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A QUARTERLY DEVOTED TO FERNS

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American Fern Journal

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Reminiscences of Fern Collecting in Fiji

A. C. Smith

During the present period of turmoil in the southwestern Pacific, botanists who have worked in any of the archipelagoes of that region are prone to wonder what changes will result from the war. There is, fortunately, no longer a possibility that the southwestern groups will pass from the control of friendly countries and become closed to occidental explorers, as have the mandated Micronesian islands. It is now only a question of time until the Pacific will again be at peace and all its islands open to further scientific exploration. Many of these archipelagoes, for example the Solomons and the New Hebrides, are very nearly unexplored from a botanical standpoint; others, such as Fiji, are much better known. Although not in the actual combat area, Fiji is strategically important for its position; from a phytogeographic viewpoint also it is highly important, lying at the edge of the supposed old continental shelf and in the route of major plant movements from Papuasia eastward.

It is just ten years ago that, as a Bishop Museum Fellow in Yale University, I made a collection of plants in Fiji.[1] Herbarium studies in the interval have kept my

[1] For brief accounts of this trip see Journ. N. Y. Bot. Gard. 35: 261–280, *figs. 1–7* (1934) and Trop. Woods 41: 1–5 (1935).

[Volume 33, No. 4 of the Journal, pages 113–148, was issued December 15, 1943.]

memories of this period vivid, and the present recollections are set down in the hope that they will interest fern students whose experiences may not extend to the Pacific tropics. In general, the Pacific islands, excluding the low limestone groups, are among the wealthier parts of the world in ferns, a large proportion of their vascular flora being made up by this fascinating group.

During the course of my nine months in Fiji, I collected on eight or ten islands of the more than 200 which make up the archipelago. With the intention of avoiding the better-collected localities visited by earlier botanists, I concentrated on the higher portions of the large volcanic islands, spending several months on Vanua Levu (the Great Land), the second island of Fiji in size. Although more than 100 miles long, Vanua Levu is comparatively narrow, averaging perhaps 20 miles in width. A nearly continuous mountain range extends for most of its length, and this range, lying athwart the southeast trade winds, sharply divides the island into a wet southern slope and a fairly dry northern slope. Like many other collectors of tropical plants, I have a certain aversion to dry countries; consequently I neglected the northern portions of Vanua Levu in order to concentrate on the wet and heavily forested southern slopes. Let him who will seek out the deserts, the grasslands, the dry reed-covered hills of tropical countries; surely fern students on the whole will agree with me in turning to the wet forests, where swollen streams pour over dark boulders and the trees are clad in masses of soaking epiphytes. Here, in these cool green recesses of the rainforest, is found the wealth of ferns that more than repays one for the sudden showers, the day-long torrential downpours, the wet camp-sites, the soaking shoes, and other attendant discomforts. Eventually, I have always found, there is a morning when the sun shines, and an open place along a creek where one can absorb the steaming heat and simultaneously let one's eyes roam over the edge of a bright green forest, with mosses and ferns cloaking the dripping branches and the drenched rocks. What equal recompense has the fern-lover in dry countries, where, parched and exhausted by desiccating winds, hot, thirsty, he may eventually stumble upon a boulder beneath which lurks a sere brown clump of some depauperate *Cheilanthes?* No, let us write only of the forest, the wet green forest, where graceful tree-ferns abound, where large-fronded epiphytes and minute mosslike filmy ferns cover the lower branches and the trunks of the canopy-forming trees.

To be sure, the reed-covered northern slopes of Vanua Levu are not devoid of ferns. Here are impenetrable tangles of stiff-fronded species of *Gleichenia;* here are extensive areas in which *Pteridium aquilinum* is dominant. But one need not go to the southwestern Pacific to study the Bracken.

To obtain representative collections of the Vanua Levu forest, I ascended the main ridge in several places from the south coast. During my work in Fiji I was accompanied by a Fijian boy of about 20—Manoa by name—who obtained additional help in each village as we needed it, and who acted as interpreter and "head boy." To obtain other local helpers was no problem, for most Fijians are woodsmen and look upon an excursion into the mountains as a lark, for which a few shillings or some trade-goods are ample recompense. Letters to the various district and village chiefs are also of the greatest value to a collector; in general these chiefs themselves are pleased to accompany such excursions, even though the motives behind the gathering of leaves and bits of moss are more or less inexplicable to them. By passing myself off as a *vunikau* (doctor of trees)—a sort of occi-

CYATHEA LUNULATA IN A FOREST CLEARING.

dental medicine man—I invariably obtained willing (if sometimes amused) cooperation from my Fijian friends. As illustrating the life of a plant collector in Fiji, I shall here confine my recollections to a period of a few days spent in western Vanua Levu.

The western end of the island is dominated by Mount Seatura, an extensive mass rising very gradually from the coasts to an elevation of about 850 meters. To collect on the slopes and summit of this mountain was my principal motive in visiting Mbua, the westernmost of the three provinces making up Vanua Levu. At this time I was making my headquarters in the village of Ndama, about two miles up the Ndama River, which debouches somewhat south of the famous—or infamous—Mbua Bay, scene of certain lurid negotiations between sandalwood traders and Fijians more than a century ago. It is not unsatisfying to a botanist that some of these traders, who made *Santalum Yasi* a rarity, found an uncomfortable permanence in Mbua.

After some days' collecting in the coastal hills of Mbua, I set out to ascend the mountain. The best approach from Ndama lies up the so-called Ndriti Gap, which cuts off the southern Seatovo Range from the main mass of the mountain. On the afternoon of the selected day, Manoa and I, accompanied by eight or ten boys "appointed" as carriers by the *mbuli* (chief) of the Ndama district, walked up the valley a few miles to the smaller village of Nangandoa. Here the Ndama is a pleasant slow stream about six meters wide, and we enjoyed a leisurely swim before dark. The *turanga ni koro* (head man) of Nangandoa turned over a little house to us, and we set up a secondary headquarters here.

In the morning we again set out, carrying only the minimum amount of baggage and leaving all drying equipment behind. The trail through Ndriti Gap passes

A. Construction of House, Showing Caudex of Cyathea lunulata Attached to End of Ridge-pole.

B. Completed House, Showing Caudices at Both Ends.

first through dry open country, in which reeds (*Miscanthus japonicus*) and species of *Gleichenia* predominate; but soon the lowland forest is entered, and the tiny village of Ndriti lies in a clearing in this forest, beside the now swift stream. Our party was expected at Ndriti; consequently we were welcomed with a *yanggona* ceremony, the inevitable traditional performance of preparing and drinking the universal beverage of the Pacific, made from the roots of *Piper methysticum*. The ritual of making and partaking of this drink readily consumes a couple of hours, but to slight the courtesies it demands is very impolitic; and anyway, this day it was raining hard, so I did not object to the time spent in social amenities. After this ceremony and an excellent lunch of prawns, *ndalo* (*Colocasia antiquorum*), and native greens, I was able to discuss with my hosts plans for ascending the mountain. As they assured me that there was no trail, I offered to pay three or four of the local men to mark a trail part way up the slope and to make an over-night shelter. This they proceeded to do, while I took Manoa and a couple of other helpers and collected in the rain in the nearby forest.

The wet forest of low and middle elevations on Vanua Levu abounds in ferns, and the most casual collector soon becomes acquainted with such terrestrial forms as *Athyrium melanocaulon, A. esculentum, A. tripinnatifidum, Microlepia speluncae, Tectaria latifolia,* and the more common species of *Dryopteris,* of which about 30 species are known in Fiji. Among the tree-ferns are *Cyathea propinqua* and *C. lunulata;* the latter, probably the most common tree-fern in Fiji, is known all over the group as *mbalambala*. It is one of the few ferns which the Fijians use in their native economy, its long caudices serving as adornments to terminate the ridge-poles of houses, and also in some cases as interior wall uprights.

The young fronds of this fern are eaten in times of scarcity, like those of many other species. Most ferns, of course, can be so eaten; but in a country as rich as Fiji, where yams, taro, breadfruit, coconuts, and many other delicious plant foods can be had at the cost of slight effort, the natives seldom rely upon ferns as food. In this tropical forest the epiphytic ferns are perhaps more conspicuous and varied than the terrestrial forms; simple-fronded epiphytes of common occurrence are *Polypodium accedens* and *Antrophyum alatum,* the latter covering tree-trunks with dense mats of creeping tangled rhizomes. Curious epiphytes with pendant fronds are *Vaginularia paradoxa* and *Vittaria scolopendrina,* the former with fronds up to 25 cm. long and only about 1 mm. broad, simulating narrow hanging grass-blades, the latter somewhat larger, with fronds up to a meter in length but proportionately broader. Among the peculiar humus-collecting epiphytes are to be mentioned *Asplenium nidus, Polypodium linguaeforme,* and *Drynaria rigidula;* these have large coarse fronds and are "nest-like" in growth, the bases of their fronds tending to collect debris and humus. Common epiphytes with attractively divided fronds are *Asplenium remotum, A. bipinnatifidum,* and *Davallia fejeensis;* to see the last species in abundance in its native home is of especial interest, for it is widely used as a greenhouse plant in hanging baskets.

Our afternoon in the forest near Ndriti having resulted in the collection of some of the above-mentioned species and numerous flowering trees and shrubs, I decided to spend the following morning in the same pursuit and to return to Nangandoa to dry the collection before proceeding up the mountain. Such flexible plans are really necessary in a region where the weather and the native temperaments are both subject to unpredictable vagaries.

In the vicinity of Ndriti, however, the weather is actually quite dependable; it is raining. Guppy,[2] in his invaluable geological study of Vanua Levu, describes Ndriti as one of the wettest places on the island. As I walked back down the trail to Nangandoa the sun was shining, but, looking behind me, I could see heavy clouds hanging in the deep valleys of Seatura.

After putting into press our collections, we again started out for the mountain. Arriving at Ndriti, we found that all the men I had engaged were on the mountain except one, who then guided Manoa and me up the trail they had marked. This trail, an overgrown surveyor's track that would have been invisible but for the recent clearing, leaves the valley of the Ndama for a small northern affluent, which is forded repeatedly. The forest here is dense and is dominated by a small ulmaceous tree, the *masivau* (*Gironniera celtidifolia*). Invisible birds, with thrushlike notes, accompanied us. Common terrestrial ferns, as one ascends the mountain ridges, are *Syngramma pinnata, Blechnum orientale,* and *Asplenium laserpitiifolium,* the last a handsome plant with quadripinnate fronds, which is often found on tree-trunks as well as on the ground. Species of *Nephrolepis,* either terrestrial or epiphytic, are abundant, among them *N. exaltata* and *N. biserrata.* A small tree-fern with large decompound fronds is *Culcita straminea,* while *Schizaea dichotoma* is common on the forest floor, with species of *Selaginella.* This *Schizaea* is not very reminiscent of our northern species; it has a stiff stipe often 30 cm. in length and a dichotomously branching fanlike blade up to 10 cm. long, with the sporangia borne on pinnately arranged spikes at the tips of the segments. *Didymochlaena truncatula* is fairly abundant at middle elevations, and its presence in the Pacific is somewhat

[2] Observations of a Naturalist in the Pacific, Vol. 1 (1903).

surprising to one who has seen it so common in South America.

Mount Seatura is a massive formation of criss-cross ridges and buttresses, and even from the high points one obtains no clear idea of the topography. Our trail led up the ridges fairly steeply, but in no parts was stiff climbing called for. By mid-afternoon, by pushing along without collecting, we found our advance party at about 500 meters elevation at a place they called "Seatura." Here the ridge flattens out momentarily and there used to be an old fortified town, the name of which has now been applied to the whole mountain, although the various peaks have other local names. The highest, for which I was aiming, is called Navotuvotu, but on some of the charts it is marked as "West Peak." At present there is no indication whatever of a town site at "Seatura"; dense heavy forest covers the ridge. I gathered that the natives of the Ndriti district used to retire to this easily defended spot in the old days, when things got too hot for them in the valley. Episodic warfare between the various tribes and villages, no more than a century ago, was a commonplace, and strategic village sites were essential.

In the present century Seatura presents a peaceful enough aspect, beneath the huge quiet trees. My advance guard had here built a frame shelter, covered with the large leaves of *Alpinia* spp. and *Heliconia Bihai*. A frame for my canvas fly was erected in a few moments, and the solicitous Manoa made me a bed of saplings raised from the ground, covering it with the fronds of *Angiopteris evecta* and *Marattia Smithii*. There is no especial significance in the specific epithet of the latter, and I doubt if the Smith for whom it was named, nearly a century ago, ever spent such comfortable nights on its soft fronds. These two huge-fronded eusporangiate ferns are among the most striking plants of the Fijian forests; in addition to their soporific qualities, the fronds of *Angiopteris evecta* are said to be eminently edible.

As soon as we were fairly settled at Seatura the daily downpour began, and soon afterward a large percentage of the female population of Ndriti toiled up the hill, bringing our supper. This shows what sort of campers Fijian bushmen are. It was a good supper; the prawns in this region are large and delicious, and I prefer them even to tinned beef and salmon, something my companions found hard to believe. In Fiji I always carried a supply of tinned meat and fish, but seldom used this myself, as native food is usually abundant. Living in a region where the rivers and coastal reefs teem with delicious fish, the inhabitants look upon a can of salmon as a real prize. During the night the rain stopped and a hazy moon sent splotches of light through the forest to our peaceful camp. There was, of course, conversation; in Fiji to talk at any time and on any subject is an inalienable right. An old man named Masima (which means salt) held forth at great length, while everyone else went to sleep or pretended to. At about three o'clock I heard one of the women making a long loud speech, which evoked no rejoinder whatever; possibly she was complaining about the crazy "papalangi" causing her to leave her comfortable bed to climb mountains in the rain. In the morning I found Manoa sleeping under my bed, for he said the shelter was crowded. As it held nine young men and boys, four women, one old man, and one small boy, I considered this an understatement. So much for roughing it in Fiji.

With seven or eight of the boys, I proceeded to Navotuvotu. Some of them went ahead to open the old trail; the rest followed slowly with me, and we collected everything in good condition. The trail follows a gradually rising ridge through dense forest, of which the tree-trunks are cloaked in masses of wet bryophytes and long drooping Lycopodiums. The hard- and simple-fronded epiphytes *Oleandra Parksii* and *Selliguea feeioides* are here abundant. Among noteworthy filmy ferns are *Trichomanes omphalodes,* a species with minute peltate fronds less than 1 cm. in diameter, forming masses on tree-trunks, and *T. apiifolium,* strikingly different, with large epiphytic quadripinnatifid fronds 30 to 50 cm. long. Toward the summit the forest is thinner in patches, and the typical ridge ferns are the harsh-fronded *Blechnum capense, B. Patersonii,* and *Dipteris conjugata.* The last of these often forms conspicuous stands, and its large orbicular dichotomously cleft fronds, with scattered minute dorsal non-indusiate sori, are suggestive of no temperate fern. One of the most peculiar Fijian ferns of the upper slopes is *Leptopteris Wilkesiana,* a member of the Osmundaceae but in no way suggesting an *Osmunda.* It is a treelike fern with a small slender caudex and comparatively small and membranaceous bipinnate fronds. Unlike the osmundaceous plants of temperate regions, *Leptopteris* bears its sori dorsally on the green fronds. The ultimate two miles of our ridge toward Navotuvotu is clothed with tangled thickets of *Freycinetia*—a relative of the screw-pines—and one of the few ferns which is thoroughly objectionable, *Histiopteris sinuata.* The sprawling fronds of this unwelcome fern, 6 meters and more in length, form interlaced tangles which are nearly impenetrable. The polished rachises and axes are tough and resilient, resisting machete strokes, so that one must crawl through a tunnel made by bodily pressure. In this manner, creeping and squirming through harsh masses of *Histiopteris* fronds, we came to the summit of Navotuvotu and found a surveyor's beacon in a small tangled clearing. The day was surprisingly clear and we had an excellent view in all directions. From this summit several adjacent islands, such as Ovalau and the mass of Viti Levu, can be seen, as well as a large part of Vanua Levu. To the east, one looks across the Wainunu and Ndreketi valleys, with their picturesque sharp peaks of curious names—Ndrandramea, Mbonolailai, Navungingumu, Osoyangairokokumilevu, and others nearly as strange.

Fijians show the greatest interest in surveying their country from the peaks, and I believe they welcomed my excursions as a legitimate excuse to ascend their little-known mountains, from whose summits they eagerly pointed out landmarks to one another. On this occasion I soon had them all collecting in the vicinity of Navotuvotu, and in a few hours we had fairly well exhausted the immediate locality. Our return trip to the camp at Seatura beat the darkness and the usual downpour by a few minutes. This night I had no difficulty in sleeping all the dark hours, conversation notwithstanding.

The procession which straggled down to Ndriti the next morning consisted of: Manoa, carrying a plant press and an axe; one botanist, carrying a machete and trying to keep his footing while looking up for flowering trees; one boy, carrying a copra sack to hold the day's collections; three boys, carrying yesterday's plants; Masima, dressed in a couple of leaves and wondering how he got into this party; four women bearing culinary accessories and even a *yanggona* bowl; one small boy, carrying a basket full of empty tin cans; five or six boys carrying assorted baggage and earning their pay very easily. This parade gradually trickled past its head, and Manoa and I, collecting the plants marked on the upward trip, were the last to reach Ndriti. Here we had a spot of *yanggona,* said farewell to our companions, and continued to Nangandoa, where the next two days were spent in preparing and drying the Seatura collections.

The preceding paragraphs will perhaps have given the reader a sketchy impression of collecting methods in Fiji—at least of the writer's methods, which will possibly seem somewhat leisurely and haphazard to collectors who follow a more rigid schedule. Ferns probably are not so conspicuous in the vegetation of Fiji as in that of some other Pacific groups—the Societies, for instance. The phanerogamic flora of Fiji is much richer than that of the eastern archipelagoes, and the pteridophytes therefore are comparatively subsidiary to the dense and varied rain-forests.

Our first knowledge of the ferns of Fiji is scarcely more than 100 years old, dating to the U. S. Exploring Expedition of 1838–1842. The ferns collected by this expedition were described by Brackenridge, one of its members, in Volume 16 of the publications of the U. S. Exploring Expedition (1854–55), one of the rarest of botanical books, now to be found in only a very few libraries. Seemann's Flora Vitiensis (1865–73), still the standard reference work pertaining to the Fijian flora, although necessarily incomplete by modern standards, includes a section on ferns (pp. 331–378) contributed by Carruthers (1873), in which the collections made by Seemann, MacGillivray and Milne, and Harvey are discussed. A later collection made by Horne was discussed by J. G. Baker[3] and 14 species were described as new. Horne's collections were uniformly poor and badly preserved, but they were said to have contained about 200 species and varieties of ferns.

The most important and most recent comprehensive treatment of Fijian ferns is Prof. E. B. Copeland's "Ferns of Fiji,"[4] in which knowledge pertaining to the group is summarized and keys to genera and species are

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[3] Journ. Bot. 17: 292–300. 1879.
[4] Bishop Mus. Bull. 59. 1929.

given. All the major fern families are present in Fiji, and Copeland recognizes 63 genera and 230 species (excluding *Lycopodium, Selaginella, Equisetum,* etc.). His treatment of generic lines was perhaps more conservative in 1929 than it would be in 1944, and the number of Fijian genera will be considerably augmented if one recognizes the many segregates in the Hymenophyllaceae.

Copeland's interesting analysis of the fern flora of Fiji shows that only 46 species were considered by him to be endemic—a mere 20 per cent of the total. This is notably low, in comparison to the percentage of endemism among ferns in such Pacific groups as Hawaii, New Caledonia, and New Guinea, and it is well below the percentage of endemism among indigenous flowering plants in Fiji. Although no figures are available for this, because our knowledge of Fijian flowering plants is still far from complete, I estimate that the percentage of endemism, excluding obvious introductions, approaches 50 per cent. The only endemic genus of ferns in Fiji is the monotypic *Orthiopteris.* That comparatively few new species of ferns remain to be discovered in Fiji is indicated by the fact that, among about 600 numbers of ferns collected by myself in 1933–34 and by Mr. Otto Degener in 1940–41, Dr. Carl Christensen and Professor Copeland discovered a total of only six species which appeared new to them.

Excluding the endemics and a few species of dubious range, Copeland analyzes the remaining 170 Fijian species as follows: 21 (12 per cent) are known only from islands to the east, whereas 149 (88 per cent) are known farther west than Fiji, although some of these also occur to the east. Of these 149 species, 45 are cosmopolitan or pantropical, 43 range into Asia beyond the Malay Peninsula, 31 are Malayan, 6 occur no farther west than New Guinea, and 24 are known from the New

Hebrides, New Caledonia, or Australia. These figures, of course, are not too accurate, primarily because of our scanty knowledge of the ferns of the New Hebrides, the Solomons, and New Guinea. As to the last huge island, a vast amount of knowledge has been accumulated since 1929 because of the collections of the Archbold Expeditions, and Copeland would doubtless now revise his figures substantially as a result of his studies of these collections. In regard to the ferns, as to flowering plants, it may confidently be stated that a true understanding of the Fijian representatives will not be gained until the flora of New Guinea is better understood, for the course of plant migration from New Guinea through the Solomons and New Hebrides and into Fiji becomes more evident with every collection from these regions. Of course, the Fijian flora had other sources than Papuasia; some elements are distinctly Australian or New Caledonian, others are Micronesian, and a comparatively few are Polynesian. But in general one must look to New Guinea for the major Fijian relationships, among ferns as among spermatophytes.

Arnold Arboretum of Harvard University.

A Southern Variety of Polypodium peltatum

C. A. WEATHERBY

In my revision of the group of *Polypodium lanceolatum*,[1] I noted under *P. polylepis* Roem. (now to be called *P. peltatum* Cav., an earlier name[2]) two collections from Chiapas and Guatemala which differed from most individuals of the species (a plant chiefly of the highland of central and southern Mexico) in their larger blades, only sparsely beset beneath with small scales. At the time, because of the scant material available, I attempted no taxonomic recognition of this variant. The ample collections of Standley cited below are, however, remarkably uniform and agree well with the two specimens originally seen. They indicate a well-established regional variant, apparently confined to the Sierra Madre of Chiapas and adjacent Guatemala, which may be described as follows:

POLYPODIUM PELTATUM Cav. var. **interjectum**, var. nov., paleis rhizomatis ut in varietate typica, a qua differt laminis lanceolatis, paleis laminae paginae inferioris diametro 0.5 mm. vel minoribus subsparsis. A *P. lanceolati*, cui habitu simillimum, varietatibus omnibus differt paleis integris, eorum rhizomatis cellulis medianis parvis lumine inconspicuo.

Rhizome-scales as in the typical variety, from which it differs in its lanceolate blades, the under surface of which is only sparsely beset with peltate scales 0.5 mm. or less in diameter. From all varieties of *P. lanceolatum* it differs in its entire scales, those of the rhizome with the cells of the dark central band small and with inconspicuous lumina.

MEXICO.—CHIAPAS: San Cristóbal, *Collins & Doyle* 135 (US).

GUATEMALA.—QUETZALTENANGO: *Kellerman* 5947 (US); on rocks, Cerro la Pedrera, south of Quetzalte-

[1] Contr. Gray Herb. 65: 10. 1922.

[2] See Christensen, "Taxonomic Fern-Studies III," *in* Dansk Bot. Arkiv, 9^2: 11. 1937.

nango, 2400 m. alt., Feb. 18, 1939, *Standley* 66488 (F); on tree in forest, 3300 m., slopes of Volcán de Santa María, above Palojunoj, March 6, 1939, *Standley* 67602 (F). TOTONICAPAM: Cumbre del Aire, 3000–3450 m., Feb. 20, 1939, *Standley* 65926 (F). SOLOLÁ: "Hohenstrasse Totonicapam," 3400 m., Jan. 23, 1929, *F. Morton* 498 (F). CHIMALTENANGO: Dense *Cupressus* forest, on tree, Cerro de Tecpam near Santa Elena, 2700 m., Dec. 4, 1938, *Standley* 58769 (F); same locality, Dec. 26, 1938, *Standley* 60957, TYPE, in herb. Field Museum.

Superficially *P. peltatum* var. *interjectum* strongly resembles both typical *P. lanceolatum* and its var. *trichophorum* (which occurs in Guatemala, but, so far as the specimens at hand show, farther north and east), and has usually been determined as *P. lanceolatum.* In all varieties of that species, however, the scales are finely erose-serrulate and the central cells of the rhizome scales are so large as to be rather readily made out under a 10× hand-lens. In the new variety, as in typical *P. peltatum,* all the scales are essentially entire and the central cells of the rhizome scales are small, with lumina difficult to see under a hand-lens.

Typical *P. peltatum* has, commonly, linear-lanceolate or linear-oblanceolate blades, the lower surface of which is densely covered with relatively large, orbicular, peltate scales 0.8–1 mm. in diameter. It also occurs in Guatemala, but, like *P. lanceolatum* var. *trichophorum,* apparently north and east of the area of the present variety. As might be expected, broad-bladed individuals of *P. peltatum* sometimes occur in Mexico, for example, *Lyonnet* 898 from the Federal District (G) and *Arsène* 1839 from Puebla (G); but they have the large scales of the lower surface characteristic of the typical variety.

I am much indebted to the staff of the Field Museum for the privilege of examining specimens and for many other courtesies during my stay there. Abbreviations after specimens cited are those usually employed for the herbaria concerned: F, Field Museum; G, Gray Herbarium; US, United States National Herbarium.

GRAY HERBARIUM.

A New Trichomanes from Colombia[1]

C. V. MORTON

The Filmy Ferns of Colombia are not well known at the present time. Nevertheless, the present species seems very different from any thus far described. It is dedicated to the collector, Mr. Oscar Haught, whose numerous and beautifully prepared specimens are adding so greatly to our knowledge of the floras of Colombia and Ecuador. I am indebted to Mr. E. C. Leonard for the illustration of this interesting species.

Trichomanes Haughtii Morton, sp. nov.

Planta epiphytica; rhizoma late repens, gracile, 0.25–0.5 mm. diam., dense nigro-pilosum; folia solitaria, distantia, 3–6.5 cm. longa, stipitibus usque ad 3 cm. longis, fere usque ad basin late viridi-alatis, basi ipsa parce et inconspicue pilosulis, alibi glabris; lamina glabra, tenuiter membranacea, viridis, valde irregularis, subpinnata, rhachi ubique valde alata, segmentis 4–6, alternis, remotis, usque ad 2.5 cm. longis, simplicibus vel dichotomis, segmentis ultimis oblongis, 2–6 mm. longis, 1.5–2 mm. latis, apice emarginatis, margine integris, planis, glabris; venae dichotomae, in segmentis solitariae; venae falsae nullae; involucra immersa, in lobis frondium venas primarias vel secundarias interiores terminantia, infundibuliformia, limbo anguste dilatato, integro, glabro, receptaculo longe exserto.

Type in the U. S. National Herbarium, no. 1,705,823. collected in vicinity of Barranca Bermeja, between Soga-

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[1] Published by permission of the Secretary of the Smithsonian Institution.

moso and Carare Rivers, Magdalena Valley, Department of Santander, Colombia, at 100 meters elevation, December 7, 1936, by Oscar Haught (no. 2095).

TRICHOMANES HAUGHTII MORTON
(NATURAL SIZE)

The present species is referable to the genus *Vandenboschia* of Copeland's "Genera Hymenophyllacearum," i.e., *Eutrichomanes* of most authors, a group containing *T. pyxidiferum* L., *T. hymenophylloides* van den Bosch, *T. scandens* Swartz, and many other species. None of the known species are very closely related to the present one, however, which is distinguished by its very broad segments and very simple branching. In its coarse aspect it strongly suggests young plants of ***Hymenophyllum caudiculatum*** Mart.

SMITHSONIAN INSTITUTION.

Diplazium lonchophyllum in Louisiana

WILLIAM R. MAXON

Following their illustration and brief description of *Diplazium lonchophyllum* in "Ferns and Fern Allies of Louisiana" (1942), Brown and Correll remark: "This Mexican and Central American species is well established in a densely wooded ravine on the south side of Avery Island. Possibly it is a natural introduction, since the species is not supposed to be in cultivation anywhere on the island."

The plant in question is represented in the National Herbarium by two specimens (*D. S. & H. B. Correll* 9491), collected in July, 1938, and reported to Dr. Correll by the writer in October of the same year as *D. lonchophyllum* Kunze, which is apparently the name to be adopted for this highly variable Mexican and Central American species, wrongly taken up by Christensen in the Index Filicum as *D. denticulosum* (Desv.) C. Chr. In response to the writer's query as to whether the plant might have been introduced upon Avery Island by the owner, Col. E. A. McIlhenny, Dr. Correll wrote: "Col. McIlhenny told me that he had not introduced any ferns on the south part of the island, where the *Diplazium* was found. I did not see any of the fern in cultivation on the island, and I believe it is most likely an introduction from Mexico. It was well established in a wooded ravine about 50 feet deep." Subsequently (Feb. 6, 1939), upon receiving from Dr. Correll a letter upon the subject, Col. McIlhenny wrote him as follows:

"So far as I know, no *Diplazium lonchophyllum* have ever been brought to Avery Island from the outside. This fern has been growing here always, apparently. It is curious that this is not the first time that plants from South America have been found on Avery Island and nowhere else in the United States. Very few Mexican or

West Indian plants have been brought here. I cannot give you a list of the plants that have been tested at Avery Island, but I will say that for the past 30 years all the plants imported by the U. S. Bureau of Plant Introduction that will grow in a similar climate to the Gulf Coast have been tested here. I have now something over 7,000 varieties that seem happy in my grounds."

From the foregoing it might be readily assumed, at first, that in some way *D. lonchophyllum* has been introduced upon Avery Island by man; nevertheless the answer to the riddle is neither simple nor certain. In the first place, Dr. Correll states that there were 25 or 30 clumps of the fern, growing luxuriantly, with every appearance of being native and quite at home in the deep, damp ravine. This, of course, would indicate natural propagation over a considerable period, for the deliberate introduction of so many individuals (unless very young plants) can hardly be assumed; besides which there is no record of this species having been available in the United States horticultural trade.

As to its possible origin from a Government source, the records of the Office of Plant Introduction, U. S. Department of Agriculture, show that no living fern plants have ever been distributed to growers and that the spores of only six species have been sent out, these all from Ceylon, Java, or the Philippines and, so far as known, all failing to reproduce. There is the bare possibility that living flowering plants of Mexican or Central American origin, distributed by the Department of Agriculture, may by accident have carried the *Diplazium* spores; but this is most unlikely, if one considers the length of time ordinarily required for propagation before living plants are ready for distribution. Of other human agencies of introduction we have no record. Individuals may have brought or sent in living plants or viable spores in ignorance or disregard of plant quarantine regulations, or before such legislation was enacted.

There remains the possibility that migrant birds, on their visits in great numbers to this well-known coastal sanctuary, may have brought in the spores on their muddy feet. But this could have happened also in the case of perhaps a hundred other fern species, equally well fitted (it would seem) to make their home in Louisiana, which are still known only from tropical regions.

Perhaps the occurrence of *D. lonchophyllum* as numerous individuals on Avery Island will remain a puzzle; yet, despite the disquieting shadow of known plant introduction, one may suggest that this species is possibly native there, either as a relict or as an adventive. Dr. Correll mentions as its common associate *Pteris cretica,* a tropical and subtropical species whose status as a native of the Southern States, though often questioned, now seems assured. Tropical elements in our southern fern flora are numerous and diverse, and the number constantly grows as exploration proceeds. Perhaps the most remarkable extension of range is that of *Dicranopteris flexuosa,* found on Mon Louis Island, in the extreme southwestern coastal region of Alabama, separated from the mainland only by Fowl River, a bayou connecting Mobile Bay and Mississippi Sound. This record,[1] which added a new fern family to the United States flora, is beyond question, though the locality has since been destroyed, and there are more than a few examples of similar disjunct distribution. *Diplazium lonchophyllum* may be another. The case is well worth looking into. At first a doubter, to say the least, the writer has nearly convinced himself that the plant under discussion is native to Avery Island, and he will not be much surprised to have it turned up by collectors at other points in southern Louisiana in the course of botanical exploration. Incidentally, *D. lonchophyllum* is well worth cultivating. Of our native species it most resembles

[1] Amer. Fern Journ. 4: 15–17. 1914.

Athyrium (or *Diplazium*) *acrostichoides,* but the pinnae are comparatively few, distant, triangular-lanceolate from an inequilateral base, and coarsely and unequally pinnatifid.

SMITHSONIAN INSTITUTION.

Shorter Notes

NOTE ON THE SOUTHEASTERN RELATIVES OF LYCOPODIUM INUNDATUM.—In reviewing a pamphlet on the ferns of Charleston, South Carolina, in the April–June number of THIS JOURNAL,[1] Mr. Weatherby noted the care with which the compilation had been done. One error frequently made by synonymizers is however copied in it,—namely, placing *Lycopodium adpressum* (Chapm.) Lloyd & Underw. as an equivalent of *L. inundatum* var. *Bigelovii* Tuckerm. If there is to be any such reduction to synonymy, it is var. *pinnatum* Chapm. which must be placed under *Bigelovii,* as they differ only in size. On the other hand, *L. adpressum* differs from all the others concerned in its strikingly appressed peduncle-leaves and sporophylls. If, as Professor Hunt holds, the entities concerned are only varietally distinct, his No. 28 should become *L. inundatum* var. *adpressum* Chapm.—EDGAR T. WHERRY, *University of Pennsylvania.*

A FERN NEW TO WORCESTER COUNTY, MASSACHUSETTS.—The present note is for the purpose of recording the recent discovery of *Polypodium virginianum* forma *cambricoides* in Worcester County, at an elevation of about 1,400 feet, by Miss Patience Fay, of Princeton, Mass. Two plants were found, each producing several fronds; they were not growing on rocks. I have myself found this fern in southern New Hampshire, at about the same altitude, along with the typical form of the species, on leaf mold so thick that rocks were not in evidence.—MRS. FRANK C. SMITH, *Worcester, Mass.*

[1] 33: 77. 1943.

NEPHROLEPIS TUBEROSA (Willd.) Presl.—At the beginning of the article containing a description of *Polypodium tuberosum* from Ecuador, in the last number of the JOURNAL, casual reference is made to a well-known "tuberous" *Nephrolepis* there called, inadvertently, *N. tuberosa,* which is a synonym of *N. cordifolia* (L.) Presl. This is a common and widely distributed tropical species. Notes regarding its supposed occurrence in Florida will shortly be published.—WILLIAM R. MAXON, *Smithsonian Institution.*

Recent Fern Literature

Dr. R. M. Tryon, Jr., has published[1] a revision of *Doryopteris,* a rather small genus of the tribe Pterideae, distinguished from related genera such as *Cheilanthes* and *Pellaea* by having the long-stalked sporangia borne on a continuous receptacle connecting the vein ends and covered with a continuous, reflexed, marginal indusium, and by the generally pedate type of division of the frond, suggesting somewhat in outline the well-known United States species *Pityrogramma triangularis* and *Bommeria hispida.* The species are all tropical and are found in various parts of the world, but they are most numerous in southern Brazil. The best known species is *D. pedata,* common in the West Indies and, in varietal forms, from Mexico south to Argentina and Bolivia.

The genus has never before had a critical treatment. Christensen's Index Filicum and Supplements recognized 44 nominal species. Dr. Tryon now recognizes 26, the others being either reduced to varietal status or to synonymy or excluded from the genus. Tryon's work impresses one as being exceptionally thorough and scholarly. Although obvious characters of habit and indument are not neglected, he has investigated especially the steles of

[1] **Contr. Gray Herb. 143: 1–80. 1942.**

the stipe, the vascular structure of the blades, and the characters of the spores, and he finds that these all afford good specific criteria, much better than those given by the division of the blade, usually stressed by previous authors. Dr. Tryon's descriptions are very well drawn, and his practice of italicizing the principal specific distinctions is an aid to the student. The fine line-drawings of all the species are especially noteworthy.

Tryon divides the genus into sections, *Lytoneuron* and *Eudoryopteris*, which were orginally proposed by Klotzsch on the basis of venation, the first having free, the second reticulate veins. It is unfortunate that Tryon has not been able to keep up this distinction. By including in *Lytoneuron* one species with areolate venation he has rendered the sectional lines somewhat obscure. This was done because he believes that in determining relationship in the genus the structure of the scales and the presence of two vascular strands in the stipe are of more importance than venation.

Exception must be taken to his choice of type for the genus. *Doryopteris* was described by John Smith in 1841 with six original species. In 1875 he chose *Pteris pedata* L. as the type of the genus, and in this he has been followed by Christensen and Tryon. This is, however, nomenclaturally an impossible choice, because *Pteris pedata* is not one of the species originally included in the genus, and was not referred to it until some ten years later. Of the six species originally included, *Pteris palmata* Willd. is the logical choice as type. It is the oldest and best known of the species, and moreover it is the one chosen by John Smith[2] to illustrate the genus.

Tryon's specific concept is broad, perhaps too much so in at least one case. *Doryopteris decipiens* is considered as merely a variety of *D. decora*, although the two are

[2] Ferns Brit. & For. 194. 1866.

typically very different and may be distinguished at arm's length. To be sure, Tryon states that there are intermediates, but those in the National Herbarium that he has so labeled do not seem to me truly intermediate; *Degener* 9193 is surely typical *D. decora,* and *Safford* 863 and *Yuncker* 3479 quite as surely *D. decipiens.* On the other hand I have no special objection to his treatment of *D. palmata* and *D. Raddiana* as varieties of *D. pedata,* because the characters separating these forms seem not quite so fundamental as those exhibited by other species of the section. Typical *palmata* is distinguished by the presence of buds at the base of the leaf blades, but not all leaves have them. In fact one specimen so identified by Tryon (*F. L. Herrera,* from Cuzco, Peru, U. S. Nat. Herb. 1,237,072) has no buds on any of the leaves, and thus is hardly distinguishable from some of the Bolivian forms of *D. pedata* var. *multipartita* (*D. Raddiana*).

Doryopteris nobilis is a species of southern Brazil, Paraguay, Argentina, and Bolivia, but Tryon cites also three specimens from Colombia, hundreds of miles outside the normal range of this species. Two of these are in the National Herbarium, and after studying them it seems to me probable that they are only slightly aberrant specimens of *D. pedata* var. *palmata,* which is very abundant in Colombia. They do not show to any perceptible extent the serrulate toothing which is characteristic of *D. nobilis.*

The few criticisms I have just made are purely minor in nature. Dr. Tryon's paper is a real advance in the taxonomy of the Pterideae. It is only after similar studies of *Notholaena, Cheilanthes, Pellaea,* and some other groups have been made that pteridologists will be in a position to redefine the genera of Pterideae along more natural lines.—C. V. M.

What we know about ferns as food is ably summarized for the regions covered in two especially well prepared and authoritative recent publications—Fernald and Kinsey's "Edible Wild Plants of Eastern North America"[1] (except peninsular Florida) and Merrill's "Emergency Food Plants and Poisonous Plants of the Islands of the Pacific."[2] The former gives a more or less detailed account of about a thousand American species which may be used for food, with the particular virtues of each and ways of preparing it; descriptions, statements of range, habitat and season of availability where needed; and comment full of information and very readable. Only two species of ferns, Bracken and Ostrich Fern, are admitted to the recommended list; Cinnamon Fern (the young central fronds of a crown, eaten raw) is given a qualified endorsement; and *Equisetum limosum*, which is said to have been used for food in Europe, is mentioned only to be condemned. Dr. Wherry's warning against eating fern fiddle-heads (THIS JOURNAL **32**: 108), though not mentioned, is evidently regarded as inapplicable to the recommended species—only, one should make sure of the identity of any wild plant he is about to eat.

Dr. Merrill's work, of pocket size, is designed primarily for the use of the armed forces in the Pacific. Necessarily much more condensed than Fernald and Kinsey's, it yet gives well illustrated and clear accounts of the appearance, habitats, and uses of the food-plants likely to be encountered in the Pacific islands. As might be expected in the tropics, the proportion of ferns is comparatively large. The buds of many tree-ferns, the whole plant of Swamp-fern (*Ceratopteris thalictroides*,

[1] Fernald, M. L. and A. C. Kinsey. Edible Wild Plants of Eastern North America. Idlewild Press, Cornwall-on-Hudson, New York. 1943. Pp. xvi, 452, 25 pls., 129 text-figs. $3.00.

[2] Merrill, E. D. Emergency Food Plants and Poisonous Plants of the Islands of the Pacific. U. S. War Dept. Technical Manual TM 10–420. 1943. Paper, 149 pp., 113 figs. For sale by the Superintendent of Documents, Govt. Printing Office, Washington, D. C. 15 cents; stamps not accepted.

experiments in the cultivation of which were described by Dr. Copeland in THIS JOURNAL **32**: 121–126), the fiddle-heads of *Athyrium esculentum,* and the young leaves of *Stenochlaena palustris* and *Acrostichum aureum* may be eaten. The *Ceratopteris* and *Athyrium* are especially recommended, cooked or raw.—C. A. WEATHERBY.

That the members of the genus *Equisetum* take up from the soil large amounts of silica is generally known, but the accumulation of aluminum by Lycopodiums is less familiar. An exhaustive study of these plants from this standpoint has just been published by Mr. G. Evelyn Hutchinson and Miss Anne Wollack.[1] They find it convenient to recognize two genera, the primitive *Urostachys,* which includes the eastern United States species *U. selago* (L.) Hert. and *U. lucidulus* (Michx.) Hert. (combinations which failed to get included in Broun's Index[2]) and the more specialized *Lycopodium* proper.

Twelve species of *Urostachys* were analyzed, and proved to be little richer in aluminum than ordinary plants. The 22 species of *Lycopodium* similarly studied were not only high in aluminum, but actually, at least in one group (*Eulycopodium*), showed a correlation between aluminum content and morphologic specialization: The relatively primitive *L. annotinum* showed the lowest content, followed in order by *L. clavatum, L. obscurum, L. sabinaefolium,* and then by the overlapping *complanatum-flabelliforme-tristachyum* series.

A complete analysis was also made of the ash of *L. flabelliforme,* and compared with the average for vegetation in general. In most constituents the percentages were roughly equal, but the aluminum content of the *Lycopodium* was 137 times that of ordinary plants.—EDGAR T. WHERRY.

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[1] Biological Accumulators of Aluminum. Trans. Conn. Acad. Arts & Sci. **35**: 73. 1943.
[2] Index to N. Amer. Ferns. 1938.

American Fern Society

Report of the President for 1943

The past year has been a quiet one for the Society. Like most other scientific associations, we have cancelled our usual meetings. Only the FERN JOURNAL—always our central activity—has gone on quite as usual, or better than usual. In the capable hands of Dr. Maxon and his fellow editors it has been notable for the readability, variety, and solid value of its contents.

The Society was founded in 1893; last year was its fiftieth. Ordinarily, such an anniversary would have been marked by special ceremonies; under war conditions, it seemed best not to attempt anything of the sort. Possibly a postponed celebration can be held later. Meanwhile, some of the looking back at the past and forward at the future which an anniversary should bring about is possible and useful.

The earlier history of the Society, up to 1910, has been well reviewed in reminiscent articles by Dr. Waters, Mr. Winslow, and Professor Clute in recent volumes of the JOURNAL. The most striking and significant feature about the whole course of action of the Society since 1910 is that it has obviously been based on faith in the vitality and permanent usefulness of the organization. The founding of the FERN JOURNAL; the setting up of life memberships with a capital fund to receive their fees; the beginning of a library; the generous and very helpful support of the Brooklyn Botanic Garden and the establishment of physical headquarters there; the incorporation of the Society—all these have testified to that faith. There is always room for improvement; some projects have failed; no doubt opportunities have been lost. But on the whole, through good times and through the difficulties incident to the last war and to the misdeeds of a too much trusted treasurer, the Society has, so far, justified our faith. Our task, now, is to see that the justification continues.

There is very much for us to do. The fear, long ago expressed by Professor Clute, that the Society's work was done and that "fern study" would in future be too technical for a largely amateur group like ours has proved groundless. I would call especial attention to the Treasurer's remarks as to the value of the contributions to science made, and still to be made, by amateurs. They are very true. Two examples, taken at random, may serve as illustrations of what any of us can do. Mrs. Griffeth's spore-cultures of Scott's Spleenwort have gone far to explain the behavior in nature of that once controversial plant; Mr. Harlow's little experiment with one of the forms of the Polypody has shown it to be only a curious and unexpected response to conditions of growth. Everyone who has a bit of back yard or even a few flowerpots in a window wherein to grow and observe ferns, everyone who will take an occasional walk, with his eyes open, through some handy bit of woodland, has the opportunity to uncover such new bits of knowledge. Careful local lists are still, and always will be, of value. The officers of the Society are ready to advise. And, above all detail, it is our duty and our privilege in these darkened and perilous times to "keep lighted the lamp of knowledge which must never go out if future generations are to profit from the advances of the past."

I stoutly believe that we can carry on effectively only if the Society continues to function actively as a rallying point for lovers of natural history, professional and amateur, who have a common interest in ferns, and to maintain the FERN JOURNAL as what it now is, a nearly unique medium of publication and source of information for them. The past year has not been altogether encouraging. Expenses have risen; receipts have fallen off.

There have been a rather large number of delinquent members and, naturally in the midst of the preoccupations of war, a rather small accession of new ones. Our only resource lies in the active interest of the members. We can but repeat and ask them to take to heart, the old, but always valid, adjurations: Pay your dues promptly; interest others as you have the chance; stand by.

C. A. WEATHERBY, *President*

Report of the Secretary for 1943

Due to the necessary curtailment of travel facilities, the Society held none of its usual meetings during the year. But to some of the members, especially those of longer affiliation, it has not been forgotten that March marked the fiftieth anniversary since a small group of friendly fern lovers got together and organized The Linnaean Fern Chapter of the Agassiz Association, which later changed its name to American Fern Society. Celebration of this half-century of work and progress must await a return to more normal travel conditions.

Since the last report we have lost by death one of our esteemed Honorary Members, Dr. Carl Christensen, and several other members of long standing: J. B. Flett, who joined in 1899; H. E. Ransier, 1902; C. L. Gruber, 1907; and Dr. T. E. Hazen, 1910. Death also has removed Dr. C. Stuart Gager, Bennet B. Bristol, Mrs. George Kelton and W. H. Cathcart. Through resignation and for non-payment of dues 34 others are missing from last year's membership list. Thirteen new members have been added, making the membership 358 on December 31st, a figure somewhat less than our maximum of a few years ago.

It is quite understandable that under the stress of war conditions some of our members have been too fully occupied with war work to keep up an active interest in ferns; to some it may seem even that it is too luxurious a "hobby" to be indulged in while the call still comes for more workers in hospitals, Red Cross activities, and other relief agencies. In common with most other scientific societies, and judging from experiences during the last war, we should expect a certain dropping-off in members. This does not indicate, necessarily, any lessening of interest, but only that for the time it has been overshadowed by greater necessity. When our "boys and girls" come home again, from possible brief adventures with foreign floras, we may expect our fair share of new and enthusiastic members.

Meanwhile we who hold the fort on this home front may well keep in mind and act upon a sentence in the first President's first report. Willard N. Clute, then president, said, "It is hoped that the members will neglect no opportunity to enlarge the Chapter." When we remember that this admonition was addressed to only about 25 members (and see how we have grown!), we may expect that at the second semi-centennial it will be possible to look back and say, "The first fifty years was the hardest!"

Respectfully submitted,
ELSIE G. WHITNEY, *Secretary*

Report of the Treasurer for 1943

In my report for 1942 I mentioned that the American Fern Society was still in fairly good financial condition but that cooperation of all members would be needed to keep it so. As in all other scientific organizations during this period of war, our financial situation has gradually deteriorated, and we find ourselves on December 31, 1943, with a cash balance of approximately $100 less than we had one year previously. This means that we did not really meet expenses during the past year. The sale of back numbers of the FERN JOURNAL was somewhat less, but the primary cause was loss of income in respect to dues and the greatly increased costs of printing. Our membership campaign of a few years past resulted in a considerable increase in our numbers which has been offset by losses of the last three years. In the new trends of natural history of the present day, popular interest in the known things around us is being stressed, rather than the oddities of foreign lands. Anyone can recognize ferns in general. They occur in all parts of the country, and the intricacies of their distribution and habits of growth and actual identity are such that the beginning amateur with good judgment can add greatly to the stock of information that has been acquired over the years by the professional botanist. This is the first time that the treasurer has entered upon a discussion of the non-financial aspect of the Fern Society, and he does so with a strong belief that the unprofessional citizen will contribute more to our future natural science. For this we need more members.

Last year the Auditing Committee recommended that the item Notes Receivable be reappraised to an inventory value of $1.00. This has been done. The liability for the note, however, remains the same. It is felt that the inventory value for the American Fern Society library has been too high and we have accordingly reduced the acount by 20 per cent in the following statement.

Receipts	*Amount*	*Sub-Total*	*Total*
Cash on hand Jan. 1, 1943			$232.42
1941 Membership Arrears	$ 4.50	$ 4.50	
1942 Membership Arrears	20.30	20.30	
1943 Membership Renewals	385.50		
1943 New Members	12.00	397.50	
1944 Membership Renewals	10.10		
1944 New Members	10.50	20.60	
1945 Membership Renewals	2.00	2.00	
1943 Subscription Renewals	67.12		
1943 New Subscribers	8.95	76.07	
1944 Subscription Renewals	44.43		
1944 New Subscribers	2.50	46.93	
1945 Subscription Renewals	1.25	1.25	

Sale of back numbers A.F.J.	64.05	64.05	
Sale of "Var. and Forms of Ferns of E. N. Am."	2.50	2.50	
Member Contribution (for postage)	1.40	1.40	
Gift (books) A.F.S. Library	3.50	3.50	
Gift (books) A.F.J. back numbers	32.87	32.87	
1943 Advertising	4.00	4.00	
Reprints	36.95	36.95	
Transferred from Bissell Herbarium Fund	10.05	10.05	$724.47
			$956.89
Deduction a/c Gift (books), A.F.S. Library[a]		3.50	
Deduction a/c Gift (books), A.F.J. back numbers[b]		32.87	
Deduction a/c Profit on Sales[c]		18.50	$ 54.87
			$902.02

[a] Transferred to A.F.S. Library Acct. (books).
[b] Transferred to Inventory A.F.J.
[c] Transferred to Reserve Fund.

Disbursements

Science Press			
A.F.J. Vol. 32, No. 4	$173.06		
A.F.J. Vol. 33, No. 1	148.85		
A.F.J. Vol. 33, No. 2	146.40		
A.F.J. Vol. 33, No. 3	123.95		
Parke, Austin & Lipscomb, Inc.			
A.F.J. Vol. 33, No. 3 (Half-tone cut)	4.77	$597.03	
Mimeographed Membership List (1942)	2.00	2.00	
Reprints	36.95	36.95	
Trade Discount	4.70	4.70	
Agency Commission	8.71	8.71	
Bank Charges	15.27	15.27	
Refund	5.23	5.23	
Prepaid Mailing Charges	.52	.52	
Expense			
Treasurer	34.90	34.90	
Secretary	27.83	27.83	
Editor	9.21	9.21	
Librarian	8.50	8.50	
Curator	21.76	21.76	$772.61
Cash on hand Jan. 1, 1944			$129.41

Statement December 31, 1943

Assets		*Liabilities*	
Cash on hand	$129.41	Capital Account	$2,302.45
In Spec. Acct. No. 1	510.15	1944 Memb. Susp. Acct.	21.10

In Spec. Acct. No. 2	54.82		1945 Memb. Susp. Acct.	2.00
In Reserve Fund	113.03	$ 807.41	1944 Subscribers Susp. Acct.	42.68
Notes Receivable		1.00	Distrib. Vol. 33, No. 4 Susp. Acct.	100.00
Inventory A.F.J.		2,006.79	Bissell Herb. Fund	510.15
A.F.S. Library (books)		218.00	Life Memb. Fund	54.82
		$3,033.20		$3,033.20

Respectfully submitted,

HENRY K. SVENSON, *Treasurer*

Report of the Judge of Elections

The results of the recent balloting for officers of the American Fern Society for 1944 is as follows:

For President	
C. A. Weatherby	82
Robert T. Clausen	1
Herbert Dole	1
T. M. McCoy	1
For Vice-President	
Joseph Ewan	82
W. Herbert Dole	1
Mrs. Frank C. Smith, Sr.	1
For Secretary	
Mrs. Elsie G. Whitney	82
E. P. Killip	1
For Treasurer	
Henry K. Svenson	83
W. S. Allen	1

I therefore declare the following candidates elected to the several offices: President, C. A. Weatherby; Vice-President, Joseph Ewan; Secretary, Mrs. Elsie G. Whitney; Treasurer, Henry K. Svenson.

Respectfully submitted,

ROBERT A. WARE, *Judge of Elections*

ERRATUM

In the October–December, 1943, number of the JOURNAL, p. 127, the following should be substituted for line 18:

state of California. This fact surely has significance

Vol. 34 April-June, 1944 No. 2

American Fern Journal

A QUARTERLY DEVOTED TO FERNS

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American Fern Journal

Vol. 34 April–June, 1944 No. 2

Collecting Ferns in Northwestern Mexico

Ira L. Wiggins

In September, 1929, I began a series of botanical field trips into northwestern Mexico and the deserts of southeastern California and adjacent Arizona. Since that time over a dozen trips have been made to various parts of the area, ranging from the Bill Williams Fork of the Colorado River in Arizona to Cajeme (or Ciudad de Obregón), Cedros, and Quiriego in southern Sonora, and from the northern edge of the Colorado Desert in southern California to San José del Cabo and Cabo San Lucas at the southern tip of Baja California, Mexico. Most of the traveling was done in automobiles, with occasional side trips by saddle and pack animals. Many miles were covered on foot, for often it was necessary to scramble over rocky hillsides or up boulder-strewn canyons to reach plants growing only where the cliffs and rocks protected them from grazing cattle. Different trips took me, together with various assistants and companions, into the field during every month in the year except November and December, so the seasonal fluctuations in the vegetation were well covered. On all occasions the objective of the field trips was the accumulation of information about the general vegetation of the area; the collection of ferns was, at the beginning, purely incidental.

Possibly because one rarely thinks of ferns in connec-

[Volume 34, No. 1, of the Journal, pages 1–36, was issued March 22, 1944.]

tion with the vegetation of the desert, these trips brought surprises in the form of numerous species of ferns and fern allies growing in canyons and ravines, on rocky hillsides and, less commonly, on the flats of the desert. After the first two or three times that ferns had been found unexpectedly in niches in canyon walls, they became something of a special objective. Thereafter, although they occasionally surprised one with their abundance or luxuriance, they no longer were "unexpected," for, paradoxically, one came to expect them in unexpected habitats.

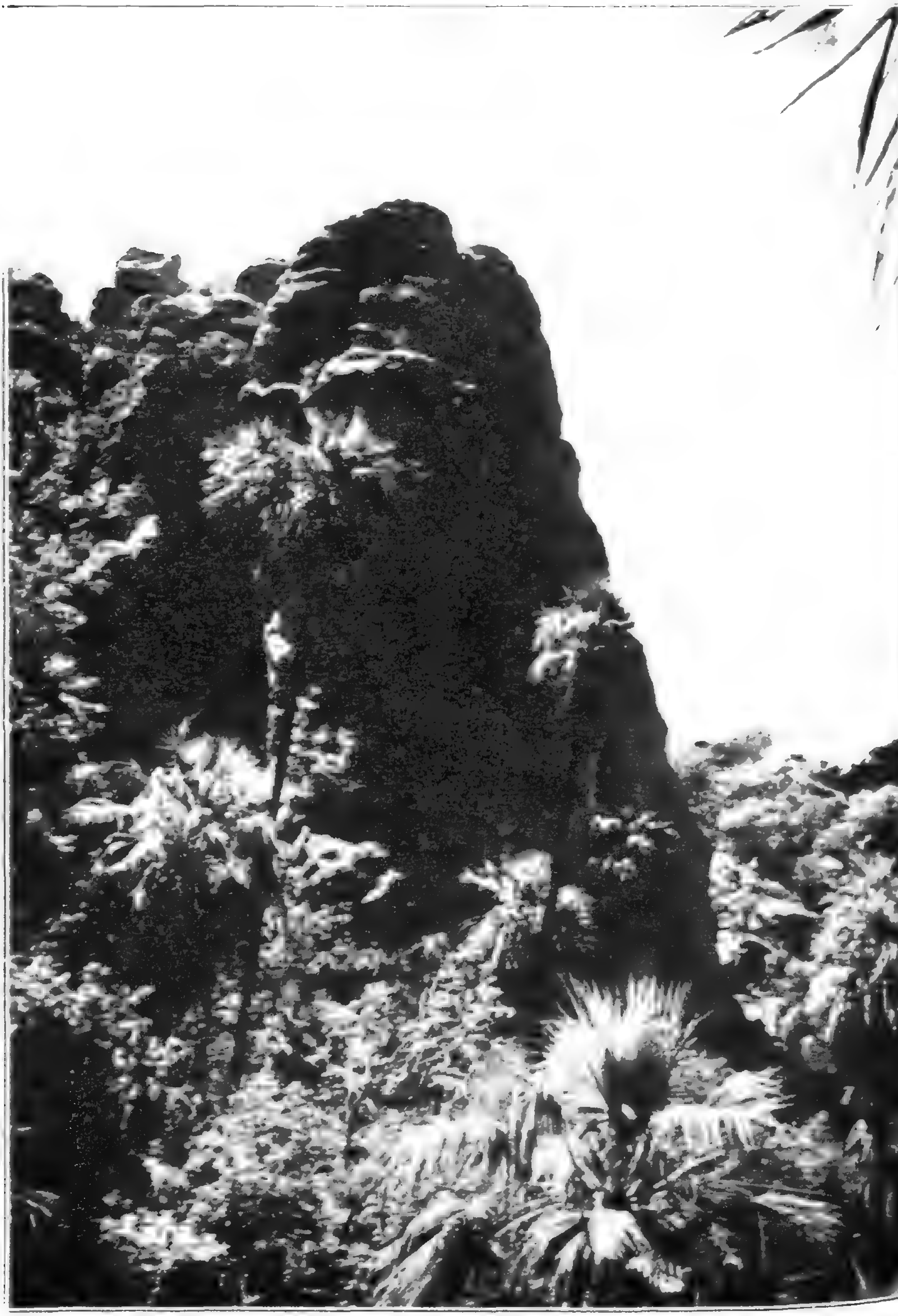
But it was almost startling to find luxuriant patches of *Marsilea Fournieri* growing in a slight swale about 20 miles south of Pozo Aleman, Baja California, in the spring of 1931. The small fronds occupied hoofprints less than a yard from the base of one of the giant cacti, *Pachycereus Pringlei!* Sporocarps were abundant, and evidently the colony was an old one. The same species was found along the margins of dry watercourses at two localities in Sonora—once between Libertad and Carbó, in the fall of 1932, and the second time between Hermosillo and Kino Bay, the late summer of 1941. At both localities the plants grew on nearly vertical banks in sandy clay soil, but were absent from the sandy beds and nearly level banks a few feet from the immediate course of the stream. The dense mats of the intertangled roots and stolons possess a remarkable resistance to the erosive power of the sand-laden floods that sweep down the canyons and spread out on the desert flats. Sporocarps were numerous at all three stations.

Equisetum, on the other hand, is rarely found on the desert, even where water is present the year around in tinajas or "tanks" in the rocky canyons. The only species representing this genus is *E. Funstonii*, and it rarely gets into the truly desert ranges, but rather clings to the margins of the deserts and is much more abundant in the chaparral and yellow pine belts than it is in or near the desert proper.

A rare fern apparently nowhere common, but long known from isolated localities in western Texas, New Mexico, Arizona, and northern Chihuahua, is *Phanerophlebia auriculata.* What seems to be the first record from Sonora was established when a party of four, consisting of Dr. Forrest Shreve, Dr. T. D. Mallery, Mr. Jack Whitehead, and the writer, found it in the Sierra Babiso, between Magdalena and Cucurpe in the summer of 1934.[1] We were attracted to the box canyon in which it grew by a fine stand of a native palm and had not anticipated the presence of ferns when we climbed the rocky canyon to investigate the palm, *Sabal uresana.* But well back under an overhanging rock at the foot of the north-facing cliff where the direct rays of the sun rarely, if ever, penetrated, we found a small colony of this striking fern and several plants of the delicate little *Asplenium Palmeri.* This fern association gave us two rare finds, and when added to the presence of the graceful palms made the locality one to be remembered. The leathery pinnae of the *Phanerophlebia* bore few sporangia—in fact, most of them were completely sterile. Since there were restrictions governing the importation of living specimens, we did not attempt to bring back rhizomes to grow. Herbarium specimens were obtained, however, and duplicates have been deposited in several herbaria. Probably a careful search in the mountains between this Sonoran station and those in Arizona would reveal the presence of *Phanerophlebia* at intermediate localities.

One of the richest fern collecting areas in the Sonoran Desert region, La Mina Verde, was mentioned by White-

[1] Whitehead, Jack. Some Arizona Ferns Collected in Sonora, Mexico. Amer. Fern Journ. 27: 43–51. 1937.



Unnamed Box Canyon in Sierra Babiso, Sonora. Phanerophlebia auriculata and Asplenium Palmeri grew at Base of this Cliff.

head (l.c.), but the remarkable assemblage of ferns there deserves further notice. On the north-facing side of the canyon, opposite the abandoned mine buildings, was an area less than 100 yards long and half as wide upon which 14 species of pteridophytes were growing. *Pellaea ternifolia* and *P. Seemannii* grew in deep leaf mold among jagged rocks and boulders. The same type of habitat was shared by *Gymnopteris hispida, Anemia anthriscifolia, Woodsia Plummerae, Notholaena Grayi,* and *Cheilanthes Kaulfussii.* All the latter species were more plentiful than the first-named pair. I believe that this is an extension of the known range of *Anemia anthriscifolia,* for I find no published record of it from Sonora.

A crumbling rock wall, which had been built without mortar or cementing material, supported *Notholaena aurea, N. sinuata,* and *Cheilanthes Lindheimeri. Asplenium Palmeri* occupied a few sheltered niches beneath the overhang of huge boulders and was the most delicate of the ferns found on the mountainside. *Cheilanthes Wrightii* and *Selaginella rupincola* clung to crevices in the rugged outcroppings of basalt.

Cheilanthes Pringlei, although not growing among the other ferns at La Mina Verde, was found a few hundred yards down the canyon toward Cumpas. Although delicate in appearance, it is a hardy endemic of the Sonoran Desert region. We found it growing in tiny green tufts from crevices in the basaltic cliffs near Los Angeles de Fábrica (a village between Carbó and Ures) in the summer of 1934; in similar situations in the canyon of the Río Magdalena about 8 miles east of Imuris, in the same season; on a dry, brushy hillside 45 miles west of the Magdalena-Hermosillo highway, in 1932; at La Palma, a canyon about 50 miles north of Guaymas, in 1933; and Dr. Reed Rollins and I obtained it again along the northern fringe of the Sierra Batuc in 1941. During the dry season the delicately dissected fronds dry out and curl into inconspicuous, gray-green balls that are easily crushed, but within a few hours after a shower they unfold, becoming bright green and leathery, able at once to continue the processes of growth and spore-production that may have been halted at almost any stage by the onset of arid conditions. This species is remarakbly well adapted to desert conditions, and although rarely very abundant at any station is widely distributed from southern Arizona to south-central Sonora.

Still another fascinating *Cheilanthes* is *C. peninsularis,* from the vicinity of Comondú, Baja California, southward to the tip of the peninsula. It somewhat resembles *C. Pringlei,* but has less finely cut fronds and brownish instead of whitish scales on the stipes and rachises. I found it between the southern end of Bahia de la Concepción and Comondú in 1931, but did not find it in the Cape Region, whence T. S. Brandegee obtained the type specimens.

Another fern endemic to Baja California, *Cheilanthes Brandegei,* reminds one of a succulent *Adiantum.* The fronds are crisp and fleshy, the upper surfaces about the same shade of green as those of *Adiantum Jordanii,* but of course they do not have the denticulate margins of that species. It is a unique fern, for the fronds are so crisp during the rainy season that the segments break when flattened in a press, unless they are allowed to wilt for a few minutes after picking. Then, in the dry months of the year the fronds are so dry and brittle that the curled pinnae shatter into minute fragments under slight pressure. The stipes are peculiarly adapted to arid conditions, for they are modified in such a way that many of the fronds are quickly separated from the plant when the ground dries out, thus preventing excessive loss of water through an abnormally large transpiring surface. The stipes have several transverse zones of weakness similar to abscission layers near the base, so they snap off close to the rhizome when dry or under slight tension. The stipe may even break into a half dozen short pieces from 1 to 10 millimeters long when placed in the press; so an herbarium specimen is very apt to be little more than a pile of fragments by the time it is ready for mounting, unless extreme care has been exercised in the preparation and handling of these fragile plants. *Cheilanthes Brandegei* grows under overhanging rocks and among the jagged fragments on basaltic hillsides; I have never found it in granitic or limestone areas. Two weird desert trees, *Idria columnaris* and *Pachycormus discolor*, grow in the vicinity (a few miles east of Punta Prieta) in which I found it most abundant in 1935, and together with the various species of cacti and agaves give the landscape a pronounced desert appearance.

One would hardly expect *Azolla* in the desert, but it was found at the margins of shallow pools along the stream flowing through Pitiquito, Sonora, and in larger quantities in pools between Cajeme and Cedros, about 40 miles east of Cajeme. In Baja California it occurs at a number of places where seeps provide permanent pools in the true desert ranges, and abundantly in the Sierra San Pedro Martir in the chaparral and yellow pine belts.

However, not all of the charming ferns in northwestern Mexico are confined to the deserts. In the spring of 1941, Dr. Albert M. Vollmer, of San Francisco, and I went on a two weeks pack trip through the southern half of the Sierra San Pedro Martir in Baja California. Dr. Vollmer was interested chiefly in the native lilies, but we made a general collection of vascular plants. During the trip we collected 14 numbers of pteridophytes, extending the known range of several ferns, and obtained what I believe to be the first collection of *Selaginella eremophila* from the Mexican side of the International Boundary.

The circuit of the Sierra San Pedro Martir began at Rancho San José de San Telmo, more commonly known among Americans as Meling's Ranch. This ranch, owned by a Mexican citizen of Norwegian birth, is situated in the foothills of the main range at an elevation of about 2,300 feet. It is on the western flank, about halfway between the northern and southern tips of the range, and is about 125 miles, air line, from the United States. On previous trips into the northern part of the range I had collected *Pellaea mucronata*, *P. andromedaefolia*, *Dryopteris arguta*, *Polypodium californicum*, *Pityrogramma triangularis*, and *Adiantum Jordanii*, all of which occur commonly in the chaparral from near sea level to elevations of 3,500 feet or more.

From the ranch we climbed to one of the series of meadows that dot the whole range at elevations of 6,000 to 9,000 feet, and camped at La Grulla, a station which has been visited by several collectors from the United States. Most of the earlier naturalists visiting this region were interested primarily in the birds and mammals, but T. S. Brandegee camped at La Grulla and worked the surrounding country for plants in the spring of 1893. He reported several ferns among his collections, notably *Woodwardia fimbriata* (as *W. radicans*), *Polypodium vulgare*, *Pellaea mucronata* (as *P. ornithopus*), *Asplenium septentrionale*, and *Woodsia oregana*.[2] So far as I have been able to learn, *Asplenium septentrionale* has not been re-collected in the vicinity, though it doubtless occurs in some of the shaded canyons leading back toward the higher peaks above La Grulla and La Encantada.

We rode southward from La Grulla to a large meadow called Ciénega de Santa Rosa or Llano de Santa Rosa, but although we passed through several small canyons we

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[2] Zoe 4: 210. 1893.

saw no ferns. After leaving Llano de Santa Rosa, the trail led upward to the summit of the pass between the tableland and the desert side of the range, at an elevation of 8,800 feet, and dropped rapidly to the floor of the San Felipe Desert at the mouth of El Cajón Canyon. In places it barely clings to the steep shoulders of the granitic and andesitic ridges. On this escarpment we found two ferns, *Pellaea mucronata* and *P. longimucronata*. *Pellaea mucronata* had not previously been collected on the desert side of the San Pedro Martirs, and *P. longimucronata* had never been found before anywhere in that range.

We saw no ferns along the desert side of the mountains until we again climbed to the summit of the divide above a spring halfway between the desert floor and the summit of a pass about 35 miles south of El Cajón. This spring, called El Banco, is marked by a splendid colony of the blue palm, *Erythea armata*, but for some reason supports no ferns. Not even *Selaginella Bigelovii*, one of the most xerophilous of the little clubmosses, was present on the sun-drenched ridges. But after we reached the summit of the divide and started down the western slope, we again found ferns and collected several species. *Selaginella Bigelovii* was particularly abundant on dry hillsides and canyon walls in the vicinity of Arroyo del Agua Amarga, and here we again found *Pellaea longimucronata*, thus establishing two new stations for the species, one on the desert side and one on the western flank of the Sierra San Pedro Martir.

We found *Selaginella eremophila* on dry hillsides in the vicinity of Rosarito, about 50 miles south-southeast of San Quintín. This locality is the first to be reported from Baja California, and is further remarkable in that it is on the western slope of the range instead of on the desert side. The type locality of this rare *Selaginella* is Palm Canyon, Riverside County, California, but it has also been collected along the western margin of the Colorado Desert in San Diego County just a few miles north of the Mexican border.

The richest fern collecting ground discovered on the 1941 trip through and around the Sierra San Pedro Martir was just below the falls of the Río Santo Domingo. The locality is less than 10 miles distant from La Grulla by air line, but is nearly 4,000 feet lower. The falls are a series of cascades that drop through an impenetrable canyon. Some of them are estimated to drop as much as 700 feet, and the whole series descends at least 1,500 feet as they twist and plunge downward around a sharp curve in the narrow gorge. The adjacent walls of rock are granite, in places polished smooth by the torrents of water that roar down the canyon after heavy rains and during the spring as the snow melts from the highlands above.

At the foot of the lowest of the main cascades gorgeous banks of *Adiantum Capillus-Veneris* cling to crevices in the spray-drenched walls of rock. *Dryopteris Feei* and *Woodwardia fimbriata* grow in profusion under huge, dripping boulders nearby. In marked contrast to these ferns of moist habitats, numerous colonies of *Notholaena californica* grow on the dry ridges less than 200 feet away, and *Selaginella Bigelovii* carpets considerable areas not much farther distant.

It seems remarkable that *Adiantum Capillus-Veneris* should be so abundant in this one locality, yet absent from the scores of canyons that cut into the main range of the San Pedro Martirs. This fern has been reported from at least two localities in southern Baja California[3,4] and collected in two others, but has been found in northern Baja California at only one other locality—a canyon about 20 miles south of the border. The last locality was

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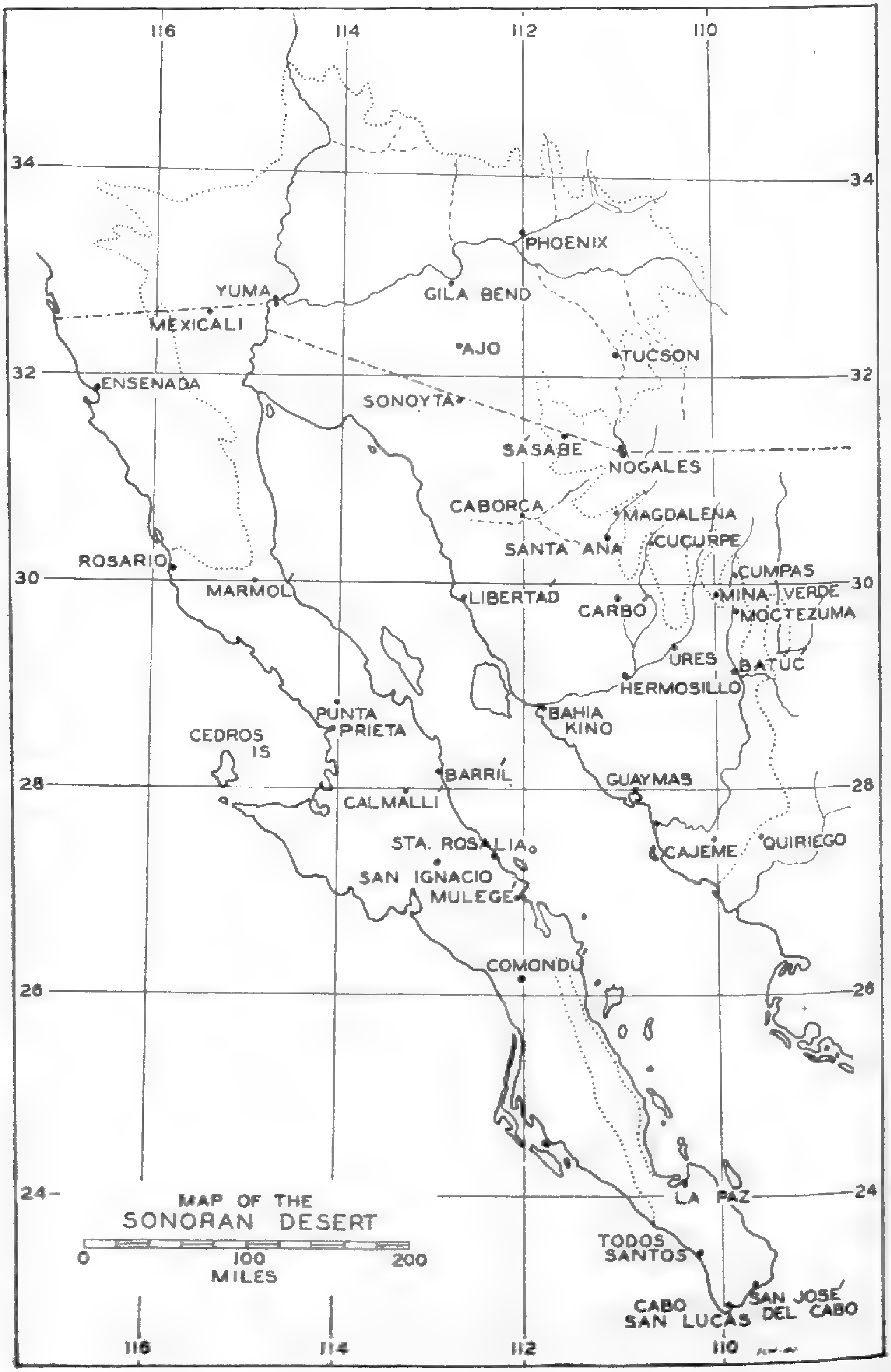
[3] Proc. Calif. Acad. II. 3: 181. 1891.
[4] Proc. Calif. Acad. IV. 12: 980. 1924.

found by Mrs. Harvey of San Diego. Brandegee did not find this species at or near La Grulla, less than 10 miles away.

The fact that many of the desert mountain ranges have not been carefully explored botanically adds to the zest of hunting ferns in the canyons that knife back into their jagged masses of granite, basalt, and andesite. The collector may wonder to himself, "What *is* growing in that canyon filled with blue haze in the Mohawk Mountains?" He is elated when he finds a colony of *Notholaena Parryi* (among other things) under a precariously balanced boulder, after he has driven 15 miles across the desert, sans road, to find out! Or he is equally pleased to find *Asplenium resiliens* in the Kofa Mountains, the only known locality for that species within the confines of the Sonoran Desert.

What are some of the ranges that should be more completely explored for ferns? The Ajo, Chocolate, Growler, and Harcuvar Mountains; Mesa del Pinal and the volcanic Tres Vírgenes; the Sierras Alamos, Babiso, Desengaños, and de la Giganta; the Superstition, Tinajas Altas, and Whipple Mountains; the Sierra Pinacate, Sierra Pinta, and Sierra Santa Maria; all these and very many more; big ones, small ones and middle-sized ones. They present enough territory to keep scores of fern enthusiasts active for decades, for each canyon presents different ecological conditions that make possible the growth of plants with varied habitat requirements.

Within the confines of the Sonoran Desert, where I have done most of my collecting in Mexico, 53 species and several varieties of ferns and fern allies are known to occur. The Schizaeaceae are represented by only one species, *Anemia anthriscifolia,* and the families Marsileaceae, Azollaceae, and Equisetaceae each by a single species also. In the Polypodiaceae are the following


116
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YUMA
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MEXICALI
AJO
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SASABE
NOGALES
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CEDROS IS
BARRIL
GUAYMAS
CALMALLI
STA. ROSALIA
CAJEME
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SAN IGNACIO
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MAP OF THE
SONORAN DESERT
0
100
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MILES
LA PAZ
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CABO SAN LUCAS
SAN JOSE DEL CABO

genera, the number of species included in each indicated by the figures in parenthesis: *Woodsia* (2), *Phanerophlebia* (1), *Asplenium* (2), *Pityrogramma* (1), *Gymnopteris* (1), *Adiantum* (3), *Cheilanthes* (17), *Pellaea* (6), and *Notholaena* (12). Four different species of *Selaginella* have been found in the Sonoran Desert, *S. rupincola* and *S. arizonica* in Arizona and Sonora, and *S. Bigelovii* and *S. eremophila* in southern California and Baja California. Does the assemblage look tempting?

STANFORD UNIVERSITY.

GAZETTEER OF MOUNTAIN RANGES

Since the accompanying map does not show the location of the mountain ranges, the following brief gazeteer will help to locate them approximately. This list includes only a small fraction of the total number of ranges and isolated peaks of the Sonoran Desert region.

Ajo Mountains. Between Ajo and the International Boundary.
Chocolate Mountains. About 40 miles northwest of Yuma; another range of same name, 50 miles northeast of Yuma.
Growler Mountains. Along the border, 30 to 40 miles west of Ajo Mountains.
Harcuvar Mountains. About lat. 34° N., long. 114° W.
Mesa del Pinal. Escarpment along western edge of desert west and southwest of Mexicali.
Sierra Alamos. Near coast west of Caborca.
Sierra Babiso. Between Magdalena and Cucurpe.
Sierra Desengaños. About 25 miles east of Punta Prieta.
Sierra de la Giganta. Main range near the Gulf of California, from about the "N" in Comondú south nearly to La Paz.
Sierra Pinacate. About 30 miles southwest of Sonoyta.
Sierra Pinta. Next range north of the Sierra Pinacate, but in Arizona; second range of same name 15 to 20 miles west of the head of the Gulf of California.
Sierra Santa Maria. Parallel to Pacific Coast from about the "S" in San Ignacio northwest to tip of peninsula, terminating just below Cedros Island.
Superstition Mountains. About 40 to 50 miles east of Phoenix.
Tinajas Altas Mountains. About 40 miles east of Yuma.
Tres Vírgenes. Volcanic peaks 20 to 25 miles northwest of Santa Rosalia.
Whipple Mountains. On California side, in sharp bend of Colorado River about 80 miles north of Yuma.

The Name of the Deer-fern

WILLIAM R. MAXON

The species under discussion is the *Osmunda Spicant* of Linnaeus (1753), which was based on European material. In North America it is a common plant in mainly coniferous forests of the Humid Transition Zone along the Pacific coast from Alaska to the Santa Cruz Mountains, California, and because of its furnishing food to elk and deer in winter is commonly called Deer-fern.

During the last century American writers mostly called this fern *Lomaria Spicant* Desv., following the lead of Hooker and Baker, who maintained *Lomaria* as generically distinct from *Blechnum,* mainly on the basis of its strongly dimorphic fertile and sterile fronds. In 1900 Underwood, also recognizing both genera, took up the name *Struthiopteris* Scopoli (1760) in place of the much later *Lomaria* Willd. (1809), but wrongly attributed the combination *Struthiopteris Spicant* to Scopoli, whereas it had not been published until 1770 and then by Weis. *Struthiopteris* has since been adopted by the writer and many other American fern students, and it is in fact the name that must be applied to the *Lomaria* element if two genera are recognized. But even in Great Britain, despite the influence of Hooker and Baker's work, our plant appeared in many fern books as *Blechnum Spicant,* and most non-English writers—for example, Kuhn, Ettingshausen, Sturm, Luerssen, Makino, and Christ—merged *Lomaria* in *Blechnum,* as advocated by Mettenius in 1856.[1] More recently, Diels, Hieronymus, Christensen, Rosenstock, and most other fern students have regarded *Blechnum* in this inclusive sense, and not without reason. This view will presumably find general acceptance in the United States.

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[1] Fil. Hort. Bot. Lips. 60–65. 1856.

It has been customary to write as authors' names of *Blechnum Spicant* either "(L.) J. E. Smith" or "(L.) Withering," but both are wrong. In his 1793 "Tentamen," Sir James Edward Smith indicated *Osmunda Spicant* as a third species of *Blechnum* but did not actually make the transfer. He has, however, been erroneously given as second author by the writer in Abrams' "Illustrated Flora of the Pacific States," by Broun in "Index to North American Ferns," and by other writers.

The Withering reference given by Christensen in the Index Filicum (p. 159) is to the third edition of "A Botanical Arrangement of All the Vegetables Naturally Growing in Great Britain," p. 765 (1796); but the transfer of *Osmunda Spicant* to *Blechnum* had been made two years earlier by Roth, as pointed out not long ago by Mansfeld,[2] the correct citation being as follows: *Blechnum Spicant* (L.) Roth in Usteri, Neue Annalen. Vol. 2, pt. 10, p. 46 (1794). The treatment of this species by Roth occupies nearly a page and includes diagnosis and detailed description, with comments.

The Distribution of Equisetum in New Jersey

WILLIAM F. RAPP, JR.

The New Jersey species of *Equisetum* have been treated in Norman Taylor's "Flora of the Vicinity of New York" (1915) and J. K. Small's "Ferns of the Vicinity of New York" (1935), but in neither is a true picture of their distribution given. Since the first volume was written much field work has been done, especially in the southern and northwestern parts of the state. The data on distribution in Small's work tend to be general, rather than specific.

The present detailed study is based on the abundant material in the following herbaria: New York Botanical

[2] Repert. Sp. Nov. Fedde 45: 202. 1938.

DISTRIBUTION OF EQUISETUM IN NEW JERSEY.

Garden; Academy of Natural Sciences, Philadelphia; Brooklyn Botanical Garden; Princeton University; Chrysler Herbarium, Rutgers University; American Fern Society; and the private herbaria of Dr. R. T. Clausen and Mr. J. L. Edwards. I am grateful to the curators for allowing me to study the specimens in their care.

It is unnecessary to present a key to the species, since several good ones are readily available. The nomenclature follows that of Broun's "Index to North American Ferns" (1938); synonyms are given only when necessary. The maps are reproduced by permission of the McKinley Publishing Company, Philadelphia, Pa.

EQUISETUM ARVENSE L. Sp. Pl. 1061. 1753.

A map of the distribution of this species is not presented. It is the commonest and most widely distributed species in New Jersey, having been found in every county of the state. However, it grows in the Pine Barrens only where it has been introduced or at localities which, although within that region, are not truly Pine Barren country.

EQUISETUM PRATENSE Ehrh. Hannov. Mag. **22**: 138. 1784.

This boreal species reaches its southernmost limit in New Jersey, where it is rare, only three localities being known, as follows: Closter, Bergen Co., *C. F. Austin.* Palisades, Bergen Co., Apr. 30, 1865, *C. F. Austin.* Sparta, Sussex Co., 1868, *C. F. Austin;* July 19, 1937, *J. L. Edwards;* Aug. 7, 1938, *Wherry.*

EQUISETUM SYLVATICUM L. Sp. Pl. 1061. 1753.

This species is found in New Jersey only in the Appalachian Valley and Highlands, and on the Piedmont Plain, the greatest number of known stations being located in the Appalachian Valley.

PLATE 5.—Fig. 1, *Equisetum pratense;* fig. 2, *E. litorale* (circles) and *E. palustre* var. *americanum* (crosses); fig. 3, *E. sylvaticum;* fig. 4, *E. fluviatile;* fig. 5, *E. prealtum;* fig. 6, *E. prealtum* var. *affine.*

EQUISETUM PALUSTRE var. AMERICANUM Victorin, Equis. du Québec 51, 121. *f.* 7. 1927.

There are only two New Jersey stations for this American variety of the Eurasian *E. palustre* L., viz.: Sparta, Sussex Co., *C. F. Austin;* Closter, Bergen Co., *C. F. Austin.*

EQUISETUM LITORALE Kühl. ex Rupr. Beitr. Pfl. Russ. Reich. **4**: 91. 1845.

Schaffner claims that *E. litorale* comprises various anomalous forms of *E. palustre* and *E. arvense,* and perhaps hybrids. Since this matter has not been definitely settled, it has been thought best to consider it as a distinct species. The specimens referred here are: Dingman's Ferry, Sussex Co., Aug. 19, 1893, *Van Sickle.* Flatbrookville, Sussex Co., June 17, 1884, *Britton & Rusby.* Belvedere, Warren Co., Aug. 2, 1885, *Britton.* Phillipsburg, Warren Co., July 23, 1886, *T. C. Porter.* Carhart, Warren Co., *Mackenzie* 5164.

EQUISETUM FLUVIATILE L. Sp. Pl. 1062. 1753.
Equisetum limosum L. Sp. Pl. 1062. 1753.

This species is chiefly found in the northern part of the state and along the Delaware River from Camden County north.

EQUISETUM PREALTUM Raf. Fl. Ludov. 13. 1817.
Equisetum hyemale auth., not L.

At present this species is known from widely scattered stations throughout the state, being commonest in the northern part. Future collections will probably show it to be more generally distributed.

EQUISETUM PREALTUM var. AFFINE (Engelm.) Broun, Index No. Amer. Ferns 93. 1938.
Equisetum robustum var. *affine* Engelm. Amer. Journ. Sci. & Arts **46**: 88. 1844.
Equisetum hyemale var. *affine* A. A. Eaton, Fern Bull. **11**: 75, 111. 1903.

This variety seems to be mainly limited to the Delaware River Valley, but there are a few stations in other parts of the state.

On the status of Botrychium dissectum var. oneidense

ROBERT T. CLAUSEN

The classification of the ternate Botrychia, despite my studies and those of other contemporaries, still stands far short of perfection. Even some of the most familiar species and their variations must be reconsidered in the light of new evidence and fresh points of view. The idea advanced in the present discussion is only an hypothesis at the present stage, an idea to be critically considered and then either accepted or rejected on a basis of the evidence.

Several careful field students have referred Gilbert's *Botrychium ternatum* var. *oneidense* to *Botrychium multifidum* rather than to *B. dissectum.* Among these may be mentioned the late E. W. Graves (1935) and Prof. W. L. Dix, both enthusiastic students of *Botrychium.* The latter, in a recent letter (April 28, 1943) to me has remarked that he has "leaned to the interpretation of Graves in regard v. *oneidense.*" Others, including myself, have leaned the other way and preferred to regard var. *oneidense* as a variation of *B. dissectum.* This difference of taxonomic opinion is sincere and is supported in each instance by a degree of evidence. Those who favor the alignment of var. *oneidense* with *B. multifidum* have in favor of that point of view the evergreen condition of the sterile blade in *oneidense,* also the rounded condition of the penultimate segments. Those who favor the other relationship have as supporting evidence the thin texture of the blade, the elongate penultimate segments, and the late fruiting time, all characteristics of *B. dissectum.* Because the latter set of details seemed more important to me than the first set, I have tried to maintain var. *oneidense* under *B. dissectum.* All along I have become increasingly aware that something must be wrong with this idea, both from the reaction of other fern students and from further observation in the field. In central New York, var. *oneidense* is fairly common. Around Utica it apparently fruits as freely as do any of the other varieties of *B. dissectum.* In the section around Ithaca and in the southern tier of counties in New York this is definitely not the case, for the plants develop fertile panicles only rarely. On many a trip I have had to search long and patiently to find a fruiting plant of var. *oneidense,* whereas fruiting plants of var. *typicum* or var. *obliquum* could easily be obtained. Desiring to check the relative fertility of var. *oneidense* and var. *obliquum,* I have counted the fertile and sterile specimens in my personal collection, with the following results:

VARIETY	TOTAL NUMBER OF SPECIMENS (STERILE OR FERTILE)	NUMBER OF SPECIMENS WITH FERTILE PANICLES	PERCENTAGE OF PLANTS WITH FERTILE PANICLES
oneidense	72	11	15%
obliquum	148	80	54%

Examination of the available fertile panicles of var. *oneidense* indicates the presence of some abortive sporangia, but in a number of specimens the panicles seem to have as good sporangia and to be as productive as any of var. *obliquum.* Most of my specimens are from the Finger Lakes region and from the southern tier of counties in New York.

A similar survey of specimens in the herbarium of Cornell University yields the following additional data:

VARIETY	TOTAL NUMBER OF SPECIMENS (STERILE OR FERTILE)	NUMBER OF SPECIMENS WITH FERTILE PANICLES	PERCENTAGE OF PLANTS WITH FERTILE PANICLES
oneidense	72	48	66%
obliquum	217	193	88%

The latter figures indicate a difference of fertility in the two varieties which is much less convincing than the figures for my own smaller series, but they do suggest a trend. By themselves, these data perhaps are not significant, particularly since most collectors strive to collect plants with fertile structures. When viewed in the light of my own experience in the field, however, they seem to substantiate the statement which S. J. Smith and I (Clausen and Smith, 1939) published regarding the condition in south-central New York, namely that "in the above area, this population produces fertile segments less frequently than do any of the other varieties of *B. dissectum.*"

To explain the decreased fertility of var. *oneidense,* also the intermediate character of this variety, which is seemingly midway between *B. dissectum* and *B. multifidum,* I now suggest the hypothesis that var. *oneidense* may be an interspecific hybrid, only more or less fertile. Arguments for and against this idea may be cited immediately. Already some of the favorable evidence is before us. The var. *oneidense* is phenotypically intermediate between the two suggested parent species; further, the plants exhibit decreased fertility. Another favorable argument derives from the geographical distribution of the so-called variety: It occurs chiefly in the northeastern states and southern Canada, in an area where the ranges of *B. multifidum* and *B. dissectum* overlap and in which hybrids naturally would be expected. The general pattern of distribution (see figs. 1 & 3 in my monograph [1938]), seems to favor the hybrid hypothesis. Wherever *B. multifidum* and *B. dissectum* occur together in eastern North America, var. *oneidense* is likely also to be present.

On the other side of the argument, details of distribution may also be mentioned. *B. multifidum* is at present unknown in eastern North America south of Pennsylvania. Yet there are records of var. *oneidense* from western North Carolina and Virginia (Rockingham Co., *G. R. Fessenden*), also from sections of Ohio, Indiana, and other localities from which *B. multifidum* has never been recorded. Another weakness with the hybrid idea is that the sporangia of the panicles of some individuals of var. *oneidense* seem to be as fertile and productive of spores as are those of either parent. Finally, there is the obvious objection that the hypothesis is simply a guess not supported by experimental evidence.

The three negative arguments may be considered in order. First there is the occurrence of var. *oneidense* in sections where *B. multifidum* has not been found. This can be accounted for in three possible ways: (1) that *B. multifidum* does occur in these localities, has been overlooked, and will eventually be discovered there as a result of further search; (2) that *B. multifidum* formerly occurred there and no longer exists, but that an intermediate population has persisted which is in process of blending with the dominant *B. dissectum;* and finally (3) that spores of hybrid plants have been blown from localities where both species occur and on germination in the new locality have produced gametophytes which, when self-fertilized, have developed F_2 hybrids. This last possibility may help to explain the fact that var. *oneidense* seems most fertile in areas where both *B. multifidum* and *B. dissectum* are frequent, whereas fertility seems to decrease in sections where *B. multifidum* is less common or absent. In other words, perhaps the F_1 is more fertile than the F_2. Another consideration concerns the possibility that some plants which have been identified as var. *oneidense* really are hybrids or back-crosses, whereas others, particularly small plants, are simply juvenile forms of *B. dissectum.*

The second argument suggested against the hybrid hypothesis refers to the occasional high fertility of plants of var. *oneidense.* This is significant, because it suggests that, since *B. multifidum* and *B. dissectum* are interfertile in the region where their ranges overlap and there produce intermediates, they are only subspecies of a polytypic species. This is definitely a possibility; but if true, the hybrids, theoretically at least, should be almost as fertile or as fertile as plants of either kind, and the population in the region of intergradation should be intermediate in character. Data presented earlier in this discussion already indicate a marked tendency towards a lower fertility. With respect to the population of the northeastern United States being intermediate in character, this is not the case. Most plants can definitely be assigned to either *B. multifidum* or *B. dissectum*, which may be found growing side by side but differing in the cutting of the sterile blade, time of fruiting, and the stoutness and texture of the whole plant. The factors isolating these two major populations seem sufficiently strong for us to regard the plants as belonging to two separate species, even if they are just in process of reaching that stage from a previous condition as freely intergrading subspecies.

The third argument against the idea that var. *oneidense* is an interspecific hybrid can be met only by actual experimental work in which the cross is produced under controlled conditions. Perhaps this will eventually be done. Meanwhile, the above information may afford basis for speculation and observational checking.

The subspecies involved in the suggested cross are the ssp. *silaifolium* of *B. multifidum* and the ssp. *typicum* of *B. dissectum.* The var. *obliquum* of the latter is probably the variation most often involved, but certain plants from Wayne and Lackawanna Counties, Pennsylvania, and from Chemung County, New York (*W. C. Wilson & R. T. C.* 2428) suggest that the dissected phase of ssp. *typicum* may sometimes participate. The late Professor Chamberlain (1920) advanced the theory that "*B. dissectum*" (var. *typicum*) is a sterile mutant. The mutant idea coincides exactly with my notions about the plant, but I question the sterility feature, though realizing that the fertility may vary in different parts of the range. In any case, this detail is probably not relevant to the status of var. *oneidense.*

The conclusion of the above discussion is that some evidence exists for regarding as an interspecific hybrid the plant which I have called *B. dissectum* var. *oneidense.* Fern students in localities where this plant occurs may aid the work of determining its status by comparing conditions in their areas with the evidence presented here. Further data may support or detract from the value of the hybrid hypothesis, which has as its chief merit the furnishing of an explanation for the intermediate characteristics and peculiar distribution of var. *oneidense.*

CORNELL UNIVERSITY.

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Clausen, R. T., and S. J. Smith. 1939. On some pteridophytes of south-central New York. Amer. Fern Journ. 29: 45–58. *pl. 6.*

Graves, E. W. Describing Botrychiums. Amer. Fern Journ. 25: 109–120. 8 figs.

Shorter Notes

× ASPLENIUM GRAVESII IN VIRGINIA.—The discovery of Graves' Spleenwort in Virginia has been expected, since the two probable parent species (*A. pinnatifidum* and *A. Bradleyi*) have been found to occur sporadically in the state. On the 6th of May, 1939, during a foray in the neighborhood of Chatham, Pittsylvania Co., Va., the region around Moses Mill Pond, west of Chatham, was visited. A part of the foray group followed the writer along the south shore of the pond. Approximately halfway up this shore one finds large boulders. On these, two distinct types of *Asplenium* were found. One was identified as *Asplenium pinnatifidum* Nutt., the second was not recognized. These were cared for and filed away in the herbarium. Some months later the specimens were shown to Dr. E. T. Wherry, who identified the questionable one as *Asplenium Gravesii* Maxon and agreed that the other was *Asplenium pinnatifidum.* The area has been visited again to search for more specimens of *Asplenium Gravesii* and for *A. Bradleyi* D. C. Eaton, but as yet only two specimens of the former have been found and none of the latter. The two of *Asplenium Gravesii* were found on the same boulder with *Asplenium pinnatifidum* and within two feet of it. Brooks and Margolin[1] report a similar situation in relation to the occurrence of *Asplenium Gravesii* in West Virginia: "The French Creek station [Upshure Co., W. Va.] for this hybrid fern . . . is on a sandstone cliff in heavy deciduous woods . . . *A. pinnatifidum* is present, but persistent search has failed to reveal *A. Bradleyi* in the locality."

The Virginia station for *A. Gravesii* is in Pittsylvania County, in the inner Piedmont, 2 miles west of Chatham along the southwest shore of Moses Mill Pond on Cherry-

[1] The Pteridophytes of West Virginia. West Va. Univ. Bull., Series 39, No. 2, 35. 1938.

stone Creek, 350 feet above sea level. The two specimens collected are filed in the herbarium of the Virginia Polytechnic Institute, *A. B. Massey* 2922 and 4404 (V.P.I. sheets 9736 and 9737).

The distribution of *Asplenium Gravesii* as given by Broun[2] is ". . . on sandstone and mica-gneiss ledges, Appalachian and Piedmont regions, northwestern Georgia and adjacent Alabama to central West Virginia and southeastern Pennsylvania; rare." Thus the Virginia station is not an extension of the range but fills in a gap.—A. B. MASSEY, *Virginia Polytechnic Institute, Blacksburg, Virginia.*

BRADLEY'S SPLEENWORT IN OHIO.—About 70 years ago Professor F. H. Bradley discovered a small new evergreen fern growing in the crevices of sandstone cliffs in eastern Tennessee, and in his honor it was named *Asplenium Bradleyi* by D. C. Eaton. Some two years ago Clyde Jones, of the Ohio State University, found this species on a cliff called Jacob's Ladder, in Fairfield County, near Lancaster, Ohio. The urge to find another locality for this fern in Ohio prompted Leslie L. Pontius and myself to explore a region of Sharon conglomerate and sandstone cliffs in Clyce Hollow, Jackson Township, Pike County—one of my favorite hunting grounds for ferns. Diligently for hours we scaled cliffs and searched the crevices, finding here and there *Asplenium platyneuron, A. pinnatifidum, A. montanum,* and *A. Trichomanes.* It was getting late and we were almost ready to quit our search, when, lo and behold! in a crevice on the south face of a cliff we found the object of our quest, *Asplenium Bradleyi.* The day ended, and two very happy men returned to their homes. The treasure was found.—FLOYD BARTLEY, *Circleville, Ohio.*

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[2] Index to North American Ferns, 20. 1938.

Recent Fern Literature

Gualterio Looser, continuing his scholarly and accurate work with Chilean ferns, has published three articles in Volume 28 of the Revista Universitaria of the Universidad Católica de Chile (1943). The first (pp. 31–34)[1] records a new station in the Province of Antofagasta in northern Chile for the very rare and geographically curious species *Polypodium masafuerae* Philippi. It is now known from Juan Fernandez, five or six localities in northern Chile, and Mollendo, Peru. Sr. Looser adds a critical discussion of the nomenclature of the species.

The second article (pp. 123–134)[2] is a supplement to a previous publication on the type localities of Chilean species of ferns and is the result of a visit to botanical institutions in Argentina and Uruguay. The type collections of some forty species are listed with nomenclatural and other notes.

The third article (pp. 169–180)[3] gives a very readable account of a collecting trip to the volcano Osorno in southern Chile, which covered many altitudes from the bare slopes just below the snow-cap of the summit to the rain-forest at the base. The narrative is interspersed with critical and descriptive comment on the ferns seen and is supplemented by an annotated list of the 22 species collected and a new key to the Chilean species of *Dicranopteris.*

Sr. Looser has also published a brief account[4] of the work of the late Dr. Christensen.—C. A. W.

Although it is not customary to review in the Journal books relating to subjects other than ferns, an exception

[1] Nueva localidad cerca de Antofagasta del helecho Polypodium masafuerae Philippi.

[2] Los localidades de los tipos de los helechos chilenos. Primera adición.

[3] Coleccionando helechos en el Volcan Osorno (sur de Chile).

[4] Revista Argentina de Agronomia **10**: 279–280. 1943.

may well be made in the present instance. "Shrubs of Michigan"[1] is an attractive and thoroughly meritorious publication. In addition to being of high scientific worth, the book is so planned as to help and encourage the amateur in the study of shrubs, and to provide him with an understanding of methods of collection and identification. Clear line-drawings illustrate each species and a map shows its distribution in Michigan. Of the blackberries and hawthorns our knowledge of species is meager, and the author has made it clear that in this, as in many other groups, problems to be investigated by the amateur are at hand. Most of these shrub species extend across the northeastern part of the country. Besides providing a ready means of identifying shrubs, the text sets a good standard for our contributors on the subject of ferns.—H. K. S..

Mr. J. P. Anderson has published[2] recently Part I of a "Flora of Alaska and Adjacent Parts of Canada," which includes the pteridophytes and conifers. The author lived for many years in Alaska and collected extensively in almost all parts of the region. His treatment, which has keys to the families, genera, and species, as well as brief descriptions, will naturally be compared with Hultén's recent account[3] covering the same territory. Fifty-four species of Pteridophyta are recognized, as compared with 53 by Hultén, the extra one being *Equisetum alaskanum* (A. A. Eaton) Anderson, which is based on the plant treated by Hultén as *Equisetum variegatum* subsp. *alaskanum*. Line drawings are given for 47 species, but these show such small portions of the fronds that their usefulness is somewhat impaired. Nevertheless, they will be helpful to many amateurs.

1 Shrubs of Michigan. By Cecil Billington. Cranbrook Institute of Science. Bulletin No. 20. 249 pp., 161 figs. and maps. Bloomfield Hills. 1943. $2.50 postpaid.

2 Reprinted from Iowa State Coll. Journ. Sci. **18**: 137–175. 1943.

3 Reviewed THIS JOURNAL **32**: 74. 1942.

Anderson's account does not take into consideration any of the fern studies of the last few years. For example, Clausen's work on the Ophioglossaceae is ignored; consequently the name *Botrychium silaifolium* Presl [*B. multifidum* subsp. *silaifolium* Clausen] is used, whereas, according to Clausen, this subspecies (or species) does not occur north of British Columbia, the Alaskan plants being referable to *B. multifidum* subsp. *robustum* (Rupr.) Clausen. The Alaskan Bracken is called *Pteridium aquilinum* var. *lanuginosum* Bong. [an error for (Bong.) Fernald], but Tryon has pointed out that this varietal epithet is not available, the proper name for the Alaskan plant being var. *pubescens* Underw. The reviewer showed several years ago that the Oak-fern must bear the name *Dryopteris disjuncta* (Rupr.) Morton, rather than *D. Linnaeana* C. Chr., as given by Anderson. There are other nomenclatural errors, such as the authorities for the following entities: *Blechnum* should be L., not (L.) With.; *Pteridium* should be Gled. ex Scop., not Scop.; *Botrychium boreale* should be Milde, not (Sw.) Milde; *Athyrium Filix-femina* var. *cyclosorum* should be (Rupr.) Ledeb., not (Rupr.) C. Chr.; and *Struthiopteris* (in the sense of *Pteretis*) should not be Scop., for Scopoli's genus *Struthiopteris* is a synonym of *Blechnum* (sens. lat.).

Mr. Anderson has attempted to simplify the keys so that they may be used successfully by untrained persons, but in some cases they are so short as to be scarcely usable; for example,

Segments reniform or fan-shaped .... *Botrychium Lunaria.*
Segments rounded .... *Botrychium boreale.*
Segments acute .... *Botrychium lanceolatum.*

Here the "segments" mentioned are not comparable. Those of *B. Lunaria* are whole pinnae, whereas those of the other two are the ultimate lobes of pinnae. Or again:

Blades 1–2-pinnate.
  Blades small, thick .... *Dryopteris fragrans.*
  Blades large, thin .... *Dryopteris oreopteris.*
Blades 2–3-pinnate .... *Dryopteris austriaca* [*D. dilatata*].

These three species are so dissimilar that a far more definite yet simple key could readily have been constructed.

The errors above mentioned are chiefly of importance to fern specialists and will not detract much from the usefulness of the work to amateurs and botanists in general. In fact, Mr. Anderson's paper will be much more usable for them than Hultén's, which contains no descriptions or illustrations. For the professional taxonomist, however, Hultén's scholarly work will be indispensable for its definite information as to ranges, complete citation of synonymy, citation of specimens, and valuable discussions of variation.—C. V. M.

American Fern Society

Report of the Auditing Committee

The undersigned have checked all the receipts and expenditures of the American Fern Society for 1943 and find the Treasurer's statement correct.

We call to the notice of the Society that our recommendation of a year ago that the valuation of the Library be reduced by 20 per cent has been entered in this report.

We recommend that the item Inventory A.F.J. (back numbers) listed in the Assets column in the sum of $2,006.79 be reappraised and entered with an Inventory value of $500.00, and that the Liability Capital Account be reduced accordingly in next year's report.

We wish to express our high appreciation to Dr. Svenson and his staff, who have given careful attention to the work of the Treasurer's office.

WALTER S. ALLEN
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Auditing Committee

Calvin L. Gruber

We regret to have to record the passing away of one of our few Life Members, C. L. Gruber. He was born in Berks County, Pennsylvania, in 1864, and for some 45 years was a teacher in the State Teachers' College at Kutztown. At an early age he took up plant collecting as a hobby, at first specializing on certain groups of flowering plants, and discovering several new hawthorns. Becoming interested also in ferns, he joined our Society in 1907, and contributed to the JOURNAL several notes on the species of his region, including the description of some new forms, the type specimens of which were placed in the Society's herbarium. Shortly before his death, which occurred July 21, 1943, he presented his collection of Berks County ferns to the Academy of Natural Sciences of Philadelphia.

Mr. Gruber was a rather small man, who spoke with a strong Pennsylvania German accent. Active, energetic, and keen-eyed to an advanced age, he was a delightful field companion, and nothing made him happier than to be able to guide members of the Fern Society to the localities of his unusual finds. The writer will always remember his keen enjoyment of a visit we made to "Cystopteris Bluff" opposite Moselem, where we found what seemed to be four different variants of *Cystopteris fragilis*.—E. T. WHERRY.

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American Fern Journal

VOL. 34 JULY–SEPTEMBER, 1944 NO. 3

The New World Species of Azolla[1]

H. K. SVENSON

The water-ferns, represented by *Salvinia* and *Azolla*, are among the most curious of plants, and would not ordinarily be taken to be related to the ferns. *Salvinia* plants consist of a shoot up to one or two inches long, with clusters of round floating leaves rarely as much as a centimeter in diameter. *Azolla* likewise is a floating plant, chiefly of the tropics; the entire surface of quiet ponds may be so covered by the tiny branching fronds as to exclude mosquitoes from the surface, and for this reason the plant is sometimes known as "mosquito-fern" (cf. Benedict, AMER. FERN JOURN. **13**: 48. 1923). These little floating plants send rootlets down into the water much in the manner of the duckweed (*Lemna*); their small size, branching habit, and the almost crystalline appearance of the tiny individual leaves may be judged from the accompanying drawings of living, non-fruiting plants from the greenhouses and out-door pools of the Brooklyn Botanic Garden (*Pl. 6, fig. 1*). The succulent leaves, in the center of which blue-green algae always live, gleam under the lens like leaves of *Mesembrianthemum*. In full sunlight the fronds often become reddish, but those in shaded localities remain bright green.

The branches of *Azolla* show a dorsiventral structure suggesting that of *Selaginella*. The leaves are two-lobed, the lower lobe being usually larger than the upper, mostly

[1] Brooklyn Botanic Garden Contributions, No. 100.

[Volume 34, No. 2, of the JOURNAL, pages 37–68, was issued June 19, 1944.]

without chlorophyll and only one cell thick. These lower lobes are so adapted for floating the plant that water comes in contact only with their lower surface. The upper lobes do not reach the water at all. During the growing stage they are flattened in the same plane as the lower lobes, and it is only in age that they become somewhat erect.

As early as 1725, Feuillée had made crude illustrations of plants from the Peruvian region. Commerson, during his romantic voyage around the world with Bougainville (1767–1769), collected somewhere in the Magellan area the specimens upon which Lamarck in 1785 founded the genus *Azolla*, based on the single species *A. filiculoides.* No other species were known until 1810, when Willdenow described *A. caroliniana,* based on material derived from Richard in Paris, and therefore probably collected by Michaux in the southeastern United States. As yet, differentiation of species was based only on vegetative aspect, *A. caroliniana* being noted as having spreading leaves in distinction to the imbricate appressed leaves of *A. filiculoides.* In the same year that *A. caroliniana* was described, Robert Brown (Prodr. Fl. Nov. Holl. 167. 1810) placed the genus upon a scientific basis; both his genius and that of his artist, Ferdinand Bauer, contributed to the essential understanding of the reproductive bodies, as illustrated in Plate 10, accompanying the Botany of Captain Flinders' voyage (1814). Martius in 1834 beautifully illustrated *A. microphylla* Kaulf. (Icon. Pl. Crypt. Bras. *pl. 74, 75*), of which the figures are perhaps based on Brazilian plants, and Meyen followed shortly in 1836 (Beiträge zur Kenntniss der Azollen) with a fine series of drawings of *A. filiculoides.* It was not until 1847 that Mettenius[2], characterized by Christensen (in Verdoorn, Manual Pterid. 523. 1938) as the keenest fern student of the nineteenth century, published a

[2] In Linnaea **20**: 259–282. *pl. 2, 3.* 1847.

monograph of the genus in which the species were carefully delimited. Unfortunately he did not describe and figure them from type material. Thus a change in the application of the names *A. microphylla* and *A. mexicana* may be necessary when the types can be studied, but I have found it expedient to follow his usage except in the interpretation of *A. caroliniana*. Since the time of Mettenius the systematic treatment of *Azolla* has gradually deteriorated; the elaborate work on the genus by Strasburger (1873) stressed details of cell structure and life history, but contributed nothing to taxonomy. The treatment by Baker (Journ. Bot. **24**: 99–101. 1886) is decidedly inferior.

Most collections of *Azolla* will be found to be nonfruiting, but careful search under a low-power binocular microscope will frequently disclose megaspores not apparent in the first casual observation. The sori, when present, will be found in pairs in the leaf axils of older portions of the frond. Each sorus is completely surrounded by an indusium. In some species the inflated globose indusia of the microsporocarps exceed 1 mm. in diameter and can be seen with the naked eye; but the acorn-shaped indusium of the megasporocarp is much smaller and is completely filled by the rigid single megaspore and its appendages. Usually there will be a pair of microsporocarps, or of megasporocarps; occasionally the pair will consist of one of each, and this is the condition most frequently illustrated. Depending somewhat upon the species, the stalked microsporangia (borne within the indusium like a bunch of toy balloons) vary from seven or eight to nearly a hundred. Each microsporangium contains 32 or 64 imbedded microspores aggregated into four to ten spore-masses (massulae). The massulae are somewhat flattened (when four, they fit together in tetrads, like fern spores in general), and when they are liberated from the microsporangium they display, in the New World species, the peculiar barb-tipped hairs (glochidia) which probably serve to anchor the floating massulae to the megaspores, and which are so necessary for the determination of the species. A compound microscope is necessary for examination of the glochidia. In the megasporocarp only a single megaspore develops. Wanda Pfeiffer has shown (Bot. Gaz. **44**: 449. 1907) that initial microsporangia develop on the stalked base of the megasporangium, and that "if the megasporangium develops, there will be a megasporocarp; while if the microsporangia develop, there will be a microsporocarp." The lower bell-shaped portion of the megaspore is important from a taxonomic point of view, since it may be smooth, reticulate, or pitted. The upper portion or lid of the sporocarp comes off at maturity in a parachute-like manner, liberating the megaspore and disclosing the three-lobed "swimming apparatus" derived from non-functional megaspore material, formerly thought to give buoyancy to the megaspore. Development of gametes takes about a week. The microspores remain imbedded in the massulae during development; they produce antheridia, and from them antherozoids escape through the gelatinous substance of the massulae. The nucleus of the mature megaspore divides repeatedly to form a small embedded prothallus in which one or more archegonia are produced, each with an egg cell. The zygote develops after fertilization, and by continuous division produces the pinnately-branched floating sporophyte with which we started. Further details of the life-history are given by G. M. Smith (Crypt. Bot. **2**: 353–362. 1938).

This study was brought about by an attempt to identify material which I collected in abundantly fruiting stage in the Galapagos Islands in 1930. The specimens in the herbaria of the Brooklyn Botanic Garden and American

Fern Society were greatly augmented by the specimens in the United States National Herbarium, which Dr. Maxon kindly sent me, and selected specimens from the Gray Herbarium. The work was difficult, since it involved examination of glochidia and megaspores over the entire range of specimens, before the more abundant sterile material could be allocated to the individual species. Many collections of *Azolla* are so meager that identification is practically hopeless. When a series of fruiting plants has been recognized, the elongate-frondose character and curled leaves of well-developed *A. filiculoides* can be perceived at a glance. The dichotomous branches of *A. caroliniana* with their unusually small leaves are also characteristic; *A. mexicana* is of similar texture, but larger and more compact. *A. microphylla*, chiefly of tropical South America, occurs in general as small isolated somewhat elongate plants; these are frequently thickened and deep purple, though thin green plants are occasional, as in *Drouet* 2659 from Ceará, Brazil. The following treatment is of the American species only, all of which are characterized by the presence of glochidia on the massulae.

For identification of material the reader is especially directed to the photographs (*Pl. 8*) which illustrate typical specimens of the four species here discussed. The identity of the West Indian material must remain doubtful, for the specimens seen are all sterile; nevertheless, their relationship is with *A. caroliniana*, and they have been so identified by practically all previous writers. In *A. filiculoides* only the upper portion of an elongate frond is shown in figure 4; the leaves are most frequently of an ashy-gray color with broad, scarious, irregularly curled margins. In *A. mexicana* the under leaf lobes, which serve as floats for the plant, are frequently much enlarged, even more so than in *A. caroliniana*.

Nothing is known of the boundary between *A. caroliniana* and *A. mexicana,* which probably lies in the Texas-Louisiana region. Finally, the reader must not be too optimistic about the identification of sterile material. Usually, however, if the specimens are well collected and in a mature stage, they can be assigned to one of these four species. It is possible that microscopic studies of leaf margins may provide a key to the species, but thus far I have been unable to make any correlation.

SYNOPSIS OF SPECIES

A. Glochidia not septate; plants small (0.5–1 cm. diam.), dichotomously branched, the nearly orbicular, divaricate leaves small (0.5 mm. long), nearly smooth, not closely imbricate; microsporangia 8–40 in an indusium.—Eastern United States and the West Indies.
1. **A. caroliniana** (*Pl. 6, fig. 3; pl. 8, fig. 1*).

AA. Glochidia not septate, or rarely with 1 or 2 septae at apex; plants elongate (frequently 2–6 cm. long), with closely appressed, imbricate, papillose, oblong to ovate leaves (1 mm. long); microsporangia 35–100 in an indusium; massulae 4–6; megasporangia with raised, irregularly hexagonal markings.—Guatemala to Alaska; Andean and southern South America; occasionally introduced in the eastern United States, Hawaii, and Europe.
2. **A. filiculoides** (*Pl. 6, figs. 1, 2; pl. 8, fig. 4*).

AAA. Glochidia many-septate; plants dichotomously branched, 1–1.5 cm. diam., with upper leaf lobes 0.7 mm. long, the under ones much larger; microsporangia usually with 4 massulae; megaspore pitted.—Mexico and of scattered occurrence in the lowlands southward to French Guiana and Bolivia, northward to Utah and British Columbia, and eastward to Wisconsin and Illinois.
3. **A. mexicana** (*Pl. 7, figs. 1–3, 5; pl. 8, fig. 2*).

AAAA. Glochidia many-septate; plants small (1–2 cm. long), pinnately branched, with nearly orbicular leaves 1 mm. long; megaspore smooth.—Chiefly in the lowlands of Brazil and British Guiana; of scattered distribution in western South America and northward to Central America, the West Indies, and "California."
4. **A. microphylla** (*Pl. 6, fig. 4; pl. 8, fig. 3*).

1. **Azolla caroliniana** Willd. Sp. Pl. **5**: 541. 1810, not of later authors except as to some descriptions and illustrations of habit. ?*A. portoricensis* Spreng. Syst. Veg. **4**: 9. 1827.

Ponds and slow streams, from Massachusetts and New York to Louisiana, and, judging from habit alone, Cuba, Puerto Rico, and Jamaica (*Harris* 10349). *Jurgensen*

229, from Santa Cruz, Rio Grande do Sul, Brazil, also has the habit of *A. caroliniana.*

Only in *Tryon & Godfrey* no. 907, from Clarendon County, South Carolina, and Garber's collection from Sanford, Florida, in 1876, did I find microsporocarps. The glochidia are non-septate, a condition otherwise characteristic of *A. filiculoides,* but somewhat smaller than in that species and acutely pointed at each end. Notwithstanding diligent search I have otherwise found no trace of fruiting bodies in this species. The sculpture of the megaspores, when they are seen, should be important for identification. Mettenius saw fruiting specimens of "*A. caroliniana*" only from Schiede's Mexican collection, which he illustrated.[3] This I take to be *A. mexicana* cannot be considered as published. It was collected in January, 1820, "inter Serpillo et Estero," a locality close to the Tecoluta River, halfway between Vera Cruz and Tuxpan.[5] In the synonymy of *A. caroliniana,* Mettenius cited *A. mexicana* Presl (Bot. Bem. Prague 150. 1844), which was based on Schiede's collection and represents the first actual publication of *A. mexicana.*[6] Schiede's plant certainly has nothing to do with true *A. caroliniana;* nevertheless Mettenius' illustration was followed by Strasburger (1873) and later by Kuhn in Martius' Flora Brasiliensis (1^2: *pl. 82.* 1884), from which it was copied by Britton & Brown (Ill. Fl. **1**: 35. *fig. 76.* 1896).

[3] Linnaea **20**: 278. *pl. 3, figs. 9–15.* 1847.

Schlecht. & Cham.,[4] which received no description and

[4] Linnaea **5**: 625. 1830.

[5] Linnaea **4**: 561. 1829.

[6] This rarely accessible publication appears under the title "Obs. Botanicae" in Abh. Böhm. Ges. Wiss. V. 3: 150. 1845, and the description is as follows: "580. Nova *Azollae* species est: *Azolla mexicana;* fronde pinnata, foliolis imbricatis laevibus subrotundis coloratis, radicibus capillaribus. Habitat in Mexico, ubi legit clar. Schiede. Affinis videtur *A. portoricensi,* differt foliolis margine non hyalinis."

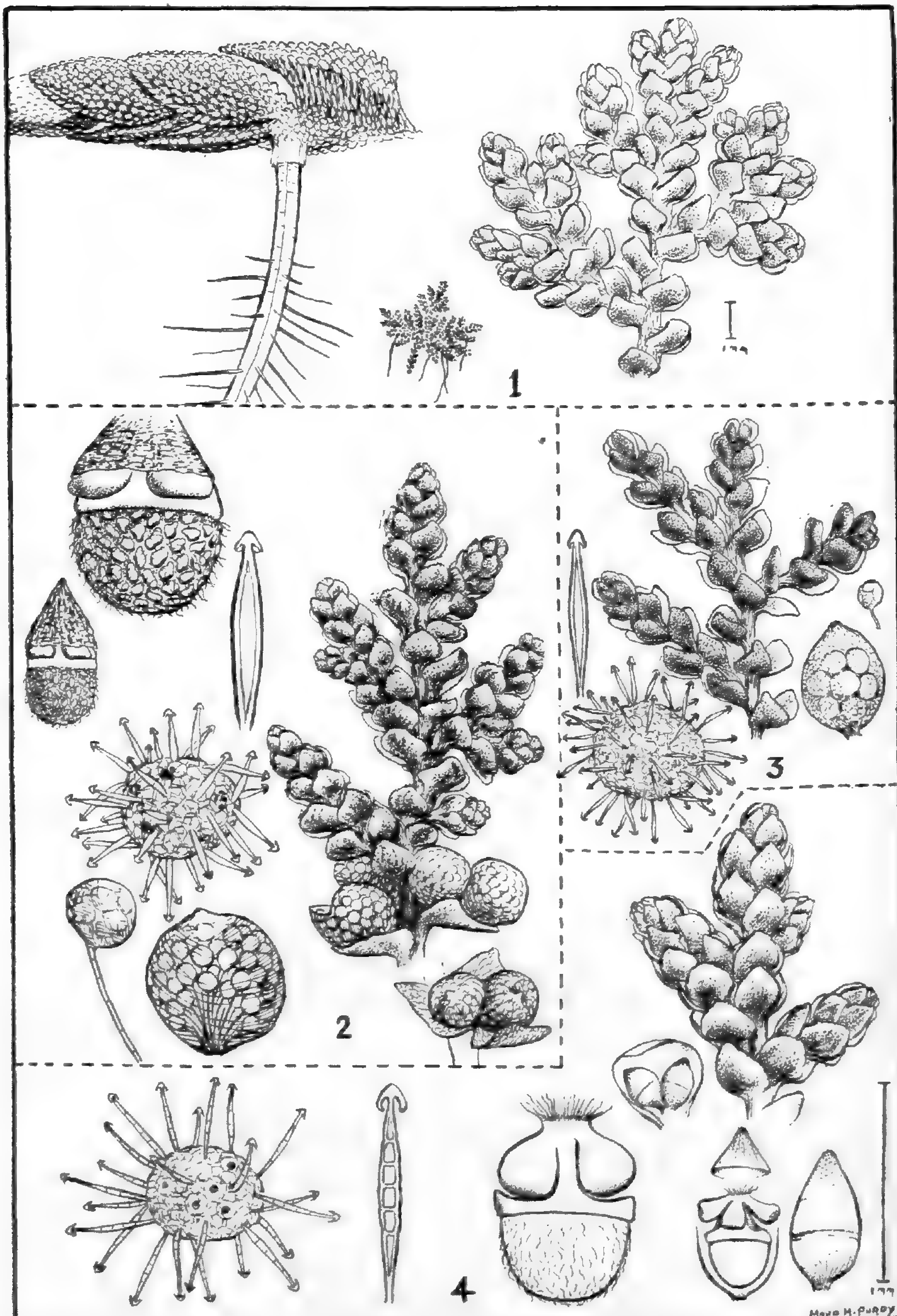

Plate 6.—Fig. 1. *Azolla filiculoides,* from living material; fig. 2. *A. filiculoides,* California, *Wheeler* in 1941; fig. 3. *A. caroliniana,* South Carolina, *Tryon & Godfrey* 907; fig. 4. *A. microphylla,* Galapagos Islands, *Svenson* 86.

A. portoricensis was based on sterile material in the Sprengel herbarium, collected by Bertero.

2. **Azolla filiculoides** Lam. Encycl. **1**: 343. 1783, and Ill. *pl. 863.* 1797; Meyen, Beiträge zur Kenntniss der Azollen, in Acad. Caes. Leop. Nov. Act. Nat. Cur. **18**: 505–524. *pl. 38.* 1836; Strasburger, Ueber Azolla 78. *pl. 6, figs. 87, 91.* 1873; Kuhn in Mart. Fl. Bras. **1**^{2}: 658. *pl. 82, figs. 9–11.* 1884; Baker, Journ. Bot. **24**: 100. 1886; Campbell, Ann. Bot. **7**: *pl. 8, figs. 27, 35,* etc. 1893. *A. magellanica* Willd. Sp. Pl. **5**: 541. 1810 (renaming of *A. filiculoides*); Mettenius, Linnaea **20**: 277. *pl. 3, figs. 16–21.* 1847. *A. squamosa* Molina, Saggio Nat. Chile, ed. 2, 125. 1810, sec. Christensen. *?A. bonariensis* Bertol. Misc. Bot. 21, in Rend. Sci. Bologna **1859–1860**: 64. *pl. 5, figs. 2a, 2b.* 1860.

Azolla filiculoides came from the Magellan region, but the actual locality is uncertain. I have not been able to make out the distinctly annular markings of the megaspore shown by Mettenius; such markings are usually angular and are better shown by Strasburger (*pl. 6, figs. 91, 92*). *Azolla bonariensis* was described from Buenos Aires, based on a collection by Fox-Strangwais, and is referred to *A. caroliniana* by Christensen (Ind. Fil. 148. 1906). Schlechtendal (Bot. Zeit **19**: 343. 1861) does not seem to value it highly, nor can Bertoloni's work as a whole be held in very high esteem.

Occasionally specimens are found in which there are one or two septae at the very apex of the glochidia, but these may be residual protoplasmic material rather than actual septae. This form is *A. filiculoides* var. *rubra* (R. Br.) Strasburger (Ueber Azolla 78. *pl. 6, fig. 86a.* 1873), based on *A. rubra* R. Br. (Prodr. Fl. Nov. Holl. 167. 1810; Baker, Journ. Bot. **24**: 100. 1886). It was originally described from Australia, but is of little if any importance geographically, since it is found scattered throughout the range of the species in America.

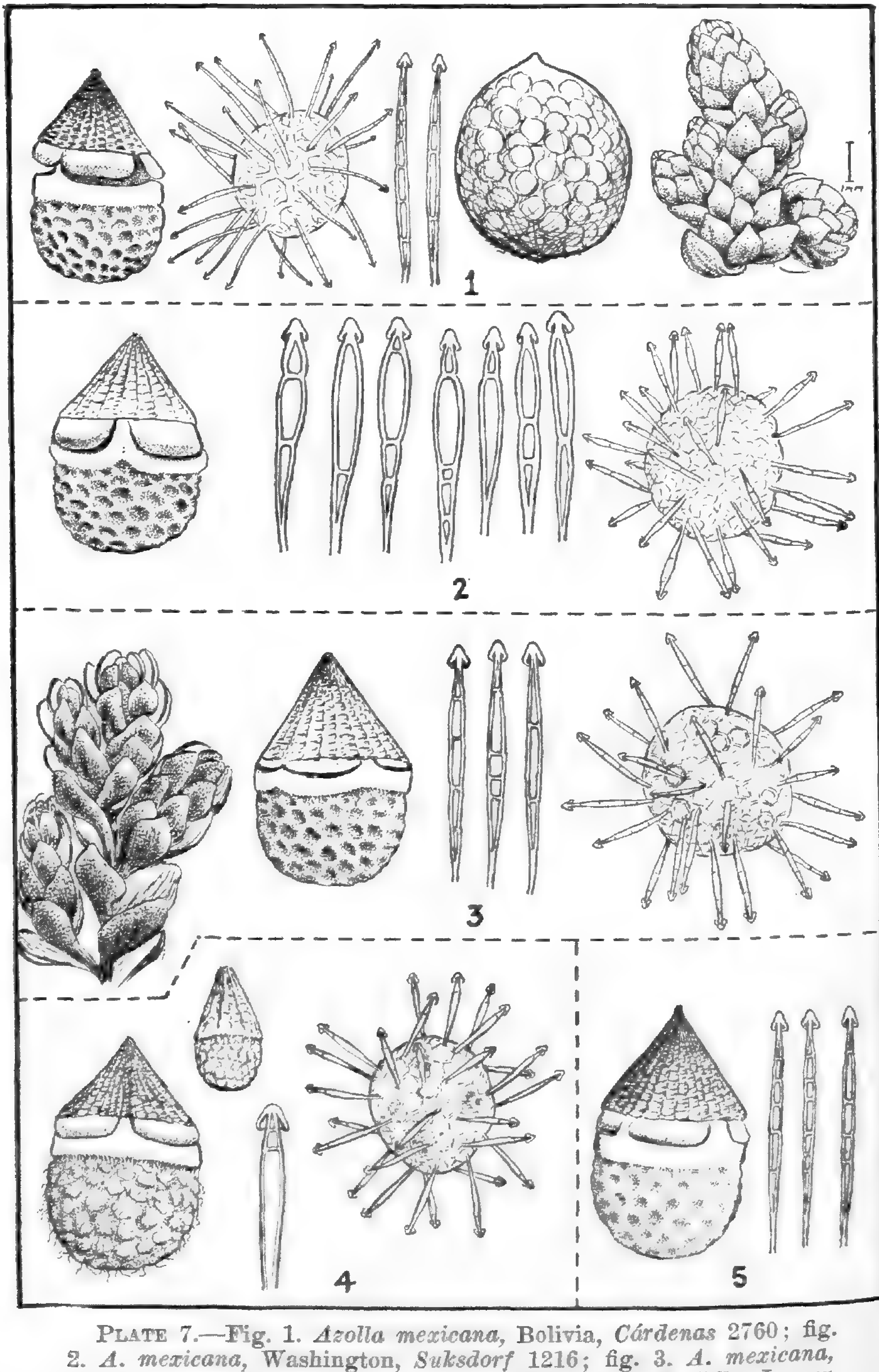

PLATE 7.—Fig. 1. *Azolla mexicana,* Bolivia, *Cárdenas* 2760; fig. 2. *A. mexicana,* Washington, *Suksdorf* 1216; fig. 3. *A. mexicana,* Oregon, *Nelson* 4176; fig. 4. *A. filiculoides* var. *rubra,* Chile, *Looser* in 1930; fig. 5. *A. mexicana,* Mexico, *Rose* 14647.

Azolla filiculoides seems to be the only species known from Argentina, Uruguay, Chile, and from the Andes. In the Andes it seems frequently to grow on a rather dry substratum, the plants being often aggregated in thick masses, with very prominent roots. Such specimens are: Bogotá, Colombia, *Apollinaire* in 1907; Chasquí, Peru, *Macbride* 3307; Quispicanchi, Peru, *Herrera* 2616, 2618; Bolivia, *R. S. Williams* 2648; Valparaiso, Chile, *Claude Joseph* 1562, 4698; Concón, Prov. Aconagua, Chile, *Looser* in 1930.

I have seen the following collections of *A. filiculoides* in fruit: Alaska: *Bischoff* in 1868. New York: Brooklyn Botanic Garden, *Benedict* in 1924. Riverhead, Long Island, *Muenscher & Curtis* 6647. California: Pacheco Pass, *Brewer* 1288. San Francisco, *Rose* 42246; *Bolander* in 1865 and 1866. San Mateo County, *Blake* 9944. Merced County, *Howell* 4206. Santa Cruz County, *Abrams* 1833. San Luis Obispo, *Summers* in 1889. Santa Barbara, *Gambel* 668. Los Angeles, *Wheeler* in 1941. La Grange, *Tracy*. San Bernardino, *Parish* 5278. San Jacinto, *Leiberg* 3104. San Diego, *Kimball*. Mission Dam, San Diego County, *Kimball* 229. Hot Springs, San Diego County, *Vasey* 694. Arizona: Tucson, *Thornber* in 1903. Mexico: Chihuahua, *Hartman* 614. Puebla, *Arsène* in 1907. Morelos, *Rose & Painter* 6878. Guatemala: Dept. Sololá, *Muenscher* 12179. Colombia: Bogotá, *Lehmann* 6363. Bolivia: Cochabamba, *Julio* 191; *Bang* 983, 1032, 1033. Chile: Santiago, *Hastings* 319. Valdivia, *Philippi* in 1888. Brazil: Rio Grande do Sul, *Malme* 290. Uruguay: Florida, *Rosengurtt* B–781. Montevideo, *Gibert* 1317, 1318. Argentina: Jujuy, *Eyerdam & Beetle* 22193, 22335. Corrientes, *Palmer* 1854. Rioja, *Venturi* 8230. Río Negro Valley, *Fischer* 233. Hawaii: Oahu, *Degener & Dowson* 12913. Honolulu, *Fosberg* 13833.

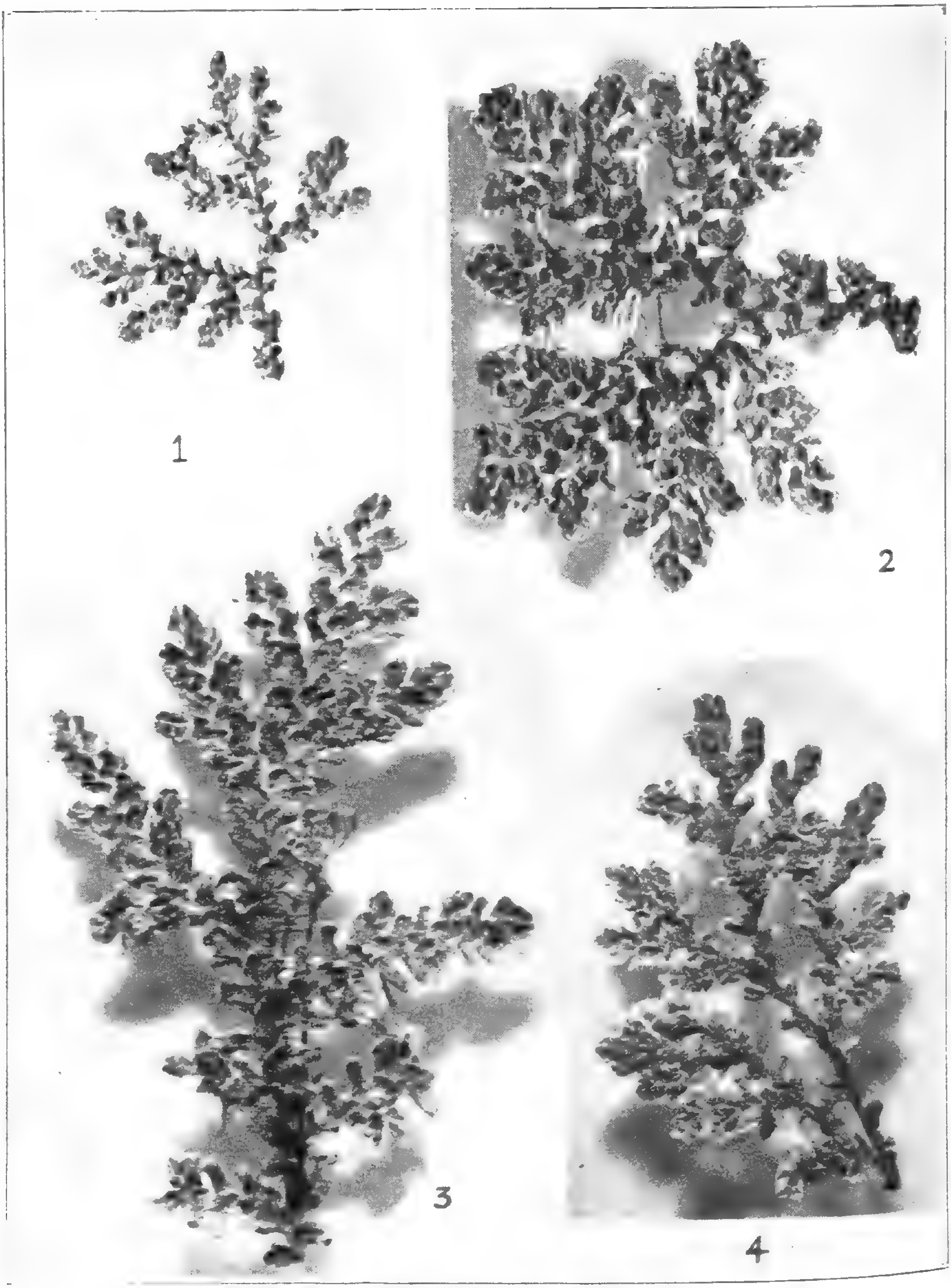

PLATE 8.—Fig. 1. *Azolla caroliniana*, South Carolina, *Tryon & Godfrey* 907; fig. 2. *A. mexicana*, Mexico, *Rose* 14806; fig. 3. *A. microphylla*, Galapagos Islands, *Svenson* 86; fig. 4. *A. filiculoides*, Argentina, *Ventura* 8230. All about 5 times natural size.

3. **Azolla mexicana** Presl, Abh. Böhm. Ges. Wiss. V. **3**: 150. 1845. *A. caroliniana* sensu Mettenius, Linnaea **20**: 278. *pl. 3, figs. 9–15.* 1847; Kuhn, in Mart. Fl. Bras. **1**^{2}: 659. *pl. 82.* 1884; Britt. & Brown, Ill. Fl. **1**: 35. *fig. 76.* 1896, not Willd. *A. mexicana* Schlecht. & Cham. Linnaea **5**: 625. 1830 (name only). ?*A. densa* Desv. Mém. Soc. Linn. Paris **6**: 177. 1827 (cited in synonymy by Mettenius).

Azolla mexicana resembles *A. caroliniana* in its flattened, dichotomously branched appearance, and it includes in general the specimens from the western United States and Mexico cited by authors under the name *A. caroliniana.* The leaves are, however, larger than those of *A. caroliniana* and do not have their slender appearance. The megaspores, before they are mature, might sometimes be mistaken for those of *A. filiculoides* because of the greenish corky-thickened markings, but when the megaspore has become dull gray and relieved of its outer covering the surface will be seen to be minutely pitted. This is undoubtedly the impression Mettenius wished to convey in his illustration of *A. caroliniana,* which, as I have mentioned previously, was drawn from a Mexican collection.

According to Weatherby (Contr. Gray Herb. **114**: 21. 1936), no specimens of *Azolla densa* Desv. or *A. arbuscula* Desv. are to be found in the Desvaux Herbarium. The only two sheets of *Azolla* are named *A. caroliniana* and *A. filiculoides,* and these identifications are confirmed by Kuhn. It seems that the names *A. densa* and *A. arbuscula* can well be disregarded.

I have seen the following collections in fruit: Wisconsin: Lacrosse, *Hale* in 1861. Illinois: Carroll County, *Waite* in 1887. Oquawka, *Patterson.* Swan Lake, Calhoun County, *Metcalf* 1110. Missouri: Cooley Lake, Clay County, *Metcalf* 1045. Utah: Provo, *Garrett* in

1926. NEVADA: Carson Sinks, *Sperry & Martin* 782. BRITISH COLUMBIA: Sicamous, *Macoun* 14205. WASHINGTON: Klickitat County, *Suksdorf* 1216. OREGON: Clackamas County, *Nelson* 2761. Salem, *Nelson* 4176; *Peck* in 1920; *E. Hall* 698. CALIFORNIA: Pitt River, Modoc County, *Gilbert.* Alturas, Modoc County, *Wheeler* 4013. Palo Alto, *Ward* in 1899. Santa Clara, *Wilkes Exped.* San Diego, *Cook* in 1921. MEXICO: Guadelupe, Sinaloa, *Rose* 14806. Rosario, Sinaloa, *Rose* 14647. Morelia, Michoacán, *Arsène* 1208, 2363; *Rosenstock Exs.* 73. HONDURAS: Tela, *Blake* 7281. COSTA RICA: Cartago, *Anderson* 17532. FRENCH GUIANA: *Leprieur* in 1838. BOLIVIA: Charagua, Oriente, *Cárdenas* 2760. Without mention of any state or collector, there is a specimen in the Gray Herbarium from "2 miles south of Columbus, overflow of Canal by Morrells, Sept. 18, 1841."

4. **Azolla microphylla** Kaulfuss, Enum. Fil. 273. 1824; Martius, Icon. Pl. Crypt. Bras. 123. *pl. 74, 75.* 1834[7]; Mettenius, Linnaea **20**: 276. *pl. 3, figs. 1–8.* 1847. *Salvinia Azolla* Raddi, Pl. Bras. **1**: *pl. 1, fig. 3.* 1825.

Azolla microphylla was supposedly collected by Chamisso in California, but in the numerous collections which I have examined from that state I have seen no trace of it in the traditional sense of Mettenius. But there is difficulty, since Mettenius derived his idea of the glochidia of *A. microphylla* from Martius, whose illus-

[7] The megaspore as illustrated by Martius is not smooth but reticulate, as is sometimes seen in young megaspores of *A. mexicana.* It was possibly drawn from the original material collected by Chamisso. Martius states (p. 125) that no wholly mature material of the calyptra had fallen under his observation. On page 126, he notes that *A. microphylla* occurs throughout much of Brazil, especially in the tropical parts; that Poeppig has sent him specimens from Las Piedras in Cuba and others have sent him material "in aquis camporum (Savanes) australiorem invenientam"; and that Roemer has sent him material collected by Chamisso in California. See the discussion under *A. mexicana* above.

trations were supposedly based on Brazilian material. In addition, the megaspores which Mettenius illustrated came from Cuba, a region from which I have seen only the sterile specimens referred to *A. caroliniana.* If the Chamisso specimen, which was fruiting, is ever examined, I suspect it will turn out to be either *A. mexicana* or *A. filiculoides;* Mettenius' drawing of the smooth megaspore, on the other hand, may possibly represent the unknown megaspore of *A. caroliniana.* The description by Kaulfuss was brief: "A. frondibus orbiculatis semipinnatis pinnis trilobis, foliolis imbricatis adpressis minutis. Frondes tri-quadrilineares orbiculatae subradiatae, folia papillosa arcte adpressa minutissima hyalina. Capsulae globuliferae semine papaveris fere duplo maiores."

Azolla microphylla was separated with difficulty by Mettenius from *A. cristata* Kaulfuss (Enum. Fil. 274. 1824), which was based on sterile material from Kunze's herbarium (without collector's name) from Demerara, British Guiana. Evidently Mettenius was able to find fruiting material, for he differentiated *A. cristata* by the crested-ciliate lid of the megaspore, well illustrated in his account (Linnaea **20**: 278. *pl. 2.* 1847). The number of massulae in a microsporangium, which Mettenius gives as 6 in *A. microphylla* and as 4 in *A. cristata,* would seem of little value for diagnosis of species, since the number is variable, being 9 or 10 in my Galapagos collection.

Chamisso, who made the original collection of *A. microphylla,* was even better known as a writer than as a botanist, and is especially remembered for the story of Peter Schlemiel, the man who sold his shadow. He was a member of the French aristocracy driven out during the Revolution, who migrated to Germany and to Switzerland. In 1815 he embarked from Copenhagen aboard the *Rurik* on a 'round-the-world expedition under the patronage of Count Romanzoff and under the command of Lieutenant Kotzebue of the Russian Navy. They explored the vicinity of St. Catherine on the Brazilian Coast, where heavy rains made collecting almost impossible, but where they obtained a goodly number of new ferns; the coast of Chile, where they arrived to find the vegetation burned up by summer heat; the California coast where, according to Jepson (Madroño **1**: 253. 1929), they explored the San Francisco peninsula during October, 1815. From the last locality, therefore, *Azolla microphylla* is supposed to have come. Then they sailed for the Hawaiian Islands and to the Aleutians, where in futile searching for a Northwest Passage they had their greatest success in botanical collecting. Kaulfuss wrote up the "Enumeratio Filicum" from this voyage; Chamisso's life, especially as to his botanical activities, is reviewed by Schlechtendal (Linnaea **13**: 83–112. 1839). An additional account of Chamisso has recently been published (Calif. Acad. Sci., Occasional Papers No. 20, 1943).

The following collections of *A. microphylla* have been seen, most of them in fruiting condition: DOMINICAN REPUBLIC: Haina River, *Faris* 413.[8] EL SALVADOR: Santa Emilia, Dept. Sonsonate, *Standley* 22121. BRITISH GUIANA: Botanic Garden, Georgetown, *Bailey* in 1921; *Hitchcock* 16540. FRENCH GUIANA: Swamps of Río Appruague, *Leprieur* in 1834. GALAPAGOS ISLANDS: Charles Island, *Stewart* 3441. Indefatigable Island, *Svenson* 86. PERU: Loreto, *Killip & Smith* 27707. BOLIVIA: Gran Chaco, Tatarenda, *Fries* 1397. BRAZIL: Maranguape, Ceará, *Drouet* 2659. Minas Geraes, *Regnell* III. 1507. Rio Grongogy Basin, Bahia, *Curran* 206. Toca de Onca, Bahia, *Rose* 20128.

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[8] This is perhaps a casual introduction; it does not represent the ordinary West Indian plant with habit of *A. caroliniana*.

Mass Collections: Equisetum sylvaticum

NORMAN C. FASSETT

It was pointed out in 1918[1] that *Equisetum sylvaticum* as it occurs in Europe has scabrous branches, while the American representative of this species usually has smooth branches. On both continents the degree of branching is variable, and the first varietal designation of the smooth American plant was a slightly branching phase which was named var. *pauciramosum* Milde. The commoner plant in the eastern United States, with branches smooth but compound, was named *E. sylvaticum* var. *pauciramosum* f. *multiramosum* Fernald. Professor Fernald, although treating the two phases of the smooth-branched American plants as forms of one variety, stated that the freely branching phase was commoner in the southern part of the range, while the phase with subsimple branches, of only occasional occurrence southward to New England and Ohio, was the characteristic plant of Greenland and Labrador. Dr. Wherry, emphasizing this difference in range, proposed varietal rank for the more freely branching plant, calling it *E. sylvaticum* var. *multiramosum* (Fernald) Wherry.[2]

The characters of these phases of the species may be most clearly shown in a key:

a. Branches scabrous .... var. *typicum*.
a. Branches smooth or scabrous only locally.
  b. Branches simple or slightly forking .... var. *pauciramosum*.
  b. Branches freely forking.
    var. *pauciramosum* f. *multiramosum*, or var. *multiramosum*.

Although most American plants have smooth branches, an occasional specimen has them as rough as those of the European plants. Such individuals, identified by Profes-

[1] Fernald, Rhodora **20**: 129–131. 1918.
[2] Amer. Fern Journ. **27**: 58. 1937.

sor Fernald with typical *E. sylvaticum,* were recorded by him from Parry Sound, Ontario, and from near Nome City, Alaska. Brother Marie-Victorin records the typical form from New York and from Quebec.[3] I have reported it as of not uncommon occurrence in Wisconsin.[4]

From a study of herbarium specimens, the presence of a plant in a particular region may be demonstrated; typical *E. sylvaticum* is thus shown to be present in 11 counties of Wisconsin and var. *multiramosum* in 16. Herbarium specimens alone cannot answer the following questions regarding these two plants: Is there any significance in the fact that we find var. *typicum* in Richland County, Wisconsin, and var. *multiramosum* in adjacent Sauk County? Do they grow in different habitats? Does the presence of one exclude the other? Is a significant connection indicated between Parry Sound, Ontario, and Nome City, Alaska, the two American localities where Professor Fernald reported the typical variety?

In an attempt to answer some of these questions, mass collections of *Equisetum sylvaticum* were made in 1940, 1941, and 1942. From each colony a large number of individuals were sampled, each sample consisting of one stem or a segment of a stem with one or two whorls of branches. Since each individual (clone) may consist of many erect stems connected by an underground rootstock, samples were taken at intervals of 25–50 feet to avoid duplication from a clone. A grant from the Wisconsin Alumni Research Foundation made possible collecting in the Black Hills of South Dakota. My student, Mr. Forest W. Stearns, made collections in Florence and Vilas Counties, Wisconsin. Especially helpful have been the mass collections made in Alaska by Professor L. J. Cole.

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[3] Contr. Lab. Bot. l'Univ. de Montréal, no. 9, 119. 1927.

[4] In Tryon, Fassett, Dunlop & Diemer, Ferns & Fern Allies of Wisconsin, 131. 1940.

The placing of all individuals in the three categories defined in the key proved to be not always a simple matter. Intermediates are of frequent occurrence. These intermediates were mentioned by Professor Fernald; indeed, an analysis of his presentation shows five categories: (1) "quite smooth," (2) "with the merest suggestion of scabridity on the angles," (3) "a more definite scabrousness on the young branches," (4) "sufficiently scabrous to be comparable with the bulk of the European specimens," and (5) "conspicuously scabrous." Some will argue that such an intergrading series merits no nomenclatorial recognition, even in the subspecific categories; but it appears to me, as it did to Professor Fernald and to Dr. Wherry, that if the extremes in the series show some geographic segregation the varietal designation is indicated.

Several sheets of the European plants, lent by the Gray Herbarium through the kindness of Mr. C. A. Weatherby, show most branches to have the first internode scabrous throughout and the successive internodes more or less scabrous to glabrous. In the following table, American plants with this condition have been called var. *typicum*. Those with the first internode of most branches scabrous only toward the distal end have been called intermediates. These intermediates can probably be considered as belonging to var. *multiramosum*, especially in view of the intraclonal variation to be discussed in the closing paragraph. I am free to admit that, returning to some collections which I had sorted some months previously, I re-sorted several individuals into different categories. With such a series of intergrades the placing of many of the individuals is a subjective matter. In spite of this, the following table throws light on some of the questions concerning the geographic relationships of the varieties of *E. sylvaticum*.

OCCURRENCE OF VARIETIES IN MASS COLLECTIONS OF EQUISETUM SYLVATICUM

LOCALITIES	*typicum*	(intermediate)	*multiramosum*	*pauciramosum*
MASSACHUSETTS: Westboro (one clone)	.....	3	17	.....
MAINE: Long Cove, Tenent's Harbor	.....	6	12	.....
Bristol	.....	5	5	.....
Ocean Point	.....	.....	10	.....
Madison	.....	1	18	3
New Sharon	.....	.....	19	2
ONTARIO: Callender	.....	3	5	1
Sudbury	.....	1	7	.....
Massey	.....	5	17	5
Garden River	.....	6	21	.....
WISCONSIN: Rocky Arbor, Juneau County	.....	2	8	.....
Antigo (one clone)	.....	5	12	.....
Irma	.....	.....	19	.....
Florence County between Tipler and Florence	.....	3	15	3
Found Lake, Vilas County	1	13	.....	.....
Barksdale	1	10	15	.....
Iron River	.....	3	23	.....
Wonewoc	3	10	3	.....
MINNESOTA: Two Harbors	6	3	3	.....
Brighton Beach, Duluth	3	5	6	.....
Central Lakes	2	6	2	.....
12 miles north of Virginia	.....	6	2	.....
SOUTH DAKOTA: Between Sylvan Lake and Custer	22	10	1	.....
Between Sylvan Lake and Harney Peak	.....	14	8	1
ALASKA: Lowing	1	.....	1	.....
Anchorage	2	.....	.....	.....
Curry	1	.....	.....	1
Mt. McKinley National Park	11	2	1	.....
Rosy Creek Placer Mine, 15 miles north of	1	2	1	.....
Fairbanks	1	2	1	.....
Coal Creek, 60 miles above Circle	1	1	1	.....

It becomes evident that there is a definite difference, in different regions, in the proportions of scabrous and of smooth individuals. Of the 27 individuals from Alaska, 17, a little more than half, are definitely scabrous. Of the 193 plants from Wisconsin and Minnesota, but 16, much less than 10 per cent, are scabrous. Of nearly 200 individuals from southern Ontario, Maine, and Massachusetts, none are scabrous. On this basis, the recognition of the smooth plant as a geographic variety seems justified. Of course, to clinch the matter, mass collections should be made in Europe, for comparison. From what information is at present available, they would be expected to be preponderantly scabrous.

The occurrence of typical scabrous *E. sylvaticum* in eastern North America appears, then, to be only as a minor constituent of a predominantly smooth-branched population. A herbarium specimen taken at random in this region might happen to be the rare var. *typicum*, but the chances are overwhelmingly in favor of its being the common smooth phase. An individual of the minority happened to be the one taken at Parry Sound, Ontario (as reported by Fernald), and at Saint-Tite, Quebec (as reported by Marie-Victorin). This does not necessarily indicate anything remarkable about Parry Sound or Saint-Tite. This idea may be illustrated by the simile recently quoted by Dr. Anderson: "There are Democrats and Republicans in both Mississippi and Vermont but their comparative frequency varies significantly between these two regions."[5] Should we tour Mississippi, stopping in each town to ask *one* person (simulating the usual representation of *one* herbarium specimen from each locality), "Are you a Democrat or a Republican?," the answer would in nearly every case be "Democrat." But if, say in Starkville, a sturdy individual should reply "Republican," this would not necessarily indicate any-

[5] Ann. Mo. Bot. Gard. **28**: 288. 1941.

thing unusual in the political complexion of Starkville. We just happened to meet a member of the minority party there.

That the glabrous, chiefly North American, phase of the species should be separated varietally from the scabrous, chiefly European, phase, was agreed upon by both Fernald and Wherry, and is substantiated by a study of mass collections. On the relation of the freely branching glabrous plant to the one with subsimple glabrous branches, however, the two authorities disagreed. Fernald stated: "The form with freely forking branches, the only form of var. *pauciramosum* which seems to merit a special designation, is less common northward than the form with simpler branches, but in the southern part of the range it is distinctly more abundant, being the common plant of southern New England, southward into Pennsylvania and locally westward to British Columbia."[6] Apparently he did not consider this geographical difference in relative abundance sufficient to merit more than distinction as forms. The present writer tends to agree with Wherry that if *multiramosum* is greatly in the majority in the northern United States and southern Canada (and that it actually is may be seen from the table) and *pauciramosum* is in the great majority in Greenland and Labrador (that this is the case is indicated by herbarium material, according to Fernald, but mass collections have not been made in these areas), they represent geographic trends, or varieties.

In a population containing plants with (1) glabrous and compound branches, (2) glabrous and subsimple branches, and (3) scabrous and compound branches, there might well be expected some plants with (4) scabrous and subsimple branches. Such plants have not appeared in mass collections. This may be because both scabrous branches and subsimple branches are so much

[6] Rhodora 20: 131. 1918.

in the minority that a combination of these two characters would be very unlikely. On the other hand, there may be a definite reason, genetic or otherwise, why such a combination does not occur.

There is indication of some intraclonal variation. Two of the collections listed in the table, one from Westboro, Massachusetts, and the other from Antigo, Wisconsin, were each taken from a rather compact isolated patch, and apparently represent single clones. Each contains some individuals which are unquestionably glabrous, and others which have the first internode of some branches scabrous distally and so are to be classified as intermediate. There are two factors here: (1) the difficulty of determining, without careful digging, the exact extent of a clone, and (2) the difficulty of drawing the line between some of the intermediates and the glabrous individuals. But since there is often some variation between branches in the same whorl, it is not unreasonable to expect variation between plants that are actually part of one individual. This variation does not destroy the significance of regional variation in the ratio of clearly scabrous individuals to clearly glabrous or slightly scabrous ones.

SUMMARY

Mass collections, consisting usually of a segment of a stem with a whorl of branches from each clone, were taken from colonies of *Equisetum sylvaticum.* Material from Maine, Massachusetts and southern Ontario, consisted of a great majority of plants with glabrous, or nearly glabrous, freely forking branches (var. *multiramosum*), and a few with glabrous subsimple branches (var. *pauciramosum,* a more northern plant). In Wisconsin and Minnesota the same varieties were represented, with the addition of some plants with scabrous freely forking branches, identified with the common

European var. *typicum*. In the Black Hills of South Dakota, and in Alaska, var. *typicum* was found to be about as common as var. *multiramosum*. Fernald's contention that the mostly North American plants with glabrous branches represent a variety distinct from the mostly European plants with scabrous branches is thus corroborated. The finding of an occasional herbarium specimen of var. *typicum* from various places in eastern North America is taken to indicate nothing particularly significant about that place; var. *typicum* is present in very small numbers and is occasionally collected by chance. Intermediates are found, often on the same rootstock with var. *multiramosum* in regions where var. *typicum* is not yet known; these intermediates are therefore considered as belonging with var. *multiramosum*.

DEPARTMENT OF BOTANY,
UNIVERSITY OF WISCONSIN.

Cystopteris Bluff

EDGAR T. WHERRY

Several years ago the late C. L. Gruber guided the writer to a locality across the creek from Moselem Station, Berks County, Pennsylvania, where he thought interesting ferns might be found. The locality is an east-facing cliff of shale alternating with small limestone lenses, rising to a height of a hundred feet or so, with occasional ledges on which one can climb. Moist and well-wooded, it forms an excellent habitat for rock ferns and, being partly in a State game preserve, it is little disturbed by man.

In the talus at the base of the cliff we found striking colonies of *Cystopteris fragilis* var. *protrusa*, which pleased Gruber especially, since it is very rare in the county. On the solid rock-ledges for a distance of several feet above the base *C. fragilis* var. *Mackayii* was well developed, along with such common species as *Asplenium platyneuron* and *A. Trichomanes.* Then we started to climb, and noticed that the Brittle Ferns in some of the cool, moist recesses had a different aspect. Inspection of sori with the hand lens showed the ovate-acuminate indusia characteristic of *C. fragilis* var. *genuina,* extending its known range considerably; for it is mostly a plant of the Appalachian uplands, and had not previously been collected southeast of Lycoming and Luzerne counties.

But this was not all. While examining the indusia I was puzzled by a seeming granularity of their surfaces in some plants, so I gathered two or three specimens for examination in the laboratory. When studied under the binocular microscope later, the indusia proved to be beset with definite stalked glands. This is a character of *C. fragilis* var. *laurentiana,*[1] an entity not known south of Nova Scotia. There is, however, considerable difference in size. In describing var. *laurentiana,* Weatherby gives the dimensions as: "Fronds 3.5–4.8 dm. high, their blades 19–34 cm. long, 7–13 cm. broad, only occasionally smaller." The largest frond noted in the Pennsylvania material is 3.2 dm. high, with blade 20 cm. long and 7 cm. broad, and most of them are decidedly smaller. There is, accordingly, some question as to whether the plant under discussion should be assigned to that variety, although the differences are surely not sufficient to justify the creation of a new varietal epithet for it.

On Memorial Day of the following year a group from the Department of Botany of the University of Pennsylvania decided to revisit the locality. Gasoline rationing having meanwhile gone into effect, we planned to go by train and bus, this involving several miles of hiking but

[1] Rhodora **28**: 129. 1926 (mistakenly cited as p. 130 in Broun's Index).

still giving us reasonable time for exploration. Glandular and eglandular plants of the curious form just mentioned were found to be about equally abundant and to occur intermingled, making unlikely the presence of two independent varieties. Then, just as we were about to leave, one of the party, Carroll E. Wood, Jr., found a plant with small but distinct bulblets on the rachises of the fronds. Though definitely not *C. bulbifera,* it nevertheless had two of the characters that go with that species—glandularity and the presence of bulblets.

As Mr. Weatherby was sponsor of two of the named varieties of *Cystopteris fragilis,* specimens were submitted to him for an opinion. He suggested hybridization between the two species, *C. bulbifera* and *C. fragilis.* Although the cliff under study seems like a favorable habitat for *C. bulbifera,* no plants of this species could be found there. It does grow elsewhere in the county, the nearest known station being some 15 miles away; and it may formerly have grown on the Moselem cliff, but have been exterminated there by landslide, competition, or disease. Or this may be just another case to be added to those mentioned by Mr. Wagner,[1] in which the spores from a remote source seemingly started prothallia which gave sperms enough to produce a hybrid, but were unable to devop adults of the incoming species.

UNIVERSITY OF PENNSYLVANIA.

Shorter Notes

OSMUNDA CINNAMOMEA F. CORNUCOPIAEFOLIA.—In 1908 Mr. W. N. Clute[2] described and illustrated under this name a peculiar form of the Cinnamon Fern with the subterminal leaf-tissue lacking and the long protruding midveins tipped by tiny funnel-shaped appendages or

[1] This JOURNAL 33: 71. 1943.
[2] Fern Bull. 16: 107. 1908.

ascidia. The type locality—apparently the only one thus far known—was near Burton, Geauga Co., Ohio.

A new find of this curious form may now be placed on record. In a swamp one-half mile northeast of Chalk Hill, Fayette Co., Pennsylvania, Mr. Frank H. Bell[1] found a single plant of it in June, 1936. He collected a frond and some time later sent it to me for identification; it is now preserved in the herbarium of the Academy of Natural Sciences of Philadelphia. In the hope of rediscovering the plant, Mr. Bell took me to the locality in the summer of 1940. However, in spite of examination of hundreds of clumps of Cinnamon Fern in the swamp, not one showing this or any other abnormality could be found.—EDGAR T. WHERRY, *University of Pennsylvania.*

TWO FERNS NEW TO TRINIDAD.—In October and November of 1943, I was somewhat surprised to find a few small yellowed sterile fronds of Adder's-tongue in the very dry, clayey soil of a mowed grassy field near Xeres Field, a small Army airfield 27 miles SSW. of Port of Spain, Trinidad, B.W.I. For several days of looking in off-hours, however, I could find nothing but these depauperate plants, none of them fertile. When I dug them up I found the remnants of many little fronds that had been stepped on or killed by the drouth. The sterility of the plants was hardly surprising, considering their exposure to the sun and the aridity of the location. Nevertheless, having resolved to discover fertile specimens, I made a very thorough search of this field and nearby fields whenever I got a chance, and finally, where the grass had not been cut by the Hindu workers, I found a number of fertile plants.

The large number of specimens I collected represented two species, which Dr. W. R. Maxon kindly separated for me—*Ophioglossum reticulatum* L. and *O. ellipticum*

[1] At present with the U. S. Armed Forces.

Hook. & Grev. The latter was by far the more generally distributed in the grassy fields, and in the shadier, moister spots where the grass had not recently been cut it was accompanied by *O. reticulatum*. Plants of *O. reticulatum* were often double, while those of *O. ellipticum* were sometimes triple, the fronds of different ages. Most of the fully developed specimens were found after several days of sporadic light precipitation.

In the "Monograph of the Ophioglossaceae" by Robert T. Clausen (1938) *Ophioglossum reticulatum* is cited from British Guiana, Venezuela, and Grenada, so this species might well be expected in Trinidad. This is probably, however, the first valid notice of it from that island. For *O. ellipticum,* Dr. Clausen gives localities in British Guiana, Dutch Guiana, French Guiana, Brazil, and, with a question mark, Bolivia and Panama. This record, then, of *O. ellipticum* is likely the first one from Trinidad, and the first one off the continent of South America.—WARREN HERBERT WAGNER, JR., *Washington, D. C.*

Recent Fern Literature

A new fossil fern which will be of more than passing interest to students of our present flora has been described[1] from material collected in the vicinity of Casper, Wyoming, by members of a U. S. Geological Survey party in 1913. It is *Lygodium pumilum* R. W. Brown, belonging to the group of species having palmately lobed pinnules. Thus the relationship, though not very close, is with living *L. palmatum* of the eastern United States. From this *L. pumilum* differs greatly in its much smaller pinnules (2 cm. broad, or less), which mostly have only four lobes. No other undoubted species of *Lygodium,* it appears, is known from the Cretaceous period in America.—W. R. M.

[1] Brown, Roland W. A Climbing Fern from the Upper Cretaceous of Wyoming. Journ. Washington Acad. Sci. 33: 141–142, *fig. 1–5.* 1943.

Dr. Werner Rothmaler has recently published[1] an extended account of *Dryopteris paleacea,* the common pan-tropic analogue of the Male-fern, *D. Filix-mas,* including description and a detailed discussion of its nomenclature and geographic distribution. The combination *D. paleacea* is usually attributed to C. Christensen (Amer. Fern Journ. **1**: 94. 1911), but the proper authority is Handel-Mazzetti (Verh. Zool. Bot. Ges. Wien **58**: 100. 1908). Because of its wide range this species has been redescribed many times, over two pages of synonyms being listed by Rothmaler. The type came from Peru. The Mexican plants were described as *Aspidium parallelogrammum* and *A. crinitum,* those from Hawaii as *Lastrea truncata* and *Dryopteris fusco-atra,* from the Himalaya as *Aspidium Wallichianum* and *A. patentissimum,* from Europe as *A. distans, A. Blackwellianum, Lastrea pseudo-mas,* and *Dryopteris Borreri,* from Madeira as *Nephrodium affine,* and from the Caucasus as *Dryopteris mediterranea.* Rothmaler states that in spite of this abundant synonymy the species is relatively uniform morphologically throughout its range, and that plants from these various widely separated regions are not separable, even varietally. He gives the principal distinctions from related species, all of which, with the exception of *D. Filix-mas,* are Asiatic. In the Western Hemisphere hybridization between these two species does not take place, because of their distinct ranges, but in Europe numerous hybrids have been found.—C. V. M.

In a recently issued number of the Bulletin of the Vermont Botanical and Bird Clubs,[2] Mr. H. G. Rugg records a bit of observation along the lines suggested in the President's report for last year. On three different occasions he has transplanted to his garden clumps of *Osmunda*

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[1] Rothmaler, Werner. Ueber *Dryopteris paleacea* (Sw.) Hand.-Mazz. Boissiera (Geneva) **7**: 166–181. 1942.

[2] No. 17, pp. 35, 37. Jan. 1944.

cinnamomea forma *incisa;* on all three occasions the fronds lost their incised character in a year. Mr. Rugg asks why. The answer is not easy to give and, as in the case of Mr. Harlow's *Polypodium* (this JOURNAL **33**: 105), it may come from a wholly unexpected quarter. One way to get it might be to observe plants of the incised form growing in the wild for a series of years, see how they behaved and, if they remained constant, try to find out what they had in the wild which they would not have in the garden, which might influence the development of the frond. Anyway, Mr. Rugg has at least shown that this particular form is inconstant when transplanted—though *O. cinnamomea*, forma *auriculata*, remained unchanged when moved to the same garden.

Mr. Rugg also noted that stations for the Male-fern in Vermont have suffered greatly from grazing cattle, though Wood-ferns and Hay-scented Ferns nearby were untouched.—C. A. W.

American Fern Society

The "high cost of living" is felt by the FERN JOURNAL, as it is by members of the Society. The Treasurer asks, therefore, if those in arrears will forward the amount of unpaid dues as soon as possible.

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Hubert Earl Ransier

H. E. Ransier, whose death occurred November 28, 1943, joined the Fern Society in 1902, one of the early band of fern enthusiasts who helped set the pattern of friendly association in fern collecting, exchange of specimens, field trips, and correspondence about these plants. During more than 40 years of membership he continued his lively interest in promoting Fern Society activities. In 1910 he helped launch the FERN JOURNAL.

Photographer and pharmacist in the village of Manlius, eight miles east of Syracuse, N. Y., Mr. Ransier was situated in a region having many fern species of special interest. Hart's-tongue localities were only a few miles distant, and *Botrychium Lunaria*—if *B. onondagense* is not counted a separate species—was found in one of its very few United States stations close to the Hart's-tongue. This is the region of limestone cliffs and gullies east of Jamesville, which comprises such a rich series of botancial and geological manifestations.

An assiduous field worker and collector of variant types in ferns, especially Hart's-tongue and Walking Fern, Ransier extended his fern interest in later years to many parts of the country. He owned one of the early, well-equipped trailers and in this he toured the country with Mrs. Ransier, especially winters, collecting and photographing ferns from the Owen Sound region in Canada, where he went to see the Hart's-tongue stations, to Florida, Cuba, and the Southwest. Postcard photographs would come in from time to time, showing a variety of scenes—a cascade of Maidenhair (*Adiantum Capillus-Veneris*) on an old wall near St. Augustine or a sahuaro cactus (*Carnegiea gigantea*) in Arizona.

Ransier was President of the Fern Society in the first decade of the century. Afterward he served the interests of ferns and fern-study in many unofficial ways. When the soda interests, in the early 1920's had to reach out for more limestone, they found in the Jamesville region plenty of limestone, and also a most convenient natural dumping-receptacle for waste material in the form of one of the natural wonders of New York State—the plunge basin of a glacial-period Niagara, about one mile east of Jamesville. A deep horseshoe-shaped recess in the limestone cliffs, with a small deep lake 300 feet below the top, made an ideal depository into which carloads of waste rock could be dumped. For botanists this meant the destruction of hundreds of Hart's-tongue plants, as well as the general devastation of classically interesting collecting ground for flowering plants as well as ferns.

Ransier and Dr. J. B. Todd, a Syracuse member, joined forces with others to save as much of the Hart's-tongue as possible. Many plants were removed and established in other sites outside the range of industrial progress, and a considerable number also were distributed to members of the Fern Society for naturalization in other sections. The only consolation for naturalists lay otherwise in the fact that the Jamesville region possessed not one glacial plunge basin, but two. The other, a little west of Jamesville, had already been saved as a State preserve, the Clark Reservation. Fortunately, it has its own Hart's-tongue station.—R. C. B.

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American Fern Journal

VOL. 34 OCTOBER–DECEMBER, 1944 No. 4

Some Conspicuous Ferns of Northern South America

OSCAR HAUGHT

The writer has only an amateur's knowledge of botany, but he is blessed with good eyes and has been fortunate enough to have the opportunity to spend several years in Colombia and Ecuador, where pteridophytes are so plentiful and conspicuous that they necessarily attract the attention of any one who is even slightly interested in botany. Such forms as *Dicranopteris, Danaea, Psilotum,* and certain species of *Lycopodium* found here are especially interesting from the viewpoint of paleobotany.

The tropical forest of northern South America or, more especially, of the Magdalena Valley, Colombia, varies greatly in aspect and composition, in accordance with differing conditions of soil and moisture. This statement is, of course, trite; still it may be worth while to emphasize the fact that even with a well-distributed annual rainfall of considerably over 100 inches, by no means *all* the terrain is necessarily covered with swamp and dense rain-forest. Forests on steep hillsides and the crests of sharp ridges, especially where the soil is residual from friable sandstones, show, even with such rainfall, distinct xerophytic features, such as the presence of many thorny small-leaved shrubs, bulbous plants (amaryllids), *Zamia,* and trees of the silk-cotton family (Bombacaceae). But nearly level areas of any considerable size, however well-drained the soil may be, carry dense humid forests, the

[Volume 34, No. 3, of the JOURNAL, pages 69–100, was issued October 10, 1944.]

composition and luxuriance of which depend upon the type and fertility of the soil. A characteristic feature of these forests—one apparently not frequently mentioned in literature—is the superficial position of large roots. These may run along upon the surface of the soil for several meters, disappearing only after they have completely broken up into much smaller roots. It may also be worth mentioning that forest fires are simply impossible in such forests. In fact, it is often difficult to start a fire for cooking without a liberal use of kerosene or of paraffine candles.

Here, as in the Temperate Zone, ferns and their relatives increase in abundance and variety with humidity, though, as will be seen, some occur under pretty arid conditions.

My first view of a tropical lowland forest was in the vicinity of Barranca Bermeja, a river port on the Magdalena, about 400 miles above the mouth of this river and only a few degrees north of the Equator. So far as the pteridophytes are concerned, the most striking feature at the outset was the fact that the Polypodiaceae were by no means so overwhelmingly predominant as they are among this group in our Atlantic States. Filmy-ferns (Hymenophyllaceae) and *Danaea* were very conspicuous everywhere, as were tree-ferns (Cyatheaceae) and *Anemia* on well-drained slopes. The hydropterids *Azolla* and *Marsilea* grow luxuriantly on small lakes (cut-off meanders and ponded water behind natural levees) near the Magdalena. Together with *Ceratopteris,* they sometimes fill these ponds nearly to the exclusion of angiospermous hydrophytes. The only fern family conspicuous in our Eastern States but totally missing here is the Osmundaceae.

The most attractive ferns of these forests are probably the Hymenophyllaceae, of which the larger forms are the most graceful of terrestrial ferns, while the many smaller species cover trunks and branches with thick mats of lacy green leaves. Of course they all dry quickly, but the largest of the local species, *Trichomanes elegans,* a very beautiful terrestrial fern, always turns black in the press. This has the habit of a polypodiaceous fern. The finely dissected fronds, growing in a suberect crown, sometimes reach a height of 80 cm.

Lygodium, such a rarity in the United States, is one of the most common ferns of the Magdalena Valley, where it fills abandoned pastures, besides growing everywhere along the larger streams. Its twining fronds are much larger than those of our Temperate Zone species (*L. palmatum*), for they reach a length of at least 20 feet. Even so, they are small compared to those of a polypodiaceous fern (*Blechnum volubile*), of the same region, which climb to a length of well over 40 feet and must be very nearly the largest of all leaves. Unlike the *Lygodium,* this *Blechnum* (often known also as *Salpichlaena volubilis*) seems to be strictly a forest plant. At least I have never seen it growing in pastures, where the *Lygodium* tends to be a troublesome weed.

High clay banks along streams and landslide scars on hillsides are covered with thick masses of *Dicranopteris* and of a coarse *Lycopodium, L. cernuum.* The *Dicranopteris* also colonizes hillside pastures, where it comes into competition with a variety of our familiar *Pteridium aquilinum.*

Tropical pteridophytes in general seem able to thrive on the poorest of soils. *Lycopodium, Dicranopteris,* and *Pteridium* grow well on red clays, hardly superior to laterite, and tree-ferns form strong colonies—sometimes almost pure stands—on "soil" that is nearly pure quartz sand. In fact, terrestrial ferns and lycopods are not generally conspicuous in areas of rich soil, though a delicate *Selaginella* here carpets moist humus-rich soil and covers decaying logs, much as do mosses in our Temperate Zone forests.

Epiphytic pteridophytes—Polypodiaceae, Hymenophyllaceae, and *Lycopodium*—are common in any wet tropical forest I have seen. The Hymenophyllaceae and *Lycopodium* seem to occur only under such conditions of abundant and nearly permanent moisture, but the polypods, having much better xerophytic adaptations, range through mesophytic forests into decidedly arid "bush." It is interesting to note the gradually increasing adaptations shown by the Polypodiaceae as one passes from rain-forest through intermediate conditions into xerophytic bush. Even in rain-forest the Polypodiaceae tend to grow under less humid conditions than the Hymenophyllaceae—generally well up in the crown of the forest, where light is stronger and evaporation greater—and hence show such adaptive features as coriaceous, fleshy, or densely pubescent leaves, and often a rosette habit resembling that of the bromeliads. Species with elongated climbing stems, which grow near the soil and often become completely epiphytic through the death of the lower part of their stems, do not as a rule possess such adaptations. As we pass into less humid conditions the variety of epiphytes decreases, but the xerophytic adaptations of those remaining become accentuated. Leaves tend to become very tomentose, and the pinnae curl up tightly when dry. Or the plants become decided tropophytes and pass the dry season in a leafless condition. The roots come to resemble those of certain orchids that grow in the same environment—large, open, spongy masses, with numerous negatively geotropic branches. The few terrestrial ferns of such forests include species of *Adiantum* and *Ophioglossum* which remain leafless throughout the dry season.

Even the epiphytic polypods have not been able to adapt themselves to extreme aridity quite so well as have certain bromeliads which grow very well on cacti and rocks in areas of genuine desert. The epiphytic ferns find their limit in savannah country and open thorny bush, where there is a dependable, though perhaps short, rainy season each year.

One of the most interesting of the epiphytes of coastal Ecuador (I have not seen it in Colombia) is *Psilotum nudum*. Here this strange and anachronistic pteridophyte—a "living fossil," if such exists!—grows on the trunks of *tagua* palms (*Phytelephas,* the producer of "vegetable ivory"). The rhizomes grow in the humus that accumulates in the armor of leaf-bases covering the trunks of these palms, while the assimilating shoots project from this armor and sometimes reach a length of 45 cm. May not the unknown Mesozoic ancestors of *Psilotum* have had a similar habitat upon the trunks of the Bennettitales?

In both Colombia and Ecuador, ferns and their relatives reach their greatest beauty and variety not in the lowlands but in moist forests at moderate altitudes—say, between 3,000 and 8,000 feet. Here the Polypodiaceae seem better represented than at lower altitudes, while the true tree-ferns (Cyatheaceae) form splendid stands on steep slopes and, individually, grow much larger than in the lowlands. On account of the usefulness of their trunks for construction purposes, good specimens of many of the tree-ferns are hardly ever seen close to roads. This mid-altitude region is also the favorite home of *Equisetum giganteum,* which grows in thickets 10 to 20 feet high along streams. This plant, occasionally at least, grows at much lower altitudes, even practically at sea-level along some of the streams southeast of Guayaquil.

In southern Ecuador the western front of the Andes is very abrupt, rising from the lowland to elevations of over 10,000 feet in only a few miles. The prevailing winds are from the west; hence this steep mountain face is nearly always covered with fog and mist produced through the expansion and cooling of the rising air. The cool moist climate resulting is almost ideal for tree-ferns, which here grow luxuriantly in open pastures—better, in fact, than they do in the forests of this area. The road from Balzapamba up the mountain front toward Guaranda, which is alleged to be passable for cars, gives a splendid view of this peculiar climatic zone as it climbs from 2,000 feet to past 10,000 in a straight-line distance of probably less than 5 miles.

At higher altitudes pteridophytes of course remain a fairly conspicuous part of the flora up to and in the *páramos* which lie at elevations of, roughly, 11,000 to 14,000 feet. Ferns are especially abundant and varied on the low *páramo* crossed by the car road between the end of the railroad and Cuenca, in southern Ecuador. They are less so on the *páramos* around Quito, presumably on account of the drier climate here. At these altitudes *Equisetum* is represented by one of its smallest species, *E. bogotense,* often only an inch or two high, and sometimes growing in nearly unaltered volcanic cinders. The contrast is sharp indeed between this dwarf and the tall *E. giganteum,* growing in the same region at only slightly lower altitudes.

In somewhat sheltered valleys, a scrubby dwarfed forest of low gnarled trees and shrubs straggles up into the *páramo* zone, as may be seen along the main highway between Quito and Latacunga where it crosses the *páramo* nearly due west to Cotopaxi. Epiphytic polypods abound in this forest everywhere, as do bromeliads and *Peperomia.* In this part of the world, at least some few epiphytes grow wherever there are trees to hold them!

Annotations on West American Ferns—III

Joseph Ewan

The present paper consists of nomenclatural and distributional notes on various species of *Athyrium, Cheilanthes, Dryopteris, Polystichum,* and *Equisetum.* In this and subsequent papers the herbaria consulted will be indicated by the standardized abbreviations of the Index Herbariorum as listed in Chronica Botanica (**5**: 142–150. 1939).[1] For the courtesy of lending material from herbaria under their care I am grateful to Dr. Carl Epling, Dr. Norman H. Giles, Jr., Dr. George Goodman, G. A. Hardy, Dr. William R. Maxon, and Miss Hester Rusk.

Athyrium

Athyrium Filix-femina (L.) Roth. Typical *A. Filix-femina* is of widespread occurrence in the western States, though apparently infrequent. A specimen (*J. W. Eastham* 7789, V), collected among rocks at the edge of Summit Lake, Nakusp, British Columbia, at an altitude of 4,000 feet, agrees very well with a Swedish collection made in August 1883 by Hyltin-Cavallius (COLO), labeled "var. *complicatum,*" a name I have not placed. J. K. Henry's record[2] of *Aspidium oreopteris* from "Shawnigan" was based on *J. R. Anderson* 667 (V), from "near water" on Shawnigan Island, B. C., August 18, 1897, which represents an immature specimen of

[1] Iowa State Agricultural College, including Parry Herbarium (ISC); United States National Herbarium (US); University of California at Los Angeles (LA); University of Colorado, including the author's herbarium (COLO); Victoria Memorial Museum (V); Yale University, including the D. C. Eaton Herbarium (YU).

In addition the herbarium of the American Fern Society, on deposit at the Brooklyn Botanic Garden, is denoted by the abbreviation AFS.

[2] Henry, J. K. Fl. So. Brit. Col. 6. 1915.

Athyrium Filix-femina. This erroneous report is subsequently repeated by F. Kermode.[3]

CHEILANTHES

Cheilanthes viscida Davenp. Coville (1893) reported this species from the Panamint Mountains, Inyo County, California. It is now to be reported from the Argus Mountains of the same county, where it was collected in "crevices in granite cliffs" in Great Falls Canyon on April 6, 1937, by Percy Train (COLO). This collection agrees very well with an authentic sheet from "White Water," 1876, *Parry & Lemmon* 427 (ISC), actually Whitewater Canyon, Riverside County, the type locality. Lemmon in a later distribution of specimens records on an undated printed label its habitat as "bluffs of the White Water River on the Colorado Desert." On March 23, 1929, the author found *C. viscida* growing in deep rock crevices on the shaded side of cliff faces along the floor of the Whitewater Canyon about one mile from its exit from the hills (*Ewan* 658), but the fern was not common at this station.

DRYOPTERIS

Dryopteris arguta (Kaulf.) Watt, Can. Nat. II. **3**: 159. 1868. This is based on *Aspidium argutum* Kaulf. Enum. Fil. 242. 1824, founded on a Chamisso collection in 1816 from the vicinity of San Francisco, most likely taken at the same time as the type of *A. munitum* Kaulf.[4] Type (B) not seen, but several specimens essentially topotypes studied. For synonymy see Broun, Index N. Amer. Ferns 62. 1938.

The specific distinctness of the Coastal Wood-fern from the European *Dryopteris rigida* has been questioned even

[3] Kermode, F. Prelim. Cat. Fl. Vancouv. & Queen Charlotte Isl. 7. 1921.

[4] Cf. Ewan, Amer. Fern Journ. 32: 96, 98. 1942.

as late as 1931.[5] J. D. Hooker and D. C. Eaton, among the earlier pteridologists, placed the Pacific Coast plants with *D. rigida* outright, reducing *Aspidium argutum* Kaulf. to synonymy. Eaton subsequently (1879) considered it a variety, as *Aspidium rigidum* var. *argutum* (Kaulf.) D. C. Eaton, writing still later[6] "it has a larger and broader frond than the European *A. rigidum*, but certainly presents no points of specific distinction; and some of the Oregon specimens collected by Mrs. Summers near the Willamette [sic] River are so nearly typical *rigidum* that they would not be challenged if mixed with European specimens." The collector referred to was Mrs. R. W. [Lucia A.] Summers, wife of an Episcopal clergyman, who, subsequent to an Oregon residence, made notable collections in San Luis Obispo County, California.[7] The collection mentioned is *Summers* 2184 (YU) from "a somewhat open copse beside the Wilhelmina [sic] River, Oregon, 20 miles south of McMinnville, 1878." The locality referred to represents, not the Willamette River, as interpreted by Eaton, which lies in the Willamette Valley, but apparently what is now known as the Yamhill River, on the Polk-Yamhill County line, in the "Northern Coast Mountain Area" of M. E. Peck. There is now a town of Willamina in present southern Yamhill County. This is where *D. arguta* would be expected—not in the Willamette Valley. Apparently a similar collection exists in the Parke, Davis & Co. Herbarium.[8] This Summers collection represents a sun-form of *D. arguta*, and though in general outline of the fronds and in their "pinnae standing obliquely forward" the

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[5] *Filix-mas rigida* var. *americana* (Hook.) Farwell, Amer. Midl. Nat. 12: 256. 1931. Incidentally, this synonym is not listed in Broun's Index.

[6] Eaton, D. C. Ferns No. Amer. 2: 4. 1880.

[7] Jepson, W. L. Madroño 2: 28. 1931.

[8] Cf. Farwell, Amer. Midl. Nat. 12: 256. 1931.

collection does suggest strongly the European *D. rigida,* it is rather an ecad of *D. arguta. Dryopteris rigida* does not occur in North America, so far as I have determined. Observations at Wildcat Canyon, Contra Costa County, California, made by me in 1934 show such narrow fronds of stiff erect habit to be the result of exposure and the influence of poor thin soils (*Ewan* 8644). On the same day, typical *D. arguta* was found in the same general locality in more favorable sites (*Ewan* 8639).

From study of a good series of European specimens the distinctions between the two species may be drawn as follows:

Fronds generally wide (except in rare sun ecads), 10–28 cm. wide, broadly lance-ovate; indusium glabrous or nearly so, sometimes glistening-smooth but not granulose, not inflated over the sporangia, tardily deciduous. Northern Baja California to southern British Columbia, to the west of the coastal ranges (except Stevens County, Washington, and Pinal and Gila counties, Arizona) .... **D. arguta**

Fronds generally narrow, 5–12 cm. wide, lanceolate; indusium appearing granulose with fine glandular puberulence, distended or often inflated about the sporangia, tending to persist after ripening of spores. Europe; Mediterranean Region, east to Afghanistan (*fide* C. Chr.) .... **D. rigida**

The distribution of *D. arguta* in the Pacific Northwest is interesting for its discontinuity. It will be noted that the fern has a large break in its range, so far as reported, passing from Cowlitz County, on the Columbia River, to Vancouver Island without any known in-between Washington stations in what Piper[9] calls the "Vancouver strip." Piper has commented on this distributional phenomenon, citing *Lilaea subulata, Festuca reflexa,* and *Microseris Bigelovii* as a few species having this interrupted range. He suggests that these species may once have occupied the Vancouver strip and have persisted northward only in the relatively drier sites of Puget Sound (Whidby, San Juan, and Vancouver Islands). It

[9] Piper, C. V. Flora of Washington, Contr. U. S. Nat. Herb. **11**: 44. 1906.

remains only to comment that these species are of more southern affinities, occupying more southern xeric habitats, and may have reached these stations following the "retreat" of the coastal Humid Transition forest of this Northwest Coast.

The following forms of *Dryopteris arguta* may be characterized:

Stipes and rachises non-chaffy or with only a few scattered small scales .... a. **D. arguta f. nudata**
Stipes, if not the rachises, chaffy toward base with prominent brown scales, the rachis sparsely to densely chaffy.
  Lower pinnae long (15–18 cm.); lower proximal pinnules 18–25 mm. long .... b. **D. arguta** f. **bella**
  Lower pinnae shorter (mostly 8–12 cm. long); lower proximal pinnules shorter, mostly less than 18 mm. long.
    Rachis cobwebby, as well as chaffy, with fine tangled whitish hairs. Northern Santa Barbara Co., California. c. **D. arguta** f. **flocculosa**
    Rachis simply chaffy, not cobwebby.
      Pinnae variously and irregularly crested, the pinnules forked or laciniate .... d. **D. arguta f. cristata**
      Pinnae neither crested nor forked, plane and regularly lobed.
        Fronds rather stiffly erect, short (25 cm. long or less), narrowly lanceolate. In open situations and poor soils .... e. **D. arguta** (sun-forms)
        Fronds ascending or erect, long (more than 25 cm.), broadly lance–ovate. In dappled shade of woodlands. e. **D. arguta** (typical)

(a) **Dryopteris arguta** forma **nudata** Ewan, f. nov. Filix nana, stipitibus pallidioribus, nudatis, subpaleaceis vel paleis paucissimis atque lineari-subulatis; laminis brevioribus, 25–30 cm. longis, rhachibus subepaleaceis atque stramineis.

Type in the University of Colorado, collected on the Merced River below Yosemite, Mariposa County, California, at an elevation of 3,800 feet, June 14, 1929, by Berry Campbell (No. 755). Additional specimen studied: Yosemite Valley, Mariposa County, alt. 4,000 feet, July 1908, *H. H. Tracy* (AFS).

Noteworthy is the fact that this replaces the typical form of the species in the central Sierra Nevada of California at the same point that *Polystichum munitum* subsp. *nudatum* replaces typical *P. munitum*.[10] So far, collections from this region are too few to show the true limits of this weakly paleaceous form.

(b) **Dryopteris arguta** forma **bella** Ewan, f. nov. Stipitibus sparse paleaceis, minute glandulosis; laminis latioribus (20–30 cm.), planis; pinnis distincte bipinnatis, longioribus, majoribus 15 (vel pinnis sterilibus 18) cm. longis; segmentis pinnatifidis, inferioribus 18–25 mm. longis.

Type in the University of Colorado, collected at Big Wash Canyon, Avalon, Santa Catalina Island, Los Angeles County, California, in shady canyon bottom, May 6, 1932, by F. R. Fosberg (No. 8127).

ADDITIONAL COLLECTIONS:

CALIFORNIA. Los Angeles County: Upper Brush Canyon, Santa Monica Mountains, *Ewan* 3482. Santa Anita Canyon, alt. 2,800 ft., *Ewan* 3530. Little Santa Anita Canyon, alt. 2,700 ft., *Ewan* 1280. Millards Canyon, alt. 3,500 ft., *Ewan* 3489. Wolfskill Fork, San Dimas Canyon, alt. 3,000 ft., *Ewan* 3042. Santa Barbara County: Cold Spring Canyon, Santa Ynez Mountains, alt. 1,800 ft., *Ewan* 5316. Marin County: Vicinity of Tomales Bay, *Ewan* 9375. Placer County: Monumental Creek, alt. 6,000 ft., *E. Flint* 5485 (COLO).

The last specimen comes from a high elevation for this species in any part of its range, especially for the northern Sierra Nevada, where it is rare.

(c) **Dryopteris arguta** forma **flocculosa** Ewan, f. nov. A *D. arguta arguta* rhachibus dense arachnoideis (vel albo-pilosis) et brunneo-paleaceis differt.

Type in the University of Colorado, collected on San Miguelito Creek, 3 miles above Lompoc, Santa Barbara County, California, May 30, 1933, by A. L. Grant, Ruth Ballou, and J. Ewan (No. 7908).

(d) **Dryopteris arguta** forma **cristata** Ewan, f. nov. A *D. arguta arguta* laminis profunde bifurcatis, pinnis

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[10] Cf. Ewan, Amer. Fern Journ. 32: 100. 1942.

irregulariter cristatis, sparse fertilibus, segmentis inaequalibus atque brevioribus differt.

Type in the University of Colorado, collected on Hermit Trail, Santa Anita Canyon, San Gabriel Mountains, Los Angeles, California, at an elevation of 2,800 feet, by J. Ewan (No. 3530a).

(e) **Dryopteris arguta** (Kaulf.) Watt. (typical).
REPRESENTATIVE COLLECTIONS:

BRITISH COLUMBIA. Norman Point, Hornby Island, *Connell* 13644, sparingly soriferous (V). "Victoria," *Anderson*.[11] Mt. Finlayson, V. I.[12]

WASHINGTON. Cowlitz County: On wooded banks near Kelso, *G. N. Jones* 6318 (COLO). Wahkiakum County: Bluffs of the Columbia River, above Cathlamet, *A. S. Foster* 814 (US). Stevens County: Chamokane River.[13]

OREGON. Sauvie's Island, *T. J. Howell*.[14] Washington County: Scoggins Valley, *F. E. Lloyd* 47 (AFS). Douglas County: Roseburg, *Cusick* 3870 (COLO). Yamhill County: "Coast mountains."[15] Coos County: Marshfield.[16] Josephine County: Wolf Creek.[17] "Rocky shady banks of upper Willamette," Lane or Douglas County, *Cusick* 1508 in 1887 (YU).

CALIFORNIA. Contra Costa County: Wildcat Canyon, *Ewan* 8161, 8639. Las Trampas Ridge, *Mason* 1166. Alameda County: Berkeley [Hills], August 1898, *L. F. Kimball* (AFS). San Francisco County: Lake Merced, May 1898, [Miss] *E. Cannon* (AFS). San Mateo County: Between Santa Cruz and Pescadero, alt. 1,000 ft., September 1929, *V. N. Poole* (COLO). Above Sears-

[11] Piper & Beattie, Fl. NW. Coast 7. 1915.

[12] Henry, J. K. Fl. So. Brit. Col. 7. 1915; also F. Kermode, Prelim. Cat. Fl. Vancouv. & Queen Charlotte Isl. 7. 1921. This record needs confirmation, but since such a southern fern as *Pityrogramma triangularis* has also been reported to occur on Mt. Finlayson the occurrence of *D. arguta* there seems altogether probable. Hardy wrote (in litt. May 14, 1942) that no collection so labelled exists in the Provincial Museum, Victoria.

[13] Frye, T. C. Ferns of the Northwest 130. 1934. A transcascadean station.

[14] Piper & Beattie, op. cit. 7.

[15] Farwell, op. cit. 256.

[16] Frye, op. cit.

[17] Frye, op. cit.

ville Lake, alt. 1,000 ft., *Keck* 1361. Santa Cruz County: Santa Cruz Mountains, May 28, 1898, *L. F. Kimball* (AFS). Monterey County: Carmel Road, *Heller* 6821. Upper Arroyo Seco, Santa Lucia Mountains, alt. 3,000 ft., *Ewan* 9348. One mile south of Salmon Creek, *Wiggins* 5744 (AFS). Santa Barbara County: Santa Cruz Island, *Fosberg* 7571.[18] Santa Rosa Island.[19] Los Angeles County: Lookout Mountain, alt. 1,000 ft., *Ewan* 2315. Tuna Canyon, Verdugo Range, alt. 1,300 ft., *F. A. MacFadden* 19E. Pasadena, 1896, *J. E. Campbell* (AFS). Las Flores Canyon, alt. 1,700 ft., *Ewan* 1285. Temescal Canyon, *Ewan* 10824. Higgins Canyon, alt. 1,600 ft., May 22, 1926, *Ewan* s.n. Mandeville Canyon, *Clokey & Templeton* 4539. San Bernardino County: San Bernardino Mountains, alt. 3,000–4,000 ft., January and July, 1904, *R. J. Smith* (AFS). San Diego County: San Miguel Mountain, *L. F. Kimball* (AFS). Jamacha Ranch, *L. F. Kimball* (AFS). Escondido, 1929, *H. E. Ransier* (AFS). Mussey Grade, *Wiggins* 2522 (AFS). Warners Hot Springs.[20]

ARIZONA. Pinal and Gila counties.[21]

BAJA CALIFORNIA. Seaward slopes 2 miles south of "Halfway House," 37 miles south of Tia Juana, *Wiggins & Gillespie* 3908 (US).

Dryopteris Filix-mas (L.) Schott. This species is more widely distributed in British Columbia than the single station reported by J. K. Henry would suggest.[22] It ranges from near the Alaska-British Columbia boundary, at Nass River (on lava beds, *W. B. Anderson* 7580, V), south to Lake Garibaldi (alt. 4,600 ft., *G. A. Hardy* 8176, V), Yale (*W. B. Anderson* 8559, V), and Chilliwack (*W. B. Anderson* 16, V), and southeast along the

[18] Erect, robust plants with close-set fronds.
[19] Brandegee, Proc. Calif. Acad. Sci. II. 1: 218. 1888.
[20] Munz & Johnston, Amer. Fern Journ. 12: 76. 1922.
[21] A member of the "Pacific" floristic group with a discontinuous distribution eastward from the coastal region of California to a floristic island principally in the Pinal and Mazatzal Mountains of Arizona (Kearney & Peebles, Fl. Pl. & Ferns Ariz. 8, 30. 1942).
[22] Fl. So. Brit. Col. 7. 1915.

Selkirk and Gold ranges, at Revelstoke (Henry, l.c. 7), Shuswap (June 15, 1916, *J. A. Munro*, V), and Sandon (*F. A. MacFadden* 823, COLO). These British Columbia collections are fairly uniform, as in general are the many North American specimens studied. Especially striking is this uniformity when Old World collections are reviewed (*e.g.*, material from Germany, England, China, and Japan).

Dryopteris Filix-mas (L.) Schott × **D. oreopteris** (Ehrh.) Maxon, n. hybr. Lamina $3\frac{1}{4}$–$3\frac{1}{3}$-plo longior quam lata, lanceolata, glabra; pinnae inaequaliter acuminatae atque apice subcaudatae, oppositae, membranaceae; lobi triangulares vel subtruncati eis *D. oreopteris* simillimi; indusium parvum, pallidum, membranaceum, leviter glandulosum.

Type in the herbarium of the Victoria Memorial Museum, collected at Alice Arm, British Columbia, July 1934, by Lohbrunner and Nichols (No. 9555). Isotype at the University of Colorado.

This putative hybrid has been transferred to the garden of Mr. Lohbrunner, where it has maintained its distinctive characters of pinnae form and indusia. Although I have seen no material of the parents from Alice Arm, I have examined a sheet of *D. Filix-mas* from a nearby locality, Nass River, taken by W. B. Anderson (No. 7580). G. A. Hardy, Botanist at Provincial Museum, Victoria, writes that the plants were growing in clumps in decidedly boggy ground at or about sea level. Other ferns in the vicinity were *Athyrium Filix-femina*, *Blechnum Spicant*, and *Dryopteris dilatata*, the two latter abundant in this coastal region; there was no sign of *D. Filix-mas* anywhere. Hardy's description of the country where this hybrid comes from (in litt. Nov. 28, 1941) contains some noteworthy points. Of the Nass River, close to the Alaskan boundary, he writes: "The greater and more northern portion flows through rolling plains broken up by slate ridges, the lower part through deep and narrow valleys. It is well timbered to 65 miles from the coast. It has an average [yearly] temperature [range] of from 19° to 65° [F.], with an average precipitation of 78 to 80 inches per annum." Nass River empties into a part of Alice Arm. The fern was re-collected in a meadow west of town, Alice Arm, August 1942, by A. D. York (V, COLO).

As Dr. T. M. C. Taylor, who examined this collection in 1941, comments, this hybrid is near *D. Filix-mas* but of weaker habit, the pinnae now spreading more at right angles to the rachis, in the manner of sterile plants of the eastern *D. Thelypteris* var. *pubescens,* now ascending as is so frequent in the Male-fern. The form of the lobes and the position of the sori approach *D. oreopteris.* I have not seen a sufficient series of *D. oreopteris* from the Old World to determine the North American var. *hesperia* (Slosson) Broun and its distinctness. The variation among North American individuals is certainly very great.

POLYSTICHUM

Polystichum Andersoni Hopkins. This species is credited to southeastern Alaska upon the basis of a specimen (*W. S. Cooper* 50) from Tracy Arm, Sumdum Bay, southeast of Juneau, as reported by Maxon.[23] An interesting addition to our knowledge of its coastal distribution is a collection (*Lohbrunner & Nichols* 9552, V) from Alice Arm, B. C., July 1934. Alice Arm is near the Alaskan boundary. This collection is a single frond, smaller than typical *P. Andersoni.*

Polystichum Braunii var. **Purshii** Fern. × **P. Lonchitis** (L.) Roth, n. hybr. Lamina 4½-plo longior quam lata, sparse paleacea; pinnae eis *P. Braunii* var. *Purshii* simil-

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[23] Amer. Fern Journ. 11: 106. 1921.

limae sed breviores, apice brevi subaequaliter et abrupte acutae; lobi apice subtruncato spinulosi; indusium leviter granulosum glabrumve, ciliolatum, ca. 2 mm. latum, tarde deciduum.

Type in the Victoria Memorial Museum, collected at "Fort Simpson," British Columbia, by W. B. Anderson, without date or number. It is illustrated by one of the two fronds as fig. B of the accompanying plate.

The intended locality must mave been Port Simpson, just north of Prince Rupert, Chatham Sound, near the Alaskan boundary. This sheet is the basis, I believe, of the report of *D. oreopteris,* under the name *Aspidium oreopteris,* from Port Simpson by J. K. Henry.[24] The peltate indusium of the genus *Polystichum* is clearly evident on the type, however. Though I have seen no collections of the parent species from Port Simpson, both are to be expected in that vicinity upon the basis of reports from localities both north and south. The character of the sori being confined to the terminal half of the frond, characteristic of both parents, is well displayed by this putative hybrid.

Polystichum Dudleyi Maxon. This endemic Californian *Polystichum,* which of all our Pacific Coast relatives of the Old World *P. aculeatum* most nearly approaches that species, was reported from San Luis Obispo County, California, by me.[25] Fine examples of it were taken February 23, 1935, at Anderson Canyon, Santa Lucia Mountains, Monterey County, where it was associated with the Canyon Oak (*Quercus chrysolepis*) and a southern relict colony of the Redwood (*Sequoia sempervirens*). This southern material (*Ewan* 9103) is thoroughly comparable with several topotypes from the Santa Cruz Mountains. It is well deserving of garden use.

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[24] Fl. So. Brit. Col. 6. 1915.
[25] Amer. Fern Journ. **24**: 7. 1934.

POLYSTICHUM SPP. AND HYBRID

Polystichum scopulinum (D. C. Eaton) Maxon. Distributional summaries by Maxon[26] and Broun[27] do not record this species as ranging north to British Columbia. J. K. Henry[28] records it from Texada Island. This is an island in Georgia Strait about opposite Comox, between lat. 49° and 50°. Kermode[29] refers to the same record as "Texada Island, *W. B. Anderson.*" I have examined this specimen (*Anderson* 666, August 1897, V), and find it to be a typical single frond, validating the northernmost locality for this species.

Wheeler[30] reports finding *Polystichum scopulinum* growing with *P. Lemmoni* in the Siskiyou Mountains, California. He also comments upon Lemmon's collecting the two Polystichums apparently "at the same time and at apparently the same station." This surmise is borne out by a Lemmon sheet (COLO) which bears a note "Mt. Eddy, n. Sierras, Cal., near Shasta, 6,000 ft., found with *mohrioides,*" referring to what Underwood later named *P. Lemmoni.* Similarly the two ferns occur together on Mt. Stuart, Washington, but again remain distinguishable, as indeed they do in the Siskiyou Mountains, as pointed out by Wheeler. This fact lends support to the recognition of these ferns as distinct species.

EQUISETUM

Equisetum palustre var. **americanum** Victorin, Equis. du Québec 51. *fig. 7.* 121. 1927. Jepson[31] reports *E. palustre* from California as follows, "Wet places, San Mateo Co., only known locality in Cal." I have not determined the basis of this record. In company with

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26 In Abrams, Ill. Fl. Pacif. States 11. 1923.
27 Index No. Amer. Ferns 149. 1938.
28 Fl. So. Brit. Col. 6. 1915.
29 Prelim. Cat. Fl. Vancouv. & Queen Charlotte Isl. 8. 1921.
30 Amer. Fern Journ. 27: 127. 1937.
31 Man. Fl. Pl. Calif. 41. 1923.

Edward Lee the author collected this *Equisetum* on March 24, 1934 (*Ewan* 8698, COLO), at the east end of Lake Merced, San Francisco County, where scattered plants occurred over an entire swale then drying out from extensive drainage operations. Here it was growing in the partial shade of *Rubus parviflorus velutinus*. This collection, except for its stouter habit, agrees well in technical characters with more northern specimens such as *Suksdorf* 11535 from Washington, *Hulbert & Spence* 517 from Idaho, and *J. P. Anderson* 7336 from Alaska.

Equisetum telmateia forma **serotinum** (A.Br.) Luerss. Maurice Broun[32] reports this form from "British Columbia; Eurasia." In my collecting along the Pacific Coast I have especially watched for this interesting form and have detected it but once: 1½ miles west of Bodega, on Bodega Bay Road, Sonoma County, California, May 12, 1935 (*Ewan* 9224, COLO), where it was growing in a gulch of an open hillslope of a coastal mesa.

UNIVERSITY OF COLORADO.

EXPLANATION OF PLATE 9

A, *Polystichum Braunii* var. *Purshii*, from Juneau, Alaska, *J. P. Anderson* 6159; B, *P. Braunii* var. *Purshii* × *P. Lonchitis*, from Port Simpson, B. C., *W. B. Anderson*; C, *P. Lonchitis*, from Tradwell Ditch, Douglas Island, Alaska, *J. P. Anderson* 6416.

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[32] Index No. Amer. Ferns 96. 1938.

A New Isoetes from Ecuador[1]

HENRY K. SVENSON

The difficulties and disappointments which beset the voyage of Chamisso, which I discussed briefly in my recent paper on *Azolla,* are likely to fall upon anyone who explores for plants. The chances of arriving in a certain locality just when the vegetation is in full bloom, unless one is prepared beforehand, are not very great—unless the ever-blooming tropical rain-forest is the place to be visited. When I visited the coast of Ecuador in the early months of 1941, with the help of the John Simon Guggenheim Memorial Foundation, I had been fearful lest the annual expected rainfall of some 4 to 6 inches would not be sufficient to bring out the vegetation in this semidesert region. The 7-year cycle of heavy rains had passed in 1939, with a fall of about 40 inches on the southwest coast, and the next heavy fall was not expected therefore until 1946. It was equally as surprising to the inhabitants of the area as it was to me to receive torrents of rain in late January of 1941. These extended—together with gales and thunder storms, both of which are unusual in the area—to beyond the middle of March. Fifteen inches of rain fell on the southwest point of the coast, and just a few miles inland the precipitation was greatly increased. Much of the countryside was impassable, and all travel along the coast ceased. But in being so restricted I did see the entire transition of a flowering season, much as Richard Spruce saw it at the little town of Chanduy, some 40 miles down the coast from Salinas, in 1864.

Sodiro has already mentioned the great scarcity of ferns in the region of Guayaquil, which lies in the fringe

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[1] **Brooklyn Botanic Garden Contributions, No. 100.**

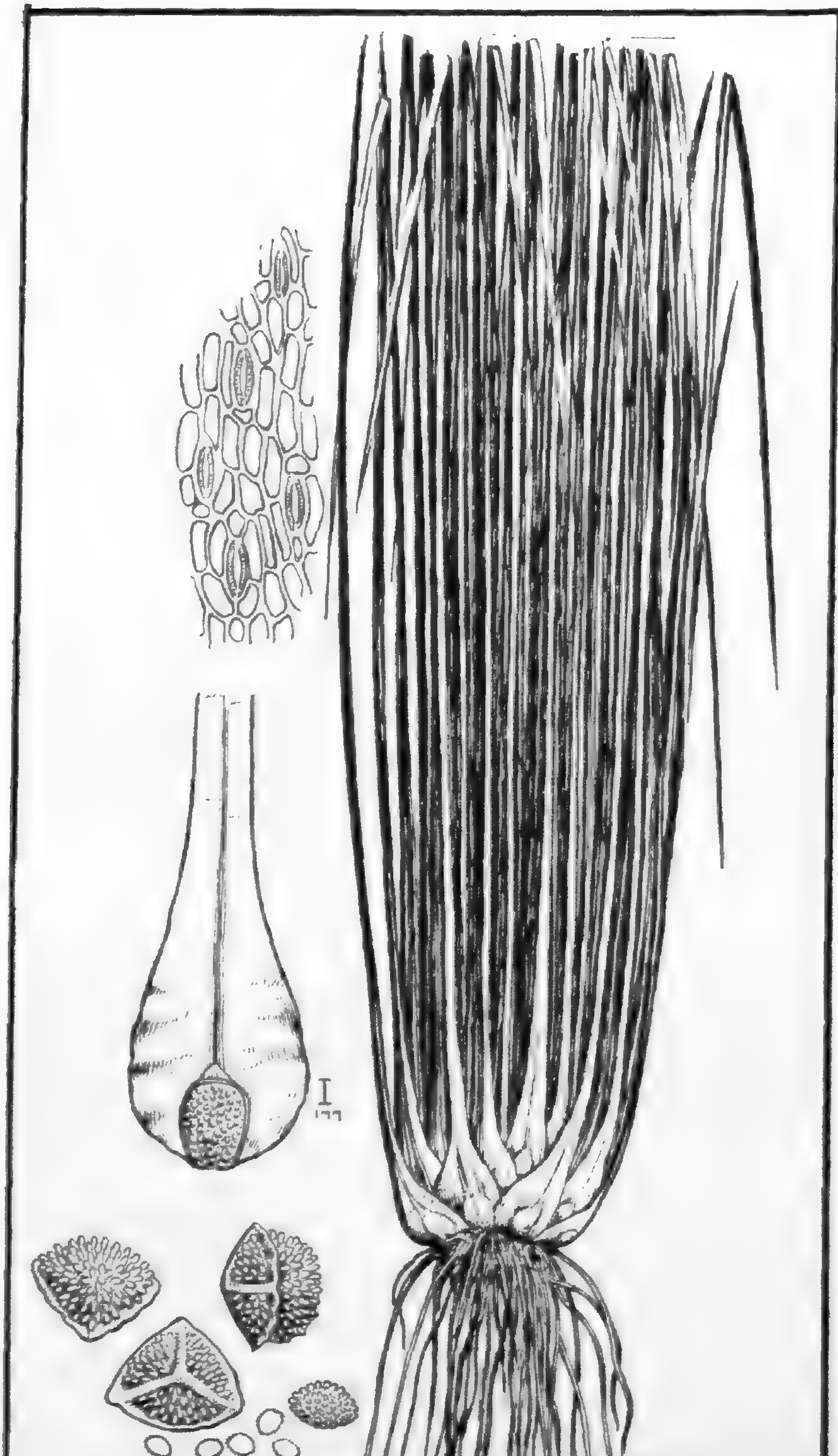
of the same dry area. It was not until I was able to get into Manglaralto, which lies on the coast in an area moistened by cloud condensation against the adjacent hills, that I came across any true ferns, and these were mostly the types found in all tropical plantations. In the dry country the fern allies were few in number but much more interesting, and included a large new species of *Isoetes,* quite different from anything previously found in this part of South America. It is described herewith. At Manglaralto were dense plantations of vegetable-ivory palms, *Carludovica* (the plant from which panama-hat fiber is obtained), bananas, and other tropical fruits; scattered on the ground, or more rarely occurring as epiphytes, were widespread species of ferns, practically all of which I had previously seen in the Galapagos Islands. Here were two species of Maidenhair: *Adiantum concinnum,* with delicate elongate drooping fronds, and *A. tetraphyllum,* with stiff upright pubescent leaves. On tree trunks grew *Asplenium auritum,* one of the most abundant ferns of tropical America, but here obviously under unfavorable conditions, since none of the plants were fruiting. On the ground was an *Asplenium* of the *lunulatum* group which I have not yet definitely identified. *Blechnum occidentale* was common, as might have been expected. Of *Dryopteris,* there were *D. patens, D. Poiteana,* and *D. subtetragona*—all abundant weedy plantation types. Of the relatively few ferns present, the only one of real interest was the epiphytic *Polypodium balaonense,* which is a variant of the widespread *P. lepidopteris* and here was in splendid fruiting condition. Of this species I also found traces on the summit of the Chanduy Hills, and without doubt it is an indigenous species; it is a form with appressed silvery scales and lacks the reddish coloration seen in Galapagos specimens.

The fern allies were also few in number, but of much greater interest than the ferns. In shaded ravines at Manglaralto were *Selaginella Kunzeana* and *S. erythropus* Spring, which Mr. Morton has kindly determined for me. All the seasonal pools in the vicinity of Salinas and Santa Elena were covered by *Marsilea ancylopoda,* which is known only from this general region. At the western base of the Chanduy Hills small pools in the grassland had *Azolla microphylla* floating on the surface, with the general appearance of the species as it is found in the Galapagos Islands. But of more interest in these pools was the *Isoetes*—a plant as large as the familiar *I. Engelmanni* of eastern United States, with leaves often a foot in length. These pools are probably completely dry throughout most of the year, and the *Isoetes* is therefore likely to be found only in the rainy season.

Isoetes pacifica sp. nov. Cormus bilobatus (?). Folia numero 20–60, flexilia, longitudine 12–30 cm., ca. 1 mm. diametro, versus apicem gradatim attenuata, basi membranacea 6 mm. lata, 4 cm. longa, stomatibus et fibris periphericis 6 instructa. Ligula triangularis, basi lata. Sporangia longitudine 6–10 mm., latitudine 4–6 mm. Megasporae albidae, diam. 480 μ, tuberculis elongatis obtusis vel subspinescentibus ornatae. Microsporae subrotundae, 36–40 μ diametro, minute papillosae.

Type (Brooklyn Botanic Garden) from pools east of Chanduy, Ecuador, March 23, 1941, *Svenson* 11002.

A large amphibious plant with the habit and appearance of *I. Engelmanni* of the eastern United States, occupying small pools which are probably dry except in the rainy season, in the grassy flat lands lying about four miles east of Chanduy at the base of the Cerro do Estancia. Growing with it were *Heteranthera limosa, Lemna minima, Echinochloa Crus-Galli* and *E. colonum* —a rather meager assemblage of uninteresting species. It is wholly distinct from any of the South American



Isoetes pacifica Svenson

species treated by Weber (Hedwigia **63**: 219–262. 1922) and the Andean *I. ecuadorensis* Asplund (Bot. Notiser **1925**: 357. 1925); and it does not fit into any of the species treated by Dr. Pfeiffer in her monograph of the Isoetaceae (Ann. Mo. Bot. Gard. **9**: 79–232. 1922). In both monographic accounts cited above, the nearest approach in size of plant and in character of megaspores is *I. Gardneriana* Kunze from Goyaz Province, Brazil, and Paraguay; but in Weber's illustration of that species (fig. 34) the spinescent tubercles are very few and, besides, the microspores are smooth.

I have been unable to find an illustration of the stomata of *Isoetes,* despite the fact that their presence or absence in the leaves is one of the principal guiding points for the taxonomist. A drawing of the stomata as seen under the compound microscope has accordingly been made. Below it is shown a leaf-base with megasporangium, surmounted by a short triangular ligule; and below the leaf-base are megaspores and microspores. One of the latter is greatly enlarged to show the roughened surface.

Another Occurrence of the Apparent Hybrid Cystopteris

WARREN HERBERT WAGNER, JR.

On Memorial Day, 1942, the writer was one of the group which visited Cystopteris Bluff, as recently chronicled by Dr. Wherry.[1] Seeing the *Cystopteris fragilis* with glandular indusia and bulblets led to the recollection of my having found a similar plant at Catoctin Furnace, Frederick County, Maryland, while fern-hunting with David E. Rawlings in 1938. A later visit in company with Neal W. Gilbert having failed to reveal any additional plants, the matter had been dismissed.

[1] This JOURNAL **34**: 92. 1944.

During a furlough on June 26, 1944, I took occasion to revisit the spot. The sumac trees growing in the debris of the old furnace had become rather large and the other vegetation very dense, so that the walls where ferns grow in crevices are now mostly well shaded. On one side of the furnace there were found many typical plants of *C. fragilis* var. *Mackayii*, in company with a few young ones of *C. bulbifera;* and out of reach, higher up the wall, there appeared to be more of both.

On another section of the furnace wall the situation was quite different. Here was seen but a single clump of *C. fragilis* var. *Mackayii;* but all around it were numerous luxuriant clumps of another entity which even on superficial examination appeared wholly distinct. The blades of the larger fronds show a marked tendency to become long and narrow toward the end, as do those of *C. bulbifera;* as in the latter, too, the lowest pinnae tend to elongate, and all pinnae to curve up at the tip, while even the largest are pinnatifid rather than pinnate. On the other hand, a resemblance to *C. fragilis* is seen in the variable cutting and the dark green coloring. Hybridization between the two species certainly seems plausible.

Proliferation is shown by most of the larger fronds on these peculiar plants, but it is rather unusual in character. Along the rachis at the base of the pinnae occur "bulblets" of varying aspect, but never so regular in form as those of normal *C. bulbifera.* They range from large irregular green masses 3 to 4 mm. in diameter, made up of several smaller ones, with colorless scales at the end, to smaller masses of vegetative tissue about 0.5 to 1 mm. in diameter, with some sporogenous tissue intermixed! And the latter extreme may also pass into an enlarged sorus just above a pinna-base.

Another deviation from *C. bulbifera* consists in the rarity of gland-tipped hairs. On examination under the binocular microscope only three of these were seen on one frond by Dr. Maxon and the writer, and subsequent search failed to yield more. Accordingly, it can not be said that the hybrid origin of this material has been conclusively demonstrated. A mere sport of *C. fragilis*, caused by the presence of iron oxides or other compounds in the furnace walls may be represented; and in this connection it is noteworthy that "freak" forms of common ferns are (or were before civilization took a hand) especially abundant on the dumps of an iron mine at Lake Grubb, Lancaster County, Pennsylvania.

The Catoctin locality, not difficult to reach by street car or bus from Frederick, deserves further investigation, and may well repay repeated visits twice a year to see how the plants develop. For those who can study only dried material, it may be placed on record that ample specimens have been deposited in the U. S. National Herbarium, the Gray Herbarium, and the herbarium of the University of Pennsylvania under my number 2000. *C. fragilis* var. *protrusa*, found a quarter of a mile from the furnace in humus-rich soil on a rocky slope, is No. 2001; immature plants of *C. fragilis* var. *Mackayii* are No. 2002, and of *C. bulbifera* No. 2003.

WASHINGTON, D. C.

Recent Fern Literature

Jesse M. Shaver has published[1] a paper entitled "The Filmy and Polypody Ferns in Tennessee," in which four species are discussed in detail: *Trichomanes Petersii*, *Trichomanes Boschianum*, *Polypodium virginianum*, and *Polypodium polypodioides*. Descriptions and excellent

[1] Journ. Tennessee Acad. Sci. **18**: 215–222. 1943; **19**: 167–174. 1944.

line drawings are given for all four, and three are illustrated also by habit photographs. *Trichomanes Petersii* is rare in Tennessee and was not discovered there until 1931; it is known only from Blount County. *Trichomanes Boschianum* is also rare, being known from two localities only, at one of which it has apparently been exterminated. Both species of *Polypodium* are abundant, but *P. virginianum* occurs only in the eastern half of the state.—C. V. M.

A notable addition to our state fern floras has recently appeared, covering Virginia.[1] The bulletin comprises brief discussions of the general distribution of ferns in the state, the structure and biology of ferns, the fern garden, methods of collecting and preserving specimens, and an elaborate check list of species, varieties, and hybrids, with descriptions and full citation of specimens in herbaria, arranged by counties in alphabetical sequence. There is finally a 10-page key and a table of pertinent literature. Illustrations of many of the species are included, some of them previously published elsewhere (such as the splendid line drawings that appeared in the "Pteridophytes of West Virginia," by Brooks and Margolin) but others new, principally halftone illustrations of Virginia occurrences.

Much care has been taken to have the nomenclature accurate and up-to-date, although not every modern "splitter" has been followed; thus, the Beech- and Marsh-fern groups are retained in *Dryopteris,* the Dwarf Chain-fern in *Woodwardia,* and the three autumnal Botrychiums under *B. dissectum.* Carefully selected common names are given for most of the species included.

An interesting addition would have been a list of spe-

[1] Massey, A. B. The Ferns and Fern Allies of Virginia. Bull. Va. Polytechn. Inst. 37, No. 7, pp. 1–110, many figs. 1944.

cies whose type locality is in Virginia, and perhaps another list of those reaching a range-limit in the state. These can be added in a future reissue, which is implied in the text as a possibility. And when preparation of a new edition is undertaken, one hopes that the regrettably numerous misprints will be corrected. One often repeated consists in attributing to R. C. Benedict specimens collected in Loudoun and Rappahannock counties by J. E. Benedict, Jr.; but there are others in personal, geographical and botanical names.—E. T. WHERRY.

American Fern Society

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American Fern Journal

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A New Fern Genus from Mexico and Guatemala

F. Ballard

Onocleopsis F. Ballard, gen. nov.

Genus Polypodiacearum, subfam. Onocleoidearum. Rhizoma crassum. Frondes dimorphae; frondarum sterilium laminae pinnatae, nervis copiose anastomosantibus iis *Onocleae sensibilis* similibus; frondarum fertilium laminae redactae, segmentis ultimis subglobosis soros binos includentibus; sori solitarii, terminales; indusium squamiforme.

Onocleopsis Hintonii F. Ballard, sp. nov.

Rhizoma erectum, crassum, breviter repens vel suberectum; paleae pallide brunneae, concolores, lanceolatae vel anguste lanceolatae, caudato-acuminatae, usque ad 1.5 cm. (vel ultra) longae, 3 mm. latae. Frondes steriles usque ad 1.4 m. longae (usque ad 2.5 m. longae ex sched.); stipites usque ad 33 cm. (vel ultra) longi, straminei vel brunneo-straminei, laeves, basi paleacei; laminae ambitu anguste ellipticae, basin apicemque versus sensim angustatae, pinnatae, apice pinnatifidae; pinnae sessiles, ligulatae vel lanceolatae, apice subcaudato-acuminatae, basi truncatae vel cordatae, marginibus grosse crenatae, crenaturis tenuiter serratis, supra glabrae, subtus secus nervos pilis brevibus pallidis sparse instructae vel glabrescentes, usque ad 20 cm. longae, 3.5 cm. latae; nervi copiose anastomosantes, venulis apice liberis nullis. Frondes fertiles 1.25 m. longae; stipites 50 cm. longi, straminei vel brunneo-straminei, glabri, laeves, basi paleis obtecti; laminae 75 cm. longae, 13 cm. latae, tri-

[Volume 34, No. 4 of the Journal, pages 101–132, was issued November 30, 1944.]

pinnatae, valde redactae; segmenta ultima incurvata subglobosa, soros binos includentia; sori solitarii terminales, apice venulae liberae siti; indusium squamiforme, fugax; sporae ellipsoideae, virides, exosporio minutissime verruculoso praeditae.

Type in the Herbarium of the Royal Botanic Gardens, Kew, collected in a wet barranca at Los Hornos, District of Temascaltepec, State of Mexico, Mexico, at 2,550 meters elevation, February 20, 1933, by George B. Hinton (No. 3297); also in the same locality by G. B. Hinton, February 2, 1935 (No. 7228) and December 25, 1937 (No. 11211). Also represented in the U. S. National Herbarium, Nos. 1,807,817–9, collected in barrancas on the northwestern slopes of Volcán Tajumulco, Dept. San Marcos, Guatemala, at 2,300 to 2,800 meters elevation, February 26, 1940, by Julian A. Steyermark (No. 36733).

The occurrence of a third genus of Onocleoid ferns is of more than usual interest. Its discovery dates from 1933, when a native collector employed by Mr. G. B. Hinton found it in Mexico (*Hinton* 3297). It was growing in water and sand at 2,550 meters altitude in a barranca, "or rather little box cañon," about 3 meters wide. Dried specimens were sent to the Royal Botanic Gardens, Kew; but although the fern was recognized as a novelty, the sterile and fertile fronds were difficult to reconcile, more especially as only the latter were attached to the rhizome. The late C. Christensen, when shown the specimens, also expressed doubts as to the relationship of the fronds. The matter was put at rest, however, when the anatomy of the stipes was examined. Both were found to possess the typical Onocleoid stelar structure as exemplified by *Matteuccia Struthiopteris* (Bower, The Ferns, **3**: 160, *f. 685c*).

In the spring of 1935, Hinton visited the original locality himself but found a total of only seven plants (No. 7228), all in bad condition due to unusually heavy rains. In the following spring he sent the original collector to re-collect the plant, but mining operations had destroyed the habitat and the only two plants remaining were brought away alive. These were eventually sent to Kew, but as they were packed in wet charcoal and were a long time traveling they were quite dead on arrival. All efforts to stimulate the rhizomes to grow were unavailing.

In 1937 Hinton learned that specimens of the fern were still growing in the original habitat and he at once ordered a fresh collection which was made in December of that year (No. 11211).

The discovery that *Onocleopsis* was not confined to Mexico was made as a result of a communication from Dr. Maxon a short time ago, who forwarded portions of a fern collected by Dr. Julian A. Steyermark in Guatemala on the Tajumulco Volcano. These were identical with the Mexican plants and were found growing under similar conditions and at a comparable altitude.

Onocleopsis falls readily into line with its congeners, *Onoclea* and *Matteuccia.* Its leaf-fall is evidently seasonal, while its moist habitat is shared with *Onoclea.* Its areolate venation is identical with that of *Onoclea sensibilis;* its tripinnate fertile frond an advance on *Onoclea* correlated with its much larger size.

The lamina of the fertile frond completely envelops the sori, producing an efficient "false indusium." The true indusium is present, though apparently only as a vestigial organ. In many sori examined it was difficult to find and in no case was it anything more than a small scale. As in *Onoclea,* the spores are not provided with a perispore.

The extension of this small subfamily so far to the south is but another indication of its presumed antiquity.

ROYAL BOTANIC GARDENS,
KEW, SURREY, ENGLAND.

Fern Hunt in Puerto Rico

Warren Herbert Wagner, Jr.

If you are an "*Oh My!* botanist" like me, you would get ready to say "Oh, my!" when you saw the ferns growing on El Yunque Mountain. But nothing would come out: You would probably be dumbfounded, as I was. For nine years I have jumped ditches, slipped off rocks, and hopped from hummock to hummock in swamps, hunting for "rare and locals" among the ferns of the Northeastern States. But to stand in the dense woods of the Caribbean National Forest on the slopes of El Yunque and see for the first time tree trunks draped with weird tropical ferns, the ground covered with *Selaginella,* and stream banks lined with tree-ferns is a thrill not soon to be forgotten.

As you fly northward along the eastern edge of the 90 by 35-mile island of Puerto Rico, you can see the ground rising a few miles inland to a series of peaks, some of them over 3,000 feet high. Almost invariably the tops are covered with haze or clouds caused by moist Atlantic air coming in with the prevailing easterlies and condensing as it is pushed up the slopes. You see from the air the dark gray-green of heavy woods growing from the tops of the mountains to deep down in the valleys of this range, called the Luquillo Mountains. I had heard of many ferns having been collected on El Yunque and Mount Britton, and I eagerly awaited a chance to go there.

Many men in the Service have carried their interests with them, as I have, to their stations of duty. The possession of a hobby that can be pursued in off moments to break the monotony of the war job is a gift to those who have it, and natural history as a diversion is excellent in this war that takes men into strange lands all over the globe. In Cuba I met another flier who had made a fine collection of snails in his spare time. My own study of ferns kept me entertained in places that would offer nothing to a Service man not interested in nature. When I learned that the Navy would sponsor an outing to El Yunque, I jumped at the chance to go.

From the bus loaded with sailors and officers, even before we had left the city of San Juan I could see the

The road, half-way up El Yunque. Here, along the road banks, *Ophioglossum reticulatum*, *Lycopodium reflexum*, and *Dicranopteris bifida* are common.

Luquillo Mountains. I feared that it might rain on El Yunque, as it very often does. But when we arrived at the top of the steep, tortuous road to the Caribbean National Forest, I could see that the weather would be clear. To collect specimens I had provided myself with three paper bags. On the return trip they were bulging with tropical ferns—more than 80 species.

As soon as the bus stopped at the El Yunque parking

A Group of Cyathea arborea

space, without further ado I set out to see the flora. My only disappointment was that there had been introductions along the road of such plants as the varicolored *Coleus* of the greenhouse, *Hibiscus,* and pot ferns. Some of the *Coleus* and ferns had got a good start and spoiled the otherwise perfect appearance of the original rain-forest. Though it had not rained, everything was damp. The humidity was like that of a greenhouse, but it was very cool. The first fern I examined was one I had seen on the way up the mountain, growing along the road in fairly open spots, sometimes alone. This, a common tree-fern, *Cyathea arborea,* grew 20 feet tall along the stream that I chose for my first jaunt on the mountain. Plate 1 shows this species in another part of the island.

As I went along the ravine I noticed that a good part of the ferns grew on the trunks of palms and other trees, and that in some places, especially in the crotches of large hardwoods, there were regular gardens of bromeliads and ferns. Here might be several species of *Elaphoglossum,* a genus that in this season (March to May) has the maddening habit of almost never producing fertile fronds. Numerous species of spleenwort and *Polypodium* grew in these places, as well as a profusion of Lycopodiums, almost all of which were pendent. One of these, *L. funiforme,* looked exactly like so much green rope hanging from the crotch of a tree. In addition to these epiphytic genera, I found *Cheiroglossa, Hymenodium, Rhipidopteris, Anetium, Vittaria, Paltonium, Cochlidium, Polybotrya, Oleandra, Nephrolepis, Trichomanes,* and *Hymenophyllum.* Most of these I didn't know or recognize at the time, but I keyed them out in "The Pteridophyta of Porto Rico" by William R. Maxon and was frankly surprised to find how simple it was to identify so many fern strangers to the genus and species.

When you collect in a tropical rain-forest you have to learn to keep your line of sight directed up as well as down, or you'll miss a lot of things. If you look on the ground and the banks of the cold, sparkling mountain streams, you get an entirely different set of plants. Here are such genera as *Ophioglossum* (in exposed gravelly spots), *Danaea, Dicranopteris, Cyathea, Hemitelia, Doryopteris, Anisosorus, Pteridium, Pteris, Hemionitis, Diplazium, Hemidictyum,* more *Asplenium, Struthiopteris, Fadyenia, Polystichum, Dryopteris, Tectaria, Lindsaea,* more *Trichomanes* and *Hymenophyllum,* and *Selaginella;* some around rocks, some in wetter, some in drier places—each with its own preference. The juvenile plants of *Danaea elliptica* growing on the wet ground among roots and rocks were beautifully iridescent, different fronds having bluish, purplish, or vivid greenish colors.

Sometimes it was hard to tell whether a plant belonged to the epiphytic or terrestrial class. *Anetium citrifolium* on El Yunque can be found either on low wet rocks or on tree trunks, while *Struthiopteris polypodioides* grows from ground level to 8 or 10 feet high on the trunk of a tree. The strange, large, oval-leafed plants of *Hymenodium crinitum* are mostly half-hearted epiphytes that rarely perch more than five feet from the ground, most of those that I saw being in fact right at the ground level at the base of large trees.

Altogether, on this trip and another, I got 115 different species on the slopes of El Yunque, and these in an area of perhaps six square miles. There were many that I missed, such as *Psilogramme portoricensis,* which is an endemic at the top of El Yunque, but I considered my series the spoils of a red-letter day. After I keyed the species, I pressed them in ordinary newspapers by putting them between the mattress and the springs of my bed. I had tried this before on another island of the Caribbean and found it to be a fine method. That time there was a Lieutenant somewhat heavier than myself who submitted to sleeping on my finds—glad, he said, to make some contribution to science.

I had one specimen which was very tough, so I put it *under the rug* in the hope that people walking on it might flatten the leaf-tissue out. The next day I was surprised to find it gone. When I asked about it, the native Puerto Rican who cleaned up the room said he had thrown it away. He then solemnly assured me that it couldn't have grown there anyway. "This *Americano,*" he must have been thinking, "is ready for an asylum."

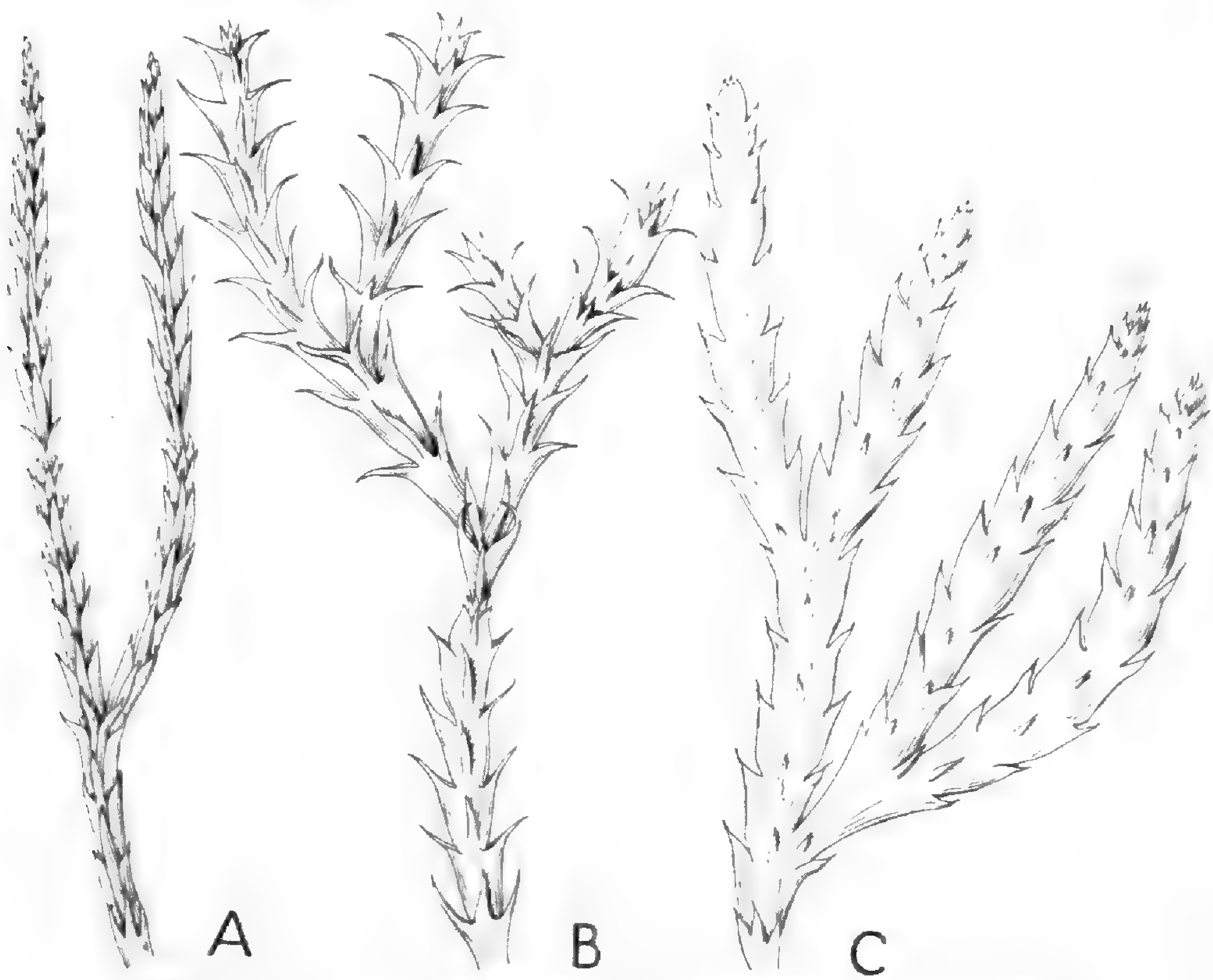
A trip to El Yunque is an experience that a fern student used to the Northeastern States can hardly forget. This spot, so easily gotten to from San Juan, offers what amounts to an education in tropical ferns to those who can get there for a hike. I'm grateful for my chance to see this rich fern flora.

WASHINGTON, D. C.

Hybrids of the Eastern North American Subspecies of Lycopodium complanatum and L. tristachyum

ROBERT T. CLAUSEN

When Wiegand and Eames prepared their edition of the "Flora of the Cayuga Lake Basin" (Memoir 92 of the Cornell University Agricultural Experiment Station, 1926), they had before them a collection of a puzzling *Lycopodium* from rich woods on the east bank of Duck Lake, Cayuga County, New York. This was the collection of Eames, Griscom, Metcalf, and Wright, no. 5444. In the "Flora" it was listed under "*L. complanatum* var. *flabelliforme,*" but said to resemble typical *L. complanatum,* though possibly only a shade form. Outstanding features of the specimens comprising this collection are the lax habit, the type of growth by elongation of the branchlets, the spreading tips of the lateral leaves, the elongate narrow ventral leaves, and the subterranean rhizomes. In all these respects the plants under discussion differ from typical "var. *flabelliforme.*" The only detail of resemblance with that variety is the flattened condition of the lateral stems, but even these are narrower.



Portions of stems and leaves of *Lycopodium tristachyum* (A), *L. complanatum* subsp. *flabelliforme* × *L. tristachyum* (B), and *L. complanatum* subsp. *flabelliforme* (C). Drawings by E. M. Abbe.

On March 26, 1944, while walking in woods on the east slope of the northernmost of the Caroline Pinnacles, in Tompkins County, New York, and in the drainage area of Cayuga Lake, I noticed a few small colonies of a *Lycopodium* which seemed at once distinctive because of the spreading habit of the lateral leaves and the subterranean rhizomes. Clearly this could not be typical "*L. com-*

planatum var. *flabelliforme.*" Close inspection revealed that the ventral leaves, instead of being deltoid-attenuate as in "var. *flabelliforme,*" are linear-subulate. Also the lateral branchlets exhibit annual constrictions, showing that growth has proceeded by elongation of these stems. As my walk continued, I saw hundreds of plants of "var. *flabelliforme,*" often in great patches, also some *L. obscurum* and one plant of *L. lucidulum.* The peculiar club-moss was none of these, nor did it seem to be *L. tristachyum,* which is usually glaucous and with appressed leaves. Trying to account for the strange plant, I must admit that I entertained the thought that it might be a hybrid of "*L. complanatum* var. *flabelliforme*" and *L. obscurum* or perhaps a peculiar variation of *L. sabinaefolium.*

Study of specimens in the herbarium of Cornell University revealed that the collection from Duck Lake and the plants from Caroline Pinnacles are good matches for each other. Also there are similar specimens from other localities in New York, North Carolina, Michigan, and Wisconsin. The perplexing nature of these is suggested by the names on their labels. Though essentially similar, they have been identified variously as "*Lycopodium complanatum,*" "*L. complanatum* var. *flabelliforme,*" and "*L. tristachyum.*" Yet they are not exactly the same as any of these. Actually they combine the characteristics of "*L. complanatum* var. *flabelliforme*" and *L. tristachyum.* Here was a puzzle which required solution. Two explanations appeared possible: Either the plants constituted a distinct variety associated with one or the other of the two species common in eastern North America or they were hybrids.

The strange specimens are not Dr. House's *Lycopodium Habereri,* described originally from rich soil in the shade of hemlocks on the town line between Hartford and Kirkland, Oneida County, New York, *J. V. Haberer*

Lycopodiums from slope near headwaters of Six Mile Creek, Dryden Tp., Tompkins Co., N. Y. Left—*L. tristachyum*; center—*L. complanatum* subsp. *flabelliforme* × *L. tristachyum*; right—*L. complanatum* subsp. *flabelliforme*. Photograph by W. R. Fisher.

no. 3022. An isotype of this, available in the Cornell herbarium, has the aspect of "*L. complanatum* var. *flabelliforme*," but some of the lateral branchlets are indeterminate and a few of the lateral leaves have spreading tips. Dr. House[1] originally described the lateral leaves of *L. Habereri* as with spreading tips. In this respect and in the condition of the lateral branchlets, the Caroline plants and *L. Habereri* are similar. In other details there is disagreement. *L. Habereri* has very small, almost obsolete, ventral leaves, whereas those of the Caroline specimens are well developed, 2 mm. long, and subulate as in *L. tristachyum.* Also, the Caroline plants are more lax, with a higher percentage of the branchlets indeterminate.

Frère Marie-Victorin[2] reduced *L. Habereri* to varietal status under *L. tristachyum.* He concluded that it has more characteristics in common with *L. tristachyum* than with "*L. complanatum* var. *flabelliforme.*" Yet, specimens from the type collection of *L. Habereri* are nearer to "var. *flabelliforme.*" A series of ten specimens in the United States National Herbarium, all representing Haberer's no. 3022, the type collection of *L. Habereri,* are very similar to "*L. complanatum* var. *flabelliforme*" with only a few branchlets indeterminate. The lateral leaves are mostly as in "var. *flabelliforme.*" The type specimen itself, preserved in the New York State Museum at Albany, likewise resembles "var. *flabelliforme,*" differing only in the tendency for a few of the branchlets to be indeterminate. A plant of this type is illustrated in Tryon *et al.,* Ferns and Fern Allies of Wisconsin, p. 143. Since Marie-Victorin had referred *L. Habereri* to varietal status under *L. tristachyum,* whereas my identification would place it with "var. *flabelliforme,*" I suspected that he too might have the strange plant which I had found on

[1] **Bull. N. Y. State Museum 176: 36. 1915.**
[2] **Contr. Lab. Bot. Univ. Mont. 3: 51–55. 1925.**

the slope of the Caroline Pinnacles. Study of 32 specimens of "*L. tristachyum* var. *Habereri*" in the herbarium of the Institut Botanique in Montreal revealed that six are similar to the *Lycopodium* from Caroline Pinnacles, 23 are typical *L. tristachyum,* one is typical *L. complanatum,* one is "*L. complanatum* var. *flabelliforme,*" and one is a mixture of *L. tristachyum* and "*L. complanatum* var. *flabelliforme.*" The single specimen of "*L. complanatum* var. *flabelliforme*" is the only one which matches Dr. House's type of *L. Habereri,* for a few of its branchlets are indeterminate.

Further trips in the Cayuga Lake Basin resulted in the discovery of more plants like the ones on Caroline Pinnacles. Between April 1 and July 1, 1944, I found additional specimens at four different localities. In all cases the plants had subterranean rhizomes, spreading lateral leaves, and indeterminate branchlets. No remains of old strobili were evident on any of the plants. The specimens appeared to be mature and well established. They cannot be explained as juvenile forms. Rather they seem intermediate between *L. tristachyum* and "*L. complanatum* var. *flabelliforme.*" The hybrid hypothesis was considered by Marie-Victorin, but he inclined to think that his specimens were more like *L. tristachyum* than "*L. flabelliforme,*" a conclusion understandable after study of the specimens in the herbarium at Montreal.

On July 1, 1944, while collecting in the hills near the headwaters of Six Mile Creek, in Dryden Township, Tompkins County, New York, I found "*L. complanatum* var. *flabelliforme,*" *L. tristachyum,* and intermediate plants all growing in close association. None of the intermediate plants had young strobili, though the "var. *flabelliforme*" and *L. tristachyum* both had them. The branchlets were mostly indeterminate, but a few were determinate. The growth of the indeterminate branchlets appeared less than in *L. tristachyum.* These intermediate plants were thriving in an open exposed situation in the cut of a power-line which was constructed several years ago. They had the appearance of being hybrids of "*L. complanatum* var. *flabelliforme*" and *L. tristachyum.* Such hybrids are nothing new to report. Darling[3] wrote about plants of this type at Hartland, Vermont and Winslow[4] reported similar ones in Berkshire County, Massachusetts. In Europe, Lindquist[5] described as "*L. complanatum* var. *intermedium*" plants which he considered to be hybrids of typical *L. complanatum* and *L. tristachyum.* The specimens which he illustrated appear more like *L. tristachyum* than a hybrid, however. Porsild[6] already has discussed Lindquist's publication and expressed doubt regarding the hybrid nature of his plants.

The relationships of typical *Lycopodium complanatum* and Professor Fernald's "var. *flabelliforme*" require further discussion. Blanchard[7] elevated "var. *flabelliforme*" to the rank of a full species in 1911. In doing this he indicated the distinctive characteristics of "*L. flabelliforme*"—the determinate branchlets, the fanlike appearance of the branches when pressed, the four or five strobiles, the long peduncles (about 7 cm. long), and the superficial rhizomes. According to him, *L. complanatum* is to be distinguished by its indeterminate branchlets, its branches not appearing fanlike when pressed, one to three strobiles, shorter peduncles (3–5 cm. long), and underground rootstocks. Several recent botanists have shared Blanchard's views, among them Marie-Victorin and Wherry. Certainly, extreme plants of the two kinds

[3] AMER. FERN JOURN. 2: 49–53. 1912.
[4] AMER. FERN JOURN. 3: 14–15. 1913.
[5] Bot. Notiser **1929**: 89–98.
[6] Medd. om Grønl. **93**: 9–10. 1935.
[7] Rhodora **13**: 168–171.

are readily distinguishable, but not all are extreme. Before me is a suite of nine specimens from localities in Newfoundland, New Brunswick, northern Maine, northern New York, Michigan, and Minnesota. All are intermediate in the characteristics just cited for separating the supposed species. If we use the indeterminate branchlets as the sole criterion, all are typical *L. complanatum;* but already we have noted that *L. Habereri*, which in other details is typical "var. *flabelliforme*," has some branchlets indeterminate. Of the nine intermediates, five have four or more strobili, two have the peduncles 7 cm. long or more, two have superficial rootstocks, five have the branches somewhat fanlike, but all have the branchlets indeterminate. Study of thousands of plants of "*L. flabelliforme*" on the Glaciated Allegheny Plateau reveals that the branchlets are almost always determinate. Less than half of one per cent of the branchlets are indeterminate. The strobili, however, may be as few as two and the peduncles as short as 3.5 cm. The rootstocks are usually on the surface. In the condition of the branchlets and rootstocks, the population of the Glaciated Allegheny Plateau, in fact of the entire Appalachian Highlands south of New England, is reasonably constant. Also the tendencies for the strobili to be four or more on a peduncle and for the peduncles to be 6 or more centimeters long are marked. Yet in the northern part of the New England geographical province, in the Adirondack Mountains, and in the northern part of the Central Lowland, transitional specimens occur. Whereas the hybrids of *L. tristachyum* and "*L. flabelliforme*" rarely produce strobili, the transitional specimens between *L. complanatum* and "*L. flabelliforme*" produce strobili as commonly as do typical plants of either supposed species. Apparently there is no genetical incompatibility between *L. complanatum* and "*L. flabelliforme*," whereas there is some incompatibility between

"*L. flabelliforme*" and *L. tristachyum*. This refutes Blanchard's idea that "*L. flabelliforme*" is as distinct from *L. complanatum* as is *L. tristachyum*. Yet "*L. flabelliforme*" and *L. complanatum* do differ from each other in a tangible way. The differences are greater than those which are usually employed for separating varieties. They are clearly of as great importance as those between *Botrychium lanceolatum* subsp. *typicum* and subsp. *angustisegmentum*. Professor Fernald, in handling these rather similar cases, has treated the eastern American *Botrychium* as a species, but the *Lycopodium* as a variety. The evidence suggests that both ought to be treated similarly. Accordingly, the following new combinations are necessary:

Lycopodium complanatum L. subsp. **complanatum** (L.) Clausen, stat. nov. Based on *L. complanatum* L. Sp. Pl. **2**: 1104. 1753.

Lycopodium complanatum L. subsp. **flabelliforme** (Fernald) Clausen, stat. nov. Based on *Lycopodium complanatum* var. *flabelliforme* Fernald, Rhodora **3**: 280. 1901. Synonyms are *L. flabelliforme* (Fernald) Blanchard, Rhodora **13**: 168. 1911; *L. Habereri* House, Bull. N. Y. State Mus. **176**: 36. 1915; and *L. tristachyum* var. *Habereri* (House) Vict., Contr. Lab. Bot. Univ. Montreal **3**: 51. 1925.

The subspecies *complanatum* is the only variation of the species present in the western part of North America. In the East it occurs in the Laurentian Upland, in the northern part of the New England geographical province (including the maritime provinces of Canada and northern Maine, New Hampshire and Vermont), and the Tug Hill portion of the Appalachian Plateau (near Parkers, Lewis Co., N. Y.); also in the extreme northern part of the central lowland in Wisconsin.[8] Intergrading specimens between subsp. *complanatum* and subsp. *flabelli-*

[8] Tryon *et al.*, Ferns and Fern Allies of Wisconsin, p. 141.

	Lycopodium complanatum subsp. complanatum	Lycopodium complanatum subsp. flabelliforme	Lycopodium complanatum subsp. flabelliforme × L. tristachyum	Lycopodium tristachyum
Rootstock	Subterranean	Superficial	Mostly subterranean	Subterranean
Branches	Irregular, ascending	Regularly fan-shaped, horizontally spreading	Spreading irregularly, some horizontally, others ascending	Fastigiate, ascending
Growth of branchlets	Indeterminate	99.5 per cent determinate	Mostly indeterminate	Indeterminate
Width of branchlets	1.5–2.5 mm.	2–3 mm.	1–2 mm.	1–1.5 mm.
Color of leaves	Dull green, not lustrous	Bright green, lustrous	Green, more or less lustrous	Glaucous, blue-green
Lateral leaves	Appressed or somewhat spreading	Appressed or somewhat spreading	Spreading	Mostly appressed
Ventral leaves	Deltoid-attenuate, 0.5–1 mm. long	Deltoid-attenuate, 0.5–1 mm. long	Linear-subulate, 1.2–3 mm. long	Subulate, 1–3 mm. long
Length of peduncles	1–6 cm.	3.5–11 cm.	4–8 cm.	3–9 cm.
Number of strobili	1–5, usually 3 or fewer	2 to many, averaging about 4	Usually none; when present, 3 or 4	1–6

forme are found in the New England Province, the Adirondack Mountains, and the northern portion of the Central Lowland, all areas in the periphery of the ranges of the two subspecies. The subspecies *flabelliforme* is distributed throughout the Appalachian Highlands, except in the northern part of the New England Province, and in the northern sections of the Central Lowland and Interior Low Plateaus. Tryon *et al.*[9] also report it from northern Wisconsin, which is in the extreme southwestern part of the Laurentian Upland. Hybrids of *Lycopodium complanatum* subsp. *flabelliforme* and *Lycopodium tristachyum* occur occasionally in places where the two species grow together. These plants usually do not produce strobili. They are darker green than *L. tristachyum,* the rootstocks are subterranean, the branchlets are mostly indeterminate, the lateral leaves of the branchlets have spreading tips, and the ventral leaves are linear-subulate, 1.2–3 mm. long, intermediate between the condition in the two supposed parents. Experimental evidence supporting this hybridization hypothesis is lacking, but observational data suggest this explanation. Besides the published records of Darling from Hartland, Vt., and Winslow from Berkshire Co., Mass., specimens appearing like hybrids of *L. complanatum* subsp. *flabelliforme* and *L. tristachyum* are available as follows:

Bois élevés à la Grosse-Isle, 40 miles au-dessous de Québec, Aug. 28, 1922, *Marie-Victorin 15179* (Mont.); Saint-Jean-de-Matha, Co. de Joliette, Que., July 8, 1934, *Gauthier 2340* (Mont.); Contrecoeur, Co. de Vercheres, Que, Aug. 5, 1932, *David* (Mont.); Bois de Filion, Co. de Terrebonne, Que., Sept. 5, 1928, *Marie-Victorin 28240* (Mont.); Pinière des Sulpiciens, Oka, Co. des Deux-Montagnes, Que., Aug. 24, 1927, *Louis-Marie 29598* (Mont.); Rigaud, Co. de Vaudreuil, Que., July 15, 1934, *Robert 1171* (Mont.); sandy woods northwest of Tripoli,

[9] Ferns and Fern Allies of Wisconsin, p. 141–142.

southern West Fort Ann, Washington Co., N. Y., May 2, 1915, *Burnham* (CU); pine woods, Moreau, Saratoga Co., N. Y., Aug. 30, 1902, *Burnham* (CU); rich woods on east bank of Duck Lake, Cayuga Co., N. Y., June 10, 1916, *Eames, Griscom, Metcalf and Wright 5444* (CU); upper slope of Cornell woodlot, Carter Creek, town of Newfield, Tompkins Co., N. Y., Aug. 22, 1942, *Muenscher 20485* (CU); east slope of North Pinnacle, Caroline Township, Tompkins Co., N. Y., Mar. 26, 1944, *Clausen 6256* (CU); slope along tributary of Six Mile Creek 5 km. south of Dryden, Tompkins Co., N. Y., April 2, 1944, *Clausen 6258;* slope north of Thatcher's Pinnacles, West Danby, Tompkins Co., N. Y., April 16, 1944, *Clausen and Schuster 6260* (CU); Michigan Hollow, Tompkins Co.; N. Y., April 16, 1944, *Clausen and Schuster* (no specimen preserved); power-line cut on slope just west of meadow in which Six Mile Creek has its source, Dryden Tp., Tompkins Co., N. Y., July 1, 1944, *Clausen 6345* (CU); Black Point, Canandaigua Lake, Ontario Co., N. Y., Sept. 18, 1913, *Gardner* (CU); Gainesville, Wyoming Co., N. Y., July 13, 1870, *Jordan* (CU); Cary, Wake Co., N. C., June 8, 1922, *Wright, Wright, Harper and Pirnie 18* (CU); Mount Mitchell, Yancy Co., N. C., May 3, 1933, *Randolph* (CU); oak wood northeast of Sugarloaf Lake, Kalamazoo Co., Mich., June 30, 1935, *Hanes 3775* (Clausen); and Camp Douglas, Wisconsin, July 25, 1890, *Mearns 2* (CU).

The differences between the subspecies of *Lycopodium complanatum, L. tristachyum,* and the hybrids of the two species may finally be summarized as in the accompanying table.

For the loan of specimens used in the preparation of this paper I desire to express my appreciation to the curators of the following herbaria: Institut Botanique, Université de Montréal, New York State Museum, and United States National Herbarium.

CORNELL UNIVERSITY

New Tropical American Ferns—XV[1]

William R. Maxon

100434

Herewith are descriptions of two new ferns of the genera *Oleandra* and *Dennstaedtia,* from the Andes of Colombia. The latter, whose pinnae somewhat resemble those of *Saccoloma elegans* Kaulf., is outstanding.

Oleandra dura Maxon, sp. nov.

Rhizoma erectum, lignosum, 1 m. altum et ultra, subcomplanatum, ca. 5 mm. latum, parte inferiore modice ramosum, dense adpresso-paleaceum, paleis imbricatis, lanceolato-subulatis, ca. 5 mm. longis, castaneis, paululo infra medium puncto affixis, laxe et tenuiter albido-ciliatis; phyllopodia 10–15 mm. inter se remota, obliqua, ca. 2 mm. longa; stipites graciles (1 mm. diam.), 7–20 mm. longi, olivacei, basi paleis castaneis curvatis ca. 2 mm. longis paucis primum praediti; laminae subcoriaceae vel rigide pergamentaceae, olivaceae, subglabrae, pleraeque 15–25 cm. longae, 2–3 cm. latae, lineares, deorsum in basin cuneatam subabrupte inequalateralem angustatae, apice longe acuminatae et caudatae, acumine ipso usque ad 3 cm. longo; costa elevata, infra sub lente minutissime puberula et deorsum parce paleacea, paleis divaricatis, e basi subhastata subulatis, ca. 2 mm. longis, castaneis, denticulato-ciliatis; venae pleraeque prope basin furcatae vel bifurcatae, ramis prope marginem callosam 23–30 per cm.; sori mediocres, indusiis orbicularibus, 1 mm. diam., parce pubescentibus et ciliolatis.

Type in the U. S. National Herbarium, no. 1,662,606, collected at summit of Cerro Umir, Department of Santander, Colombia, altitude about 1000 meters, August 11, 1934, by Oscar Haught (no. 1329). A single additional collection from Colombia is at hand: Near Villavicencio, Intendencia de Meta, June 1916, *Dawe* 254.

Oleandra dura is related to *O. Lehmannii* Maxon and *O. pilosa* Hook., which also have closely spaced vein-branches. However, *O. Lehmannii* differs notably in its

[1] Published by permission of the Secretary of the Smithsonian Institution.

long slender phyllopodia, its narrow, strongly coriaceous, glabrous blades, and its glabrous indusia, and *O. pilosa* is readily distinguished by its broader blades, which are pilose beneath and densely ciliolate, and it long-pilose indusia.

Dennstaedtia arcuata Maxon, sp. nov.

Rhizoma repens, parte praesente ca. 10 cm. longa et 8–10 mm. diam. Folia pauca, fortasse 2 vel 3, inter se haud distantia, suberecta, saltem usque ad 1.4 m. longa; stipites usque ad 65 cm. longi, 5–7 mm. diam., opace brunnescentes, primum tenuiter et microscopice puberuli, prope basin radices crassas etiam interdum novellam emittentes; laminae anguste oblongae, usque ad 75 cm. longae et 30 (40) cm. latae, apice longe acuminatae, basi paulum angustatae, 1-pinnatae, rhachibus stipitibus simillimis; pinnae infra apicem gradatim angustatum pinnatifido-lobatum utrinque 10–12, alternae, obliquae, leviter falcatae, pleraeque subsessiles (basales subpetiolulatae, apicales semiadnatae), lineares, apicem versus acuminato-attenuatae, basi latissime cuneatae vel rotundato-subtruncatae, herbaceae, supra glabrae, subtus in costis inconspicue et minutissime primum puberulae; pinnae basales 12–14 cm. longae; pinnae mediales maximae 18–22 cm. longae, 2.5–3.5 cm. latae, basin versus interdum late crenatae vel undulatae; venae majores 20–25-jugae, obliquae, arcuatae, utrinque prominulae, pleraeque 3–5-furcatae, prope marginem apice hydathodis rotundatis vel ellipticis incrassatis terminatae; sori ambitu transverse ovales, ca. 2 mm. longi et 1.5 mm. lati, humiles, numerosissimi, contigui, linea continua marginem totam occupantes, pulviniformes, sporangiis numerosissimis receptaculo ca. 1 mm. longo transverse lineari-oblongo nigro nitido sitis; indusia pateriformia, textura membranacea et colore ubique aequabilia, latere utroque vix emarginata, inter se connata, integra.

Type in the U. S. National Herbarium, nos. 1,144,228 and 1,144,229, a complete frond collected in forest above La Cumbre, Department of El Valle, Colombia, altitude 1800 to 2100 meters, May 14–19, 1922, by E. P. Killip (no. 5565). The following additional material has been studied:

COLOMBIA: Alto Mercedes, Dept. El Valle, alt. 2,000 meters, *Dryander* 2446. La Resina, Dept. Huila, *Juzepczuk* 6570.

PERU: Hacienda Ballisteros, Pozuzo, Dept. Huánuco, *Bryan* 674.

The present species is at once distinguished from other members of *Dennstaedtia* by its simply pinnate blades. The sori are terminal upon all the veinlets and are crowded against each other in a continuous marginal line, giving an evenly crenulate appearance to the pinnae. The outer half of the large, oval, saucer-shaped indusium is precisely like the proximal portion and is evenly joined to it at either side, contiguous indusia having in fact a common rim at this point. No other species of *Dennstaedtia* has the sori crowded together in an unbroken line throughout, the nearest approach being in *D. grossa* Christ, of Costa Rica and western Panama, a plant with huge bipinnate-pinnatifid fronds and suborbicular sori.

Fern Names in Bartram's "Travels," 1791

E. D. MERRILL

Doubtless some botanists will agree with Dr. Rickett[1] that the binomials published in Bartram's "Travels" (1791) may be ignored, in that the International Code of Botanical Nomenclature provides that names published in other than the binomial form in any post-Linnaean work serve to invalidate the binomials that are included. It is true that Bartram did publish two descriptions without binomials, utilizing pre-Linnaean descriptive sentences. However, I judge that Bartram's *intent* was to follow the binomial system, because he used well in excess of 340 different binomials; and even where he proposed

[1] Rickett, H. W. Legitimacy of names in Bartram's "Travels." Rhodora **46**: 389–391. 1944.

and described new species with short Latin descriptions, the first name being the generic one and the second the specific name, he sometimes used these as strict binomials elsewhere in his work. For those who may not agree with Dr. Rickett, attention is called to the following hitherto overlooked fern names, which do not occur in our standard indices.

FELIX [FILIX] SCANDENS Bartr. Trav. 41. 1791.

"Felix scandens, perhaps a species of Trichomanes; the leaves are palmated, or radiated; it climbs and roves about, on shrubs, in moist ground." Broad River (Oglethorpe Co.), Georgia. In edition 2, p. 41 (1792), *Felix* was corrected to *Filix*.

PTERIS SCANDENS Bartr. Trav. 478. 1791.

"Observed near Cambelton a very curious scandent Fern (Pteris scandens) rambling over low bushes in humid situations, the lower larger fronds were digitated, or rather radiated, but towards the tops or extremities of the branches they became trifid, hastated, and lastly lanciolate; it is a delicate plant, of a yellowish lively green, and would be an ornament in a garden." Near Fayetteville, North Carolina.

These two entries merely add to the synonymy of our eastern North American *Lygodium palmatum* (Bernh.) Sw. In spite of the fact that the Bartram descriptions are actually earlier than Bernhardi's, fortunately for the stability of nomenclature the former's specific name *scandens* is invalidated in *Lygodium* by *Lygodium scandens* (L.) Sw., the latter a widely distributed Old World species.

FILEX [FILIX] OSMUNDA Bartr. Trav. 173. 1791.

" : and here were great quantities of a very large and beautiful Filex osmunda, growing in great tufts or clumps." Northeastern Florida.

This name is scarcely worthy of record, as it is a *nomen nudum.* One suspects that Bartram intended to speak of the "large and beautiful *fern, Osmunda";* but whatever his intent, he actually published a binomial.

ARNOLD ARBORETUM.

Recent Fern Literature

An extensive investigation of the alkaloids present in species of *Lycopodium* is under way in the National Research Laboratories, Ottawa, Canada. During the past two years four papers on these have been published.[1] Some taxonomic difficulty developed at the outset. Workers in specialized fields of botany, such as ecology, cytology, and phytochemistry, rather naturally tend to feel that infra-specific entities or species segregated by confirmed "splitters" are of no interest to them. This attitude is, however, a mistake; for the variations in morphology on which the taxonomist bases his segregates are intimately related to the phenomena considered in these marginal lines of research. Much past work in the latter by specialists who were supercilious of taxonomic quibbling—and at times have not hesitated to say so—is accordingly of little value and will some day have to be done over. Fortunately in the present instance little reworking will be necessary. The plant studied in the first paper of the series was designated *L. complanatum;* then someone called the authors' attention to taxonomic segregation in this group, and in the third paper they note that what they had previously studied has now been reidentified as *L. flabelliforme.* They also

[1] Manske, Richard H. F., and Léo Marion. The Alkaloids of Lycopodium species: I. Lycopodium complanatum L. Canadian Journ. Research, Sect. B, **20**: 87–92. 1942; III. Lycopodium annotinum L., op. cit. **21**: 92–96. 1943; IV. Lycopodium tristachyum Pursh, op. cit. **22**: 1–4. 1944; V. Lycopodium obscurum L., op. cit. **22**: 53–55. 1944.

took steps to have the other plants chemically investigated determined by a recognized authority on modern taxonomy.

Lycopodium flabelliforme yielded 8 alkaloids, 6 of them new to science. One was lycopodine, which had been discovered 60 years before in European *L. complanatum;* another was nicotine, here reported for the first time in a pteridophyte. The latter alkaloid was found to be present also in *Equisetum arvense.*

The same number of alkaloids were obtained in *L. annotinum,* but there were certain differences; the most abundant was a new compound, to which the name annotinine is given, while lycopodine was present in lesser amounts, and nicotine was not recognizable.

In *L. tristachyum* there were but 5 alkaloids, with lycopodine the principal one, along with some nicotine and minute amounts of three others, apparently new. Chemically, then, this species is not so close to *L. flabelliforme* as the morphology might have led one to expect.

The last report covered in the present review concerned what was identified as *L. obscurum* var. *dendroideum.* This yielded lycopodine and one named obscurine, which had also been found in minor amounts in the earlier studied species; there was one not as yet named which had also been present in *L. tristachyum,* and two new compounds different from those in any other species.

Reports on additional species are promised. On reading these articles, the thought naturally occurred, Wouldn't it be interesting to have similar studies made on some of the intermediates between recognized species which have given taxonomists so much difficulty, and are usually ignored? But a restriction soon came to light: The amounts of material used in these studies ranged from 15 to 103 kilograms of dried plant. Alas, few of the critical infra-specific entities grow by the kilogram!—E.T.WHERRY.

American Fern Society

Report of the President for 1944

Because of continuing war conditions the Society has again had a quiet year. An attempt was made to hold a meeting at Cleveland in September, in connection with the American Association for the Advancement of Science; but, as none of our officers proved able to attend and no one locally could be found to take charge of arrangements, the attempt was abandoned. The Journal, though somewhat reduced in size, has not suffered any decline in quality and has, as usual, supplied good, readable, and well edited matter, varied enough to serve the different interests of our members.

The Treasurer has been notified of a bequest of $1,000 to the Society by the late Miss Amy E. Lillibridge, long a member. Such expression of confidence is indeed heartening; our one regret is that we cannot thank the donor.

The Society ends the year in much better financial condition than at the beginning. This is the result of increased sales of back numbers of the JOURNAL, accomplished largely by Dr. Maxon's persuasive efforts. So far, purchases have been mostly by institutions; we are now endeavoring to stimulate sales to individuals. As yet, it is too early to estimate results; but in any case, such sales cannot be expected to continue at the present, or any given, level, and are in the nature of a temporary expedient. In order to insure the permanent increase of income required to meet added expenses of printing, more members are needed. An effort is now being made to obtain them, using the entire present membership as a committee of the whole for the purpose. So far, results have been encouraging, as noted in the Secretary's report, but again it is too soon for final appraisement. It is, however, eminently fitting and hopeful that the work will go on under the leadership of Dr. Fagley, who suggested the method being used.

There remains for me only the pleasure of acknowledging, with deep gratitude, the cordial, kindly, and effective support I have received from officers and members of the Society during my term of office. I extend to them all, and especially to my successor, confident good wishes for the future.

C. A. WEATHERBY, *President*

Report of the Secretary for 1944

During the year just closed the list of new members has been impressively large—thirty-four; but we have lost the same number, so the membership stands as at the beginning of 1944. This is, I believe, a record to be proud of in war-time.

Eight of our members were lost by death, including two Life Members, Dr. Dow and Mr. Gruber. We shall miss, indeed, such long-time members as Mr. Burnham, who joined the Society in 1897, and Miss Corne and Mr. Ridlon, who came in the early nineteen hundreds.

For many of you this will be remembered as the "year of the late ballots." Shortly after the nominations were received, all ballots were posted at the same time in one-and-one-half cent open mail, according to usual procedure. Under normal circumstances they should have reached their destinations in ample time to have the votes returned by the date indicated. Under the pressure of war-time duties and Christmas mail the postal service doubtless did its best. This experience, however, points the need for sending ballots by first-class mail, even at some additional cost for postage.

Sincere thanks are extended to the many members who so generously cooperated in sending in the names of friends. The number who so contributed to the welfare of the Society is too long to be covered by individual letters, but our appreciation of the help is very sincere. It indeed gives a "lift" to the soul to get such a demonstration of interest and responsibility.

Respectfully submitted,

ELSIE G. WHITNEY, *Secretary*

Report of the Treasurer for 1944

The financial condition of the Fern Society is somewhat better than anticipated a few months ago. This is owing largely to the sale of several sets of the JOURNAL, which has brought in approximately $300.00 more than was received from this source during the preceding year. The "Complete Your Set" circulars which were sent out in the fall we expect will keep up the financial response.

The cash on hand, $310.04, compares very favorably with $129.41 which the Society had a year ago. Two gifts in cash, one for $25 and another for $5.00, were made anonymously during the past year, and a gift of books was received for which we have assigned a value of $11.84. We also have a new Life Membership given by one of our members to another member.

The treasurer wishes to thank all the members for their cooperation. The financial report follows:

Receipts	*Amount*	*Sub-Total*	*Total*
Cash on hand Jan. 1, 1944			$ 129.41
1938–1941 Membership Arrears	$ 6.00	$ 6.00	
1942 Membership Arrears	4.50	4.50	
1943 Membership Arrears	30.00	30.00	
1944 Membership Renewals	355.40		
1944 New Members	31.50	386.90	
1945 Membership Renewals	16.54		
1945 New Members	18.00	34.54	
1943 Subscription Arrears	1.25	1.25	
1944 Subscription Renewals	72.86		
1944 New Subscribers	13.75	86.61	
1945 Subscription Renewals	71.66		
1945 New Subscribers	8.75	80.41	
1946 Subscription Renewals	.93	.93	

Life Membership	25.00	25.00	
Sale of back numbers A.F.J.	366.33	366.33	
Sale of "Vars. and Forms of Ferns of E. No. Am."	1.00	1.00	
Sale of A.F.J. Cumulative Index	.50	.50	
Gift (cash)	30.00	30.00	
Gift (books), A.F.J. back numbers	11.84	11.84	
1944 Advertising	4.00	4.00	
Reprints	43.98	43.98	
Transferred from Bissell Herbarium Fund	10.00	10.00	$1123.79
			$1253.20
Deduction a/c Gift (books), A.F.J. back numbers[a]		11.84	
Deduction a/c Profit on Sales[b]		112.96	
Deduction a/c Life Membersh[c]		25.00	$ 149.80
			$1103.40

[a] Transferred to Inventory A.F. J.
[b] Transferred to Reserve Fund.
[c] Transferred to Spec. Acct. No. 2.

Disbursements

Science Press			
A.F.J., Vol. 33, No. 4	$162.04		
A.F.J., Vol. 34, No. 1	159.02		
A.F.J., Vol. 34, No. 2	131.52		
A.F.J., Vol. 34, No. 3	123.74	$576.32	
2000 printed clasp envelopes	17.60	17.60	
Reprints	43.98	43.98	
Sales Discount	39.72	39.72	
Agency Commission	12.57	12.57	
Bank Charges	26.98	26.98	
Expense			
Treasurer	29.00	29.00	
Secretary	19.19	19.19	
Editor	8.00	8.00	
Librarian	10.00	10.00	
Curator	10.00	10.00	$ 793.36
Cash on hand Jan. 1, 1945			$ 310.04

STATEMENT, DECEMBER 31, 1944

Assets

Cash on hand	$310.04	
In Spec. Acct. No. 1	510.30	
In Spec. Acct. No. 2	80.91	
In Reserve Fund	228.26	$1129.51
Notes Receivable		1.00
Accts. Receivable		37.80

Liabilities

Capital Acct.	$1063.17
Suspense Cr.	
1945 Memb.	36.54
1945–1946 Subscribers	81.34
Distrib. Vol. 34, No. 4	100.00
Bissell Herb. Fund	510.30

Inventory A.F.J. ...	500.00	Life Memb. Fund	80.91
A.F.S. Library (books)	196.20		$1872.26
Suspense Dr. 1945–46 Agency Com.	7.75		
	$1872.26		

Respectfully submitted,

HENRY K. SVENSON, *Treasurer*

Report of the Auditing Committee

The undersigned have checked all the receipts and expenditures of the American Fern Society for 1944 and find the Treasurer's statement correct. We call to the notice of the Society that our recommendation of a year ago, that the valuation of the back numbers of the AMERICAN FERN JOURNAL, listed in the Assets column as Inventory A.F.J. (back numbers) be reduced to $500.00, has been entered in this report.

We wish to again express our high appreciation to Dr. Svenson and his staff, who have given careful attention to the work of the Treasurer's office.

ARTHUR H. GRAVES
WALTER S. ALLEN
Auditing Committee

Report of the Judge of Elections

The tabulation of votes in the recent balloting for officers of the American Fern Society for 1945 is as follows:

For President	
Dr. Frederick L. Fagley	62
Herbert W. Dole	1
For Vice-President	
Joseph Ewan	63
For Secretary	
Mrs. Elsie G. Whitney	63
Dr. H. L. Blomquist	1
For Treasurer	
Dr. Henry K. Svenson	63
Dr. Frederick K. Butters	1

I therefore declare the following nominees elected: President, Dr. Frederick L. Fagley; Vice-President, Joseph Ewan; Secretary, Mrs. Elsie G. Whitney; Treasurer, Dr. Henry K. Svenson.

Respectfully submitted,

C. H. KNOWLTON, *Judge of Elections*

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Vol. 35 April-June, 1945 No. 2

American Fern Journal

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The American Fern Society

Council for 1944

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American Fern Journal

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Volume I, six numbers, $2.00; other volumes $1.25 each. Single back numbers 35 cents each. Vol. I, No. 1; vol. III, nos. 2, 3 and 4; and vol. IV, no. 1, cannot be supplied except with complete volumes. Ten per cent discount to members and institutions on orders of six volumes or more.

Matter for publication should be addressed to William R. Maxon, Smithsonian Institution, Washington 25, D. C.

Orders for back numbers and other business communications should be addressed to the Treasurer of the Society.

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CURATOR OF THE HERBARIUM

MISS HESTER M. RUSK, Brooklyn Botanic Garden, Brooklyn 25, N. Y.

A regular loan department is maintained in connection with the Society herbarium. Members may borrow specimens from it at any time, the borrower paying all postal or express charges. The pages of the Journal are also open to members who wish to arrange exchanges; a membership list is published to further assist those interested in obtaining specimens from different localities.

American Fern Journal

Vol. 35 APRIL–JUNE, 1945 No. 2

Elizabeth Billings and Her Fern Garden

ELSIE M. KITTREDGE

After a brief illness, Miss Elizabeth Billings, of Woodstock, Vermont, and New York City, died in her Woodstock home, September 10, 1944. She was not quite 74 years old. Although never in good health, she had great energy and will power to accomplish what she desired to do, and thus concealed her frailty, so that her sudden collapse was a great shock to her friends.

Miss Billings was interested in all phases of nature and was an acknowledged authority on the birds of Woodstock and vicinity. In her youth she was an ardent amateur botanist and made a special study of the grasses found on the Billings estate and elsewhere in Woodstock. Later she started collecting all the ferns, fern allies, and flowering plants of the vicinity, limiting the collecting area to a six-mile radius from the center of Woodstock village. The mounted specimens were arranged in specially constructed cases, and for many years were displayed in two rooms in the D. A. R. chapter-house at Woodstock. In September, 1943, Miss Billings presented the herbarium to Dartmouth College, and it is now on exhibition in the College Museum.

Miss Billings' chief botanical interest was in ferns; it was a great pleasure to her that a large proportion of the New England species were to be found on the hill, known as Mount Tom, which is part of the Billings estate. Not only do the usual ferns grow there abundantly, but since 1920 some very interesting varieties and

[Volume 35, No. 1, of the JOURNAL, pages 1–32, was issued April 11, 1945.]

forms of the common species have been located there. Some time prior to 1900 Miss Billings established a fern garden near her house. Here were planted all the common ferns of the region and some of the rare ones found elsewhere in the state. Also she brought fern plants from the foreign countries in which she traveled. This fernery attracted many visitors. For a number of years after 1909 she was unable to superintend its care, and the more delicate ferns were killed by the growth of the sturdy ones and by the weeds which soon became rampant. So in 1928 a new fern garden was started at some distance from the first. As in the old garden, colonies of the common ferns were planted, and each group was provided with a bronze tag bearing the common name of the fern.

In this fernery, brought over from the old one, were two plants of the Ruggles Fern, *Osmunda regalis* forma *orbiculata* Clute, a peculiar form of the American Royal Fern found by Byron P. Ruggles on his Hartland farm some time previous to 1900. Mr. Ruggles gave crowns of his fern to Miss Billings and other fern-lovers soon after it was described in the Fern Bulletin; so there are plants in several gardens, and the original clump is still growing in the Hartland pasture. There were also two plants of the striking form of the Interrupted Fern found by Mrs. W. E. Mack at Bridgewater Corners, and named for her *Osmunda Claytoniana* forma *Mackiana* Kittredge. Mrs. Mack's station was totally destroyed by road work following the flood of 1927; so far as is known these two plants are the only ones now in existence. A plant conforming in all particulars to Mrs. Mack's was found in South Londonderry some years ago by Mrs. Chisholm and Miss Jenkins and set in the lovely Chisholm fern garden, but for some reason it either reverted or did not live, as it cannot be located in the garden now.

Other rare, or at least uncommon, ferns in the Billings garden included the lovely crested Lady-fern, *Athyrium angustum* forma *cristatum* (Hopkins) Broun, each plant producing one or more heavily fruiting fronds each year, and a dwarf crested Lady-fern found on Mount Tom more than 50 years ago but still not identified, though suspected to be a European form. None of its fronds have exceeded nine inches in length, and there never have been any fertile ones. Also there are several plants of Lady-fern which may be called *Athyrium angustum* forma *elegans* (Gilbert) Butters, although they differ somewhat from each other. It may be said in passing that, although Lady-ferns are the commonest ferns to be found in Woodstock, it would seem that no two plants are alike. The Ragged Lady-fern, *Athyrium angustum* forma *laciniatum* Butters, grows in two widely separated places on Mount Tom; but the plant set in the fernery from the first colony found did not live, and so no others were removed from the woods. Three plants of *Polystichum acrostichoides* forma *Gravesii* Clute were found in 1927 and two more taken to the fernery, where they promptly reverted; at least, when they were sought for removal to the new fernery they were as plain as plain, and at first it was thought to cast them out. Fortunately, however, they were transplanted and marked with care, for in 1938 one plant bore two sterile fronds showing *Gravesii* characteristics and has continued to produce such fronds ever since. Both plants bore fine fertile fronds when found, as is evidenced by several herbarium specimens, but none have appeared since. The second plant has remained "plain"; perhaps it will wake up some day. The plant left in the woods disappeared; whether it died or was stolen is not known.

Several plants of Christmas Fern bearing fronds with all the pinnae forked or crested are in the Christmas Fern group. Some plants of the Fragile Bladder-fern with crested fronds were brought to the fern garden from a hill some distance from the Billings estate but within the six-mile radius; they grew well for several years, but then disappeared—we think because of an unusual sheet of ice which remained until very late in the spring. A lovely variety of the Male-fern was found in the old fernery and transferred to the new garden. When questioned, Miss Billings had no idea where it came from or how it got into her garden. Mr. Weatherby determined it as "*Lastrea Filix-mas* var. *abbreviata* Babingt.," a European form; so presumably Miss Billings brought it home from some place in Europe and forgot all about it. In 1939 three plants of an attractive crested form of *Dryopteris spinulosa* var. *intermedia* were found on the hill near the house. The colony was left undisturbed; all three individuals grew well and produced the tasseled fronds, some of them heavily fruited, each year.

During the summer of 1944, Miss Billings had arranged to send to the Brooklyn Botanic Garden plants of Mrs. Mack's fern and some other rare forms. Soon after her death, since there was no longer anyone especially interested in ferns or the fern garden, the Mack Fern, one plant of the Ruggles Fern, and seven other unusual forms of common species were sent to the Garden. The second Mack Fern, one of the crested Lady-ferns, and one crested Spinulose-fern were given to Mr. Rugg of Hanover, New Hampshire. The second Ruggles Fern and some other good plants were sent to Mrs. H. E. Hoselton, of Taftsville, Vermont; Mrs. Arthur Doubleday, of Woodstock, received one of the crested Lady-ferns. So is is expected that some of the plants most valued by Miss Billings will be well cared for by these friends of hers who are also devoted to ferns.

RUTLAND, VERMONT.

Observed Characteristics of Botrychium multifidum var. oneidense

W. L. DIX

Whether one subscribes to the interspecific hybridity theory[1] of Dr. Robert T. Clausen for *Botrychium multifidum* var. *oneidense,* or prefers to accept the "persistent juvenile state" of Dr. E. T. Wherry[2] as the solution of this variety's relation to the species of its immediate group, the observation that it appears to exhibit a lesser degree of fertility than the other members of its group deserves further consideration. Not that this statement is not correct, for if one bases his opinion of the degree of fertility of plants on the number of fertile individuals observed, one is likely to conclude that var. *oneidense* is less fertile than either *B. dissectum* or *B. obliquum.* Whether this apparent condition of var. *oneidense* is the result of hybridity or not, it will be worth while to notice other causes of sterility, and to discover also whether this variety reproduces in sufficient quantity for self-perpetuation.

In the first place, var. *oneidense* is a plant of the woods, and is seldom found in open fields. Insufficient sunlight is a common cause of sterility among most plants. On the other hand, *B. dissectum* and *B. obliquum* grow in many different habitats; but when they grow in woods and thickets, in my observation, they exhibit even less fertility than var. *oneidense.* In recent counts in southern Bucks County, Pennsylvania—one in a dry situation and another in wet soil—out of well over a hundred plants only one had a fertile spike. On the average these plants were fully grown and mature. If the lack of sunlight produces this effect on plants of the parent generation,

[1] This JOURNAL **34:** 2. 1944.
[2] Wherry, E. T., Guide to Eastern Ferns, 21. 1937.

what must be its effect on theoretical hybrids and juveniles?

That var. *oneidense* has ample fertility for self-propagation is evidenced by the large number of younger plants frequently growing around a fertile parent. Often some six to ten such plants of various ages can be seen, which is certainly doing well for hybrids and juveniles. I have not noticed such a striking condition with either *B. dissectum* or *B. obliquum,* but have occasionally found it with *B. multifidum.*

It is also quite possible that the later ripening of spores, usually advanced as evidence against the classification of var. *oneidense* with *B. multifidum,* may be in part the result of its shade-loving habit. In Wayne County, Pennsylvania, raspberries (*Rubus strigosus*) are frequently ripe in open sunlight the first of July, but in the woods they ripen from three weeks to a month later.

Other supposed characters of var. *oneidense* are the thinness of the blade and the less coriaceous segments. Again, these are ordinary features of plants growing in shade. But when specimens of var. *oneidense* growing under similar conditions with other plants of its immediate group are examined and measurements of thickness are made, considerable doubt is raised about the "thinness of the blade" character. Some time ago I began to believe from field observations that this supposed character was somewhat legendary, having been handed down from one taxonomist to another. The thinness and the texture of the blades do vary with the habitat, shade forms of *Botrychium* always being relatively thinner than those growing in sunlight.

In a recent measurement of the blades of *B. multifidum, B. dissectum,* and var. *oneidense* from the same locality and similar environment, and having about the same degree of development, the results, although not conclusive, do show interesting trends. The plants were collected at approximately the same period and kept in a preserving fluid till examined. Sections were made from corresponding areas away from the veins and edges and near the middle of the blades. Measurements were made both from the basal and the apical region of ultimate segments of each specimen. Although the thickness was greater in the basal areas, the same relative results appeared. The averages are as follows, the unit of measurement being one division of the ocular micrometer: var. *oneidense* 21, *B. multifidum* 18, and *B. dissectum* 17. Although it is evident that this single test proves little positively, it does show that the old story about the relative thinness of var. *oneidense* should be omitted from taxonomic discussion of this group till further examination of material from similar environments is made.

Another consideration affecting the taxonomic position of var. *oneidense* is the difficulty in separating this variety not from *B. obliquum,* but rather from *B. multifidum* var. *silaifolium.* In a group of plants such as *Botrychium,* where so many of the taxonomic distinctions are related to differences in the shape and cutting of the sterile blade, it seems a little inept to disregard this feature entirely in the case of the too-much-orphaned var. *oneidense.*

The purport of these observations is that: (1) The theoretical sterility and the comparative thinness of the blade of var. *oneidense* may be due to environment rather than to hybridity or a juvenile condition; (2) in reality the plant under discussion is sufficiently fertile for self-propagation; (3) actual measurements tend to disprove the "thinness of the blade" characteristic; and (4) the evidence of its closer relationship to *B. dissectum* than to *B. multifidum* has become rather feeble.

MORRISVILLE, PENNSYLVANIA.

Schizaea pusilla from Ontario, Canada

HUBERT H. BROWN

Quite recently I have received from Mr. E. A. Moxley, among a number of other ferns, a folder with three mounted specimens of Curlygrass (*Schizaea pusilla* Pursh), which were collected by him at Sauble Beach, Bruce County, in July, 1928. These ferns, done up in a package, were inadvertently left in the house in Owen Sound at the time of Mr. Moxley's removal to Toronto, many years ago now, and only lately were discovered by the present occupant and forwarded to Mr. Moxley, who on March 16th last presented them to me. As there is no possibility of misidentification, I think it desirable that a record of this station should be made.

A friend of mine here, who knows the New Jersey pine barrens, assures me that the habitat there could be duplicated at Sauble Beach, which he also knows very well. This Sauble Beach area is a flat stretch of sandy soil along about six miles of the shore of Lake Huron at the southwest end of the peninsula of Bruce County. There are several lines of dunes, between which are strips of shallow water. Back of the first dune *Juniperus communis* var. *depressa* and *J. horizontalis* are quite abundant, and then the woods of white cedar and poplar.

The stations in Nova Scotia and Bruce County would be about equal in distance from New Jersey, and the Newfoundland station about twice the distance; but Bruce County is inland, while all other stations are coastal. In this disjunct distribution there is the somewhat parallel case of *Cheilanthes siliquosa* Maxon, a species of the Rocky Mountain region westward, which was gathered by Dr. Ami near Durham, Grey County, in 1883, but has not been reported from Ontario since; incidentally this locality is only about 25 miles from the *Schizaea* at Sauble

Beach. In the East, *Cheilanthes siliquosa* is otherwise well known from the Gaspé region, Quebec.

TORONTO, ONTARIO.

Fern Collecting in Southern Costa Rica

ALEXANDER F. SKUTCH

That large section of Costa Rica which lies to the south of San José, its capital city, is nearly all wild, mountainous, sparsely inhabited, forested country. The backbone of the region is the non-volcanic Cordillera de Talamanca, which rises in the craggy summits of Chirripó (12,580 feet) to the most elevated point between Guatemala and Colombia. On the highest treeless summits of this range are found the northernmost outposts of the *páramo* formation of the Andes; corresponding elevations in Guatemala support a vegetation far more Arctic-alpine than Andean in composition and appearance. The broken foothills of the Cordillera push down nearly or quite to the coasts, leaving at best a narrow coastal plain. Lofty, humid forests sweep up almost unbroken from the seashore nearly to the tops of the highest mountains. Although to the north of the Gulf of Nicoya the Pacific coast of Central America is nearly everywhere arid or semi-arid, in southern Costa Rica this side is almost as wet as the opposite Caribbean slope. Seven years' records from Pedregoso in the basin of El General show an annual rainfall ranging from 88 to 167 inches.[1]

The Pacific slopes of the Cordillera de Talamanca drain into the Río Grande de Térraba, which flows for a long way parallel to the Cordillera. The upper portion of the Térraba Valley is the valley, or more properly basin, of El General. Aside from the pioneer explora-

[1] For these records I am indebted to Don Isaías Retana, of Pedregoso.

tions of Henry Pittier and Adolfo Tonduz, made chiefly during the nineties of the last century, very little natural history work has been done in any portion of the Térraba Valley. Despite heroic efforts, these botanical collectors obtained hardly more than a sample of the rich flora of the region.

In 1935, when I decided to combine botanical collecting with ornithological studies in Costa Rica, the Térraba Valley was still difficult to reach by the usual modes of travel. The highways leading south from the central plateau went no farther than Santa María de Dota and El Copey, and except for a few months during the dry season even these roads were impassable by any vehicle swifter than an ox-cart. From Santa María to San Isidro del General, near the head of the Térraba Valley, there was still a two- or three-day journey over a difficult mountain trail crossing El Cerro de la Muerte (11,200 feet)—the Mountain of Death, so called because so many travellers, who came out of the mild valleys with nothing more adequate than a coffee sack to cover them on the high, bleak summit, made here their final bivouac. The highway builders at present struggling to pass the Inter-American Highway over this grim, gray peak have still other reasons for thinking the name appropriate.

At the time of which I write, people had hardly begun to talk about the highway. A year or so earlier, an aviation company had begun service between San José and the Térraba Valley. This offered a quick and, everything considered, cheap way of getting there. The aeroplane left San José early in the morning, carrying 15 people and a heterogeneous cargo of barbed-wire fencing, tins of kerosene, sacks of bread, bales of merchandise, and a little calf tied up in a sack with only his head exposed. Mounting above the low buildings of the capital, we enjoyed a wonderful panorama of the chain of volcanoes to the north—huge, sprawling Irazú, extinct Barba, and Poás with two crater lakes in its truncate summit. But our route lay in the opposite direction, and soon we were soaring above the nearest of the steep mountains that rise sharply on the southern edge of the narrow central plateau. At first we flew over a broken terrain completely denuded of forest from narrow valley

CERRO CHIRRIPÓ (12,580 FT.) AND RÍO CHIRRIPÓ

to sharp ridge. Coffee plantations occupied the sheltered valleys and open pastures covered the ridges, along which ran roads of red clay.

The clearings rapidly disappeared, and a dark green mantle of forest was spread over all the rugged country, meeting the blue plain of the Pacific on our right, and rising on our left to the *páramos* of the peaks, still high above us. Here and there a long, white column of falling water shot out from some more abrupt slope and descended gracefully into the green depths of a mountain gorge. As we continued for about a half-hour over this impressively wild, unspoiled country, I concluded that it was better to be flying easily over it than toiling by muddy trails across its endless sharp ridges and V-shaped valleys. After a while, the solid ranks of the mountains divided into two columns—the high craggy peaks of the Cordillera to the left, and the rounded, green summits of the coastal range to the right. Between them the broad Térraba Valley stretched far away toward the southeast, covered with a fleecy white blanket of mist.

The landing field, then about two miles from San Isidro, was in the midst of an extensive, open, rather sterile plain. The road to the village led between bushy fields, enclosed pastures, and stretches of unspoiled forest. I saw much of the two most abundant ferns of the region, the first being the ubiquitous—and iniquitous!—bracken, which covers whole fields with an almost impenetrable tangle far more than head-high. It jumps up again with redoubled fury when burned or cut, and is one of the most troublesome weeds with which the Costa Rican farmer has to contend. The bracken is strictly confined to cleared lands and is never seen in primary forest, where its place is taken—in point of abundance, at least—by a climbing fern, *Salpichlaena volubilis,* whose fronds twine about saplings and small trees in the undergrowth, ascending to a height of about 20 feet and forming dense tangles. The primary divisions of the fronds are pinnately compound and resemble somewhat the leaves of the ash or sumach. One cannot walk through the forests of El General without being tripped and entangled by the cordlike stipes of *Salpichlaena.* A more agreeable fern growing in the forests in this vicinity is the rare *Lophidium elegans,* a relative of *Schizaea* and *Lygodium,* whose little flabelliform blades stand up on clustered stipes in the shade.

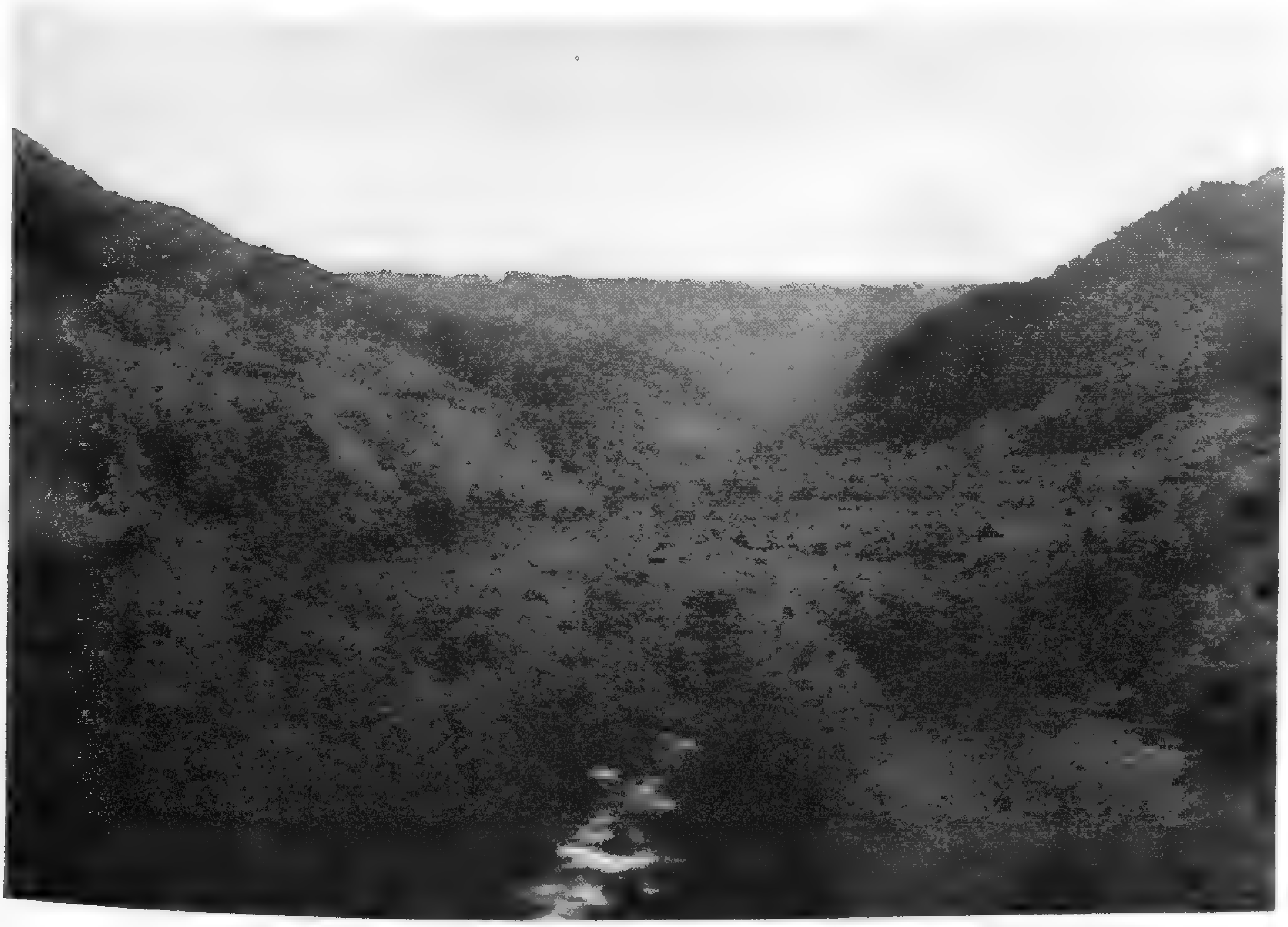
I established my headquarters at Rivas, about 6 miles to the north of San Isidro, on the tumultuous Río Bueno Vista at an altitude of 2,900 feet. Although agricultural operations had begun to encroach upon the lofty forests on the steep slopes that hemmed in the valley, a great deal still remained; and a ten-minute walk brought me to unbroken primeval woodlands so extensive that I never explored them to their end. In a region so heavily forested as this, ferns did not form so prominent a constituent of the whole mass of vegetation as they did, for example, in the far lighter woodland on the upper slopes of the Blue Mountains of Jamaica, where I first collected tropical ferns. Yet by careful searching one could find a satisfying variety of them. The massive "sotacaballo" trees (*Pithecolobium*) on the banks of the river were nearly always laden with epiphytes of the most varied kinds, ranging from mosses, liverworts, and filmy ferns, through orchids, aroids, bromeliads, and larger ferns to epiphytic trees such as figs, *Clusia, Coussapoa,* and *Cosmibuena.* On the trunks grew *Asplenium fragrans, A. auritum,* and *Polypodium pectinatum,* while hanging limply below the horizontal branches were the cordlike fronds of *Vittaria filifolia* and *V. stipitata,* and also the broad, soft, pinnate fronds of *Polypodium chnoodes.*

Back in the forest grew *Hemitelia multiflora,* a rather abundant small tree-fern, with a slender, spiny caudex reaching about 10 feet in height, and broad, finely divided fronds. On the tree trunks, especially near the ground, were found *Trichomanes polypodioides, T. rigidum,* and a new species of *Polypodium,* as yet undescribed. These forests above Rivas had an average height of about 125 feet, with many trees towering still higher. As in heavy forest almost everywhere, trees that in their blossom-time made a colorful display were a disappointingly small minority; and in the understory there was even less color than at the roof. In general there were few species of terrestrial ferns, although some of these were monotonously abundant, such as the *Adiantum*-like Lindsaeas (*L. horizontalis, L. lancea,* and *L. quadrangularis*). Juvenile plants of *Salpichlaena* were a principal constituent of the ground cover.

Patient examination of a mossy tree trunk yielded the delightful little fern *Hecistopteris pumila,* whose dichotomous fronds were scarcely over half an inch in length when full grown. Even more interesting was a dwarf "Hart's-tongue" whose pilose fronds, rooting at the tip in the fashion of the Walking-fern of our northern cliffs, gave rise to new plants, and so formed extensive mats over the tree trunks. This proved to be a new species, which was aptly named *Elaphoglossum proliferans* Maxon & Morton. Another interesting "Walking-fern" of the region was *Leptochilus cladorrhizans,* a terrestrial species whose tall, elegantly divided fronds have long, tail-like tips that strike root where they touch the ground and produce new individuals. Much rarer was *Leptochilus Bradeorum,* with trifoliolate fronds, which seems restricted to the deepest and most humid ravines.

Although the forested slopes were rather unproductive collecting ground for ferns, these grew in the greatest profusion in glens and deep ravines. Here were such tall, wide-spreading, terrestrial species as *Dryopteris Linkiana, D. exculta* var. *guatemalensis, D. subincisa, Diplazium obscurum, D. grandifolium, Asplenium abscissum,* and *Tectaria Sodiroi.*

One of the most interesting excursions I made from Rivas was to the first high summit on the eastern side of the valley, on the divide between the Buena Vista and Chirripó Rivers. The forest trail was so wretchedly muddy, now in early December at the end of the long wet season, that I forsook it to continue upward through the trackless forest. Progress was at first difficult through the undergrowth and over fallen logs; but soon we came to a ridge that was narrow and steeply ascending and covered with tall slender *Euterpe* palms almost to the exclusion of other arborescent vegetation. This broad avenue of palms led us directly to the summit, where



Valley of the Río Buena Vista

the aneroid barometer registered 5,000 feet. On this flat mountain top many trees of *Clusia flava*, about 25 feet high, grew among the palms. They were just coming into blossom, and their broad white flowers—the staminate ones nearly two inches wide—shed a delightful fragrance over the whole mountain top. Beneath the palms and Clusias the ground was thickly carpeted with sphagnum, in which grew the curious fern *Oleandra costaricensis*. This is found, at least at lower elevations, chiefly as an epiphyte on the trunks of trees, but here the slender, rodlike stems, covered with brown scales, rose obliquely out of the moss. Some were eight feet long, and supported themselves on the bifid leaves of *Carludovica* and other vegetation. Other ferns abundant near the summit were *Polypodium fraxinifolium* and *Cyathea divergens,* a tree-fern with a caudex 18 feet high and drooping fronds 10 feet long.

Although my original intention had been to spend only five or six months amid these forests, I stayed in my cabin at Rivas for a year and a half, and later worked for ten months in two other portions of the basin of El General. But my collections do not contain a complete representation of the ferns, nor of any other section of the flora. Many years of steady collecting would be necessary to complete our knowledge of the plants of this rich and varied region. When finally opened to traffic, the Inter-American Highway will enable botanists to collect with ease and comfort in this and other parts of tropical America hitherto difficult of access. Rich rewards in new species await those who first take advantage of the unique opportunities for collecting the highway will afford; but to be most effective the work should be done promptly, for despite a good deal of conservation talk, the original vegetation along the route of the road will doubtless rapidly vanish.

SAN ISIDRO DEL GENERAL, COSTA RICA

A New Species of Isoetes from Colombia[1]

C. V. MORTON

The genus *Isoetes* is represented in South America by about 22 species, almost all of which are rare and known from only one or two localities. The five species thus far known from the northern Andes are: *I. Karstenii* A. Br.

[1] Published by permission of the Secretary of the Smithsonian Institution.

(Venezuela), *I. triquetra* (Ecuador), *I. ecuadoriensis* Asplund (Ecuador), *I. pacifica* Svenson (Ecuador), and *I. Lechleri* Mett. (Venezuela and Colombia to Bolivia). These all belong to the section Tuberculatae Pfeiffer. A species belonging to the small section Reticulatae Pfeiffer has recently been collected in Colombia by Mr. Killip and Mr. Lehmann. It may be described as follows:

Isoetes Killipii Morton, sp. nov.

Planta terrestris; cormus bilobatus (?); folia numerosissima, 7–9 cm. longa, ca. 1 mm. diam., subrigida, attenuata, stomatibus instructa, basi dilatata membranacea 12 mm. longa et 8 mm. lata; ligula anguste triangularis, ca. 1.5 mm. longa, apice subulata; velum incompletum, ad lineam mediam ca. $\frac{1}{3}$ sporangii longitudine; sporangia 5–6 mm. longa, ca. 3 mm. diam.; macrosporae maximae, albae, 1 mm. diam., carinis prominentibus, areolis perspicue reticulatis; microsporae pallidae, bilaterales, ca. 50 μ longae et 30 μ latae, laeves.

Type in the U. S. National Herbarium, No. 1,856,468, collected on the western slopes of the Páramo de Puracé, Central Cordillera, Valley of Río Cocuy, Department of El Cauca, Colombia, on a steep wet bank at 3,200 to 3,400 meters elevation, May 26, 1944, by E. P. Killip and F. C. Lehmann (No. 38536).

In most characters *Isoetes Killipii* is evidently related to the geographically remote *Isoetes foveolata* A. A. Eaton of New Hampshire, but may be distinguished at once by its much larger macrospores (about twice as large), which are much more sharply reticulate. The only South American species of this section is *I. Martii* A. Br., of southern Brazil, which has similar but much smaller macrospores and much larger leaves (60 to 75 cm. long). In Weber's treatment of the South American species *I. Killipii* will go into the section Amphibiae and will key to *I. Martii*.

Smithsonian Institution.

Campyloneurum phyllitidis in Southern Florida

ALEX D. HAWKES

Of the four species of *Campyloneurum* indigenous to Florida—*C. phyllitidis* (L.) Presl, *C. latum* Moore, *C. costatum* (Kunze) Presl, and *C. angustifolium* (Sw.) Fée—*C. phyllitidis* is the most frequent in the hammocks around Miami. Almost every area of forest boasts at least a few specimens of this beautiful fern, and in some of the hammocks it forms one of the most prominent forms of herbaceous vegetation. This species grows in a wide variety of habitats, being found in the thick humus on the ground surface, on the limestone ledges of large sink-holes, on the perpendicular sides of smaller limestone pot-holes, on rotting prostrate tree trunks, part way up the trunks of trees, or even high in their branches.

The most beautiful colony of this fern which I have seen was in Lysiloma Hammock, near the hamlet of Silver Palm. This hammock, although rather large and dense, had a surprising paucity of interesting ferns, orchids, and bromeliads, although a few of the pot-holes contained such species as *Asplenium dentatum*, *A. verecundum*, *Dryopteris ampla*, *Tectaria heracleifolia*, and *Adiantum tenerum*. The great group of Campyloneurums, numbering perhaps 30 in an area about 10 feet square, consisted of plants with immense leaves three feet long or more and four or five inches wide. They were growing on several large trees which leaned out precariously over a yawning sink-hole many feet across. The great rosettes of fronds sparkled in the sunlight which filtered through the dense growth overhead. Many young plants were thriving at the base of the parent clusters, and some few youngsters had found a congenial location some distance up a nearby tree. Large mats of the lovely epiphytic *Peperomia obtusifolia* almost obscured other parts of the rotting trees, and a few scattered bromeliads were perched on the trunks around the great cavity, their odd silvery-gray leaves adding a somewhat sombre note to the scene.

Recently we had a rather severe cold spell here in southern Florida, and a couple of days after one of our frosts I went to several of the hammocks to see what harm had been done. Many of the plants of *Campyloneurum phyllitidis, Asplenium serratum,* and *A. dentatum* were severely injured. Those growing in sheltered locations were for the most part not hurt by the cold, but in relatively exposed positions the rosettes of the first two species were of a dull gray color and the leaves were limp and frequently prostrate on the ground. The little *Asplenium* had tightly shrivelled and darkened in exposed places, but here again the protected plants withstood the frost without any apparent harm.

Campyloneurum phyllitidis is a large and certainly a very striking plant. At first glance it would probably never be taken for a fern by the layman, with its stiff, ascending, strap-shaped leaves arranged in a spreading rosette. Usually the plants in this region are found well inside the hammocks, growing in dense shade in a fairly moist location. The leaves range in length from about six inches in stunted specimens to three and a half or four feet in the huge plants occasionally found growing in an ideal situation.

This species is widely distributed in the lower two-thirds of the peninsula of Florida, and is also found on some of the Florida Keys and throughout the West Indies. On the continent it ranges from Mexico well into South America. It was first described by Linnaeus (in 1753) as *Polypodium phyllitidis,* which is the name used by those who regard *Polypodium* in the broad historic sense.

COCONUT GROVE, FLORIDA.

Shorter Notes

ABUNDANCE OF SELAGINELLA IN OKLAHOMA.—While I was stationed at Fort Sill Military Reservation in Comanche County, Oklahoma, last summer, I noted with surprise that the mountain tops and rocky slopes were covered with a species of *Selaginella*. This has been identified by Dr. Maxon as *S. Sheldonii* Maxon, a species occurring also in New Mexico and western Texas. The whole western slope of Mt. Hines (alt. 1,600 feet), extensive areas on Signal Mountain (alt. 1,700 feet), and (inside the Wichita Mountain Park) about 20 acres of the rocky, dry flats at the base of Little Baldie Mountain are covered with the Selaginella. Growing with it are cacti (*Opuntia* and *Echinocereus*) and various other flowering plants. In summer the temperature may get as high as 120° F., and during this period the Selaginella is dried up and looks as if dead.—HUGH H. ILTIS.

THE EARLIEST COLLECTION OF ONOCLEOPSIS.—Mr. Ballard's recent description of *Onocleopsis* has settled for me a question which has long awaited solution. Some 25 years ago, while ordering up some of the pteridophytes in the Gray Herbarium, I came across four sheets of a Mexican fern determined by Davenport as *Acrostichum Caenopteris* Kunze—that is, *Polybotrya serratifolia* (Fée) Klotzsch. In view of the very different venation of the leaf, this seemed rather a poor guess, and I removed the specimens from the *Polybotrya* covers. But I could not place them anywhere else; they eventually came to rest among the unnamed material and have remained there ever since, occasionally taken out, looked at, and given up by me and various visitors. When Dr. Maxon recently showed me some of the Hinton material of *Onocleopsis*, I was reminded of these specimens and now find them to be very good *Onocleopsis*.

The specimens in question were collected Sept. 26, 1897, at Cerro de San Felipe, Oaxaca, at an altitude of 2000 meters, by Conzatti and Gonzalez and distributed under their number 480. The material is excellent—complete, or nearly complete, sterile and fertile fronds, stipe-bases, and a rhizome. Conzatti and his assistant evidently realized that they had something unusual; it is not much to my credit that I let their well and intelligently collected specimens lie so long without a more vigorous effort to work them out. However, it now appears that, unless a still earlier collection is buried in some European herbarium, the discovery of *Onocleopsis* dates from 1897 instead of 1933.—C. A. WEATHERBY.

PTERIS MULTIFIDA IN TEXAS.—While in Kountze, Hardin Co., southeast Texas, on October 27, 1944, Dr. B. C. Tharp, of the University of Texas, found *Pteris multifida* growing abundantly in sandy soil around the margins of some frame office buildings. Specimens were collected and deposited in the University of Texas Herbarium, No. 44408, from which material was forwarded to Dr. Maxon for verification. So far as known, this is the first record of the westward extension of this species into Texas.

Kountze is a small place 24 miles northwest of Beaumont, where a greenhouse has been selling potted and yard plants of this species. Mr. P. A. Winkler who lives in the northwest outskirts of Beaumont and who is interested in the flora of his part of the State, especially the ferns, advises that several small plants were observed in his fern garden which have since developed enough to be recognized as *P. multifida*. Where they came from, he does not know. However, their occurrence at this point makes it very probable that the colony discovered by Dr. Tharp at Kountze has its origin in wind-borne spores from Beaumont or some intermediate point.—G. M. SOXMAN, *Dallas, Texas.*

THE INDUMENT OF CYSTOPTERIS FRAGILIS.—Although it is customary to characterize the stipe, rachis, and secondary rachises of *Cystopteris fragilis* as essentially glabrous, they actually bear some appendages. The stipe often has a scattering of flat chaffy scales, which mostly fall off early in the season but may in part persist. In grooves on the primary rachis and around the axils of the secondary ones, there often occur aggregations of a few long septate hairs, some of which may be tipped by a rather coarse, dark brown gland. Comparison shows that the varieties *genuina* and *laurentiana* are likely to possess such axillary hairs in considerable number, var. *Mackayii* fewer, and var. *protrusa* fewest of all.

These points are here mentioned in order to prevent misunderstanding as to the glandularity reported for var. *laurentiana.* This consists of minute pale glands, borne on short stalks rarely consisting of more than a single cell, which are limited to the indusium and under surface of the pinnules. In *Cystopteris bulbifera* there are glands both on the indusia and in the axils, and they are mostly the minute, pale, short-stalked type.

Recently Mr. Albert Chandler, of St. Louis, submitted for identification a specimen of *C. fragilis* from Colorado Springs which he thought might represent var. *laurentiana;* but it proved to lack the minute indusial glands, though having unusually copious coarse axillary ones, and so may be regarded as merely var. *genuina.*

And now, just as this note is being written for the JOURNAL, another specimen of interest has come to hand. Professor H. A. Wahl of State College, Pennsylvania, submits a plant from that vicinity which proves to be identical with that recently reported[1] as a possible occurrence of var. *laurentiana* in Pennsylvania. Not only are the maximum frond dimensions the same, but the in-

[1] This JOURNAL **34**: 93. 1944.

dusium is beset with readily visible, minute, short-stalked glands. The finding of such an entity at two stations a hundred miles apart lends support to the view that var. *laurentiana,* though best developed in the St. Lawrence region, also ranges south, in a modest-size form, to latitude 40° 30′ in Pennsylvania.—EDGAR T. WHERRY, *University of Pennsylvania.*

TWO CHILEAN PTERIDOPHYTES OF COMMERCIAL IMPORTANCE.—Large quantities of fronds of *Lophosoria quadripinnata* (Gmel.) C. Chr. (*Alsophila quadripinnata* or *A. pruinata*) and branches of *Lycopodium paniculatum* Desv. are gathered, chiefly in autumn, winter, and spring, for florists doing business in the cities of Chile. The fronds of *Lophosoria* and the branches of *Lycopodium* often reach a length of more than a meter and are used to embellish wreaths and sprays of flowers. Fertile fronds of the *Lophosoria* are often included, but only sterile branches of the *Lycopodium* are employed. The material comes from the provinces of Valdivia and Cautín, where both species grow in great abundance. I can give no definite figures, but collecting these pteridophytes is the basis of a business of considerable size and importance, since it meets all demands of a trade which serves a million people in the city of Santiago alone.

As is well known, *Lophosoria* has a very wide range on the American continent, extending northward to Mexico. Its Chilean area is isolated, being cut off from the rest of its range by the deserts of northern Chile, the Andean Cordillera, and the Argentine Pampas.

Besides these two species, small quantities of *Dryopteris argentina* (Hieron.) C. Chr., *Blechnum auriculatum* Cav., and *Adiantum glanduliferum* Link are sometimes collected in the spring for the use of florists. These three species are obtained in the vicinity of Santiago, where they usually abound in certain localities.—GUALTERIO LOOSER, *Santiago, Chile.*

FURTHER SUGGESTIONS FOR THE UTILIZATION OF BRACKEN IN GREAT BRITAIN.—Bracken, in the Britsh Isles, has become an abundant and damaging weed in pastures and clearings and considerable sums have been spent in efforts to eradicate it. Occasionally, some one has maintained that, instead of merely destroying it, bracken might be treated as a crop and used in paper-making and in various ways as a substitute for straw.[1] The latest suggestions along such lines come from a British chemist, Maurice Capisarow, of the Research Laboratory of Manchester.[2] He points out that the rhizomes have a content of 13 per cent of carbohydrates, useful for food and fermentation, and that their extraction would yield, as a by-product, a considerable amount of strong fiber. Since as much as 50 tons of rhizomes may be produced per acre on heavily infested lands, he believes that extraction would be commercially feasible.

Furthermore, a mulch of bracken is an effective weed-killer. It is peculiarly resistant, and even actively inimical, to parasitic fungi, to such an extent that it may protect other plants. When used to cover stored potatoes, other root-crops, or stacked cereals and hay, it tends to protect them from infection.—C. A. WEATHERBY.

NEW STATIONS FOR EQUISETUM LAEVIGATUM F. PROLIFERUM.—In Broun's "Index to North American Ferns" the distribution of *Equisetum laevigatum* forma *proliferum* Haberer *ex* House (N. Y. State Museum Bull., Nos. 243–244, 1923, p. 47) is given as New York. Recently, while collecting along the Illinois Central Railroad south of Champaign, Illinois, the author found this form growing in fair abundance, together with the typ-

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[1] See this JOURNAL 30: 134 and 31: 112.

[2] A rational approach to the bracken problem. Gardeners' Chronicle, III, 117: 58. 1945.

ical form. A study of specimens in the herbarium at the University of Illinois reveals the following stations: ARKANSAS: Helena, Phillips Co., May 28, 1939, *Demaree.* IDAHO: Falk's Store, Canyon Co., July 7, 1910, *Macbride.* ILLINOIS: Urbana, June 23, 1941, *Jones;* July 15, 1878, *Seymour;* Joliet, June 28, 1907, *Hill;* Concord, July 1904, *McDonald;* Thornton, June 19, 1865, *Hill;* Lake Matanzas, July 19, 1910, *Gates.* MISSOURI: Livonia, Sept. 21, 1915, *Bush;* Courtney, July 13, 1915, *Bush.* WYOMING: Poison Spider Creek, July 28, 1894, *Nelson.*

Forma *proliferum* may be easily recognized, and I quote Dr. House's description: "One to six short branches at each of the upper nodes, sometimes these bearing small or reduced strobili." I believe that further study will show forma *proliferum* to be as widely distributed as the typical form of *E. laevigatum.*—WILLIAM F. RAPP, JR., *University of Illinois.*

Recent Fern Literature

Mr. C. A. Weatherby has recently published[1] an account of the North American species of *Selaginella* related to *S. oregana,* of the subgenus *Euselaginella.* This subgenus, of which the best known species is *S. rupestris,* has usually been known as subgenus *Homoeophyllum* Hieron., but the name *Euselaginella* has priority. The group of species treated is characterized by lax, prostrate habit, usually elongate, slender stems, relatively distant branches, and appressed to strongly ascending, non-dimorphic leaves. Both stems and branches remain horizontal when growing on the ground, only the strobiles assuming an upright position.

Ten species are keyed and described, four of which (*S. oregana, S. Underwoodii, S. mutica,* and *S. ciner-*

[1] Weatherby, C. A. The Group of Selaginella oregana in North America. Journ. Arn. Arb. 25: 407–419. 1944.

ascens) occur in the United States, the remaining species being confined to Mexico. These include three new species: *S. porrecta* (Nuevo Leon, San Luis Potosí, Tamaulipas, and Durango), *S. Arsenei* (Queretero) and *S. Hintonii* (State of Mexico). Three new varieties are described: *S. Underwoodii* var. *dolichotricha* (New Mexico and Arizona), *S. mutica* var. *texana* (western Texas), and *S. mutica* var. *limitanea* (western Texas, New Mexico, and Arizona). All the species are illustrated by excellent line drawings of the leaves and spores by Mrs. Una Weatherby. Mr. Weatherby's treatment adds much to our understanding of this difficult group of species and it is to be hoped that he will continue his interest in the genus.—C. V. M.

Our South American colleagues give us frequent occasion to congratulate them on their progress in dealing with the botanical problems of their part of the world. The latest item of the sort, relating to ferns, which has come to our attention is Juana S. Lichtenstein's "Ofioglosaceas de la Argentina," a detailed and well-illustrated taxonomic study, accompanied by much collateral information and interesting discussion.[1] The author modestly calls it a supplement to Clausen's general monograph of the family; actually, with the resources of the botanical institutions of Argentina, Uruguay, and Chile at her disposal—far more than Clausen had—she has modified considerably the taxonomic and floristic picture of the group in temperate South America.

Eight species of *Ophioglossum* are recognized, four of *Botrychium*. *O. opacum* is reduced to varietal rank under *O. crotalophoroides* and is recorded from Uruguay. The range of *O. ellipticum* is extended to include Paraguay and northeastern Argentina. *O. valdivianum* Phil.,

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[1] **Darwiniana 6: 380–441, 14 figs. 1944.**

of south-central Chile and adjacent Argentina, listed as a doubtful species by Clausen, is made a variety of *O. vulgatum,* thus extending the range of that species into the southern hemisphere. Considerable material from northern and central Argentina is referred to typical *Botrychium australe,* which Clausen did not record from South America. This is a geographic surprise; one would expect an Australian species to turn up in Chile rather than east of the Andes. The author doubts if the posture of parts in the bud can be successfully used to separate the South American varieties of *B. Lunaria* and *B. matricariaefolium*—a statement which itself raises doubts as to whether these varieties are correctly referred to their respective species.

New varieties are proposed in *Ophioglossum crotalophoroides* and *O. nudicaule,* both based principally on size and therefore not wholly convincing. Their ultimate fate, however, is a small detail; the paper as a whole adds largely and most usefully to our understanding of South American Ophioglossaceae.—C. A. WEATHERBY.

Jesse M. Shaver, continuing his studies of Tennessee ferns, has published a paper[1] on the Bracken and Maidenhair. Of the Bracken both var. *pseudocaudatum* and var. *latiusculum* occur in Tennessee, the latter being somewhat more common; some specimens intermediate between them are discussed. *Adiantum pedatum* is common almost throughout the state, but *A. Capillus-Veneris* is less abundant, due to its habit of usually growing near waterfalls. Two forms of the latter are differentiated but not named except as forms A and B. The paper is illustrated by photographs, excellent drawings, and distribution maps.—C. V. M.

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[1] Some Notes on the Bracken and Maidenhair Ferns of Tennessee. Journ. Tenn. Acad. Sci. 19: 203–227. 1944.

A check list of the ferns of another Middle Atlantic region appeared not long ago.[1] The arrangement of the groups is a standard one, with Ophioglossaceae coming first. In some cases the author follows conservative lumpers, in others modern splitters. Thus, while *Ophioglossum vulgatum* is recognized to fall into two varieties (which are so similar that even specialists can scarcely distinguish them), the Coarse-lobe Grape-fern, readily recognized by any amateur, is classed as a mere form of *Botrychium dissectum.* Again, the Wood-ferns, Marsh-ferns, Beech-ferns, and Oak-ferns are all kept under *Dryopteris,* yet *D. cristata* is kept apart from *D. Clintoniana,* and *D. spinulosa* from *D. intermedia.*

A number of records which, though not designated as new, are not known to the reviewer to have been published or generally recognized previously, deserve notice here. *Botrychium simplex* var. *tenebrosum* is recorded from two counties, and *B. dissectum* var. *oneidense* and *B. multifidum* var. *intermedium* from one each; the last represents a surprising range extension southward and may need confirmation. *Dryopteris Clintoniana* is separated into three varieties, the typical one (not awarded an infraspecific epithet), var. *australis,* and var. *atropalustris,* the last (based on *Dryopteris atropalustris* Small) representing a new combination. *D. Thelypteris* var. *Haleana,* a southern entity, extends into two southeastern Maryland counties.

Under *Equisetum arvense* there are recognized four forms and one variety, var. *boreale. E. laevigatum* is recorded from Baltimore County, a considerable range-extension from the west. The nowadays much-used epithet *prealtum* is not accepted, but the entity appears

[1] Reed, Clyde F. County Distribution of the Ferns and Fern-allies in Maryland, Delaware, and the District of Columbia. Bulletin Natural History Society of Maryland 13: 47–54. 1943. (Mimeographed)

in two varieties: *Equisetum hyemale* var. *affine* and var. *robustum*. In the *Lycopodium inundatum* complex three varieties are distinguished, viz., the typical (not named), *Bigelovii*, and *adpressum;* in the Ground-pines, two: *L. obscurum* (typical) and var. *dendroideum*. The epithet *Isoetes riparia* is expanded to cover six entities, some proposed under that species, others under *I. saccharata*. And in this genus there is a surprising range-extension reported—*I. macrospora*, a northern and mountain type, from low-lying New Castle County, Delaware; this should not be accepted without further study of the material.—E. T. WHERRY.

Another state fern flora—"Ferns of Utah," by Seville Flowers[1]—has recently appeared. The principal treatment consists of keys, descriptions, and drawings of all the species known to occur in Utah, following a discussion of their ecology, distribution, and relative abundance, and a section on the general morphology of ferns. The number treated is 53, as compared with 38 reported from Utah by Maxon.[2] The additions are mostly due to recent exploration. Of the 53 species 19 are known from only one or two localities, and some others are rare also. That Utah has a relatively poor fern flora is attested by a comparison with other western states (Washington 72 species, Arizona 78). Noteworthy are the presence of but a single species of *Dryopteris* and the complete absence of *Lycopodium*. The largest genera are *Equisetum* (6 species) and *Cheilanthes* (5 species). *Asplenium, Notholaena, Selaginella*, and *Isoetes* follow, with 4 species each.

The table giving a comparison of the number of species in Utah and the United States as a whole is misleading to

[1] Bull. Univ. Utah, Vol. 35, no. 7, pp. 1–87, figs. 1–164. Nov. 15, 1944.

[2] In Tidestrom, Flora of Utah and Nevada, Contr. U. S. Nat. Herb. **25**: 43–52. 1925.

some extent, since introduced species are counted the same as native ones. The total of 234 species of Polypodiaceae, taken from Broun's Index, includes 17 introduced ones. The counting seems to be erroneous in some other respects also, the total of 18 species of *Equisetum* being arrived at by counting three species specifically excluded by Broun. In Isoetaceae there are 20 species, not 19 as given, and there are only 18 of Ophioglossaceae, not 19 as given.[3]

Some of the statements in the section on general morphology leave a good deal to be desired, such as "A leaf is simply pinnate when it is not cut up into leaflets, and compound pinnate when portions surrounding the side veins are cut out as distinct leaflets." The illustration (fig. 1A) of a "pinnate" leaf is in reality of a deeply pinnatifid leaf, such as is common in *Polypodium,* and that of a "bipinnately compound leaf" (fig. 1B) is really pinnate-pinnatifid. Or again, "Tripinnate or ternate means three times compounded." Ternate is, of course, not synonymous with tripinnate. The statement that "A leaf consists of a *stipe* or stalk, *blade* and *veins*" implies that a leaf has three parts, whereas actually the veins are only a part of the blade. Some of the definitions in the glossary are, to say the least, unconventional, e.g., "Pinnate: a leaf with a midvein like a feather" or "Fertile: a fern bearing spores when collected or observed." Some

[3] Incidentally, it may be mentioned that Broun's own tabular summary on pages 168 and 169 of his Index is even more misleading, if taken at face value. We find, for instance, that *Osmunda* is represented by two species and two varieties, a figure arrived at by counting *Osmunda regalis* var. *spectabilis* as a variety only, since typical *regalis* does not grow in the United States. Yet for purposes of comparison with other regions it is obviously necessary to say that we have three species of *Osmunda* in the United States. In like manner we see that *Cryptogramma* is represented by one species and one variety, *Phyllitis* by no native species, et cetera. It may be mentioned also that Broun's table includes five introduced species of *Isoetes,* an obvious error, but one which affects the totals given nevertheless.

statements in the text are open to question also, such as in the key (p. 22), where the indusium of *Asplenium* is said to be "hoodlike," or on p. 15, where the Ophioglossaceae are said to be "mostly tropical." The genus *Botrychium*, at least, is best developed in temperate regions.

There can be nothing but praise for the fine drawings, which make the book a valuable addition to any fern library. These, drawn on an unusually large scale, are very lifelike. Habit drawings and details are furnished for each species, and both are accurately and tastefully executed.—C.V.M.

Dr. George Neville Jones has recently published[1] a Flora of Illinois, which includes a treatment of the ferns and fern allies. The keys seem to be accurate and usable, but the absence of any comments or discussions is regrettable, especially so in the case of the common Adder's-tongue, for which the name *Ophioglossum pusillum* Raf. is adopted, rather than the universally accepted *O. vulgatum* L. This early species of Rafinesque was rather inadequately characterized, and was completely overlooked until Clausen noted it as a doubtful synonym of *O. crotalophoroides* Walt.; Merrill[2] placed it as a synonym of *O. vulgatum*. It seems from Jones' synonym "*O. vulgatum* of Am. auth., not L." that he is regarding the United States plants as distinct from those of the Old World, but surely some discussion of this point is desirable. It would be especially unfortunate to be obliged to adopt the name *O. pusillum* Raf., since *O. pusillum* Nutt., though published four years later than Rafinesque's name, has been fairly well known for the plant of the Southern States now known as *O. tenerum* or *O. nudicaule* var. *tenerum*. It was so used by Christensen in the Index Filicum.

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[1] Amer. Midl. Nat. Monogr. 2: 1–317. 1945.
[2] Amer. Fern Journ. 33: 52. 1943.

The treatment in general would be more useful by discussion of several other divergences from currently accepted usage. In some groups a conservative viewpoint may be observed, as for instance in *Equisetum,* which differs from Schaffner's treatment in not recognizing *E. kansanum, E. trachyodon,* or *E. Nelsonii.* On the other hand, *Polypodium polypodioides* var. *Michauxianum* Weatherby and *Lycopodium Selago* var. *patens* (Beauv.) Desv. are recognized as distinct species, as *P. ceteraccinum* Michx. and *L. porophilum* Underw. & Lloyd respectively, the conservative treatments of Clausen in *Botrychium* and Tryon in *Pteridium* are not followed, and *Phegopteris* is recognized on the wholly inadequate and artificial basis of lack of indusium.

In all, 63 species are reported from the state. No varieties or forms are mentioned. A good many species are rare, some of those known from one or two localities only being *Lycopodium inundatum, Ophioglossum Engelmannii, Trichomanes Boschianum, Phegopteris connectilis* [*Dryopteris Phegopteris*], *Asplenium cryptolepis, Asplenium ebenoides,* and *Woodwardia virginica.* —C. V. M.

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American Fern Journal

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Problems and Objectives in the Study of Fern Hybrids

RALPH C. BENEDICT

The study of fern hybrids in the United States has had a history of just about 50 years, since Raynal Dodge first suggested that a puzzling intermediate New England form of *Dryopteris* might be explained as a hybrid between two known species, *D. cristata* and *D. marginalis.* This suggestion was accepted by George E. Davenport,[1] who formally described the plant as *Aspidium cristatum × marginale,* proposing *Dryopteris cristata × marginalis* as an alternative name. He discussed the matter at some length before a meeting of the American Fern Society at Boston in 1898, and his paper appeared in a Fern Society publication.[2]

Dodge's suggestion and Davenport's paper served as a stimulus to further study, to the reexamination of herbarium specimens that had been doubtfully identified, to increasing watchfulness in the field, to experimental work, and to published descriptions and discussions of the problems. Gradually, as additional data accumulated, and as the difficulties of any alternative explanation for an increasing number of plants and specimens were recognized, the validity of the theory of natural

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[1] Two new ferns from New England, with some observations on hybridity and nomenclature. Bot. Gaz. 19: 492–497. 1894.

[2] Papers Presented at the Boston Meeting, 1–11. 1899.

[Volume 35, No. 2 of the JOURNAL, pages 33–64, was issued July 11, 1945.]

fern hybrids came widely to be accepted. It is a matter of interest that active study of fern hybrids in this country has been closely associated with the half-century of the existence of the American Fern Society, that a great majority of the studies of this problem have been made by members of the Society, and that many of the published studies have appeared in its journals.

At the present time probably more members are actively interested in the problem than ever before, not only in field and herbarium study but particularly in the observation of these types in outdoor gardens, and in the possibility of raising from spores any that may prove fertile. The present paper has been prepared in the hope of pointing up the problems which still exist, and of suggesting how further descriptive and experimental studies may fruitfully be carried out. My own interest in these plants, which is of 40 years' duration, has recently been actively renewed by a visit to Richard Harlow's fern garden in Pennsylvania, and by the opportunity afforded to see the large series of hybrid ferns which he has growing and to learn about the extensive spore culture work with these and other fern variants which he has been carrying on. Records of these cultures and of others like them ought to be put in shape for publication, so that the results obtained may be available for general information and use.

EXPERIMENTAL METHODS IN SPECIES CROSSING

At the Boston meeting in 1898, Davenport discussed the problem in general and suggested the desirability of carrying on experimental work. He proposed that, following the lines of procedure reported by Lowe in England, an effort be made to produce under cultural conditions some of the crosses which were reported from field study. The suggestion was promptly accepted by

Margaret Slosson, and about two years later, at the New York meeting of the Fern Society, she reported her results to that date.[3] In this first report she recounted partial success with the Dodge hybrid (*Dryopteris cristata* × *marginalis*), but negative results as yet with *Asplenium ebenoides,* now recognized as *Asplenium platyneuron* × *Camptosorus rhizophyllus.* For the Dodge *Dryopteris* hybrid, she reported one immature intermediate plant in a culture containing a number of plants of *D. cristata* and *D. marginalis.*

The experiments with Scott's Spleenwort were continued, however, and in 1902 Miss Slosson reported the successful completion of her efforts to produce this hybrid fern under experimental conditions.[4] By illustration and description she showed the developmental stages of the two parents and of the hybrid offspring, the latter raised to maturity. Herbarium material from her experiments was deposited in the herbarium of the New York Botanical Garden. A little later, in her book "How Ferns Grow," she published similar developmental series in the growth of a considerable number of common hardy ferns. Although this book does not deal directly with hybrids, its descriptions and figures of juvenile stages of various fern species are important for anyone who is interested in cultural and field studies of fern hybrids, because it is highly important in such work to be able to recognize the different parent types in all stages of development.

Accomplishing cross-fertilization is much more difficult in ferns than in flowering plants. The prothallia, on which the eggs and sperms are formed, are small and usually produce both kinds of sex cells at close quarters.

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[3] Experiments in hybridizing ferns. Fernwort Papers, 19–25. 1900.

[4] Bull. Torrey Club 29: 487–495. 1902.

Moreover, when the prothallia are sectioned so as to separate the male and female organs, regenerative growths may be expected to provide a second crop of the opposite sex. Miss Slosson manipulated prothallia in several ways, the most critical of which consisted in cutting them in such a way as to separate portions with each kind of sex organs and then planting in contact appropriate pairs of parts of the two species which it was desired to cross. When new sporophytes of intermediate character were obtained promptly, before there had been time for the regeneration of the excised sex organs, the conclusion was practically inescapable that interspecific cross-fertilization had taken place.

The renewal of efforts to produce cross-fertilization of fern species is much to be desired, both according to the technic already used and by more critical methods. One plant physiologist who attempted in the first decade of this century to bring fern sperms into contact with eggs under direct microscopic observation came to the conclusion that his negative results were strong evidence against the probability of the occurrence of fern hybrids in nature. But, as was pointed out at the time, unfortunately he attempted chiefly to cross fern species that had given no evidence of a disposition to hybridize.

In general, Miss Slosson's results have been accepted as good evidence for the fern hybrid hypothesis, but more experiments of the same type and on a more extensive scale would be valuable. It would be of great interest to have her original crosses repeated, with care to determine whether reciprocal crosses give the same results. Field and herbarium studies have suggested that the Dodge hybrid (*cristata* × *marginalis*), for example, occurs in two types: one more slender, like *cristata* in outline; the other broader, like the other parent.

Such a project and careful experiments to reproduce other hybrids now recognized from field studies are possible of accomplishment by anyone who has achieved success in the spore culture of fern species. It would be necessary first to raise pure cultures of the prothallia of the prospective parent species, and then to make as many prothallial contacts between them as possible. The most critical step in the process would lie in so cutting the prothallia as to separate the sex organs before planting together. Patience in this part of the operation and persistence in its repetition are the primary qualities needed for the conduct of this experiment. A dissecting microscope would be helpful at this stage, but it is probable that a rule-of-thumb technic could be developed in cutting the prothallia which would enable the experimenter effectively to separate the antheridial and archegonial portions. A transverse cut a little back of the notched growing end of a mature prothallium, made with a sharp, fine-pointed pair of scissors (manicure or iridectomy), would give a somewhat bean-shaped piece containing only archegonia. The remaining older, pointed portion, with most of the rhizoids, contains the sperm-producing antheridia. But instead of using the cut halves of older prothallia as the source of sperms, it is sible to use younger, entire prothallia, which have not yet formed archegonia. After the pieces have been planted in contact, each pair should be flooded with a drop of sterile water, to supply a medium for the passage of the active sperms. Any sporophyte which develops in the archegoniate (maternal) portion of a prothallium within a month after the contact has been made may be expected to show hybrid characteristics. Studies in the regeneration of prothallia made by Albaum[5] indicate that new antheridial outgrowths need not be expected to appear in less time.

[5] Amer. Journ. Bot. 25: 37–44. 1938.

SECOND GENERATION CULTURES

At the time of the early studies of fern hybrids, the assumption was widespread that species hybrids must perforce be sterile. L. M. Underwood argued against the idea that Scott's Spleenwort could be a hybrid because of a large colony near Auburn, Alabama, where many young plants were found. A contrary view was expressed by Maxon,[6] who stated the case at some length. My own conclusions, based on extensive microscopic study of eight or ten different putative fern hybrids, were expressed as follows: "This sterility manifests itself either in the form of abortive, undersized sporangia, or, if the sporangia attain full size, in abnormal, granulated spores. Only in a few mounts, out of scores examined, have any normal spores been seen, and in these few instances their presence may have been accidental. But as in hybrids generally, it is probable that the sterility is relative rather than absolute, and we may expect occasionally to find fern hybrids capable of reproducing by spores."[7]

Without anticipating any informally reported results at this time, I am certain that more than one experimenter has already obtained second generation or F_2 cultures of some of our fern hybrids, and that a new and very promising line of study is just waiting for systematic exploitation and reporting. One or two suggestions as to methods and records may be offered here:

Leaves of hybrid types from which spore material is taken for sowing should be carefully pressed and preserved, with data as to source and the date of planting spores. Later, in the event of successful germination, pressed specimens of the offspring should be made, to

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[6] Notes on the validity of *Asplenium ebenoides* as a species. Bot. Gaz. **30**: 410–415. 1900.

[7] New hybrids in *Dryopteris*. Bull. Torrey Club **36**: 41–49. 1909.

show various stages of development. Care will have to be taken that "foreign" spores do not get into the cultures, to confuse the results. Records should be kept of unsuccessful cultures, where no germination occurs. It is a foregone conclusion that whereas some hybrid types may be fairly fertile, others will remain obstinately infertile. The mule is a good illustration of a completely self-sterile animal hybrid, although even in this case female mules have twice been successfully bred with jackasses—the progeny pure jackass.

The fact that the F_2 generation of a number of fern hybrids has been reported is a matter of great interest. The value of such experimental cultures will be multiplied many times if the kind of record suggested in the preceding paragraph is kept, and if the procedures and results are carefully prepared for publication. Earlier numbers of the JOURNAL carry descriptions of methods of raising ferns from spores.[8]

Given a hybrid, even partially fertile, the chance of getting second generation results is much better than for the production of the F_1 or first generation cross between the parent species. Another intriguing aspect lies in the fact that the progeny to be expected cannot be predicted with any certainty. Four types of results seem to be indicated as possible: (1) Offspring like the F_1 type and relatively uniform; (2) a wide range of intermediate types, approaching both parents in characteristics; (3) progeny showing a close resemblance to either one or the other of the parent forms; (4) complete sterility—no offspring.

There are two other possible procedures by which fern hybrids—even completely sterile ones—may give rise to

[8] R. C. Benedict, Growing ferns from spores. Amer. Fern Journ. **29**: 95–98. 1939. Also, Josephine Edson and Grace Griffeth, Our way with ferns. Amer. Fern Journ. **29**: 98–101. 1939.

offspring other than by spores or by natural branching. The phenomenon of apospory is well known in scientific experience. In this the frond itself bears prothallial outgrowths, with sex organs and fertilization possible. Young plants formed by this method may be expected to have a double chromosome number, and may show somewhat greater size and vigor than the parent.[9]

Another method by which sterile hybrids in flowering plants have been caused to form seeds has been extensively used and reported upon within the last ten years, viz., the use of colchicine. The successful application of this technic to sterile fern hybrids would result in the production of spores and sporophytes with a doubled chromosome number. A few years ago the writer tried this method very hopefully on some of the spore-sterile sports of the Boston Fern. In this experiment the runners by which these plants are vegetatively produced were immersed in various concentrations of colchicine solution. The runners swelled to more than twice normal size and great expectations were entertained, but the swellings turned out apparently to be entirely pathological; no reproduction was obtained.[10]

DESCRIPTIVE STUDIES OF FERN HYBRIDS

Basic to any acceptable experimental work with fern hybrids there must be sound and accurate knowledge of the structural characteristics and environmental adaptations of these plants. Recognition and discrimination of the features of the presumptive parents are first essentials. It was this kind of careful study in the early years which forced conviction as to the hybrid nature of these discontinuously variable intermediate types on cautious,

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[9] Elva Lawton, Regeneration and induced polyploidy in ferns. Amer. Journ. Bot. **19**: 303–333. 1932.

[10] Brooklyn Bot. Gard. Rec. **29**: 68. 1940.

thorough workers like Philip Dowell, a former President of the Fern Society and an early editor of the JOURNAL. In a paper entitled "Observations on the occurrence of Boott's fern"[11] he accepted as proved the hybrid nature of the Dodge hybrid (*D. cristata × marginalis*) on the basis of its experimental production, but he remained doubtful regarding the interspecific origin of *D. Boottii.* Two years later, however, he had come to accept the hybrid nature of Boott's Fern, to which he gave the technical name *D. cristata × intermedia.*[12] At the same time he described and named four other *Dryopteris* hybrids: *D. Goldiana × intermedia, D. Goldiana × marginalis, D. Clintoniana × Goldiana,* and *D. Clintoniana × intermedia.* Reference to Dowell's papers is strongly recommended for their accuracy, caution, and thoroughness.

Although the possibilities of experimental work have been put first in this paper, there is still plenty of worthwhile observational and descriptive work to be done. Field and garden studies through all stages of growth, especially in comparison with parental types, have much to contribute. Anatomical studies in various degrees of fineness can produce much additional information. Has anyone applied to fern hybrids Dr. Waters' method of differentiating species by studying their stipe characters?

The value of a hand lens in separating presumptive crosses involving one of the "spinulose" species of *Dryopteris* is familiar; at least in lowland types the presence of glistening indusial glands warrants the assumption that *intermedia*, rather than the non-glandular straight *spinulosa*, is one of the responsible parental types. That studies with a compound microscope would add further valuable information is indicated by the results obtained by Sidney Greenfield.[13] His reports showed recognizable

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11 Torreya **6**: 205–209. 1906.
12 Bull. Torrey Club **35**: 135–140. 1908.
13 Amer. Fern Journ. **28**: 55–62. *pl. 6, 7.* 1938.

differences in the cellular structure of the indusia and scales of *Dryopteris Goldiana* and *D. marginalis*—features which could be picked out in the hybrid material.

By way of summation it may be noted that the field of study presented by fern hybrids, not alone in *Dryopteris* but in *Asplenium* and other genera, offers many and diverse problems of considerable interest, of greater and lesser difficulty. This field should appeal to Fern Society members, both because of our past contributions and of present and future additions to knowledge which can be made.

BROOKLYN COLLEGE AND BROOKLYN BOTANIC GARDEN.

Ferns on Pacific Island Coconut Trees

WARREN HERBERT WAGNER, JR.

On the low, tropical islands of the Pacific the coconut is a dominant tree, a fact especially noticeable when the islands are seen from the air. Not only are there extensive plantations, but individual trees are scattered everywhere—in open fields, along roads, at the edge of forests, and along the shore. Because of their smooth trunks and their usual occurrence in relatively dry, exposed situations, coconut palms might seem unsuitable hosts for fern epiphytes. There are, however, a small number of species of ferns that are almost sure to be found on them, and those that I have found are here listed.

The commonest and most conspicuous fern growing on the bole (the swollen base), where the numerous, stubby, exposed roots make a rough surface, and sometimes climbing some distance up the smooth axis is *Polypodium scolopendria*, a species rather commonly seen in cultivation in the United States. In Guam and on Los Negros

Island (Admiralty Islands) I have seen it thus growing with fronds two and a half feet long. Even on the devastated island of Kwajalein, in the Marshall Islands, you can find little plants of this fern on the remaining stumps of bombed trees. In the Bishop Museum in Honolulu there are specimens collected from the bases of coconuts on Nassau Island, near Samoa, and from Fanning Island in northern Polynesia. On Los Negros Island I found a large number of healthy plants of a closely related species, *P. nigrescens,* growing on the bole and extending several feet up the trunk of a roadside coconut tree not far from the beach.

The most conspicuous ferns of coconut groves in the Pacific grow not on the boles but higher up on the trunks. *Davallia solida* is common in such situations on Saipan, Guam, and Los Negros Island, and another species of *Davallia* occurs in the same situation in Samar, Philippine Islands. Even commoner is *Cyclophorus adnascens* and, to a lesser extent, *C. varius.* Nearly everywhere that coconuts grow in the Marianna Islands, the Philippines, and the Admiralty Islands you will find *Cyclophorus* on the trunks, and Mr. D. F. Grether has shown me a photograph he took in the Admiralty Islands of a trunk which was "fuzzy" from base to crown with *Cyclophorus.* In Guam it frequently grows in company with *Taeniophyllum,* a curious leafless, spiderlike orchid.

Drynaria quercifolia is another fern well suited to epiphytic existence on exposed coconut trunks, and I have found many plants at Tugnug Point, Samar. The tightly clinging, brown, humus-gathering leaves and the very different fertile fronds of this plant may be seen growing as much as 20 feet from the ground. *Stenochlaena palustris* clambers at least 15 feet up the trunks in the Admiralty Islands, and fertile fronds are difficult to obtain because they are produced only on the uppermost part of the rhizome. The boles are a favorite habitat for the smaller sword-ferns of the group of *Nephrolepis exaltata* and *N. hispidula*, and in fields and other exposed areas these may frequently be found only in such spots. Another pteridophyte growing on the bases and stumps is *Psilotum nudum*, as I have seen it Oahu and Samar. Mr. J. T. Conover found a very luxuriant plant on a coconut tree near Agana, Guam.

When individual coconut trees occur in wet, shady places many additional species may be found on the trunks. A tree growing in a shady, brushy location on the wooded side of a limestone hill in Guam had *Hymenolepis mucronata, Asplenium Nidus, Polypodium scolopendria, P. punctatum,* and young plants of *Vittaria elongata* and *Humata heterophylla* growing within four feet of the base; higher up, near the crown, were *Cyclophorus adnascens* and *Davallia solida.* On a tree farther down the hill were very large plants of both *Asplenium Nidus* and *Polypodium punctatum,* growing on the axis 10 to 15 feet from the ground. On Los Negros Island I found a tree growing in woods the bark of which was completely covered almost to the top with *Humata heterophylla.* Nearby, eight feet high on a tree in an exposed place, I found a fully developed plant of *Lycopodium Phlegmaria* clinging to the smooth bark. I have heard of *Schizaea dichotoma* being found on coconut trunks, but I have not found it there yet.

In all I have found 17 species growing on coconut trees. In rainy regions, at higher altitudes, other species may be expected.

WASHINGTON, D. C.

Some Nomenclatural Changes in the Genus Isoetes

CLYDE F. REED

It has been pointed out several times[1] that the name *Isoetes Braunii* Dur. is a later homonym of *Isoetes Braunii* Unger, a fossil species of central Europe. The problem of finding the correct name for this common species of the northern United States has resulted in the following paper, which attempts to settle some of the nomenclatural and taxonomic difficulties involved. That the stress placed on the markings of the gynospores by Miss Pfeiffer in her monograph of the Isoetaceae[2] has resulted in a rather distorted presentation of the relationships of the species is the conclusion reached by the author after a study of a wider range of morphological characters, of the ecological habits, and of the geographical distribution. Three species of this relationship are here recognized, all of which are distinct from the European *I. echinospora* Dur., with which they have frequently been united. The writer is indebted to C. A. Weatherby, C. V. Morton, and Joseph Ewan for suggestions.

Durieu's original descriptions of *Isoetes Braunii* and *I. muricata*[3] were merely observational notes, as his foot-

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[1] *E.g.*, Engelmann (Trans. St. Louis Acad. Sci. 4: 380. 1882), Clute (Fern Allies 223. 1905), and Cockerell (Muhlenbergia 3: 9. 1907). Engelmann's remark is, "I may state here that the name of *I. Braunii* is preoccupied, as it has already been given to one of the two species of the Tertiary deposits, the well marked spores of which have been discovered in the German Brown Coal strata; Prof. Braun therefore proposed for our plant, if it should eventually be considered distinct, the name of *I. ambigua*." Obviously *Isoetes ambigua* A. Br. is a *nomen provisorium* and therefore invalid.

[2] Ann. Mo. Bot. Gard. 9: 79–232. 1922.

[3] These descriptions may be translated as follows:

Isoetes muricata. Related to *Isoetes riparia* Engelm., it is distinguished by its spores being covered with stout papillae, not note indicates: "Ces notes ne sont point de véritable descriptions, mais ont simplement pour objet de signaler pour chaque espèce un caractère de fructification de première valeur, suffisant d'abord la spécifier." Three years later, Engelmann reduced these species to varieties of *I. echinospora* (a disposition of them maintained for many years), adding at the same time another variety, *Boottii*, which came from the same locality (Woburn, Massachusetts) as the type of *I. muricata* and has proved to be essentially identical with that species. The original material of *I. Braunii* came from Lake Winnepesaugee, New Hampshire,[4] and specimens from Mt. Mansfield, Vermont, and Concord, Massachusetts, were also known to Durieu. Later, Engelmann added another variety, *E. echinospora* var. *robusta*, based on material from Lake Champlain, which was reduced by A. A. Eaton to *I. echinospora* var. *Braunii*, but which was maintained as a form by Clute and Miss Pfeiffer.

In 1907 Cockerell[5] created the new name *I. echinospora* [var.] *Brittonii*, based on *I. Braunii* Dur., non Unger, again observing that the fossil species invalidates Durieu's name. However, *Braunii* as a varietal epithet is legitimate under Article 69 of the Rules, which permits

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with sinuous crests, thin and more or less anastomosing. The plants seem to thrive in association with *I. Engelmannii* A. Br.; there has developed one individual of this last plant among the stocks collected at Woburn, Massachusetts, and sent to Durand by Boott.—Bull. Soc. Bot. France 11: 100. 1864.

Isoetes Braunii. The spores resemble those of *I. echinospora* of the Old Continent, and it is this same resemblance which permits one to distinguish *I. Braunii* from its congeners of the New World, it being unique in having echinate spores. Close examination of the spines which cover the spores of these two species reveals that in *I. echinospora* they are compressed, almost lamellar and very fragile, whereas in *I. Braunii* the spinules are conical and solid. The androspores of *I. Braunii* are smaller and smooth all over, the edges with close, rounded crenulations, not fine distinct teeth as in *I. echinospora*.—Bull. Soc. Bot. France 11: 101. 1864.

[4] The specimens were collected by Engelmann, and identified by him as *I. riparia* (forma minor sporis minoribus).

[5] Muhlenbergia 3: 9. 1907.

an author, in this case Engelmann, to validate an illegitimate epithet by transferring it to a new status, provided that no legitimate epithet is available. The varietal name *Brittonii* is therefore illegitimate, since it was superfluous when published.

An unfortunate nomenclatural situation has been thrust on the taxonomist by Iversen,[6] who made three new forms of *I. echinospora*, and then proceeded to describe under identical names two subforms of each form. This practice is, of course, contrary to Article 30 of the Rules, which provides that no two subdivisions of a species may bear the same epithet. Broun transferred all three forms to *I. Braunii*. A somewhat similar treatment is that of Glück,[7] who likewise used the same form names several times within a species. All these forms are based on superficial variations in the frequency of stomata or degree of submergence or emergence, and are here placed in synonymy.

The segregation of the plants of this alliance from western North America was begun in 1888, when Underwood described *I. maritima*, and continued by A. A. Eaton with the description of *I. echinospora* var. *Flettii*, *I. echinospora* var. *truncata*, and *I. Macounii*, which has proved to be a synonym of *I. maritima*. There seems to be an increase in the number of stomata on the leaves as the plants occur westward, reaching a climax in *I. maritima* and those western plants referred by Miss Pfeiffer to *I. Braunii*, but which are here described as a new variety, *hesperia*. There is a tendency for the spinules of the gynospores to become more confluent into columns or ridges in the western plants. The androspores range from having smooth surfaces in the eastern varieties to spinulose or papillose ones in the western

[6] Bot. Tidsskr. 40: 128–129. 1928.
[7] In Pascher, Die Süsswasser-Flora Mitteleuropas 15: 10–21. 1936.

	I. ECHINOSPORA	I. MURICATA	I. MARITIMA	I. TRUNCATA
Stomata	Absent	Present, few	Numerous	Numerous
Sporangia	Unspotted	Pale-spotted	Pale-spotted	Profusely dark-spotted
Velum	Very narrow	Covering $\frac{1}{2}$–$\frac{3}{4}$ of the sporangium	Covering $\frac{1}{4}$–$\frac{1}{2}$ of the sporangium	Covering $\frac{1}{4}$–$\frac{1}{2}$ of the sporangium
Gynospores	440–540 μ, densely echinate with fine truncate spines, sometimes toothed	250–620 μ, covered with broad spinules, sometimes forked or toothed; spinules sharp to blunt	380–570 μ, the spines thick, blunt, sometimes confluent into toothed ridges	430–520 μ, thickly covered with truncate columns or blunt spines
Androspores	23–35 μ, sometimes marked with slight reticulations, usually smooth	25–33 μ, smooth to rarely spinulose	29–39 μ, chiefly papillose	27–33 μ, papillose

plants. The characters of *I. echinospora* and the three New World species here recognized may be summarized as in the accompanying tabulation.

[At this place some mention may appropriately be made of an Asiatic plant of this alliance, *I. asiatica* (Makino) Makino,[8] which is described by Miss Pfeiffer as follows: "Differs from the type [*I. echinospora*] in having a broad velum, covering ⅔ to ¾ of the sporangium, in bearing coarser spinules on the megaspores, and in the smoothness of the microspores." Miss Pfeiffer had seen no material, and her description was drawn from Makino. However, material collected in Japan and labelled *I. echinospora* var. *asiatica* Makino in the National Herbarium has the gynospores with reticulate or foveolate surfaces and lacks spinules. *Isoetes asiatica* is said to range from Honshu to Saghalin, the Kurile Islands, and Kamtchatka. The material from these regions needs to be carefully studied.]

Isoetes muricata Dur. Bull. Soc. Bot. France **11**: 100. 1864.

Isoetes echinospora var. *muricata* Engelm. in Gray's Manual, ed. 5, 676. 1867; Clute, Fern Allies 222. 1905; A. A. Eaton, in Gray's Manual, ed. 7, 60. 1908.
Isoetes Boottii A. Br. ex Engelm. loc. cit. (in syn.).
Isoetes echinospora var. *Boottii* Engelm. loc. cit.
Isoetes echinospora [var.] *Braunii* f. *Boottii* Clute, Fern Allies 258. 1905.
Isoetes echinospora [var.] *Braunii* f. *muricata* Clute, Fern Bull. **16**: 55. 1908.

Submersed leaves 10–30, flaccid, spiral, 15–40 cm. long, 1 mm. in diameter, the emersed ones 5–8 cm. long, slender, recurved; stomata present; sporangia pale-spotted, globose; velum covering ½ to ⅔ of the sporangium; gyno-

[8] **Isoetes asiatica** (Makino) Makino, Bot. Mag. Tokyo **28**: 184. 1914; Takamine, op. cit. **35**: 184. 1921; Döpp, in Manual Pteridology 259. 1938.
Isoetes echinospora var. *asiatica* Makino, Bot. Mag. Tokyo **18**: 129. 1904; Iversen, Dansk Bot. Ark. **5**, No. 23: 2. 1928.
Isoetes echinospora sensu Hultén, Fl. Kamtchatka 64. 1927, non Dur.

spores 400–620 μ (average 510 μ) in diameter, covered with slender, round spines and flat, blunt or retuse lamellae; androspores 25–31 μ long, smooth or slightly granular, white.

DISTRIBUTION: Nova Scotia to northern Maine and New Jersey.

Isoetes muricata f. **robusta** (Engelm.) Reed, comb. nov.

Isoetes echinospora var. *robusta* Engelm. Trans. St. Louis Acad. Sci. **4**: 380. 1882.

Isoetes echinospora [var.] *Braunii* f. *robusta* Clute, Fern Allies 258. 1905.

Isoetes Braunii f. *robusta* Pfeiffer, Ann. Mo. Bot. Gard. **9**: 173. 1922.

Leaves numerous, as many as 75, smaller than in typical *muricata*, 12–15 cm. long; stomata abundant; gynospores 400 μ in diameter.

DISTRIBUTION: Vermont, New Hampshire, Massachusetts.

Isoetes Gravesii A. A. Eaton should be mentioned at this point, since Miss Pfeiffer treats it as a synonym of f. *robusta*, from which however, it differs in several striking morphological characters: (1) Bast bundles are present in the leaves; (2) the gynospores are smaller and are greatly flattened in the upper hemisphere and densely covered with stout, truncate, mostly single columns; and (3) the plants are dioecious. Clute more naturally places *I. Gravesii* as a variety of *I. valida* (a synonym of *I. Eatonii*), with which it agrees in the characters pointed out above.[9]

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[9] **Isoetes Eatonii** Dodge, Ferns and Fern Allies N. Engl. 39. 1896; Bot. Gaz. 23: 32–39. *pl. 4–5.* 1897; Underw. Nat. Ferns, ed. 6, 146. 1900; A. A. Eaton, in Gray's Manual, ed. 7, 60. 1908; Pfeiffer, Ann. Mo. Bot. Gard. 9: 177. 1922.

Isoetes Engelmannii [var.] *valida* Engelm. in Gray's Manual, ed. 5, 677. 1867.

Isoetes valida Clute, Fern Allies 236. 1905.

DISTRIBUTION: New Hampshire, Massachusetts, New Jersey.

Isoetes Eatonii forma **Gravesii** (A. A. Eaton) Reed, comb. nov.

Isoetes Gravesii A. A. Eaton, Fernwort Pap. 14. 1900; Gray's Manual, ed. 7, 61. 1908; Britt. & Brown, Ill. Fl. ed. 2, 1: 54. 1913.

Isoetes valida [var.] *Gravesii* Clute, Fern Allies 243. 1905.

DISTRIBUTION: Connecticut.

Isoetes muricata var. **Braunii** (Dur.) Reed, comb. nov.
Isoetes Braunii, Dur. Bull. Soc. Bot. France **11**: 101. 1864, non Unger.[10]
Isoetes echinospora var. *Braunii* Engelm. in Gray's Manual, ed. 5, 676. 1867.
Isoetes ambigua A. Br. ex Engelm. Trans. St. Louis Acad. Sci. **4**: 380. 1882 (*nom. provis.*).
Isoetes echinospora [var.] *Brittonii* Cockerell, Muhlenbergia **3**: 9. 1907 (*nom. abort.*).
Isoetes echinospora f. *polystoma* Ivers. Bot. Tidsskr. **40**: 128. 1928 (partim).
Isoetes echinospora f. *polystoma* subf. *lativelata* Ivers. op. cit. 129.
Isoetes echinospora f. *oligostoma* Ivers. loc. cit. (partim).
Isoetes echinospora f. *oligostoma* subf. *lativelata* Ivers. loc. cit.
Isoetes echinospora f. *astoma* Ivers. loc. cit. (partim).
Isoetes echinospora f. *astoma* subf. *lativelata* Ivers. loc. cit.
Isoetes Braunii f. *polystoma* Broun, Index N. Amer. Ferns 99. 1938.
Isoetes Braunii f. *oligostoma* Broun, loc. cit.
Isoetes Braunii f. *astoma* Broun, loc. cit.

Leaves 10–30, up to 25 cm. long (average 12 cm.), dark green, occasionally red at base, half-erect in water, rigid and inclined to curve backward; stomata few, on the tips of the leaves; sporangia pale-spotted, oblong, 4–7 mm. long; ligule deltoid; velum half covering the sporangium; gynospores 250–550 μ in diameter, covered

[10] **Isoetes Braunii** Unger, in Bruckman, Fl. Oening. Fossilis, Jahresb. Ver. Vaterl. Naturk. Wurttemb. 6[2]: 226. 1850; Heer, Fl. Tert. Helv. 1: 44. *pl. 14, fig. 2–7*. 1855.
Isoetes lacustris fossilis A. Br. Neues Jahrb. f. Mineral., Geologie **1845**: 167. 1845.
Isoetites Braunii Unger, Gen. et Sp. Foss. 225. 1850; Denkschr. Akad. Wiss. Wien, Math. Naturw. Kl. 4: 13. *pl. 4, fig. 18*. 1852.

DISTRIBUTION: This fossil species has been found in the following formations: Tertiary (Germany); Miocene (Oeningen, So. Germany); Upper Oligocene (Bohemia, Prussia); and "Dolje" (So. Slovakia).

with broad spinules, these sometimes forked or toothed, sometimes recurved, occasionally confluent into short crests, white; androspores 26–30 μ long, white or gray, smooth, very numerous, up to 300,000 in a sporangium.

DISTRIBUTION: West Greenland, Iceland, and Gaspé County, Quebec, to Pennsylvania, Ohio, Minnesota, and Ontario.[11]

Isoetes muricata var. **hesperia** Reed, var. nov.

Minor; folia 10–18, 5–10 (raro 13) cm. longa; velum angustius; gynosporae 400–480 μ longae, spinis longissimis, tenuibus; androsporae 26–33 μ longae.

Plants smaller; leaves 10–18, 5–10 (rarely 13) cm. long; stomata few; velum narrower, covering about $\frac{1}{4}$ of the sporangium; gynospores 400–480 μ in diameter, the spinules very long (80 μ), fine; androspores 26–33 μ long.

Type in the U. S. National Herbarium, No. 694891, collected at head of Bear Creek, Idaho, altitude 2,250 meters, September 1, 1897, by John B. Leiberg (No. 2971).

DISTRIBUTION: Idaho, Colorado, Utah, California, Washington, and Vancouver Island, at elevations of 1,800 to 3,500 meters.

This variety includes the specimens from the western United States referred to *I. Braunii* by Miss Pfeiffer. Other specimens studied in the National Herbarium are: Base of Mount Heyburn, Sawtooth Range, Idaho, submerged in small lake, alt. 8,000 feet, Aug. 4, 1936. *Thompson* 13657; Mount Rainier, Washington, in lakes, alt. 4,500 feet, Aug. 23, 1901, *Flett* 1929; Chiquash Mountains, Washington, in shallow pond, Aug. 16, 1900, *Suksdorf* 2210; Lake Whatcom, Washington, July 23, 1937, *Muenscher* 7543; Seven Lakes, Colorado, alt. 3,500 meters, *Clements* Sept. 1, 1902; Head of Trinity River, California, in lakes, alt. 8,000 feet, Sept. 1, 1882, *Pringle;* Mount Arrowsmith, Vancouver Island, B. C., alt. 4,000 feet, Aug. 1, 1931, *Howell* 7646.

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[11] Further study of the material from the northernmost localities may show that it belongs to the following variety or to *I. maritima*.

Isoetes maritima Underw. Bot. Gaz. **13**: 94. 1888.

Isoetes Macounii A. A. Eaton, Fern Bull. **8**: 12. 1900; Trelease, in Harriman Alaska Exp. **5**: 395. 1904.

Isoetes echinospora var. *maritima* A. A. Eaton, Fern Bull. **13**: 52. 1905; Tatew. and Kobay. Contr. Fl. Aleut. Isl. 25. 1934; Hultén, Fl. Aleut. Isl. 62–63. 1937.

Isoetes echinospora [var.] *Braunii* f. *maritima* Clute, Fern Bull. **16**: 55. 1908.

Isoetes Braunii var. *maritima* Pfeiffer, Ann. Mo. Bot. Gard. **9**: 174. 1922.

Isoetes lacustris sensu Tatew. Trans. Sapporo Nat. Hist. Soc. **11**: 156. 1930, non L.

Isoetes beringensis Komarov, Bull. Jard. Bot. Acad. Sci. U. S. S. R. **30**: 196. 1932; Fl. U. S. S. R. **1**: 128. 1934 (Bering Island).

Isoetes truncata sensu Tatew. & Kobay. Contr. Fl. Aleut. Isl. 26. 1934, non A. A. Eaton.

Leaves 8–12, rigid, 2.5–5 cm. long, green, chiefly slender, with fine-pointed tips and rather wide membranaceous border at base; stomata numerous; sporangia globose to oblong, 3–4 mm. long, pale-spotted; ligule triangular, a little longer than wide; velum usually narrow, sometimes covering ½ of the sporangium; gynospores 380–500 μ (rarely 600 μ) in diameter, with rather thick, bluntish spines, these sometimes confluent into toothed ridges, white; androspores 30–39 μ (rarely up to 44 μ) long, chiefly papillose.

Distribution: Washington, Vancouver Island, Aleutian Islands (Unimak, Unalaska, Atka, type locality of *I. Macounii*, Amtchitka, Attu), and Commander Islands (Bering Island, type locality of *I. beringensis*).

Isoetes maritima var. **Flettii** (A. A. Eaton) Reed, comb. nov.

Isoetes echinospora var. *Flettii* A. A. Eaton, Fern Bull. **11**: 85. 1903 (*nom. nud*); op cit. **13**: 51. 1905; Clute, Fern Allies 222. 1905.

Isoetes echinospora [var.] *Braunii* f. *Flettii* Clute, Fern Bull. **16**: 55. 1908.

Isoetes Flettii Pfeiffer, Ann. Mo. Bot. Gard. **9**: 186. 1922.

Leaves 10–20, 5–8 cm. long, coarse, tapering, spreading or recurved, with a wide basal sheath extending upward $\frac{1}{3}$ the length of the leaf; stomata numerous; sporangia oblong, 4 mm. long, spotted; ligule blunt-triangular; velum usually covering the sporangium from less than $\frac{1}{2}$ to $\frac{2}{3}$; gynospores 480–570 μ in diameter, with few spines, these very short, almost wartlike, and short crests, and rarely more or less meandriform-reticulate; androspores 29–33 μ long, finely spinulose.

DISTRIBUTION: Washington, British Columbia.

Isoetes truncata (A. A. Eaton) Clute, Fern Allies 260. 1905; Pfeiffer, Ann. Mo. Bot. Gard. **9**: 175. 1922.

Isoetes echinospora var. *truncata* A. A. Eaton, in Gilbert, List N. Amer. Pterid. 10, 27. 1901; Clute, Fern Allies 222. 1905.

Isoetes Braunii sensu Hultén, Fl. Alaska and Yukon 76–77. 1941, non Dur.

Leaves 20–40, 6–13 cm. long, stout, rather rigid, finely tapering, with an almost setaceous apex and a wide membranaceous margin at base; stomata numerous; sporangia oblong, 4–6 mm. long, marked profusely with brown patches of sclerenchyma cells; ligule short-triangular; velum covering $\frac{1}{4}$ to $\frac{1}{2}$ of the sporangium; gynospores 430–520 μ (rarely 680 μ) in diameter, thickly covered wth truncate columns or blunt spines, white; androspores 27–33 μ long, papillose.

DISTRIBUTION: Vancouver Island to Alaska and Kodiak Island.

BALTIMORE, MARYLAND.

Valid Names in the Gleicheniaceae: Pacific Plant Studies No. 4[1]

HAROLD ST. JOHN

Occasionally two or more systematists have the misfortune to revise a group of plants almost at the same time. One has the good fortune to have his paper printed first, while the others have the bad luck of creating later synonyms. The writer was one of several who worked independently but simultaneously upon the genera now segregated from *Gleichenia,* and proposed new combinations under them. It now appears that the first of these publications to be printed was by R. C. Ching.[2] Doubtless due to the war, this number was not widely distributed outside of China, none of the five sets of the journal in Honolulu having it even now, and apparently the only copy to reach the United States being in the library of the Gray Herbarium. Needless to say, this paper of Ching's was unknown to the present writer when working on *Gleichenia,* and at the time of his publication.[3]

Recently when returning from South America, it was possible to visit the Gray Harbarium and to read and collate Ching's paper. C. A. Weatherby discussed it there and has helped in evaluating certain of the older names. Ching accepted as genera the following: *Dicranopteris, Gleichenella, Hicriopteris, Sticherus, Calymella, Stromatopteris,* and *Platyzoma.* He lists them, but gives no key or discussion of the validating morphologic characters.

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[1] This is the fourth of a series of papers designed to present descriptions, revisions, and records of Pacific island plants. The preceding papers were published as Bishop Mus. Occ. Pap. **17**(7), 1942; **17**(13), 1943; **18**(5), 1945.

[2] Sunyatsenia **5**: 201–268, 1 chart. 1940.

[3] Bishop Mus. Occasional Papers **18**: 79–84. 1942.

Because of the earlier *Gleichenia* Necker (1790) Ching wholly rejects *Gleichenia* Smith (1793), the traditional generic name for many of the species in this family. Instead, he adopts *Calymella* Presl (1836) for the species remaining in the genus after the removal of various segregate genera. Certainly *Gleichenia* of Smith is a later homonym, but it is not necessary to reject this long-familiar name at this time, since Becherer has formally proposed it[4] as a *nomen conservandum.* This authorizes the continued use of *Gleichenia* Smith until its conservation is voted upon at the next International Botanical Congress. Ching did not mention this proposal.

Because of the rarity of this Chinese publication, it is desirable to summarize certain of its contents. Below are listed Ching's new combinations with the page references for the ones which antedate those by the present author.

Hicriopteris pinnata (G. Kunze) Ching, p. 280
Hicriopteris glauca (Thunb.) Ching, p. 179
Sticherus Cunninghami (Heward) Ching, p. 283
Sticherus oceanicus (Kuhn) Ching, p. 284
Sticherus owhyhensis (Hook.) Ching, p. 284
Sticherus pedalis (Kaulf.) Ching, p. 284 (misspelled as *pedalus*)
Sticherus quadripartitus (Poir.) Ching, p. 284

One Hawaiian species which the writer previously accepted as *Dicranopteris sandwicensis* Degener should now be known by an older name:

Dicranopteris emarginata (Brack.) W. J. Robinson. Bull. Torrey Bot. Club **39**: 240. 1912.
Mertensia emarginata Brack. U. S. Expl. Exped. **16**: 297–298. 1854, not of Raddi, Pl. Bras. **1**: 72. 1825.

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[4] Candollea **7**: 137–139. 1936.

Gleichenia emarginata (Brack.) T. Moore, Ind. Fil. 377. 1862.
Gleichenia dichotoma (Thunb.) Hook. var. *emarginata* (Brack.) Hillebrand, Fl. Haw. Ids. 545. 1888.
Gleichenia dichotoma var. *tomentosa* Luerss. Flora **58**: 419. 1875.
Mertensia hawaiiensis Nakai, Bot. Mag. Tokyo **39**: 181. 1925.
Gleichenia hawaiensis (Nakai) C. Christensen, Ind. Fil. Suppl. 3, 106. 1934 (misspelled for *hawaiiensis*).
Dicranopteris kawaiensis (Nakai) Ching, Sunyatsenia **5**: 275. 1940 (misspelled for *hawaiiensis*).
Dicranopteris sandwicensis Degener, Fl. Haw. fam. 5, March 15, 1940.

Brackenridge, when giving the first description of this species, called it *Mertensia emarginata*, a later homonym and hence illegitimate. But later, T. Moore validated the specific name when he transferred it to *Gleichenia*. That made it available for transfer to the appropriate segregate genus. Degener has rejected it because of *G. emarginata* Raddi, Pl. Bras. 1: 76, 1825, a binomial which does not seem to exist on that or any other page of Raddi's book. Being non-existent, it does not invalidate T. Moore's combination which thus makes the specific name available for use on transfer to any of the genera concerned except *Mertensia*, which in any case is a *nomen rejiciendum*. Consequently there is no justification for a new name, either the misspelled names *G. hawaiensis* (Nakai) C. Chr. or *D. kawaiensis* (Nakai) Ching or for the new name *D. sandwicensis* Degener. There are no impediments to the use of the valid name *D. emarginata* (Brack.) W. J. Robinson.

BERNICE P. BISHOP MUSEUM, HONOLULU, T. H.

Some Notes on Arizona Ferns

WALTER S. PHILLIPS

Recently I undertook to put in order the pteridophytes in the herbarium of the University of Arizona. This group had been much neglected here and with the addition of the ferns from Dr. Forrest Shreve's herbarium, recently acquired by the University, a complete revision of the various genera and families was undertaken and completed.

Of the two recent floras of Arizona published, Kearney & Peebles' "Flowering Plants and Ferns of Arizona" has the most definite information on the ferns of this state, including many specific citations. The fern portion was contributed by Dr. William R. Maxon from material in the U. S. National Herbarium and from collections by the two authors of the flora.

The present notes concern one addition to the fern flora of Arizona and two recently discovered new stations for species already noted within the state.

ADIANTUM PEDATUM var. ALEUTICUM Rupr. This fern, omitted by Kearney and Peebles, is represented in our herbarium by four sheets from two widely separated localities. Three are from Oak Creek Canyon, Coconino County, collected by Chester Deaver, August 4 and 9, 1928; they are good typical plants of the variety. The fourth is a collection (without date) by Goodding (no. 1456), from the Huachuca Mountains of Cochise County, and consists of a single plant, representing a very depauperate form of the variety.

ASPLENIUM SEPTENTRIONALE (L.) Hoffm. This plant has been reported in Arizona only from the northern part of the state, in the region of the San Francisco Mountains, Coconino County.[1] Last summer, while collecting

[1] AMER. FERN JOURN. 31: 99. 1941.

in the Santa Catalina Mountains of Pima County, I discovered two small colonies in a crevice on a granitic rock face on the southern slope of Mt. Lemmon at 8,500 feet. This plant (*Phillips* 2463), is in our herbarium. There was not time enough on this trip for further search, but another visit in November turned up several more colonies in the same general locality and proves that this little plant is here well established, hundreds of miles south of its previously reported station in the state. It probably will be found on other high mountains in the region when a more thorough search is made.

POLYSTICHUM LONCHITIS (L.) Roth. Reported by Maxon from a collection by Thornber and Shreve (no. 7767) from the Pinaleno Mountains, Graham County. This locality is further defined (by personal conversation with Shreve) as being in Frye Canyon, along "Columbine Trail," above the sawmill that was formerly known as "Clarson's Mill," which has long since gone. On a collecting trip last September with Dr. L. M. Pultz and Dr. R. A. Darrow to these same mountains, we located another station in a canyon east of the original station, viz. Marihilda Canyon, below Shannon Camp, at 8,300 feet, on the shaded canyon sides in rich soil (*Phillips* 2482). This species was well established at this station and numbered hundreds of individuals.

UNIVERSITY OF ARIZONA.

Shorter Notes

NOTES ON ILLINOIS PTERIDOPHYTES.—The review of the treatment of the pteridophytes in Jones' "Flora of Illinois" which appeared in the last number of the JOURNAL[1] brought to mind several trips taken to study these plants there some years ago. In 1904 W. N. Clute had described an *Equisetum Ferrissi* (ignored by Jones) from a station near Joliet, Illinois. Although this had been carefully differentiated from *E. hyemale* [*E. prealtum*], it is assigned to synonymy under that in Broun's "Index." A visit to the type locality yielded the entity subsequently named by Schaffner *E. kansanum*—also ignored by Jones. Such plants, instead of being hidden in synonymy or ignored, should be carefully investigated; there is a possibility that the name *Ferrissi*, which has priority, must displace *kansanum* for a widespread midland species.

No discussion of the variants of *Cystopteris fragilis* is given by Jones; however, the habitat stated, "moist soil in woods," confirms the experience of the writer that var. *protrusa* is the common entity in the state.

For many years there was no specimen in any public herbarium of Miss Steagall's interesting addition to the fern flora of Illinois, *Trichomanes Boschianum*, but Jones records the good news that one is now so preserved.

Anyone who thinks that *Lycopodium porophilum* is a distinct species should turn to the frontispiece of Bower's "Origin of a Land Flora," for that illustration, which could well have been drawn from an Illinois instead of a British specimen, is labelled without question *Lycopodium Selago*, and the evolutionary significance of this plant is referred to repeatedly in that classic work of over 700 pages.—EDGAR T. WHERRY, *University of Pennsylvania.*

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[1] Morton, C. V. This JOURNAL 35: 64. 1945.

NORTHWESTERN LIMITS OF CYSTOPTERIS FRAGILIS VAR. LAURENTIANA.—When I described this variety in 1926, it was known only from the region about the Gulf of St. Lawrence. Broun's "Index of North American Ferns" (1938) added the Bruce Peninsula, Ontario, and in 1935 it had been found, though not publicly recorded, on Manitoulin Island, somewhat to the northwest—*Pease & Ogden, no. 24,997*. Tryon, in his "Ferns of Wisconsin" (1940), reported it from four counties in that state—Dane, in the south, Dorr, in the region of Green Bay, and Douglas and Bayfield at the western end of Lake Superior. It has now turned up in a collection of plants from the north shore of Lake Superior recently received at the Gray Herbarium from the National Herbarium of Canada. Data of collection are: Canyon walls, Black River, about lat. 48° 45′ North, long. 87° 15′ West, July 20, 1937, *R. C. Hosie, S. T. Losee, & M. W. Bannan, no. 43.* This new station gives the variety a range including all the northern part of the Great Lakes region, with an outpost in southern Wisconsin.—C. A. WEATHERBY, *Gray Herbarium.*

American Fern Society

FERNS TO EXCHANGE.—Recently I acquired at last a complete set of the Fern Journal. As I eagerly read through the early issues, I was impressed by the number of specimens offered in exchange. In fact, in Vol. 1, No. 2, there is a list nearly three pages long of species in the Fern Society's own "Exchange Department." And many individual members offered material from time to time, often in return for postage only. In recent years it would seem, however, that collecting zeal has reached a very low ebb, judging from the pages of the Journal. This may make it easier for the survival of rare species, which is good; but on the other hand, for persons who, like myself, wish to accumulate a private herbarium for study purposes, such a lack of published exchange offers means a good deal of fruitless correspondence. And in these days of necessarily curtailed travel, the obtaining of material by exchange is of special value. Accordingly, I would like to make the following offer: I will undertake to supply specimens of any species of Pteridophyta known to grow in the New England states, New Jersey, Pennsylvania, Delaware, or Maryland, in exchange for species of *Asplenium, Pellaea, Cheilanthes, Notholaena,* or *Woodsia* that are *not* known to grow in the above-mentioned states. I would be interested also in alleged fern hybrids of any genus, with information regarding their occurrence.

The specimens I supply will be well pressed, well developed, and fertile, and will include rhizomes when these are not too bulky or the species too rare. They will be accompanied by typed labels bearing full data. I would like to receive material in a similar condition. I can also send living plants of Delaware and Maryland species in very small quantities.—GEORGE R. PROCTOR, *140 West Main St., Newark, Delaware.*

FERN SOCIETY SERVICES TO NEW AND OLDER MEMBERS.—The accession of many new members, as listed in recent issues, prompts this note as a reminder of the supplementary services which the Fern Society offers. The second cover page of each Journal carries formal mention of the existence of a Fern Society Library and a Fern Society Herbarium, both housed at the Brooklyn Botanic Garden under the care of Miss Hester Rusk. From each of these collections members may receive loans for help in the identification and study of ferns from various parts of the country. The procedure in borrowing is simple. For the Library, lists of books may be obtained from Miss Rusk, from which selections may be made; similarly for the Herbarium. The only charge is the cost of packing, shipment, and insurance. Arrangements may be made also to borrow through Miss Rusk special fern lantern slides for use in talks to local groups.

From time to time, through its more than half century of existence, Fern Society members have been given occasional additional helps—herbarium specimens and living plants of interesting species, and reprints of fern articles contributed by members or provided by the Society. At the present time, there are, in varying number, extra copies of the articles listed below. These may be obtained, as long as they last, by forwarding ten cents for postages, etc., to the Treasurer, American Fern Society, Brooklyn Botanic Garden, 1000 Washington Ave., Brooklyn 25, N. Y. The articles are:

WATERS, C. E. Analytical key for the ferns of the Northeastern States, based on stipes. (1928.)
WHERRY, E. T. Range extensions and other observations, 1931–1932.
——— Fern field notes, 1933.
——— Fern field notes, 1934.
THURSTON, SUSAN H. Forcing a collection of native ferns of New England and the Middle Atlantic States for exhibition. (1939.)
BLAKE, S. F. State and local fern floras of the United States. (1941.)

R.C.B.

Members of the Fern Society will be interested in a new publication just started by the Brooklyn Botanic Garden entitled "Plants and Gardens." The new journal, a quarterly, is issued as Volume 1, No. 1, of a new series of the Botanic Garden Record. Emphasis will be placed on topics of interest to plant and garden lovers in general. An excellent start has been made in the spring issue of 64 pages, including many illustrations, of which four are fine color plants. Two of the contributors, Dr. A. H. Graves and Dr. H. K. Svenson, are Fern Society members. The contents of the first number are as follows:

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A regular loan department is maintained in connection with the Society herbarium. Members may borrow specimens from it at any time, the borrower paying all postal or express charges. The pages of the Journal are also open to members who wish to arrange exchanges; a membership list is published to further assist those interested in obtaining specimens from different localities.

American Fern Journal

Vol. 35 October–December, 1945 No. 4

Ferns and Fungi

John A. Stevenson

It will perhaps come as a surprise to fern lovers to learn that these interesting and often delicate plants are as much subject to attack by parasitic fungi as are the higher plants. The fungi occur not only as parasites, but as symbiotic forms in the roots, as epiphytes on fronds and stems, and in a wide and bewildering variety as saprophytes or scavengers on all parts of dead and dying plants. Even the prothallia of ferns are attacked and destroyed by a number of the lower fungi.

Seymour in his standard "Host Index of the Fungi of North America" lists approximately 200 species of fungi as growing on nearly 100 fern species—an array of enemies to make the stoutest fern quail! *Pteridium*, the common Bracken, for example, is host to some 30 fungi, a number of them distinctly parasitic. A forthcoming supplement to the "Index" will increase this record substantially.

The interrelationship, as alternate rust hosts, which exists between the wheat crop and the barberry and between our white pines and currant bushes to their mutual disadvantage has been thoroughly publicized. It is not so well known, though unfortunately only too true, that a considerable number of North American ferns and our fir forests are involved in a similar rust fungus complex.

There are three such rust genera concerned, all abundantly represented in this country: *Uredinopsis*, *Milesia*,

[Volume 35, No. 3 of the Journal, pages 65–96, was issued September 11, 1945.]

and *Hyalopsora*. The first of these is characterized by masses of white spores produced in pustules on the lower surface of the fronds, in contrast to the yellow or brown spore-masses of most other rusts. A second or resting-spore stage develops within the tissues of the fronds. At least 25 species are known, all marked by their occurrence on ferns with various species of fir (*Abies*) as alternate hosts. Of these, 13 occur in America north of Mexico. They attack *Athyrium, Cheilanthes, Cystopteris, Dryopteris, Pteretis, Onoclea, Pellaea, Pteridium,* and *Woodwardia,* of the Polypodiaceae, and *Osmunda,* of the Osmundaceae.

It has been found that each species of *Uredinopsis* is restricted to certain ferns and that other species, though closely related, remain immune. For example, *Uredinopsis Copelandi* is known only on *Athyrium cyclosorum* in California, whereas *U. osmundae* attacks *Osmunda Claytoniana, O. cinnamomea,* and *O. regalis* from Canada to Florida, wherever these hosts occur. Similarly, *U. Atkinsonii* restricts itself to *Dryopteris Thelypteris* var. *pubescens,* but follows it throughout its range as far as Bermuda. Most ferns have but one rust to support, but *Pteridium aquilinum* and its varieties have the doubtful distinction of serving as host to three species of *Uredinopsis.* The balsam fir (*Abies balsamea*) takes the brunt of the burden of playing alternate host to these rusts, although the western firs are known to be attacked by the several species of the Pacific Coast area. Moreover, inoculation studies have shown that all firs are susceptible to these rusts.

A second and very similar white- or colorless-spored group of some 33 species constitutes the genus *Milesia,* of worldwide distribution. Nine of these have been found and studied in the United States and Canada. All produce white masses of urediospores in pustules on the lower surface of infected fronds, and the telial or resting stage follows within the tissues. Some species cause large irregular dark blotches on the fronds, disfiguring and even killing them at times.

In eastern Canada, New England, and New York four species of *Milesia* occur on *Dryopteris spinulosa, D. marginalis,* and *Polypodium virginianum.* Three of these also develop a further stage on the balsam fir. The five species of the Pacific Coast region have been collected on *Cryptogramma, Dryopteris* spp., *Polypodium* spp., and *Polystichum munitum.* An alternate host for these latter forms is unknown, but there is no doubt that, as in the case of the eastern species, *Abies* will be found in due time to fill this undesirable role. *Milesia* rather commonly overwinters in the fronds of its hosts, since they pass the winter season in a more or less green condition.

The third genus of fern rusts, *Hyalopsora,* differs from the two already discussed in having abundant masses of golden-yellow powdery urediospores. These spore-masses are produced in round pustules on the lower surface of the fronds, often in discolored areas. The three American species are widely distributed from Alaska and the Pacific Coast states across the northern United States and Canada to New England and Nova Scotia. The fern hosts are *Dryopteris, Cystopteris, Woodsia, Cheilanthes, Cryptogramma, Notholaena, Pellaea,* and *Pityrogramma. Abies balsamea* is the alternate host of *Hyalopsora aspidiotus,* but similar information is lacking for the other two.

In sharp contrast to the rusts, the smuts have completely failed to gain a foothold as parasites of American ferns, although leaf-inhabiting forms are known in Europe and the Orient. Many years ago, *Ustilago osmundae* was reported as causing galls on *Osmunda* *regalis* in New York, but later studies have shown that a true smut fungus was not involved.

Perhaps the most striking of the parasitic fungi attacking the ferns are the several species of *Taphrina*, which form a palisade-like layer of microscopic spore-sacs or asci on yellow to brown diseased areas of infected plants. In the past it has been customary to refer all American collections to *T. filicina* and one or two other species, but careful studies by Dr. A. J. Mix have shown that at least ten species of this genus are present in this country. *Taphrina filicina*, it now appears, attacks only *Dryopteris spinulosa*, and, so far as known, this only in New York State, causing small, fleshy, cream-colored galls on the fronds. *T. fusca* may be found causing similar galls or tumors on the same fern in several states. *T. gracilis* produces small yellowish to brown thickened spots on fronds of the Marginal Shield-fern (*Dryopteris marginalis*) in New York, and the related *D. arguta* of California has brown fleshy galls due to *Taphrina californica*. In New York and Maine the Marsh-fern (*Dryopteris Thelypteris*) is subject to round to irregular, yellow-brown spots and the pathogene has been named, appropriately enough, *T. lutescens*.

The Christmas Fern (*Polystichum acrostichoides*), although not subject to *Taphrina filicina*, does not escape entirely and throughout the eastern and central United States will be found with large swollen yellowish spots on the fronds. The parasite is *T. polystichi*. In Oregon *Polystichum munitum*, the Sword-fern, exhibits small round or elliptical spots due to *T. Faulliana*, again as named by Dr. Mix. *Taphrina cystopteridis* causes swollen, greenish to brown lesions on fronds of *Cystopteris fragilis* in a number of the Central States. The Sensitive Fern, *Onoclea sensibilis*, in New York and Pennsylvania is marked with elongate or irregular, rust-yellow spots due to *T. Hiratsukae.* Of even more limited occurrence is *T. struthiopteridis* in Wisconsin, on the Ostrich Fern, *Pteretis nodulosa.* This is an unpleasantly long list, and we hope that it is not "only a beginning."

The powdery mildews, so abundantly present on innumerable other hosts from apples to zinnias, are strangely lacking on the ferns. The record to date for this country consists of the innocuous, though interesting, species *Phyllactinia corylea* on the Sensitive Fern (*Onoclea sensibilis*).

Not the least noteworthy of all the fern fungi are the several tar-spot fungi. The Bracken is particularly burdened with these forms, the most common and widespread being a species with the intriguing technical name *Cryptomycina pteridis,* or *Cryptomyces pteridis* as it has more commonly been known. This fungus covers the lower surface of infected fronds with numerous, linear, dull black, slightly raised patches in which the spores are produced. Infected areas of the Bracken do not produce sori freely and it is possible that in this way the fungus may play some small part in checking the growth of this weedy fern.

On the upper surface of the same host occurs another tar-spot fungus, *Catacauma flabellum,* appearing as gray to black, smooth, slightly raised pustules, disfiguring, but not particularly dangerous to, the plant. Attempts have been made in Europe and New Zealand, where it has become a serious weed, to control the Bracken by means of parasitic fungi, but without any particular success.

Fern growers in Florida have been troubled with a brown leaf-spot disease of the Leather-leaf Fern, *Polystichum adiantiforme.* This is characterized by large irregular reddish-brown lesions on the pinnae and rachis, making the fronds unsightly and unfit for market. It has been found possible to transfer the guilty fungus, *Cylindrocladium pteridis,* to other species as well, including *Dryopteris normalis* and *Nephrolepis exaltata.*

Among that vast assemblage of the simpler fungi known as the Fungi Imperfecti are numerous fern parasites of which only brief mention can be made. Included in the spot-producing group are *Cercospora phyllitidis* on *Polypodium, C. camptosori* on *Camptosorus rhizophyllus, Marssonina necans, Septoria pteridis,* and *S. aquilina* on *Pteridium, S. asplenii* on *Athyrium pycnocarpon* (*Asplenium angustifolium*), *Sclerotium deciduum* on *Adiantum* and *Pteris,* and *Phyllosticta pteridis* on *Adiantum.*

Thus far we have discussed the fungi as they occur in the native habitats of their fern hosts, but it is in the greenhouse that they truly come into their own as parasites, under the favorable conditions of constant high temperatures and abundant moisture prevailing there. In fact, under these conditions species known commonly as saprophytes have at times developed definite parasitic tendencies.

Cephalothecium roseum, an ubiquitous mould on all types of dead vegetable matter, was found damaging the prothallia of *Pteris longifolia* in Indiana. Several of the common "damping-off" fungi, so destructive to seedlings of higher plants, are known to attack fern prothallia also. Chief among these are *Pythium Debaryanum, Completoria complens,* and *Rhizoctonia solani,* which cause infected tissues to blacken and die.

The Boston Fern (*Nephrolepis exaltata*), widely grown for indoor decorative purposes in the North, has suffered from a fungus of the anthracnose group, *Glomerella nephrolepis.* Affected plants present a blighted, sickly appearance, due to numerous dead fronds. A fungus of similar behavior, *Pestalotia cibotii,* attacks living fronds of a Mexican tree-fern, *Cibotium Schiedei,* under greenhouse conditions, bringing about their destruction. Still a third fungus, *Alternaria* sp., has been found causing lesions on fronds and stems of *Polypodium* in a Canadian greenhouse. Brown, circular to elliptical lesions which became concentrically zoned appeared on the fronds and ruined affected plants from a decorative point of view.

Several ferns, particularly in the South, harbor fungi that are known also as serious disease-producers of important economic crop plants. Among these are the "mustard seed" fungus, *Sclerotium Rolfsii*, a destroyer of tomatoes, peppers, and a wide range of other crop plants. The *Rhizoctonia* disease is of first rank with the potato, the beet, and various other crops, and it too has been found at work on the ferns. The related "Koleroga" disease (*Pellicularia koleroga*) of tropical and subtropical regions has been noted on ferns. This interesting and destructive form sends hyphal strands up along the branches and petioles to spread out on leaves or fronds, which are then rapidly discolored and destroyed.

As might be expected, the fossil ferns are not without their fungi, although few have been definitely found and studied for North America. Such fossil forms are known for the Carboniferous period and may have occurred much earlier, since the delicate nature of the fern tissues involved makes diagnosis difficult. Fern fungi were doubtless common enough in those prehistoric times, but the necessary conditions for preserving them in fossil form probably occurred only rarely. Many such forms (or forms suspected of being fungi) consist of mycelium-like structures only and so cannot be further identified.

Scarcely more than casual mention has been possible here of the myriad fungus forms which have adapted themselves to life with the ferns. In fact, only the more striking of the parasites have been enumerated and the great array of saprophytic species growing on dead stems and fronds, and often the most intriguing so far as the fungi themselves are concerned, have perforce been ignored.

Perhaps enough of the subject has been brought out to prove of interest to collectors and to entice them into looking for these co-dwellers with the ferns. There are many new points to be discovered in this field: new fungi, new hosts, new localities for old species, new facts on occurrence and behavior. When fern collecting in itself proves dull, turn to the fungi!

PLANT INDUSTRY STATION,
BELTSVILLE, MARYLAND.

A Crested Form of the Broad Beech-fern

CLYDE F. REED

In May, 1944, Mr. Andrew Simon, an ardent fern-lover, found a colony of a beautiful crested form of the Broad Beech-fern on one of his numerous trips in search of forms and varieties of ferns along the Gunpowder River, Baltimore County, Maryland. In September, Mr. Simon and the author made another trip to the colony, which consists of about 100 plants. The locality is a north-facing hillside about 250 feet above the river. Due to the long-running rhizome one might suspect that a single mutation had taken place and the plant had then spread vegetatively by means of the rhizome, but a careful search over the hillside revealed several other colonies of the same crested and dichotomous form, all fronds on each plant being crested. No normal plants were observed in any of the colonies of the crested form, but nearby there were innumerable colonies of vigorous plants of the typical form in the more shaded places. Mr. Simon has been growing this form in his fern garden since the original discovery and no reversion to normal fronds has occured yet. It may appropriately be named:

Dryopteris hexagonoptera forma **Simonii** Reed, f. nov. Pinnae pinnatifidae, apice cristatae vel dichotomae, vel interdum cristatae et dichotomae, apice frondis cristato vel dichotomo, vel cristato et dichotomo.

Type in the U. S. National Herbarium, No. 1,872,563, collected along Gunpowder River, 1 mile below Harford Road, Baltimore County, Maryland, September 17, 1944, by Clyde F. Reed (No. 3618). A cotype is *Reed* 3619 in the Gray Herbarium of Harvard University.

BALTIMORE, MARYLAND.

Recent Range Extensions of Botrychium matricariaefolium

G. R. FESSENDEN

In the seventh edition of Gray's Manual (1908) the range of Matricary Grape-fern (*Botrychium matricariaefolium* A. Br.), there listed as *B. ramosum* (Roth) Aschers., is given as from eastern Quebec to Maryland and westward. In the "Index to North American Ferns" (1938) Broun states the range as "Labrador and Newfoundland to Alberta, south to Maryland, Ohio, South Dakota, Nebraska and Idaho; northern Eurasia." In his monograph of the Ophioglossaceae[1] Dr. R. T. Clausen bases the occurrence of this species in Maryland on a collection made by C. E. Waters at Towson, Baltimore County, Maryland, and extends the range southward to the District of Columbia in consequence of a report by Tidestrom[2] that Mrs. E. S. Steele had discovered *B. neglectum* Wood within four miles of Washington, D. C. Dr. Waters' specimens, in the Gray Herbarium, were collected June 8, 1895, and July 12, 1901.[3]

[1] Mem. Torr. Bot. Club **19**: 87. 1938.
[2] Torreya **5**: 160. 1905.
[3] Weatherby, C. A., communication to the writer, June 1, 1944.

New localities for *B. matricariaefolium* in Maryland were reported in 1941 by Mr. W. H. Wagner, Jr.,[4] who in July, 1939, discovered a plant growing in bushy woods at the edge of a salt marsh on the northern branch of the West River near Mayo, Anne Arundel County. Mr. Wagner states that he later found a colony of about 70 plants in damp open woods near his original station, and that he collected plants near Sykesville, Carroll County, Maryland, along a small tributary of the Patapsco River. He also found one plant in the vicinity of Marlboro, Prince Georges County, Maryland, and recently (July, 1944) has found the species near Sligo Drive in Sligo Park, Silver Spring, Montgomery County, Maryland.

Dr. E. T. Wherry[5] has informed the writer that Mr. Coe, a medical student at the University of Pennsylvania, had reported to him the finding of several plants of *B. matricariaefolium* in association with *B. simplex* Hitchc. var. *tenebrosum* (A. A. Eaton) Clausen in Edgemoor (Bethesda), Montgomery County, Maryland. These were later (July, 1944) observed by the writer, accompanied by Mr. Wagner, and it was noted that they were growing in old rich woods where large trees of *Acer saccharum, Quercus alba, Q. velutina, Cornus florida,* and *Liriodendron tulipifera* predominated.

Dr. Clausen also reports[6] that he has specimens of this species collected in Rock Creek Park, Washington, D. C., by Lt. L. J. Kezer, of the U. S. Army Medical Corps.

On May 28, 1941, the writer, in company with Dr. Wherry and Dr. F. R. Fosberg,[7] discovered *B. matricariaefolium* growing under large trees of *Acer saccharum* in Swift Run Gap near the Spotswood Wayside Spring in Shenandoah National Park, Rockingham

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[4] Wagner, W. H., Jr. Amer. Fern Journ. **31:** 21. 1941.
[5] Wherry, E. T., communication to the writer, May 25, 1944.
[6] Clausen, R. T., communication to the writer, May 25, 1944.
[7] Wherry, E. T. Va. Journ. Sci. **2:** 289. 1941.

County, Virginia. Ten plants were found and the specimens collected were deposited in the National Herbarium, the Gray Herbarium, and the herbaria of the University of Pennsylvania and Cornell University.

An additional Virginia locality was discovered May 14, 1944, in Manassas Gap, about one mile north of Linden, Fauquier County. One plant was found here in a dense growth of grass and sedges in a somewhat boggy spot close to the main Appalachian trail and collected jointly with Dr. E. H. Walker. The specimen is deposited in the National Herbarium.

Recently also (May 7, 1944) the writer came upon a sizable stand of *B. matricariaefolium* in Montgomery County, Maryland, in a fairly young wooded growth in the vicinity of the old mica mine near Northwest Branch, approximately 4¼ miles north by 5° east from Silver Spring, Maryland. This station, in which 107 plants were counted, was revisited later in the month with Dr. Maxon, Dr. Walker, and Dr. E. A. Chapin, all of whom collected a limited number of specimens.

Mr. P. L. Ricker, who also visited this location with the writer, took the accompanying photographs, which show the density of the vegetation under which the plants were growing. The colony is confined to a triangular area approximately 30 yards on each side and is almost completely screened from view by a waist-high growth of Poison Ivy. The principal trees in this area are *Liriodendron tulipifera* and *Cornus florida*, interspersed with a few of *Acer rubrum*, *Quercus alba*, *Q. velutina*, *Q. stellata*, *Robinia Pseudo-Acacia*, *Nyssa sylvatica*, and *Carya* sp. There were also numerous shrubs and small saplings, mainly of *Viburnum dentatum*, *V. prunifolium*, *Vaccinium* sp., *Benzoin aestivale*, *Rubus* sp., *Crataegus* sp., and *Ilex opaca*. This island of young hardwood growth was surrounded by a somewhat older growth of *Pinus* *virginiana* and several small pine seedlings were noted within the area. On one side a mat of *Lonicera japonica* had blanketed the ground and almost completely stifled the less vigorous vegetation, with the exception of a few

Botrychium matricariaefolium, growing under a waist-high cover of poison ivy in a wooded area near Silver Spring, Montgomery County, Maryland.

plants of *Asplenium platyneuron* which appears to be able to survive the encroachment of this vine. A number of plants of *Ophioglossum vulgatum*, many of *Botrychium virginianum*, and a few of *B. dissectum* and *B. dissectum* var. *obliquum*, were found in this area also.

WASHINGTON, D. C.

A Unique Habitat for Maidenhair Spleenwort

ALTON A. LINDSEY

Within thirty yards of heavy transcontinental traffic, yet so well concealed that scarcely anyone except a few Acoma herdsmen can have seen it, is a sunken garden of exceptional interest and beauty.

A 350-square-mile lava flow of post-Pleistocene age is saddled across the continental divide in west-central New Mexico. Its vegetation is sparse, consisting largely of a few of the more xeric "Upper Sonoran" shrubby species. The black lava is extremely rough and broken; some of the smoother surface is ropy, like slag from a blast furnace. Tube caves are characteristic of many lava areas, and in this Grants Flow the great hollow tubes permeate the body of the lava. They were formed when the deeper or more rapidly moving portions of the molten rock drained away from beneath the cooled surface crust. Visible evidence of the subterranean tubes appears in the numerous sink-holes, ranging from two square yards to an acre in extent, formed by the collapse of the roof at various points along the course.

Many recent extrusions in arid parts of the west are similar in the above respects. The feature that sets the Grants Flow apart from all other lava beds known to the writer is its possession of a permanent subterranean water reservoir within the caves and fissures. A creek called the Rio San Jose flows eastward through a narrow valley along the south edge of the northeast lobe of the lava area. Ninety-five open sink-hole ponds dot this part of the lava; many of them are perfectly circular, some are elongate, and a few of the longer of these are sinuous. The water is 12 feet below the general lava surface. The motorist on east-west highway U. S. 66 drives for two miles across the lava bed between the villages of Grants and McCarty's and sees on both sides of the highway many depressions containing cattails, round-stemmed bulrushes, and *Phragmites,* with considerable to no open water in the center. The traveler on the Santa Fe railroad 230 yards farther north, skirting the edge of the lava, may see the same ponds from the south windows of the train.

Another type of sink-hole, involving the collapse of much less of the tube cavern roof, cannot be seen from either highway or railroad. The entrance may be just large enough to allow a man to go down in by rope; but beneath the overhanging roof the cave widens out on all radii, so that it would be quite impossible to get out without the rope. In one such cavern is a thriving colony of Maidenhair Spleenwort, *Asplenium Trichomanes* L.

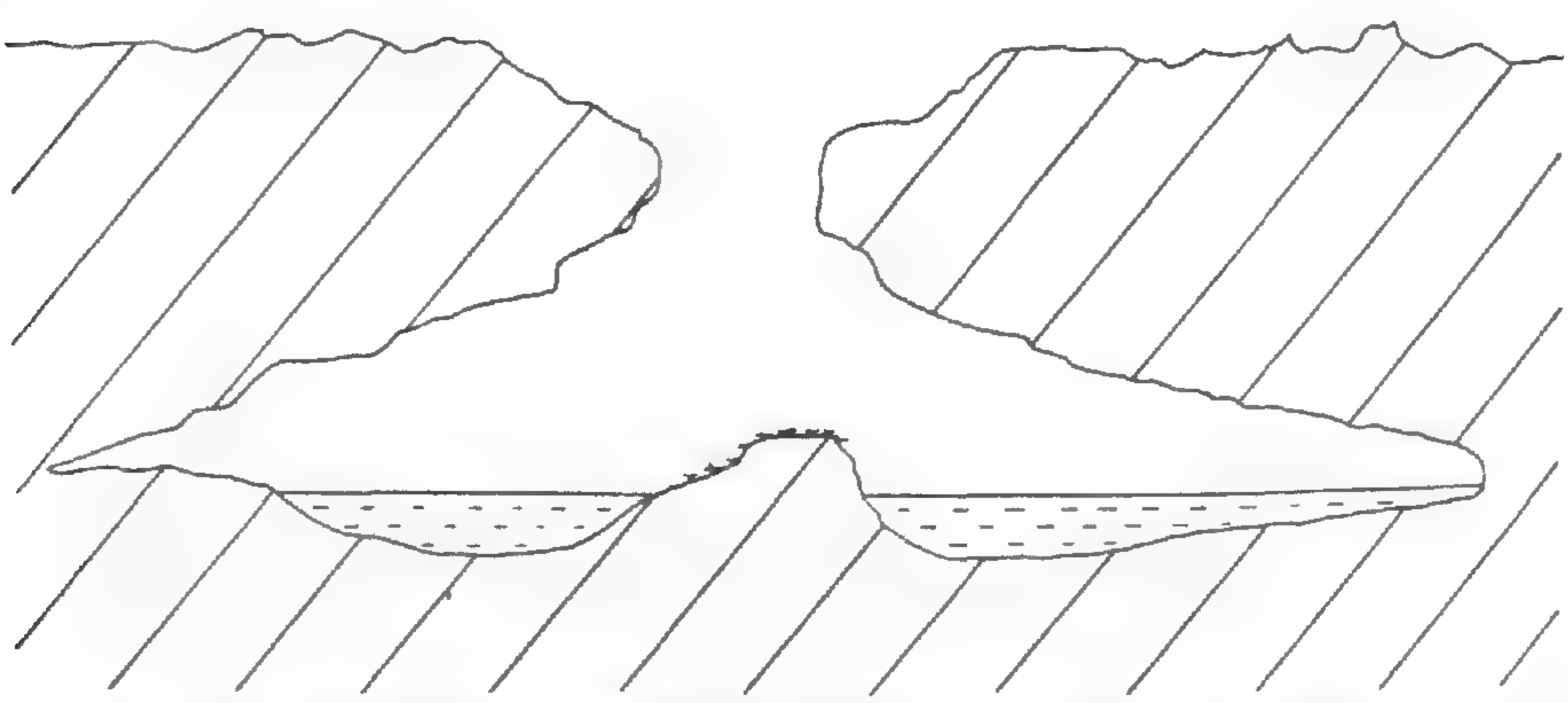
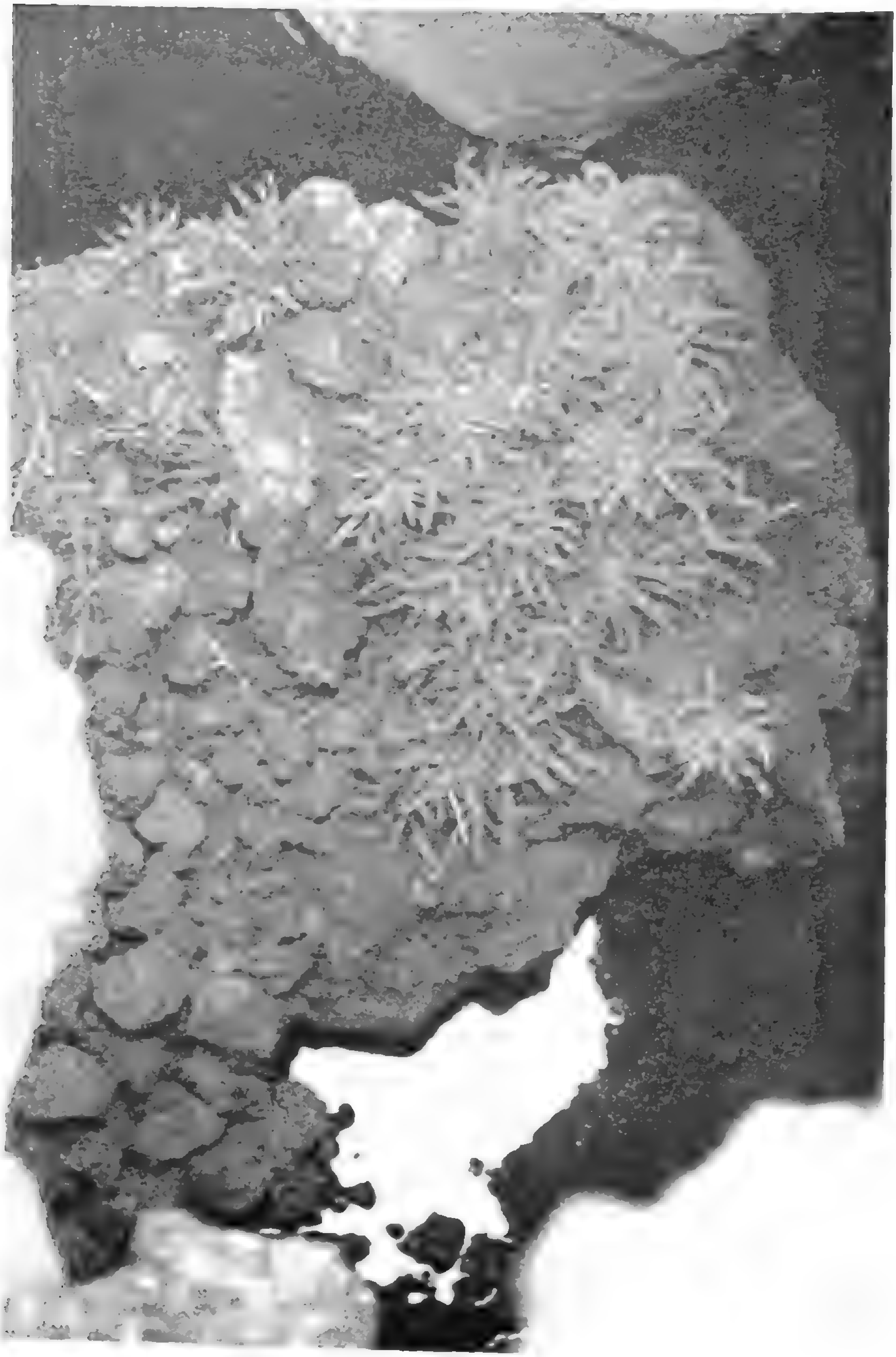


Fig. 1.—Diagram of a vertical section through the center of the fern cavern and its entrance. Lava rock forms the roof, floor, and the central island upon which the ferns grow. A circular pond surrounds the island.

When fairly high in the sky, the sun shines directly upon at least some of the plants. As one looks down through the five-foot entrance, the rich green fronds 10 feet beneath the lava surface are spotlighted into vivid contrast to the dimness of the rest of the cavern. A photograph taken May 12 (Plate 3) shows the ferns in the morning before the sun has reached them. They occupy the higher part of a central island of lava 8 feet wide (Fig. 1), which dropped there when the roof fell in to form the opening. The island is surrounded by a permanent, doughnut-shaped pond two feet deep, its water extending outward to or near the cave's periphery. The cavern is circular and 40 feet in diameter. Often the water surface is covered with a bright greenish-gold bloom composed of a heavy concentration of a very minute unicellular green alga, *Chlorella vulgaris* Beyerinck.

The *Asplenium* fronds are so oriented that the light, coming from directly above, strikes them chiefly at right angles. It is the writer's impression that the central fronds of each plant, in particular, are held much closer to the horizontal plane than is the case in individuals he has seen growing in more normal habitats in the eastern states, and that the lava grotto plants show a decidedly brighter green color. The pinnae retain their intense color and turgidity the year around. Specimens collected July 15, 1944, bore ripe sporangia. Dr. Maxon has verified the identification, and a set of the material is deposited in the U. S. National Herbarium.

The altitude of the water table in this pit is 6,263 feet above sea level. The water temperature fluctuates relatively little with the seasons, lava rock being a poor conductor of heat. January 14 it was 47° F. in the pool's surface water; July 30 it was 57° F. These readings were strikingly higher and lower, respectively, than the estimated mean daily temperatures of these days. The static air within the cavern likewise varies little throughout the year, in comparison with the outside air. The cavern air temperature over the ferns at midday January 14 was 47.5° F.; May 12, 59° F.; and on July 30, 66° F. All three temperatures are presumably quite suitable for photosynthesis and growth in Maidenhair Spleenwort. Observations during every month of the



View of the Fern Island from Directly Above.

year show that this colony has no season of dormancy, despite the extreme summer heat on the lava bed outside the pit.

The relative humidity May 12 at noon over the lava bed was only 4 per cent; that in the cavern close above the ferns was 45 per cent. January 14 at 1 P.M. the relative humidity outside was 29 per cent; within, the reading showed 55 per cent humidity. Both these days were cloudless.

The hydrogen ion concentration of the water in the moat-like pool averages pH 7.6, and all the soil on the rock-island is moistened by capillary rise from the pool.

In addition to the fern cavern described, nine other concealed pits, with overhanging roofs capable of maintaining a high relative humidity, were found in a lava area 1300 yards long by 200 yards wide. Four of the nine caverns have central rock islands similar to that supporting the fern colony, and most of the others have ledges where ferns might find a foothold near the water. Why this species occurs in only one of the ten pits is not easily explained. A species of moss, not yet found fruiting, creeps beneath the ferns. It seems a reasonable assumption that this moss constitutes a stage of succession preceding the stage of fern dominance here. For some reason, no substantial moss mat has developed in any of the other pits; and, therefore, soil to support *Asplenium* is still lacking in them.

The fern garden is fortunately located for freedom from human disturbance or destruction. This part of the Grants Flow is just within the western boundary of the Acoma Indian Reservation, and is communal property of the Pueblo, used only for a limited amount of grazing. These circumstances hold promise for the indefinite preservation of this unusual habitat.

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Sources of the Fern Flora of Colorado

JOSEPH EWAN

The 56 pteridophytes definitely known to occur in Colorado have probably been derived from three chief sources. These are, in the order of their importance, the (1) holarctic, with a few dubious secondary derivatives, (2) Sierra Madran (Mexican), with a secondary Appalachian center of origin, and a (3) "stratospheric" source, the last both small and puzzling.

Wherry classified the ferns of Colorado (1938, p. 139) from the geographic standpoint in two main divisions: a cool-climate or northern and a mild-climate or southern group. The cool-climate group, in Wherry's opinion, includes (a) 23 "circumboreal" species, growing also in Eurasia, (b) eight northern North American derivatives and (c) two Rocky Mountain endemics. The mild-climate group includes (d) nine southwestern upland species, (e) four Pacific slope plants, (f) five midland or eastern species, and (g) five widespread species of western North America.

The present analysis of the sources of Colorado's fern flora stresses the past migrations of its species and recognizes the part Colorado plays in the recognized floristic patterns of western North America. To be sure, the climatic basis for distinguishing two major sources is fundamental in both Wherry's and the present analyses.

HOLARCTIC SOURCE

The species group including those ferns and lycosphens having origins from an holarctic source is the largest and most important, as might be anticipated. To this group belong 28 species, or one-half of the total fern flora. Characteristic species are:

Asplenium viride
Athyrium alpestre var. *americanum*
Cryptogramma Stelleri
Cystopteris montana
Dryopteris Filix-mas
Polystichum Lonchitis

All these occur today in northern North America, and in southern latitudes only as relicts along the higher mountain chains. Such relict distributions are to be interpreted as southward migrations stimulated by the refrigeration which took place over vast areas of the more northern portions of this continent and Eurasia at times of the Pleistocene glaciations. The distribution of these holarctic ferns in Colorado lends support to this concept of Pleistocene interglacial migrations; *Cystopteris montana* and *Dryopteris dilatata,* for example, linger as rare colonies in protected pockets below the broad tundra summits along the Continental Divide. This series of Pleistocene migrations was a feature of both the Rocky Mountain and the Pacific Coast cordilleras. Thus, one of Colorado's holarctic species, *Cryptogramma crispa* subsp. *acrostichoides,* reached as far south on the Pacific Coast as Mt. San Jacinto, in Riverside County, California (N. Lat. 34°), where a stranded relict colony persists at an elevation of 10,805 feet. This recognition of past plant migrations is further substantiated by our knowledge of a group of holarctic flowering plant species likewise persisting on these outpost summits; thus, on Mt. San Jacinto occur also relict colonies of an orchid of northern distribution, the twayblade (*Listera convallarioides*), and the alpine sorrel (*Oxyria digyna*)—both species known from Colorado's tundra as well. Again, a little to the north, in California's barrier range lying between the coastal plain and the interior deserts, rises Mt. San Antonio with a small coterie of boreal species, among them the circumpolar composite *Crepis nana.*

One member of the holarctic group in Colorado deserves special comment for a pattern of distribution which it corroborates. This is the Grape-fern *Botrychium multifidum* subsp. *Coulteri,* which ranges in the Rocky Mountains from Montana and northern Idaho southward to Colorado. It is notably absent, however, from the adjacent Rocky Mountains of eastern Washington but appears again in the Olympic Peninsula, an outlying station. This northern Idaho–Olympic Peninsula pattern is shared by other plant species, among them *Hedysarum occidentale.* Reed Rollins, who has reviewed the genus (1940, p. 229), believes *Hedysarum occidentale* made preglacial migrations into the present disjunct areas where it persists. The Oregon and California stations of *Botrychium multifidum* subsp. *Coulteri* are then, conceivably, colonizations from older populations living today in the Olympics; they are distinct in origin from the Colorado colonies, which I believe to have been derived from Idaho populations of this subspecies.

Two Colorado ferns seem to show fundamentally a distant holarctic origin and yet a more immediate one from some secondary source. *Polypodium vulgare* var. *columbianum* may be a member of the group designated by Piper (Fl. Wash., p. 52) as the Columbian Basin element. *Athyrium Filix-femina* var. *californicum* ranges widely along the Pacific Coast, occupying a greater variety of sites. It is not always associated either with the North Coast coniferous forest element (cf. Mason, 1942, p. 287), or with the California element (cf. Piper, l.c.), but has invaded both plant communities. It must, too, have had an ancient holarctic source. The presence of these two ferns in Colorado may be due to one of three events, or to combinations among them. There has been either: (1) A floristic movement southward in the western cordilleras along two routes, or (2) a west-to-east intermontane movement, or (3) a simply fortuitous dispersal. If the present distribution is the result of a two-way southward movement in the western cordilleras, then one element passed down the Cascade-Sierra axis, another down the Rocky Mountains, without west-east movements across the Great Basin, judging from the morphologic distinctness of the two populations. This seems to have been the floristic history of *Senecio triangularis,* which has a western phase, *Senecio trigonophyllus,* in the Cascade-Sierra cordillera reaching into the mountains of southern California. Again, *Delphinium Brownii* grows in the northern Rocky Mountains and *Delphinium glaucum* replaces it in the Cascade-Sierra axis. In the species-pairs of both *Senecio* and *Delphinium* the Rocky Mountains of British Columbia harbor a population of what may prove to be infraspecific races. The second possible interpretation is that more or less extensive west-to-east migrations took place through the Great Basin, the migrants possibly passing from one mesic habitat of an interbasin range to another across dry valleys and playas during more moist intervals of Pleistocene time.

SIERRA MADRAN SOURCE

The Sierra Madran element is a prominent component of the flora of the western United States.[1] Species having their origin in the Mesa del Norte of northern Mexico and its bounding cordilleras have migrated northward, perhaps in successive migrations at intervals, during the increasing aridity of the Southwest through Tertiary time. This Sierra Madran element is well known among flowering plants, some 40 species having been recognized in the flora of Colorado by Miss Dorothy Hay (Univ.

[1] Cf. Axelrod, Carnegie Inst. Wash., Publ. no. 476, 1937, and no. 516, 1939.

Colo., M.A. thesis, 1939). Four characteristic species are: *Pinus edulis, Datura meteloides, Eupatorium texense,* and *Pericome caudata.* Three fern genera in Colorado, i.e., *Cheilanthes, Notholaena,* and *Pellaea,* are diagnostic members of this Sierra Madran element. There are seven species in Colorado, as follows:

Cheilanthes Eatoni	*Notholaena Fendleri*
Cheilanthes Feei	*Notholaena Standleyi*
Cheilanthes Fendleri	*Pellaea longimucronata*
Cheilanthes Wootoni	

A group of vascular plant species in North America has presumably originated, in part, as a secondary development of this Sierra Madran source. This is the Appalachian element of the southeastern United States, now somewhat differently interpreted from the date of its first definition by C. C. Adams in 1902. Five Colorado pteridophytes may be recognized to have their sources to the eastward. These are: *Asplenium platyneuron, Athyrium angustum* var. *rubellum, Pellaea atropurpurea, P. glabella* var. *occidentalis,* and *Pteridium latiusculum.* Among seed-plants there exists collateral evidence of such Appalachian species persisting today in the state. For example, three species, all occurring in Boulder County, are *Apios tuberosa, Sanicula marylandica,* and *Eupatorium maculatum.* The probable route of migration of these Appalachian species into the Colorado area is not clear. They represent what the ecologist terms "mesic species," that is, plants requiring a moderate but constant water supply. Today they are separated from their eastern congeners by the broad semi-arid high plains. Gleason has pointed out (1906, p. 150) that "migration routes from this [Appalachian] center extend to the north and northwest, mainly along the uplands, and by far the largest part of the flora of the wooded portion of eastern United States, north to the transition zone, can be referred to it." The Appalachian group, having clear floristic relationships with the Mexican Sierra Madran element, represents, historically, a secondary source. It is possible to trace the sources of many genera of the eastern United States to this old Mexican center of differentiation. The present distribution of the sweet gum (*Liquidambar styraciflua*), which ranges northward from the Vera Cruz coast, demonstrates this relationship.

Furthermore, Pennell notices (1935, p. 579) that the scrophulariaceous genus *Seymeria* has "convincingly" moved northward. This fact is demonstrated by the existence of structurally primitive species of *Seymeria* in southern Mexico, more advanced species in northern Mexico, and those showing the greatest transformation living today on the coastal plain of the southeastern United States. The same trend has been noticed by Trelease for the American oaks. Gleason, in his survey of the North American Vernonias (1906, p. 150), directed attention to the fact that "it is an easy matter to trace the species of Vernonieae in the United States back to an origin in Mexico." Again, he comments that "migration . . . has proceeded in two directions, northward through the prairie region and eastward along the coastal plain. . . . In each direction one or more of the primitive structures have been lost, until in Michigan and Massachusetts they have disappeared completely" (1923, p. 197).

In so far as the Colorado fern members of this Appalachian group are concerned, migration into the state has apparently been along the Arkansas River catchment drainage, judging from their present-day distribution.

Endemism in all plant groups is weak in Colorado, and no pteridophytes are well-marked endemics. All those species which are more or less geographically isolated in the region have clear affinities with either the holarctic or the Sierra Madran groups. All appear to be forms of relatively recent origin. Three selaginellas (i.e., *Selaginella densa, S. Standleyi,* and *S. scopulorum*), though characteristic Rocky Mountain species, show diverse origins and affinities and today range beyond Colorado's borders. *Botrychium matricariaefolium* subsp. *hesperium* Maxon & Clausen, localized in Colorado, may be seen from an examination of Clausen's map[2] to be a southwestern derivative of the northern plant. The nearest station of typical *B. matricariaefolium* is in the Black Hills of South Dakota. *Botrychium lanceolatum,* on the other hand, is an example of an holarctic species, frequent in the Pacific Northwest, which, though occurring today in widely separated stations in the Rocky Mountains, has so far failed to differentiate into an endemic phase at the southern limit of its range (cf. fig. 17). Asa Gray and J. D. Hooker in a consideration of the "vegetation of the Rocky Mountain region and a comparison with that of other parts of the world" recognized (1880) that "the characteristics of the Rocky Mountain flora . . . are in no small degree negative. What this flora lacks is perhaps more remarkable than what it possesses."

STRATOSPHERIC SOURCE

The anomalous distribution of *Asplenium Adiantum-nigrum* leads me to consider the possibility of a "stratospheric" source. The distribution of this *Asplenium* in North America is its occurrence reputedly in Marion County, Florida,[3] and in three western states: Arizona, at Flagstaff (Wherry, 1941, p. 97); Utah, at Zion National Park; and about the mouth of Boulder Canyon[4]

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[2] Mem. Torrey Bot. Club 19(2): 83. *fig. 16.* 1938.
[3] Correll, Amer. Fern Journ. 28: 49. 1938.
[4] Type locality of *Asplenium Andrewsii* A. Nels., a synonym.

and at White Rocks near Valmont, Boulder Co., Colorado. Beyond this continent *Asplenium Adiantum-nigrum* ranges from England and France to Africa, Asia Minor, and the Himalayas. More recently it has been detected in the Hawaiian Islands, where it is said to grow at elevations of 500 to 13,500 feet on the highest mountain of Hawaii, the extinct volcano Mauna Kea (Hartt and Neal, 1940, p. 263).[5] The North American occurrences, alone, are anomalous when Florida is added to a more familiar Rocky Mountain pattern of holarctic relicts. The possible misidentification of the Florida specimen must be considered.

The anomalous distribution of certain other ferns known from North America would appear to place them in a group having a stratospheric origin. Thus, *Ceterach Dalhousiae* is known from the New World only from the Huachuca and Mule mountains of Arizona, otherwise from Abyssinia and the Himalayas.[6] *Asplenium platyneuron* is a familiar fern of the southeastern United States, otherwise known from South Africa; this instance of disjunct distribution is approximated by the genus *Menodora* (Oleaceae), discussed by Cain (1944, p. 247) from Steyermark's data. *Asplenium exiguum* is a species of southeastern Arizona and northern Mexico, otherwise known from China and the Himalaya Mountains.[7] Are these several ferns having discontinuous distributions (a) epibiotics or "survivals of a lost flora," (b) polytopic endemics, or (c) stratospheric species? Or do they indicate some other event in the past history of the world's floras?

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[5] Christensen, Index Fil. (p. 99) lists the Hawaiian Islands and "? Puerto Rico." Cf. Christ, Farnkräuter der Erde, 202. 1897; Fowler, Amer. Fern Journ. **30**: 12. 1940.

[6] Cf. Poyser, Fern Bull. **19**: 36, and Clute, *ibid.* **19**: 38–42. 1911.

[7] Cf. Maxon, Fern Bull. **19**: 69. 1911; Amer. Fern Journ. **28**: 140–141. 1938.

If these ferns are "survivals of a lost flora," using Ridley's phrase, for which he proposes the name "epibiotics," we must look to some pattern of distribution of which they are a part. The general subject of "discontinuous distribution" has been treated most recently by Cain (1944, p. 242). Epibiotics are well illustrated, for example, by *Aesculus.* There eight species or species-groups exist as living members of the genus (cf. Cain, fig. 34), along with their Tertiary fossil relatives which occupied more or less intervening areas. In short, the disjunct present-day distribution of the species of *Aesculus* is readily seen as less disjunct when the fossil species are included in the total world picture. Edward W. Berry has elaborated this topic in detail with convincing maps for several tree species in his "Tree Ancestors."

There is no collateral evidence from this body of data, however, which may illuminate our present problem with several ferns of spotwise around-the-world distribution. Cain's general thesis is, in the main, valid when he says that plants with light-weight propagules or dispersal units (that is, spores of mosses, ferns, etc.) "show the same kinds of areas and disjunctions as do the relatively heavy-seeded flowering plants. Phytogeographical conclusions concerning the flowering plants can be extended to cryptogams, and are supported by cryptogams" (1944, p. 284). To be sure, the fact that replicated distributional patterns are not displayed by *Asplenium Adiantum-nigrum, A. exiguum, A. platyneuron,* and *Ceterach Dalhousiae* does not rule out the possibility of their being epibiotics. New information in plant dispersal mechanisms and plant distributions accumulates in ever-mounting volume with every critical generic study reported upon, and this may yet demonstrate the alignment of these now anomalous fern distributions with existing or recognized patterns or other patterns not now distinguished. Hultén encourages the search, with the opinion that "the large disjunctions often noticed in the areas of vascular plants are not due to sudden recent extensions of the area but to reductions" (1937, p. 140).

The second possibility, that of "polytopic endemics," may next be considered. A polytopic endemic is a disjunct species confined to two or more far separated areas, which may have had either a monophyletic or polyphyletic origin. Cain musters the evidence for a monophyletic and against a polyphyletic origin (1944, p. 274), but our chief concern at present is his observation that in the instance of "transcontinental discontinuities, which are purported to be explained by long-distance dispersal" the "exceptional activity of winds, bird flight, etc., must be invoked." In general, however, Cain stresses the "most widely accepted hypothesis," namely, that "polytopic forms are genetically and immediately related, and that the intervening area has been bridged in the past by a continuous series of populations, although not necessarily at any one time."

Closely related is the view that *Asplenium Adiantum-nigrum,* or similarly disjunct species, may be considered "vicarious polydemics," paraphrasing Willis, a term suggesting their "accidental dispersal." However, the views of the biogeographer P. J. Darlington are cogent here, when he says, "the first objection to the term 'accidental' dispersal . . . is that many factors besides accident are involved" (1938, p. 274). It is no accident that some organisms, because of their nature and position, are able to cross water or be borne through the air more often than others. The dispersal of individual land organisms is of course largely accidental, but in the span of time statistical probability determines *what sorts* of organisms will be dispersed.

There remains the third hypothesis of causal agency to be considered here, that of dispersal as "stratospheric species." Stratospheric species are those whose spores travelled in the upper air currents, possibly enormous intercontinental distances, survived the drying effects of transport, and successfully established themselves in ecologically favorable far distant sites.

We are familiar with the prodigious number of spores produced by ferns. Bower, for example, gives a computation for *Polypodium aureum* of 57,600 spores per single sorus! For *Marattia fraxinea,* where the soral areas are well defined, 45,000 spores have been computed for a single synangium. Follow up these facts with a second, that of the lifting power of air, and the basis for a consideration of the wind dispersal of spores has been laid. Darlington points out that air currents, which act upon surface, have a proportionately greater effect upon small objects than upon large ones. To illustrate: An adult house mouse, weighing one ounce, has about fourteen times more surface for its weight than has an animal the weight of an average man. Finally, pressure exerted upon an object by wind varies about as the square of the velocity; thus, a wind of 100 miles an hour exerts 16 times more pressure upon a given object than a wind of 25 miles an hour. Or, to return to our mouse, a wind of 100 miles per hour has about 224 times more effect upon a mouse than a wind of 25 miles an hour has upon man.

Once the spores or light seeds are carried above the ground by whirlwinds they belong to a realm where rising air currents are common. Though we think of wind as a horizontal force, meteorologists know that vertical air currents are really common above the ground. Furthermore, the zoologist R. C. L. Perkins describes small whirlwinds in the Hawaiian Islands which sometimes carry dust up more than 2,000 feet (cf. Gulick, 1932).

Do we have exact data on the transport of fern spores through the air for great distances? Our chief knowledge that fern spores do travel and reach new habitats and establish themselves successfully there is circumstantial, and quite necessarily so. After the destruction of the vegetation of the East Indian island Krakatau by volcanic flow and smothering ash, botanists visited the island and noted the recovery of its flora. Gams reports (1938, p. 396) that after an interval of three years Krakatau supported 10 species of ferns; after fourteen years, 12 species; after 36 years, 49 species; and that, after 46 years, 63 species had established themselves upon the island. In this connection of spore and seed transport, the data presented by P. A. Glick in the course of his studies upon the floating insect populations of the air are of pertinent interest (1939). Glick and his associates took data upon the distribution of insects in the atmosphere, with the use of gelatine collecting-plates carried aloft on airplane flights over Tallulah, Louisiana, in 1931. Seeds were recovered, along with the insect materials, and seeds identified as those of *Erigeron* were taken at altitudes of 3,000 feet, *Populus* seeds at altitudes of from 200 to 3,000 feet, and, on those days when the upper air was "slightly rough" to "rough," and when convection currents were strong, the seeds of *Paspalum Urvillei* were encountered up to 5,000 feet.

R. E. Holttum reviews the topic of spore dispersal among tropical pteridophytes (1938, p. 422) but has few precise data to offer. He says, "it is well established that spores may be distributed freely by the wind, and the factor which limits the ability of a fern to spread and establish itself on new ground is not the ability to travel over long distances, but the ability to survive during the process of transport. . . . Fern spores carried by winds in the tropics must be able to withstand full exposure to sun and relatively dry air during the day for considerable periods if they are to travel far." Thin-walled spores would surely be sharply limited in their dispersal range. J. J. Christensen, in writing of the spores of fungous pathogens (1942, p. 78), has no supporting evidence for transoceanic dispersal when he writes, "there is virtually no information in regard to wind dissemination of spores of pathogens across the equatorial zone. There is circumstantial evidence that spores are not blown commonly from [the North American] continent to [the South American] continent." Furthermore, "the fact that only a relatively few races of stem rust of wheat occur in Kenya, Africa, and in Australia is indicative that large bodies of water are effective barriers to long-distance dissemination of pathogens by air currents." In this regard, "precipitation in many regions unquestionably plays a very important rôle in preventing long-distance spread of spores and perhaps is the most important agent in preventing intercontinental exchange of wind-borne spores." Of the three objections which Cain says may be marshalled against the theory of long-distance dispersal (1944, p. 284), the third of his trio is critical, namely, that "it must be demonstrated that the arriving diaspores [or propagules] can be delivered, so to speak, in a viable condition to a suitable habitat where they must also be able to enter and compete in a closed community." The fact that many habitats are not closed, or only temporarily so, is of course to be remembered. Studies of Krakatau give us data for relatively short transport by air, and not for dispersal over great oceanic distances.

To those who cannot admit stratospheric dispersal as effective for the anomalous distribution of such ferns as *Asplenium Adiantum-nigrum,* let it be said that to deny is easier than to affirm. Our present need is for abundant data from gelatine plate collections made on trans-oceanic flights by aircraft. It is essential to have precise information as to what types of fern spores are most widely distributed, and in what numbers and at what altitudes they occur. For, of the many agencies which operate in seed dispersal among higher plants it is said that "none . . . are adequate to traverse the thousands of miles necessary to cross the oceans." Yet, "some mosses and ferns have minute spores which remain viable for long periods and may very well have been widely spread by air currents" (D. H. Campbell, 1943, p. 5).

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SMITHSONIAN INSTITUTION.

Shorter Note

OUR MOST-RENAMED NATIVE FERN.—The dubious honor of fitting this characterization can apparently be claimed by the American Ostrich Fern. It has been referred successively to the genera *Onoclea, Struthiopteris, Matteuccia,* and *Pteretis;* and under these its species epithet has been variously *nodulosa, struthiopteris, germanica, pensylvanica* (as first spelled), and *pennsylvanica.* In addition, it has been made a variety: Many years ago Lowe classed it as *Struthiopteris germanica* var. *pensylvanica;* and the late O. A. Farwell, who revelled in creating complicated new combinations, managed to find bases for naming it both *Pteretis struthiopteris* and *Struthiopteris struthiopteris* var. *pensylvanica.* In 1916 Nieuwland made it *Pteretis nodulosa,* which stood up under the scrutiny of all the authorities on fern nomenclature for some 29 years. But now Prof. M. L. Fernald[1] finds that, as well as all other combinations of these multiple epithets heretofore made, to be invalid! He holds that a strict application of the current rules of nomenclature requires one that no one happened to create before—*Pteretis pensylvanica.* How long will this stand? —EDGAR T. WHERRY, *University of Pennsylvania.*

[1] Rhodora 47: 123. 1945.

Recent Fern Literature

In a brief article in the Missouri Botanical Garden Bulletin for April, 1945, Henry N. Andrews traces the ancestry of the modern Pine-fern, *Anemia adiantifolia,* of Florida and the American tropics generally, back through geologic time. In Cretaceous shale-beds in western Wyoming are found fossil Anemias very similar in foliage to this surviving relative and with well-preserved fruiting panicles. If these are coated with celloidin and the mineral matter is dissolved out with hydrofluoric acid, sporangia sticking to the celloidin film can be dissected in an oxidizing chemical and any spores they contain made to fall out, much as with living material. Fossil spores thus obtained are very like those of living Anemias in their markings; the cell-structure of the sporangia is similar also in modern and fossil specimens. Fossil fern-stems in the same formations, known under the name *Tempskya,* are suspected to belong with the *Anemia* foliage, but this has not been proved.

In much older formations (Carboniferous) are found ferns called *Seftenbergia,* widely different in foliage, but having sporangia with thickened cells at the apex much as in Schizaeaceae of the present day—thus carrying the ancestral line far back in the earth's history.—C. A. WEATHERBY, *Gray Herbarium.*

Gualterio Looser continues his excellent work on the ferns of Chile with a thorough and scholarly treatment of the genus *Asplenium* in that country,—the first, he tells us, since that in Gay's "Historia" (1853). Looser recognizes 9 species: *A. trilobum, A. Gilliesii, A. fragile* (in an endemic variety only), *A. monanthes, A. obliquum* (in two varieties), *A. macrosorum, A. stellatum, A. triphyllum,* and *A. dareoides* (*A. magellanicum*). Of these, four—*A. macrosorum, A. stellatum, A. obliquum* var. *chondrophyllum,* and *A. dareoides*—are found on the small archipelago of Juan Fernandez,—the first three only there, though Señor Looser remarks that the variety of *A. obliquum* differs very little from the plant of the mainland. Aspleniums, like other ferns, are rare in the dry and arid northern half of Chile. Four species—*A. dareoides, A. fragile, A. Gilliesii,* and *A. triphyllum*—have been found there, all in comparatively recent years and at single localities. All but the first are Andean species, spreading southward; it has presumably migrated from the south.

The other species, and in by far the greatest abundance, are inhabitants, terrestrial or epiphytic, of the forests of the southern half of Chile. Two of them, *A. dareoides* and *A. trilobum,* are known only from Chile and the immediately adjacent parts of Argentina.

Señor Looser gives a key to the species, and for each a full bibliography, citation of specimens, and an illustration—where possible a reproduction of that accompanying the original description. There is also a list of species doubtfully or wrongly attributed to Chile.[1]—C. A. WEATHERBY, *Gray Herbarium.*

Professor Jesse M. Shaver has continued his studies of Tennessee ferns with an article on the lipferns.[2] Three species of *Cheilanthes* are known from the state, *C. tomentosa, C. lanosa,* and *C. alabamensis,* the first being rather rare and the others fairly common in suitable habitats. As in others of this series of papers complete descriptions are given, line drawings with details for each species, and maps showing distribution within the state.—C.V.M.

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[1] Looser, G. Sinopsis de los "Asplenium" (Filices) de Chile. Lilloa **10:** 233–264, 3 pls., 2 text figs. 1944.

[2] Some notes on the Tennessee lipferns. Journ. Tenn. Acad. Sci. **19:** 306–322. 1944.

American Fern Society

Carl Christensen

Carl Fredrik Albert Christensen was born January 16, 1872, at Døllefjelde, on the island of Lolland in southern Denmark, and died November 24, 1942. He entered the University of Copenhagen in 1891, where he studied botany with the famous ecologist Eugenius Warming. He received the degree Master of Science in 1900 and later the same year married Miss Aff Derschen. For a number of years he taught in the secondary schools of Copenhagen until, in 1916, he was appointed Amanuensis at the Botanical Museum of the University. In 1920 he was appointed Curator of the Museum, a position he held until 1933.

Christensen's interest in ferns dated from his student days. When preparing his first publications on ferns he felt keenly the lack of an Index to the group, notable for its intricate synonymy. He undertook the gigantic task of going critically through all the literature, the result being his "Index Filicum" (1905–1906), a remarkably finished work, considering the relatively few years spent in its preparation, that brought him fame. Collectors and museums in nearly all parts of the world sent him their ferns for determination. In connection with this work he published numerous descriptions of new species and memoirs on taxonomic and phytogeographical problems in pteridology. Among the more important of these papers are his "Revision of the Cochlidiinae and Drymoglossinae" (1929), the "Pteridophyta of Madagascar" (1932), beautifully illustrated with line drawings of almost all the species, and his chapter on Filicinae in the "Manual of Pteridology" (1938).

His most important contribution to fern literature is his "Monograph of the Genus Dryopteris" (1913–1920), in which he devised a classification into subgenera based largely on new characters of hairs, scales, and venation. This fundamental work deals only with the species of tropical America. He never found time to extend his monographic work to the species of other parts of the world.

Christensen is well known also for his works on historical botany. In 1918 he published a book on the life and journeys of Pehr Forsskål, a contemporary and pupil of Linnaeus. In this book he showed a talent for historical writing, and in the next year was requested by several botanists to write a history of Danish Botany. He acceded to the request and wrote the "History of Danish Botany with Bibliography" (1924–1926), a book written in a manner that makes it not only informatory but also entertaining reading. He was keenly interested also in Danish floristics, and in company with four other botanists formed a society called "Pentandra," which made botanical excursions each year to different parts of Denmark. His only extensive collecting trip to foreign countries was to Spain and Portugal in 1921, accompanied by the Danish botanist Axel Lange.

Christensen was a delegate of Denmark to the International Botanical Congresses in Cambridge (1930) and Amsterdam (1935), and was appointed a member of the International Committee of Nomenclature. He was elected an honorary member of the American Fern Society in 1915. His loss will be regretted by all members and by a world-wide circle of friends and correspondents.—E. ASPLUND, *Naturhistoriska Riksmuseet, Stockholm.*

CONSTITUTION OF THE AMERICAN FERN SOCIETY, INC.[1]

ARTICLE I. NAME

Section 1. The name of this society shall be THE AMERICAN FERN SOCIETY, INCORPORATED.

ARTICLE II. OBJECTS

Section 1. The objects of the Society shall be to affiliate those who are interested in the study of ferns and allied plants, to foster such an interest, to encourage correspondence and exchange of specimens between members, and the publication of matter pertaining to this group of plants.

ARTICLE III. MEMBERSHIP

Section 1. Any person interested in the objects of the Society shall be eligible to membership.

Section 2. Application for membership accompanied by the required fee of one dollar and fifty cents may be made at any time to the Secretary, and when so received, approved by two members of the Council, and acknowledged, the applicant shall be considered a member for the current year.

Section 3. The admission fee shall be one dollar and fifty cents payable when application for membership is made. This fee shall also constitute the dues for the current year.

Section 4. The annual dues shall be one dollar and fifty cents, payable on January first of each year.

Section 5. Any eligible person may become a life member on payment, at any one time, of a fee of twenty-five dollars, and shall thereafter be subject to no dues nor assessments. All such fees shall be held and invested as a permanent fund, the principal of which shall not be expended, but the income from which may be used for the purposes of the Society on vote of the Council. Contributions for the purpose and other available moneys may be added to this fund at the discretion of the Council.

Section 6. Honorary members may be chosen when unanimously nominated by the Council, and their names submitted to the members at the next succeeding annual election. Three

[1] As amended by the membership at the annual elections of 1935, 1936 and 1940.

fourths of the votes cast on the question shall be required for election, and the total number cast must be at least twenty. Honorary members shall be entitled to all the privileges of the Society without payment of dues. The number of such members shall not exceed five at any one time.

Section 7. Every member in good standing is entitled to all the privileges of the Society including its publications.

Section 8. Members one year in arrears for dues who have been twice notified of their indebtedness shall be considered not in good standing and shall forfeit all privileges of the Society including its publications. Any such member may be reinstated at any time during the succeeding year by the payment of arrears to the Treasurer. If at the expiration of this second year and without justifying cause his dues shall remain unpaid, he shall cease to be a member of the Society, provided, however, that the Council shall have the power to remit any dues for reasons which it considers sufficient.

ARTICLE IV. OFFICERS

Section 1. The officers of the Society shall be a President, Vice-President, Secretary, and Treasurer. Their term of office shall begin January first and they shall serve for one year, or until their successors are duly chosen.

Section 2. The President shall be in immediate charge of the general interests of the Society; he shall appoint all committees not otherwise provided for, and shall report annually to the Society. On or before December 31 of each year, he shall appoint one who is not an officer, and need not be a member of the Society, who shall audit the accounts of the treasurer for that year and who shall report to him as soon after the close of the year as possible.

Section 3. The Vice-President shall act in the absence or disability of the President.

Section 4. The Secretary shall keep the records of the Society, including the official list of members, and conduct the correspondence pertaining to his office. He shall turn over to the Treasurer all money received and shall report annually to the Society.

Section 5. The Treasurer shall receive and hold all moneys belonging to the Society subject to the direction of the Council, receipt for dues, pay bills when approved in the manner prescribed by the Council, make an annual report to the Society, and at the end of his term of office shall deliver to his successor all money and other property of the Society in his possession.

At such times as the Council shall direct, he shall furnish the Council with a statement showing his financial transactions since the date of his previous report, any outstanding indebtedness, the cash balance in hand, and such other simple facts as shall enable the Council to know clearly the financial condition of the Society at the time. He shall close his accounts for the year promptly as of December 31 of each year, and as soon as practicable thereafter shall place in the hands of the auditor such records, vouchers, etc., as shall make possible a proper auditing of his accounts.

Section 6. The unexpired term or vacancy in any office shall be filled until the ensuing election by appointment by the Council.

ARTICLE V. COUNCIL

Section 1. The President, Vice-President, Secretary, Treasurer, and Editor-in-Chief shall constitute a standing committee to be known as the "Council."

Section 2. The Council shall have general charge of the affairs of the Society; of its publications and property; shall have power to expend the Society's money and to act upon all questions not requiring a vote of the Society.

ARTICLE VI. ELECTIONS

Section 1. Before the first day of September of each year, the President, with the approval of the Council, shall appoint a nominating committee, consisting of a chairman and two other members, none of whom shall be an officer of the Society.

Section 2. This committee shall nominate officers for the ensuing year and forward the list of nominees to the President before October fifteenth. Any other nominations, if endorsed by three members in good standing and received by the Secretary not later than October fifteenth, shall be incorporated in the ballot for that year.

Section 3. The President shall immediately thereafter appoint some member not a candidate for office to act as Judge of Elections, and shall forward his name together with the list of nominees to the Secretary.

Section 4. The Secretary shall before November first send to each member of the Society a notice of the election, giving a list of the nominees and the name and address of the Judge of Elections, to whom each member shall send his ballot.

Section 5. Balloting shall begin November first and end December first. Immediately after election the Judge of Elections shall send to the Secretary a true statement of the ballots cast and shall send the ballots to the chairman of the nominating committee. The candidate receiving the largest number of votes shall be declared elected, and shall be notified of his election by the Secretary. In case of a tie the nominating committee shall cast the deciding vote and shall notify the Secretary of its action.

ARTICLE VII. AMENDMENTS

Section 1. Proposed amendments to this Constitution must be presented to the Secretary in writing before October first, signed by three members. The Secretary shall publish such proposed amendments with the notice of the next annual election and they shall be voted upon at that election. If two-thirds of the votes cast for any proposed amendment are in favor of its adoption, and provided that not less than twenty votes are cast on the question of its adoption, the amendment shall be declared adopted.

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ERRATA

Page 36, line 29: For Hoselton, read Haselton.
Page 69, line 23: For "sible," read possible.
Page 76, line 8: Insert word "in" at beginning of line.
Page 78, line 15: For "E," read "I."
Page 93, line 10: For Dorr, read Door.
Page 96, line 3: For plants, read plates.