  of the acroscopic margin, the distal  $\frac{1}{4}$  entire to minutely denticulate, the basisopic margin entire or with 1-4 cilia at the base, the cilia spaced, translucent, up to 0.25 mm long, midvein inconspicuous, laminar surface hairy in the basisopic half and toward the apex, hairs 0.05-1.5 mm, frequently some to many leaves glabrous or glabrescent, sometimes with very short idioblasts, only seen on the abaxial side, the cells rounded, stomata not seen. *Median leaves* 0.8-1.2 × 0.3-0.6 mm, approximate to imbricate, lanceolate to broadly lanceolate, inequilateral, the inner side wider than the outer one, short-acuminate, exauriculate, long-ciliate, the cilia similar to those of the lateral leaves, glabrous, the midvein somewhat prominent adaxially. *Axillary leaves* 0.7-1.2 × 0.8-1.1 mm, ovate, slightly inequilateral, acute, the base truncate to subcordiform, long-ciliate to the proximal part of both margins, adaxially hairy, abaxially with inconspicuous idioblasts. *Strobili* ending in the lateral branches, neither compact nor quadrangular, 3-5 × 1.5-2.5 mm. *Sporophylls* 0.9-1.2 × 0.4-0.5 mm, uniform, concolorous, ovoid-attenuate, acuminate, glabrous, the keel ciliate-denticulate, the margins rigidly ciliate. *Megaspores* lemon-yellow, 250-300 µm in diameter, the exine cristate. *Microspores* orange, finely baculate, 20-40 µm.

**Specimens seen** — CUBA: PINAR DEL RÍO: Finca La Guira, San Diego, 14.8.1953, *Acuña & al. 18846* (HAC); Sagua, orillas del arroyo, 16.11.1968, *J. Bisse & H. Lippold 10515* (HAJB, JE); Guillén, Lomas Contadoras, Guane, 100-300 m, 15.5.1984, *A. Alvarez de Zayas & al. 54347* (HAJB); Cayo Ratones, Alturas de Pizarras del Sur, 250 m, 20.1.2007, *Caluff & Urquiola 6271* (BSC); Cayo Ratones, Alturas de Pizarras del Sur, San Juan y Martínez, 300 m, 4.2.1990, *Caluff & al. 2860* (BSC); Sierra de Cabras, on Guane road, 9.9. 1910, *M. A. Chrysler 7291* (B); Sierra de Cabras, 6.3.1911, *M. A. Chrysler 9791* (B); Mantua, Damují and Rincón del Prado, 31.5.1920, *E. Ekman 11042* (B); prope Viñales, 9.11.1923, *E. Ekman 18006* (B); banks of Río Ancón,

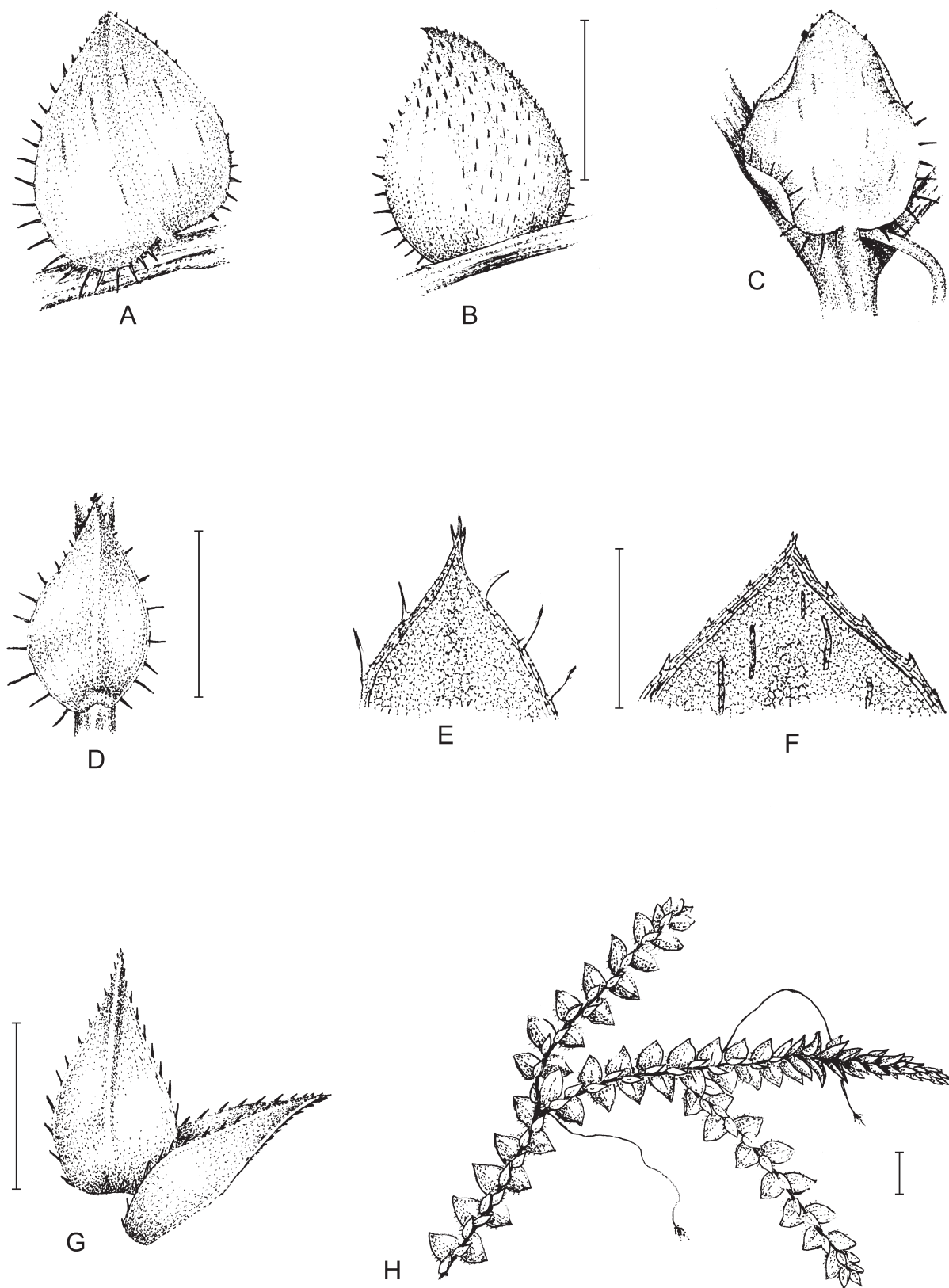


Fig. 5. *Selaginella epipubens*. – A-B: lateral leaves, abaxial side (A), adaxial side (B); C: axillary leaf; D: median leaf; E: apex of a median leaf; F: apex of a lateral leaf; G: sporophylls; H: habit. – Scale bars: A-D, G = 1 mm, E-F = 0.5 mm, G = 1 mm, H = 3 mm. – Drawn by M. G. Caluff from *Caluff & Shelton 4565* (BSC).



Boquerón del Abra, Viñales, 100 m, 15.3.2003, *Shelton & Caluff* 4568 (BSC). — HABANA: ISLA DE LA JUVENTUD: Spillway of Los Indios ditches, 120 m down below, 20 m, 10.2.2003, *Shelton & Caluff* 4564, 4565 (BSC); between San Francisco de las Piedras and Cerro de La Cañada, 27.1.1955, *E. P. Killip* 44612 (HAC); San Pedro region, 9.2.1956, *E. P. Killip* 45569 (HAC).

**Distribution and habitat** — Endemic to W Cuba, Pinar del Río province, and Municipio Especial Isla de la Juventud (former Isla de Pinos), Habana province, growing in gallery forest, pine forest and white savannas, mainly on rivulet slopes, terrestrial, epipetric or rarely epiphytic on the trunk base of the tree fern *Cyathea myosuroides* Liebm., always on acidic substrate such as slate, serpentine, derived soils, and on silica sand, at 20–350 m, in shade or with filtered sun, uncommon.

**Notes** — Specimens cited by Alston (1952) as *Selaginella plagiochila* from W Cuba are actually *S. epipubens*.

In S Mexico and Central America, the greatest affinity of *Selaginella epipubens* is with *S. lindenii* Spring and *S. correae* Valdespino, both species having lateral leaves hairy adaxially (Fraile & al. 1995; Mickel & Beitel 1988). *S. lindenii* differs mainly in the subacute lateral leaves, without spicular idioblasts, whereas those of *S. epipubens* are acute to apiculate and with idioblasts; the median leaves are subauriculate in *S. lindenii* but exauriculate in *S. epipubens*; the megaspores are white in *S. lindenii* but lemon-yellow in *S. epipubens*. *S. correae* differs in the moss-like habit, with less than 4 cm long stems with only one level of branching, whereas in the not moss-like *S. epipubens* the stem reaches up to 21 cm in length, with three orders of branching; the leaves are entire to serrate in *S. correae* but strongly ciliate in *S. epipubens*; in *S. correae* the sporophylls are dimorphic, with the ventral ones nearly translucent, whereas those of *S. epipubens* are uniform.

In northern South America *Selaginella epipubens* has affinities with *S. smithiorum* Valdespino, which has lateral leaves hairy on the adaxial face (Smith 1990; Valdespino 1992). In *S. smithiorum* the median leaves are hairy, whereas those of *S. epipubens* are glabrous.

## Discussion

*Selaginella* species of the West Indies may present three types of epidermal structures: papillae, denticulations and hairs. Sometimes the hairs are formed by a lengthening of denticulations, as can be appreciated in *S. urquiolae*, where some individuals possess denticulations only, others in a mixture with hairs of different length, and others yet, only hairs. In other regions some species possess hairy stems (Fraile & al. 1995).

In bryophytes, the presence of foliar hairs appears to be correlated with an optimisation of light harvesting,

as the hairs reflect part of the solar radiation and behold a layer of still air around the plants, both of which helps to reduce evaporation and increase the time available for photosynthesis (Johnson & Kokila 1970). In some *Selaginella* species the hairs are deciduous (Valdespino 1992), suggesting that their function is transitory.

In the *Selaginella* species treated here, the fact that the hairs are antrorse, in some cases even appressed and thus increasing their reflection potential, supports the inferred relationship between the presence of indumentum and an optimal light harvest. This assumption is consistent with the distribution of the indumentum, as hairs are abundant on the exposed parts of the leaves (the basiscopic and subapical portions), but absent or almost so on the acroscopic side that is often shielded by the overlapping basiscopic side of the neighbouring leaf. In *S. urquiolae*, denticulations or hairs are restricted to a narrow band adjacent to the basiscopic leaf margin. In herbarium specimens the basiscopic side of the leaf lies below the acroscopic one, and the band with the indumentum is usually curved downward; but in the living state, the basiscopic side is placed above the acroscopic one, with its margin patent. In *S. leonardii* the hairs are scarce and tiny, restricted to a small area near the lower margin of the auricle in the median leaves, so that their functionality is questionable; perhaps they can be interpreted as vestigial.

The situation in *Selaginella plagiochila* admittedly does not fit the above scenario. This species has hairs on both faces of the lateral leaves, with those of the abaxial side (that faces the floor, as the plants are prostrate) being longest, more erect and more copious than those of the adaxial face. Also we observed that, at least in Cuba, plants living in well lit situations, even in full sun, almost lack hairs, and those present are generally very short, whereas it is those growing in shady and moist places that possess long hairs and cilia. Therefore, the function of hairiness for the retention of humidity is not clearly demonstrable.

The function of some structures in *Selaginella*, such as the ligule, is still enigmatic (Horner & al. 1975). Similarly, the presence, orientation and spatial distribution of hairs and denticulations on the laminar surface is still unexplained in terms of their possible physiologic function and the question needs further study.

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