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THE GROUP OF SELAGINELLA OREGANA IN
NORTH AMERICA

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With two plates

THE SUBGENUS *Euselaginella*¹ of *Selaginella* is one of those groups in which, apparently, mutation is easy and migration difficult. The result, or, more accurately, the existing condition, is a large proportion of local populations which differ minutely and sometimes rather by recombinations of certain stock characters than by individual and distinctive traits. These populations are difficult to group into sectional divisions or into nexi of species and varieties. They are often widely variable within themselves in such features as length and number of cilia and length of seta, but they show little intergradation with each other. I have seen only one instance of anything which looks like hybridization. Most of them occupy relatively restricted areas. Years ago Professor Fernald and I found similar conditions in *Puccinellia*; now, as then, the only possible taxonomic course is to describe the existing populations as species and make as valiant an effort as one can to arrange and key them out—though a dichotomous key in a group where there are no well marked divisions is no easy assignment.

The group of *S. oregana*, as here limited, is characterized by its lax, prostrate habit, usually elongate, slender stems, relatively distant branches, and appressed to strongly ascending leaves. The plants form loose, intricate mats. So far as can be made out from herbarium specimens, both stems and branches remain horizontal when growing on the ground, only the strobiles tending to assume an upright position.² The main stems are

¹ *Selaginella* subg. *Euselaginella* Warb. *Monsunia* 1: 100 (1900). Subg. *Homoeophyllum* Hieron. in Engler & Prantl, *Nat. Pflanzenf.* I. 4: 669 (1901). Although Hieronymus's name is derived from Spring's Sect. *Homoeophyllae* (*Monog. Lycopod.* 2: 53 [1849]), Warburg's is technically preferable as the first to be used in subgeneric rank and in proper form for that rank.

²Mr. U. T. Waterfall, however, tells me that in at least one patch of *S. mutica* in west Texas the branches are upright.

usually, with the leaves, not over 1 mm. in diameter; the more densely leafy new branches are often thicker. In dried specimens the leaves are almost always rather closely appressed; their behavior when boiled out, however, suggests that in life they assume an ascending position in wet weather. Standley (Amer. Fern Journ. 5: 78 [1915]) states that they do in New Mexican species. Only in *S. mutica* and *S. cinerascens* do the leaves remain appressed after boiling.

So defined, the group corresponds roughly to *S. rupestris* β *tropica* Spring, Monog. Lycopod. 2: 57 (1849) — a name under which Spring cited no specimens and which cannot be definitely applied, but under which he placed those portions of the all-inclusive *S. rupestris* of his time which had a lax and sprawling habit. Hieronymus, though using upright habit as the basis of a primary division, made no distinction between species with short, creeping stems and close-set, assurgent branches and those of the present group. I may at once admit that the revival of Spring's division is more a matter of convenience than of obvious affinity. There are nodes of affinity within the group: *S. oregana* and *S. Underwoodii* seem to be related (however far apart they come in the key); so do *S. mutica* and *S. viridissima*. *Selaginella Sartorii*, *S. Hintonii* and *S. Arsenei* quite certainly belong together; in foliar characters, *S. porrecta* seems to go with them, though its spores of both sorts are wholly different. But the group as a whole rests on habit alone and its boundaries have to be drawn more or less arbitrarily.

They may cut across real relationships. *Selaginella mutica*, for instance, is in leaf-characters much more like the short-stemmed *S. Watsoni* Underw. than the species with which it is here associated. On the other hand, *S. Chrismari* Hieron., though prostrate, is in its densely leafy, relatively thick stems, its pattern of branching, and its minute characters, so like the erect *S. rupicola* Underw. that it seems best left in that vicinity. *Selaginella Wallacei* Hieron. and *S. Hansenii* Hieron. occasionally produce long, prostrate stems; they are excluded because in both the strongly prevailing tendency is to form close mats with assurgent branches. Anyone attempting to name specimens by the present treatment should bear in mind that there are such borderline species and that they may not be accounted for here. If this paper adds somewhat to the understanding of the species included, that is all that can be hoped for it.

In any division of *Selaginella* based on habit parallel leaf- and spore-variations will be found in different groups. But in any division based on leaf- or spore-characters parallel variation in habit and other features will be found to quite as great an extent. And, as a primary basis for systematic arrangement, habit has very real and practical virtues — so much so that, within the two great homophyllous and heterophyllous subgenera, it has been used by all taxonomists up to the present time. Moreover, in subg. *Euselaginella* at least, divisions based on it fall into distinctive and reasonable geographic groups. That of *S. rupestris* proper (with short, prostrate stems, assurgent branches and more or less spreading leaves) includes by far the greatest number of species and occurs everywhere in the range of

the subgenus except the extreme north and extreme south. The more specialized small group of *S. Parishii* Underw., like the preceding, but with somewhat dimorphic leaves, is confined to the arid regions of the southwestern United States, from southwestern Texas to southern California, and northern and central Mexico. The present group has a mainly north-and-south distribution in the region of the North American Cordillera from Colorado to southern Mexico, with two outlying species on the Pacific coast, and reappears in southern Brazil, Uruguay, Paraguay and northern Argentina. This holds, whether the border-line species are included or not. The group with upright, shrub-like habit has, on the contrary, a generally east-and-west range, from the Piedmont and Coastal Plain of the southeastern United States in a narrow belt through western Texas, the southern half of New Mexico and Arizona and adjacent Mexico, to southern California.

In the taxonomic treatment which follows, descriptions of individual species are merely supplementary to the key and include no characters mentioned in it. Measurements are intended to give average dimensions; they may not cover extremes. Bibliography is meant to include only references to original descriptions and to literature which adds illustration or further information to the originals. In the key, the characters of number and length of cilia and length of terminal setae, much used by Hieronymus, have been for the most part omitted or stated in general terms. Cilia are easily broken off in dried material, so that an accurate count of them is difficult; and the length both of cilia and setae varies so much within species and even in the same colony that an attempt to find other characters which, even if seemingly incapable of altogether definite statement, could be more easily seen and better relied upon, seemed worth while. The type of cilia, whether narrow-based and hair-like or broad-based and more or less dentiform, their texture, and the texture of the setae, whether hyaline, subtranslucent and somewhat colored, or chalk-white and opaque, may well prove more significant than measurements. In all the species, the leaves are broadly sessile, the sometimes swollen base containing spongy mesophyll through which the single vascular strand makes its way into the blade. The shape and degree of adnation of these leaf-bases and the relative thickness of the blade, as well as its shape, seem also to be significant. Characters of the megaspores need to be used with some caution, since the depth and appearance of their sculpturing varies considerably with age; but its pattern is constant within species and aids greatly in defining them and in fortifying one's confidence in their validity.

The microspores offer equally distinctive characters, but mature ones are not easy to find. Those adhering to herbarium specimens or dissected out of sporangia are often still clinging together in their original tetrads and frequently covered with, and their sculpture-patterns obscured by, a dark, wrinkled membrane, presumably the persistent wall of the mother-cell. Fragments of this membrane often remain attached to the spores after they have separated from the tetrad; Hieronymus says it is permanently persistent in *S. lepidophylla*. In the present group, I have not seen it in

S. Underwoodii or *S. mutica* and scarcely in *S. oregana* and *S. extensa*. In the other species, it is a conspicuous feature; but whether this means that it is really longer persistent in them, or is merely due to accident, I cannot determine.

The key, an experiment in using the characters above indicated, is in part, for practical reasons, artificial. To use it most effectively, material should be examined under magnifications of 20–50 diameters for leaves, etc., 300–400 for microspores.

In addition to the material in the Gray Herbarium (G), I have seen all that in the Herbarium of Yale University (Y), and all the specimens of *S. mutica* and all those from Mexico in the United States National Herbarium (US).

I am much indebted to my wife for the accompanying drawings, to Prof. Hempstead Castle for the loan of specimens from the Eaton Herbarium at Yale University, to Mr. C. V. Morton for friendly and helpful criticism, and to Dr. William R. Maxon for loans from the United States National Herbarium and in many other ways. The attentive reader will observe that at various points I have merely followed in his foot-steps.

KEY TO THE SPECIES AND VARIETIES

- a.* Leaves soft and thick, strongly convex dorsally, long-adnate (up to $\frac{1}{4}$ their length) at the cuneate base, with a short, hyaline terminal seta and few, short, mostly dentiform marginal cilia; sporophylls not strongly differentiated from the foliage-leaves; commissural ridges of megaspores connected near base by cross-ridges. 1. *S. oregana*.
- a.* Leaves short-adnate at the usually rounded or truncate base; sporophylls conspicuously differentiated from the leaves; commissural ridges of megaspores connected at their apices by an equatorial ring or free. *b.*
- b.* Leaves oblong-, elliptic-, or ovate-lanceolate, thick and strongly convex dorsally, especially at the cucullate apex, at least on new growth mostly 1.6 mm. or less long. *c.*
- c.* Cilia of the foliage-leaves long, weak and spreading; sporophylls definitely ciliate. *d.*
- d.* Leaves muticous or at most short-mucronate. 3. *S. mutica*.
- d.* Leaves with a terminal seta up to 0.4 mm. long. . . . 3a. *S. mutica* var. *texana*.
- c.* Cilia, at least the upper, short, stiff, strongly ascending; sporophylls merely short-fimbriate; leaves with a short (0.2 mm. or less) terminal seta. 3b. *S. mutica* var. *limitanea*.
- b.* Leaves subulate- or oblong-linear, mostly more than 1.6 mm. long. *e.*
- e.* Leaves with a short, flat hyaline apex or wholly muticous; cilia few and short. *f.*
- f.* Leaves bright green, somewhat thickened; stems lax, forming a loose mat; megaspores finely reticulate-rugose. *g.*
- g.* Leaves oblong-linear, acute or obtusish, quite without modified apex, rounded or narrowed at base, as seen in profile passing obliquely into the stem; megaspores subglobose with short, slender commissural ridges and no equatorial ring. 4. *S. viridissima*.
- g.* Leaves subulate-linear, acuminate, with a short, flat, outwardly bent hyaline apex, abruptly truncate at base; megaspores flattened, with prominent commissural ridges and a strongly and irregularly tuberculate equatorial ring. 5. *S. extensa*.

- f.* Leaves glaucous, thin and papery, with an obtusish, minutely serrulate, hyaline or herbaceous apex; stems forming a closely prostrate mat; megaspores coarsely reticulate-rugose on outer face, with a prominent, thin, irregular equatorial ring.....6. *S. cinerascens*.
- e.* Leaves with a straight, hyaline terminal seta. *h.*
- h.* Leaves abruptly truncate at base, thin and firm, nearly plane on both surfaces. *i.*
- i.* Cilia hyaline, 0.1 mm. or less long, ascending. *j.*
- j.* Leaves glaucous-green; cilia relatively few and distant. *k.*
- k.* Leaves subulate-linear, long-acuminate, commonly with a tuft of hairs at base; cilia piliform except near apex of leaf; outer face of megaspores coarsely reticulate-rugose.....7. *S. porrecta*.
- k.* Leaves oblong-linear, short-tapering to apex, usually without hairs at base; cilia reduced to minute teeth; outer face of megaspores very finely and shallowly reticulate.....8. *S. Arsenei*.
- j.* Leaves green; cilia numerous, piliform, strongly ascending; megaspores finely reticulate.....9. *S. Hintonii*.
- i.* Cilia chalk-white, subopaque, piliform, laxly ascending or the basal spreading, up to 0.18 mm. long; outer face of megaspores reticulate with areoles of moderate size.....10. *S. Sartorii*.
- h.* Leaves rounded or abruptly narrowed at base, thickened and dorsally convex, in profile passing obliquely into the stem; megaspores as in no. 10. *l.*
- l.* Seta 0.3–0.5 mm. long; cilia often reduced to small teeth or nearly obsolete.....2. *S. Underwoodii*.
- l.* Seta 0.8–1.8 mm. long; cilia tending to become well developed and piliform.....2a. *S. Underwoodii* var. *dolichotricha*.

1. *Selaginella oregana* D. C. Eaton in Wats. Bot. Cal. 2: 350 (1880); Maxon in Amer. Fern Journ. 11: 35 (1921), in Abrams, Ill. Fl. Pacific States, 1: 48. fig. 103 (1923). PLATE I, 1.

Selaginella struthioloides (Presl) Underw. in Bull. Torr. Bot. Club 25: 132 (1898), as to plant, not *Lycopodium struthioloides* Presl; Frye & Jackson in Amer. Fern Journ. 3: 75. pl. 3, fig. 4 (1913).

Stems very long, up to 9 dm. (according to Mrs. Summers "1–6 ft.," but this may refer to the dimensions of the mat rather than to individual stems). Leaves green, subulate-lanceolate, 2–2.6 mm. or more long, 0.5–0.6 mm. wide, acuminate, flat on the ventral surface, with a broad, conspicuous dorsal furrow. Seta nearly smooth, 0.3 mm. or less long, whitish or yellowish. Spikes up to 3 cm. long. Sporophylls similar to foliage-leaves, but broader, 2.2–2.4 mm. long, 0.8–1 mm. wide, scarcely biauriculate at base, long-acuminate, the cilia and seta as in leaves. Megaspores yellow, about 0.4 mm. in diameter, more or less flattened, shallowly reticulate on the outer face with areoles of moderate size, somewhat more strongly and less regularly reticulate on the commissural face, without an equatorial ring, but with a band of rather close reticulation, the rugae showing as irregular projections when seen in profile. Microspores about 50 μ in diameter, irregularly rugulose, with an irregular, rather broad wing.—Northern California, Oregon and Washington, near the coast; pendent from trees or on rocks.

LECTOTYPE: Port Orford, Curry Co., Oregon, 1855, *Kautz* in herb. Yale University (dupl. G). After the custom of his time, Eaton designated no type. He cited two collections, that of *Kautz* and one from Tillamook Valley, Oregon, 1878, *Mrs. Summers* 2209. The former was incidentally designated as type by Maxon, Amer. Fern Journ. 11: 36 (1921), and this designation may stand, though the *Summers* specimen is better

fruited and has more mature spores. Eaton wrote on his sheet of it: "Macrospores detected March 15, 1880!!! D. C. E." The Kautz specimen is better vegetatively.

The following specimens may be cited as representative. CALIFORNIA: near Adams, Del Norte Co., *Eastwood 12185* (G). OREGON: hanging from moss of trees, Coos River, Oct. 29, 1881, *Pringle* (G, Y); on maple trees by the Trask River, July 12, 1882, *Howell* (G, Y); without locality, 1871, *Hall* (Y). WASHINGTON: shaded ledges, base of Mt. Col Bob, Gray's Harbor Co., *Thompson 9399* (G); rocks, banks of Columbia River at Altoona, Wahkiakum Co., *Suksdorf 6811* (G); Leban, Pacific Co., *Piper 3802* (G); "Observatory Mt.," *Scouler 335* (G).

2. *Selaginella Underwoodii* Hieron. in Engler & Prantl, Nat. Pflanzenf. I. 4: 714 (1901); Underw. in Fern Bull. 10: 11 (1902); Standley in Amer. Fern Journ. 4: 114 (1914), 5: 78 (1915); F. C. Greene, op. cit. 17: 129 (1927); Maxon, op. cit. 27: 111 (1937); Wherry, op. cit. 28: 30 (1938). PLATE I, 2(A-F).

Selaginella rupestris var. *Fendleri* Underw. in Bull. Torr. Bot. Club 25: 127 (1898). *Selaginella Fendleri* (Underw.) Hieron. in Hedwigia 39: 303 (1900), not Baker (1887).

Stems mostly less than 15 cm. long. Leaves loosely imbricate, oblong-linear, 2–2.5 mm. long, 0.3–0.4 mm. wide, the dorsal groove not reaching the somewhat thickened and subcucullate, obtusish apex. Seta scabrous. Sporophylls ovate-deltoid, about 2 mm. long and 1 mm. wide, subabruptly narrowed above the broad, widely biauriculate base to the acute, somewhat thickened and cucullate apex; dorsal groove not reaching the apex; seta as in foliage-leaves; margins densely or sparsely ciliolate-serrulate with often dentiform cilia. Megaspores about 0.3 mm. in diameter, somewhat flattened, shallowly and rather regularly reticulate on the outer face with thin ridges forming areoles of moderate size, more closely and irregularly sculptured on the commissural face with thicker ridges; commissural ridges prominent; no equatorial ring. Microspores about 50 μ in diameter, nearly smooth on the commissural face, finely and regularly punctate on the outer, with a narrow, irregular wing. — Wyoming, Colorado, western Oklahoma, southwestern Texas, northern New Mexico and northern Arizona. Presumably on rocks, often associated with *S. mutica*.

TYPE: *Fendler 1024* from near Santa Fe, New Mexico, in herb. New York Bot. Gard.; isotype, G.

The following are representative. COLORADO: Royal Gorge, Fremont Co., July 30, 1888, *Demetrio* (G); Minnehaha Falls, Pike's Peak region, El Paso Co., *Johnston 2421, 2425* (G). TEXAS: Mt. Livermore, Davis Mts., Jeff Davis Co., Aug., 1938, *Hinckley* (G). NEW MEXICO: moist cliffs, Ute Park, Colfax Co., alt. 2200–2900 m., *Standley 14688* (G). ARIZONA: near Flagstaff, Coconino Co., 1921, *Ferriss* (G, US).

2a. *Selaginella Underwoodii* var. *dolichotricha* var. nov. PLATE I, 2(G).

A varietate typica differt seta terminali foliorum 0.8–1.8 mm. longa, ciliis saepius bene evolutis piliformibus.

NEW MEXICO: Mogollon Creek, Mogollon Mts., alt. about 8000 ft., Socorro Co., July 20, 1903, *Metcalfe 276*, TYPE in Gray Herb.; Silver City, Grant Co., alt. 5700 ft., *Metcalfe 711* (US); Lookout Mine, south end of the Black Range, alt. about 8600 ft., Sierra Co., *Metcalfe 991* (G). ARIZONA: Frye Canyon, Pinaleno Mts., Graham Co., alt. 5500 ft., *Maguire, Richards & Moeller 11745* (G); Paradise, Cochise Co., March, 1904, *Ferriss* (G); Santa Rita Mts., Pima Co., *Goodding 5* (US). Specimens from Cave Creek, Chiricahua Mts., Cochise Co., Arizona, *Ferriss* in 1904 (US), and from the Organ Mts., New Mexico, *Wootton*, March 3, 1907 (US), though best placed under the variety, represent phases more or less intermediate in length of seta and in association of long seta and cilia.

Although the variation in length of seta and cilia is no greater than in

some other species, *S. arizonica* for instance, there seems to be here sufficient geographic segregation to justify the recognition of a variety, parallel to *S. mutica* var. *limitanea*. Long setae appear to occur consistently, and only, in the southern part of the range of the species; and long cilia are much more common there, though the association of the two is by no means constant.

3. *Selaginella mutica* D. C. Eaton in Underw. in Bull. Torr. Bot. Club 25: 128 (1898); Underw. in Fern Bull. 10: 10 (1902); Wherry in Amer. Fern Journ. 28: 136 (1938). PLATE I, 3(A-F).

Stems rather short for the group (10 cm.), forming a relatively dense mat. Leaves pale green, variable in size, 1–2 mm. long, 0.4–0.5 mm. wide, obtuse or acutish. Spikes up to 1.5 cm. long. Sporophylls ovate-deltoid, 1.4 mm. long, 0.6–0.8 mm. wide, evenly narrowed from above base to a normally mucronate acute apex. Megaspores subglobose, orange-yellow, finely and irregularly reticulate on both faces or nearly smooth on the outer, with low, short commissural ridges and low, inconspicuous ring or none. Microspores about 50 μ in diameter, very lightly granular or smooth, narrow-winged. — On rocks of various kinds (limestone, basalt and sandstone are mentioned by collectors), montane regions of Colorado, eastern Utah, southwestern Texas, northern and central New Mexico, and northern Arizona, with a single record from the southeastern part of that state.

AS LECTOTYPE I would choose a specimen in herb. Yale University collected in "crevices of rocks, mountains of Colorado, 1871" by *Meehan*. In publishing the species from Eaton's manuscript, Underwood designated no type. Of the specimens in Eaton's herbarium, the only one labelled *S. mutica* is a fragment without data of locality. The cited specimen of the Mexican Boundary Survey is of the phase here treated as var. *texana*. Presumably Eaton overlooked the inconspicuous and fragile terminal seta present in this collection, though often broken off in the older leaves. In any case, his description and the name he chose preclude the choice of a setigerous specimen as type. The cited specimen which he seems especially to have studied and from which he made a drawing of a leaf, is the Colorado one collected by *Meehan*. I am accordingly regarding that as the type.

The following are representative. COLORADO: Estes Park, Larimer Co., 2250 m., July 20, 1914, *Wooton* (US); Idaho Springs, Clear Creek Co., alt. 13000 ft., *Shear 4616* (US); columnar basalt cliffs southwest of Lyons, Boulder Co., June 20, 1937, *Wherry* (US); Manitou, El Paso Co., Dec., 1924, *Goldsmith* (G); same locality, shallow soil covering limestone, piñon belt, alt. 6600 ft., *Johnston 3871* (US); canyon of Arkansas River, Fremont Co., *Bacigalupi 1015* (G), July 31, 1888, *Demetrio* (G); Canyon City, 1871, *Brandege* (Y); rocks in canyon, San Miguel River near Gateway, Montrose Co., *Maguire & Piranian 11371* (G); shaded gulch in dry, rocky hills, alt. 5800 ft., *Paradox, Walker 365* (G, US). UTAH: Vernal, Uintah Co., *Graham 7592* (US); under and about rocks, canyon and talus slopes, head of Calf Spring Wash, San Rafael Swell, Emery Co., 6800 ft., *Maguire 18450* (G). TEXAS: Sierra Diablo, Hudspeth Co., Sept. 13, 1921, *Goodding* (US); El Paso, *Mearns* (US); calcareous soil in crevices of limestone ledges, Victoria Canyon, Sierra Diablo, *Waterfall 4811* (G). NEW MEXICO: Sierra Nacimiento, Rio Arriba Co., *Goodding 6142* (US); Rio Grande Canyon, west of Taos, Taos Co., *Wilkins 2422* (US); Nambe Creek, Santa Fe, *Arsène 21118* (G); on rocks in woods along Pecos River, Pecos, San Miguel Co., *Drouet & Richards 3311* (G, US); Santa Rosa, Guadalupe Co., 1450 m., *Arsène & Benedict 16643* (US); sandstone cliffs south of Grant's, Valencia Co., May 18, 1939, *Goodding* (US); Magdalena Mts., northwest of Socorro, Oct., 1922, *Ferriss* (US). ARIZONA: near Betatakin ruins, Navajo Co., *Wetherill 536* (US); on and about exposed rocks (sandstone?) near rim of canyon, Grand Canyon, Coconino Co., alt. 6500 ft., Nov. 17,

1905, *Wm. Palmer* (US); Chiricahua Mts., Cochise Co., Sept. 20, 1896, *Toumey* (US, Y).

There is much variation in the leaves of *S. mutica*. Typically, those of the new growth are oblong-lanceolate or even ovate-oblong in outline, closely imbricated, obtuse and not more than 1.4 mm. long. This condition grades into one in which the leaves of the new growth are ovate-lanceolate, rather loosely imbricate, tapering to an acute apex, 1.8–2 mm. long and more often mucronate. The two extremes are striking enough to the eye, but taxonomically are inextricable (though Hieronymus gave a manuscript name to a sheet of the second). Not only are there various intermediates, but the two frequently occur in the same collections and even in the same colonies and have no regional differentiation. Some of the long-leaved plants show a tendency to develop narrowed and lengthened leaf-bases suggestive of hybridization with *S. Underwoodii*, which frequents the same habitats as *S. mutica* and not uncommonly grows intermingled with it. Such hybridization may be an element in the variability of the plants here considered as belonging with typical *S. mutica*.

Two other variants show geographic segregation and may profitably be set apart as varieties.

3a. *Selaginella mutica* var. *texana* var. nov.

A varietate typica differt foliis sporophyllisque seta terminali laevi albescente hyalina ad 0.4 mm. longa praeditis.

TYPE: shaded rocky hillside, ridges south of Emory Peak, Chisos Mts., Brewster Co., Texas, alt. 2300 m., June 23, 1931, *Moore & Steyermark 3196*, in Gray Herb.; isotype, US.

Other specimens seen — TEXAS: "Mexican Boundary" (Y); Pulliam Canyon, *Sperry 428* (US); moist cliffs and crevices, rhyolite cliffs, north exposure, near Mt. Livermore, Davis Mts., alt. 2400 m., *E. J. Palmer 30871* (G); exposed rock crevices, Little Ajuga Canyon, Davis Mts., alt. 1495 m., *Moore & Steyermark 3046* in part (G, US); Limpia Canyon, *Tracy & Earle 275* (G, US; toward var. *limitanea*).

This is a rather indefinite variety, combining the long, spreading cilia of typical *S. mutica* and the terminal seta of var. *limitanea*, and known only from west Texas where the ranges of these two meet. Morphologically, it is little more than a series of intermediates between them, and one may doubt if it represents any established genetic line. Nevertheless, the specimens here brought together have a recognizable association of characters: the terminal seta is generally longer than in var. *limitanea*; and, from the standpoint of practical taxonomy, the recognition of the variety clarifies the arrangement of material.

Wright 2115, distributed with a label-caption reading "New Mexico," but actually collected at Frontera, in what is now El Paso County, Texas, represents an occasional variant of *S. mutica* toward var. *texana*. Some of its leaves have short setae, some do not.

3b. *Selaginella mutica* var. *limitanea* var. nov. PLATE I, 3(G).

A varietate typica differt foliis sporophyllisque seta terminali brevi (ad 0.2 mm. longa) fere laevi albescenti-hyalina praeditis, ciliis sparsis brevibus plerumque minus quam 0.1 mm. longis adscendentibus, sporophyllis erosofimbriatis.

TYPE: mountains west of Deming, Luna Co., New Mexico, Oct. 4, 1937, *Goodding* (US).

Other specimens seen — TEXAS: Mt. Franklin, El Paso Co., Dec., 1924, *Slater* (US); Ft. Davis, *Ingram* 2723 (US; transitional); exposed rock crevices, Little Ajuga Canyon, Davis Mts., alt. 1890 m., *Moore & Steyermark* 3046 in part (G); on sometimes wet ledges and cliffs of porphyritic rock, Mt. Livermore, Davis Mts., *E. J. Palmer* 31951 (US), *Hinckley* 1155 (US) (the last three localities in Jeff Davis Co.). NEW MEXICO: Van Patten's, Organ Mts., Dona Anna Co., Sept. 10, 1899, *Wootton* (US), June 9, 1906, *Standley* (US); Filmore Canyon, April 8, 1903, *Wootton* (US) and three other collections by *Wootton* from the Organ Mountains without more definite locality. ARIZONA: Paradise, Cochise Co., *Ferriss* (G).

This is a well-marked variant, morphologically and geographically, but it is connected by intermediates with var. *texana* and through it with typical *S. mutica*. I borrow from *Notholaena* Dr. Maxon's very appropriate epithet for a population occurring in a narrow strip of territory along the Mexican border.

The similarity in range between this variety and *S. Underwoodii* var. *dolichotricha*, as also between the typical forms of the two species, is apparent. Evidently there is, at least for these species, a phytogeographic break between northern and southern Arizona and northern and southern New Mexico west of the Rio Grande — a break which follows roughly the line of the mountain-mass which extends westward from the Sierra Mimbres, on the watershed between the Rio Grande and the Gila River, to the vicinity of Prescott, Arizona, and beyond at lower altitudes to the Colorado River valley, and which also forms the southern boundary of Fenneman's Colorado Plateau Province. East of the Rio Grande, where the mountain-ranges run north and south, the northern elements of both species run south to the Davis Mountains of Texas.

4. *Selaginella viridissima* Weatherby in Journ. Arnold Arb. 24: 326 (1943). PLATE I, 4.

Stems of moderate length, up to 10 cm. Leaves somewhat thickened and convex above, especially toward apex, 1.6–2 mm. long, 0.3–0.4 mm. wide, with sparse, very short (0.1 mm. or less long), ascending, mostly dentiform cilia, reduced to teeth toward apex. Spikes up to 1 cm. long. Sporophylls ovate-deltoid, 1.8–2 mm. long, 0.8–1 mm. wide, somewhat dilated above base, thence tapering evenly to the acuminate apex, the margins densely erose-serrulate with very short teeth. Seta none. Megaspores yellow, 0.4–0.5 mm. in diameter, subglobose or somewhat flattened on the commissural face. Microspores very regularly alveolate-punctate (at least on outer face), irregularly winged.

TYPE: shaded cliffs in deep canyon, in hanging mats 1 m. in diameter, Cañon de Calabasa, north wall of Sierra Mojada, Coahuila, Mexico, Oct. 27, 1941, *Stewart* 2204, in Gray Herb.

One other collection has been seen: mats on shaded cliffs, Tinajas del Osos, vicinity of Aguaje del Pajarito, west end of Sierra de la Fragua, 2–3 km. north of Porto Colorado, Coahuila, Sept. 1–8, 1941, *Johnston* 8683.

5. *Selaginella extensa* Underw. in Bull. Torr. Bot. Club 25: 131 (1898). PLATE I, 5.

Selaginella rupestris subvar. *viridis* Fourn. Mex. Pl. 1: 146 (1872), at least in part.

Stems elongate, up to 3 dm. long. Leaves appearing somewhat fleshy,

but not thickened at apex, 1.6–2 mm. long, 0.3–0.4 mm. wide, with few and distant, strongly ascending, very short, thick and dentiform cilia. Spikes 1–2 cm. long. Sporophylls narrowly deltoid, 1.8–2 mm. long, 0.5–0.6 mm. wide, long-acuminate, closely serrulate with short, thick, broad-based, pungent teeth; apex as in foliage-leaves. Megaspores densely and finely rugose on both faces, more strongly on the commissural. Microspores about 35 μ in diameter, coarsely and irregularly punctate, with a narrow, somewhat irregular wing, the mother-cell membrane soon shed, but the spores long adhering in tetrads. — Central Mexico.

TYPE: on rocks and trees, Las Canoas, San Luis Potosí, Mexico, Aug. 21, 1891, *Pringle 3900*, in Herb. New York Bot. Gard.; isotypes, G, US, Y.

Other specimens seen — SAN LUIS POTOSÍ: limestone cliffs, Las Canoas, alt. 900–1000 m., *Pennell 17947* (US). HIDALGO: shallow leaf-mold on dry rock, Jacala, alt. 5000 ft., *Hoogstraal & Chase 7308* (US), *Frye 2537* (US). VERA CRUZ: old trees, Sierra Madre, Naolinco, *Purpus 6052* (G, US); région d'Orizaba, Oct., 1865–66, *Bourgeau 2541* (G, Y); Borrego, Orizaba, June 19, 1865–66, *Bourgeau 2541* (G); ad arborum truncos repens in sylvis umbrosis humidis, Cordoba, Sept., 1856, *Mohr 12* (Y).

Selaginella extensa is a very well marked species, set apart from all others of its alliance by its peculiar flattened and spreading leaf-tips and its equally peculiar, equatorially tuberculate megaspores.

6. *Selaginella cinerascens* A. A. Eaton in Fern Bull. 7: 33 (1899); Maxon in Abrams, Ill. Fl. Pacific States, 1: 47. fig. 102 (1923); Munz, Man. So. Cal. Bot. 13 (1935); Munz & Johnston in Amer. Fern Journ. 13: 3 (1923); Wiggins, op. cit. 22: 92 (1932). PLATE II, 6.

Stems not greatly elongate (at most 15 cm.) and rather closely branched. Leaves oblong-linear, about 2.4 mm. long and 0.4–0.5 mm. wide. Cilia strongly ascending, mostly few and irregularly spaced, very short (0.1 mm. or less long), but not dentiform. Spikes short, about 5 mm. long. Sporophylls broadly deltoid, about 1.8 mm. long by 1.2 mm. wide, broadly acuminate, without a seta, finely and densely ciliolate with very short ciliola. Megaspores pale yellow, lightly rugose on the commissural face. Microspores up to 50 μ in diameter, with delicate radiating striae on the commissural face, finely granular on the outer face, with a broad, entire wing. — Southern California and adjacent Baja California, on clay-banks, forming closely prostrate mats.

TYPE: National City, San Diego, California, *Miss L. F. Kimball*, in Gray Herb.

The following are representative: Mission Hills, San Diego, *Abrams 3399* (G); Ensenada, Baja California, *Johnston 3004* (US), *Wiggins 4213* (G).

The "prominent spinules" mentioned by A. A. Eaton in his description of the microspores I have observed only at the junction of the body of the spore and the wing; I believe they are to be interpreted as wrinkles in the spore-coat outlined by transmitted light rather than as actual spinules such as occur in *S. selaginoides*.

7. *Selaginella porrecta* sp. nov. PLATE II, 7.

Caules plerumque nec valde elongati, graciles foliis inclusis ca. 1 mm. diametro, prostrati, fere ad apicem radicanes, pinnatim alternatimque ramosi, ramulis vix ultra 1 cm. longis. Folia arcte adpressa, subulato-lineararia, longe acuminata, pallide viridia, paginis ambobus plana dorso usque ad apicem sulcata, ea ramulorum ca. 2.5 mm. longa 0.4 mm. lata, ea caulis ad 3 mm. longa 0.5 mm. lata, nonnumquam basi fasciculo ciliorum

ornata, marginibus sparse breviterque ciliata, ciliis ca. 10 vel paucioribus adscendentibus versus apicem folii vel rarius ubique ad denticulos reductis, apice seta subhyalina albescente flavescenteve scaberula usque ad 1 mm. longa praedita. Spicae ad apices ramulorum gestae ca. 1 cm. longae. Sporophylla anguste deltoidea, ca. 2.2 mm. longa 0.8 mm. lata, e $\frac{1}{3}$ longitudinis supra basim leviter auriculatam ad apicem acuminatum seta subhyalina albescente flavescenteve fere laevi 0.3–0.8 mm. longa ornatum gradatim angustata, marginibus basim versus dense breviterque ciliolatis ciliolis subdentiformibus 0.1 mm. vel minus longis. Megaspori ca. 0.4 mm. diametro subglobosi aurantiaci vel flavi, latere commissurali tenuius latere altero valde crasseque reticulato-rugosi, exannulati, costis commissuralibus prominentibus. Microspori aurantiaci, ca. 40–45 μ diametro, latere commissurali costis exceptis laeves, latere altero irregulariter plus minusve rugosi, ala crassa irregulari valde rugosa ornati. — Northeastern and north-central Mexico.

TYPE from red sandstone slope, alt. 1650–1700 m., "Alamar," Pablillo, southeast of Galeana, Nuevo León, July 2–3, 1934, *Pennell 17198* in U. S. Nat. Herb., sheet no. 1,685,291.

Other specimens seen — NUEVO LEÓN: La Silla Mt. near Monterrey, *Orcutt 1151a, 1142* (US); Topo Chico, near Monterrey, *Orcutt 1098* (US); Monterrey, *Tharp 1792* (US). SAN LUIS POTOSÍ: *Orcutt 5125* (US); thin soil over limestone, alt. 2100 m., Sierra de Alvarez, *Pennell 17753* (US); in montibus circa urbem San Luis Potosí, *Schaffner 933* (Y). TAMAULIPAS: Cerro de los Armadillos, vicinity of San José, alt. 2600 ft., *Bartlett 10355* (US); Cerro Zamora, vicinity of El Milagro, *Bartlett 11039* (US). DURANGO: Sianori, *Ortega 5319* (US).

Much of the material placed here was long ago indicated by Maxon as belonging to a new species but was not given a name. Its status is somewhat doubtful, for the reason that, of all the specimens cited, only the type has mature spores and on their characters the claim of the group to specific rank largely rests. These characters seem pronounced enough; the wing of the microspores, so wrinkled and folded as to suggest a ruffle on an old-fashioned gown, is particularly distinctive. But, should they prove inconstant or in the case of the microspores abnormal (though aside from the peculiarity of the wing, there is no evidence of abnormality), *S. porrecta* might have to be united with *S. Arsenei*, to which, as noted in the introduction, it is very similar in foliar characters, or reduced to a variety of *S. Sartorii*.

8. *Selaginella Arsenei* sp. nov. PLATE II, 8.

Caules prostrati, cum ramis fere ad apicem radicantes, nec valde elongati (ad 15 cm. longi), foliis inclusis vix ultra 1 mm. diametro, pinnatim alternatimque ramosi; rami bene evoluti ad 7 cm. longi ramulis ad 1.5 cm. longis dense foliosis. Folia glaucescentia tenuia paginis ambobus plana dorso usque ad apicem anguste sulcata, subchartacea, arcte vel sublaxe adpressa, oblongo-linearum, 1.8–2.4 mm. longa, 0.35–0.4 mm. lata, in apicem acutum seta albescenti-hyalina scaberula ad 0.5 mm. longa ornatum subbreviter angustata, marginibus subsparse ciliato-serrulata, ciliis brevissimis plerumque dentiformibus. Sporophylla anguste deltoidea fere e basi levissime biauriculata ad apicem acuminatum seta albescenti-hyalina brevi ornatum gradatim angustata, marginibus dense ciliolato-serrulata. Megaspori subglobosi ca. 0.4 mm. diametro dense leviterque reticulato-rugosi, exannulati,

costis commissuralibus brevibus vix prominentibus. Microspori diametro 40–50 μ aurantiaci (luce transeunte flavi), latere commissurali, ut videtur, radiatim, latere altero irregularius rugulosi, ala angusta plana integra.

TYPE: Queretaro, Mexico, 1914, *Arsène 10641*, in U. S. Nat. Herb., sheet no. 1,000,066. Other specimens, same locality and collector: 1850 m. alt., 1911, *no. 9983*; 1914, *no. 10643*, both US.

This also was indicated by Dr. Maxon as a probable new species.

9. *Selaginella Hintonii* sp. nov. PLATE II, 9.

Caules graciles ad 30 cm. longi, foliis inclusis ca. 1 mm. diametro, repentes, cum ramis fere ad apicem radicantes, pinnatim alternatimque ramosi, ramis ad 8 cm. longis, ramulis plerumque simplicibus vix ultra 1 cm. longis dense foliosis. Folia subulato-linearia in caule ca. 2.5 mm. longa 0.4 mm. lata, in ramis ca. 2 mm. longa 0.3 mm. lata, acuta viridia, paginis ambobus plana, dorso usque ad apicem sulcata, arcte adpressa, marginibus dense ciliata ciliis brevibus numerosis (20 vel pluribus) valde adscendentibus albescentibus subhyalinis, apice seta albescente lutescenteve hyalina scaberula 0.6–0.8 mm. longa praedita. Spicae 1 cm. vel minus longae. Sporophylla anguste deltoidea ca. 1.8 mm. longa 0.8 mm. lata, fere e basi leviter biauriculata gradatim ad apicem acuminatum angustata, marginibus dense ciliolato-serrulata ciliis brevissimis subdentiformibus. Megaspori flavi subglobosi ca. 0.4 mm. diametro levissime reticulato-rugosi vel fere laeves, costis commissuralibus inconspicuis, inter amba latera non, vel non manifeste, annulati. Microspori lateribus ambobus plus minusve subalveolato-punctati, ala lata integra. — Known from the type collection only.

TYPE: cliffs, Ypericones, Dist. Temascaltepec, State of Mexico, Sept. 7, 1935, *Hinton 8423*, in Gray Herb.

Closely related to *S. Sartorii*, from which, however, it seems to differ sufficiently by the characters given in the key.

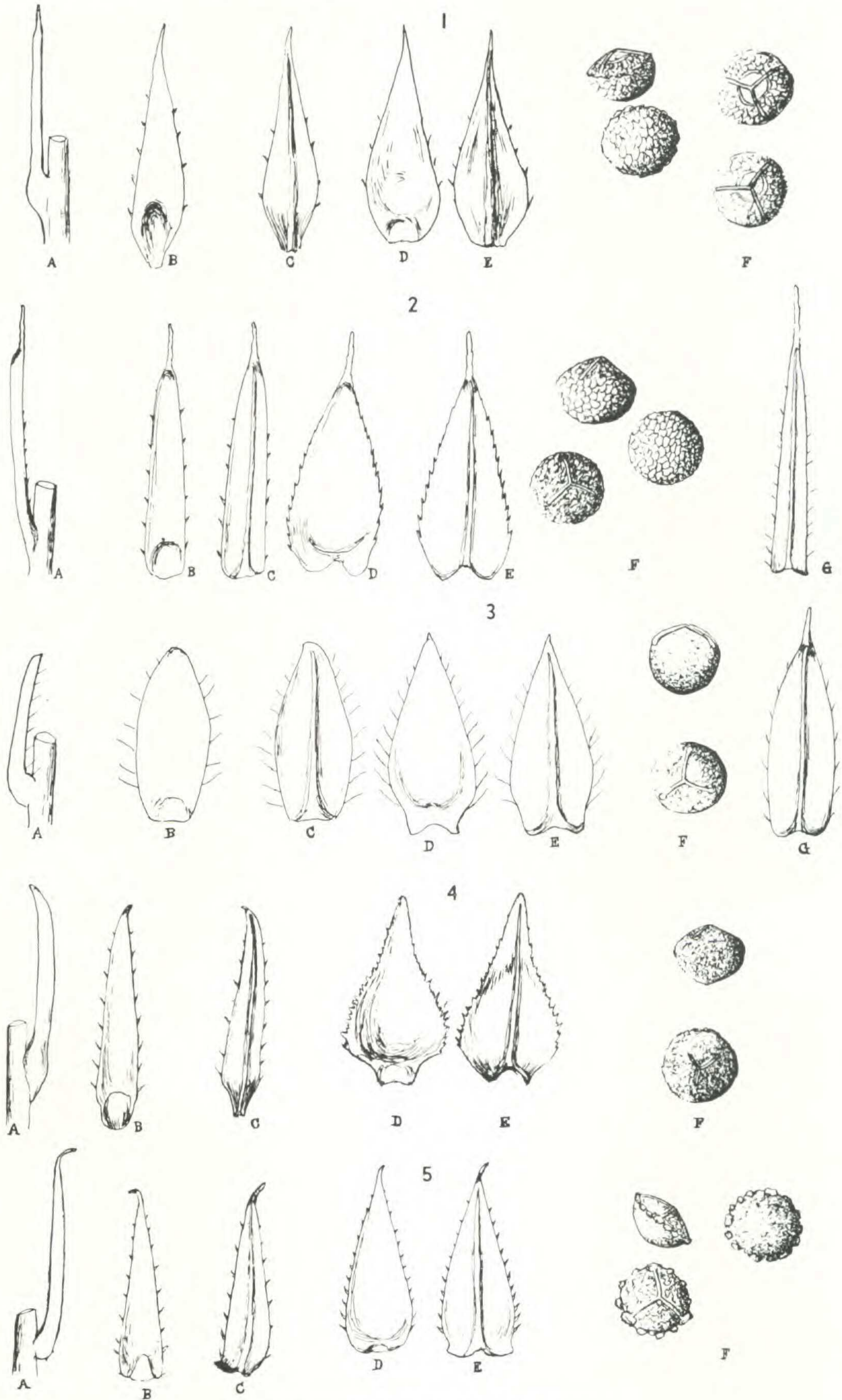
10. *Selaginella Sartorii* Hieron. in *Hedwigia* 39: 304 (1900). PLATE II, 10.

Stems elongate (in herbarium specimens up to 3 dm. long), lax, the branches mostly distant, forming loose mats. Leaves oblong-linear, acute or acuminate, about 2.2 mm. long on old stems, 1.5 mm. on branches, 0.25–0.3 mm. wide, so far as can be made out from dried specimens gray-green, often turning red. Spikes 1 cm. or less long. Sporophylls ovate-deltoid, 1.5 mm. long, 0.8 mm. wide, evenly acuminate from a point about $\frac{1}{3}$ above base, below narrowed to the biauriculate base. Megaspores about 0.3 mm. in diameter, yellow, subglobose, irregularly rugose on the commissural face, rather regularly on the outer, the commissural ridges prominent. Microspores about 40 μ in diameter, minutely punctate or subreticulate on both faces, with a narrow, entire wing. — On rocks, central and southern Mexico.

Type not designated; the specimen cited from Mirador, Vera Cruz, Mexico, *Sartorius*, in the Berlin Herbarium (now probably destroyed) should be regarded as TYPE.

Other specimens seen — VERA CRUZ: in rupibus trachyticis prope Mirador, Aug., 1841, *Liebmann* (G); steinige Stellen, oberes Savannen-gebiet, 6–700 m. alt., Palmilla, *Purpus 120* (US), *8463* (G, US). OAXACA: prope Oaxacam, *Andrieux 2* (G).

What *Selaginella Aschenbornii* Hieron. in *Hedwigia* 39: 305 (1900) may be I do not know; but the description of the leaves as spreading indicates



GROUP OF SELAGINELLA OREGANA