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Contents

VOLUME 56, NUMBER 1, PAGES 1–48, ISSUED APRIL 26, 1966

VOLUME 56, NUMBER 2, PAGES 49–96, ISSUED JULY 18, 1966

VOLUME 56, NUMBER 3, PAGES 97–144, ISSUED OCTOBER 5, 1966

VOLUME 56, NUMBER 4, PAGES 145–196, ISSUED DECEMBER 23, 1966

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CONTENTS

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American Fern Journal

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American Fern Journal

VOL. 56 JANUARY-MARCH, 1966 NO. 1

Ralph C. Benedict 1883–1965

BENJAMIN R. ALLISON

In the American Fern Journal in 1954, Ralph Benedict wrote an obituary of Matthew D. Mann, Jr., at that time treasurer of the American Fern Society. He said, "Mr. Mann's death was a real loss to the fern world. He was so interested, and such a delightful, unassuming person." This statement applies well to Dr. Benedict; many others outside the fern world will miss him.

Born in Syracuse, N. Y., on June 14, 1883, he graduated from Syracuse University, and received his Ph.D. degree from Columbia University in 1911. He taught biology in various New York City high schools until 1931, when he became associate professor of biology in Brooklyn College. From 1937 until his retirement in 1953 he was a full professor; upon his retirement he became professor emeritus. He was a dedicated teacher, and a host of devoted, grateful students were among his friends. His physician during his last illness was a former student. The proprietor of a restaurant in Chinatown where he occasionally lunched with his fern friends was another.

Dr. Benedict was one of the organizers of the American Fern Society and a member since 1905. He served as president from 1952 to 1955. For 50 years he was a member of the editorial board of the American Fern Journal. His many interests included building up the living fern collections in the Brooklyn Botanic Garden and the New York Botanical Garden.

An account of his first research work in ferns in 1906 was written in a letter to his children on June 20, 1964. Part of this letter follows:

Volume 55, No. 4, of the JOURNAL, pp. 145-188, was issued January 21, 1966, not December 30, 1965, as listed in the Contents for Volume 55.

I have written, with Prof. W. H. Wagner of the Univ. of Michigan, who has had more students doing graduate work on ferns than I believe anyone else has ever had, what may be the last of the series on the Boston Fern work. I am glad to have what may be the end of my engagement now 50 years after I started this particular line of research. The revision of the fern treatment for the second edition of L. H. Bailey's "Encyclopedia of Horticulture" started me with maybe 100 different kinds of ferns to deal with; all were easy until I came to *Nephrolepis*. For some ten years I traced the origins of some scores that florists had produced, produced dozens of new kinds at the Brooklyn Garden, made repeated visits to growers from eastern Mass. to central Ohio, and south to Washington. I paid my way with grants of some $600.00 mostly from the A.A.A.S., and before I finished had registered over 400 separate accessions, a good many of them duplicates. Collections were imported from France and England and collected for me in Florida and Puerto Rico.

Four main articles resulted and a score or so of shorter ones, some on a popular basis. I am writing this as a record to go along with the copies of the three main papers I recently sent to you.

Benedict made many other contributions to fern literature. The last was an article in the American Fern Journal in 1964 entitled "Ferns in the Florists' Trade in 1964."

The members of the Department of Biology of Brooklyn College after his death on August 5, 1965 passed resolutions praising his service "in many different capacities in the department, the College and the Community." He was a born teacher and was particularly interested in teaching teachers to teach. He believed that biology teachers should be not only masters of the technical and factual aspects of their subject matter, but also should be imbued with the humanitarian and philosophical implications of science. He was indeed a Humanist; he knew and loved people. His friendliness and humility added to his charm. On field trips when a beginner asked if oak ferns grew only under oak trees, or if the little dots on the back of the leaves were a disease, he patiently gave the answers. He was also a true naturalist. At his home on Lake George, where he spent his last years, he was a friend of the animals and birds, the woods, the brooks, and the hills. As he walked around his property, the birds perched on his shoulders, and his favorite skunk, Amber, visited him daily.

I talked with him the day before his operation, from which he did not recover, and he said, "I will be glad to have this over so I can get back and be cured by the birds and the ferns." If there is a place somewhere in the skies reserved for God's Noblemen, I am sure Ralph Benedict will be found in the front row.

HEWLETT, LONG ISLAND, NEW YORK.

Two New Species of Ferns from the United States[1]

W. H. WAGNER, JR.

During the course of a broad survey of "problem" fern groups in the United States a number of novelties have turned up; many of these are hybrids which seem to be sterile and incapable of normal reproduction. However, the two ferns to be described below, although probably of hybrid origin, do possess mechanisms for reproduction by spores, and indeed form sizeable populations extending over wide ranges. Both are "critical" species, in the sense that they show close similarities to other well-known ferns, and that is probably the reason they were heretofore overlooked.

POLYSTICHUM

Holly ferns of the north temperate regions have always presented a confusing picture to general taxonomists, especially the species with divided leaflets. Part of the problem has been nomenclatural (Alston, 1940), part the tendency of early authors to collect practically all of the bipinnate species under one taxon, *Polystichum aculeatum* (L.) Roth (Christensen,

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[1] Research was conducted under NSF project GB-2025, "The evolutionary characters of ferns." I wish to acknowledge the curators of the following herbaria for lending necessary specimens: University of British Columbia (UBC), New York Botanical Garden (NY), Gray Herbarium (GH), U. S. National Museum (US), University of Washington (WTU), and Yale University (YU). Also the following persons contributed suggestions and materials: H. E. Ahles, H. G. Baker, D. L. Branscomb, Thomas Darling, Jr., E. S. Ford, R. K. Godfrey, C. Leo Hitchcock, John D. Lovis, C. V. Morton, V. M. Morzenti, and Edgar T. Wherry.

1906, pp. 575–578; Copeland, 1947, p. 108), and part the apparently strong ability of the species of this genus to generate confusing hybrids (Manton and Reichstein, 1961; Meyer, 1959). It has long been known that the polystichums of the western United States involve a baffling series of populations. Of the more recent workers, Joseph Ewan (1942) has made some pioneering efforts to clarify their relationships. The following new species represents a "missing link" in the broad pattern of species relationships which will be discussed in a future paper.

POLYSTICHUM **kruckebergii** Wagner, sp. nov., *Plate 1*

Species *P. scopulino* similis sed foliis minoribus, pinnis magis triangularibus et magis profunde et acriter dentatis, dentibus paucioribus, venis primariis ex costa paucioribus, stipite saepe breviore vel fere nullo differt.

A small, tufted, stout fern of cool rocky places, with ca. 6 (2–11) leathery leaves and masses of densely packed stipes covering the rhizome to make its apparent diameter 2.2 (1.0–3.0) cm. Rhizome upright, up to 10 cm long, covered with matted roots below and with stipe bases above, the actual stem concealed in leaf armor, ca. 0.3–0.7 cm in diameter, occasionally forking. Scales of the stipe bases numerous, pale tan, essentially concolorous, 2–8 mm long, 1.0–2.5 mm broad, diminishing to much smaller size on the rachis. Fronds linear-lanceolate, 18.2 (8–30) cm long, 2.5 (1.3–4.0) cm broad, rigid and coriaceous, dark green and shiny, slightly paler and duller below, the lower pinnae narrowed to nearly sessile, the blade base with small more or less triangular pinnae, except in apparent shade or deep-crevice forms with stipes up to 10 cm long. Lamina provided with scattered, sparse glands. Stipes and lower rachises stout, drying to 1–3 mm thick, pale green or straw-colored. Rachis at first heavily scaly with reddish to pale whitish brown paleae 1.0 mm long or less and 0.5 mm wide or less, these deciduous in older leaves. Pinnae overlapping except in shade forms, mostly ovate-triangular, the median ones, 0.5–1.5 mm long, acute, and with well-developed anterior auricles. Pinnae margins with usually 4–8 conspicuous spreading, pointed teeth more or less tipped with short, hard bristles. Major veins usually ca. 6 (3–9) pairs from the leaflet axis. Sori submedial, in a single row on either side of the costa, except in luxuriant, deeply divided specimens with similar rows of sori on the pinnules. Sori usually becoming confluent at maturity, except in shade forms. Indusium peltate with wavy margins. Sporangia bearing occasional paraphyses, these simple glands like those of the lamina, but borne on the capsules. Spores similar to those of *P. scopulinum* but with more rugose perispores (higher and more numerous crests) than those of *P. mohrioides*. Chromosomes $n = 82$ pairs.

TYPE: Trail to Mt. McLean at Lillooet, British Columbia, Canada, open grassy bank in opening in coniferous woods at 5100 ft., occasional locally, *J. A. Calder 15550* and D. B. O. Savile, J. M. Ferguson (WTZ). Although the bulk of this species' range appears to be in the United States, this Canadian specimen was chosen to be the type because it shows the distinctive features more clearly than any other we have seen.

OTHER COLLECTIONS:

CALIFORNIA: SISKIYOU CO.: near Mt. Shasta, *Lemmon* in 1878 (UC—mounted on same sheet with *P. mohrioides*); TUOLUMNE CO., in deep rock crevice of metamorphics, s. slope Twin Peaks, head of Virginia Canyon, alt. 10,500 ft., Sierra Nevada, *Edward Butts 192* (UC—very small, compact form); COUNTY?: mountains about the head waters of the Sacramento River, alt. 7500–8500 ft., *C. G. Pringle* in 1881 (NY).

OREGON: KLAMATH CO.: near Klamath Lakes, *B. W. Evermann* in 1897 (US); moist slopes, Pete's Point, Wallowa Mountains, alt. 2700 m., *Morton E. Peck 18059* (WTU—mounted on same sheet with *P. scopulinum*); No data, *T. J. Howell* in 1882 (US).

WASHINGTON: YAKIMA CO.: crevices of rocks, Mount Adams, 6-7000 ft. alt., *W. N. Suksdorf* in 1882 (UC—specimen extremely lax, the pinnae of thin texture and widely spaced, apparently growing in deep crevice); *W. N. Suksdorf* in 1881 (US—2 sheets). PIERCE CO.: Mount Rainier, *E. C. Smith 876* (WTU—2 sheets). CLALLAM CO.; a low spreading, stoutish fern growing in inaccessible crags beneath Obstruction Point, alt. 6,200 ft., Olympic Mountains, *F. G. Meyer 1240* (US); Olympic Mountains, without definite locality, *J. Nieman* in 1932 (WTU—extremely small form); high alpine slope of Hurricane Ridge, 6500 ft., *J. W. Thompson 14178* (WTU).[2]

IDAHO: IDAHO CO.: on talus and in crevices above Sheep Creek Lakes #2, Dry Diggins area, Seven Devils Mountains, Nez Perce National Forest, 7500 ft., *A. R. Kruckeberg 3192* (UC, NY); CUSTER CO.: crevices of high cliff near Stanley Lake, Challis National Park, Sawtooth Mountains, 8500 ft., *J. W. Thompson 14039* (UC, NY).

UTAH: BOX ELDER CO.: infrequent dry places in crevices of cliffs, in contact with quartzite and serpentine, head of Middle Fork of Drum

[2]An additional specimen, *Henderson 1209* (US), is indicated as from "Mts. Adams and Hood," and thus is from either Washington or Oregon.

POLYSTICHUM KRUCKEBERGII N. SP. TYPE SPECIMEN (WTU

Canyon, 9500 ft., *B. Maguire 2225* and *A. H. Holmgren* (US, UC, NY—the US collection shows the extremely lax, presumably "shade" condition, and that in NY includes an exceedingly small specimen roughly resembling a small *Woodsia ilvensis*).

BRITISH COLUMBIA: Elizabeth Mine, up Blue Creek, Lillooet Area, 6550 ft., *B. F. Frugtman 610767* (UBC); Creek from s. e. of Big Dog Mountain, Lillooet Area, 6600 ft., under rock in meadow above stream, *Frugtman 610661* (UBC); on serpentine rocks along Ladner Creek, 8–9 mi. in from Jessica, K. V. R., *L. R. Harrison* in 1944 (UBC); Bridge River Mountains, *F. Perry* in 1926 (UBC); Mount Moor, Middle Creek River, 7200 ft., *W. Bird 3455* (UBC); Noaxe Lake, *V. C. Brink* in 1957 (UBC); summit ridge of Cadwallader Range, Bridge R. Mountains, 7000 ft., *E. J. Grieg* in 1954 (UBC).

Some idea of the past problems of identifying this species may be gained from examining the herbarium sheets cited above, and noting their most recent determinations. Of those which had been annotated, one was named "*P. lemmonii*," one as "*P. mohrioides*," 16 "*P. scopulinum*," and seven as "*P. lonchitis*." The newly described fern clearly resembles most closely the latter two species. ("*P. lemmonii*" and "*P. mohrioides*," the most finely divided taxa in this assemblage, are regarded by the present author as the same species.) *Polystichum lonchitis* is a circumboreal, very familiar species of fairly high latitudes (and altitudes in the western mountains); so far as I know, it is never so divided as to be bipinnate, as is *P. kruckebergii*. The problem is much greater in separating the new species from *P. scopulinum*.

Polystichum scopulinum (D. C. Eat.) Fern. was first designated as "*Aspidium aculeatum* var. *scopulinum*" (Eaton, 1880, p. 125). In checking the original description I found it completely insufficient to tell whether the type material of that taxon might not indeed be the fern described as new here. This possibility was increased by the fact that Eaton's original identification of his new "variety" was as "*Aspidium lonchitis*" (= *Polystichum lonchitis*). I therefore requested on loan its type specimen ("Herb. D. C. Eaton. Aspidium aculeatum ['lonchitis' had been erased, and 'aculeatum' written over] Swz. var. scopulinum D. C. Eaton. Upper Teton Cañon, July 28. Hayden's Yellowstone Exped. 1872," YU) which was sent for my study by Dr. John Reeder, and is illustrated in *Plate 2.* The plant is definitely not *P. kruckebergii*; the long segments and general cutting are characteristic of what I have been treating as *P. scopulinum.*

For the diagnosis of the new species, I choose merely to compare it with *P. scopulinum,* the one species which I believe can cause the most serious difficulty. *Polystichum scopulinum* ranges widely in the mountains of western North America from New Mexico to British Columbia, and there is a remarkably isolated population of this fern on Mount Albert in Quebec. Evidently *P. scopulinum* is very much more common than *P. kruckebergii.* Typically *P. scopulinum* is a larger plant, and the pinnae are usually more oblong and longer (sometimes reaching over 4 cm.) than in *P. kruckebergii.* The number of marginal teeth and lateral veins per side of the median pinnae usually is about 12 (8–25) in *P. scopulinum* instead of approximately six in *P. kruckebergii,* thus reflecting the gross difference in pinna form. The pinna margins of *P. scopulinum* are not so bristly and the pinna tips are not so pointed as in *P. kruckebergii.* Also, *P. scopulinum* tends to have a longer stipe, this usually accounting for one-sixth to one-third of the length of the frond, and the series of "auricle-like" triangular pinnae which commonly run nearly to the leaf base in *P. kruckebergii* is lacking.

On the basis of our present knowledge we must conclude that the genetic relationships of the new species are with the complex of *P. lonchitis, P. scopulinum,* and *P. mohrioides.* A broader study of all western United States holly-ferns by the author (to be reported in the near future) leads to the hypothesis that *P. kruckebergii* is a species of hybrid origin between *P. lonchitis* and *P. mohrioides,* the two diploid species between which it is most nearly intermediate. Both of these presumed ancestors have $n = 41$ chromosomes, but their intermediate, *P. kruckebergii,* has double that number, i.e., $n = 82$, indicating that the latter probably arose as an allotetraploid species from an originally sterile diploid hybrid, by spontaneous doubling of the chromosome complements. By the same token, *P. scopulinum* also proves to be morphologically intermediate between two diploids, and it is likewise a tetraploid with $n = 82$. The resemblance of *P. scopulinum* to *P. kruckebergii* may be accounted for in part by their probable sharing of one ancestor, the diploid *P. mohrioides*. The other ancestor of *P. scopulinum* is evidently the diploid *P. munitum* (the abundant western "sword fern"), a species which resembles *P. lonchitis* to some extent, but which is clearly distinct. The characteristics by which *P. munitum* differs from *P. lonchitis* correspond to those in which *P. scopulinum* differs from *P. kruckebergii*, and thus confirms that the two species with divided leaves had different once-pinnate ancestors.

Polystichum kruckebergii evidently extends sporadically over a range from Utah and California north to British Columbia. It has been taken at altitudes as high as 10,500 ft. in California and as low as 5,100 ft. in British Columbia. The commonest habitat is in crevices in rock bluffs or talus, but the plant apparently favors colder and bleaker sites on the average than does *P. scopulinum*. Dr. Kruckeberg describes the Hurricane Ridge locality as follows: "The ferns are accessible with difficulty. The plant grows in rock fissures and crevices, high above the trail to Deer Park, about one-half mile northeast of Obstruction Point. It is well above the loose talus, on a northeast-facing rock wall of what must be Obstruction Point itself. The fern is not common, although it is practically the only fern in this otherwise botanically fruitful habitat. The only other fern present is *Polystichum lonchitis*—one lone plant about 50 yards to the north." (letter, August 3, 1963).

The new species is named for Professor Arthur R. Kruckeberg, in recognition of his contributions to its study, as well as his broad investigations of edaphic factors in the distribution of plants in the western United States.

AMERICAN FERN JOURNAL VOLUME 56, PLATE 2

POLYSTICHUM SCOPULINUM (D. C. EATON) MAXON
TYPE SPECIMEN (YU)

ASPLENIUM

Historically the Florida plant known as *Asplenium heterochroum* Kunze has been a source of confusion. Small (1938) wrote that the species was found in Florida "perhaps as early as *Asplenium resiliens,* but was not distinguished from that plant until many years later." Long after the two species were distinguished, Roland M. Harper (1916) said that *A. heterochroum* is "Very similar to *A. resiliens,* . . . which has a similar habitat but much wider range." As late as 1935, the St. John brothers commented that some plants of *A. resiliens* "are hard to distinguish" from *A. heterochroum.* Nevertheless, the two species are distinct. Maxon (1913) discussed the group of *Asplenium trichomanes* and its American allies in some detail and distinguished 19 species in all, including the two under discussion. In regard to *A. heterochroum* he wrote (op. cit. p. 140), "From *A. resiliens,* with which it was long confused in Florida, it differs conspicuously in its chaff, which, though attenuate, is never hair-pointed, in the shape and position of its sori (these longer and much nearer the midvein), in its thin rather than decidedly coriaceous texture, and usually in the character of its margins. The reduced lower pinnae also are broadly cuneate and more or less flabelliform, never auriculate-cordate as in *A. resiliens.*"

In view of the above it is interesting to recognize the fact, apparently overlooked until recently (Morzenti and Wagner, 1962), that there is a distinct species which is morphologically intermediate between *A. heterochroum* and *A. resiliens.* Evidence from range, morphology, and chromosomes indicates that this taxon probably arose as a hybrid between these two species, and the details of the evidence will be described in the near future by Miss Virginia M. Morzenti. The intermediate plant is capable of spore reproduction, and its geographical range extends beyond that of at least one of its parents. The recognition of this fern as a new species is based upon the fact that it becomes abundant in a number of localities (especially in Florida and North Carolina), it can reproduce independently, and good specimens can be distinguished readily from either of the species with which it has previously been confused. The binomial to be proposed below was published as a *nomen nudum* (Wherry, 1964, p. 164), and the taxon was also listed as "*Asplenium heterochroum* × *resiliens*" (by Wagner, *in* Radford, Ahles, and Bell, 1964).

Asplenium **heteroresiliens** Wagner, sp. nov., *Plate 3*

E gregis *A. trichomanes,* pinnis triangulari-ovatis vel oblongo-ovatis, inferioribus plus minusve descendentibus et saepe in latere postico leviter auriculatis, marginibus subintegris vel dentatis, laminis plus minusve firmis et coriaceis, venis soriferis furcatis supra auriculis basalibus saepe 1 vel 2, soris paullo supramedialibus, sporis magnis, ca. 40–50 μ longis, 32 per sporangium et sporis abortivis tamen paucis, chromosomatibus 180.

A member of the *Asplenium trichomanes* group, with triangular-ovate to oblong-ovate pinnae, the pinnae in the lower third of the frond somewhat descending and tending to form a low auricle on the posterior side of the base; pinna margins subentire to dentate; lamina somewhat firm and leathery; forked sorus-bearing lateral veins above the basal auricle usually 1 or 2; sorus slightly supramedial; normal spores large, ca. 40–50 μ long, 32 per sporangium but abortive spores also observed; chromosomes 180.

Type: About 5 miles northwest of High Springs, Columbia County, Florida, September 8, 1960, *Ernest S. Ford* (MICH). This complete specimen was kept as a living experimental plant at the University of Michigan Botanical Gardens (Accession no. 21689) and pressed on April 20, 1961. It served also as the voucher for chromosome observations. Fronds from this plant will be distributed to other herbaria).

The diagnosis above should serve to bring out the salient characteristics of the plant. A lengthy taxonomic description is not called for here, because most of it would be a repetition of the characters familiar throughout the *Asplenium trichomanes* group. The most important and useful features for the recognition of *A. heteroresiliens* will be discussed below in terms of the corresponding features of its nearest relatives.

The *pinna shape* is intermediate between the nearly oblong pinnae of *A. heterochroum* in which the upper and lower margins are approximately parallel, and the more triangular-ovate ones of *A. resiliens*, the upper and lower margins converging toward the apex. The *lower pinnae* (i.e., in the lower third of the leaf) are somewhat descending as seen in dried specimens, not mostly perpendicular as in *A. heterochroum,* nor mostly descending as in *A. resiliens.* The *pinna margins* are variable, but they are usually shallowly dentate; they are only rarely as sharply crenate-dentate as in *A. heterochroum,* or as subentire or entire as in *A. resiliens.* *Anterior (or upper) auricles* are found at the pinna bases in all three ferns, but *A. heteroresiliens* shows a tendency to form in addition a *slight posterior auricle* also, especially in the basal third of the frond. In *A. heterochroum* a lower auricle is normally completely absent, but in *A. resiliens* it is normally present, and is sometimes nearly as prominent as the upper one.

The *texture* of *A. heteroresiliens* is firm and somewhat leathery, not so herbaceous as in *A. heterochroum* nor as coriaceous as in *A. resiliens.* One of the most useful distinguishing characters among these ferns involves the degree of *forking of the veins,* which may usually be observed directly in *A. heterochroum* but may need a drop of 70 per cent alcohol to be visible in thicker-textured plants. Usually the basal auricles of the pinnae show one or two vein furcations in all three ferns, so that the differences are seen in the sorus-bearing veins above the basal auricles. In *A. heteroresiliens*, a sample of 25 herbarium sheets (the largest frond examined on each) showed variation in number of sorus-bearing veins on the anterior side of the pinnae which were forked from 0 to 4. The average number of forked veins was 1.6. Corresponding observations of a sample of Florida *A. heterochroum* gave a range of 0 to 1, and an average of 0.3. In *A. resiliens* the veins show much more forking (and often a vein will fork twice); the sample of this species (all eastern U.S.) showed a range of 2 to 5, and an average of 3.6.

AMERICAN FERN JOURNAL VOLUME 56, PLATE 3

ASPLENIUM HETERORESILIENS N. SP. TYPE SPECIMEN (MICH)

The *sori* of *A. heteroresiliens* are a little closer to the margin than the costa. The sori in these ferns must be compared in the largest and most ample fronds, for those which are dwarfed or

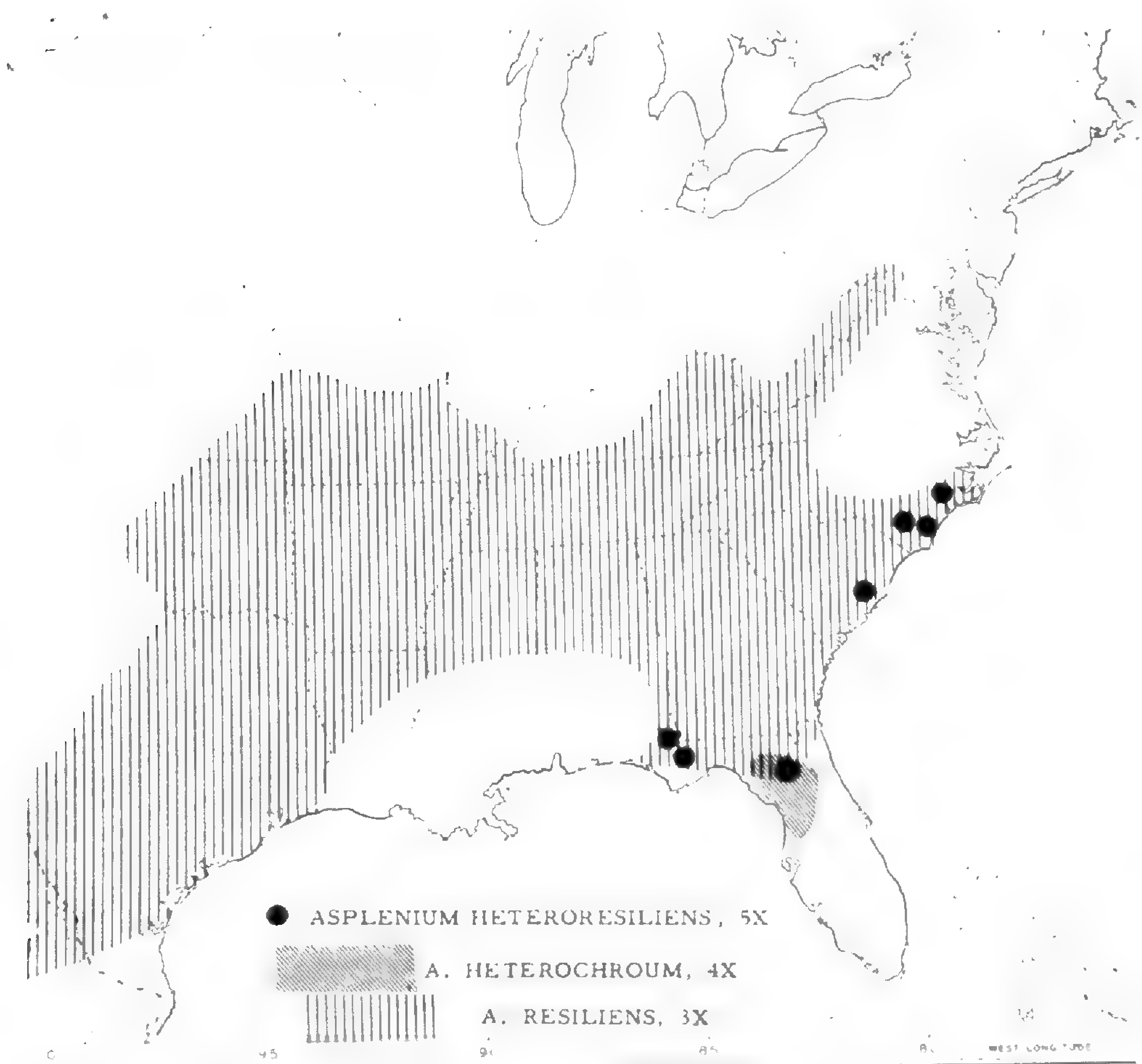

FIG. 1. RANGES OF ASPLENIUM RESILIENS, A. HETEROCHROUM, AND A. HETERORESILIENS, WHICH IS ALSO KNOWN FROM SOUTHEASTERN GEORGIA.

narrowed all appear to be medial. In *A. heterochroum* the sori are normally medial, lying roughly half-way from the margin to the costa; in *A. resiliens* the sori tend to be submarginal except in narrowed pinnae. The *spores* of *A. heteroresiliens* are not 64 per sporangium as in *A. heterochroum*, but are usually 32 per sporangium as in *A. resiliens*. The spores of *A. heteroresiliens* that are not aborted average larger than those of either other species.

The cytogenetic variations in the *Asplenium trichomanes* group of spleenworts have been shown to be extensive. The subject is being investigated by Dr. John D. Lovis of the University of Leeds. In the mountains of the southeastern United States, *A. trichomanes* itself occurs in three sporophytic forms: a sexual diploid, a sterile triploid, and a sexual tetraploid (Wagner, unpublished). The cytological studies of Miss Virginia M. Morzenti and the writer (1962) revealed that *A. resiliens* is an apogamous fern, with a sporophytic chromosome number of 108 ($= 3x$), and a gametophytic number of 108; it lacks sexual fertilization. *Asplenium heterochroum,* on the contrary, is a sexual species; but there are two types in Florida; one of them a tetraploid ($2n = 144$), and the other a hexaploid ($2n = 216$). *Asplenium heteroresiliens* is a pentaploid apogamous fern (in which both "$2n$" and "n" $= 180$). Thus the chromosome situation accords with the hypothesis that *A. heteroresiliens* probably arose from hybridization of a tetraploid, sexual species and a triploid, apogamous species, and the most likely parentage is *A. heterochroum* ($4x$ form) and *A. resiliens* ($3x$). The data to support these statements will be published in the near future by Miss Morzenti. She will also enumerate the known collections of this plant, as shown by the dots in *Figure 1* in comparison with the approximate ranges of its presumed ancestors.

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An Annotated List of the Pteridophytes of San Luis Obispo County, California

Robert F. Hoover

This list represents a small part of the work on a county flora, which has been in progress for nearly twenty years. Most of the specimens here cited are in the herbarium of the California Academy of Sciences,[1] where most of the preparation of this paper was done. Specimens cited without indication of collector are mine.

San Luis Obispo County is in coastal southern California, above Santa Barbara County. The region is largely one of low mountains, both adjacent to the coast and inland, with peaks rising to approximately 4300 feet. The principal ranges are the Santa Lucia Mountains in the northwest, the La Panza

[1]The officers and staff of the California Academy of Sciences, particularly Mr. John Thomas Howell, Curator of Botany, were most helpful in making facilities available and in various other ways. Thanks are also due my wife for secretarial and other help, not only in preparing this report, but in many phases of the entire project.

Mountains in the south, and the Temblor Mountains, which form the eastern border of the county. A subtropical dry or "mediterranean" climate prevails. The summers are hot, the winters mild, and usually light rain falls during the winter season.

POLYPODIACEAE

POLYPODIUM CALIFORNICUM Kaulf.

Common in rocky places from the coast eastward to the La Panza Range.

Whether var. *kaulfussii* D. C. Eaton, a variant with thicker leaves growing in exposed coastal sites, occurs this far south is questionable. Plants from an ocean bluff at San Simeon (*6651*) and from the coast just south of the Monterey County line (*6676*) are of the typical variety, with thin leaves.

POLYPODIUM SCOULERI Hook. & Grev.

North slope of Morro Rock, *Robert M. Lloyd 3378*. Hybrids with *P. californicum* were also found here.

PTERIDIUM AQUILINUM (L.) Kuhn. Bracken.

Common in coastal woodlands (less often in exposed places, where it is dwarfed), in woods in the Santa Lucia Mountains, and occasional in sheltered, shaded places east of the Salinas River: Rocky Canyon near Atascadero. Plants growing wild in Great Britain which I saw were pubescent, just like the plants in western North America. There seems little point, therefore, in following authors who have called our plants var. *pubescens* Underw. or var. *lanuginosum* (Bong.) Fernald.

PITYROGRAMMA TRIANGULARIS (Kaulf.) Maxon. Goldback Fern.

Unquestionably our commonest fern in the wooded hills and rocky places throughout the Santa Lucia, San Luis, and La Panza Ranges and the hills between. It occurs even in exceptionally sheltered and shaded spots in the northern Temblor Range. The following less common varieties are noticeable, but do not have very much geographic significance.

Variety *semipallida* J. T. Howell is a "silverback" fern, having white instead of yellow powder on the lower leaf surfaces. It is found in the northern Sierra Nevada, and apparently also from Del Norte County to San Diego County, including the Santa Barbara Islands. Alt and Grant (1960, p. 161) cited collections from Santa Rosa and Santa Cruz Islands as subsp. *viscosa* (Nutt. ex D. C. Eaton) Alt & Grant; but the specimens which I have examined from those islands, if having the backs of the leaves white, showed none of the resinous secretion visible in plants from farther south. There is in fact no readily apparent way to distinguish these specimens from topotype material of var. *semipallida*. Some of the plants in the Santa Lucia Mountains, especially in Lopez Canyon, have the look of var. *semipallida* when fresh, but after drying the powder appears pale yellow rather than white.

Variety **viridis** Hoover, var. nov.[2] has the backs of the leaves bearing small and sparse waxy granules. Less green than the type specimen, but still characterized by the sparsity of yellow wax, are the following collections: Sycamore Canyon, La Panza Range, *Twisselmann 2513*; Ravenswood, Santa Cruz Island, *J. T. Howell 6231;* Aptos Creek, Santa Cruz Co., *Peñalosa 1487*; Cobb Mountain, Jordan Park, Lake Co., *M. S. Jussel 10*; between Pinecrest and Cow Creek, Tuolumne Co., *J. T. Howell 29010*. This "greenback" fern, as it may very aptly be called, looks quite distinctive among the associated plants. Without magnification it seems to lack any waxy powder, but a lens reveals scattered granules which do not conceal the green surface.

WOODWARDIA FIMBRIATA J. E. Smith.

Wet places around springs and along small streams, mostly in shaded, sheltered stations, near the coast and in the Santa Lucia Mountains. This plant is notably plentiful in the upper

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[2]Foliis in superficie dorsali granulis ceraceis parvis et sparsis praeditis. Type: Tassajera Creek, San Luis Obispo County, California, on wooded slope, mixed with "goldback" and "silverback" ferns, May 13, 1964, *Hoover 8819*.

part of Lopez Canyon, where there are magnificent natural ferneries. After once becoming established, plants may persist where there is no surface indication of moisture, as on a rhyolite outcrop on the coast east of Avila.

ADIANTUM PEDATUM L. Five-fingered Fern.

Cool, permanently moist, more or less shaded banks: upper Lopez Canyon (plentiful); Coon Creek in San Luis Range; coast north of San Carpoforo Creek. Californian plants can be closely matched by specimens from the eastern states; therefore I do not believe that the name var. *aleuticum* Rupr. should be used for our plants, as is done by most recent authors.

ADIANTUM CAPILLUS-VENERIS L. Maidenhair Fern.

Rocky banks kept permanently moist by seepage: first ravine north of San Carpoforo Creek; apparently also in upper Lopez Canyon (plants very few, sterile, and in poor condition). This is an evergreen species, in contrast to *A. jordanii.*

ADIANTUM JORDANII C. Muell. California Maidenhair.

Wooded or rocky slopes in summer-dry places, usually in shade: common from near the coast eastward through the La Panza Range. Plants of this species grow best when rooted in a soil composed largely of decomposed leaves. This species is summer-dormant in nature, but if planted in suitable soil and judiciously watered, it will become evergreen.

DRYOPTERIS ARGUTA (Kaulf.) Watt. California Wood Fern.

Common in shaded woods from the coast eastward to the La Panza Range.

ATHYRIUM FILIX-FEMINA (L.) Roth var. SITCHENSE Rupr. Lady Fern.

Wet places along the coast: near Piedras Blancas Point (*7327*).

I have found variety *californicum* Butters in Hazard Canyon, in a moist thicket (*7368*). Although outside the normal area of the variety, as recorded by Munz (1959, p. 43), the specimen is definitely referable to var. *californicum*, having the branches of the rachis puberulent rather than scaly.

POLYSTICHUM MUNITUM (Kaulf.) Presl. Sword Fern.

Shaded, rather moist places: San Luis Range, especially in the Coon Creek watershed, north slope of Morro Rock, and near the coast from Cambria northward; densely wooded or sheltered, rocky places in the Santa Lucia Mountains.

Subsp. *curtum* Ewan occurs back from the coast, often in drier sites, such as Lopez Canyon (*8813*) and near Rocky Butte. Perhaps most of the sword ferns in the Santa Lucia Range proper, as distinguished from the coastal hills, belong to this less scaly variant. Insufficient attention has so far been given to the plants in their various habitats.

POLYSTICHUM DUDLEYI Maxon.

Damp shaded, rocky banks: upper part of Lopez Canyon (*8807*); coast just south of the Monterey County line (*6672*). Wagner (1963, p. 8) has said, "*Polystichum dudleyi* is so similar to the Hawaiian *P. haleakalense* that it may be the same species."

PELLAEA ANDROMEDIFOLIA (Kaulf.) Fée var. ANDROMEDIFOLIA. Coffee Fern.

Openly wooded or rocky slopes, common in the western part and occasional in less extremely arid localities of the eastern part of the county.

Provisionally referred to var. *pubescens* D. C. Eaton is a distinctive local form found on serpentine rock around San Luis Obispo. The plants are smaller than typical, form a dense clump of leaves, and lack the extensively creeping rhizomes of the typical variety. The rachises and their branches are usually microscopically hairy, but this is not an invariable feature. Similar plants have been seen from San Clemente Island off southern California and from Cedros Island, Baja California.

PELLAEA MUCRONATA D. C. Eaton var. MUCRONATA. Bird's-foot Fern.

Rocky places, most common in the central part of the county; not usually found west of the Santa Lucia Mountains, except for a local variant on the sandstone hills north of Arroyo Grande and east of Pismo Beach. This variant is very vigorous, with many leaves, has leaflets almost twice as long as the typical variety, and its leaves remain greener in age. Herbarium specimens which resemble it have been seen from Santa Barbara and Ventura Counties.

Another variety occurs along the upper San Juan River (*Rodin 7127*). It is var. *californica* (Lemmon) Munz & Johnston, which Maxon called *P. compacta.*

CHEILANTHES CALIFORNICA (Hook.) Mett.

Occasional in sheltered, rocky places, mostly on sandstone or granite, and not ordinarily on serpentine: scattered through the western half of the county, seldom abundant.

CHEILANTHES SILIQUOSA Maxon.

Upper Chorro Creek, among serpentine rocks (*6569* in part); Cypress Swamp, Cypress Mountain (*Twisselmann 3230*). In the California Coast Ranges, the distribution of this species is closely correlated with that of serpentine. The same holds true across the continent in Quebec. But in the Sierra Nevada and in most of the remainder of the wide range of this species, it grows on many other kinds of rock.

Forma **carlotta-halliae** (Wagner & Gilbert) Hoover, comb. nov.[3] grows with typical *C. siliquosa* in the region of upper Chorro Creek (*6569* in part, *Condit* in 1910), and there it is locally plentiful. The authors of *C. carlotta-halliae* correctly stated that it is intermediate between *C. siliquosa* and *C. californica,* and drew the conclusion that it originated by hybridization between the two. However, examination of many specimens shows that it is not a rare and local plant of the Coast Ranges, as previously supposed, but is mixed in several collections of *C. siliquosa* from the higher Sierra Nevada, and apparently occurs even in Quebec (*Fernald & Collins 150*). Frequently on a single leaf some of the pinnules correspond to typi-

[3]Basionym: *Cheilanthes carlotta-halliae* Wagner & Gilbert, Amer. J. Bot. **44**: 738. 1957.

cal *C. siliquosa* in having a continuous marginal indusium, while others have the deeply lobed or interrupted indusium of *C. siliquosa* f. *carlotta-halliae*. My conclusion is that the latter is neither a distinct species nor a proved interspecific hybrid, but rather a sporadic variant which might be found by careful search over much of the extensive area where *C. siliquosa* occurs. Sierra Nevada collections in which some or all of the pinnules are referable to f. *carlotta-halliae* include: talus slope south of Gifford Lakes, Lassen Park, *Gillett & Leschke* in 1957; Jonesville, Butte Co., *E. B. Copeland 328;* Vernal Falls, Yosemite Valley, *C. F. Saunders* in 1906; between Pinto Lake and Black Rock Pass, Tulare Co., *J. T. Howell 17337*.

CHEILANTHES COOPERAE D. C. Eaton.

Crevices in limestone or calcareous sandstone: Franklin Creek, Camp Natoma in Adelaida district, according to Hardham (1960, p. 129).

CHEILANTHES CLEVELANDII D. C. Eaton. (*C. covillei* Maxon).

Rocky places, most commonly on sandstone or granite: summit of Mount Bishop near San Luis Obispo (*R. J. Rodin*); hills near upper Salinas River; more frequent in the La Panza Range, but not common even there; upper San Juan River (*Rodin 7126*). Of the plants found in this county, only a collection from Pine Mountain in the La Panza Range (*6584*) shows the creeping rhizomes with comparatively widely spaced leaves which have been supposed to characterize *C. clevelandii*. The rest are more closely tufted, corresponding to *C. covillei*, but it seems most unlikely that two different species are involved. Since I find a continuous range of variation and no geographic separation of the plants into distinguishable groups, I include all collections under the earlier-published name.

CHEILANTHES INTERTEXTA (Maxon) Maxon.

East of the Middle Branch of Huerhuero Creek, six miles south of Creston, tightly wedged in crevices of granite (*6578* in 1946). The only known station for the species in the county was obliterated by road-building operations about 1950.

CYSTOPTERIS FRAGILIS (L.) Bernh.

Rare locally, in shaded, moist places: between Rocky Butte and Pine Mountain above San Simeon (*8014*); Garcia Mountain south of Pozo; trail from Stoney Creek to Colwell Mesa (*7968*).

MARSILEACEAE

MARSILEA VESTITA Hook. & Grev.

Rare in depressions which are flooded during the growing season but often dry in summer; rare in the upper Salinas Valley: formerly at Atascadero Lake, according to F. M. Essig; seven miles southeast of Santa Margarita (*8169*). At the latter locality, where both *Marsilea* and *Pilularia* were collected on May 11, 1952, no trace of either could be found on the same date in 1964.

PILULARIA AMERICANA A. Braun

Beds of vernal pools, which usually become very dry in summer, in the upper Salinas Valley: near Estrella (*Eastwood & Howell 4201*); seven miles southeast of Santa Margarita (*8170*). Easily overlooked and probably of more frequent occurrence.

SALVINIACEAE

AZOLLA FILICULOIDES Lam.

Ponds, pools, and sluggish streams: noticed particularly in Los Osos Valley and among the dunes south and west of Arroyo Grande; Trout Creek east of Santa Margarita. In late summer the surface of the water may become red from solid masses of this plant.

EQUISETACEAE

EQUISETUM TELMATEIA Ehrh.

Common near the coast in moist ground, and extending into canyons of the Santa Lucia Mountains. When once established, it may spread by its creeping rhizomes into drier ground or persist when the soil becomes drier. Californian plants are generally called var. *braunii* Milde, but it is not clear just how they differ from the Old World typical form of the species.

EQUISETUM ARVENSE L.

In a low, swampy place just north of Piedras Blancas Point (*7768*).

EQUISETUM LAEVIGATUM A. Braun.

Occasional in moist places in or near the Santa Lucia Range: between Rocky Butte and Pine Mountain; forks of San Simeon Creek; Santa Rita Creek; Morro Creek; Serrano Canyon; Alamo Creek near the Cuyama River. Following the recent work of Hauke (1962a, p. 34) I place *E. kansanum* Schaffn. and *E. funstonii* A. A. Eaton in synonymy under *E. laevigatum* as inconsequential variants.

EQUISETUM FERRISSII Clute.

Moist places near the coast from Villa Creek between Cayucos and Cambria to Morro Creek, and probably overlooked elsewhere. These plants, according to Hauke (1962b, p. 61) are hybrids between *E. laevigatum* and *E. hyemale*. In general appearance some individuals resemble more closely one of the presumed parents, some the other.

EQUISETUM HYEMALE L. var. AFFINE (Engelm.) A. A. Eaton.

Low, moist places near Oceano (*6422*) and Arroyo Grande, and probably elsewhere. The species is insufficiently collected, and some specimens of it can readily be confused with robust plants of *E. ferrissii*. Hauke (1962b, p. 60) has referred all North American plants of the species to var. *affine*, although there is complete intergradation with the typical Eurasian form.

SELAGINELLACEAE

SELAGINELLA BIGELOVII Underw.

Common in rocky places, on sandstone, serpentine, granite, etc., from the coast eastward through the La Panza Range.

ISOETACEAE

ISOETES NUTTALLII A. Braun.

In damp soil of meadow between Rocky Butte and Pine Mountain, Santa Lucia Range (*7897*).

ISOETES ORCUTTII A. A. Eaton.

In moist swales in sandy soil under pines at Cambria (*6948*, *7855*). The plants which I have identified as *I. orcuttii* may simply be individuals of *I. nuttallii* which average smaller in all of their parts. In any case, size differences do exist between the plants at Cambria and those in the mountains above.

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Native Ferns in a Tennessee Wild Garden

HELEN BULLARD KRECHNIAK

Ferns are so plentiful on the Cumberland Plateau in Tennessee where I live that years ago I had dozens brought in from the woods to plant about our log cabin on a wooded hillside. But not until we built a small pond in the ravine behind the cabin and cleared the brush and weed trees from the surrounding hills did I begin my long-cherished plan to develop this area as a wild landscape. Native ferns, it seemed to me, would be the best, as well as the cheapest, means of enhancing the natural beauty of the area. Used with the wealth of Mountain Laurel, Rhododendron, Flame and Pink Azalea, equally available, and some already there, ferns should heighten the effect of the wild landscape. Dogwood is everywhere!

By the time my yard boys and I had brought several loads of ferns from the already staked right-of-way for the new Interstate Highway about half a mile away, I began to realize that I was moving too fast and in unknown territory. I sought help from an old friend, an amateur naturalist of long experience with Plateau and Great Smokies flora and fauna. He loaned me his copy of Jesse M. Shaver's book, *Ferns of Tennessee.* This excellent and lovingly put together study disclosed that my Ozone area, 60 miles west of Knoxville on U. S. Highway 70, was a rich repository of fern species, all sandstone types. About 20 species were listed as growing along our Fall Creek.

Soon afterward a coincidence put me in touch with a nationally known fern enthusiast in Niles, Michigan. Kay Boydston sent me much fern material on loan, including back issues of the AMERICAN FERN JOURNAL, and excellent advice. I began to learn the possible scope of my undertaking and to approach my fern collecting with serious study. I soon decided to limit my garden and my study to ferns of the Ozone area, and to keep a simple herbarium. Surprisingly, to me at least, I have found and identified 32 species, all but five of which I have managed to establish in my fern gardens.

In the beginning I had tried simply to provide the ferns I brought into my garden with conditions resembling those from which I had dug them. With study I could work with more assurance, although this simple principle is still the cardinal one. The acid soil and semi-shade from which most of them were taken is about all my oak- and pine-covered dry hillside has to offer. On this, only the Christmas Fern and Leatherwood Fern will endure in places too distant for watering. But in the beds which can be watered during the dry spells—which occur almost every year in August and September—careful preparation by terracing, digging deeply, and incorporation of well-rooted sawdust and rotted manure, has produced fine stands of ferns. A thick mulch of old sawdust is maintained at all times.

During the four years since we made the pond, I have brought in more than 2,000 ferns, most of which are thriving. Since two of the summers brought severe drought and one winter was the coldest on record, I believe the ferns which have survived are safe.

FIGURE 1. FERN GARDEN ALONG A ROCK WALL, INCLUDING DRYOPTERIS MARGINALIS, ADIANTUM PEDATUM, POLYSTICHUM ACROSTICHOIDES, ASPLENIUM PLATYNEURON AND CAMPTOSORUS RHIZOPHYLLUS. (PHOTOGRAPH BY JOHN D. KAVICH.)

One long bed near the pond is kept moist to suit the needs of the ferns there, which include all but the wet-loving species. Cinnamon Fern, Royal Fern, and Sensitive Fern, and other moisture-demanding species are at the head of the pond and behind the 120-foot dam where the spring branch resumes its flow to the gulf. This spring some of the over-exuberant species, such as Hay-scented Fern and New York Fern, which serve admirably in covering raw features like stumps, will have to be disciplined.

With the basic landscape design set, the Laurel, Rhododendron, Stewartia, and other wild shrubs and ferns thriving, it is sheer pleasure in the spring to add clumps of wild flowers in suitable spots. A new drift of bird-foot violets and a broad colony of yellow *Trillium* surrounded by ferns are adequate reward for all the effort and patience expended on the plantings.

My 2,000 ferns seem all too few and I can see myself trailing the bulldozers which soon will come to tear a cut through the wonderful talus slope overlooking Fall Creek, and bringing home another 2,000 ferns for a new area. I may even get them planted if the increasing flood of visitors, wishing to see my wild garden, does not keep me talking away all of the daylight hours.

OZONE, TENNESSEE

Isoëtes echinospora var. braunii in Interior Alaska

VERNON L. HARMS

Isoëtes echinospora Dur. var. *braunii* (Dur.) Engelm. (including var. *maritima* and var. *truncata*) has previously been reported in Alaska only from the Pacific Coast regions of the Aleutian Islands, Kodiak Island, and southeastern Alaska (*Fig. 1*). A collection of *Isoetes* made by Eyerman in 1939 from Prince William Sound, Alaska, was referred by Boivin (1961) to *I. asiatica* (Makino) Makino (*I. echinospora* var. *asiatica* Makino), apparently representing the first report of this entity in North America. In northwestern Canada, distributional records for *I. echinospora* var. *braunii* have been cited (*Fig. 1*) for northeastern Alberta from Lake Athabasca (Porsild, 1943), for Mackenzie District from Prelude Lake near Yellowknife (Thieret, 1963) and Great Bear Lake (Porsild, 1943), and for southeastern Yukon from Sheldon Lake along the Canol Road (Porsild, 1951). The latter collection was noted by Porsild as constituting "a considerable extension of the northwestern range of the species."

During August, 1964, I collected several plants of *Isoëtes echinospora* var. *braunii* at George Lake in Interior Alaska (63°46′N, 144°35′W) about 40 miles southeast of Delta Junc-

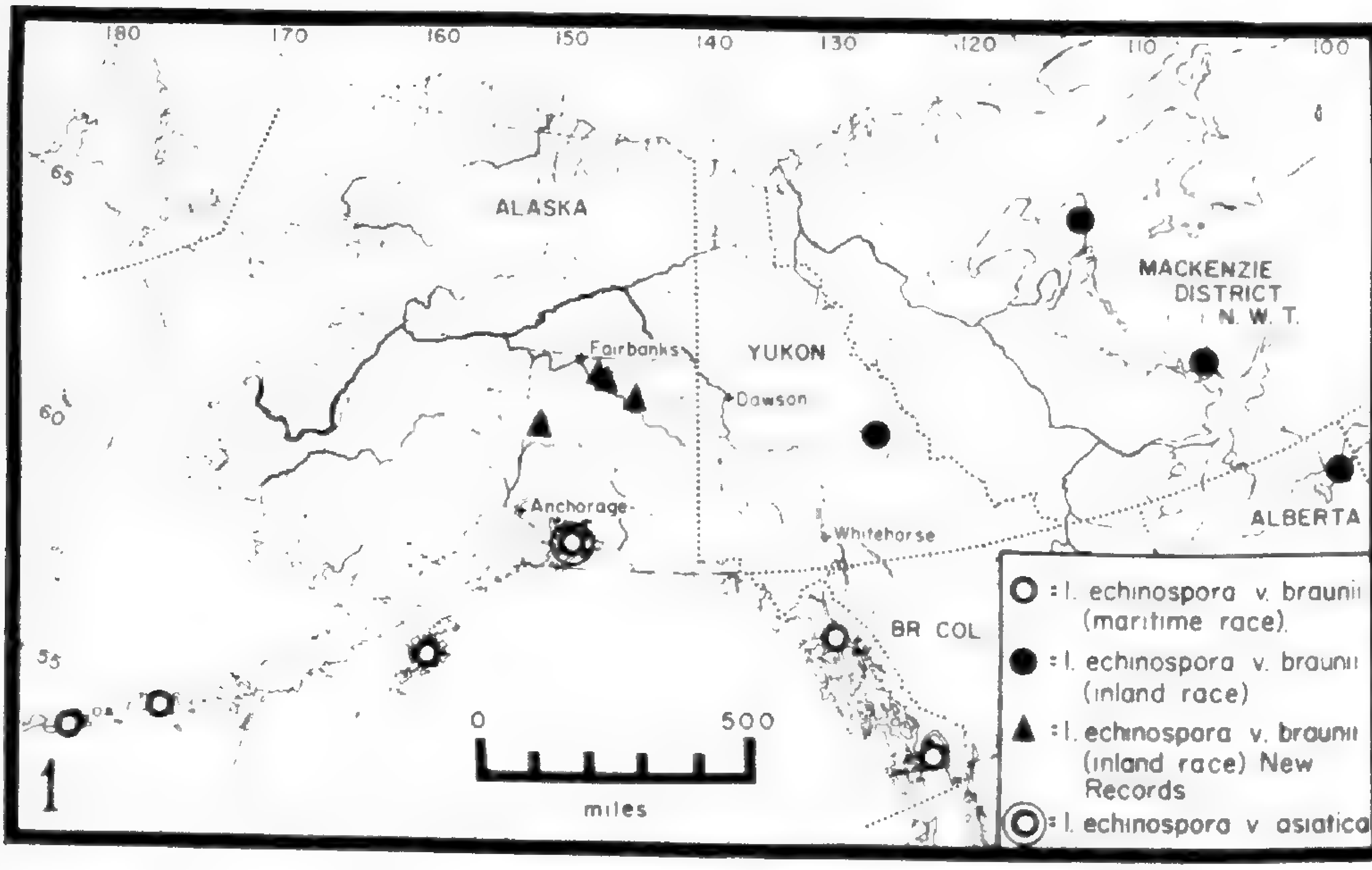

FIGURE 1. KNOWN DISTRIBUTION OF ISOETES IN NORTHWESTERN NORTH AMERICA.

tion, alt. ca. 1275 ft. (*Harms* 3173-B). Subsequently, while working through previously unidentified or unprocessed materials at the University of Alaska Herbarium, I encountered the following additional specimens of this entity from Interior Alaska: Harding Lake (64°25′N, 146°52′W), ca. 50 mi. SE of Fairbanks, alt. 800 ft., 21 Aug. 1951, *Brina Kessel;* Harding Lake, 15 Sept. 1953, *Galen Smith* 2283; Birch Lake (64°18′N, 146°40′W) ca. 60 mi. SE of Fairbanks, alt. 800 ft., 15 Sept. 1963, *Galen Smith* 2274; and an alpine lake near Summit on the Alaska Railroad, Alaska Range (63°20′N, 149°08′W) alt. ca. 2400 ft., 4 Sept. 1953, *Galen Smith* 2205. It is of interest that the label on the latter specimen indicates that the plant was "common" in the area. All of the specimens cited above are deposited in the University of Alaska Herbarium.

The Harding Lake locality in Interior Alaska represents a significant 500-mile westward extension of range for *Isoëtes echinospora* var. *braunii* from Porsild's Sheldon Lake site and about an equal extension northward from Kodiak Island (*Fig. 1*). It would represent at least a 250-mile extension north of the aforementioned Prince Williams Sound locality of var. *asiatica*. This taxon may eventually prove to be far more widely distributed in Alaska and the Yukon than formerly supposed.

Most of the *Isoëtes* specimens from Interior Alaska clearly belong to the inland *braunii* (or *truncata*) type, which both Boivin (1961) and Löve (1962) included under *I. echinospora* subsp. *muricata* (Dur.) Boivin var. *braunii* (Dur.) Engelm. However Galen Smith's collection (#2274) from Summit, in the Alaska Range, could possibly be referred to the Pacific Coast var. *maritima* on the basis of its shorter leaves averaging only 4.4 mm (2.4-6.2 mm), more stomata on the leaves, and the somewhat shorter, thicker, and blunter spines on the megaspores. All previous collections in Alaska, excepting Boivin's (1961) report of var. *asiatica* at Prince William Sound, have been referred to var. *maritima* (Hultén 1941, 1960). Boivin (1961) submerged var. *maritima* under var. *braunii*, not considering it worthy of taxonomic recognition, but Löve (1962) gave it subspecific rank as *I. echinospora* subsp. *maritima* (Underw.) Löve. Since many of the plants from Summit, and at least some from Harding Lake and George Lake, could have been assigned almost as easily to var. *maritima* as to var. *braunii*, a really clear-cut distinction between these supposed taxa, at least in Alsaka, seems doubtful. Thus, I would tend to accept Boivin's viewpoint that they should be merged and henceforth will refer to them merely as the "maritime" and "inland" races of *I. echinospora* var. *braunii* respectively without necessarily implying the existence of taxonomically meaningful differences between them. However, in possible support of Löve's taxonomic interpretations, it should be pointed out that intermediates between subspecies or geographical varieties are to be expected where, and if, their ranges meet. I do not know how consistent the reported differences between the "maritime" and "inland" races of *I. echinospora* var. *braunii* are elsewhere, but the intermediacy of Interior Alaskan populations may be attributable to the fact that Alaska probably represents the past, and perhaps even the present, geographical connection between these races which have previously been thought disjunct in their distribution. I suspect, but at present can hardly substantiate, that in Interior Alaska there may be a positive correlation of both the altitude above sea level and the depth of submergence under water with the degree of morphological approach that plants of the "inland" race make to the "maritime" race (i.e., shorter leaves and blunter megaspore spines). The 21 individual plants from Interior Alaska included in the five above-cited collections of this species still represent too small a sampling to warrant many taxonomic conclusions.

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DEPARTMENT OF BIOLOGICAL SCIENCES, UNIVERSITY OF ALASKA, COLLEGE, ALASKA

A Checklist of Ferns in Lincoln Parish, Louisiana

ROBERT S. MAPLES, JR. AND DALLAS D. LUTES

This is the first of a series of studies on the ferns of north central Louisiana. Consideration of distribution of fern species in this region has been neglected except for incomplete references made by Brown and Correll (1942) and Moore (1956). The present study was initiated to prepare a checklist of species and their habitats within Lincoln Parish.

Lincoln Parish is located in the central part of north Louisiana (Lat. 32°27′ to 32°45′N and Long. 92°25′ to 92°55′W). The terrain consists of low, rolling, sandy or clay hills. The present vegetation is mainly second growth coniferous forest, with hardwood species restricted to small stream valleys and in related swampy or boggy regions.

A preliminary survey indicated the existence of a number of probable fern habitats, such as open fence rows, open woodland, dense woodland, open bogs, and shaded bogs. The selection of twelve sites for examination and collection of fern species was made to include all the habitat types.

Prior to 1962, ten fern species had been reported from this area. These were: *Osmunda cinnamomea*, *Athyrium filix-femina*, *Thelypteris hexagonoptera*, *Polystichum acrostichoides*, *Pteridium aquilinum* var. *pseudocaudatum* (Brown & Correll, 1938); *Botrychium virginianum*, *Botrychium dissectum* var. *obliquum*, *Woodwardia areolata*, *Onoclea sensibilis*, and *Polypodium polypodiodes* (Moore, 1956).

During the present study, six species previously unreported from this area were found: *Asplenium platyneuron*, *Osmunda regalis* var. *spectabilis*, *Woodwardia virginica*, *Thelypteris normalis*, *Ophioglossum vulgatum*, and *Cystopteris fragilis*. In addition, the reported, but unconfirmed, presence of the following species were noted: *Woodsia obtusa*, *Athyrium thelypterioides*, *Adiantum pedatum*, and *Lygodium japonicum*.

DISTRIBUTION OF FERNS IN LINCOLN PARISH

ASPLENIUM PLATYNEURON (L.) Oakes.—The Ebony Spleenwort was collected in seven of the selected stations, always restricted to open, well-drained sandy sites. It was often found growing with herbaceous species along fence rows.

ATHYRIUM FILIX-FEMINA (L.) Roth ex Mertens.—The Lowland Lady Fern occurred in ten stations. The individual habitats varied from steep, moist, well shaded slopes to shaded, very moist bogs.

BOTRYCHIUM DISSECTUM Spreng. var. OBLIQUUM (Muhl.) Fern. —The Grape Fern was observed in seven of the assigned stations. The common habitat was shaded, moist, humus-rich soil forming high level banks along small streams.

BOTRYCHIUM VIRGINIANUM (L.) Sw.—The Rattlesnake Fern was found in five collecting stations, generally occurring along steep, shaded slopes that extended away from a stream basin.

CYSTOPTERIS FRAGILIS (L.) Bernh.—The Fragile Fern was observed in six stations, generally found in cut-over areas near surface water sources.

ONOCLEA SENSIBILIS L.—The Sensitive Fern occurred in six of the selected stations, usually occurring near surface water in sparsely shaded areas. In one site, plants were found under a low bridge, completely shaded.

OPHIOGLOSSUM VULGATUM L.—The Common Adder's Tongue was collected in two widely separated stations, but in similar habitats: shaded, well drained, level soil with a high humus content.

OSMUNDA CINNAMOMEA L.—The Cinnamon Fern was found in eight of the collecting sites. The specific habitat was a shaded, very moist, humus-rich soil. The maximum development occurred in semi-swampy to boggy sites.

OSMUNDA REGALIS L. var. SPECTABILIS (Willd.) A. Gray.—The Royal Fern occurred in eight stations and exhibited the most varied habitats of the species observed in this study. The maximum development was noted in specimens that occupied shaded, moist, boggy areas. Specimens that occupied more open, drier areas were smaller.

POLYPODIUM POLYPODIOIDES (L.) Watt.—The Resurrection Fern was observed in ten selected stations. All specimens collected were epiphytic on the larger stems of several hardwood species, including *Ulmus americana*, *Quercus phellos*, *Nyssa sylvatica*, and *Fraxinus americana*.

POLYSTICHUM ACROSTICHOIDES (Michx.) Schott.—The Christmas Fern was found in eleven of the selected stations. The preferred habitat appeared to be shaded, steep slopes with a north-facing exposure.

PTERIDIUM AQUILINUM (L.) Kuhn var. PSEUDOCAUDATUM (Clute) Heller.—The Bracken Fern occurred in ten collecting stations. The specific habitat varied from open forest to open meadow sites on well-drained, sandy soil.

THELYPTERIS HEXAGONOPTERA (Michx.) Weatherby.—The Broad Beech Fern was collected in five of the selected stations. The habitat varied from well-shaded hillhides to shaded, moist bogs.

THELYPTERIS NORMALIS (C. Chr.) Moxley.—The Southern Shield Fern was not found in any of the collecting stations, but was discovered in a shaded ditch near Ruston. The specimen could have been an escape from an ornamental planting, but has lived for at least three years in the natural state and in this study was considered native to this area.

WOODWARDIA AREOLATA (L.) Moore.—The Dwarf Chain Fern was found in seven of the stations. The only observed habitat was a well-shaded, moist bog.

WOODWARDIA VIRGINICA (L.) J. E. Sm.—The Virginia Chain Fern was observed in two widely separated stations, but of similar habitat type: shaded, moist bog.

This study has established the presence in Lincoln Parish of approximately 35 percent of the recognized fern species of Louisiana.

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DEPARTMENT OF BOTANY AND BACTERIOLOGY, LOUISIANA POLYTECHNIC INSTITUTE, RUSTON, LOUISIANA.

Shorter Notes

A SELAGINELLA NEW TO MEXICO AND TWO NEW STATIONS.—Although Knobloch and Correll's *Ferns and Fern Allies of Chihuahua, Mexico* described most of the species and varieties known to occur in Chihuahua, the authors realized that other taxa would be found there in time. Being the largest state in Mexico, there are many areas yet untouched botanically. In August of 1964 I accompanied a small group of naturalists from El Paso, Texas into the Juarez Mountains (Sierra del Paso del Norte). This range borders the city of Juarez on the south and, in fact, the suburbs of the city have extended into the lower, northern part of the range. At the base of Cerro Bola in the shade of some large boulders I found *Selaginella mutica* D. C. Eaton var. *mutica* (*Knobloch 2110*). This is the first record of this species in Mexico. Its occurrence near the border in Mexico is not surprising in view of its presence in the Franklin Mountains just to the north across the Rio Grande River in the United States. The identification was kindly checked by Dr. Rolla Tryon, Jr., and specimens have been deposited at the Gray Herbarium and the herbarium of Michigan State University.

Five days earlier I made a small collection in the vicinity of the railroad station at Temoris on the line from Ojinaga, Chihuahua, to Topolobampo, Sinaloa. This is a new locality record for all of the specimens gathered there, including *Selaginella pallescens* (Presl) Spring (*Knobloch 2106*) and *S. rupincola*, (*Knobloch 2104*).—I. W. KNOBLOCH, *Department of Botany and Plant Pathology, Michigan State University, East Lansing, Michigan 48823.*

ADDITIONS TO THE FERN FLORA OF MISSISSIPPI.—In two years of fieldwork with the vascular flora of Mississippi I have discovered two species of ferns that have apparently not been recorded before from the state. Voucher specimens have been deposited in the University of Mississippi Herbarium.

Ophioglossum vulgatum L. was found in low, rich woods at Bay Springs about 12 miles northeast of Oxford, Lafayette County, on June 22, 1965 (*Riley W. Brooks & Thomas M. Pullen 49*). *Asplenium pinnatifidum* Nutt. was discovered in a crevice in a vertical face of a sandstone cliff overlooking Bear Creek in Tishomingo State Park, Tishomingo County, on August 5, 1965 (*Thomas M. Pullen 65353*). The nearest known locality for this species is probably in south-central Tennessee.

This work was supported by a grant from the Committee on Faculty Research of the University of Mississippi.—THOMAS M. PULLEN, *Department of Biology, University of Mississippi, University, Mississippi 38677.*

Notes and News

THE ILLUSTRATED FLORA OF ILLINOIS.—A multi-volumed work on the complete flora of Illinois is under preparation at Southern Illinois University. Robert H. Mohlenbrock, chairman of the Botany Department at that institution, is editor and chief contributor to the series. The work will provide an account of every kind of plant known to occur in Illinois. Keys for identification will be provided, along with descriptions, synonymy, discussions of ecology and economic uses, chromosome numbers, and distribution maps for each species. In addition, line illustrations of each species, showing diagnostic features, are being prepared by a staff of illustrators. Publication will be by the Southern Illinois University Press. Financing for the project is by the University Press, the Graduate School, and the Mississippi Valley Investigations, all of Southern Illinois University. A board of advisers has been created to screen the manuscripts and serve as consultants for the project. The board is composed of Dr. Gerald W. Prescott, Michigan State

University; Dr. C. J. Alexopoulos, University of Texas; Dr. A. J. Sharp, University of Tennessee; Dr. Rolla M. Tryon, Jr., The Gray Herbarium; and Dr. Robert F. Thorne, Rancho Santa Ana Botanic Garden. The first volume, dealing with the ferns of Illinois, is scheduled for publication in the autumn.—R.H. MOHLENBROCK, *Department of Botany, Southern Illinois University, Carbondale, Illinois 62903.*

FERN AND SHADE PLANT SHOW.—The Third Annual Los Angeles International Fern Society Fern and Shade Plant Show will be held Saturday, May 21 from 1:00 PM to 10:00 PM and Sunday, May 22 from 10:00 AM to 6:00 PM in the International Building at the Los Angeles County fair grounds at Pomona, California. This year's show is expected to be much larger than the previous ones since it will be held in quarters with ample room for all exhibitors. The show is open to everyone, including commercial growers and non-members of the Los Angeles International Fern Society. Exhibits will include garden, competitive, educational, and commercial displays of ferns, exotics, and shade plants, as well as materials including baskets and pottery used to grow ferns.—BEE OLSON, *13715 Cordary Ave., Hawthorne, California.*

American Fern Society

ANNUAL MEETING IN 1966.—The annual meeting of the Society will be held in conjunction with that of the American Institute of Biological Sciences at the College Park campus of the University of Maryland. The AIBS meetings are scheduled from August 14 to 19. The Society will hold a luncheon on Monday, August 15, with papers to be read that afternoon.

A post-meeting field trip will be led by Dr. Clyde F. Reed, 10105 Harford Road, Baltimore, Maryland. Additional information will appear in the next issue. Persons wishing to present papers at our session should immediately send their name, the title of their paper, and the presentation time and projection equipment required to Dr. I. W. Knobloch, Department of Botany, Michigan State University, East Lansing, Michigan 48823.

Report of the President for 1965

With much satisfaction I report that the Society is in good shape and that it will be in good hands during the forthcoming year. The steadfast and dependable work of the various officers during the past year is to be commended.

Our annual field foray preceding the American Institute of Biological Sciences meetings at the University of Illinois at Urbana, August 15–20, was well attended. We were most fortunate to have Dr. Robert H. Mohlenbrock, of Southern Illinois University, Carbondale, as our leader. Dr. Mohlenbrock and several of his student assistants together with the University administration, our most hospitable host, extended to members of the foray some of the finest hospitality ever accorded a foray party of the Society. The University provided free buses and other vehicles for transportation and "published in conjunction with the American Fern Society Foray, 1965," at its expense, an illustrated and descriptive 24-page pamphlet prepared by Dr. Mohlenbrock entitled "Habits and Habitats of Southern Illinois Ferns." This, I am sure, will be sent free of charge to any member of the Society who requests a copy from Dr. Mohlenbrock. For two days we were shown choice ferns in beautiful habitats in southern Illinois, and we were also treated to some fine evening illustrated talks on the flora of the region. The Society is, indeed, grateful to Dr. Mohlenbrock and his University for their warm hospitality.

At the formal meeting in Urbana on Monday, August 16, our local representative, Dr. G. Neville Jones, presided over a short but stimulating program that Dr. Irving W. Knobloch, our Vice President and Program Chairman, had assembled. Dr. Jones also arranged for a fine luncheon that was well attended. It was an honor for the Society to have as its guest at the luncheon Dr. Henry Conard, of Grinnell College. The Council also held its annual meeting in Urbana; several items of Society business were dealt with.

Special services to the Society have been rendered this year by Mr. Robert G. Aborn, who served as Judge of Elections, and by Mr. Luke S. Albert, who served as Auditor. The Society is indebted to both of them and appreciates very much their generosity.

The year was marked by the passing of one of the Society's most beloved and respected members, Dr. Ralph C. Benedict, who was a founder of the American Fern Journal and who served the Society as its president from 1952 through 1955. On field trips Dr. Benedict's robust enthusiasm for all nature was contagious to everyone. He was, indeed, a boon companion who will be sorely missed by all of us.

It is a source of much gratification to those of us who are close to Mr. Conrad V. Morton that during the year the Society bestowed upon him an Honorary Membership. It was the Society's modest way to show its great appreciation of Conrad for his many outstanding contributions to the field of pteridology, not to mention his many generous services to the Society.

It has been a distinct honor to me to have served as president of the American Fern Society during the past year, and to have had the support and cooperation of my fellow officers and the entire membership of the Society.

Respectfully submitted, DONOVAN S. CORRELL, *President*

Report of the Secretary for 1965

At the close of 1965 The American Fern Society had 662 members from all of the United States except the Dakotas, Nevada, and New Mexico, and from 26 countries abroad.

I regret to report the death of six members: Dr. Otto Emery Jennings, a member since 1911; Mr. Thomas O. Carlson, 1946; Dr. Howard F. L. Rock, 1954; Mr. E. Wiper, 1963; Dr. William N. Steil, a member for nearly 50 years whose publications on the apogamy of ferns are well known; and Dr. Ralph C. Benedict, an Honorary Member of The American Fern Society, whose keen interest in and service to the Society dated from 1905. Dr. Benedict was editor of the first issue of the American Fern Journal in 1910, was a member of the editorial board for 50 years, and was president of the Society for four years.

The annual meeting of the Society, held August 16 with the American Institute of Biological Sciences on the campus of the University of Illinois, was attended by about 30 people. Dr. Donovan S. Correll, president of the Society, introduced Prof. G. Neville Jones, who presided over the morning's program. Titles of papers follow in the order of presentation: "The Genus *Polypodium* in Florida," by A. Murray Evans; "The Ferns of Alabama," by Blanche E. Dean, read by Mrs. Amy Mason; "New Approaches to the Analysis of Spore Detail," by Clara S. Hires; "The Ferns Among Biogeographic Affinities of Tristan da Cunha," by Alice F. Tryon; "Some Problems in the Genus *Cheilanthes*," by Irving W. Knobloch; and "The Gametophyte of *Diplazium*," by Lenette R. Atkinson. Miss Clara Hires had an excellent exhibit dealing with ferns in the exhibit hall.

At a meeting of the Council on August 15 it was voted to reprint the constitution of the Society, incorporating the amendments passed since its 1961 printing.

Respectfully submitted, LENETTE R. ATKINSON, *Secretary*

Report of the Treasurer for 1965

Receipts this year are up slightly and expenses are down, so the Society has finished another year in good shape. Receipts from sale of back numbers were less than anticipated. However, several large orders are pending, so next year this item should improve. Another area of improvement will be gifts. Most of these this year represent royalties from Dr. Wherry's *Fern Guide*. In December 1965 Dr. Wherry deeded all title and interest in both his northeastern and southeastern Fern Guides to the Society.

This report represents my last official act as treasurer of the American Fern Society. During the past four years I have become acquainted with many members by name, and have met some of the people who go with the names. Now when I hear certain places mentioned I automatically think, "There is a Fern Society member there," and I feel more involved. It has been interesting to maintain the contact I have had with most of you; my only regret is that the numerous duties of the treasurer's office precluded development of a more extensive correspondence with the members.

I hope that you will treat my successor, Dr. Henry, as well as you have me. I turn over to him this office with much pleasure at being released from the time-consuming duties, but with reluctance at losing contact with so many of you.

Receipts

Cash on hand, January 1, 1965			$220.91
Membership dues			
Arrears	$ 60.00		
Renewals	1,997.17		
Sustaining	200.00		
New	293.43		
Advances	128.60		
		$2,679.20	
Subscriptions			
Arrears	3.00		
Current	444.80		
Advances	781.95		
		1,229.75	
Sale of back numbers		356.32	
Sale of reprints		264.24	
Gifts		498.76	
Advertising in Journal		67.00	
Miscellaneous		47.01	5,142.28
			$5,363.19

Disbursements

American Fern Journal			
Vol. 54, No. 4	$863.36		
Vol. 55, No. 1	916.13		
Vol. 55, No. 2	880.01		
Vol. 55, No. 3	958.24		

	$3,617.74	
Reprints	182.40	
Envelopes, mailing of Journal	30.00	
Printing, stationery	69.56	
Treasurer's expense	126.24	
Secretary's expense	81.46	
Editor's expense	60.00	
Shipping and handling back numbers	22.22	
AIBS	400.00	
AAAS	10.00	
Miscellaneous	39.82	
		4,639.44
Cash on hand, January 1, 1966		$723.75

Statement, 31 December 1965

Assets

Cash in Industrial National Bank	$723.75	
Cash in Green Point Savings Bank		
Bissell Herbarium Fund	887.45	
Life Membership Fund	1,388.09	
Una Weatherby Fund	3,750.45	
Accounts Receivable	129.95	
Inventory, Journal	6,660.10	
Library	396.00	
		$13,935.79

Liabilities

Advance Dues	$128.60		
Advance Subscriptions	781.95		
Fund Balances			
Bissell Herbarium Fund		887.45	
Life Membership Fund		1,388.09	
Una Weatherby Fund		3,750.45	
General Fund		6,999.25	
			$13,935.79

Respectfully submitted, Richard L. Hauke, *Treasurer*

Report of the Auditing Committee

I hereby certify that I have seen the books and accounts of Dr. Richard L. Hauke, treasurer of the American Fern Society, Inc., and have obtained confirmation of the correctness of the Society's balances on hand as set forth in detail in the accompanying Report of the Treasurer for 1965.

LUKE S. ALBERT, *Auditor*

Report of the Judge of Elections

The results of balloting for officers of the American Fern Society are as follows:

For President	
Mildred E. Faust	310
Warren H. Wagner, Jr.	3
Irving W. Knobloch	1
Rolla M. Tryon, Jr.	1
For Vice-President	
Irving W. Knobloch	309
Donald Branscomb	1
Neill D. Hall	1
Donald G. Huttleston	1
Warren H. Wagner, Jr.	1
For Treasurer	
LeRoy K. Henry	312

I therefore declare the following candidates elected to office: Mildred E. Faust, President; Irving W. Knobloch, Vice-President; LeRoy K. Henry, Treasurer.

The amendments to the Constitution were voted on as follows:

Under Article VI, Section 2 replace "October 15" by "October first"

For—304 Against—7

Under Article VI, Section 3 replace "immediately thereafter" by "October first"

For—306 Against—3

I therefore declare these amendments to the Constitution of the American Fern Society approved by the membership and now in force.

It is also my privilege to declare Conrad V. Morton elected to Honorary Membership in the American Fern Society.

Respectfully submitted,

ROBERT G. ABORN, *Judge of Elections*

Report of the Librarian and Curator for 1965

The function of this office during the year has been, as it has over the past years, largely to provide information on techniques of culturing ferns, about suitable localities for study and exploration, and concerning fern identification. It seems to me that there does exist some need for a general information center, and that this could be provided by an officer of the Society.

The Society's collection of pteridophytes, made up as it is of dried herbarium specimens, mostly a half-century old and from the northeastern United States, is not suitable for demonstration purposes. I am thus unable to provide demonstrations upon request. Also, the collection is not large or significant enough to warrant requests for loans from investigators. I strongly recommend, therefore, that the Society sell the collection if possible, and use whatever money that results for publication costs of the Journal.

Likewise, the library is rarely consulted. It is not an extensive or important collection of literature, and most of the items have little use to most members of the Society. The publication over the past decade of a number of excellent modern guides to pteridophytes with accurate keys and illustrations makes much of the literature in the library out of date and superfluous.

I should like to suggest that the office of Librarian and Curator either be abolished as no longer needed, or that it be redefined to emphasize what through the years has become its present function: a source of information and advice. There is no longer any interest in the herbarium and library as such.

and the maintenance of these collections by our Society has become an anachronism.

Respectfully submitted,

WARREN H. WAGNER, JR., *Librarian and Curator*

Report of the Spore Exchange

The Spore Exchange in 1965 has been reasonably active. Seventy-seven letters have been received requesting lists or spores. There were 888 packets of spores distributed; spore lists were mailed to 160 members.

Only seven members in the United States contributed spores to the Exchange. Even though the number of domestic species received was small, the total number of species was gratifying, as nearly one hundred species of rare ferns from far away lands were received. The Exchange includes spores of 270 species and varieties contributed in 1964 and 1965.

Members are urged to send in spores or fertile fronds before October. The ferns you consider common may be desired in another part of the country, or in other countries. The success of the Spore Exchange depends on the participation of all the membership. Even if you have sent the same species before, remember that the stock in the Exchange must be fresh.

About seventy species of fresh stock were collected in New Zealand and other South Sea areas. During the month I spent in New Zealand, I collected spores of many rare ferns. Those that are new to the Exchange are included in the current list, and about thirty of the New Zealand species that were listed on the 1962 list have been stocked with fresh spores. Over five hundred species of fern spores have been available through the Exchange during the years 1962 to 1966.

My sincere thanks go to the many contributors who have made the exchange prosper.

Respectfully submitted,

NEILL D. HALL, *Custodian of the Spore Exchange*

New Members

Mr. Michel Bertrand, 72 Saint-Pierre, Rigaud, Quebec, Canada
Mr. Ginko Craig, 2124 Rock Ave., Apt. 1, Mountain View, Calif.
Mr. Paul R. Dennison, 1539 Maple St., Pasadena, Calif. 91106
Mr. James K. Falconer, 1222 S. Patton Ave., San Pedro, Calif. 90731
Mrs. T. (Elfreda) Finch, R. R. 1, Box 75, N. Maple Ave., Basking Ridge, N. J.
Mr. Ronald R. Nerkowski, 2116 Denny St., Simi, Calif. 93065
Mr. Victor J. Larson, 1726 N. 73rd St., Wauwatosa, Wis.
Mr. Gilles Lemieux, Faculté de Foresterie et de Geodesie, Université Laval, Quebec 10, P. Q., Canada
Miss Frances H. Rathbun, 82 Woodcrest Blvd., Kenmore, N. Y. 14223
Mr. Howard Markell Smith, Dept. of Biology, Univ. of Virginia, Charlottesville, Va.
Mrs. W. L. Smith, 404 Lansdowne St., Marshall, Texas 75670
Dr. Ian M. Sussex, Dept. of Biology, Yale University, New Haven, Conn. 06520
Miss Roberta Tunquist, 224 Kennebec Hall, University of Maine, Orono, Maine 04473
Mrs. Hilda G. Watson, 1129 W. Lovers Lane, Arlington, Texas 76010

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CONTENTS

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VOL. 56 APRIL–JUNE, 1966 No. 2

Northwest Vacations

THOMAS DARLING, JR.

In the late summer of 1953 I decided to visit my sister in Seattle, spend some time in that vicinity, and then continue to Alaska on an extended tour. Although my primary objective was sight-seeing, I planned to search for ferns when opportunity permitted.

On August 28th I took the midnight plane from New York to Seattle, reaching my destination in the early morning. My sister met me at the airport, and in the afternoon we left on a camping trip to the Olympic Peninsula. That night we spent under the stars on the shore of Lake Crescent halfway across the peninsula, spreading our sleeping bags beneath towering Douglas Firs amidst a luxuriant bed of the Sword Fern (*Polystichum munitum*).

The next day dawned bright and clear as we headed toward the Rain Forest along the Hoh River on the western coast, where prevailing winds bring excessive moisture from the Pacific, causing an annual rainfall averaging 140 inches or more. Near the entrance to the nature trail were gigantic specimens of the Western Bracken (*Pteridium aquilinum* var. *pubescens*) considerably taller than a man's head.

Here also I first became acquainted with the Deer Fern (*Blechnum spicant*), which I was to see later many times in Alaska and elsewhere. This species is a source of food for deer, elk, and caribou during the winter.

In the Rain Forest itself giant trees reached skyward as we made our way along the nature trail—Sitka Spruce, Western Hemlock, Douglas Fir and Western Red Cedar. In the depths of the forest tree trunks and fallen logs were covered with a dense

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carpet of luxuriant mosses, and enormous mushrooms of varied hues were everywhere in evidence. Although ferns were plentiful, no rarities were observed in the limited time we had available.

The following day I took an early morning plane for Juneau, the Alaskan capital. While there I made it a point to visit the famous Mendenhall Glacier, one of the largest in the world, and most impressive in its vast expanse and vivid coloration. We were told that natural ice from this glacier is generally used in the city in preference to that made artificially. On rock ledges at the foot of the glacier was a plentiful growth of the Parsley Fern (*Cryptogramma acrostichoides*).

A short boat trip over a picturesque section of the Inside Passage took me from Juneau to Skagway on Chilkoot Inlet, starting point of old-time prospectors headed for the Klondike during the days of the gold rush. In the local cemetery, where the victims of gun battles lie buried (including a notorious outlaw as well as the town sheriff), the Oak Fern (*Phegopteris dryopteris*) was conspicuous. The western form of the Licorice Fern *(Polypodium vulgare* var. *occidentale)* was common in the crevices of Skagway cliffs.

From Skagway I journeyed to White Horse in Yukon Territory by way of a quaint narrow-gauge steam railroad (since converted to Diesel), traversing the rugged White Pass along the Trail of '98 in Alaska, cutting across part of British Columbia, and finally entering Yukon Territory, with breath-taking views and magnificent mountain scenery the entire distance.

Continuing by plane to Fairbanks, I spent about a week in this area at the height of the autumn coloration, using the city as a base for trips north of the Arctic Circle. First I flew to the colorful Eskimo village of Kotzebue on the Bering Strait, spent the night in this interesting community, then returned to Fairbanks by way of Nome. The weather was so clear that as we passed over the western tip of the Seward Peninsula the Diomede Islands in Bering Strait were plainly visible, and just beyond, the rocky headland of Siberia.

My second tour out of Fairbanks was again by plane. This time I crossed the Arctic Circle in eastern Alaska en route to the Indian village of Fort Yukon on the Yukon River. Here I chartered a bush plane to fly along the East Fork of the Chandalar River to take pictures of moose and caribou. Returning by commercial plane from Fort Yukon to Fairbanks, we stopped briefly at Circle Hot Springs. Here, in the shadow of the Arctic Circle, hot baths and warm swimming pools are found. Assisted by the tepid environment and long summer days, enormous vegetables are grown in the thermal gardens, with fifty-pound cabbages not uncommon. On rocks just above the springs, where the steaming water seeps out and is carried in pipes to the baths, I noted a thriving colony of an arctic form of the Lady Fern (*Athyrium filix-femina* var. *sitchense*). This previously reported station has been cited as one of the few locations for this species in the entire Central Yukon River District, the other locations also being at hot springs.[1]

Journeying by Alaska Railway from Fairbanks to Anchorage, I stopped off for several days at McKinley National Park to glimpse the big game and wild life for which this area is noted, and also to get close-up views of snow-capped Mt. McKinley. Exploring the tundra and foothills back of the hotel, I found the Rusty Woodsia (*Woodsia ilvensis*) and the Fragrant Shield Fern (*Dryopteris fragrans*) abundant on rocky ledges. The latter was also plentiful at the base of Castle Rock, a striking formation overlooking the Savage River. It seemed strange indeed to find this fern, so rare in New England, actually common in McKinley National Park.

I continued by railroad via Anchorage to Seward in the southern part of the Kenai Peninsula, where I embarked on a week's cruise over the famed Inside Passage to Seattle. It was the last year the Alaska Steamship Co. carried passengers over this scenic route, thenceforth restricting its activities to freight

[1]Seamman, Edith. 1949. Ferns and fern allies of the central Yukon Valley. Amer. Fern J. **39**: 47–48.

traffic only. Passing the Columbia Glacier, then stopping at Valdez, we docked briefly at Cordova on the Gulf of Alaska. Here I ventured along a trail into the coastal rain forest, where *Blechnum spicant*, the Deer Fern, grew in profusion. On an exposed cliff near Cordova Harbor I found an unusual form of the Fragile Fern (*Cystopteris fragilis*), remarkable by reason of the pinnae not being deeply incised into the usual divisions, giving a blunt-lobed effect. Specimens were later requested by, and donated to, the National Herbarium, Smithsonian Institution, Washington, D.C.

Passing snow-capped mountain peaks, glittering glaciers and steep-walled fjords, with stops at Juneau and Ketchikan, we traversed the final stretch of the Inside Passage and reached Seattle on September 24th, where I again visited my sister. I then made several trips into the Cascade Mountains. On a fold-boating expedition to Lake Kachees we explored the lake shores and adjacent ravines. In addition to the Parsley Fern (*Cryptogramma acrostichoides*), the graceful Fragile Fern (*Cystopteris fragilis*), and the ubiquitous Licorice Fern (*Polypodium vulgare* var. *occidentale*), the most interesting find of the day was the beautiful Holly Fern (*Polystichum lonchitis*).

Dr. Wherry had suggested that while I was in Seattle I look up Carl S. English, Jr., employed by the Government as a landscape gardener at the Lake Washington Ship Canal, who is thoroughly familar with the ferns of the Northwest. Mrs. English, who is also a professional student of the botany and zoology of this region, often accompanies her husband on his various field trips. Together they have taken beautiful color photographs of wild flowers, animals, birds, and mountain scenery, and their lectures are in constant demand.

In the brief space of an hour or so a visitor to the Englishes' luxuriant fern garden becomes acquainted with most rarities of the Northwest, representing collections from far distant localities. Here can be seen an unusual dwarf form of the Maidenhair Fern (*Adiantum pedatum*) collected in the state of Washington, the Oregon Shield Fern (*Dryopteris oregana*) from a locality near Mount Hood, Bird's-foot Cliff Brake (*Pellaea mucronata*) from California, the Green Spleenwort (*Asplenium viride*) from lime-bearing high mountain cliffs, Anderson's Shield Fern (*Polystichum andersonii*) from the Cascades, Giant Chain Fern (*Woodwardia fimbriata*) from southern Oregon, the Northern Grape Fern (*Botrychium boreale* var. *obtusilobum*) from the north side of Mount St. Helens, Skamania County, Washington, and the Gold-back Fern (*Pityrogramma triangularis*) from the Columbia River region.

One day Mr. English invited me on an expedition to Wenatchee National Forest in Kittitas County. Here, on serpentine cliffs above the Teanaway River, he showed me two uncommon species of *Polystichum*, Eaton's Fern (*P. scopulinum*) and the Shasta Fern (*P. lemmonii*), in company with the more frequently encountered Holly Fern (*P. lonchitis*). Also found were the Dense Cliff Brake (*Pellaea densa*) and the delicate, little Lace Fern (*Cheilanthes gracillima*). At higher altitudes, growing on the rocky ledges of cascading rivulets in a setting of variegated mountain wild flowers, we saw the Alpine Maidenhair (*Adiantum pedatum* var. *aleuticum*), in strange contrast to the shady, forest habitat of its eastern cousin.

On the first day of October I accompanied Mr. and Mrs. English on a visit to the slopes of Mount Rainier. The autumn coloration, featuring the Vine Maple, was at its height as we drew near the snow-capped mountain. In rock crevices along the White River at the northern approach we saw the Rocky Mountain Woodsia (*Woodsia scopulina*), and in evergreen woods near Silver Springs the Sword Fern (*Polystichum munitum*) formed a thick covering on the forest floor. We attempted to drive to Yakima Park on the north side of Mount Rainier, but a severe snowstorm forced us to turn around at the halfway point. As Mr. English stopped to put on chains, a large black bear appeared in the roadway, watched curiously for a few moments, then disappeared before his photograph could be taken. With this Rainier trip my 1953 visit to the Northwest came to an end, and I flew back East on the midnight plane.

It was the summer of 1962 before I made a return visit to the Pacific Northwest, this time for a reunion with my two sisters, my brother, and his family. In late July we met at Lake Louise in the Canadian Rockies for several days of sightseeing and enjoying the beauty of this mountain paradise. One interesting side trip featured a visit to the Columbia Icefield on the border between Banff and Jasper National Parks, where melting glacier waters flow in three different directions—northward into the Arctic Ocean, eastward into Hudson Bay and the Atlantic, and southwestward into the Pacific Ocean. By snowmobile we bounced unsteadily over the Athabasca Glacier, largest body of ice south of the Arctic Circle, to Mount Andromeda and the "hanging glaciers."

Following our sojourn in the Canadian Rockies, we traveled by train and boat to Seattle to attend the World's Fair. We enjoyed the various exhibits, rode the monorail to downtown Seattle, and had breakfast in the revolving restaurant atop the Space Needle. Although the view over the city was superb, cloudy weather marred the distant view, and Mount Rainier unfortunately failed to put in an appearance.

Before leaving Seattle I renewed my acquaintance with Carl English and his wife, and arranged to join them on August 11th for another field trip into the Cascade Mountains. This time we planned to go to Mount Baker National Forest in an area farther north than I had previously visited. At a point about one mile east of Monte Cristo, Snohomish County, we began climbing the talus slope of the steep mountainside. At an elevation of approximately 4000 feet we detected a few scattered but vigorous clumps of the rare Anderson's Shield Fern *(Polystichum andersonii)* under low, spreading Mountain Alder (*Alnus sinuata*). This handsome fern is noted for the occasional proliferous buds on the upper surfaces near the ends of the fronds. In sunny locations in the near vicinity the Alpine Lady Fern (*Athyrium alpestre* var. *americanum*) was plentiful.

Continuing our climb to high cliffs at an elevation of about 4700 feet, we found occasional specimens of the attractive little Green Spleenwort (*Asplenium viride*). Nearby the Alpine Maidenhair (*Adiantum pedatum* var. *aleuticum*) and the Long Beech Fern (*Phegopteris polypodioides*) were conspicuous. All during the ascent we saw beautiful wild flowers of all colors in great profusion, varying in species according to the elevation and location. Colorful members of the Heath family were particularly in evidence. In one locality Mr. English pointed out the Alaskan Buttercup (*Ranunculus cooleyae*), an extreme rarity in this latitude.

Returning to the car via a circuitous route past the Columbia Cirque and an eroded trail down a steep gully, we passed a shaded area where the relatively rare Mountain Wood Fern (*Dryopteris oreopteris*) grew sparingly beside the path, together with the more common Oak Fern (*Phegopteris dryopteris*).

In mid-August I left Seattle and flew back to Washington after a fairly strenuous but most enjoyable Northwest Vacation.

5008 LARNO DRIVE, ALEXANDRIA, VIRGINIA 22310.

Fern Records for Echols County and the State of Georgia

JUANITA NORSWORTHY

Echols County is in the Coastal Plain Province, in south-central Georgia. Its soils are mainly sandy and of Pleistocene origin. Older geologic formations occasionally outcrop along the banks of larger streams. The topography is generally flat and has poor drainage. The dominant vegetation consists of pines (*Pinus caribaea* Morel., *P. serotina* Michx.) and Saw Palmetto (*Serenoa repens* (Bartr.) Small). Along the major streams the flatwoods vegetation yields to upland deciduous associations.

Intensive collecting of ferns and fern allies in Echols County has revealed 28 species, including three species not known previously from Georgia. Most of the taxa collected were reported by McVaugh and Pyron (1951). But the list given in this report represents new records for Echols County and extensions of range within the Coastal Plain. The first three ferns are reported here for the first time as members of the fern flora of Georgia.

THELYPTERIS TORRESIANA (Gaud.) Alston.[1]—This fern was found at several stations in the county and is the commonest of the three new discoveries. The largest colony was in a deciduous-hardwood forest on west-facing bluffs of the Alapaha River, 6 miles south of Stockton, on US Highway 129, *Norsworthy 132*). This species is an introduction from the Old World, and now is common in southern Florida. Apparently it is spreading rapidly.

BLECHNUM OCCIDENTALE L.—The New World Mid-sorus Fern has been reported from Florida since 1916. It is a rare species in the United States. Only one colony was located during this study, in a dry, sandy area under a bridge over Little River, along Georgia Highway 135, 2.5 miles from the Florida State line (*Norsworthy 148*).

PTERIS VITTATA L.—Found in a dry, shaded area beneath a bridge 0.3 mile east of the Alapaha River, on Georgia Highway 187, near the town of Mayday (*Norsworthy 158*). This introduced species is rather common in Florida, and has been found in Alabama, Louisiana, and in South Carolina, but not previously in Georgia.

Three species infrequent in Georgia were found also. *Azolla caroliniana* Willd. was found floating on shallow water in an abandoned sand pit, south of the Southern Railroad, on the east bank of the Alapaha River, near Mayday (*Norsworthy 188*). Eyles collected it on 19 April 1939 in a cypress pond along US

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[1] Since this paper was in press another report of this species in Georgia has been published by Wilbur H. Duncan (Amer. Fern J. **55**: 151. 1965 [1966]).

Highway 41, south of Valdosta (*Eyles 3806*). This collection was reported as coming from Echols County, but the locality probably is in Lowndes County.

Ophioglossum nudicaule L. occurred on moist sand at the water's edge at the Mayday locality (*Norsworthy 189*).

Ophioglossum petiolatum Hook. was collected in a dry, shaded area near a bridge 0.3 mile east of the Alapaha River, along Georgia Highway 187, near Mayday (*Norsworthy 230*).

The following species apparently have not been reported previously from Echols County:

Lycopodiaceae.—*Lycopodium adpressum* (Chapm.) Lloyd & Underw., *L. alopecuroides* L., *L. carolinianum* L., *L. prostratum* Harper.

Selaginellaceae.—*Selaginella apoda* (L.) Fernald.

Ophioglossaceae.—*Ophioglossum nudicaule* L., *O. petiolatum* Hook.

Osmundaceae.—*Osmunda cinnamomea* L., *O. regalis* L.

Schizaeaceae.—*Lygodium japonicum* (Thunb.) Sw.

Polypodiaceae—*Onoclea sensibilis* L., *Thelypteris dentata* (Forsk.) E. St. John, *D. ludoviciana* (Kze.) Sm., *Thelypteris normalis* Moxley, *T. palustris* var. *pubescens* (Laws.) Fern., *T. ovata* St. John, *T. torresiana* (Gaud.) Alston, *Pteris vittata* L., *Asplenium platyneuron* (L.) Oakes, *A. platyneuron* var. *bacculum-rubrum* Fern., *A. resiliens* Kunze, *Woodwardia areolata* (L.) Moore, *W. virginica* (L.) Sm., *Pteridium aquilinum* var. *latiusculum* (Desv.) Underw., *Polypodium polypodioides* (L.) Watt., *Blechnum occidentale* L.

Salviniaceae.—*Azolla caroliniana* Willd.

Specimens of these taxa are filed in the U.S. National Herbarium, Washington, D. C., where the identifications were checked by C. V. Morton, in the herbaria of the University of Georgia, Athens, and of Valdosta State College, Valdosta, Georgia.

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Valdosta State College, Valdosta, Georgia.

A New Species of Anemia from South America

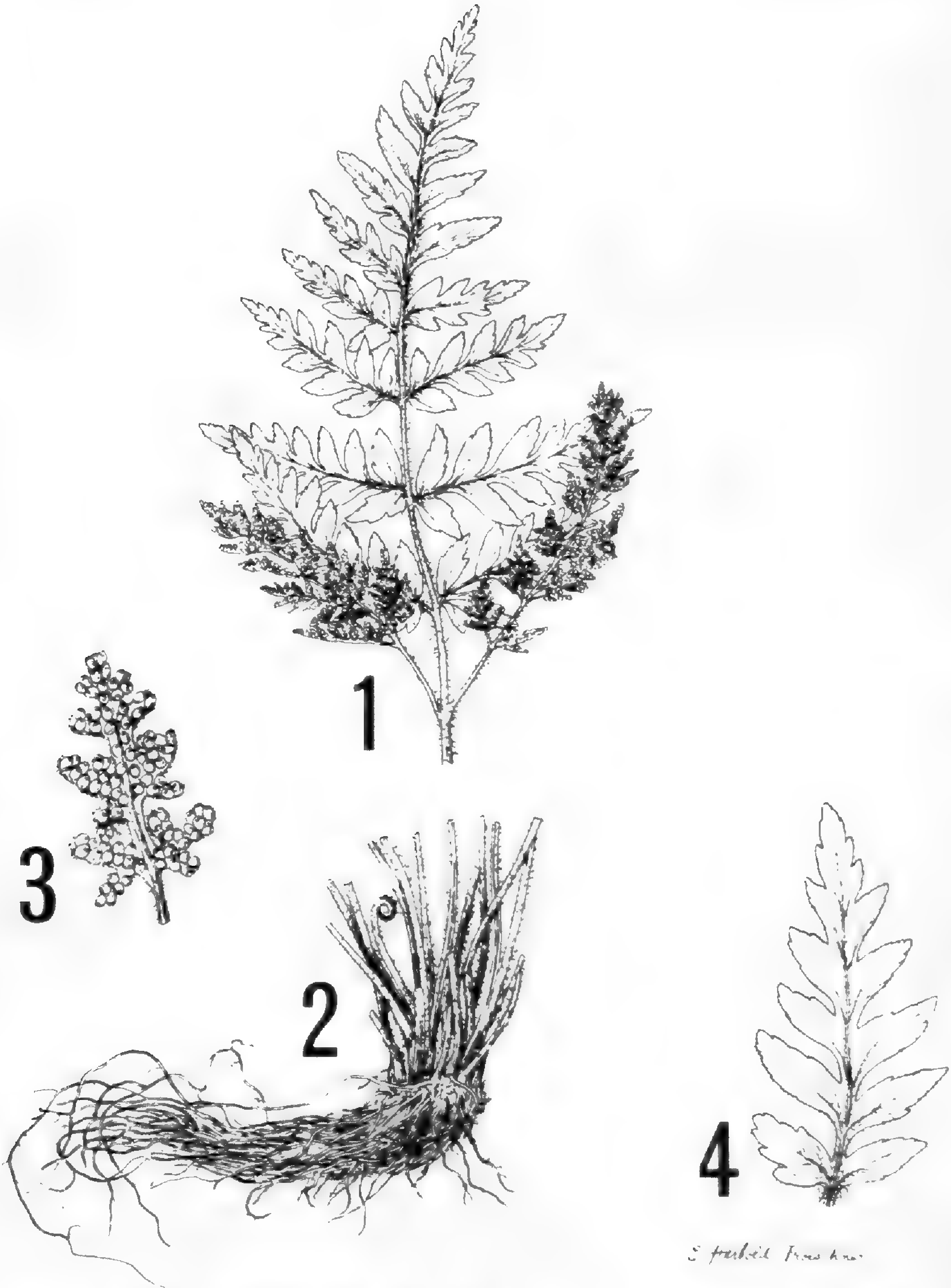
JOHN T. MICKEL[1]

During the preparation of a monograph of *Anemia* subgenus *Coptophyllum*, a series of specimens from western South America and Panama was seen which was strikingly different from the species of *Anemia* familiar to me. Some of the specimens were noted as possibly belonging to a new species. The plants resemble *A. flexuosa,* also of western South America, in their dissection, oblique rhizomes, and hirsute stipes, and some specimens were labelled with this name. However, on closer examination, they were found to be quite distinct, being of smaller size, and possessing rather lax, short-petiolate fertile pinnae and floating stomates. These last characters tie it closely to *Anemia brandegeea* and *A. intermedia* of Mexico. The specimens closely matched the description and drawing of *A. smithii* Brade (1929) of western Brazil. Since I was unable to borrow the type of that species at the time, I tentatively placed these specimens under that name in my revision (Mickel, 1962). It was grouped with *A. brandegeea* and *A. intermedia* in a new section *Adetostoma*. Subsequently, however, I have obtained photographs of the isotype of *A. smithii* from the British Museum (Natural History), which shows that there is no question but that *A. smithii* is actually only a small specimen of *A. tomentosa* and not the same as the plants from the Andean regions. These plants thus represent an undescribed species.

ANEMIA **clinata** Mickel, sp. nov. Plate 4

Rhizomatibus apice ascendentibus atque petiolorum basibus vestitis; pilis aurantiacis; petiolo tereti, 2–15 cm longo, minus quam 1 mm lato, brunneo vel atrobrunneo, hirsuto; lamina deltoideo-elongata, bipinnata, chartacea, 4–13 cm longa; pinnis 5–11-jugis; pinnulis oblongis, late adnatis, integris vel crenatis, pilosis; stomatibus liberis; pinnis fertilibus brevipetiolatis, suberectis, remotis a pinnis sterilibus, brevioribus quam lamina

[1]The work on this paper was partially supported by a grant from the National Science Foundation (NSF-GB-1230).



ANEMIA CLINATA MICKEL, SP. NOV. FIG. 1. BLADE, × 0.9. FIG. 2. RHIZOME, × 0.9. FIG. 3. FERTILE PINNA, × 1.3. FIG. 4. STERILE PINNA, × 1.3. TYPE SPECIMEN (US) sterili; sporis 81–87 μ longis, tetraedro-globosis, angulorum umbonibus conspicuis, laesuris levibus, solidis.

Type specimen: PERU. Dept. Junín: Along Río Perene, near "Hacienda 3," Colonia Perene, alt. ca. 600 m, June 16–18, 1929, *E. P. Killip* and *A. C. Smith 25191* (US; isotypes F, NY).

ADDITIONAL SPECIMENS EXAMINED:

PANAMA. CHIRIQUÍ: Trail from San Felix to Cerro Flor, *Allen 1925* (GH, MO, US).

COLOMBIA: META: Río Duda, *Fosberg 19475* (US).

PERU. JUNÍN: East of Quimiri Bridge, near La Merced, *Killip & Smith 23951* (NY); Colonia Perene, *Killip & Smith 25036* (NY, US); Chanchamayo Valley, *Schunke 78* (F, US); Schunke Hacienda, above San Ramón, *Schunke A137* (US).

BOLIVA. LA PAZ: Pata, *Williams 2584* (GH, NY, US), *2586* (NY, US).

The species derives its name from the slanting or lax position of the fertile pinnae (L., sloping) in contrast to the vertical position in most Anemias.

The South American specimens are fairly uniform, though they vary somewhat in size (8–28 cm) and the segments are more distant in the Colombian specimens than in the others. The specimens from Panama appear different in their very short fertile pinnae (1–2.5 cm long), more rounded segments, and ovate blades. Whether these plants are merely immature or represent yet another species is not known, but for the present they are placed in *Anemia clinata*. These Panamanian plants were indicated by Maxon as a new species, but I did not take up his herbarium name for the species since his plants were the most atypical of those seen.

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Natural Apospory in Pteridium?

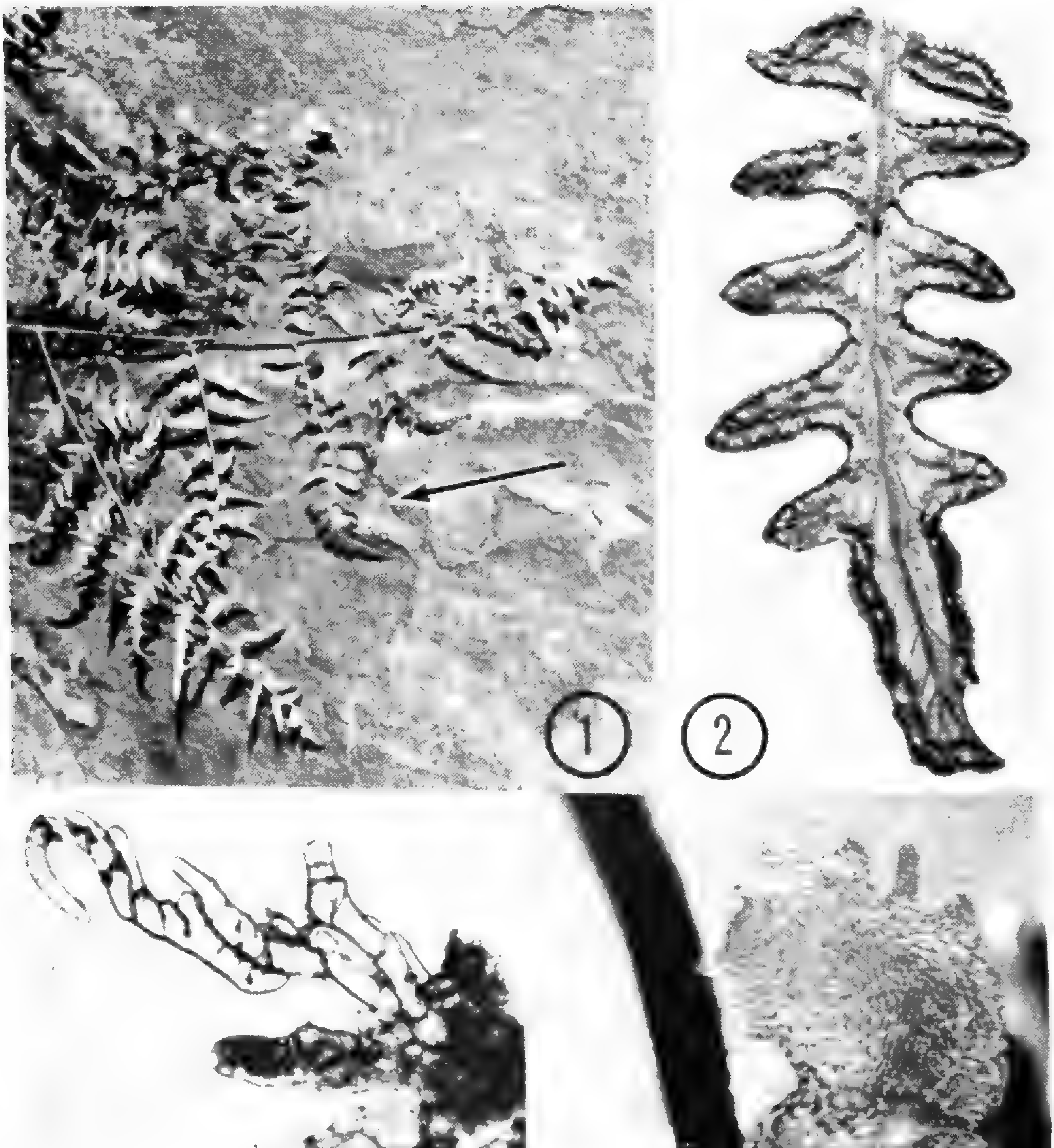
DEAN P. WHITTIER

From a population of the bracken fern in New Hampshire, Farlow (1889) described prothalloid outgrowths from the marginal sori. He concluded that natural apospory, i.e. the formation of a gametophyte vegetatively from a sporophyte under normal environmental conditions, had occurred as reported by Druery (1884) and Bower (1884). Steil (1949) studied prothalloid outgrowths on *Pteridium* leaves from Wisconsin. He reported that these outgrowths never produced rhizoids or sex organs nor became cordate under natural or experimental conditions. Since gametophytic characters were absent, Steil concluded that the outgrowths were not aposporous gametophytes.

In recent years I have studied this abnormality of the leaves of *Pteridium aquilinum* (L.) Kuhn var. *latiusculum* (Desv.) Underw. ex Heller from three localities in Massachusetts: Boston, Lincoln, and Millbury. At Millbury observations were made for eight years and a specimen from this locality has been deposited in the Vanderbilt University Herbarium, VDB 38094.

This abnormality produces morphological modifications of the *Pteridium* leaf. The leaf is more dissected and the ultimate segments are narrower and somewhat twisted (*Fig. 1*). The abnormality may be on only a few leaves of a rhizome and may affect a part of a leaf (*Fig. 1*), but it occurs in the same population in successive years. The abnormal leaf bears prothalloid-like outgrowths which appear as a green mass protruding from under the revolute margin of the leaf (*Fig. 2*). These proliferations *(Fig. 3)* arise from the receptacle of the *Pteridium* sorus. The outgrowths are sporangia in various stages of abortion and other proliferations without sporangial characters. Occasionally, normal sporangia develop along with these outgrowths. The outgrowths are never cordate and do not bear sex organs or rhizoids.

Marginal pieces of the abnormal leaves were cultured on the agar surface of an inorganic nutrient medium (Whittier &



Pteridium aquilinum var. latiusculum

Steeves, 1960). The outgrowths increased in size but did not become cordate prothalli with sex organs and rhizoids. Bell & Richards (1958) reported a moist agar surface is conducive for induced apospory, i.e. the formation of a gametophyte vegetatively from a sporophyte under experimental conditions. Juvenile leaves of *Pteridium* isolated from the sporophyte and laid on the agar surface produced aposporous gametophytes (*Fig. 4*). If the outgrowths on the abnormal *Pteridium* leaves are aposporous gametophytes, gametophytic characters should develop under the conditions which induce apospory. Rarely, cordate prothalli did form from the marginal leaf pieces, but these were due to spores from the occasional sporangia among the prothalloid-like outgrowths.

Farlow (1889) raised the possibility of a dry summer causing these outgrowths. However, at the locality observed for eight years the abnormality occurred in wet and dry years and also it was recognized on immature leaves early in the spring. Steil (1949) suggested that some physiological or pathological factor caused the abnormality. With the cause of the outgrowths undetermined, an earlier report of a "parasitic dimorphism" of *Pteridium* leaves in France by Molliard (1898) was considered. He reported a leaf gall on *Pteridium* which was similar to the descriptions of the *Pteridium* abnormality by Farlow (1889) and Steil (1949). In Molliard's case the leaf gall was caused by a mite which he described and named *Phytoptus pteridis;* it is listed by Nalepa (1928) as *Eriophyes pteridis* (Moll.).

Pteridium leaves from the Massachusetts localities had mites only on abnormal leaves or abnormal portions of leaves. The

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FIGURES 1—5. FIG. 1. TERMINAL PINNAE OF AN ABNORMAL PTERIDIUM LEAF. ARROW DENOTES PART OF ONE PINNA WITH NORMAL DEVELOPMENT, × 0.4. FIG. 2. PINNULE WITH PROTHALLOID-LIKE OUTGROWTHS GROWING FROM UNDER REVOLUTE MARGIN, × 6. FIG. 3. PROTHALLOID-LIKE OUTGROWTHS ISOLATED FROM MARGIN, × 100. FIG. 4. APOSPOROUS GAMETOPHYTE FROM THE PETIOLE OF A JUVENILE PTERIDIUM LEAF, × 10. FIG. 5. ERIOPHYID MITE FROM UNDER REVOLUTE MARGIN OF LEAF, FIXED IN FAA, × 150.

mites were beneath the revolute margins with the prothalloid-like outgrowths. In areas of heavy infestations the leaf margin turned brown and had a necrotic appearance. The small (about 0.4 mm long), translucent white mites could be observed moving over the outgrowths if the leaf margin was unrolled. Keifer (pers. comm., 1965) reports the mites from this leaf material belong to two species of the genus *Eriophyes*. Whether one is *E. pteridis* has not been resolved due to an inadequate original description, and the other species may be undescribed.

This study corroborates and extends the investigation of Steil (1949) by confirming the abnormality as a pathological condition, the outgrowths of the gall from the receptacle of the sorus being without gametophytic characters under normal and experimental conditions. Thus these outgrowths cannot represent natural apospory. I wish to thank Dr. H. H. Keifer, Bureau of Entomology, California Department of Agriculture, Sacramento, California, for identifying the mites from the abnormal *Pteridium* leaves.

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The Validity of the Generic Name Ctenopteris

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Since the adoption by E. B. Copeland (1947, p. 218) of the generic name *Ctenopteris* Blume for a group of species that had generally been referred previously to *Polypodium*, this name *Ctenopteris* has been rather widely adopted, mostly without a critical evaluation of its validity. Copeland was aware of some of the difficulties, but chose to adopt the name anyway.

The name first appears in Blume's Flora Javae 2: 132. 1828 [1829] under the genus *Polypodium* L., which is divided into two subgroups (of unspecified category) called "a. *Polypodia vera*" and "b. *Polypodia spuria*." The latter is subdivided into four sections (unnamed), the second of which is characterized as follows:

> "2. Filices venis lateralibus simplicissimis, versus marginem apice plerumque incrassato sorum singulum gerentibus. Omnes habitu conforme insignes, ut genus proprium *Ctenopteris* a *Polypodiis* separari merentur. Huc recensimus *P. Celebicum, venulosum, obliquatum, nutans, mollicomum, fuscatum* et *subfalcatum*."

Blume lists these species as "*P.*" i.e. *Polypodium* species here, and later on in the text describes them all as species of *Polypodium*. The generic name *Ctenopteris* is suggested but not accepted, and is thus invalid by Art. 34 of the International Code of Botanical Nomenclature (1961 ed.), which states: "A name is not validly published (1) when it is not accepted by the author who published it." It is also a true case of a *nomen provisorium*, as shown by the word "merentur," which is a *future* passive, the meaning being that separation as a genus of its own will be deserved [at some future unspecified time]. Such provisional names are also invalid under the same article of the Code: "A name is not validly published . . . (2) when it is merely proposed in anticipation of the future acceptance of the group concerned . . . (so-called provisional name)." In a letter to me some time ago Dr. Holttum said that Mr. Bullock thought that the words "Huc recensimus *P.*

Celebicum," etc. indicated that Blume accepted *Ctenopteris* as a genus, but this is merely a list of the species that belong to the group in the event of its ultimate acceptance as a genus. Naturally, all provisional names have such an indication of the composition of the group, but this in itself does not indicate the acceptance of the group. Thus there is no valid publication of a genus *Ctenopteris* Blume in 1829, nor is there any *Polypodium* sect. *Ctenopteris* Blume, as mentioned by some authors, for Blume did not assign any sectional names.

The next mention of the name *Ctenopteris* is by Presl (1836, p. 177), who divided *Polypodium* into two sections named *Ctenopteris* and *Phegopteris.* There was no intention on Presl's part of segregating from *Polypodium* those species that Copeland calls *Ctenopteris.* On the contrary, *Ctenopteris* was used to distinguish what Presl considered true *Polypodium* from *Phegopteris* (which included the present-day *Phegopteris, Dryopteris, Thelypteris,* and others). Since *Polypodium vulgare* L., the type of the genus *Polypodium* L., was included in sect. *Ctenopteris* Presl, this section should be typified on the basis of *P. vulgare* L., and sect. *Ctenopteris* Presl becomes a nomenclatural synonym of sect. *Polypodium* by our current rules.

The next appearance of the name *Ctenopteris* is in Kunze's (1846, p. 425) "In filices Javae Zollingerianas aliasque ex herbario Moricandiano observationes." The entire entry is as follows:

"1724. *Ctenopteris* venulosa* Bl. fl. Jav. p. 132. *Polypodium venulosum* enum. 128.

"Specimina congrua accepi e collectione javanica Kollmanniana. Frons firmula subcoriacea distincte ciliata, laciniis inferioribus diminutis; sed magis oblongis quam ovatis. Hisce planta nostra a phrasi l. l. paululum, nec specie, ut opinior, differt. Sori minus profunde immersi quam in reliquis, imprimis *Ct. papillosa.*

"1725. *Ctenopteris rufescens* Kze.: fronde coriacea, curvata, supra margineque puberula, subtus glabra, rufescente, lanceolata, acuminata progineque puberula, subtus glabra, rufescente, lanceolata, acuminata profunde pinnatifida; laciniis oblongis, acuminatis, obtusiusculis, margine reflexo integerrimis, inferioribus diminutis, subtriangularibus; soris submarginalibus, distinctis, modice immersis; rhachi stipiteque brevi s. brevissimo, submarginato fusco-hirtis; caudice repente, fusco-paleaceo-setoso.

"Species *C. fuscatae* Bl. affinis, differt: fronde coriacea, elastice curvata, puberula, nec pilosiuscula, laciniis inferioribus decrescentibus, triangularibus, soris non confluentibus, rhachi stipiteque non villosis, sed hirtis. A *Ct. mollicoma* differt subtus glabra et soris distinctis.

"*Genus insigne, alio loco illustrandum."

I have quoted this entry verbatim, inasmuch as Kunze's publication is not everywhere readily available. This was cited as *Ctenopteris* (Bl.) Kunze by Alston, Ballard, and Holttum in their proposal to conserve *Ctenopteris* as against *Xiphopteris* and *Prosaptia*, but as shown above Blume did not publish a sectional name *Ctenopteris* and consequently he cannot be cited as a parenthetical author.

I have argued in the past that the genus *Ctenopteris* can not be considered published by Kunze. The appropriate part of the Code (Art. 32) indicates that "In order to be validly published, a name of a taxon must . . . be accompanied by a description of the taxon or by a reference (direct or indirect) to a previously and effectively published description of it." There is here certainly no description; Kunze's footnote shows that he intended to publish a figure, and presumably a description also, at some other place, but he never did so. There is no direct reference to *Ctenopteris* Blume nor any discussion of it, but there *is* an indirect reference, by the citation of "Bl. fl. Jav. p. 132," which refers back to Blume's mention of *Ctenopteris*. It is certain that Kunze did intend to follow up Blume's suggestion about accepting *Ctenopteris* as a genus, Blume did give a brief description, and Kunze did make an indirect reference to it. My present belief is therefore that *Ctenopteris* Kunze is validly published as a genus, by Kunze's acceptance of it and by his indirect reference to a published description.

It is fortunate that *Ctenopteris* can be accepted as validly published, since so many new combinations have already been made using this name. The alternative name, *Cryptosorus* Fée, has never been widely adopted. I do not myself think that *Ctenopteris* is a good genus, for it can be separated from *Grammitis* and *Xiphopteris* only in an arbitrary and unnatural manner, but there are those who will disagree, and they are free to use *Ctenopteris* if they choose. However, the Committee for Pteridophyta of the International Committee for Nomenclature refused to conserve *Ctenopteris* by a vote of five to two,[1] and so if either *Xiphopteris* or *Prosaptia* are combined with it, these names will have priority. Of course, *Grammitis* Swartz (1801, p. 17) has priority over all of them.

The lectotype of the genus *Ctenopteris* Kunze (not "(Blume) Kunze," as some authors have it) was chosen by Copeland (1947, p. 218) as *Polypodium venulosum* Blume = *Ctenopteris venulosa* (Blume) Kunze, which is the appropriate choice, since this is one of the species referred to the tentative group by Blume and the first species mentioned by Kunze in the validation of the genus. In 1875, John Smith (1875, p. 184) took up the genus *Ctenopteris* in approximately the sense of Kunze, and indicated the type to be *Polypodium trichomanoides* Swartz, but this is impossible, since this species was not one of the original ones of Kunze (or of Blume either).

There is another genus, *Ctenopteris* Newman (1851, App. xxviii), which is based on *Polypodium* sect. *Ctenopteris* Presl. It has the same type as Presl's section, namely *Polypodium vulgare* L., and thus *Ctenopteris* Newman (not Kunze) is a superfluous name, since it has the same type as the valid genus *Polypodium* L.

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Studies on Indian Hymenophyllaceae, Part VIII. Contributions to our Knowledge of Mecodium exsertum (Wall.) Copeland

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A study of the Indian species of Hymenophyllaceae has been undertaken in the Department of Botany, University of Lucknow. Earlier papers on *Mecodium badium* (Sharma, 1962), *Crepidomanes latealatum* (Sharma, 1960), *Meringium edentulum* (Rao & Sharma, 1960), *Hymenophyllum simonsianum* (Sharma, 1963), and *Pleuromanes kurzii* (Rao & Khare, 1965) have already appeared. This paper deals with morphological and anatomical investigations of *Mecodium exsertum*. The material was collected by Dr. B. B. Sharma and Dr. D. D. Awasthi in October, 1964, from Darjeeling.[1] It corresponds with *Hymenophyllum exsertum* Wall. ex Hook., as cited by Beddome (1883).

MORPHOLOGY

The plants of *M. exsertum* (*Fig. 20*) are hygrophyllous and epiphytic, measure 6 to 10 cm long, and consist of a jet-black, creeping, branched, hairy rhizome bearing thin-branched, dark-colored roots and two rows of pinnately lobed leaves. The petioles are long, winged, and are smooth above and hairy below. The pinnae are small, narrow, one cell thick, and are traversed by a single midvein. The pinnules have an entire margin, and are 2 to 5 mm long. The apical pinnules are lobed, while the lower ones are free. Short uniseriate hairs 2 to 4 cells long (*Fig. 1A–C*), laterally attached by a short papilla as in *Hymenophyllum simonsianum* (Sharma, 1963), are present. These are the only dermal appendages, and occur on the midribs of the leaves, on the rhizomes, the lower parts of the petioles, and on the sorus also.

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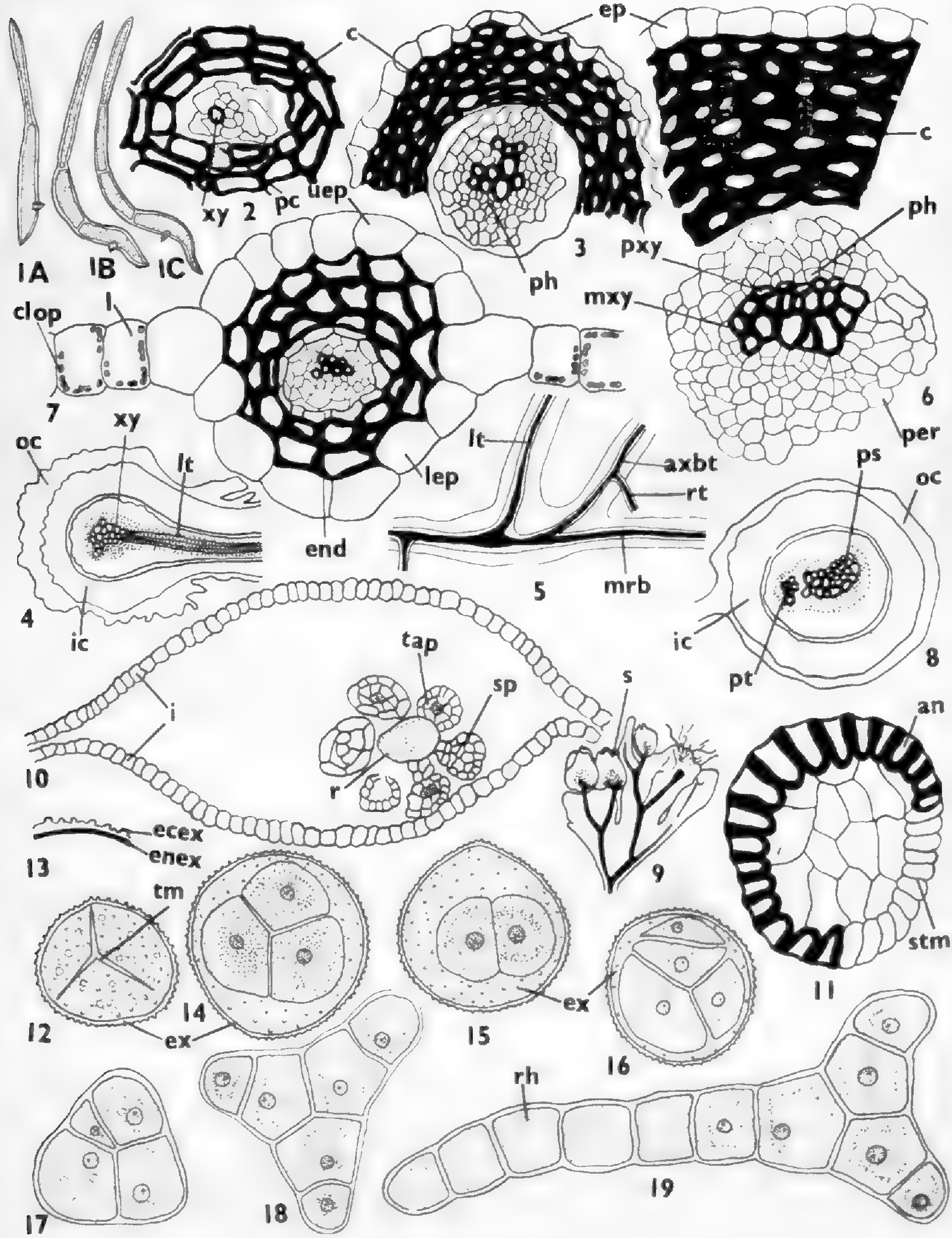
[1]Our best thanks are due these gentlemen. To Dr. B. K. K. Nayar, of the National Botanic Gardens, Lucknow, we are deeply indebted for identifying the material.



MECODIUM EXSERTUM

The sorus is terminal on the pinnules (*Fig. 20*). The receptacle is never extruded, and bears the sporangia in basipetal succession (*Fig. 21*). The indusium is cup shaped, united only at the base, and has free lips with toothed margins.

SPOROPHYTE ANATOMY

The cortex of the root is sclerenchymatous, with the outer layers disorganizing. In the innermost layers of the sclerenchyma a thin-walled passage cell (*Fig. 2*, pc) can be seen. The xylem is reduced to just one or two tracheids. The endodermis and pericycle are not clear in old material (*Fig. 2*).

In a transverse section of the rhizome (*Fig. 3*) the epidermis is single layered and thin walled. The cortex is sclerenchymatous and 4 to 6 cells thick. The concentric stele is an exarch protostele with one or two protoxylem points. The endodermis is usually not very distinct due to the breaking of the tissues in this region. The pericycle is 1 to 3 cells thick, as in *H. simonsianum* (Sharma, 1963) and *H. scabrum* A. Rich. (Boodle, 1900). The centrally placed xylem consists of 10 to 18 tracheids. The

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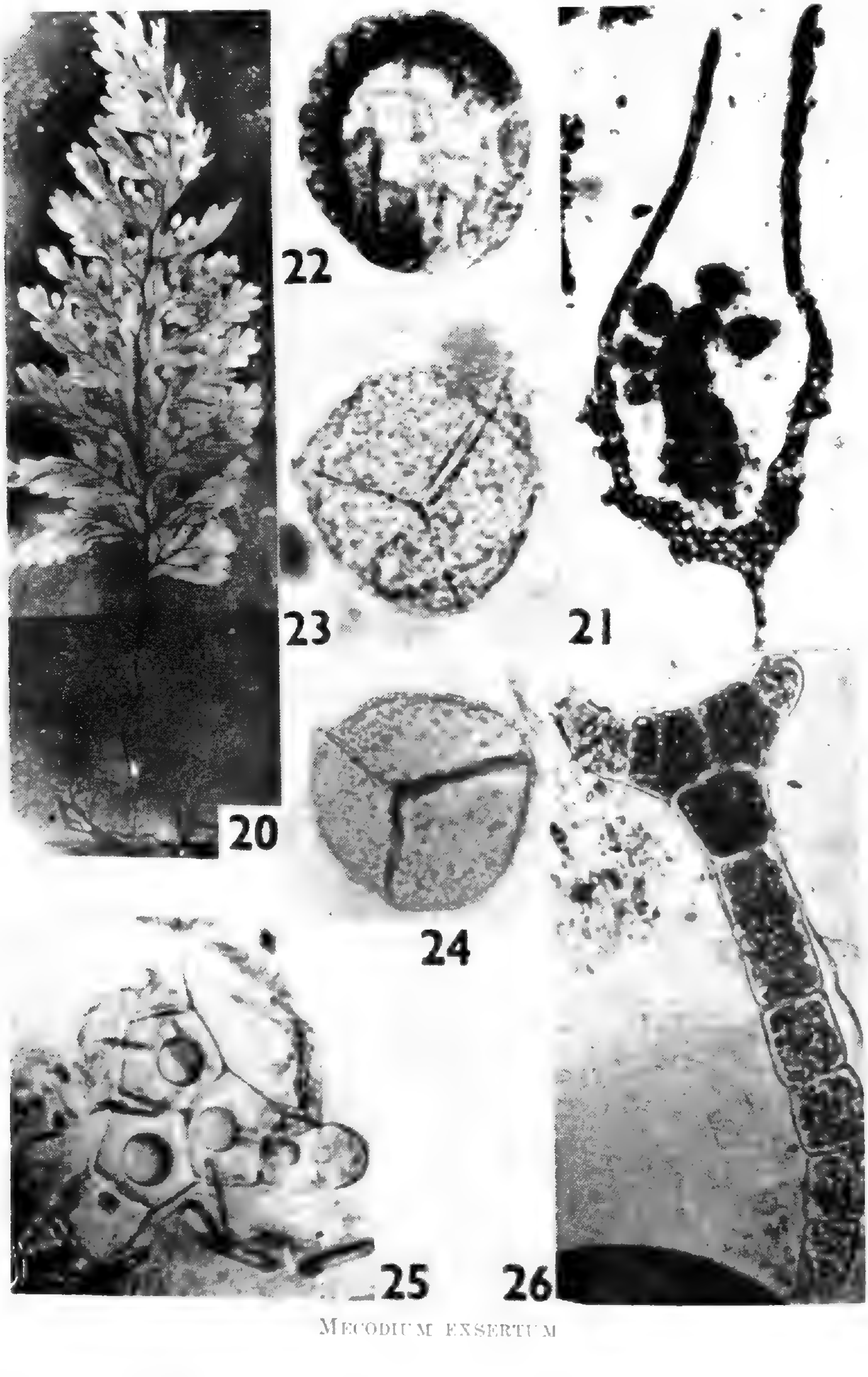
FIG. 1A–C. DERMAL HAIRS, × 25. FIG. 2. PORTION OF TRANSVERSE SECTION OF ROOT, × 250. FIG. 3. TRANSVERSE SECTION OF RHIZOME, × 120. FIG. 4. TRANSVERSE SECTION OF RHIZOME SHOWING DEPARTURE OF LEAF TRACE, × 50. FIG. 5. CLEARED MOUNT SHOWING LEAF TRACE AND AXILLARY BRANCH TRACE, × 15. FIG. 6. PORTION OF THE TRANSVERSE SECTION OF PETIOLE, × 185. FIG. 7. PORTION OF TRANSVERSE SECTION OF THE LEAF, × 185. FIG. 8. TRANSVERSE SECTION OF PETIOLE SHOWING PINNULE TRACE, × 50. FIG. 9. CLEARED MOUNT OF THE SORUS, × 3. FIG. 10. TRANSVERSE SECTION OF THE SORUS, × 50. FIG. 11. SPORANGIUM, × 85. FIG. 12. SPORE, × 250. FIG. 13. EXINE PATTERN, × 565. FIGS. 14–19. EARLY STAGES OF SPORE GERMINATION, × 250. The abbreviations are: an = ANNULUS, axbt = AXILLARY BRANCH TRACE, c = CORTEX, clop = CHLOROPLAST, ecex = ECTOEXINE, end = ENDODERMIS, enex = ENDOEXINE, ep = EPIDERMIS, ex = EXINE, i = INDUSIUM, ic = INNER CORTEX, l = LAMINA, lep = LOWER EPIDERMIS, lt = LEAF TRACE, mrb = MAIN RHIZOME BUNDLE, mxy = METAXYLEM, oc = OUTER CORTEX, pc = PASSAGE CELL, per = PERICYCLE, ph = PHLOEM, ps = PETIOLE SUPPLY, pt = PINNULE TRACE, pxy = PROTOXYLEM, r = RECEPTACLE, rh = RHIZOID, rt = ROOT TRACE, s = SORUS, sp = SPORANGIUM, stm = STOMIUM, tap = TAPETUM, tm = TRIRADIATE MARK, uep = UPPER EPIDERMIS, xy = XYLEM.



Mecodium exsertum

phloem is more developed on the dorsal side. Root and leaf traces are given off from the protoxylem points of the stele (*Fig. 4*). The stele in this plant is comparable to that of the *Mecodium* subtype of the *Hymenophyllum* type (Nozu, 1950). Leaf traces are formed without leaf gaps (*Fig. 5*). The axillary branch trace comes off from the main axis strand after the leaf trace has separated from it. All the traces are, like those of the axis, protostelic and exarch, a primitive feature that is characteristic of the Hymenophyllaceae.

A transverse section of the petiole (*Fig. 6*) shows the outer, thin-walled, one-cell-thick epidermis and below it the thick-walled, narrow-lumened, sclerenchymatous cortex. The endodermis is not distinct. The pericycle is 2 to 4 cells thick, enclosing the platelike exarch xylem, with the phloem present all around. The condition is comparable to that in *H. tunbridgense* (Boodle, 1900).

In transverse section (*Fig. 7*) the leaf is one cell thick with chloroplasts mostly appressed to the walls of the cells. The midrib is thick and sclerenchymatous. The endodermis is clear in young stages. The pericycle usually consists of 1 or 2 layers of cells enclosing the platelike exarch xylem, which has phloem on one side. The pinna trace is abstricted from the leaf trace (*Fig. 8*). In the tip region of the pinnule the vascular element is replaced by parenchyma.

The sorus is terminal on the pinnules, and is about 1 to 1.5 mm long. The receptacle is elongated within the involucre (*Fig. 9*). The indusium is hairy and is deeply lobed, the lobes being dentate. Chloroplasts are present in the cells, as in *Crepidomanes latealatum* (Sharma, 1960) and *Pleuromanes kurzii* (Rao & Khare 1965). The sorus is gradate (*Fig. 21*), basi-

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FIG. 20. HABIT, × 1. FIG. 21. LONGITUDINAL SECTION OF THE SORUS, × 135. FIG. 22. SPORANGIUM, × 20. FIG. 23. SPORE SHOWING ORNAMENTATION, × 425. FIG. 24. SPORE SHOWING TRIRADIATE MARK, × 425. FIG. 25. YOUNG STAGE OF SPORE GERMINATION; THE EXINE IS STILL ATTACHED TO THE GAMETOPHYTE, × 360. FIG. 26. YOUNG GAMETOPHYTE WITH RHIZOIDAL END, × 265.

petal, but occasionally slightly mixed also (*Fig. 10*). A similar condition has been reported by Sharma (1960) in *Crepidomanes latealatum*. In a transverse section of the sorus (*Fig. 10*), one or two developing sporangia are seen. Satisfactory material for tracing the development of the sporangia was not available, but in a few of the sporangia in the sori (*Fig. 10*) the sporogenous cell, the jacket cells, and the tapetum could be seen clearly.

The short-stalked sporangium (*Fig. 11*) is about 350 $\mu \times$ 298 μ, having an incomplete annulus of 15 to 20 thick-walled cells and a well-marked stomium of 8 to 12 cells. The dehiscence is by a lateral transverse slit. Air spaces have been observed in the annulus cells extending up to the middle lamellae, as in *Hymenophyllum simonsianum* (Sharma, 1963).

The spores are tetrahedral with a tri-radiate mark, and measure 60 $\mu \times$ 70 μ (*Fig. 12*). The exine (*Fig. 13*) is 3.2 μ thick, with a 1.6 μ thick, smooth endoexine and an equally thick, granulate ectoexine; granulae are variable in size. The spore contents include some oil globules along with chloroplasts and starch grains. About 110 spores could be counted in a sporangium.

GAMETOPHYTE ANATOMY

Germination of spores could not be undertaken, as only alcohol-preserved material was available. Some spores which had already germinated in the sporangia showed some early stages of gametophyte formation. The earliest stage shows the division of the spore into three unequal, uninucleate cells by septation. The exine becomes quite loose by this time (*Fig. 14*). One cell then divides by a transverse or an oblique wall (*Fig. 16*). The exine now separates (*Fig. 17*), and the other two cells also undergo similar divisions, resulting in a six-celled, triangular body (*Fig. 18*). At this stage one or more rhizoidal ends may develop, which soon lose their chloroplasts. Sharma (1962) has observed more than one rhizoid developing in one set of cells. Rhizoid formation usually starts from the third cell (*Fig. 19*), but it may develop from the second or even the fourth cell. Further developmental stages could not be observed in the preserved material, but Sharma (1962) has described and figured some stages where an apical cell plate is formed, which she regards as the initiation of an apical meristem. No hairs have been found on the young gametophyte, which is in conformity with the observations of Sharma (1962) and Stokey (1960). The development of the gametophyte in early stages resembles that of *M. badium* (Sharma, 1962), *Hymenophyllum* spp. (Stokey, 1940), and *Trichomanes reniforme* (Holloway, 1930).

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Ferns New to Illinois

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During the preparation of a treatment of the ferns for the first volume of a projected illustrated flora of Illinois,[1] a rather remarkable number of ferns and fern allies previously unreported from Illinois were discovered. Some of the new records are the result of extensive field work throughout the state during the last few years, while others were discovered through intensive searches of various herbaria in the country. Eight species and two varieties are reported in this paper for the first time from Illinois. Unless otherwise indicated, all specimens cited are mine and are deposited in the herbarium of Southern Illinois University.

BOTRYCHIUM BITERNATUM (Sav.) Underw.

This evergreen fern, which is distinguished from *B. dissectum* by its sharply serrate pinnules and its membranous blades which remain green during the winter, was discovered growing near the base of an open hillside in Little Grand Canyon, nine miles southwest of Murphysboro, Jackson County, on August 10, 1963 (*15150*). Associated species included a few specimens of *B. dissectum* var. *obliquum*. The dominant trees of the lower slope were white oak and beech. This is the species which in the past has been known mostly as *B. obliquum* var. *tenuifolium*, but Wagner[2] has given reasons for recognizing it as a species, in which case the correct name is *B. biternatum*.

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[1]Amer. Fern J. **56**: 37. 1966.

[2]Taxon **10**: 165–169. 1961.

PTERIDIUM AQUILINUM (L.) Kuhn var. PSEUDOCAUDATUM (Clute) Heller

Although *P. aquilinum* var. *latiusculum* is rather common throughout the state, var. *pseudocaudatum* was unknown from Illinois until its collection from the edge of an oak woods one mile north of Elizabethtown, Hardin County, on August 14, 1963 (*Mohlenbrock s.n.*). However, the occurrence of this variety was to be expected in Illinois, since it is known from the adjacent states of Indiana and Missouri. These two varieties are rather difficult to distinguish; var. *pseudocaudatum* can be distinguished by the rhizome always having a tuft of brown hairs at the growing tip. A subsidiary character is that the ultimate leaf segments are smaller than in var. *latiusculum*, measuring up to 4.5 mm broad, and the margins are glabrous.

DRYOPTERIS × BOOTTII (Tuckerm.) Underw.

This handsome fern was discovered in a deep, mesic ravine in Matthiesen State Park, La Salle County, on June 13, 1962 (*14973*). It is a sterile hybrid between *D. intermedia* and *D. cristata*. The aborted spores indicate its hybrid nature. *Dryopteris boottii* differs from *D. cristata* by its glandular indusium and from *D. intermedia* by its leaf broadest near the middle rather than near the base. One of the parents, *D. intermedia*, grows in the vicinity. This is primarily a northeastern plant, which has been recorded from as close as Indiana.

DRYOPTERIS × TRIPLOIDEA Wherry

This is considered to be a hybrid between *D. intermedia* and *D. spinulosa*; once again the aborted spores indicate its hybrid nature. It differs from *D. spinulosa* in its glandular indusium and from *D. intermedia* by its short-creeping rhizome and its pinnae ascending rather than at right angles to the rachis. It was collected in a damp woods near Barrington, Lake County, on June 14, 1962 (*14988*).

ATHYRIUM FILIX-FEMINA (L.) Roth var. ASPLENIOIDES (Michx.) Farw.

This, one of the most handsome ferns in the state of Illinois, is considered by some authors to be a distinct species, but there are apparently too many intermediate specimens between it and var. *rubellum* to justify this. It differs from var. *rubellum* in its eglandular rachis, glandular indusium, and petiole which is about as long as the blade. The specimen was found along a moist sandstone cliff two miles east of Makanda, Giant City State Park, Union County (***R. M. Tryon s.n.*** (MO)).

ASPLENIUM × GRAVESII Maxon.

There are several hybrid spleenworts known from Illinois, this one being a hybrid between *A. pinnatifidum* and *A. bradleyi*. The all-green rachis and the several pairs of distinct lower pinnae distinguish it from the parents. The spores are abortive. Both parents occur where the hybrid is found. This specimen was collected in a crevice of a sandstone cliff in Panther's Den, Union County, in 1960 (*R. R. MacMahon s.n.*, originally identified as *A. pinnatifidum*).

ASPLENIUM × TRUDELLII Wherry.

An even rarer hybrid spleenwort is *A. × trudellii,* which is very similar to *A. × gravesii* except that the petiole is brown for only half its length. Its spores are abortive. The parents of this hybrid are *A. pinnatifidum* and *A. montanum*. This hybrid is completely unexpected from Illinois since one of the parents, *A. montanum,* is unknown from the state. This specimen, which has been verified by Dr. Warren H. Wagner, Jr., was found on sandstone cliffs in Giant City State Park in 1871 (*G. H. French 3719,* originally identified as *A. pinnatifidum*).

CYSTOPTERIS × TENNESSEENSIS Shaver.

This hybrid between *C. fragilis* var. *protrusa* and *C. bulbifera* is the same as *C. fragilis* f. *simulans* Weatherby. It is known from Champaign County.

AZOLLA CAROLINIANA Willd.

Although *A. mexicana* is found occasionally in Illinois, there is only a single collection of *A. caroliniana,* from a pond in St. Clair County (*J. Neill s.n.* (MO)). *Azolla caroliniana* differs by lacking cross-walls in its glochidia. It is rather smaller.

EQUISETUM × LITORALE Kuhl.

This horsetail is a hybrid between *E. arvense* and *E. fluviatile.* The spores are abortive. Specimens are known from two counties in northern Illinois, have been deposited in the herbarium of the University of Illinois, and were verified by Dr. Warren H. Wagner, Jr.

BOTANY DEPARTMENT, SOUTHERN ILLINOIS UNIVERSITY, CARBONDALE, ILLINOIS 62901.

Shorter Note

THE USE OF CLIMBING FERN, LYGODIUM, IN WEAVING.—It is well known among ethnobotanists that the dark, polished stems of maidenhair, *Adiantum pedatum,* and probably other species, have been used for ornamenting baskets woven by the Indians of western North America, but perhaps it has not been reported that the climbing fern, *Lygodium salicifolium* Presl, is similarly used in southeastern Asia. The rhachis of this fern is rather coarse, normally 1.5 to 2 mm. in diameter, and it may reach extraordinary lengths, up to 40 feet it is said on good authority. Mr. Hugh M. Smith reports that at Patalung in southern Thailand these rhachises are used not just for ornamenting baskets but as the primary weaving material.

The stems of this climbing fern, which is known there locally as "Ya li pao," are dried in the sun, after being stripped of their leaves. They dry various shades of color, and therefore no dyes are needed for weaving patterns. Only the outer part of the stem, which is evidently quite flexible, is employed. This is split into as many pieces as may be required, usually two, three, or four, according usually to the size of the stem.

The weaving of artistic baskets is dying out because of the great amount of time required, for a man needs three or four weeks to complete even a small basket such as that shown in the accompanying illustration (*Fig.2*). Most of the weaving is perhaps now done by prisoners, who possibly find that time is one of the things they have most of.

The species used, *L. salicifolium,* is reported to be rather widespread in southern Asia and Malaysia, extending from Assam to Malaya, Java, Borneo, and New Guinea, but it is apparently nowhere really common. In Thailand it is reported only from the south and is said not to grow so far north as Bangkok. The illustrations *(Figs. 1, 2)* show some stems ready for weaving and a completed basket—C. V. MORTON, *Smithsonian Institution, Washington, D. C.*

Recent Fern Literature

THE GARDENER'S FERN BOOK, by F. Gordon Foster. D. Van Nostrand Company, Inc., Princeton, New Jersey, 1964. 240 pages. 71 line drawings and 16 color photographs by the author plus 18 black-and-white photographs. $7.95.—A long-felt need among horticulturists and fern enthusiasts has been a book devoted to fern cultivation. I am glad to report that this book quite fills this need, particularly for growers in temperate regions. The author, from his extensive experience, treats both outdoor and indoor cultivation.

Though identification is treated, cultivation is the primary concern, and this is covered most thoroughly. Chapters on characteristics and identification as well as on cultivation and propagation are very detailed and copiously illustrated with excellent photographs and drawings by the author. I do feel that the importance of humidity for ferns in ordinary homes should have received more stress, but this is a minor point.

Experienced growers may be disappointed that only forty hardy ferns and twenty-seven tender kinds are treated individually. However, they will still find a great deal of helpful information. The novice will find all he needs to know to be successful in growing ferns.—DONALD G. HUTTLESTON, *Longwood Gardens, Kennett Square, Pennsylvania 19348.*

FIGURE 1. STEMS OF LYGODIUM SALICIFOLIUM READY FOR WEAVING. FIGURE 2. BASKET WITH COVER, WOVEN FROM STEMS OF LYGODIUM SALICIFOLIUM.

SPORES. FERNS. MICROSCOPIC ILLUSIONS ANALYZED. VOLUME I, VARIED GROUPS INTRODUCE TRUE FERNS THROUGH SPORE TETRAD STRUCTURE, by Clara S. Hires. Mistaire Laboratories, Millburn, N. J. 1965. xxiv + 548 pp. 246 plates. $22.50 —This book was written for people of diverse interests—such as the artist or designer, the model maker, the practical grower, to name a few—as well as for scientists in the fields of geology, archaeology, oceanography, mathematics and numerous branches of biology. "The purpose of this book is to share with others the results of many years of research, accurately examining and recording fern spores, as well as organizing known facts about actual structure, to facilitate future research." Because Miss Hires prepared and wrote her treatise to be used by so many disciplines, some ultra-scientific individuals may feel that her presentation is too simple. In the opinion of these reviewers, however, Miss Hires has done an admirable job in presenting such a difficult subject to such a wide audience.

Since the author feels that the appearance of microscopic tetrads and spores has often been misinterpreted, she has developed basic patterns illustrated by diagrams and models so that microscopic tetrads and spores can be compared and their analysis simplified for a clearer concept of microscopic phenomena.

The plates listed above are made up of about 350 photomicrographs, including 14 in color, and 100 photographs. In addition, there are 700 drawings. Legends for the photomicrographs give detailed interpretations of the structures at different levels of focus so that the viewer may not only understand the illustrations in the book but may form a clear concept of his own slides as viewed under his own microscope.

The organization of the book is out of the ordinary. One does not find an introduction, chapters (by name), glossary, bibliography, etc., as such, but there is an historical summary of studies on spores and pollen, and the body of the book has beautiful illustrations of ferns and spores and selected pollen of higher plants, followed by a section on techniques, a long list of references, and a list of word meanings.

The book is rather extravagantly printed on heavy permanent paper, with an attractive, strong, buckram binding. The type is large and easy to read, and an impression of spaciousness is conveyed by the lack of overcrowding on the pages. The entire format of the production invites a leisurely perusal of its pages. The work will be an embellishment to any library, and a ready source of reference to anyone who is at all interested in the complexities of fern spores.—HELEN B. CORRELL AND D. S. CORRELL, *Texas Research Foundation, Renner, Texas 75079.*

TWO NEW FAMILIES OF FERNS, AND REMARKS ON THE CERATOPTERIDALES.—In recent papers R. E. G. Pichi-Sermolli has published two new families of ferns: Cryptogrammaceae and Actiniopteridaceae. Both families, as stated by Pichi-Sermolli, belong to the order Pteridales, and are described in connection with the Flora of Ethiopia. As these publications cause some changes in the systematics of higher taxa, their contents may be summarized:

CRYPTOGRAMMACEAE Pic.-Serm., Webbia **17**: 299. 1963. Type genus *Cryptogramma* R. Br. in Richardson.

The family is divided into two tribes—Cryptogrammeae (with *Cryptogramma* R. Br. in Richards., and *Llavea* Lag.) and Onychieae (Ching) Pic.-Serm. (With *Onychium* Kaulf.). According to Pichi-Sermolli, the new family is allied to the Pteridaceae and the Actiniopteridaceae, but I believe that there also exists a strong relationship to the Sinopteridaceae.

ACTINIOPTERIDACEAE Pic.-Serm., Webbia **17**: 5. 1963. Type (and sole) genus *Actiniopteris* Link.

The family consists of the sole genus *Actiniopteris*, with five species, with an Afro-Asiatic distribution. Pichi-Sermolli places this family in the order Pteridales, which is now composed of the families Negripteridaceae, Pteridaceae, Adiantaceae, Sinopteridaceae, Cryptogrammaceae, Actiniopteridaceae, Vittariaceae, and Gymnogrammaceae.

The Parkeriaceae (= Ceratopteridaceae), once[1] considered in

[1] Filicopsida. Enciclop. Agr. Ital. 649–662. 1960.

the Pteridales by Pichi-Sermolli is now treated by Pichi-Sermolli as Ceratopteridaceae and, furthermore, has been removed from the Pteridales to form a monotypic order, Ceratopteridales. As a genus *Ceratopteris* has recently been placed in the Adiantaceae by Alston.[2] Ching[3] referred it to the Ceratopteridaceae, and Copeland[4] (p. 83) placed it in the Parkeriaceae. This is a typically troublesome case of priority rights. *Ceratopteris* was published by Brongniart in 1821, and *Parkeria* by Hooker in 1825. In 1825 Hooker published the family Parkeriaceae, based on his genus *Parkeria,* and about a hundred years later, Maxon, taking the older name *Ceratopteris,* raised the genus to family rank in 1926 as Ceratopteridaceae. The name Parkeriaceae has priority. Therefore, are the Ceratopteridaceae correctly named?[5]—G. Kunkel, *Las Palmas, Gran Canaria.*

FLORE LAURENTIENNE by Frère Marie-Victorin, 2nd Ed. 1964, completely reviewed and corrected by Ernest Rouleau. Les Presses de L'Université de Montréal, Case Postale 6128, Montreal 3, Canada. $16.50 plus .25 handling.—According to the publisher's release the second edition of Flore Laurentienne is "completely reviewed and corrected" and "the species at present known in the vascular flora of Quebec are described and commented upon: 637 new species." "Complete keys to the families, genera and species." After comparing the second edition with the first, one concludes that the operative word is indeed "reviewed," not revised. The book size is now 6½ x 9½ instead of 8¾ x 11¼ and the text is 927 pages against 917 pages, although throughout most of the book the pagination is unchanged. The reduction in page size has been achieved by drastically reducing

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[2] The Ferns and Fern-Allies of West Tropical Africa. London. 89 pp. 1959.

[3] On Natural Classification of the Family "Polypodiaceae." Sunyatsenia **5**: 201–268. 1940.

[4] Genera Filicum. Waltham, Mass. 247 pp. 1947.

[5] There is no rule that says that the names of Orders have to be based on the correct names of families, and therefore Ceratopteridales is a correct name, even though it is based on the incorrect family name, Ceratopteridaceae. On the other hand, since the names of Orders are exempted from the principle of priority, an ordinal name based on the family name Parkeriaceae could be proposed, if that were considered desirable.—[C.V.M.]

margins, slightly reducing figures and changing the type. However, if one is going to print a book so that each page ends at precisely the same word as before, it is then quite difficult to make additions. The 637 new species are added by mentioning them by name in very small print under the individual genera. Sometimes there is a word or two about some outstanding character of the species, and the distribution is given briefly. Since the keys and descriptions of the first edition are used, it follows that the 637 new species are not described and that keys to the species are not complete.

The pteridophytes are treated in 29 pages. In the first edition there were 22 genera, 64 described species and 16 cited species, whereas in this edition there are 23 genera, 64 described species and 24 cited species. The eight species added are: *Pellaea glabella*, *Woodsia obtusa*, *Cystopteris dickieana*, *Polystichum lonchitis*, *Dryopteris simulata*, *D.* × *boottii*, *Asplenium cryptolepis* and *Athyrium alpestre*. Using the second species as an example, the full addition reads—"On trouve aussi dans la région de St.-Armond, le *W. obtusa* (Spreng.) Torr." The additions are extremely brief. The intent in the first edition was to describe in detail all those vascular plants in the southeastern part of the province of Quebec which is the most densely populated and most accessible (p. 2–3 and Map A). This area did not include the interesting Gaspé peninsula. The cited species were those found outside the designated area. However, in the second edition with the method used to make additions, this distinction is lost.

Because the original format is used, the key for the genera does not include *Pellaea*, and since *Woodsia ilvensis* is the only *Woodsia* described, there is no key to delineate the other five species cited. Dr. Rouleau has made certain changes and corrections in names, e.g., *Equisetum fluviatile* for *E. limosum*, *Matteuccia* for *Pteretis*, *Dryopteris* for *Thelypteris* (although he uses *Dryopteris* to include oak ferns, beech ferns, marsh ferns and wood ferns), etc.

There is little point in this reviewer discussing the number of species that are recognized in *Botrychium* (high) and *Dryopteris* (low), and whether the designation *Dryopteris spinulosa* can encompass *D. intermedia* (2x), *D. spinulosa* (4x), and *D. campyloptera* (4x) together with their various hybrids, if one is really reviewing a book published in 1935.

Rouleau has changed the number of species of pteridophytes in the world from 7000 (first edition) to 9200, and yet he uses the same number of species in the second edition as the first under each of the families. One might ask where the 2200 additions came from?

The book is a useful one for Canadians as it is well illustrated and has fewer species to recognize than the general manuals for northeastern North America. Nevertheless, it is apparent that it cannot take the place of manuals which have keys to, and descriptions of, all 88 species, rather than just the 64 described. It is disappointing to purchase a book published in 1964, to find that the keys, descriptions and species concepts are those of 1935. —D. M. BRITTON, *University of Guelph, Canada.*

Notes and News

CORRESPONDENCE INVITED.—Mrs. Frank Netzel, Route 1, Lake Geneva, Wisconsin, is interested in corresponding with individuals or local groups of amateur fern growers. She would like to receive living plants suitable for growing out-of-doors.—D. B. L.

American Fern Society

ANNUAL MEETING.—Registration materials for attendance, housing details, and meal service during the AIBS meeting are printed in the March through June issues of *Bioscience* or may be procured by writing to AIBS Registration, 3900 Wisconsin Avenue NW, Washington, D. C. 20016. Early registration (before July 29) is advisable.

The American Fern Society luncheon will be held in the University of Maryland Student Union at 12:00 noon on August 15, 1966. Please send a postcard to Dr. Russell Brown, Department of Botany, University of Maryland, College Park, Maryland 20740, to reserve places. Luncheon tickets may be purchased at the banquet ticket desk in the Armory on the University of Maryland campus.

Following the luncheon, at 1:30 PM, the Society will present its paper reading session. Twelve speakers have been scheduled. Information as to the building and room for the session will be published in *Bioscience* and will also be available at the ticket desk in the Armory.

Mr. C. V. Morton is planning a pre-meeting field trip on Sunday afternoon, August 14, to the Fern Valley at the National Arboretum, to the Botanical Gardens, and to "Lebanon," the riverside estate of Mrs. Paul Bartsch. Details on this and the post-meeting field trip to the Eastern Shore on August 18 and 19 will be announced in a special bulletin mailed to Society members. Non-members may request the bulletin from Dr. David B. Lellinger, Smithsonian Institution, Washington, D.C. —I. W. KNOBLOCH, *Department of Botany and Plant Pathology, Michigan State University, East Lansing, Michigan 48823.*

Report of the Retiring Editor

It was with mixed feelings that I submitted my resignation as Editor-in-Chief of the American Fern Journal during the autumn of 1965. Through the few years that it had been my privilege to serve in that capacity, seeing the material go through the editorial and printing processes to emerge as sequential numbers of the Fern Journal had brought me real pleasure with the appearance of each issue. Were that phase of the situation the only one to be considered, you would still be saddled with me as Editor-in-Chief, and a vigorous, thoroughly trained younger botanist denied, for a time, the opportunity to perform the services he is so well fitted to render. Relinquishment of the post has resulted both in a reduction in the pressure on my time and energy and in a real pleasure that such an able man as David Lellinger has found it possible to assume the editorial duties.

It is fitting that acknowledgement be made of the unselfish and substantial aid which the former Editor of the American Fern Journal, Conrad V. Morton, continued to extend to me even when he was facing serious health problems which made it imperative that he reduce his work load. All through the years he has been ready to help anyone interested in, and puzzled by, ferns and fern allies. He has given most generously of his knowledge and of his strength in order to provide such help and to come to the aid of the editor whenever called upon. It is with gratitude and humility that I pay tribute to Conrad's patience with me when slips that should have been caught at my desk escaped me and were detected by him while he continued to serve on the Editorial Board. Thanks are due him, too, for consenting to guide and advise Dr. Lellinger when such help is needed.

It is a pleasure to express my appreciation to the other two members of the Editorial Board, Dr. Rolla M. Tryon and Dr. John H. Thomas. Each of them has read the galley proofs, and made corrections and suggestions that have been of great help in the publication of the Fern Journal. They have read many of the manuscripts submitted for possible publication and used good judgment and a high degree of objectivity in their recommendations regarding such matters and others connected with the Journal.

The contributions of several able pteridologists during my period as Editor-in-Chief have been a source of considerable satisfaction. Those of Dr. R. E. Holttum and his associates have been welcome, for they have brought to our Society's members several excellent papers dealing with ferns from parts of the world largely unknown to most of us. Dr. Warren H. Wagner, Jr. has never failed to send along good material when there was a slack period among our writers and the stock of manuscript was at a low level. No single author has presented as many papers for the Fern Journal as Conrad Morton has written, at least during my term as Editor. His steady, dependable work with ferns of the Western Hemisphere has produced paper after paper of high quality. I trust that he will continue to do so for years to come. And to every author of a paper submitted to the Fern Journal, of whom there are too many to enumerate, thanks are offered with full appreciation of the effort each expended in producing good and interesting articles.

The officers of the Society have given me loyal support, helped increase the annual budget devoted to the Fern Journal when printing costs have climbed, and given encouragement when other problems arose. Presidents Lommasson, Brown, and Correll constantly helped to keep operations moving forward. Two treasurers, Phillips and Hauke, handled tedious and seemingly endless details connected with the subscription lists and changes in the address of members, thus relieving the Editor of such duties. The secretaries of the Society have done endless amounts of paper work and assisted the Editor in numerous ways. To all of these fine people I extend my sincere thanks.

My judgment is biased; it is impossible for me to dispassionately evaluate the degree of excellence—or the inadequacy—of the American Fern Journal during my incumbency as Editor-in-Chief. It is with a twinge of regret that I step out of the office, but I wish the new Editor-in-Chief great success. I am quite willing that the members of the American Fern Society decide, each one as he or she views the overall picture, whether my obligations during the last four years were discharged poorly or well.

IRA L. WIGGINS,
111 Pope Street, Menlo Park, California 94025.

Report of the 1965 Fern Foray

Dr. Robert H. Mohlenbrock, with the help of some of his students, did a spectacular job of preparing for and conducting the foray in southern Illinois, going so far as writing and having printed an illustrated booklet entitled "Habits and Habitats of Southern Illinois Ferns." Since foray participants were scattered in hotels and motels throughout Carbondale, Dr. Mohlenbrock arranged for a considerable amount of taxi service.

The group first met at 7:45 PM on August 12 in the Agricultural Building of Southern Illinois University, at Carbondale. Dr. Mohlenbrock welcomed us and gave an excellent illustrated talk on the ferns of Illinois. Following the talk, coffee and cookies were served.

At eight the next morning we met on campus and boarded a University bus. The first stop was in Giant City State Park south of Carbondale, where we visited a mesic woods, seeing thirteen ferns as well as a number of interesting flowering plants. The second stop, also in the Park, was at a drier sandstone ledge, where we added three ferns to those already seen. We next traveled to Shawnee National Forest, where we made a brief stop, mainly to see the only colony of *Equisetum hyemale* we were to see.

At the Pine Hills Recreation area, which we visited next, we saw seven more species, most notably *Asplenium resiliens*, which was rare on limestone cliffs. We ate lunch at the top of the bluffs and enjoyed a magnificent view of the Mississippi Valley. We were warned when we visited the swamps at the foot of the cliffs to watch out for rattlesnakes, copperheads, and moccasins, but none were seen.

North along the river near Grant Tower we stopped at Devil's Bake Oven, a small limestone cliff hanging over the river, to see our only *Cheilanthes feei*. The last stop of the day was at Piney Creek, a dry sandstone ravine where there were a few plants of *Asplenium bradleyi*.

After dinner in the Agriculture Building, Dr. Mohlenbrock gave an extremely interesting illustrated talk on the flora of Southern Illinois. He revealed that while scouting sites for the fern foray he had added two species to the known flora: an orchid, *Habenaria clavellata*, which had not been collected in Illinois for over 100 years, and a grass, *Poa interior*, the first record for the state. We were again served refreshments after the talk.

On Saturday morning we met at 7:30 for the trip to the southeastern part of the state. On this day not only was the bus full, but three extra vehicles were used, since a number of Dr. Mohlenbrock's students accompanied us. Our first stop was at Split Rock Hollow, a beautiful mesic woods with sandstone ledges; here we saw twenty-one species of ferns and fern allies, more than in any other area. Most notable was the handsome cliff clubmoss, *Lycopodium porophilum,* which is similar to *L. lucidulum.*

After box lunches at picnic tables in a rural churchyard, we proceeded to Jackson Hollow where everyone was looking forward to seeing the colony of filmy fern, *Trichomanes boschianum.* After seeing patches of *Selaginella rupestris* on the top of the sandstone bluff, we descended into the ravine and saw the extensive colony of filmy fern, which extended some fifty feet in the wet seepage at the base of the cliff under overhanging sandstone ledges. If there was a high point on the foray, this was undoubtedly it.

For the last stage of the trip, the bus took us to Massac Fire Tower. Since this was a mile from the low, moist woods we were to visit, the three smaller and more maneuverable vehicles ferried most of us over almost non-existent lanes and through fallow fields. Though we saw a number of ferns here, including our only Royal and Marsh Ferns and a colony of unusually large Broad Beech Ferns, the most interesting plants were several Green Woodland Orchis, one of which was still in flower.

When the bus developed engine trouble on the way back to Carbondale, there were some anxious moments, since we were fifteen miles from our destination and it was already 5:30 PM. However, the resourceful driver carefully drove about a mile to a branch campus, where an empty bus awaited us, as if by prearrangement.

Dr. Mohlenbrock, his students, and the University of Southern Illinois are to be thanked for providing an outstanding fern foray.

Of the forty-five ferns and fern allies known from southern Illinois, thirty-five were seen: *Adiantum pedatum, Asplenium bradleyi, A. pinnatifidum, A. platyneuron, A. resiliens, A. rhizophyllum, A. trichomanes, Athyrium filix-femina, A. pycnocarpon, A. thelypterioides, Azolla caroliniana, Botrychium dissectum* var. *obliquum, B. virginianum, Cheilanthes feei, C. lanosa, Cystopteris fragilis, Dryopteris intermedia, D. marginalis, Equisetum arvense, E. hyemale, Lycopodium porophilum, Onoclea sensibilis, Osmunda cinnamomea, O. regalis, Pellaea atropurpurea, Polypodium polypodioides, P. vulgare, Polystichum acrostichoides, Pteridium aquilinum, Selaginella apoda, S. rupestris, Thelypteris hexagonoptera, T. palustris, Trichomanes boschianum,* and *Woodsia obtusa.*

Participants in the foray were: Mr. Robert G. Aborn (New Jersey), Dr. and Mrs. R. H. Benedict (Illinois), Dr. and Mrs. Correll, Miss Selena Correll (Texas), Dr. and Mrs. Lewis Dickinson (Kentucky), Mr. Warrick J. Dickson (Louisiana), Mr. Frederick Dunlap (Missouri), Mr. David L. Emory (Pennsylvania), Miss Alice N. Gobin (California), Dr. and Mrs. LeRoy Henry (Pennsylvania), Dr. Donald G. Huttleston (Pennsylvania), Dr. Irving W. Knobloch (Michigan), Mr. Thomas N. McCoy (Kentucky), Mr. William Marberry (Illinois), Dr. and Mrs. Ray A. Martin (Kentucky), Mrs. James H. Mason (Indiana), Mr. and Mrs. William B. Meinders (Ohio), Miss Eva Sobol (New York), Mr. and Mrs. Walter W. Willis (Ohio), and Dr. Mohlenbrock (Illinois).

Students joining the foray on Saturday were: Sharon Andress, Carl Bollwinkel, Ron Boyd, Tom Elias, Max Felty, Gene Garrett, Jack Hayes, Jerry Hinkley, John Kleeblatt, John Kobec, Barbara Luddington, Stewart McNames, Richard Maxwell, Dan Mitchell, Sharon Poellot, Noel Schanen, Mr. and Mrs. John Schwegman, William Tuttle, William Walton, and Mrs. Sharon Wunderle.—DAVID L. EMORY, *Mercersburg Academy, Box 188, Mercersburg, Pennsylvania 17236.*

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. The admission fee shall be $4.00 payable when application for membership is made. This fee shall also constitute the dues for the current year.

Section 3. The annual dues shall be $4.00, payable on January first of each year. Sustaining membership is credited to any person upon the annual payment of $8.00.

Section 4. Any eligible person may become a life member on payment, at any one time, of a fee of $80.00, 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 5. 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-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 6. Every member in good standing is entitled to all the privileges of the Society including its publications.

Section 7. Members who have not paid their dues by January 15 of any year shall be considered not in good standing and shall forfeit all privileges of the Society including its publication. Any such member

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[1]As amended by the membership at the annual elections of 1935, 1936, 1940, 1947, 1949, 1954, 1958, 1962, 1963, 1965.

may be reinstated at any time during that year by the payment of arrears to the Treasurer. However, 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. The term of office for the President and Vice-President shall be one year and that of the Secretary and the Treasurer shall be two years. Election of the Secretary shall be in even numbered years and the election of the Treasurer shall be in odd numbered years.

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. He shall also act as Program Chairman for the annual meetings of the Society.

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.

Section 3. No funds accruing to the Society may be paid to any individual members as dividends or income.

Section 4. In case of dissolution of the Society the Council shall have the power to distribute the assets of the Society in conformity with the laws which govern its incorporation, providing that such distribution be made to non-profit plant science societies of national scope incorporated within the United States of America.

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 first. Any other nominations, if endorsed by three members in good standing and received by the Secretary not later than October first, shall be incorporated in the ballot for that year.

Section 3. The President shall by October first 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 vote 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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American Fern Journal

A QUARTERLY DEVOTED TO FERNS

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AMERICAN FERN SOCIETY

CONTENTS

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American Fern Journal

VOL. 56 JULY–SEPTEMBER, 1966 No. 3

The Anatomy of Cystodium

U. SEN AND D. MITTRA[1]

Cystodium is a genus of little-known tree ferns containing a single species, *C. sorbifolium* (J. E. Smith) J. Smith, which is distributed in Malaysia. It grows only in lowland country and is adapted to a temperature of about 80°F all through the year, having continuous growth. The status of *Cystodium* as a genus distinct from *Dicksonia,* another genus of tree ferns, has often been questioned. Recent morphological and cytological studies by Holttum (1963) and Roy and Holttum (1965) indicate that the two genera are indeed distinct. Christensen (1938) and Copeland (1947) considered *Cystodium* to be probably derived from *Dicksonia.* The anatomy of *Dicksonia* is now well known (Holttum and Sen, 1961, and Sen, 1965), but this is the first detailed account of the anatomy of *Cystodium* yet published.

Material was collected by Prof. R. E. Holttum during his visit to New Guinea in 1963, and was sent to us by Mr. J. S. Womersley of the Department of Forests at Lae. Specimens were fixed in FAA, and the usual method of paraffin sectioning was followed. Sections were stained with Orange G and Safranin.

The stem of *Cystodium* is usually creeping, rarely erect, and is unbranched and cylindrical with an obconical base. The lower part of the stem is covered with the remains of petioles of old leaves and with numerous roots. At the distal end of the stem there is a crown of several bipinnate leaves.

Both the stem and the leaves in the young condition are protected by multicellular, uniseriate hairs in various stages of development. These hairs are the only epidermal appendages.

[1]We wish to thank Prof. R. E. Holttum for his advice, Dr. S. P. Sen for his encouragement, and Mr. J. S. Womersley for supplying material for this investigation.

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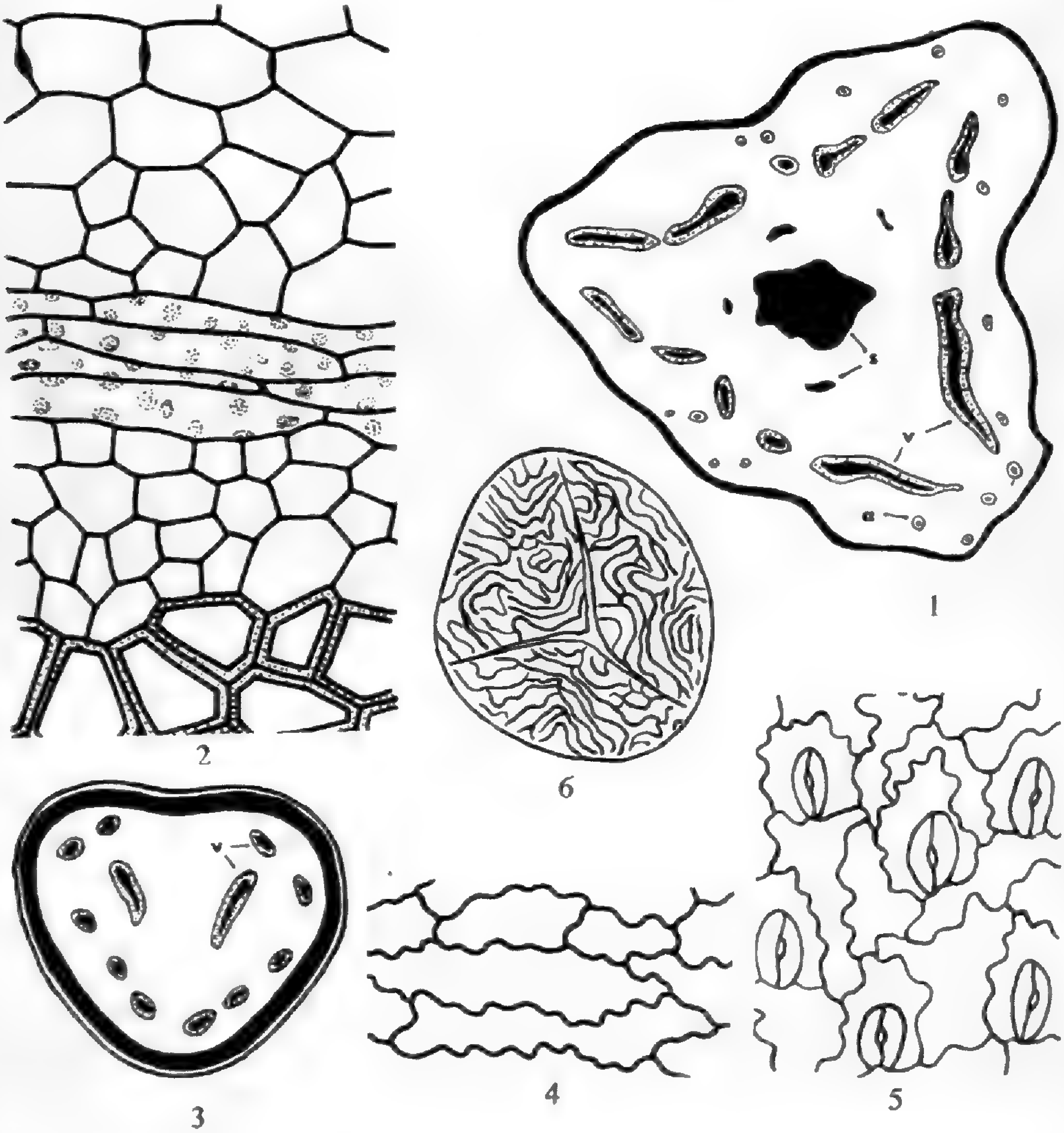

FIGURES 1–6. FIG. 1. TRANSVERSE SECTION OF STEM (DIAGRAMMATIC), × 0.5. FIG. 2. TRANSVERSE SECTION OF PART OF A MERISTELE SHOWING TANGENTIAL CELLS WITH SIEVE AREAS, × 220. FIG. 3. TRANSVERSE SECTION OF PETIOLE SHOWING CHARACTERISTIC PATTERN OF VASCULAR TRACES, × 1. FIG. 4. SURFACE VIEW OF EPIDERMAL CELLS FROM THE ADAXIAL SURFACE OF THE LAMINA, × 80. FIG. 5. SURFACE VIEW OF EPIDERMAL CELLS FROM THE ABAXIAL SURFACE OF THE LAMINA, × 80. FIG. 6. PROXIMAL FACE OF A SPORE, × 460. The abbreviations are: a = ADVENTITIOUS ROOTS PASSING THROUGH THE CORTEX, S = SCLERENCHYMATOUS TISSUE, V = VASCULAR TISSUE.

They are thin-walled and brown.

The internal structure of the stem is relatively simple. The epidermis is composed of elongated cells with slightly thickened external walls.

The cortex is differentiated into three zones: 1) the outer zone consists of vertically elongated parenchyma, the cells of which in the older stems are heavily lignified, and are then barely distinguishable, when viewed in cross section, from 2) the middle sclerenchymatous fibrous layer; towards the center this zone gradually merges into 3) an inner parenchymatous zone composed of thin-walled cells with intercellular spaces. This inner zone contains many irregularly distributed patches of sclerenchyma.

The vascular cylinder in an adult stem is dictyostelic (*Fig. 1*). The meristeles are surrounded by an endodermis, which is of a secondary type. The parenchymatous pericycle is about three cells thick. The phloem cannot be differentiated into proto- and metaphloem, but the sieve cells adjoining the pericycle are elongated tangentially as seen in a transverse section (*Fig. 2*). Hence they are cut transversely in a radial longitudinal section. These tangential cells often form a layer three or more cells deep. The xylem consists of scalariform tracheids and parenchyma, vessels being absent. The tracheids often show elongated to almost circular pits. The parenchymatous pith contains several irregularly distributed patches of sclerenchyma.

The petiole is slightly grooved on its adaxial surface. A dozen or more leaf traces enter the petiole. *Figure 3* is a transverse section showing the typical pattern of these bundles. Pneumathodes form an irregular line on either side of the petiole along the shoulders of the adaxial surface.

The epidermal cells on the adaxial surface of the lamina (*Fig. 4*) are sinuous and are more elongated than those of the abaxial surface. Stomata, which are confined to the abaxial surface, are of the syndetocheilic type, having one or two subsidiary cells associated with a pair of guard cells (*Fig. 5*).

The pinnules are slightly dimorphous. The sterile ones are serrate, while the fertile ones have a slightly narrower lamina and have enlarged teeth that form the adaxial lips of the indusia. The adaxial lip of the indusium is not very different from the lamina proper in having stomata and intercellular spaces, but the abaxial one is very delicate, and is without such structures. The receptacles are slightly raised and are circular in transverse section. The spores are tetrahedral and are ornamented with a delicate network of irregular ridges (*Fig. 6*).

Anatomical characteristics suggest that *Cystodium* and *Dicksonia* are sharply distinct. The cortex of the stem of *Dicksonia* is composed of five distinct layers, while in *Cystodium* it is of three layers. Several islets of parenchyma are found within the second layer of the cortex of *Dicksonia,* but these are absent from *Cystodium*. Cubical cells and mucilage cells are found in *Dicksonia,* but not in *Cystodium*. The receptacle is flattened or slightly raised and distinctly elongate in *Dicksonia,* whereas it is slightly raised and circular in *Cystodium*. The orientation of the subsidiary cells and guard cell mother cells is different in the two genera. The spore walls in *Dicksonia* are thick, especially at the angles, which are truncate, and the exine may be smooth, faintly granulate, or verrucate. In *Cystodium* the spores are ornamented with a delicate network of irregular ridges.

In view of these differences it seems unlikely that *Cystodium* is a direct descendant of *Dicksonia*. In spite of these differences, however, these two genera share many fundamental and peculiar characters: the sieve cells adjoining the pericycle are tangentially elongated, hairs are the only epidermal appendages, the leaves are dimorphous, leaf traces form a characteristic pattern common to both genera, the sori are marginal, and the indusia are two-lipped. Morphological characteristics of the gametophyte (Atkinson, 1965) are also significant. These and other characteristics justify keeping these two genera as members of the Cyatheaceae (*sensu* Holttum & Sen, 1961) and do not contradict the possibility of their origin from a common ancestor.

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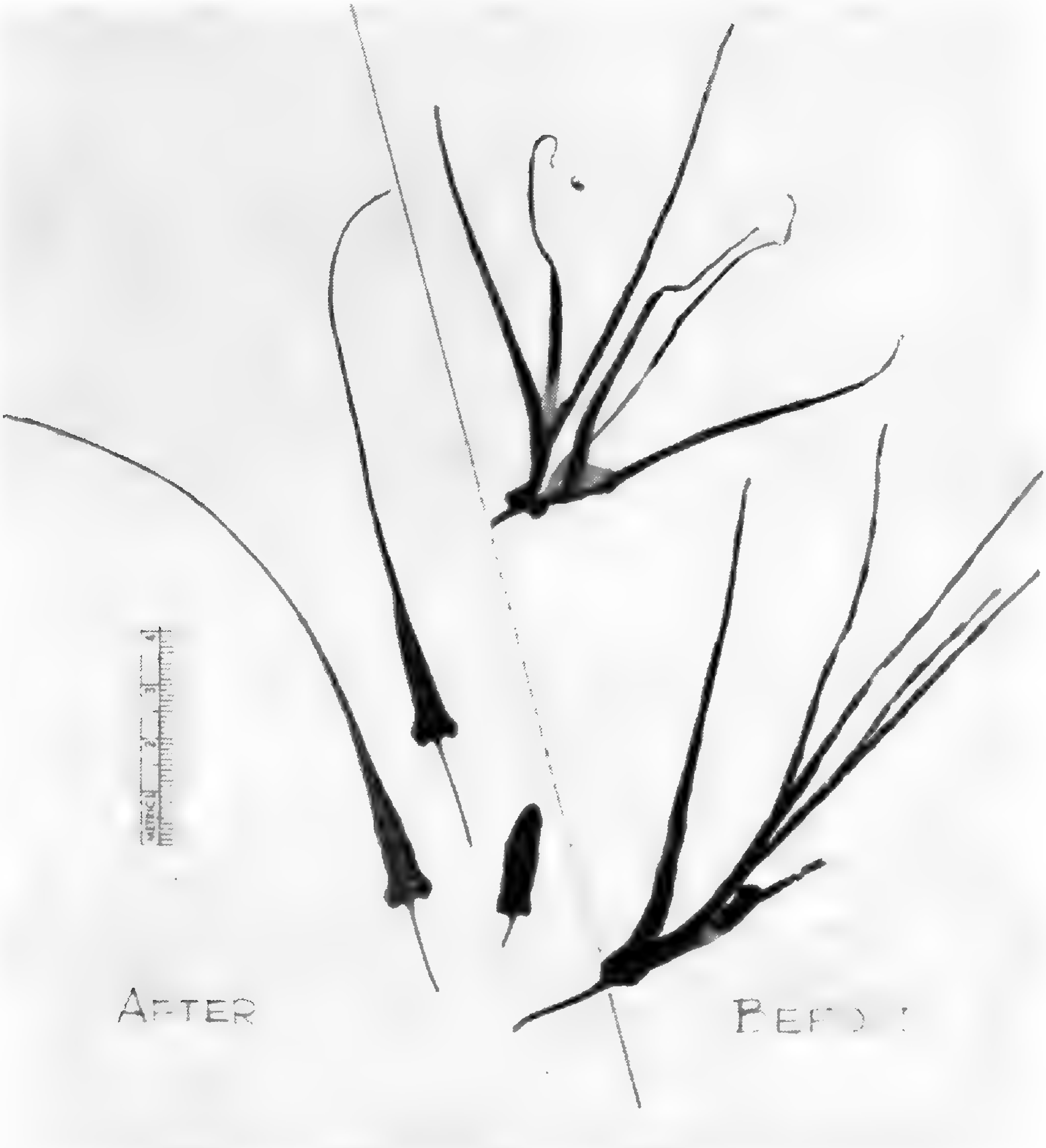
Illustrations of Transient Fern Forms

W. H. WAGNER, JR.

In the winter of 1964, Professor R. B. Channell of Vanderbilt University sent me an extraordinary plant of the walking-fern (*Camptosorus rhizophyllus*) which had been discovered by one of his students. The specimen appeared to have a dozen leaves altogether, but in fact it had only two. The pair of leaves were each repeatedly forked close to their blade bases so as to produce an apparent "spray" of many leaves, each of them with the typical long-attenuate tip. In classical taxonomy such a specimen as this might well have been described and given a latin name as a new form. Fortunately, Dr. Channell had the foresight to send the plant in question alive, so that we could carry out the experiment to be described below.

The specimen was originally discovered by Mr. Paul Weatherby on 27 November 1964, growing on a bluff about two miles south of Ashland City on River Road, across the Cumberland River from Marrowbone Creek, Cheatham County, Tennessee. Examples of the original leaves and those which resulted from the procedures of growing the plant will be deposited in the



FORMS OF CAMPTOSORUS LEAVES FROM THE SAME PLANT. "BEFORE" = LEAVES OF THE PLANT AS RECEIVED FROM DR. CHANNELL. "AFTER" = LEAVES FROM THE PLANT AND ONE OF ITS PROLIFERATIONS AFTER CULTIVATION AT ANN ARBOR.

University of Michigan Herbarium.

We carefully planted the specimen on mossy rocks in a large, glass-covered terrarium. Each of the tips was bent down into contact with the moist surface, so that it would proliferate a new plant. Not only did the tips produce new, healthy individuals, but the original rhizome itself also continued to grow, and we soon had a "family" of plants. We had hoped in this way perhaps to establish a clone of this bizarre "form" which we could distribute to those members of the Fern Society devoted to growing unusual and attractive cultivars of ferns. Surely this form would make an excellent addition to any collection of living fern variations.

Our experiment was successful in the sense that the original plant grew very well and it produced the hoped-for new progeny by proliferations from the tips of the leaves. Unfortunately, however, the plants themselves did not cooperate—every leaf produced was like that of the ordinary walking-fern, simple and undivided. In fact, other normal plants were later introduced into the terrarium, and even after months of growth the new fronds of the novel "form" never did develop the crested condition and could not be distinguished from the normal specimens *(Plate 10)*.

In some ways our efforts to maintain the remarkable walking-fern were not entirely in vain, however. At least, the experiment did illustrate the dangers of naming "forms" without culture studies. The phenomenon of transient leaf forms in ferns is well known. Many of the designated forms of ferns are now known to be merely the result of temporary growth conditions that are brought on by abnormal factors. For example, a perfectly ordinary colony of sensitive fern *(Onoclea sensibilis)* growing in the Saginaw Forest near Ann Arbor was mowed down a couple of years ago, and dozens of fronds of the so-called forma *obtusilobata* (Schkuhr) Gilbert appeared, making it possible for me to obtain a complete series for demonstration purposes showing the transitions between the sterile leaves and the fertile leaves in this extremely dimorphic species.

Forms of "fertile panicles" in Botrychium dissectum leaves from the large population near the Headquarters of Pinkney Recreation Area, Washtenaw County, Michigan.

The grapeferns *(Botrychium)* are well known for their transient abnormalities involving the development of the so-called "fertile panicles." Some of the small, deciduous species like the Mingan moonwort *(B. minganense)* and the Matricary grapefern *(B. matricariifolium)* tend to show much forking and disorganization of the fertile panicles in many of the old, over-sized individuals. The medium-sized and small specimens do not show these unusual fertile segments so often.

In the evergreen species of grapeferns, on the other hand, peculiarities are less common, but when they occur they are more interesting because they illustrate rather nicely how the fertile segment is actually derived. The top two leaves shown in *Plate 11* are normal. In these it is necessary to make anatomical studies to demonstrate that the fertile panicles are morphologically the result of the total fusion of the two basal pinnae. The lower left hand leaf shows this fusion only in the lower part of the panicle; in the upper part the pinnae become free. The lower middle leaf shows no fusion at all, so that there appear to be two distinct fertile segments. That on the right is still different, and it shows two whole pairs of pinnae which have become fertile, the basal pair being completely fused, the second pair unfused. These and many other variations can be expected in any colony of evergreen grapeferns, but in my experience the same plant will not repeat the following year. In fact it is often the case that the following year's leaf is wholly sterile. The ones illustrated are *Botrychium dissectum* taken from an excellent large colony near the Headquarters of the Pinkney Recreation Area, Washtenaw County, Michigan, where dozens of variations like these can be gathered every year in August and September. They make fine demonstrations for plant morphology classes.

In our cytogenetic experiments on spleenworts *(Asplenium)* we have occasionally observed the sudden appearance of forked or crested leaves. One of our best examples came from some individuals of lobed spleenwort *(Asplenium pinnatifidum)* which were originally collected by Mr. Thomas Darling along the cliffs beside the Shenandoah River, northeast of Front Royal, Clarke

CRESTED LEAVES FROM PLANTS OF ASPLENIUM PINNATIFIDUM. THESE WERE FORMED ONLY DURING THE SUMMER OF 1956, NOT BEFORE NOR AFTER.

County, Virginia. The plants were normal in every way when they arrived, and they remained so until the summer of 1956, when, for no obvious reason, they began producing weird leaves, some of them (especially like those shown on the lower left of *Plate 12)* divided so many times as to produce apical crests. Afterward, however, these plants again formed normal leaves.

In this case, and that of the odd specimen of walking-fern sent by Dr. Channell, it is plausible that some external factors brought on the crested condition. Some writers have considered the forked condition to represent an "atavism," a "throwback" to primitive conditions when ferns were alleged to have always had forked or dichotomous leaves. This conclusion, however, is purely speculative, and there is no strong evidence to support it. Indeed, all of the evidence we have now indicates just the opposite, namely that the immediate ancestor of the modern ferns had typical midribbed fronds. Furthermore, it is well known that forking can be artificially induced merely by carefully slicing a growing leaf tip with a sharp razor blade. Presumably when transient conditions of leaf forking occur in a plant, some factor operates which injures the growing leaf tip one or more times, thus producing two or more growing tips. In those rare cases where the forking of leaves is genetically fixed, there must be a hereditary tendency for the apical cells to abort and new leaf tips to be constituted.

With these examples of transient abnormalities before us, we are justified in cautioning the namers of "forms" to make sure that their "forms" are truly fixed and genetic. For that matter, there is a real question whether any scientific purposes are served by naming "forms" at all, even if they are genetically fixed. It would be far more to the point, scientifically, to find out what *causes* the abnormal growth. With the current focus of interest on the processes of plant development that is appearing in laboratories around the world, we may well expect increasing interest in the ferns from this standpoint.

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Growth of Pteridium aquilinum (L.) Kuhn Gametophytes in Submerged Culture

BILL D. DAVIS[1] AND S. N. POSTLETHWAIT[2]

The culture of fern gametophytes under aseptic conditions is commonly carried out on various mineral solutions with or without agar. In these methods the ferns develop on the surface of the culture medium. In order to obtain a higher yield of gametophyte tissue, an attempt was made to develop a method for growing these plants in submerged, agitated, liquid cultures, thereby utilizing the entire volume of the medium instead of the surface alone. Since submerged gametophytes develop very slowly, the plants were aerated by bubbling sterile air through the medium. This paper will describe the method developed and will compare the development of gametophtyes grown by this method to that of ferns grown by more standard culture procedures.

Two papers were found in the literature that described the development of lower archegoniates in agitated cultures: Nakazawa (1956) reported on the germination of *Equisetum* spores in aerated submerged cultures, and Machlis and Doyle (1962) described a technique for the growth of liverworts, mosses, and *Equisetum* in flasks agitated on a rotary shaker. Voeller (1964) has described the growth of fern gametophytes in submerged cultures that were not agitated; the development was stimulated by the addition of coconut milk to the medium.

Spores of the Bracken Fern, *Pteridium aquilinum* (L.) Kuhn, were collected in September, 1963, in Pulaski County, Indiana, and stored under refrigeration. The spores were filtered through six layers of lens paper to remove sporangia. For agitated cultures or cultures using a medium solidified with agar,

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the spore surface was sterilized with Chlorox (20%, for 15 sec) and suspended in 0.2% "Tween 20." Dry, unsterilized spores were used when they were to be floated on the surface of the liquid medium. In all cases the medium was composed of Moore's salt solution plus Nitsch's modified trace element solution (Kelley and Postlethwait, 1962). All cultures were maintained at 24° C and were illuminated continuously with fluorescent lamps (approximately 200 ft-c.).

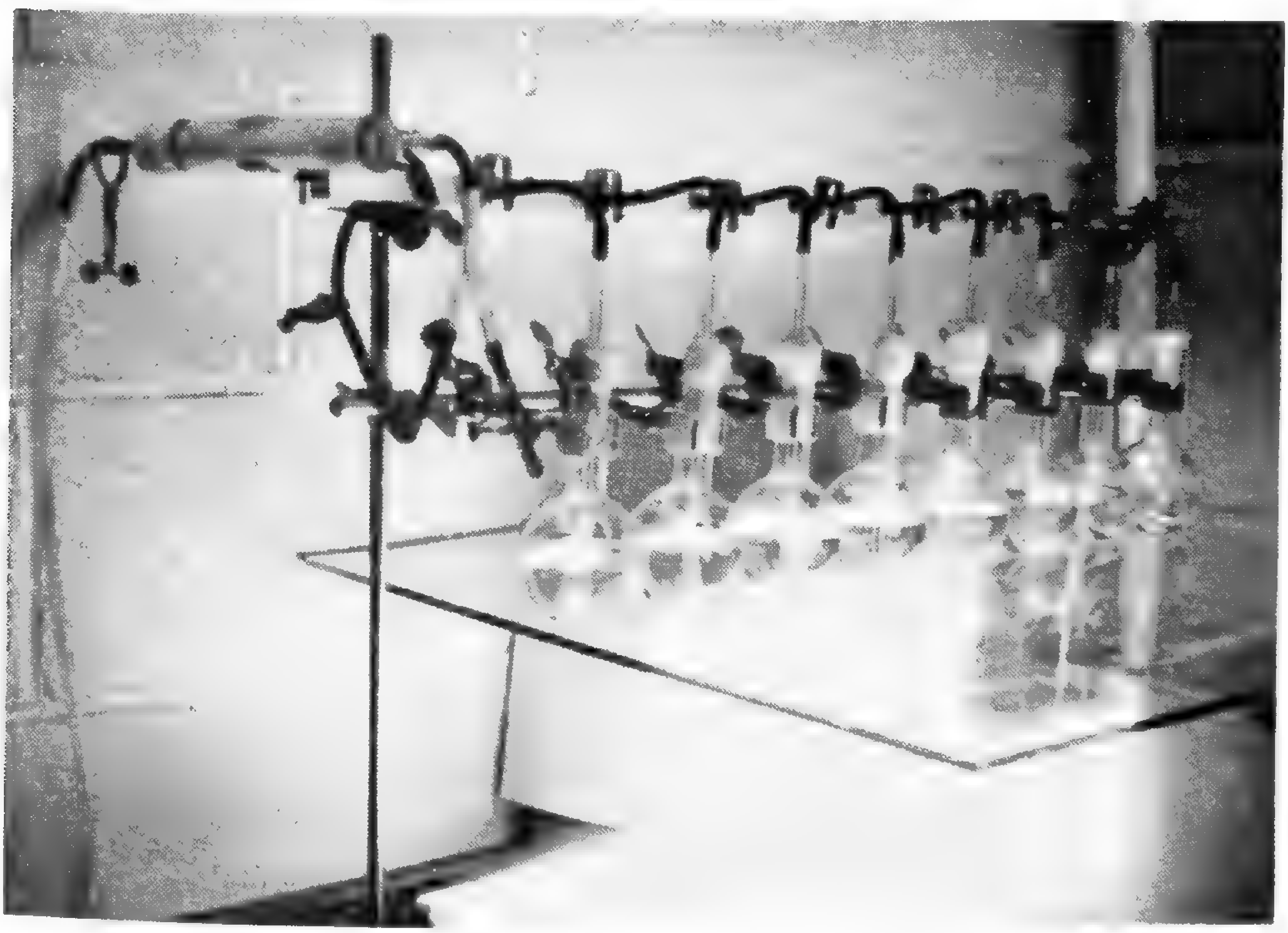
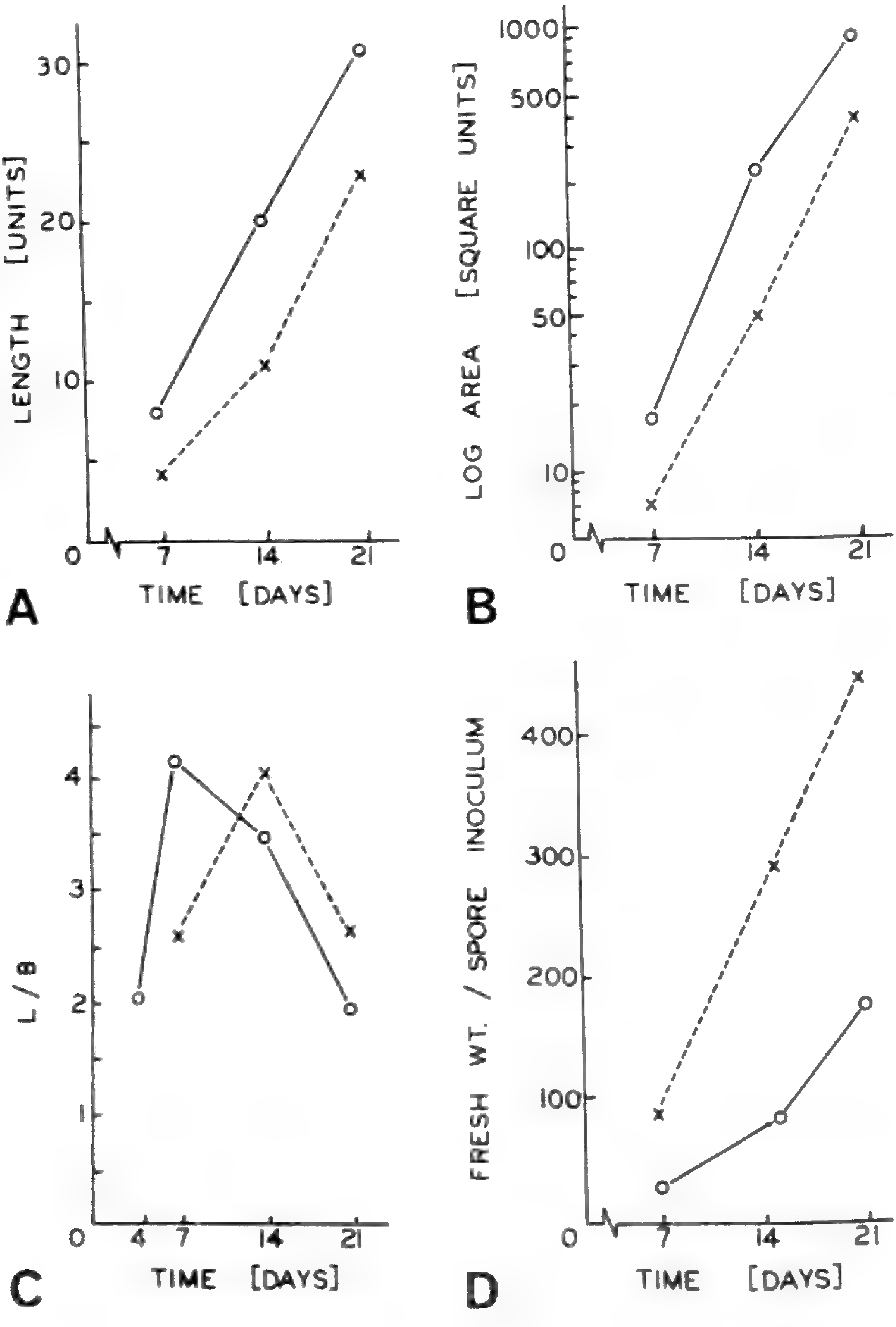


FIG. 1. ARRANGEMENT OF CULTURE APPARATUS.

The general arrangement of the apparatus is shown in *Fig. 1.* Only half of the apparatus was photographed; the rest was a mirror image directly in front of the section shown (removed for clarification). Air was passed through 6 inches of glass wool (tube to upper left of *Fig. 1*) and then through cotton plugs in the air delivery tubes. No attempt was made to measure the rate of air flow.

In the first series of experiments, the gametophytes from agitated cultures were compared to ferns grown in 2-inch Petri



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dishes containing 10 ml of the medium solidified with 1% agar. Four cultures were examined for each method on the 7th, 14th, and 21st day after inoculation; 50 plants per culture were measured for maximum length and breadth with a microscope equipped with an ocular micrometer. In a second series, the yield was compared for gametophytes grown in agitated culture and in still liquid culture. Statistical differences were determined by the *t*-test (Steel and Torrie, 1960).

Although the aeration resulted in the gametophytes being periodically subjected to a turbulence, the morphogenesis of these plants did not seem to be altered. The plants developed their normal cordate form. Numerous antheridia could be seen on most of the ferns by the 21st day; archegonia were observed within 28 days. When the gametophytes were transferred to still liquid cultures, young sporophytes were formed.

The growth of gametophytes from agitated cultures and from still cultures (medium solidified with 1% agar) was measured by estimation of maximum length and breadth. The mean length (*Pl. 13A*) and area (*Pl. 13B*) on each date were significantly higher for gametophytes from agitated cultures (differences significant at 0.01 level). However, the rate of growth, as indicated by the slope of the curves, was the same in both culture methods. The development of the gametophytes was also measured by the "morphogenetic index" of maximum length divided by maximum breadth (L/B; cf. Mohr, 1956). As the ferns developed in the filamentous manner, the morphogenetic index increased (i.e., the gametophytes grew in length but not in breadth); once two-dimensional growth was initiated, the morphogenetic index became stationary or actually decreased

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PL. 13. COMPARISON OF DEVELOPMENT OF GAMETOPHYTES FROM AGITATED CULTURES (————————) TO THOSE GROWN ON STILL CULTURES (- - - - - - -) ON MEDIUM SOLIDIFIED WITH AGAR (A–C) OR ON LIQUID MEDIUM (D). A. INCREASE IN MAXIMUM LENGTH. B. INCREASE IN AREA (MAXIMUM LENGTH TIMES MAXIMUM BREADTH). C. CHANGE IN MORPHOGENETIC INDEX (L/B: MAXIMUM LENGTH DIVIDED BY MAXIMUM BREADTH). D. FRESH WEIGHT ACCUMULATION. [1 UNIT = 32 μ.]

(i.e., the gametophytes became wider than long). The morphogenetic index of the gametophytes from agitated cultures differed statistically (0.01 level) on the 7th day, but not on the subsequent days (*Pl. 13C*). Therefore it may be concluded that the plants from agitated cultures were more precocious than those on agar-solidified medium, but that the rate of growth (as measured by the rate of increase in length or in area) and the development (as measured by the morphogenetic index) are the same.

Measurement of fresh weight can be used as an index of growth, and is indeed more basic to the goal of this study. Since it is difficult to separate the gametophytes from agar, yield measurements were made by comparing ferns from agitated cultures to those from still liquid cultures. *Plate 13D* shows the fresh weight accumulation to be higher (different at the 0.01 level) in still liquid cultures than in agitated cultures. The rates of growth were also different in the two culture methods.

The submerged culture technique has the same advantages for the study of higher plants as it does for microbes. However, it is also important to determine whether the technique alters the development of the material being studied. For example, Albaum (1938) described "irregular changes in form [which] take place unless the experimental plants are always kept in the same position relative to the light source." In this experiment the gametophytes in agitated cultures were periodically subjected to turbulent movement caused by the air bubbling through the medium. When these gametophytes were compared to those grown on agar-solidified medium, it was found that the rates of growth (increase in length and in area) and the development (changes in morphogenetic index) were the same. The development of *Pteridium aquilinum* gametophytes was not altered by the culture technique.

The major advantage of submerged culture technique is the potential for increased yield of tissue. In this study it was found that the fresh weight accumulation in still liquid cultures was greater than in agitated cultures. One must therefore conclude that the agitation culture technique in this case is superior to culture on an agar-solidified medium, but is inferior to standard techniques in which the gametophytes develop on the surface of a liquid medium.

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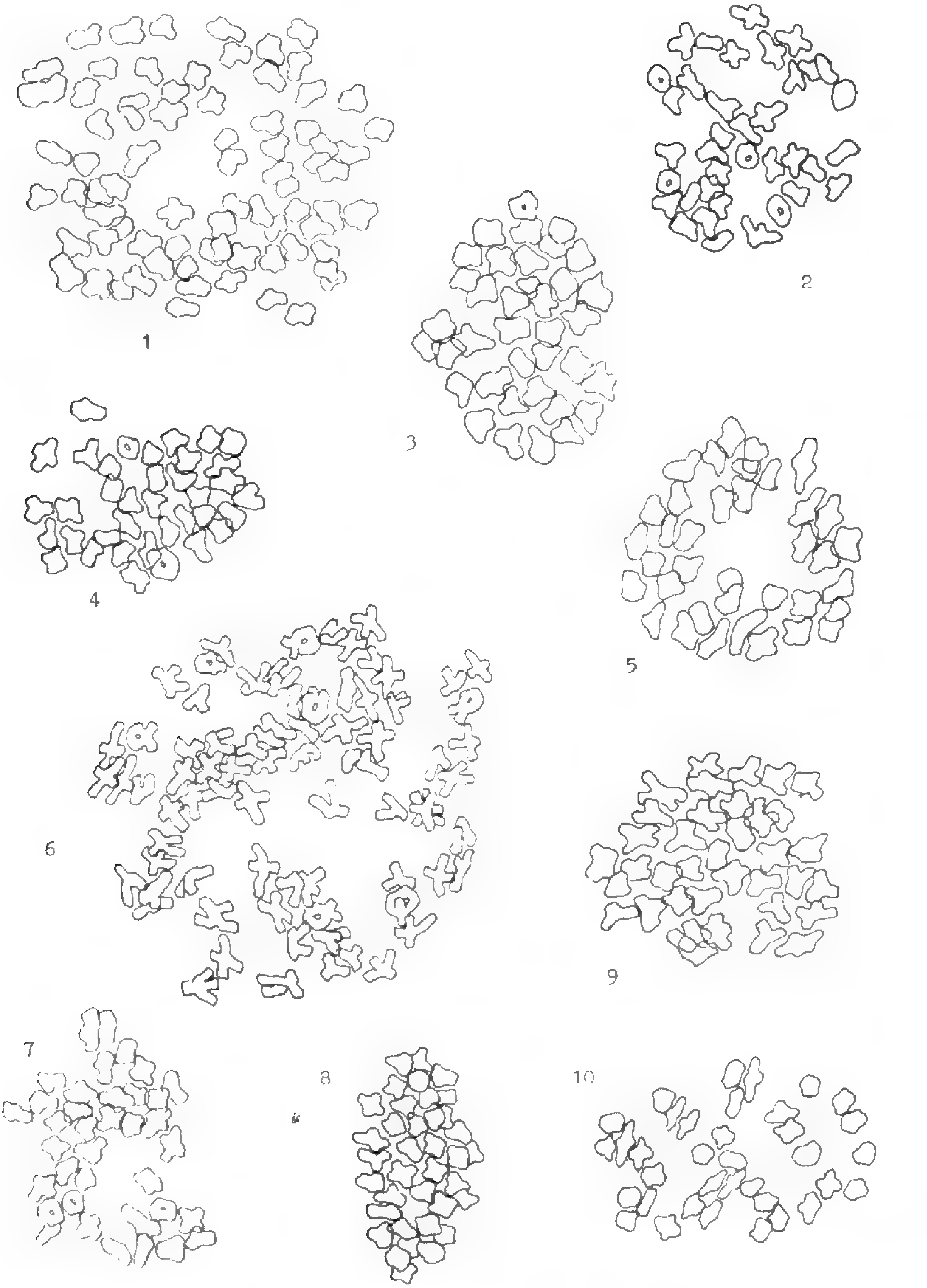
Chromosome Studies in the Polypodiaceae

VEIKKO SORSA

The Polypodiaceae are typically epiphytic, rarely terrestrial, mostly tropical ferns. The type genus has been considered one of the largest fern genera by many pteridologists, but Copeland (1947) has construed it narrowly, and includes only about 75 species, mostly in the American tropics. Chromosome counts of about 35 species mostly from southeast Asia have been published (Chiarugi, 1960, Fabbri, 1963, Evans, 1963a), while the American species have been reported by Manton (1951), Knobloch (1962), Evans (1963a, b), Lloyd (1963), Taylor and Lang (1963), and Wagner (1963).



FIGURES 1–10. CAMERA LUCIDA DRAWINGS OF THE CHROMOSOMES AT THE FIRST MEIOTIC DIVISION, CA. × 1200.

Material for the present study was obtained from the Botanical Garden of the University of California at Berkeley in 1963 and 1964, and their accession numbers are indicated in the list of species. Young sporangia were fixed in acetic acid-alcohol (1:3) and stained about one to four hours later in aceto-carmine solution. After squashing and preliminary inspection, the preparations were restained with acetic acid-iron-hematoxylin solution. These investigations were carried out in the Department of Genetics at the University of California, Berkeley. Names and other information on the species are according to the register at the Botanical Garden of the University (UCBG). Voucher specimens of most of the species are deposited in the University's herbarium (UC).[1]

POLYPODIUM ANGUSTIFOLIUM Swartz. 57.006-S1, Costa Rica. *Fig. 1.* n = ca. 74.

The number $n = 74$ has been counted in *P. leucorhizon* Klotzsch, which is possibly identical with this species. The same number has been reported by Fabbri (1957) and Evans (1963a) for this species under *Campyloneurum*. Inclusion of this species in *Goniophlebium* (Conzatti, 1946) does not seem correct, for Patnaik and Panigrahi (1963) report only $n = 36$ for that genus.

POLYPODIUM ANGUSTUM (Humb. & Bonpl.) Liebm. 50.434-1, Guatemala. *Fig. 2.* $n = 37$.

Some taxonomists (e.g., Conzatti, 1946) have included this species in *Phymatodes*, but all known species of this genus have $n = 36$ (Chiarugi, 1960, Fabbri, 1963). Copeland (1947) included *Phymatodes* in *Microsorium*, which has $n = 36$ (Chiarugi, 1960, Fabbri, 1963).

POLYPODIUM FEEI (Bory) Mett. 61.697-1, Java. *Fig. 3.* $n = 37$.

Copeland (1947) considered this species to be a *Selliguea*.

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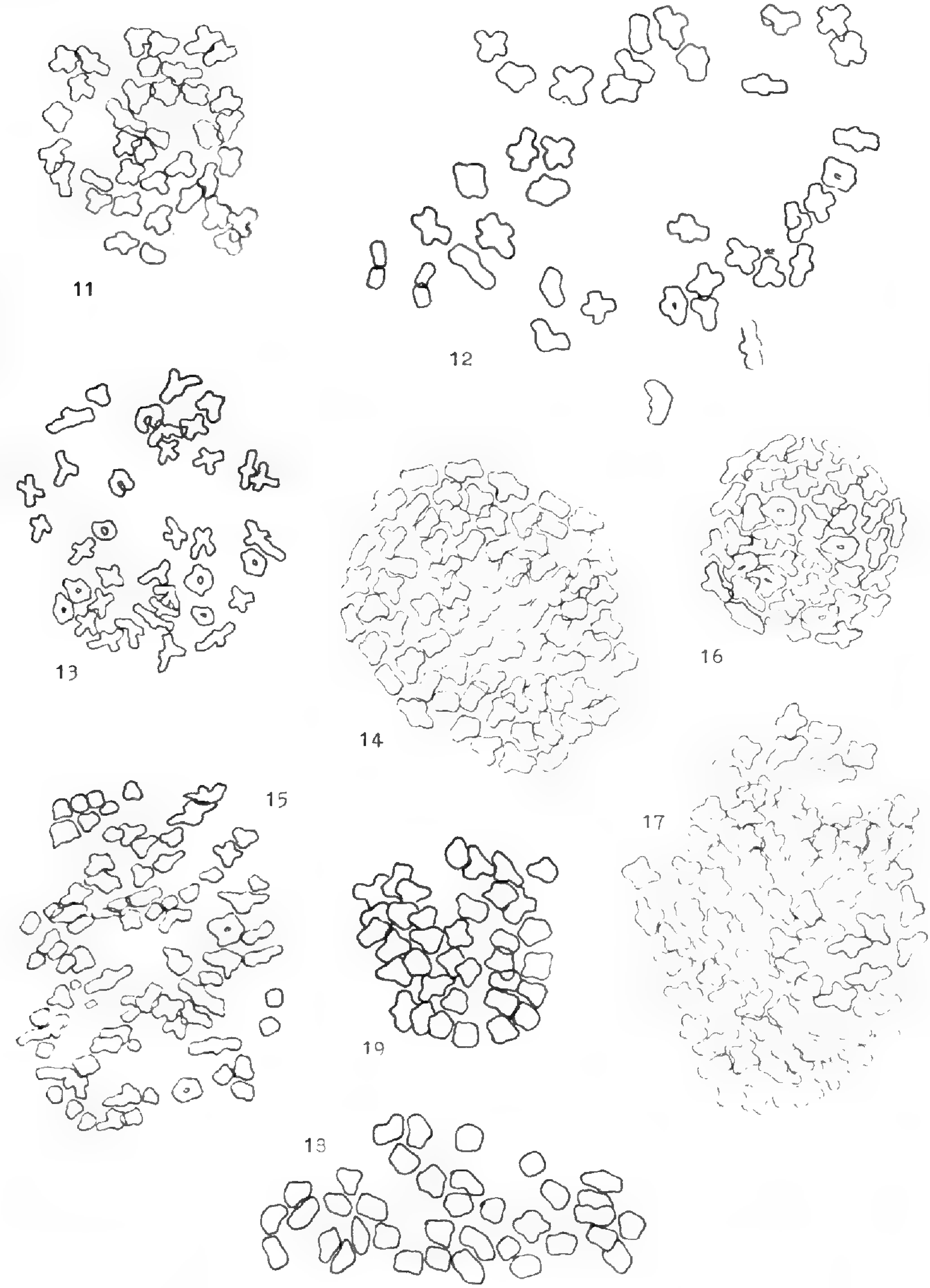
[1]The author is very much obliged to Dr. H. G. Baker and Dr. D. R. Cameron, University of California, Berkeley, for reading the manuscript of this paper, and to Mr. P. C. Hutchison, Senior Botanist of the UCBG, for many valuable notes concerning the names and the identifications of the species studied.



FIGURES 11–19. CAMERA LUCIDA DRAWINGS OF THE CHROMOSOMES AT THE FIRST MEIOTIC DIVISION, CA. × 1200.

POLYPODIUM FRAXINIFOLIUM Jacq. 57.017-1, Costa Rica. *Fig. 4.* $n = 37$.

This species is also known as *Goniophlebium distans* (Raddi) J. Smith.

POLYPODIUM LACHNIFERUM Hieron. 58.1122-1, Peru. *Fig. 5.* $n = 37$.

Evans (1963a) reported the same number.

POLYPODIUM LEUCORHIZON Klotzsch. 58.1124-S1, Peru. *Fig. 6.* $n = 74$.

POLYPODIUM LYCOPODIOIDES L. 57.151-S1, Costa Rica. *Fig. 8.* $n = 37$.

This species has been referred to *Phymatodes, Pleopeltis,* and *Anapeltis.* Copeland (1947) used the name *Microgramma.* While *Phymatodes* has $n = 36$, *Pleopeltis* has been reported by Manton (1953, 1959) to have $n = 35$ and by Wagner (1963) as $n = 51$. *Microgramma owariensis* (Desv.) Alston from tropical West Africa has $n =$ ca. 37 according to Manton (1959) and *M. vacciniifolium* (Langsd. & Fisch.) Copel. has $n = 36$ according to Evans (1963a), who also reported $n = 37$ for Costa Rican material of *P. lycopodioides.*

POLYPODIUM PHYLLITIDIS L. 58.1125-S1, Peru. *Fig. 9.* $n = 37$.

This species is sometimes included in *Campyloneurum,* and has previously been found to be tetraploid (Pal, 1961, $n = 76$, Evans, 1963a, and Wagner, 1963, $n = 74$). Evans (1963a) found $n = 37$ in diploid Peruvian material of this species, in *C. costatum* (Kunze) Presl, and in *C. latum* Moore.

POLYPODIUM PLEBEIUM Cham. & Schlecht. 52.1322-1. *Fig. 10.* $n = 36$–37.

The evidently aneuploid number, $n = 36$, is not common in *Polypodium,* but has been reported by Patnaik and Panigrahi (1963) and by Evans (1963a).

POLYPODIUM PLECTOLEPIS (Fée) Hook. 50.438-1, Mexico. *Fig. 11.* $n = 37$.

Evans (1963a) reported the same number.

POLYPODIUM PTILORHIZON Christ. 59.113-1, Costa Rica. *Fig. 7.* $n = 37$.

POLYPODIUM RHODOPLEURON Kunze. 53.1091-1, Mexico. *Fig. 12.* $n = 37$.

Evans (1963a) reported the same number.

POLYPODIUM ROSEI Maxon. 59.1499-1, Mexico. *Fig. 13.* $n = 37$.

POLYPODIUM SCOLOPENDRIA Burm. 54.1142-S1, Guam. $n = 72$–74.

This species is also called *Microsorium.* In southern India it has $n = 36$, according to Abraham et al. (1962).

POLYPODIUM THYSSANOLEPIS A. Braun. 59.1506-1, Mexico. *Fig. 15.* $n =$ ca. 74.

Meiosis seems to be irregular; both bivalents and univalents and possibly some multivalents are present in the first metaphase. Evans (1963a) reported $n = 37$ in diploid Peruvian material.

POLYPODIUM VITIENSE Baker. 55.092-S1, Admiralty Islands. *Fig. 16.* $n = 37$.

Considered a *Microsorium* by some pteridologists.

POLYPODIUM CALIFORNICUM Kaulf. 50.733-1, California. *Fig. 17.* $n = 74$.

Manton (1951), Lloyd (1963), and Evans (1963a) reported the same number.

MERINTHOSORUS DRYNARIOIDES (Hook.) Copel. 55.078-1, New Guinea. *Fig. 18.* $n = 36$.

DRYNARIA QUERCIFOLIA (L.) J. Smith. 56.660, Java. *Fig. 19.* $n = 36$–37.

Similar numbers have been reported by Manton and Sledge (1954) from Ceylon, by Abraham et al. (1962) from southern India, and by Patnaik and Panigrahi (1963) from eastern India.

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The Mexican Species of Tectaria

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The genus *Tectaria* has not attracted pteridologists, and consequently it is one of the lesser-known of the larger fern genera. Some 200 species are attributed to it, but the actual number must be very much smaller. Like most ferns, these plants are exceedingly variable and many of the variations have received specific names. Many segregate genera have also been proposed, mostly on characters of venation, among them being *Sagenia, Pleocnemia, Dictyopteris, Bathmium, Dryomenis, Podopeltis, Cardiochlaena,* and *Arcypteris.* These have long been recognized as synonyms, but two of them (*Pleocnemia* and *Arcypteris*) have recently been recognized by Holttum (1951a, 1951b) as distinct genera, chiefly on venation characters. Some additional segregates may possibly be recognized among the Old World species, but it does not appear practicable or necessary to segregate any American species.

This genus was long known under the name *Aspidium* Swartz, and it was so treated in the Index Filicum. However, *Aspidium* Swartz was an illegitimate (superfluous) name when published, and it attained a wide usage in different senses (for *Dryopteris, Polystichum,* or *Nephrolepis,* in addition to *Tectaria*) and was thus a source of confusion. A proposal to conserve it in the sense of *Tectaria* was rejected by the Pteridophyta Subcommittee of the International Committee on Nomenclature in 1954.

Because of the proliferation of specific and generic names, the synonymy is extremely confused and complicated. An attempt to determine the correct names of the Mexican species has resulted in the following paper. Fortunately, the best-known species have proved to have correct names, but two of the lesser-known species require name changes. The study has brought to light a number of variations the significance of which remains to be determined. These should be studied cytologically when material becomes available. So far as can be judged from herbarium material, none of them are hybrids, although they may prove to be eventually. I have supplied names for some of these, as subspecies, varieties, or forms as seems appropriate, considering their morphology and distribution. Specimens cited without indication of herbarium are in the United States National Museum.

KEY TO THE MEXICAN SPECIES

Indusia peltate, without sinuses or lobes, coriaceous, persistent, the margins inrolled at maturity, or sometimes apparently absent; blades entire or once-pinnate.

Fronds simple and unlobed; indusia often apparently absent. 1. *T. plantaginea*

Fronds trilobed, trifoliate, or 5-foliolate, the lowermost pair of pinnae stalked, mostly with an acute basiscopic lobe. Upper leaf surface not pubescent except on the veins, the sinuses of the lobes not ciliate; areoles often with a free included veinlet. 2. *T. heracleifolia*

Indusia reniform, attached at a sinus, the basal lobes often overlapping, thus closing the sinus and making the indusia appear peltate; blades simple to bipinnate-pinnatifid.

Stipes much longer than the blades, the latter small, usually merely lobed, the larger fronds with a pair of basal, subsessile or partly adnate pinnae, these with several rounded lobes on the basal side, not with an elongate, acute basal auricle-like lobe; rhizomes creeping, slender, 2–3 mm in diameter. 3. *T. lobata*

Stipes shorter than or about equaling the blades, the larger fronds fully pinnate to subtripinnate at base, if simply pinnate the basal pinnae normally with a single, elongate, acuminate, auricle-like basal lobe (or with several elongate lobes in *T. incisa* subsp. *transiens*); rhizomes thick, 8–20 mm in diameter.

Blades simply pinnate, with 3 pairs of pinnae or more, the basal pinnae with an elongate, acuminate basal auricle-like lobe or rarely with several acute basiscopic lobes; rhizomes erect; areoles often with a free included veinlet; margins of the pinnae essentially eciliate; stipe scales not pubescent on the back at the base. 4. *T. incisa*

Blades bipinnate-pinnatifid or subtripinnate at base, the basal pinnae basiscopically developed, with several elongate, pinnatifid basal pinnules; rhizomes creeping; areoles mostly without included veinlets; margins of the pinnae ciliate, especially in the bases of the lobes; stipe scales pubescent on the back at the base. 5. *T. mexicana*

1. TECTARIA PLANTAGINEA (Jacq.) Maxon, Contr. U. S. Nat. Herb. **10**: 494. 1908.

Polypodium plantagineum Jacq., Coll. **2**: 104, *t.3, f.1.* 1788.

Polypodium latifolium Vahl, Eclog. Amer. **3**: 50. 1807, *non* Forst., 1786. TYPE: Montserrat, *Ryan* (not seen).

Dryomenis plantaginea (Jacq.) J. Smith, Bot. Voy. Herald 229. 1854.

Aspidium plantagineum (Jacq.) Griseb., Abhandl. Ges. Wiss. Goett. **7**: 268. 1857.

Bathmium plantagineum (Jacq.) Fourn., Bull. Soc. Bot. France **19**: 254. 1872.

Rhizomes repent, 3–10 cm long, ca. 3 mm in diameter, excluding the roots and stipe bases, scaly, the scales dark, lanceolate, long-attenuate, scarcely 4 mm long, not ciliate; leaves 2-ranked, erect, 25–60 cm long, the stipe shorter than the blade, 5–15 cm long, provided with numerous, brown, spreading, subulate-lanceolate scales 4–6 mm long, 1–1.6 mm broad; leaf blades herbaceous, dark green, simple, not at all lobed or pinnate, 20–50 cm long, 4.5–11 cm wide, oblong to oblanceolate or pointed-elliptic, the apex usually emarginate and proliferous, the base strongly decurrent, the margins entire or sinuate, the costa sulcate above and glabrous, beneath dark, elevated, minutely pilosulous with hyaline, acute, 1-celled hairs, obviously paleaceous, the scales similar to those of the stipe, sometimes at length deciduous, the leaf-surfaces and veins glabrous above, the veins sometimes minutely pilosulous beneath, the margins not ciliate; costules more or less straight, 7–10 mm apart; areoles in 4 or 5 rows between the costules, often with a free, included veinlet; sori round, small (1 mm diam.) or large (up to 2.5 mm diam.), in 2 rows between the costules, compital, not borne on the apices of the included veinlets, the lowest 2 borne on the outer angles of the costal areole (or sometimes of the 2 costal areoles); indusia lacking.

TYPE: Martinique (not seen).

RANGE: Puerto Rico, Lesser Antilles, Trinidad, Tobago, British Honduras and Honduras south to Peru and Brazil. Very likely to be found in southern Mexico (Yucatan, Tabasco, Campeche, or Quintana Roo).

ILLUSTRATIONS: Hook. Exot. Fl. 2, *t. 114.* 1825; Ettingsh. Farnkr. Jetztw. *t. 130.* 1865; Mart. Fl. Bras. **1**(2): *t. 31.* 1870.

Typical *T. plantaginea*, described from Martinique, has discrete, minute, round, exindusiate sori, hardly over 1 mm in diameter. The form occurring in Central America is similar, except that the sori are larger, sometimes as much as 2.5 mm in diameter; there appear to be no other differences, and specimens with small sori are also found in Central America. A more significant variation is found in Trinidad, Tobago, and Puerto Rico, and perhaps elsewhere. In this, some of the lower sori are confluent, and the sporangia are borne along an elongate receptacle. The meaning of this variation is far from clear; it suggests the admixture of another species, perhaps not even of this genus. Still, in other respects the plants do not suggest hybridity. In order that this plant may have a name, it may be called:

10667 1a. TECTARIA PLANTAGINEA (Jacq.) Maxon var. **confluens** Morton, var. nov.

Sori infimi plurimi confluentes, receptaculo elongato incrassato nigricante; indusium nullum.

TYPE: Trinidad, *L. H. & E. Z. Bailey T 15*, March 13, 1921 (US no. 1,058,555).

SOME ADDITIONAL COLLECTIONS EXAMINED:

Puerto Rico: Sierra de Luquillo, Jan. 31, 1926, *E. E. Dale, s. n.* **Trinidad**: *Fendler 118*. **Tobago**: Main Ridge, Roxborough-Parlatuvier Road, *Cowan 1435*. Englishmans Bay, *Broadway 4700*.

10668 1b. TECTARIA PLANTAGINEA (Jacq.) Maxon var. **macrocarpa** (Fée) Morton, comb. nov.

Bathmium macrocarpon Fée, Gen. Fil. 288. 1852.

?*Bathmium sinuatum* Fée, *loc. cit.* TYPE: French Guiana, *Leprieur* (not seen).

?*Aspidium sinuatum* (Fée) Moore, Ind. Fil. 104. 1858, *non* Labill., 1824.

?*Podopeltis sinuata* (Fée) J. Smith, Hist. Fil. 199. 1875.

TYPE: French Guiana, *Poiteau* (not seen).

RANGE: Known only from the Guianas.

SPECIMENS EXAMINED:

Surinam: Brownsberg Mountain, summit, June 25, 1924, For. Bur. [Surinam] *6540*. Nassau Mountain, *Lanjouw & Lindeman 2316*. Almost surely belonging here, although no indusia are still present, are *Maguire 24128* and *24829*, from Tafelberg. **British Guiana**: Pacatorit, Potaro River, March 1907, *Jenman*.

This extremely interesting variation, apparently found only in the Guianas, has a large, circular, centrally-attached indusium, conspicuous in young plants and sometimes more or less persistent. This may very well represent the primitive form of the species; throughout the rest of the range the indusium seems to have been wholly lost. The species *B. sinuatum* was supposed to differ in having sinuate-lobate margins, but this may have been a casual variation. No indusium was seen by Fée, but it may have been deciduous. An additional character shown by var. *macrocarpa* is that the costules are manifestly flexuous or zigzag, and are perhaps somewhat more distant than in var. *plantaginea,* in which the costules are often essentially straight.

2. TECTARIA HERACEIFOLIA (Willd.) Underw. Bull. Torrey Bot. Club **33**: 200. 1906.

Aspidium heracleifolium Willd. in L. Sp. Pl. ed. 4, **5**: 217. 1810.

Polypodium cordifolium Mart. & Gal. Mém. Acad. Brux. 15: 31. *t.4, f.2.* 1842, *non* L., 1753. TYPE: Antigua, Veracruz, Mexico, *Galeotti 6313* (BR, Morton photograph 5175). Juvenile.

Bathmium heracleifolium Fée, Gen. Fil. 287. 1852.

Aspidium trifoliatum [subsp.] *heracleifolium* Clute, Fern Bull. **16**: 82. 1908..

Tectaria trifoliata var. *heracleifolia* Farw. Amer. Midl. Nat. **12**: 261. 1931.

Tectaria trifoliata sensu Millsp. Field Mus. Publ. Bot. **3**: 3. 1903, *non* Cav., 1802.

Rhizome erect, 6–11 mm in diameter, excluding the stipe bases, densely scaly, the scales small, 2–3 mm long, lanceolate, acuminate, slightly fimbriate, blackish and shining, with a narrow brown margin; leaves mostly 9–13, subfasciculate, erect, 30–70 cm long, the stipes longer than the blades, 20–45 cm long, stramineous, the base darker, shining, strongly angulate, deeply sulcate adaxially, glabrous essentially even when young, sparsely scaly near the base, the scales rather large, many cells broad, slightly fimbriate, glabrous on the back; leaf-blades papyraceous, deltoid-ovate, (14) 20–45 (50) cm long, 14–40 cm wide, pentagonal, the juvenile merely trilobate, the mature trifoliolate or 5-foliolate, the basal pair of pinnae much the largest, 12–20 cm long, deltoid, petiolulate, the petiolules 3–13 mm long, 2- or 3-lobed, the basiscopic lobe elongate, 5–7 cm long, entire or sinuate, the acroscopic lobe (if present) small, the apex acuminate, subentire or sinuate or shallowly lobate, the costae septate-puberulous above, the veins often puberulous beneath, the leaf-surfaces glabrous on both sides, the margins not ciliate, even in the sinuses, the second pair of pinnae (if present) oblong-lanceolate, long-attenuate, subsessile or short-petiolulate, subentire or slightly lobed, occasionally with a more or less prominent basiscopic lobe, the apex deltoid, acuminate, trilobed at base or sometimes with additional lobes, not or not much decurrent on the rhachis; venation complexly reticulate, a single costal areole present between the costules, this with several, free, included veinlets arising from the outer margin, these sometimes uniting to form secondary areoles, the other areoles in 9–12 rows between the costa and the margin, in ca. 4 rows between the costules, pentagonal or hexagonal, often with a single, free, included veinlet; sori compital, in 2 rows along the costae, large, 2–3.5 mm wide; indusia orbicular, flat when young, centrally attached, entire, persistent, at maturity thick, 4-angled from the strongly incurved margins.

TYPE: Hispaniola (ex Plumier, Tract, Fil. Amer. 126, *t. 147.* 1705) and Philippine Islands. No specimen in Willdenow Herbarium.

RANGE: Florida, West Indies; Mexico to Peru. The "Philippine Islands" must have been an error.

ILLUSTRATIONS: Small, Ferns Southeast. States 205. 1938 (not typical).

SPECIMENS EXAMINED:

Nuevo Leon: Guajuco, 1880, *Palmer 1457.* Sierra Madre near Monterrey *Pringle 1983.* Haujuco Canyon, *Clausen 7543.* Hacienda Vista Hermosa, *Harvey 1037.* **Tamaulipas**: Victoria, 1907, *Palmer 184, 568.* Gómez Farías, 1907, *Palmer 294.* Rancho de las Calabazas, Río Sabinas, *Sharp et al. 5038.* **San Luis Potosí**: Without special locality, *Parry & Palmer 976.* **Nayarit**: María Magdalena Island, *Maltby 162.* María Madre Island, *Maltby 136, Nelson 4280.* **Jalisco**: Barranca Río Blanco, near Guadalajara, *Rose & Painter 7506.* **Veracruz**: Pueblo Viejo, 1910, *Palmer 574.* Orizaba, *Seaton 306, Bourgeau 1939, Mohr s. n.* Teocelo Falls, *Rhoads.* Motzorongo, *J. C. Smith 62.* Fortín, *Fisher 35378.* Atoyac, *Kerber 116.* Jalapa, *C. L. Smith 2007.* San Juan de Dios, Jan. 30, 1893, coll.? [*J. G. Smith* ?]. Colipa, *Liebmann.* Huatusco, *Mohr, s. n.* Zacuapan, *Purpus 1978, 16602.* Tezonapa, *Orcutt 3119, Leeds 222.* Zapoapan, SE of Catemaco, *Dressler & Jones 84.* Vicinity of Córdova, *Finck 63.* **Puebla**: Falls of Necaxa, Sept. 10, 1905, *Roby s. n.* **Morelos**: Cuernavaca, *Reko 4653, Rose & Painter 6868, 10198, Storer 101.* **Michoacán**: Aquila, *Hinton 16026.* **Colima**: Colima, 1891, *Palmer 1126, 1127; Ibid.*, 1897, *Palmer 47.* San Marcos, *Jones 503.* **Guerrero**: Achotla, *Mexía 8894.* **Oaxaca**: Cafetal Concordia, *Morton & Makrinius 2554, 2659.* Chiltepec, *Martínez-Calderón 746.* Lacava, *Reko 4085.* Cafetal Nueva Esperanza, *Conzatti, Reko, & Makrinius 3078.* **Tabasco**: Retiro, Tenosique, *Matuda 3416.* **Chiapas**: Corcega, Comaltitlán, *Matuda 17899.* Los Lagos, *Carlson 1771, 1847.* Palenque, *Seler 5473.* San Quentin, *Sohns 1588, 1691.* Ona, near Yxtacomitan, *Rovirosa 77.*

Juvenile forms are ovate or elliptic, cordate or lobed at base, the sinus rounded or acute, the basal lobes rounded or acute. Slightly older leaves are pentagonally lobed. Sometimes juvenile leaves are fertile.

2a. TECTARIA HERACLEIFOLIA var. **trichodes** Morton, var. nov.

A var. typica laminis foliorum supra perspicue et persistenter hirsutis differt. Plantae saepe simplices trilobatae, lobis basalibus obtusis vel acuminatis, saepe parvae, vel interdum pinnatae, pinnis 1-jugis, basaliter unilobatis, lobo elongato acuminato, indusia peltata.

TYPE: Cerro de Agua Tortuga (Sahocoe), in the vicinity of Cubilgüitz, Department of Alta Verapaz, Guatemala, 350–450 m elev., March 4, 1942, *J. A. Steyermark 44586* (US no. 1,916,929).

ADDITIONAL COLLECTIONS EXAMINED:

Guatemala, Department of Alta Verapaz: Chamá, 300 m, *Johnson 389*. Limestone cliff, Finca Mocca, *Johnson 148*. Languin, 600 m, in 1875, *Salvin*. Sinaju, Finca Sepacuite, *Cook & Griggs 483, 484*. Finca Sepacuite, *Cook & Griggs 56*.

In its aspect, peltate indusia, and many other characters this variety resembles typical *T. heracleifolia*, appearing to be a small, merely trilobate form. However, the upper leaf-surface is not glabrous as in var. *hercleifolia* but is densely hirsute, and this is such a peculiar character, not shown by dozens of other specimens of the species that I have examined from various parts of the West Indies and continental North and South America, that it appears worthy of some recognition. It is evidently an extremely local variation, being known only from the Department of Alta Verapaz, Guatemala. Such collections as have been named previously have been called *T. trifoliata*, to which there is no near alliance; that species differs in having laterally attached indusia (rather than peltate), sori in more than two rows, and in other ways.

2b. TECTARIA HERACLEIFOLIA var. **maxima** Morton, var. nov.

Lamina foliorum basi bipinnata, pinnis 4-jugis, basalibus longe petiolulatis (3.6 cm) pinnatis, pinnulis 1-jugis, pinnula basiscopica ca. 19 cm longa, breviter petiolulata, profunde lobata, lobo basali ca. 7 cm longo et 2 cm lato, pinnula acroscopica lanceolata, ca. 10 cm longa, basi plus minusve lobata, apice elongato ca. 17 cm longo, profunde lobato, attenuato, pinnis ceteris magnis, usque ad 20 cm longis, inferioribus manifeste petiolulatis, apice laminae trilobato, lobis basalibus elongatis, marginibus lobatis.

TYPE: In dense wet tropical forest on steep limestone slopes near Pueblo Nuevo, Veracruz, Mexico, alt. 95 m, Aug. 12, 1953, *J. R. & C. G. Reeder 1975* (US no. 2,084,827, Isotype YU). The collectors note that the plant is frequent on the forest floor.

Because of the bipinnate blade, I at first thought that this plant was a form of *T. dilacerata*, but the peltate indusia and other characters show that it is allied with *T. heracleifolia*. However, its size, four pairs of pinnae, and bipinnate division is outside the normal range of variation of typical plants, and so I describe it as a variety. Because of a certain irregularity of frond form, however, it may very well represent a cross with *T. dilacerata;* it shows a number of abortive sporangia.

3. TECTARIA **lobata** (Presl) Morton, comb. nov.

Polypodium lobatum L. C. Richard ex Willd. in L. Sp. Pl. ed. 4, **5**: 164. 1810, *non* Hudson, 1762.

Sagenia lobata Presl, Tent. Pterid. 87. 1836. A new name for *Polypodium lobatum* Rich., *non* Hudson, 1762.

Tectaria minima Underw. Bull Torrey Club **33**: 199. 1906. TYPE: In hammocks near the homestead road, between Cutler and Longview Camp, Florida, Nov. 9–12, 1903, *Small & Carter s. n.* (Isotype US).

Aspidium trifoliatum [subsp.] *minimum* Clute, Fern Bull. **16**: 82. 1908.

Aspidium minimum Brick, in Just. Bot. Jahesber. **34**(3): 399. 1908.

Tectaria trifoliata var. *minima* Farwell, Amer. Midl. Nat. **13**: 261. 1931.

Rhizome creeping, 1–5 cm long, 2–3 mm in diameter excluding roots and stipe-bases, paleaceous, the scales brown, lanceolate-subulate, ca. 3 mm long, 0.15 mm wide at base, long-attenuate, not ciliate, not pubescent on the back, 7–10 cells wide, the cells elongate, rather thin-walled; leaves ca. 5, clustered near the apex of the rhizome, erect; stipes stramineous, much longer than the blades, 9–18(28) cm long, slender, 0.5–0.9(1.5) mm thick, scaly only at base, the scales similar to those of the rhizome but slightly larger, channelled on the upper side and septate-pilose, rounded and glabrate on the lower side; leaf-blades deltoid or deltoid-pentagonal, lobate or once-pinnate at base in the largest leaves, 5.5–15(21) cm long, 6–10(18) cm wide; merely lobed blades deeply cordate at the base or subexcavate, the apex acuminate, the lobes 3–7 on either side, gradually decreasing in size to the apex of the blade, joined by a broad wing 5–10 mm wide, the lowest lobes the largest, somewhat unequal-sided, more prominently lobed on the lower side but without a prominent basal auricle, these secondary lobes 3–5 on the lower side, 0–3 on the upper side, rounded, the middle and upper lobes of the blade subentire or slightly lobed, mostly rounded; pinnate blades with 1 pair of pinnae (rarely 2 in the largest leaves, the second pair, if present, fully adnate throughout), these not petiolulate (or very rarely subpetiolulate), usually slightly adnate at the distal base, excavate at the proximal base, 6–9 cm long, 2.4–2.7 mm wide at base, slightly unequal-sided, lobed on both sides, the basal lobe the largest (but the pinnae not auriculate), the lobes 5–8, obtuse; blades thin-membranous, light green, septate-pilosulous on the costae and veins of both sides, the leaf-surface essentially glabrous or sometimes with a few, lax, flaccid, septate hairs on the upper surface near the margin; costal areoles of the lobes (or pinnae) elongate, solitary between the costules, sometimes with 1 or 2 short, free, included veinlets from the outer margin; areoles usually ca. 4 between the costa and sinus and between costule and margin, mostly elongate-pentagonal, mostly without a free included veinlet, although some free veinlets present; sori large, in 2 rows along the costa (or in free pinnae along the costules), mostly borne at about the middle of the outer margin of the costal areoles at the base of a short, outwardly extending spur or veinlet; indusia persistent, circular, appearing peltate but actually with a narrow sinus, this closed by the overlapping lobes, at maturity the margins inrolled but not coriaceous and thickened as in *T. heracleifolia*.

TYPE: Bahama Islands. Apparently no type in Willdenow Herbarium. The holotype probably in Paris.

RANGE: Florida, Bahama Islands, Cuba, Hispaniola, and Yucatán.

ILLUSTRATIONS: Small, Ferns Southeast. States 207. 1938 (as *T. minima*).

SPECIMENS EXAMINED:

Yucatán: Pozo de Guayma, *Schott 780*. Cenote de Santa Ana, *Schott 780 bis*.

The species *Polypodium lobatum* L. C. Richard has been considered as dubious, and it has been rejected from further consideration also because it is an illegitimate later homonym. However, the species was transferred to *Sagenia* by Presl in 1836, and according to the International Code of Botanical Nomenclature this is considered as a valid publication of a new name rather than a new combination. The original description corresponds exactly with the species more recently described at *Tectaria minima* Underwood, and the identification is confirmed by the locality. *Polypodium lobatum* was described from a single specimen, which came from the Bahama Islands, and *T. minima*, which was described in part on material from the Bahamas, is the only species of *Tectaria* growing in these islands, which are now quite well known and extensively collected.

The larger specimens of *T. lobata*, which are pinnate at base rather than merely lobed as in the smaller, could be confused with small plants of *T. heracleifolia*, and the two species are mixed in Wright's no. 1802 from Cuba. The two may be distinguished as follows:

Rhizome creeping, very slender, 2–3 mm in diameter; leaf-blades thin-membranous, flaccid; blades, if lobate, with rounded lobes, not auriculate, if pinnate, the basal lobe of the lowest pinnae rounded; costal areoles mostly without free included veinlets from the outer margin; sori rotund but attached at a sinus, this closed by the overlapping lobes, the margins inrolled at maturity but remaining thin, not coriaceous .... *T. lobata*

Rhizome erect, 6–11 mm in diameter; leaf-blades papyraceous, firm; blades normally large and pinnate, with long-stalked basal pinnae, when juvenile and merely lobate, the basal lobes elongate and pointed, if slightly larger and pinnate the basal pinnae auriculate by an elongate acuminate basal lobe; costal areoles always with several free included veinlets arising from the outer margin, these sometimes uniting into secondary areoles; indusia orbicular, peltate (attached centrally, without a sinus, the margins becoming inrolled at maturity and coriaceous-thickened) .... *T. heracleifolia*

4. TECTARIA INCISA Cav. Descr. Pl. 249. 1802.

Polypodium expansum Poir in Lam. Encycl. Méth. 5: 523. 1804. TYPE: "Amerique" (holotype Lamarck Herb., P, Morton photograph 2664).

Aspidium martinicense Sprengel, Anleit. Kenntn. Gewächse 3: 133. 1804. TYPE: said to be from Martinique, but actually supplied to Sprengel by Rudolphi, the material collected in Santo Domingo by Poiteau.

Aspidium macrophyllum Rudolphi, Bemerkungen aus dem Gebiet der Naturgeschichte 2: 103. 1805 (*nota*). A renaming of *A. martinicense* Spreng. because of the incorrect locality stated by Sprengel and the consequently inappropriate specific name "*martinicense*" for a plant from Santo Domingo [Republica Dominicana]; nevertheless, the name *macrophyllum* was superfluous and consequently illegitimate.

Polypodium repandum Vahl, Eclog. Amer. 3: 53. 1807, *non* Swartz, 1801. TYPE: Montserrat, *Ryan* (not seen).

Aspidium longifolium Desv. Mag. Ges. Naturforsch. Freunde Berlin 5: 319. 1811. TYPE: Antilles. Probably based on a specimen, but cited also is *Aspidium macrophyllum sensu* Willd. in part, excl. syn. From the description it is typical *T. incisa.*

Aspidium bifidum Presl, Delic. Prag. 1: 173. 1822, *non* Carm., 1818. TYPE: Brazil [Probably collected by Pohl] (not seen). From the description it is typical *T. incisa.*

Aspidium fraxinifolium Schrad. Goett. Gelehrt. Anzeig. **1824:** 1868, *nom. nud.*

?*Polypodium hastatum* Vell. Fl. Flum. **11:** *t. 68.* 1827; Arch. Mus. Nac. Rio Janeiro **5:** 447. 1881, *non* Thunb., 1784

Polypodium variolatum sensu Mett. Abhandl. Senckenb. Naturforsch. Ges. Frankfurt 2: 406, 1858, *non* Willd. in L. Sp. Pl. ed. 4, 5: 192 1810. Mettenius placed *P. variolatum* as an undoubted synonym of *Aspidium martinicense*, and so it may be presumed that he saw a specimen labeled *P. variolatum*, possibly in the Sprengel Herbarium. However, the holotype of *P. variolatum* Willd. (Herb. Willd., B, sheets 19685 [1–3], photograph of one sheet by Tryon US) is a species of true *Polypodium*, sect. *Goniophlebium*, closely allied to or identical with *P. menisciifolium* Langsd. & Fisch.

Rhizome erect, 1.5–2 cm in diameter, densely scaly, the scales castaneous, strongly fimbriate, lanceolate, 3–6 mm long, 1–2 mm wide; leaves several (3–6), fasciculate, erect, 70–150 cm long, the stipes about equalling the blades, 40–60 cm long, stramineous, deeply bisulcate on the adaxial side, rounded on the abaxial side, glabrous, scaly at the base only; leaf-blades membranous, oblong to ovate-oblong, 40–75 cm long, 20–50 cm wide, once-pinnate, the rhachis sulcate above, minutely septate-puberulous in the channel; pinnae 3–10 pairs, oblique, the basal pair petiolulate, with an elongate, acute basal lobe and a shorter proximal lobe, otherwise subentire or shallowly lobed, the other pinnae oblong, acuminate, mostly 20–25 cm long, 4–5 cm wide, the lower sessile, the upper adnate throughout, subentire or shallowly lobed, septate-puberulous on the costae and costules above, the apex composed of coadunate pinnae, acuminate, decurrent, the margins glabrous or subciliate but the sinuses not ciliate; areoles in numerous rows, the costal solitary or 2 between each costule, the proximal elongate parallel to the costa, the distal at right angles and parallel to the costule, the others mostly pentagonal or hexagonal, in 7–9 rows between the costa and the margin, the major ones in 2–4 rows between the costules, subdivided into numerous minor areoles, often with a free, included veinlet; sori large, compital, in 2 rows on either side of the costae, borne on the outer margin of the costal areole at the base of an outwardly extending spur or veinlet; indusia persistent, reniform or circular, with a basal sinus, the lobes overlapping and closing the sinus, the indusia thus appearing peltate, the margins incurved at maturity.

TYPE: Puerto Rico, received by Cavanilles from Ventenat.

RANGE: Throughout the West Indies; Mexico to Bolivia and Brazil.

SPECIMENS EXAMINED:

Veracruz: Córdoba, *Conzatti & Gonzalez 609.* Tepinapa, *Liebmann s. n.* Santa Lucrecia, *Reko 4634.* **Oaxaca:** Río Concordia, *Conzatti, Reko, & Makrinius 3055.* **Tabasco:** Arroyo del Macayal, near San Juan Bautista, *Rovirosa 514.* **Chiapas:** Colonia Zintalapa, Escuintla, *Matuda 18163.* Finca Mexiquito, *Purpus 6762.* Esperanza, *Matuda 17955.*

The above synonymy, extensive as it is, is probably not complete, for there are several other names to be considered, which may turn out to be synonyms also when authentic material can be studied, an indication of the variability of the species. Fée (in his Cryptogames Vasculaires du Brésil) described eight varieties, and many others have been described since. The synonymy given lists only the basic names, most of which have been transferred at various times to *Nephrodium, Bathmium, Cardiochlaena, Dryopteris, Sagenia,* and probably other genera. Nevertheless, the species can be readily recognized among the Mexican species by its large size, several pairs of pinnae, the basal pair with a conspicuous, elongate, acuminate basal lobe.

2165 4a. TECTARIA INCISA Cav. forma **vivipara** (Jenm.) Morton, comb. nov.

3264 *Nephrodium macrophyllum* var. *viviparum* Jenm. Bull. Dept. Jamaica 3: 238. 1896. TYPE: British Guiana, *Jenman* (not seen).

Aspidium macrophyllum var. *biolleyanum* Christ in Pittier, Prim. Fl. Costa Ric. 3: 30. 1901. TYPE: Santa Clara, Costa Rica, *Cooper 10274.* (not seen).

?*Aspidium plumieri* var. *brasiliense* Rosenst. Hedwigia **46**: 113. 1906. SYNTYPES (all from Brazil): Passo Mansa, Blumenau, Santa Catarina, *Hadlich 124*; Indaial, Santa Catarina, *Hadlich 18*; Itapocu, Santa Catarina, *Hadlich 48*. Joinville, Santa Catarina, *E. O. Müller 30a, 88*. Coast mountains, São Paulo, *Wacket 54*. Campinas, São Paulo, *Ulbricht 127* (none seen).

Tectaria martinicensis var. *vivipara* Domin, Rozpravy Král. Čes. Spol. Nauk, Tr. Math., nov. rad. **2**: 231. 1929.

Differs in the presence of buds, often bearing young plants, on the bases of some of the middle and upper pinnae on the adaxial side, or sometimes on the backs of the midribs of the pinnae.

TYPE: British Guiana, *Jenman* (not seen).

RANGE: Probably throughout the range of the species, but rare. Specimens are known from Mexico, Costa Rica, British Guiana, and Brazil.

SPECIMENS EXAMINED:

Veracruz: Sanborn, *Orcutt 2979, 3011*. Santa Lucrecia, *C. L. Smith 2015*.

4b. TECTARIA INCISA Cav. var. **pilosa** (Fée) Morton, comb. nov.

Aspidium puberulum Gaud. in Freycinet, Voyage Uranie 242. 1828, *non* Desv., 1827. TYPE: Rio de Janeiro, Brazil, *Gaudichaud* (not seen).

Aspidium macrophyllum var. *puberulum* Gaud. *loc. cit. in syn.*

Cardiochlaena pilosa Fée, Mém. Foug. **10**: 45, *t. 40, f. 4*. 1866.

Nephrodium macrophyllum var. *pilosum* Jenman, Bull. Dept. Jamaica **3**: 238. 1896.

Nephrodium macrophyllum var. *hirsutum* Rosenst. Hedwigia **43**: 227. 1904. TYPE: San Jose, Santa Catarina, Brazil, *von der Goltz 31* (not seen).

Tectaria martinicensis var. *pilosa* Domin, Rozpravy Král. Čes. Spol. Nauk, Tr. Math., nov. rad. **2**: 231. 1929.

Aspidium martinicense var. *puberulum* Suesseng. Revist. Sudamer. Bot. **1**: 81. 1934.

Fronds obviously septate-pilose or hirsute on both surfaces, even at maturity.

TYPE: Rio de Janeiro, Brazil, *Weddell* 656 (not seen).

RANGE: Uncertain, but seemingly widespread but rare (Jamaica, Costa Rica, Colombia, Brazil).

SPECIMENS EXAMINED: None from Mexico.

The significance of this entity is problematical. From its scattered occurrence throughout much of the range of the species, it would seem not to represent a true variety. Still, the plant deserves a name of some sort. Normal plants of *T. incisa* are glabrous on the leaf-surfaces, especially on the upper surface, whereas in this the upper surface is strongly pubescent, perhaps as a result of a mixture with some other species in which the upper surface is normally pubescent. Since this plant does occur sporadically, it may yet be found in southern Mexico.

4c. TECTARIA INCISA Cav. subsp. **transiens** Morton, subsp. nov.

Frondes magnae, pinnis basalibus ca. 35 cm longis vel majoribus, 20 cm latis (lobis inclusis), basiscopice lobatis, lobis magnis 2 vel 3 et lobis plurimis minoribus, pinnis medialibus 2 vel 3, magnis, usque ad 28 cm longis et 8 cm latis, utrinque latere sublobatis, pinna terminali trilobata.

TYPE: Córdoba, Veracruz, Mexico, April 1889, *Hugo Finck 57* (US no. 831,525).

PARATYPE: Córdoba, Veracruz, Mexico, January 1890, *Finck 171* (US no. 831,328–9).

Throughout much of its range *T. incisa* is quite uniform in its frond shape, the basal pair of pinnae having a single, elongate, acute basiscopic lobe. In the two Mexican specimens cited above the basal pinnae have several basiscopic lobes, and also several low lobes on the upper side; the middle pinnae are also slightly lobed. Some similar plants apparently occur in Guatemala and elsewhere in Central America. The significance of this form is doubtful, but it appears to be transitional to some of the more compound species. However, it does not appear to be a sterile hybrid, for the sporangia and spores are normally developed.

5. TECTARIA **mexicana** (Fée) Morton, comb. nov.

Aspidium latifolium Presl. Rel. Haenk. 1: 30. 1825, *non T. latifolia* (Forst.) Copel., 1907. TYPE: Mexico, *Haenke* (not seen). Presl's description does not agree in every detail with the species here treated, and it is conceivably different. It will be necessary to see the type.

Sagenia mexicana Fée, Gen. Fil. 313. 1852.

Aspidium cicutarium auctt., non Polypodium cicutarium L.

Tectaria dilacerata sensu auctt., non Aspidium dilaceratum Kunze.

Rhizomes creeping, 9–16 mm long or more, 8–20 mm in diameter excluding roots and stipe-bases, densely paleaceous at the apex, the scales lanceolate-subulate, 7–9 mm long, 0.7–1 mm wide at base, dark brown, the margin paler, shining, ciliate, not pubescent on the surfaces, the cells elongate, with thickened, dark walls; leaves distichous, few at a time, erect, 50–100 cm long;

stipes shorter than or about equalling the blades, 25–60 cm long, stramineous to brown, deeply bisulcate on the adaxial side, rounded on the abaxial side, pilose with numerous, spreading hairs 0.4–0.6 mm long, these flaccid, septate, 3–6 cells long, the cross walls dark, or rarely glabrate, scaly at base, the scales large, many cells broad, densely pilose on the outer surface at base or nearly throughout; rhachis densely pubescent or glabrate, not gemmiferous, free, only the upper pinnae decurrent; leaf-blades bipinnate-pinnatifid or subtripinnate at base, deltoid, 25–50 cm long, the pinnae 3–5 pairs; basal pair of pinnae deltoid, 16–33 cm long, 12–27 cm wide, long-petiolulate, the petiolule 1.8–4 cm long, slender, often densely pubescent, 0.7–1.5 mm thick, slightly anadromous, the distal basal pinnule borne first, but very close to the proximal pinnule, the pinnules ca. 5 pairs below the acuminate, pinnatifid apex, the basal proximal pinnule the largest, up to 22 cm long, 5–9 cm wide at the middle, narrowed somewhat toward the base, deeply pinnatifid or subpinnate at base, the segments 10–15 pairs below the acuminate, lobed apex, the lowest inferior segment nearly free in the largest leaves, the others joined along the costa by a wing 3–4 mm wide, the largest segments 3–5 cm long, 9–13 mm wide, acuminate, lightly lobed, the costa septate-puberulous above, septate-pilose beneath, the second and upper pinnules deeply pinnatifid but without any free segments, gradually decreasing in size toward the apex of the pinnae; second pair of pinnae and superior ones catadromous throughout, the basal pinnule coming off from the rhachilla before the proximal pinnule, pinnate-pinnatifid or the upper merely pinnatifid or lobed, the second pair usually short-petiolulate (or merely sessile), the upper sessile and the uppermost adnate at base; blades membranous or herbaceous, dark green, the upper surface mostly with a single septate hair in each areole or at least in the marginal areoles, the margins septate-ciliate, especially in the sinuses of the lobes, beneath glabrous except on the veins and veinlets, here septate-pilosulous; costal areoles 2, the proximal elongate along the costa, the distal at right angles along the costule; areoles 7–10 along the costules of the larger segments of the basal pinnae, ± elongate parallel to the costule; areoles in 3 rows between the costa and the sinus between the segments, in 3 or 4 rows between the costules and the margin of the segments, varied in shape but mostly elongate-pentagonal, without free, included veinlets; sori in 2 rows, one on either side of the costules, or in the largest leaves with a partial second row, the primary ones borne on the outer margin of the elongate costular areole at the base of an outwardly extending veinlet, the secondary (if present) compital, none borne terminally on included veinlets; indusia persistent, rotund, with a deep sinus and rounded, overlapping lobes, thus appearing peltate, remaining membranous and not thicked at maturity, ruffled at maturity but without strongly incurved margins, ciliate when young.

SYNTYPES: Etlapa, Mexico, *Galeotti 6484;* Oaxaca, Mexico *Galeotti 6542.*

RANGE: Mexico to Colombia.

SPECIMENS EXAMINED:

Nayarit: Tepic, 1892, *Palmer 1946.* Zopelote, *Lamb 572.* Mina Esperanza, *Ortega 6659.* **Jalisco:** San Sebastian, *Mexía 1493.* Ravine 11 miles SSW of Autlán *Wilbur 2333.* Quimixto, *Mexía 1234.* **Veracruz:** Santa Lucrecia, *C. L. Smith 2014.* Córdova, *Orcutt 3210.* Zacuapan, *Purpus 4341.* Mirador, *Purpus 16644.* **Michoacán:** Aquila, Distr. Coalcoman, *Hinton 16039.* **Guerrero:** Tibor, *Langlassé 291.* **Oaxaca:** Calvario, *Makrinius 487.* Cafetal Concordia, *Morton & Makrinius 2332.* Yaveo, Distr. Choapam, *Mexía 9180.* Along Trans-Isthmian Highway 13 km S of Matías Romero, *King 890.*

It is unfortunate that the earliest name for this species, *Aspidium latifolium* Presl (1825) cannot be adopted, but the epithet *latifolia* is preoccupied under *Tectaria.* In early works this species was usually referred to *Aspidium cicutarium* and more recently to *Tectaria dilacerata* (Kunze) Maxon. Apparently it was Maxon who revived the name *dilacerata* for this plant, after it had lain in synonymy for a long time; he assumed that the type was a Guatemalan plant. It is likely that he was partly right, for Kunze's (1850, p. 300) original citation of his material is as follows: "Specimina vidi spontanea e Guatemala, cultis minora," and (p. 226) "Guatemala. Chile? C. H. Makoy, H. V. Houtt. 1846. H. Lips. 1847." Kunze's species was thus based on a wild specimen collected in Guatemala and on cultivated material that he knew first hand in the botanical garden in Leipzig. It should be pointed out that the description is contained in Kunze's paper on the ferns cultivated in European botanical gardens. It appears likely that the material is a mixture. In his revision of *Aspidium,* Mettenius (1858, pp. 202–204), who had access to Kunze's material, both the wild specimen and the cultivated one, referred the Guatemalan plant,[1] to *Aspidium latifolium* Presl var. *rufescens* Mett., indicating as a synonym: "*Aspidium dilaceratum* Kz. Linn. 23, 300 ex parte," but kept *A. dilaceratum* Kunze (ex parte) as a valid species (his no. 282), referring to it Jamaican material, material that belongs, it seems to me, to *Tectaria cicutaria* (L.) Copel., as it occurs in Jamaica. Thus cultivated material studied by Kunze evidently was material of *T. cicutaria*, probably originally from the West Indies. Mettenius' decision as to which element should retain the name (i.e. be chosen as lectotype) must be upheld. Actually he was undoubtedly right, for a careful reading of Kunze's description shows that it agrees in all respects with *T. cicutaria* from Jamaica, and does not agree with the Mexican plant that was called *dilacerata* by Maxon; in particular, Kunze indicates that the rhizome is erect, as it is in *T. cicutaria* (creeping in the Mexican plant), the blades pinnate-pinnatifid or bipinnate only at base, as in *cicutaria* (bipinnate throughout in the Mexican plant and subtripinnate at base), and the rhachis rufous-hirtous on the costae above (these hairs are much redder and longer in *cicutaria* than in the Mexican plant). Thus, *Aspidium dilaceratum* Kunze should again be placed as a synonym of *Tectaria* [*Aspidium*] *cicutaria*, as it was in the Index Filicum. The identity of the Friedrichsthal Guatemalan collection is uncertain, and can possibly never be determined, since Kunze's herbarium was destroyed in the war; however, it is essentially irrelevant, since it can not be considered the basis of the name *dilaceratum*. Mettenius was wrong in joining it with his *Aspidium latifolium* var. *rufescens*, which is based on *Sieber 187* from Trinidad. *Tectaria trinitensis* Maxon,[2] a species closely

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[1] Indicated as collected by Friedrichsthal.
[2] The synonymy is as follows:

TECTARIA TRINITENSIS Maxon, Amer. Fern J. **20:** 3. 1930.

Sagenia rufescens Presl, Tent. Pterid. 87. 1836, *nom. nud.* Based on Sieber, Syn. Fil. no. 187.

Aspidium latifolium Presl var. *rufescens* Mett. Abhandl. Senckenb. Naturforsch. Ges. **2:** 402. 1858. TYPE: Trinidad, *Sieber 187*.

allied to *T. mexicana*, is the same as var. *rufescens*, an isotype of which is in Leiden (Morton photograph 2292).

5a. TECTARIA MEXICANA var. **pilosula** Morton, var. nov.

A var. typica superficiebus ambobus laminarum minute pilosulis, pilis minutis plurimis in quisque areolis.

TYPE: On banks at Panuco, on the Pacific slope of Sinaloa, Mexico, alt. 500–600 m, August 28–31, 1935, *Francis W. Pennell 20009* (US no. 1,685,393).

ADDITIONAL SPECIMENS EXAMINED:

Sinaloa: Mazatlán, in 1926, *Ortega 6182* (US). Near Colomas, foothills of the Sierra Madre, *J. N. Rose 1778* (US).

This plant is known only from three collections from Sinaloa which differ in having both surfaces of the blade minutely pilosulous, the hairs being numerous within each areole, this being most conspicuous on the upper (adaxial) surface. The upper surface in the usual plants of this species normally has, oddly enough, a single, elongate, flaccid, jointed hair in each areole, thus making the blade very sparsely pilose, and these hairs are often deciduous, or perhaps sometimes absent except in the marginal areoles. Very likely var. *pilosula* is a restricted local variant.

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SMITHSONIAN INSTITUTION, WASHINGTON, D.C. 20560.

Aspidium rufescens (Mett.) Hieron. Hedwigia **46**: 353. 1907, *non* Blume, 1828. Attributed to "Kaulf." in error, *Aspidium rufescens* Kaulf. in Sieber, Syn. Fil. no 187, being a *nom nud, in sched.*
TYPE: Cascade Valley, St. Annes, Trinidad, *Hombersley 326* (US).
RANGE: Trinidad and Colombia (Santa Marta, *H. H. Smith 1016*, *Stübel 360*, *fide* Hieron.).

Shorter Notes

TRICHOMANES HOLOPTERUM NEW TO THE UNITED STATES. – In June of 1964 I received in the mail a fern leaf and a note requesting an identification. I phoned Richard and Rhoda Stone to tell them that they had collected a species of *Trichomanes* unknown to me and surely one not previously known from Florida. The following weekend the Stones showed me where they had found the plant in Collier County, a few miles south of Tamiami Trail (U.S. 41). Material collected that day was sent to Conrad V. Morton at the Smithsonian Institution and to Daniel B. Ward at the University of Florida. Both identified it as *Trichomanes holopterum* Kunze, previously known from Cuba, Jamaica and other West Indian islands.

Trichomanes holopterum differs from other Florida filmy ferns in a number of ways. The fronds are clustered radially on a short rhizome, are 5–6 cm long (occasionally to 10 cm), pinnatifid, with crisped lobes overlapping each other, and bear large sori at the end of nearly every vein. Our other filmy ferns have fronds only 1–2 cm long, spaced distantly along a creeping, thread-like rhizome, and bear relatively few sori. *Trichomanes krausii* is pinnatifid, but *T. lineolatum*, and *T. punctatum* ssp. *floridanum* both have simple fronds.

The swamp in which *T. holopterum* has been found is also in sharp contrast with the relatively dry hammock habitat of our other filmy ferns. The locality is cypress land that was lumbered about thirty years ago. The two most conspicuous trees here are Bald-cypress (*Taxodium*) and Cocoplum (*Chrysobalanus*). *Trichomanes holopterum* grows on moss-covered logs, stumps, and tree trunks all within a foot or two above the high water line. No real effort has been made to determine the local distribution of this fern, but in the small area where it was first found the number of plants has increased markedly in the last two years, and recently a few plants have been seen about a quarter of a mile away.

Specimens have been placed in the herbaria of the University of Miami, University of Florida and the Smithsonian Institution. Living material sent to Dr. W. H. Wagner at the University of Michigan has been used for chromosome and life cycle studies soon to be published.—C. E. DELCHAMPS, *Division of Natural Science, University of Miami, Coral Gables, Florida 33146.*

TRICHOMANES HOLOPTERUM IN CULTIVATION.—I have been trying to grow a specimen of *T. holopterum* collected by Dr. C. E. Delchamps and myself from an unnamed hammock in Collier County, Florida, on March 26, 1966. The plant is about 11 cm tall and has three mature and two young fronds. In nature the specimen was barely epiphytic, as it was attached to an old stump or log a few centimeters above the damp soil.

On the evening of March 26, the specimen was put on some moist sphagnum in a screwtop glass jar for the trip home. On March 30, I transferred it to a large, lightly covered brandy snifter. I embedded the fern on a small piece of dead bark in the sphagnum and covered it with a thin layer of "Living Earth," a kind of organically enriched house plant soil. By April 7 one frond had withered, and by April 24 all but the smallest frond had browned along the edges. I learned from Dr. Delchamps that adding the earth may have been my mistake; epiphytic ferns are light feeders. It remains to be seen whether removal of the rich soil will save the plant.— J. W. JOHNSTON, JR., *217 N. Wayne Street, Arlington, Virginia 22201.*

APOSPORY IN PTERIS.—In 1919 the late Prof. William N. Steil published a paper entitled "Apospory in Pteris sulcata L." (Bot. Gaz. **57**: 469–482. 1919), a work which has been often cited since in papers dealing with apospory. The plant being investigated was stated to be *Pteris sulcata* L., but there is no such species. I wrote to Professor Steil in 1949 as to whether it was possible, after a lapse of 30 years, to establish definitely the identity of the species studied. He replied (March 1, 1950): "Please excuse the delay in answering your letter. '*Pteris sulcata*' should be given as *Pteris flava,* native of the Philippines. Ref. Hedwigia **55**: 337. 1914. In Botanical Gardens of Berlin, Leipsic, and Kew known as *P. sulcata.*" This identification must be viewed with extreme suspicion. I think that Steil looked in Supplement II of the Index Filicum, where *P. sulcata* Meyen ex J. Smith (1846) is referred to *P. flava* Goldm. on the authority of Hieronymus (in the Hedwigia reference cited by Steil). This species *P. flava* is a little known plant of the Philippine Islands, considered by Copeland (Fern Flora of the Philippines 1: 134. 1958) as a synonym of *P. glaucovirens* Goldm. I do not believe that this species is or was in cultivation in Berlin or Kew. My guess is that the plant studied was *Pteris vittata* L., but this can probably not be proved at the present time. This instance points up the desirability of keeping permanent voucher specimens for plants under experimental studies filed in a permanent herbarium. I would guess also that the classic studies on apospory by Goebel in 1909 which were said to be based on plants of *Pteris longifolia* L. were really also based on plants of *Pteris vittata* L., which was formerly combined with *P. longifolia* until Hieronymus differentiated them (Hedwigia **54**: 283–294. 1914), because *P. vittata* is much commoner in cultivation than the true *P. longifolia*. C. V. MORTON, *Smithsonian Institution, Washington, D. C. 20560.*

MARSILEA QUADRIFOLIA L. IN WESTERN MASSACHUSETTS.—The water clover, *Marsilea quadrifolia* L., originally introduced from Europe, is found occasionally throughout the northeastern United States and adjacent Ontario. Miller[1] noted that it is still very local and has not become a pest of waterways like the introduced flowering rush, *Butomus umbellatus*, or the water hyacinth, *Eichornia crassipes.*

The species has been found in several lakes and rivers in eastern Massachusetts[2]; it first appeared in western Massachusetts in Paradise Pond on the Smith College campus at Northampton. Paradise Pond was formed by damming the Mill River at a time prior to the founding of the college.

[1]Miller, B. A New Locality for *Marsilea quadrifolia* L. Amer. Fern J. **46**: 90–91. 1956.

[2]Churchill, J. R., et al. Reports of the Flora of Massachusetts, II. Rhodora **35**: 351–359. 1933.

Marsilea was apparently absent from the pond in 1941; by 1945 it was well established next to the college greenhouses in a small lily pool from which it has more recently been eradicated. Since that time it has spread along the banks of the 25-acre pond and downstream a distance of two miles along the Mill River to the large marsh at Arcadia Wildlife Sanctuary.

In the pond *Marsilea* occupies areas of deeper water than *Sagittaria* and other emergent aquatic vegetation. Plants of *Lemna minor* have been observed overlying the floating leaves of *Marsilea*, but the water clover seems to thrive best in sites where a gentle current carries the duckweeds away. *Marsilea* does not grow in the part of the pond where the currents of the Mill River are strongest near the bank.

Abundant growth of *Marsilea* seems to be associated with man-made disturbance. When the pond has been drained to remove *Elodea* and other submerged aquatics, the growth of *Marsilea* has been particularly vigorous. Near Arcadia Wildlife Sanctuary, where the presence of a dump and bull-dozing activities have disturbed the marsh environment, *Marsilea* occurs in ponds with *Nuphar* and other aquatic plants. In undisturbed sites within the marsh, *Marsilea* is absent although its native associates are present. The downstream dispersal is effected by fragmented rhizomes and possibly sporocarps of the plant which are carried by the current.

Distribution upstream has been slower. By the fall of 1965, a more or less continuous colony extended 1078 feet upstream from the drain through which the *Marsilea* originally was introduced into Paradise Pond. In 1964, isolated plants were found in a small inlet near the entrance of Mill River to the pond, about 300 feet upstream from the main colony. During 1965, this colony spread downstream 134 feet, and small new colonies appeared about 180 feet upstream.

In 1953, *Marsilea quadrifolia* was found in a pond on the campus of the University of Massachusetts at Amherst; since then it has over-run the pond and become a serious pest.—C. JOHN BURK, *Smith College, Northampton, Massachusetts 01060.*

A NEW LOCALITY FOR LYGODIUM PALMATUM.—I found a mound about two feet across of this fern growing at the edge of a thicket of *Alnus incana* near Taberg, Oneida County, New York. This station is a few miles farther north than the *Lygodium* locality at Gansevoort, Saratoga County, which was considered to be the northernmost point in the range. The specimen was growing within a few feet of a single specimen of *Kalmia latifolia* and came up from the edge of a clump of *Osmunda cinnamomea*. Other species growing within a few feet were *Betula populifolia, Osmunda regalis, Onoclea sensibilis* and a species of *Solidago* which was not flowering at the time. The area was quite damp and mossy.

Another site, near the corner of Dutherville and Salt Roads in Oswego County, New York, was reported to me by Mr. Thomas Wood, who said it was the source of the *Lygodium* he was offering for sale in his wild flower catalog and that he had removed it from a field which was subsequently plowed over.—M. DORISSE HOWE, *Division of Science and Mathematics, Utica College of Syracuse University, Utica, New York 13502.*

Recent Fern Literature

SPORES. FERNS. MICROSCOPIC ILLUSIONS ANALYZED. VOLUME I . . . , by Clara S. Hires. Mistaire Laboratories, Millburn, N. J. 1965.—This is a monumental volume. It consists in large part of superb photographs of fern spores and spore-bearing structures as well as photographs of meticulously fashioned models of spores and spore "tetrads." Its entire raison d'être appears to be the elaborate and detailed elucidation of three rather obvious and well-known facts: (1) Fern spores may be either monolete or trilete. (2) Each of these types may have a number of different appearances when viewed from different aspects. (3) Depending upon conditions of viewing as well as freshness and turgor, the monolete and trilete spore types may in some instances resemble each other and therefore be wrongly classified.

The title implies that microscopic illusions exist and are troublesome when one attempts to establish true spore shape. It would appear that the third point mentioned above is what is referred to in the title. It is evident, however, that such illusions and misinterpretations really pose no problems to an experienced microscopist familiar with optical sections of total mounts and serial sections of fixed and sectioned spores. To one who has devoted many years to studies of developmental processes of fern spores and mature spore structure, the entire question appears minor, and scarcely justifies the publication of a volume such as this one.

In an attempt to explain the supposed illusions mentioned in the title, a novel approach is employed. Spores are studied microscopically and models then constructed, based upon observations presumably subject to illusory effects. The models are then photographed from various angles, sectioned and the sections photographed. This supposedly clarifies any illusions which might have given rise to an erroneous interpretation of the spore structure as first observed.

At least two structures described have escaped the notice of professional and amateur botanists since the time of Hooke, and their existence is highly problematical. One of these is the "nutriole," a supposedly nutritive area within the spore. The other is the protoplasmic "bowl." In a quarter of a century's study of sporogenesis and spore structure, this reviewer has yet to see in fresh material or in serial sections of spores, either the "nutriole" or the protoplasmic bowl. "Nutriole" is an admitted neologism, but its very existence is illusory, as is that of the protoplasmic bowl.

In places the language appears scarcely appropriate for scientific publication. On page 406, we have the following:

"We enjoyed working with Dryopteris marginalis spores because so many little figures could be distinguished over the surface. We did not know how to interpret them in the beginning, but names were given to each of these effect as characters that indicated D. marginalis. Some of the effects frequently seen are illustrated in these pictures, such as hind legs of a frog, little men running, or the initial 'H'. Later they were interpreted in terms of actual structure."

On pages 36 and 37 appears a totally incomprehensible section in which spore structure is interpreted on the basis of plastic model projections. This must be read to be appreciated. In this same section the trilete spore walls which partition the spore mother cell are referred to as "spherical triangles," instead of segments of a circle, which they are. The spherical triangles, of course, are the outside spore faces of newly formed trilete spores.

No amount of criticism of the text can detract from the breathtaking beauty of the photomicrographs. It should be stated, however, that never in the history of botany, has so much been so lavishly expended in an attempt to prove so little. —NORMAN P. MARENGO, *C. W. Post College of Long Island University, Greenvale, New York 11548.*

LEARN OF FERNS WE GROW, by Sylvia B. Leatherman and Dorothy S. Behrends. Los Angeles, California, May 1965. 166 pp. $3.85. [Obtainable from Sylvia B. Leatherman, 2637 North Lee Avenue, South El Monte, California 91733].—This small, non-technical book is designed to introduce people to the pleasures of growing ferns, both indoors and outdoors, and to give detailed instructions. Although prepared with the climatic conditions of southern California particularly in mind, the book will be useful elsewhere, especially for the comments about indoor cultivation. The suggestions about growing ferns in unusual ways, such as on "totem poles," driftwood, and so forth, will be helpful to many persons. The book is primarily concerned with the cultivation of ferns; it does not attempt to describe the many kinds that are in cultivation, although it does recommend certain ones that are particularly adapted to certain situations. There are unfortunately a large number of misspelled scientific names and some misuses of technical terms, such as "sporophyte" for "sporeling," but these will not interfere greatly with its usefulness by amateurs.—C. V. M.

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American Fern Journal

A QUARTERLY DEVOTED TO FERNS

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CONTENTS

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American Fern Journal

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Asplenium × kentuckiense on Granitic Gneiss in Georgia

WILBUR H. DUNCAN

The rare Kentucky Spleenwort has recently been found in Stephens County, Georgia, far south of the nearest previously known station in Floyd County, Kentucky. The fern appears to grow in a habitat not previously reported for the species. Mr. G. W. McDowell, of Asheville, North Carolina, and Mr. F. D. Snyder, of Toccoa, Georgia, visited the new locality on 19 April 1964, and found *Asplenium pinnatifidum* there in crevices of ledges and boulders bordering a relatively smooth, sloping expanse of granitic gneiss. McDowell (1965) reported the find, pointing out that *A. platyneuron* also occurred at the site and that some of the plants possibly were hybrids. I was unable to visit the station until Mr. Snyder took me there on 31 December 1965. Unfortunately our stay was limited, but I was able to collect a representative specimen of *A. pinnatifidum* for the University of Georgia Herbarium. In addition, the largest leaf was taken from each of several other aspleniums that exhibited interesting variations compared to the collected plant. *Asplenium platyneuron* was observed in the crevices of the ledges and boulders, as well as in soil in the vicinity.

At the University of Georgia the individual leaves were examined for evidence of hybridity, but lacking herbarium specimens for comparison, I set them aside for the expected visit of Dr. W. H. Wagner, Jr., in March 1966. One of the leaves was identified by Dr. Wagner as *A. × kentuckiense*. We therefore arranged to visit the collection site on 26 March. On this visit we were unable to locate the plant of *A. × kentuckiense* from which I had collected the leaf. This plant had been seen in the crevice

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of a south-facing ledge. I did locate another specimen of this fern on a partially-shaded east-facing ledge in a crevice which was oriented up and down the slope. This specimen was collected by Dr. Wagner for culture, study, and experiments at the University of Michigan. A graduate student (Bobby Lane) and I, together with our wives, returned to the habitat on 2 April and spent considerable time in an unsuccessful search for more specimens of the Kentucky Spleenwort. A few dead plants of *Asplenium* were seen in the crevices of the south-facing ledges. One of these may have been the first of the two plants of the Kentucky Spleenwort that were located, the plant having died during the dry and severely cold weather that occurred between 31 December and the late March and early April visits to the locality. Very small plants which were also seen in the crevices may prove to be the Kentucky Spleenwort when they become larger, but at present their identity is not certain.

Wagner (1954), Smith et al. (1961), and Smith and Levin (1963) have presented data indicating that *A.* × *kentuckiense* is a hybrid between *A. pinnatifidum* and *A. platyneuron*. Since both of these species occur in adjacent crevices of the ledges and boulders of the Stephens County station, an excellent opportunity exists for hybridization between them. The identity of the specimens of *A.* × *kentuckiense* thus is supported by the presence of the two parents. In addition the abortive spores of the two plants are indicative of the $3x$ condition of hybrids between the tetraploid *A. pinnatifidum* and the diploid *A. platyneuron*. *A.* × *kentuckiense*, therefore, remains known by sterile plants only. There seems to be no parallel yet known in Appalachian spleenworts to the hybrid species *A.* × *ebenoides*, which has both sterile and fertile elements.

The habitat where the specimens of the Kentucky Spleenwort were found is unusual in that it combines the conditions necessary for both parents. At other localities *A. pinnatifidum* more frequently occurs on shaded cliffs where *A. platyneuron* is absent or rare. At the new locality most ledges and boulders are only partially shaded by vegetation on the surrounding relatively shallow slopes. *Asplenium platyneuron* also seems better adapted to other habitats, being more abundant in thickets, fence rows, rich upland woods, and moist wooded ravines not far away. The conditions where the plants of *A.* × *kentuckiense* were found seem to be somewhat marginal for the two parents. However, their ability to grow under the same combination of conditions favored the formation of the two hybrid plants.

The general nature of the habitat where the *A.* × *kentuckiense* plants were found may be seen in *Fig. 1.* The southern exposure of the ledge is evident, as are deciduous trees, which will provide more shade after their leaves appear. The second plant of *A.* × *kentuckiense* was found on the east face of this same ledge about 30 feet up the slope from the right margin of the photograph. This locality is, of course, protected from the afternoon sun and is partially shaded by trees earlier in the day.

Growing in the crevices of the ledges and boulders of the area in addition to the three aspleniums are plants of *Cheilanthes tomentosa, Campanula flexuosa, Carex* sp., and *Panicum* sp., plus small plants of *Smilax glauca, Vaccinium arboreum, Quercus montana, Pinus virginiana,* and *Kalmia latifolia.*

The habitat of the adjacent slopes is relatively dry. The forest is not dense and is composed of species characteristic of poor sites. The most abundant species are *Pinus virginiana, P. taeda, Quercus marilandica, Q. montana, Q. falcata, Carya pallida, Nyssa sylvatica, Diospyros virginiana,* and *Oxydendrum arboreum.* The understory near the ledges includes scattered individuals of *Vaccinium arboreum, Prunus americana, Viburnum rufidulum, Amelanchier canadensis, Rhododendron canescens, Asimina parviflora, Callicarpa americana, Vitis rotundifolia, Vaccinium vacillans, Bignonia capreolata, Rhus toxicodendron, Chimaphila maculata, Pteridium aquilinum, Chrysopsis* sp., and *Viola pedata.*

The granitic gneiss rocks upon which the *A.* × *kentuckiense* plants were found apparently represent a new type for the taxon. Rocks at previously reported stations, when specified, have all been sandstone. In the original description for the taxon, based on specimens from Kentucky, McCoy (1936) reports the habitat as "Found on sandstone cliffs . . .". Wagner (1958) summarizes data concerning the habitats of the fern from other localities. Collections from sandstone rocks are listed from Pike County, Ohio, and Benton County, Arkansas. He also points out a collection two miles west of Chatham, on a boulder in open woods,

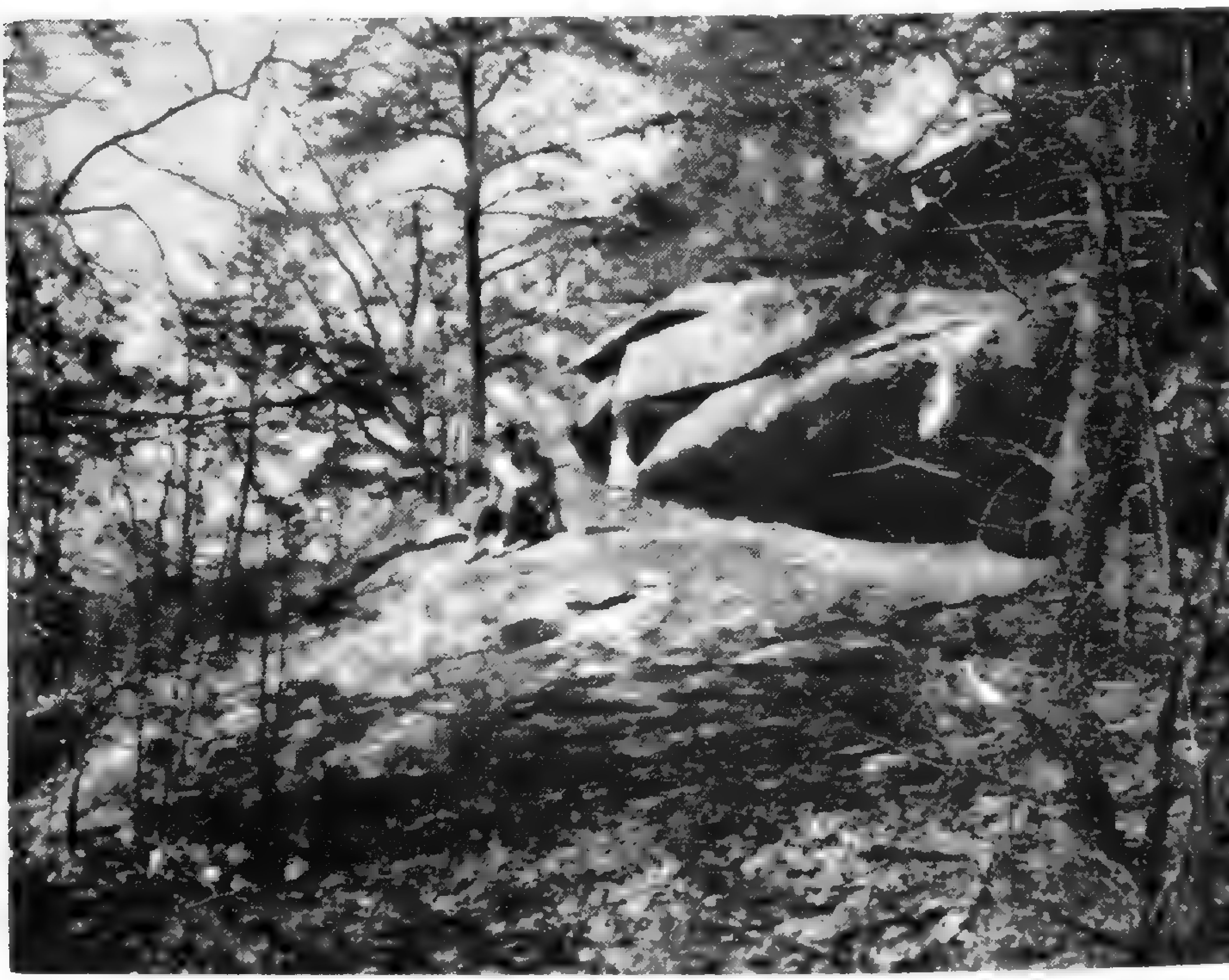

FIG. 1. GRANITIC GNEISS LEDGE IN STEPHENS COUNTY, GEORGIA, SHOWING CREVICES IN WHICH A. PINNATIFIDUM AND A. PLATYNEURON OCCUR. A. × KENTUCKIENSE WAS FOUND IN SIMILAR CREVICES NEARBY.

Pittsylvania County, Virginia. According to a recent geologic map of Virginia (Calver, 1963), this locality is in an area of metamorphosed sedimentary and interlayered igneous rocks, predominantly mica schists. Residual boulders in such an area are very likely quartzites and related to, if not similar to, the sandstone rocks indicated earlier. Smith et al. (1961) describe an additional collection from a sandstone outcrop in Floyd County, Kentucky. It appears, therefore, that *A.* × *kentuckiense* usually occurs on sandstone or perhaps other types of quartzite rocks. It is now known to occur on granitic gneiss in Georgia.

Asplenium pinnatifidum is known from eight other counties in Georgia. Sandstone rocks are involved in the habitat of this fern in three of these: Walker and Dade Counties in northwestern Georgia and Twiggs County in the inner margin of the Coastal Plain in central Georgia. The other five counties are in the Piedmont where the rocks are granitic. Since *A. platyneuron* is abundant in these areas it is possible that *A.* × *kentuckiense* occurs on granite rocks at one or more other localities of the Piedmont.

The leaf specimen of *A.* × *kentuckiense* from Stephens County, Georgia, is deposited in the University of Georgia Herbarium and bears the following data: Crevice of south-facing granitic gneiss ledge about 2 miles NNE of Toccoa. Elevation about 1100 feet. Margin of Blue Ridge and Piedmont Provinces. *Wilbur H. Duncan 22575* and Frank Snyder. 31 December 1965.

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Notes on Michigan Pteridophytes, II. Distribution of the Ophioglossaceae

DALE J. HAGENAH

In the years since the publication of *Ferns of Michigan* (Billington, 1952) no part of the fern flora of the state has been the subject of as much intensive study as the genus *Botrychium,* the Moonworts and Grape Ferns. The fact that all of the Michigan species, even the supposedly rare Moonworts, are locally abundant in suitable habitats has made possible field observation of variation within large populations. The occurrence of many mixed populations, with from two to five species existing together, has permitted the testing of species criteria on living or freshly collected plants from identical habitats rather than on pressed, dried material, a great advantage in a group such as this where the differences between taxa are rather subtle and are frequently lost or obscured in pressing.

As the result of these studies two taxa previously regarded as forms by many botanists have been shown to deserve species status, *Botrychium minganense* Victorin and *B. oneidense* (Gilbert) House, while a third which had been overlooked in recent treatments of American ferns is now recognized as occurring here, *B. ternatum* (Thunb.) Swartz. At the same time it has become apparent that some so-called varieties and forms are responses to environment while others appear to be merely the youngest or oldest plants in the population. The taxonomic and cytological phases of these studies, largely the work of Dr. Warren H. Wagner, Jr., of the University of Michigan, have been reported in detail in this Journal and elsewhere (Wagner, 1955, 1959, 1960a, 1960b, 1961a, 1961b, 1961c, 1961d, 1962, 1963a, 1963b; and Wagner and Lord, 1956).

I have had the pleasure of joining Dr. Wagner on many of the Michigan field trips during his *Botrychium* studies. In addition, my wife and I have made special efforts to find and collect grape ferns during nearly twenty years of fern hunting. The fact that our field books show nearly 70 localities in 39 of Michigan's 83 counties for one species, *Botrychium matricariifolium* A. Braun, may serve as an indication of our success. The actual discovery of many of these plants was made by Mrs. Hagenah, and on numerous occasions I have returned from an excursion up a *Woodsia* cliff or into a *Dryopteris* swamp to find some area near the road hung with markers indicating the locations of one or more species of grape ferns.

In view of the taxonomic realignments within the group and the large number of new records available it seems desirable to present a completely new set of distribution maps plus some observations on variation within the species and on the ecology and local distribution of each species. I am grateful to Dr. Wagner for the opportunity to include many new records and for his assistance in checking determinations of difficult specimens. During the preparation of the maps I have consulted the herbaria of the University of Michigan, Michigan State University, Wayne State University, Western Michigan University, the University of Notre Dame, the University of Illinois, the University of Wisconsin, the Field Museum of Natural History, and Albion College. I wish to thank the curators of these herbaria for the many courtesies extended to me. My own collections are deposited in the herbarium of Cranbrook Institute of Science. No keys are included since all of the species are described and illustrated in the most recent regional fern guide (Wherry, 1961).

ABUNDANCE AND ECOLOGY

For many of the flowering plants, especially the more common and showy species, there is fairly reliable information as to their abundance at various times since botanists began to record our local flora. But, except for *Botrychium virginianum*, few such observations are available for the Ophioglossaceae, for even today the general collector tends to overlook most members of this family because they are so inconspicuous and because many of their best habitats hold little attraction for the botanist looking for flowering plants. However, by comparing my observations made in essentially virgin forests, in the Huron Mountains of Marquette County and the Porcupine Mountains in Ontonagon County, with observations in second-growth woods, old abandoned fields, and roadside excavations, I have reached the conclusion that the species of this family have undergone a population explosion since the original forests were lumbered. Much of this population growth appears to be fairly recent because the colonies occur on what was once farm land. Unfortunately, we have little information about how soon a species can become established. In southeastern Michigan many good grape fern fields are found on marginal lands now in public ownership as recreation or hunting areas. Although dates of acquisition can be obtained for these tracts it is difficult to obtain information on how long ago farming ceased there. An extensive population of *Botrychium matricariifolium* containing plants up to nine inches high was found in Kent County in an old field believed to have been out of cultivation less than thirty years. Hiltunen (1961) established a possible date for a roadside borrow pit in Chippewa County. *Botrychium multifidum, B. simplex,* and *Ophioglossum vulgatum* were well established there twenty-five years after the excavation was made.

At first glance the range of habitats for the family seems varied in the extreme, but analysis shows that all have one thing in common: some type of disturbance which opened the area to colonization. Many habitats show various stages of gradual revegetation after lumbering, cultivation, or roadbuilding. Some types of intermittent disturbance such as seasonal flooding seem to favor the development of colonies of the ferns by discouraging growth of competing vegetation. In virgin forests the habitats are subject to the flow of run-off water in ravines, to water level changes at the edge of swamps, lakes, or seasonal ponds, and to disturbance by travel along woodland trails. Wagner (1963b) has called attention to the effects of grazing by cattle, horses, and deer; and, in fact, *Ophioglossum* is not infrequently found at the edge of marshes in pasture fields. Among our best localities for grape ferns are fields and orchards reverting to brambles, poison ivy, and small trees and shrubs. In second growth woods the ferns especially favor former trails and roadways.

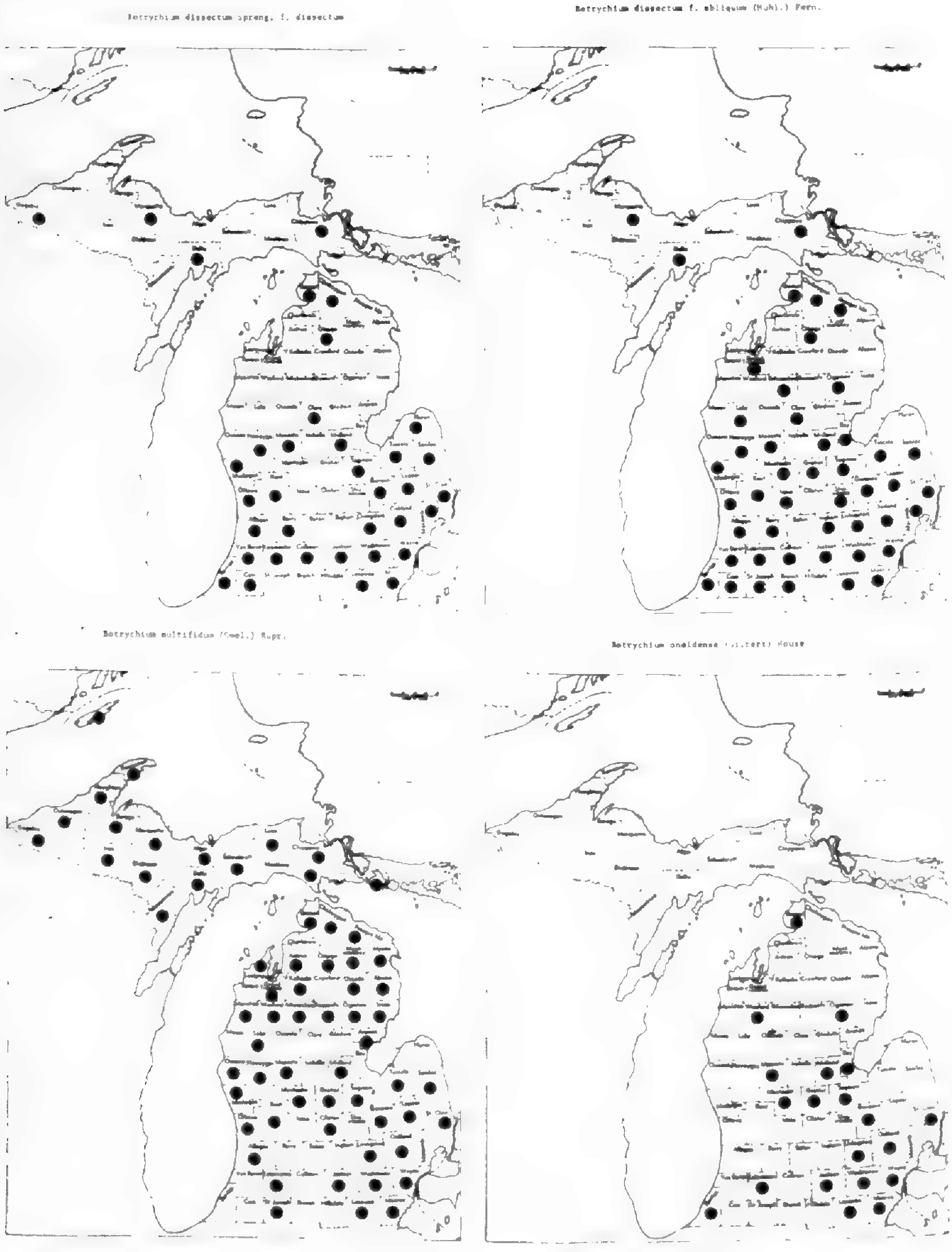
Several species frequently share the same habitat, and discovery of one of the larger species can lead to the finding of others. An example is a Luce County locality where I chanced to notice some *Botrychium multifidum,* and when I bent over to look at them I then saw some small plants of *Ophioglossum.* Kneeling to examine the *Ophioglossum* I only then saw some tiny plants of *Botrychium simplex.* All four species of the evergreen grape ferns found in Michigan have been found in one old field on several occasions, sometimes with other members of the family as well.

ABNORMAL PLANTS

Most, if not all, of the species of *Botrychium* have a tendency to produce abnormal plants, with plural fertile spikes or with sporangia borne on parts of the normally sterile leaf tissue. These types of variation have been discussed in detail by Chrysler (1926). Some examples of these forms are preserved in the herbaria examined, including some showy specimens of *Botrychium dissectum* with double or triple fertile spikes, *B. dissectum* with entire pinnules on the lateral pinnae transformed to fertile parts, and numerous examples of the smaller grape ferns, especially *B. matricariifolium* and *B. simplex,* with sporangia on the tissue of the sterile segment. Three collections have been seen of large forms of *B. simplex* in which there were two additional fertile spikes produced at the bases of the lateral lobes of the sterile segment, giving the plants three fertile spikes in all. While names have been proposed for abnormal forms they represent the naming of aberrant individuals from otherwise normal populations, and I have chosen to ignore them in preparing the distribution maps.

BOTRYCHIUM

As now interpreted the genus *Botrychium* in Michigan includes ten species: four of the *Sceptridium* or Evergreen Grape Fern group (*B. dissectum, B. multifidum, B. oneidense,* and



MICHIGAN DISTRIBUTION OF BOTRYCHIUM DISSECTUM F. DISSECTUM, B. DISSECTUM F. OBLIQUUM, B. MULTIFIDUM, AND B. ONEIDENSE.

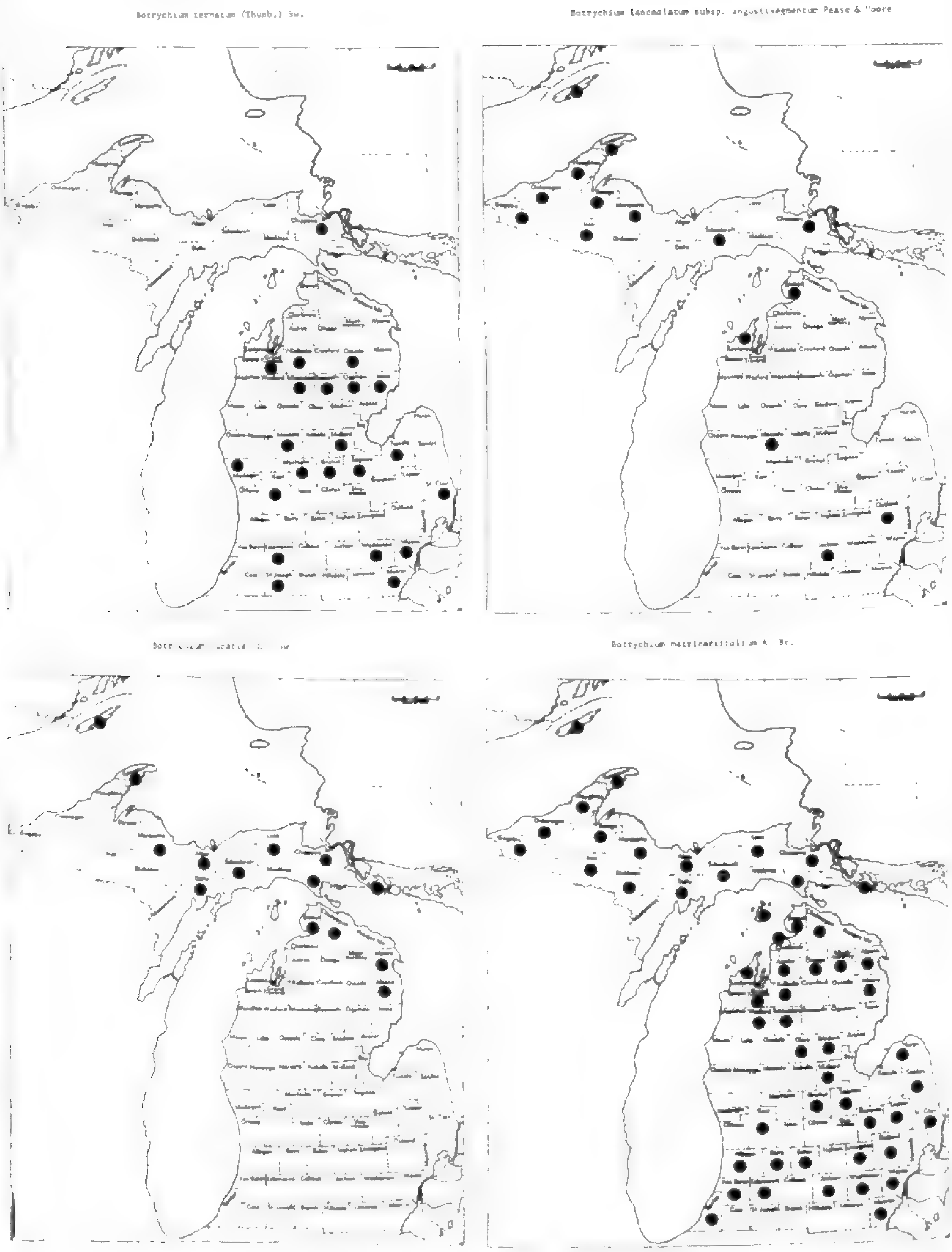
B. ternatum), five of the *Eubotrychium* group (*B. lanceolatum, B. lunaria, B. minganense, B. matricariifolium,* and *B. simplex*), and the common *B. virginianum* of the *Osmundopteris* group. *Botrychium boreale* was reported from the state in Beal's *Michigan Flora* (1904), but the specimen was a misidentified *B. matricariifolium,* and the species was not included by Billington.

BOTRYCHIUM DISSECTUM Spreng. PLATE 16.

Most authors include both the highly dissected leaf form and the "*obliquum*" forms under this species, although Wherry (1961, pp. 230, 232) has maintained the two as separate species while noting that there is much intergradation between the two in the Great Lakes region. Since many botanists segregate their collections of the plants with dissected fronds from the others, I am including maps for each. As can be seen, in most counties there are records for both leaf forms. During our fieldwork we found that while the "*obliquum*" forms are the more prevalent, careful search of most populations will reveal some plants of the dissected form. While I have seen one or two plants of the dissected form growing alone I have never seen an extensive population in which it was not greatly outnumbered by the "*obliquum*" forms. In Southern Michigan this species, in a great variety of leaf forms, is a common plant of old fields and second-growth woods. Northward it becomes less frequent, and the Marquette County records, from the Huron Mountains, are the most northerly known in the Great Lakes region. Both leaf forms were found there.

BOTRYCHIUM MULTIFIDUM (Gmel.) Rupr. PLATE 16

Although *Botrychium multifidum* and the variety *intermedium* were mapped separately in *Ferns of Michigan* such a separation now appears to be purely arbitrary. During our field investigations we have seen plants varying in size from those with little three-lobed fronds still attached to the gametophytes on up to plants with great, fleshy, sterile fronds as much as ten inches across. Although found throughout the state it is more common northward, and in the Upper Peninsula it is the only common



MICHIGAN DISTRIBUTION OF BOTRYCHIUM TERNATUM, B. LANCEOLATUM SUBSP. ANGUSTISEGMENTUM, B. LUNARIA, AND B. MATRICARIIFOLIUM.

member of the *Sceptridium* group.

BOTRYCHIUM ONEIDENSE (Gilbert) House PLATE 16

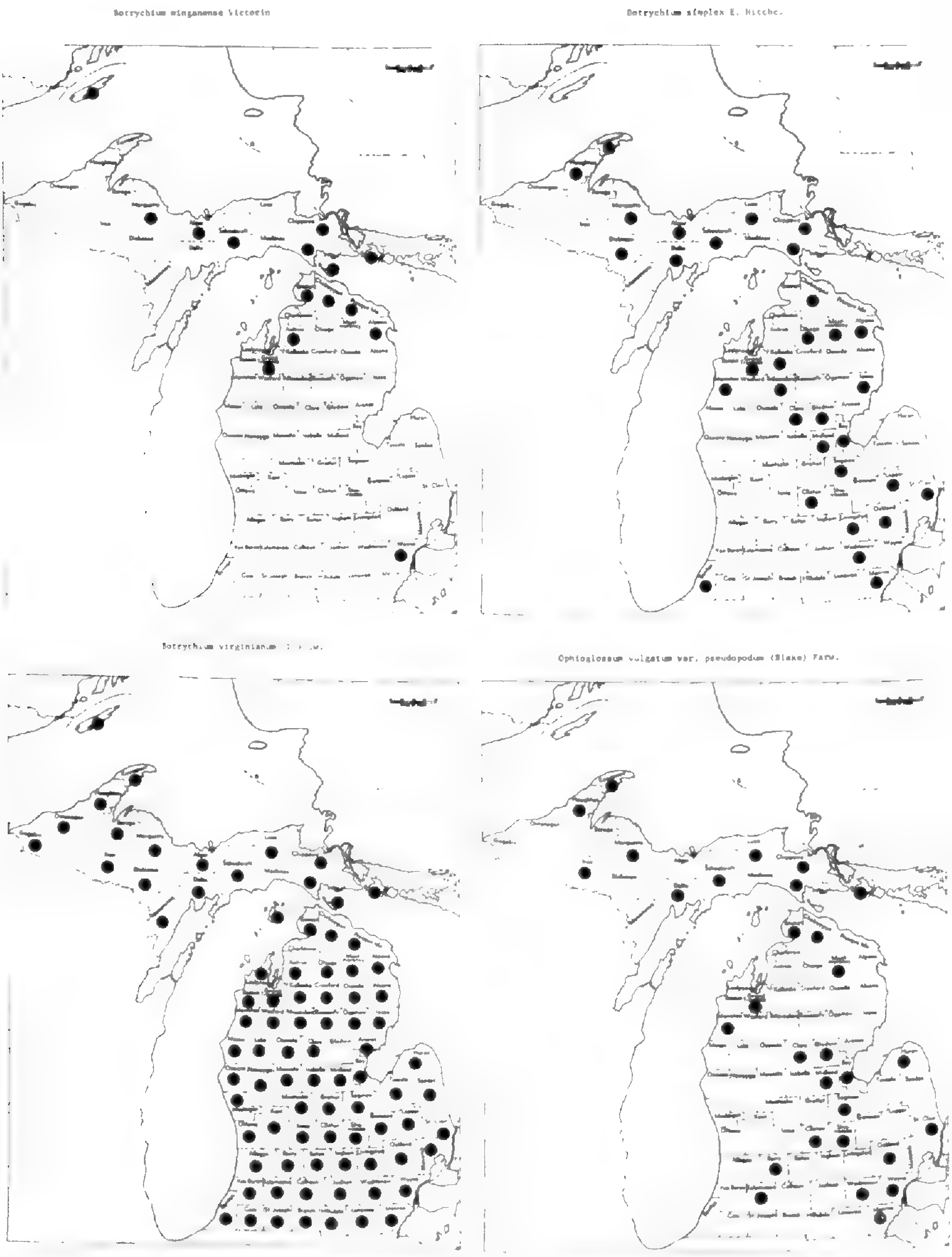
This species has been assigned to both of the preceding species as a variety, and records for it were included with *B. dissectum* in *Ferns of Michigan.* However, mature plants have a very distinctive look in the field, and it has now been shown to deserve species status. It is most frequent in the southern half of the Lower Peninsula where it seems to favor moist woodlands, although it is sometimes found in old fields.

BOTRYCHIUM TERNATUM (Thunb.) Swartz PLATE 17

For years all members of the *Sceptridium* group were assigned to this species under one or another varietal name. When they were then separated as species it was thought that *B. ternatum* in the true sense was confined to Japan and eastern Asia. American collections were referred to *B. multifidum.* However, Wagner (1959) pointed out that a fern that is apparently indistinguishable from the Japanese plant does occur here. He has outlined the characters which distinguish it from the other American species. The small, compact plants of *B. ternatum* that occur in some parts of the Great Lakes region were described as *B. multifidum* f. *dentatum* Tryon. In the living plants the tendency for the pinnae to be concave beneath is the most readily noticed character. As yet the distribution of this newly recognized species is poorly known. Most collections are from sandy soil; in the jack pine areas of the northern Lower Peninsula large colonies have been found around lakes and ponds where there has been a marked drop in water levels. As in the other members of the *Sceptridium* group, plants of open places tend to be small and compact whereas in moist woodlands the plants are larger and somewhat membranaceous.

BOTRYCHIUM LANCEOLATUM subsp. ANGUSTISEGMENTUM (Pease & Moore) Clausen. PLATE 17

Most of our records are from the western part of the Upper Peninsula. There it is most common in alluvial soil along stream courses in ravines and other moist woodland situations. By con-



MICHIGAN DISTRIBUTION OF BOTRYCHIUM MINGANENSE, B. SIMPLEX, B. VIRGINIANUM, AND OPHIOGLOSSUM VULGATUM VAR. PSEUDOPODUM.

trast the collections from Mecosta and Oakland counties in the southern Lower Peninsula are from old fields.

BOTRYCHIUM LUNARIA (L.) Swartz PLATE 17

The Moonwort, a very elusive plant in those parts of the United States where it does occur, has been found mostly in the region near the Straits of Mackinac, where large areas in several counties have limestones and dolomites close to the surface. Some rather large colonies have been found in old fields there. The woodland form, f. *onondagense* (Underw.) Clute, is less common than the typical form.

BOTRYCHIUM MATRICARIIFOLIUM A. Braun PLATE 17

Although known from only a few counties in 1952, this species has been found to be widely distributed throughout the state. It is extremely variable in size and leaf architecture, much of the variation apparently due to age. An interesting adaptation was noted in plants growing on the wooded lee slope of an active sand dune near Grand Marais, Alger County. In the larger plants, where the rhizome had been more deeply buried by the gradual buildup of sand on the slope, the buds for the next year had elongated as much as two inches so that in late August they were about the same distance below the surface as those of plants with more shallow rhizomes.

BOTRYCHIUM MINGANENSE Vict. PLATE 18

Formerly treated as a variety or form of *B. lunaria* by most authors and included under that species in *Ferns of Michigan*, the Mingan Moonwort has been shown by Wagner and Lord (1956) to be a distinct species with twice as many chromosomes as *B. lunaria.* It has the same habitat requirements as that species and is found with it in many places in the limestone belt. The most unusual locality is that in Wayne County, in the southeastern Lower Peninsula, far to the south of all other stations. Although only one plant was found here originally (*Wagner 62093*, MICH), it was observed for several years, and now there are two. Further search may be productive here, for parts of Wayne and adjacent Monroe County are underlain by limestone.

BOTRYCHIUM SIMPLEX Hitchcock PLATE 18

The Little Grape Fern, despite its small size, is one of the most variable species in the genus. While various authorities have attempted to segregate forms or varieties based on the shape and insertion of the sterile blade, the field botanist who encounters a large population in Michigan frequently finds that plants corresponding to two or more of these variants could be selected from the assortment before him, but that the placement of many others would be difficult. Clausen (1938) lists four varieties, but at the same time points out that they tend to intergrade. Fernald (1949) refers to five recognizable variants, but then says of them, ". . . these too often seeming like responses to environment or to be stages of development."

Ecological factors appear to influence both the leaf form and time of appearance. As early as the middle of May *Botrychium simplex* has been collected in old fields, jack pine barrens, sandy borrow pits, and even on the shoulder of the highway, all situations which may be extremely dry later in the summer. These early plants mature and disappear rapidly. At a location in Berrien County where a number of plants were seen on a grassy hillside in May no trace of them could be found a month later. The prevalent form in these early colonies is var. *simplex*, with occasional plants approaching var. *compositum* (Lasch) Milde, but intermixed with them are slender plants with the sterile blade much reduced and inserted high.

Woodland plants appear somewhat later, my own collections being as late as the first week in September. Some of these late plants are rather lax and may even be decumbent under a carpet of leaf mold. A frequent habitat is along the highwater mark of seasonal ponds in low, sandy woodlands. Most of these plants might be referred to var. *laxifolium* Clausen or to var. *tenebrosum* (A. A. Eaton) Clausen, but plants with blades inserted low occur with them. An interesting variation in the late season plants has been found in six counties in the Upper Peninsula and northern Lower Peninsula, most stations being in humus in woods in the limestone belt. These plants have a very prominent fertile segment with a thick, fleshy stalk and sterile blades variously inserted and frequently poorly developed.

In view of the great diversity within the various populations it has seemed advisable to include all of the variations on one map.

BOTRYCHIUM VIRGINIANUM (L.) Swartz PLATE 18

The Rattlesnake Fern, the most common member of the family, and the best known because it shares the woodland habitat of many spring flowers, has now been collected in all except one of Michigan's counties, Gladwin, a county whose ferns were poorly represented in the herbaria examined. In the Upper Peninsula it is sometimes found in exposed habitats as well as in the woods. In roadside clearings and similar open places it is more compact in form and has a firmer texture, changes similar to those found in other Botrychiums in such surroundings. Although subsp. *europaeum* (Angstr.) Clausen has been attributed to the state, the Michigan specimens all seem to represent ecological variations.

OPHIOGLOSSUM

Only one member of the genus is known from Michigan, the Common Adder's-tongue. The report of the Limestone Adder's-tongue, *Ophioglossum engelmannii* Prantl, by Beal (1904) was based on a misidentified specimen.

OPHIOGLOSSUM VULGATUM var. PSEUDOPODUM (Blake) Farw. PLATE 18

The Common Adder's-tongue is among the least known of our ferns although it probably occurs throughout the state. Usually the first plant in a locality is difficult to find due to the way this species blends with the grasses and other vegetation, but after the first one is noticed search may reveal scores or even hundreds more. One of the interesting habitats found was an interdunal meadow just back of the first row of dunes along Lake Michigan in Schoolcraft County where many plants in a large colony had two fronds from the same rootstock.

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A Preliminary Review of Spore Number and Apogamy within the Genus Cheilanthes

IRVING WILLIAM KNOBLOCH[1]

Interesting connections exist among spore number, apogamy, xerophytism, and hybridization. Wagner, Farrar, and Chen (1965) summarized, in a very clear fashion, our knowledge about spores and apogamy. We wish to paraphrase their summary and add other observations: apogamy, which is known in 80 species of ferns, involves no fertilization and new sporophytes grow out of the gametophytes as "buds." Since there is no fusion of gametes, the chromosome numbers of the gametophytes and sporophytes are the same. Usually only eight spore mother cells, instead of 16, are produced in each sporangium, and one division each of the mother cell and of the daughter cells finally produces 32 spores which are usually well-formed and viable. There is a doubling of the chromosomes in the spore mother cells prior to meiosis. After meiosis (reduction) each spore will thus have the same number of chromosomes as that of the sporophyte which produced it, and the spore will produce a gametophyte with the same number of chromosomes as the sporophyte. The presence, then, of 32 spores per sporangium is presumptive evidence that the species involved is apogamous. The most direct evidence of apogamy, of course, would be the observation that the gametophyte lacked archegonia (female sex organs).

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[1]It is a pleasure to acknowledge the aid of Miss Phyllis Frank and the financial support and encouragement of the National Science Foundation (Grant No. GB-4630) and the All-University Research Fund.

TABLE 1.

Species	*Collector, Number and Source*	*Spore Number*
C. aemula Maxon	Knobloch 2024A; Nuevo Leon, Mex.	64
	Knobloch 1974B; Nuevo Leon, Mex.	64
C. alabamensis (Buckl.) Kunze[2]	Knobloch 2024B; Nuevo Leon, Mex.	32
	Knobloch 1978; Nuevo Leon, Mex.	32
C. californica (Nutt. ex Hook.) Mett.	D. R. Harvey, acc. 63-5; San Diego Co., Cal.	64
	L. Kiefer 1182, acc. 64-9; San Diego Co., Cal.	64
C. castanea Maxon	B. Warnock, acc. 63-60; Davis Mts., Texas	32
	J. K. Baker, acc. 63-49D; Carlsbad Cav. Nat. Park., N. Mex.	32
C. cooperae D. C. Eaton	E. Taylor, acc. 63-18; near La Porte, Cal.	64
C. covillei Maxon	L. Kiefer 1160, acc. 64-6; San Bernardino Co., Cal.	64
C. eatonii Baker	J. K. Baker, acc. 63-49B; Carlsbad Cav. Nat. Park., N. Mex.	32
C. feei T. Moore	F. Rose, acc. 64-14; Whitehall, Montana	32
	Knobloch 1688; El Paso Co., Texas	32
C. fendleri Hook.	Knobloch 1623; Santa Catalina Mts., Arizona	32
C. horridula Maxon	D. S. & H. B. Correll 30762, acc. 65-1; Kinney Co., Texas	64
	Knobloch 2029A; Nuevo Leon, Mex.	64
C. kaulfussii Kunze	Knobloch 884; Chihuahua, Mex.	64
C. lanosa (Michx.) D. C. Eaton in Torr.	Knobloch 1950; Ironto, Va.	64
C. lendigera (Cav.) Swartz	U. Cal. Bot. Gard. 58-046-1, acc. 65-2; Sanitorio Duran, Costa Rica	64
C. leucopoda Link	Knobloch 2025; Nuevo Leon, Mex.	32
C. mexicana Davenport	Knobloch 2075; Chihuahua, Mex.	64
C. notholaenoides (Desv.) Maxon ex Weatherby[2,3]	Lefebure 1284, acc. 64-51; Hidalgo, Mex.	32
C. parryi (D. C. Eaton) Domin	L. Kiefer 1180, acc. 64-4; San Bernardino Co., Cal.	64
	R. Lloyd 2814, acc. 63-12; Inyo Co., Cal.	32
C. pringlei Davenport	Knobloch 1809; Pima Co., Ariz.	64
C. pyramidalis Fée[3]	Knobloch 2127; Durango, Mex.	32
	Knobloch 1881; Chihuahua, Mex.	32
	C. K. Horich, acc. 63-56; Dept. F. Morazan, Honduras	32

Species	*Collector, Number and Source*	*Spore Number*
C. siliquosa Maxon	Thurman's Garden, acc. 63-9; Spokane, Washington	64
	L. Kiefer 1461, acc. 64-19; Humboldt Co., Cal.	64
C. tomentosa Link	Knobloch 2048A; Blount Co., Ala.	32
	D. Moore, acc. 64-16; Ark.	32
	E. Castetter, acc. 63-60; Carlsbad Cav. Nat. Park., N. Mex.	32
C. villosa Davenport ex Maxon	Knobloch 2108; Chihuahua, Mex.	32
C. viscida Davenport	L. Kiefer 1163, acc. 64-1; San Bernardino Co., Cal.	32
C. wootonii Maxon[2]	Knobloch 1698; Santa Catalina Mts., Arizona	32

[2]Reported as apogamous by Dr. Lenette Atkinson (pers. comm. 1966).
[3]Reported as apogamous by Dr. Thomas Pray (pers. comm. 1965).

Occasionally an apogamous species will produce 16 spore mother cells and 64 spores, but the latter are usually inviable. Presumably the production of non-viable spores is due to a lack of chromosome doubling and subsequent lack of chromosome homology and pairing. Such spores lack the balanced number of chromosomes and genes necessary to function properly.

In the genus *Cheilanthes, sensu lato,* the following species have been recorded as apogamous: *C. alabamensis* (Whittier, 1965), *C. bullosa* (*Aleuritopteris b.*) (Mathew in Fabbri, 1965), *C. farinosa* (Manton and Sledge, 1954), *C. feei* (Steil, 1933), *C. hirsuta* (Brownlie in Fabbri, 1965), *C. sieberi* (Brownlie, 1958), *C. tenuifolia* (Verma in Mehra, 1961), and *C. tomentosa* (Whittier, 1965). Dr. Thomas Pray has informed me (pers. comm., 1965) that *C. myriophylla* is also apogamous.

The present study, summarized in *Table 1,* notes eleven more presumptive apogamous ferns in this genus, based mostly on spore count. Since spores are frequently ejected from the sporangia on herbarium sheets, only fresh material was used. Single sporangia were crushed under a cover slip in a drop of mounting medium. Ten slides were made of each species. The accession numbers are mine. Fourteen species in *Table 1* have 32 spores per sporangium and are thus presumed to be apogamous. These, plus six others mentioned above that are not in the table, bring the total in the genus to 20 species.

Cheilanthes parryi has two spore counts, 32 and 64, and presumably has both apogamous and sexual forms. No abortive spores were noted in the 64-spored specimens. Of course, not all apogamous species are obligately apogamous. Some species may be in an evolutionary transitional period and may be facultatively apogamous. Some 64-spored specimens of *C. horridula, C. lanosa, C. mexicana, C. covillei, C. aemula*, and *C. siliquosa* showed a tendency toward spore abortion, i.e., some of their spores were either smaller than others or shrunken.

There are two principal cautions to be observed in interpreting these data: some of the species here reported as apogamous may be found to have sexual forms in localities other than those listed in *Table 1*, or some of the 64-spored species, presumed to be sexual, may prove to be facultatively apogamous in other areas or under other conditions.

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Morphological and Cytological Data on Southeastern United States Species of the Asplenium heterochroum–resiliens Complex

VIRGINIA M. MORZENTI[1]

In a recent issue of this JOURNAL, Wagner (1966) named a new species, *Asplenium heteroresiliens.* This paper supplies morphological and cytological data which support the hypothesis that Wagner's species is the $5x$ hybrid between a $4x$ sexual plant of *A. heterochroum* and an apogamous $3x$ plant of *A. resiliens.*

I am grateful to Mr. Thomas Darling, Jr., of Washington, D. C., who collected plants at Cat Hammock, near Sumterville, Sumter County, Florida, and Dr. E. S. Ford, who sent plants from near Gainesville, Alachua County, and from Columbia County, Florida, about 5 miles northwest of High Springs. These plants were received at the Botanical Gardens of the University of Michigan and grown in the greenhouse under optimum conditions until suitable meiotic stages developed. Chromosome numbers were determined; other observations are summarized in Table 1.

The Alachua County plant, identified as *A. heterochroum*, was a sexual hexaploid, $2n=216$, having 64 haploid spores per sporangium (*Pl. 19D; Pl. 20B, J*). The Sumter County plant, also identified as *A. heterochroum*, was found to be a sexual tetraploid, $2n=144$ (*Pl. 19C; Pl. 20C*). The third plant, from Co-

[1] I express thanks to Professor Warren H. Wagner, Jr., for help in carrying out this research, which was supported in part by his National Science Foundation Grants G–10846 and GB–3366.

Table 1. Comparison of Four Spleenworts (From Living Plants Grown under Uniform Greenhouse Conditions, U.M. Botanical Gardens)

Taxon			
4x A. heterochroum	*6x A. heterochroum*	*3x A. resiliens*	*5x A. heteroresiliens*
Source			
Sumter Co., Fla.	Alachua Co., Fla.	Cheatham Co., Tenn.	Columbia Co., Fla.
Habit			
Leaves mostly strict *(Pl. 19C)*	Leaves mostly strict *(Pl. 19D)*	Older, smaller leaves more spreading *(Pl. 19A)*	Older, smaller leaves somewhat spreading *(Pl. 19B)*
Leaf texture			
Herbaceous	Herbaceous	Coriaceous	Subcoriaceous
Leaf and leaflet length			
Small: lvs. to 12.5 cm; median pinnae to 8 mm	Larger: lvs. to 18.5 cm; pinnae to 8 mm.	Large: lvs. to 20 cm; pinnae to 13 mm	Moderate: lvs. to 16 cm; pinnae to 9 mm
Laminar color ("L," Villalobos, 1947)			
Yellow-green, more lustrous (lightness 8-9; chromaticity 11°-12°)	Yellow-green, more lustrous (lightness 7-9; chromaticity 11°-12°)	Gray-green, dull (lightness 6-7; chromaticity 7°-8°)	Green, more dull; (lightness 5-8; chromaticity 7°-11°)
Pinna tips			
Truncate-dentate *(Fig. 1C)*	Truncate-dentate *(Fig. 1D)*	Rounded, nearly smooth *(Fig. 1A)*	Rounded, smooth to crenate *(Fig. 1B)*
Angle of pinna attachments (upper ⅓ of leaf)			
Right angles	Right angles	Oblique	Right angles

Anterior pinna margins			
Coarsely dentate	Coarsely dentate	Smooth, (mainly) undulate, or crenate	Dentate to (mainly) crenate
Anterior pinna auricles (lower ⅓ of leaf)			
Weakly developed, rounded-dentate	Weakly developed, rounded-dentate	Strongly developed, pointed, entire	Somewhat developed and pointed
Petiolules (upper ⅓ of leaf)			
Hardly visible to naked eye; pinnae nearly sessile	Hardly visible to naked eye; pinnae nearly sessile	Short, definite, c. ⅓-½ mm long, visible to naked eye	Pinnae nearly sessile
Sorus position (especially distal basicopic sori)			
Medial to inframedial *(Fig. 1C)*	Medial to inframedial *(Fig. 1D)*	Supramedial *(Fig. 1A)*	Medial *(Fig. 1B)*
Average number of forked veins (above the basal auricle)			
0.3 (0-1)	0.3 (0-1)	3.6 (2-5)	1.6 (0-4)
Rhizome scales			
Short; broad base narrowing gradually to apex *(Pl. 21G)*	Long; broad base narrowing gradually to apex *(Pl. 21F)*	Long; narrow entire length, becoming filiform *(Pl. 21H)*	Long; med.-wide base, narrowing to attenuate apex *(Pl. 21I)*
Epidermal cell sizes (Upper; Lower)			
Medium *(Pl. 21J)* c. 83.9μ; c. 109.7μ	Large *(Pl. 21K)* c. 98.9μ; c. 145.7μ	Small *(Pl. 21L)* c. 67.0μ; c. 96.3μ	Med. to lge. *(Pl. 21M)* c. 89.6μ; c. 141.6μ
Stomate length			
Short, c. 44.6μ	Long, c. 51.2μ	Very long, c. 56.2μ	Very long, c. 56.9μ
Spore length; degree of abortion			
(Pl. 20E) $2x$ spore, c. 35μ; minimal	*(Pl. 20F, J)* $3x$ spore, c. 41μ; minimal	*(Pl. 20G)* $3x$ spore, c. 42μ; considerable	*(Pl. 20H, I)* $5x$ spore, c. 47μ; considerable
Sporophytic chromosome number			
$2n=144$ *(Pl. 20C)*	$2n=216$ *(Pl. 20B)*	"$2n$"$=108$ *(Pl. 20A)*	"$2n$"$=180$ *(Pl. 20D)*

Plate 19. Fronds of: A. A. resiliens. (Cheatham Co., Tenn., *Wagner 9334*). B. A. heteroresiliens (Columbia Co., Fla.). C. 4*x* A. heterochroum (Sumter Co., Fla.). D. 6*x* A. heterochroum (Alachua Co., Fla.).

lumbia County, was neither a sexual $4x$ nor $6x$ plant, but rather an apogamous pentaploid. Its spore mother cells, containing 180 bivalents at meiosis, formed 32 diploid spores per sporangium (*Pl. 19B; Pl. 20D, I*).

It was first hypothesized that the apogamous $5x$ *A. heteroresiliens* was the hybrid between sexual $4x$ and $6x$ *A. heterochroum*. However, the latter two plants looked very much alike

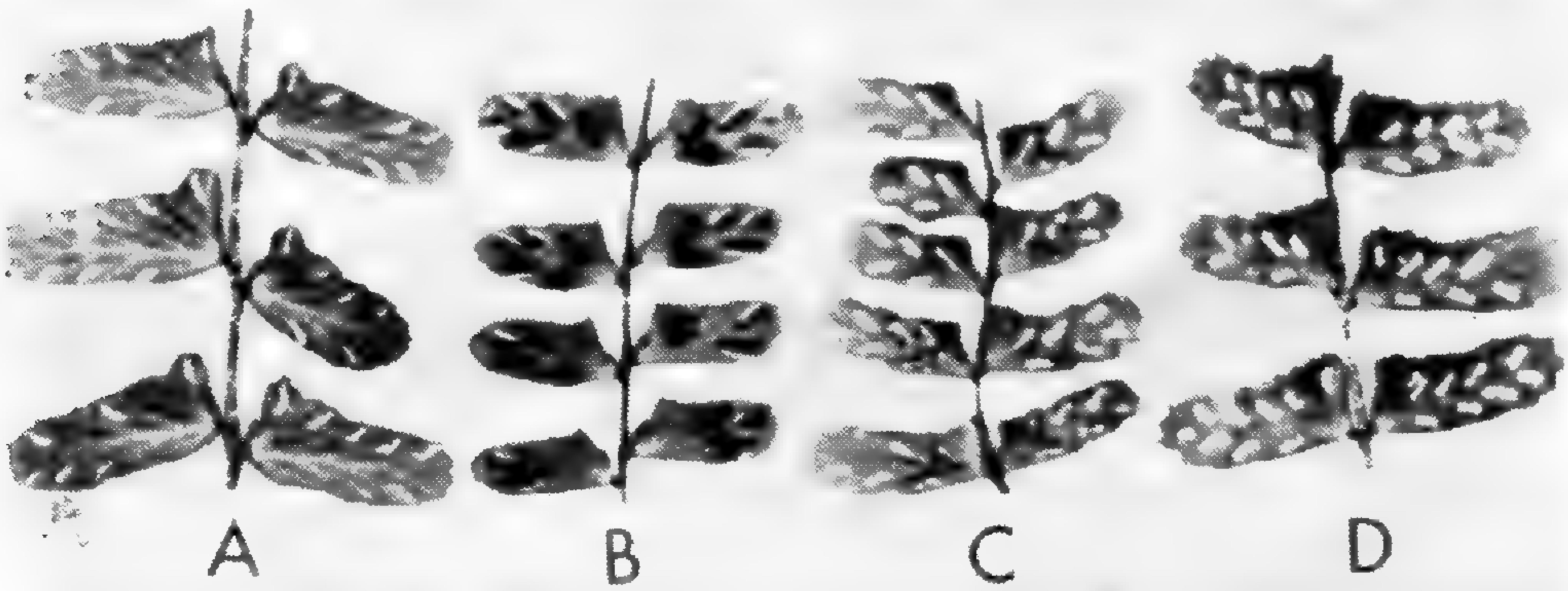
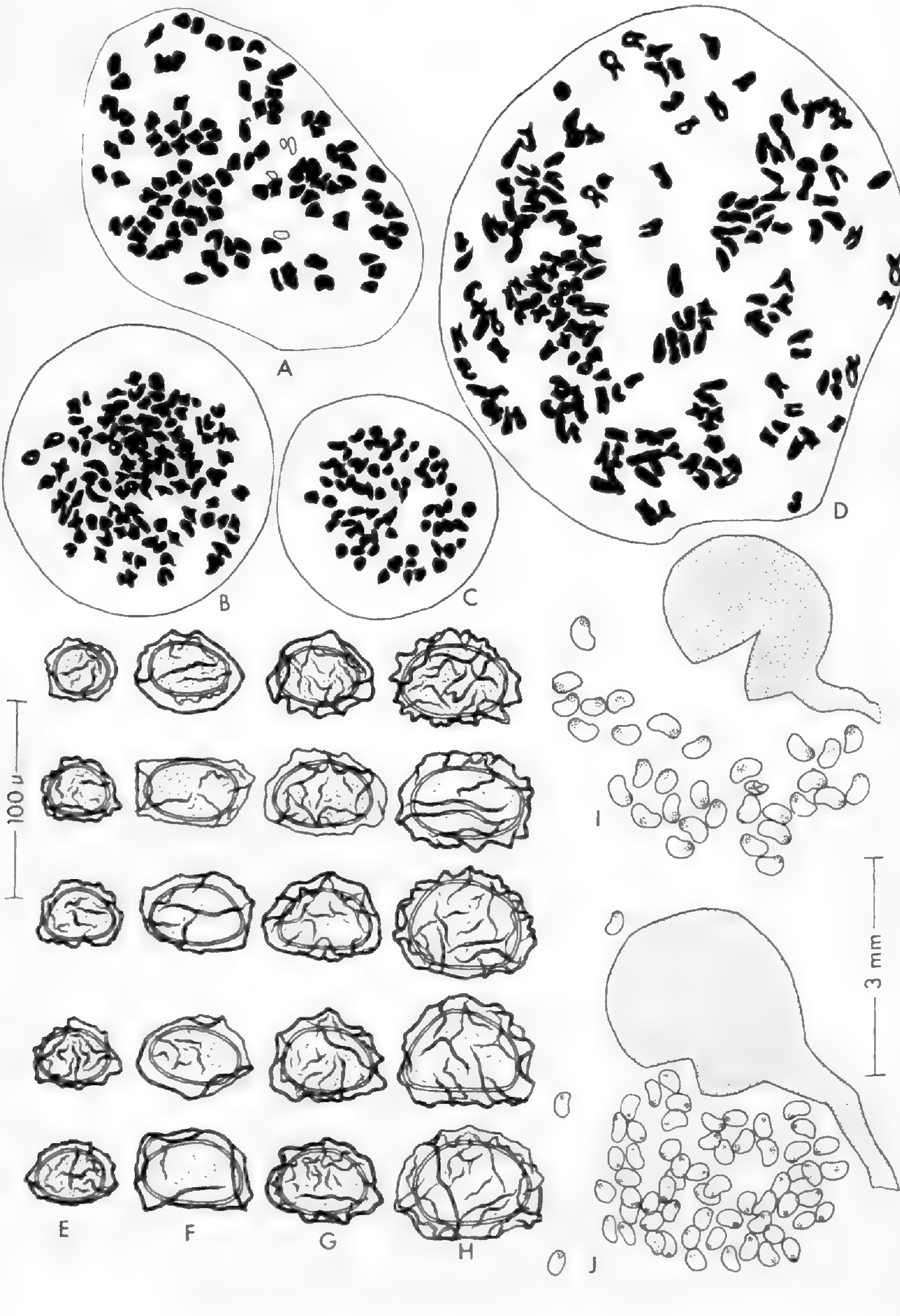


FIGURE 1. MEDIAN PINNAE OF: A. A. RESILIENS. B. A. HETERORESILIENS. C. $4x$ A. HETEROCHROUM. D. $6x$ A. HETEROCHROUM.

morphologically except in size (*Pl. 19C* and *Fig. 1C* versus *Pl. 19D* and *Fig. 1D*), whereas the former seemed to differ on gross examination, particularly in its darker color. A study of anatomical and morphological characters was then undertaken, including those of *A. resiliens*, an apogamous triploid with both "n" and "$2n$"$=108$ (*Pl. 19A*), which closely resembles *A. heterochroum* and *A. heteroresiliens*.

The results of the investigation led to the conclusion that the $5x$ hybrid originated as the cross between $4x$ *A. heterochroum* and $3x$ *A. resiliens*. As shown in *Table 1, Plates 19* and *20F–I*, and *Fig. 1*, the $5x$ hybrid is intermediate between the above parents in growth habit, leaf texture, leaf and leaflet length, lamina color, pinna tips, anterior pinna margins, anterior pinna auricles (lower 1/3 of leaf), sorus position, degree of forking in the sorus-bearing veins above the basal auricles, and rhizome scales.


A
B
C
D
100 μ
E
F
G
H
I
J
3 mm

One of the characters of $3x$ *A. resiliens* is its large stomates, which nearly equal those of $6x$ *A. heterochroum.* Those of $4x$ *A. heterochroum* are small. The stomates of the pentaploid are larger than any of the above plants, being even slightly larger than those of the sexual hexaploid. Spore characteristics (*Pl. 20E–H*) also indicate the hybrid nature of $5x$ *A. heteroresiliens*: the spores are intermediate in size and relative convolution of the perispore. The $2x$ spores of $4x$ *A. heterochroum* are the smallest, averaging 35μ in length, and have a relatively large number of convolutions. Triploid *A. resiliens* spores are larger, averaging 42μ, and are also quite convoluted. Hexaploid *A. heterochroum* has $3x$ spores similar in size to *A. resiliens,* averaging 41μ, but with a much less convoluted perispore.

Not only does *A. heteroresiliens* share the morphological characteristics of its parents, but it has also evidently inherited the apogamous life cycle of *A. resiliens.* Although the 32-spored sporangia indicated this type of life cycle for the hybrid, spore cultures were made in order to study the complete life cycle and to confirm apogamy. Fronds were washed under violently running tap water to remove foreign spores, placed between clean sheets of paper, and dried (away from heat) in a plant press. The spores were then sown on agar plates containing 1½% agar in Beijerinck's nutrient solution. Within two weeks the spores germinated and began to form long uniseriate filaments (*Pl. 21A–C*). In three to four months they had greatly increased in length and also somewhat in width. Antheridia but no archegonia were observed. Sporophytes were budded off from the lower surfaces in the proximal half of the gametophytes; the distal half continued to grow, often being considerably narrower

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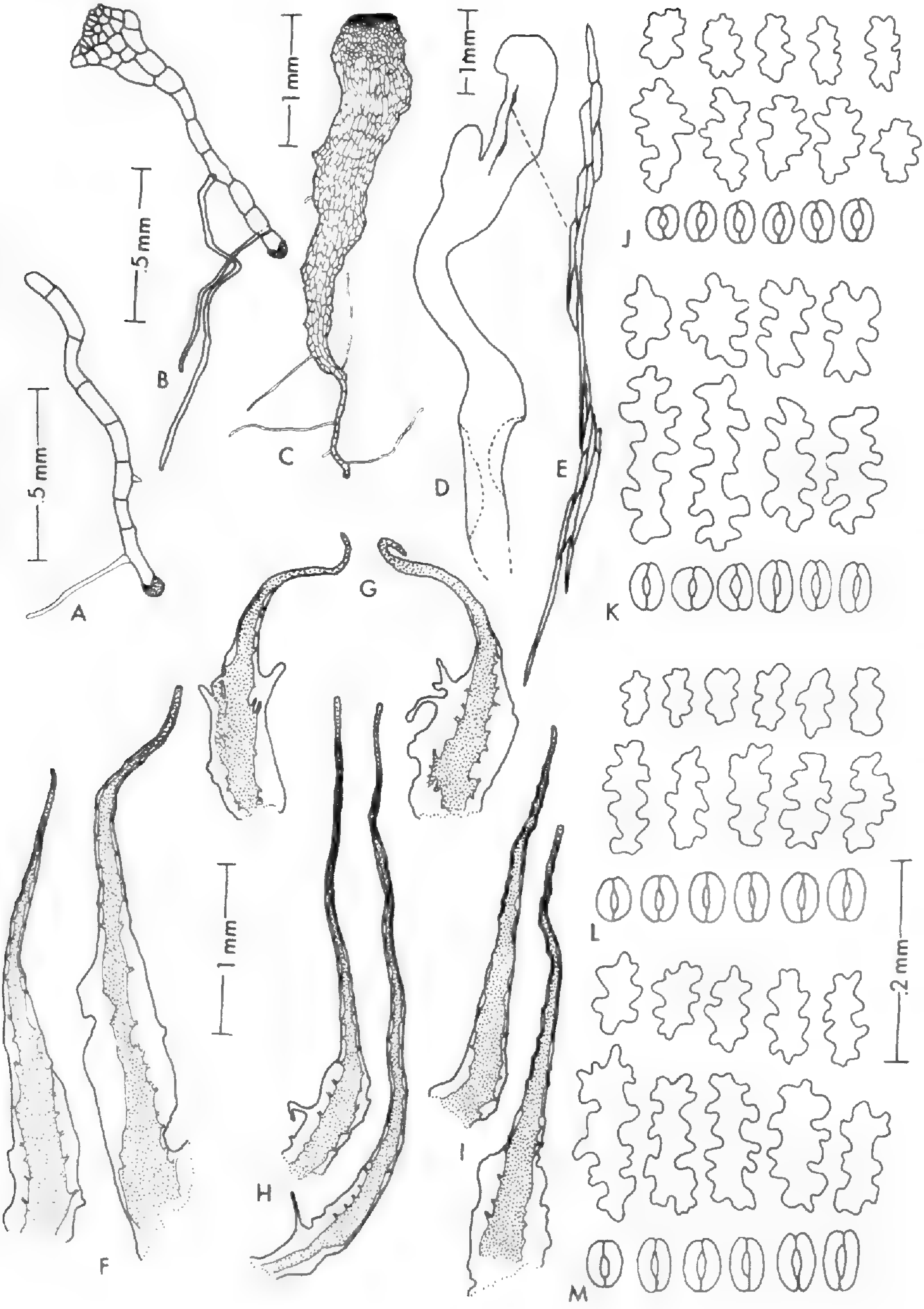
PLATE 20. CHROMOSOMES OF: A. A. RESILIENS (*Wagner 9333*), $106^{II}+4^{I}$. B. $6x$ A. HETEROCHROUM (UMBG 21690), 108^{II}. C. $4x$ A. HETEROCHROUM (UMBG, SUMTER CO., FLA.), 72^{II}. D. A. HETERORESILIENS (UMBG, 21689), 178^{II} (c. 180^{II}). E. $2x$ SPORES OF $4x$ A. HETEROCHROUM. F. $3x$ SPORES OF $6x$ A. HETEROCHROUM. G. $3x$ SPORES OF $3x$ A. RESILIENS. H. $5x$ SPORES OF $5x$ A. HETERORESILIENS. I. A. HETERORESILIENS, 32 SPORES PER SPORANGIUM. J. $6x$ A. HETEROCHROUM, 64 SPORES PER SPORANGIUM.


A
B
C
D
E
F
G
H
I
J
K
L
M
.5 mm
.5 mm
1 mm
1 mm
1 mm
.2 mm

than the middle portion. This long upper half was multiseriate and appeared, under 400× magnification, to have vascular tissue running through it. About seven months after the spores were sown, clearings were made of 30 gametophytes, most of which had developed tracheids (*Pl. 21D, E*). This was true whether or not the gametophytes had produced sporophytes. In my opinion, the regular occurrence of vascular tissue in fern gametophytes in positions separate from sporophytic buds is an unusual phenomenon.

Despite the clear relationships of the species discussed here, the situation involving other taxa in this complex—particularly those outside of Florida—is far more complicated and will involve much further study. For example, the existence of $4x$ and $6x$ *A. heterochroum* presupposes the past or present existence of $2x$ *A. heterochroum*. Spore measurements made on many herbarium specimens from the West Indies indicate that $2x$ plants of this species do exist. Also, the existence of a $6x$ form of *A. heteroresiliens* can be anticipated. Such an apogamous hybrid should be sought in areas where the potential parents, sexual $6x$ *A. heterochroum* and apogamous $3x$ *A. resiliens*, co-exist. The occurrence of several other genomic conditions in backcross hybrids can be hypothesized, and presumably they are occasionally produced in nature.

Voucher Specimens (all in MICH):

$4x$ *Asplenium heterochroum:* Cat Hammock, near Sumterville, Sumter County, Florida, Nov. 12, 1960, *Thomas Darling, Jr.* (UMBG).

$6x$ *Asplenium heterochroum:* Alachua County, Florida, Sept. 8, 1960, *E. S. Ford* (UMBG 21690).

$5x$ *Asplenium heteroresiliens:* Columbia County, Florida, Sept. 8, 1960, *E. S. Ford* (UMBG 21689).

PLATE 21. A, B. EARLY GAMETOPHYTE STAGES OF A. HETERORESILIENS. C. TWO-MONTH OLD GAMETOPHYTE OF A. HETERORESILIENS. D, E. GAMETOPHYTE SHOWING LOCATION OF AND ENLARGED DRAWING OF TRACHEARY TISSUE OF A. HETERORESILIENS. RHIZOME SCALES OF: F. $6x$ A. HETEROCHROUM. G. $4x$ A. HETEROCHROUM. H. A. RESILIENS. I. A. HETERORESILIENS. UPPER AND LOWER EPIDERMAL CELLS AND STOMATES OF: J. $4x$ A. HETEROCHROUM. K. $6x$ A. HETEROCHROUM. L. A. RESILIENS. M. A. HETERORESILIENS.

3x *Asplenium resiliens:* Big Marrowbone Creek, about ¼ mi. E of Tenn. Route 1W, Ashton City Road, Cheatham County, Tennessee, Oct. 23, 1960, *W. H. Wagner, Jr., 9333.*

Additional specimens of *Asplenium heteroresiliens* examined:

FLORIDA. **Columbia Co.**: between High Springs and Fort White, on open moist rocks in open woods, *D. S. Correll* 6449A (GH); about 3 mi. W of High Springs, limestone ledges, deciduous woods, *R. K. Godfrey 55355* and *H. Kurz* (GH). **Jackson Co.**: Marianna Caverns State Park, on limestone ledges in deciduous woods, *R. K. Godfrey 55333* (GH); near Florida Caverns State Park, on rocky ground, *J. B. McFarlin 11438a* (US); Natural Bridge, near Marianna, on rocks, Dec. 5–6, 1934, *J. K. Small & Wm. A. Knight* (NY); Florida Caverns State Park, locality 2, just S of main picnic grounds, among outcroppings of Marianna limestone, *W. H. Wagner 62044, R. K. Godfrey,* and *R. S. Mitchell* (MICH); **Liberty-Gadsden Co. Line**: shaded rocks, Appalachicola River, near Aspalaga, *A. H. Curtiss 3720* (GH, NY, US, Barnard College); E side of Appalachicola River at Aspalaga, with *A. platyneuron,* along tops of "weedy" boulders, *W. H. Wagner 62034, R. K. Godfrey* and *R. Mitchell* (MICH).

GEORGIA. "Collected on mortar between rocks of an old wall in the SE part of the state," *Donald Blake,* Sept. 8, 1963. (according to Duncan and Blake, 1965).

SOUTH CAROLINA. **Berkeley Co.** (erroneously listed as Charleston Co. by Wagner, in Radford et al., 1964): Enteric Springs, Santee Canal, *H. W. Ravenel, s. n.* (GH).

NORTH CAROLINA. **Bladen Co.**: 8 mi. SE of Elizabethtown, calcareous sandstone in beech woods, near Walker's Bluff, on Cape Fear River, *A. E. Radford 6854* (NCU). **Jones Co.**: 6.5 mi. E of Pollocksville, on consolidated marl rocks and ledges along Island Creek, *R. K. Godfrey 52238* and *E. E. Radford* (NCU); Marl outcrop in hardwood forest on Island Creek, *A. E. Radford 6782* and *G. R. Cooley; ibid., A. E. Radford 5722, 6059* (NCU); Limestone in woods on Reedy Creek, *A. E. Radford 5639* (NCU); 5 mi. S of New Bern, marl outcrop on Island Creek, Aug. 8, 1954, *Silliman & Munson* (NCU). **New Hanover Co.**: Wilmington, *M. A. Curtis* in 1831 (NCU).

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Some New Combinations in Thelypteris

C. V. Morton

In 1959,[1] I showed that *Hemionitis pozoi* Lagasca[2] had long been misidentified as being a species of *Pleurosorus* but that actually it was the earliest name for the fern that had been called *Dryopteris africana* C. Chr. in the Index Filicum. This species belongs to *Thelypteris* subg. *Cyclosorus* sect. *Leptogramma* (J. Smith) Morton,[3] as I have classified this group. Some workers, e.g. Alston, have considered *Leptogramma* as a genus, but it seems to be no more than a section of subg. *Cyclosorus* with the sori elongate and exindusiate. Such elongate sori occur in other groups of *Thelypteris* (e.g. *Meniscium*) and in some species otherwise typical of the section *Lastrea*, e.g. *Dryopteris linkiana* and others, not yet transferred to *Thelypteris.*

The latest worker on this group, Dr. K. Iwatsuki, has treated *Leptogramma* as *Stegnogramma* Blume sect. *Leptogramma*,[4] but he has not adduced any convincing reasons for recognizing *Stegnogramma* as distinct from *Thelypteris.* In a more recent paper,[5] Iwatsuki has summarized the characters of *Stegnogramma* as follows: "Short rhizome with well marked collenchymatous tissues, the pinnate or pinnatifid fronds having the indistinct apical pinnae, the exindusiate sori elongate along the

[1] Sur la nomenclature de deux Fougères rares d'Espagne. Bull. Soc. Bot. France **106:** 231–234. 1959.
[2] Nov. Gen. et Sp. 33. 1816.
[3] Amer. Fern J. **53:** 153. 1963.
[4] Acta Phytotax. Geobot. **19:** 116. 1963.
[5] Mem. Coll. Sci. Univ. Kyoto, Ser. B, **31:** 19. 1964.

veinlets, the setiferous sporangia, and the simple setose hairs densely throughout the plants." None of these characters is distinctive or generic: short rhizomes are characteristic of most *Thelypteris,* as are fronds pinnatifid at apex (With "indistinct apical pinnae"), setiferous sporangia are found in various unrelated species (e.g. *T. concinna* of sect. *Lastrea* and *T. tetragona* of sect. *Goniopteris*), and the "setose" hairs are characteristic of all *Thelypteris* species, and are in fact one of the chief indications that *Leptogramma* and *Stegnogramma* belong with *Thelypteris* rather than an argument that they ought to be separated from it.

The Asiatic representatives of the section *Leptogramma* have been treated as distinct species, but they seem to me to be very closely allied with typical *T. pozoi* (Lagasca) Morton, which seems to be very widespread in distribution. I agree with Iwatsuki that *mollissima* is best treated merely as a geographic subspecies, and in my opinion *himalaica* is also merely a dwarfish subspecies, for which the following new combinations are proposed:

THELYPTERIS POZOI (Lagasca) Morton subsp. **mollissima** (Kunze) Morton, *comb. nov.*

Gymnogramma mollissima Fischer ex Kunze, Linnaea **23**: 255, 310. 1850, *nom. nud.*

Gymnogramma totta Schlecht. var. *mollissima* Kunze, Linnaea **24**: 249. 1851. SYNTYPES: Niligiri Mountains, India, *Schmid-Koch 8, 79, 145; Weigle-Schaeffer 39;* and cultivated plants (or specimens) from the botanical garden in St. Petersburg.

Leptogramma mollissima Ching, Sinensia **7**: 102, *t. 9.* 1936.

Stegnogramma pozoi (Lagasca) K. Iwatsuki subsp. *mollissima* K. Iwatsuki, Acta Phytotax. Geobot. **19**: 125. 1963.

In the Index Filicum *Gymnogramma mollissima* Fischer ex Kunze is cited as though it were validly published, with no indication that it is a *nomen nudum.* Ching evidently did not see the original publication, because he cited this *nomen nudum* as the basis for his new combination *Leptogramma mollissima,* and in proposing this as a subspecies Iwatsuki has done likewise. Apparently neither Ching nor Iwatsuki saw the first valid publication of the epithet *mollissima,* which is as a variety of *G. totta* Schlecht., a year later than the name *G. mollissima* as a species. This error is picked up in the new Supplement IV of the Index Filicum.

THELYPTERIS POZOI subsp. **himalaica** (Ching) Morton, *comb. nov.*

Leptogramma himalaica Ching, Sinensia **7:** 100. 1936. TYPE: Simla, India, *R. R. Stewart.*

Stegnogramma himalaica K. Iwatsuki, Acta Phytotax. Geobot. **19:** 122. 1963.

This subspecies is smaller than subsp. *mollissima,* with relatively broader, more obtuse pinnae. It has been supposed to be confined to the northwestern Himalaya Mountains, but I have seen a recent collection from southern India: Kodiakanal, 7000 feet elevation, *Abraham 1067*

The other undoubted species of Asiatic Leptogrammas are:

THELYPTERIS **tottoides** (H. Ito) Morton, *comb. nov.*

Leptogramma tottoides H. Ito, Bot. Mag. Tokyo **49:** 434. 1935. TYPE: Mount Arisan, Taiwan, in 1912, *Hayata & Sasaki.*

Stegnogramma tottoides K. Iwatsuki, Acta Phytotax. Geobot. **19:** 121. 1963.

THELYPTERIS **gymnocarpa** (Copel.) Morton, *comb. nov.*

Dryopteris gymnocarpa Copel. in Elmer, Leafl. Phil. Bot. **3:** 807. 1910. TYPE: Mount Apo, at falls of Cati Creek, 1750 m., Mindanao, Philippine Islands, *Elmer 11508.*

Stegnograma gymnocarpa K. Iwatsuki, Acta Phytotax. Geobot. **19:** 122. 1963.

THELYPTERIS GYMNOCARPA subsp. **amabilis** (Tagawa) Morton, *comb. nov.*

Leptogramma amabilis Tagawa, Acta Phytotax. Geobot. **7:** 76. 1938. TYPE: Sate, Okinawa, Ryukyu Islands, *G. Koidzumi.*

Stegnogramma gymnocarpa subsp. *amabilis* K. Iwatsuki, Acta Phytotax. Geobot. **19:** 123. 1963.

A local subspecies, apparently confined to the Ryukyu Islands, where it is seemingly common.

THELYPTERIS **scallanii** (Christ) Morton, *comb. nov.*

Aspidium scallanii Christ, Bull. Soc. Bot. Ital. **1901:** 296. TYPE: Szechwan, China, *Scallan.*

Stegnogramma scallanii K. Iwatsuki, Acta Phytotax. Geobot. **19:** 124. 1963.

U. S. NATIONAL MUSEUM, WASHINGTON, D. C. 20560.

Nephopteris, a New Genus of Ferns from Colombia

DAVID B. LELLINGER

Although twenty years have passed since Dr. William R. Maxon retired from his curatorship, reliquiae of his productive tenure are still uncovered occasionally in the Smithsonian's collections of ferns. Some time ago two specimens were found in a cover labelled "Nephopteris, gen. nov. Colombia" in Maxon's hand; soon after, another specimen was received for identification. Judging by the high altitude at which these plants were collected, "Cloud Fern" is indeed an appropriate generic name.

Nephopteris maxonii Lellinger, *gen. et sp. nov.* PLATE 22

Rhizoma repens, aliquantum contortum, 1–2 mm diam., usque ad 2 cm longum, strigosum, frondibus in 3-4 seriebus supra et radicibus infra instructum, trichomatibus acicularibus, recte cylindraceis, 5–10-cellularibus, brunneis, semipatentibus. Frondes dimorphae, coriaceae, imparipinnatae, opacae, glabratae, praeter stipites sparsim strigosos et nitidos, stipitibus et rhachidibus teretibus, sulcatis vel complanatis, ergo rectis sive contortis, brunneis, minute vittatis, maturitate fuscis, pinnis marginibus planis vel leviter revolutis, venulis flabellatis, prominulis, nitidis, brunneis et minute vittatis ad basin, submersis ad margines praecipue in pinnis, fertilibus. Frondes steriles ad 2 cm longae, ascendentes, rhachibus contortis, laminis 3-foliolatis, pinnis late obovatis aliquantum irregularibus, subsessilibus, surcurrentibus, ca. 5 mm longis et latis, pinnis terminalibus maioribus quam pinnis lateralibus. Frondes fertiles (2)3.5–9 cm longae, erectae, stipitibus rectis, basi contortis, laminis (3)5-foliolatis, pinnis plus minusve orbicularibus aliquantum irregularibus, breviter petiolulatis, surcurrentibus, ca. 3–5 mm longis et latis, pinnis lateralibus maioribus quam pinnis terminalibus. Sporangia dispersa, dorsalia et subsessilia in venis, annulis ca. 16-cellulis, paraphysibus multicellulosis, laxis, usque ad 1 mm longis, brunneis, sporangia obtegentibus.

TYPE: Páramo de Chaquiro, Cordillera Occidental, Departments of Bolívar-Antioquia, Colombia; grassy páramo, alt. 3000–3200 m, Feb. 23, 1918, *Francis W. Pennell 4258* (US; isotype NY). If actually collected near the boundary of the two departments, then the locality presumably is about 110 km north-northwest of Medellín, at the south end of the Serrania de Ayapel.

TYPE SPECIMEN (US) OF NEPHOPTERIS MAXONII N. SP.

PARATYPE: Beside mule trail up the steep "Alto del Oso," just northeast of Cobugon, on the way to Laguna Seca, Sierra Nevada de Cocuy, Cordillera Oriental, Dept. Boyacá, Colombia; on peaty banks on steep, open hillside, alt. ca. 2900–3200 m, Aug. 18, 1957, *P. J. Grubb & D. A. Guymer P.68* (US). Duplicates are probably at BM and CGE. The collectors note that this species was never seen elsewhere.

The two known localities for *N. maxonii* are about 400 km distant and lie on a nearly east-west line in different mountain ranges. This species may well be rather widely distributed at high altitudes in northwestern Colombia, and, if so, has been overlooked, probably because of its small size and the difficulty of collecting in the cold, wet páramos.

It seems most likely that *Nephopteris* is a reduced offshoot of *Eriosorus,* for it resembles that genus far more than it does any of the genera related to *Eriosorus.* The soriation, rhizome and frond indument, stipe coloration, and segment architecture of *N. maxonii* all agree with *Eriosorus,* but the dimorphic fronds that are not large and are neither scandent and indeterminate nor elongate and strongly pinnate are sufficient, in my opinion, to warrant separation of the two genera.

DEPARTMENT OF BOTANY, U. S. NATIONAL MUSEUM, WASHINGTON, D.C. 20560.

Shorter Notes

SOUTHERN RECORDS OF OPHIOGLOSSUM VULGATUM.—In this JOURNAL, volume 56, p. 37, there is a report of what was presumed to be the first find of *Ophioglossum vulgatum* in Mississippi. However, on April 8, 1922, I was visiting in that state and chanced to enter a tract of moist pineland just east of Columbus, Lowndes County. Growing there in the subacid, humus-rich loam were two plants that I had seen not long before in a strikingly different environment—sphagnous meadowland in northern Vermont—namely, *Ophioglossum vulgatum* and the orchid *Listera australis.* Pressed specimens were duly placed in the U. S.

National Herbarium, but the record was not deemed worthy of publication at the time.

It is now realized that *O. vulgatum* is divisible into multiple infra-specific taxa, the two in the southeastern United States having been named var. *pseudopodum* and var. *pycnostichum*. These may of course be ignored by anyone who does not care to undertake the observation of minor details; but science would never advance if its devotees followed the path of least resistance. There is an indication that the contrasted morphologic features of these two varieties are correlated with geography, climate, soil character, etc., and so their separation does seem worth while.

My specimen (US 1,466,600) was kindly checked by Dr. Lellinger, who reports that while the blade-outline is somewhat intermediate, the plants correspond more closely to var. *pycnostichum*. It will accordingly be desirable to ascertain which variety is represented by the 1965 collection in the University of Mississippi herbarium. Interestingly enough, in the same number of the JOURNAL (p. 34) *O. vulgatum* is recorded from two widely separated stations in Lincoln Parish, Louisiana; again no varietal identification is indicated, but it should be made.

On turning to the recent *Ferns of Alabama*,[1] I noticed a curious mixup: in the text only var. *pycnostichum* is mentioned, but the illustration represents var. *pseudopodum*. Do both grow in Alabama or does this merely mean that the artist, not realizing the complexity of the situation, copied the figure from some book on the ferns of one of the northern states where var. *pseudopodum* grows?

Here, then, is an ecologic—geographic problem awaiting study: how far south does var. *pseudopodum* really extend, and is its apparent restriction to rather acid soils significant or may it sometimes enter the circumneutral soils which seem to favor the growth of var. *pycnostichum*?—EDGAR T. WHERRY, *Leidy Laboratory, University of Pennsylvania, Philadelphia, Pa. 19104.*

[1]Dean, Blanche E. Ferns of Alabama and fern allies. American Southern Publ. Co., Northport, Ala. 1964. xxiv + 232 pp. illustr. $7.50.

IS THELYPTERIS PARASITICA IN CULTIVATION IN THE UNITED STATES?—Many of the ferns formerly placed in the genus *Dryopteris* are now properly called *Thelypteris,* among them *Dryopteris parasitica* (L.) Kuntze, which now becomes *Thelypteris parasitica* (L.) K. Iwatsuki.[1] There are plants in cultivation in the United States under this name and also plants being offered by dealers, but all that I have examined have proved to be *Thelypteris dentata* (Forsk.) E. St. John. These two species belong to one of the most difficult groups of ferns, and the difficulties are not to be solved readily, for they are inherent in the group by reason of its almost worldwide range (the tropics of Africa, Asia, and America), its great variability, and also probably because of extensive hybridization in the wild.

Ching[2] attempted to distinguish *T. parasitica* and *T. dentata* by characters of the venation: Both have the lowest pairs of veins united into an excurrent veinlet running out toward the sinus between the lobes of the pinnae, but in *T. parasitica* the second anterior vein is supposed to run to the margin above the sinus or occasionally exactly to the sinus, but not to join with the excurrent veinlet. But in *T. dentata* the second anterior veinlet is said to join with the excurrent veinlet. However, an examination of specimens from China studied and annotated by Ching does not support this distinction at all. Both kinds of venation seem to be found in both species.

Wagner[3] at first distinguished *T. dentata* by having the fronds only sparsely hairy, the indusium with very short hairs, and the segments closest to the rhachis usually not enlarged, but these characters do not always hold when these species are considered in their worldwide ranges. Later, he[4] used addi-

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[1] J. Jap. Bot. **38**: 315. 1963.

[2] "A Revision of the Chinese and Sikkim-Himalayan Dryopteris," Bull. Fan. Inst. Biol., Bot. **4**: 170–178, 204, 208. 1938.

[3] "Pteridophytes of Guam," Occas. Pap. Bernice P. Bishop Mus. **19**: 48. 1948.

[4] "Ferns Naturalized in Hawaii," Occas. Pap. Bernice P. Bishop Mus. **20**: 108, 109. 1950.

tional characters, and his treatment remains the latest study. His key, reproduced below, may be tentatively accepted as a working basis for distinguishing these species.

Fronds dimorphic, the fertile ones narrower, with more remote pinnae, sharply distinct from and standing high above the more spreading sterile fronds; lamina darker green, usually chartaceous in texture, more or less short-hairy, without glands below; basal pinnae 1—5 pairs, reduced in size often to mere auricles and becoming distant; all pinnae relatively broad, and cut usually less than half-way down to the midrib; anterior basal segment or lobes of the lower pinnae not extended or but little extended and not overlapping the adjacent pinnae; excurrent veinlet below the sinus formed by the basal pair of veinlets plus one or two more distal veinlets; indusium sparsely short-hairy.
T. dentata (Forsk.) E. St. John

Fronds uniform, the fertile fronds of nearly the same shape as the sterile ones, but many fronds incompletely fertile, the sori in these paired at the bases of the segments; lamina pale green, membranaceous, densely long-hairy, often with dark-orange glands on the lower surface; basal pinnae of the same size as those above or only slightly smaller; pinnae all narrower, and cut usually half-way down to the midrib; anterior basal segments of the lower pinnae extended, often overlapping the rhachis or the lowest segments of the adjacent pinnae; excurrent veinlet formed only by the basal pair of veinlets, the next veinlets ending at the margin above the sinus; indusium densely long-hairy.
T. parasitica (L.) K. Iwatsuki

It would be interesting to me to know if plants corresponding to the characterization of *T. parasitica* given above are really in cultivation in the United States. They would be expected outdoors only in southern California or perhaps in southern Florida.—C. V. MORTON, *Smithsonian Institution, Washington, D. C. 20560.*

ASPLENIUM SERRATUM IN SOUTH FLORIDA.—One of the most impressive ferns to be found in South Florida, in my opinion, is *Asplenium serratum,* one of the so-called Bird's-nest Ferns. I grow this strikingly attractive plant in my garden, and have in relatively recent times had the pleasure of observing it in the wild.

In this southern part of peninsular Florida, *Asplenium serratum* occurs primarily as a true epiphyte, perched on mossy, frequently horizontal branches, oftentimes in close proximity to *Campyloneurum phyllitidis.* Ten or fifteen years ago it was reasonably common in certain selected localities, even including a couple of the hammock formations within the city limits of Miami. But the inexorable advance of the bulldozer coupled with over-zealous amateur (and commercial) fern collectors have made it now a distinct rarity hereabouts.

For instance, in Matheson Hammock, a jungled area adjacent to our wonderful Fairchild Tropical Garden, this *Asplenium* in former days could readily be seen on many of the large trees of Live Oak (*Quercus virginiana*) and Mastic (*Sideroxylon foetidissimum*) from the main trails which traverse this protected park. But recent search has disclosed only a half-dozen or so specimens still remaining, and these, fortunately, are well hidden from the casual visitor's view.

The vivid, glossy, bright-green fronds of this fern form a neat ascending vaselike specimen, much less dense than its Old World ally *Asplenium nidus.* They may, in exceptional cases, reach lengths in excess of two feet, though they are generally considerably shorter. The new fronds appear from the center of the plant in a single flush of growth, and expand with remarkable rapidity.

I keep this glorious fern rather firmly potted in a mixture of osmunda and shredded tree-fern fiber, much like that utilized for orchids and bromeliads. Rather deep shade seems essential, and constantly moist conditions are apparently obligatory as well. Periodic applications of an organic fertilizer have proved to be beneficial.

Though *Asplenium serratum* is widespread in the American tropics, it appears infrequently in cultivation. This is regrettable, since it is a spectacular fern of easily-met cultural needs that would grace any collection of ferns.—ALEX D. HAWKES, *P. O. Box 435, Coconut Grove, Florida 33133.*

Notes and News

EXTRA COPIES OF THE FERN BULLETIN.—Professor W. W. Judd, Department of Zoology, University of Western Ontario, London, Ontario, Canada, has 36 issues of the *Fern Bulletin*, predecessor of the AMERICAN FERN JOURNAL, for sale at one dollar each. The issues are: vol. 5 nos. 1, 2, and 4, vol. 6 no. 4, vols. 9–12 nos. 1–4, vol. 13 nos. 1–3, vol. 14 nos. 3 and 4, vol. 15 nos. 1 and 2, vol. 16 no. 2, vol. 17 nos. 2–4, and vol. 18 nos. 1–4. Anyone wishing to fill gaps in his own library should write to Professor Judd directly.—D.B.L.

A NEW FERN GARDEN ON THE CANARY ISLANDS.—In 1965, at Tafira Alta (Las Palmas de Gran Canaria, Canary Islands, Spain), a new private fern garden was founded, called the "Pteridarium E. B. Copeland." It was begun with native plants and other locally obtained species. Thanks to the generous provision of numbers of living plants from Kew Gardens and from the Botanical Gardens of Berlin, Antwerp, Leiden, München, and Tübingen, as well as from some commercial nurseries in Spain and The Netherlands, the number of species grown successfully in 1966 has risen to about two hundred, plus some varieties and cultivars. This number includes both true ferns and fern-allies. The plants are growing in a warmhouse and a coolhouse as well as out-of-doors.

The "Pteridarium E. B. Copeland," honoring the memory of the great American pteridologist Edwin Bingham Copeland (1873–1964), is a purely private foundation. Its purpose is the development of a small but specialized botanical garden for the preservation of certain species, the study of adaptation of plants, and to provide our visiting students of ferns with as much material as possible from living plants. After 1967 it is intended to begin a regular spore exchange with other institutions. In the meantime, because the number of available species is still limited, any contributions of spores or living plants will be much appreciated.—G. KUNKEL, *Camino Viejo 9, Tafira Alta, Las Palmas de Gran Canaria, Canary Islands, Spain.*

Recent Fern Literature

THE PTERIDOPHYTA OF TAIWAN, by Charles E. DeVol. Taiwania **10:** 89–104. 1964; **11:** 41–55. 1965.—Dr. DeVol has spent many years in the study of the ferns of China and Taiwan [Formosa] and has now begun the publication of a comprehensive treatment of the species of Taiwan. The first part is mostly devoted to a general key to the genera and an account of the single species of *Equisetum* occurring in Taiwan. The second part deals wholly with the genus *Lycopodium,* of which 20 species are recognized. The species are keyed, briefly described, and mostly illustrated with line drawings. A serious shortcoming from a scientific point of view is the omission of references to the original publication of the species; on the contrary, the references are "those most easily accessible to our students," a procedure that might be justified if the work is to be used only as a manual for students in Taiwan but not for a work for general use. Even students will need to have the original citations available at least for knowing the date of publication, even though the original books are not locally available. A usage I do not understand, and which is presumably an error, is the adoption of the name *Lycopodium laxum* Presl, which dates from 1825, and the reduction to synonymy of *L. carinatum* Desv., which dates from 1813 (erroneously stated as 1823 by DeVol); it may be that he intends *L. carinatum sensu* authors not Desvaux. Although correctly cited in the bibliography as H. Nessel, this monographer of Lycopodium is cited in several places in the text as "Nessler." However, these small inaccuracies will not detract seriously from the value of the work, which will be considerable when completed.—C.V.M.

PELLAEA WRIGHTIANA IN NORTH CAROLINA AND THE QUESTION OF ITS ORIGIN, by W. H. Wagner, Jr. J. Elisha Mitchell Sci. Soc. **81:** 95–103. 1965.—*Pellaea wrightiana* has not been known previously east of Texas, and consequently the discovery of it in North Carolina recently is rather surprising. The author believes that the Carolina population is a "relict of an ancient center of origin." I would not rule out myself the possibility of an intentional or accidental introduction in fairly recent times. The Carolina population is tetraploid, and is considered to have arisen by hybridization between *P. longimucronata* and *P. ternifolia,* with a subsequent doubling of the chromosomes; thus it should be regarded as a species and not as a variety of either of the two species mentioned above.—C. V. M.

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Index to Volume 56

Errata

Page 97, line 12: For "Sen, 1965" read "Sen, 1966."

Page 101, line 13: For "SEN, U. 1965. . . ." read "SEN U. 1966. . . . **18**(1,2): 26–34."

Page 117, line 18: For "*vacciniifolium*" read "*vacciniifolia*."

Page 128, line 12: For "2.4–2.7 mm" read "2.4–2.7 cm."

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A QUARTERLY DEVOTED TO FERNS

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Contents

VOLUME 57, NUMBER 1, PAGES 1–48, ISSUED MARCH 24, 1967

VOLUME 57, NUMBER 2, PAGES 49–96, ISSUED JUNE 29, 1967

Volume 57, Number 3, Pages 97–144, Issued October 18, 1967

Volume 57, Number 4, Pages 145–196, Issued December 22, 1967

VOL. 57 JANUARY-MARCH, 1967 No. 1

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CONTENTS

The American Fern Society

Council for 1967

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An illustrated quarterly devoted to the general study of ferns, owned by the American Fern Society, and published at 3110 Elm Ave., Baltimore, Md. 21211. Second-class postage paid at Baltimore. The pages of the Journal are open to members who wish to arrange exchanges; a membership list is published at intervals, to assist those interested in obtaining specimens from different localities.

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American Fern Journal

Vol. 57 JANUARY-MARCH, 1967 No. 1

Mecodium wrightii in British Columbia and Alaska

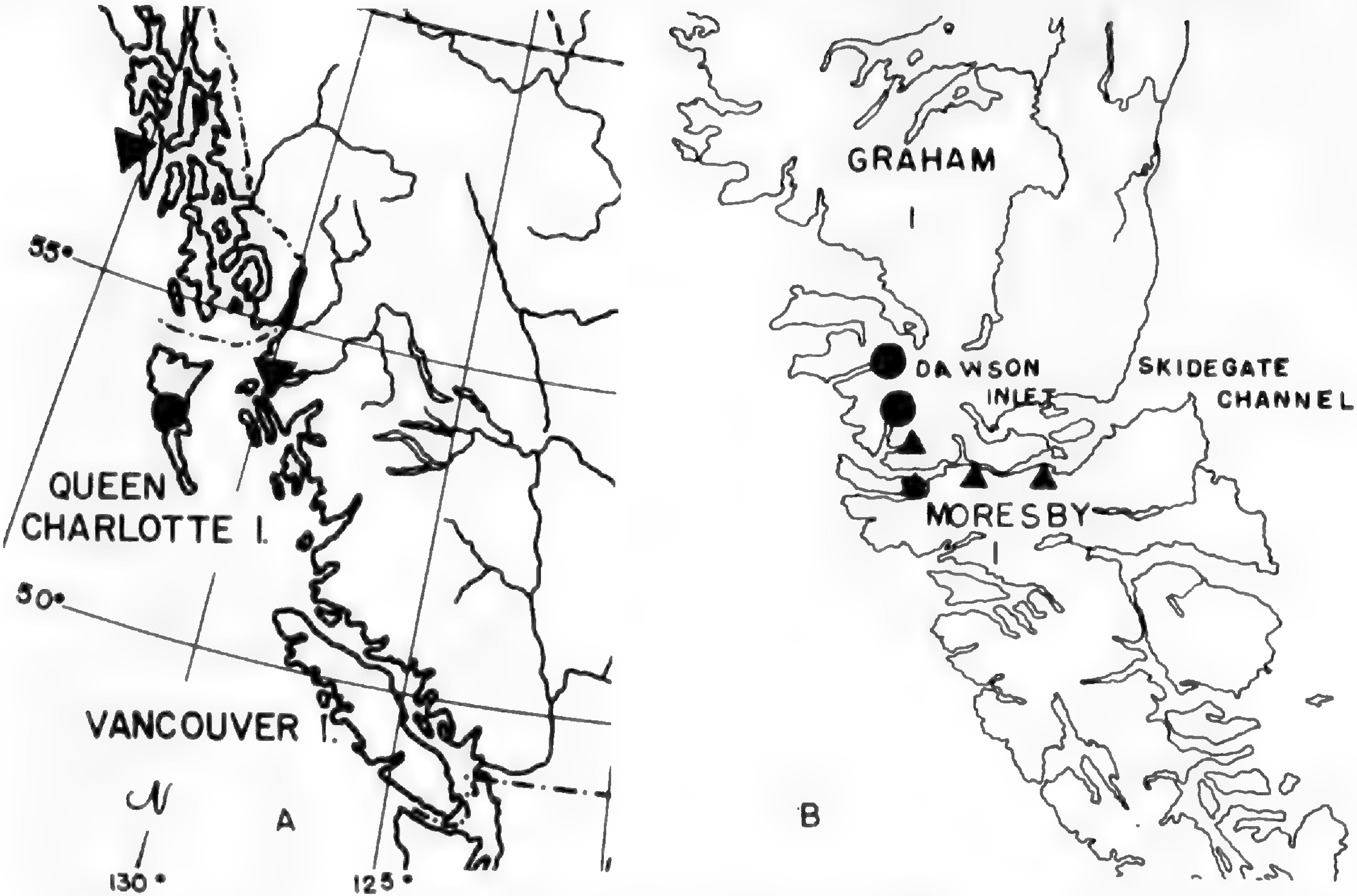
T. M. C. Taylor

Almost as a footnote the following appears in the Bryologist for 1958: "In this hyperoceanic region (Queen Charlotte Islands) I collected, in one locality, the fern *Mecodium wrightii* (v.d. Bosch) Copeland known before from Japan, Korea and Saghalin, and the first representative of the Hymenophyllaceae ever found in western North America" (Persson, 1958). Iwatsuki (1961) confirms this identification and briefly discusses the general habitat and distribution of the species. Specimens of *Mecodium wrightii* collected by my bryological colleague, Dr. W. B. Schofield, are the basis for the following notes and observations.

The sporophyte of this fern has been collected several times at Dawson Inlet, Graham Island, and in the summer of 1966 Dr. Schofield collected abundant fruiting material at the head of Van Inlet, which is the next large inlet north of Dawson Inlet *(Plate 1B)*.

In 1961 Schofield (1962) collected a puzzling hepatic-like plant that was growing freely on wet cliffs on the mainland about 100 miles northeast of Dawson Inlet. Careful study of his material (*Schofield 13945*) satisfied him that it was not a bryophyte, but was more likely a hymenophyllaceous gametophyte. In 1965 an ample collection of similar material was made on Biorka Island, Alaska, by Dr. A. Mathieson. This plant is now known from seven different localities. Despite the different seasons of collection the plants are remarkably uniform in morphology; all are surely the same kind of plant. The thallus is consistently one cell thick with no differences in cell shape except for those of the margin that may develop into rhizoids. It is

Volume 56, No. 4, of the Journal, pp. 145-196, was issued December 23, 1966.



American Distribution of Mecodium wrightii long and ribbon-like, 10–15 cells wide when mature, and up to several millimeters long. Rhizoids may or may not be numerous; they are always marginal, dark in color and unicellular (*Plate 2G*). Often they are limited to only one side of the thallus.

A careful search has not revealed any structures that could be identified with certainty as gametangia. Often, however, there are numerous marginal structures that may be antheridia. Unfortunately I do not have the gametophytes in culture, and so cannot determine the exact function of these structures.

Many gemmae are produced, early in the growing season at least. They are always marginal, unicellular structures terminal on a basal stalk-cell (*Plate 2A*). These gemmae show a dark abscission line which persists and can be seen as a scar on the stalk cell from which each gemma has been shed. Occasionally single marginal cells become globular and so round up that they appear to be easily detached; perhaps these too are gemmae. The gemmae grow directly into a ribbon-like thallus (*Plate 2B–C*).

The thalli also reproduce by fragmentation. Filamentous outgrowths from the gametophyte gradually become several cells wide and develop their own rhizoids (*Plate 2D–F*).

The identification of this thallus is, of course, a matter of great interest. Dr. Schofield is emphatic that it is not a bryophyte, and so one must look for it among the Pteridophyta. Wagner and Sharp (1963) report sterile prothallia of *Vittaria lineata* in the southeastern United States and contrast its features with those of gametophytes of Hymenophyllaceae. In all respects our gametophytes agree with the filmy fern features rather than those of *Vittaria*. In my sporophyte collections of *M. wrightii* from Japan and in those from Graham Island, gametophytes have been found that differ in no essential features from the hepatic-like gametophytes. Our material also agrees very closely with the gametophytes of *Hymenophyllum pulcherrimum* described and illustrated by Holloway (1930), with those of sev-

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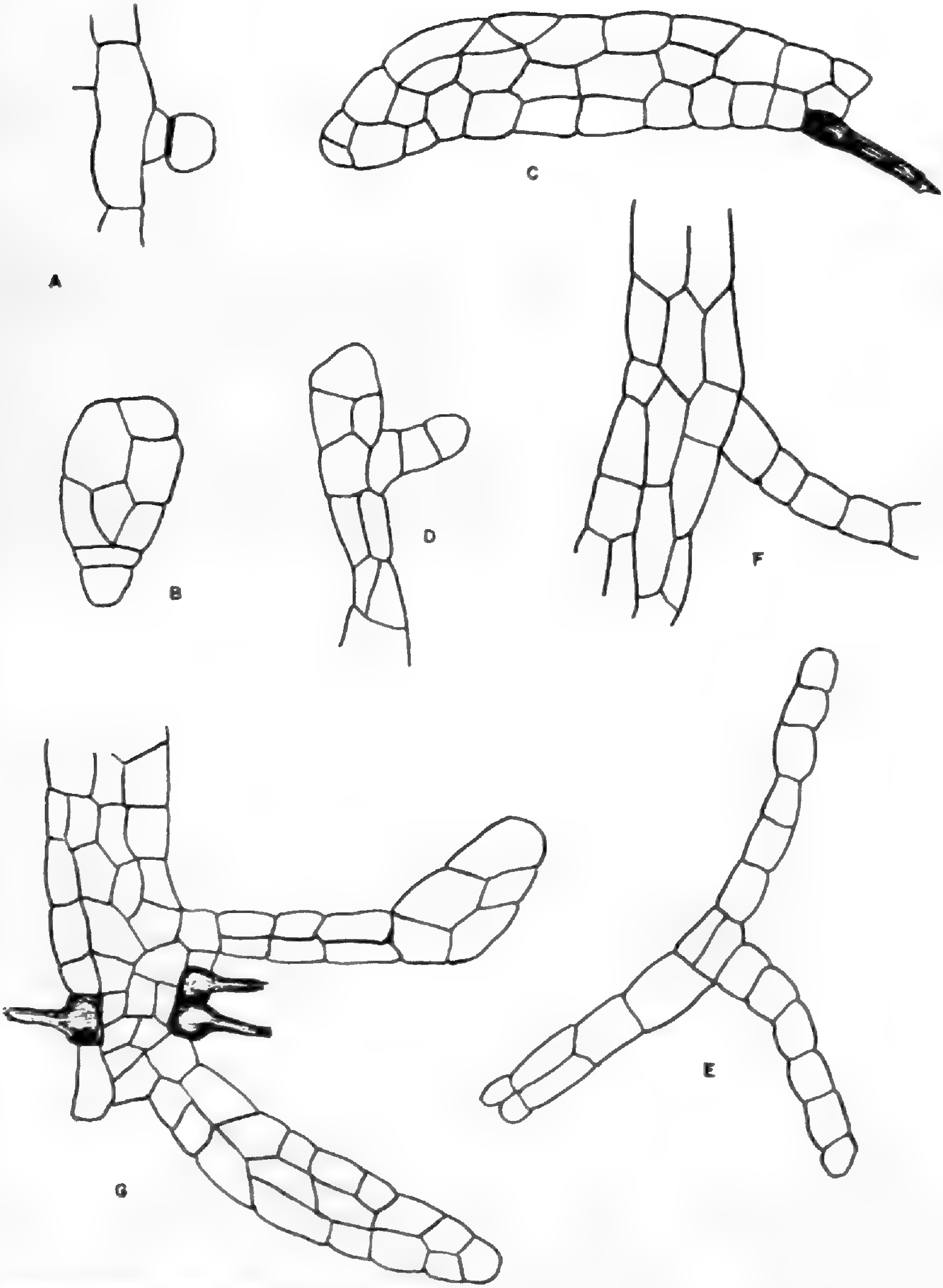
FIG. A. COAST OF BRITISH COLUMBIA AND ALASKA. FIG. B. CENTRAL PORTION OF QUEEN CHARLOTTE ISLANDS. CIRCLES INDICATE COLLECTIONS OF SPOROPHYTES, TRIANGLES THOSE OF GAMETOPHYTES.



MORPHOLOGY OF MECODIUM WRIGHTII GAMETOPHYTES, $\times$ 180. FIG. A. GLOBULAR UNICELLULAR GEMMA WITH STALK CELL AND DARK ABSCISSON LINE. FIG. B. YOUNG THALLUS DEVELOPING FROM GEMMA. FIG. C. LATER STAGE OF eral species of *Hymenophyllum* (Stokey, 1940), with several illustrations of *Mecodium* by Atkinson (1960) and with those of Victorian Hymenophyllaceae illustrated by Stone (1965).

To know precisely why *M. wrightii* occurs as sexually sterile gametophytes in certain areas where no sporophytes have yet been found requires more than the current ecological and distribution information. Botanists collecting in the general area where this fern has been found, particularly bryologists, since they have sharp eyes for such plants, should keep especially alert for this species.

All specimens examined are in the University of British Columbia Herbarium (UBC):

ALASKA: **Biorka Island**, 56°52′ N, 135°33′ W, 30 June 1965, *A. Mathieson s.n. (gametophytes only).*

BRITISH COLUMBIA: **Queen Charlotte Islands**: On rocks in forest near lake at head of Van Inlet, Graham Island, 22 July 1966, *W. B. Schofield s.n.;* dark, shady areas along cliffs in coniferous woods near shoreline, moist dripping rocks, North end of Dawson Inlet off Skidegate Channel, Graham Island. *Persson et al. 22850;* on cliff face, Dawson Inlet, Graham Island, 29 Aug. 1961, *W. B. Schofield s.n.;* under cliff ledge near streamlet, east side, head of Dawson Inlet, Graham Island, *Schofield 15823* (gametophytes only); on earth of overturned stump at ca. 500 ft. above sea level, Chaatl Island, *Schofield & Boas 18797* (gametophytes only); deeply shaded cliff crevices on north face of Moresby Mountain, Moresby Island, *Schofield 30193* (gametophytes only); with *Tetradontium brownianum* on boulder face in forest, south side of West Narrows, Skidegate Channel, Moresby Island, *Schofield 30666* (gametophytes only). **Mainland collections**: Wet cliff crevices, Kloiya Bay, 12 miles east of Prince Rupert, *Schofield 13945* (gametophytes only); on a tree near east end of Rainbow Lake, ca. 20 miles east of Prince Rupert, *Schofield & Boas 20836* (gametophytes only).

THALLUS WITH FIRST RHIZOID. FIG. D. INITIATION OF FILAMENTOUS BRANCH FROM THALLUS. FIGS. E–F. LATER STAGES OF FILAMENTOUS BRANCH. FIG. G. TERMINAL PORTION OF BRANCHED GAMETOPHYTE WITH RHIZOIDS.

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DEPARTMENT OF BOTANY, UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER, B. C., CANADA.

A New Habitat and Physiographic Province for Botrychium lunarioides

FLORENCE I. MONTGOMERY

Botrychium lunarioides (Michx.) Swartz has been reported from a few widely disjunct locations in South Carolina, Florida, Alabama, and Burke County, Georgia. In these locations the habitat has been described as dry grassy knolls, woods, or sandy pastures, all in the Coastal Plain Province.

This fern has recently been found in three additional locations in the Georgia Piedmont. It has been found associated with granitic outcrops in Hancock and Clarke Counties and in a sandy pasture in Warren County, Georgia. The vegetation associated with the granitic outcrops is unique and is limited to species that can survive either in the harsh environment on the margins of the rock or in the shallow soil-filled depressions, or in both places. At the granitic rock locations, *Botrychium lunarioides* was found only in the marginal area.

In April, 1965, a small plant of *Botrychium* was discovered on a small outcrop east of Athens, Clarke County, Georgia. This fern was growing among plants of *Bryum pseudotriquetrum* (Hedw.) Gaertn., Meyer & Scherb., a moss that forms a characteristic marginal ring of plants surrounding moist areas of the outcrop in winter and early spring. The fern plant was so minute that no specific identification could be made at that time. In late spring the fern died back and the surrounding moss became dormant. *Isoëtes melanopoda* Gay & Durieu and summer annuals such as *Talinum teretifolium* Pursh, *Crotonopsis elliptica* Willd., and *Oenothera linifolia* Nutt., became dominant in the moss. In November, 1965, the plant was relocated and observed during the winter and into the spring. During the growing season the plant increased in size three-fold over the previous year's growth. The fertile spike began to emerge, but aborted before maturity. In February, 1966, it was identified as *Botrychium lunarioides* by Don Blake; this was verified by Dr. W. H. Wagner, Jr.

On March 25, 1966, this rare fern was found in another location in the Piedmont south of Sparta in Hancock County, Georgia. As in the Athens location, it was associated with a granitic outcrop. Two colonies of about 50 plants each were found 40 feet apart. Both colonies were near the shoulder and about 30 feet from the highway. The soil is sandy and varies from one to twelve inches in depth. The Botrychiums occur where the soil is three to five inches deep. The fronds of the Botrychiums were buried in *Bryum pseudotriquetrum* with only the tips and the fertile spikes protruding above the surface of the moss. The ferns receive full sun in the morning, but by early afternoon they are shaded by the trees that form a small woods beyond the area. Here the dominant trees are *Pinus taeda* L., *Ulmus* *alata* Michx., *Liquidambar styraciflua* L., and *Acer rubrum* L. *Gelsemium sempervirens* (L.) Ait. grows abundantly over nearby small trees and a fence.

In the spring other species of plants associated with *B. lunarioides* on the granite outcrops are characteristic of that type of habitat, such as *Riccia dictyospora* Howe, *Ophioglossum crotalophoroides* Walt., *Nothoscordum bivalve* (L.) Britt., *Arenaria brevifolia* Nutt., *Oenothera fruticosa* L., *Lepuropetalon spathulatum* (Muhl.) Ell., *Phacelia dubia* var. *georgiana* McVaugh, *Lindernia monticola* Muhl. ex. Nutt., *Houstonia pusilla* Schoepf, and *Senecio smallii* Britt. Other common species that were present include *Gnaphalium* sp., *Potentilla* sp., a small *Trifolium*, and some species of grasses.

The Sparta collection is in the lower Piedmont and essentially in line with the Coastal Plain records in Lee County, Alabama and Aiken County, South Carolina. The Athens collection, however, extends the range far into the Piedmont. These discoveries suggest that this fern may be common in the Piedmont and may have been overlooked in this region.

The term "subevergreen" which has been used in describing this fern apparently does not apply to it. The growing season is from November through April, when the spores are shed. The leaves then die back and the plant remains dormant until the following November. The fern perhaps can best be described as a winter herbaceous perennial.

Voucher specimens from the three stations reported here are on file in the University of Georgia Herbarium.

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Megasporal Aberrations in Marsilea minuta L. in India

BRIJ GOPAL AND T. N. BHARDWAJA

The genus *Marsilea* is well known for spore aberrations, particularly in the microspores. Russow (1872) recorded for the first time aberrant microsporangial contents in *M. drummondii* A. Braun. Mehra (1938) observed abnormal sporangia in sporocarps of *M. minuta* populations from Punjab. These abnormal

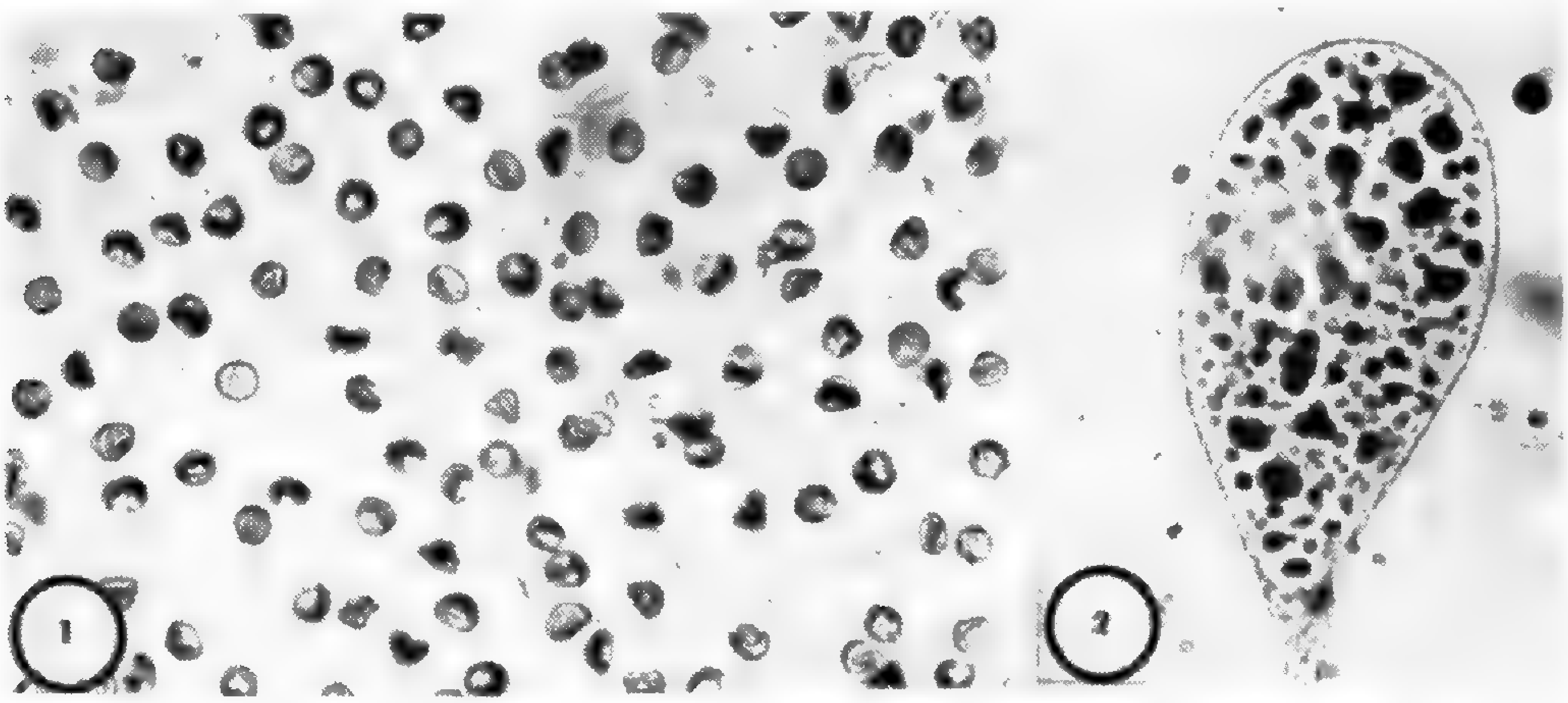

FIG. 1. NORMAL AND ABERRANT MICROSPORES FROM VARANASI. FIG. 2. ABERRANT MICROSPORES IN MICROSPORANGIUM FROM BANSWARA.

sporangia contained "16 fairly large irregularly angled spores" instead of normal micro- or megaspores. Subsequently, Bhardwaja (1959) observed microsporal aberrations in a number of natural populations of *Marsilea*, especially in *M. minuta* and in *M. rajasthanensis*. Certain populations in these two species were found to possess abnormal sporocarps which contained no megaspores, but only irregular spores (Bhardwaja, 1959; Gupta, 1962, p. 55). A large number of such populations were examined by Gupta and Bhardwaja (1957, 1958) from all over India. The populations of *M. minuta* and *M. rajathanensis* with abnormal sporocarps were treated as varieties of these species by Gupta (1962). Mehra and Loyal (1960) also observed *M. minuta* populations in which sporocarps had no megaspores; they recognized them as cytological biotypes.

MEGASPORES OF MARSILEA MINUTA

FIGS. A, C. ABERRANT MEGASPORES FROM VARANASI. FIG. B. NORMAL MEGASPORE. FIG. D. ABERRANT MEGASPORE FROM BANSWARA. FIGS. E-I. VARIABLE MEGASPORES FROM UJJAIN. FIG. J. ABNORMAL MEGASPORE FROM KARAULI.

We wish to describe for the first time megasporal aberrations in some populations of *M. minuta.* One of us (B. Gopal) discovered a population of this species growing in a pond at the Diesel Locomotive Works Colony, Varanasi, which is not distinguishable externally from any other population in that locality or elsewhere. The megaspores occur singly in each megasporangium, as is characteristic of the genus. Normal megaspores in *Marsilea* (*Plate 3B*) have a protruding anterior papilla in which the nucleus of the megaspore is lodged. In the abnormal megaspores from Varanasi a shallow or deep depression is present in place of the papilla (*Plate 3A, C*). The aberrant megaspores also are flat, more or less oval, and measure 459.2–582.4μ $\times$ 369.6–481.6μ, and are about 145.0–170.0μ thick. The measurements here and elsewhere in this paper are based on observations of a total of 100 megaspores from 20 different sporocarps.

Similar aberrant megaspores have been found by T. N. Bhardwaja in *M. minuta* populations from Banswara, Rajasthan (*Plate 3D*). These megaspores measure 392.4–504.5μ $\times$ 257.8–380.9μ, and are about 131.0–147.0μ thick. The only important difference between the two populations is that in the former, microsporangia contain both normal and aberrant microspores, whereas in the latter the microspores are all aberrant and are of different shapes and sizes (*Figs. 1, 2*).

Another type of abnormality in megaspore structure has been observed in collections made from Ujjain, from Karauli, and from one other population from Banswara. These megaspores, although present singly in each megasporangium, are much smaller than normal ones and vary from round, oval, or elliptical to trigonal or even polygonal in outline (*Plate 3E–I*). The size range in the Ujjain population is 257.8–325.1μ $\times$ 235.0–331.2μ in round to oval megaspores, 291.0–367.7μ $\times$ 168.2–302.7μ in more or less elliptical ones, and 201.6–246.6μ $\times$ 280.3–336.3μ in trigonal ones. Like the larger megaspores mentioned above, these do not possess an anterior papilla. In the last named three populations normal megaspores also are present, but in very small numbers. In one megaspore from the Karauli population the papilla was found displaced to one side and a second papillate protrusion was present at the dense zone of the megaspore *(Plate 3J)*.

Although the aberrations described above are from natural populations of *M. minuta*, Shattuck (1910) noticed certain megasporal aberrations in *M. quadrifolia* subjected to various experimental conditions. He observed the formation of secondary megaspores in many microsporangia, and found that in a few cases "megaspores did not develop perinium, but enlarged considerably and become gorged with starch." Pande (1923) also reported certain aberrations and observed some megasporangia containing 5–8 megaspores in wild populations of *M. erosa* (= *M. minuta*) from Lahore, West Pakistan.

The great significance of spore aberrations lies in the fact that such forms cannot reproduce sexually or by way of parthenogensis, but are solely dependent on vegetative propagation by means of tubers or propagules, as emphasized by Gopal (1966). However, populations like those from Ujjain, Karauli, and one from Banswara may possibly produce parthenogenetic embryos because they do develop a few normal megaspores.

The authors wish to express their most sincere thanks to Prof. R. Misra and Dr. K. C. Misra, of Banaras Hindu University, and Dr. K. M. Gupta, of Government College, for their help and encouragement. Thanks are also due Dr. L. P. Mall, of Vikram University, for sending material of *Marsilea* from Ujjain.

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Ceratopteris thalictroides, a Fern New to Texas

C. V. MORTON

The Water Fern, *Ceratopteris*, is commonly grown in home aquaria[1] and (in the southern United States) outdoors in fish ponds, so it is not surprising that it should become naturalized where climatic conditions are favorable. A recent collection from Texas of plants growing outside of cultivation has recently come to my attention through the kindness of Dr. Neil Hotchkiss, of the Fish and Wildlife Service. The plants, which I identify as *Ceratopteris thalictroides* (L.) Brongn. (Bull. Soc. Philom. **1821**: 186, based on *Acrostichum thalictroides* L. Sp. Pl. 1070. 1753), were collected in a spring-fed backwater of the San Marcos River, on the southeast side of San Marcos, Hays County, Texas, June 7, 1966, by F. M. Uhler and Neil Hotchkiss (no. *8198*) and are now deposited in the National Herbarium; they

[1] In this connection see R. C. Benedict, "Ceratopteris, a Much Mis-identified Aquarium Fern," Amer. Fern. J. **38:** 150–152. 1948.

are common in the shady part of the stream. Whether this species will persist and spread in Texas remains to be seen.

According to the treatment of *Ceratopteris* by Benedict (No. Amer. Fl. **16**: 29, 30. 1909) there are three species in the New World—*C. thalictroides*, *C. deltoidea* Benedict, and *C. pteridoides* (Hook.) Hieron., the first of which was believed to be strictly Old World (except for introduced plants in Jamaica) and the other two New World. However, Charles DeVol showed in his paper "The Geographic Distribution of *Ceratopteris pteridoides*" (Amer. Fern J. **47**: 67–72. 1957) that *C. pteridoides* occurs also in Asia.[2] And it now seems likely that *C. thalictroides* occurs native in South America; at least there are now several collections from Ecuador, Brazil, and the Guianas, some of them old collections of a hundred years ago and more, which were unknown to Benedict when he was writing in 1909. The distinctions between *C. thalictroides* and *C. pteridoides* were pointed out by DeVol in the paper mentioned above. The former is illustrated in this JOURNAL, vol. 32, page 124, 1942, the latter in the paper by DeVol; *Ceratopteris deltoidea* is illustrated by DeVol in another paper (Amer. Fern J. **46**: *pl. 10.* 1956).

The chromosome number of $n = 77$ is peculiar and perhaps unique, and indicates that along with other characters that this genus is best regarded as a monotypic family, the Parkeriaceae, which is an older family name than Ceratopteridaceae; it is based on the genus *Parkeria*, which is a taxonomic synonym of the earlier *Ceratopteris*.

Although not previously reported from Texas, *C. thalictroides* has been recorded from Palm Beach County, Florida by Curtis F. Dowling, Jr. (Amer. Fern J. **48**: 168. 1958). This record was apparently overlooked in Wherry's Southern Fern Guide (1961).

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[2]It should be pointed out that in this paper through an unfortunate typographical error not attributable to DeVol the captions for the illustration and distribution map are wrongly and confusingly labelled as *C. thalictroides*, instead of *C. pteridoides* as intended by DeVol.

Morphology of the Spores and Prothallus of Christiopteris tricuspis

B. K. NAYAR

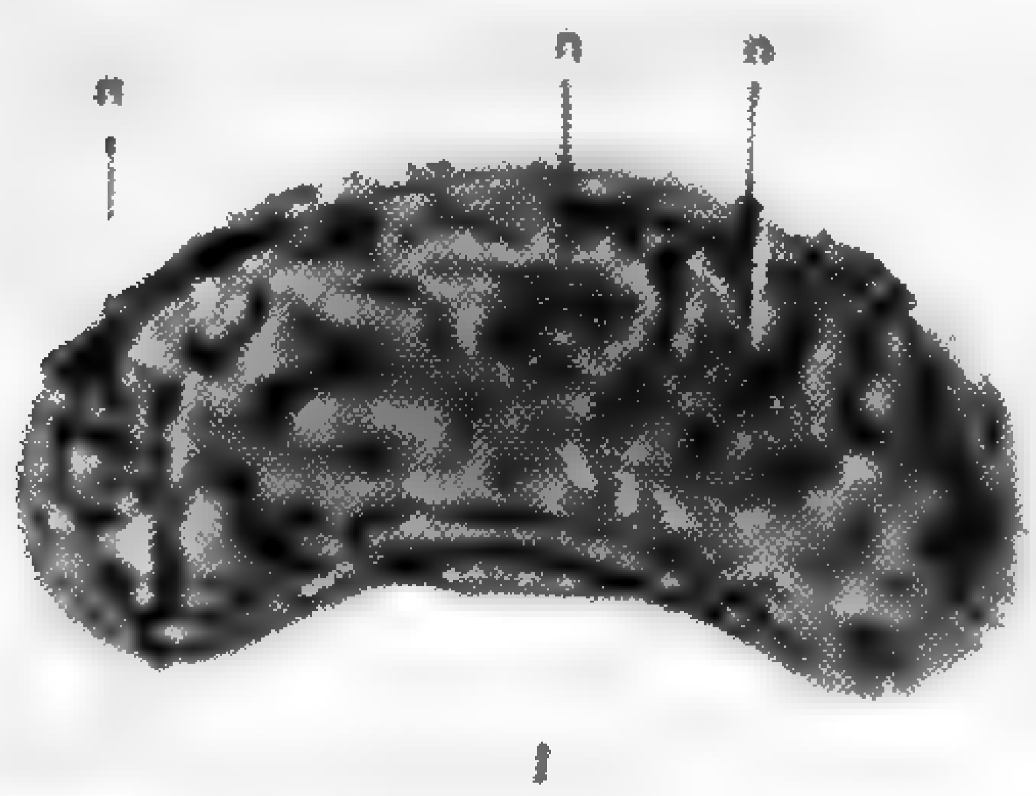
Christiopteris Copel. is a small genus of epiphytic, polypodiaceous ferns that has morphologically better-known sporophytes than many other genera of leptosporangiate ferns. Three species are recognized, one of Sikkim, Annam, and Malaya, another of the Philippines, and the third of New Caledonia. Bower (1928, pp. 213–218) was much impressed by the diplodesmic vascular system of the reduced fertile lamina of *C. tricuspis* (Hook.) Christ, and he made a somewhat detailed study of the sporophyte, concluding that it represents a primitive form in the polypodioid phylum, along with *Cheiropleuria* and *Dipteris*. Holttum (1954, p. 211) and Copeland (1947, p. 179) regard the genus as probably related to *Crypsinus*. Fertile material of this rather rare genus is not easily obtained, and little is known regarding the spores and prothalli.

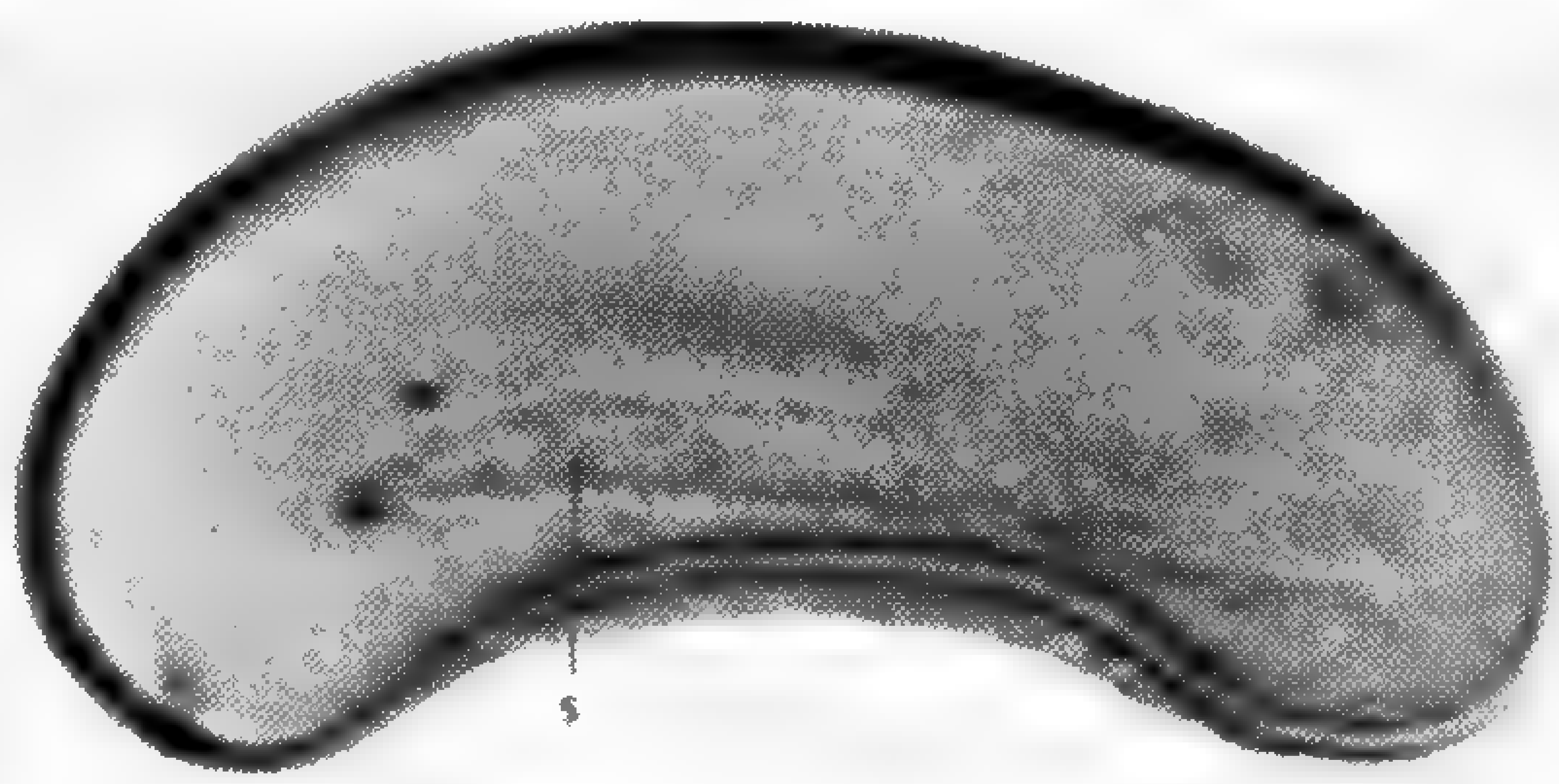
In October, 1964, Prof. R. E. Holttum[1] sent me a bit of a fertile frond of *C. tricuspis* that was cultivated at Kew (originally collected in Malaya). Spores from this sample were promptly cultured on Knop's Agar medium (Nayar, 1962a) maintained at a temperature of 24 ± 2°C under a light intensity of 600 ft-c. No prothalli grew to the point of archegonium formation, although they were in culture for nearly a year. Further samples of spores were obtained in 1965, but again the prothalli could not be maintained long enough to produce archegonia. Spores (stored in plastic bags in a refrigerator) lost their viability in about two months. Techniques followed in the study of the spores are the same as reported earlier (Nayar, 1964; Nayar and Devi, 1964a). For the study of fresh spores, samples mounted in acetocarmine were used in addition to those mounted in glycerine jelly.

[1] I am indebted to Prof. Holttum for this material and to Mr. M. K. Tandon, who prepared the photographs of the spores. To the Director, National Botanic Gardens, I am thankful for providing facilities for this work.

SPORES AND SPORE GERMINATION

The spores of *C. tricuspis* are monolete, bilateral, concavo-convex (crescent-shaped) in lateral view, and are elongate-oblong (with parallel sides and smoothly rounded ends) in polar view (*Fig. 3*). Fresh, unacetolysed spores (*Fig. 1*) are markedly smaller than acetolysed ones, and average 20 (26 minus 28)$\mu \times 43\mu \times 20\mu$ (polar diameter $\times$ longest equatorial diameter $\times$ shortest equatorial diameter). The laesura is about 28μ long and is tenuimarginate. Fresh spores are deep yellow with a greenish tinge. Their contents are dense and include many small, pale green plastids and one or two large, golden brown masses of oil which partially mask the other contents.





FIGURES 1, 2. CHRISTIOPTERIS TRICUSPIS SPORE, LATERAL VIEW, $\times$ 650. FIG. 1. FRESH SPORE WITH THREE NUCLEI, n. FIG. 2. ACETOLYSED SPORE WITH LATERAL LENTICULAR OPENING, s.

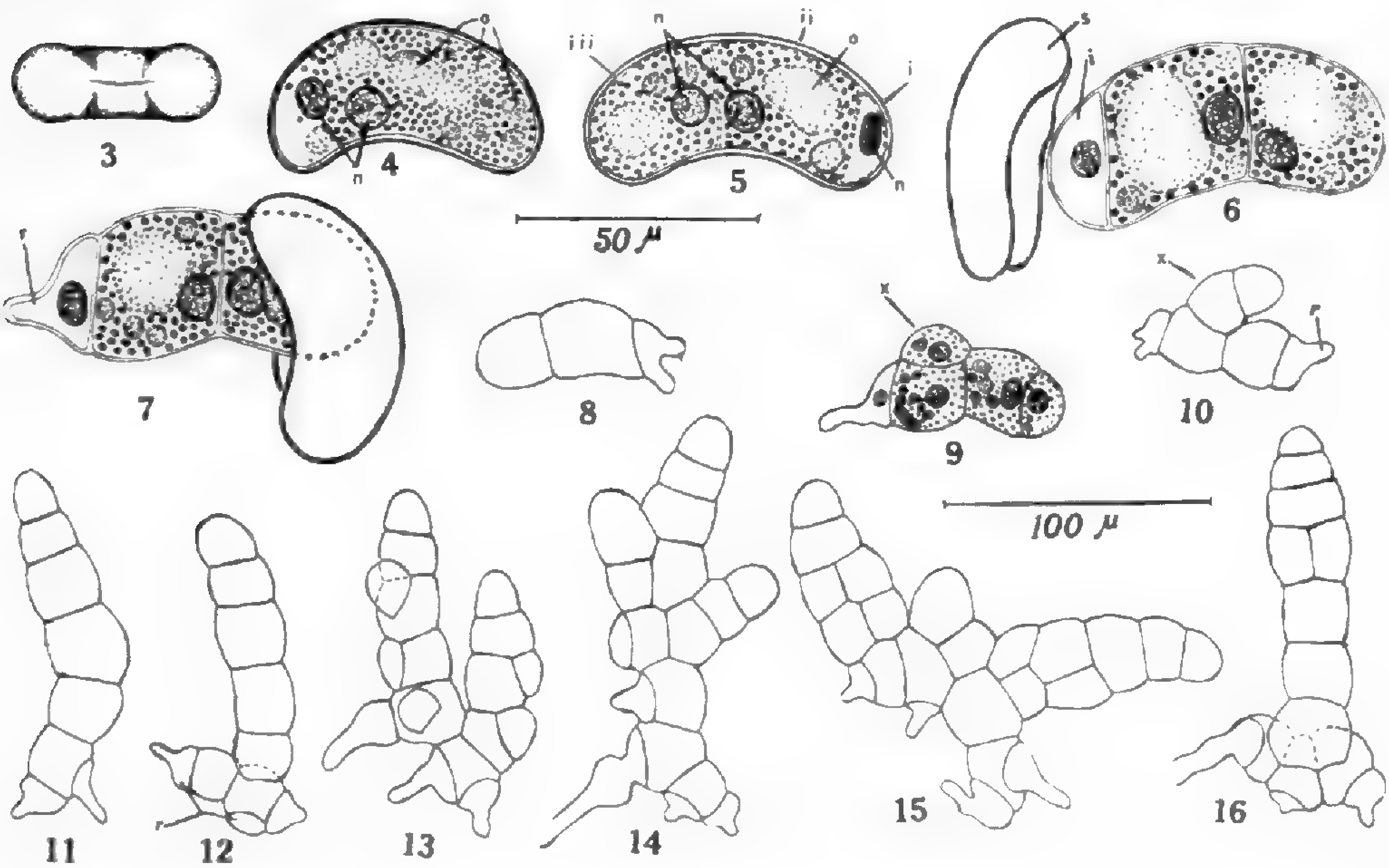
Acetolysed spores average 38 (46 minus 48)$\mu \times 76\mu \times 32\mu$. There is little variation in size; the majority measure 30–40$\mu \times$ 70–80$\mu \times$ 27–35μ, although some of the smallest are nearly $30\mu \times 58\mu \times 27\mu$. The exine is less than 2μ thick, light yellowish brown, smooth, and clearly subdivided into a sexine and nexine of nearly equal thickness. On acetolysis the exine of many spores develops a lateral lenticular slit on one side that is 25–50μ long and 5–10μ broad (*Fig. 2, s*). A perine is absent.

There is considerable irregularity in spore germination. Some spores may start to germinate before they are shed from the sporangium, others may germinate soon after sowing, while still others may remain dormant in culture up to about six months. Thus, in all cultures prothalli at different stages of development can be found. Many spores are 3-nucleate (*Fig. 1*) or even

3-celled when shed. Two of the nuclei occupy the center of the spore and the third is usually towards one end, which is often devoid of chloroplastids. Some of the spores may have only one or two nuclei.

Upon sowing, the spores of *C. tricuspis* swell slightly. If the spore is uninucleate, the nucleus moves to one end of the spore and divides into two in a plane nearly parallel to the longest equatorial axis of the spore (*Fig. 4*); the daughter nucleus nearer the end of the spore is often the smaller. The cytoplasm surrounding this smaller nucleus becomes devoid of plastids. A transverse wall is formed between the two daughter nuclei, cutting off the smaller nucleus as the first rhizoid initial (*Fig. 5, i*). Rarely a few stray plastids and a small oil globule are included in this small rhizoid initial. Meanwhile, the main body of the spore becomes densely chlorophyllous and the large oil globules sometimes split into many small droplets. The nucleus in this region soon occupies a central position, and there divides in the same plane as the first division into two equal daughter nuclei. The large oil globule also splits nearly equally. A transverse wall develops between the two nuclei, separating two large, cylindrical prothallial initials (*Fig. 5, ii, iii*). The three cells lie end-to-end within the spore coat.

The two prothallial initials swell; consequently the spore coat is split open along the laesura. Generally the laesura at that end of the spore bearing the rhizoid initial opens first, and the 3-celled primary germ filament emerges from the spore coat, often with the basal end foremost (*Fig. 7*). Although the entire spore coat is often shed (*Fig. 6*), the anterior prothallial initial may remain enveloped by the spore coat (*Fig. 7*). It is often very difficult to differentiate an unopened, 3-celled spore from a primary germ filament which has shed the spore coat because the spore coat is thin and transparent and the primary germ filament after emerging from it retains the same shape as the mature spore (*Figs. 5, 6*). Soon after emergence of the primary germ filament the rhizoid initial develops a papilla (*Fig. 7, r*), generally towards one side. The cell wall of the papilla becomes brownish. The papilla may remain short, but generally it elongates into a short, reddish brown rhizoid. The nucleus remains at the broad, basal end. Rarely two papillae develop on a rhizoid initial (*Fig. 8*), and in some cases the basal portion of the papilla even becomes bulbous. The anterior prothallial initial, meanwhile, either divides transversely and equally, so that



FIGS. 3–16. SPORES AND STAGES OF SPORE GERMINATION IN C. TRICUSPIS. FIG. 3. POLAR VIEW. FIG. 4. FIRST NUCLEAR DIVISION. FIG. 5. THREE-CELLED STAGE. FIG. 6. EMERGENCE OF PRIMARY GERM FILAMENT. FIG. 7. PRIMARY GERM FILAMENT WITH FIRST RHIZOID. FIG. 8. SAME WITH TWO RHIZOIDAL PROTUBERANCES ON FIRST RHIZOID INITIAL. FIG. 9. PRIMARY GERM FILAMENT WITH LATERAL PROTHALLIAL FILAMENT. FIG. 10. PRIMARY GERM FILAMENT WITH RHIZOIDS AND LATERAL PROTHALLIAL FILAMENT. FIG. 11. PRIMARY GERM FILAMENT WITH TERMINAL PROTHALLIAL FILAMENT. FIG. 12. PRIMARY GERM FILAMENT WITH PROTHALLIAL FILAMENT AND TERMINAL AND LATERAL RHIZOIDS. FIG 13. PRIMARY GERM FILAMENT WITH TWO PROTHALLIAL FILAMENTS. FIG. 14. BRANCHED PROTHALLIAL FILAMENT. FIG. 15. PRIMARY GERM FILAMENT WITH TWO PROTHALLIAL FILAMENTS AT INITIATION OF PROTHALLIAL PLATE. FIG. 16. INITIATION OF PROTHALLIAL PLATE IN THE PROTHALLIAL FILAMENT. The abbreviations are: i=FIRST RHIZOID INITIAL, ii, iii=PRIMARY GERM FILAMENT CELLS, n=NUCLEUS, o=OIL GLOBULE, r=RHIZOID, s=SPORE COAT, x=PROTHALLIAL FILAMENT.

there is a row of three prothallial initials *(Fig. 9)*, or it does so unequally, so that the anterior daughter cell is small, devoid of chloroplastids, and resembles the rhizoid initial at the opposite end (*Fig. 10*). This second rhizoid initial also develops a papilla which often elongates as a second rhizoid (*Fig. 10, r*).

PROTHALLI

Soon after the development of the primary germ filament any one or more of the prothallial initials may proceed to develop a single, independent prothallial filament. Rarely a cell of the primary germ filament may bear more than one prothallial filament. If the primary germ filament bears a rhizoid only at the basal end, the anterior end may grow out as a uniseriate prothallial filament (*Fig. 11*). Usually, however, it is the cell adjacent to the first rhizoid initial that produces the filament (*Figs. 9, 10*). To develop a filament the prothallial initial bulges out laterally on one side and its nucleus divides in a plane perpendicular to the long axis of the cell. One of the daughter nuclei moves into the bulged-out region; this is later cut off as a lens-shaped cell (*Fig. 9, x*). By a series of transverse divisions this cell develops into a uniseriate prothallial filament (*Figs. 10, 12*). In most cases the prothallial initial that has developed a prothallial filament on one side produces a rhizoid on the opposite side soon after the initiation of the prothallial filament, or sometimes preceding it. These rhizoids are developed from large, lens-shaped initials (*Fig. 12, r*); the central region of the peripheral wall of the rhizoid initial develops a papilla which later elongates into a brown rhizoid with a conspicuously dilated base. Other rhizoids with dilated bases may develop laterally on the basal cells of the prothallial filament.

Before the formation of a plate is initiated the prothallial filament becomes 4–6 cells long, and is composed of short, barrel-shaped, densely chlorophyllous cells (*Figs. 11, 12*). Occasionally the filaments may be branched (*Figs. 13, 14*). To initiate plate formation, cells towards the middle of the prothallial filament divide longitudinally (*Fig. 16*), and gradually cells next

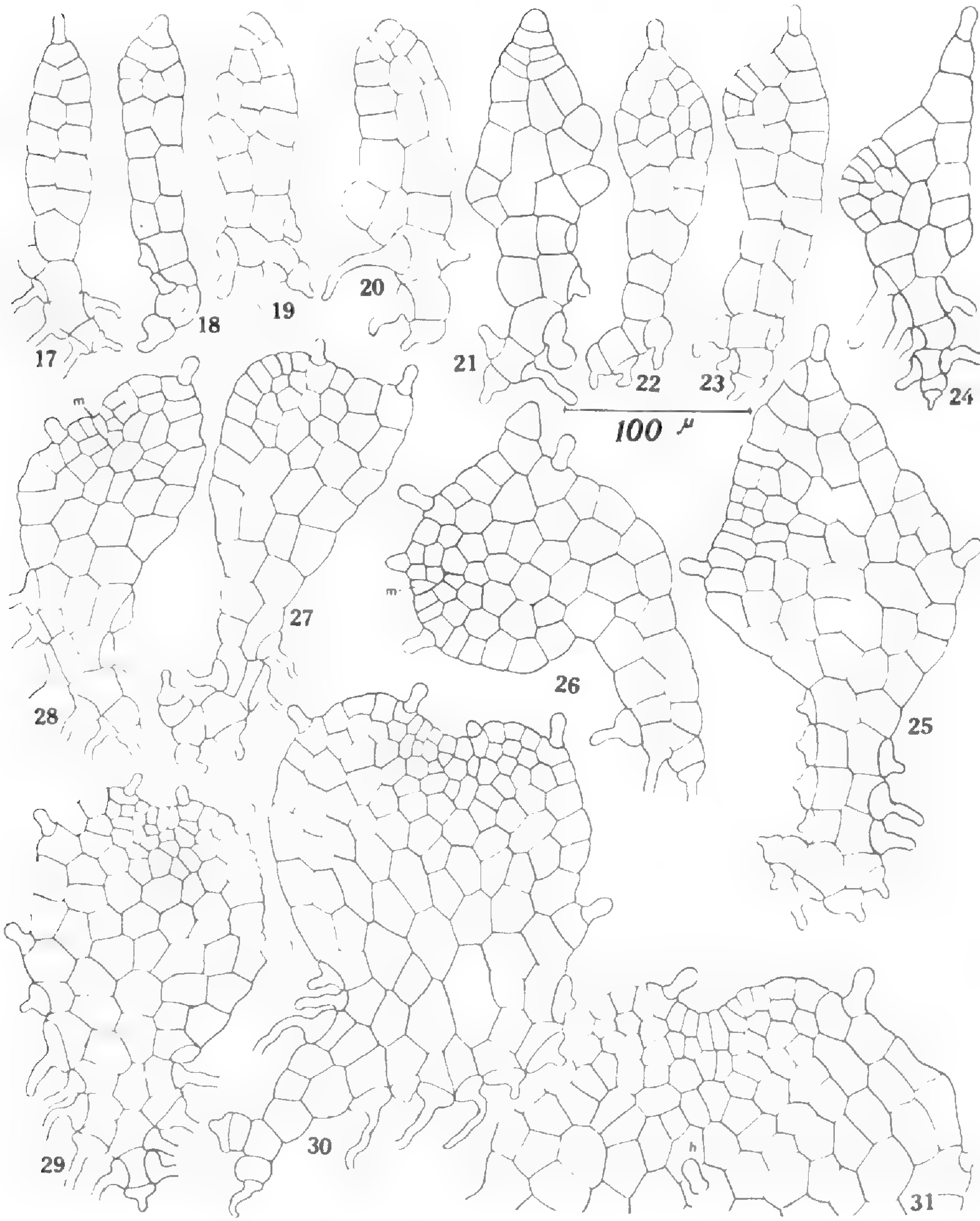


PLATE 4. STAGES IN EARLY DEVELOPMENT OF THE PROTHALLUS IN C. TRICUSPIS. FIG. 17. PROTHALLIAL FILAMENT WITH TERMINAL CELL ENDING IN A HAIR. FIG. 18. SAME, WITH TERMINAL CELL PAPILLA-LIKE. FIGS. 19, 20. PROTHALLI WITH LONGITUDINAL DIVISIONS IN TERMINAL CELL. FIG. 21. PROTHALLUS WITH INACTIVE TERMINAL REGION. FIGS. 22, 23. SUBAPICAL, ASYMMETRICAL PROTHALLIAL PLATE. FIG. 24. MEDIAL, ASYMMETRICAL PROTHALLIAL PLATE. FIG. 25. NON MERISTEMATIC PROTHALLUS WITH MARGINAL

to them follow suit, except for the terminal cell of the prothallial filament and the basal cell, which was the first cell originally cut off by the prothallial initial (*Fig. 15*). The daughter cells broaden and the prothallial filament becomes ribbon-like. Eventually the anterior region of the ribbon-like prothallus broadens into a spathulate plate (*Fig. 17–21*). The broadening becomes more pronounced on one side, leading to an asymmetrical plate with the terminal cell no longer median. (*Figs. 22–24*).

While the prothallus is still narrow the terminal cell of the germ filament becomes inactive and usually produces a terminal papilla-like hair (*Fig. 17*) before its growth ceases. Sometimes development of a terminal hair is delayed or omitted. In the latter case the terminal cell may be papilla-like (*Fig. 18*) or bluntly conical (*Figs. 20, 21*). In many cases both the terminal and the penultimate cell of the germ filament are inactive (*Fig. 24*). In yet other cases the terminal cell itself undergoes divisions, thus taking part in plate formation; rarely it may undergo oblique divisions, so that one of the daughter cells appears to be (but actually is not) a meristematic cell (*Figs. 19, 20*).

By about a month after spore germination the prothallus has expanded to a broad plate, often 4–6 cells broad, which lacks an organized growing point or a single, discrete meristematic cell. Unicellular hairs similar to the terminal one are developed by marginal cells of the plate. The more expanded side of the plate then develops a marginal obconical meristematic cell (*Fig. 28, m*) by an oblique division of one of the marginal cells. This cell usually is formed when the plate is 8–12 cells wide (*Fig. 26*), but may be differentiated when the plate is only 4 or 5 cells broad (about six weeks after spore germination). The primary meristematic cell itself does not contribute substantially to the expansion of the young prothallus, for it soon develops into a

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HAIRS. FIG. 26. PROTHALLUS WITH LATERAL MERISTEMATIC CELL. FIGS. 29, 30. PROTHALLI WITH SYMMETRICAL, NOTCHED APEX, ANTERIOR MARGINAL HAIRS, AND POSTERIOR RHIZOIDS. FIG. 31. APICAL HALF OF PROTHALLUS WITH MERISTEM AND SUPERFICIAL HAIR. The abbreviations are: h=SUPERFICIAL HAIR, m=MERISTEMATIC CELL.

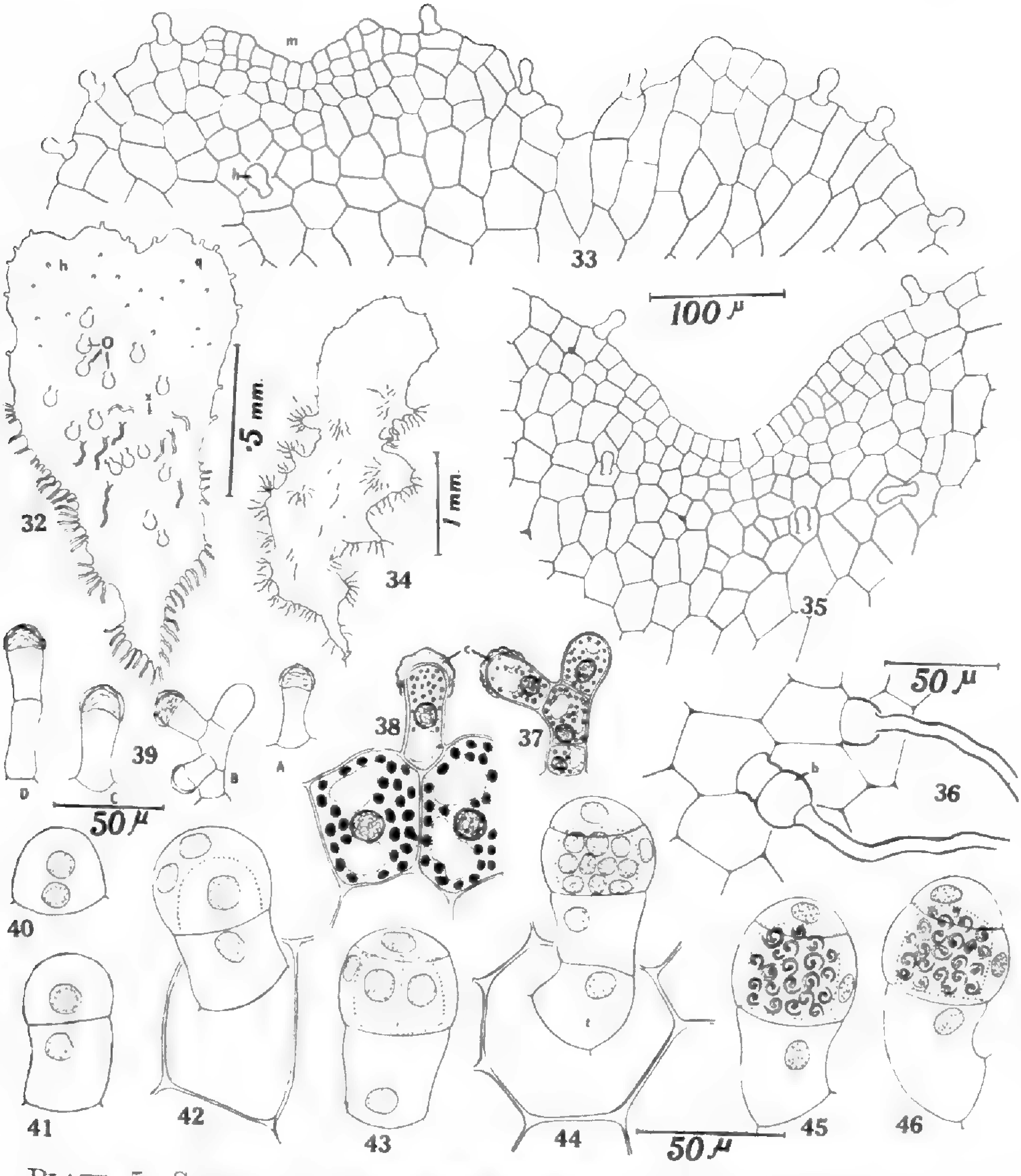

PLATE 5. STAGES IN LATER DEVELOPMENT OF THE PROTHALLUS IN C. TRICUSPIS. FIG. 32. RIBBON-LIKE PROTHALLUS WITH SUPERFICIAL RHIZOIDS. FIG. 33. SAME, APICAL REGION, WITH MERISTEMATIC APEX AND PORTION OF LATERAL LOBE. FIG. 34. EIGHT-MONTH-OLD PROTHALLUS. FIG. 35. SAME, APICAL REGION. FIG. 36. SUPERFICIAL PROTHALLIAL RHIZOIDS, ONE WITH BULBOUS, TWO-CELLED BASE. FIG. 37. SUPERFICIAL "POLYPODIACEOUS" HAIR. FIG. 38. MARGINAL PAPILLATE HAIR. FIG. 39A. MARGINAL HAIR. FIG. 39B. SUPERFICIAL "POLYPODIACEOUS" HAIR. FIG. 39C. SUPERFICIAL PAPILLA-LIKE HAIR. FIG. 39D. SUPERFICIAL SEPTATE HAIR. FIGS. 40–44. STAGES OF ANTHERIDIUM DEVELOPMENT. FIGS. 45, 46. FULLY DEVELOPED ANTHERIDIA. The abbreviations are: b=BULBOUS RHIZOID BASE, c=CAPPED LATERAL

multicellular meristem (*Figs. 30, 31*). In many cases a single, obconical meristematic cell is never formed and the multicellular meristem develops directly from the marginal cells of the plate (*Figs. 25, 27*). In either case, the meristematic region gradually becomes apical by unequal growth of the prothallial plate, and the apex becomes slightly notched (*Fig. 29*). Marginal unicellular hairs are produced profusely by young prothalli. Rhizoids are produced continuously from marginal cells on the posterior half of the prothallus, and in most cases nearly all of the posterior marginal cells bear rhizoids (*Figs. 25, 29*). All rhizoids are similar to those borne on the primary germ filaments, and give the prothalli their characteristic appearance.

The prothalli of *C. tricuspis* are slow growing; after the establishment of a meristem it takes weeks before they show any appreciable growth. The prothallus elongates, becomes irregular and ribbon-shaped, and often develops marginal lobes that are "ameristic," i.e., are devoid of an organized meristem. Some of these lobes have the appearance of short branches. The apex of the prothallus remains flat or notched, and is never cordate (*Figs. 32, 33*). Growth of the prothallus is diffused; the meristem is neither very active nor well defined (*Figs. 33, 35*). All cells of the anterior region (or groups of them) exhibit meristematic activity. The prothallus becomes 3–5 mm long and 1–2 mm broad about 5–7 months after spore germination.

Many marginal unicellular hairs are produced in the anterior region; clusters of marginal rhizoids develop in the posterior region, often more profusely on one margin than the other (*Fig. 32*). Superficial rhizoids are developed when the prothalli are nearly four months old. These are usually in small patches and, like the marginal rhizoids, possess funnel-like bases. Occasionally the swollen base of a superficial rhizoid may become septate at the constriction, and rarely the bulbous basal cell so formed is again divided (*Fig. 36, b*). Superficial hairs also develop in the

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BRANCH OF HAIR, h=HAIR, m=MERISTEMATIC APEX, o=ANTHERIDIA WITH NUCLEI SHADED, q=LATERAL LOBE, t=STALK CELL, x=MULTICELLULAR, SUPERFICIAL CUSHION.

anterior region on both surfaces (*Figs. 31–33, h*). These are commonly larger than the marginal hairs (*Fig. 39*); some may be elongate and septate (*Fig. 39D*).

The prothallus at the stage of antheridium formation is composed of small, densely chlorophyllous cells having faint, collenchyma-like thickenings at the corners. The prothallus lacks a midrib and is one cell thick, except for irregularly circular areas two or three cells thick occurring medianly in the posterior half of the ribbon-like prothallus (*Fig. 32, x*) or medianly on the larger marginal lobes. Unicellular hairs and rhizoids are borne on the lower surface of these superficial cushions, as are branched "polypodiaceous" hairs that are composed of two or three barrel-shaped cells and a lateral unicellular branch (*Figs. 37, 39B*). These latter hairs are profusely chlorophyllous; the lateral branch has a conspicuous, extracellular, waxy secretion forming a cap at the tip (*Fig. 37*, c).

SEX ORGANS

Antheridia are scattered superficially on the lower surface of the ribbon-like prothalli (*Fig. 32, o*). They are of the type found in advanced leptosporangiate ferns. In this species the basal cell is elongate, rather narrow, barrel-shaped, and is often curved so that the antheridia are parallel to the prothallial surface (*Figs. 45, 46*). In rare cases the antheridia are stalked, with the basal cell borne on a similar stalk cell (*Fig. 44*).

Antheridium formation begins with the division of a prothallial cell. One of the daughter nuclei moves to the ventral side of the cell, where the wall forms a hemispherical bulge with the daughter nucleus centrally placed. A transverse wall forms, separating this antheridial initial from the prothallial cell. The initial elongates markedly and the protoplasmic contents become denser towards the anterior end, which is cut off as a small, hemispherical cell from the lower, barrel-shaped stalk cell (*Figs. 40, 41*). The wall separating the stalk cell and the anterior cell is flat. The anterior cell then expands and its nucleus divides in a plane perpendicular to the long axis of the antheridium. A dome-shaped wall forms around the lower daughter nucleus, cutting off the central androgonial cell (*Fig. 42*). The nucleus of the outer cell, meanwhile, divides in a plane slightly oblique to the long axis of the antheridium (*Fig. 42*), and a transverse wall is formed between the daughter nuclei, touching the dome-shaped wall of the androgonial cell. This differentiates the broad, lens-shaped cap cell, which later becomes disc- or even cap-shaped, from the ring-shaped outer cell (*Fig. 43*). Meanwhile the nucleus of the androgonial cell undergoes repeated divisions to produce the antherozoid mother cells (*Figs. 43, 44*).

Archegonia were not produced by the prothalli studied because the prothalli died soon after reaching this stage of antheridium formation.

CONCLUSIONS

Christiopteris exhibits several peculiarities in its prothallial morphology that are uncommon in the Polypodiaceae. Formation of a short primary germ filament bearing lateral prothallial filaments that develop into separate prothalli has not been reported in any other fern. The characteristic funnel-like base of the rhizoids of *C. tricuspis* also seems unique.

The one-sided development of the prothallial plate preceded by cessation of growth in the terminal region of the prothallial filament and the establishment of a lateral meristem are uncommon in the Polypodiaceae, but are found in *Merinthosorus drynarioides*, a microsorioid derivative of the Polypodiaceae (Bajpai 1964; Nayar, 1964). Among ferns of other phyletic lines this pattern is found in several blechnoid ferns (Nayar, 1962b; Nayar et al. 1966) and in some aspidiaceous genera. However, a ribbon-shaped prothallus, similar to that of *C. tricuspis,* is found in several microsorioid genera of the Polypodiaceae, e.g., *Kaulinia* (Nayar, 1963b), *Colysis* (Nayar, 1962a), *Leptochilus*, *Paraleptochilus* (Nayar, 1963a), and *Loxogramme* (unpublished data). The characteristic prothallial trichomes of *C. tricuspis* are also of the typical "polypodiaceous type."

Although of the general polypodioid type, the exact kind of antheridia found in *C. tricuspis,* with its barrel-shaped basal cells, is uncommon among the Polypodiaceae; somewhat similar types do occur in some species of *Polypodium* (Nayar, 1962a). The antheridia and the development of prothalli in *C. tricuspis* recall those of *Stenochlaena.* The dome-shaped androgonial cell is similar to that of *Blechnum,* as described by Stone (1961). The simple antheridium of *C. tricuspis,* in contrast to the complex, multicelluar antheridium wall of *Dipteris* (Stokey, 1945) and *Cheiropleuria* (Stokey and Atkinson, 1954), indicates that *Christiopteris* probably is not a primitive member of the Polypodiacae.

Christiopteris seems to be more nearly related to microsorioid than to crypsinoid stock, although it is different from both groups in some details. Crypsinoid ferns have spores with a spinose exine (Nayar and Devi, 1964b) and have cordate, symmetrical prothalli (Nayar, 1962a). Several of the microsorioid ferns, particularly those related to *Kaulinia,* possess spores with a smooth, thin exine (Nayar and Devi, 1964b) and ribbon-like prothalli.

Like *Christiopteris,* several genera of microsorioid ferns exhibit a tendency toward reduction of the fertile lamina and acrostichoid spreading of the sori, as seen in *Leptochilus* and *Dendroglossa.*

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The Influence of Replacing Calcium with Strontium on the Development of Woodsia obtusa[1]

ABBIE LOU BRYAN AND JOSEPH C. O'KELLEY

A calcium requirement has been demonstrated only rarely for fern species. Generally it has been assumed that ferns resemble seed plants in needing this element. In spite of this, there is evidence that the quantitative requirement for calcium varies greatly among fern species (Schwabe, 1951; Bloom and Voth, 1956). That such a requirement by ferns might be satisfied in total or in part by strontium apparently has not been investigated. This paper deals with the culture of *Woodsia obtusa* gametophytes in studies designed to determine the effect of

[1]Research supported in part by Grant AM-03680-04 NTN from the National Institute of Arthritis and Metabolic Diseases. This paper is based on a portion of a thesis submitted by the senior author to the Faculty of the Graduate School of the University of Alabama in partial fulfillment of the requirements for the degree of Master of Science, 1963.

calcium and strontium on growth and development of prothallia, sex organs and resulting sporophytes.

Spores of *Woodsia obtusa* were sown on nutrient solutions that were prepared with distilled water deionized using Amberlite MB_3 ion exchange resin in a plexiglass column. The formulae are indicated in *Table I*. Two solution series were used: one with the 25 mg/liter $CaCl_2$ replaced stepwise (see *Table II*) with a

TABLE I. BASAL MEDIUM FOR GROWTH OF WOODSIA OBTUSA GAMETOPHYTES FROM SPORES.

Salt (or acid)	*Conc., mg/liter*
$NaNO_3$	250
KH_2PO_4	175
K_2HPO_4	75
$MgSO_4 \cdot 7H_2O$	75
[2]$CaCl_2$	25
$NaCl$	25
$FeCl_3$	2.52
$CoCl_2 \cdot 6H_2O$	0.840
$MnCl_2 \cdot 4H_2O$	0.720
H_3BO_3	0.570
$(NH_4)_6Mo_7O_{24} \cdot 4H_2O$	0.360
$ZnCl_2$	0.312
$CuCl_2 \cdot 2H_2O$	0.107

[2]Substitution solutions contained a chloride equivalent of $SrCl_2$ or NaCl for the $CaCl_2$ of the basic medium.

molar equivalent of $SrCl_2$ and a second with the $CaCl_2$ replaced stepwise with a chloride equivalent of NaCl. Cultures were kept at 20±2°C and illuminated with cool-white fluorescent bulbs at approximately 300 ft-c on a 12 hr light–12 hr dark cycle maintained throughout the growth period. Microscopic observations and measurements were made at regular intervals on the developing gametophytes.

The effect of calcium and strontium on vegetative growth was determined by measuring lengths and widths of floating gameto-

TABLE II. AVERAGE SIZE (IN MICRONS) OF TEN WOODSIA OBTUSA GAMETOPHYTES SHOWING THE EFFECT OF CA REPLACED STEPWISE BY CHLORIDE EQUIVALENTS OF NA OR SR.

Elements in soln. series	*Measurement*	*Proportional parts of elements* 1.0/0	0.8/0.2	0.5/0.5	0.2/0.8	0/1.0
Ca/Sr	Width	4.98	6.38	5.01	5.16	1.70
	Length	9.01	9.99	8.75	10.67	5.99
Ca/Na	Width	6.14	6.60	5.95	3.97	2.69
	Length	9.23	9.98	10.52	7.26	6.81

TABLE III. DEVELOPMENT OF WOODSIA OBTUSA GAMETOPHYTES SHOWING THE EFFECT OF CA REPLACED STEPWISE BY CHLORIDE EQUIVALENTS OF NA OR SR. ++ = STRUCTURES NUMEROUS (MORE THAN 10/GAMETOPHYTE); + = STRUCTURES PRESENT; − = STRUCTURES ABSENT.

Structure	*Elements in soln. series*	*Proportional parts of elements* 1.0/0	0.9/0.1	0.8/0.2	0.5/0.5	0.2/0.8	0.1/0.9	0/1.0
Archegonia	Ca/Na	+	+	+	+	−	−	−
	Ca/Sr	+	+	+	++	+	+	−
Antheridia	Ca/Na	+	+	+	+	−	−	−
	Ca/Sr	+	+	+	+	+	+	−
Sporophytes	Ca/Na	+	−	+	−	−	−	−
	Ca/Sr	+	+	+	+	+	+	−

phytes at the age of 29 days. As determined by these measurements, vegetative growth was impaired in solutions totally lacking calcium, regardless of whether strontium or sodium replaced this element (*Table II*). No evidence was obtained to show that at low calcium levels, strontium acted as a satisfactory substitute for calcium in supporting vegetative growth. In the absence of calcium, strontium appeared to be less favorable for vegetative growth than sodium.

As the gametophytes reached maturity, however, strontium with a limiting supply of calcium permitted sexual development, whereas sodium with the same calcium supply did not (*Table III*). At the age of 75 days low calcium solutions containing strontium had permitted the development of archegonia, whereas solutions with the same low quantity of calcium with sodium contained prothallia with no archegonia; at the age of 97 days a similar situation was observed for antheridia. At 109 days only Ca/Na solutions of 20.0 and 25.0 mg/ml $CaCl_2$ contained gametophytes with sporophytes; all Ca/Sr solutions of $CaCl_2$ levels from 2.5 to 25.0 mg/ml contained prothallia that bore sporophytes. Prothallia with archegonia, antheridia, and sporophytes never developed in the total absence of calcium.

Strontium is known to substitute for calcium, at least in part, in maize (Walsh, 1945) and in a variety of lower plants, including the fungus *Allomyces arbuscula* (Ingraham and Emerson, 1954) and the alga *Chlorella* sp. (Walker, 1953). In two algae, *Protosiphon botryoides* (O'Kelley and Herndon, 1959) and *Chlorococcum echinozygotum* (Gilbert and O'Kelley, 1964), the replacement of calcium by strontium permits continued growth, but haploid motile cells, which ordinarily function as gametes or zoospores, are not released by the treated gametangia or zoosporangia.

In *Woodsia* gametophytes strontium can substitute for part of the calcium ordinarily required for sexual development. However, it is apparent that there is a small calcium requirement which cannot be met by strontium; this involves vegetative growth adequate to permit development of antherida and archegonia, sexual reproduction, and subsequent sporophyte growth. When this minimal requirement has been met, there appears to be an additional quantitative requirement which can be satisfied by either calcium or strontium. The latter is evident from the development of archegonia, antheridia, and sporophytes on *Woodsia* gametophytes cultured with 2.5 mg/liter calcium with strontium, since these structures did not develop on gametophytes cultured with the same quantity of calcium and no strontium.

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Shorter Notes

PILULARIA AMERICANA A. BRAUN IN OKLAHOMA.—On the basis of available botanical collections, one of the rarest of all ferns in North America is the pillwort, *Pilularia americana* A. Braun. As far as I know, up to now this tiny plant has been found only in

California, Georgia, Louisiana, Texas, and Arkansas (where it was originally discovered). Now Oklahoma should be included in its area of distribution. A few plants of pillwort were collected by Mr. John R. Crutchfield, a field assistant who is working with my husband, Dr. Donovan S. Correll, and me on a project concerning aquatic plants of the southwestern United States that is sponsored by the Texas Research Foundation and supported by a grant (WP00685) from the U. S. Department of Health, Education, and Welfare, Public Health Services. The collection data are: Comanche County, Oklahoma, on mud flat, Quanah Parker Lake, Wichita Mountains Wildlife Refuge, June 25, 1966, *J. R. Crutchfield 1766* (LL, OKL, US).—HELEN B. CORRELL, *Texas Research Foundation, Renner, Texas 75079.*

A WESTERN RANGE EXTENSION OF TRICHOMANES BOSCHIANUM IN ILLINOIS.—Evers[1] reported nine stations for the filmy fern, *Trichomanes boschianum* Sturm, along a band of sandstone cliffs for a distance of 8.5 miles across Johnson and Pope counties in extreme southern Illinois.

On April 3, 1966, the senior author, while looking for *Sphagnum* in western Johnson County, discovered a small patch of filmy fern growing well back under a wet, sandstone overhang. On April 5, accompanied by Mr. Max Felty, Mr. A. C. Skorepa, and Mr. William Hopkins, the authors revisited the station and were surprised and delighted to discover a much larger colony of the filmy fern about 75 yards from the original locality. These stations mark the westernmost extent of *Trichomanes boschianum* in Illinois. It is ten air miles west of the closest station, which is south of Ozark in the eastern part of Johnson County.

The locality is in the NW 1/4 of the SW 1/4 of section 32, T. 11 S., R. 3 E., 4.75 miles southeast of Goreville, in a horseshoe canyon in the "Benson Hollow" area. The canyon is enclosed on three sides by bluffs of Pounds Sandstone, which rise 20–60 feet above the valley floor. The shallow, east-facing canyon is approximately 250 feet across and 210 feet deep. At its end a cavern extends some 60 feet back under the bluff. A small

[1] Illinois Nat. Hist. Surv. Div. Biol. Notes **44:** 1–16. 1961.

stream drops from above the northern end of the cavern to the canyon floor and flows out of the canyon along the northern bluff of the horseshoe. The fern grows at an elevation of 520–540 feet above mean sea level.

The first-discovered station, which is along the north wall of the canyon, is extremely moist and shows an indication of being washed by rushing water during periods of high water. The fern occupies an area about five feet wide and hangs from the roof of the slightly undercut cliff. It receives no direct sunlight. The pH of the fern (Beckman 180 Pocket pH-meter) was 4.9–5.2, whereas the pH of the rock was 7.2–7.4.

The second station is at the southern end of the cavern. The fern colony occupies a band 17 feet long and 10–18 inches wide. The cliff is much drier than at the first station. Many plants of *Dodecatheon frenchii* (Vasey) Rydb. grow with the fern at the second station, while *Plagiothecium roeseanum* B. S. G. grows among and around the ferns at both places. The pH of the fern was 4.75–5.2, and that of the rock was 7.0–7.2. At this site, the fern is north-facing.—JERRY SNIDER and ROBERT H. MOHLENBROCK, *Department of Botany, Southern Illinois University, Carbondale, Illinois 62903.*

THE VALID PUBLICATION OF CHEILANTHES VILLOSA.—A rather uncommon fern of the southwestern United States and northern Mexico is *Cheilanthes villosa*, which was for a long time confused with the closely allied tropical American species *C. myriophylla* Desv. The publication of this species is usually cited as *C. villosa* Davenp. Cat. Davenp. Herb. Suppl. 45. 1883, e. g. by Wooton & Standley (Flora of New Mexico, 1915), Braun (Index to North American Ferns, 1938), Maxon in Kearney & Peebles (Flowering Plants and Ferns of Arizona, 1942), Correll (Ferns and Fern Allies of Texas, 1956), and Knobloch & Correll (Ferns of Chihuahua, 1962). This catalog of the Davenport Herbarium is rather rare, and so I reprint below the treatment of this species on the page cited:

"Cheilanthes villosa, n. sp. (provisional in Herb.)

"Southeastern Arizona, September, 1881, Lemmon. I am indebted to the courtesy of Prof. Eaton for the privilege of naming this fern, which, on its face, appears to be quite distinct. It has, however, nearly the same structure as *C. elegans*, Desv., and may prove to be only a very unusually villous form of that species—but more material is needed to determine this. Prof. Lemmon, whose splendid collection of 1882 has enriched the herbarium with so many fine specimens of rare ferns, promises to make an effort to get more of this fern during the present season; meanwhile I give a partial description of the specimens already received:—

"Fronds 8′ to 14′ l., 1¼′ to 1¾′ br., oblong-lanceolate, tri- to quadripinnate, scaly beneath with nearly colorless entire scales; both surfaces villous with a loosely-entangled webby tomentum which gives to the whole frond a greyish appearance much like *C. lanuginosa.*"

The question at issue is whether or not this species is validly published here, or whether it is a provisional name and therefore invalid. Article 34 of the International Code of Botanical Nomenclature (1961 ed.) says: "A name is not validly published . . . when it is merely proposed in anticipation of the future acceptance of the group concerned, or of a particular circumscription, position, or rank of the group (so-called provisional name)." Most cases involving provisional names are debatable, and the present is no exception. It can be argued that Davenport assigned a species name and gave a description, and that he therefore did accept the species. But this is not a good argument, for all provisional names have an epithet and a description; if they do not, the names are invalid under rules other than the one regarding provisional names. It is likely that many of the authors mentioned above who have accepted the 1883 date for the publication of this species have not investigated the question of whether the name is provisional or not, but have followed Maxon in his acceptance of the name (Proc. Biol. Soc. Washington **31:** 142. 1918). I should be inclined to go along were it not for Davenport's very first sentence. I do not see how it can be argued that this is not a provisional name when Davenport himself calls it a provisional name in the herbarium. Many botanists, myself included, have assigned provisional names in the herbarium, often while awaiting more and better material, but most of us have refrained from mentioning these names in print. Davenport did mention the name but I do not think that this removes it from the category of a provisional name.

Fortunately, no other specific name has ever been published for this species, and so the discovery of the invalidity of the original mention of the name in 1883 will not result in a change in the specific epithet. The only change will be in the citation and date of publication. So far as I can determine, the first person to accept the species was Maxon, and so the proper citation will be: CHEILANTHES VILLOSA Davenp. ex Maxon, Prov. Biol. Soc. Washington **31:** 142. 1918.

This question was submitted to Dr. H. W. Rickett, of the New York Botanical Garden, who is highly regarded as an authority on nomenclature, who replied: "I am sure I cannot see any basis for an objection to your decision that *Cheilanthes villosa* was published as a provisional name."—C. V. MORTON, *U. S. National Museum, Washington, D. C. 20560.*

Recent Fern Literature

INDEX FILICUM, SUPPLEMENTUM QUARTUM PRO ANNIS 1934–1960,[1] by R. E. G. Pichi-Sermolli and collaborators. International Bureau for Plant Taxonomy and Nomenclature, Utrecht, 1965. xiv + 370 pp. 40 D. fl. (ca. $12.00).—Carl Christensen's Index Filicum (1905–1906) is the fundamental index to fern names, an indispensable working tool of the fern student. The original index is an undoubted masterpiece, remarkably complete and accurate, especially considering that it was written by a very young man; it has stood the test of time for its usability. Christensen published three supplements, the third and last containing names published up through 1933. The period since 1933 has been unusually active in fern study, especially in the segregation of genera. There are thus large numbers of new

[1]Available from the International Bureau for Plant Taxonomy and Nomenclature, 106 Lange Nieuwstraat, Utrecht, The Netherlands. Published with financial support by UNESCO and IUBS.

combinations, some of them exceedingly difficult to find in the absence of a current index.

This lack has now been supplied by the publication of a fourth supplement, which will be absolutely necessary for all libraries and fern students. This supplement has been prepared by a committee of the International Association for Plant Taxonomy, with Dr. R. E. G. Pichi-Sermolli as Chairman and editor. An index of several thousand names prepared by Mr. F. Ballard formed a basis for the work, but the other members of the committee (Holttum, Ito, Jarrett, Jermy, Schelpe, Tardieu-Blot, and Tryon) all assisted by searching botanical periodicals for new fern names. All concerned are to be congratulated on the appearance of this new work. The number of names listed is not stated, but it is enormous, somewhere between 7,000 and 9,000, I should estimate.

Unlike the original index and supplements, this supplement does not try to decide on a taxonomic disposition of the various genera and species. Such an attempt at the present time would be difficult, in fact impossible for a committee to undertake, because of the divergences of opinion on the status of many segregate genera. The present supplement is simply an index, with cross-references to basionyms, of validly published names (and a few invalid ones, e.g. some *nomina nuda*), with no attempt to decide on legitimacy or correctness. This is as it should be.

Dr. Pichi-Sermolli has not limited the supplement to names published after 1934 but has included also some older names, if these were omitted from the original index or supplements or were incorrectly cited.

The work concludes with a catalog of the literature cited (continued in the form that Christensen started), including some new references to publication dates of older works, a list of authors, with dates of birth and death when known, and a list of serials with their abbreviations.

I understand that fern names published since 1960 are now being collected at the Royal Botanic Gardens, Kew, under the supervision of Dr. F. Jarrett, and that future supplements will be published by Kew. It is good to know that there will not again be any long period when no current index is available.—C. V. M.

SEVERAL PAPERS BY DR. J. GHATAK, Systematic Botanist, Botanical Survey of India, Calcutta, India, have been received for review, among them "Observations on the Cytology and Taxonomy of Some Ferns from India,"[1] which reports chromosome counts for 24 species of Indian ferns, including first counts for *Pityrogramma chrysophylla* (sexual octoploid), *Pteris biaurita* L. (apogamous triploid), *Cyrtomium falcatum* var. *caryotideum* (apogamous triploid), *Rumohra simulans* (sexual tetraploid), *Dryopteris sparsa* var. *viridescens* (sexual tetraploid), *Tectaria incisa* (sexual tetraploid) [but if this count was made on specimens collected in India, it is almost surely a wrong identification because this American species is not known to occur in Asia], *Tectaria subtriphylla* (sterile triploid hybrid), *Tectaria decurrens* (sterile tetraploid hybrid), *Thelypteris subochthodes* (sexual diploid), *Blechnum occidentale* (sterile hybrid), *Leptochilus decurrens* (sexual tetraploid), and *Lepisorus* sp. (n=ca. 36). "Problems involved in the Proper Identification of Ferns,"[2] gives chromosome counts of six species of Indian ferns: *Hicriopteris glauca* ($n=56$), *Pteris vittata* ($n=58$), *Pteris biaurita s. l.* ($3n=87$), *Blechnum orientale s.l.* ($2n=34$), *Cyclosorus dentatus s.l.* ($n=36$), and *Polystichum aculeatum s.l.* ($n=82$). Ghatak overestimates the value of chromosome counts in determining the taxonomy. For instance, he makes the statement: "The specimen which yielded a clear meiotic count could be identified either as *Gleichenia longissima* Bl. if we follow Holttum (1954) or as *Hicriopteris glauca* according to Copeland (1947). The presence of 56 clear bivalents in the spore mother cells clearly supports Copeland's treatment of the group." The chromosome count alone shows nothing of the kind. Holttum showed that Copeland had mis-

[1] The Nucleus **5**: 95–114. 1962.
[2] Bull. Bot. Surv. India **3**: 79–82. 1961.

used the generic name *Hicriopteris* Presl, which really applies to an aberrant species of a different group. If considered as a genus, the group of *"Hicriopteris" sensu* Copeland must be called *Diplopterygium* (Diels) Nakai. So much is factual. The question as to whether this group ought to be considered a distinct genus (as by Copeland) or as a subgenus of *Gleichenia* (as by Holttum) is a matter of opinion, and the chromosome number found will not influence this decision one way or another presumably. Finally, the species *Gleichenia longissima* Blume is Malaysian and *G. glauca* is of China and Japan; whether or not these two species are conspecific is debatable; in any case the identity of the Indian plant counted by Ghatak will have to be determined by the usual taxonomic study and not by a chromosome count. This kind of isolated chromosome counting makes one question its value. Ghatak's count for a plant from India called *"Polystichum aculeatum"* is clearly valueless; there is no indication that he is aware of the two senses in which this name has been used in Europe, or that according to the presumably correct usage this species does not occur at all in Asia. It is possible that the plants of India that were formerly called *P. aculeatum* are referable to *P. setiferum* (Forsk.) Woynar, but this has not really been demonstrated; it would require extensive taxonomic study. One could almost assume that all the species of the *"aculeatum"* group will have $n=41$ or 82.[3]—C.V.M.

EVOLUTIONARY SIGNIFICANCE OF POLYPLOIDY IN THE PTERIDOPHTA, by Edward J. Klekowski, Jr. and Herbert G. Baker. Science **153**: 305–307. 1966.—Most ferns are homosporous and readily self-fertile, and thus are highly homozygous. Polyploidy, which is concentrated in homosporous species, allows for the mutation of some genes which can take on new functions without depriving the organism of essential processes which are maintained by their former homologues.—C.V.M.

[3] Other papers by Ghatak received are: "Apogamy in *Adiantum philippense* L. and its Cytology," Bull. Bot. Soc. Bengal **13**: 63–65. 1959, and "Two New Species of the *Adiantum caudatum* Complex," Bull. Bot. Surv. India **5**: 71–77. 1963.

A FLORA OF NORTHEASTERN MINNESOTA, by Olga Lakela. University of Minnesota Press, Minneapolis, Minn. 1964. xv + 541 pp. $10.00.—Professor Lakela has devoted extensive time during the last 30 years to a study of the plants of the northeastern part of Minnesota, both in the field and in the herbarium. Her flora is thus not a compilation but a major contribution that contains many original observations. She treats 49 species of ferns and fern-allies, most of which are species ranging widely into the northeastern United States and Canada. The treatment is conservative, and generally follows that of Fernald in Gray's Manual.—C. V. M.

ZUR KENNTNIS DER FLACHEN BAERLAPPE IN BAYERN, by J. Damboldt. Bericht Bayer. Bot. Ges. **36**: 25–28. 1963.—The plants formerly grouped as *Lycopodium complanatum* L. *sens. lat.* are considered as *Diphasium alpinum*, *D. issleri*, *D. complanatum*, *D. tristachyum*, and *D. zeilleri*, with a discussion of the morphology, distribution, chromosome counts, and a key to the three last named.—C. V. M.

ON HYPODEMATIUM KUNZE, by Kunio Iwatsuki. Acta Phytotax. Geobot. **21**: 43–50. 1964.—The author believes that this Old World genus, usually placed among the thelypteroid ferns, belongs to the athyrioid series, perhaps distantly related to *Woodsia*, judging from characters of anatomy and chromosomes. Keys and descriptions are given for the four species.

Notes and News

FERN AND TROPICAL PLANT SHOW.—The Los Angeles International Fern Society will present its fourth annual fern and tropical plant show in the International Building (gate 1) at the Los Angeles County fair grounds at Pomona. The show will be open from 1 PM to 10 PM on May 20 and from 10 AM to 8 PM on May 21. Tickets for one dollar will be available at the fairgrounds; advance tickets costing only 75 cents may be purchased from Bee Olson, 13715 Cordary Ave., Hawthorne, Calif. 90250. Plenty of free parking will be available. In addition to the many kinds of exhibits presented in past years, lectures by oustanding garden consultants will be given hourly.—D.B.L.

FOR EXCHANGE OR GIFTS the following plants are available: *Adiantum capillus-veneris, Cheilanthes castanea, C. feei, C. lanosa, C. tomentosa, C. wootonii, Cyrtomium falcatum, Pellaea atropurpurea, Polypodium aureum, P. hesperium, P. phyllitidis, P. plesiosorum, P. polycarpon* cv. '*Cristatum,*' *Polystichum tsus-simense, Thelypteris dentata* and *Dryopteris ludoviciana.* Species of *Anthurium, Crassula, Philodendron, Sedum,* and *Spathyphyllum* are also available. In exchange I would particularly like tree ferns and other tropical ferns, especially species of *Cheilanthes, Notholaena,* and *Pellaea.*—Dr. I. W. Knobloch, *Department of Botany and Plant Pathology, Michigan State University, East Lansing, Michigan 48823.*

ANNUAL MEETING in 1967.—The annual meeting of the Society will be held in conjunction with that of the American Institute of Biological Sciences at the Texas A&M University, College Station, Texas. The AIBS meetings are scheduled from August 27 to September 1. The Society will hold a luncheon on Monday, August 28, with papers to be read that afternoon.

A pre-meeting field trip will be led by Dr. Donovan S. Correll, of the Texas Research Foundation, to the Edwards Plateau in central Texas. Headquarters and accommodations will be at the Lazy Hills Guest Ranch near Kerrville. Participants will assemble at the Ranch on Thursday evening, August 24 (dinner at 7 P.M.). Trips will be made August 25 and 26. Departure for College Station will be in the afternoon of August 27. Please write to Dr. Correll if you need or can provide automobile transportation between College Station and the Ranch. Rates for a single, air-conditioned room are $19.00 for one person, $15.00 each for two, $14.00 each for three, and $13.00 each for four. These prices include all the first-rate food one can eat, box lunches, and the use of a swimming pool and horses. For information and guaranteed reservations write before July 1 to: Mrs. Carol Steinruck, Lazy Hills Guest Ranch, Ingram, Texas 78025.—D.B.L.

Report of the President for 1966

The year 1966 has been a very profitable one for the American Fern Society. As an adherent society of the American Institute of Biological Sciences we were asked to prepare a history, which was published under the section "Know Your Adherent Societies" in the June, 1966, issue of *BioScience*, pp. 410–411. We are grateful to Dr. Ira L. Wiggins for this excellent report.

The Society plans to take an active part in the Ninth International Botanical Congress, which will take place in Seattle, Washington, August and September, 1969. A planning committee, serving as liaison between the Council of the Fern Society and the National Committees has been appointed, consisting of Dr. Warren H. Wagner, Jr., University of Michigan (chairman), Dr. A. R. Kruckeberg, University of Washington, and Dr. T. M. C. Taylor, University of British Columbia.

Dr. Walter H. Hodge, our representative to the American Association for the Advancement of Science, has taken up duties for a two year period as the National Science Foundation representative in Tokyo, and Dr. Warren H. Wagner has consented and been appointed to complete his term of office.

Since it was impossible to have our regular two-day field trip prior to the AIBS Meetings, Conrad Morton and David Lellinger offered to lead a trip on the prior Sunday, August 14. This was a very enjoyable and pleasant trip due to their fine planning. We drove first to Mrs. Paul Bartsch's Fern Garden at "Lebanon" near Lorton, Virginia, where there were over 40 different species of ferns appearing in native habitats. Mrs. Bartsch greeted us and assisted in conducting us through the extensive and beautiful area, which she has kept in fine condition. For lunch, we went to the well known "Old Club" restaurant, in Alexandria, Virginia, where we had time to renew old acquaintances and meet new friends. In the afternoon we returned to Washington, D. C. First we visited the Botanical Garden greenhouses, with their many interesting tropical ferns; then we took a walk through "Fern Valley" at the National Arboretum, where in 1959, 1,000 donated ferns were planted in correct habitats, and later many associated native plants were added. Through the efforts of Dr. Robert Lommasson, then (1964) president of the Fern Society, a number of our members contributed money for the display case for fern pictures of Fern Valley. (see this JOURNAL **54**: 46. 1964.). Conrad Morton, with cordial hospitality, served the group cocktails at his home, adding a most pleasant finish to the day.

We owe a great deal of thanks to Dr. Russell G. Brown, our AIBS meeting representative, who planned an excellent luncheon and made arrangements for the meeting at the University of Maryland. Among the Society members at the luncheon we were especially honored by having two Honorary Members present, Edgar Wherry and Conrad Morton.

Our Vice-president, Irving Knobloch, planned a very successful and well organized set of papers for the afternoon session. It was well attended and there was a good response.

The two day post-meeting field trip on August 18 and 19 was held near the coast in Maryland, Delaware, and Virginia. It was led by Dr. Clyde F. Reed, who is very familiar with the ferns in this area. It was rewarding to find so many ferns in an area where they are not abundant. We are indebted to him for showing us so many and varied habitats. We are also grateful to Dr. and Mrs. Lellinger for mimeographing and sending notices to the members.

We wish to thank Dr. Norman Marengo for acting as Judge of Elections and to Mr. W. E. Buker as auditor.

I appreciate very much the kind consideration and help of members of the Society and especially the fine cooperation of council members in making this a profitable and pleasant year.

Respectfully submitted,

MILDRED E. FAUST, *President*

Report of the Secretary for 1966

At the close of 1966 The American Fern Society had 655 members from all of the United States except the Dakotas, Nevada, and New Mexico, and from 25 countries abroad.

I regret to report the death of 5 members: Miss Clara C. Mark, a member since 1913; Miss Bertha Bill, 1944; Mr. Hollis Koster, 1940; Miss Eleanor McGilliard, 1935; Miss Lena J. Russell, 1959.

The annual meeting of the Society held August 15th with the American Institute of Biological Sciences on the campus of the University of Maryland was preceded by a luncheon attended by 33 members and presided over by our President, Dr. Mildred Faust, who also presided at the well-attended afternoon program. Titles of papers presented follow: "New collections of Psilotaceous gametophytes" by David W. Bierhorst; "Comparative anatomy of false veins in ferns" by Warren H. Wagner, Jr.; "The fern genus *Pterozonium*" by David B. Lellinger; "Some fossil ferns" by Chester A. Arnold; "Some ferns of the Juan Fernandez Islands" by Frederick G. Meyer; "Ferns of Utah" by Seville Flowers; "The gametophyte of *Platycerium andinum* Bak." by Lenette R. Atkinson; "Taxonomic significance of stomatal patterns in the pteroid ferns" by Lawrence E. Thurston; "Unusual features of the epidermis of *Adiantum*" by Grace A. Schuler and John T. Mickel, read by Dr. Mickel; "Some fern habitats in Jamaica" by Mildred E. Faust; "Studies on spore apomixes" by Virginia M. Morzenti; and "Spore tetrad detail" by Clara S. Hires.

Those who did not have to hurry away enjoyed an open house at the Smithsonian Institution in Washington, Tuesday evening, August 16. During the evening we found our way above the splendid exhibits to the U. S. National Herbarium, where Mr. Morton and Dr. and Mrs. Lellinger welcomed us to their offices. Refreshments were served in the seminar room, where there were some interesting exhibits, including Mr. Morton's mock fossil and evolutionary history of the paper clip!

Respectfully submitted,

LENETTE R. ATKINSON, *Secretary*

Report of the Judge of Elections

The results of balloting for officers of the American Fern Society are as follows:

For President	
Mildred E. Faust	307
John T. Mickel	1
Warren H. Wagner, Jr.	1
Rolla M. Tryon, Jr.	1
For Vice-President	
Irving W. Knobloch	311
For Secretary	
Lenette R. Atkinson	308
Norman P. Marengo	1
Elizabeth Bartholomew	1

I therefore declare the following candidates elected to office: Mildred E. Faust, President; Irving W. Knobloch, Vice-President; Lenette R. Atkinson, Secretary.

Respectfully submitted,

NORMAN P. MARENGO, *Judge of Elections.*

Report of the Treasurer for 1966

In 1966 receipts were $2804.39 more than expenses, putting the Society in good financial condition. Receipts from the sale of back numbers exceeded those of last year by $857.00, as the former Treasurer expected, because of the large orders pending in December 1965. Royalties from Dr. Wherry's *Fern Guides* netted the Society $385.98. The placing of this item in "Royalties" naturally left the "Gifts" item very small. Advances for dues this year totaled $2177.90, a large increase over 1965, probably due to the fact that dues notices for 1967 were sent out in early December. I now believe that this was a little too early. The fees for advertisement in the JOURNAL increased by $31.00, doubtless due to the efforts of our Editor. Mr. Neill Hall, continuing with the work of the spore exchange, netted $58.87 beyond his expenses. In all we have had a pretty good year, in spite of the fact that your new Treasurer has had to learn as he carried out his duties. Many times he has been perplexed and has had to call for help from Dr. Hauke, who has always responded willingly.

Receipts

Cash on hand, January 1, 1966			$723.75
Membership Dues			
Renewals	$2,000.40		
Sustaining	184.00		
New	240.30		
Advances	1,364,30		
Arrears	20.00		
		$3,809.00	
Subscriptions			
Current	300.20		
Advances	813.60		
Arrears	8.20		
		1,122.00	
Sale of Back Numbers		1,213.33	
Sale of Reprints		316.21	
Royalties (Wherry's Books)		385.98	
Gifts		24.56	
Advertising in Journal		98.50	
Miscellaneous		138.87	
Total Receipts			7,108.45
Total			$7,832,20

Disbursements

American Fern Journal			
Vol. 55, No. 4	$902.39		
Vol. 56, No. 1	932.02		
Vol. 56, No. 2	904.58		
Vol. 56, No. 3	921.79		
		$3,660.78	
Reprints and postage		415.93	
Envelopes for mailing Journal		82.00	
Printing stationery, envelopes and bills		94.90	
Treasurer's expense		125.40	
Secretary's expense		93.63	
Editor's expense		54.81	
Foray expense		29.15	
Shipping and handling Back Numbers		31.81	
AIBS dues		400.00	
AAAS dues		10.00	
Miscellaneous		4.00	

Total disbursements		$5,002.41
Cash on hand, January 1, 1967		$2,829.79

Statement, December 31, 1966

Assets

Cash in Union National Bank	$2,829.79	
Cash in Green Point Savings Bank		
Bissell Herbarium Fund	918.84	
Life Membership Fund	1,437.21	
Una Weatherby Fund	3,883.22	
Accounts Receivable	817.15	
Inventory, Journal	6,951.50	
Library	396.00	
Total		$17,233.71

Liabilities

Advance Dues	$1,364.30	
Advance Subscriptions	813.60	
Fund Balances		
Bissell Herbarium Fund	918.84	
Life Membership Fund	1,437.21	
Una Weatherby Fund	3,883.22	
General Fund	8,816.54	
Total		$17,233.71

Respectfully submitted, LEROY K. HENRY, *Treasurer*

Report of the Auditing Committee

I hereby certify that I have seen the books and accounts of Dr. LeRoy K. Henry, Treasurer of the American Fern Society, Inc., and have obtained confirmation of the correctness of the Society's balances on hand as set forth in detail in the accompanying report of the Treasurer.

W. E. BUKER, *Auditor*

Report of the Spore Exchange

The Fern Spore Exchange has realized a healthy growth in 1966 over 1965. The number of members contributing fern spores to the Exchange has doubled, both from members of the United States and from other countries. Lists were mailed to

170 members. The same number of packets were distributed as in 1965; however, these went to a much greater number of members.

A complete new list was issued late in 1966 covering all the species and varieties collected in 1965 and 1966. This list covers 311 domestic and exotic species and varieties.

Individuals and institutions of six countries in Europe, four in Asia, Australia, and New Zealand are actively participating in the Exchange. Sincere thanks is tendered to all these participants, as well as the many individuals and institutions in the United States and Canada, for their active support of the Exchange.

It is urgently requested that members continue to send in spores or fertile fronds as they become available. The success of the Spore Exchange depends on the continuing support of all the membership. It is important that a fresh stock of spores be maintained in the Exchange at all times.

Respectfully submitted,

NEILL D. HALL, *Director of the Spore Exchange*

New Members

Mr. Forrest A. Hartman, Route #3, Lockport, Ill. 60441
Mrs. David Hentzel, Terralinds Trailer Court, Warrensburg, Mo. 64093
Mr. G. Richard Jimenez, P.O. Box 5172, Tampa, Fla. 33605
Mr. Edward J. Klekowski, Jr., Botany Department, Univ. of California, Berkeley, Calif. 94704
Mr. Blaine D. Miller, Springs, Penna. 15562
Mrs. Laurence K. Parker, US AID, Lagos, Nigeria, c/o American Embassy, State Department, Washington, D. C. 20520
Miss Louise Sheller, 206 E. Barnett Street, Ventura, Calif. 93001
Mr. James Snyder, 222 Oneida Drive, Loveland, Ohio 45140
Mr. Hiroyuki Takahashi, c/o Mr. Kawabata, 1460, 4-chome, Nakameguro, Meguro-ku, Tokyo, Japan
Mrs. Helen H. Wheelwright, 92 Mill Street, Sherborn, Mass. 01777

Change of Address

Miss Emily L. Hartman, Dept. of Biology, Univ. of Colorado Denver Center, 1100 14th Street, Denver, Colo. 80202

Dr. Richard L. Hauke, c/o Organization for Tropical Studies, Apt. 16, Ciudad Universitaria, San José, Costa Rica
Dr. Francis J. Scully, 16 Conway Blvd., Hot Springs, Ark. 71901
Mrs. Paul Swanson, 11503 – 108th Street North, Largo, Fla. 33542
Mr. Robert I. Wilson, 1646 Charlinda Street, West Covina, Calif., 91790

Statement of Ownership, Management and Circulation

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The statements made above are certified to be correct, and are signed by: David B. Lellinger, editor-in-chief of the American Fern Journal on October 1, 1966.

Vol. 57 April–June, 1967 No. 2

American Fern Journal

A QUARTERLY DEVOTED TO FERNS

Published by the

AMERICAN FERN SOCIETY

CONTENTS

The American Fern Society

Council for 1967

MILDRED E. FAUST, 1216 Westcott St., Syracuse, New York 13210. *President*
IRVING W. KNOBLOCH, Department of Botany & Plant Pathology, Michigan State University, East Lansing, Michigan 48823. *Vice-President*
LENETTE R. ATKINSON, 415 S. Pleasant Street, Amherst, Massachusetts 01002. *Secretary*
LEROY K. HENRY, Division of Plants, Carnegie Museum, Pittsburgh, Pennsylvania 15213. *Treasurer*
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WARREN H. WAGNER, JR., Dept. of Botany, University of Michigan, Ann Arbor, Michigan 48104. *Representative to A. I. B. S.*

American Fern Journal

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An illustrated quarterly devoted to the general study of ferns, owned by the American Fern Society, and published at 3110 Elm Ave., Baltimore, Md. 21211. Second-class postage paid at Baltimore. The pages of the Journal are open to members who wish to arrange exchanges; a membership list is published at intervals, to assist those interested in obtaining specimens from different localities.

Matter for publication should be addressed to Dr. David B. Lellinger, Smithsonian Institution, Washington, D. C. 20560.

Changes of address, applications for membership, subscriptions, orders for back numbers, and other business communications should be addressed to the Treasurer.

Subscription $4.50, exclusive of agency handling fees; sent free to members of the American Fern Society (annual dues, $4.00; sustaining membership, $8.00; life membership, $80.00). Extracted reprints, if ordered in advance, will be furnished authors at cost, plus postage.

Back volumes $5.00 to $6.25 each; single back numbers of 64 pages or less, $1.25; 65-80 pages, $2.00 each; over 80 pages, $2.50 each; Cumulative Index to Volumes 1-25, 50 cents. Ten percent discount on orders of six volumes or more.

Library and Herbarium

Dr. W. H. Wagner, Jr., Department of Botany, University of Michigan, Ann Arbor, Michigan 48104, is librarian and curator. Members may borrow books and specimens at any time, the borrower paying all postal or express charges.

Spore Exchange

Mr. Neill D. Hall, 1225 Northeast 95th Street, Seattle, Washington 98115, is Director of the Spore Exchange. Viable spores are received and dispatched, and lists of the collections are sent on request.

American Fern Journal

VOL. 57 APRIL-JUNE, 1967 NO. 2

Observations on Pteridophyte Life Cycles: Relative Lengths Under Cultural Conditions

EDWARD J. KLEKOWSKI, JR.[1]

A recent investigation of pteridophyte breeding systems (Klekowski and Baker, 1966) has indicated that some ferns have unexpectedly short life cycles (measured as the time from spore germination to spore production, i.e., from spore to prothallus to sporophyte to spore). Because of heteroblastic leaf development, it has generally been thought that the shortest life cycle attainable in ferns, even under optimal conditions, was two or three years. Included in the literature are reports of a two- or three-year life cycle in *Pteridium aquilinum* (Conway, 1949; Webster and Steeves, 1958), a three-year life cycle in *Dryopteris abbreviata* × *filix-mas* hybrids (Manton, 1950), a two- or three-year life cycle in members of the *Polypodium vulgare* complex (Shivas, 1960), and a two and a half year life cycle in members of the *Asplenium aethiopicum* complex (Braithwaite, 1964). The data presented in this paper document a number of fern life cycles of sexual and apogamous species that take less than a year, and one that can be completed in six to seven months.

Spores utilized in this study came from the following sources: *Thelypteris normalis* (C. Chr.) Moxley, *T. augescens* (Link) Munz & Johnston, *T. puberula* (Baker) Morton, and *Asplenium adiantum-nigrum L.* were obtained from Barbara Joe Hoshizaki, Los Angeles, California; *Adiantum capillus-veneris* L. and *Woodwardia fimbriata* J. E. Smith were collected in Woodwardia Canyon, Angeles National Forest, California; *Adiantum seemannii*

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Hook. and *Osmunda regalis* L. were obtained from the University of California Botanical Garden at Los Angeles; and *Thelypteris dentata* (Forsk.) E. P. St. John and *Microlepia speluncae* (L.) Moore were obtained from the University of California Botanical Garden at Berkeley.

The spores were sown on inorganic nutrient agar (Parker and Bold, 1961; modified B solution was supplied by B. C. Parker) and grown under continuous fluorescent illumination (600 ft-c). After attaining the prothallial stage, the gametophytes were isolated in small plastic petri plates (60 x 15 mm), watered, and allowed to self-fertilize; each yielded a completely homozygous sporophyte (for further details see Klekowski and Baker, 1966). After the initiation of the second or third frond, the sporophytes were transplanted into potting soil, and their maturation was completed in a greenhouse at the Garden at Berkeley.

Table I gives lengths of the life cycles for the fern species grown under the conditions described above. The total life cycle has been divided into two periods, the first being the length of time from sowing of the spores until the appearance of the sporophyte, the second period being the length of time from the appearance of the sporophyte until the adult plant produced viable spores.

Life cycle lengths of two years were found in *Microlepia speluncae* and *Osmunda regalis*.

The *Thelypteris* species, both the sexual and the apogamous *Adiantum* species, *Woodwardia fimbriata,* and *Asplenium adiantum-nigrum* all have life cycles of one year or less in duration. The finding of a one-year life cycle in *Asplenium adiantum-nigrum* and the previous report of a two-and-a-half-year life cycle in *A. aethiopicum* by Braithwaite (1964) indicate that life cycle length probably is not constant in a genus, but represents an aspect of the adaptation of each species to its environment.

The shortest life cycle discovered was that of *Thelypteris normalis* (6.5 months). The short life cycle together with the ease of forming completely homozygous sporophytes should make this species a very useful genetic tool. Experiments are presently in progress utilizing this species in irradiation studies.

The discovery of life cycles of less than one year's duration in eight species of ferns representing four genera indicates that this phenomenon may be much more common than was previously suspected.

TABLE I. LENGTHS OF LIFE CYCLES IN DAYS

Species[2]	*Period 1*	*Period 2*	*Total*
Thelypteris normalis	70	136	206
Thelypteris dentata	61	160	221
Adiantum capillus-veneris	90	184	274
Thelypteris augescens	83	191	274
Asplenium adiantum-nigrum	—	280	280+
Woodwardia fimbriata	113	188	301
Thelypteris puberula	57	249	306
Adiantum seemannii[2]	53	274	327
Microlepia speluncae	68	471	539
Osmunda regalis	65	498	563

[2]All except the apogamous *Adiantum seemannii* are sexual species.

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Notes on the Distribution of Some American Cheilanthoid Ferns

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The following notes are based upon a 10-year study of the cheilanthoid ferns. My fieldwork in the southwestern United States and Mexico has been concerned particularly with collecting spore-bearing material of as many species as possible to be used for studies of the gametophytes. In a number of instances species and varieties were collected in areas not previously recorded for the plants in question. These notes are intended, therefore, to bring distribution records and related matters up to date. The most recent floras and monographs are accepted as accurate accounts of previous collections. Unless otherwise stated, the collection numbers are mine.

CHEILANTHES MEXICANA Davenp.

Knobloch and Correll (1962) state that this species is confined to Chihuahua and San Luis Potosí. However, its distribution is known to be more general. It is very abundant and well-developed in the mountains of Guanajuato between the towns of Guanajuato and Dolores Hidalgo (*1968, 3078*). It also occurs in northern Jalisco (*1981*) and to the northwest in Durango (*3166, 3173*). In the last named localities the plants were in much more exposed and drier habitats than the oak woods of Guanajuato. Ecologically this very close relative of *C. lendigera* (Cav.) Swartz is quite distinct; at least, all of my collections of the latter came from much more moist situations than those occupied by *C. mexicana*.

C. LINDHEIMERI (J. Smith) Hooker

A collection from Zimapan, Hidalgo (*3109*) represents a southeastern extension of the range from that recorded by Knobloch and Correll (1962).

C. PARISHII Davenp.

Until 1964 this species was unknown except from its type

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locality in Andreas Canyon, near Palm Springs, California. During the spring of 1964, Mr. Larry Kiefer collected specimens of this rarity in Sentenac Canyon, San Diego County (*Kiefer 1228*) and at Quail Springs, San Bernardino County (*Kiefer 1167*). At both new localities as well as at the type locality very few plants were found. A part of the *Kiefer 1228* collection was cultivated for a time and a study of its sporogenesis was made. This species appears to be sterile and is probably of hybrid origin. Some further observations will be published elsewhere.

C. COOPERAE D. C. Eaton

Since the publication of the most recent California flora (Munz, 1959) several new localities have been found for this widely scattered but uncommon endemic species. It occurs on limestone in the southern Sierra Nevada in the canyons of the Kaweah (*1531*), Kings (*1502*), and Tule (*2009*) Rivers. These collections close the gap between the central and southern California areas of distribution. All collections of the species (except those from Santa Barbara County) that I have examined were from limestone outcrops. The recent discovery (Thomas, 1961, p. 61) of *C. cooperae* in Santa Cruz County some distance from the other localities was also on limestone. Very likely this species will be found elsewhere in the state at moderate elevations on limestone where there is sufficient rainfall (cf. Hoover, 1966).

PELLAEA LONGIMUCRONATA Hooker

In a paper on the gametophytes of *Pellaea*, Pray (1967) lists this species from California. Surprisingly, only Shreve and Wiggins (1964) report it for this state, since it is relatively abundant in the mountains of the eastern Mohave desert region. Although there are earlier collections of this species in herbaria from the Providence Mountains (*Dunkle 4251*, AHFH) and from the New York Mountains (*Ferris & Bacagalupi 8076*, RSA) these were not cited by either A. Tryon (1957) or Munz (1959). Recognition of the species in the California flora was probably obscured by the fact that the eastern Mohave also includes the eastern limits of *P. mucronata* (D. C. Eaton) D. C. Eaton

(*3193*), and many intermediates exist between the two species in that region which are undoubtedly hybrids (*3194*). Plants which are good examples of *P. longimucronata* and indistinguishable from Arizona collections of the latter species beyond the range of *P. mucronata* are present, however (*1041, 1043, 3195*). Because the mountains of the eastern Mohave are also the western limit for *Notholaena sinuata, Cheilanthes feei,* and *C. wootonii* (Munz, 1959), the occurrence there of *P. longimucronata* is not too surprising. The western distribution of all of these species seems to be limited, at least in part, by the summer rainfall pattern. Summer rains usually do not occur west of this area but are typical of the climate to the east.

P. WRIGHTIANA Hooker

In 1964 this species was found in Zion Canyon, Washington County, Utah, along the lower portion of the Angel's Landing trail (*2030*). This collection appears to be the first record for the species in Utah and it is decidedly more northern than the distribution illustrated by A. Tryon (1957). There were relatively few plants in the area examined, but it is certainly possible that this region does contain other stations on the inaccessible cliffs. The species was not listed for Zion Canyon by Presnall (1937, p. 8).

P. TERNIFOLIA (Cav.) Link

Previous reliable reports of this species in Texas have indicated that it occurs only in the Big Bend Region of southwest Texas (A. Tryon, 1957), with the exception of an isolated locality in Pecos County (Correll, 1955, p. 88). I have collected it in the Jeff Davis Mountains approximately 130 miles north of the Big Bend locality. A few plants were found intermingled with *P. wrightiana* on the western slopes of these mountains. More significantly, the form collected (*1698, 1702*) is an unusual one with simpler leaves than the typical, very widely distributed form. The plants in the Chisos Mountains of the Big Bend are of the typical form, judging by the collection (*Tryon & Tryon 5097*) which I have examined. The form collected in the Jeff

Davis Mountains differs from typical *P. ternifolia* by a complex of characters which have been found in several other collections from Durango (*3148, 3173*), Michoacán (*3117*), and Hidalgo (*Pringle 10025*), Mexico. These collections can be distinguished from the typical form by the following characteristics:

1. The pinnae of the upper half or two-thirds of the leaf are simple and unlobed, regardless of leaf size. In one leaf from *Pray 3117* all 19 pairs of pinnae are simple. In the typical form only the terminal and sometimes the penultimate pinnae are undivided, except in juvenile leaves.

2. Persistent, long, soft, uniseriate hairs are conspicuous on the stipes and rachises. The latter tend to be stouter. Similar hairs may also occur sparingly on the lamina. The typical form is completely glabrous at maturity except for a few scales at the base of the stipe.

3. The texture of the lamina is softer and more herbaceous. This is especially apparent in the living state but also shows in dried material.

4. The pinnae are distinctly glaucous, whereas the typical plants have bright to dark green leaves.

5. The clear margins of the pinnae are much broader, more apparently modified, than in typical *P. ternifolia*, and there is little or no development of mucronate tips. In the typical form the pinnae are strongly mucronate.

6. Both the spores and cells of the gametophytes are larger. This has been reported for the Texas material (Pray, 1967), and is also true for the other collections. This suggests that these atypical collections represent the tetraploid phase of *P. ternifolia* reported by Tryon and Britton (1958). Their report was based on a collection from Valle de Bravo, Michoacán, very near the locality for *Pray 3117*.

This complex of distinguishing characters always remains together in the collections I have cited and in the populations from which they came. There is no evidence of any recombination of these features with those of the typical form, even when the two occur together in the same area, as in Durango and Michoacán.

This lack of intermediates in conjunction with an assumed difference in chromosome number supports the opinion that these plants represent either a distinct subspecies of *P. ternifolia* or deserve recognition as a species. Because the plants are extremely fertile and their gametophytes are sexual (Tryon and Britton, 1958; Pray, 1967) it is likely that this form is an amphidiploid for which *P. ternifolia* is one parent, rather than simply an autotetraploid of the typical (diploid) form. In the latter case reduced fertility or apogamy would be expected. If the assumed amphidiploidy, as suggested by the regular meiotic synapsis reported by Tryon and Britton (1958), proves to be true, then I believe that this entity should be regarded as a distinct species of *Pellaea*. Among living Pellaeas in their present distribution none seems a particularly suitable candidate as the other parent. Perhaps the newly described diploid form of *P. glabella* var. *glabella* from Missouri (Wagner et al., 1965) was involved if formerly it and *P. ternifolia* were sympatric.

According to A. Tryon (1957, p. 151) the fern under discussion here is presumably *Pellaea languinosa* Fée. If examination of the type (*Schaffner 321*, P) should prove this, then the Fée name is the correct one. If the Fée name does not apply, then a new epithet will be in order.

P. SEEMANNI HOOKER and P. SKINNERI Hooker

Pellaea seemanni appears to be widespread in western Mexico, whereas *P. skinneri* is reported from Chihuahua and Jalisco only (Knobloch and Correll, 1962). I have found *P. seemanni* (*1780*) and *P. skinneri* (*1781*) in the mountains of the Cape Region of Baja California south of La Paz. These two were growing together at an elevation of 4000 to 5000 feet in the same area which contains the endemic *Notholaena peninsularis*.

NOTHOLAENA GRAYI Davenp.

The occurrence of this species in Hidalgo (*3106*) extends the range of the species as stated by Tryon (1956, p. 58) considerably to the southeast.

N. INCANA Presl

This species occurs in western Durango near the Nayarit border (*3157*). This collection fills a gap in the distribution indicated by Tryon (1956, p. 92) between Sonora and Chihuahua and Jalisco to the south.

N. DELICATULA Maxon & Weatherby

Collections of this species from northeastern Mexico (*2079, 3008, 3029*) seem to verify its distinction from *N. incana,* although some immature specimens are difficult to place. One collection from Iturbide, Nuevo Leon (*3029*), is particularly distinctive and, indeed, it is different from typical *N. delicatula* also. This collection has creamy-yellow cereous indument on the lower surface of the pinnules which is quite distinct from the white indument of the other collections I have seen and from those examined by Tryon (1956). The scattered cereous glands on the upper surface are also yellow. In other respects the collection seems to be referable to *N. delicatula.* The fairly abundant plants at this site all agreed in indument color. One collection (*3008*) is actually somewhat intermediate in that it is glabrous on the upper surfaces of the pinnules but has the lighter colored stipes of *N. delicatula.* Since both species are sexual (Pray, unpublished), some recombination of characters through hybridization of these very close species is a distinct possibility.

N. WEATHERBIANA Tryon

Previous collections of this species have indicated that it is a rare endemic in southwestern Chihuahua (Knobloch and Correll, 1962). A collection from a canyon just south of the city of Chihuahua (*3184*) is noteworthy since the latter locality is more than 150 miles from the Batopilas area to which the species was thought to be confined. It is apparently very rare in the new locality also because only a single, large clump was found.

N. PALMERI Baker

The most significant find in *Notholaena* was the collection of this species in Guanajuato (*1971, 3078*). The plants were restricted to a rather small, exposed, rocky area in the mountains east of the city of Guanajuato. According to Tryon (1956, p. 78) this species was previously known only from the type collection from San Luis Potosí, all other reports of the species being referable to *N. pallens* Weath. There can be no doubt that the Guanajuato collections are distinct from the latter species; they appear to correspond to *N. palmeri* as it is described by Tryon. These collections consist of specimens which are quite distinct from *N. pallens,* in that the stipes are scaleless and shiny and the upper surface of the lamina lacks cereous glands and is bright green. A distinctive field difference not mentioned by Tryon (1956, p. 78) for these species is the upright position of the leaves in *N. palmeri.* Those of *N. pallens* tend to spread in a flat rosette; the habit of the two is superficially quite distinct.

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Sexuality in a Wild Population of Equisetum arvense Gametophytes

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Studies of the gametophyte generation of *Equisetum* have occupied botanists ever since Vaucher (1821) first reported the germination of spores and illustrated early stages in gametophyte development. Buchtien (1887) summarized the knowledge of gametophytes up to his time. Gametophytes have occasionally been found and described from naturally occurring populations (Kashyap, 1914; Walker, 1921, 1931; Mäckel, 1924; Schratz, 1928). All except Schratz reported that wild gametophytes bear archegonia at first, with some subsequently producing antheridia. Schratz, however, counted 848 wild gametophytes and stated that 46.9% were male and 53.1% were female or, in a few cases, bisexual.

Equisetum gametophytes have been studied frequently in culture (Buchtien, 1887; Ludwigs, 1911; Kashyap, 1914, 1917; Walker, 1921, 1931, 1937; Schratz, 1928; Rumberg, 1932; Hurel-Py, 1949, 1959; Wollersheim, 1957; Slade, 1964). Descriptions of gametophytes in culture differ from those of wild gametophytes chiefly in the frequency with which small gametophytes bearing only antheridia occur in culture. All of these workers found definitely antheridial gametophytes in their cultures. They are smaller, paler, and shorter-lived than archegonial or bisexual gametophytes. Under crowded conditions antheridial gametophytes usually predominated, whereas under conditions of better nutrition the proportion of archegonial gametophytes increased.

Production of archegonia by initially antheridial gametophytes has been reported (Ludwigs, 1911; Walker, 1931; Wollersheim, 1957), but is not common. Initially archegonial gametophytes, on the other hand, frequently produce antheridia under conditions of poor nutrition or increased age. Kashyap (1917) found that spores of *E. debile* (= *E. ramosissimum* subsp. *debile*) produced mostly archegonial gametophytes under all conditions. Walker (1937) reported a tendency for gametophytes of *E. scirpoides* to remain unisexual. Hurel-Py (1959) found that isolated spores growing in Knop's agar produced "prothallial colonies," which are regularly monoecious gametophytes having both archegonial and antheridial lobes.

Based on both studies of cultured and wild gametophytes, the generally accepted interpretation of sexuality in *Equisetum* gametophytes is: (1) *Equisetum* gametophytes are inherently bisexual, (2) Nutritional and other environmental conditions determine the sex of the gametophytes at an early stage, and (3) Once determined, the sex is usually maintained, but can be reversed.

Joyet-Lavergne (1926, 1927, 1930, 1931) maintained a position strongly opposed to this. Through the use of indicator dyes he showed that *Equisetum* is physiologically heterosporous, although the spores are morphologically identical. He claimed that some spores have a lower oxidation-reduction potential and more osmic-acid-reducing fats than do others. These produce female gametophytes.

The uncertainty concerning the nature of gametophyte sexuality in *Equisetum* is reflected in morphology textbooks. Campbell (1895) called them dioecious, Eames (1936) said monoecious, Foster and Gifford (1959) stated that they were homothallic, and Bold (1957) observed them to be heterothallic.

In the discussion that follows, monoecious and dioecious will be used; the first is synonymous with bisexual, the second with unisexual. The terms antheridial or male and archegonial or female are used interchangeably.

In June, 1961, I discovered an extensive colony of *Equisetum arvense* gametophytes in Kingston, Rhode Island, growing on two earth mounds about two feet high which consisted of gravelly glacial till of circumneutral acidity. The mounds were shaded by a willow and a maple tree, and around them were growing *Solidago* sp., *Impatiens biflora, Rubus* sp., *Cerastium* sp., *Polygonum* sp., *Onoclea sensibilis, Symplocarpus foetidus,* and various graminoids. Because the population was young, I was able to study the development of sexuality in the gametophytes at four times over a period of about 12 weeks.

It was possible that earlier workers had collected only those wild gametophytes which they could see with the unaided eye and, therefore, had missed any dwarf males, if any were present. To avoid this, I carefully cut out small pieces of the mound about 15 mm deep and transported them to the laboratory, where they could be inspected thoroughly. There all gametophytes were removed from the soil surface with the aid of a pair of forceps and a dissecting microscope and were tabulated by sex. Antheridial gametophytes are usually readily recognizable because of their light color and sparse appendages. Archegonial gametophytes are usually larger, dark green, and bear more well-developed appendages. If there was any doubt about the presence or type of sex organs, the gametophyte in question was mounted in water and studied under 100$\times$ or greater magnification. The number of gametophytes observed on various dates is recorded in *Table I*.

Many of the gametophytes collected on June 2 were juvenile, so the collection was placed in a moist chamber and kept for a week. Archegonia, which occur at the base of the vertical appendages, are difficult to observe, and possibly the actual number of archegonial gametophytes was higher than the 10% observed on June 8.

Gametophytes were collected again on July 7. Two of the antheridial gametophytes were growing in a cluster with two of the archegonial gametophytes; this cluster resembled one large, bisexual gametophyte. Such clustering is also found in cultures, and probably results from the interlocking of elaters of two or more spores. Most of the male gametophytes appeared old, with many necrotic antheridia and but a few younger antheridia containing motile sperms. These males were 0.5–1.0 mm in diameter. Most of the female gametophytes appeared vigorous and were mostly 2–3 mm in diameter. A few were becoming dried and brown, and a few were nearly buried by silt. The sporelings were very small (up to 11 mm tall) and had only 1–3 nodes.

On August 3 antheridial gametophytes were still present at the site, but they were mostly brownish, overgrown by mosses, and difficult to detect. However, one isolated, large, green male was observed. Most of the archegonial gametophytes were still green; some had grown to 4 mm in diameter, and all bore sporophytes. In some cases three or four sporophytes were found on a single gametophyte. The sporelings had up to five nodes, and branches were developing from their bases.

TABLE I. SEXUALITY OF WILD EQUISETUM ARVENSE GAMETOPHYTES

Condition	*June 2*	*June 8*[1]	*July 7*	*Aug. 22*
Antheridial	2 (18.2%)	13 (26.0%)	42 (51.2%)	3 (14.5%)
Archegonial	1 (9.1%)	5 (10.0%)	35 (42.7%)	17 (80.9%)
Bisexual	0	0	2 (2.4%)	1 (4.8%)
Asexual	8 (72.7%)	32 (64.0%)	3 (3.7%)	0
Total	11	50	82	21

[1]This sample is a portion of the remainder of the June 2 collection incubated in a moist chamber for one week.

The last collection was made on August 22. By that date most sporophytes appeared independent because the gametophytes were brown and dried. The single apparently bisexual gametophyte was too disintegrated at the base to tell with certainty whether it consisted of connected antheridial and archegonial portions or whether there were separate gametophytes in a cluster.

The most important conclusion to be drawn from this wild population of *Equisetum arvense* gametophytes is that dwarf male gametophytes are common in naturally occurring populations. Although a few archegonial gametophytes may bear antheridia secondarily after producing archegonia, certainly the most common sexual pattern in nature is the dioecious one. In the population I studied antheridial gametophytes are a normal component and were nearly as long-lived as the archegonial ones. Despite the small sample I tabulated, compared with that used by Schratz (1928), my results are in greater agreement with his than with those of other workers, most of whom give no actual counts, but certainly imply that all wild gametophytes are initially archegonial. My observations directly contradict Walker's (1931), who observed dwarf male gametophytes and claimed that they were short-lived, abnormal, and resulted from crowding and starvation. She concluded that the normal gametophytes were at first archegonial and later bisexual!

It seems that *Equisetum arvense* gametophytes growing in the wild and those growing in uncrowded culture are comparable, for about 50% male and 50% female gametophytes are produced in both under a variety of conditions. Sufficiently non-normal conditions can change these proportions, however. Enriching the medium or improving the quality of light increases the percentage of gametophytes bearing archegonia, whereas growing the gametophytes under poor light, poor nutrition, or in crowded cultures increases the percentage of gametophytes bearing only antheridia (Wollersheim, 1957; Hurel-Py, 1959). Although a high percentage of dwarf male gametophytes can be obtained under unfavorable conditions, this does not justify the conclusion that dwarf male gametophytes are due only to poor conditions. If wild antheridial gametophytes resulted from starvation, the percentage of antheridial gametophytes should vary widely from population to population. Yet I have seen some well-isolated and presumably well-fed male gametophytes both in culture and in this wild population. I have also seen several crowded and presumably ill-fed clusters of both male and female gametophytes which grew from spores in such close proximity that they could not have been subject to much difference in available nutrients. Thus the close approach to an equal proportion of male and female gametophytes suggests a chromosomal mechanism for determining sex.

The possibility of an antheridial substance produced by gametophytes which promotes the formation of antheridia, as described for *Pteridium* by Döpp (1950) must be considered as a possible explanation for the development of 90% or more antheridial gametophytes in crowded cultures.

Since dioecious *E. arvense* gametophytes are not simply the result of poor nutrition affecting a bisexual spore, there must be an internal mechanism for developing dioecious gametophytes. One definite possibility is a physiological heterospory. Joyet-Lavergne's work (1926, 1927, 1930, 1931) should certainly be reconsidered. He claimed to have observed two kinds of spores that were separable according to oxidation-reduction potential. Schratz (1928) repeated Joyet-Lavergne's tests and discredited his results. Schratz's argument was that there are two extremes of spores with all intermediate conditions. If this is true, it might provide the answer to the problem of how sexual expression in *E. arvense* is controlled. If the spores vary in their physiology, those at one extreme would always develop as male and those at the other as female. The intermediates would differ according to environmental conditions. Under normal conditions all of those on one side of a median metabolic threshold would be of one sex, whereas those on the other side would be the other sex. With improved conditions more and more of the spores would be above the threshold needed to produce archegonia, whereas with poorer conditions fewer and fewer would be above the threshold, and most would produce antheridia. With advancing age or changing conditions, a given gametophyte might drop below the metabolic threshold necessary for archegonial production and might revert to producing antheridia.

The presence of morphological heterospory in *E. arvense* has been claimed (McLean and Ivimey-Cook, 1951), but I was unable to find any differences among the spores produced by plants from the Kingston locality. The biochemical differences which seem to exist in *Equisetum* spores and gametophytes appear to be an early stage in the evolution of morphological heterospory, as suggested long ago by Curtis (1907, p. 307). The implications of this incipient heterospory should not be overlooked. By studying sexual expression in *Equisetum*, perhaps insight can be gained into the development of heterospory, an evolutionary tendency which has culminated in the highly successful seed plants.

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Notes on the Ferns of Dominica and St. Vincent[1]

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Among the islands of the Lesser Antilles, the largest islands—Guadeloupe, Martinique, and Trinidad—have been botanized most intensively. Not enough attention has been paid the smaller islands like Dominica and St. Vincent, and many of the smallest islands have had almost no botanical exploration. Until recently the smaller islands were without airports; visiting them by sea required a slow and often uncomfortable journey.

In 1947 the senior author sailed by open boat on a 36-hour passage in order to collect plants on St. Vincent.

From 1963 until the present time the Bredin-Archbold-Smithsonian Biological Survey of Dominica has permitted botanists, zoologists, and anthropologists to study the natural and cultural history of that island on a continuing basis. Among the botanists in this program who have made collections of pteridophytes are

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Our studies of these botanists' collections have resulted in the following notes. Specimens cited are in the U. S. National Herbarium, unless stated otherwise.

ASPLENIUM AURITUM var. MORITZIANUM Hieron. Bot. Jahrb. Engler **34**: 467. 1904.

Domin (1929, p. 176) mentions the variability of *A. auritum* and considers the larger, more divided specimens to be var. *rigidum* (Swartz) Hooker. But none of the specimens we have seen from the Lesser Antilles has the superior basal pinnules of the lower pinnae at all divided, as does *Freyreis*, "ad later. rup. Brasilia" (S, Morton photograph 5780a), which is the type of *A. rigidum* Swartz.

The larger Lesser Antillian specimens with several free, scarcely adnate to short-stalked pinnules on each pinna closely resemble *Lehmann 4409* (B, Morton photograph 9632), from Colombia, which is the lectotype of *A. auritum* var. *moritzianum*, chosen by Morton & Lellinger (1966, p. 20). In our opinion, even the smaller Dominican specimens (*Lellinger 409, Lloyd 162, 540, 800*) that have most of the pinnules decidedly adnate should be considered var. *moritzianum*. Neither size nor frond morphology correlates with epipetrism or epiphytism. More of the epiphytic plants come from the higher altitudes.

Some of the specimens from Guadeloupe (*Duss 4198b*), Dominica (*Hodge 1015, Lellinger 419, 514*), and Martinique (*Stehlé 4721*) have a few of the segment or pinna apices elongate-attenuate. We do not think this slight variation is worthy of taxonomic distinction, however striking it is in the living specimens, for many intergrades with typical var. *moritzianum* exist in the herbarium specimens.

BLECHNUM **binervatum** (Poir.) Morton & Lellinger, comb. nov.

Polypodium binervatum Poir. in Lam. Encycl. Méth. **5**: 521. 1804. TYPE: Locality and collector unknown [but probably from the Lesser Antilles], Herb. Jussieu, Cat. 1365 (P, Morton photograph 3115). The holotype shows that this is the species that has been known as *Blechnum plumieri* (Desv.) Diels, which was based on *Lomaria plumieri* Desv. (Ges. Naturf. Freund. Berlin Mag. **5**: 325. 1811), which was based apparently solely on a description and illustration by Plumier (Tract. Fil. *t. 90.* 1805), of a plant from Martinique.

This is an epiphytic species with thick, wide-creeping rhizomes; the rhizome scales are numerous and concolorous, lacking a central dark stripe. The deeply pinnatisect blades with fully adnate segments have the rhachis beneath pale and without a dark stripe. This species is related to *Blechnum fragile.*

BLECHNUM **fragile** (Liebm.) Morton & Lellinger, comb. nov.

Osmunda polypodioides Swartz, Nov. Gen. Sp. Pl. Prodr. 127. 1788. TYPE: Jamaica, *Swartz.*

Blechnum onocleoides Swartz, J. Bot. Schrad. **1800**(2): 75. 1801. Based on *Osmunda polypodioides* Swartz. Since the epithet *polypodioides* was at the time available under the genus *Blechnum* and should have been adopted, the epithet *onocleoides* was superfluous when published and is therefore illegitimate.

Onoclea polypodioides (Swartz) Swartz, Fl. Ind. Occ. 3: 1585. 1806, *non* L. 1771.

Lomaria polypodioides (Swartz) Desv. Mém. Soc. Linn. Paris **6**: 288. 1827, *non* Gaud., 1825.

Lomaria onocleoides Spreng. in L. Syst. Veg. ed. 4, 4: 62. 1827. To be considered as a new name for *Osmunda polypodioides* Swartz and not as a transfer of the illegitimate *Blechnum onocleoides* Swartz. *Lomaria onocleoides* Spreng. is a legitimate epithet, but it may not be transferred to *Blechnum.*

Lomaria fragilis Liebm. Dansk. Vid. Selsk. Skrift. V, **1**: 232. 1849. TYPE: Huitamalco, Mexico, *Liebmann* (fragment US).

Spicanta onocleoides (Spreng.) Presl, Epim. Bot. 114. 1849 [1851].

Blechnum polypodioides (Swartz) Kuhn, Fil. Afr. 92, 1868, *non* Raddi, 1819.

This much-named species has been passing in the "Index Filicum," in Proctor's (1953, p. 13) "A Preliminary Checklist of Jamaican Pteridophytes," and elsewhere as *Blechnum polypodioides* (Swartz) Kuhn, but this is an obviously illegitimate name, a later homonym. The earliest legitimate and available specific epithet is *Lomaria fragilis* Liebm.

This species differs from *Blechnum binervatum* in having at least the older rhizome scales with a dark central stripe, and usually also in having the older sterile leaves with a dark line running halfway up the midrib beneath. The South American plants of this alliance are often somewhat larger, but may not be different.

If they do prove distinct, the proper name will be *Blechnum kunthianum* C. Chr.[2]

BLECHNUM LINEATUM (Swartz) Hieron. Bot. Jahrb. Engler **34:** 473. 1904.

Osmunda lineata Swartz (Nov. Gen. Sp. Pl. Prodr. 127. 1788) was very briefly described from specimens collected by Swartz in Jamaica. Christensen (1910, p. 21) indicated that the type consisted of sterile blades of *Cyclopeltis semicordata* (Swartz) J. Smith and fertile blades of some species of *Blechnum* subg. *Lomaria*. Since it was based on a mixture, the name should be abandoned, according to Christensen. This is not necessarily the case if such a name can be satisfactorily typified. It is true that two sheets of *Osmunda lineata* at Stockholm consist of sterile blades of *Cyclopeltis*, which are probably a part of the type of *Polypodium semicordatum* Swartz, and fertile blades of a *Blechnum* (see Morton photographs 5904 and 5905). If this were all of the type material, one would probably have to agree with Christensen. However, there is a third sheet at Stockholm, apparently overlooked by Christensen, which was also collected in Jamaica by Swartz and named and labelled *lineata* by him in red ink. There is a photograph of this sheet in the U.S. National Herbarium that was made by Maxon in 1928. According to Maxon's notes and the photograph, the two sterile fronds on this sheet belong to the species that has usually been called *B. lineatum*. These can therefore be designated as lectotype, and the name thus preserved in its usual sense for this common species of the Greater Antilles. According to a note by Maxon, the fertile frond on this sheet does not belong with

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[2]The appropriate synonymy is:

BLECHNUM KUNTHIANUM C. Chr., Ind. Fil. Suppl. 1: 16. 1913. Based on *Lomaria angustifolia* H. B. K.

Lomaria angustifolia H. B. K. Nov. Gen. & Sp. 1: 18. 1815. TYPE: Villa de Ibarra, Ecuador, *Humboldt & Bonpland* (B, not seen).

Lomaria meridensis Klotzsch, Linnaea **20:** 345. 1847. TYPE: Merida, Venezuela, *Moritz 297* (B, Morton photograph 9967; isotype BM, Morton photographs 7380 and 7382).

Blechnum meridense (Klotzsch) Mett. Fil. Hort. Lips. 61. 1856, *non B. meridense* Klotzsch, 1847. An illegitimate name.

Blechnum angustifolium (H. B. K.) Hieron. Bot. Jahrb. Engler **34:** 472. 1904, *non* Willd., 1810. An illegitimate name.

the sterile and is not *B. lineatum.* It is hard to be sure of this from the photograph, and in any case fertile pinnae of *Blechnum* subg. *Lomaria* generally look much alike and are rarely distinctive, so the fertile part can be excluded as a part of the lectotype.

BLECHNUM **insularum** Morton & Lellinger, sp. nov.

A *B. underwoodiano* simile sed rhizomate epiphytico, pinnis lanceolato-linearibus longe et acriter attenuatis differt.

Rhizome epiphytic, erect, 25–50 cm high, 6–7 mm in diam. (excluding stipe bases and scales) or probably somewhat more, densely paleaceous, the scales acicular, 11–14 mm long, ca. 2–2.5 mm broad at base, abruptly narrowed above base to ca. 0.8 mm broad, strongly bicolorous, the central dark part ca. 0.5 mm broad, more than one cell thick, the narrow margins pale brown, one cell thick, the apex long-attenuate, the margins entire throughout; stipes of the sterile blades 18–25 cm long, 2–3 mm in diam., glabrous, scaleless except at very base, green beneath, purplish above, deeply sulcate above; sterile blades elliptic, 55–65 cm long, 17–23 cm broad, fully pinnate, the pinnae 10–13 pairs in mature plants, alternate, not at all imbricate, chartaceous in texture, lanceolate-linear, the larger 13–14 cm long, 1.8–2.1 cm broad, long and sharply attenuate at apex, cuneate at base, the lower free from the rhachis and sessile or very shortly petiolulate, the upper adnate and more strongly decurrent than surcurrent, the apical pinna conform with the others, not stalked but adnate at the base to the next lower pinna, the basal one or two pairs of pinnae slightly smaller than the others, the stipe with several vestigial, glandlike pinnae, the margins entire, the surfaces dark green above, paler beneath, the rhachis and costae beneath with a few, pale, deciduous scales, the rhachis beneath with an inconspicuous, low, ridgelike aerophore at the base of the pinnae, the primary veins often forked, the veins at the middle between the costa and margin of the larger pinnae ca. 34–38 per 3 cm, mostly 0.6–0.8 mm apart, inconspicuous, not elevated; fertile pinnae (from *Shafer 3581*) narrowly linear, ca. 20 cm long and 4 mm broad, ascending, upwardly curved, sessile; soral veins subcostular, thickened, dark, the sporangia numerous, spreading and covering the narrow leaf-surface of the "false indusium"; spores bilateral, monolete, plano-convex in profile, ca. 50 μ long and 35 μ high, exclusive of the somewhat loose, weakly cristate perispore. Annulus of 22–25 thickened cells.

TYPE: Cumberland Mountain, St. Vincent, B. W. I., 750–1000 m alt., May 14, 1947, *C. V. Morton 5822* (US No. 2,358,423).

PARATYPES: **St. Vincent:** Mountain forests, on trees, 2800–3300 ft, alt. *H. H. & G. W. Smith 1023* (BM, lower right and upper right hand plants, Morton photograph 7395); Grand Bonhomme, 800–930 m alt., May 24, 1947, *Morton 6134* (US nos. 2,358,489–90). **Puerto Rico:** Quebrada Grande to Cuchilla Firme, Sierra de Naguabo, 660–810 m alt., Aug. 6, 1914, *Shafer 3581* (US). Poor specimens, doubtless referable here, are: Sierra de Naguabo, May 8, 1914, *Hess 309* (US); Rio Prieto, Sierra de Naguabo, Aug. 10–15, 1914, *Shafer 3650* (US); Sierra Luquillo, March, 1912, *Hioram 340* (US).

The small section *Lomariocyas* (J. Smith) Morton (Amer. Fern J. **49:** 68. 1959) contains a few species characterized by acicular scales with a dark central portion more than one cell thick and usually by an erect, sometimes conspicuous trunk, which gives the plants a cycad-like appearance. The South African *B. tabulare* (Thunb.) Kuhn and the southern South American *B. magellanicum* (Desv.) Mett. are well known examples. The only representative known from the Lesser Antilles has been *B. rufum* (Spreng.) C. Chr., a plant confined to Guadeloupe; it is terrestrial with a thick trunk and has thick, stiff, coriaceous, closely set or even imbricate pinnae rounded at the apex. The present species differs in its epiphytic habit, slenderer rhizome, longer and relatively narrower pinnae, which are thinner in texture and long-attenuate at their apex. The relationship of *B. insularum* is not with *B. rufum*, but altogether with *B. underwoodianum* (Broadh.) C. Chr., of Jamaica, which is quite similar in general appearance. Its pinnae are longer and more linear in outline, with straighter sides and are merely acuminate at the apex, rather than long-attenuate. *Blechnum underwoodianum* is usually but not always a terrestrial species, which develops a trunk like other species of the section *Lomariocycas*. The Hispaniola species *B. ekmanii* Brause has been considered as a straight synonym of *B. underwoodianum*, but it appears to be slightly different in having a very short and densely scaly stipe. It may be known as *Blechnum underwoodianum* var. **ekmanii** (Brause) Morton & Lellinger, comb. nov. The basionym is *Blechnum ekmanii* Brause, Ark. för Bot. **17**: 69. 1922. It appears that *B. insularum* is confined to Puerto Rico and St. Vincent.

BLECHNUM RYANII (Kaulf.) Hieron. Hedwigia **47**: 245. 1908.

Onoclea striata Swartz. Syn. Fil. 304, 422. 1806. TYPE: St. Christopher [St. Kitts], B. W. I., *Forstrom* (S-PA, 3 sheets, Morton photographs 5922 and 5923).

Lomaria ryani Kaulf. Enum. Fil. 155. 1824. TYPE: Montserrat, B. W. I., *Forstrom* (isotype BM, Morton photograph 7393).

Blechnum striatum (Swartz) C. Chr. Ind. Fil. 160. 1905, *non* R. Brown, 1810.

Blechnum nesioticum Kramer, Acta Bot. Neerl. **9**: 299. 1960. Based on *Onoclea striata* Swartz.

Kramer recently renamed the illegitimate *Blechnum striatum* (Swartz) C. Chr., a later homonym, as *B. nesioticum*, believing that *B. ryanii* (Kaulf.) Hieron. represented a different species differing in having falcate, pubescent pinnae. A study of material from the type locality of *B. ryanii* (Montserrat) and from that of *B. striatum* (the nearby St. Kitts) shows that there are no differences in these characters. Material from Martinique, Guadeloupe, Dominica (*Hodge 86, Hodge & Hodge 1856*), St. Vincent (*Beard s. n., Eggers 6911*), and Grenada bears this out. The pinnae are all more or less falcate, and they are always pubescent while young, and sometimes some pubescence persists into maturity. This is the common species of the section *Parablechnum* in the Lesser Antilles; it is a coarse, terrestrial plant growing mostly on rocks at the higher elevations.

BOLBITIS CLADORRHIZANS (Spreng.) Ching

Lellinger 519 is the first record for this species on Dominica. It was found occasionally on the rocky floor of a ravine near the south end of the island. The species has been known from both Martinique and Guadeloupe, and is rather widespread in tropical America. It is rather large, erect, and terrestrial, with radicant sterile frond tips, in contrast to the scandent habit of *Bolbitis nicotianifolia* (Swartz) Alston, the only species of the genus mentioned from Dominica by Hodge (1954, p. 93).

DANAEA ALATA J. E. Smith, Mem. Acad. Turin **5**: 420. 1793.

Danaea fendleri Underw. Bull. Torrey Bot. Club **29**: 673. 1902. TYPE: Trinidad, *Fendler 147* (NY, not seen; isotypes US).

These two species have been kept nominally distinct since Underwood separated them in 1902, but it is peculiar that no specimens are ever referred to *D. alata*, which is ascribed a range of Martinique, St. Vincent, and Grenada by Underwood. Specimens from Grenada and Martinique were referred by Underwood also to his *D. fendleri*. Although Underwood states that the two differ in habit, he does not state in what way, and his descriptions do not show any differences. It seems very likely that the two are quite synonymous. The allied *D. stenophylla* Kunze is doubtless distinct by virtue of its closer veins and abruptly cuspidate-acuminate pinnae.

DIPLAZIUM LEGALLOI Proctor

Hodge (1954) does not mention this species, which is now known from the slopes of some of the larger mountains on Dominica (*Lellinger 481, 605*). *Diplazium callipteris* Fée, the name under which this species has long passed, has been shown by Proctor (1966, pp. 466–7) to be a synonym of *D. celtidifolium* Kunze, a strictly South American plant.

ELAPHOGLOSSUM LONGIFOLIUM (Jacq.) J. Smith

This species is not reported on Dominica by Hodge (1954, p. 69), and no specimens of it are in the Gray Herbarium, the Arnold Arboretum Herbarium (A. F. Tryon, pers. comm.), or the herbarium of the New York Botanical Garden (G. Jones, pers. comm.). The only specimen we have seen is *Fisher D65–8* from the northeast side of Fresh Water Lake.

ELAPHOGLOSSUM SCANDENS (Bory ex Fée) Moore, Ind. Fil. 14. 1857.

At the time Morton (1948) wrote his brief account of the species of *Elaphoglossum* in the French West Indies, this species was known from Martinique, Guadeloupe, and Dominica. It has since been collected in Grenada (*Proctor 17047*). A similar plant occurs in St. Vincent in the mountains above the Chateaubelair River (*Morton 5306*) and along the South Fork of the Cumberland River (*Morton 5809*) which perhaps tentatively can be referred here also. It differs in having a much thicker rhizome (ca. 3.8 mm in diameter, rather than 1.5–2.8 mm, as in typical *E. scandens*). Further study and material may very well show it to be different. In Morton's paper the type of *E. scandens* was said to be *de Thiouville*, from Matouba, Guadeloupe, in 1844. This must be considered a lectotype, for it was only one of two specimens cited originally. The second syntype is *Linden*, from Caracas, Venezuela, in 1842. The De Thiouville collection (P, Morton photograph 3902) agrees with the species as delimited in Morton's paper.

GLEICHENIA FURCATA (L.) Spreng.

Hodge (1954, p. 57) lists this species only from the French islands neighboring Dominica, but now one collection (*Chambers 2746*) is known from Dominica. Because *G. furcata* resembles the widespread *G. bifida* (Willd.) Spreng., it may be a fairly common but usually overlooked species.

HYMENOPHYLLUM HIRSUTUM (L.) Swartz.

Hymenophyllum atrovirens Fée & L'Herm. in Fée, Mém. Foug. 11: 120, *pl. 30, f. 4.* 1866. TYPE: Guadeloupe, *L'Herminier* (P, Morton photograph 4577).

Hymenophyllum atrovirens, which was not mentioned by Morton (1947), is by no means a synonym of *H. fucoides* (Swartz) Swartz, where it is placed in the "Index Filicum," but is a very narrow and elongate form of *H. hirsutum* (syn. *H. ciliatum* Swartz). Fée's original figure illustrates it very well. The error arose from Fée's description of the margins as dentate, which they are not.

Incidentally, it may be mentioned that Morton (1947, p. 155) cited the type of *Sphaerocionium vestitum* Presl, another synonym of *H. hirsutum*, as "Rio de Janeiro, Brazil, *Beyrich*," which should rather have been indicated as a lectotype. This was the first collection cited. The other syntypes are: Martinique, *Kohaut*, and Martinique, Plumier Tract. Fil. 73, *t. 50, f. B.* 1705.

HYMENOPHYLLUM HIRTELLUM Swartz var. GRATUM (Fée) Proctor

In Morton's revision of American *Hymenophyllum* section *Sphaerocionium* (1947, p. 156), *H. gratum* Fée is indicated as a large form of *H. hirsutum* (L.) Swartz. Two specimens collected in

Guadeloupe by L'Herminier are probably the holotype (P, Morton photographs 4583 and 4584); these show that Proctor (1966, p. 465) is probably right in considering these as a variety of *H. hirtellum* rather than of *H. hirsutum*, although the question is not easily decided. Although these two species are reasonably distinct as they occur in Jamaica, the type locality for both, the specific lines seem to break down in the Lesser Antilles, and many specimens seem to be somewhat intermediate. In general, *H. hirtellum* (including var. *gratum*) can be distinguished by its greater size, larger number of pinnae, larger number of segments (normally about 6 or 7 on the lower sides of the pinnae, compared with usually 4 in *H. hirsutum*), with the lowermost segments with forking rather than simple veins, longer and thicker stipes, and especially by the stipes being only slightly alate near the apex only. The stipes of typical *H. hirsutum* usually are alate to the middle or nearly to the base and are more slender, although many of them are somewhat more than the "0.3 mm. in diameter" stated in Morton's key and description; for this reason some undoubted specimens of *H. hirsutum* may run down to *H. hirtellum* in that key.

NEPHROLEPIS FALCATA (Cav.) C. Chr. cv. 'FURCANS'

This cultivar has remained in cultivation in Dominica (at Pointe Mulâtre Estate, for instance), and also persists at abandoned house sites, in one case on rock walls (*Lellinger 464*). Its erect fronds bear pinnae which fork once to four times. Proctor (1961, p. 32) points out that the variety is referable to *N. falcata* of New Guinea, and not to *N. exaltata* or *N. davallioides*.

NEPHROLEPIS HIRSUTULA (Forst.) Presl cv. 'SUPERBA'

Cultivar '*Superba*' has also remained in cultivation, and not only persists in abandoned gardens, but is spreading from them at a slow rate (*Lellinger 351*). The rhizomes of this variety are most firmly attached to the soil, the fronds are erect, the rhachises and pinna axes bear many reddish-brown, toothed scales, and the pinnae are irregularly pinnatifid to pinnate. This variety usually has been named *N. floccigera* f. *monstruosa* (see Morton, 1958, p. 20).

PITYROGRAMMA CHRYSOPHYLLA (Swartz) Link

The specimens referred to *P. schaffneri* (Fée) Weatherby by Hodge (1954, p. 86) and to *P. chrysophylla* var. *gabrielae* Domin by Domin (1929, p. 151) are considered by Tryon (1962, p. 68) to be a white color form of this typically yellow-colored species.

On Dominica the white form is by far the more abundant. Most of the white plants are small and have twisted stipes, as if they had been sprayed with a sublethal amount of herbicide (*Lellinger 337, 358*). A few of the white forms are larger and less twisted; their habit matches that of the yellow forms (*Lellinger 338*). Tryon was correct in assigning these white specimens to *P. chrysophylla*, rather than to *P. calomelanos* (L.) Link. Young, sterile pinnules and ultimate segments of the former species tend to have blunt or scarcely toothed apices and margins (*Haweis 14, Hodge 76, 1290*), while those of the latter are nearly serrate (*Haweis 9, Hodge 78*).

Domin's (1929, p. 151) other varieties of *P. chrysophylla* (*plumeriana, divulgata*, and *dominicensis*) seem to apply to plants of this species with various statures and degrees of dissection. Not having seen type specimens, tentatively we include them here. Whether some of these varieties are hybrids remains to be seen; a wide-ranging biosystematic study of this genus is certainly needed.

POLYPODIUM (Goniophlebium) TRISERIALE Swartz

Most of the specimens collected on Dominica by Lellinger (*379, 412, 416, 594*) have only two rows of sori. Domin (1929, *pl. XXIII, f. 1*) also illustrates a Dominican specimen with most of the sori in two rows. He adopted several varietal names under *P. brasiliense* Poir. for various atypical Dominican specimens. Of those mentioned as varieties or forms by Domin (1929, pp. 131–132), we maintain as distinct the Brazilian species *P. menisciifolium* Langsd. & Fisch. and the Greater Antillian *P. attenuatum* Humb. & Bonpl. ex Willd. in L. The latter presumably includes *P. ampliatum* (Maxon) Proctor, which is a renaming of *P. gladiatum* Kunze, *non* Vell. *nec* Wallich.

Despite their variation, the Dominican specimens all seem to belong to *P. triseriale.* Their fronds are generally large, slightly to considerably glaucous, grayish-blue, and fairly thin; their pinnae are generally broad, and, if so, they tend to have three rows of sori. Both *P. menisciifolium* and *P. attenuatum* normally have but one or two rows of sori; their fronds are generally smaller, less glaucous, and thicker, and their pinnae are narrower. Accurate delimitation of *P. triseriale s. l.* awaits intensive study.

TECTARIA PLANTAGINEA var. CONFLUENS Morton, Amer. Fern J. **56**: 123. 1966.

This variety, described recently from Puerto Rico, Trinidad, and Tobago, has also been found in Dominica at Fresh Water Lake, near Laudat (*A. C. Smith 10270*). It is characterized by having the sori irregularly elongate rather than round.

THELYPTERIS (Lastrea) COOLEYI Proctor

The type of this species, which was recently described by Proctor (1966, p. 468), is from Soufrière Crater on St. Vincent. Additional localities on the island are Cumberland Mountain (*Morton 5836*) and Mount Brisbane (*Morton 5965*).

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Frond Articulation in Species of Polypodiaceae and Davalliaceae

D. A. PHILLIPS AND RICHARD A. WHITE[1]

Abscission, the natural detachment of a plant organ, is being studied by physiologists (e.g., Addicott, 1964; Rubinstein and Leopold, 1964; Jacobs and Kirk, 1966) after many years of interest on the part of morphologists. As new facts are discovered about growth-regulating substances, the physiological mechanisms governing senescence are becoming increasingly apparent. All such mechanisms must be correlated with anatomical characteristics of the abscission zone, thus necessitating a thorough knowledge of the cell types and patterns in this region of the plant. Mühldorf (1925) summarized the work done in the lower groups and also referred to the comprehensive coverage given to the higher plants: Monocotyledons (Bretfeld, 1880; Fouilloy, 1899) and dicotyledons (Tison, 1900; Lee, 1911). There are, however, several gaps in the anatomical literature concerning abscission, and one noticeable omission is a thorough description of the disarticulation of the rachis from the rhizome in ferns. In one early work (Bäsecke, 1908) three categories were described: (1) The frond falls before clear abscission lines are formed; (2) Disarticulation occurs along a line of cells present from the youngest stages; and (3) The frond disarticulates along a separation layer formed during maturity.

Pfeiffer (1928, p. 163) examined other groups in addition to the ferns and established twelve classes of abscission based on various combinations of three characteristics of the separation layer. These included cell morphology, time of differentiation, and physiological condition of the cells after disarticulation. Most ferns are placed in class I of this system, in which the separation layer is formed by obtuse parenchyma, is evident as

[1] Our appreciation is expressed to the following who so generously donated plant materials: Longwood Gardens, Kennett Square, Pa.; The New York Botanical Garden; Garfield Park Conservatory, Chicago, Ill.; University of California, Berkeley; and the Royal Botanic Gardens, Kew, England. The study was supported by National Science Foundation grants GY-58 and GB-2279.

soon as the frond elongates, and contains lignified cell walls after disarticulation. Class III is similar to the first, except that cutinized cell membranes are present instead of lignified walls. This class was formed to accommodate species of ferns that might prove to have cutinized cell walls, but none such have ever been found.

A survey of several genera with articulate fronds in the Polypodiaceae and Davalliaceae was undertaken for two primary reasons. First, information relating to the secondary meristematic activity associated with articulation in ferns is incomplete. Bäsecke found two Davalliaceae species exhibiting this phenomenon, but whether it is more widespread in the family is unknown. Second, questions remain as to whether the separation layer becomes lignified after disarticulation in ferns. With improved staining procedures and microtechniques it is possible to place ferns in Pfeiffer's classification scheme with greater assurance. Fourteen species were investigated in the present study: *Phlebodium aureum* (L.) J. Smith, *Polypodium virginianum* L., *P. polypodioides* (L.) Watt, *P. pellucidum* Kaulf., *Pyrrosia lingua* (Thunb.) Farw., *Platycerium hillii* Moore, *Microsorium spectrum* (Kaulf.) Copel., *Pleopeltis thunbergiana* Kaulf. (all Polypodiaceae), *Davallia solida* (Forst.) Swartz, *D. fejeensis* Hook., *D. trichomanoides* Blume, *Humata tyermanii* Moore, *Oleandra sibbaldii* Grev., and *Araiostegia hymenophylloides* (Blume) Copel. (the last six Davalliaceae). Only the articulation of the *Phlebodium* has been described previously.

A selection of fronds and frond scars was taken the length of the rhizome in order to study the ontogeny of the separation layers as well as post-disarticulation characteristics. All specimens were prepared for sectioning by the usual paraffin embedding procedure (Johansen, 1940) and sectioned at 10 microns. A variety of stains were used, including phloroglucinol-hydrochloric acid, the Mäule reaction (Rawlins, 1933), and Sharman's series (Sharman, 1943).

There is one basic difference in petiole anatomy between the Polypodiaceae and the Davalliaceae. In general, the cortex area of petioles of species of Polypodiaceae appears to be composed of two morphologically different types of parenchyma cells (*Fig. 1*). In contrast, the parenchyma tissue in the petioles of the Davalliaceae is more homogeneous. In the former, the extension of the rhizome to the base of the rachis in younger fronds is composed of isodiametric parenchyma, whereas the cortex and epidermis of the rachis itself contain elongated cells. Thus a nominal separation layer is formed at the interface of these two cell types. Undoubtedly it was this fact which led Bäsecke (1908) to place the Polypodiaceae in his second category. As the frond matures, some of the cells in the rhizome protrusion begin to elongate, forming a true separation layer of isodiametric to obtuse parenchyma where disarticulation later occurs (*Fig. 2*). It appears doubtful that there is any secondary meristematic activity that results in the formation of a separation layer in the species of Polypodiaceae studied.

Bäsecke's observation that a separation layer is formed in the mature rachis of *Davallia bullata* and *D. recurva*[2] was found to be true for the Davalliaceae species included in this study. This secondary meristematic activity commences in the periphery of the rachis with numerous divisions in the parenchyma cells (*Fig. 3*). With continued mitotic divisions, a separation layer three to five cells thick forms across all of the living cells in the rachis. In most cases the rupturing of the rachis appears to occur between the third and fourth or the fourth and fifth cells in the distal portion of the layer. The nonliving tracheary elements are left to break mechanically during disarticulation.

The actual separation of the frond from the rhizome is similar in both the Polypodiaceae and Davalliaceae. All species investigated possessed separation layers which parted along the middle lamellae (*Fig. 4*). A chemical process involving conversion of calcium pectate to water-soluble pectin may occur (Facey, 1950). Various environmental factors probably account for cell walls that become damaged at the abscissed surface

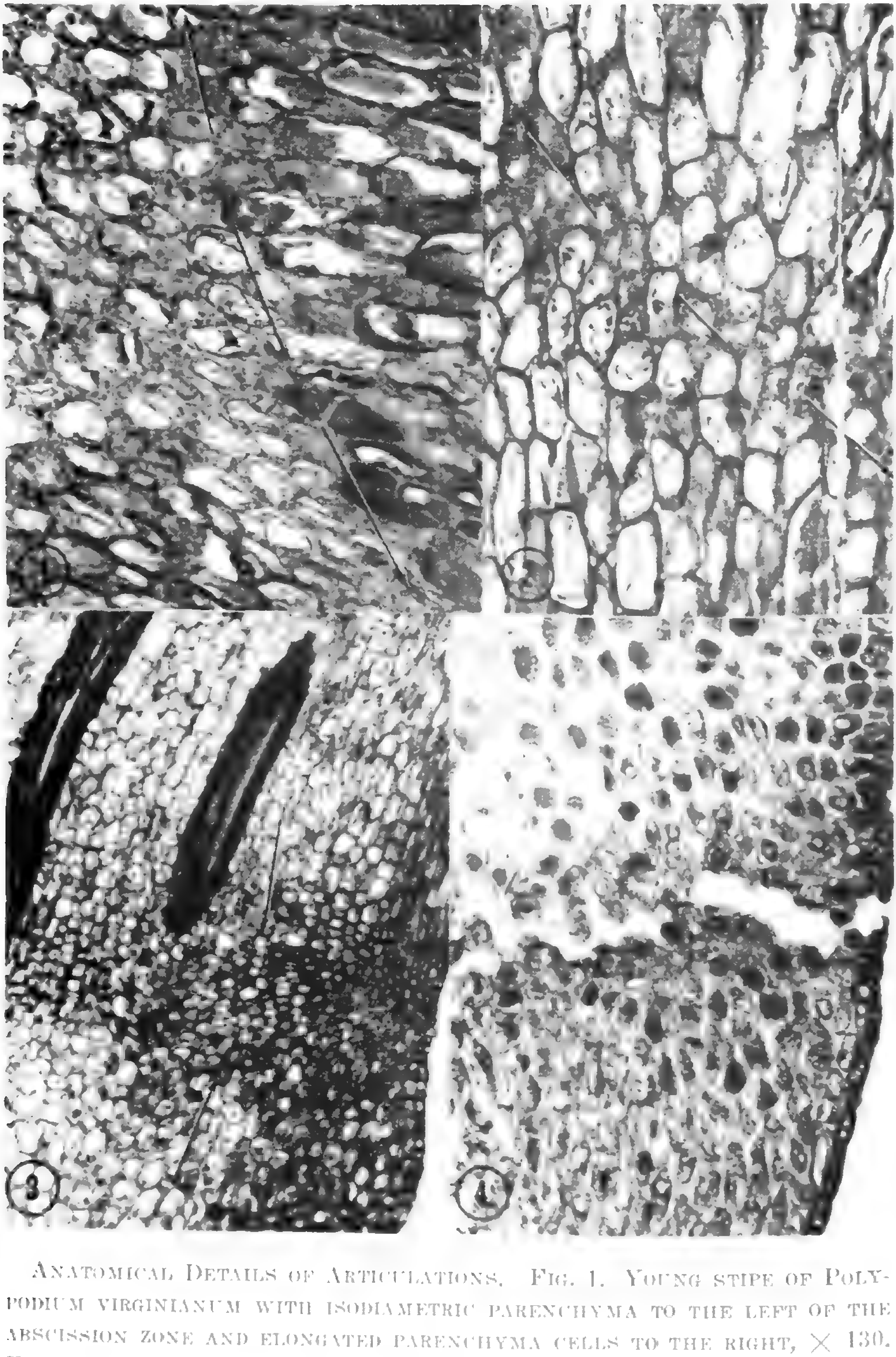
[2] There is no valid species *D. recurva*. The name is listed in Moore's Index as being from Linden's Catalogue of 1856. Presumably it is a *nomen nudum*.—Ed.

(*Fig. 5*). Normally a cicatrice or scar is formed soon after disarticulation, but for a short period of time the cell walls are exposed and the tracheary elements remain open.

Pfeiffer (1928) indicated that the ferns that had been investigated produced a lignified scar. Of the species included in this study only *Davallia solida* and *Humata tyermanii* failed to show lignification of some type in the separation layer (*Fig. 6*). A phloroglucinol-hydrochloric acid solution, the Mäule reaction, and Sharman's series were used in an effort to locate lignified tissue. *D. solida* gave a positive reaction in phloroglucinol but no definite lignin reaction in the Mäule test, thus indicating that it may contain the unidentified wound gum found to react in this manner in higher plants (Hewitt, 1938). A specimen of *Microsorium spectrum* was mechanically wounded and formed a cicatrice at the wound surface similar to that at the sites of disarticulation (*Fig. 7*). On this basis, it appears that cicatrice formation may be a process characteristic of any disrupted cell rather than a special physiological attribute of the cells forming the separation layer. This observation contrasts with the results of studies in higher plants. These produce scar or callus tissue at wound sites which has a distinctively different appearance from the orderly periderm protective layer present in many of the same species beneath the site of abscission.

In view of the fact that *D. solida* and *H. tyermanii* appear to produce a scar composed of some substance other than lignin, they must be placed in a separate group, indicated by Pfeiffer (1928) but not included in his twelve classes because he could find no examples. Perhaps this group could be termed class XIII as an addition to Pfeiffer's classification scheme. Both species exhibit a separation layer that develops late in the ontogeny of the frond. In both cases the separation layers are composed of isodiametric parenchyma cells, and the cicatrices do not give positive microchemical tests for lignin.

Davallia fejeensis, *D. trichomanoides*, and *A. hymenophylloides* represent a group with articulation characteristics very much like *D. solida* and *H. tyermanii*, the only difference being



ANATOMICAL DETAILS OF ARTICULATIONS. FIG. 1. YOUNG STIPE OF POLYPODIUM VIRGINIANUM WITH ISODIAMETRIC PARENCHYMA TO THE LEFT OF THE ABSCISSION ZONE AND ELONGATED PARENCHYMA CELLS TO THE RIGHT, × 130. FIG. 2. STIPE OF PLEOPELTIS THUNBERGIANA WITH SIMILAR PARENCHYMA that the former species produce scars that react positively to lignin tests while the latter do not. Thus they are the first examples of Filicineae that may be placed in Pfeiffer's class II, which is characterized by having some secondary meristematic activity, isodiametric parenchyma cells, and the presence of lignin in the cell walls. It is interesting to note that the only previous example of this class was a group of dicotyledons that drop their twigs (Pfeiffer, 1928).

Another morphological trait worth commenting on is a sheath of cells filled with a resinous substance that surrounds the tracheary elements in the rachis above the separation layer in all species investigated except *Oleandra sibbaldii.* Serial sections taken obliquely to the tracheary elements as they cross the separation layer make this point quite obvious (*Fig. 8*). As mentioned earlier, there is a difference between the cortex parenchyma below and above the separation layer in the petiole of species in the Polypodiaceae which is lacking in the Davalliaceae. However, in the Davalliaceae there appears to be a difference in the bundle sheath above and below the separation layer which is not found in Polypodiaceae species. The development of the separation layer in Davalliaceae raises interesting questions as to why the bundle sheath would vary from the upper to the lower zone in such anatomically similar cells.

In addition to the lack of a specialized bundle sheath in either the rhizome or the frond side of the separation layer, two other characteristics distinguish *O. sibbaldii* from the other species studied. First, a definite lignin reaction in all tests was obtained in the cell walls at the separation layer before disarticulation occurred (*Fig. 9*). With the exception of *D. fejeensis,* which exhibited a trace of lignification in the cell walls immediately before rupturing, none of the other species studied showed lignification or suberization before disarticulation. Second, a longitudinal section of a developing separation layer in

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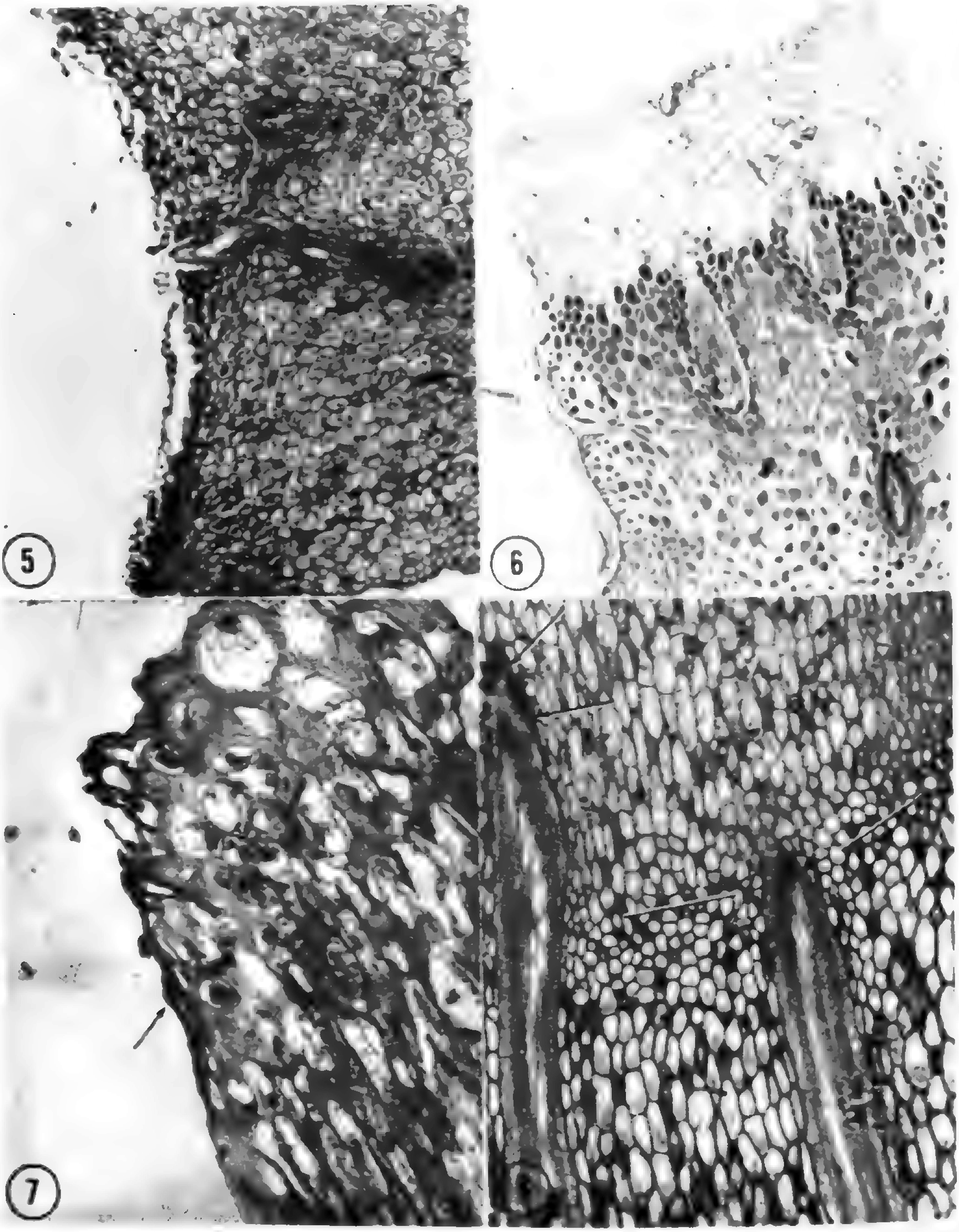
CELLS ON BOTH SIDES OF THE ABSCISSION ZONE, × 130. FIG. 3. STIPE OF HUMATA TYERMANII IN WHICH MITOTIC DIVISIONS PRECEDE ABSCISSION ZONE FORMATION, × 25. FIG. 4. STIPE OF DAVALLIA FEJEENSIS SHOWING DISARTICULATION ALONG THE MIDDLE LAMELLAE BETWEEN CELLS, × 130.



ANATOMICAL DETAILS OF ARTICULATIONS. FIG. 5. TYPICAL FROND SCAR OF MICROSORIUM SPECTRUM WITH LIGNIFIED CELLS ON THE SEPARATION SURFACE, × 15. FIG 6. TYPICAL FROND SCAR OF DAVALLIA SOLIDA REVEALING NO LIGNIN REACTION IN SHARMAN'S STAINING SERIES, × 10. FIG. 7. WOUNDED STIPE OF MICROSORIUM SPECTRUM WITH LIGNIN REACTION (ARROW) SIMILAR TO THAT FOUND IN THE NORMAL ABSCISSION AREA, × 130. FIG. 8. VASCULAR BUNDLES WHICH TRAVERSE THE SEPARATION LAYER (INDICATED BY LINES) IN

O. sibbaldii (*Fig. 10*) shows that articulation occurs much further up the rachis than in any other species studied. The ratio of the rachis diameter to the distance between the rhizome and the separation layer is approximately 1:12 as opposed to 1:1 for *Polypodium pellucidum* and 2:1 for *Phlebodium aureum*.

The eight Polypodiaceae species studied conform to Pfeiffer's class I and thus are additional support for his classification. They are characterized by separation layers composed of obtuse parenchyma formed during the youngest stages of development which become lignified after disarticulation. Although Pfeiffer (1928) formed class III on the assumption that some ferns with the same cell morphology in the separation layer and a similar time of differentiation might prove to be cutinized instead of lignified, there are no recorded examples of this group.

The general morphology of the separation layers and the resulting scars are not especially characteristic for each species. The customary shape of the disarticulated surface is concave to the transverse plane of the rachis (*Fig. 5*). Occasionally a slight protuberance is visible where the xylem elements have ruptured mechanically at a point distal to the separation layer. Only *Platycerium hillii* and *Pyrrosia lingua* differed significantly in the morphology of the scar. Both of these species exhibit a strikingly similar, generally concave separation layer with a sharply recessed area in the cortical zone. The protruding hypodermis is composed of sclereids (*Fig. 11*). Recent scars show a steeper declivity in the region of the hypodermis than older ones.

Beneath the epidermis in *P. lingua* is a hypodermis composed of several rows of thick-walled cells which contain yellow staining substances. The cells composing a row just beneath the hypodermis reveal a thickening in their walls which reacts like the Casparian strips of the endodermis with the staining methods employed (*Fig. 12*). The thickenings are not found chiefly

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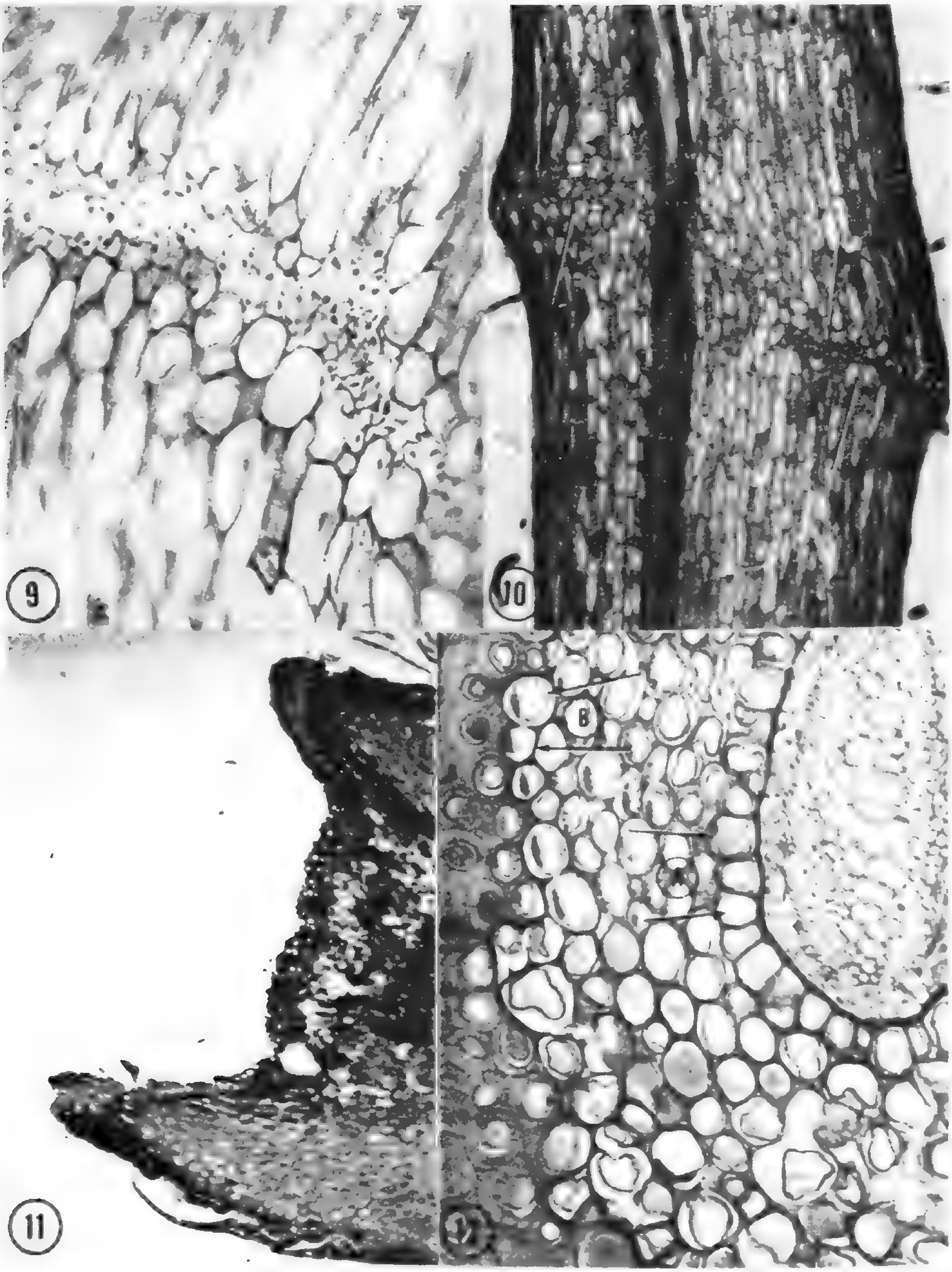
POLYPODIUM PELLUCIDUM; ARROWS INDICATE A SHEATH AROUND THE BUNDLE ABOVE THE ABSCISSION LINE; SUCH A SHEATH IS ABSENT BELOW THE LINE, × 25.



Anatomical Details of Articulations. Fig. 9. Separation zone of Oleandra sibbaldii with lignin (dark stain) revealed by the Mäule reaction, × 130. Fig. 10. Early development of the separation zone (area between arrows) in O. sibbaldii, × 15. Fig. 11. Typical separation scar for Pyrrosia lingua (and for Platycerium hillii), contrast-on the tangential walls, as in the case of the cells of the endodermis, and no gaps are apparent as they weave from radial to tangential walls in this irregular layer of cells. Thus it appears that two Casparian strips are present in *P. lingua:* one surrounding the individual tracheary bundles and another enclosing the entire vascular system just inside the hypodermis. This phenomenon is not to be confused with the "double endodermis" that has been mentioned in the literature (Ogura, 1938), a confused concept regarding the endodermis and pericycle in certain plants.

Davallia solida, D. fejeensis, D. trichomanoides, and *H. tyermanii* contain varying amounts of a suberin substance on the edges of the protuberance of the rhizome immediately beneath the separation layer. In contrast to the hypodermis of *Pyrrosia lingua* and *Platycerium hillii,* however, the yellow stain is restricted to the cell walls and no deposits fill the lumina. It is not known what this yellow staining substance is, and although this condition may be related to articulation, there appears to be no definite pattern of deposition of the substance in any of the species. A longitudinal radial section of any of the species will generally reveal a group of suberized cells two to ten cells wide extending from the rhizome to the separation layer. *Davallia solida* has the narrowest band of cells (usually less than four cells wide), whereas *H. tyermanii* often has patches up to ten cells across. The amount of suberin often decreases in *D. trichomanoides* and *H. tyermanii* before the rachis disarticulates, but no definite ontogeny was noted in *D. fejeensis* or *D. solida.*

One must conclude from this investigation that Pfeiffer's classification is well supported by the ferns. Anatomical evidence tends to substantiate an ontogenetic difference in the separation layers of Polypodiaceae versus Davalliaceae. Future studies will attempt to determine whether this diversity is evident in those species with articulate pinnae.

ING WITH ALL OTHER SPECIES STUDIED (CF. FIG. 6), × 15. FIG. 12. RHIZOME OF P. LINGUA WITH INNER (A) AND OUTER (B) CASPARIAN STRIPS, × 130.

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Shorter Notes

BOTRYCHIUM MULTIFIDUM IN OHIO.—The Leather Grapefern, *Botrychium multifidum* (Gmel.) Rupr., is evidently an extremely rare species in Ohio. Clausen[1] did not list this state in his enumeration of localities. Vannorsdall[2] lists Fairfield and Highland Counties for this species. The former record is based upon a 1952 collection (*Wagner 8101,* MICH) that has since been correctly identified as *B. oneidense.* The basis for citing Highland County is unknown. It seems a most unlikely locality, being much further south than one might expect the species to occur. I have found what are probably the first authentic records for the state at three stations in northeastern Ohio. In the western part of the state, specimens should also be sought in the north, e.g., in Lucas County, which is adjacent to Monroe County, Michigan, where *B. multifidum* has been found.

One station is in Mahoning County in a small, rich woodlot near a roadside park along State Route 18, Lake Milton Township. I collected a single frond on April 27, 1966; the identification has been verified by W. H. Wagner, Jr. The specimen was found on a raised area between two small streamlets which traverse the woods. Subsequent visits have failed to produce more collections, although the closely related *B. dissectum* is frequent in the same area. Other associated pteridophytes include *B. virginianum, Cystopteris protrusa, Onoclea sensibilis, Thelypteris noveboracensis,* and an undetermined *Dryopteris.*

Another plant of *B. multifidum* was discovered in Ashtabula County on May 8, 1966, at Pymatuning Lake. The specimen was growing with *B. dissectum* under red maples and apple trees in a cleared area near a cabin in the cabin area at Pymatuning State Park, southeast of Andover, Andover Township. I revisited the spot on June 12 and found eight more individuals of *B. multifidum,* together with ten of *B. dissectum* and eight of *B. oneidense.* The *Botrychium* colony measured approximately 50

[1] Mem. Torrey Bot. Club **19**(2): 34. 1938.
[2] Ferns of Ohio, p. 116. Edwards Brothers, Ann Arbor, Michigan. 1956.

by 20 feet. The dry, grassy area was newly mown. No fertile specimens were found and many blades were injured or dwarfed.

Also on June 12 I found additional specimens of *B. multifidum* about two miles away in Pymatuning State Park in a picnic area and park along County Route 166 southeast of Andover, Williamsfield Township. Here the grass had not been mown; except for that, the area was similar in every respect with the one at Pymatuning Lake and the specimens were generally much larger than at the cabin area. One blade of *B. multifidum* measured 8.5 × 13.0 cm; one of *B. dissectum* was 12.3 × 18.1 cm.

Specimens from each station are in the herbarium of Kent State University. Duplicates of the Ashtabula County material are at Ohio State University and the University of Michigan.—ALLISON W. CUSICK, *Department of Biological Sciences, Kent State University, Kent, Ohio 44240.*

THE BIBB COUNTY, GEORGIA, OCCURRENCE OF ASPLENIUM PINNATIFIDUM.—The notes on the habitats of the Lobed Spleenwort in Georgia in this JOURNAL, volume 56, page 149, brought back memories of my search for this fern in Bibb County many years ago. I had come across a record of its having been found in that county in the Coastal Plain, southeast of Macon. Because that seemed unusual for an upland fern, I went to look for it. There proved to be a sandstone hill at the locality (not mentioned in Dr. Duncan's list); naturally I explored its presumably cooler north-facing ledges fully, with negative results. So I went around to the south side to see if any ferns of interest might occur there. A small spring emerged from the base of the hill, and on the adjacent sandstone outcrops there was the Lobed Spleenwort! It was well shaded by trees, and its roots were kept cool by the evaporating moisture, which accounted for its survival. This seems worth placing on record as an object lesson to beginning fern explorers: Don't ignore seemingly unlikely habitats. Microclimates can sometimes result in unexpected occurrences.—EDGAR T. WHERRY, *University of Pennsylvania, Philadelphia, Pa. 19104.*

LYCOPODIUM LUCIDULUM IN THE BOSTON MOUNTAINS OF ARKANSAS.—In connection with field studies (supported by National Science Foundation grants GY-210 and GB-4095) of the bryophytes of the Interior Highlands during the spring of 1966, two populations of *Lycopodium lucidulum* Michx. were found. Apparently this clubmoss has not been reported previously from Arkansas.

One population is in an area known as Spy Rock Hollow in Franklin County, 2.5 miles east of Cass, sec. 20, T. 12 N., R. 26 W. (*Redfearn & Bowers 18420;* SMS, UARK). Our attention was directed to this area by a paper on its interesting bryoflora by Wittlake.[1] The hollow is long and relatively narrow, with extensive north-facing shale and sandstone bluffs and a mixed mesophytic forest containing a high percentage of beech and sweetgum. The population of *L. lucidulum* was small, but in good condition, and occurred on a lower talus slope.

The second population of *L. lucidulum* was found in a narrow ravine just west of Beech Creek, about two miles south of Boston, in Madison County, sec. 12, T. 13 N., R. 25 W. (*Redfearn 18553;* SMS, NCU, MICH), in the general area from which Clark[2] reported the filmy fern, *Trichomanes boschianum*. This extensive population was growing on vertical sandstone of a north-facing bluff. The forest of this area is also a mixed mesophytic type.

These localities are of a particular interest because of the relic mixed mesophytic forests occurring there, as Braun[3] has commented, and because several bryophytes were found in these areas that typically occur in the mixed mesophytic forests of the Southern Appalachians. The presence in the Boston Mountains of *L. lucidulum* and bryophytes such as *Bryoxiphium norvegicum, Hookeria acutifolia, Rhytidiadelphus triquetrus, Bazzania trilobata,* and *Campylostelium saxicola* is further evidence for

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[1] Proc. Ark. Acad. Sci. **3**: 39–40. 1950.
[2] Amer. Fern J. **52**: 85–86. 1962.
[3] Deciduous Forests of Eastern North America, pp. 170–172. Blakiston Press, Philadelphia. 1950.

the thesis that its flora was derived from the Mesophytic Arcto-tertiary Geoflora.—FRANK BOWERS and PAUL L. REDFEARN, JR. *Southwest Missouri State College, Springfield, Missouri 65802.*

Recent Fern Literature

INDEX SELAGINELLARUM, by Clyde F. Reed. Memórias da Sociedade Broteriana **18**: 1–287. 1966.—The fern-allies were not included in Christensen's "Index Filicum," and so there was never any index to the species of these important groups. Dr. Reed undertook about 15 years ago or more to prepare indices, a time-consuming task because this involved a careful search of all the literature, which is widely scattered among many publications, some of them exceedingly rare. The "Index Isoëtales" was published in 1953, and the "Index Marsileata et Salviniata" in 1954. Just recently the "Index Marsileata et Salviniata Supplement" was published,[1] which brings this index up to date. Now the much greater index to *Selaginella* has appeared. No count is given of the number of names, but the number must be in excess of 2,500. These are all cited with not only the original citations but also with a listing of many of the important supplementary references where the name has appeared, a feature that will make the index much more useful than a mere list of names, however useful that may be of itself. Reed has attempted to indicate the recognized species and the synonyms, another useful feature, but of course this is not intended to be authoritative. Reed has not made taxonomic decisions himself, but has been obliged to follow the treatments of others, chiefly the works of Hieronymus and Alston. The basis of Reed's Index was an unpublished index by the late A. H. G. Alston, who was the most noted modern authority. Alston's index was a working index probably not intended for publication. It was quite incomplete and also contained many entries with only partial citations. Reed has checked these so far as possible, but it has not been possible to check some

[1]Boletim da Sociedade Broteriana II, **39**: 259–302. 1965.

entries that were given to horticultural catalogues that are not available in the United States. In addition to living species the index contains the names of such fossils as are reputed to belong to the family. The book is available from Clyde F. Reed, 10105 Harford Road, Baltimore, Md. 21234.—C.V.M.

FLORA OF NEW ZEALAND, volume I, Indigenous Tracheophyta (Psilopsida, Lycopsida, Filicopsida, Gymnospermae, Dicotyledones), by Harry Howard Allan. pp. (i)–liv, 1–1085. 1961. Published by R. E. Owen, Government Printer, Wellington, New Zealand.—Although not now brand new, this valuable work deserves a mention in the FERN JOURNAL for its fine, up-to-date treatment of the ferns and fern-allies of New Zealand, which is at once more technical and more scientific than that of Dobbie and Crookes in the only previous readily available work on New Zealand ferns. This is not to downgrade the latter, which is useful for its fine illustrations and for the readability of its text. The present work by Allan has no illustrations and is not "readable," for it consists of keys and descriptions, with very few comments, but it does have much information not in Dobbie and Crookes, such as full citations, full synonymy so far as it applies to New Zealand fern literature, citation of types, and mention of all the varieties and hybrids described from New Zealand. The ferns are treated on pages 1 to 104. It is impossible to comment in detail on such an extensive treatment, which has many points of interest. *Leptopteris* is kept as a subgenus of *Todea*, which may not be to everyone's liking; although it may not have any very strong generic characters, it does seem that its filmy-fern-like texture might be sufficient to keep it generically distinct from the rather coarse-textured *Todea barbara*. The generic name *Loxsoma* is replaced by *Loxoma*, which is the original spelling, which has not been adopted in the last century, or at least not generally; the matter deserves a discussion, on the basis of etymology. The new names noted are as follows, but there may be others that I have overlooked or which are not clearly indicated: *Lycopodium australianum* (Herter)

Allan, *Gleichenia* subg. *Sticherus* (Presl) Allan [but as a subgenus the name *Mertensia* has priority], *Trichomanes* subg. *Vandenboschia* (Copel.) Allan, *Trichomanes* subg. *Crepidopteris* (Copel.) Allan, *Trichomanes* subg. *Selenodesmium* (Prantl) Allan, *Trichomanes* subg. *Macroglena* (Presl) Allan, *Trichomanes* subg. *Cardiomanes* (Presl) Allan, *Thelypteris pennigera* (Forst. f.) Allan, *T. gongylodes* (Schkuhr) Allan [but this combination was previously made by Small, 1938], *T. dentata* (Forsk.) Allan [but this combination was previously made by E. St. John, 1936], *T. palustris* Schott [not "(Salisb.) Schott" as Allan has it] var. *squamigera* (Schlecht.) Allan [but this combination was previously made by Tardieu-Blot, 1953], *Asplenium falcatum* Lam. var. *caudatum* (Forst. f.) Allan, and *Blechnum minus* (R. Brown) Allan [combination previously made by Ettingshausen, 1864].—C. V. M.

Notes and News

WORD HAS BEEN RECEIVED from Dr. T. Namegata, president of the Japanese Fernist Club, conveying the sympathy of our Japanese friends and colleagues over the loss of Dr. Ralph C. Benedict, a charter member of the American Fern Society. Dr. Namegata writes, "We have always highly appreciated his courtesy offered to us at the start of the Japanese Fernist Club. He encouraged us by informing the circumstances of the American Fern Society and telling the difficult conditions encountered at the establishment of the Society. Probably none of us have met with him but we will remember the great man forever."—D.B.L.

FERN FORAY RESERVATIONS must be made immediately. Write to Dr. Donovan S. Correll, Texas Research Foundation, Renner, Texas 75079. For room reservations write to Mrs. Carol Steinruck, Lazy Hills Guest Ranch, Ingram, Texas 78025. Details may be found in the previous issue of this JOURNAL.

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CONTENTS

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American Fern Journal

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Errera's Law and the Monolete Spore

NORMAN P. MARENGO

Throughout the literature dealing with the three-dimensional shape of undifferentiated cells, there runs the theme of the principle of minimal surface area as applied to the partitioning of protoplasmic volume into its sub-units, cells. At no place is there a clear or forceful statement made to this effect, although Errera's[1] (1886) statement that "at the time of its formation, a cell membrane tends to assume the same form that a weightless fluid layer would assume under the same conditions," is referred to as "Errera's Law" by D'Arcy Wentworth Thompson (1952).

Conclusions reached by Lewis (1925, 1944) ascribe polyhedral cell shape to both surface tension and the necessities of spherical geometry. Matzke and Duffy (1955) conclude, after a study of interphase cells within the apical meritsem of *Anacharis densa*, that "... the variation in number, kinds, combinations and arrangements of faces in these cells is the result of the interplay of numerous factors and that the frequent occurrence of pentagonal faces is correlated with angular stability under liquid and semiliquid conditions at the time that the cell plate is formed in the cells within the apical meristem."

Matzke (1940) described the three-dimensional shape of bubbles in soap foam and stated that they closely approached in three-dimensional shape the cells previously described by Lewis (1944) and Marvin (1939), and concluded that this evidence strongly supports the view that surface tension, along with such

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[1] The author is indebted for accurate translation of Errera's paper to Sp. 4 Robert F. Marengo, U.S. 51585875 HHB, 1st BN, 22nd ARTY, APO N. Y. 09696.

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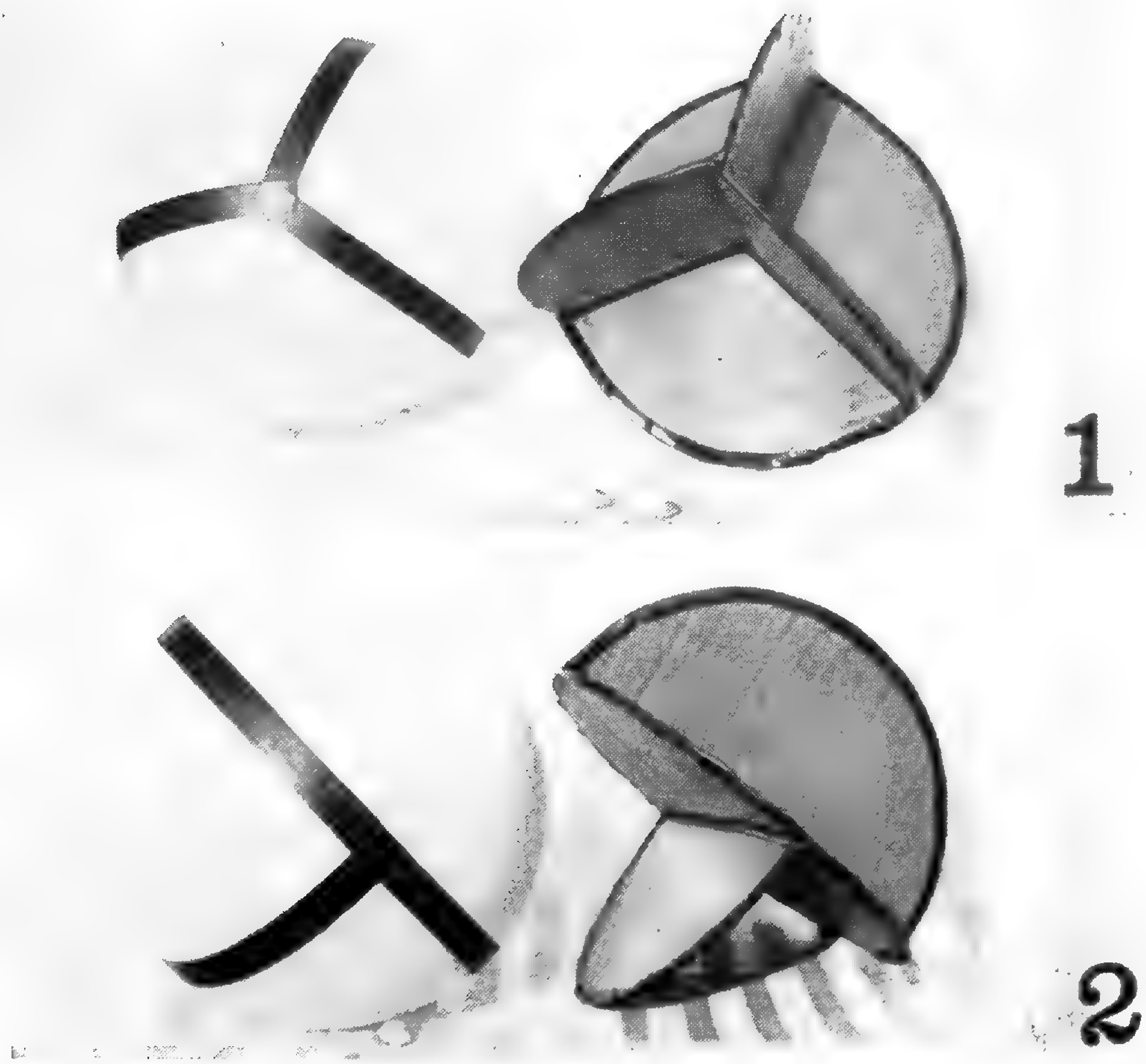

MODELS ILLUSTRATING SURFACE FEATURES AND INTERNAL PARTITIONS OF NEWLY-FORMED QUARTETS OF SPORES. Fig. 1. TRILETE SPORES. Fig. 2. MONOLETE SPORES.

other factors as contact and pressure, is important in the determination of cell shape.

In this paper I propose to examine critically this least-surface principle called Errera's Law, as it relates to one of the simplest types of subdivision of space which occurs in nature: the equal partitioning of the spherical spore mother cell of the fern into the spore quartet.

The development of the argument that the newly-formed monolete spore quartet negates this principle must allow two basic assumptions: first, that the newly-formed spore at the moment of completion of cytokinesis is an undifferentiated cell, and, second, that the physical environmental conditions within sporangia forming trilete spores as opposed to monolete spores are essentially the same.

Figure 1 illustrates surface features and internal partitions of a spore quartet of the trilete type immediately following completion of cytokinesis. In a spherical spore mother cell partitioned into four tetrahedrally symmetrical (trilete) spores, the four lines which internally delimit the six planes partitioning the sphere meet at a point which would be the center of symmetry of a regular tetrahedron inscribed in the sphere. The angle between any two of these lines is the tetrahedral angle, or Maraldi's angle (Thompson, 1952) of 109° 28′ 16″ or about 109.5°. Since our system of angular measurement is based upon a frame of reference of two dimensions, the circle, a system of tetrahedral symmetry involving four lines extending from a point in space and angularly equidistant from each other can never be exactly expressed in terms of angular measurement based upon the subdivision of the circle. Hence Maraldi's angle is incommensurable with conventional angular measurement. Inspection of the partitioning planes in *figure 1* will show that the total angular distance included in these planes is 6×109.5 or 657.0°.

Figure 2 illustrates surface features and internal partitions of a spore quartet of the monolete type. The total angular distance included in these partitioning planes is shown by inspection to be $4 \times 180°$ or 720°. For spheres of equal diameter partitioned into four equal parts it is evident that the trilete type follows Errera's Law but the monolete does not.

The occurrence of spore quartets of the monolete type under sporangial conditions no different physically from those holding for trilete spore quartets would suggest that a protoplasmic tendency to produce a specific spore type was present in the spore mother cell prior to the maturation divisions of sporogenesis.

The entire question of undifferentiated cell shape as it is related to position in the cell mass, surface forces, pressure, and tension, would appear on the basis of the preceding analysis to be more readily explained by reference to dynamic protoplasmic tendencies to compartmentalize into functional units of given shape, size and arrangement. The undifferentiated cell, whether it be a monolete or trilete fern spore, *Anacharis* meristem or *Eupatorium* pith, is the shape it is, not because of external pressure or surface forces, but because it is bearing the protoplasmic potentialities of the organism of which it is a part, and the development of these potentialities is a reflection of the genetic code expression of the cell's part in the organismic whole.

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A New Species of Notholaena from Mexico[1]

THOMAS R. PRAY

In the course of a collecting trip to central Mexico during the summer of 1964, a *Notholaena* was found that has proved to be distinct from previously described species. The new species belongs to the group characterized by cereous indument of the leaf. It seems to be most closely allied to *N. candida*. The superficial appearance of the plant, particularly its narrower lamina and smaller, more remote segments (*Fig. 1*), however, suggests *N. greggii*. Apparently it bears no close relationship to the latter.

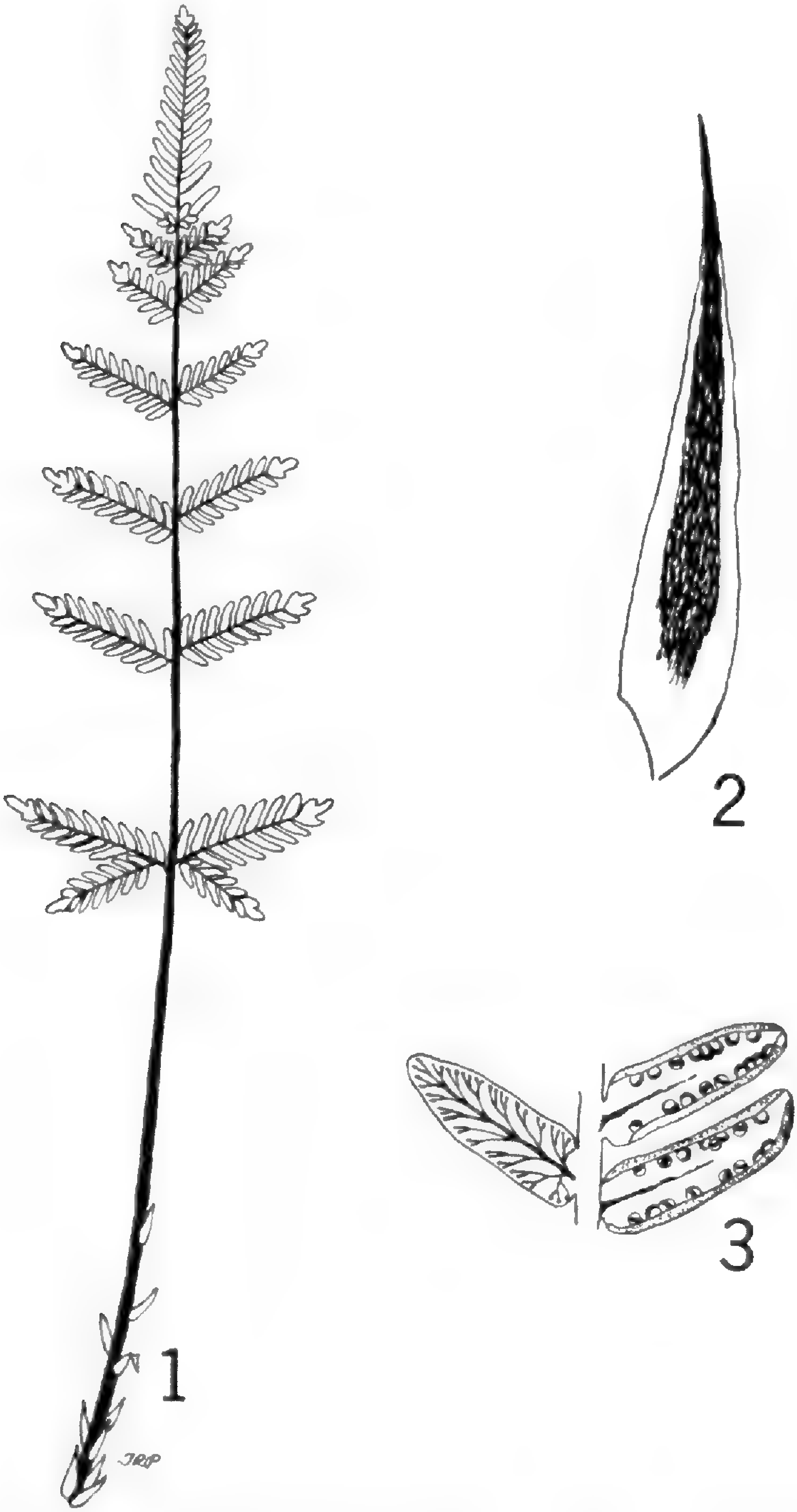
NOTHOLAENA **jacalensis** Pray, sp. nov. Plate 10

Rhizoma breve, horizontale, ramosum; squamae lanceolatae, 3–4 mm longae, brunneae, marginibus angustis pallidioribus, taenia sclerotica lata, marginibus integris. Folia plerumque 10–25 cm alta; stipes crassus nitide niger, teres, glaber praeter aliquot squamas ad basim, has dilute brunneas, concolores, aut centrum angustum obscurius habentes, paululo brevior quam lamina, uno fasciculo vasculari praeditus. Lamina lanceolata, bipinnata praeter pinnas infimas, acuta, coriacea, superficie superiore glabra aut indumento cereo levissimo praedita, superficie inferiore dense cerea dilute flava; rhachis valde sulcata, glabra. Frons 4–7, pinnata, pinnis lanceolatis, 6–14 paria segmentorum lanceolatorum discretorum integrorum, sessilium sed non adnatorum habentibus, marginibus revolutis, non mutatis; pinnae basales unicam pinnulam interiorem inferiorem longissimam pinnatamque, cum 4-8 segmentis praebentes. Venae 1- vel 2-furcatae; sporangia (64 sporas ferentia) in cacuminibus subflabellatis venarum disposita.

TYPE: Jacala, Hidalgo, Mexico, roadside 1 km south of village, along highway #85, July 2, 1964, *Pray 3095* (US).

This species is very distinct from known Notholaenas, among which the only close relationship seems to be with *N. candida*. The prominent development of the basal pinnules of the lowest pair of pinnae is reminiscent of var. *copelandii* in particular. However, *N. jacalensis* is readily distinguished in a number of

[1] The financial support of the National Science Foundation (Grant #GB-1716) is gratefully acknowledged.



NOTHOLAENA JACALENSIS PRAY, SP. NOV. FIG. 1. LEAF, × 0.9. FIG. 2. SCALE FROM RHIZOME, × 26. FIG. 3. UNDERSIDE OF PINNA SEGMENTS, × 5.7. TYPE SPECIMEN (US).

ways. The most obvious of these are: (i) a narrower lamina; (ii) the gradual narrowing of the apex of the lamina; (iii) the wide spacing of the lower pairs of pinnae; (iv) the yellow color of the cereous indument. The rhizome scales of *N. jacalensis* (*Fig. 2*) are entire, unlike those of var. *copelandii* but similar to those of var. *candida*. The species also differs from both varieties of *N. candida* in that the margins of the utimate segments are strictly entire rather than crenulate or lobed. Thus, the new species shares certain features with each of the varieties of *N. candida* but is clearly separable from both in several respects. In addition, the constricted bases of the segments (*Fig. 3*) distinguishes *N. jacalensis* from *N. candida* and all of its close allies. Because of its particular combination of characters, *N. jacalensis* cannot be placed in Tryon's key, which will need considerable alteration to accommodate this new species.

Notholaena jacalensis appears to be rare and has not been collected previously so far as I am aware. The collection consisted of two multibranched individuals. It produces 64-spored sporangia and is quite fert'le. The gametophytes are of the normal sexual type, as was to be expected, and bear cereous trichomes similar to those of the sporophytes. This gametophytic character is characteristic and distinctive for the group of Notholaenas to which the new species belongs (Giauque, 1949; Pray, 1961).

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Selaginella apus or apoda ?

C. V. MORTON

The question of the proper name for our common creeping *Selaginella* of the eastern United States has been a vexing one, even for scholars. From 1753 until 1840 this plant was known as *Lycopodium apodum* L., but in segregating *Selaginella* from *Lycopodium* in 1840 Spring called it *Selaginella apus* (L.) Spring, a name it retained generally until 1915, when the late Merritt L. Fernald called it *Selaginella apoda* (L.) Fernald. Since that time, a period now of over 50 years, there has been no general agreement as to the specific epithet or the authority. Broun, in his "Index to North American Ferns" (1938) used *S. apoda* (L.) Spring, and his nomenclature had the blessing of C. A. Weatherby, the noted authority on the Code, or the "Rules," as they were called at that time. Fernald, in "Gray's Manual of Botany" (1950) continued to use *S. apoda* (L.) Fernald, whereas I, in the "New Britton and Brown Illustrated Flora" (1952), used *S. apoda* (L.) Spring. I hope to demonstrate that the latter is correct.

At the Ithaca meeting of the American Institute of Biological Sciences some years ago, Marcel Raymond gave a paper on this subject, in which he indicated that there was no adjective *apodus, apoda, apodum,* and that therefore Linnaeus made an error in naming this plant *Lycopodium apodum.* He stated that the only classical word was *apus,* a noun, and that therefore Spring was right in correcting the Linnean name to *Selaginella apus.*

More recently, I submitted the question to Dr. William T. Stearn, who is an authority on Latin and Greek as well as on Linnaeus. I should like to quote in part from his reply:

"In answer to your enquiry of the 14th June, 1965, regarding *apodus* and *apus,* let me begin with some wise remarks of Ben Johnson which express the basis of this letter: 'Custom is the most certain mistress of language . . . yet when I name custom, I understand not the vulgar custom . . . but that I call custom of speech, which is the consent of the learned, as custom of life, which is the consent of the good.' There exists, to my knowledge, no classical precedent for *apodum* as an adjective meaning 'footless' or 'sessile,' but botanical Latin would never have become a widely used international medium for the naming and description of so many different kinds of plants if its users had been bound instead of guided by classical precedent. Linnaeus' use of the epithet *apodum* provided precedent for the use of it and analogous compounds by other authors. They have all received 'the consent of the learned,' which I take as fairly consistent acceptance and usage by nineteenth-century botanists of acknowledged scholarship. Linnaeus undoubtedly had the name *Lycopodium apodum* suggested to him by Dillenius's phrase-name *Lycopodioides . . . spicis apodibus* and in his haste to complete the *Species Plantarum* he probably accidentally failed to notice, rather than ignored deliberately, that the ablative plural *apodibus* implies the nominative singular *apus*, which was the borrowed Latin designation of a reputedly footless bird, the swift (*Apus apus* (L.), *Hirundo apus* L.) and that had Dillenius been using a nominative singular *apodus* the ablative plural would then have been *apodis*. Nevertheless, Linnaeus, as the virtual founder of modern botanical Latin, thereby coined the first of a series of useful botanical Latin adjectives having *-podus, -a, -um* as their final element, and one cannot justifiably reject or amend these on the assumption that they are orthographic errors. Amendment of *apodus* to *apus*, as was done by the erudite Spring under *Selaginella* would necessitate, if accepted, the alteration of all other botanical epithets having *-podus* as their basis. Among the names affected would be *Ainsliaea pteropoda* DC., *Anthemis coelopoda* Boiss., *Arceuthobium campylopodum* Engelmann, *Berberis brachypoda* Maxim., *Bulbophyllum apodum* Hooker f., *Carex micropoda* C. A. Meyer, *Carex ornithopoda* Willd., *Eucalyptus leptopoda* Benth., *Gigartina apoda* J. Agardh, *Ilex macropoda* Miquel, *Rhododendron lasiopodum* Hutchinson, and many others with the epithets melanopoda, dasypoda, gymnopoda, and so forth. Unless one is prepared to treat all these names as orthographic errors on the part of authors whose scholarship, to put it mildly, was at least as good as our own, then the correct name will be *Selaginella apoda* (L.).

"The question of the authority for this combination is admittedly debatable. Personally, I regard the adjectives *brachypus* and *brachypodus*, *macropus* and *macropodus*, *apus* and *apodus* not as simple orthographic variants but as different although corresponding words since they are of different declensions *brachypus* being of the third declension and *brachypodus* of the second. One can hardly regard, however, '*apus*' of Spring as an orthographic error, being indeed correctly formed. I should therefore cite the combination as *Selaginella apoda* (L.) Fernald, and treat *S. apus* Spring as the illegitimate substitute of a new name since Spring does not state that he is merely correcting the spelling."

I heartily agree with Dr. Stearn's informative comments in the first paragraph quoted and with his conclusion that *Selaginella apoda* is the correct name. It would indeed be unfortunate, and unnecessary, to rename all the species that have been described since the time of Linnaeus with the terminations *-podus, -a, -um.*

There does seem to be a good deal of substance to Stearn's argument that *brachypus* and *brachypodus* are different words and not orthographic variants, and *apus* and *apodus* likewise. It is apparently true that in classical Latin, *apus* was only used as a substantive, the name for the swift mentioned by Stearn. But it was, of course, adopted from the Greeks, and the Greeks used it not only for this bird but for other "footless" things, and moreover had an adjective *apus* (ἄπους, a compound of the α privative and πους, a foot). Doubtless the Romans would have adopted this adjective also from the Greeks, had they felt a necessity for the word. In any case, the person responsible for finding the examples of orthographic variants for the International Code of Botanical Nomenclature must have felt that *apus* could be an adjective, for one of the examples of epithets to be treated as orthographic variants (Art. 75, 1961 ed.) is *heteropus* and *heteropodus.* If *heteropus* and *heteropodus* are orthographic variants, then of course *apus* and *apodus* must also be. (This does not, of course, mean that either one or the other is an orthographic *error*, to be changed; both are correct, and the original author's spelling is to be adopted.) Therefore, in *Selaginella apus* (L.) Spring the *apus* is to be considered not as a change of name but as an orthographic variant of the Linnaean *apodum*; it is not a different name nor an illegitimate renaming, but is an incorrect name because Spring should have adopted the form accepted by Linnaeus. Thus, the name should be *S. apoda* (L.) Spring or, technically, *S. apoda* (L.) Spring (as "*apus*").

Incidentally, Fernald in 1915 was not the first to use the name in the form *S. apoda*, for it was widely used in horticultural literature long before, as in Linden, Cat. 8: 15. 1853, Morren, Belg. Hort. 4: 70. 1843, Nicolson, Dict. Gard. 3: 409. 1887, Lauche, Verz. Hort. Augst. 8. 1856, Sandford, Man. Exot. Ferns and Selag. 258. 1882, and doubtless elsewhere. The above references come from "Index Selaginellarum" by Dr. Clyde F. Reed.

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Antheridium Induction and the Number of Sperms per Antheridium in Anemia phyllitidis

BRUCE R. VOELLER AND ERIC S. WEINBERG

Schraudolf (1962, 1964) and Voeller (1964a, b) have demonstrated that young gametophytes of 12 species of ferns in the Schizaeaceae form antheridia when supplied with gibberellic acid (GA). Hormonal concentrations of seven different gibberellic acids, GA_7, GA_4, GA_3, GA_9, GA_1, GA_5, and GA_8, in order of decreasing relative activity, have been shown to be strikingly active in initiating formation of male reproductive organs in *Anemia phyllitidis* (L.) Swartz. In contrast, gibberellic acid has little or no effect on the gametophytes of a wide range of species from other families, such as the Blechnaceae, Pteridaceae, Polypodiaceae, Osmundaceae, Cyatheaceae, Davalliaceae, or Aspidiaceae (Voeller, 1964a, b).

In a remarkable variety of respects, the effects of gibberellic acid on *Anemia phyllitidis* are indistinguishable from the effects of the naturally occurring antheridium-inducing hormone, antheridogen-B, produced by *A. phyllitidis:* (i) the two substances each show specificity of organ induction, i.e., antheridia are induced, but archegonia, rhizoids, papillae, etc., are not; (ii) the time interval between application of and response to either hormone is quite similar; (iii) the sequence of cell divisions giving rise to the organ is the same, and the resultant sperms swim actively and are apparently functional; (iv) and the dosage-response curve of the antheridogen is distinctive and paralleled by that for gibberellic acid.

Because of the evident similarity of effects of antheridogen-B and gibberellic acid and because of the commercial availability of the latter, gibberellic acid has been employed in physiological, biochemical, and electron microscopic studies of antheridium formation. However, the limited chemical evidence thus far published suggests an apparent *lack of identity* between the antheridogens and the *known* gibberellic acids, although many chemical and physical resemblances exist.

The justifications for use of gibberellic acid in experimental studies rest on the over-all indistinguishability of its effects from those of antheridogen-B. Any recognizable difference could be of significance. Thus, it is interesting and important to consider one such possible distinction suggested from the literature; it involves the number of sperms per antheridium.

Eames (1936, p. 280) compiled data for various families and stated that the Schizaeaceae have "more than 32" sperms per antheridium, presumably, that is to say, 64 or more. In studying *A. phyllitidis*, Twiss (1910) found the remarkably large number of 156 sperms per antheridium. Mickel (1962), in his recent monograph on the genus *Anemia*, indicated that there were "30–50 in one optical section" in *A. adiantifolia*.

Our own observations with GA-induced antheridia suggested that only 16 sperms were present in most antheridia. It therefore seemed imperative to develop critical techniques for quickly and accurately evaluating the sperm number and to establish whether GA-induced antheridia differed from those which arose spontaneously.

In general, fern cultures were grown aseptically in 25-ml Erlenmeyer flasks containing 5 ml of mineral salts medium prepared as previously described (Voeller, 1964a). However, 3-month cultures of *A. phyllitidis* were grown on similar medium solidified with 0.9 percent agar. Such agar cultures were grown in 6-cm Petri plates wrapped with Saran wrap. All cultures were kept in continuous illumination (22 lumen/m^2) at 22°C.

Inductive gibberellic acid solutions were filter-sterilized and used at a final concentration of 10^{-4} gm/ml. Five-times crystallized GA_3 of authentic melting point was prepared from commercially available sources. Antheridogen-B was obtained from culture filtrates of *A. phyllitidis* (Voeller, 1964a). The natural hormone was used at various concentrations, including a level giving a response comparable to that obtained with 10^{-4} gm/ml GA_3.

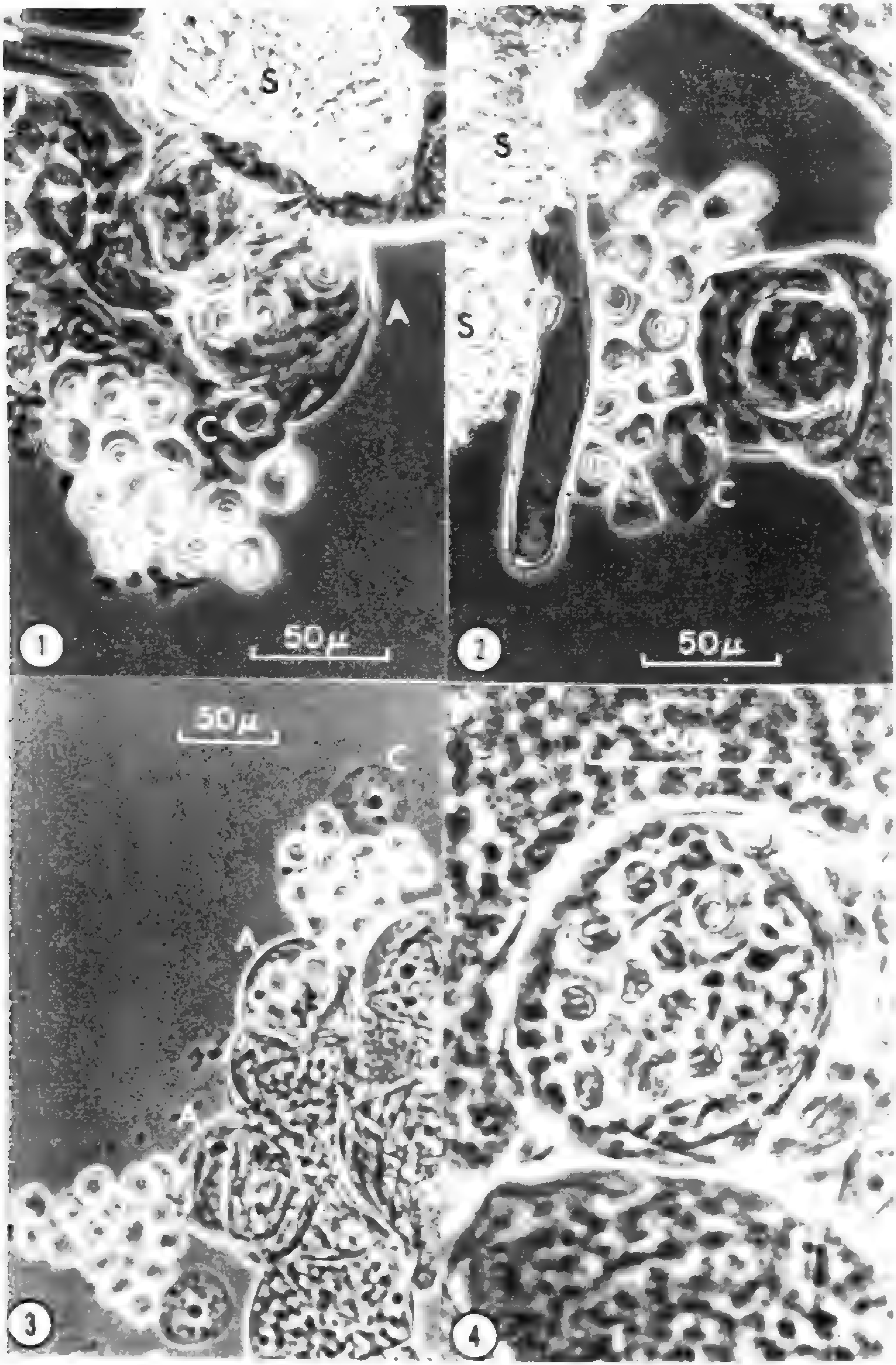
In making sperm counts, a modified Feulgen-squash method was employed in which the sperms were pressed from the antheridium. Gametophytes were placed in test tubes and carried through the staining procedure outlined below. In each step in which HCl is normally employed in the Feulgen procedure, trichloroacetic acid (TCA) was used at equimolar concentration (Block and Godman, 1955), including the preparation of the Feulgen reagent. This modification was found to lead to striking staining of the nuclei of sperms, spermatocytes, and archegonia. The following procedure was used: 3:1 ethanol-acetic acid (30 min), 1:1 ethanol-acetic acid (15 min), 45% acetic acid (15 min), 1M TCA at room temperature (2 min), 1M TCA at 60°C (12 min), distilled water (1 min), Feulgen reagent (TCA) (2–5 hr), 45% acetic acid (5 min), and 45% acetic acid (5 min).

Squashes were prepared in the usual cytological manner and microscopically examined under phase contrast. In all cases, counts of sperm number in unruptured antheridia were made.

In order to compare antheridia, *Anemia* spores were cultured in the presence of GA_3, antheridogen-B, and in the absence of a hormonal supplement. The supplemented cultures were examined approximately 12 days after inoculation, and the unsupplemented after several weeks.

Table I and *Plate 11* summarize and illustrate the observations made on gametophytes raised under the three sets of conditions described. Of these, two sets of conditions were essentially "natural", i. e., those in which cultures contained naturally occurring hormone (*Figs. 1* and *2*) or no supplements (*Fig. 4*). One was "unnatural," in that cultures contained gibberellin (*Fig. 3*). In each case, comparison was made between counts obtained from intact antheridia and those made on squashes.

From the data presented it is evident that the squash technique gives much more uniform and consistent results than does counting the sperms within an antheridium. In the latter method variability was due to the great difficulty of recognizing sperms which overlapped one another in the visual field, i. e., along the optical axis of the microscope. When the sperms were carefully pressed from the antheridium, they could easily be seen and counted in a single focal plane; the number rarely deviated from 16. The few examples



SPERMS OF ANEMIA PHYLLITIDIS

in which 15 sperms were counted probably resulted from loss of a sperm during preparation of a squash.

Of chief interest are the observations that: (i) the predominant number of sperms per antheridium is 16, this value occurring in 88% of the counts from squashed material; (ii) the number of sperms in GA-induced antheridia, predominantly 16, falls unmistakably within the range exhibited by the two classes of

TABLE I. RANGE IN NUMBER OF SPERMS PER ANTHERIDIUM IN ANEMIA PHYLLITIDIS.

Treatment	*Preparation*	*Number of antheridia with* 8	13	14	15	16	32
GA	squash	0	0	0	0	40	0
	intact	0	1	7	5	10	0
Antheridogen-B	squash	1	0	0	0	44	0
	intact	0	0	7	7	8	0
Unsupplemented	squash	7	0	0	3	72	11
	intact	0	1	1	3	7	0

"naturally occurring" antheridia; and (iii) a number of the "spontaneously" arisen organs, 21 of 93, showed major variation in the number of sperms (8 or 32 per antheridium). In the last-mentioned case it seems probable that the number of sperms resulted from a failure or an excess of one mitotic division throughout the developing spermatogenous tissue. It is noteworthy that in a few instances two spontaneously-formed antheridia on the same gametophyte were observed to have 16 and 32 sperms, respectively. This condition was observed only in spontaneously-formed antheridia.

Twenty-nine additional counts were obtained from antheridia of another strain of *A. phyllitidis* grown from spores collected in 1963 at the Munich Botanic Garden. In these GA-treated gametophytes, the predominant (69%) sperm number was 8; the remaining antheridia each contained 16 sperms.

FEULGEN-STAINED SPERMS FROM THE ANTHERIDIA OF ANEMIA PHYLLITIDIS, UNDER PHASE CONTRAST. Figs. 1 and 2. INDUCED WITH ANTHERIDOGEN-B. Fig. 3. INDUCED WITH GIBBERELLIC ACID. Fig. 4. SPONTANEOUSLY FORMED. The abbreviations are: A = ANTHERIDIUM, C = CAP CELL, S = SPORE COAT.

Thirty-three counts were made on a third strain of *A. phyllitidis* collected in 1964 near Villa Alta, State of Oaxaca, Mexico. GA-treated gametophytes yielded values intermediate between those of the Jamaican and the Munich stocks. Seventy-nine percent of the antheridia contained 16 sperms, 21 percent 8 sperms.

From the data presented and those of initial counts from several other species of *Anemia*, it appears that 8 or 16 is the common number of sperms in an antheridium under our conditions of culture, and that the much higher values reported by previous workers are by no means universal. Indeed, the great difficulty inherent in counting cells *inside* antheridia, directly or in histologically sectioned gametophytes, suggests that previously published values may require re-evaluation. Recognition that the three races of *A. phyllitidis* studied here showed different modal values, however, makes clear that the species is polytypic and higher values may obtain in other varieties and species.

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A Revision of the Fern Genus Mildella

CARLOTTA C. HALL[1] AND DAVID B. LELLINGER[2]

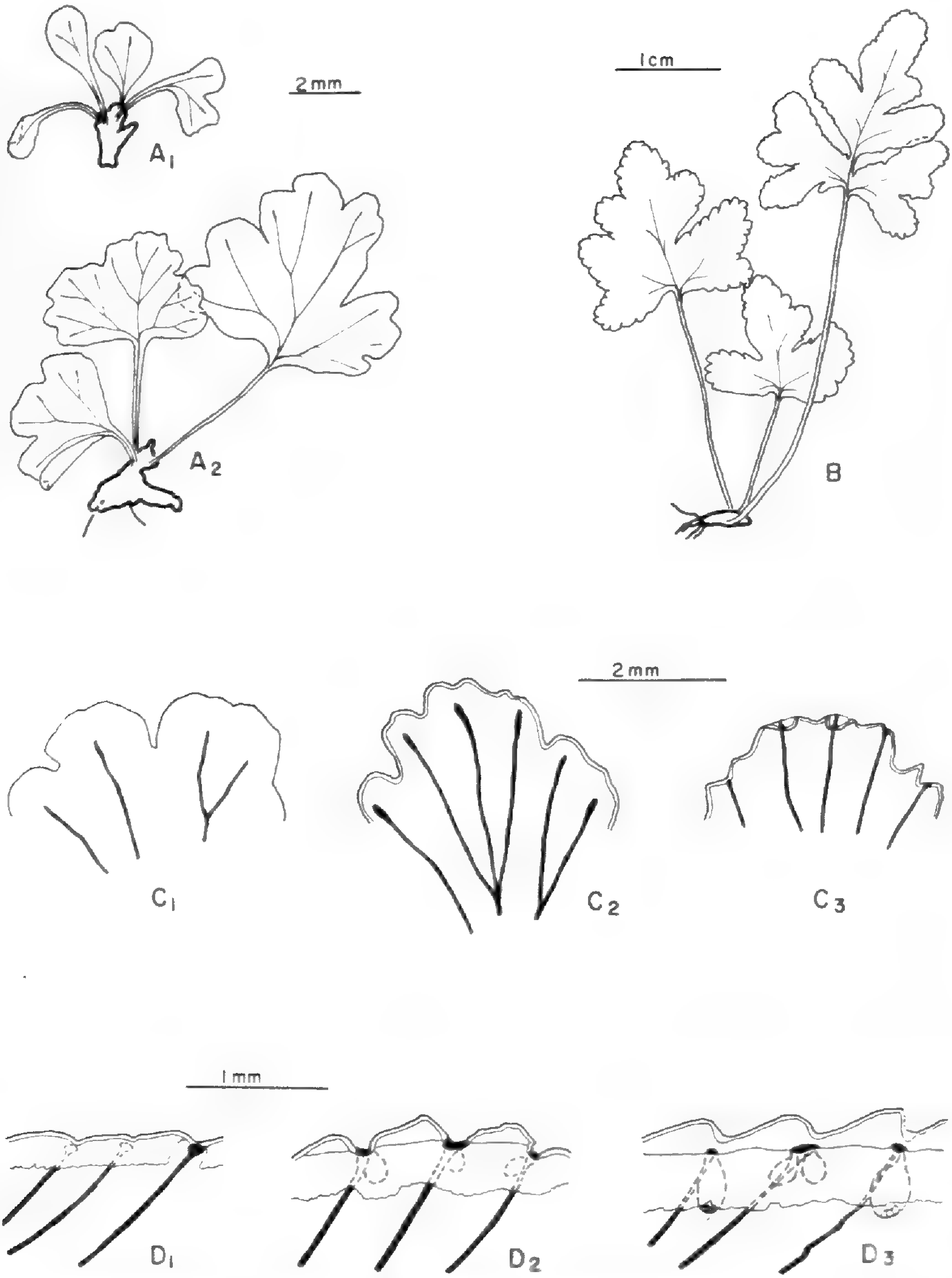
The genus *Mildella* was named by Trevisan in 1876 to honor the German pteridologist Dr. J. Milde (1824–1871). Trevisan included a single species, *M. intramarginalis* (Kaulf. ex Link) Trev., in *Mildella*; until now no other species has ever been added to the genus. This genus was reduced to synonymy under *Pellaea* or *Cheilanthes* by virtually all pteridologists until Copeland (1947, p. 68) upheld it as a genus distinct from, but related to, *Cheilanthes*—an opinion we share.

The principal distinguishing characteristics of the genus are the marginal flange of the segments, the inframarginal indusium, which is ciliate in some of the taxa, and the generally many, short, stiff or lax, one- to few-celled, cylindrical to slightly clavate hairs on the adaxial face of the stipes and rhachises. The species of the genus *Cheilanthes* lack any marginal flange; their indusia, although sometimes ciliate, are directly modified segment margins. Stipe and rhachis scales are common in *Cheilanthes*, as are lax, often woolly hairs.

The following characteristics of *Mildella* are also found scattered in the species of *Aleuritopteris*, *Negripteris*, and *Sinopteris*, all genera apparently derived from *Cheilanthes*, as well as in *Cheilanthes* itself. In the species of *Mildella*, the basal pinnae are strongly inequilateral and the inferior basal pinnules often show one degree of dissection greater than the remainder of the frond. The sporangia are protected by a continuous, usually translucent, inframarginal indusium, which is vaulted over the sporangia at maturity and which varies from entire or occasionally erose to ciliate in the several species. In most species the principal axes are adax-

[1] Mrs. Hall left copious notes for this paper at the time of her death in 1949. Considerable additions and emendations have been made by the junior author, who has been able to add several species to the genus and to examine types and many more specimens than were available to Mrs. Hall.

[2] We wish to thank the curators of the herbaria from which we borrowed specimens for their cooperation. Partial cost of publication of this paper has been borne by the Smithsonian Institution.



Morphological Details of Mildella intramarginalis var. intramarginalis. Figs. A, B. Young sporophytes. Fig. C. Development of the sterile frond margin. Fig. D. Development of the fertile frond margin. See text for details.

ially grooved or at least flattened. The sporangia typically are borne in pairs on flaring, but not uniting, vein tips.

In the New World one species of *Mildella* grows in Mexico and Central America and another is confined to the island of Hispaniola. Four of the Old World species are in China, one of which extends to Taiwan. A fifth Old World species grows in Tibet and a sixth in India, Pakistan, and Nepal. All of the species are found in fairly high, mountainous regions and are absent from coastal lowlands.

Mildella intramarginalis is by far the best known species of the genus. Both the typical variety (with entire indusia and entire, crenate, or subserrate segment margins) and var. *serratifolia* (with ciliate or erose indusia and generally decidedly serrate segment margins) exhibit the generic characteristics: marginal flange of the segments, inframarginal indusium, and stipe and rhachis hairs. Both have dark brown to atropurpureous, more or less scaleless stipes and rhachises. The development of the segment margins and indusia in var. *intramarginalis* is shown by a series of specimens grown from the spores of *Copeland 86* (MICH–Copel. Herb. 15986) which have been prepared by Mrs. M. F. Ashley Giauque, of Berkeley, California. Through her kindness we have been able to study them.

Figures A_1 and A_2 show two young sporophytes taken from nutrient solution 9.33 months after the spores were sown. *Figure B* depicts a plant taken from the nutrient solution at the same time as the aforementioned sporophytes and then grown on soil for 2.4 months. This specimen shows the crenulate margins often seen in sterile, young, and rather juvenile blades of var. *intramarginalis*. These juvenile crenulations, which are often lost through growth of the segment margins as young fronds mature, should not be confused with the crenulate margins of fertile, mature blades.

Figures C_1–C_3 illustrate the development of a portion of a sterile frond margin. In the youngest stage (frond 1.0 cm long) the vein tips are not swollen and end well behind the apices of the marginal lobes. In the middle stage (frond 2.4 cm long) outward growth along the thickened margin is confined to sinuses and lobe areas not directly in front of the typically swollen vein endings. Some small, sterile fronds of var. *intramarginalis* may exhibit this condition or a stage transitional to the next when their growth is complete. In the last stage (frond 4.2 cm long) the former sinuses and their adjacent areas have grown outward to form an entire or a crenulate margin, whereas the vein tips are slightly flared, have in most cases reached the margin, and now almost always lead into sinuses rather than teeth. In mature, sterile fronds of var. *intramarginalis* development of the margin stops when the margin is slightly crenulate. (In var. *serratifolia* the margin of sterile fronds continues to grow between the vein endings until the typical serrate margin is produced.) There does exist something of a continuum in marginal overgrowth between var. *intramarginalis* and var. *serratifolia*; because of this and the juvenile crenulations found in some sterile blades, the character of the blade margin is not entirely reliable for separating the two varieties.

Figures D_1-D_3 show the development of a portion of a fertile frond margin. This is of interest because it sheds light on the proper classification of those fertile, mature, crenulate-margined specimens of var. *intramarginalis* that can be confused with specimens of var. *serratifolia*. This sequence diverges from the sterile margin sequence between the second and third stages of the latter sequence. The indusium arises almost marginally, just behind the cartilaginous edge. It is tightly appressed to the surface of the segment, and is so scarious as to be nearly invisible. (In var. *serratifolia* marginal cilia develop at this early stage, which occurs before most of the marginal overgrowth, hence at a time when the margins of the two varieties appear nearly identical.) The vein tips swell from clavate to capitate and then flare and may meet the cartilaginous margin. The margin continues its outward growth, especially between the flaring vein endings, and becomes entire to crenate at maturity. (In var. *serratifolia* this process continues until the margin is definitely serrate.) As the sporangia mature, the indusium becomes vaulted over them and is decidedly inframarginal. The thickness of the cartilaginous edge diminishes in the last growth stage.

The rhizomes of *M. intramarginalis* are simple and erect or ascending when young (*Copeland 86*, UC). Then they branch and become multicipital with erect or ascending branches (*Sohns 646*, US) that become horizontal and short- to long-creeping as they continue to grow (*Runyon 981*, US; *Purpus 5685*, UC). The more or less prostrate branches apparently grow separately after the old, multicipital portion of the rhizome has died. Both the early and late stages are commonly collected, but we have observed the multicipital condition only in *Sohns 646*. It seems reasonable that the rhizomes of the other species of *Mildella* probably develop similarly, although we have no conclusive evidence that they do.

MILDELLA Trev. Rendic. Ist. Lombardo, Milano II, **9**: 810. 1876.

Small, epipetric or terrestrial ferns to ca. 40 cm tall, with rather stiff fronds clustered near the tips of short-ascending to long-creeping branches of a multicipital rhizome. Rhizome scales linear-lanceate, strongly bicolorous (young stages only weakly bicolorous and attenuate with a fragile tip, terminated by a globose, oblong cell) to concolorous. Stipe and rhachis stramineous, light brown or chestnut to nearly atropurpureous or black, adaxially grooved or flattened, smooth, rather lustrous, always with many one- to few-celled, amber to brown, short, stiff or lax, cylindrical to slightly clavate hairs on the adaxial face. Blades pinnate-pinnatifid to bipinnate. Basal pinnae opposite, inequilateral, basiscopically developed with broadly adnate, triangular, oblong, or linear, subcoriaceous segments. Inferior basal segment of the basal pinna pair entire or more or less deeply pinnatifid. Upper pinnae gradually simpler and diminished, less strongly inequilateral. Upper segments simple or 1-lobed, usually ascending, broadly adnate and decurrent on the rhachis, and (especially those near the frond apex) often adnate to one another. Veins free, dichotomous (once-forked) or simple, their tips often reaching nearly to the margin of the segments and there flaring to accommodate usually a pair of short-stalked sporangia. Indusia thin, inframarginal, entire, erose, or ciliate. Annulus of 18–22 thick-walled cells. Spores tetrahedral, minutely roughened, light gray, pale brown, or yellowish pale brown to dark brown.

Type species: *Pteris intramarginalis* Kaulf. ex Link (=*Mildella intramarginalis* (Kaulf. ex Link) Trev.).

KEY TO THE SPECIES AND VARIETIES OF MILDELLA

Stipes and rhachises dark brown to atropurpureous; rhachis hairs all short and mostly stiff.

Stipes and rhachises persistently scaly; indusium margins ciliate (China) 8. *M. mairei*

Stipes not or scarcely scaly above the stipe bases, the rhachises not scaly.

Indusium margins essentially entire, rarely erose, never ciliate.

Terminal segment of fronds (6)8–21(32) mm long; lobed or divided sessile pinnae (2)3–5(6) pairs; frond margins entire, crenulate, or occasionally subserrate (Mexico to Panama) 1a. *M. intramarginalis* var. *intramarginalis*

Terminal segment of fronds (20)30–65 mm long; lobed or divided sessile pinnae 1–3 pairs; frond margins serrate or nearly so (Hispaniola)....................................2. *M. leonardii*

Indusium margins erose, short-ciliate, or long-ciliate.

Segment margins decidedly serrate or occasionally merely subserrate or crenulate in young fronds (Mexico & Guatemala) 1b. *M. intramarginalis* var. *serratifolia*

Segment margins entire or crenulate.

Pinna segments generally ovate-triangular and distant at maturity; inferior segments of basal pinnae 3 or 4; veins of the segments more or less immersed, rarely striate like the costules; short, stiff stipe hairs generally confined to the adaxial surface (India, Pakistan, & Nepal)..........................3. *M. nitidula*

Pinna segments generally parallel-sided and contiguous at maturity (somewhat ovate-triangular and distant in specimens from coastal China and Taiwan); inferior segments of basal pinnae (4)5–6(7); veins of the segments decidedly superficial, usually minutely striate like the costules; short, stiff stipe hairs often spreading around the stipes (China & Taiwan)....4. *M. henryi*

Stipes and rhachises stramineous to light brown, persistently scaly; some rhachis hairs long, even the short ones somewhat lax.

Terminal segments of pinnae less than 8 mm long; indusium margins entire (Tibet)....................................5. *M. straminea*

Terminal segments of pinnae more than 10 mm long; indusium margins ciliate.

Largest pinnae with 1–3 inferior pinnules, often with 1 fewer superior pinnule; no pinnules lobed (China)...............6. *M. paupercula*

Largest pinnae with 4–6 inferior pinnules, usually with the same number of superior pinnules; usually some basal pinnules with a single lobe (China)....................................7. *M. smithii*

1. MILDELLA INTRAMARGINALIS (Kaulf. ex Link) Trev. Rendic. Ist. Lombardo, Milano II, **9**: 810. 1876.

Pteris intramarginalis Kaulf. ex Schlecht. & Cham. Linnaea **5**: 613. 1830, *nomen nudum*.

Pteris intramarginalis Kaulf. ex Link, Hort. Reg. Bot. Berol., ed. 2, **2**: 34. 1833. Published as "*inframarginalis*" in error; corrected by Kunze (1837, p. 27), who pointed out that Link unintentionally erred in publishing *intramarginalis* as *inframarginalis*: "P[teris]. inframarginalis (lapsu calami) Link hort. reg. Berolin. II. p. 34." Presumably Link verbally admitted his unintentional error to Kunze. Because Link was obviously adopting Kaulfuss' manuscript name and because the two names are different, being based on different Latin words, the correction from "f" to "t" is permissible.

Allosorus intramarginalis (Kaulf. ex Link) Presl, Tent. Pterid. 153. 1836.

Cassebeera intramarginalis (Kaulf. ex Link) J. Smith, J. Bot. Hook. **4**: 159. 1841 (as "*inframarginalis*").

Cheilanthes intramarginalis (Kaulf. ex Link) Hook. Sp. Fil. 2: 112. 1852.

Pellaea intramarginalis (Kaulf. ex Link) J. Smith, Cat. Kew Ferns. 4. 1856.

Platyloma intramarginalis (Kaulf. ex Link) Lowe, Ferns Brit. & Exot. 3: 85, *t. 31*. 1857.

Rhizomes at first erect and unbranched, then multicipital, the branches ascending to short-creeping, then becoming long-creeping in age, to 5–8 cm long and 5 mm thick, scaly, the scales sharply bicolorous. Stipes and rhachises adaxially grooved (except flat proximally or throughout in small specimens), castaneous to dark brown, sometimes approaching atropurpureous, the bi-cellular, short, stiff hairs confined to the adaxial face. Blades long-lanceolate to ovate-triangular. Lower, sessile pinnae inequilaterally triangular, pinnatifid or pinnate, strongly basiscopic, the segments adnate; upper, adnate segments simple, linear to triangular, often ascending, regularly diminishing to a pinnatifid apex, the terminal segment (3)8–21(32) mm long.

LECTOTYPE: Judging from his description, Link (1833, p. 34) studied living specimens in the Botanical Garden at Berlin that were grown from spores. According to Schlechtendal and Chamisso (1830, p. 613), the original plants were collected by Schiede and Deppe at Jalapa, Veracruz, Mexico. We have seen no herbarium specimens of *M. intramarginalis* annotated in Link's hand. Besides *Schiede & Deppe s.n.* there is a specimen in the Berlin Herbarium which was cultivated in the garden at Berlin. It is labelled "Pteris intramarginalis Klf. . . . Hort. Berol." The "Hort. Berol." is in a second, later hand, and the same person has (incorrectly) changed the "t" to an "f" in *intramarginalis*. We choose this specimen as the lectotype.

Most of the specimens of var. *intramarginalis* are entire-margined, but there is a continuum between these specimens and a few, mostly small, crenate-margined specimens (*Purpus 2843*, UC, US). Some of the latter kind of specimens look much like subserrate specimens of var. *serratifolia*. This variation in margin condition is reflected in the conflicting descriptions provided by the early authors. Link (1833, p. 34) said, "Pinnulae steriles . . . *obtusae denticulatae*, . . . pinnulae steriles . . . denticulatae, denticuli apicis majores bifidi . . ." This is a fair description of some of the small, crenulate-margined specimens of var. *intramarginalis*. And the "*obtusae denticulatae*" agrees with the lectotype we have chosen. Kunze (1837, p. 27) said, "Margo laciniarum obtuse serratus, seu serrulatus, seu crenatus, subintegerrimus . . ." Although the "*seu serrulatus*" is typical of var. *serratifolia*, we found no specimens of that variety among those lent to us from Berlin that he could have examined.

The following key will help to separate the two varieties:

Segment margins entire, crenulate, or occasionally subserrate (sometimes irregular, particularly at the segment apices of young fronds), never sharply and simply serrate; indusia entire or rarely erose; rhizome scales bicolorous with broad margins and usually the central 0.33–0.75 dark and sclerotic (Mexico to Panama) . . . . var. *intramarginalis*

Segment margins serrate or subserrate, occasionally merely crenulate (particularly in some young stages); indusia irregularly ciliate; rhizome scales bicolorous with narrow margins and usually the central 0.75–0.90 dark and sclerotic (Mexico & Guatemala) . . . . var. *serratifolia*

1a. MILDELLA INTRAMARGINALIS var. INTRAMARGINALIS.

Central band of the rhizome scales sclerotic and brown (less commonly reddish or black), 0.33–0.75 the width of the scale, the margins broad, thin, and pale brown. Fronds (13)20–35(39) cm long, the stipes (0.8)1–1.6(2.6) times longer than the rhachises. Weakly bicolorous rhizome-type scales present mostly near the stipe bases. Blades (3)7–15(24) cm long, usually 1.5–2 times longer than wide. Pinnae (1)2–5(6) pairs. Segments above them adnate, (1)2–6(9) pairs. Blade margins entire, crenulate, or occasionally subserrate at maturity. Indusium margins entire, rarely erose in age. Spores gray to brown.

Range and habitat: From central Mexico to northern Panama (except British Honduras) at altitudes of (600)1000–2100(2400) m. Generally epipetric (sometimes terrestrial) in moist shady to rather dry and open sites.

Additional specimens examined:

Mexico: **Tamaulipas:** Sierra de Guatemala above Gómez Farías, *Sharp et al. 52079* (US). **Querétaro:** 67 mi NE of Zimapan, *Waterfall & Wallis 14248* (US). **Hidalgo:** N of Jacala, km 310, alt. 1500 m, *Copeland 86* (MICH, UC, US); near Otlamalcatle [Otlamalacatl], Distr. Zacualtipan, *Seler & Seler 884* (B). **Veracruz:** Jalapa, *Arsène 7039* (US), *Couch M69* (US), "im Monte Pacho," alt. 1450 m, *Endlich 1571, 1571a* (B), "entre les pierres," alt. 900 m, *Galeotti 6329* (BR), Oct. 1906, *Johnson* (US), *Schiede 784* (B), *C. L. Smith 2163* (F); near Jalapa, *Rose & Hay 6089* (US), alt. 4600 ft, among rocks, *MacDaniels [L. H. Bailey Herb.] 342* (F); 5 mi SE of Xalapa, *Barkley et al. 2554* (F); "rochers de Xalapa & Mirador 3. 4000 [feet]," *Galeotti 6389* [another sheet bearing the same number is apparently mislabelled "Cordillera (Oaxaca)," and a third sheet of the collection is var. *serratifolia*] (BR); Orizaba, Feb. 27, 1885, *Farlow* (UC), alt. 1200 m, *Fisher 79* (US), *F. Müller 66* (B, BR), alt. 1200 m, *Seaton 40* (F, US), *J. G. Smith 106* (US), *Weber* in 1864 (B); environs d'Orizaba, *Botteri & Sumichrast 1414* (B), *Bourgeau 1641* (B, BR, C); Chavarillo, *Chamberlain & Land 98* (F); near Teocelo, on wet rocks, *Correll 14299* (US); Teocelo Falls, March, 1849, *Rhoads* (PH, US); County of Córdova, *Finck 113* (US), *116* (UC); Córdoba, *Matuda 211* (MICH, US); La Luz, near Córdoba, *Kerber 61* (B, BR); Rio Blanco, alt. 1450 m, *Fisher 20* (US); S slope of Volcán San Martín Tuxtla, Jan. 23, 1958, *Etheridge* (MICH); Huatusco [de Chicuellar?], May, 1857, *Mohr* (US); Mirador, *Purpus 242* (US), *Sartorius* (B); Zacuapan [not the same as Arroyo Zapoapán], *Purpus 5685* (B, E, MICH, UC), on moist rocks, *Purpus 15756* (MICH, UC), on rocks not in the shade, *Purpus 16480* (US), on rocks, *Schenck 558* (B); Barranca de Tenampa, Zacuapán, *Purpus 1963* (F, UC, US), *4365* (B, E, F, UC); Fortín, Zacuapán, moist rocky slopes, *Purpus 2843* (F, UC, US), Coatepec, *J. Sanchez 8* (US). **Puebla:** Teziutlán, *Orcutt 3982* (US); Hecaxa, Feb., 1927, *Reiche* (UC). **Morelos:** El Parque, *Orcutt 4233* (US). **Michoacán:** Morelia, Cerro Azul, alt. 2100 m, *Arsène 6526* (US); 3 mi S of Tancitaro, on rocks in pedregal, alt. 1800 m, *Leavenworth & Hoogstraal 1022* (F); Tancitaro, Uruapán, alt. 2075 m, *Hinton et al. 15544* (US). **Guerrero:** Manchon, Distr. Mina, alt. 1200 m, *Hinton et al. 9490* (F, PH, US). **Oaxaca:** near Comialtepec, *Liebmann 2469* (C). **Chiapas:** *Ghiesbreght 440* (US); Volcán Tacana Norte, alt. 2100 m, *Matuda*

2991 (F, US); Cerro del Boqueron, *Purpus 7244* (UC, US). **State unknown:** *Garrigues* (MICH); environs de Teguitla, *Hahn* in 1865–1866 [presumably June 1866] (BR, C, US); *Leibold 110* (B); *Linden 40* (BR); "Cordileire du Méxique," *Linden* in 1853 (B); *Sartorius* (B); *Schaffner 52* (B).

GUATEMALA: **El Quiché:** *Aguilar 779* (F); Santo Tomás, Chichicastenango, alt. ca. 2400 m, *L. Schultze Jena 936* (B); Nebaj, on roadside earth bank, alt. ca. 1800 m, *Proctor 24945* (US); Valley of Río de las Violetas, N of Nebaj, on crumbling shale bank, alt. 1750–1800 m, *Proctor 25370* (US). **Huehuetenango:** Jacaltenango, *Seler & Seler 3206* (B, US); Río Pucal, alt. 1775 m, *Standley 65843* (F); Río Pucal, ca. 14 km S of Huehuetenango, moist bank, alt. ca. 1780 m, *Standley 82300* (F), *82342* (F). **Alta Verapaz:** Tamachú, alt. 750 m, *Johnson 985* (US). **Baja Verapaz:** Santa Rosa, *Cook 242* (US); near Santa Rosa, alt. 1600 m, *von Türckheim II 2177* (C, US). **San Marcos:** Above Finca El Porvenir, south-facing slopes of Volcán Tajumulco, alt. 1300–1500 m, *Steyermark 37956* (F). **Quezaltenango:** Río Naranjo, Coatepeque, *Salas 360* (US); Volcán Santa María, base of Volcano, March 21, 1936, *Leeds* (PH), near San Marcos, alt. 2000 m, *Lehmann 1561* (B, US), Santa María de Jesús, alt. 1530 m, *Standley 66812* (F), near Santa María [de Jesús], *Kellerman 5570* (US), alt. 1500–1800 m, *Maxon & Hay 3596* (US), along Río Samalá, alt. 1500–1650 m, *Standley 84758* (F), canyon, on open, moist banks, alt. 1500 m, *L. O. Williams 14316* (F, US), on rocks, along dry, forested sides of volcano 1 mi below Santa María de Jesús, alt. 1530 m, *Steyermark 34373* (F), Finca Pirineos, lower south-facing slopes, between Santa María de Jesús and Calahuaché, alt. 1300–1500 m, *Steyermark 33184* (F), between Santa María de Jesús, Los Mojadas, and the summit of the volcano, on rocks in forest, alt. 1500–3000 m, *Steyermark 33955* (F). **El Progreso:** hills between Finca Piamonte and slopes SE of Finca Piamonte, alt. 2400–2500 m, *Steyermark* 43403 (F). **Zacapa:** Upper slopes of the Sierra de Las Minas, on rocks, alt. 2100–2400 m, *Steyermark 42440* (F, US). **Chiquimula:** Shaded rocks around lake margin, Volcán Ipala, near Amatillo, alt. 900–1510 m, *Steyermark 30472* (F). **Jalapa:** Laguna de Ayarza, alt. 2400 m, *Heyde & Lux 4097* (B, E, PH, UC, US); vicinity of Jalapa, damp thicket, alt. ca. 1360 m, *Standley 76483* (F). **Guatemala:** Volcán Pacaya, in woods, *Brenckle 49* (US), above Las Calderas, alt. 1800–2400 m, *Standley 58354* (F); Guatemala, alt. 1500 m, *Donnell Smith 2428* (B, PH, US); "Barrancas y lugares secos y aridos cerca de Guatemala," alt. 1400 m. *Tonduz 754* (US). **Sacatepéquez:** Alotenango, Barranca Honda, alt. 1260 m, *Donnell Smith 2715* (US). **Chimaltenango:** Bananera, *Lewis* (US); near Río Pixcayó, between Chimaltenango and San Martín Jilotepeque, alt. 1650–1800 m, *Standley 64471* (F). **Sololá:** Volcán Atitlan, *Kellerman 5889* (US), S slope, Finca Mocá, Cafetales, on log in sun, alt. 1200 m, *Hatch & Wilson 356* (US). **Dept. unknown:** "Sa. Maria—Costa grande," alt. 1950 m, *Bernoulli & Cario 357* (B); *Heyde 462* (US); March 1, 1859, *Skinner* (B).

HONDURAS: **Intibucá:** Vicinity of La Esperanza and Intibucá, alt. 1500–1600 m, *Standley 25557* (F). **Francisco Morazán:** La Montañita, in oak-pine forest, alt. 1800 m, *Molina R. 51* (F, US); Montaña La Tigra, SE of San Juancito, bosque nebuloso, alt. 2200 m, *Molina R. 10102* (F, US); near Rosario Mine, San Juancito Mtns., in cleared pine forest, alt. 1500 m, *Morton 7324* (US); above El Sauce, road to Santa Ana, alt. 1500 m. *Standley 24776* (F); lower slopes of Cerro de Uyuca, alt. 1530–1600 m, *Standley & Molina R. 4244* (F); between Peña Blanca and Lo de Ponce, common in pine—Liquidambar forests on rocks, alt. 1600 m, *Williams & Molina R. 17132* (F, US).

EL SALVADOR: **Santa Ana:** E side of Cerro del Aguila, on shady roadbank in forest, alt. 1650 m, *Tucker 1277* (US). **San Salvador:** Volcán de San Salvador, alt. 600 700 m, Nov. 20–26, 1911, *Hitchcock* (US), open bank, rim of crater, alt. 1000–1800 m, *Standley 22942* (US), *22948* (US), western slopes above Finca Florencia, alt. 1680–1890 m, *Carlson 424* (F).

NICARAGUA: **Matagalpa:** Between Disparate de Potter and Aranjuez, Cordillera Central, alt. 1300 m, *L. O. Williams et al. 23713* (F). **Jinotega:** Jinotega, *Howard 75, 76, 80, 107* (US); along trail between Jinotega and Las Mesitas, W of Jinotega, alt. 1100–1400 m, *Standley 9776* (F).

COSTA RICA: **Alajuela:** Zarcero, on nearly open road cut, alt. 1700 m, *A. Smith 48/133a* (US). **Heredia:** Carrizal, N of Heredia, on decomposing rock, alt. 1400 m, *Chrysler 4882* (MICH, UC). **San José:** San José, alt. 1135 m, *Alfaro 8069* (B, US); slope of mountain S of Escasú and W of San José, alt. ca. 1200 m, *Chrysler 5480* (UC); Cerro de Piedra Blanca, above Escasú, on exposed rocks, *Standley 32588* (US); between San Pedro de Montes de Oca and Curridabat, alt. ca. 1200 m, *Standley 32846* (US); 3 mi. S of Sta. Maria, *Stork 1810* (MICH). **Cartago:** Cartago, *Werckle 371* (US); vicinity of Cartago, alt. ca. 1450 m, *Biolley 84* (US), rocky border of stream, alt. 1500 m, *Maxon 36* (US); N of Cartago, on stone fence, *Stork 302* (US), on roadside bank, *Stork 1032* (MICH). **Province unknown:** Uruca, *Biolley* [*Pittier 917*] (BR), at the edge of Río Virilla, near San José, alt. 1100 m, *Pittier 351* (BR), rocky pastures, *Tonduz* [*Pittier 7220*] (B, BR, US); Carpintera, alt. 1500 m, *Brade & Brade 156* (B); Cerros de La Carpintera (Tres Ríos), *Quiros C. 770* (F); near Alajuelita, *Tonduz* [*Pittier 8808*] (BR); Arrabal, alt. 1400 m, *Torres R. 33* (US); Tablazo, alt. 1750 m, *Brade 156* [*Ros. Fil. Costaric. Exs. 236*] (B, UC, US); near San Isidro, *Maxon 8502* (US); region of Zarcero, *A. Smith H129* (F); talus of a pasture at the edge of Río Torres near San Francisco de Guadalupe, *Tonduz* [*Pittier 7242*] (BR); without locality, Nov. 1886, *Cooper* (US).

PANAMA: **Chiriqui:** Vicinity of El Boquete, alt. 1000-1500 m, *Cornman 1024* (US), *1389* (US), Llanos Francia, alt. 990 m, *Stern et al. 1216* (US), vicinity of Casita Alta, alt. ca. 1500–2000 m, *Woodson et al. 979* (US); Valley of the Río Caldera, from El Boquete to the Cordillera, alt. 1400–1600 m, *Killip 5023* (B, US).

CULTIVATED SPECIMENS: Hort. Berol. (B); Hort. Lips. (B, BR, US); Hort. Loddiges (B); Hort. Bot. Petropol. (B, US).

1b. MILDELLA INTRAMARGINALIS var. **serratifolia** (Hooker & Baker) Hall & Lellinger, comb. nov.

Pteris fallax Mart. & Gal. Mém. Acad. Brux. **15**: 53, *t. 14, f. 2.* 1842. Type: *Galeotti 6467* (BR, 2 sheets, Morton photo 5134).

Cheilanthes intramarginalis var. "*grosse serrata*" Hooker, 2nd Cent. Ferns *t. 72.* 1861. The invalid varietal phrase name was perhaps inspired by Mettenius (1858, p. 94).

Pellaea intramarginalis var. β *serratifolia* Hooker & Baker, Syn. Fil. 149. 1867. A renaming of *Cheilanthes intramarginalis* var. "*grosse serrata.*"

Central band of the rhizome scales sclerotic and black, 0.75–0.90 the width of the scale, the margins narrow, thin, and pale brown. Fronds (8)11–32(41) cm long, the stipes 1–2(2.8) times longer than the rhachises. Weakly bicolorous or concolorous rhizome-type scales present mostly near the stipe bases. Blades (3.5)6.5–19(21) cm long, usually 1.3–3 times longer than wide. Pinnae (1)2–4(5) pairs. Adnate segments (2)4–8(9) pairs. Blade margins serrate, subserrate, or occasionally merely crenulate, particularly in young fronds. Indusium margins irregularly ciliate, sometimes becoming erose in age. Spores brown.

LECTOTYPE: *Galeotti 6467* (BR). In proposing the variety, Hooker and Baker cite *Pteris fallax* Mart. & Gal. and *t. 72.* of Hooker's *Second Century of Ferns.* Since we cannot determine what specimen Hooker's plate illustrates, it seems logical to choose the type of *Pteris fallax* as lectotype.

RANGE AND HABITAT: From northeastern and central Mexico to Guatemala at altitudes of (960)1350–2400(2700) m. Generally epipetric (sometimes terrestrial) in moist to rather dry sites.

ADDITIONAL SPECIMENS EXAMINED:

MEXICO: **Nuevo Leon:** Chipuiqui, Verrado Creek, *Lacás 158* (F); shaded, grassy slopes of the Sierra Madre near Monterrey, *Pringle 1986* (B, BR, E, F, PH, MICH, UC, US); La Trinidad, common on moist arroyo banks in pine—oak forest, *Muller 2856* (UC); "Alamar," Pablillo, SE of Galeana, rich woodland, alt. 1800–1900 m, *Pennell 17165* (PH, US). **Tamaulipas:** La Vegonia, vicinity of San José, alt. 960 m, *Bartlett 10098* (MICH, US); Pico del Diablo, vicinity of Marmolejo, *Bartlett 19921* (MICH, US); Santa Rita Ranch, widespread on mountainside, alt. 1500 m, *Runyon 981* (US); 6 km S of Huisachal, limestone cliffs and slopes, alt. 1950 m, *Stanford, Lauber & Taylor 2071* (US). **Jalisco:** Sierra del Halo, abundant on rocks, alt. 2000 m, *McVaugh 16256* (US). **Hidalgo:** Municipio of Jacala, alt. 1500 m, *Chase 7371* (F, MICH);

Jacala, *Kenoyer 585* (F); Durango, *Fisher 37114* (US); E of Acaxochitlan, *Knobloch 681* (US); barranca below Trinidad Iron Works, alt. 1620 m, *Pringle 13257* (B, CU, F, US); Velasco, *Sanchez M. 141* (US). **Veracruz:** Las Vigas, Perote, on old lava rock in pine woods *Balls 4744, B4744* (E, UC, US); "bei Jalapa," March 1849, *von Chrismar* (B); "rochers de Zalappa," *Galeotti 6389* (BR) [other sheets bearing this number are var. *intramarginalis*]; near Orizaba, *Lemmon & Lemmon 334* (UC); "baranca de Zacuapan," *Liebmann 2466*, also probably *2468* (C); Huatusco, alt. 1350 m, *Liebmann* (O). **Puebla:** Hacienda Alamos, vicinity of Puebla, alt. 2200 m, *Arsène 121* (US), alt. 2160 m, *Arsène 1910* (PH, US); "barrancas près d'Hacienda Alamos, route de Veracruz," vicinity of Puebla, alt. 2170 m, *Arsène 1227, 2005* (US); Boca del Monte, vicinity of Puebla, alt. 2300 m, *Arsène 2182* (US); Pelouse, near Mayorazgo, Río San Francisco, vicinity of Puebla, alt. 2130 m, *Arsène 9972* (US); Manzanitla, vicinity of Puebla, alt. 2250 m, *Arsène 1632* (MICH, US), *9989* (US), *s.n.* [Ros. Fil. Mex. Exs. 23], Dec. 27, 1909 (B, S, US); Puebla, near Chinantla, alt. 2100 m, *Liebmann 2467* (B, US); Puebla, Port de Mexico, *Nicolas 5095* (UC); Cerro del Gavilan, alt. 2100–2400 m, *Purpus 4036* (UC). **Tlaxcala:** ca. 5 mi. E of Panzacola on the western slope of [Cerro] La Malinche, *Sohns 646* (US). **Morelos:** El Parque, *Orcutt 4232* (US). **México:** Amecameca, alt. 2430 m, *Fisher* (F). **Distr. Fed.:** Pedregal de Contreras y Ajusco, *Lyonnet 234* (US); Sierra de Ajusco, alt. 2700 m, *Pringle 15019* (F, MICH, US), *s.n.*, Nov. 20, 1902 (US). **Michoacán:** Rincón, Morelia, Oct. 1909, *Arsène* (F, US). **Guerrero:** Taxco, *Kenoyer A17* (MICH). **Oaxaca:** Manzanar, E of Oaxaca, on road through San Augustín toward Natividad, alt. 2265 m, *Carlson 1387* (US). **Chiapas:** 5 km WNW of Ciudad de Las Casas (San Cristóbal), alt. 2100 m, *Little & Sharp 9868* (US); Salto de Agua, *Purpus 1581* (UC, US); without definite locality, *Ghiesbreght 239* (F); *ibid.*, *s.n.* (B). **State unknown:** "im Magdalenenthal," *L. Hahn* in 1869 (B); Santa Rosa, San José del Oro, July 1827, *Karwinski* (B); Galipán, *Liebmann 2462* (C); *Hohenacker 226* (B); *Schaffner* (B); *Schmitz* (B); *Stokes* in 1831 (E).

GUATEMALA: **El Quiché:** Santo Tomas, near Chichicastenango, March 17, 1936, *Leeds* (PH, US); Valley of Río de las Violetas, N of Nebaj, on crumbling shale bank, alt. 1740–1800 m, *Proctor 25367* (US). **Huehuetenango:** Ravine near ruins of Zacaleu, near Huehuetenango, alt. 1800 m, *L. O. Williams et al. 22427* (F); along road 13 km W of Huehuetenango, near Puente de Xinaxó, alt. ca. 1800 m, *Standley 81580* (F); "Los Pinitos," just SE of Huehuetenango, alt. 2000 m, *Steyermark 48200* (F, US); near crossing of Río San Juan Ixtán, E of San Rafael Pétzal, alt. ca. 1730 m, *Standley 83031* (F). **Quezaltenango:** Cerro La Pedrera, S of Quezaltenango, alt. ca. 2400 m, *Standley 65560* (F, US), dry, rocky hillside, *Standley 65552* (F), on rocks, *Standley 66492* (F); without definite locality, *Bernoulli & Cario 240* (B). **Sacatepéquez:** Antigua, *Kellerman 4876* (US); Volcán de Agua, alt. 1800 m, *Salvin* (K, fragm. US); slopes of Volcán de Agua, N of Santa María de Jesús, moist bank, alt. 1800-

2100 m, *Standley 59458* (F). **Chimaltenango**: Chichavac, dry banks along roads and above streams, alt. 2400–2700 m, *Skutch 317* (US); Barranca de La Sierra, SE of Patzúm, alt. ca. 2100 m, *Standley 61644* (F).

2. Mildella **leonardii** (Maxon) Hall & Lellinger, comb. nov.

Cheilanthes leonardii Maxon, J. Wash. Acad. Sci. **14**: 87. 1924.

Rhizomes multicipital, the shorter branches ascending, the longer ones short-creeping, to ca. 3 cm long and 3 mm thick, scaly, the scales bicolorous, the central band broad, sclerotic, and black, the margins extremely narrow, thin, and pale brown. Fronds (9)15–32 cm long, the stipes 2–3.5(4) times longer than the rhachises. Stipes and rhachises thin and wiry, shallowly grooved on the adaxial side, reddish brown becoming brown in age, the short, cylindrical, unicellular hairs few or absent on the stipe, abundant particularly on the shoulders of the rhachis groove, the weakly bicolorous scales present only near the stipe bases. Blades broadly lanceolate to pentagonal or triangular in outline, (2.5)4.5–9 cm long, (0.8)1.1–2.5(2.7) times longer than wide, the pinnae few and somewhat irregular in length. Lower, sessile pinnae 1–3 pairs, pinnatifid or pinnate, inequilaterally triangular, strongly basiscopic, the segments adnate, few, the inferior ones usually outnumbering and up to 3 times longer than the superior ones; upper, adnate segments 1–6 pairs, simple, long, linear, ascending, the terminal one (2)3–6.5 cm long. Segment and pinna margins subserrate (in some young fronds) to decidedly serrate. Indusium margins entire, not ciliate. Spores grayish pale brown.

TYPE: Rocky banks of ravine, vicinity of Furcy, Haiti, alt. ca. 1300 m, June 5, 1920, *Leonard 4552* (US, isotype C).

RANGE AND HABITAT: Confined to the Massif de la Selle, in the vicinity of Furcy, alt. 1300–1700 m, on dry to moist rocky or mossy banks. Most of the collections are from an area of basaltic rocks.

Mildella leonardii is distinct in the long, narrow terminal segments of the blades and in its long, nearly filiform stipes. Its rhizomes seem to be longer and to branch more freely than those of other species in the genus, but this character is difficult to assess from herbarium specimens. The species is named in honor of Mr. E. C. Leonard, a specialist on the flora of Hispaniola, who was for many years a curator in the herbarium of the U. S. National Museum.

ADDITIONAL SPECIMENS EXAMINED:

HISPANIOLA: **Haiti:** Massif de la Selle, between Morne Tranchant and Morne Brouet, Pétionville, Furcy, alt. 1450–1550 m, *Ekman H1194* (S, US); Morne Tranchant, alt. 1600 m, *Ekman H10023* (S); flancs du Morne Tranchant, alt. 1600–1700 m, *Picarda 738* (B); Morne de Wéyan, vicinity of Furcy, alt. ca. 1300 m, *Leonard 4483* (UC, US), *4498* (US); Crête-à-Piquants, Morne Gregoire, alt. 1100 m, *Ekman H7396* (S).

3. MILDELLA **nitidula** (Wallich ex Hooker) Hall & Lellinger, comb. nov.

Pteris nitidula Wallich, Num. List. no. 89. 1828, *nomen nudum.*
Allosorus nitidulus Presl, Tent. Pterid. 152. 1836, *nomen nudum.*
Cheilanthes nitidula Wallich ex Hooker, Sp. Fil. 2: 112. 1852.
Pellaea nitidula (Wallich ex Hooker) Baker in Hooker & Baker, Syn. Fil. 149. 1867.

Rhizomes multicipital, the shorter branches ascending, the longer ones creeping, to ca. 6 cm long and 5 mm thick, scaly, the scales bicolorous, the central band broad, sclerotic, and castaneous to dark brown, the margins extremely narrow, thin, and pale brown. Fronds (4)6–14(18) cm long, the stipes (1.3)1.6–3 times longer than the rhachises in young plants, 1–1.8 times longer in older, larger ones. Stipes more or less terete, the rhachises flattened or slightly grooved on the adaxial face, both dark brown becoming atropurpureous in age, the unicellular hairs few, scattered, not confined to the adaxial face, the stipe base scales weakly bicolorous, the distal ones scattered and few, concolorous, lax, hair-like. Blade outline variable (lanceolate-ovate in young fronds, lanceolate to linear-lanceolate in larger, older ones), (3)3.5–6.5(9) cm long, (1)1.2–2.8(3) times longer than wide. Lower, sessile or subsessile pinnae (2)3–4(5) pairs, ovate-triangular, pinnatifid or pinnate, only the lowest pair strongly inequilateral with the basal inferior pinnules sometimes pinnatifid; upper, adnate segments (3)4–5(6) pairs, simple, mostly linear and acute, ascending, diminishing to a terminal segment 2–10 mm long. Segment and pinna margins essentially entire. Indusium margins sparingly ciliate, somewhat irregular or erose. Spores pale brown to dark brown.

LECTOTYPE: *Wallich* (K–Herb. Hook., photo by Weatherby US; isolectotype B, Morton photos 10267 and 10272). According to Dr. Jarrett (in litt.), Hooker did not annotate the specimen in the Wallich Herbarium. Neither Dr. Jarrett nor we have been able to match *t. 912* in Hooker's *Icones Plantarum* with any of the syntypes. Although it is not certain that the Wallich specimens in the Hooker Herbarium are Wallich Cat. no. 89, it is likely that they are, for Dr. Jarrett reports that "they match quite well no. 89 in the Wallich herbarium." In addition, both this number and the details of entry no. 89 in Wallich's *Numerical List*, "Cheilanthes nitidula RB [R. Brinkworth, a collector for Wallich] Kamoon [Kamaoun]," are cited with Hooker's (1852, p. 113) description. The second syntype is "Simla, on rocks," *Thomson* (K), which Dr. Jarrett (in litt.) believes may be a wrong locality or only a very general one, since Thomson himself wrote additional localities on the sheet. Most of the Thomson specimens are from Kashmir, and no single specimen can be ascribed to Simla. The third syntype is "Pundkester, N. India," *Edgeworth* (K).

RANGE AND HABITAT: Highlands of Nepal and along the south Himalayan slopes of northwestern India and eastern West Pakistan.

The morphological differences between this species and its close relative, *M. henryi*, are often subtle. In addition to the characters included in the key, which seem to be the most useful ones, *M. nitidula* generally has longer laminae in relation to the stipes, a more regularly ciliate indusium with shorter cilia, and blunter segments than *M. henryi*. Christ (1899, p. 7) noted the ochraceous undersides of the fronds of *M. henryi* versus the pale undersides of *M. nitidula*, a character useful for fully mature specimens that are not discolored with dirt or by improper drying.

ADDITIONAL SPECIMENS EXAMINED:

INDIA: **Jammu Kashmir:** alt. 1000–1100 m, *Thomson* (B, Morton photos 10269 and 10273); Baltal, *Thomson* (K); Nasmon, Chenab Valley, *Thomson* (K); Barumgulla, Chittapan Valley, Poonch, alt. 1800 m, *Levinge* (E). **Punjab:** Kangra, alt. 2100–2400 m, *Duthie 23379* (UC). **Himachal Pradesh:** Chambra [Chumba?], alt. 1800–2100 m, Sept. 1897, *Marten* (E), alt. 1800 m, Oct. 1889, *MacDonell* (E); Chamba Distr., Kalel to Tissa, alt. 1800 m, *Stewart & Stewart 2346* (PH, US). **Uttar Pradesh:** Tehri Garhwal Distr., Gongotri, alt. 1200–3000 m, *Dudgeon & Kenoyer 16* (PH); Tehri Garhwal, *Duthie* in 1877 (UC); Tehri Garhwal Distr., Lambatach, alt. 2100 m, *Gamble 22999* (US). **State unknown:** "Mautar Khad, Jaunsar, 5000," Oct. 22, 1902, *comm. R. C. Wroughton*, British Museum (US); Jaunsar, near Konain, alt. 2100–2400 m, *J. F. D[uthie] 12956* (B, Morton photo 10270).

WEST PAKISTAN: **Swat:** between Maina and Ilam Mountain, alt. 1500 m, *Rodin 5478* (US). **Peshawar:** Hazara [Distr.], Jabori, Aug. 28, 1899, *Duthie* (UC); Hazara Distr., Abbottabad, *Stewart 13686* (US), hill SE of town, *Burtt 488* (E); Changla Gali, Murree Hills, alt. 2400 m, *Stewart & Stewart 4061* (US), *Stewart 23483* (US). **Kashmir**(?): Ravi Valley, "NW Himalaya," alt. 1800 m, *MacDonell* in 1882 (US).

NEPAL: Jumla, alt. 2250 m, *Polunin, Sykes & Williams 921* (E).

4. MILDELLA **henryi** (Christ) Hall & Lellinger, comb. nov.

Pellaea henryi Christ, Bull. Herb. Boiss. **7**: 7. 1899.

Rhizomes multicipital, the branches ascending or creeping, to ca. 3 cm long and 5 mm thick, scaly, the scales bicolorous, the central band broad, sclerotic, very dark brown, the margins narrow, thin, and pale brown. Fronds (6)11–21(32) cm long, the stipes (1.2)2–3.5(4) times longer than the rhachises. Stipes more or less terete, the rhachises flattened or slightly grooved on the adaxial side, both dark brown becoming atropurpureous in age, the unicellular hairs many (particularly on the rhachises), closely set, not confined to the adaxial face; stipe-base scales weakly bicolorous, the distal ones few, scattered, concolorous. Blades triangular, ovate-lanceolate to linear-lanceolate, (2.5)4–8(12) cm long, (1.33)1.5–2.67(3.9) times longer than wide. Lower, sessile or subsessile pinnae (2)3–5 pairs, triangular to ovate-triangular, the lowest 1 or 2 pairs always pinnate, the remainder merely pinnatifid, the lowest 2 or 3 pairs strongly inequilateral; upper, adnate segments (4)5–6(8) pairs, simple, mostly linear and acute or obtuse, ascending, diminishing to a terminal segment 2–5 mm long. Segment and pinna margins essentially entire. Indusium margins sparingly ciliate, somewhat irregular or erose. Spores pale brown to dark brown.

TYPE: Mengtze Hills, Yunnan, China, alt. 5000 ft, *Henry 11832* (P, not seen; isotype K).

RANGE AND HABITAT: Highlands of southeastern China and the mountains of Taiwan. No habitat data are available.

Occasional specimens of *M. henryi* from Taiwan and coastal China (*Bartlett 6286*, *Dunn 3917*) with distant pinnae and linear-lanceolate blades may be mistaken for *M. nitidula*, particularly if their veins are not strongly superficial and striate, their pinnae are thin, and their segments are acute. The terminal segments of the fronds never exceed 5 mm, while those of *M. nitidula* may reach 10 mm. The species is named for Augustine Henry (1857–

1930), an Irish medical and customs officer turned botanist and dendrologist, who is celebrated for his collections of Chinese plants made during the period from 1880 to 1900.

ADDITIONAL SPECIMENS EXAMINED:

CHINA: **Sikang:** Kangting District, *H. Smith 13369* (C). **Yunnan:** *Henry 12532* (P, photo by Weatherby US); Yunnanfu, *Ducloux 561* (US); *Forrest 24696* (E); Shih Peng, alt. 1200 m, *Henry 13223* (P, photo by Weatherby US); Tong Tchouan, *Maire 6503* (MICH), *6576* (B, Morton photo 10276); Ma-kong, Oct. 1913, *Maire* (C, GH); P'ing-pien Hsien, *Tsai 61462* (C). **Sze-ch'uan:** *Smith 1717, 2320* (S-PA); "in monte Mo-mi-san prope Teen-to-sen," Sept., 1899, *Scallan* (B, Morton photo 10275). **Kweichow:** Gan Chouen, *Cavalerie* [Ros. Fil. Chin. Exs. 53] (B, Morton photos 10266 and 10271, C, E, UC, US), *Cavalerie 1841* (C, UC), *Michel 1046* (E); District of Tsin-gay, Kao-tchay, *Laborde & Bodinier 2085* (E). **Kwangsi:** *Ching 6659* (UC, US). **Kwangtung:** "in rocks, M 28," without collector (MICH). **Fukien:** Ye Shap To, alt. 600 m, *Dunn 3917* (MICH).

TAIWAN: Western slope of Niitakayama, between Rakrak and Taikwan, alt. 1950–2160 m, *Bartlett 6286* (MICH, UC, US); Lu shan, Nantou Hsien, *A. M. E ans 130* (Herb. Evans).

5. MILDELLA **straminea** (Ching) Hall & Lellinger, comb. nov.

Pellaea straminea Ching, Bull. Fan Mem. Inst. Biol. 2(10): 203, *pl. 17.* 1931.

Rhizomes multicipital, tufted, retaining old stipe bases, the branches short, erect or ascending, to ca. 2 cm long and 2.5 mm thick, scaly, the scales weakly bicolorous, the central band brown or castaneous, shading into broad, pale brown margins. Fronds 6–12 cm long, the stipes 1.8–2.1(3) times longer than the rhachises. Stipes (at least near their apices) and rhachises deeply grooved on the adaxial side, stramineous, the one- to many-celled, usually bicellular, hairs lax, particularly abundant on the rhachises, scattered on the adaxial face, the short hairs many, the long ones fewer; scales of the stipe bases abundant, essentially concolorous, castaneous, those of the blades narrower, more lax, stramineous. Blades lanceolate, 4–7 cm long, 1.6–2.3 times longer than wide. Lower, subsessile pinnae 3–5 pairs, ovate-triangular, pinnatifid, inequilateral, with the inferior segments somewhat longer in the basal pinna pair; next 0 or 1 pairs of subsessile pinnae with either a single inferior or single superior basal lobe; upper, fully adnate segments 3–5 pairs, simple, linear to triangular, ascending, diminishing to a terminal segment 6–9 mm long. Segment and pinna margins entire. Indusium margins entire. Spores pale brown.

TYPE: "Kyichu Valley 15 miles east of Lhasa," Aug. 1904, *H. J. Walton* (K). PARATYPE: Lhasa, Tibet, alt. 12,000 ft, Sept. 16, 1904, *L. A. Waddell* (K). In publishing this species Ching did not designate a type; however, he did write "type" on the Walton specimen but not on the Waddell one.

RANGE AND HABITAT: Known to us only from the type collections; no habitat data available.

This is the only eastern hemisphere species of *Mildella* with entire indusium margins.

6. MILDELLA **paupercula** (Christ) Hall & Lellinger, comb. nov.

Pteris paupercula Christ, Bull. Acad. Inst. Géogr. Bot., Mans **16**: 131. 1906.
Pellaea paupercula (Christ) Ching, Bull. Fan Mem. Inst. Biol. **2**(10): 203. 1931.

Rhizomes multicipital, somewhat tufted, retaining old stipe bases, the branches ascending, up to ca. 2 cm long and 3 mm thick, scaly, the scales linear-triangular, sharply bicolorous, the central band dark brown, the margins pale brown. Fronds 15–25 cm long, (0.5)1–2 times longer than the rhachises. Stipes and rhachises nearly terete to deeply grooved on the adaxial side, stramineous, the one- to many-celled hairs lax, mostly on the rhachises, not confined to the adaxial face, the short hairs many, the long ones fewer; scales abundant on the stipes and rhachises, concolorous, reddish brown, lax. Blades more or less lanceolate, 8–15 cm long, 1.4–2.5 times longer than wide. Lower, subsessile pinnae 3–4(6) pairs, pinnate, with the segments adnate, broad, and tapering when young, linear at maturity; upper, adnate segments 1–3 pairs, ascending, diminishing to an unlobed terminal segment (2)3–4.2(5.5) cm long. Segment and pinna margins entire. Indusium margins sparingly short-ciliate and somewhat erose. Spores pale brown or yellowish pale brown.

TYPE: Tung Valley, western Sze-ch'uan [see Christ, 1906, p. 97], July 1903 or 1904 [the 1904 date is on the field label, the earlier date on the printed label of the isotype at K], *E. H. Wilson 5275* (P–Herb. Christ, not seen; isotype K).

RANGE AND HABITAT: Sze-ch'uan and Sikang Provinces of western China. In rocky places, according to the specimen data.

Fertile, fully mature specimens of *M. paupercula* (*Wilson 5275*) are similar to those of *M. smithii* in their extremely narrow and linear pinnae and segments, whereas juvenile and young fronds of *M. paupercula* (*Smith 10254*) are broader. Such fronds closely resemble small fronds of *Pteris*.

ADDITIONAL SPECIMENS EXAMINED:

CHINA: **Sikang**: Kangting (Tachienlu), in rocky places between Lutingchiao and Haulinpin, alt. ca. 1500 m, *H. Smith 10254* (NY, S-PA).

7. MILDELLA **smithii** (C. Chr.) Hall & Lellinger, comb. nov.

Pellaea smithii C. Chr., Acta Horti Gotob. **1**: 84, *t. XVIIIa–c.* 1924.

Rhizomes multicipital, the branches short, ascending, up to ca. 2 cm long and 4 mm thick, scaly, the scales sharply bicolorous, the central band dark brown, the rather broad margins pale brown, becoming erose in age. Fronds 6.5–18 cm long, the stipes 1.5–3.2 times longer than the rhachises. Stipes and rhachises terete, flattened or slightly grooved on the adaxial side, stramineous, the one- to many-celled hairs lax, scattered on the adaxial face of the stipes and rhachises, the short ones many, the long ones fewer; scales abundant, particularly on the stipe bases, concolorous, pale reddish brown, linear-triangular with long filiform tips. Blades lanceolate, (2)3–12 cm long, (1.4)2–2.67 times longer than wide. Lower, sessile pinnae 2 pairs (in small specimens) to 6 (in large ones), broadly ovate-triangular, pinnatifid or pinnate, inequilateral, with the segments linear, adnate, usually ascending; upper, adnate segments 3–5 pairs, simple, linear, diminishing to a terminal segment 7–17 mm long. Segment and pinna margins shallowly crenate to subentire. Indusium margins long-ciliate. Spores very pale brown.

TYPE: Sze-ch'uan, Hsü-ting, China, on sunny rocks, alt. ca. 2200 m, *H. Smith 4799* (C, Morton photo 5585, fragment US).

RANGE AND HABITAT: Western China in the provinces of Sze-ch'uan, Yunnan, and presumably Sikang.

Christensen (1924, p. 84) compared this species with *Pellaea brachyptera* Baker, a Californian species it superficially resembles. Among the species of *Mildella*, its closest relatives are *M. paupercula* and *M. straminea*.

ADDITIONAL SPECIMENS EXAMINED:

CHINA: **Yunnan**: Hung-mun-ko, on the Yangtze River N of Likiang, *Feng 2572* (GH); Shi-koo, on the Yangtze River N of Likiang, *Feng 419* (GH); mountains NE of the Yangtze Bend, *Forrest 10463* (UC).

8. MILDELLA **mairei** (Brause) Hall & Lellinger, comb. nov.

Pellaea mairei Brause, Hedwigia **54**: 201, *t. IVc.* 1914.

Rhizomes presumably multicipital with ascending or creeping branches (only seen in small juvenile specimens), scaly, the scales sharply bicolorous, the central band broad, sclerotic, dark brown to black, the margins narrow, thin, reddish pale brown. Fronds (4)11–15 cm long, the stipes about equaling the rhachises in young plants, 2–3 times longer in older, larger ones. Stipes more or less terete; rhachises flattened on the adaxial face; both atropurpureous, the unicellular hairs many; scales of the stipe bases weakly bicolorous, those above the bases concolorous, many, lax, persistent, attenuate from a slightly expanded base. Blade outline ovate-lanceolate in young fronds, long-ovate in older ones, (2.5)3.5–10.5 cm long, (1)1.2–1.8(2.2) times longer than wide. Lower, subsessile pinnae 4–6 pairs (1 or 2 pairs in juveniles), ovate to almost triangular, inequilateral, pinnatifid or pinnate, with linear segments, the inferior basal and the terminal segments much the longest; upper, adnate segments 3 or 4 pairs, simple, linear, acute, ascending, diminishing to a terminal segment 12–22 mm long. Segment and pinna margins crenulate or entire and appearing somewhat crenulate because of the outwelled, inflated indusia. Indusium margins irregularly short-ciliate. Spores pale brown.

TYPE: Tong Tchouan, Yunnan, China, Nov. 1910, *Maire 6575* (B, Morton photos 10265, 10268, 10274).

RANGE AND HABITAT: In the mountains of Yunnan and Kwangtung. To be expected in Kwangsi.

ADDITIONAL SPECIMEN EXAMINED:

CHINA: **Kwangtung**: *Tsoong D1149* (UC, fragment US).

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Shorter Notes

ASPLENIUM PLATYNEURON IN DENTON COUNTY, TEXAS.—In 1963, C. W. McMatt showed the authors some ferns and other plants on the wall of an old hand-dug well on the site of the defunct Hawk School located on his land. The school building was moved about 1930 and the well abandoned. The well has since gone dry, but seeping water along the vertical sandstone wall has provided a favorable environment for the growth of various ferns, mosses, and liverworts. The most prolific growth has been at depths of eight to 12 feet below the surface, but a few plants can be found almost from the top to the bottom, which is down about 25 feet.

On May 16 and October 14, 1966, we collected specimens of ferns from the well. These were identified as *Woodsia obtusa* (Spreng.) Torrey, which is found in nearby Copper Canyon, and *Asplenium platyneuron* (L.) Oakes reported by Correll[1] to be found in Cooke, Fannin, and Parker counties, but not in Denton County or other nearby counties.

The well is located approximately 7.5 miles south of the Denton County courthouse and approximately 8.0 miles northwest of Lewisville, Texas. The well is 114 feet southeast of U. S. Coast and Geodetic Survey bench mark U946.—DAVID L. SMITH and ARCHIBALD W. ROACH, *North Texas State University, Denton, Texas 76203.*

[1]Correll, Donovan S. *Ferns and Fern Allies of Texas.* Texas Research Foundation. Renner, Texas. 1956.

LIGHT AND THE GERMINATION OF MARSILEA QUADRIFOLIA SPOROCARPS.—Germination of the sporocarp of the water fern *Marsilea* involves absorption of water by the gelatinous sorophore, which swells considerably and soon protrudes from the sporocarp as a sorus-bearing ring.

While conducting some experiments on the effect of heat on *Marsilea* spore viability,[1] we were surprised to observe a light effect in *M. quadrifolia* L. that was absent in *M. aegyptica* from India, *M. brownii* from Australia, *M. minuta* from India, *M. rajasthanensis* from India, and *M. vestita* from North America.

Ripe sporocarps of these *Marsilea* species were collected from plants growing at the botanic garden of Government College, Ajmer, India in 1964 and were stored dried in paper envelopes. For the present work sporocarps of these *Marsilea* species were kept at 60°C. For one week, beginning at 8 AM and continuing at regular 12-hour intervals, we scratched one sporocarp of each species to facilitate water entry and placed the sporocarps in distilled water in the laboratory. In most species the sporocarps germinated irrespective of the time they were placed in the water, but in *M. quadrifolia* none of the sporocarps scarified and placed in water at 8 AM extruded sorophores, whereas all of those prepared at 8 PM did.

In order to confirm the exceptional behavior of *M. quadrifolia*, we attempted to germinate many sporocarps of this species in direct sunlight, in the laboratory under artificial light, and in complete darkness. The results confirmed the earlier observations that in this species the sporocarps extruded the sorophore only in complete darkness. The percentage of embryos formed differed considerably in these species of *Marsilea* relative to the time for which sporocarps were heated at 60°C. In *M. quadrifolia*, 19% of the megaspores formed embryos in unheated sporocarps, the megaspore viability showing a gradual decline thereafter in proportion to the length of time for which the sporocarps were heated.

We would appreciate receiving sporocarps of some more species

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[1] Bhardwaja, T. N. and Subir Sen. 1966. Effect of temperature on the viability of spores of the water fern Marsilea. Sci. and Cult. **32**: 47–48.

of *Marsilea* from different regions for similar studies. We also would like to learn the results of germination experiments in sunlight and in darkness made with sporocarps of local *Marsilea* material by other interested workers. We wish to thank Dr. D. M. Britton, of Ontario Agricultural College, Guelph, Ontario, Canada, who sent live plants of *M. quadrifolia* which were subsequently grown at the botanic garden of Government College, Ajmer, India.—T. N. BHARDWAJA and A. M. S. MOHAMMAD, *Department of Botany, College of Science, Mosul, Iraq.*

PILULARIA AMERICANA A. BRAUN NEW TO NEBRASKA.—While collecting around the shore of Hackberry Lake, 17 miles south of Valentine, Cherry County, Nebraska, on August 14, 1966, I found a small colony of the American Pilularia and proceeded to make a search of the area for this inconspicuous plant.

Hackberry Lake is one of many lakes located in the large sand-hill region of north-central Nebraska. It has a shore line dominated by bulrushes, arrowheads, and cattails, and it is rich in submerged and floating plants. Large areas have less than two feet of water; the clean, sandy bottom is easily observed.

While wading in the lake I observed the species growing in clear water up to 20 inches deep. The rhizomes were wide-creeping and the setiform leaves, which were 1–4 cm long, were generally single and spaced 0.5 to 1 cm. apart. Of hundreds of plants observed, not one had produced sporocarps.

A search of about one-half mile of shoreline revealed three small, open areas dominated by a dense growth of *Eleocharis acicularis* (L.) R. & S. and a few other sedges. These sites are inundated in the spring but are exposed by midsummer. In such places dense colonies of *Pilularia,* all with immature sporocarps, were found.

The American Pilularia has previously been known from Oregon, California, Texas, Oklahoma, Kansas, Arkansas, and Georgia. The Nebraska location extends the range of the species 350 miles northwest of the Kansas locality.—R. L. McGregor, *University of Kansas, Lawrence, Kansas 66044.*

A CRISPED BRACKEN.—Crisped pinnae, with the margins curled and ruffled, have been reported in several species of ferns, and often have been the basis of new *formae*. ***Polystichum acrostichoides*** (Michx.) Schott f. *crispum* Clute readily comes to mind as a common instance of crisped pinnae. Judging from a survey of several regional floras, such a condition has not been noted previously in *Pteridium aquilinum* (L.) Kuhn var. *latiusculum* (Desv.) Underw.

While collecting in dry, rocky woods along a trail above the Cuyahoga River in Gorge Metropolitan Park, Akron, Summit County, Ohio, on August 10, 1966, I came across a single, sterile frond of this species with crisped pinnae that was growing in a small patch of "normal" fronds. The crisped frond differed from the "normal" ones only in its ruffled pinnae. The only associated pteridophyte was *Botrychium dissectum* Spreng., which is rare at this station.

It seems best not to dignify this single specimen with "forma *crispum*" or some other formal name. Its discovery is merely recorded here as a matter of interest and curiosity.—ALLISON W. CUSICK, *Department of Biological Sciences, Kent State University, Kent, Ohio 44240.*

Notes and News

DR. ALMA G. STOKEY.—It is with pleasure that the American Fern Society pays tribute to Dr. Alma G. Stokey who, on June 17, 1967, celebrated her 90th birthday. Now an emeritus professor of botany at Mount Holyoke College, she has been a member of the American Fern Society for 18 years and one of its five Honorary Members since 1953. Dr. Stokey has maintained a life-long interest in ferns, particularly in their gametophytes. Her pioneer work among the numerous fern families has dealt with the development and characteristics of the fern thallus as an aid to understanding relationships and evolution. Scarcely a paper on these subjects now fails to mention her work. The American Fern Society extends congratulations to this able teacher and indefatigable investigator.

Recent Fern Literature

STUDIES OF THE SINUOUS CLOAK-FERN (NOTHOLAENA SINUATA) COMPLEX, by Richard H. Hevly. J. Ariz. Acad. Sci. **3**: 205-208, fig. 1. 1965.—Since the time of Weatherby's work in 1943, *Notholaena sinuata* has been regarded as consisting of three varieties—var. *sinuata,* with rather large, more or less lobed pinnae, var. *cochisensis,* with small, entire pinnae, and var. *integerrima,* with somewhat intermediate pinnae. Hevly has decided, on the basis of extensive morphological and physiological studies, that *N. sinuata* and *N. cochisensis* represent distinct species and that *integerrima* is a hybrid between them and consequently should also be treated as a species rather than as a variety of *N. sinuata:* for this, presumably apomictic species, he proposes the name *N. integerrima.* The restricted *N. sinuata* is divided into four varieties, grouped in two subspecies—*N. sinuata* subsp. *sinuata* (with var. *sinuata* and var. *robusta* Hevly, the type from Zitacuaro [not "Zitacuroro", as Hevly has it] and subsp. *madriensis* Hevly (with var. *madriensis,* the type from Temescaltepec, Mexico, and var. *pruinosa* (Fée) Fourn.). It would seem that "*madriensis*" may be a typographical error for the usual *madrensis,* the name referring presumably to the Sierra Madre of western Mexico. It is unfortunate that the Latin diagnoses of the novelties have several misspellings (or typographical errors). None of the varieties of *N. sinuata* occurs in the United States except var. *sinuata* itself.—C.V.M.

THE EVOLUTIONARY PATTERNS OF LIVING FERNS, by Warren H. Wagner, Jr., Mem. Torrey Bot. Club **21**: 86–95. 1964.—Wagner has attempted to determine the primitiveness or specialized nature of the characters of living ferns by using correlations within the group and with other classes of vascular plants. In general, primitive characters can be expected to be correlated with other primitive characters. He concludes that primitive ferns were characterized by being terrestrial, with upright, simple stems, with a vascular and cork cambium, with midribbed fronds which are circinate in vernation, with stipules and free veins, with homosporous, massive (many-celled) sporangia, these solitary or in simple sori, and with trilete spores, which give rise to massive gametophytes with large, sunken sex organs, and with endoscopic, 1-leaved embryos. By these characters primitive ferns were very like primitive cycads, in some ways more like them than they are like the most specialized modern ferns. Very little help has been obtained from palaeobotany, because unquestionably true ferns are not known before the Carboniferous, by which time several of the modern fern families, such as Gleicheniaceae and Osmundaceae, were already well developed and hardly different from their modern descendants.—C.V.M.

AN INTRODUCTION TO EMBRYOPHYTA, VOL. II. PTERIDOPHYTES. ed. 5., by N. S. Parihar, Central Book Depot, Allahabad, India, 1965. vi + 331 pp. $2.50 or 16/– s.—This book is, as the author states in the reprinted preface to the first edition, "in large part a compilation based upon literature and a large number of selected references are appended to each chapter to support descriptions and interpretations." Although primarily intended to cover the graduate syllabus of most Indian universities, this volume is a most concise, compact, up-to-date, and useful survey of the morphology, anatomy, and embryology of the vascular cryptogams. Notes on ecology, cytology, and economic uses are also included. Much of the work is of a brief, descriptive nature, but controversial points of interpretation are discussed at sufficient length. Due to the spare style, the principal value of the book to most readers will be as a reference rather than a text. Except for the Salviniales, which are omitted, a chapter is devoted to each of the orders of pteridophytes (Lycopodiales, Selaginellales Equisetales, Ophioglossales, Osmundales, Filicales, and Marattiales), with a special chapter for the Polypodiaceae and a terminating chapter entitled "Resume and Discussion," which weaves some of the morphological theories concerning more than a single order into a summary of the data presented in the previous chapters. Bibliographies, updated to 1964, are included with each chapter. A glossary, an index, and a fold-out table comparing the characteristics of representative genera of the various orders concludes the volume.—D. B. L.

PTERIDOPHYTES OF THE MOUNTAIN LAKE AREA, GILES CO., VIRGINIA: BIOSYSTEMATIC STUDIES, 1964-65, by W. H. Wagner, Jr. and Florence S. Wagner. Castanea **31**: 121–140. 1966.—Of the 75 pteridophytes known from Giles County, Virginia, over one-fourth exhibit cytological peculiarities or deviate from the normal sexual life cycle. Thirteen are apparently interspecific hybrids, of which only three (*Asplenium bradleyi, A. pinnatifidum,* and *Dryopteris campyloptera*), all of them tetraploids, reproduce regularly from spores. Four others (*Cheilanthes alabamensis, Pellaea atropurpurea, P. glabella,* and *Asplenium resiliens*) are triploids or have other cytological irregularities. And three of the most common (*Athyrium asplenioides, Asplenium trichomanes,* and *Polypodium virginianum*) have undergone complex cytogenetic differentiation, each of them having diploid, triploid, and tetraploid races which are apparently morphologically indistinguishable.—C.V.M.

FERNS OF ALABAMA AND FERN ALLIES, by Blanche E. Dean. American Southern Publ. Co., Northport, Ala., 1964. xxiv + 232 pp. $7.50.—This book can best be described as an uneven compedium of knowledge of pteridophytes known to occur in Alabama. To its credit, it summarizes not only the information usual to state fern floras, but also much recent and past research, mostly from this JOURNAL, that does not often find its way into floristic literature with the speed that it ought. Changes of nomenclature, extensions of range, results of some recent research, and special comments on the rarities are all included, as are distribution notes, remarks on fern culture, a glossary, and a page devoted to the American Fern Society. Keys below the ordinal level are lacking, which limits the book's usefulness for identification purposes. This is in part ameliorated by the readily usable drawings. Unfortunately, both typographic and scientific accuracy are lacking throughout the work. There are errors in the introductory material ("toothed" in reference to a rounded lobe and "2-pinnate" to a scarcely lobed pinnule), in the authorities for some of the names ("*Pteris* (Tourn.) L." and "Botrychium lunarioides (Michx.) Underw. sensu Wagner"), in the captions (of Christmas Fern, "the spores are in two rows on the upper end of the fertile frond"), and in the glossary ("*Sporophyll*, The specialized organ which produces the spores" versus "*Sporophyte*, The frond or structure producing the spores"). The bibliography is in no rational order at all.—D. B. L.

NEW DATA ON NORTH AMERICAN OAK FERNS, GYMNOCARPIUM, by Warren H. Wagner, Jr. Rhodora **68:** 121–138, fig. 1–7. 1966. The Oak Ferns, *Gymnocarpium dryopteris* and *G. robertianum* (until recently commonly known as *Dryopteris disjuncta* and *D. robertiana*) are circumpolar in their distribution and are usually rather readily distinguished by the narrower frond-outline and glandularity of G. *robertianum.* Wagner has found that numerous intermediates exist in Pennsylvania, Michigan, Wisconsin, Minnesota, Ontario, and Alaska; these are intermediate in morphological characters and have abortive, very irregular spores. Cytological examination of at least one population shows that these plants are triploids, and therefore presumably hybrids. This plant is described as *G. heterosporum* Wagner, the type from Pennsylvania. The western United States population of *G. dryopteris* occurring in Idaho, Oregon, and Washington, has been found to be diploid. The new species is therefore considered to have arisen by a cross of the western diploid *G. dryopteris* var. *disjunctum* with the eastern and northern tetraploid *G. robertianum.* All four entities, tetraploid *G. robertianum*, tetraploid *G. dryopteris* var. *dryopteris*, diploid *G. dryopteris* var. *disjuncta*, and triploid *G. heterosporum* probably occur in Alaska, and some plants can probably not be identified without chromosome counts, because they are often depauperate and atypical morphologically because of the adverse northern climatic conditions.

A recent number of Taxon contained the disturbing news that the General Committee on Nomenclature had decided that *Gymnocarpium* Newm. was only an orthographic variant of the earlier genus *Gymnocarpum*, and consequently illegitimate and not available for use. I immediately wrote to Dr. Ross, the Secretary of the committee, asking if the matter could not be reconsidered, in view of my recent discussion of this question

(Amer. Fern J. **55:** 85. 1965), in which I showed that *Gymnocarpium* was really a diminutive of *Gymnocarpum*, and therefore a different word and not an orthographic variant. I admit that these two names are quite similar, but since they belong to different major groups of plants there is no real danger of their being confused. The fern genus *Gymnocarpium* is only just now coming into general use, and it would indeed be too bad to have it displaced now.—C. V. M.

FERNS AND FERN ALLIES OF CALIFORNIA, by Steve J. Grillos. University of California Press, Berkeley and Los Angeles, 1966. 104 pp. $1.50.—This useful little manual is number sixteen in the California Natural History Guides series. In it are an illustrated key to families, keys to genera and to species, and descriptions, illustrations, and ecological and distributional data for about three-quarters of the species of ferns known to occur in California. All those likely to be encountered at all commonly are included. The rare species are mentioned under their genera, along with their distribution. Varieties or subspecies of several problematical species (e.g., in *Athyrium* and *Pityrogramma*) are noted but not discussed, in the interest of simplicity. All species are cross-referenced with the more complete treatment in Munz and Keck's "A California Flora."

Introductory material includes a discussion of a fern life cycle and how to identify ferns. A chapter on activities describes how to make a fern herbarium, how to raise ferns from spores, and several decorative and picture-making techniques for use with ferns. A glossary, checklist, and short bibliography complete the volume, which will be of extensive help to all hobbyists and beginning students of California ferns.—D. B. L.

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CONTENTS

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American Fern Journal

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An Advanced Course in Pteridophyte Biology in Costa Rica

John T. Mickel[1]

The Organization for Tropical Studies (OTS) was founded in 1962 as a consortium of several North American universities, the University of Costa Rica, and the Smithsonian Institution, with the common purpose of promoting scientific study in the tropics. This has been implemented by renting office, classroom, and laboratory space at the University of Costa Rica near San José. Although the University is the center of operations, most of the class time is spent in the field at various field stations. In each two-month session there is usually one class in the fundamentals of tropical biology and one or more advanced courses in various aspects of botany, zoology, geography, or forestry. Courses are given in February–March and July–August and are open to all North and South American graduate students and occasionally to postdoctoral students.

The pteridophyte flora of Costa Rica is extremely rich. The vascular flora of the country is estimated to contain approximately 10,000 species, of which perhaps 800 are ferns and fern allies. There are few places in the world with as great diversity in such a small area, which is less than that of West Virginia.

The greater diversity in Costa Rica compared with the other Central American countries is due to the greater number of habitats. A backbone of mountains divides the country lengthwise. A chain of volcanoes runs from Nicaragua half way down the country past San José, the capital. The four nearest San José

[1] I wish to express my thanks to the Organization for Tropical Studies for enabling a course in tropical pteridophytes to be taught and to the National Science Foundation for its support.

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(Poás, Barba, Irazú, and Turrialba) are the largest, all with peaks about 9000 feet high. Non-volcanic mountains extend from

FIG. 1. MAP OF COSTA RICA SHOWING MAJOR AREAS VISITED BY THE 1967 OTS ADVANCED BOTANY CLASS. SHADED AREAS INDICATE ELEVATIONS OVER 3300 FEET. THE LARGEST VOLCANOES ARE DESIGNATED BY THEIR INITIALS: BARBA, IRAZÚ, POÁS, AND TURRIALBA.

San José to Panama; these reach 12,500 feet. The major areas for plants are a lowland wet forest on the Atlantic side, a lowland wet forest on the Pacific side, a lowland dry area (Province of Guanacaste) on the Pacific, and various montane areas ranging from dry to very wet and from subtropical to alpine. There are no deserts in Costa Rica. Some of the wettest and richest areas are the saddles between the volcanoes, where rains fall from both Atlantic and Pacific winds. Ferns, however, are common from the lowlands all the way to the mountain tops.

Costa Rica is one of the better known Latin American countries botanically. Yet there is no work that includes the pteridophytes of Costa Rica. Standley's (1937–38) *Flora of Costa Rica* covers only seed plants. Wercklé's collections of the early 1900's were sent to Hermann Christ in Basel, Switzerland, who published a series of papers based on these specimens. These are largely annotated lists of species found or described as new. Edith Scamman's recent papers on *Adiantum* (1960), *Pteris*, (1961), *Oleandra* (1961), and *Eriosorus* (1962) of Costa Rica have been very helpful for these genera.

In spite of the number of collectors there is still a great deal to be learned floristically in the country, to say nothing of the biology of the plants. Of the approximately 800 species of pteridophytes, many are represented by few specimens in herbaria, suggesting our scant knowledge of them.

Much of the country is being devastated by the Costa Ricans. Some areas are being cut for lumber, often large areas for a few commercially valuable trees. Forests at high elevations are cut for charcoal. Vast areas at middle elevations are being burned to make more land available for coffee and sugar cane. In the dry season fires can be seen in all directions, and the smoke creates a dense haze on the horizon. Some interesting areas I visited in March 1967 were gone in June. The population pressure is extremely great; Costa Rica has the highest birth rate in the world. The one consolation from this devastation is that new areas are being made available for plant exploration and study as roads are built into the back country, so although the native flora of Costa Rica is disappearing, our knowledge of it is increasing. We can only hope that the native flora will not be completely lost.

In the summer of 1967 the OTS advanced botany course was on the biology of tropical pteridophytes. Ten outstanding students were selected from nine universities across the United States.[2] The students' specialties in pteridology included taxonomy, morphology, anatomy, paleobotany, physiology, cytology, and horticulture. The diversity of class interests greatly benefited the class members, who shared their special knowledge and ability to discover different things in the field that otherwise might have gone unnoticed.

The emphasis in the course was biological rather than purely taxonomic. The pteridophytes were defined as all vascular plants possessing a life-cycle with two free-living generations, i.e., lacking seeds. Much attention was devoted to observing the stages of life-cycle and modes of reproduction. The approach was one of analyzing problems: adaptations of pteridophytes and their significance, ecological specializations of the vegetative and reproductive parts, correlation of reproduction with season and habitat, and many other questions. One of the greatest interests in this course concerned the structure and growth of fern stems and petiole axes, especially those of large plants, which for practical reasons are rarely collected or preserved.

Two of the faculty were present for the entire course. I was course coordinator and the official professor. Dr. Elías R. de la Sota, Facultad de Ciencias Naturales y Museo, La Plata, Argentina, was the assistant professor for the course. Three other faculty members were with the class for part of the summer. Dr. Warren H. Wagner, Jr., University of Michigan, was with the class for the first two weeks to give the basic lectures. Dr. A. Murray Evans, University of Tennessee, and Dr. David B. Lellinger, Smithsonian Institution, were there for the next five

[2] L. Earl Bishop, University of Hawaii; Donald R. Farrar, University of Michigan; Barbara Joe Hoshizaki, Los Angeles City College; Dr. Richard C. Keating, Southern Illinois University; Robert M. Lloyd, University of California; Bruce W. McAlpin, Duke University; Virginia M. Morzenti, University of Michigan; Aleta J. Petrik, University of Kansas; Alan R. Smith, Iowa State University; Judith E. Troop, University of Connecticut. Also with us were James P. Smith, Iowa State University, as a teaching assistant, and Ramón J. González V., Ministerio de Agricultura y Ganadería, San José, as a field assistant.

weeks as consultants and lecturers while pursuing their own research at the same time.

During the first two weeks lectures were given in San José on the taxonomy, morphology, phylogeny, and ecology of lower vascular plants. Short trips were also taken to several areas on the Meseta Central (central plateau) and to the nearby volcanoes. These included the classic collecting localities of La Palma and La Hondura, located in the saddle between Volcán Barba and Volcán Irazú, and Varablanca, between Barba and Poás. These areas are still extremely interesting from the standpoints of the diversity of the flora and the way they have withstood the ravages of cultivation and botanical collecting. At La Hondura we first noticed the curious slime sheaths on crosiers of *Thelypteris* sect. *Glaphyropteris* and *Blechnum viviparum*. This covering helps explain the occurrence in these species of scale-like aerophores on the stipes and at the base of each pinna (*Fig. 2*). One of the most impressive angiosperms of the area is *Gunnera*, with leaves up to eight feet across. These served us well as umbrellas during the heavy rains of the early afternoon.

The road to the top of Volcán Poás is negotiable by car, but the road is hardly in condition to attract most tourists. The view of the present main crater is spectacular when it is not foggy. Near the top there is a lake in the old crater. Here we found the rare and interesting *Loxsomopsis costaricensis* along the shore and *Isoëtes storkii* in the water.

The southeast slopes of Volcán Barba proved to be quite interesting too. Here the oak forest is especially rich in epiphytes. The abundance of grammitid ferns was striking. The small oval leaves of *Lycopodium cuneifolium* caused it to be mistaken at first for a slender, pendent *Peperomia*. *Loxsomopsis* was found again here in marshy areas. An apparently undescribed member of the *Lycopodium cernuum* group close to *L. pendulinum* was found in an open area near the trail.

One of the richest areas we visited was located southeast of Cartago near the village of Tapantí. It was here that we discovered *Hyalotricha anetioides* (*Fig. 4*). The phylogenetic position of this

Fig. 2. Crosier of Thelypteris sect. Glaphyropteris with aerophores. Fig. 3. Class at Poás Lake. Left to right: Virginia Morzenti, Bruce McAlpin, Prof. Warren H. Wagner, Jr., Donald Farrar, Barbara Joe Hoshizaki.

fern has been in question since the genus was described by Copeland in 1953. It was originally described as a *Polypodium* by Christ. Possible relationships with polypodioid, grammitid, thelypteroid, dryopteroid, and vittarioid ferns have been suggested.

Although the genus *Equisetum* includes only three species in Costa Rica, some members are extremely impressive. In a warm spring marsh near Desamparados, a suburb of San José, there are several acres covered by *E.* × *schaffneri*, the hybrid between *E. giganteum* and *E. myriochaetum*. The plants are spectacular, not only in their abundance here, but also in their size. Most of the plants are 10–15 feet tall, but where the stems leaned against an old tree trunk they reached 22½ feet. The marsh is also notable because *Acrostichum aureum* is common, although it is far from any coast and is at an altitude of 3500 feet.

During the introductory period the class became acquainted with the genera and the "malezas," or common species which were weedy in the sense that we found them rather abundant and quite widespread.

After the first two weeks of the course the class took longer trips to several other areas of the country in order to visit a variety of habitats. Our first extensive trip was a five-day trip to the Osa Peninsula, an area of wet forest in the Pacific lowland. The entire class and its equipment were carried there by light airplanes, as there are no roads that extend from the mainland to the peninsula. We made our headquarters in a field station of the Tropical Science Center, which adjoined the airstrip. The only road on the peninsula runs toward the Pacific Ocean for about 15 kilometers southward from the field station and northward to the lumber station of Rincón and up onto a ridge nearly 2000 feet high.

Within the first hour we were at the Osa station we were confronted by our first poisonous snake, a six-foot bushmaster (*Lachesis muta*), near a stream. There are said to be about 15 species of venomous snakes in Costa Rica, the bushmaster being perhaps the most vicious. This one was rather retiring, however. We also encountered a palm viper (*Bothrops schlegeli*) coiled on a palm leaf waist high by the trail. Fortunately the class found only one other poisonous snake, another bushmaster, all summer.

The forest on the Osa Peninsula is dark and humid. The fern flora is not so rich as that of the volcanoes, but very interesting nonetheless. Notable among the pteridophyte flora is one of the largest species of *Selaginella*, *S. exaltata*, which is four feet high with large, frond-like branches. The megaspores in this species have a diameter up to 1.3 mm. All five genera of Costa Rican Vittariaceae are found in the low wet forest: *Ananthacorus*, *Anetium*, *Antrophyum*, *Hecistopteris*, and *Vittaria*. Twelve species of *Trichomanes* were found in the area. *Metaxya*, a primitive, trunkless member of the Cyatheaceae, and *Tectaria plantaginea*, a simple-leaved, apically-budding plant, were also interesting. On the forest floor we found a curious, juvenile plant that had quite finely dissected, almost lacy fronds. It did not resemble closely any of the mature ferns of the area, but after continuous searching we found the intermediate stages in which the lamina became broader and the veins anastomosed. These were the juvenile stages of *Pteris altissima*, a striking example of leaf change in a heteroblastic series.

On our next trip we drove from San José northwest into the province of Guanacaste, the Texas of Costa Rica. It has a pronounced dry season which greatly restricts the plants that can grow there. Many beef cattle graze in the lowlands of this province. We stayed for five days at Finca La Pacifica near Cañas (elevation 300 feet). This ranch, managed by Mr. Werner Hagenauer, is one of the best-managed farms in Costa Rica.

With La Pacifica as a base camp we traveled northward past Liberia to collect in the savanna regions and along the several rivers that flow to the Pacific Ocean. In the savannas there are relatively few ferns, but they are quite distinct from any we had seen in other parts of the country. The Schizaeaceae were well represented. *Anemia oblongifolia* and *A. hirsuta* were frequent on the rocks, and *Lygodium venustum* was common on the ground. *Schizaea* is reported from the province, but we were unable to find it. There had been no rain for four weeks until the night we arrived, at which time there was a fierce downpour. The following day we found *Marsilea* sporocarps opening in small meadow pools formed by the rains. In fact, we found the gelatinous sorophores in the water before we saw the sporophyte plants.

The rivers and their associated limestone outcrops provided additional distinctive habitats. *Anemia adiantifolia* and *Thelypteris puberula* found here had not previously been recorded from the country. *Thelypteris resinifera*, rare in Costa Rica, was also found here.

Not all of our trips were rewarding. One day in Guanacaste we went to the nearby agricultural experiment station at Taboga. That area is noted foı being hot and humid. The beautiful gallery forest we went to see had been destroyed. When we took a side road, one vehicle became stuck in the sand, and the winch on the other vehicle would not work. We had a flat tire for the third straight day. To make the day complete, we saw only three species of ferns, all uninteresting.

Going east from Cañas into the low mountains of the Tilarán area (elevation 1500–2100 feet) provided much richer areas for pteridophytes. We found several interesting localities near the road between Tilarán and Lake Arenal. We found here a number of the common ferns of the wet lowland forest of the Osa Peninsula, such as *Ananthacorus*, *Bolbitis*, *Cyclopeltis*, *Lomariopsis*, and *Tectaria*. Along the road *Thelypteris torresiana*, an Old World species, was discovered for the first time in Costa Rica; subsequently we found it in several other regions. Apparently it is spreading as widely here as it is in other parts of tropical America. Another common species, *Thelypteris dentata*, is one of the most widespread ferns in Costa Rica, and yet there are but two collections of it from Costa Rica in the United States National Herbarium.

The so-called "living fences" are as interesting as the forests. On the boles of these sprouted fence posts we found a number of species of *Asplenium*, *Lycopodium*, and *Polypodium*.

On our return trip from Cañas we stayed for two days in San Ramón at the small, comfortable Hotel El Jardín. The town is at

FIG. 4. LOWER SURFACE OF HYALOTRICHA ANETIOIDES. FIG. 5. FIELD STATION AT LA SELVA NEAR PUERTO VIEJO WITH SLEEPING QUARTERS ABOVE AND COOKING AND DINING AREA BELOW.

about 3000 feet elevation; the ridges directly behind the city catch the rains that come from both the Atlantic and Pacific, much as they do near Tilarán and between the larger volcanoes. The constant cool mist and rain make it a luxuriant and interesting fern locality. We spent most of our time on a ridge seven miles north of San Ramón, where the ferns were abundant both in the forests and on old trees in pastures. *Hymenophyllum* and *Elaphoglossum* were especially abundant with 10 species each. One species of *Elaphoglossum* had plantlets at the tips of the leaves, a phenomenon we had not seen in this genus; (*E. proliferans* of southern Costa Rica does this, but we did not find that species). We found the small *Vittaria minima* growing in profusion among the Hymenophyllums on tree trunks. *Oleandra bradei,* which we had seen previously, here completely covered the trunk of an old oak tree.

One problem that deserves more attention is the phyllotaxis of tree ferns. One large species of *Cyathea* collected near San Ramón had conspicuously whorled leaves, a remarkable condition for ferns. In most species they are spirally arranged. *Cyathea mexicana,* one of the most common tree fern species in the country, appeared to have both conditions and some intermediate stages on different plants. Perhaps the whorled condition in these plants represents merely the coordinated development of members of several spirals.

A hedgerow of *Cupressus* provided an interesting array of epiphytes, including species of *Antrophyum, Pleopeltis, Polypodium, Trichomanes,* and the rare *Marginariopsis,* which looks like a coenosoric *Pleopeltis.*

In early August we flew in small planes southeast from San José to the village of San Vito de Java near the Panama border. San Vito is accessible by land transportation, but the trip is long and arduous and the road is bordered by long stretches of cultivated land. Near San Vito we stayed in a well-equipped field station donated anonymously for the use of students and researchers on tropical biology. It is located on a finca owned by Mr. and Mrs. Robert Wilson, retired nurserymen from Florida, who most graciously manage the station and have overseen its construction. The elevation is 4000 feet, with wet forest just below and a cloud forest above, both within walking distance (15 minutes and one hour respectively). The forest is marked by an abundance of tree ferns. The most common species, *Cyathea mexicana*, is especially interesting in that it was the only species of tree fern we saw that produced branches. Although we saw only one tree that had several branches arising high on the trunk, all specimens had branch buds to one side of the leaf bases. These usually aborted or remained dormant.

Species of *Asplenium*, *Diplazium*, *Elaphoglossum*, and *Polypodium* were also very common. One species of *Diplazium* was very striking because of its eight-foot long, fleshy fronds.

Our return flight to San José was segmented. One or two planes left at a time, but before the last group could leave, the weather became worse along the route, forcing them to land at Palmar Sur. They reached San José late in the day by flying a roundabout route.

The following trip took us southeast from San José along the Pan American Highway into the high mountains at 10,000–11,000 feet to the region known as the Cerro de la Muerte. The hotel where we stayed, La Georgina, had no heat, so most of us kept our jackets on nearly the entire time we were there. The temperature ranged from 40 to 58 °F inside the hotel. Because of the near-freezing temperatures, we did not anticipate finding many ferns at this elevation, but this proved to be a false assumption. In the oak forest immediately behind the hotel we found more than 50 species of pteridophytes. Several genera characteristic of high elevations were common: *Culcita*, *Histiopteris*, *Plagiogyria*, and *Polystichum*. *Elaphoglossum* (10 species) and *Grammitis* (9 species) were especially noticeable. A species of *Cyathea* was frequent in the woods, but apparently it was damaged periodically by frost as evidenced by the many wilted fronds. Filmy ferns, too, are usually associated with a tropical climate, yet there were four species of *Hymenophyllum* at this locality. The robust terrestrial *Lycopodium hippurideum* was frequent in the woods.

The rather dry, clayey páramos at about 11,000 feet in this region are especially interesting. They lack trees, the dominant large shrubs being mostly *Chusquea* (a bamboo) and *Hypericum*. The most conspicuous and distinctive pteridophytes of the area are the several species of *Lycopodium*, *L. contiguum*, *L. saururus*, *L. thyoides*, and two species of *Jamesonia*, *J. rotundifolia* and *J. scammanae*.

We spent several hours at some marshy páramos at about 8500 feet elevation. These are dominated by *Blechnum buchtienii*, one of a few species of *Blechnum*, placed in sect. *Lomariocycas*, that form a heavy, erect trunk up to eight feet tall. Another species with a shorter trunk, *B. werckleanum*, is less common. *Isoëtes* was found in a small pool.

In order to see the lowland Atlantic wet forest, we drove northward to Puerto Viejo in mid-August. Although the road is paved as far as Varablanca, about half the way from San José, the road is very difficult going down the Atlantic slope. It is exhausting, both for the driver and the passengers, for portions are exceedingly rough and winding. At the river in Puerto Viejo we were met by a long canoe (with motor) that took us upstream 15 minutes to the Finca La Selva, another field station of the Tropical Science Center (*Fig. 5*). The station lies in a patch of virgin and near-virgin wet forest at about 400 feet elevation, and is bordered on two sides by cacao, banana, pineapple, and pejibaya (a delectable palm fruit) plantations.

Many of the fern genera here were the same as those in the Pacific wet lowland forest, for example, *Cyclopeltis*, *Diplazium*, *Lomariopsis*, *Polybotrya*, *Trichomanes*, and the five vittarioid genera. Some genera, *Adiantum*, *Asplenium*, *Goniopteris*, *Tectaria*, were much more diverse here than at the Osa Peninsula. We found at least three species of *Danaea*. The most common species, *D. wendlandii*, in some places covered the forest floor. This species is peculiar because it is so much smaller than all the other species we saw; in fact, it closely resembles the juvenile forms of other species. It is possible that this species might really be a neotenous derivative of some other species.

The most peculiar fern we found at La Selva was a creeping epiphyte with simple sterile leaves. The fertile leaves were either simple or deeply three-lobed. The sori were linear and exindusiate. It resembles no other fern of the New World and seems closest to *Colysis*, a splinter genus from *Polypodium*, which is known only from southeast Asia. It also seems possible that it is a tectarioid fern which has evolved multiple resemblances to *Colysis*.

For our final trip we traveled to Turrialba where we stayed at the Interamerican Institute for Agricultural Sciences. The dormitory rooms were comfortable, and we ate our meals in the cafeteria. A laboratory and classroom were furnished us. Turrialba (elevation 2000 feet) lies lower than San José and is warmer and wetter. The Turrialba area is reported to be the world center of fer-de-lance (*Bothrops atrox*) abundance. These extremely dangerous snakes are largely nocturnal, and we avoided them entirely.

Directly behind the Institute there is a good trail through the forest down the steep slope to the Reventazón River. *Asplenium* (9 species) and *Selaginella* (7 species) were especially abundant among the 60-odd species there. Along the trail *Adiantum seemannii* was one of the most attractive ferns we saw.

Driving 20 kilometers southeast from the Institute, we reached the small village of Platanillo. Here there is easy access to the rich ridges where there are dense forests of massive trees, including *Engelhardtia* (Juglandaceae). The rainfall is over 200 inches per year, and the forest provided the richest fern flora we found all summer. In three hours we found 112 species of pteridophytes. The forest at the top of the ridge appeared to have the understory nearly 100% ferns, including 7 tree ferns, 20 filmy ferns, 9 *Elaphoglossum*, 9 *Asplenium*, 6 *Diplazium*, 7 *Thelypteris*, 6 *Blechnum*, 9 polypodioids, and 7 grammitids.

Each student in the class conducted an individual research project for the summer. Some selected two or three problems. These were later presented in the form of both oral and written reports. None of the projects was strictly taxonomic, although several of them concerned phylogenetic relationships. Several of the projects were strongly anatomical, utilizing hand sectioning techniques and dissecting microscopes. Branching patterns of the dennstaedtioid ferns were examined by Miss Troop, who found that branches arise from the petioles throughout this group. To some extent the same is true in the Cyatheaceae and Grammitidaceae. Stelar patterns of the Grammitidaceae were studied in detail by Mr. Bishop. Studies of the stipe anatomy of cyatheoid and dennstaedtioid ferns by Dr. Keating and the dryopteroid and thelypteroid ferns by Mr. Smith showed several lines of specialization.

General morphology was taken up with different approaches. Mr. McAlpin described the diversity of stelar patterns and general morphology in *Selaginella*. Miss Petrik's comparison of the morphology of *Bolbitis* and *Tectaria* showed these genera to be quite close in many morphological characters. Different means of vegetative reproduction in the ferns were studied by Miss Morzenti. These included rhachis buds, laminar buds, rooting of the frond apex, stolons, and root proliferations. Vegetative reproduction was especially abundant in the wet forests. The distribution of the types of reproduction was in some cases correlated with taxonomic relationships.

Mr. Farrar found gemmiferous fern gametophytes to be extremely diverse, and collected additional material for more detailed microscopic study. Gemmae were found in the Grammitidaceae, Hymenophyllaceae, and Vittariaceae.

Data were recorded by Mr. Smith on aerophores and lenticels, which are largely unavailable from studies of herbarium specimens.

Ecological studies were made by some students. Mrs. Hoshizaki studied the periodicity (seasonality) of fruiting of the ferns in several habitats in various parts of the country. She also noted certain aspects of frond dimorphism. In the thelypteroid ferns the different sections of *Thelypteris* were found by Mr. Smith to have distinct ecological preferences which were investigated with an emphasis on their evolutionary significance.

An attempt was made by Mr. Lloyd to see if morphological features in *Elaphoglossum* were related to habitat differences. Certain features of 70 species of *Elaphoglossum* were studied.

Dr. de la Sota made some interesting observations regarding the ecology of epiphytes, correlating the percentage of the epiphyte flora of each fern group with the habitat. Certain groups showed definite trends or preferences, but others had no apparent pattern.

From these projects and other studies made by individuals or by the whole class during the course, considerable evidence was brought forth that reflects on the phylogeny of the ferns, supporting some and refuting other commonly held hypotheses regarding their phylogeny at all taxonomic levels.

This type of field and laboratory course proved to be a very effective way to study biological problems of the pteridophytes. It enabled students to see a large assemblage of species, genera, and families in one relatively small area. Plants could be studied in the living condition as well as from dried and preserved collections made by the students, and additional fresh material was readily available during the course of study. Use of dissecting microscopes was, of course, essential, and more extensive use of compound microscopes would have aided many problems.

The 1967 class only touched the surface of the problems existing in Costa Rican pteridophytes. Further work is needed in all aspects of fern biology: both floristic and systematic taxonomy, morphology, ecology, cytology, and anatomy. New areas are being made available, but more work is also needed in the places we visited this year. It is our hope therefore that this course will be offered periodically in the future.

It is not necessary to wait for future classes to be offered in order for pteridologists to continue the work with OTS in Costa Rica. The OTS facilities are available for researchers in tropical studies. These include laboratories, vehicles, field stations, and valuable contacts throughout the country. Dr. Richard L. Hauke, for example, spent most of the past year with OTS, studying the biology of *Equisetum*.

The important point that must be made is that we are now progressing well beyond the stage of mere collecting and naming of tropical pteridophytes. Our concern now is more and more with their biology, which can be studied only in the natural environment by observing the plants in the living state. This field experience results in many views of pteridophytes and their characteristics that differ markedly from traditional ideas gained from textbooks. The stimulation of a group of students interacting with one another, each with his own special approach to the study of pteridophytes, and studying together the plants in their natural environment is an exceptionally rewarding experience.

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Induction of Selaginella Sporelings under Greenhouse and Field Conditions

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Because of the usefulness of *Selaginella* in teaching the concept of heterospory, methods for readily obtaining reproductive stages of this genus are of practical importance. According to the method described by Bierhorst (1964), megaspores collected from soil around *Selaginella* sporophytes are placed on wet filter paper, where they germinate to produce megagametophytes. For microgametophytes, whole microsporangia are sown on filter paper. According to Bold's (1967) method, spores are sown on plaster of

Paris blocks which have their lower surface immersed in distilled water or inorganic medium. If the plaster of Paris blocks are sufficiently moist, fertilization occurs and sporelings appear in the cultures.

During the current study a method was found for producing abundant sporelings of *S. kraussiana* A. Braun in greenhouse cultures. The same method was used for *S. apoda* (L.) Spring growing under natural conditions in the field.

Selaginella kraussiana was obtained from The New York Botanical Garden and from the Julius Roehrs Company, Rutherford, New Jersey. This common greenhouse species has a decumbent habit and forms mats which spread along the surface of the soil. Mats of *S. kraussiana*, which had been growing in pots, were transplanted to wooden flats. Two mats were transplanted into each flat. The temperature of the greenhouse was kept at 70–75° F (21–24° C). The mats were allowed to grow undisturbed until a single dense mat completely covering the surface of the flat was formed, which required a minimum of 12 weeks after transplanting from pot to flat. Careful observations showed that beneath such mats abundant spores were present. Megaspores could be seen with the naked eye, and the presence of microspores in the soil was determined by examining bits of soil with the aid of a microscope. In contrast to the large number of spores, sporelings were usually few beneath these mats. The few times that numerous sporelings were found beneath mats, the mats were not so dense as those beneath which few sporelings occurred. Sporelings found growing beneath mats were not normal morphologically, as evidenced by marked elongation of the hypocotyl and a lack of shoot branching.

Observations of *S. apoda* were made on a natural stand growing in a moist woodland near Storrs, Connecticut, during 1966. *Selaginella apoda* exhibits a growth habit similar to that of *S. kraussiana*. At the site examined, extensive mats of *S. apoda* completely covered the soil. Many microspores and megaspores, but few sporelings, were present on the soil beneath such mats. In the same site there were areas of loose mats with exposed soil beneath. In such places naturally-occurring sporelings were found. For sporeling induction experiments, only areas of dense growth were chosen. Thus, in both *S. kraussiana* in the greenhouse and *S. apoda* in the field, similar conditions of dense sporophytic mats overlying numerous spores on the soil were chosen for these experiments.

To induce sporeling production, areas of soil approximately 10 cm square were exposed by removing part of the overlying mat of *Selaginella*. Scissors were used to make vertical cuts through the dense growth along the boundary of the area to be cleared. Then aerial roots anchoring the shoots were severed at soil level by cutting beneath the mat. This operation allowed part of the mat to be removed with a minimum of disturbance to the underlying soil or to the surrounding parts of the mat, which were left intact. Surrounding each cleared area were undisturbed areas left covered by dense growth (*Fig. 1*).

Twelve areas were cleared in dense mats of *S. kraussiana*. Nine of these yielded abundant (i.e. at least 50 per area) sporelings 25 to 29 days after clearing. In two areas there were abundant sporelings 35 days after clearing, and one area yielded abundant sporelings 22 days after clearing. Twelve areas were cleared in dense mats of *S. apoda* growing in the field. Eight cleared areas yielded abundant sporelings 28 days after clearing. Observations on the four cleared areas which did not yield abundant sporelings of *S. apoda* suggest that the scarcity of sporelings may have been due to low temperature. Although temperature records were not kept on the site examined during this study, records of air temperature at a station near Storrs, Connecticut, were available for 1966, courtesy of the College of Agriculture, University of Connecticut. Average temperature for the 28-day period after clearing areas in late May was 61.1° F; in early August it was 67.6° F, and abundant sporelings occurred for both periods. But the average temperature for areas cleared in September was only 53.7° F, and few sporelings were produced. Further work is necessary before definite conclusions concerning the effect of low temperatures on sporeling production can be made. For *S. kraussiana* and *S. apoda* it was

YOUNG SPOROPHYTE PRODUCTION IN SELAGINELLA KRAUSSIANA observed that once sporelings began to appear in cleared areas, the production of new sporelings continued for several weeks. Thirty-five days after areas of both species were cleared, adjacent uncleared areas were examined for the presence of sporelings. By spreading apart the thick growth covering the uncleared areas, soil beneath the mat could be examined. In both species, only a few sporelings were seen scattered throughout the uncleared areas (*Fig. 2*).

In one flat of *S. kraussiana*, an attempt was made to repeat sporeling induction in areas where sporelings had been induced previously by clearing. After observations on sporeling induction were completed, the cleared areas were allowed to become overgrown by a dense sporophytic mat. Approximately six months after the initial clearing, the surrounding mat had grown sufficiently to completely cover the cleared areas. Examination of the soil beneath the reformed mat revealed the presence of some young sporelings, but noticeably fewer than the number induced by clearing. Three areas were recleared, exposing soil which had been cleared six months earlier. In 22–28 days abundant new sporelings were present in these areas. Examination of adjacent uncleared areas 35 days after clearing showed that relatively few sporelings were present beneath the mat. These results indicate that sporeling induction may be repeated in the same areas, provided a dense sporophytic mat is allowed to reform after each successive clearing operation.

The method described above for inducing sporelings of *S. kraussiana* and *S. apoda* has the advantage of simplicity of technique and equipment. The author has found this method to be quite reliable; as many as 80 sporelings of *S. kraussiana* have been obtained from a single 10 cm square cleared area of soil. Possible factors controlling sporeling production by this method are

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FIG. 1. TWO CLEARED AREAS IN A DENSE MAT ABOUT FIVE WEEKS AFTER CLEARING. NOTE YOUNG SPORELINGS. SCALE = 15 cm. FIG. 2. CLEARED AREA (BELOW SCALE) AND ADJACENT UNCLEARED AREA (ABOVE SCALE) 35 DAYS AFTER CLEARING. THE UNCLEARED AREA WAS EXPOSED AT THE TIME OF PHOTOGRAPHING. SCALE = 3.4 cm.

currently under study. This work was supported by a grant from the University of Connecticut Research Foundation.

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The Fern Herbarium of André Michaux

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André Michaux, born in Versailles, France, March 7, 1746, was one of the earliest and most assiduous plant collectors in the eastern United States. Only P. Kalm had made such extensive collections previously. William Bartram had travelled the eastern seaboard just a few years prior to Michaux, but he did not make extensive collections.

Michaux was commissioned by the French Government, still the monarchy, to collect seeds and living plants to be grown in France. He left by ship September 29, 1785 and arrived in New York November 15, 1785. He first established a garden in New Jersey about ten miles from New York City to grow young plants and seeds, and then proceeded to Charleston, South Carolina, where he established another similar garden. His expeditions took him all over the United States (as then known) and eastern Canada. In 1787 he collected in the Alleghany Mountains. Most of 1788 was spent in Florida, where he had his headquarters in St. Augustine. In later years he explored the mountains of North Carolina, Virginia, and Pennsylvania. In 1792 he sold the garden in Charleston and returned to New York, going later to Lake Champlain, Montreal, and north in Canada to Hudson Bay, being the first botanist to collect in this remote area. He was again the first botanist to visit the midwest, travelling in 1793 to 1795 in Kentucky, Tennessee, Ohio, and Illinois.

In 1796 he returned to France and started to work on his monumental Flora Boreali-Americana (2 volumes, 1803), the first relatively complete flora of the United States. However, before this was completed he was induced to join Baudin on a voyage to Australia. While docked in Mauritius he suddenly had the ill-conceived idea of leaving the Australian expedition and going to Madagascar, which he did, alone. Once there he contracted a fever and died suddenly on November 5, 1802.

The above brief account of the life of Michaux is taken from Asa Gray[1] and especially from the indispensable and erudite Lasègue.[2] Neither Gray nor Lasègue discusses the publication of the Flora Boreali-Americana. It seems that Michaux left it in an unfinished state and that it was completed by L. C. Richard. Just how much of it is the work of Richard is uncertain. Some writers, as for instance Pritzel in his Thesaurus Litteraturae Botanicae (1872), have attributed the whole work to Richard, whereas most American authors have attributed it only to Michaux. The latter seems to be the only possibility really, since in the book itself there is no mention of Richard, either on the title page or elsewhere. If Richard did in fact write the work he must have been exceedingly modest.

The herbarium of Michaux is in the Muséum National d'Histoire Naturelle, Paris, where I was privileged to study it by courtesy of the Directors M. Humbert and M. Aubreville. Michaux did collect in Persia and perhaps elsewhere prior to his American excursion, but I do not know where these collections are at present. Fortunately, the American collections that form the basis of the Flora

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[1] Gray, A. Notes on a Botanical Excursion to the Mountains of North Carolina, etc.; with some remarks on the Botany of the higher Alleghany Mountains. London Journ. Bot. 1: 2–10. 1842.

[2] Lasègue, A. Musée botanique de M. Benjamin Delessert 60–65. 1845.

are kept in a separate herbarium in Paris, which allows one to determine exactly the material that was used. Some of the collections, and not all duplicates either, were given to M. Delessert, and are now in the Delessert Herbarium, Geneva. These I have not examined.

In 1954, while on a Guggenheim Fellowship, I examined the ferns of the Michaux Herbarium carefully, comparing them with the published flora, and identifying them by present-day nomenclature. I photographed many of the more interesting specimens. Many of these specimens have not been critically studied since the time of Michaux, although naturally many of them have been consulted. It seems worth while to publish a listing of the collection as it exists today. All the types were located. Fortunately the study has not resulted in any name changes of well-known species.

VITTARIA ANGUSTIFRONS Michx. (p. 261, "Hab. in Florida, juxta amnem Aisa-hatcha.") The holotype in the Michaux Herbarium (Morton photograph 3356) is labeled "Sur les bords de la Riv. Aisahatcha le 1[er] Avril, Florida," collected by Michaux. It represents *Vittaria lineata* (L.) J. E. Smith, as that is currently regarded. There is an isotype in the Jussieu Herbarium (Cat. 1351, Morton photograph 3107), also collected in Florida by Michaux.

PTERIS ATROPURPUREA L. (Michx. p. 261, "Hab. in montibus Alleghanis saxosis.") There is a sheet in the Michaux Herbarium so named, which has specimens on it of both *Pellaea atropurpurea* (L.) Link and var. *bushii* Mack. (*P. glabella* Mett.).

PTERIS GRACILIS Michx. (p. 262, "Hab. in rupibus Canadae, juxta Malbaye.") The holotype in the Michaux Herbarium (Morton photograph 3357) was collected by Michaux "près la Malbaye," Canada, as noted in the original description. It is a typical specimen of *Cryptogramma stelleri* (S. G. Gmelin) Prantl, as usually considered. A specimen in the Jussieu Herbarium (Cat. 1314, Morton photograph 3082) collected in Canada by Michaux is identical and undoubtedly an isotype.

PTERIS AQUILINA L. (Michx. p. 262, "Hab. a sinu Hudson ad Floridam.") A sheet in the Michaux Herbarium is marked "Hauteur des terres, Canada"; it has the costae and midribs hairy and is *Pteridium aquilinum* (L.) Kuhn var. *latiusculum* (Desv.) Underw. Another sheet, without locality but probably from the south, seems on casual study to be var. *pseudocaudatum* (Clute) Heller.

ADIANTUM PEDATUM L. (Michx. p. 263, "Hab. in Pennsylvania, etc.") There is no specimen in the Michaux Herbarium, but the name was undoubtedly correctly applied.

WOODWARDIA BANISTERIANA Michx. (p. 263 "Hab. in montibus Carolinae.") This species has been considered to be a synonym of *W. virginica* (L.) J. E. Smith (as for example in the Index Filicum), and the illustration cited by Michaux, Plukenet *t. 179, f. 2,* does represent this species, but the Michaux specimen labeled "*Blechnum banisterianum*. Hab. in montib. Carolina," is a sterile plant of *Osmunda cinnamomea* L.! The original description is: "W. fronde pinnata; pinnis pinnatifidis: fructificatione juxta nervum pinnarum pinnularumque interrupta, Pluck. t. 179, f. 2." It is evident that Michaux wrongly identified his specimen with the Plukenet illustration, and that the description of the fructifications comes from the illustration cited. In cases of this kind there is general agreement that an undoubtedly authentic specimen should have precedence over a cited illustration as a type, and I therefore consider this Michaux specimen the holotype.

BLECHNUM SERRULATUM Michx. (p. 264, "Hab. in Florida, juxta amnem Aisahatcha.") There is no specimen in the Michaux Herbarium, but there is one in the Jussieu Herbarium (Cat. 1388A), labeled *B. serrulatum* and collected in Florida by Michaux. This should be regarded as the holotype. It represents *B. serrulatum* L. C. Richard. Very likely the intention was to refer this Florida plant to this published species rather than to describe a new species. Still, there is no reference to a previous publication and the treatment is exactly like the other new species published by Michaux, and so it should be considered as new and based on a different type.

In the Index Filicum, Christensen referred *Blechnum indicum* Burm. to *B. serrulatum* with a query, and Maxon in his Pteridophyta of Porto Rico and the Virgin Islands adopted *B. indicum* as the correct name without a query,[3] doubtless going on Christensen's reference and the original description. I cannot find that Maxon published any note on the subject. I have seen the type of *B. indicum* in the herbarium at Geneva, collected by Burmann in India. The sheet bears a label reading "Filix lonchitidis facie alis denticulatis dupliciter auriculatis." It is by no means *Blechnum serrulatum* L. C. Richard or indeed a *Blechnum* at all, but is *Asplenium longissimum* Blume, as it has been annotated by Mr. F. Ballard. The name *B. indicum* has long priority over *Asplenium longissium,* but the epithet *indicum* may not now be transferred to *Asplenium* because of the recently proposed name *Asplenium indicum* Sledge.[4]

ASPLENIUM RHIZOPHYLLUM L. (Michx. p. 264, "in montium rupibus, a Canada ad Tennassee.") There is a specimen in the Michaux Herbarium, correctly identified, from New Jersey, *Michaux*. Recent cytological and genetical studies seem to show that this species should be regarded as an *Asplenium* rather than a distinct genus *Camptosorus*.

ASPLENIUM TRICHOMANES L. (Michx. p. 264, "Canada, Pennsylvania, et in excelsis montibus Carolinae.") There is a correctly identified specimen in the Michaux Herbarium bearing similar data.

ASPLENIUM TRICHOMANOIDES Michx., non Houtt., 1786. (p. 265, "Hab. in Carolina.") The holotype in the Michaux Herbarium (Morton photograph 3358) was collected in "Hautes montagnes de Caroline" by Michaux. It is a typical specimen of *A. platyneuron* (L.) Oakes. This synonym is omitted in Broun's Index to North American Ferns.

ASPLENIUM ANGUSTIFOLIUM Michx., non Jacq., 1786. (p. 265, "Hab. ad ripas fluminis Ohio.") The holotype in the Michaux Herbarium (Morton photograph 3360 bis) was collected "ad ripas Ohio," as stated in the original description. It is a typical, fertile specimen of *Athyrium pycnocarpon* (Spreng.) Tidestrom.

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[3] In Britt. & Wils., Sci. Surv. Porto Rico **6**(3): 456. 1926.

[4] "The Ceylon species of *Asplenium,*" Bull. Brit. Mus. (Nat. Hist.) **3**: 264. 1965.

ASPLENIUM THELYPTERIOIDES Michx. (p. 265, "Hab. in montibus Virginiae et Carolinae septentrionalis.") The only specimen in the Michaux Herbarium labeled *A. thelypterioides* is filed among the Polypodiums, following the sheet of *P. bulbiferum*, and is the right hand plant on the same sheet with the type of *Nephrodium thelypterioides* Michx. The error in mounting doubtless was due to these two quite different species having the same specific epithet *thelypterioides*. This small plant bears the same locality data as given in the original description and must be the holotype. It is sterile; inasmuch as Michaux describes the sori he must have had fertile material also, which has been lost or misplaced. From my photograph and notes, it was not quite clear whether this small sterile specimen represented the common species that is generally known as *Athyrium thelypterioides* (Michx.) Desv. [the spelling sometimes unwarrantedly changed to "*thelypteroides*"] or not. Consequently, I asked my colleague Dr. Lyman B. Smith to examine this type on his recent visit to Paris, which he kindly did. He reports that the plant is indeed the plant usually known as *Athyrium thelypterioides*, but that it appears unusual because it is young and the margins are somewhat inrolled. I was afraid that this might not be the case, and that it might be necessary to change the name of this species, well known to fern lovers as the Silvery Spleenwort. My doubt was occasioned by the statement by D. C. Eaton[5] that this small plant was doubtful, but perhaps referable to *Asplenium filix-femina*.

ASPLENIUM ADIANTUM-NIGRUM L. (Michx. p. 266, "Hab. in altis montibus Carolinae.") The sheet in the Michaux Herbarium (Morton photograph 3360) is labeled "varietas? minor; in montium rupibus Carolina septentrionalis." It is by no means referable to *A. adiantum-nigrum* but is a typical, rather large specimen of *Asplenium montanum* Willd.

ASPLENIUM RUTA-MURARIA L. (Michx. p. 266, "Hab. in fissuris rupium montium excelsorum Carolinae septentrionalis.") The specimen in the Michaux Herbarium which bears identical data, is *A. ruta-muraria* var. *cryptolepis* (Fernald) Massey.

[5] Canad. Naturalist, n.s. **5**: 28. 1870.

NEPHRODIUM ACROSTICHOIDES Michx. (p. 267, "Hab. in Pensylvania, Carolina et Tennassee.") The holotype in the Michaux Herbarium is labeled "Pensylvania, Carolina, Tennessee, Carol. Marit." It is a typical specimen of the Christmas Fern, *Polystichum acrostichoides* (Michx.) Schott.

NEPHRODIUM THELYPTERIOIDES Michx. (p. 267, "Hab. in Canada et in montibus alleghanis.") The type (Morton photograph 3365) is filed among the Polypodiums in the Michaux Herbarium following the sheet labeled *P. bulbiferum* and is mounted on the same sheet with the frond labeled *Asplenium thelypterioides*, perhaps because of a confusion in the mounting due to the identity of the specific epithets. The *Nephrodium*, the left hand frond, is labeled "*Nephrodium thelypterioides*; montibus allegeni a Canada. Habitat in Canada et Lac Champlain." It is correctly annotated by D. C. Eaton as *Aspidium thelypteris* Swartz, i.e. the Marsh Fern *Dryopteris thelypteris* (L.) A. Gray, now best called *Thelypteris palustris* Schott. Nevertheless, Eaton placed *N. thelypterioides* as a synonym of the New York Fern *Aspidium noveboracense* (L.) Swartz (now *Thelypteris noveboracensis*) in his Ferns of North America.[6] His annotation on the type is not dated, and it may be that Eaton saw it after the publication of his book. Eaton's disposition of *N. thelypterioides* as a synonym of the New York Fern has been followed up to the present time, e.g. in Broun's, Index to North American Ferns. However, the type is definitely *Thelypteris palustris* var. *pubescens* (Lawson) Fernald.

NEPHRODIUM MARGINALE (L.) Michx. (p. 267, "Hab. a Canada, ad Kentucky et Virginiam.") The specimen in the Michaux Herbarium, which is correctly identified, is labeled as "Kentucky, Pensylvania, *Nectoux*," which indicates that some of the specimens in the Michaux Herbarium were collected by Nectoux and not by Michaux himself.

NEPHRODIUM PUNCTILOBULUM Michx. (p. 268, "Hab. in Canada.") The holotype (Morton photograph 3364) was collected in Canada by Michaux. It is as usually identified *Dennstaedtia punctilobula* (Michx.) Moore.

[6] The Ferns of North America, ed. 1, vol. 1, p. 50. 1878.

NEPHRODIUM BULBIFERUM Michx. (p. 268, "Hab. in Canada.") This has usually been considered a new combination, based on *Polypodium bulbiferum* L., but this is an inference only, for Linnaeus' name is not cited or referred to in any way, and so the Michaux publication must be considered as a new species. There is a sheet in the Michaux Herbarium so named and bearing the original data "Hab. in Canada." It is *Cystopteris bulbifera* (L.) Bernh.

NEPHRODIUM FILIX-FOEMINA Michx. (p. 268, "Hab. in Canada.") This too must be considered as a new species since there is no reference to any previous publication, even though from the choice of epithet there is no doubt that Michaux did intend the Linnaean *Polypodium filix-femina*. The specimen in the Michaux Herbarium from "in Canada" is marked "à rapporter à sou esp[èce]," showing that Michaux knew that his collection was not identical with the European plants. It is to be referred to *Athryium filix-femina* var. *michauxii* (Spreng.) Farwell. Since the basionym of this variety is *Asplenium michauxii* Spreng. and that was based on *Nephrodium filix-foemina* Michx., this sheet is the holotype of *Asplenium michauxii*. As a species this should be known as *Athyrium angustum* (Willd.) Presl, based on *Aspidium angustum* Willd.,[7] and since this species was also based on *Nephrodium filix-femina* Michx., the Michaux collection in Paris should be regarded as the holotype of this species also.

NEPHRODIUM ASPLENIOIDES Michx. (p. 268, "Hab. a Nova Anglia ad Caroliniam.") The holotype is marked "A Nova Anglia ad Caroliniam" (Morton photograph 3363). It appears to me possible that it represents the large form that is known as *Athyrium filix-femina* var. *michauxii* f. *elatius* (Link) Clute, which would be unfortunate, for that would leave the well-known Southern Lady Fern that has been known as *Athyrium filix-femina* var. *asplenioides* (Michx.) Farwell or *Athyrium asplenioides* (Michx.) Eaton without a tenable name. The type should be studied further as to spores, indusia, and other characters before a decision can be made. Unfortunately, I did not have equipment for such a study in Paris.

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[7] In L. Sp. Pl. ed. 4, 5: 277. 1810.

NEPHRODIUM CRISTATUM Michx. (p. 269, "Hab. in Canada.") This species must also be regarded as new, since *Polypodium cristatum* Linn. is cited as a synonym with a query. The type sheet in the Michaux Herbarium is labelled "montib. Carolinae? et certe in Canada." It is by no means a synonym of *Dryopteris cristata* (L.) A. Gray but is typical *Dryopteris intermedia* (Willd.) A. Gray.

NEPHRODIUM TENUE Michx. (p. 269, "Hab. in Canada.") The holotype in the Michaux Herbarium gives the locality as Quebec. In his recent "A monographic Study of the Fern Genus *Cystopteris*,"[8] Dr. Blasdell places this species as *Cystopteris diaphana* × *fragilis*, apparently on the basis of the description, for he does not indicate that he has seen the type. This disposition can hardly be accepted since it is hard to believe that this can be a hybrid when one of the presumed parents, *C. diaphana*, does not occur near Quebec or indeed anywhere in the United States or Canada. I did not examine the spores of the type to see if they might be of the "*dickieana* type," that is rugose rather than echinate, but in gross characters *N. tenue* appears to be the same as the common *C. fragilis* var. *mackayi* Lawson.[9] According to Blasdell's synonymy an earlier varietal name would be *C. fragilis* var. *regia* (Forster) Milde,[10] but it remains to be demonstrated that this European variety is really identical with the American var. *mackayi*.

NEPHRODIUM RUFIDULUM Michx. (p. 269, "Hab. in rupibus Canadae et Novae Caesareae.") The holotype (Morton photograph 3361) bears the data "Hab. in rupibus Canadae, Novae Angliae et Novae Caesareae," thus repeating the wide range given in the original description. The sheet bears the erroneous name "*Polypodium rufidulum.*" The plant is, as usually considered, *Woodsia ilvensis* (L.) R. Brown. There is an isotype in the Jussieu Herbarium (Cat. 1127A, Morton photograph 2966), marked as collected in Canada by Michaux. It shows an unusually large, coarsely dissected form with large scales.

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[8] Mem. Torrey Bot. Club 21(4): 53. 1963.
[9] Fern Fl. Can. 233. 1889.
[10] Hoh. Sporenpfl. 69. 1865.

NEPHRODIUM LANOSUM Michx. (p. 270, "Hab. in montibus saxosis Tennassée et Carolinae septentrionalis.") The holotype in the Michaux Herbarium (Morton photograph 3367) bears the data "Hab. in excelsis montibus saxosis Tennessee et Carolinae septentrionalis." The type, consisting of six detached fronds, belongs to the species with villous fronds having hairs only and no scales that was generally correctly treated as *Cheilanthes lanosa* (Michx.) D. C. Eaton up until the publication by M. L. Fernald of an article entitled "The Presumable Identity of *Cheilanthes lanosa*."[11] Fernald argued that the plants labeled as *lanosum* in the Michaux Herbarium were not the species described by Michaux, going wholly on the description by Michaux of the fronds as being "*totum lanosissimum*." According to Fernald's idea, the species passing as *Cheilanthes lanosa* has the fronds "hirsute" and he could not believe that Michaux would describe them as "lanosissimum" [very woolly], and consequently he takes up for this species the name *Cheilanthes vestita* (Spreng.) Swartz, conveniently overlooking the fact that Sprengel also described his *Adiantum vestitum* as covered with "feinen wollichten Haaren" [fine woolly hairs]. Actually, the hairs in this species are not straight as they should be for a description as "hirsute," but are more or less curled, and a description of them as woolly is by no means unlikely or even incorrect. That the fronds are not as woolly as those of *C. tomentosa* Link is beside the point. Fernald assumed some mislabeling on the type, but that this is not true is shown by an isotype in the Jussieu Herbarium (Cat. 1049, Morton photograph 2910), which was also collected in "Tennessee et Carolina septent." by Michaux; this isotype is identical with the holotype, and bears the name *Nephrodium lanosum*. That this specimen also would have been accidentally mislabeled is extremely unlikely. There is therefore no reason at all to follow Fernald in making the confusing shift in the application of the name *Cheilanthes lanosa* as given in the eighth edition of Gray's Manual.

NEPHRODIUM DRYOPTERIS (L.) Michx. (p. 270, "Hab. in Canada.") Based on *Polypodium dryopteris* L. The sheet in the

[11] Rhodora 48: 383–388. 1946.

Michaux Herbarium is labeled "juxta l'Assomption," the meaning of which I do not understand. The specimen is correctly *Gymnocarpium dryopteris* (L.) Newman. Recently I published a note on the name of this genus on page 85 of "Report on Botanical Excursion to the Boreal Forest Region in Northern Quebec and Ontario," by W. K. W. Baldwin.[12]

POLYPODIUM VULGARE L. (Michx. p. 271, "Hab. a Canada ad Carolinam.") The specimen in the Michaux Herbarium is marked "Hab. in arborib. a Canada ad Floridam." It is *P. virginianum* L., which Michaux cites as a doubtful synonym. Presumably the observation that this species occurs on trees ("in arborib.") was made in the south because this species is very seldom epiphytic in the north.

POLYPODIUM CETERACCINUM Michx. (p. 271, "Hab. parasiticum in Kentucky, Tennassée, Florida.") Based on *Acrostichum polypodioides* L., the specific epithet probably changed because the name *Polypodium polypodioides* was considered unsuitable. The specimen in the Michaux Herbarium is labeled and filed as *Acrostichum polypodioides*. In the Jussieu Herbarium (Cat. 1090A) is a specimen collected in Florida by Michaux identified by Michaux as *P. ceteraccinum*. These two specimens are *Polypodium polypodioides* (L.) Watt var. *michauxianum* Weatherby.[13] Weatherby did not base his variety on this Michaux plant, but explicitly on a different type.

POLYPODIUM HEXAGONOPTERUM Michx. (p. 271, "Hab. in Carolina et Virginia.") The holotype in the Michaux Herbarium (Morton photograph 3366) is labeled "Hab. in Virginia, Carolina terrestre," thus agreeing with the original data. It is a typical frond, without rhizome, of the Southern Beech Fern, *Dryopteris hexagonoptera* (Michx.) C. Chr. or more acceptably at present *Thelypteris hexagonoptera* (Michx.) Weatherby. If the genus *Phegopteris* Fée (1852) is recognized, chiefly on cytological grounds, it will consist (in the United States) of only the two species *P. connectilis* (Michx.) Watt and *P. hexagonoptera* (Michx.) Fée.

[12] This portion was reprinted in the Amer. Fern J. **55**: 85–87. 1965.
[13] Contr. Gray Herb. 124: 31. 1939.

POLYPODIUM CONNECTILE Michx. (p. 271, "Hab. in Canada.") The holotype in the Michaux Herbarium (Morton photograph 3362) is labeled "Hab. in Canada," agreeing with the original data. The plant is, as usually interpreted, the Northern Beech Fern, long known as *Dryopteris phegopteris* (L.) C. Chr. and recently as *Thelypteris phegopteris* (L.) Slosson. If the genus *Phegopteris* should prove distinct, the correct name will be *Phegopteris connectilis* (Michx.) Watt., as adopted in Wherry's Guide.

ACROSTICHUM AUREUM L. (Michx. p. 272, "Hab. in Florida, ad amnem Aisa-hatcha.") The specimen in the Michaux Herbarium, bearing the data "Sur la riv. Aisa hatcha florida" is by no means *A. aureum* but rather *A. danaeifolium* Langsd. & Fisch., which had not been distinguished from *A. aureum* in the time of Michaux.

ONOCLEA SENSIBILIS L. (Michx. p. 272, "Hab. a Pensylvania ad Georgiam.") The specimen in the Michaux Herbarium is marked "Hab. Nova Anglia." It is correctly named as *O. sensibilis* L.

ONOCLEA NODULOSA Michx. (p. 272, "Hab. in Carolinae limosis umbrosis.") Michaux cites *Acrostichum areolatum* Linn. and *Osmunda caroliniana* Walter as synonyms of his *Onoclea nodulosa*, which was therefore a change of specific epithet on transferring the species to the genus *Onoclea*, a procedure not in accordance with the current Code of Nomenclature but which was not uncommon in the past. It renders the name *O. nodulosa* superfluous and illegitimate. It seems that Michaux did understand the species correctly in part. He published the locality as "Hab. in Carolinae limosis umbrosis", and there *is* a specimen in the Jussieu Herbarium, Paris (Cat. 1392A, Morton photograph 3139), collected in Carolina by Michaux and labeled as *Onoclea nodulosa*, which is *Acrostichum areolatum* L., i.e., *Woodwardia areolata* (L.) Moore. His description may, however, have been based in part on specimens of the American Ostrich Fern, *Matteuccia struthiopteris* var. *pensylvanica* (Willd.) Morton, at least it would seem so from the character "pinnis pinnatifidis," which does not apply to *Woodwardia areolata*. The only specimen in the Michaux Herbarium is one collected in Canada "juxta Montreal" and labeled as *Acrostichum nodulosum* with a query (Morton photograph 3368). This specimen does represent the American Ostrich Fern, but it can by no means be regarded as a type of *Onoclea nodulosa*. The locality is wrong and the identification queried. In any case the name *O. nodulosa* must be regarded as a superfluous name, having the same type as the synonym cited, *Acrostichum areolatum* L., of which it is a renaming. As a species, the American Ostrich Fern should be known as *Matteuccia pensylvanica* (Willd.) Raymond, as a variety *M. struthiopteris* var. *pensylvanica* (Willd.) Morton.

OSMUNDA REGALIS L. (Michx. p. 273, "Hab. a Canada ad Floridam.") There is one sheet in the Michaux Herbarium labeled "Hab. in Nova Anglia ad Carolinam" and another "Hab. in Canada." Both are *O. regalis* var. *spectabilis* (Willd.) A. Gray.

OSMUNDA CINNAMOMEA L. (Michx. p. 273, "Hab. a Nova Anglia ad Carolinam.") The specimen in the Michaux Herbarium from "Basse Caroline" is correctly identified.

OSMUNDA INTERRUPTA Michx. (p. 273, "Hab. in Canada, Pennsylvania et Kentucky.") The holotype (Morton photograph 3369) has two labels, one saying Kentucky and the other Canada. The plant is *O. claytoniana* L., a name which was overlooked by Michaux.

BOTRYPUS VIRGINICUS (L.) Michx. (p. 274, "Hab. a Canada ad Virginiam et in montibus Carolinae.") *Osmunda virginica* L. is cited as a synonym. The specimen in the Michaux Herbarium (Morton photograph 3370) bearing the data quoted above is correctly named, i.e., it is a large, coarse specimen of *Botrychium virginianum* (L.) Swartz. The genus *Botrypus* L. C. Richard was presumably published in "Cat. Hort. Med. Paris 120. 1801," a publication I have not seen. It is thus published in the same year as *Botrychium* Swartz,[14] which has been presumed to have priority.

BOTRYPUS LUNAROIDES Michx. (p. 274, "Hab. in pascuis, circa Charlstown.") The holotype (Morton photograph 3371) is labeled "in pascuis sabulosis juxta Charleston." W. H. Wagner, Jr. has published[15] some notes on this species, concluding that it repre-

[14] J. Bot. Schrad. **1800**(2): 110. 1801.
[15] "Nomenclature and typification of two Botrychiums of the southeastern United States." Taxon **10**: 165–169. 1961.

sents a valid species that has erroneously been identified as *B. biternatum* (Savigny) Underw.; the latter is the proper name for the plant recently known as *B. tenuifolium* Underw. or *B. dissectum* var. *tenuifolium* (Underw.) Farwell.

CTEISIUM PANICULATUM Michx. (p. 275, "Hab. in occidentalibus Virginiae, ad fines Kentucky et in Tennassée.") The holotype (Morton photograph 3372) bears essentially the same data "Hab. in occidentalibus Virginiae Carolinae septentrionalis ad Kentucky Tennessee." It represents a fine fertile and sterile specimen of the Climbing Fern, *Lygodium palmatum* (Bernh.) Swartz, which had been described two years earlier as *Gisopteris palmata* Bernh. (1801). As a matter of fact the Climbing Fern received independently seven different generic names between 1801 and 1803. The exact dates are uncertain, but not of too much importance, now that *Lygodium* has been added to the list of *nomina conservanda.*

OPHIOGLOSSUM VULGATUM Michx. (p. 275, "Hab. in Nova Caesarea.") The specimen in the Michaux Herbarium from Nova Caesarea" (i.e., New Jersey) was not studied critically to see if it represents var. *pycnostichum* Fernald or var. *pseudopodum* (Blake) Farwell.

OPHIOGLOSSUM BULBOSUM Michx. (p. 276, "Hab. in sabulosis Carolinae.") The holotype in the Michaux Herbarium (Morton photograph 3373) is labeled "in sabulosis Carolinae," agreeing with the original description. Michaux thought that his species *might* be the same as *O. crotalophoroides* Walter, which he cites as the same with a query. It is, in fact, the same, and the name of Walter is the older. Clausen in his monograph of the Ophioglossaceae[16] makes a peculiar error. He cites *Ophioglossum bulbosum* Michx. as a *nomen nudum* at the place cited and then gives as a correctly published name "*Ophioglossum pusillum* Michaux, Fl. Bor. Amer. 2: 276. 1803." The name *O. bulbosum* is of course not a *nomen nudum* but is validly published with a description, the first words of which are "*O. pusillum: radice subgloboso,*" etc. in which the word *pusillum* is merely a descriptive adjective and not a species

[16] Mem. Torrey Bot. Club 19(2): 157. 1938.

name. Incidentally, it appears that, perhaps because of this error, Clausen has omitted mention entirely of *O. pusillum* Nuttall, an entirely different plant.

EQUISETUM SCIRPOIDES Michx. (p. 281, "Hab. in vetustis sylvis Canadae.") The holotype, labeled merely "Amer. sept.," is a fragment only, corresponding to the plant universally known as *E. scirpoides*. A duplicate, rather better specimen is in the Jussieu Herbarium.

PSILOTUM FLORIDANUM Michx. (p. 281, "Hab. in Florida.") The holotype does not bear the name *P. floridanum* but "Lycopodium caule dichotomo sulcato foliis setaceis, florib. solitariis axillaribus. n. 45 florida à 2 mi. du fort Matança." It represents *P. nudum* (L.) Beauv.[17] Another specimen without locality labeled *Lycopodium nudum* is probably an isotype; this sheet bears the name "*Buchosia infelix* Com."

LYCOPODIUM CLAVATUM L. (Michx. p. 282, "Hab. in Canada.") The holotype consists of three sheets, all from Canada. They are correctly identified.

LYCOPODIUM DENDROIDEUM Michx. (p. 282, "Hab. a Canada et Nova Anglia ad Carolinam montosam.") The holotype consists of a sheet with two labels, one "in Carolina septen. altis montibus," the other "montagn. de Carol. sept." The specimens contain a mixture of typical *L. obscurum* L. and *L. obscurum* var. *dendroideum* (Michx.) D. C. Eaton. Those representing the latter can be designated the lectotype in order to preserve the present nomenclature. It is uncertain that these varieties are taxonomically significant.

LYCOPODIUM ALPINUM L. (Michx. p. 282, "Hab. in Canada.") The specimen so named in the Michaux Herbarium was misidentified. It is partly *L. complanatum* L. and partly *L. sabinifolium* Willd.

LYCOPODIUM COMPLANATUM L. (Michx. p. 283, "Hab. in Canada et Carolina.") The specimen is labeled "in Canada et in altis montibus Carolin. sept." It is a mixture of *L. complanatum* var. *complanatum* and var. *flabelliforme* Fernald.

[17] Often erroneously cited as *P. nudum* (L.) Griseb.

LYCOPODIUM ANNOTINUM L. (Mlclx. p. 283, "Hab. in Canada"). There is only a single sheet, fom Canada; it is correctly identified.

LYCOPODIUM INUNDATUM L. (Michx. p. 283, "Hab. a sinu Hudson ad lacus Mistassins.") The sheet is labeled "a sinu Hudsonis ad lacus Mistassins, au bas de Monte a peine dans les marecages." It is correctly identified as *L. inundatum* L. var. *inundatum*.

LYCOPODIUM ALOPECUROIDES L. (Michx. p. 283, "Hab. in humidis herbosis Carolinae.") The specimen is labeled "in pratensib. humidis Carolinae." It is correctly identified.

LYCOPODIUM CAROLINIANUM L. (Michx. p. 283, "Hab. in pratensibus udis Carolinae.") The specimen, labeled "in herbosis humidis Caroline" is correctly identified.

LYCOPODIUM SELAGINOIDES L. (Michx. p. 284, "Hab. in borealibus Canadae.") The specimen, labeled "in borealibus Canadae, hauteur des Terres," is correctly named *Selaginella selaginoides* (L.) Link.

LYCOPODIUM APODUM L. (Michx. p. 284, "Hab. in umbrosis herbosis, a Virginia ad Floridam.") The specimen bears two labels, one reading "Pensylvania ad floridam," the other "de Caroline et de Georgie, parties maritimes." The specimens are *Selaginella apoda* (L.) Spring.

LYCOPODIUM RUPESTRE L. (Michx. p. 284, "Hab. in rupibus montanis, a sinu Hudson ad VIrginiam et Carolinam montosam.") The specimen is labeled "Lac Champlain, Pensyl., Virgin., etc." It is typical *Selaginella rupestris* (L.) Spring.

LYCOPODIUM LUCIDULUM Michx. (p. 284, "Hab. a Canada ad Carolinam montosam.") The holotype, the only specimen in the Michaux Herbarium, is from New Jersey. It is typical *L. lucidulum*, with the leaves prominently toothed.

ADDITIONAL SPECIES

There are only a few additional ferns in the Michaux Herbarium other than those listed above. These are all omitted from the published Flora Boreali-Americana.

"BLECHNUM ONOCLEOIDES" *ined.* in Herb. Michaux. Under this unpublished name (not at all the same as the West Indian *B.*

onocleoides Swartz) is a specimen collected by Michaux "in Carolina, Georgia," which is *Woodwardia areolata* (L.) Moore.

EQUISETUM ARVENSE L. and E. FLUVIATILE L. Two specimens so named, mounted on same sheet. Both are typical *E. arvense* L.

EQUISETUM LIMOSUM L. "varietas brevius vaginata vaginis minus dentatis" "Hab. Montagnes de Caroline." The specimen is fragmentary and sterile, but it probably represents *E. hyemale* var. *affine* (Engelm.) A. A. Eaton.

MARSILEA QUADRIFOLIA L. "Rives de la Rivière Kaskeskie aux Illinois." This is probably identified correctly, although I did not study the specimen in detail. *Marsilea quadrifolia* has been generally considered as naturalized from Europe, but this collection, much the earliest known, makes it seem likely that this species is really native in parts of the United States. The specimen bears the names "Lemna jussieui" and "L. theophrasti."

OSMUNDA sp., labeled *O. lunaroides*, "Au nord de Monte a peine," i.e. north of Montreal. It is by no means *O. lunaroides* Michx., but a juvenile plant of the *Botrychium ternatum* alliance, probably *B. multifidum* (S. G. Gmel.) Rupr.

POLYPODIUM sp. indet. Florida, *Michaux*. A hand later than Michaux has identified the plant as *P. plumula* Humb. & Bonpl. I did not study it critically, but it is *P. plumula*, *P. pectinatum*, or an allied plant.

U. S. NATIONAL MUSEUM, WASHINGTON, D.C. 20560.

Notes and News

XI INTERNATIONAL BOTANICAL CONGRESS.—Although the next botanical congress is not scheduled until the summer of 1969, advance planning for this important botanical meeting is already in progress. This will be the first full-scale botanical congress in the United States in more than forty years. More than 6,000 people are expected to attend the Congress, which will take place in Seattle, Washington. Because of more pressing committments for funds, the various agencies of the Federal Government which were expected to help finance the Congress will be able to participate only on a sharply reduced scale. Therefore, the National Committee of the Congress is asking for donations from botanical societies, industries, and individuals in order to make the Congress a botanical and a person-to-person international success. Some of the botanical societies with strictly professional memberships have adopted an assessment system in order to support the Congress. But because our membership consists of both professional and amateur botanists, the Council of the Society thinks it more appropriate to ask for donations on a voluntary basis. We urge all who are able to enclose a contribution equal to a year's dues to the Society, more or less, when they renew their membership. These contributions will be forwarded by the Treasurer to the National Committee for the Congress and are tax deductible.—D.B.L.

FERNS WANTED.—Mrs. A. W. Kraxberger, 8450 S. W. Oleson Road, Portland, Oregon 97223, would like to learn a source for *Trichomanes radicans* and *Hymenophyllum tunbridgense* or to receive plants of these species.—D.B.L.

American Fern Society

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Index to Volume 57

Errata

Page 71, line 11: For "*Lomariocyas*" read "*Lomariocycas.*"
Page 135, line 8: For "*aegyptica*" read "*aegyptiaca.*"
Page 138, line 17: For "Temescaltepec" read "Temascaltepec."
Page 141, line 25: For "*disjuncta*" read "*disjunctum.*"

19

37