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# A Brief Report on the Progress of Pteridological Research in China

CHING REN-CHANG* and WANG ZHU-HAO**

**Historical sketch.**—Like other branches of botany, serious study of modern pteridology in China was not launched until 1927, when the senior writer decided to switch his interest from Chinese dendrology to pteridophytes. There was then no one in China who knew ferns or how to study ferns. There was no literature available except Engler and Prantl's "Die Natürlichen Pflanzenfamilien" (1898–1902), and there was not a single fern specimen correctly identified in the small herbarium that had just been initiated in Beijing. It seemed unimaginable to start studying ferns under such hopeless circumstances. It was his strong will that surmounted all the difficulties he met with at the beginning. For literature, for example, he wrote to the then world authorities on ferns, such as H. Christ, C. Christensen, W. R. Maxon, and E. B. Copeland, asking for reprints of their papers and monographs on ferns. Thanks to their generous help, he obtained within a few years practically all the available literature chiefly concerning Asiatic ferns of that time to start his work with.

After a few years of preparation, including extensive fern collecting particularly in the fern-rich provinces south of the Yangtze River and making preliminary identifications by consulting the literature then available, he soon realized that type specimens are the key to plant taxonomy. The status of any taxon must be decided by its type specimen, not by its description. Therefore, he decided to visit Europe in the early spring of 1930. He went first to Copenhagen where, under the direction of Dr. Carl Christensen, with whom he had had contact by previous correspondence, he began seriously to carry out a study of Chinese ferns. Both Christensen and he participated in the Fifth International Botanical Congress at Cambridge, England in the fall. At the Congress, he met in person with great joy all of the then leading pteridologists from the United States, Germany, England, and other countries. After the Congress, he stayed at Kew for over a year, mostly working on Chinese and Himalayan ferns and taking photographs of type specimens, as well as making critical notes on the types. Afterwards he went back to Copenhagen and stayed there for some months to discuss problems with Christensen concerning the classification of ferns in general and the guiding principles of classification in particular. Leaving Copenhagen in the early spring of 1932, he proceeded to visit most other leading European herbaria as far away as Vienna and Prague, looking up type specimens of ferns and taking photographs. After he returned from Europe in the fall of 1932, he joined the Fan Memorial Institute of Biology in Peiping and devoted himself with great zeal to the cause of Chinese fern study. During the period of the Japanese invasion of China, he evacuated to Yunnan, collecting and studying the rich fern

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flora there. After liberation in 1949, he was transferred to the Institute of Botany, Academia Sinica, Beijing, as head of the Taxonomic Section, where he has continued his fern studies until now.

**Fern hunting in China.**—In 1911, the British fleet surgeon Dr. C. G. Matthew published in the Journal of the Linnaean Society of London an "Enumeration of Chinese ferns" totalling a little over 1,000 species then known in China, of which a considerable number have subsequently been reduced as synonyms of earlier-described taxa.

Today, after seventy years have elapsed, the species of ferns and fern-allies known in China have been estimated at roughly 2,200 species, about doubling Matthew's enumeration. Yet this is far from the final figure for the Chinese fern flora. In the spring of last year, for example, the senior writer had a chance to identify four fern collections from different parts of China and found the number of new species is still mounting. In a collection made by the Sino-American Joint Botanical Expedition to Western Hupeh, in central China, 13 new species of ferns were found in five weeks time, including one extraordinary *Matteuccia*. From another collection made in southwestern Yunnan, nine new species have been identified, one a species of *Platycerium*, a genus first recorded from China in the evergreen rain forest in the border of Upper Burma. In a third, small collection from northeastern China (formerly known as Manchuria), at least two species are new, one of them a *Phyllitis*, a genus never known in China before. Five new species were recognized from a collection made in Chekiang province along the eastern coast of China. From these instances, one will certainly be amazed at the extraordinary richness of the Chinese fern flora. In our estimate, by the end of the third decade of the twenty-first century, the number of Chinese ferns will most likely have increased by at least three to four hundred more species. This is simply because of the vast expanse of China's extremely rugged topography and diversified ecology. The richness of her flora in many provinces never can be exhaustively explored by only a few visits. The famous sacred Mount Omei in Szechuan, for example, has been visited by at least 60 botanists, both foreign and Chinese, since 1883; yet just last year three more new ferns were discovered by the cytotaxonomical team of the Institute of Botany, Academia Sinica. Consequently, fern hunting in China is still a most rewarding adventure. One can easily collect 20–40 different specimens in a day, depending upon the locality one may visit. An exactly similar situation exists with China's phanerogam flora.

**Fern herbaria.**—As pointed out above, prior to 1927 there were no fern herbaria in China, and in fact only very few specimens had been collected. Strange to say, before 1927 the senior writer had collected thousands of herbarium specimens of flowering plants in different provinces, but very few ferns, in which he then had no interest. Through the effort of many botanists and collectors all over China during the last 50 years or so, the fern herbarium at the Institute of Botany, Beijing, has grown quickly and now has in excess of 150,000 numbers, of which about 95% are of Chinese origin. It is already in a position to serve as a working herbarium for the study of Chinese ferns. In addition to the herbarium specimens, there are kept over 1,000 photographs of types and isotypes of ferns taken during the senior writer's tour in Europe. There is now little difficulty in identifying Chinese fern collections in the herbarium.

All other affiliated botanical institutions of the Academia Sinica and most universities in different provinces or regions also have a herbarium of local ferns and fern-allies for compiling local Floras and for research use. Nevertheless, local herbaria still have a long way to go as far as the sufficiency of their collecting activities. At present, even many botanically rich areas within their reach still remain little explored. As a matter of fact, their first and foremost task should be to launch extensive botanical explorations in their respective provinces or regions for many years to come.

To meet the urgent need of housing a steady influx of specimens from all parts of the country, a new, modern, 6-storied National Herbarium is under construction and will be completed by the end of 1982. The herbarium of the Institute of Botany will be removed from the Beijing Zoo to its new site in the Botanical Garden, Beijing.

**Fern research.**—In the past 55 years, a considerable amount of research on pteridophytes has been carried out in China, with fern taxonomy the chief activity. Many short papers, monographs, iconographies, and some fern Floras have been published. With over 2,000 species of ferns and fern-allies, the study of Chinese pteridophytes is no mean task, and taxonomic study will continue to be an important aspect of pteridological research in China for many years to come. However, for the purpose of enhancing the scientific level of taxonomic studies, other aspects of the biology of ferns should also be studied. In the past 23 years, a great amount of work on fern spores has been conducted. As a result, a monograph on spore morphology of Chinese ferns, "Sporae Pteridophytorum Sinicorum," was published in 1976. It is a 414-page volume dealing with 52 families, 174 genera, and over 1,000 species of Chinese pteridophytes. It includes numerous drawings and photographs, a chapter on the geography of Chinese ferns, and another on fossil spores in different geological times.

Preparation was made as early as 1964 for the cytotaxonomical study of Chinese ferns, when about 300 species of ferns had been introduced into cultivation in the Beijing Botanical Garden. In the following years, work on chromosome counts was launched successfully. Unfortunately, the entire work was frustrated by the so-called "cultural revolution," and 300 well grown potted ferns were thrown out of the greenhouse in the winter of 1966. However, with the visit of Mr. A. C. Jermy to China in the fall of 1978 and the lectures he gave on the biosystematic study of *Dryopteris,* the interest in cytotaxonomy in China was promptly renewed. Studies on chromosomes are being carried out at several institutions at present.

**Fern Flora of China.**—There will be five volumes of the "Fern Flora of China" as part of the 80-volume "General Flora of China." The first volume was published in October, 1959. Two other volumes were ready for printing, but, alas, this, too, was frustrated by the "cultural revolution" for a time. The remaining two volumes are now in preparation. It is hoped that the first edition of the "Fern Flora of China" will all be published shortly after 1985. Other fern Floras published up to now are the "Fern Flora of Hainan, vol. 1" (1964), "Flora Tsinlingensis, Pteridophyta, vol. 2" (1974), "Herbaceous Flora of Northeastern China, vol. 1" (1959), and the "Flora of

Jiangsu Province, vol. 1 (Pteridophyta)." The "Fern Flora of Tibert" was scheduled for publication about the end of 1981 as part of the "Flora of Tibet." Several local fern Floras are in preparation, including those for the provinces of Szechuan, Fukien, and Yunnan, each with 400–1,000 species. It is a strenuous task for local botanists to complete their respective fern Floras. It has been planned that each Chinese province or region will eventually have its own Flora with the pteridophyta as a component.

To coordinate and promote fern studies all over the country, the Botanical Society of China in the fall of 1979 set up a section of Chinese Pteridology as an affiliated organ. At the inaugural meeting held in October, 1979 at Tian Mo Shan, Chekiang province, the senior writer was elected president of the section. A plan for developing and popularizing fern study in China was formulated at this meeting.

**Fern systematics.**—Since 1940, the classification scheme pteridophytes has attracted the attention of many fern students and has undergone great changes. Up to now, there have evolved at least 11 different systems by different authors, of which the first breakthrough was "On natural classification of the family 'Polypodiaceae'" by the senior writer (Sunyatsenia 5:201–270. 1940), which was soon followed by Copeland's and Holttum's classifications. In 1954, the senior writer put forth a paper titled "Systematic arrangements of families and genera of Chinese pteridophytes with corresponding names in Chinese" (Acta Phytotax. Sinica 3:93–99). In 1978, he published a treatise on "The Chinese fern families and genera: Systematic arrangement and historical origin" (Acta Phytotax. Sinica 16(3):1–19, 16(4):16–37. 1978). In spite of all the defects of one kind or another in these systems, we may well say that the phylogenetic study of ferns has made decidedly marked progress in the last 40 years over the Hookerian and Dielsian systems with which we are all familiar. It may be presumed that to most fern students the interrelationships of fern families and genera as a whole are now self-evident, although a few taxa still remain uncertain as to their proper systematic position, as indicated in the lastest classification scheme by the senior writer. It may be that many of these isolated ferns are survivors from ancient times whose ancestors or relatives are no longer in existence today, nor are their fossil records available so far. In systematic treatments, we prefer to keep these taxa isolated as such, rather than to combine them with apparently not closely related families. This is of course entirely a matter of personal taste. Regarding this and other problems of fern systematics, the late, revered Carl Christensen had liberal views, but his rather early death prevented him from putting all these down in his writings.

# The Asplenium trichomanes Complex in the United States and Adjacent Canada

ROBBIN C. MORAN*

The Maidenhair Spleenwort, *Asplenium trichomanes* L., is a delicate, evergreen fern that grows in rock crevices or, less frequently, on talus slopes. The species is wide ranging, occurring in North America, Europe, Australia, New Zealand, and Asia. Since Manton (1950) reported the existence of diploid and tetraploid cytotypes in European populations of *A. trichomanes*, both cytotypes and their sterile triploid hybrids have also been found in North America (Britton, 1953; Wagner & Wagner, 1966). The diploid and tetraploid cytotypes that occur in North America have been named, the diploid as subsp. *trichomanes* and the tetraploid as subsp. *quadrivalens* D. E. Meyer emend. Lovis. This paper examines for the first time the occurrence and relative abundance of all three *A. trichomanes* cytotypes in the United States and Canada, and compares this information to what is known about this species complex in Europe.

## METHODS

Spore size was used to determine cytotype. To determine the validity of this approach, a pilot study was undertaken that involved an examination of spore length from 30 herbarium specimens that were cytologically determined by Drs. F. S. and W. H. Wagner. Tetraploids consistently had much larger exospore diameters than the diploids (*Fig. 1*). In fact, differences in spore size were so obvious that laborious measurements of spore size were unnecessary to distinguish diploids from tetraploids.

The total number of plants examined for spore size was 115 (1725 spores) for the diploids, and 52 (810 spores) for the tetraploids. Triploid plants were recognized by the presence of aborted spores. Thus, for this study, the presumed cytotype was extrapolated from spore size or spore abortion rather than direct chromosome counts.

Over 700 herbarium specimens were examined from the following institutions: EIU, F, ILL, ILLS, ISM, MICH, MO, NCU, NHA, RM, SIU, TENN, VDB, and WTU. For each specimen examined, a permanent spore slide was made using Hoyer's Solution as a mounting medium and sealing the cover slip with clear nail polish enamel. After the slides had been examined, they were placed in a paper envelope and glued to the herbarium sheet for permanent reference; the specimens were annotated indicating the presumed cytotype. Locality data of individual collections are available from the author.

## RESULTS AND DISCUSSION

The mean spore size for diploid plants was 29.4 μm ($s=2.3$) and for tetraploid plants 41.0 μm ($s=2.6$). These results support those of Lovis (1964), who found similar differences in mean spore size of *A. trichomanes* cytotypes in Europe.

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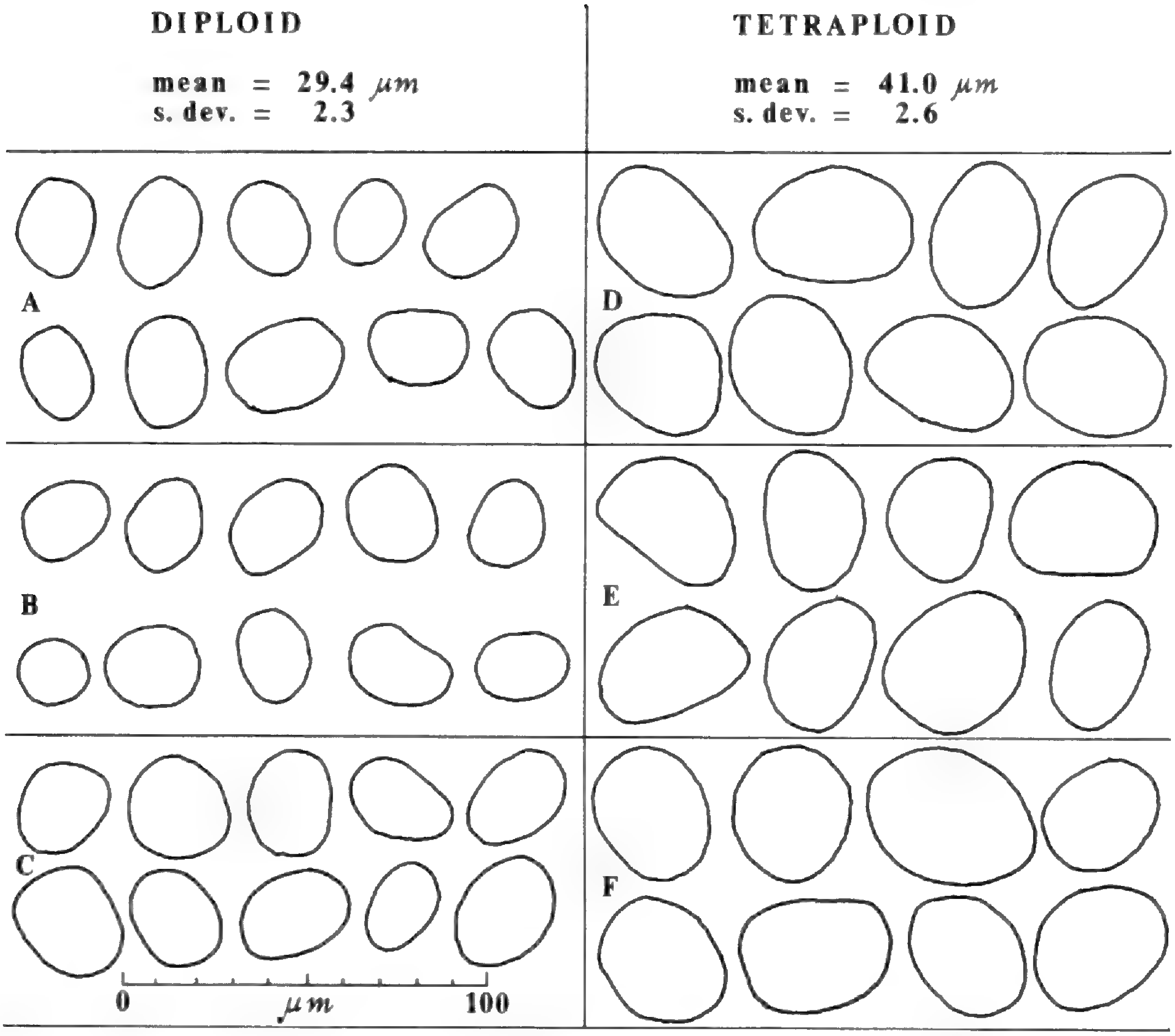


FIG. 1. Outlines of random spore samples mounted in Hoyer's Solution. A. Virginia, Giles County, limestone along Sinking Creek, 1 mile north of Newport (specimen cytologically det.), *W. H. Wagner 64113* (MICH). B. Illinois, Hardin County, sandstone outcrop in Blind Hollow, southeast of Lamb, *R. A. Evers 20091* (ILLS). C. Kansas, Chatauqua County, 3.5 miles east and 4 miles north of Sedan, wooded sandstone canyon, *L. Hauser 3134* (NCU). D. Same location as A, specimen cytologically det., *W. H. Wagner 64115* (MICH); E. Virginia, Loudoun County along Potomac River, north-northeast of Leesburg, *H. E. Ahles 61196* (NCU). F. Canada, British Columbia, limestone cliffs at head of Cumshewa Inlet near Moresby logging camp, Moresby Island, part of Queen Charlotte Islands, *J. A. Calder & R. L. Taylor 36254* (NCU).

European workers (Jermy et al., 1978; Jermy & Page, 1980; Lovis, 1964) have found that plants of diploid and tetraploid *A. trichomanes* can usually be distinguished without recourse to micro-characters. However, this is extremely difficult, if not impossible, to do satisfactorily from herbarium specimens; thus the reliance in this study on the more constant character of spore size. The morphological characters listed in the key given below are best observed in living plants. Lovis (1964) has published shadow diagrams that illustrate morphological differences in well developed fronds of diploid and tetraploid plants. North American pteridologists would do well to become familiar with the characters listed in the key below and to pay close attention as to their applicability in living specimens of North American plants.

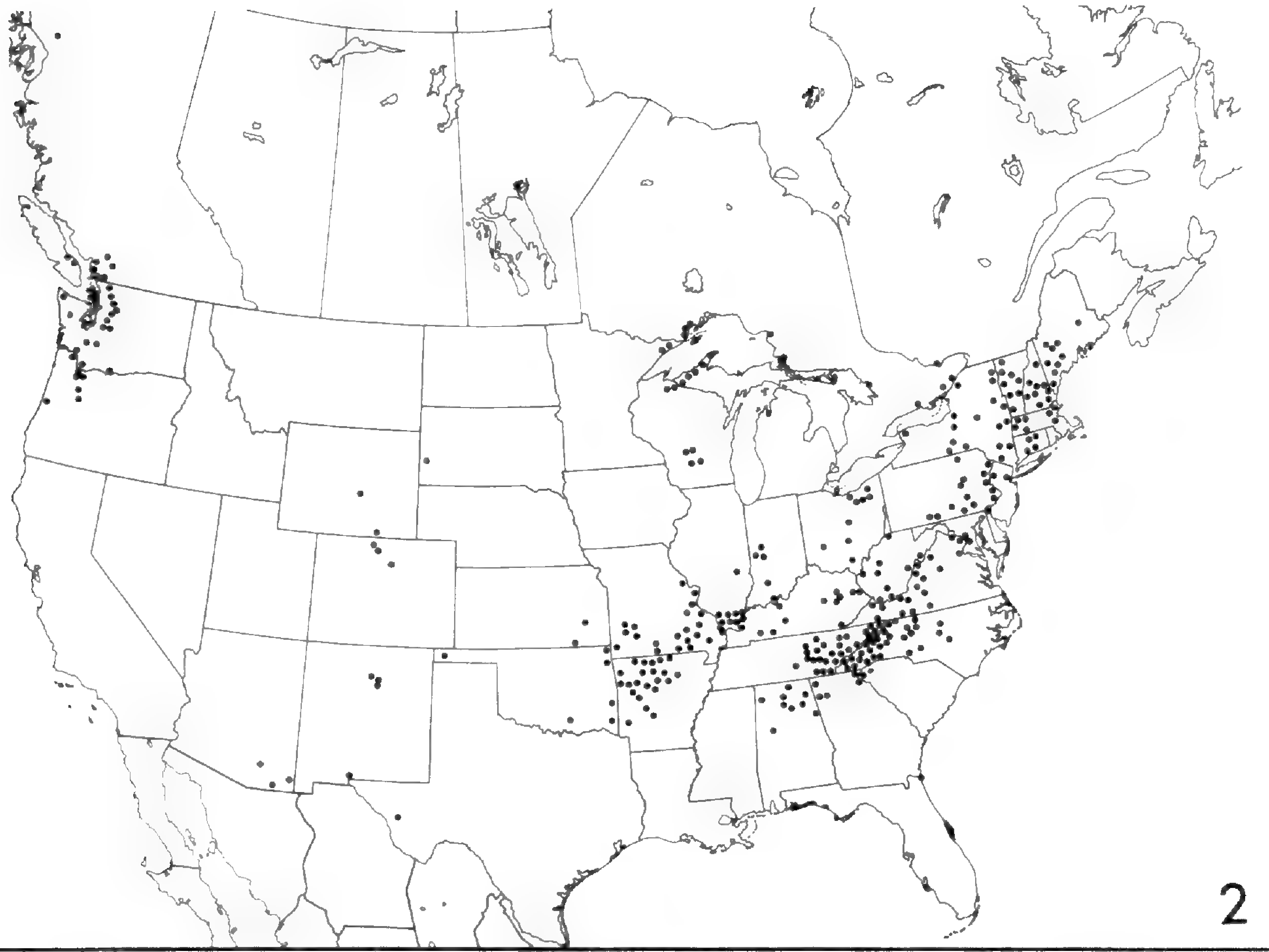
Plants mostly of non-calcareous rocks; rhizome scales up to 3 mm long; stipe relatively thin, shiny coppery or bronze red; fronds arching upwards and outwards, away from rock faces; pinnae mostly alternate, suborbicular, more distant, thinner, set more oblique to the rachis, the basiscopic margin often auriculate, pinnae usually shed from the rachillae during the first winter, the rachillae retained during first winter, except in exposed habitats; sori 4–6(9), up to 2 mm long; indusia delicate, not conspicuous, spores generally 29–36 μm long; guard cells generally 38–43 μm long; plants diploid ........................................................................subsp. *trichomanes*

Plants of calcareous rocks; rhizome scales up to 5 mm long; stipe relatively thicker, blackish-brown; fronds closely adpressed to rock faces, sinuously spreading in all directions; pinnae mostly opposite, oblong, more crowded, thicker, nearly perpendicular to the rachis, the basiscopic margin rarely auriculate; pinnae usually retained during the first winter, the rachillae shed with, or soon after, the pinnae; sori 4–9(12), up to 3 mm long; indusia thicker, conspicuous; spores generally 34–43 μm long; guard cells generally 41–49 μm long; plants tetraploid ........subsp. *quadrivalens*

The diploid is the most abundant and widespread cytotype, constituting 87% of the specimens examined. Specimens of this cytotype from the southwestern United States (*Fig. 2*) are from high altitudes in isolated mountain ranges, such as the Rincon and Santa Catalina mountains in southern Arizona, where several collections were made between 2500 and 3000 meters elevation. Diploids are found primarily on acid rock types such as sandstone, basalt, olivine, etc. However, 12 specimens were collected from limestone. There was no discernable geographic pattern to the diploid plants found on limestone.

Tetraploid plants are primarily northern in distribution, being common in the middle Great Lakes and New England regions (*Fig. 3*). Approximately 12% of the 700 specimens examined were tetraploid. This cytotype appears to be an obligate calciphile, as every specimen examined was collected from limestone habitats. In Europe and Australia, Lovis (1964) also found the tetraploid cytotype confined to calcareous habitats. Wagner and Wagner (1966) studied a population of *A. trichomanes* on limestone cliffs along Sinking Creek, about 1 mile north of Newport, in Giles County, Virginia. From a random sample of 89 plants, 85 proved to be tetraploid, 3 triploid, and 1 diploid. The abundance of tetraploids at this site emphasizes the calciphilous nature of this cytotype. One may wonder why the tetraploid is not more widespread, as suitable limestone habitats certainly exist in many localities outside its main range, such as the Ozarks of Missouri.

The distribution of diploid and tetraploid plants in the Great Lakes region also graphically demonstrates their substrate preferences. The tetraploid is restricted to the Niagara escarpment of Silurian limestone, which forms an arc running from Door County, Wisconsin, across the lower northern peninsula of Michigan to Manitoulin Island, the Bruce Peninsula, and thence southeastward to Niagara Falls in New York. Southwest of Door County, Wisconsin, and southeast of Niagara Falls, the Niagara limestone escarpment becomes gradually covered by glacial tills and is not exposed. The great number of herbarium specimens from locations on the Niagara escarpment suggests that the tetraploid is fairly common there. In contrast, the diploid in the Great Lakes region occurs primarily on Precambrian igneous and metamorphic rocks, such as those that form the Keweenaw peninsula and the escarpments along the north shore of Lake Superior.



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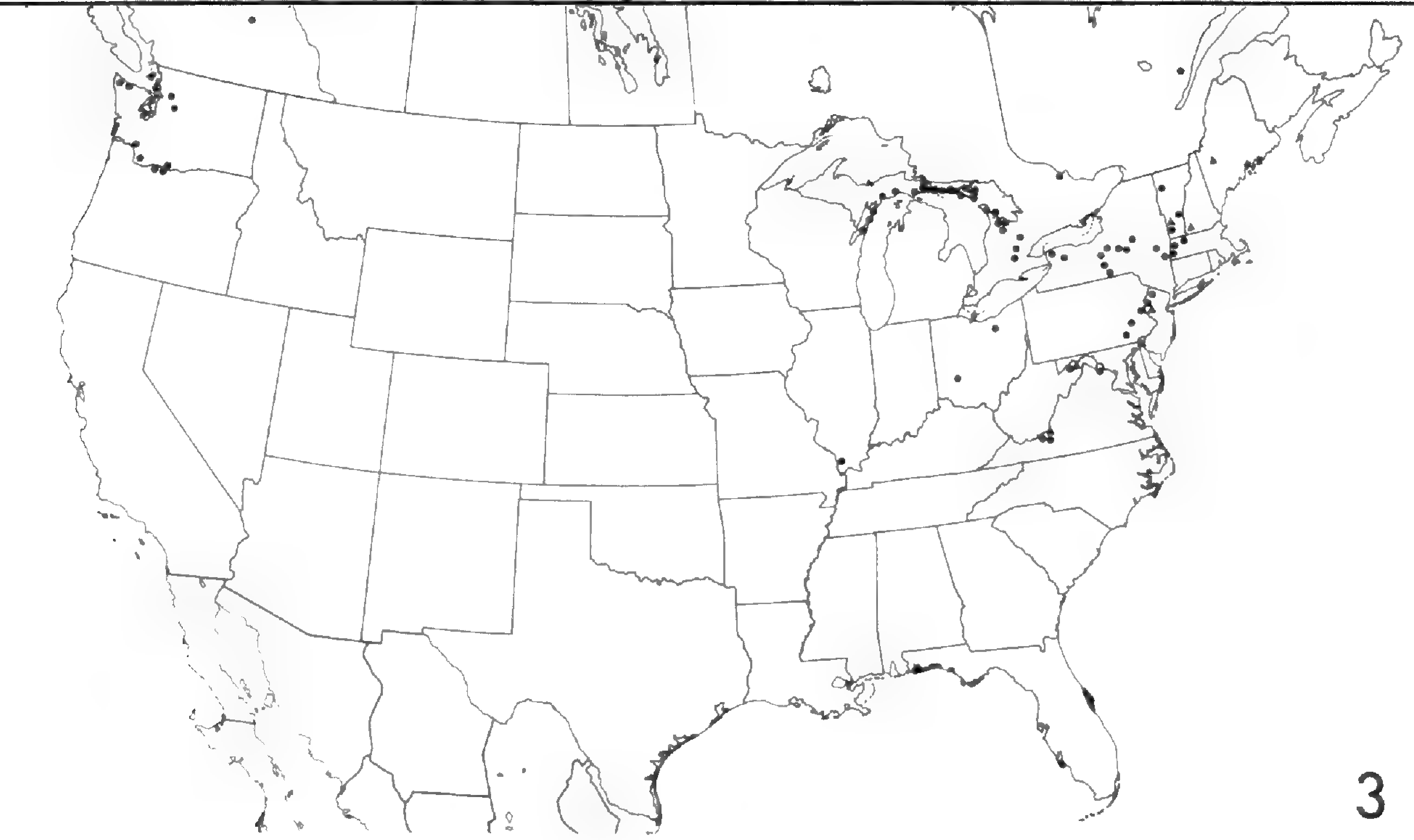

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FIG. 2. The distribution of diploid *Asplenium trichomanes* in the United States and southern Canada.
FIG. 3. The distribution of tetraploid (dot) and triploid (triangle) *Asplenium trichomanes* in the United States and southern Canada.

The triploid is the rarest cytotype; only seven collections (1.0%) were seen from the eastern United States (*Fig. 3*). The triploid occurs sporadically where the diploid and tetraploid populations overlap in the eastern Appalachians. Limestone was given as the rock type in all cases where herbarium labels provided such information.

It is important to note, since many triploid plants are apogamous, that there was no indication of large, globose, unreduced spores in any of the triploids examined. Furthermore, in the above-mentioned population of *A. trichomanes* studied by Wagner and Wagner (1966), the triploids appeared to be the result of *in situ* hybridization from diploid and tetraploid plants occurring at the site.

*Figures 2* and *3* show only the main range of *A. trichomanes* in the United States and southern Canada, but *A. trichomanes* also occurs sporadically eastward in Canada to Newfoundland (Cody, 1968) and northward as isolated occurrences in the western cordillera of Alberta and British Columbia to southeastern Alaska at ca. 58° north latitude (Hultén, 1968; Scoggan, 1978). I have not seen specimens from these extremes of the species range. *Asplenium trichomanes* also occurs on limestone rocks on the Queen Charlotte Islands of British Columbia. All collections examined from this locality were tetraploid, which agrees with the cytological determinations of Taylor and Mulligan (1968). The disjunct *A. trichomanes* individual reported by Cody (1968) from Newfoundland is probably a diploid since it occurred on serpentine rocks.

It is important to note that hexaploid plants are known from Madeira, Australia, and New Zealand. However, only in New Zealand is the hexaploid a prevalent cytotype (Lovis, 1977). No evidence of hexaploid plants was found in this study, based on spore size, although their occurrence in North America could be expected from chromosome doubling of a triploid plant.

No apparent morphological differences were found between European and North American *A. trichomanes*. Indeed, the fact that the same rock habitat differences exist between the diploid and tetraploid cytotypes in both Europe and North America suggests that they are the same taxa. Furthermore, no specimens of *A. trichomanes* subsp. *inexpectans* Lovis, a diploid subspecies known only from central and southeastern Europe, were found among diploids in North America which grew on limestone. This subspecies is similar to subsp. *trichomanes*, but occurs only on calcareous rocks and has a slightly different frond morphology (Lovis, 1964, fig. 2).

Unlike other *Asplenium* species in the eastern United States, *A. trichomanes* rarely hybridizes and its genome is not implicated in any widespread allopolyploid taxa. In Europe, however, a diploid form of *A. trichomanes* has hybridized with diploid *A. viride* Huds. giving rise to the fertile allotetraploid known as *A. adulterinum* Milde., which is widely dispersed in northern and central Europe (Lovis, 1977). Four sterile, interspecific hybrids involving *A. trichomanes* have been found in the eastern United States, these are: *A.* ×*clermontae* Sim (*A. ruta-muraria* × 4*x* *A. trichomanes*), *A.* ×*virginicum* Maxon (supposedly *A. platyneuron* × 2*x* *A. trichomanes*), ×*Asplenosorus herb-wagneri* (Taylor & Mohlenbrock) Mickel (×*A. pinnatifidum* × 2*x* *A. trichomanes*) and ×*A. shawneensis* R. C. Moran (2*x* *A. trichomanes* × *Camptosorus rhizophyllus*). Each of these hybrids is exceedingly rare, being known from only one or two localities. It is extraordinary that × *A. shawneensis* has been found only once, especially since its two parents often grow side-by-side throughout much of the well botanized eastern United States (Moran, 1981).

Certain aspects of the origin of tetraploid *A. trichomanes* remain enigmatic. The tetraploid cytotype appears to be of autopolyploid constitution, as shown by the high levels of autosyndetic chromosome pairing seen in various hybrids (Lovis et al., 1966; Lovis & Reichstein, 1969; Vida, 1970) and an experimentally produced polyhaploid sporophyte (Bouharmont, 1972). However, Lovis (1977) postulates that the origin of tetraploid *A. trichomanes* is polyphyletic, in that tetraploid forms may have arisen by different means at different times and in different parts of the world. The North American tetraploid cytotype may have originated by direct autopolyploidy from diploid forms or by hybridization between diploid subspecies, followed by chromosome doubling, producing intersubspecific autopolyploidy (Lovis, 1977, p. 369). Whatever the case may be, the calciphilous nature of the tetraploid must be taken into account when postulating its polyploid origin from a diploid ancestor. The tetraploid's remarkable habitat preference for limestone is not what would be expected from direct autopolyploidy of a diploid taxon that predominantly occurs on acid rocks. Perhaps the North American tetraploid arose via autopolyploidy from a calciphilous diploid; or perhaps this diploid, calciphilous race hybridized with the more common acidic rock race, with subsequent allopolyploidy, and in so doing imparted a dominant adaptive gene complex enabling the tetraploid to thrive in calcareous habitats. Although many techniques seem inadequate to resolve such a potentially complex evolutionary history, an analysis of isozyme variation from populations throughout the entire range of the complex might yield interesting results.

I would like to thank the following for their help with various aspects of the study: Drs. Almut Jones, James H. Peck, W. Carl Taylor, Charles Werth, Florence S. Wagner, and Warren H. Wagner, Jr. Special thanks is given to Dr. Kenneth R. Robertson of the Illinois Natural History Survey for providing the writer with research time and encouragement for this project.

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## REVIEW

**"ILLUSTRATION OF THE PTERIDOPHYTES OF JAPAN, VOLUME I,"** by Satoru Kurata and Toshiyuki Nakaike. University of Tokyo Press. 628pp. 1979. Yen 50,000.—This book represents the first volume of a series of works devoted to illustrating and mapping the more than 600 species of Japanese (including the Ryu-Kyu and Bonin Islands) pteridophytes. This volume treats 100 species from a variety of families and includes large segments, though regrettably not all, of many genera such as *Dryopteris*, *Polystichum*, and *Pteris*. The treatment of individual species includes photographs depicting habit, line drawings of whole plants as well as details of sori, venation, cuticle, scales, and rhizome anatomy, a short description of the species, and an enumeration of specimens examined with a full page grid-map of Japan showing their location. The entire volume is beautifully produced with excellent paper and binding, something of which more American publishers ought to be envious.

Although the descriptive material is entirely in Japanese (Latin names are included), the illustrations and detailed distributions will be quite useful to American botanists, not only pteridologists, but phytogeographers and ecologists as well. It is hard to ignore, for instance, the close resemblance of our *Dryopteris ludoviciana* with *D. tokyoensis* after examining the photograph and illustration of the latter. Although it is unlikely that many individuals will be able to purchase this book, they should certainly encourage their institutional libraries to do so.—*R. Cranfill, Department of Botany, University of California, Berkeley, CA 94720.*

# The First Record of Platycerium ridleyi in Sumatera

N. A. P. FRANKEN* and M. C. ROOS**

*Platycerium ridleyi* Christ, one of the well-known staghorn ferns, was thought to be restricted to a few localities in Malaya, Singapore, northeastern Borneo, and the Lingga Archipelago. It was not known to occur on Sumatera (formerly Sumatra). In general, this species is regarded as rare (Ridley, 1926, p. 110); few collections have been made during the last 20 years, and according to Holttum (pers. comm.), this species must be regarded as extinct in Singapore.

During some field trips in Jambi Province, Central Sumatera, in 1980, the authors visited two places where *P. ridleyi* appeared to be rather common. One locality is the Nature Reserve of Berbak along the river Air Hitam Laut (± 1°25′S, 104°30′E) about 15–25 km upstream from the east coast. The second locality is in the center of the island near Pasir Mayang, close to the head of the Batang Hari River (± 1°0′S, 102°0′E), in a timber concession to P.T.I.F.A. (Asiatic Forest Industry, Ltd.), where the species may become extinct. These two places are rather far from each other, but fit well in the previously known distribution pattern.

*Platycerium coronarium* (König ex Müller) Desv., the sister species of *P. ridleyi*, can be found in both *P. ridleyi* localities. The latter is a common and widely distributed species in the ever-wet lowlands of Malaya and the Greater Sunda Islands. Although the two species are closely related, they can be distinguished easily by their different habits. *Platycerium ridleyi* has erect foliage fronds, an oval soral lobe, and entire base fronds (with very prominent veins) forming a large bulb. *Platycerium coronarium* has elongate, pendulous foliage fronds, a kidney-shaped soral lobe, and lobed base fronds forming a basket. There is another striking difference between the two species: *P. ridleyi* grows solitarily, but with many specimens in one tree (at least 10, mostly 15), whereas *P. coronarium* is present in one or two clusters, which are formed by vegetative reproduction.

Ridley (1908, p. 56), who was the first author to distinguish *P. ridleyi* (as *P. biforme* var. *erectum*), mentioned its occurrence on lofty branches of trees like *Shorea*, at least 30 m above the ground. He never saw *P. ridleyi* and *P. coronarium* growing on the same tree. Furthermore, he cited Motley for specimens from Borneo, which were growing on the highest branches of trees in very exposed places. Holttum (1954, p. 140) remarked that *P. ridleyi* grows on tall trees, but sometimes also on low branches along rivers. It never grows in open country like *P. coronarium*. Corner (1978, p. 162) noted *P. ridleyi* to be frequent on high branches in swamp forests.

Our own observations more or less agree with the above findings. In the Berbak Nature Reserve, *P. ridleyi* occurred along the rivers and smaller streams in the swamp forest and grew exposed to the sun in the crowns of high emergent *Shorea* trees from the first trunk fork upwards. *Platycerium coronarium*, on the other hand,

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occurred distinctly lower in the trees, always in a more shady situation, and apparently was less frequent than *P. ridleyi*. However, we may have overlooked stands of *P. coronarium* because of their less exposed habitat. As seen from the river, the branches of emergents and their load of *P. ridleyi* stand out much more clearly.

Where the *Pandanus* zone starts, *P. ridleyi* seems to be more common than *P. coronarium*. Closer to the coast in the *Nipa* zone, the former is absent, whereas the latter can still be found. Also, outside the reserve near the coast, in open country and anthropogenic situations, only *P. coronarium* was seen.

Pasir Mayang, although drier than Berbak and forming a mosaic of swampy and well-drained places, also produced several localities where *P. ridleyi* and *P. coronarium* grew in profusion. But near Muara Bulian, a much drier, non-swampy area, both staghorn ferns were absent. This could indicate that at least *P. ridleyi* prefers—or may be even entirely restricted to—swamp forest, as Corner indicated.

Growing high up in the trees, *P. ridleyi* can be rather easily seen from a logging road or river. From inside the primary forest, detection is much more difficult. However, when dead, the mass of base fronds falls down intact. Finding these on the forest floor indicates that there is (or was) a tree with *P. ridleyi* in the neighborhood.

The bulging mass of base fronds is very characteristic. It is formed by many dead, old base fronds enclosed in two new green ones. Mostly these fronds are not rounded, but have an elliptical upper part. When the tree branch is not too thick, it is totally enclosed by the base fronds. As a matter of interest, the illustration given by König (Müller, 1785), who was the first to describe *Acrostichum coronarium* in his letter to Müller, shows a fertile frond of *P. coronarium* and a characteristic base frond of *P. ridleyi*. This illustration is the type of *P. coronarium*, but the base frond must be excluded from the protologue.

We observed the frequent association of *P. ridleyi* with *Lecanopteris*, also reported by Ridley (1908). We collected *P. ridleyi* growing together with *L. crustacaea* Copel. The Staghorn Fern has colonies of ants in its base fronds, whereas *Lecanopteris* has them in its thickened rhizome.

*Platycerium coronarium* also is a host for ants, but it is never associated with *Lecanopteris*. Other epiphytes were not found growing with *Platycerium*.

Oldeman (in Hallé et al, 1978, p. 332) proposed a method for describing the structure of forests by means of a profile diagram. Of great importance is the distinction between trees of the future, present and past. One of the characters used is the presence of epiphytes. Trees of the present have some epiphytes, whereas trees of the past are overgrown by numerous epiphytes. We do not think that *Platycerium* species are an indicator of trees of the past, although, as said before, in the case of *P. ridleyi* they may occur in great quantity on a single vigorous tree and are almost the only epiphytes present, except for *Lecanopteris*.

We are grateful to Dr. Soetrisno Soewoko of P. P. A. Jambi for giving us the opportunity to do research in Berbak Nature Reserve. We want to thank the Rijksherbarium, Leiden, where we wrote this paper. Our special thanks to Mr. G. J. de Joncheere for his advice. Finally we would like to thank W. W. F. Holland, Stichting W. S. O. and Studiefonds Van Oosterom for their financial support.

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## REVIEW

√ **"FERNS AND FERN ALLIES OF GUATEMALA, PART II. POLYPODIACEAE,"** by Robert G. Stolze, Fieldiana, Botany n.s. 6: i–x, 1–522. 1981.—This is the second of three parts of Stolze's monumental and indispensable work on Central American ferns. (The first part, containing the Ophioglossaceae, Marattiaceae, Osmundaceae, Schizaeaceae, Gleicheniaceae, Hymenophyllaceae, Plagiogyriaceae, Dicksoniaceae, and Cyatheaceae, was reviewed in Amer. Fern J. 67:94. 1977.) The present part matches the format and quality in both text and illustrations (all genera and some species are illustrated) of the earlier part and covers the remainder of the ferns, which are all placed in the Polypodiaceae *sensu latissimo*, alphabetically from *Acrostichum* to *Woodwardia*. Although this arrangement is handy for finding the 67 genera and over 500 species and infraspecific taxa treated in the volume, it does not group related species or genera together, which can be a disadvantage when browsing through the volume while making identifications. However, the keys are ample and well constructed, and so will surely be used for this purpose. The genera are construed broadly, especially *Polypodium*, but that is no disadvantage to the user, and the correct names in the segregate genera are given in the synonymies. The species treatments each include a brief synonymy, habitat and range statements, an original description, and often copious notes. Of special value are Stolze's comments on unresolved taxonomic difficulties which point students of ferns toward areas of fruitful research. Dubious and excluded species are accounted for. Presumably an index will conclude the third part, and that will add greatly to the utility of all the parts.—*D.B.L.*

# Comparison of Chromatographic Spot Patterns of Some North American Isoëtes Species

L. S. KOTT and D. M. BRITTON*

Few comparative phytochemical studies have been done among the species of *Isoëtes*. A comparison of the phenolic compounds in some species in the orders Isoëtales, Lycopodiales, and Selaginellales (Vorin, 1972) showed only biflavones, whereas other members of the Isoëtales and Lycopodiales had other types of flavones. Vorin (1972) also isolated the flavones apigenin and luteolin from European *I. delilei* Rothm. and *I. durieui* Bory. Shortly thereafter, Vorin, Jay, and Hautville (1975) isolated the unique flavone, isoetin, in these same two species, and this clearly separated the quillworts from the lycopods chemically. In further work on four European species (*I. durieui*, *I. delilei*, *I. lacustris* L. and *I. velata* A. Braun), seven compounds were isolated: apigenin, luteolin, isoetin, selagin, chrysoeriol, tricin, and orientin (or isoorientin) (Vorin & Jay, 1978). Each species showed a specific grouping of these compounds.

In other chemotaxonomic studies of *Isoëtes* species from the southeastern United States, it was discovered that very little taxonomic information could be gleaned from chromatographs (Matthews & Murdy, 1969, Boom, 1979). They considered that there was more variation between populations within a species than between species.

The present phytochemical study was initiated to survey the patterns of the phenolic compounds as part of a larger taxonomic study of the genus *Isoëtes* in northeastern North America (Kott, 1980). No attempt was made to isolate or identify the compounds.

## MATERIALS AND METHODS

Populations of *Isoëtes* species used in the chromatographic survey were determined morphologically (Kott, 1980) and cytologically (Kott & Britton, 1980). The species examined were: *I. macrospora* Dur., *I. tuckermanii* A. Braun, *I. riparia* Engelm., *I. acadiensis* Kott (Kott, 1981), *I. eatonii* Dodge, *I. echinospora* Dur., and one population of *I. engelmannii* A. Braun. *Isoëtes hieroglyphica* A. A. Eaton was not analyzed chemically because too few collections were available of this rare species. In all, 35 populations were sampled, and several duplicate chromatographs were prepared for each population. Extracts were prepared by powdering dried leaves from several plants in a population and soaking 0.1 gm of material in 0.1 cc of absolute methanol for 48 hours. Paper chromatographs were prepared by applying 200 μml of each sample to standard Whatman #1 paper using the spot method. The chromatographs were run ascendingly in butanol:acetic acid:water (BAW) (12:3:5) in one direction (30 hours) and in a 2% formic acid solution in the other direction (6 hours). Dried chromatographs were examined in the presence of long wave ultraviolet light and ammonia vapor. Average Rf values were determined for all obvious and constantly recurring spots (major spots) (*Table 1*).

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## RESULTS AND DISCUSSION

The spot patterns were not strikingly different overall from species to species, but some differences existed in the presence or absence of certain major spots. The chromatographs of the seven *Isoëtes* species examined fell into one of two spot patterns, the *I. echinospora* type and the *I. macrospora* type.

*Isoëtes echinospora, I. eatonii* and *I. riparia* all generally shared a common pattern with a maximum of 8 major spots (*Fig. 1a*). Although only one population of *I. engelmannii* was sampled, it perhaps should also be included in this group. It differs by the absence of spots 2, 3 and 7 (*Table 1*). *Isoëtes eatonii* and *I. riparia* have almost identical patterns to *I. echinospora*, except that the two former species have one spot each that may be weak or absent at times (*Table 1*).

TABLE 1. ANALYSES OF SPOT PATTERNS FOR SEVEN SPECIES OF *Isoëtes*.

| | | 1 | 2 | 3 | 4a | 4b | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| color of spot: | UV | DP | P | P | DP | DP | P | P | P | P |
| | UV + $NH_3$ | Y | P | P | YG | YG | Y | OY | P | P |
| Rf : BAW | | .84 | .83 | .85 | .49 | .47 | .34 | .25 | .55 | .49 |
| Rf : 2% Formic acid | | .0 | .05 | .19 | .05 | .13 | .02 | .02 | .02 | .10 |
| *I. echinospora* | | + | + | + | + | | + | + | + | + |
| *I. eatonii* | | + | ± | + | + | | + | + | + | + |
| *I. engelmannii* | | + | | | + | | | + | | + |
| *I. riparia* | | + | + | + | + | | + | + | ± | + |
| *I. macrospora* | | + | ± | + | | + | + | + | | |
| *I. acadiensis* | | + | | + | | + | + | + | | |
| *I. tuckermanii* | | + | ± | + | | | + | + | | |

Color code: DP = dark purple; P = purple; Y = yellow; YG = yellow-green; OY = orange-yellow

The remaining three species, *I. macrospora, I. tuckermanii*, and *I. acadiensis*, generally share the other spot pattern. Basically their pattern resembles the first but with fewer major spots (*Fig. 1b*). In these three species, the purple spots 7 and 8 present in the *I. echinospora* type are absent. *Isoëtes tuckermanii* lacks spot 4b and *I. acadiensis* lacks spot 2, both of which are present in *I. macrospora* (*Table 1*).

The large yellow-green spot (4a) at Rf .49/.05 in the *I. echinospora* type of pattern may be a different compound from the yellow-green spot (4b) at Rf .47/.13 in the *I. macrospora* type pattern. Until the compound is analyzed chemically, it cannot be determined whether these spots are similar, but it appears that this yellow-green spot is consistently in a slightly different position in each of the two patterns.

In conclusion, it appears that gross chromatography can add some taxonomic information to well established morphological and cytological data. Spore morphology of *I. tuckermanii* and *I. macrospora* share some similarities, and it is not unlikely that they share a common ancestor. This is reflected to some extent in the spot pattern that they share. *Isoëtes tuckermanii* has a spot pattern different from that of *I. riparia*, a species with which it is often confused using spore morphology

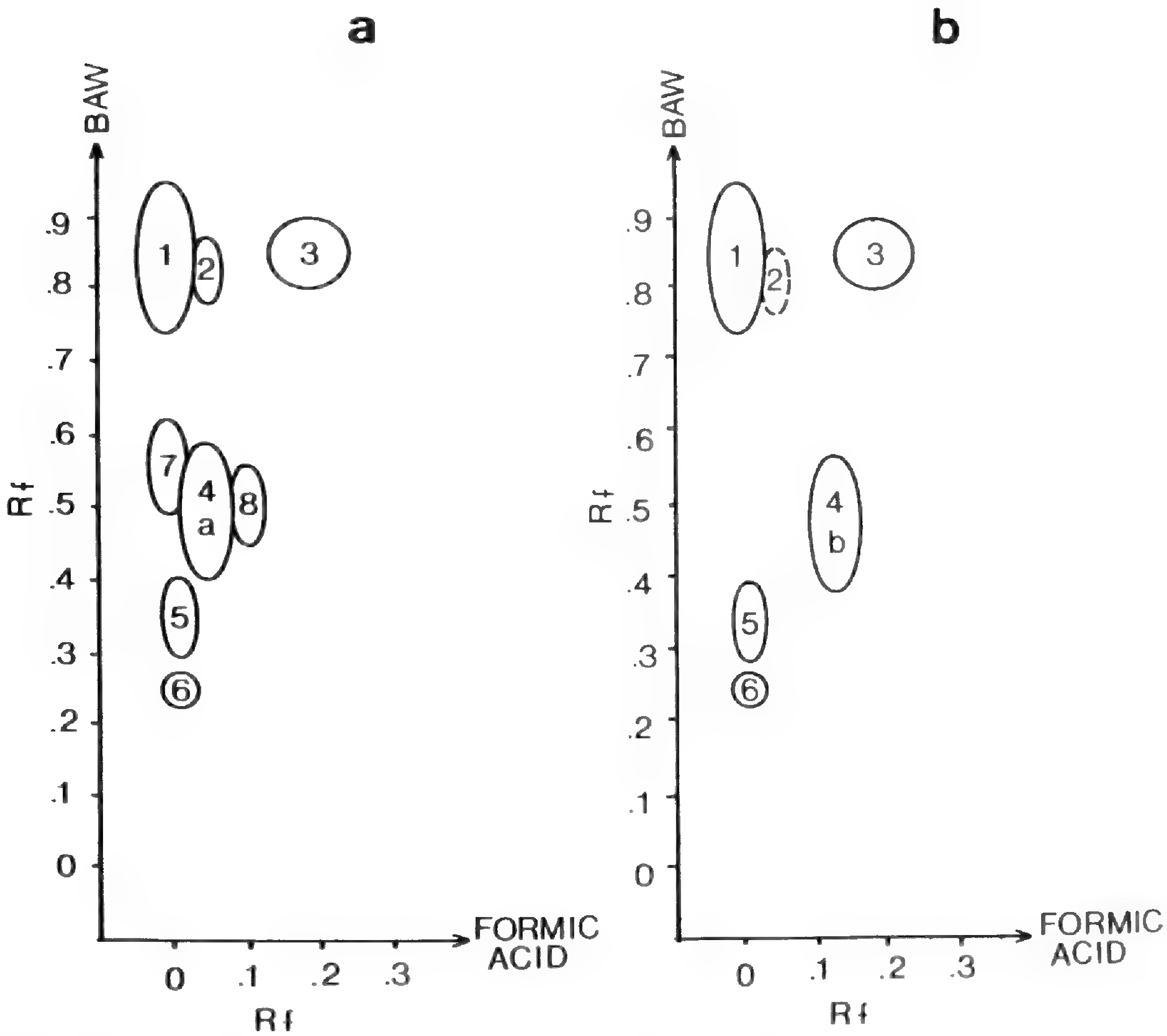

FIG. 1. Comparative spot patterns produced by two dimensional chromatography on *Isoëtes* species. a. Composite spot pattern of *I. echinospora* type. b. Composite spot pattern of *I. macrospora* type.

and habitat preference. *Isoëtes riparia*, however, has great affinities with *I. echinospora* in spot pattern, and perhaps one of the parents of this tetraploid species is the diploid *I. echinospora*. This is supported by spore morphology of *I. riparia*, which is intermediate between the spiny and the ridged spore type.

The three diploid species *I. eatonii*, *I. echinospora* and *I. engelmannii*, although unique in spore pattern, have similar chromatographic spot patterns. The phytochemical spot pattern appears to yield no further taxonomic information about these species at this level of comparison. Identification of the compounds that produce the spots may lead to a better understanding of the relationships among the groups, since the unique spore morphology of each of the three diploid species indicates that they are not closely related.

We wish to thank Natural Science and Engineering Research Council for financial support for this project.

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## REVIEW

**"LOUISIANA FERNS AND FERN ALLIES,"** by J. W. Thieret. vi + 123 pp., 75 plates. Lafayette Nat. Hist. Museum. 1980. $17.95.—This is a semitechnical floristic treatment, and so is useful to botanists and is at the same time understandable to non-specialists. Each species native to or naturalized in Louisiana is treated. The scientific name, sometimes one or more common synonyms, the vernacular name, a very brief description that is supplemented by a plate of several figures, notes, and a general statement of range are given. The keys to the species of each genus are ample and usable. The introductory portion of the book will acquaint non-specialists with some of the intricacies of pteridology. Unfortunately, there is no conventional key to the families or genera. Instead, there is a "guide" consisting of a series of sequential, non-contrasting statements each leading to one or more genera. By reading through the statements, according to the author, "Eventually you will come upon a statement descriptive of the fern or fern ally you wish to identify." This procedure is roughly twice as cumbersome as a conventional key. The plates, which are reproduced from other publications with permission, are diagnostic, but any grace or delicacy they had as originals has been lost in reproduction. A dot map by parishes (the equivalent of counties) is included on each plate. The plates are grouped near the center of the book and are unpaged, but are numbered. The work concludes with a checklist of Louisiana pteridophytes, a glossary, literature cited, and an index. The book is paper-backed and perfect bound, and so will not withstand extensive rough handling. Presumably the book can be obtained only from the publisher, in Lafayette, Louisiana 70501.—*D.B.L.*

# Anatomical Studies of the Neotropical Cyatheaceae. II. Metaxya and Lophosoria

TERRY W. LUCANSKY*

The classification of the monotypic tree fern genera *Metaxya* and *Lophosoria* has undergone several revisions. Early taxonomists placed these genera, with the dicksonioid group, in the family Cyatheaceae (Diels, 1902; Christensen, 1906; Maxon, 1912). Bower (1926) stressed the importance of soral position and placed these primitive genera in the family Protocyatheaceae. Later workers (Christensen, 1938; Copeland, 1947) included the two genera in the Cyatheaceae, but excluded the dicksonioid group from that family. Based upon morphological, developmental and anatomical data, Holttum and Sen (1961) again placed *Metaxya* and *Lophosoria* and the dicksonioid ferns into the single family Cyatheaceae. More recently, Tryon (1970) revised the classification of the Cyatheaceae, excluding members of the Dicksoniaceae. He recognized *Metaxya* and *Lophosoria* as distinctive genera and placed them in an independent position at the base of his phyletic scheme for the family.

In this study, the anatomy of *Metaxya rostrata* (H.B.K.) Presl and *Lophosoria quadripinnata* (Gmel.) C. Chr. is elucidated and an attempt is made to determine whether the proposed phyletic relationship between these two taxa and the squamate genera of tree ferns is supported by anatomical data.

Developing shoot tips of *M. rostrata* and *L. quadripinnata* were collected in montane and lowland rainforests in Costa Rica. The plant materials were killed and fixed in formalin–acetic acid–alcohol (FAA) and sectioned on a macrotome (Lucansky, 1976a). The slices were partitioned into manageable sizes, dehydrated in a tertiary-butyl alcohol series and embedded in paraffin (Johansen, 1940). Sections (10 μm) were made and stained in a safranin–fast green series. Stained sections were photographed with a Nikon M-35S camera, whereas entire slices were photographed with a Pentax 35 mm single lens reflex camera. Voucher specimens are deposited in the herbarium of Duke University.

## RESULTS AND DISCUSSION

Based upon stem and petiole indument, nodal patterns, and vascular anatomy, *Metaxya* and *Lophosoria* are similar and represent distinctive and primitive genera in the neotropical Cyatheaceae (Lucansky, 1974a; Lucansky & White, 1974). Both genera are characterized by unbranched, multicellular trichomes on both the rhizome (stem) and petioles. *Metaxya rostrata* possesses a prostrate, dorsiventral rhizome, whereas a short, upright radial stem occurs in *Lophosoria quadripinnata (Figs. 1* and *2)*. The presence of trichomes and a procumbent habit are considered primitive characters in the Cyatheaceae (Bower, 1913). The squamate genera of the New World tree ferns have an arborescent habit, except for an acaulescent habit in *Cnemidaria* (Tryon, 1970). *Metaxya* has once-pinnate leaves inserted laterally and dorsally on the rhizome, whereas *Lophosoria* has decompound leaves inserted over

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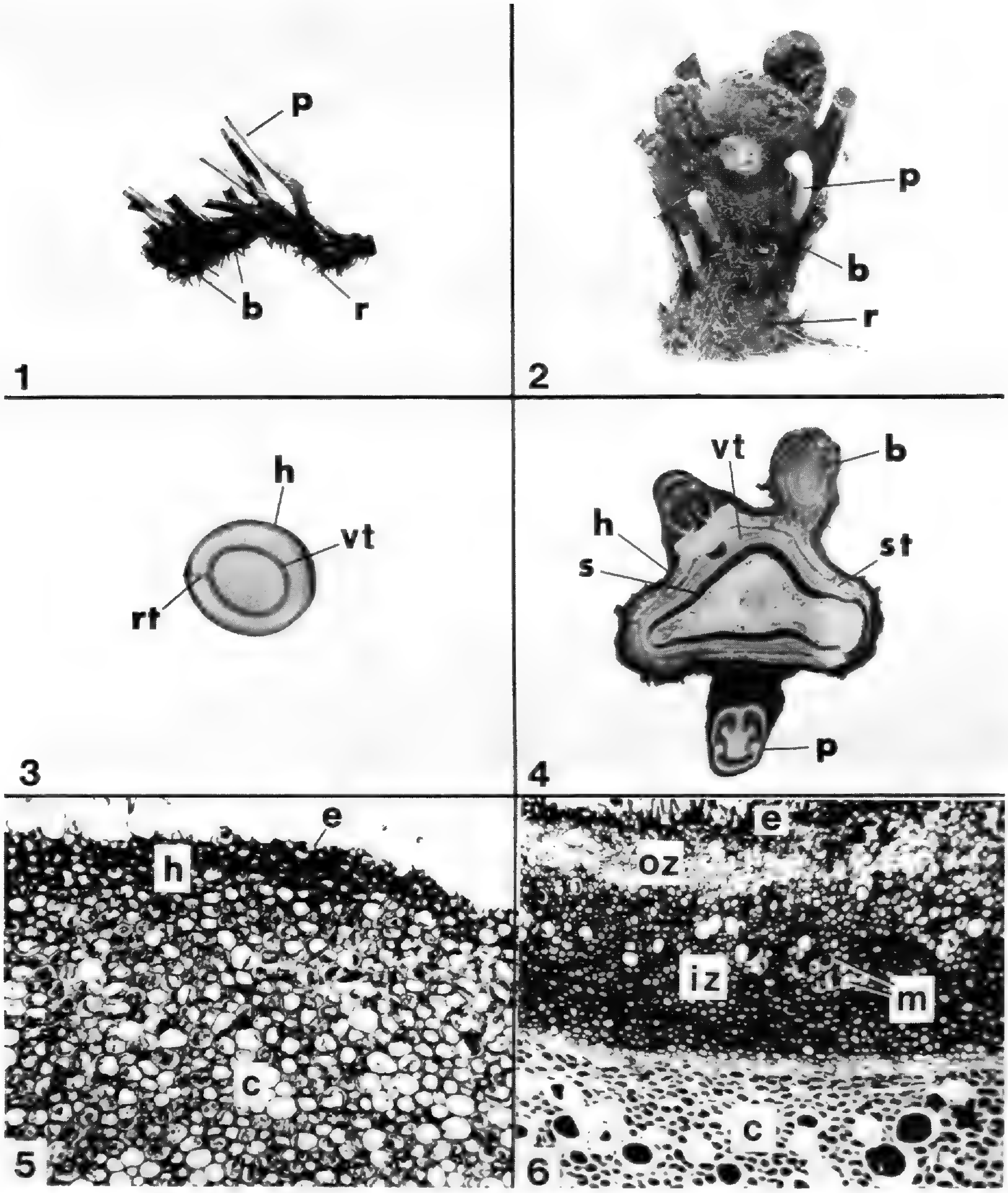


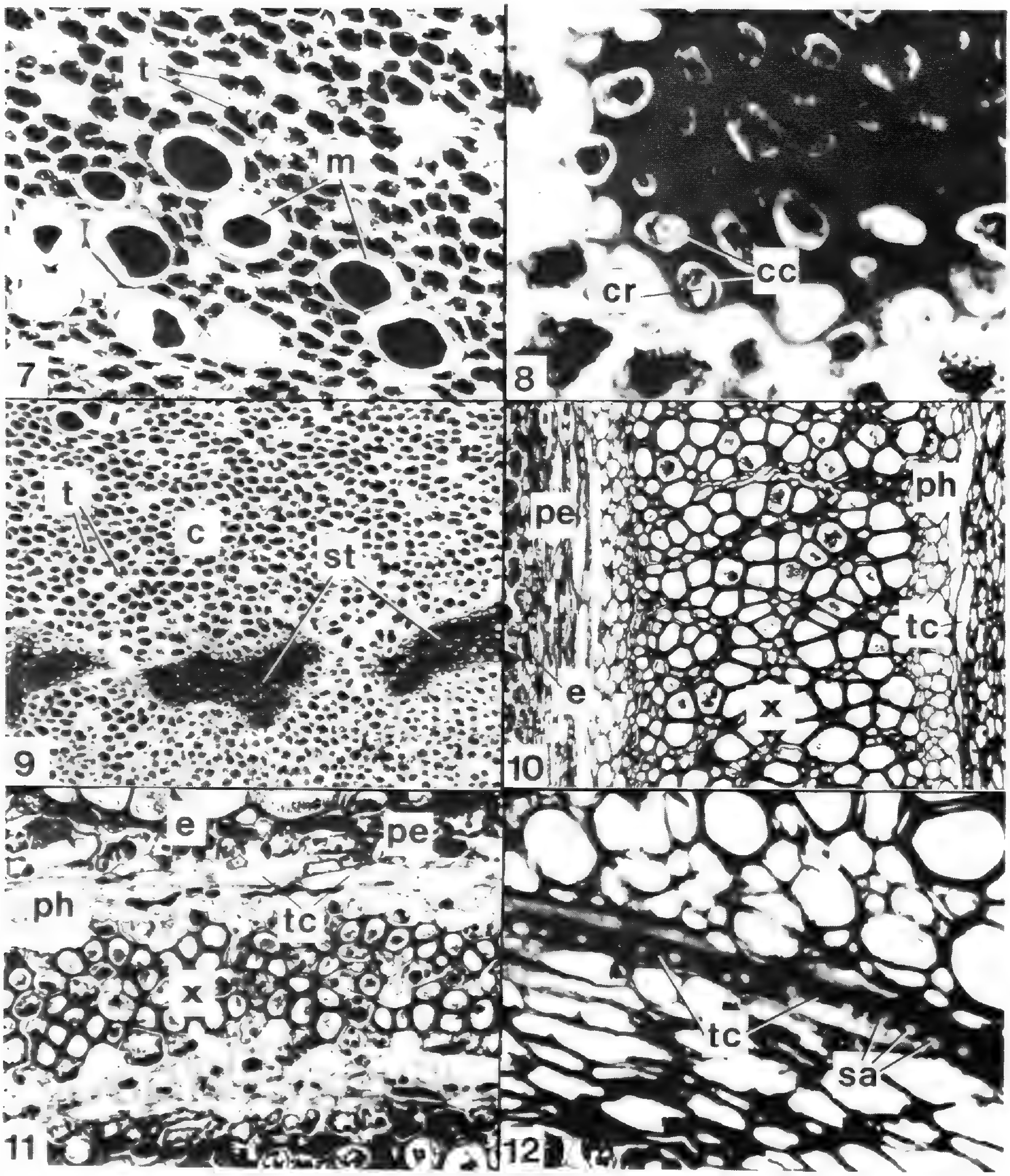
FIGS. 1–6. Habit, transections, and anatomical details of tree fern stems. FIG. 1. Prostrate rhizome of *Metaxya rostrata*. ×0.5. Note adventitious buds. FIG. 2. Short, upright stem of *Lophosoria quadripinnata*. ×0.6. FIG. 3. Transection of rhizome (amphiphloic siphonostele) of *M. rostrata*. ×1.7. FIG. 4. Transection of rhizome (dictyostele) of *L. quadripinnata*. ×0.4. FIG. 5. Hypodermis of *M. rostrata*. ×54. FIG. 6. Two-zoned hypodermis of *L. quadripinnata*. ×57. The abbreviations are: b = adventitious bud, c = cortex, e = epidermis, h = hypodermis, iz = inner zone, m = mucilage-sac cell, oz = outer zone, p = petiole, r = adventitious roots, rt = root trace, s = stelar sheath, st = sclerenchyma tissue, and vt = vascular tissue.

the entire surface of the stem. Adventitious roots arise from the leaf bases, buds and stems of both species (*Figs. 1* and *2*). While much is known morphologically about these two genera, comparative anatomical data are almost totally lacking for these neotropical species.

Both *Metaxya* and *Lophosoria* have an amphiphloic siphonostele, although a dictyostelic pattern with overlapping leaf gaps frequently occurs in *L. quadripinnata* (*Figs. 3* and *4*). Bower (1912) found no such stelar pattern in this species, but did indicate an approach to dictyostely in some specimens. No dictyostelic pattern is observed in *Metaxya*. The siphonostelic axis devoid of overlapping leaf gaps is a relatively primitive feature in the Cyatheaceae, and according to Holttum (1965), a siphonostelic, dorsiventral rhizome is an evolutionary development related to the growth habit of the plant.

Stem transections of *Metaxya* and *Lophosoria* are anatomically similar in some respects, but differ in certain anatomical features. In both genera, a single-layered epidermis composed of thick-walled, variously shaped cells filled with tannins is generally persistent in the mature sporophyte (*Figs. 5* and *6*). In *Culcita* and *Cystodium*, the outer epidermal walls may be either thickened (Sen & Mittra, 1966) or cutinized (Sen, 1968). In the squamate genera, the epidermal layer is typically sloughed off in the mature plant (Lucansky, 1976b, 1977), although remnants of this layer may persist. Beneath the epidermis in *Metaxya* is a hypodermis composed of sclerified parenchyma cells filled with tannins and infrequently starch grains (*Fig. 5*), whereas a two-zoned hypodermis is found in *Lophosoria* (*Fig. 6*). The outer zone (8–10 cells thick) is composed of thick-walled parenchyma cells filled with tannin droplets; the inner zone (20–25 cells) consists of smaller, sclerified parenchyma cells filled with tannins. Groups of large mucilage-sac cells are randomly scattered within this latter zone (*Fig. 6*). Previous workers had reported that the hypodermis of certain tree fern species consists solely of sclerenchymatous fibers (Ogura, 1938; Mehra & Singh, 1955); however, the squamate genera typically possess a two-zoned hypodermis composed of thick-walled parenchyma cells and sclerified parenchyma cells (Lucansky, 1976b, 1977). Except for *Metaxya*, a two-zoned hypodermis is characteristic of the neotropical Cyatheaceae.

In *Metaxya*, the cortex is composed of large, irregularly shaped, thick-walled parenchyma cells filled with tannins and starch grains (*Fig. 5*). In older rhizomes, the cortical cells become sclerified and resemble fibers. In *Lophosoria*, the cortex consists of large, thin-walled parenchyma cells filled with tannins and starch grains, although the outermost layers may be thick-walled. Within the cortex, large mucilage-sac cells are randomly distributed, either singly or in groups of 3–15 (*Fig. 7*). Distinctive cells called cubical cells occur between the hypodermal and cortical regions in *Lophosoria* (*Fig. 8*), whereas these cells are lacking in these regions in *Metaxya*. Holttum and Sen (1961) reported only solitary cubical cells in the cortex of *Lophosoria*, but they may form a discontinuous layer. Cubical cells also occur in the cortical region of the squamate genera of the neotropical Cyatheaceae (Lucansky, 1976b, 1977) and are found in the cortex of certain dicksonioid species (Sen, 1964). These distinctive cells usually contain a single, large, irregularly shaped crystal that is thought to be composed of silica (Sen, 1968). Although Ogura (1938) thought that



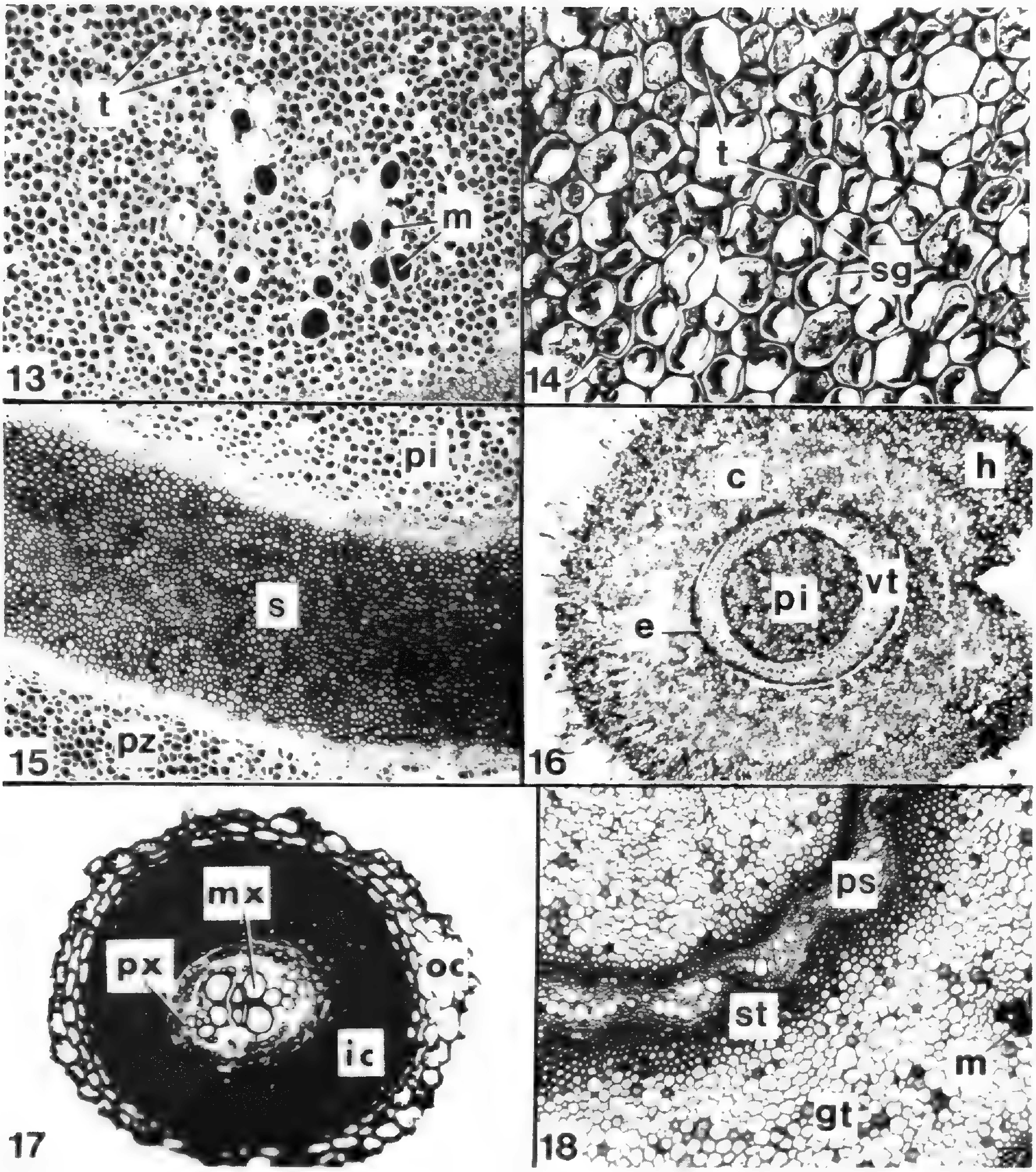
FIGS. 7–12. Anatomical details of tree fern stems. FIG. 7. Cortex of *L. quadripinnata*, ×127. Note mucilage-sac cells. FIG. 8. Cubical cells with crystals in *L. quadripinnata*, ×429. FIG. 9. Localized sclerenchymatous areas (dissected external stelar sheath) in cortex of *L. quadripinnata*, ×50. FIG. 10. Meristele of *L. quadripinnata*, ×124. Note tangential cells. FIG. 11. Tangential cells in stele of *M. rostrata*, ×220. FIG. 12. Tangential cells with lateral sieve areas in primary phloem of *L. quadripinnata*, ×464. The abbreviations are: c = cortex, cc = cubical cell, cr = crystal, e = endodermis, m = mucilage-sac cell, pe = pericycle, ph = phloem, sa = sieve area, st = sclerified tissue, t = tannins, tc = tangential cell, and x = xylem.

cubical cells were sclerenchyma cells, their living protoplast, wall morphology, position, and resemblance to parenchyma cells in young stems shows that they are thick-walled parenchyma. Sen's (1964) report that they were not sclerenchyma cells is based upon their rate of cell division and cellular inclusions. Also scattered in the cortex of *Lophosoria* are localized areas of sclerified tissue (transitional parenchyma-to-sclerenchyma cells) that vary in shape and size (*Fig. 9*). The stelar sheaths in certain squamate genera arise from the fusion of such localized areas of sclerenchyma cells (Lucansky & White, 1976), and these areas in *Lophosoria* occasionally fuse to form a dissected stelar sheath and may represent an early evolutionary stage in the development of an external stelar sheath. Localized patches of sclerenchyma tissue have also been noted in the cortical region of *Trichipteris microphylla* and *Cyathea suprastrigosa* (Lucansky, 1977) and in *Cystodium sorbifolium* (Sen & Mittra, 1966). Cubical cells filled with solitary crystals (*Fig. 8*) frequently occur between these sclerenchymatous areas and the thin-walled parenchyma cells of the cortex in both *Lophosoria* and certain squamate species (Lucansky, 1977). No sclerenchyma tissue and cubical cells are found in the cortical region of *Metaxya*.

Cortical bundles are a characteristic feature of certain genera and species in the Cyatheaceae (Lucansky, 1974b, 1976b, 1977), but these vascular bundles do not occur in either *Metaxya* or *Lophosoria*.

A distinct, single-layered endodermis filled with tanniniferous substances delimits the stelar tissue in both *Metaxya* and *Lophosoria* (*Figs. 10* and *11*). A pericycle composed of 1–5 rows of thin-walled parenchyma cells filled with tanniniferous substances encircles the primary phloem. Although Ogura (1927, 1938) reported anatomical differences between the proto- and metaphloem in certain squamate species, these two tissues are indistinguishable in the present study. Earlier workers (Schütze, 1906; Ogura, 1927) found that the primary phloem in certain species is composed of distinct rows of sieve cells and phloem parenchyma, but these two cell types are randomly interspersed in *M. rostrata* and *L. quadripinnata*. A similar random arrangement has been noted for certain squamate species (Lucansky, 1976b, 1977). The outermost 1–3 layers of primary phloem in both *Metaxya* and *Lophosoria* are composed of distinctive cells called tangential cells (*Figs 10–12*), whereas these cells typically occur between the proto- and metaphloem in certain squamate species (Lucansky, 1976b, 1977). These cells represent specialized sieve cells that are devoid of nuclei, possess sieve areas on their lateral walls, and accumulate callose (Sen, 1964), although they have been referred to as false sieve tubes (Schütze, 1906) or as elongated mucilage cells (Ogura, 1927). Although tannin droplets occasionally occur in these cells, they are typically devoid of contents. Previous workers had reported that they contained oil and mucilage (Schütze, 1906; Ogura, 1927). Tangential cells are a characteristic feature of the Cyatheaceae, and have previously been found in certain neotropical squamate species (Lucansky, 1976b, 1977).

The primary xylem in both *Metaxya* and *Lophosoria* consists primarily of tracheids with scalariform pitting, with xylem parenchyma interspersed among these xylary elements. Xylem maturation is mesarch in both genera, with metaxylem tissue comprising the bulk of the xylary mass (*Figs. 10* and *11*). The cellular



FIGS. 13–18. Anatomical details of tree fern stems. FIG. 13. Pith region of *L. quadripinnata*. ×58. Note mucilage-sac cells. FIG. 14. Pith region of *M. rostrata*. ×125. FIG. 15. Internal stelar sheath in pith region of *L. quadripinnata*. ×50. FIG. 16. Transection of adventitious bud of *M. rostrata*. ×118. Note sclerified inner cortex. FIG. 18. Transection of adaxial petiole strand of *L. quadripinnata*. ×50. Note mucilage-sac cells in ground tissue. The abbreviations are: c = cortex, e = endodermis, gt = ground tissue, h = hypodermis, ic = inner cortex, m = mucilage-sac cell, mx = metaxylem, oc = outer cortex, pi = pith, ps = petiole strand, px = protoxylem, pz = parenchymatous zone, s = internal stelar sheath, sg = starch grain, st = sclerenchyma tissue, t = tannins, and vt = vascular tissue.

composition and arrangement of the primary xylem is similar in the squamate genera (Lucansky, 1976b, 1977).

The pith in *Lophosoria* is composed of large, irregularly shaped, thin-walled cells filled with tannins and/or starch grains. Within the pith region of *Lophosoria*, large mucilage-sac cells are randomly distributed, either singly or in groups of 2–10 (*Fig. 13*), whereas no such cells occur in the pith of *Metaxya* (*Fig. 14*). Mucilage-sac cells, however, have been reported in the pith region of certain squamate genera of the Cyatheaceae (Lucansky, 1976b, 1977). The pith comprises the bulk of the rhizome in *Metaxya* and consists of thick-walled, variously-shaped parenchyma cells filled with tannins and/or starch grains (*Fig. 14*). In older rhizomes, these cells become sclerified and closely resemble fibers. An extensive band of sclerified cells in the peripheral region of the pith of *Lophosoria* occurs and constitutes an internal stelar sheath (*Fig. 15*) which possibly helps to support both the stem and leaves. The thin-walled parenchymatous zone that separates this stelar sheath from the stele may function in the conduction and storage of carbohydrates (Schütze, 1906). Stelar sheaths are a characteristic feature of the Cyatheaceae and have been noted for all advanced neotropical genera (Lucansky, 1974b, 1976b, 1977), yet no sclerified stelar sheaths are found in *Metaxya*. Although the stelar sheaths of the advanced squamate genera are delimited externally and internally by cubical cells (Lucansky, 1976b, 1977), no cubical cells are found between the stelar sheath and pith region in *Lophosoria*. The lack of these distinctive cells may be due to the gradual transition, rather than an abrupt one, from the sclerified cells to the thin-walled cells of the pith. In addition to the stelar sheath, one or more large, localized areas of sclerenchyma tissue frequently occur in the central region of the pith in *Lophosoria*, whereas no sclerenchyma cells occur in the pith region of *Metaxya*. Although no large, sclerified areas occur in the pith region of the squamate genera, numerous small areas do occur (Lucansky, 1974b) and may or may not be associated with medullary bundles (Lucansky, 1976b, 1977). These latter accessory bundles represent another characteristic feature of the Cyatheaceae (Lucansky, 1974b, 1976b, 1977), but they do not occur in either *Metaxya* or *Lophosoria*.

In both *Metaxya* and *Lophosoria*, adventitious buds arise from the rhizome (stem) and occur on the abaxial surfaces of the leaf bases (*Figs. 1* and *2*). Anatomically these reproductive structures are similar to the stem in each genus, although some differences are noted. The outer boundary of the buds in both genera is a thick-walled epidermis bearing multicellular trichomes. Beneath the epidermis in *Metaxya* is a hypodermis composed of sclerified parenchyma cells (*Fig. 16*), whereas the hypodermal layer in *Lophosoria* is composed of one (thin-walled or sclerified parenchyma) or two (thin-walled and sclerified parenchyma) layers. The cortex of *Metaxya* consists of thick-walled parenchyma cells filled with tannins, whereas the cortical region in *Lophosoria* is composed of thin-walled parenchyma cells. Mucilage-sac cells are randomly distributed singly or in groups of 2–10 in the hypodermal and cortical regions of *Lophosoria*, but no such idioblasts are found in these tissues in the buds of *Metaxya*. The stelar pattern in the buds of both genera is an amphiphloic siphonostele with no leaf gaps (*Fig. 16*). The stele is delimited on either side by distinct endodermal layers filled with tanniniferous substances. Cellular composition and arrangement of tissues of the bud stele are similar to those of the stem stele. The pith region of a bud in *Metaxya* consists of either thick- or thin-walled parenchyma cells filled with tannins and starch grains. In *Lophosoria*, the pith consists primarily of thin-walled parenchyma cells, although the central and peripheral zones of this tissue may become sclerified in older buds. Large mucilage-sac cells are also present in the pith of older buds of *Lophosoria*.

Transections of the adventitious roots of both genera show similar anatomical features (*Fig. 17*). The epidermis is typically sloughed off in mature roots, and the outer cortex, composed of thick-walled parenchyma cells, forms the outer boundary of the root. The inner cortex is composed of isodiametric sclerenchymatous fibers and forms the bulk of the cortical zone (*Fig. 17*). A two-zoned cortex is also characteristic of the squamate genera (Lucansky, 1976b, 1977), although other workers found the position of these cell layers reversed in certain species (Schütze, 1906; Sen, 1968). A distinct endodermal layer composed of cells filled with tanniniferous substances delimits the stele. A pericycle (1–2 cells thick) composed of large, thin-walled parenchyma cells filled with tannins surrounds the vascular tissue. The primary phloem consists of sieve cells and phloem parenchyma, whereas the primary xylem is composed primarily of scalariform-pitted metaxylem, with some transitional reticulate-to-scalariform and spiral protoxylem noted. The xylem is typically diarch with exarch maturation (*Fig. 17*), although triarch and tetrarch xylem occasionally occur in larger roots of both species.

A single, undivided leaf trace departs from the stem axis in orderly fashion in *Metaxya*, whereas a three-parted trace separates from the stem stele in *Lophosoria* (Lucansky, 1974a). Although Bower (1912) found the leaf trace of *Lophosoria* to be an undivided, single strand that only became divided in larger leaves, the leaf trace is typically three-parted in both small and large leaves.

The petiole strand in *Metaxya* is an undivided, corrugated, horseshoe-shaped structure with distinct lateral folds and inflexed ends, whereas in *Lophosoria* the petiole strand is a three-parted structure consisting of an abaxial arc and an adaxial arc composed of two series (Lucansky, 1974a). The horseshoe-shaped configuration of the petiole strands of both genera show an affinity with both the cyatheoid (Ogura, 1927, 1938; Lucansky & White, 1974) and dicksonioid (Bower, 1913; Holttum & Sen, 1961; Sen, 1968) tree ferns, although the division of the petiole strand of *Lophosoria* anticipates the greater dissection of the strand in the more advanced genera of the Cyatheaceae (Lucansky & White, 1974).

The petiole bases of *Metaxya* and *Lophosoria* are anatomically similar (*Fig. 18*). A single-layered, thick-walled epidermis is persistent in the mature leaves, whereas this epidermal layer is sloughed off in certain squamate genera (Lucansky, 1976b). Beneath the epidermis is a hypodermis composed of sclerified, thick-walled parenchyma cells. In *Lophosoria*, mucilage-sac cells in groups of 2–6 are randomly distributed in this tissue, whereas no such idioblasts are found in the hypodermis of *Metaxya*. The bulk of the petiole in both genera is ground tissue composed of thin-walled parenchyma cells filled with tanniferous substances, although thick-walled parenchyma cells may occur in both genera. Mucilage-sac cells are scattered in this tissue in *Lophosoria* (*Fig. 18*), but are lacking in the ground tissue of

*Metaxya*. Numerous small, intercellular spaces also occur in the ground tissue of both genera. In certain squamate genera, parenchyma cells with tannins or mucilage comprise the ground tissue (Lucansky, 1976b, 1977). The vascular tissue of the petiole in both *M. rostrata* and *L. quadripinnata* is delimited by a distinct endodermis filled with tannins. Cellular composition and arrangement of each petiole strand is similar to the stem stele, except no tangential cells are found in the primary phloem of a petiole. In both species, transitional parenchyma-to-sclerenchyma cells form a sheath on either side of the petiole strands, with the more extensive sheaths towards the center of the petiole base (*Fig. 18*).

TABLE 1. COMPARATIVE ANATOMICAL AND MORPHOLOGICAL DATA ON *Metaxya*, *Lophosoria* AND THE SQUAMATE GENERA IN THE CYATHEACEAE.

| *Character* | *Metaxya* | *Lophosoria* | *Squamate Genera* |
|---|---|---|---|
| Habit | prostrate rhizome | short, erect stem | arborescent |
| Hypodermis | single zone | two zones | two zones |
| Sclerenchyma tissue in cortex and pith | no | yes | yes |
| Mucilage-sac cells in cortex and pith | no | yes | yes |
| Cubical cells | no | yes | yes |
| Tangential cells | yes | yes | yes |
| Stelar pattern | amphiphloic siphonostele | amphiphloic siphonostele, dictyostele | dicytostele |
| Stelar sheath | no | yes | yes |
| Accessory bundles | no | no | yes |
| Petiole strand | undivided, horseshoe-shaped | divided, horseshoe-shaped | divided, horseshoe-shaped |

Previous anatomical and morphological data indicate that *Metaxya* and *Lophosoria* are distinctive and primitive genera, and, in some respects, show an affinity with the dicksonioid tree ferns (Lucansky, 1974a). Gastony and Tryon (1976) also found the spore morphology of these two genera to be distinctive. Gastony (1981, 1982) later reported that the spore morphology of *Metaxya* and *Lophosoria* is similar to certain genera in the Dicksoniaceae, and on the basis of palynological characters. Although similarities exist between *Metaxya* and *Lophosoria*, any relationship between them remains unclear. The present study indicates that significant differences do occur in these two monotypic genera (*Table 1*), and their affinity with the cyatheoid tree ferns is questionable. Based upon anatomical data, *Lophosoria* is more closely related than *Metaxya* to the squamate genera in the Cyatheaceae, although some similarities to the Dicksoniaceae are noted. A chromosome number $n=65$ (Walker, 1966) for the genus also shows a relationship to both the cyatheoid and dicksonioid tree ferns. *Metaxya*, on the other hand, it quite distinctive from both *Lophosoria* and the cyatheoid tree ferns and may be better placed in another family or its own family. A chromosome number of $n=96$ in *Metaxya* (Roy & Holttum, 1965) also supports its isolated position and the segregation of this genus from the family Cyatheaceae.

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## ALOYSIO SEHNEM (1912—1981)

Aloysio Sehnem was born in Sítio, near Vila Progresso, Brazil, on 24 November 1912, the second son of João Sehnem and Rosa Jungblut. His primary schooling was in Vila Progresso. From 1925 to 1930 he studied at a provincial seminary in São Leopoldo. He joined the Jesuit order as a novice in 1930 and continued his studies in classical languages and philosophy. In 1940 he became a teacher at the Colégio Catarinense de Florianópolis, taught courses in Portuguese and in English, and began his theological studies. He was ordained in 1943, and became a lecturer at the Colégio Santo Inácio de Salvador do Sul, where he rose to the post of Rector (1954–57). Following this, he was a member of the Faculty of Philosophy, Sciences, and Letters at Cristo Rei, which became the Universidade do Vale do Rio dos Sinos (Unisinos), where he taught graduate courses in botany. He was awarded the degree of Livre Docência in November 1974; his thesis was "The ferns of southern Brazil: their ecology, geographical distribution, and routes of migration."

Padre Sehnem's interest in mosses and ferns dated from 1935. During his studies of philosophy and theology, he often collected plants with his colleague Padre Balduino Rambo. His specimens in early years were deposited in the herbarium ASSL at São Leopoldo. Later Padre Sehnem did much to develop the Herbarium Anchieta (PACA), which was founded by Padre Rambo at Porto Alegre but eventually was moved to São Leopoldo. This herbarium concentrates on the fungi and higher plants of southern Brazil, especially of Edo.Rio Grande do Sul. In addition to his work on ferns, which culminated in his publishing almost all the pteridophyte fascicles in Padre Raulino Reitz's "Flora Ilustrada Catarinense," Padre Sehnem was interested in growing prize-winning orchids, and he promoted a number of amateur orchid study groups in southern Brazil.

Padre Sehnem died on 19 March 1981; with his death Brazilian pteridology has suffered a great loss.—*From material provided through the kindness of Dr. Raulino Reitz.*

## SHORTER NOTES

**AN ALTERNATIVE SIMPLIFIED MEDIUM FOR GROWING PROTHALLIA.**—It has been brought to my attention that the company which was the source of the nutrient plant tablets specified in my article on nutrient media (Amer. Fern J. 69:122. 1979) is no longer in business. A greenhouse and garden supply store has provided a suitable substitute. Seven drops per liter of agar of "Schultz-Instant Liquid Plant Food" provides a suitable nutrient medium. The wholesale source is the A. Y. Schultz Company, St. Louis, MO 63043. If this specific nutrient is not available, any commercial liquid plant food would be suitable, using the concentration specified by the manufacturer.—*Norman P. Marengo, Department of Biology, C. W. Post College, Long Island University, Greenvale, NY 11548.*

**POLYSTICHUM MUNITUM ON BARANOF ISLAND, SOUTHEASTERN ALASKA.**—During August of 1981, while conducting plant surveys from the M/V SITKA RANGER, I found Western Sword-fern (*Polystichum munitum* (Kaulf.) Presl) at two localities on southeastern Baranof Island. These are the first reports of *P. munitum* from this island and extend the plant's range westward about 18 km.

The first site was on the steep north shore of Port Walter at the western end of the narrows 5 km from the fjord's entrance (56°23′N, 134°41′W) at an elevation of about 10 m. The plants (*Muller 4630*) were common on the western edge of an old rock-slide in a well drained, wet area carpeted by mosses, with herbaceous vegetation and an open canopy of deciduous shrubs. I also collected *P. munitum* 10 km to the south of Port Walter, in Port Armstrong (*Muller 4623, 4625, 4626*), where it grew on the north shore around the ruins of an abandoned whaling station (56°18′N, 134°40′W). The plants were abundant on rocky, sloping, upper beach meadows and in the adjacent forest of *Picea sitchensis* (Bong.) Carr. and *Tsuga heterophylla* (Raf.) Sarg. It is surprising that the fern has not previously been collected here, since the whaling station once was a significant settlement and port.

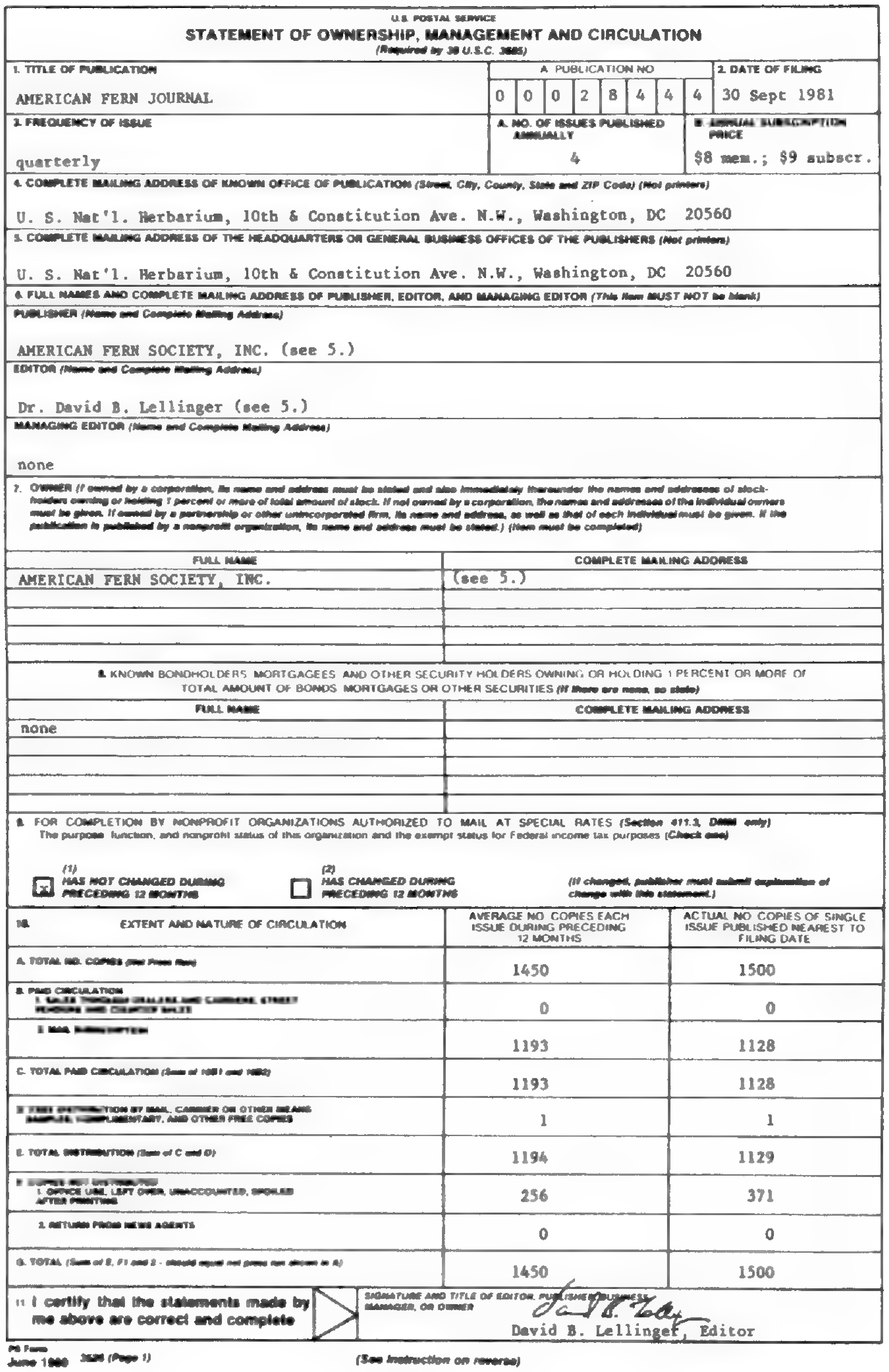
Additional colonies of *P. munitum* undoubtedly will be found further north and west as Baranof Island is more fully explored. The plant is known to occur across Chatham Strait on Kuiu Island, and its range extends down the Pacific Coast to Idaho, Montana and California.

Voucher specimens are at the U.S.D.A. Forest Service herbarium, Sitka, Alaska (TNFS), the University of Washington herbarium, Seattle (WTU), and the herbarium at the University of Alaska Museum, Fairbanks (ALA).—*Mary Clay Muller, Chatham Area, Tongass National Forest, P.O. Box 1980, Sitka, AK 99835.*

**CHEILANTHES LANOSA AND CYSTOPTERIS PROTRUSA IN FLORIDA.** —Recently, Dr. Evans reported (Amer. Fern J. 65:1–2. 1975) a specimen of *Cheilanthes lanosa* (Michx.) D. C. Eaton, presently in the FLAS herbarium, from Florida. This was the first report of this fern in the state. During a brief visit to the Missouri Botanical Garden, St. Louis in January, 1981, we located a second Florida specimen of *C. lanosa*. The MO specimen was collected almost one hundred years earlier than the FLAS specimen, but was correctly identified. The herbarium sheet consists of four fronds without rhizomes. The label reads "*Cheilanthes lanosa*, det. JMG, Jan. 29, 1919, *F. Rugel*, 1842–1849, Florida, Ex Herbario Musei Britannici." Although the locality in Florida is not given on the label, we think that this second record should not go unnoticed and that it further substantiates the existence of *C. lanosa* in Florida, at least in an earlier period. There should also be no doubt that this fern was collected in Florida, as Dr. Rugel is known to have collected plants in Florida during the 1840's (Bull. Torrey Bot. Club 6:311–312. 1879).

In addition to the above specimen at MO, we also found a sheet of *Cystopteris protrusa* (Weath.) Blasdell consisting of one frond without rhizome, labeled "*Cystopteris fragilis*, Chipley, Florida, Aug. 1896, *E. Pleas*, From the Sadie F. Price Herbarium, Bought 1904." Although the characteristic horizontal, creeping rhizome was absent, there was no difficulty in recognizing this species by its petiolulate basal pinnae and stramineous stipe. A search of pertinent Florida fern literature published by D. S. Correll (Amer. Fern J. 28:11–16, 46–54, 91–100, 1938), J. K. Small (Ferns of Florida, 1931), O. Lakela and R. W. Long (Ferns of Florida, 1976), and R. F. Blasdell (A Monograph of the Fern Genus *Cystopteris*, Mem. Torrey Bot. Club 21(4):1–102. 1963) did not indicate the presence of any *Cystopteris* in Florida. To the best of our knowledge, the present paper represents the first report of this genus attributed to Florida.

The area about Chipley, Florida (Washington County) is characterized by limestone outcrops and springs. It is not unusual that *C. protrusa* could have been found amongst the more shaded, damp outcrops, although it usually does prefer more circumneutral situations, such as rich humus. Certainly, this area would provide a habitat suitable to *C. protrusa*. The site in Washington County, Florida represents a range extension of approximately 280 miles south from its closest known site in Walker County, Georgia, according to R. McVaugh and J. H. Pyron (Ferns of Georgia, 1951) and approximately 230 miles south of its closest known sites in Tuscaloosa and Jefferson Counties, Alabama (B. E. Dean, 1969, Ferns of Alabama) .—*Aleta Jo Petrik-Ott* and *Franklyn D. Ott, Department of Biology, Memphis State University, Memphis, TN 38152.*



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# The Chromosomes of Lycopodium lucidulum

JOSEPH M. BEITEL* and FLORENCE S. WAGNER*

The Shining Fir-moss, *Lycopodium lucidulum* Michx. *(Huperzia lucidula* (Michx.) Trevisan), is an eastern North American endemic which forms colonies in moist coniferous and deciduous woods as well as swamps. The upright, isodichotomous stems root along their length as they become decumbent with age. The evergreen leaves, which are broadest above the middle, have stomates only on the undersides, and are usually coarsely serrate. They are produced in zones of longer and shorter leaves roughly corresponding to sterile and fertile leaves. Kidney-shaped sporangia are produced adaxially on the leaf base, and propagation organs (gemmae) develop at the end of each year's growth. In areas of overlap between *L. lucidulum* and the related northern species *L. selago* L. *(Huperzia selago* (L.) Bernh. ex Schrank & Mart.), intermediate sterile hybrids are occasionally found with either or both parents. These hybrids can be distinguished from *L. lucidulum* by their abortive spores and the presence of stomates on both surfaces of the leaves.

The chromosome number of *Lycopodium lucidulum* Michx. has been reported several times from North America and India. The counts from India (Mehra & Verma, 1957; Ninan, 1958) based on *Lycopodium lucidulum sensu* Clark (1880), however, are actually from a distinct species, *Lycopodium herterianum* Kümmerle (*Huperzia herteriana* (Kümm.) Sen & Sen, *L. sikkimense* Herter 1909 *non* K. Muell. 1861), and not the nearctic *Lycopodium lucidulum* Michx. Löve and Löve (1958) first reported $2n = 264$ for *Lycopodium lucidulum* from Quebec, but without an accompanying photograph, a drawing, locality data, or a voucher specimen citation. Later (1965), they reported chromosome counts from Mt. Washington, New Hampshire (without citation of voucher) of *Lycopodium lucidulum* and *L. selago* (which they made into subspecies of *Huperzia selago*) remarking ". . . it has been at last possible to make exact counts of the chromosomes of material of ssp. *selago* with appressed and patent leaves from Mt. Washington and also ssp. *lucidula* from lower levels of that mountain. The chromosome number arrived at is $2n = 272$."

The first indication that a lower ploidal level existed in *L. lucidulum* came from fertile material collected in Minnesota (Clearwater Co., Twin Lakes, 16 June 1977, *Wagner 77303*, MICH) and examined by F. S. Wagner. It appeared to have either 66, 67, or 68 pairs of chromosomes at meiosis, but the exact number of pairs could not be determined. A similar low count was obtained by J. M. Beitel in fertile material from Michigan (Livingston Co., Schwark Woods, W side of Merrill Road just S of Sheldon Road; T1N, R5E, SW sec. 35, 20 June 1979, *Beitel 79041*, MICH), which yielded approximately 66–69 pairs at meiosis. Material of *L. lucidulum* was collected in an acidic conifer swamp in Gray Co., Ontario (Osprey Township, 0.8 miles W of Rt. 24 on the S side of road dividing Concession 2 and 3) on 25 July 1981 by J. Beitel, W. H. Wagner and F. S. Wagner (*Beitel 81024*, MICH). The possibility of confusion with *L. selago* or its hybrids was ruled out by the presence of well formed spores and the lack of stomates on the adaxial leaf

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*Division of Biological Sciences, University of Michigan, Ann Arbor, MI 48109.

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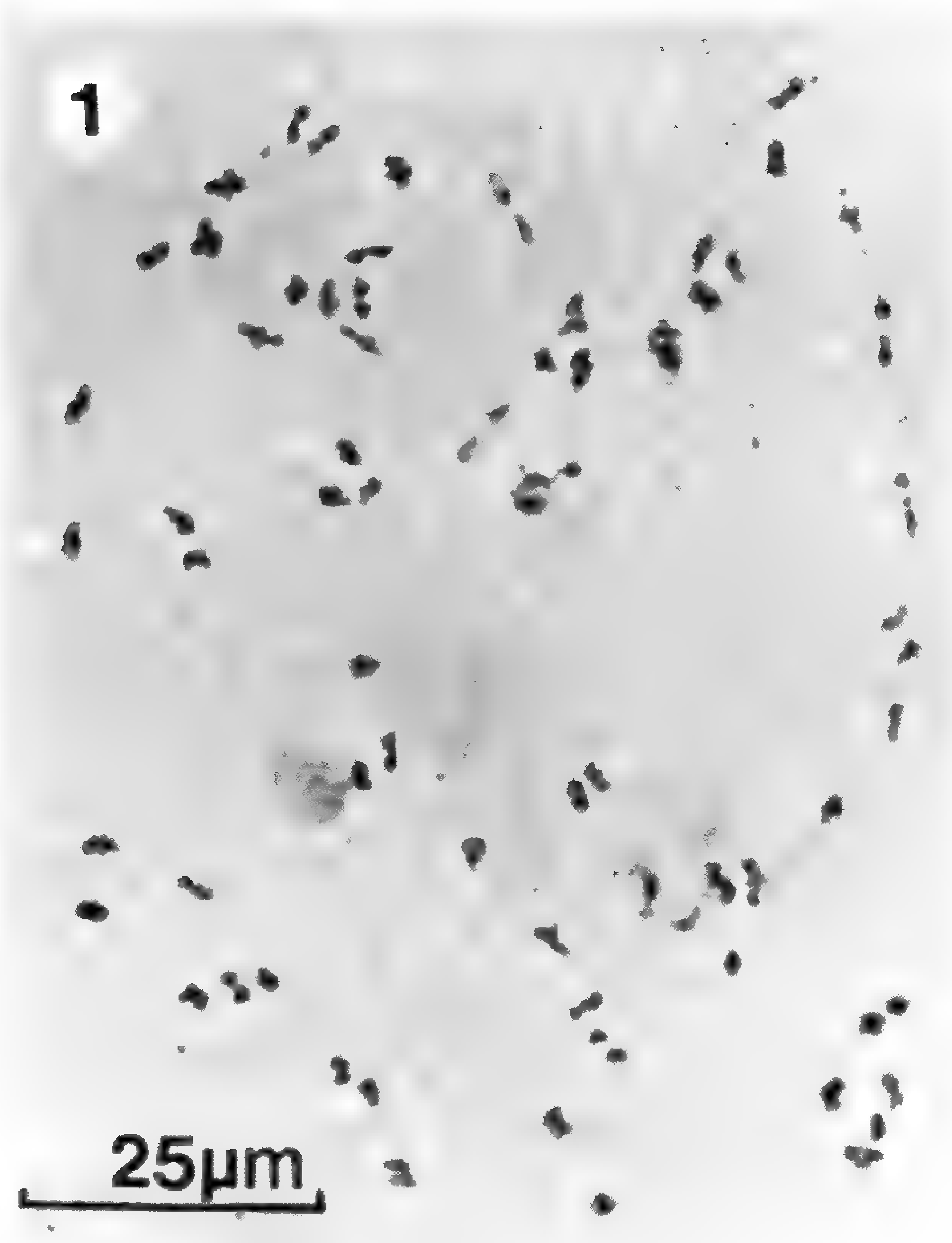

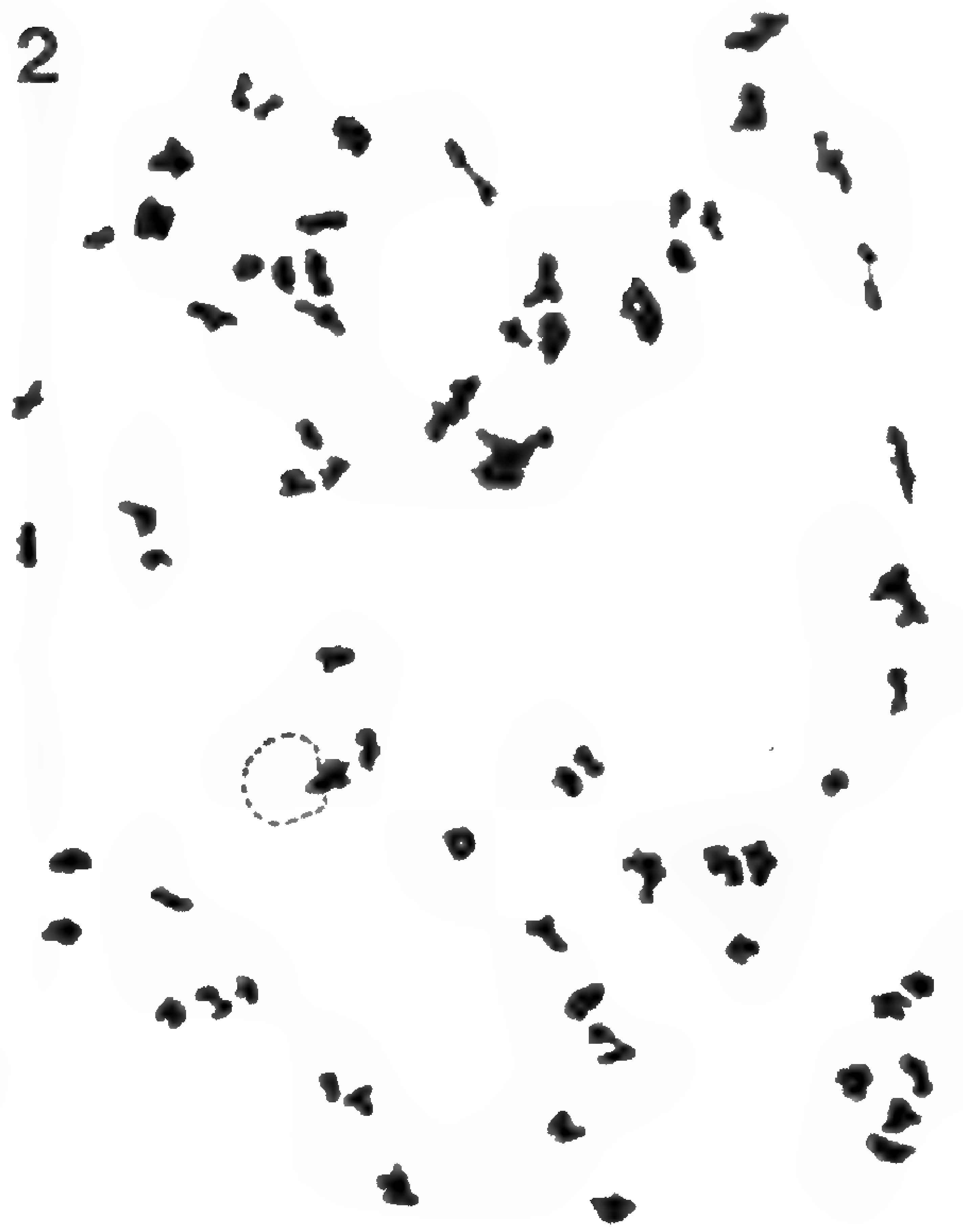

FIG. 1. Photograph of meiotic chromosomes of *Lycopodium lucidulum* Michx. (*Beitel 81024*), $n = 67$.
FIG. 2. Interpretation of chromosome figure (dotted circle = nucleolus).

surfaces. The material was kept in a coldroom for two days, then submerged in distilled water in a clear plastic box kept at room temperature in the light for three days. Shoot tips bearing young, developing sporangia were placed in a saturated aqueous solution of para-dichlorobenzene and refrigerated at ca. 4°C for 24 hours. This use of a PDB treatment for condensing the meiotic chromosomes prior to fixation by Mehra and Verma (1957), Wilce (1965) and F. Wagner (1980) has reduced some of the problems involved in obtaining interpretable squashes. Excess water was blotted from the tips which were then placed in Newcomer's solution (Newcomer & Brant, 1954), left at room temperature for two hours, and placed in the freezer. Acetocarmine was used as a stain and squashing medium, Hoyer's solution was used for permanent mounting, and the slides were ringed with Eukitt plastic mounting medium.

Diakinesis was found to be the best stage for counting as the Metaphase I chromosomes, although darkly stained and well outlined, have the unfortunate tendency to clump. During diakinesis it was possible to discern the homologous chromosomes of each pair. Those undergoing early disjunction were coupled by a thin chromatin strand (as reported by Wilce, 1965). *Figures 1* and *2* clearly show a complement of $n = 67$. Two large chromosome pairs were visible in all the figures examined. They can be seen slightly above the center of the photograph; the lower pair has a characteristic satellite. The nucleolus is seen slightly below and to the left of center. In over fifty figures observed and drawn, none exhibited a higher ploidal level than this figure.

The count of $n=67$ represents a new chromosome number for *Lycopodium lucidulum* and a new base number for the *L. selago* group of the segregate genus *Huperzia*. It is almost one-half the numbers previously reported from North America ($2n=264$, 272), but without voucher specimens or photographs of the chromosomes those records cannot be confirmed as to taxon or interpretation of the figures obtained. The previous low number of $n=$ ca. 68 reported by Löve and Löve (1961) for *Huperzia selago* ssp. *appressa* was discounted by them (1965) as ". . . most likely counted on an admixture of roots of a species of *Lycopodium* s. str. . . ."

The base number of $n=67$ fits into the gametophytic denominator scheme of Wagner and Wagner (1980) for *Lycopodium s. l.* based on multiples of 11 plus one aneuploid addition. Thus, $n=78$ of *Lycopodiella* equals $(7\times11)+1$, $n=34$ of *Lycopodium s. s.* equals $(3\times11)+1$, and $n=23$ of *Diphasiastrum* equals $(2\times11)+1$. This, however, does not explain the numbers reported for *L. cernuum* and the various epiphytic species (Löve, Löve & Pichi-Sermolli, 1977), nor for *L. carolinianum* (Bruce, 1976). The field of chromosome numbers in *Lycopodium s. l.* remains an open one with many species yet to be counted and many existing counts in need of confirmation.

We would like to thank W. H. Wagner, Jr. for his invaluable assistance in the field and lab, and D. M. Johnson, K. S. Walter, N. A. Murray and W. W. Thomas for reading and commenting on the manuscript.

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# Axenic Culture and Induction of Callus and Sporophytes of the Appalachian Vittaria Gametophyte

JAMES D. CAPONETTI,* MARK WHITTEN,**
and MICHAEL J. BECK***

Asexually-reproducing gametophytes of the four tropical fern genera *Hymenophyllum, Trichomanes, Grammitis,* and *Vittaria* occur in the uplands of the southeastern United States (Farrar, 1967). The most common and abundant of these is the Appalachian *Vittaria* gametophyte, which Farrar (1978) has described in detail. Dr. A. J. Sharp of the University of Tennessee was the first to find and collect the Appalachian *Vittaria* gametophyte in the area of the Mountain Lake Biological Station in Virginia. Since that time, Dr. W. H. Wagner, Jr. of the University of Michigan collected it in the same area and catalogued it into a pteridophyte flora (Wagner, 1963). Other pteridologists have collected it in the area of the Highlands Biological Station in North Carolina (Wagner et al., 1970; Pittillo et al., 1975) and in Tennessee (Wofford & Evans, 1979). Other collections have located these gametophytes in several eastern states in and around the southern Appalachians (Farrar, 1978; Gastony, 1977).

Appalachian *Vittaria* gametophytes are long-lived and produce extensive colonies in deep, protected crevices of non-calcareous rock. Although antheridia and archegonia are produced on the gametophytes, reduced, juvenile sporophytes have been found only once in the field by Farrar (1978). They were recognizable as *Vittaria*, but lacked sufficient characters for identification to species. Since most taxonomic characters for determining fern species are based on sporophyte morphology, the origin and affinities of these gametophytes are uncertain. They were first assigned to the genus *Vittaria* by Wagner and Sharp (1963) based on finding similar morphological characters between the gametophytes of the Appalachian *Vittaria* and those of *Vittaria lineata* (L.) J. E. Smith from Florida. The chromosome counts reported by Gastony (1977) have provided further evidence of their relationship.

The experimental production of sporophytes might provide additional taxonomic characters for comparison with the *Vittaria* species. Farrar (1978) reported that Appalachian *Vittaria* gametophytes were difficult to maintain in axenic culture and ceased to grow on defined media. We report here successful axenic culture of the Appalachian *Vittaria* gametophyte and the spontaneous formation of callus and sporophytes.

## MATERIALS AND METHODS

Gametophytes were collected from shaded, moist, sandstone conglomerate ledges along a cliff in Conkles Hollow State Park, Hocking County, Ohio. They were maintained under non-sterile conditions in culture dishes on washed perlite moist-

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ened with quarter-strength Knudson's medium (Steeves et al., 1955) without sugar. The dishes were maintained in a culture room at 25°C under a table where they received 25 foot-candles of diffuse white light consisting of a combination of fluorescent and incandescent lamps on an 18/6 hour light-dark photoperiod. Distilled water was added to the dishes as required. When the growing gametophytes half filled the dishes, fresh subcultures were initiated from small masses of gametophytes in freshly prepared culture dishes. At the moment, non-sterile cultures are being maintained in this manner.

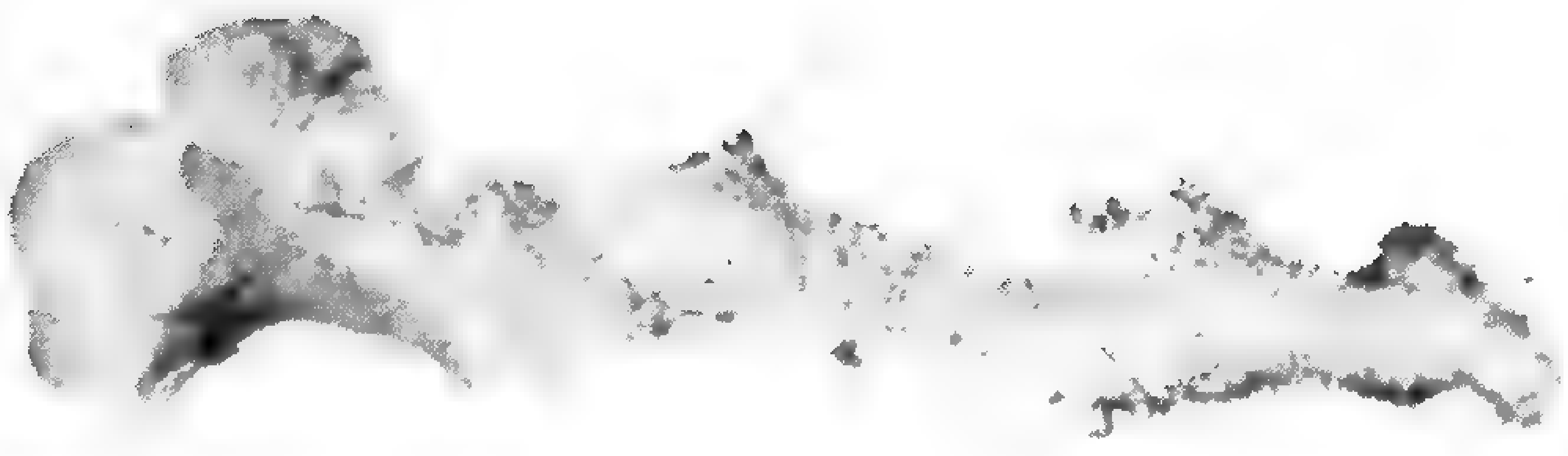
Aseptic gametophyte cultures were obtained by placing a number of small gametophyte pieces into a 25 × 150 mm screw cap culture tube. About 25 ml of a 1% Alconox solution was added to wash and wet the gametophyte pieces, and the tube was agitated for two minutes. The Alconox solution was decanted, 35 ml of a 10% (V/V) Clorox solution was added, and the tube was agitated gently for one minute. In a UV-sterilized room, the gametophyte pieces were transferred from the Clorox solution to a 100 × 15 mm sterile, plastic Petri dish containing 30 ml of sterile, double-distilled water. Under continued sterile conditions, the gametophyte pieces were then transferred to 25 × 150 mm culture tubes which were plugged with cotton and a plastic cap (Kaput). Each tube contained 20 ml of Knudson's medium (Steeves et al., 1955) supplemented with 2% sucrose. One gametophyte piece was placed in each tube, with some in liquid media and others on media solidified with 0.8% agar. Some gametophyte pieces in liquid media were placed on filter paper supports above the medium. In an attempt to induce apogamy, gametophyte pieces were also cultured on media containing 0 to 4% sucrose in a series of cultures.

Aseptic gametophyte cultures can also be obtained from non-sterile stock cultures heavily contaminated with bacterial and fungal spores by forcing such spores to germinate before surface sterilization. Gametophyte pieces were floated on non-sterile, half strength Knudson's medium without sucrose and agar for one day. The gametophyte pieces were then surface-sterilized and placed into culture as described previously.

## RESULTS AND DISCUSSION

Gametophytes in non-sterile cultures grew slowly in a concentric pattern. They produced gemmae, but did not produce either antheridia or archegonia.

Gametophytes in sterile culture showed signs of growth within two weeks of culture initiation, and slowly formed a near-spherical mass of ribbon-like prothallial lobes in each tube, whether in liquid or on agar-solidified media, over a period of several months. Based on visual inspection, it appeared that the gametophytes developed more rapidly on media containing 2% sucrose. Gametophytes on media containing sucrose concentrations above and below 2% developed at a reduced growth rate and appeared to be thinner and smaller than those exposed to 2% sucrose. Over a period of seven months, no gemmae or sex organs were observed in any cultures. Although the prothalli appeared normal in overall size and shape on media containing 2% sucrose, they produced an abundance of short, knob-like rhizoids (*Fig. 1*) in addition to the more normal, elongated rhizoids.



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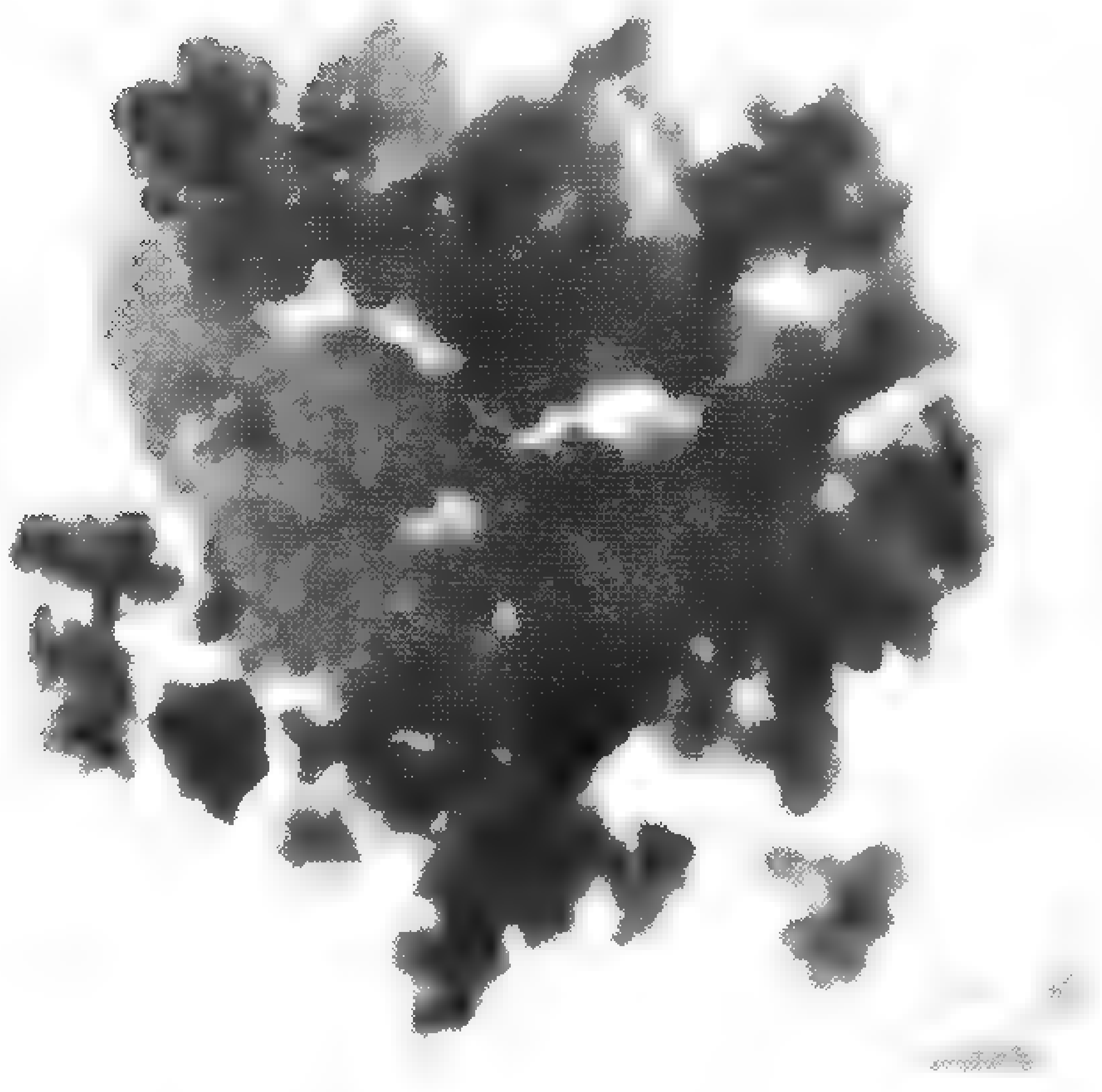

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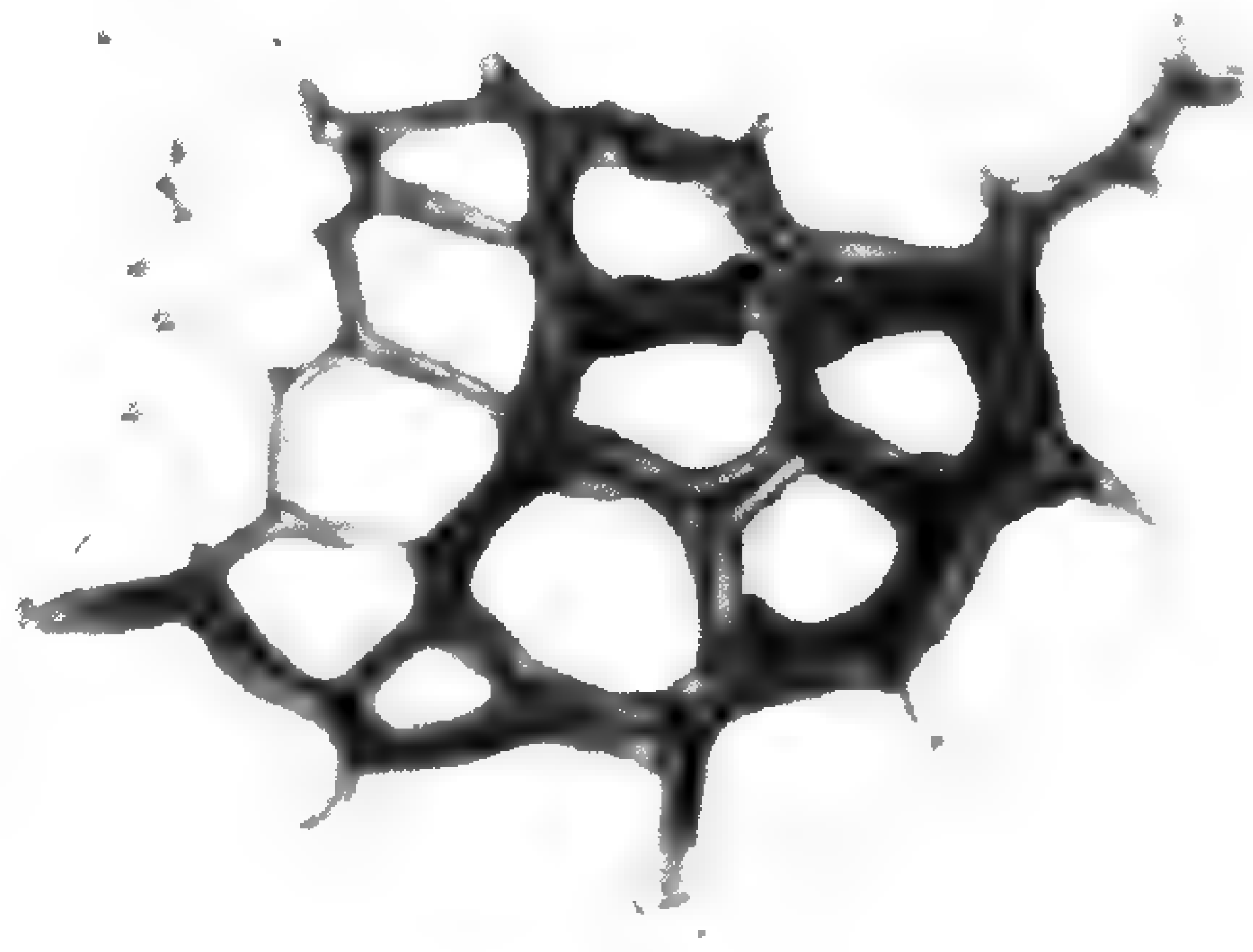

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FIG. 1. Appalachian *Vittaria* gametophyte from sterile culture, ×6.5. FIG. 2. Callus produced by gametophyte, ×1.3. FIG. 3. Enlarged view of rhizome showing clathrate scales, ×26. FIG. 4. Appalachian *Vittaria* sporophyte from sterile culture, ×5.2. FIGS. 5 and 6. Enlarged view of clathrate scales, ×260.

Spontaneous callus formation was observed in the cultures kept by one of us (Whitten) in three out of nine tubes maintained for seven months on media containing 2% sucrose without transfer to fresh media. The callus (*Fig. 2*) formed a friable mass varying in color from yellow to dark brown, and appeared to originate from the center of the near-spherical mass of gametophytes. Adjacent to the callus tissue toward the center of the prothallial mass, occasional aberrant gametophytes with enlarged, irregular cells occurred. A total of six sporophytes were produced in two of the three callus-containing cultures after about nine months. The sporophytes arose from the edge or center of a mass of callus tissue, and did not appear to be associated with normal gametophyte tissue. The largest sporophyte had produced fronds up to 7 mm in length when all cultures died during an air conditioning failure in the laboratory.

Before death, the young sporophytes (*Figs. 3* and *4*) had produced a distinct rhizome which bore clathrate scales (*Figs. 5* and *6*), which are typical of the genus *Vittaria*. No roots were observed. The fronds were linear or unequally dichotomously branched, and each contained a distinct vascular bundle.

Since the sporophytes appeared to arise from callus tissue and no sex organs were observed, it is presumed that they arose apogamously. Further work on living material is needed to determine their exact origin and ploidy. The production of presumably apogamous sporophytes on Appalachian *Vittaria* gametophytes has been noted in both natural populations (Farrar, 1978) and in material cultured under non-sterile conditions by Alma S. Stokey, as cited by Farrar (1978). In both instances, the sporophytes aborted after producing a few small fronds. The sporophytes in our cultures were also small, but appeared healthy until their untimely death. In all instances, the sporophytes were too immature to provide taxonomic data useful at the species level. Attempts to obtain viable, mature sporophytes are in progress. The appearance of sporophytes in our old, crowded, and tightly closed cultures suggests that ethylene may play a role in callus formation and apogamy. Ethylene is produced by a wide range of plants and causes many different responses (Burg, 1962). Moreover, Elmor and Whittier (1973) have demonstrated that ethylene can induce apogamy in gametophytes of *Pteridium aquilinum* (L.) Kuhn. They further demonstrated this effect in nine of its strains (Elmore & Whittier, 1975). Future experiments involving ethylene are needed not only on Appalachian *Vittaria* gametophytes but also on other gametophytes of the southern Appalachians in the genera *Hymenophyllum*, *Trichomones*, and *Grammitis* (Farrar, 1967).

We thank Mr. Kenneth McFarland for the gametophyte collections and Dr. A. Murray Evans for reading the manuscript and offering suggestions.

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## REVIEW

**"THE FERN GENUS DAVALLIA IN CULTIVATION [DAVALLIACEAE]," "DAVALLIA RELATIVES IN CULTIVATION: ARAIOSTEGIA, DAVALLODES, HUMATA, AND SCYPHULARIA [DAVALLIACEAE],"** and **"THE GENUS PYRROSIA IN CULTIVATION [POLYPODIACEAE],"** by Barbara Joe Hoshizaki, Baileya 21:1–42, 43–50, and 53–76. 1981.—These papers continue the author's long series of useful treatments of cultivated ferns. Each paper contains an introduction, key to the species, and a brief synonymy and notes on the morphology, distribution, and cultivation of each species and its cultivars. The cultivars, although not included in the key, are distinguished in the text and, like the wild species, are illustrated with silhouettes. Anyone needing to identify cultivated Davalliaceae and *Pyrrosia* will find these papers invaluable.—*D.B.L.*

# Cystopteris × illinoensis: a New Natural Hybrid Fern

ROBBIN C. MORAN*

*Cystopteris* is a relatively small, cosmopolitan genus of ferns comprised of about ten species and several hybrids. In eastern North America, the genus as currently interpreted consists of six taxa, two of which are known to be of hybrid origin (Blasdell, 1963). The hybrids are *C. tennesseensis (C. bulbifera × protrusa)* and *C. laurentiana (C. bulbifera × fragilis* var. *fragilis)*. Both are fertile allopolyploids which reproduce themselves sexually throughout their respective ranges. This paper concerns a new *Cystopteris* hybrid having aborted spores and sporangia and presents evidence showing that *C. bulbifera* and *C. fragilis* var. *mackayi* are the parents.

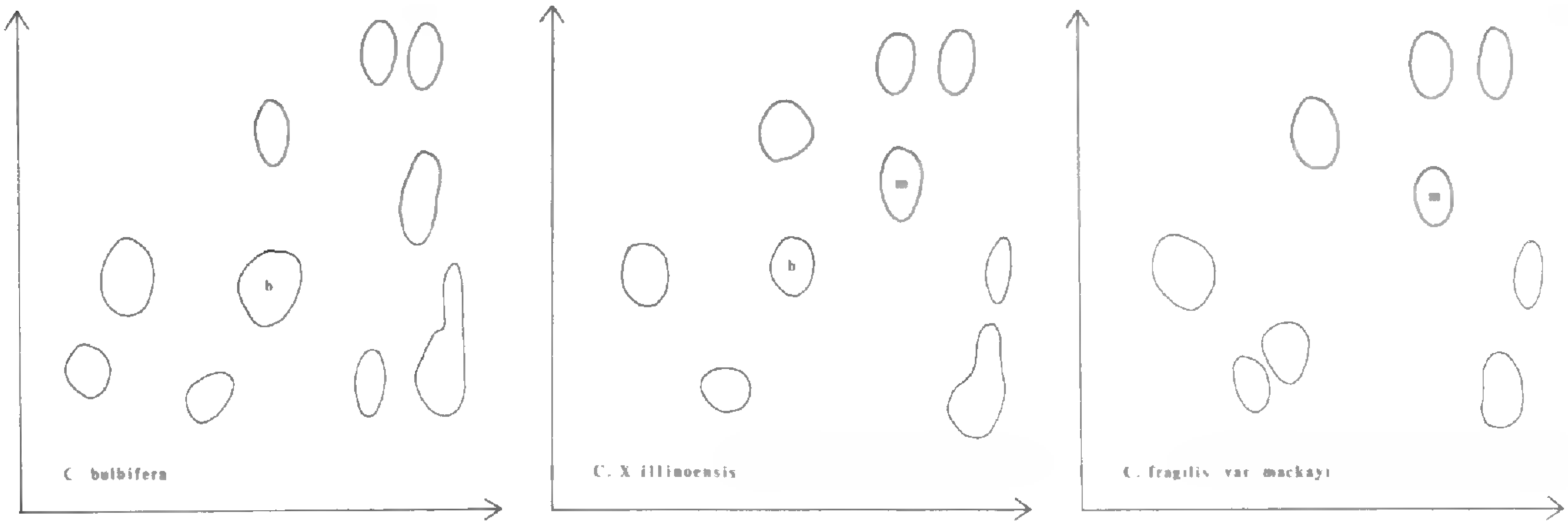

FIG. 1. Comparison of patterns of phenolic compounds separated by two dimensional paper chromatography in *Cystopteris × illinoensis* and its parents.

The writer first came across this unusual new hybrid fern when, as a graduate student at Southern Illinois University/Carbondale, he was asked to verify identifications of a box of fern specimens sent to the herbarium. The specimens were donated ten years earlier by Dr. Ralph C. Benedict, of Rockford, Illinois, who was a fern taxonomist and a long time active member of the American Fern Society. In the box of pressed unmounted specimens was a collection identified by Dr. Benedict as "*C. bulbifera* × *C. fragilis* var. *mackayi*". Location data stated that the hybrid was, "Very rare, found only once in Winnebago County, Ill. Old quarry with colony of var. *mackayi—Cystopteris bulbifera* a few yards away." The exact location of the quarry (almost certainly a dolomite quarry, since this is the only rock type in the area) was not given. However, Dr. Benedict removed the hybrid from the quarry and cultivated it in his garden in Rockford. The material sent to the Southern Illinois University herbarium (SIU) consisted of fronds gathered from the hybrid growing in cultivation. Since *C. bulbifera × fragilis* var. *mackayi* represented an undescribed hybrid, the writer decided to study the fern further.

Unfortunately, Dr. Benedict's house in Rockford was demolished years ago. A search of the vacant, weedy lot where the house once stood revealed no evidence of any cultivated ferns. Therefore, the current existence of the hybrid is unknown.

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HOLOTYPE

Cystopteris X illinoensis R.C. Moran

(C. bulbifera X C. fragilis var. mackayi)

WINNEBAGO COUNTY, ILLINOIS
[illegible] location unknown. Collector's [illegible] reads: "Sterile, very rare, [illegible] once in Winnebago County - [illegible] with colony of var. [illegible] - Cystopteris bulbifera a few [illegible]. I removed plant, now have [illegible] it. A very beautiful large [illegible] hybrid." These fronds [illegible] Mr. [illegible]'s cultivated [illegible]

[illegible] Benedict (s.n.) [illegible] 1960's)

FIG. 2. Photograph of the holotype of *Cystopteris* × *illinoensis*.

Morphological evidence indicates that the hybrid is intermediate between *C. bulbifera* and *C. fragilis* var. *mackayi*. The small, scaly bulblets, typical of other taxa of hybrid origin involving *C. bulbifera*, were found with the specimen material, but not attached to the fronds. Examination of the spores showed them to be aborted; in addition, many sporangia were also aborted. No known *Cystopteris* hybrid in eastern North America has aborted spores. Presumably this plant represents a sterile triploid hybrid, since *C. bulbifera* is a diploid and *C. fragilis* var. *mackayi* is a tetraploid (Blasdell, 1963). The large size of the fronds also suggests a triploid condition, for many triploid hybrid ferns are large in comparison to their parents (W. H. Wagner, pers. comm., 1980). The fronds have somewhat elongate apices with many pinna pairs and with occasional glandular hairs. These latter characters are typical of *C. bulbifera*. Dr. Benedict indicated on his handwritten label that the plant was, "a very beautiful large black stemmed hybrid." However, the pressed specimens have rich, red-brown, rather than deep black stipes. The dark, sclerotized stipe would appear to be a character acquired from *C. fragilis* var. *mackayi*. Unfortunately, the rhizome was not preserved; however, a short note found with the specimen stated, "Rhizome not creeping." Certainly the circumstantial evidence that the hybrid was growing with *C. bulbifera* and *C. fragilis* var. *mackayi* suggests the likelihood that these are the parents involved.

It was decided to gain further evidence of the plant's hybrid nature by using two-dimensional paper chromatography to study patterns of phenolic compounds. It was hypothesized that the hybrid's chromatogram might be additive with respect to different phenolic compounds observable in the two parental chromatograms. The phenolics were extracted in 80% methyl alcohol and examined by standard methods (Mabry et al., 1970). Plants of *C. bulbifera* and *C. fragilis* var. *mackayi* used in the chromatographic analysis were collected in Winnebago County, Illinois.

The results showed that all observable phenolic compounds present in the chromatogram of hybrid material were also present in one or both chromatograms of the parental material, i.e. the hybrid did not contain any unique compounds that were not present in either parent (*Fig. 1*). Most importantly, the hybrid material contained one phenolic compound present in *C. bulbifera* which was not present in *C. fragilis* var. *mackayi*, and one other phenolic compound present in material of *C. fragilis* var. *mackayi* but absent in material of *C. bulbifera*. Thus, the hybrid's chromatogram is, in large part, additive and supports the hypothesis that *C. fragilis* var. *mackayi* and *C. bulbifera* are the two parent species involved. The following is given as a formal diagnosis:

**Cystopteris × illinoensis R. C. Moran** **Fig. 2.**

Taxon originis hybridae ex *Cystopteride bulbifera* et *C. fragili* var. *mackayi;* parentibus ambobus sporis abortivis et vel bulbilis parvis squamosis statim distinctum. Frondes usque ad 50 cm longi; stipes et rhachis inferna atrorubella-brunnea; lamina morphologiae intermediae inter ambas parentes plerumque latissima basi; planta saxatilis saxis calcareis.

TYPE: Cultivated in the garden of Ralph C. Benedict at Rockford, Illinois, from wild material found once in an old quarry in Winnebago County, Illinois, date uncertain (probably 1960's), *R. C. Benedict* (ILL; isotypes ILLS, SIU).

I would like to thank Drs. P. Mick Richardson and David A. Young for their help with the chromatographic analysis and Drs. Warren H. Wagner, Jr. and James H. Peck for many interesting discussions and encouragement.

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## REVIEW

**"FLORA OF CHIAPAS, PART 2. PTERIDOPHYTES,"** by Alan R. Smith. 370 pp. California Academy of Sciences. 1981. $30.00 + postage.—This is the first pteridophyte Flora of a state of Mexico to be published in twenty years, and the first modern pteridophyte Flora for any of the more tropical Mexican states. The number of pteridophytes is much greater than in the drier states of northern Mexico; Smith treats 46 fern allies in five genera and 563 ferns in 99 genera. The volume begins with an introduction, followed by a key to the genera of ferns; Smith notes that tropical ferns can be keyed more reliably to genus than to family because of the technical characters which must be used to distinguish ferns at the family level. The genera and species are treated alphabetically, rather than in systematic order. The synonymies pertain mostly to species described from Mexico and Central America, and include valuable data concerning types. Many species are handsomely illustrated, and literature references are given to illustrations in other works, which is useful to those who have access to good pteridological libraries. Original descriptions, habitat notes, and phytogeographical notes are included for each taxon. Some specimens, especially those collected by Dennis Breedlove, are cited. The fern-allies are similarly treated following the ferns. An appendix of abbreviations, an addendum, and an index to accepted names and synonyms concludes the volume. Because of the affinities of the Chiapas flora to that of Guatemala, neighboring countries, and to the adjacent Mexican states, Smith's Flora will be useful beyond the boundaries of Chiapas. Everyone concerned with Central American pteridophytes should have a copy of this book. Readers interested in a full discussion of the vegetation of Chiapas are directed to "Flora of Chiapas, Part 1. Introduction to the Flora of Chiapas," by Dennis E. Breedlove, who is the general editor of the entire "Flora of Chiapas," which is projected to appear in many volumes over several years. The California Academy of Sciences is to be congratulated for publishing these well prepared works at an affordable price.—*D. B. L.*

# New Records and Distributional Notes on Maryland Pteridophytes

STEVEN R. HILL* and RICHARD E. RIEFNER, JR.**

During the course of a critical appraisal of the state list of rare and endangered vascular plants of Maryland (Broome et al., 1979), we discovered several interesting range extensions for the pteridophytes. A full treatment of the ferns and fern-allies of Maryland, Delaware, and the District of Columbia was prepared by Reed (1953), who provided dot distribution maps for all of the taxa. These two reports have enabled us to determine gaps in distribution, and our extensive field and herbarium studies have turned up county records for twelve Maryland species. We hope that this information will be of use to those interested in the ferns of the eastern United States in general.

**Lycopodium clavatum L.**—In our experience, the Running Club-moss in Maryland is most frequent in moist areas of the mountains of Garrett County. If is far less frequent in the piedmont and coastal plain regions of the state. This new locality is at the border between the latter two phytogeographic provinces.

**Anne Arundel Co.:** 2.9 mi SW of Odenton post office, floodplain of the Little Patuxent River, 25 Oct 1970, *D. Bystrak s. n.* (MARY).

**Lycopodium tristachyum Pursh**—The infrequent Ground Cedar is historically known from Cecil, Garrett, Prince George's, Wicomico, and Worcester Counties in Maryland (Reed, 1953), but few current localities are known. Our new record is from an old collection, and the current status of the species in the state should be examined.

**Montgomery Co.:** Cropley Falls, 9 Dec 1950, *J. H. Penson s. n.* (MARY).

**Selaginella rupestris (L.) Spring**—The Rock Spike-moss in Maryland is known from Allegany, Baltimore, Frederick, and Montgomery Counties, with a possible site in Garrett County (Reed, 1953). It seems to be locally frequent on the slightly calcareous shale barrens of Allegany and Washington Counties, but is quite infrequent overall in the state. The species is declining in Massachusetts (Coddington & Field, 1978), is vulnerable and declining in New Jersey (Snyder & Vivian, 1981), and has apparently become extinct in Delaware (Tucker et al., 1979). It should probably be considered for inclusion in the Maryland list of threatened and endangered species.

**Washington Co.:** Shale barren ledges, High Germany Road ca. 0.3 mi N of Sideling Hill Creek, 2 May 1981, *S. R. Hill & R. E. Riefner 9931* (MARY, VT); Shale barren at E side of Sideling Hill Creek at Rte. 40, 2 May 1981, *S. R. Hill & R. E. Riefner 9949* (MARY, VT).

**Ophioglossum vulgatum L.**—This new locality for the Adder's-tongue is a western range extension of ca. 50 miles within Maryland. It also seems significant in that most known populations of the species occur on the coastal plain, rather than in the ridge and valley province of the northwestern portion of the state (Reed, 1953).

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**8716 Avondale Rd., Baltimore, MD 21234.

**Washington Co.:** Along Rabble Run, Catholic Church Road near Forsythe, 13 June 1981, *S. R. Hill & R. E. Riefner 10325* (MARY, NY, TAES, VT).

**Osmunda claytoniana L.**—The Interrupted Fern is the least frequent of the three *Osmunda* species in Maryland and is nearly always restricted to the piedmont and mountain regions of the state (Reed, 1953). This new record places the species at the edge of the coastal plain, a region where it is rare.

**Anne Arundel Co.:** 1.1 mi S of Odenton post office, hillside, 7 June 1970, *D. Bystrak s. n.* (MARY).

**Adiantum pedatum L.**—The Northern Maidenhair is frequent in the piedmont and mountain areas of Maryland, but is rare on the coastal plain. If the label data on the St. Mary's County specimens are accurate (the locality is imprecise), this population would be the southernmost known in the state.

**Prince George's Co.:** Vicinity of College Park, 14 July 1949, *W. S. Glidden 22* (MARY); Paint Branch Creek, College Park, Oct 1953, *R. E. Zarza s. n.* (MARY). St. Mary's Co.: Shaded woods near Patuxent River, 21 May 1964, *S. A. Riley s. n.* (MARY).

**Asplenium ruta-muraria var. cryptolepis (Fern.) Wherry**—The American Wall-rue Spleenwort was included on the Maryland list of threatened vascular plants (Broome et al., 1979) and was given undetermined (UNDT) status. We have located ten healthy populations on the calcareous bluffs along the Potomac River from Allegany to Frederick Counties and feel that while it is local, it is not at present endangered in the state. Reed (1953) recorded it from Washington and Frederick Counties only.

**Allegany Co.:** Limestone crevices along Western Maryland Railroad at Pinto, 10 May 1981, *R. E. Riefner 81-78* (MARY).

**Cheilanthes lanosa D. C. Eaton**—The Hairy Lip Fern is occasional on rock outcrops on the piedmont and towards the mountains of western Maryland. The new county record is adjacent to known localities in Baltimore County. The fern has not yet been found in Garrett County, but is to be expected there.

**Howard Co.:** Rock ledges of overlook at Patapsco State Park along Patapsco River near Rte. 40 bridge, 19 Nov 1981, *R. E. Riefner 81-850* (MARY).

**Dryopteris goldiana (Hook.) Gray**—Goldie's Fern has been frequently confused with *Dryopteris celsa* (Palmer) Small in several fern treatments (e.g., Reed, 1953), and these have combined records for the two. Others recognize *D. celsa* as *D. goldiana* subsp. *celsa* Palmer. Studies on the cytology of the species complex involved (Montgomery, 1975; Walker, 1962) demonstrate that the two species are distinct. In addition, *D. celsa* is a coastal plain species, whereas *D. goldiana* is a mountain species. The specimen cited was growing in a rich, moist, beech woodland in the mountains. We have not examined all of the voucher specimens involved in Reed's treatment, but those from Montgomery, Garrett, and Baltimore Counties that we have seen (at US) seem to be *D. goldiana*, although the specimen from Worcester Co. cited by Broome et al. (1979) is probably *D. celsa*, which is less frequent in the state.

**Frederick Co.:** Slopes near Owens Creek, Foxville Road, Catoctin Mountain National Park near Thurmont, 4 Oct 1981, *S. R. Hill & A. D. Cress 10820* (MARY, NY, VT).

**Matteuccia struthiopteris (L.) Todaro**—The Ostrich Fern is an endangered species in Virginia known from few locations (Porter, 1979), but its status in Maryland was considered to be undetermined by Broome et al. (1979). We have located five populations extant in the state in Allegany, Baltimore, Harford, and Washington Counties, and the plant is historically known from Carroll, Howard, Montgomery, and Prince George's Counties as well (Reed, 1953). We are convinced that the Washington County population is indigenous despite Reed's (1953) suggestion that the western and southwestern populations are escaped from cultivation. The Roundtop population was associated with several other infrequent plants of alkaline alluvial soils, such as *Gleditsia triacanthos, Ptelea trifoliata*, and *Chasmanthium latifolium*.

**Washington Co.:** Rich woods and bottomland along the Potomac River just W of Roundtop Mountain, 7 June 1981, *R. E. Riefner 81-138* (MARY).

**Woodsia ilvensis (L.) R. Br.**—The Rusty Cliff Fern is very rare in Maryland, having a preference for exposed shale cliffs associated with shale barrens. At the Washington County locality the shale is calcareous, although Reed (1953) remarks on the non-calcareous preference of the species. It was growing in full sun with *Phlox subulata, Arenaria stricta, Cystopteris fragilis, Comandra umbellata*, and *Tephrosia virginiana*. The only other population that we have seen is at the shale barren at Town Creek (also calcareous shale) in Allegany County, where only a few plants survive (Riefner, 1981). We have discovered one other old collection from Allegany County (Flintstone, 3 June 1928, *N. C. Knappa s. n.*, Patuxent Res. Refuge Herb.).

**Washington Co.:** Shale cliff along Sideling Hill Creek, High Germany Road, 2 May 1981, *R. E. Riefner & S. R. Hill 81-55* (MARY).

**Azolla caroliniana Willd.**—The Mosquito Fern is said to be very frequent in watercress beds near the Monocacy River by Reed (1953). We have seen only the specimen from Prince George's County and a specimen from Kenilworth Gardens, Washington, DC (*W. Preston, Jr. s. n.*, MARY). These seem to have been chance introductions and probably did not persist. The Mosquito Fern is undoubtedly a frequent "hitchhiker" on waterfowl migrating north in the spring from warmer regions, where the plant is frequent in swamps and on still-water ponds. The plant may also be introduced from aquaria.

**Prince George's Co.:** Golf course pond, 14000 Old Marlboro Pike, Upper Marlboro, 15 July 1976, *K. Hummel s. n.* (MARY).

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## REVIEW

**"ILLUSTRATIONS OF PTERIDOPHYTES OF JAPAN,"** volume 2, S. Kurata and T. Nakaike, eds. x + 648 pp. + map. 1981. University of Tokyo Press, yen 10,000 (about $47).—This is the latest of a great array of excellent plant books produced in Japan for the large portion of the population seriously interested in botany. On the glossy paper of this lavish and heavy volume 100 Japanese ferns (from a total of nearly 800) are presented, each with a black and white photo of its appearance in the wild, a line drawing with insets of important details, and a dot map showing precise distribution in Japan. A separate section in the back has a photomicrograph of a spore of each species.

Almost everything is in Japanese, except for botanical names and numbers, so the value of the book for the non-reader of Japanese is in the illustrations. The sharp-detail photos put you inside the forests of Japan looking at moss-covered and lichen-covered trunks, and at boulders and embankments, and the ferns are right there looking just as they really do. The line drawings are not cosmeticized or stylized—the occasional small insect bite or other imperfection is faithfully rendered. What you see is what you get.

This volume deals mainly with *Asplenium* and the genera allied to *Polypodium* and *Grammitis*. Two new combinations are made, presumably due to the reinterpretation of a type specimen by Dr. Toshiyuki Nakaike: the fern usually known as *Neocheiropteris subhastata* (Bak.) Tagawa is renamed *N. buergeriana* (Miq.) Nakaike, and the fern that was *Microsorium buergerianum* (Miq.) Ching is now *M. brachylepis* (Bak.) Nakaike.

My only criticism is that about half the book is taken up by lists of localities that to a large extent duplicate infomation already available from the fine dot maps.—*M. G. Price, Herbarium, University of Michigan, Ann Arbor, MI 48109.*

# Grammitis succinea, the First New World Fern Found in Amber

LUIS DIEGO GÓMEZ P.*

Although Dominican ambers are known for their arthropod fauna, no systematic examination has ever been attempted of the plants they contain, even though plant remains usually are well preserved in ambers (Czeczott, 1960). Non-vascular cryptogams (mosses and lichens) also are commonly preserved, but apparently only two vascular cryptogams have ever been reported, both ferns from Baltic ambers (Caspary & Klebs, 1907; Magdefrau, 1957). The present report is the first record of a fern from New World amber and is the first species of the genus *Grammitis* to be found in amber.

There are several deposits of amber in Central and South America, but the most famous New World deposits are at Simojovel, Chiapas, Mexico, and in the Dominican Republic on the Caribbean island of Hispaniola. The latter, considered like the Chiapas deposits to be late Oligocene in age, has been known since Columbus reported on it in the account of his second voyage to the West Indies (Langenheim, 1964). Dominican amber contains many well preserved arthropods and some fragmentary, little-studied plant materials. This has led to extensive exploitation of these fossil resins, which are sold as elaborate jewelry or in bulk, but almost always without precise data as to their location on the island.

The plants from which the Dominican amber originated was for many years unknown. Sanderson and Farr (1960) suggested *Pinus* as a possible source because of the strong, turpentine-like odor obtained from freshly sawed or filed amber. Recently, Langenheim (pers. comm., 1980) has indicated that Dominican amber is the fossilized resin of *Hymenaea* trees (Leguminosae).

The fragment of Dominican amber containing the fern described in this paper was donated to the Museo de Entomología, Universidad de Costa Rica, where it was polished by abrasion with carborundum and water on rotating, leather-covered wooden disks. The amber was photographed on a light table. All microscopic observations and measurements were made under a dissecting microscope using transmitted light, reducing refraction by immersing the amber in a 95% solution of ethanol. Two small samples of amber were chipped from the specimen in an unsuccessful attempt to find spores of the fern. No attempt was made to extract the fern from the amber because of the scarcity of the material, although extraction is possible using Voigt's (1936) method. The reconstruction was traced from a photographic print, correcting for curvature in the material.

**Grammitis succinea L. D. Gomez, sp. nov.** **Figs. 1–2.**

Rhizome and stipe unknown. Fronds of unknown length, probably ca. 35 cm long, ca. 60–70 mm wide near the apex, pinnate, herbaceous. Rachis dark brown, terete, without scales, densely hairy; hairs unicellular, setose, stiff, 1–1.8 mm long, ca. 0.3 mm in diameter at the widest point. Pinnae 30–40 mm long, 4–6 mm wide, lanceolate, opposite, entire except shallowly crenate towards the apex, rounded to

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*Museo Nacional de Costa Rica, Apartado 749, San José, Costa Rica.

FIG. 1. Fragment of amber bearing *Grammitis succinea;* an embedded insect is circled, × 3.6.

obtuse at the apex, inequilateral at the base, the upper base rounded, subauriculate, truncate, the lower base decurrent. Laminae and costae pilose on both surfaces, the hairs similar to those of the rachis. Costae prominent dorsally, straight in the proximal two-thirds, flexuose and tenuous near the apex. Veins free, 1-forked, never reaching the margin, slightly curved towards the pinna apex. Sori discrete, 12–14 per pinna, medial, subalternate to opposite, round, small, exindusiate, terminal on the acropetal branch of the vein, usually 1 per vein pair, exceptionally 2. Spores unknown.

TYPE: Without precise locality, Dominican Republic, *Monge 80–12*, deposited in the Museo de Entomología, Universidad de Costa Rica.

Because of the presence of setose, stiff hairs (rather than scales along the rachis) and sporangium stalks of only one column of cells, this fern is readily placed in the Grammitidaceae, rather than the Polypodiaceae, which is the other fern family to which it could belong. (The free, forked veins are found in both families, particularly in species of the *Polypodium pectinatum-plumula* complex, but setose hairs are

**2**

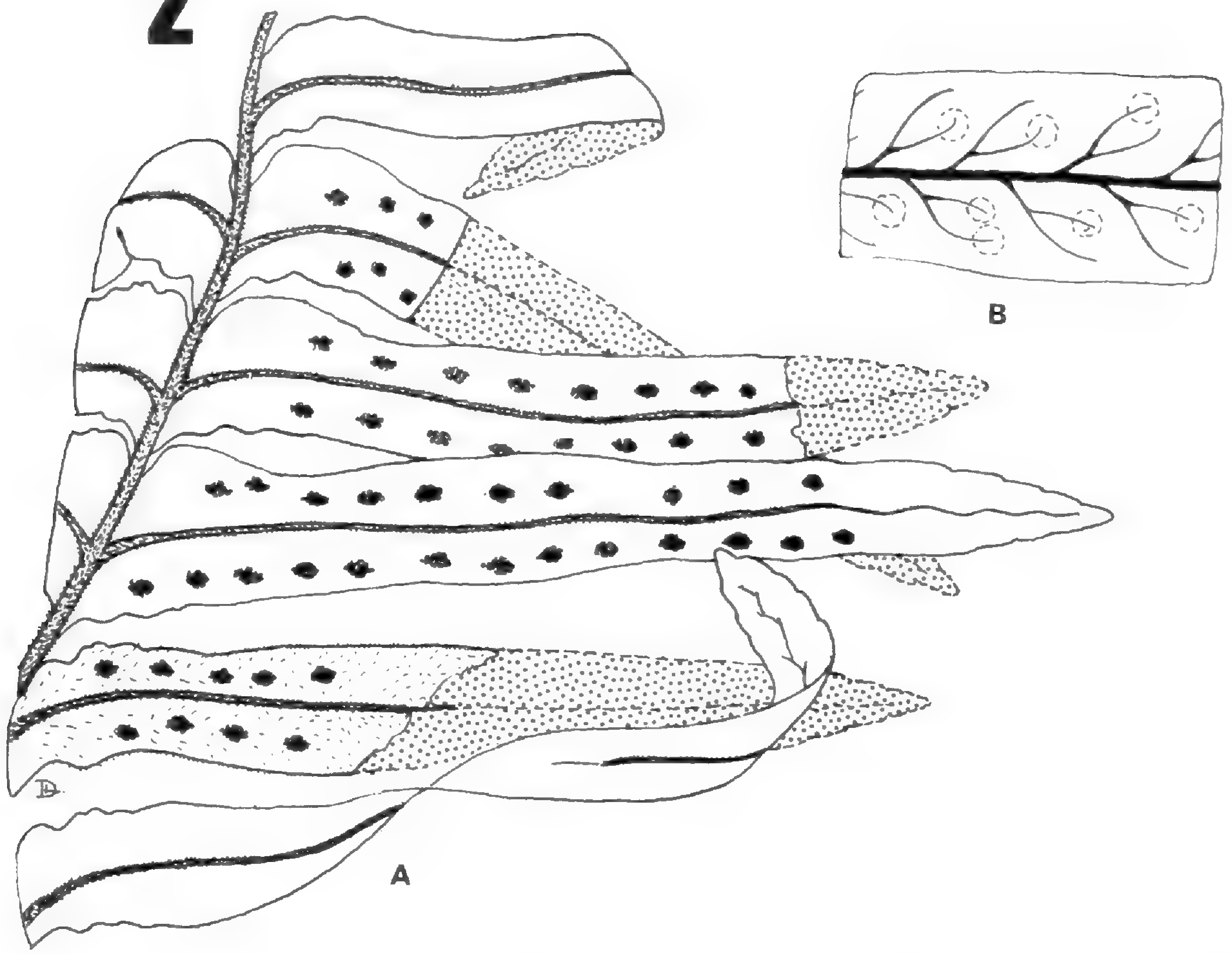

FIG. 2A. Reconstructed apical portion of *Grammitis succinea* frond, ×3.6. FIG. 2B. Pattern of venation and soriation, × 6.3.

unknown in Caribbean species of the Polypodiaceae.) Spores, which are monolete in the species of Polypodiaceae but trilete in those of the Grammitidaceae, would be useful to confirm the placement of the species, but unfortunately have not been recovered from the amber, an absence previously reported in some European ambers (Schubert, 1961), but not others (Wetzel, 1953). Among the New World genera of Grammitidaceae, the plant is obviously referable to *Grammitis* sect. *Cryptosorus*, which has pinnatisect laminae bearing several sori on each elongate lobe, rather than to any other genus of the family.

Other plant remains known from Dominican ambers need systematic study to develop information on the age of the deposits, as well as to provide floristic data for use in comparing them with plant remains found in Chiapas, Haiti, and Cuba. It is likely that such data would be useful in solving biogeographical problems in the Caribbean area.

This research was partially funded by a grant from the Consejo Nacional de Investigaciones Científicas y Tecnológicas (CONICIT), Costa Rica.

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## REVIEW

**ASPECTS OF PLANT SCIENCES, VOLUME 3. PTERIDOPHYTES,** edited by S. S. Bir. Today and Tomorrow's Printers and Publishers, New Delhi. vi + 157 pp. $15.00.—This volume contains several substantial research papers by well known Indian botanists. The focus of the papers is on the anatomy, classification, cytology and morphology of pteridophytes. B. K. Nayar writes on fern classification. T. N. Bhardwaja reviews the cytology, morphology, and morphogenesis of *Marsilea*. S. P. Khullar and S. S. Sharma revise the Himalayan species of *Onychium*, with emphasis on their cytology and anatomy. S. N. Patnaik and B. L. Narasama report their experimental work on growing fern leaves *in vitro*. B. D. Sharma surveys the Indian pteridophyte fossils from the Mesozoic Era. S. S. Bir *et al.* survey the stomatal types found in 33 species of Indian *Athyrium, Cystopteris, Diplazium, Dryoathyrium* and *Hypodematium*. Lastly, S. S. Bir and C. K. Trikha report on the stelar anatomy of 19 species of Indian Polypodiaceae. This reasonably priced volume will be of interest to many pteridologists. It is available from the publisher at 24-B/5, Original Road, Karol Bagh, New Delhi 110005, India.—*D. B. L.*

# A New Tropical American Species of the Genus Lycopodium

BENJAMIN ØLLGAARD*

During studies of the Lycopodiaceae for the "Ferns and Fern Allies of Guatemala" by Robert G. Stolze, a total of 24 species was found to be represented in this country. One of these is an undescribed species which occurs also in northern Andean South America.

**Lycopodium amentaceum B. Øllgaard, sp. nov.** **Fig. 1–4.**

Species *Lycopodio callitrichifolio* Mett. et *L. cuneifolio* Hieron. proxime affinis, caulibus tenuibus pendentibus usque ad 60 cm longis, dichotomis, ca. 0.6–1.3 mm crassis in sicco foliis exclusis, apicem versus gradatim usque ad 0.5 mm decrescentibus, teretibus vel striato-sulcatis, præsertim parte inferiore saepe rubris; rami foliis dimorphis; rami basales foliis expansis usque ad 50 cm longi, (10)12–20 mm crassi foliis inclusis, usque ad quinquies bifurcati; rami apicales foliis valde reductis imbricatis, zonatim vel continuiter sporangiferis, usque ad 30 cm longi, usque ad decies bifurcati; folia ramorum basalium decussata vel subdecussata, internodiis 2.5–4 mm longis, patentia vel perpendicularia, oblonge lanceolata vel lanceolata, apicibus obtusis vel breviter mucronulatis, basibus et apicibus saepe fere symmetricis, recta vel recurvata, (4)6–10 mm longa, 2–3(3.5) mm in medio lata, laminis plerumque torsione basali verticalibus, plana vel venas secus deorsum parum plicata; folia ramorum apicalium decussata vel subdecussata, internodiis 1–3 mm longis, laxe vel arcte imbricata, fere uniformia, late ovata, apice rotundata, acuta vel mucronata, intro subfalcata, basibus amplectentibus, abaxialiter rotundata usque ad carinata, 1.2–1.7 mm longa, 1.2–1.5 mm lata; sporangia reniformia, ca. 1 mm lata.

TYPE: Camino al Páramo de Los Monsalves, Edo. Mérida, Venezuela, epifito péndulo, sobre tronco, en la faja superior de la selva montanera, 3000 m alt., 10 June 1952, *Vareschi & Pannier 1817* (VEN; isotype M).

According to information kindly provided by Dr. Julian A. Steyermark, the location of the Páramo Los Monsalves is just northwest of the main city of Mérida, ca. 8°42′N, 71°08′W.

PARATYPES:

**GUATEMALA: Depto. Quiché:** *José Ignacio Aguilar 828* and *1019* in 1942 (F). **Depto. Guatemala:** On tree in dense forest, slopes of Volcán de Pacaya, between San Francisco Sales and the base of the active cone, 1800–2300 m alt., 20 Dec 1940, *Standley 80538* (F). **COLOMBIA: Depto. Cundinamarca:** Road to east from Guasca, on wet bank, 3200 m alt., 6 Jun 1947, *Haught 5826* (COL). Monserrate, Bogotá, 2900 m alt., *Lindig 1504* (P). **Depto. Norte de Santander:** Ocaña, páramos, 8000–10000 ft alt., *Schlim 468 p. p.* (P). **VENEZUELA: Edo. Mérida:** Selva de Podocarpus, Páramo Monsalves, 3190 m alt., 10 Nov 1952, *Vareschi 2232* and *2272* (VEN).

*Lycopodium amentaceum* has been found in high montane forest and in cloud forest, as an epiphyte, or occasionally hanging from banks. It is a close relative of *L. callitrichifolium* Mett. and *L. cuneifolium* Hieron., a group of very delicate pendent species from the northern Andes and Central America. The main differences which separate *L. amentaceum* from these species are shown by the typical outline of the expanded leaves (*Figs. 5–6*). In the size of the expanded leaves it also resembles *L. phylicifolium* Desv. ex Poir., but its leaves are broader and more obtuse, both at the base and apex.

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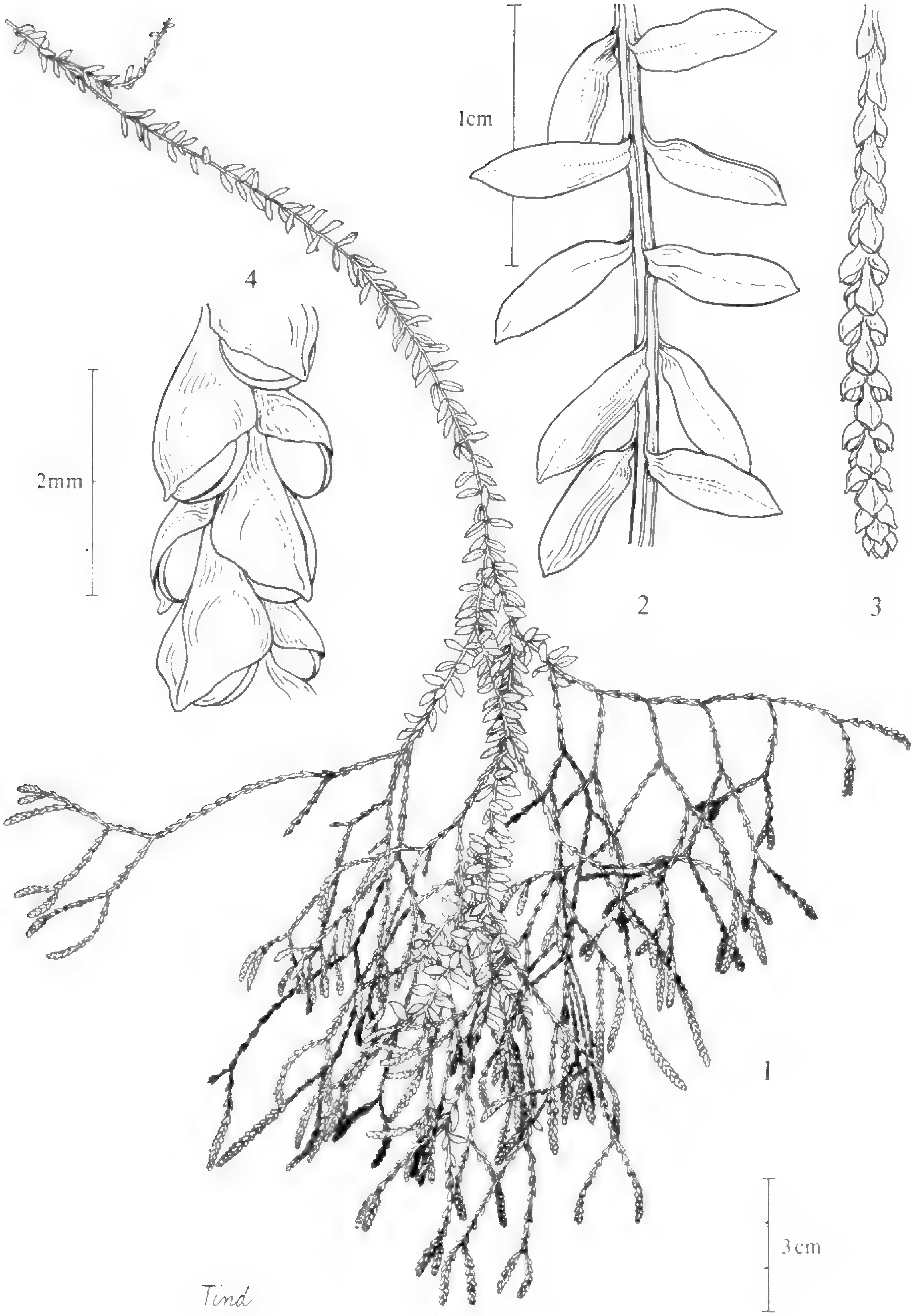
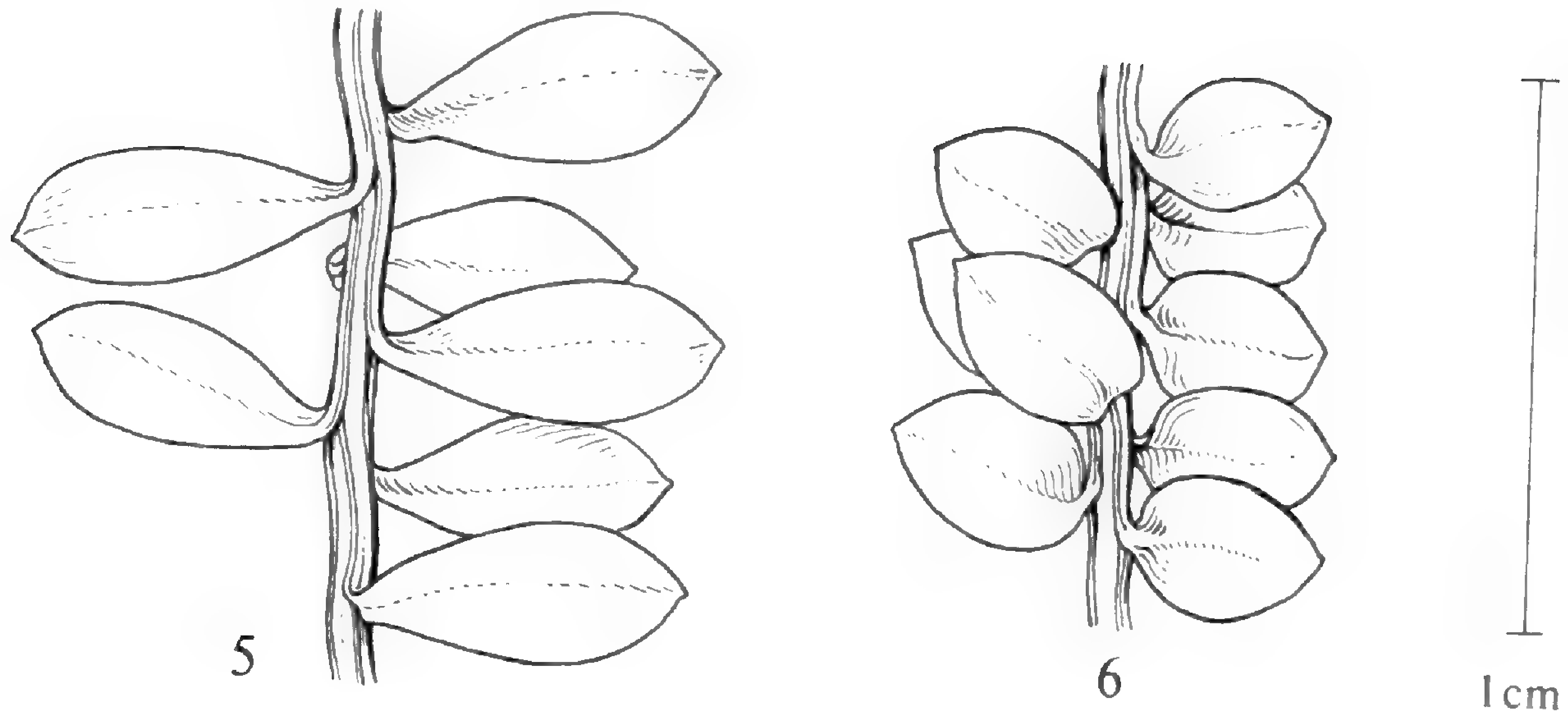


FIGS. 1–4. Isotype of *Lycopodium amentaceum, Vareschi & Pannier 1817* (M). FIG. 1. Habit. FIG. 2. Portion of basal division with expanded leaves. FIGS. 3 and 4. Portions of apical sporangiate divisions.



FIGS. 5–6. Portions of basal divisions with expanded leaves. FIG. 5. *L. cuneifolium* Hieron., *Schlim 881* (P). FIG. 6. *L. callitrichifolium* Mett., *Holm-Nielsen et al. 3988* (AAU).

The plants treated and illustrated as *L. callitrichifolium* by Vareschi in Lasser (Flora de Venezuela 1(1):41, *t. 2A*. 1969) belong to *L. amentaceum*, and include the type of the latter. The Guatemalan specimens had been identified as *L. skutchii* Maxon, a name which I regard as a synonym of *L. myrsinites* Lam. From the latter species it can be distinguished by its red stems, smaller sporophylls (more than 2 mm long in *L. myrsinites*), almost uniform leaves (highly variable and often recurrent to expanded in shape in *L. myrsinites*), and obtuse leaves (acute in *L. myrsinites*).

# Specimens from Fée's Pteridological Collection at the Botanical Garden of Rio de Janeiro

PAULO GÜNTER WINDISCH*

As cited in a recent note (Windisch, 1981), specimens from A. L. A. Fée's pteridological, lichenological, and phanerogamic collections can be found in the Herbarium of the Botanical Garden of Rio de Janeiro (RB), as the result of the acquisition made by the Brazilian Emperor Dom Pedro II during his visit to Fée in 1871. Although this has been known by some botanists, for many the latest information about this collection was presented by Stearn (1962, p. 220), who held the traditional view that Fée's private herbarium had not been traced and was believed to have been lost at sea en route to Brazil.

In fact, the pteridophytes at RB are represented by 2,940 specimens bearing Fée's original annotations and labels, which are a clear indication that the material belonged to Fée's private collection. In addition, some specimens have been remounted without the original labels and with incomplete data on the new labels, making it difficult to ascertain with certainty the origin of the material, although it is likely that these specimens do belong to the Fée collection. Of the original material, 381 specimens appear to be types of taxa described by Fée. A few of these specimens have a note indicating that they were used to prepare lithographs (which were used in Fée's "Mémoires"), and some sheets have pencil drawings copied from original plates or have illustrations cut out from lithographs. A great number of specimens bear Fée's unpublished herbarium names. In addition to the foregoing specimens, many others are classical collections by such men as Cuming, Galeotti, Martius, and Gardner, some of which are isotypes of taxa described by Fée's colleagues Kunze, Klotzsch, Bory, and John Smith.

Among the pteridophytes, some groups are poorly represented, such as the tree ferns. It may be that the acquired collection was not complete, that parts of it are still misplaced, or that some specimens have been excluded from the Herbarium due to excessive damage. It will be difficult to determine precisely what happened to the specimens since their acquisition.

The following list of presently available pteridophyte types (or probable types, in a few cases) with relevant label data will certainly be of help to those working on nomenclatural problems related to the taxa represented. In some cases, no collector was indicated on the specimen label. In other cases, there is no collector's number, but the year of collection was given; these are cited as "in 1865" or whatever year applies. Numerals which are illegible on the specimen labels but which are known from being published in Fée's "Mémoires" have been placed in brackets in the list. Similarly, missing collectors or herbaria of origin also have been placed in brackets.

*Abacopteris truncatum* (Philippines, *Cuming 298*).

*Acrostichum alatum* (Guyane Française, *Leprieur* in 1839), *A. angustifolium* (Bolivia, *Bridges 1850*), *A. attenuatum* (*ex horto Lipsiae*), *A. blepharodes* (Mexique, Galeotti 6297), *A. callolepis* (Mexique, *Galeotti*), *A. cochleariaefolium* (Andes de Quito, *Jameson 21[3]*), *A. crispatulum* (Quito, *Jameson*), *A.*

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*Dombeyanum* (Venezuela, *Linden*), *A. erythrolepis* (Perou, *Dombey*), *A. gratum* (Mexique, *Schaffner 322b*), *A. Hartwegii (Hartweg 1486)*, *A. Herminieri* (Guadeloupe, *L'Herminier*), *A. intermedium* (Mexique, *Schaffner 22*), *A. lonchophyllum* (Mexique, *Schaffner 19*), *A. micradenium* (Iles Sandwich, *Gaudichaud* in 1836), *A. minutum* (*Pohl* in 1817-21), *A. obcrenatum* (Guadeloupe, *L'Herminier* in 1864), *A. plumosum* (Guyane, *Schomburgk 44[6]*), *A. rhabdolepis* (Quito, *Jameson* in 1845), *A. Schlimense* (Amerique Trop., Ocaña, *Schlim 622*), *A. stigmatolepis (Neilgherries)*, *A. stramineum* (Brésil, *Glaziou 3322*), *A. tenuiculum* (Venezuela, Tovar, *Fendler 272*).

*Adiantum Claussenii* (Brésil, Nouv. Fribourg, *Claussen 124*), *A. extensum* (Mexique, Veracruz, Orizaba, *Schaffner 41*), *A. fuliginosum* (Guyane Française, *Leprieur 256 ex Herb. Moug.*), *A. gracile* (Brésil, *Claussen*), *A. jacobinae* (Brésil, Jacobine, *Blanchet*), *A. jamaicense* (Jamaica, *Wilson*), *A. nigrescens* (St. Domingue, Port-au-Prince, *L'Épagnier*), *A. obliquetruncatum* (Guadeloupe, *L'Herminier*), *A. ovalescens* (St. Domingue, [*ex Herb. Bory*]), *A. parvifolium* (St. Domingue, *Poiteau*), *A. pseudocapillus* (Cap de Bonna Spéi, *Drège*), *A. subaristatum* (Brésil, Bahia, *Blanchet 2373*), *A. tomentellum* (Brésil, Minas Gerais, *Claussen*), *A. trapezoides* (Mexique, Veracruz, *Galeotti 6317*), *A. tricholepis* (Mexique, *Galeotti 6445*).

*Alsophila Schaffneriana* (Mexique, San Martín, *Schaffner 232*).

*Amblya latifolia* (Nouv. Grenade, Ocaña, *Schlim 656*).

*Aspidium acrocarpon* (St. Domingue, *Tussac*), *A. agatolepis* (Mexique, S. Agostin, *Schaffner 309b*), *A. ameristoneuron* (Cuba, orig. inconnue), *A. asperulum* (Guadeloupe, *L'Herminier* in 186[1]), *A. capitainii* (Guadeloupe, *L'Herminier* in 1861), *A. chrysolepis* (Ile du Cap Vert, *Webb*), *A. dissectum* (Nouv. Grenade, Ocaña, *Schlim 323*), *A. frondulosum* (Bourbon, *Bory*), *A. germani* (Guadeloupe, *Germain* in 1861), *A. jucundum* (Mexique, *Galeotti* and Cuba, *Linden 2115*), *A. microthecium* (Philippines, *Cuming 13*), *A. obtusifolium* (Mexique, Huatusco, *Schaffner 213*), *A. pachychlamys* (Guadeloupe, *L'Herminier* in 1861), *A. pauper* (Martinique, *Mlle. Rivoire*), *A. trichophorum* ("Cuba," *ex Herb. Bory*), *A. trichotomum* (Cochinchine, Tourane, *Gaudichaud*).

*Asplenium bifissum* (Cuba, *Linden 1888*), *A. cladolepton* (Nouv. Grenade, Ocaña, *Schlim 324*), *A. coriaceum* (Mexique, *Galeotti*), *A. debile* (Bolivia, *Weddell 3790*), *A. depauperatum* (Bolivia, *Weddell 4235*), *A. distans* (Mexique, *Galeotti 6579*), *A. extensum* (Nouv. Grenade, Ocaña, *Schlim 629*), *A. flageliferum* (Nouv. Grenade, Ocaña, *Schlim 63*), *A. Galeottii* (Mexique, *Galeotti 6369*), *A. herbaceum* (Nouv. Grenade, *Schlim 326*), *A. inaequalidens* (Guadeloupe, *L'Herminier*), *A. integrum* (Guadeloupe, *L'Herminier*), *A. lamprocaulon* (Mexique, *Galeotti 6340*), *A. leptophyllum* (Mexique, *Galeotti 6446* and Mexique, *Schlim 479*), *A. macrodon* (Quito, *Jameson* in 1845), *A. myapteron* (Mexique, Orizaba, *Schaffner 70* and Mexique, Popocatepetl, *Schaffner 294*), *A. neo-granatense* (Nouv. Grenade, Ocaña, *Schlim 492*), *A. progrediens* (Mexique, Huatusco, *Schaffner 54*), *A. pumilum* var. *hymenophylloides* (Abyssinia, *Schimper*), *A. surinamense* (Guyane Hollandaise, *Kappler 183b*), *A. tenellum* (Quito, *Jameson* in 1848), *A. ternatum* (Nouv. Grenade, Ocaña, *Schlim 327*).

*Bathmium ebenum* (Bourboun, *Montbrison* and Madagascar, Nos-Beh, *Pervillié*), *B. villosum* ("*in* hort. ludg. Batavo").

*Blechnum extensum* (Brésil, *Claussen*), *B. helveolum* (Venezuela, Caracas, *Moritz 17*), *B. heterocarpum* (Brésil, *Claussen*), *B. Schlimense* (Nouv. Grenade, *Schlim 752*.

*Campyloneuron caudatum* (Mexique, Cordoba, Huatusco, *Schaffner 176*), *C. cubense* (Cuba, *Linden 1912*), *C. jamesoni* (Quito, *Jameson*), *C. minus* (Brésil, Rio, *Glaziou* and Ameriq. Sud, Brésil, *Glaziou* ex Herb. Gauthier), *C. Moritzianum* (Caracas, *Moritz 3*), *C. xalapense* (Mexique, *Galeotti 6273*).

*Cardiochlaena alata* (Philippines, *Cuming 148*), *C. ampla* (Guadeloupe, *L'Herminier*), *C. confluens* (Guadeloupe, *L'Herminier*), *C. laevis* (Philippines, *Cuming*), *C. macrophylla* var. *crenata* (Caracas, *Moritz 112*), *C. macrophylla* var. *distans* (Brésil, *Martius*), *C. pilosa* (Brésil, Rio de Janeiro, *Weddell 656*), *C. sinuosa* (Philippines, *Cuming*).

*Cassebera paradoxa* (Brésil, Serra dos Orgãos, *Gardner 59[3]0*), *C. petiolata* (Buenos . . . Argen.).

*Cheilanthes aspidioides* (Mexique, *Galeotti 6557*), *C. cucullans* (Mexique, *Schaffner 82*), *C. glaberrima* (Brésil, Ile Ste. Catherine, *Desterro*), *C. griffithiana* (Ind. Oriental., *Griffith*), *C. malaccensis* (Malacca, *Cuming 408*).

*Chrysodium scalpturatum* (Panama, *Bonpland*).

*Chrysopteris martinicensis* (Martinique, *Mlle. Rivoire*), *C. microdictya* (Mexique, *[Schaffner 203]*).

*Craspedaria borbonica* (Bourbon, *Bory*), *C. Gestasiana* (Brésil, Rio de Janeiro, *de Gestas*), *C.*

*javanensis* (Java, *Zollinger 1086*), *C. lanceolata* (Surinam, *Hostmann 324*).

*Cryptosorus dionaea* (Java, *Lobb 270*).

*Culcita Schlimensis* (Nouv. Grenade, Ocaña, *Schlim 322*).

*Cyathea Commersoniana* (Ile de France, *Commerson*).

*Cystopteris azorica* (Açores, Fayal, *Hochstetter*).

*Dicksonia incisa* (Guadeloupe, *L'Herminier* in 186[4]), *D. neglecta* (Philippines, *Cuming 108*$^2$), *D. stenochlaena* (Bourboun, *Montbrison*).

*Didymoglossum fructuosum* (Guadeloupe, *L'Herminier* in 1861), *D. Krausii* var. *subpinnatifida* (Mexique, *Schaffner*).

*Diplazium acutale* (Mexique, *Galeotti 6289*), *D. anthraxacolepis* (Mexique, Huatusco, *Schaffner 267b* and Mexique, Huatusco, *Schaffner 627a*), *D. camptocarpon* (Mexique, Cordoba, *Schaffner 69*), *D. dissimile* (Brésil, Ste. Catherine, *Mors* in 1860), *D. Feei* (Mexique, Veracruz, Barrancas de San Martín, *Schaffner 265*), *D. firmum* (Ceylon, *Thwaites 1349*), *D. grammatoides* (Guadeloupe, *L'Herminier*), *D. melanopodium* (Philippines, Luzon, *Cuming 29*), *D. mohillense* (Madagascar, Ile Mohilla, *Hell*), *D. parallelogrammum* (Brésil, Rio Negro, *Spruce 3832*), *D. praelongum* (Ile de France, [ex Herb. T. Moore]), *D. Schlimense* (Nouv. Grenade, Ocaña, *Schlim 601*), *D. Tussaci* (St. Domingue, *Tussac*).

*Doryopteris raddiana* var. *patula* (Brésil, Rio de Janeiro, *Glaziou 1740*).

*Drymoglossum abbreviatum* (Cochinchine, Tourane, Voy. de la Bonite, *Gaudichaud*), *D. subcordatum* (Amboine, *Gaudichaud*).

*Drynaria acuminata* (Brésil, Rio Negro, Barra, *Spruce* in 1850-51), *D. compacta* (Ste. Hélène, *Cuming 431*), *D. crassinervata* (Mexique, Orizaba, *Schaffner 489* and Mexique, Cordoba, *Schaffner 174a*), *D. elastica* (Guadeloupe, *L'Herminier*), *D. mexicana* (Mexique, Puebla, *Schaffner 179* and Mexique, Popocatepetl, *Schaffner 292*), *D. pinnata* (Philippines, Luzon, *Cuming 263*), *D. Prieurei* (Guyane Française, *Le Prieur*, provenant de M. Mougeot), *D. stenoloma* (Mexique, *Galeotti 6532*), *D. torulosa* (Cuba, *Linden*).

*Eriosorus Ruizianus* (Perou, Machi, *Ruiz & Pavon*), *E. scandens* (Perou, *Ruiz & Pavon*).

*Goniophlebium acuminatum* (Guadeloupe, *L'Herminier* and Rivière St. Louis, au Matuba, Guadeloupe, *L'Herminier* in 1861), *G. anisomeron* (Mexique, Orizaba, *Schaffner* in 1856), *G. arcuatum* (Martinique, *Mlle. Rivoire*), *G. calaguala* (Mexique, Orizaba, *Schaffner 184*), *G. chondrocheilon* (Nouv. Grenade, Páramo Río Hacha, *Schlim 1007*), *G. coriaceum* (Bourbon, *Bory*), *G. Gauthieri* (Brésil, Ste. Catherine, *Gauthier*), *G. intermedium* (Guadeloupe, *L'Herminier*), *G. invertens* (Mexico, Orizaba, *Schaffner 494*), *G. lepidotrichum* (Mexique, Córdoba, *Schaffner 198* and Mexique, Orizaba, *Schaffner 451*), *G. longicaule* (Nouv. Grenade, Río Hacha, *Schlim 847*), *G. molestum* (Mexique, Córdoba, *Schaffner 180* and Mexique, Orizaba, *Schaffner 180*), *G. pectinans* (Brésil, *Claussen*), G. *plectolepis* (Mexique, Orizaba, *Schaffner 187*), *G. pleopeltis* (Java, *Lobb 263*), *G. Villeminianum* (Nouv. Grenade, Ocaña, *Schlim 1009*).

*Goniopteris Feei* L'Herm. & Fée (Guadeloupe, *L'Herminier* in 1861), *G. ferax* (Guadeloupe, *L'Herminier*), *G. guadalupensis* (Guadeloupe, *L'Herminier* in 1861), *G. leptocladia* (Guadeloupe, *L'Herminier*), *G. Lobbiana* (*Lobb 27[6]* in 1845), *G. macroclada* (Brésil, Ste. Catherine, *Albuquerque*), *G. martinicensis* (Martinique, *Mlle. Rivoire*), *G. mollis* (Tabasco, *Linden 1499*), *G. patens* (Afrique austral, Port Natal, *Guenzius*), *G. pyramidata* (Guadeloupe, Grande Terre, *L'Herminier*), *G. quadrangularis* (Trinité, *Germain* in 1862), *G. repanda* (Cochinchina, Pulo-Pinang, *Gaudichaud*), *G. rostrata* (Guadeloupe, *L'Herminier* in 1861), *G. strigosa* (Ste. Domingue, Port-au-Prince, *L'Épagnier* in 1844), *G. tenera* (Guadeloupe, *L'Herminier* in 1861).

*Grammitis limbata* (Guadeloupe, *Perrotet* in 1824), *G. longa* (Java, *Lobb 271*), *G. zeylanica* (Ceylon, *Gardner 56*).

*Hemicardion crenatum* (Cochinchina, *Gaudichaud*), *H. cumingianum* (Philippines, *Cuming 68*), *H. macrosorum* (Nouv. Grenade, Ocaña, *Schlim 658*).

*Hemistegia contracta* (Indiae Orientale, *Lady Dalhousie*), *H. elegantissima* (Mexique, *Linden*), *H. insignis* (Guadeloupe, *L'Herminier* in 1861), *H. lucida* (Mexique, Oaxaca, *Galeotti 6537*), *H. repanda* (Cuba, *Linden*).

*Hewardia diphylla* (Brésil, Bahia, *Blanchet*), *H. serrata* (Brésil, Bahia, *Luschnath*).

*Hydroglossum mexicanum* (Mexique, Oaxaca, *Galeotti 6419*).

*Hypolepis chilensis* (Chile, Valparaiso, *Gaudichaud*), *H. helenensis* (Ste. Hélène, *Cuming 4[3]3*), *H. parviloba* (Brésil, Rio Negro, *Spruce 2119*).

*Jamesonia rotundifolia* (Nouv. Grenade, Ocaña, *Schlim 363*).

*Leptochilus subquinquefidus* (Philippines, Mindora, *Cuming 3*), *L. Thwaitesianus* (Ceylon, *Thwaites 1316*, *L. zeylanicus* (Ceylon, *Thwaites 1317)*.

*Lindsaya curvans* (Mexique, *Galeotti 6489*), *L. consanguinea* (Guadeloupe, *L'Herminier* in 1864 and Brésil, Bahia, *Luschnath 22*), *L. crenulata* (Ind. Orient., Malacca, *Griffith*), *L. elegans* (Colombie, *Moritz 238*), *L. Galeottii* (Mexique, *Galeotti 6469*), *L. L'Herminieri* (3 specimens, all Guadeloupe, *L'Herminier*), *L. montana* (Guadeloupe, *L'Herminier* in 1862 and 1864), *L. multifrondulosa* (Mexique, *Galeotti*), *L. parvula* (Trinité, *Germain* in 1862).

*Litobrochia affinis* (3 specimens, all Guadeloupe, *L'Herminier*), *L. brevinervis* (Guadeloupe, *L'Herminier*), *L. Galeottii* (Mexique, *Galeotti 6485*), *L. grandis* (Mexique, Mirador, *Schaffner 144*), L. hemipteris (Mexique, *Schaffner*), *L. inaequalis* (Trinité, *Germain* in 1862), *L. mexicana* (Mexique, Teotalcingo, *Galeotti 6376*), *L. microdictyon* (Philippines, *Cuming*), *L. Montbrisonis* (Bourbon, *Montbrison*), *L. organensis* (Brésil, Orgãos, *Glaziou 3329*), *L. setifera* (Mexique, Cerro S. Martin, *Galeotti 6571*), *L. Tussacii* (Ste. Domingue, *Tussac*).

*Lomariopsis elongata* (Brésil, Bahia, *Luschnath 19*), *L. erythrodes* (Brésil, *Martius 366*), *L. Prieuriana* (Guyane Française, *Leprieur*), *L. sorbifolia* var. *caudata* (Guadeloupe, *L'Herminier*).

*Lonchitis stechnochlamis* (Cap de b. Spéi, *Drège*), *L. tomentosa* (Madagascar, *Pervillié*).

*Lophosoria acaulis* (Brésil, Serra do Couto, *Glaziou 3164*), *L. prostrata* (Brésil, Serra do Couto, *Glaziou 3165*).

*Lycopodium eriostachys* (Brésil, Orgãos, *Glaziou 1788*).

*Mertensia grandis* (2 specimens, both Mexique, Huatusco, Mirador, *Schaffner 230*).

*Microlepia caudata* (Mexique, Teotalcingo, *Galeotti 6257*), *M. effusa* (Pul-Pinang, *Lady Dalhousie*, ex herb. Graham), *M. Galeotti* (Mexique, Teotalcingo, *Galeotti 6526*).

*Microsorium longissimum* (Philippines, *Cuming 66*).

*Myriopteris cheiloglyphys* (Mexique, [Orizaba, *Schaffner 91]*), *M. gracilis* (Ameriq. nord., *Riehl 529*), *M. marsupianthes* (Mexique, [Orizaba]), *M. rufa* (Mexique, Orizaba, [*Schaffner 83]*).

*Nephrolepis Schkhurii* var. *minor* (*Linden 1882*).

*Notholaena pruinosa* (Mexique, Toluca, *Schaffner 167c*).

*Onychium carvifolium* (Philippines, *Cuming 3[2]*), *O. multifidum* (Cuba, *Linden*).

*Oochlamys Rivoirei* (Martinique, *Mlle. Rivoire*).

*Pellaea mucronata* (Mexique, *Schaffner 150*), *P. palmescens* (Philippines, *Cuming*), *P. Weddelliana* (Bolivia, *Weddell 3778*).

*Phegopteris adnata* (Brésil, Rio de Janeiro, *Glaziou 2398*), *P. Blanchetiana* (Brésil, *Blanchet 2928*), *P. blepharodes* (Bourbon, *Montbrison*), *P. brevinervis* (Brésil, *Claussen*), *P. cordata* (Cuba, *Linden 1873*), *P. ctenoides* (2 specimens, both Ste. Domingue, *Tussac*), *P. delicatula* (Guadeloupe, *L'Herminier* in 1864), *P. dilatata* (2 specimens, both Guadeloupe, *L'Herminier* in 1861), *P. elata* (Bourbon, *Montbrison*), *P. fluminensis* (Brésil, Rio de Janeiro, *Glaziou 965*), *P. germaniana* (Guadeloupe, *L'Herminier*), *P. Helliana* (Bourbon, *Hell*), *P. impressa* (Mexique, Huatusco, *Schaffner 218*), *P. inaequalis* (Mexique, Huatusco, *Schaffner 240*, Mexique, Huatusco, *Schaffner 241a*, and Mexique, Tututla, *Schaffner 241b*), *P. lanata* (Bourbon, *Montbrison*), *P. leptoptera* (Ste. Domingue, *Tussac*), *P. macrotheca* (Guadeloupe, L'Herminier in 1864), *P. melanorhachis* (Mexique, Huatusco, *Schaffner 238*), *P. mollivillosa* (Brésil, *Martius 320*), *P. Montbrisoniana* (Bourbon, *Montbrison*), *P. nervosa* (Philippines, *Cuming*), *P. nitens* (Ceylon, *Walker*), *P. oreopteridastrum* (Brésil, Rio de Janeiro, *Glaziou 963*), *P. pilulosa* (Mexique, *Linden*), *P. polystichiformis* (Cuba, Santiago de Cuba, *Linden 1874* in 1844), *P. rustica* (Guadeloupe, *L'Herminier* in 1861), *P. scalpturata* (Bourbon, *Pervillié* and Madagascar, *Pervillié*), *P. scrobiculata* (Brésil, Rio de Janeiro, *Glaziou 1780*), *P. stenolepis* (Mexique, prope Huatusco, *Schaffner 239*), *P. straminea* (Bourbon, *Montbrison 1898*), *P. villosa* (La Guadeloupe, *L'Herminier* in 1861).

*Phlebiogonium impressum* (Ind. Orientales, *Griffith*).

*Plecosorus leptocladon* (Nouv. Grenade, Ocaña, *Schlim 438*), *P. peruvianus* (Perou, *Ruiz*).

*Polybotrya cyathifolia* (Guadeloupe, *L'Herminier*), *P. scandens* (Mexique, *Galeotti 187*), *P. semipinnata* (2 specimens, both Brésil, Rio de Janeiro, *Glaziou 2427*).

*Polypodium arthropodium* (Mexique, Cordoba, *Schaffner 185* and Mexique, Orizaba, *Schaffner 186b*), *P. australe* (Tenerife, [*Bory*] and Corse, *Requien* in 1845), *P. blandum* (Amerique merid.), P. callolepis (Mexique, Mecameca, *Schaffner 271* and Mexique, Popocatepetl, *Schaffner 272*), *P. camptoneuron* (Cuba, *Linden 1886*), *P. cancellatum* (Cuba, *Linden*), *P. cheilostictum* (Mexique, Orizaba, *Schaffner 453*), *P. cryptocarpon* (Mexique, Cordoba, *Schaffner 194*), *P. cubense* (Cuba, *Linden*), *P. echinolepis* (Mexique, Cordoba, *Schaffner 188*), *P. ellipsoideum* (Mexique, prope S. Angel, *Schaffner 211*), *P. filipendulaefolium* (Java, *Lobb 269*), *P. funiculum* (Cuba, *Linden 1885*), *P. glycirrhiza* (Guadeloupe, *L'Herminier* in 1861), *P. inaequale* (Guadeloupe, *L'Herminier* in 1861), *P. incanoides* (Mexique, Huatusco, *Schaffner 199*), *P. leptostomum* (Mexique, Orizaba, *Schaffner 210*), *P. macrosorum* (Quito, *Jameson* in 1845), *P. nivosum* (Mexique, Huatusco, *Schaffner 193*), *P. oulolepis* (Mexique, Huatusco, *Schaffner 191*, Mexique, Orizaba, *Schaffner 191b*, and Mexique, Valle de Mexique, *Schaffner 192*), *P. pubescens* (Mexique, Huatusco, Dos Puentes, *Schaffner 181*), *P. rhagadiolepis* (Mexique, *Linden*, and Mexique, prope Orizaba, *Schaffner 200b*), *P. Schaffneri* (Mexique, *Schaffner 310*), *P. Schaffneri* var. *crispum* (Mexique, Popocatepetl, *Schaffner 273*), *P. serricula* (1 sheet: Guadeloupe, *L'Herminier* and Guadeloupe, *Perrotet*), *P. senile* (Nouv. Grenade, Ocaña, *Schlim 364*), *P. tenuiculum* (Guadeloupe, *L'Herminier*).

*Polystichum chlaenosticta* (Nouv. Hollande, *L'Hostschy*), *P. falcatum* (Ste. Domingue, Port-au-Prince, *L'Épagnier*), *P. guadalupense* (Guadeloupe, *L'Herminier*), *P. heterolepis* (Cuba, Santiago de Cuba, *Linden 1742(2)*), *P. ilicifolium* (Cuba, Santiago de Cuba, *Linden 2193*), *P. incisum* (Philippines, *Cuming 146*), *P. lepidomanes* (Java, *Lobb 262*), *P. rachichlaena* (Mexique, Popocatepetl, *Schaffner 290*), *P. schizolobium* (Bourbon, *Montbrison*), *P. viviparum* (Cuba, Santiago de Cuba, *Linden 1742(1)*).

*Pteris aspera* (Bourbon, *Montbrison*), *P. croesoides* (Bourbon, *Montbrison*), *P. gracilis* (Brésil, *Claussen*), *P. heteromorpha* (Malacca, *Cuming 409*), *P. melanocaulon* (Philippines, *Cuming*), *P. muricella* (Mexique, Cordoba, *Schaffner 143*), *P. mysorensis* (Indes, Mysore, *Hook fil. & Thompson*), *P. oppositi-pinnata* (Philippines, *Cuming*), *P. paucinervata* (Mexique, Mirador, *Schaffner 152*), *P. philippinensis* (Philippines, *Cuming 8*), *P. prionitis* (Philippines, *Cuming 46*), *P. punctata* (Bourbon, *Bory*), *P. rostrata* (Perou, *Spruce*), *P. semidentata* (Nouv. Grenade, Ocaña, *Schlim 482*).

*Sagenia gemmifera* (Madagascar, *Pervillié*), *S. mexicana* (Mexique, *Galeotti 6484* and Mexique, Oaxaca, *Galeotti 6542*).

*Schizoloma javae* (Java, *Zollinger 1504*).

*Synochlamys ambigua* (Nouv. Grenade, Río Hacha, *Schlim 877*).

*Vittaria amboinensis* (Amboine, *Labillardière*), *V. filifolia* (Mexique, *Linden 168*), *V. Gardneriana* (Brésil, Orgãos, *Gardner 147*), *V. latipes*, (Madagascar, *Boivin* in 1853), *V. loricea* (Java, *Zollinger 1001*), *V. minor* (Philippines, *Cuming 381*), *V. Owariensis* (Oware et Beni, *Palisot-Beauvois* in 1820), *V. remota* (Nouv. Grenade, Ocaña, *Schlim 611*), *V. Ruiziana* (Perou, Huassa-Haasi, *Ruiz & Pavon*), *V. sarmentosa* (Cap de Bonna Spéi, *Drège*), *V. tenera* (*Guenzius*), *V. zeylanica* (Ceylon, *Walker 210*).

*Woodsia mexicana* (Mexique, S. Angel, *Schaffner 306*).

This survey was made possible by the cooperation of the officers of the Botanical Garden of Rio de Janeiro, and by support from the Brazilian Research Council (Conselho Nacional de Desenvolvimento Científico Tecnológico, Proc. 30.1339/77) and the Universidade Estadual Paulista Júlio de Mesquita Filho (UNESP).

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WINDISCH, P. G. 1981. Specimens from Fée's herbarium in Rio de Janeiro (RB). Taxon 30:730.

## SHORTER NOTES

**A GERMINATION METHOD FOR ISOËTES.** — Engelmann (Trans. Acad. Sci. St. Louis 4:359–390. 1886), Campbell (Ann. Bot. 5:231–258, *t. XV–XVII*. 1891), La Motte (Amer. J. Bot. 20:217–233. 1933; Ann. Bot. n.s. 1:695–715. 1937), and Boom (Amer. Fern J. 70:1–4. 1980) all described a similar procedure for germinating *Isoëtes* spores in order to obtain endosporic megagametophytes. Their methods, however, allow the introduction of soil on the spore wall, archegonial pad, and among the rhizoids. This makes necessary the tedious separation of all mud and grit from the plant material before embedding and sectioning if torn ribbons and nicks in the microtome knife are to be avoided, according to Johansen (Plant Microtechnique, 1940). Recently I was successful in germinating megaspores of *I. engelmannii* A. Br. on an inorganic nutrient medium, which totally avoids the problem of soil on the specimens.

Material of *I. engelmannii* was collected on 5 Sept 1981, at a time when the spores were nearly mature. All plants were from the lake at Hanging Rock State Park, one of the most easterly mountain areas in North Carolina, located 32 miles north of Winston-Salem on roads NC-89 and NC-66. Mature, fertile plants along with adhering mud were removed from the bottom of the lake with as little disturbance as possible and were brought to the Duke University greenhouse. Inact plants were transplanted for future studies. Sporophylls broken off in moving the plants were used in culture studies.

The nutrient medium was that of Dr. B. C. Parker, Washington University, St. Louis, Missouri, which was used by Klekowski (J. Linn. Soc. London 62:361–377. 1969) for culturing gametophytes of the Blechnaceae. This medium was slightly modified by adding 0.30 g per liter of Mycostatin (=Nystatin, available from SIGMA) and 15 g (rather than 10 g) of agar per liter of nutrient solution. All but the very base of the sporophylls was removed and discarded. The sporangia were then sterilized in 1.31% aqueous sodium hypochlorite solution and rinsed thoroughly with sterile, charcoal-distilled water in a germ-free transfer case in a P1 physical containment laboratory to insure that the culture plates were not contaminated with fungal spores. Both micro- and megaspores were inoculated on each plate using sterilized needles and forceps. The plates were sealed with parafilm to help retain moisture. Initially, the plates were kept in the laboratory where they were exposed to normal ambient light fluctuations. After about a month in which no prothallia were observed, the cultures were placed in darkness at a temperature of $0^0$C for 2 days. Following removal from these conditions, megagametophytes at various stages of development were observed in 7–10 days. The mature female gametophyte of *I. engelmannii* exhibits an abundance of rhizoids, as well as a conspicuous protrusion of gametophytic tissue.

This technique should be suitable for other species of *Isoëtes* with little or no modification. Appreciation is extended to Bryan J. Taylor, Chief Park Naturalist of the North Carolina Division of Parks and Recreation Department, for granting a plant collecting permit.—*Sterling J. Sam, Department of Botany, Duke University, Durham, NC 27706.*

**A NEW STATION FOR LYGODIUM PALMATUM**—The senior author discovered *L. palmatum* (Bernh.) Swartz along the Blue Ridge Parkway in Swain County, North Carolina in 1980. Together we visited the site in August 1981 and collected a voucher specimen (*Stupka & Sharp 811*, TENN). The stand, which seems to be in very good health, is of interest because of its proximity to the Great Smoky Mountains National Park, where *L. palmatum* is rare. Only four stations for the American Climbing Fern have been found in the Park, and at these the species is no longer extant or the colony is diminishing. The population at the Swain County site will be monitored to see if it, too, declines or disappears. Radford, Ahles, and Bell, in their "Manual of the Vascular Flora of the Carolinas," indicate that *L. palmatum* is known from only ten counties in North Carolina. The discovery in Swain County adds an eleventh county to the list. *Lygodium palmatum* does occur in counties near Swain, but none of them are contiguous to the Park.—*Arthur Stupka, R.* #3, Gatlinburg, TN 37738 and *A. J. Sharp, Department of Botany, University of Tennessee, Knoxville, TN 37916.*

Contribution from the Botanical Laboratory, University of Tennessee, n.s. No. 539.

**THE NAME OF A HYBRID ×ASPLENOSORUS.**—The backcross hybrid between *Asplenium platyneuron* (L.) B.S.P. and ×*Asplenosorus ebenoides* (Scott) Wherry has never received a formal epithet. I wish to name it in honor of Kathryn Boydston of Fernwood, Niles, Michigan, in recognition of her many contributions to the culture of native ferns, especially of asplenioids.

**× Asplenosorus boydstonae K. S. Walter, hybr. nov.**

Herba inter *Asplenium platyneuron* et ×*Asplenosorum ebenoidem* intermedia et ex hybridatione harum specierum genita. Frons ad 21 cm longa, ad 3.5 cm lata, lanceolata, ad basim truncata, ad apicem caudata; pinnis irregulariter dispositis, inaequaliter deltoideo-lanceolatis quasi subfalcatis, obscure retroflexis. *A. platyneurone* apice minore differt, a ×*A. ebenoide* circumscriptione pinnarum differt.

Fertile fronds up to 21 cm long and 3.5 cm wide (in cultivation), lanceolate, truncate at the base. Rachis and midrib very dark brown, more or less glossy. Pinnae up to 27 on each side of the rachis, irregular in size and in placement on the rachis, inequilaterally deltate, lanceolate or subfalcate, obscurely retroflexed, occasionally auricled, the margins crenulate. Sori linear, up to 2 mm long, irregularly placed. Chromosomes 36 pairs and 36 univalents.

TYPE: Havana Glen, 1.2 km NNW of the Havana Post Office, Hale County, Alabama, *Wagner & Walter 70011* (MICH).

× *Asplenosorus boydstonae* is distinguishable from *Asplenium platyneuron* by its narrow apex and from ×*Asplenosorus ebenoides* by its greater dissection of the blade. See Walter, Wagner, and Wagner (Amer. Fern J. 72(3). 1982) for illustrations and a full discussion of this hybrid.—*Kerry S. Walter, Division of Biological Sciences, University of Michigan, Ann Arbor, MI 48109.*

**THE DELETION OF NEPHROLEPIS PECTINATA FROM THE FLORA OF FLORIDA.** — On November 22, 1959, in company with Mr. John Beckner of St. Petersburg and others, I visited the Big Cypress region east of Naples on a botanical expedition into Collier County, Florida. Leaving Bonita Springs before heading for the royal palm section west of Deep Lake, where some of the rarest Florida pteriodphytes were to be seen, we traversed a new road recently cut through the wilderness, in the hope of finding something unusual in a little explored area southeast of Corkscrew Swamp.

Along State Route 858 about 20 miles northeast of Naples we made what appeared to be an interesting discovery, a *Nephrolepis* high in a cypress tree. Since *N. exaltata* (L.) Schott (Wild Boston Fern) is the most common species in Florida, being both epiphytic and terrestrial, this would have been the most logical identification; but this fern somehow looked different, and we speculated that it might just possibly be *N. pectinata* (Willd.) Schott, a species widely distributed in tropical America. I collected and pressed one specimen, while Mr. Beckner obtained a living plant for his fern garden. Unfortunately, his plant died shortly thereafter in an early frost. Since all of his other *Nephrolepis* plants survived that freeze, this seemed further evidence that the plant we collected might actually be *N. pectinata*. However, when I showed my material to Conrad Morton, then Curator of Ferns at the Smithsonian Institution, he said that it was beyond question *N. exaltata*, calling my attention to the round or auricled pinna bases, rather than the acuminate triangles that characterize *N. pectinata*. I wrote Dr. Edgar Wherry following publication of his "Southern Fern Guide" in 1964, in which *N. pectinata* is listed among the ferns of Florida (from Collier County), and informed him of Morton's identification. He replied that he had not actually seen any living or pressed material, but had included *N. pecinata* in his book on the basis of Mr. Beckner's description and report.

In Clifton E. Nauman's article "The Genus Nephrolepis in Florida" (Amer. Fern. J. 71:35–40. 1981), he noted that he had "seen no specimens of this species in the herbaria or field. It is doubtful that this species exists in Florida." After reading his article, I wrote Mr. Nauman, enclosing photocopies of my herbarium sheet. He agreed that the fern was indeed *N. exaltata*. In view of this, *N. pectinata* should be deleted from the floristic record for Florida and the United States.—*Thomas Darling, Jr., 5008 Larno Drive, Alexandria, VA 22310.*

**A FILMY DANAEA.**— One of the rarest species of Costa Rican Danaeas is *D. crispa* Endres in Reichenb. f., which was first collected by Endres in the 1870's, probably in the northern Atlantic lowlands of the country. *Danaea crispa* is related to *D. wendlandii* and to *D. jenmanii* (the latter two may not be distinct from each other), but differs from them in having thin, crispate pinnae.

A recent collection provided the following information: the rhizome is creeping, tortuous like that of *D. carillensis* Christ, and bears a fascicle of fronds more or less spirally arranged around the tip. The fronds are pinnate and have up to 17 pairs of subalternate pinnae. The basal pinnae are much reduced, and the apical pair subtends a usually proliferous bud. The pinnae are translucent, with distant, free, forked veins. In cross section, the lamina is made up of three layers of cells, all photosynthetic. The epidermal cells are thin-walled, elongate, measure 33–61 μm in the upper surface, 53–76 μm in the lower surface, and 25–38 μm deep in each layer. The mesophyll is one-layered; its cells are equal to or smaller than the epidermal cells. From upper to lower cuticle, the laminae are 215–219 μm thick. No palisade tissue is differentiated. Chloroplasts are more or less evenly distributed in the cells, and vary from 4.1 to 10.6 μm in diameter. Around the veins, the lamina is multilayered: one row of epidermal cells, 1 or 2 layers of parenchyma, one layer of sclerenchyma, and amphiphloic vascular tissues are present. At the margins and apices of segments, the two epidermal layers join, with or without small parenchyma cells between them. There are no stomates in my specimen.

With such thin laminae, *D. crispa* is the only known filmy species in the genus, a quality which restricts its distribution to areas of extremely high relative humidity. The fronds dehyrate in less than five hours at 50% r.h. or in three hours at 45% r.h. Rehydration can take place in 2 or 3 hours by total submersion of the leaves, which regain complete turgidity and erectness.—*Luis Diego Gómez P., Museo Nacional de Costa Rica, Apartado 749, San José, Costa Rica.*

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# Ecological, Biosystematic, and Nomenclatural Notes on Scott's Spleenwort, × Asplenosorus ebenoides

KERRY S. WALTER, WARREN H. WAGNER, JR., and
FLORENCE S. WAGNER*

The best known and historically most interesting fern of the Appalachian region is the Scott's Spleenwort, ×*Asplenosorus ebenoides* (Scott) Wherry (Alston, 1940; Weatherby, 1949), a bigeneric hybrid between *Asplenium platyneuron* and *Camptosorus rhizophyllus*. The Ebony Spleenwort, *A. platyneuron* (L.) Oakes, has tall, pinnately compound leaves with shiny, blackish midribs; its veins are simple and bear parallel sori. The Walking Fern, *Camptosorus rhizophyllus* (L.) Link, has attenuate, simple leaves with green midribs; its veins are reticulate and bear arching sori. Proliferous leaves of the Walking Fern bear a plantlet at their long and thread-like tip. The hybrid fern combines the parental characteristics in a spectacular and often highly asymmetric manner.

The hybrid was first found near Philadelphia along the Schuylkill River around 1862 by a horticultural writer, Robert Robinson Scott, and has been known as Scott's Spleenwort ever since (Weatherby, 1949). Scott published a short description in Thomas Meehan's "Gardener's Monthly" in 1865 and called it *Asplenium ebenoides* (i.e., "like *ebeneum*," the then-current synonym of *platyneuron*). However, Meehan in an editorial note suggested that it might be a hybrid, and the following year the British naturalist Rev. M. J. Berkeley proposed its parents correctly (Weatherby, 1949).

A number of problems center around Scott's Spleenwort. There has been a question about the correctness of the epithet *ebenoides*. A fern considerd by some to be identical to it had been named *Asplenium hendersonii* by Houlston a decade and a half earlier than *A. ebenoides*.

It was assumed that Scott's Spleenwort was a sterile hybrid because in the original locality it occurred singly with the parents. However, around 1874, Julia L. Tutwiler, a teacher, discovered a large population of Scott's Spleenwort in Rock Hollow, near Havana in Hale Co., Alabama, a ravine later known to botanists as "Havana Glen." This apparently fertile population grew on a conglomerate rock of "pudding stone." Although Slosson (1902) proved hybridity experimentally using the gametophytes of the parents, fertility was demonstrated only much later by showing that the Havana Glen plants have doubled chromosomes and so are fertile and sexual (Wagner, 1954; Wagner & Whitmire, 1957).

Further studies have involved experimentally recreating fertile forms of ×*A. ebenoides* from sterile ones, backcrossing it, and demonstrating by chromatography that ×*A. ebenoides* contains the combined flavonoid compounds of both parents and that the $2x$ and $4x$ forms are alike in this respect (Wagner, 1954, 1956; Wagner & Whitmire, 1957; Wagner & Boydston, 1958; Smith & Levin, 1963).

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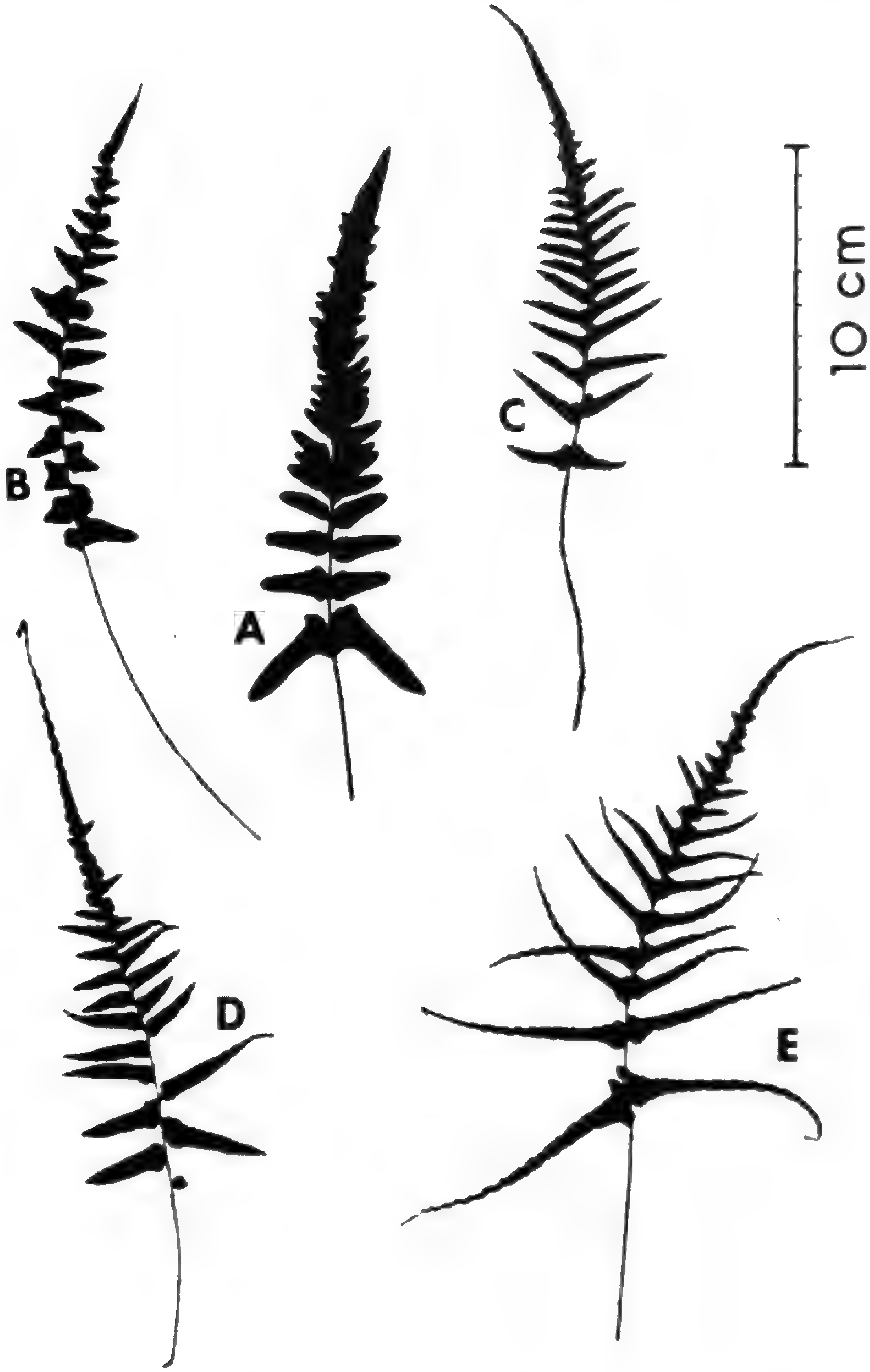


FIG. 1. Silhouettes. A. Type specimen (BM) of *Asplenium hendersonii* with stipe increased to approximate length of original description. B–E. ×*Asplenosorus ebenoides*. B. Sterile form, Mercer Co., KY, *Wagner 9127 & D. M. Smith* (MICH). C. Fertile form, Hale Co., AL, *Maxon & Pollard 335* (US). D, E. Sterile form, Giles Co., VA, *Wagner 10324.5* (MICH).

## NOMENCLATURE

For over 75 years there has been some question about the proper epithet for ×*A. ebenoides*. Carl Christensen (1905) first suggested that it might be *Asplenium hendersonii* Houlston (1851), rather than *A. ebenoides* R. R. Scott (1866). The late C. V. Morton wrote (*in litt.*, 7 February 1968), "I have really no doubt that *hendersonii* is an earlier name for *ebenoides*. It is too bad to have this well-known name abandoned, but I see no alternative." To support this proposition, Morton sent a copy of his photograph of the type specimen of *A. hendersonii* from the British Museum.

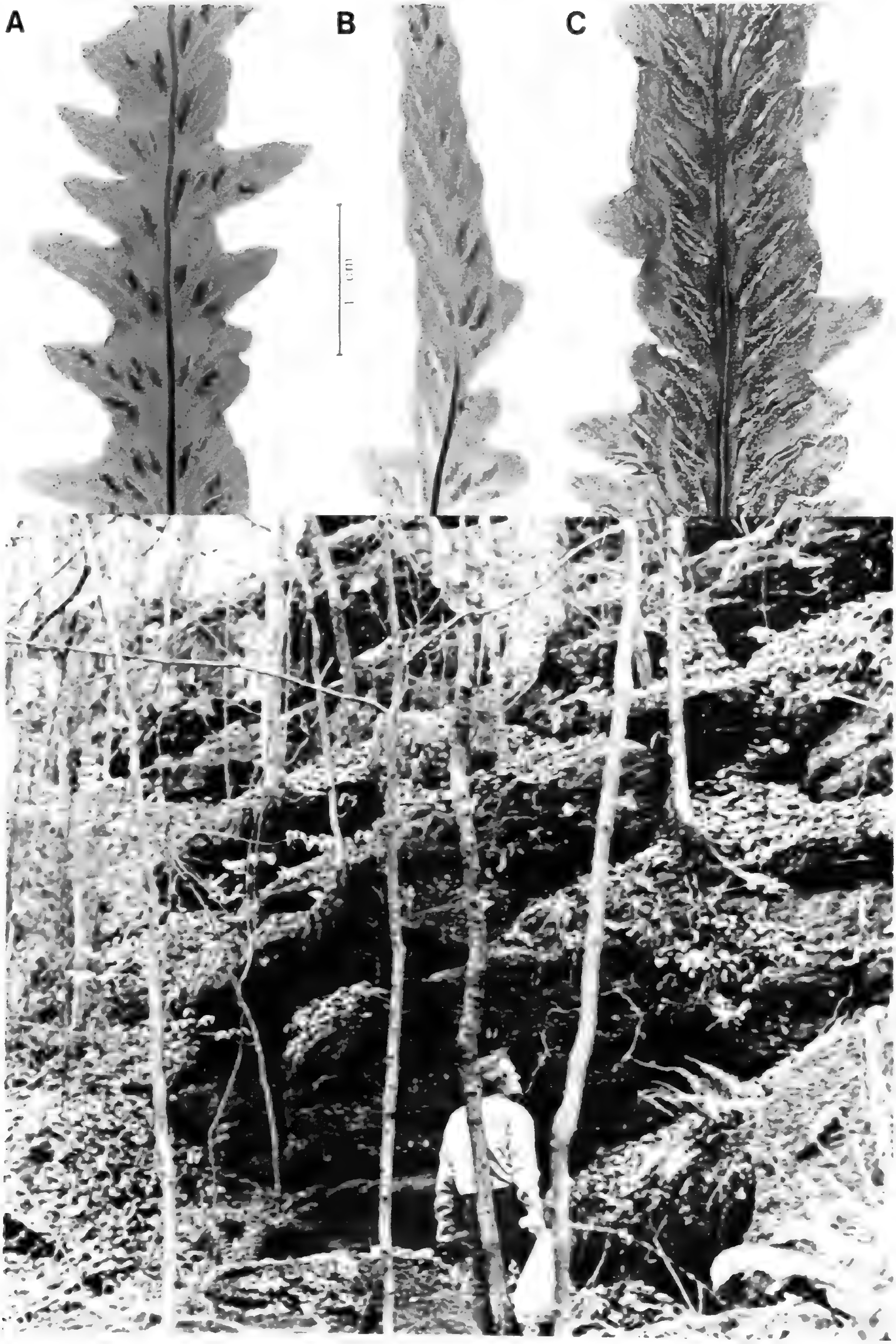
We compared the type photo (silhouette is shown in *Fig. 1A*) with fronds of equivalent size of variations of unquestioned ×*A. ebenoides (Fig. 1B–E)*. We found two important differences: in *A. hendersonii*, the basal pinnae are much broader and rounded apically while in ×*A. ebenoides*, large fronds always have narrowly caudate tips, inherited from *Camptosorus rhizophyllus*. Careful examination frequently reveals a tiny plantlet or proliferation at the extreme apex *(Fig. 1D)*. *Asplenium hendersonii* has tips ca. 3–5 times broader than those of comparable ×*A. ebenoides* specimens.

The type specimen of *A. hendersonii* is annotated as folows: ". . . this plant was raised by Mr. Henderson ('Gardener to Earl Fitzwilliam at Wentworth') from spores, but from what country received he was unable to say." According to the original description (Houlston, 1851), the stipes are "about three inches long, and thinly covered with long brown narrow scales," the latter character not found in mature specimens of ×*A. ebenoides*.

Examination of the type of *A. hendersonii* revealed the existence of several significant differences. The sori of ×*A. ebenoides* are usually 1–3 mm long and only rarely are longer *(Fig. 2A)*; those of *A. hendersonii* are mostly 2–5 mm long *(Fig. 2B)*. Many sori and indusia in the upper half of the blades of *A. hendersonii* are double, and arise from two adjacent veins which meet one another, precisely as is found in the Hart's-Tongue, *Phyllitis*. The other distinctions of *A. hendersonii* can be readily explained if *Phyllitis*, rather than *Camptosorus*, is postulated as one of the parents. The "stubby" pinnae tips, the broad leaf apex, and the long sori are, of course, all features of *Phyllitis* and not *Camptosorus*.

We conclude, therefore, that *A. hendersonii* is really an ×*Asplenophyllitis* Alston, i.e., a spontaneous hybrid between *Phyllitis scolopendrium* and some species of *Asplenium*, perhaps the Sea Spleenwort, *A. marinum*, which is widespread along the coasts of England and Europe. Natural hybrids of *Phyllitis* with *Asplenium* are well known (Alston, 1940, listed three) as are artificial ones (Lovis, 1973). It is even possible that spores of *Phyllitis*, a very popular species in cultivation, germinated together with spores of an *Asplenium* in cultures sown by Henderson, giving rise to *A. hendersonii*. It is clear, therefore, that *hendersonii* is not the correct epithet for the Appalachian hybrid.

If Scott's Spleenwort is kept in the genus *Asplenium*, the name should appear as *Asplenium* ×*ebenoides*, using the multiplication sign, as prescribed by the International Code of Botanical Nomenclature, to indicate its hybrid nature. As to the rare fertile form, it has been argued elsewhere (Wagner, 1969) that it is irrelevant whether


A
B
C
1 cm

the plant is sterile or fertile. Since it is a hybrid, diploid or tetraploid, the hybrid sign should be used, and the cytological condition be indicated by a descriptive phrase "sterile diploid form" or "fertile tetraploid form." In the case at hand, the fertile tetraploid form has been produced in culture directly from the sterile form (Wagner & Whitmire, 1957).

However, we believe the name of the plant should be ×*Asplenosorus ebenoides* (Scott) Wherry, with the multiplication sign before the generic name, as this plant is, according to most present thinking, an intergeneric hybrid (Mickel, 1974). *Camptosorus* should be maintained as a genus because its differences from *Asplenium* are of the same magnitude as those of other genera in the Asplenioideae such as *Diellia* and *Phyllitis*. There is no reason to abandon the genus *Camptosorus* simply because it hybridizes with *Asplenium*. Lovis (1973) discussed intergeneric fern hybrids and pointed out that not only are there *Asplenium* × *Camptosorus* (= ×*Asplenosorus* Wherry) hybrids known, but *Asplenium* × *Phyllitis* (= ×*Asplenophyllitis* Alston), *Asplenium* × *Ceterach* (= ×*Asplenoceterach* D. E. Meyer), *Camptosorus* × *Phyllitis*, and *Asplenium* × *Pleurosorus* as well.

## STATUS OF THE HAVANA GLEN POPULATION

This report is based upon field studies by W. H. Wagner and K. S. Walter in 1971 and by Dr. R. R. Haynes of the University of Alabama in 1978; the most recent previous report is that by Wherry and Trudell (1930). The locality is approximately 40 km south of Tuscaloosa outside of Havana. Winters are relatively mild, with the leaves off the deciduous trees and shrubs, and most annual herbaceous shoots withered.

What we call "Havana Glen" is known locally as "Rock Hollow." It is owned by Mrs. R. B. Lavender, of Mobile, Alabama, who has strict rules governing who can enter the area and whether logging is permitted in or near it. We discussed the past history of the unusual fern populations with her relative, Mrs. T. N. Lavender, who remembered the botanists who had visited, especially H. E. Ransier of Manlius, New York, who traveled to Havana at least twice[1].

Miss Tutwiler originally described the habitat as "about eight miles from the Black Warrior River . . . The soil is either red clay or a mixture of sand and gravel except in the creek and river bottoms. The country is rolling, covered with hills

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[1] According to our records, the following botanists visited the locality. Most made collections now deposited in well-known herbaria: 1884—Julia T. Tutwiler; 1890—J. W. A. Wright; 1892—L. T. Ward; 1896—L. Underwood; 1900—C. L. Pollard and W. R. Maxon; 1905—E. A. Smith; 1907—J. W. Moreland; 1912—G. L. Fischer; 1918, 1920—E. W. Graves; 1928, 1933—H. E. Ransier; 1929—E. T. Wherry and H. W. Trudell; 1967, 1974—B. E. Dean; 1971—W. H. Wagner, Jr. & K. S. Walter; 1978—R. R. Haynes.

FIG. 2. Comparison of ×*Asplenosorus ebenoides* and Asplenium hendersonii. A–B. ×*Asplenosorus ebenoides*. A. Abaxial side of frond near tip showing short, unpaired sori, *Wagner 76016* (MICH). B. Same, *Wagner s. n.*, 5 Dec 1955 (MICH). C. Type specimen of *Asplenium hendersonii*. Abaxial side of frond from a comparable area showing longer, paired sori, and broader lamina. FIG. 3. Havana Glen, Hale Co., AL, habitat for ×*Asplenosorus ebenoides*, showing moss- and lichen-covered boulders of conglomerate rock.

about 200 feet above sea level" (Dean, 1969). The Hollow lies along a brook below farm fields 1.2 km NNW of the Havana Post Office. The valley side where the rock crops out slopes approximately 20–35° *(Fig. 3)*. The slopes are occupied mainly by deciduous trees; toward the bottom of the valley increasing numbers of mountain laurel, *Kalmia latifolia*, appear. Haynes (pers. comm.) considers the forest an excellent representative of the deciduous forest of Alabama, "as natural as you can get in the state." It shows no evidence of logging. Some of the prominent trees include *Quercus alba*, *Q. rubra*, *Q. prinus*, *Fagus grandifolia*, *Illicium floridanum*, *Liriodendron tulipifera*, and *Magnolia macrophylla*. Scattered shrubs and woody vines include *Vitis* spp., *Smilax* spp., *Euonymus americanus*, and *Hydrangea quercifolia*. The forest is somewhat open and park-like.

The rock outcrops in the valley are 0.5–8 m tall, and most are north-facing. Wherry and Trudell (1930) described the rock as a brownish conglomerate of siliceous pebbles in a ferruginous and slightly calcareous cement and the soil reaction at the roots of the ×*Asplenosorus* plants as being minimacid[2]. The more or less crowded pebbles in the sandy substratum are smoothly rounded, indicating stream wear prior to consolidation.

The rocks are coated with green bryophytes and/or fine, white, crustose lichens. Those collected in association with ×*Asplenosorus ebenoides* were identified by Howard A. Crum of the University of Michigan Herbarium. The crustose lichen is a species of *Parmelia*. The most abundant mosses are *Anomodon attenuatus* (Hedw.) Hub. *(Wagner 71167)* and *Bryoandersonia illicebrum* (Hedw.) Robins. *(71168)*. Together with the liverwort *Metzgeria furcata* (L.) Dum. *(71169)* were mixed small quantities of the moss *Brachythecium oxycladon* (Brid.) Jaeg. & Sauerb. and two liverworts of the genera *Radula* and *Frullania*. Two additional mosses occur frequently, viz. *Fissidens cristatus* Wils. ex Mitt. *(71170)* and *Anomodon rostratus* (Hedw.) Schimp. *(71171)*. Vouchers are deposited in the University of Michigan Herbarium (MICH).

The majority of ferns and herbs occur on and around the rock outcrops rather than on the leaf-covered forest floor. Scattered plants of *Polystichum acrostichoides*, *Dryopteris marginalis*, and *Hexastylis* sp. may grow in the flatter, non-rocky areas, but all three tend to be more common at and around the rock bases. On the boulders themselves are such herbs as *Mitchella repens* and *Saxifraga virginiana*. The latter, together with *Hepatica americana*, may sometimes be found in bloom as early as January or February.

In addition to the *Polystichum* and *Dryopteris*, we found nine additional fern species or hybrids at the locality. The most common are *Polypodium polypodioides*, *Asplenium platyneuron*, and *A. trichomanes*. Along the upper slopes are large plants of *Cheilanthes lanosa*. Masses of tangled green filaments in sheltered, deeply shaded crevices of the rock are clonal gametophytes of the filmy fern genus *Trichomanes*. A large patch of sporophytes of *T. boschianum* occurs on the vertical wall in a recess of one of the larger cliffs.

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[2] Donald Farrar reports (pers. comm.) that this substrate is Pottsville sandstone of Pennsylvanian age, with a slightly acidic pH (5 to 6).

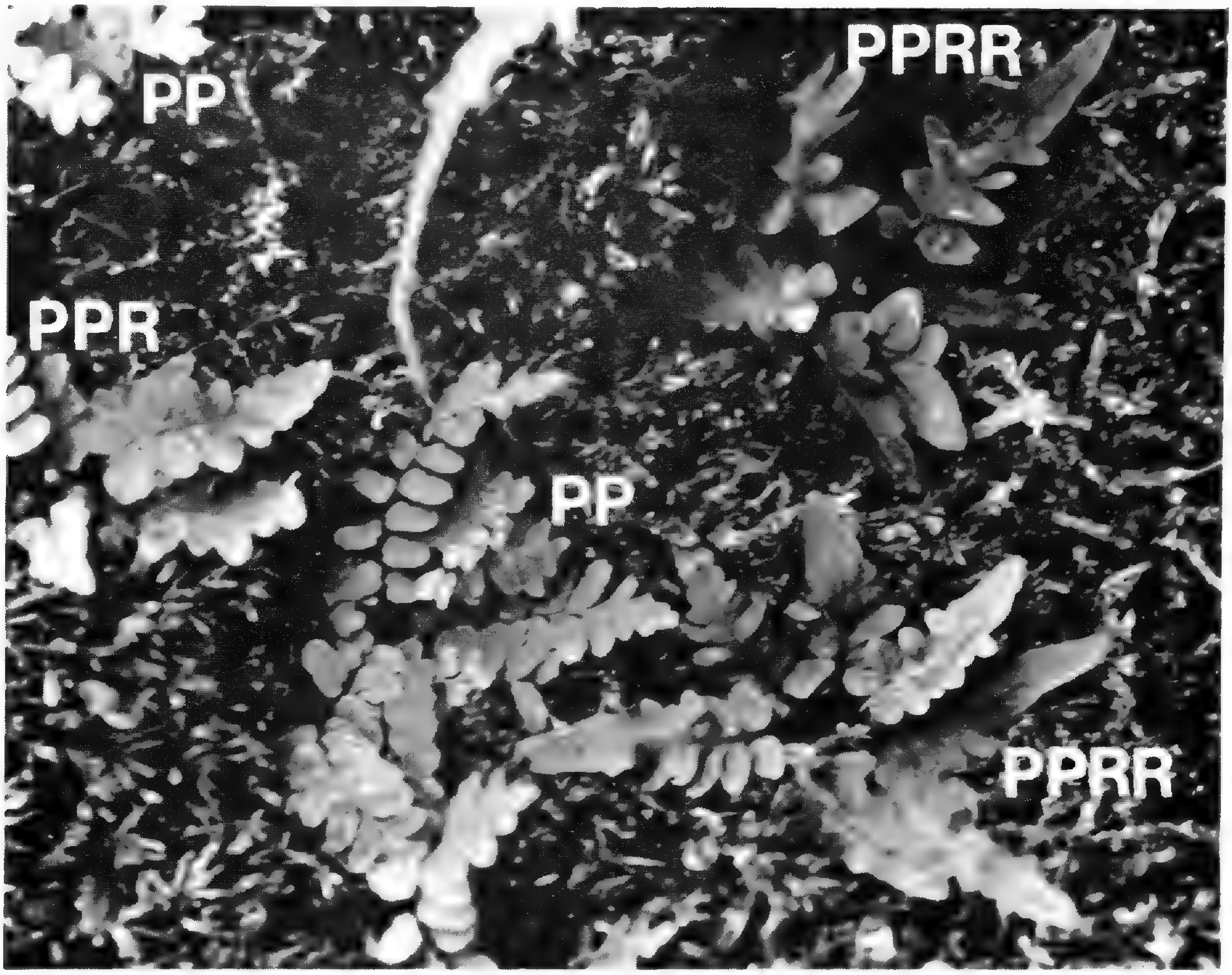

FIG. 4. Young spleenworts on moss-covered rock at Havana Glen, AL. PPR = ×*Asplenosorus boydstonae* (= *Asplenium platyneuron* ×*Asplenosorus ebenoides*). PP = *A. platyneuron*. PPRR = × *A. ebenoides*.

We did not find *Camptosorus rhizophyllus* in our explorations. Wherry and Trudell (1930) had the same experience, although Wherry wrote (*in litt.*, 1972) that "The St. John brothers told us that they had visited the 'glen' and found . . . the two parents," and the original discoverer, Miss Tutwiler, had written that she found walking fern there (Dean, 1969). It is possible that all of these people were in some other valley nearby. For example, Wherry, (op. cit.) wrote,

> After I visited the "Glen" I thought it would be interesting to see what was in other ravines nearby. . . . Assuming that I started north, the road descended down the conglomerate-rock escarpment (on the east side of the Glen) and joined an east-west road running along the valley. I walked eastward along this road, repeatedly ascending small cliffs, and entering small ravines, probably for a distance of a mile. *Asplenium platyneuron* was conspicuous everywhere; but the *ebenoides* did occur repeatedly on both moist and dry rock surfaces.

Although Wherry did not find *Camptosorus*, his finding other nearby ravines suggests that a detailed exploration of the whole area in the vicinity of Havana Glen might be profitable. Not only might populations of *Camptosorus* turn up, but other interesting pteridophytes as well.

FIG 5. Silhouettes of medium- and large-sized fronds of plants collected at Havana Glen, AL, and cultured in greenhouse. Left = ×*Asplenosorus boydstonae*. Right = *Asplenium platyneuron*.

## THE TETRAPLOID EBENOIDES POPULATION AND ITS BACKCROSSES

In view of Wherry's comments quoted above, it is possible that *A.* ×*ebenoides* is considerably more widespread in the Havana area than has been believed. The following is based upon our observations made during the 1970's. The fertile Scott's spleenwort is much less common in the Glen than either *A. platyneuron* or *A. trichomanes*. Juvenile specimens are abundant intergrown with juveniles of other spleenworts. The number of ×*A. ebenoides* plants is estimated to be between 200 and 300. Most are small, the number of fronds ranging from 3 to 7 and the frond size 3 cm or less *(Fig. 4)*. Isolated, single plants are exceptional; most of the individuals are in groups of several to 2–3 dozen. Plants with sori had fronds as short as 4 cm long including the petiole when they occurred in relatively dry, exposed places, and up to more than 14 cm long in damper, shady places. We observed fewer than three dozen soriferous plants, these widely scattered and not confined to a single area.

No plants, even the largest, showed frond-tip proliferations visible to the naked eye, although such proliferations have been reported in the past. According to Wherry (pers. comm.), the proliferous tip illustrated by him and Trudell (1930) was not from the Glen, but from outcrops of dry conglomerate half a mile or so east. Functional proliferations must be extremely rare, and vegetative reproduction is of little or no importance in maintaining the population. Virtually all of the plants evidently arise from spores.

The small plants grow slowly, especially during dry years (even though in culture they may be vigorous and fast growing, almost becoming greenhouse weeds). Similarly, many of the spleenwort populations in peninsular Florida are noted for waxing and waning year to year, depending upon climate. During drought, populations become reduced to tiny plants, many so small as to simulate sporelings. In moister periods, the spleenworts spring up and form large, soriferous plants of mature form. The conditions at Havana Glen may be similar.

In the Appalachian spleenworts, backcross hybrids are rare, the exception being the sterile triploid hybrid ×*Asplenosorus pinnatifidum* × *Asplenium montanum*, (= ×*Asplenosorus trudellii* (Wherry) Mickel) (W. Wagner, 1954). This is so common in some localities that it must have some method of propagation, although the spores are highly abortive, and meiosis involves both univalents and bivalents.

Some backcrosses of ×*Asplenosorus ebenoides* have been produced in the laboratory, including the tetraploid, fertile form with its parents. The backcross to *Asplenium platyneuron* (= ×*Asplenosorus boydstonae* K. S. Walter) was first synthesized experimentally at the University of Michigan (Wagner, 1956); and this as well as the backcross to *Camptosorus rhizophyllus* at Fernwood, Niles, Michigan (Wagner & Boydston, 1958).

Backcross leaves are intermediate in structure. The *A. platyneuron* backcross has leaves like *A. platyneuron* but possesses a caudate tip shorter than that of ×*A. ebenoides*. The leaves of the *Camptosorus rhizophyllus* backcross look like irregularly lobed Walking Fern leaves. In describing the *A. platyneuron* backcross, we noted that it "has very little likelihood of ever being discovered in the wild, except possibly in one small area in Hale Co., Alabama," by which we meant Havana Glen. A particularly fine mixed colony was found by K. S. Walter in 1971 on the east-facing side of a boulder. Here we encountered the first wild examples of ×*Asplenosorus boydstonae*. This boulder was approximately 1 m high and 2.5 m wide. Mosses covered roughly one-half of its surface; the remainder was white with crustose lichens. In the mosses were 35 plants of ×*Asplenosorus ebenoides*, 12 large, fertile, up to 15 cm long, and the remainder small, like those in *Fig. 4*. There were 23

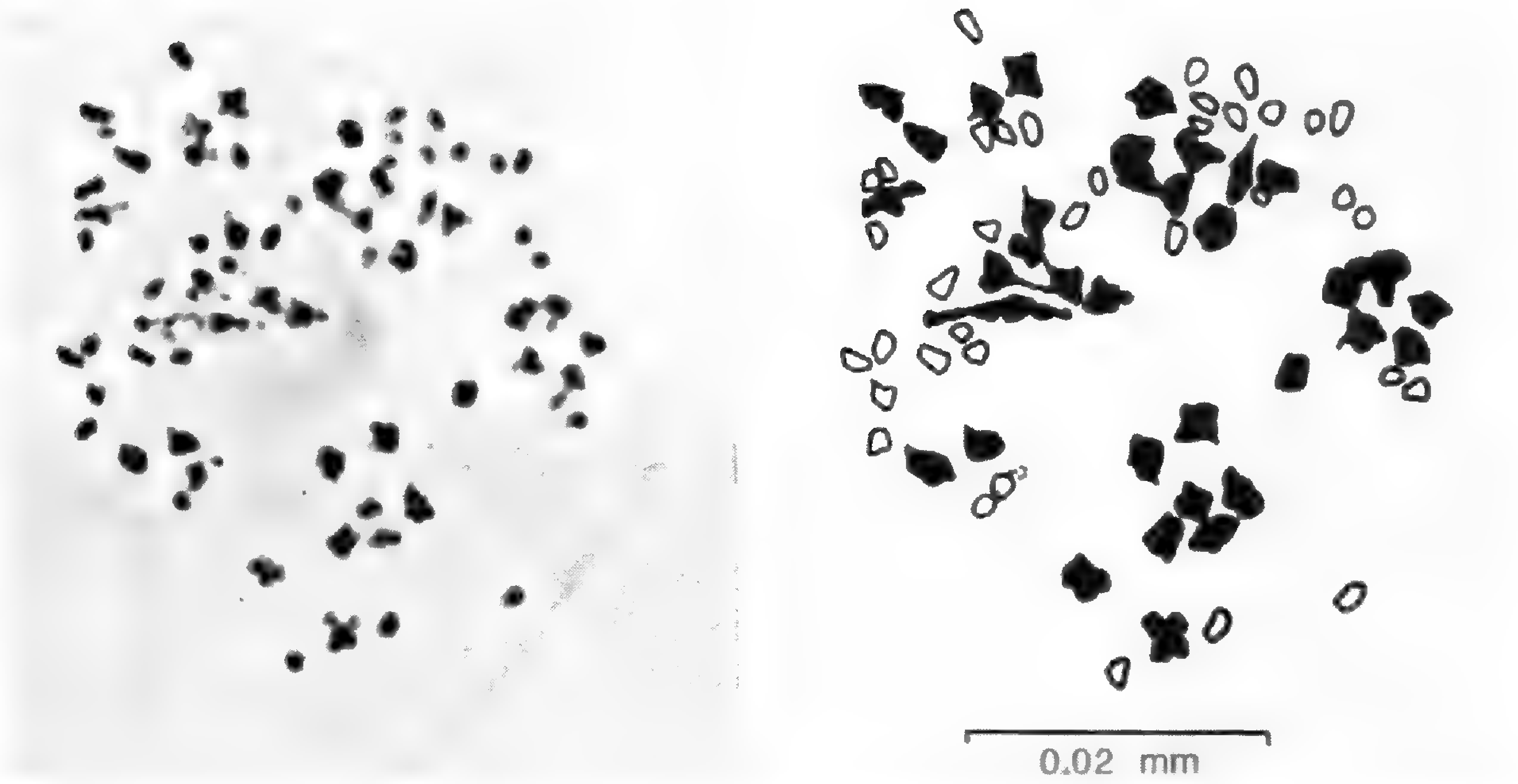

FIG 6. Chromosomes of a natural ×*Asplenosorus boydstonae* hybrid from Havana Glen, AL, showing 36 pairs (PP) and 36 singles (R).

plants of *Asplenium platyneuron,* of which only four were fertile and up to 15 cm long. One small plant of *A. trichomanes* was present.

Growing with them were three plants of small size but obviously greater blade division than in equal-sized plants of typical ×*Asplenosorus ebenoides* (see *Fig. 4*). Two specimens were taken alive for culture purposes. We grew them to full size *(Fig. 5),* and found them to be morphologically identical with the experimentally produced backcrosses. They have 108 chromosomes (i.e., the triploid condition, with 36 pairs of chromosomes from ×*Asplenosorus ebenoides* and 36 singles from *Asplenium platyneuron, Fig. 6*), as had the laboratory specimens (Wagner & Boydston, 1956, pl. V, figs. $A_1$–$A_4$).

The discovery of the sterile backcrosses, ×*Asplenosorus boydstonae,* at Havana Glen may be the first case in pteridology in which a taxon was produced initially in the laboratory under experimental conditions and only discovered later as a wild plant growing under natural conditions.

We wish to express thanks to R. R. Haynes, Clive Jermy, Mrs. T. N. Lavender, Mary R. Rainey, Donald Rainey, James Rainey, the late Edgar T. Wherry and to the late Blanche E. Dean for their assistance in this study.

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# Cheilanthes feei New to Virginia

THOMAS F. WIEBOLDT* and STAN BENTLEY**

The Slender Lip Fern, *Cheilanthes feei* Moore, is a widely distributed species of the western United States which occurs eastward to Arkansas, Missouri, Kentucky, and Illinois (Fernald, 1950; Steyermark, 1963; Cranfill, 1980; Mohlenbrock, 1967). The easternmost station for this fern was along Cedar Creek in Bullitt County, Kentucky, in a region known as The Knobs. This small population, discovered originally by Clyde Reed (Reed, 1952), is thought to be disjunct from the next nearest stations along the Ohio River in southern Illinois (Cranfill, 1980). *Cheilanthes feei* was discovered in 1979 by Bentley during a routine survey of the plants of Claytor Lake State Park, Pulaski County, Virginia. The actual identity of the plant went unknown until the station was visited by the authors on May 8, 1981, when the first voucher collections were made. This discovery is a remarkable disjunction of approximately 450 km eastward from the Bullitt County, Kentucky station and nearly 650 km from the more contiguous portion of its range from Illinois westward.

The preferred habitats of this fern are dry, exposed crevices in limestone or dolomite cliffs (Wherry, 1961; Mohlenbrock, 1967). Extensive exposures of this kind may be found along the New River in Virginia. Claytor Lake is a large impoundment of some 4500 acres formed in 1939 when the Appalachian Power Company built its Claytor Dam on the New River just upstream of Radford, Montgomery County, Virginia. In the southeastern sector of Pulaski County, the New River is deeply entrenched where it has cut through thick beds of limestone of the Rome formation and Elbrook dolomite, both of Cambrian origin. The more resistant dolomite forms nearly vertical cliffs, frequently several hundred feet high. The station for *C. feei* is a rather small but precipitous cliff, perhaps fifty feet high, which forms a nose-like projection along a westward facing portion of the shoreline. Because of the configuration of the rock, the exposures range from northwestern to southern. During a second visit to the outcrop on May 14, 1981, an estimate of 1200 plants was made. Most of these are extremely small and occupy nearly every minute fracture in the rock. Several hundred larger, mature plants crowd the deeper cracks and more protected, overhanging sites. Several smaller, shaded outcrops in oak woods adjacent to the main cliff support a considerable number of additional plants. Adjacent areas of the lake shore, where similar outcrops and exposures occur, were searched for additional populations of *C. feei*, but only six other plants were found on a very small ledge at the water level several hundred feet to the north. Since the normal pool elevation is approximately eighty-feet above the former river level, this same outcrop was undoubtedly much more extensive prior to flooding. A much larger population may have existed and, of course, other nearby populations may have been inundated by the lake waters.

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The flora of this outcrop is typical of many other outcrops in this portion of Virginia. Chestnut Oak (*Quercus prinus*) and Red Cedar (*Juniperus virginiana*) occur on a rather broad ledge and in deep crevices of the rock. Other woody species include *Rhus aromatica, R. radicans, Rhamnus lanceolata*, and *Clematis viorna*. Where soil accumulation is sufficient, a mat of vegetation has developed which is made up principally of *Poa compressa, Carex eburnea, Aquilegia canadensis, Aster oblongifolius*, and *Solidago sphacelata*. The *Carex* is particularly representative of such sites. Other ferns associated with the Lip Fern site are *Pellaea atropurpurea* and *Asplenium ruta-muraria*. A few individuals of *Pellaea glabella* were also found. Interestingly, the Slender Lip Fern overwhelmingly dominates the available space on the outcrop, despite the presence of other rock ferns characteristic of the habitat and common in this portion of the state. The presence of many individuals of various ages and colonization of such minute cracks is indicative of reproduction by spores. It is interesting that *Cheilanthes feei*, seemingly prolific at one station, has not colonized other available spaces in its proximity.

Other important fern distributions in Virginia are associated with the New River. The Venus Maidenhair, *Adiantum capillus-veneris*, was known only from a single 1879 collection from the same region of Pulaski County (Stevens, 1973). One of only two former stations for *Cheilanthes alabamensis* was a dolomite cliff along the New River in Giles County, Virginia, this being the northeasternmost record for the species.

The occurrence of *C. feei* in the Appalachian Valley of Virginia is particularly notable for several reasons. This record adds another species to the list of pteridophytes distributed primarily in the West or Southwest which occur as long-range disjuncts in the Southern Appalachians. Included in this list are *Asplenium septentrionale* (Emory, 1970), *Cheilanthes castanea* (Knobloch & Lellinger, 1969), and *Notholaena sinuata* (Univ. of Georgia Herbarium, pers. comm.). How these species have come to occur in the eastern states is an interesting question. The newly discovered Lip Fern station could be regarded as a relict from a former, more widespread distribution, or it could be considered an example of a long-distance dispersal. For other kinds of plants, the objections to the latter hypothesis are varied, but for leptosporangiate ferns, these are largely unfounded. Aerial dissemination of the minute spores over great distances does not stretch the imagination. This is pointed out by Shaver (1954) in a discussion of the disjunct occurrence of a coastal plain species, *Woodwardia virginica*, in Tennessee. Since the possibility of such an event is very small, time is a major constraint on the theory. The relictual theory attibutes a more eastern (and presumably broader) distribution to more favorable climatic conditions sometime in the past. This is a concept familiar to most phytogeographers in the region. The shale barren flora, with its western affinities, has already drawn speculation as to how that endemic flora may have evolved (Keener, 1971). An eastward migration of several of these species (or their ancestral populations) may have occurred in response to a presumed warmer and drier climate, perhaps the Xerothermic Period (Sears, 1942). Even if such a climatic extreme did happen, it is reasonable to assume that the precipitous, xeric cliff habitat preferred by *C. feei* would still have occurred as isolated habitats and necessitated some rather long "jumps" to get from one place to another. This kind of migration would have required long periods of time, as well. The fact that *C. feei* is found along New River is important in this regard. The New River, despite its name, is believed to be one of the oldest rivers in the world, being a remnant of the old Teays River which drained the area since the late Cretaceous Period. Consequently, there has been plenty of time—so much, in fact, that either hypothesis is plausible. The antiquity of the river affords us a dimension unavailable in most studies in plant geography. It is important to consider the many interesting plants which occur along New River, their distribution, and biology. Since there is so much more than a single, bizarre disjunction associated with the river, we prefer to think of this as another example in support of a relictual interpretation of the facts. The occurrence of *C. feei* in Pulaski County, Virginia substantiates the importance of the New River as an ancient source of specialized habitats and as a corridor for plant migrations through eons.

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# A New Woodsia Hybrid From Kansas

RALPH E. BROOKS*

*Woodsia* R. Br. is a genus of about 25 species distributed worldwide except for Australia and Antarctica (Brown, 1964). Rosendahl (1915) was the first to describe a hybrid *Woodsia (alpina × ilvensis)* from specimens collected near Stockholm, Sweden. Butters (1941) reported *W. cathcartiana* (= *W. oregana* var. *cathcartiana*) × *ilvensis* and Tryon (1948) reported both *W. glabella* × *ilvensis* and *W. cathcartiana* × *scopulina*, all from southern Minnesota or southwestern Ontario. Thus, compared to genera such as *Asplenium* or the promiscuous *Dryopteris*, hybridization would appear to be an unusual event among woodsias.

In June 1976, while collecting along a sandstone outcrop in an upland prairie in the Smoky Hills of central Kansas, I discovered a mixed colony of *W. obtusa* (Spreng.) Torr. and *W. oregana* D.C. Eat. var. *oregana*. A thorough search of the outcrop revealed an abundance of *W. oregana* in the drier, exposed sites, a fair number of *W. obtusa* in more protected, mesic sites, and a few individuals which appeared to be morphological intermediates of the two species. A limited sample of specimens was removed from the colony for further study.

Examinations of the hybrid and parental plants revealed morphological intermediacy occurring in several characters on the hybrid plants. This is demonstrated by polygonal graphs of mean values for six characters (*Fig. 4*), including frond length, blade width and texture, stipe base color, stipe vestiture, and the shape of indusium segments. The indusia, which are traditionally used as a primary diagnostic character in *Woodsia*, were viewed with the aid of a Phillips 501 scanning electron microscope (*Figs. 5–10*). The indusia of *W. obtusa* consist of 4–6 wide, plate-like segments while those of *W. oregana* consist of 5–9 filamentous segments. Hybrid individuals have indusia with 5–10 segments that were each several cells wide and 2–3-furcate or otherwise irregularly lobed apically.

Spore characteristics were also examined with the SEM. Brown (1964) stated that *Woodsia* spores were of no diagnostic value. While this may be true for light microscope studies, it would appear not to be so for SEM work. Surface ornamentation for *W. obtusa* and *W. oregana* in Kansas, as well as several other sites in the Great Plains, are consistent with those illustrated herein (*Figs. 11–16*). Of particular interest are the walls forming the reticulate surface in each species. Those of *W. obtusa* are 3–4μm high and form complete areoles. In *W. oregana* the walls are 1–2μm high and frequently "dead end," i.e. they do not always connect to form complete areoles. In addition, there is an obvious difference in the surface texture in each species. Spores from the hybrids were typically abnormal and abortive, although a very few nearly normal spores were observed (*Figs. 13–14*). The latter spores display some degree of intermediacy, having the disconnected walls of *W. oregana* and surface texture of *W. obtusa*.

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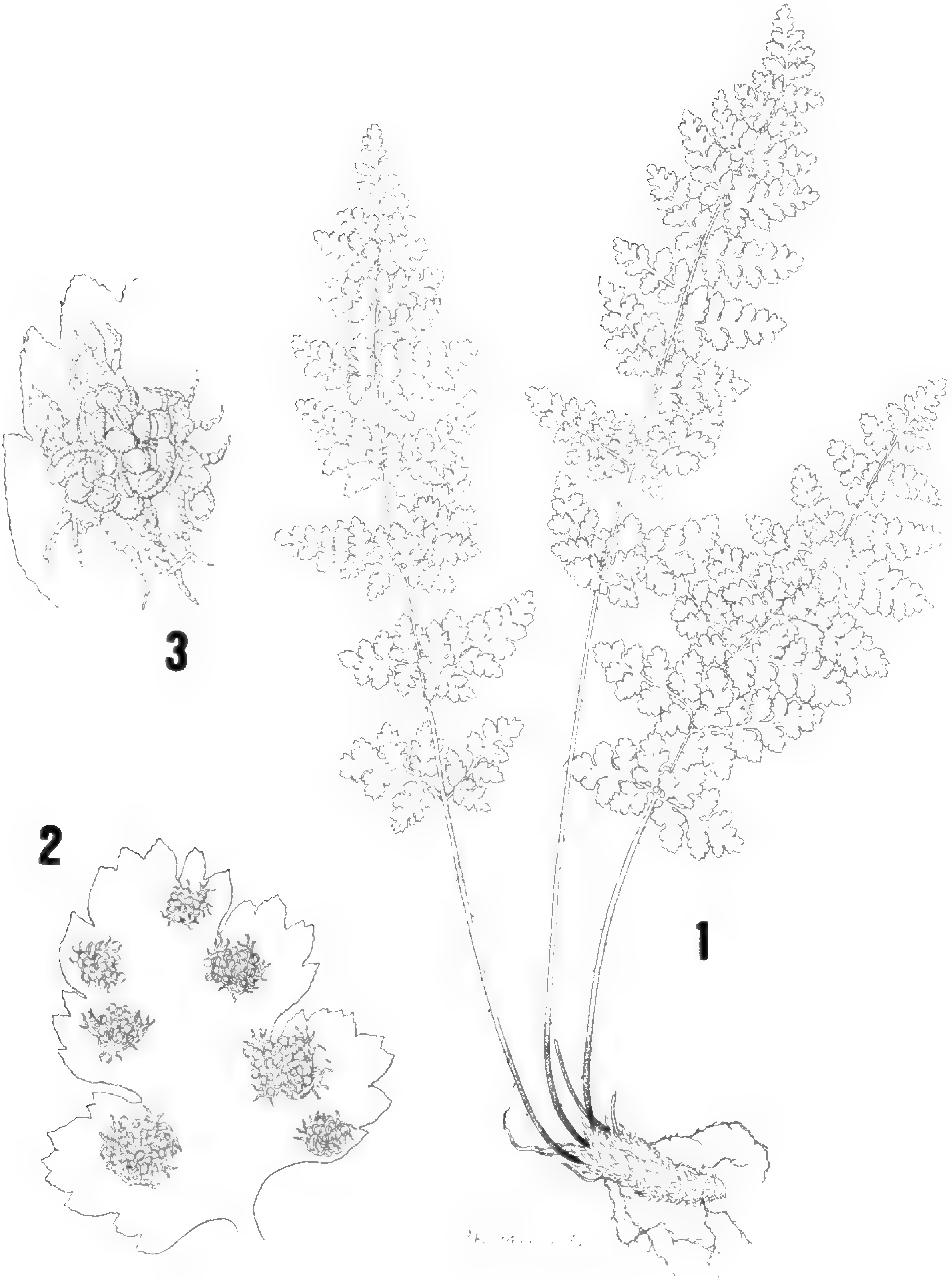


FIGS. 1–3. Holotype of *Woodsia* ×*kansana*, *Brooks 12259d* (KANU). FIG. 1. Habit. FIG. 2. Pinna. FIG. 3. Sorus.

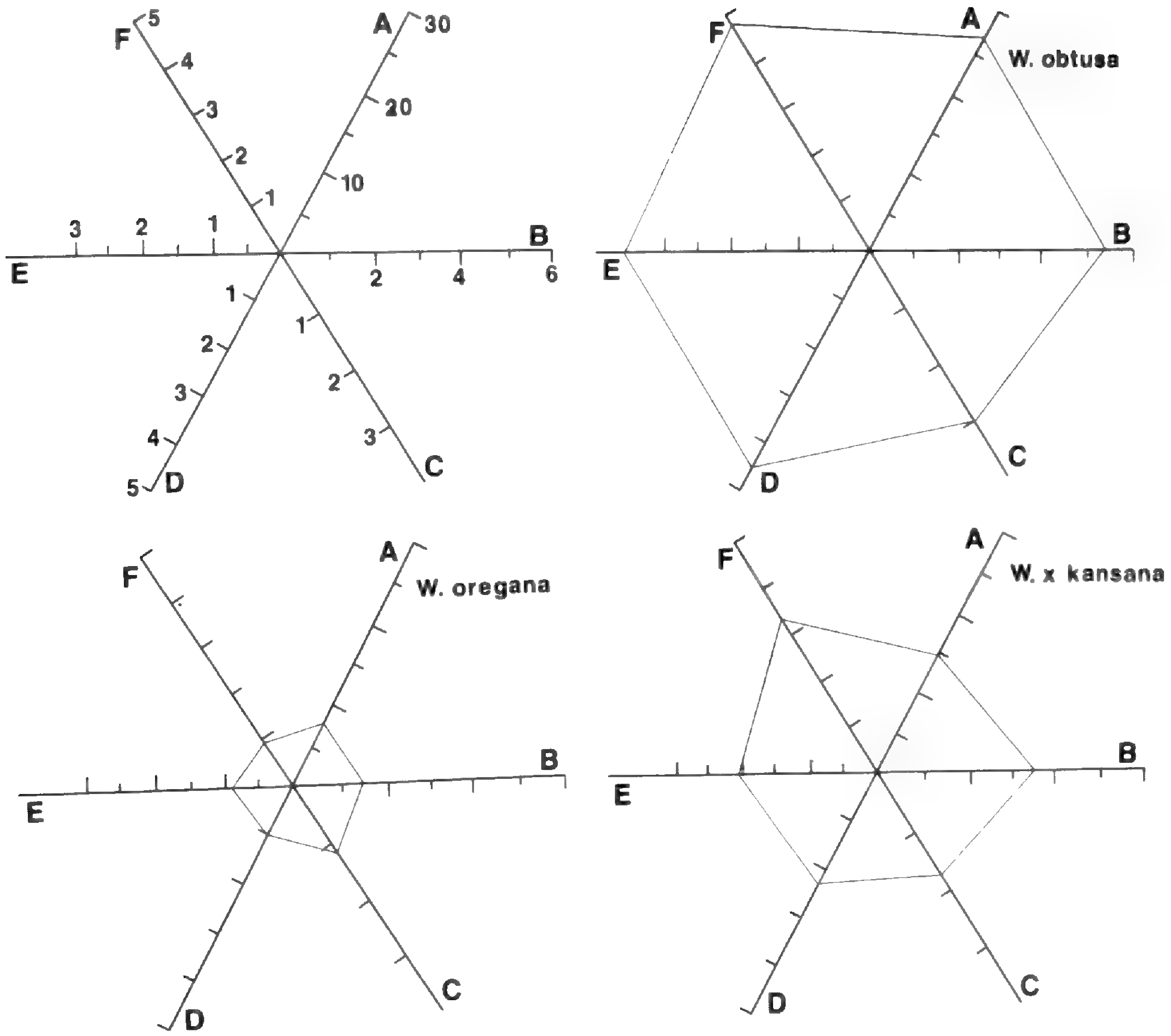
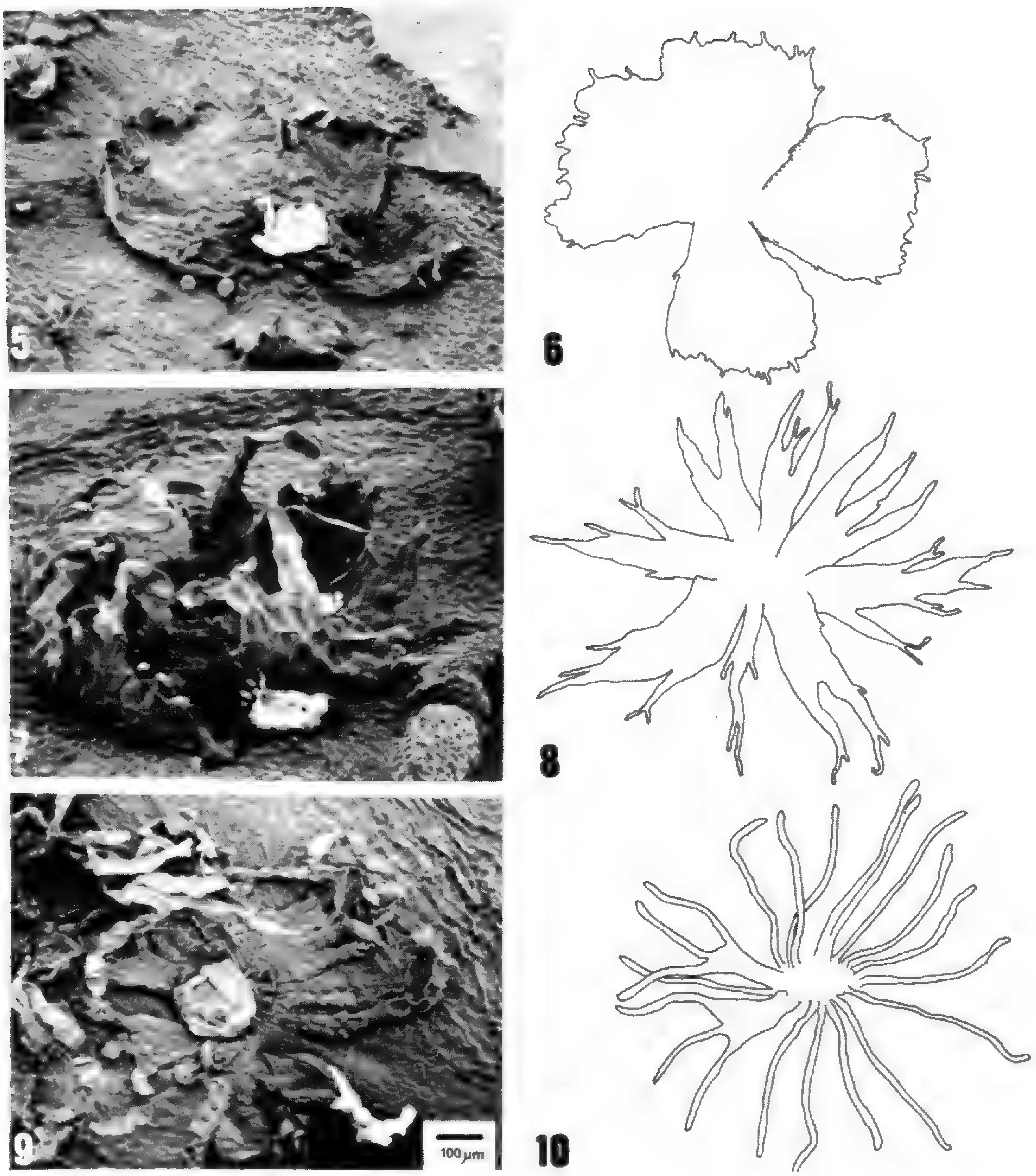


FIG. 4. Polygonal graphs of mean values of six characters for central Kansas Woodsias. The abbreviations are: A = frond length (cm), B = frond width (cm), C = blade texture (coriaceous to membranaceous), D = stipe base color (dark reddish brown to stramineous), E = stipe vestiture (lacking scales to scaly), and F = indusium segments (filamentous to wide and plate-like).

Cytologically, Brown (1964) indicates that *W. obtusa* is a tetroploid, $n = 76$, probably derived from *W. oregana*, $n = 38$. A firm chromosome count has not been established for the hybrid plants. However, my colleague Dr. Christopher Haufler has observed meiotic irregularities, as one might expect given the differences in chromosome numbers of the parental species.

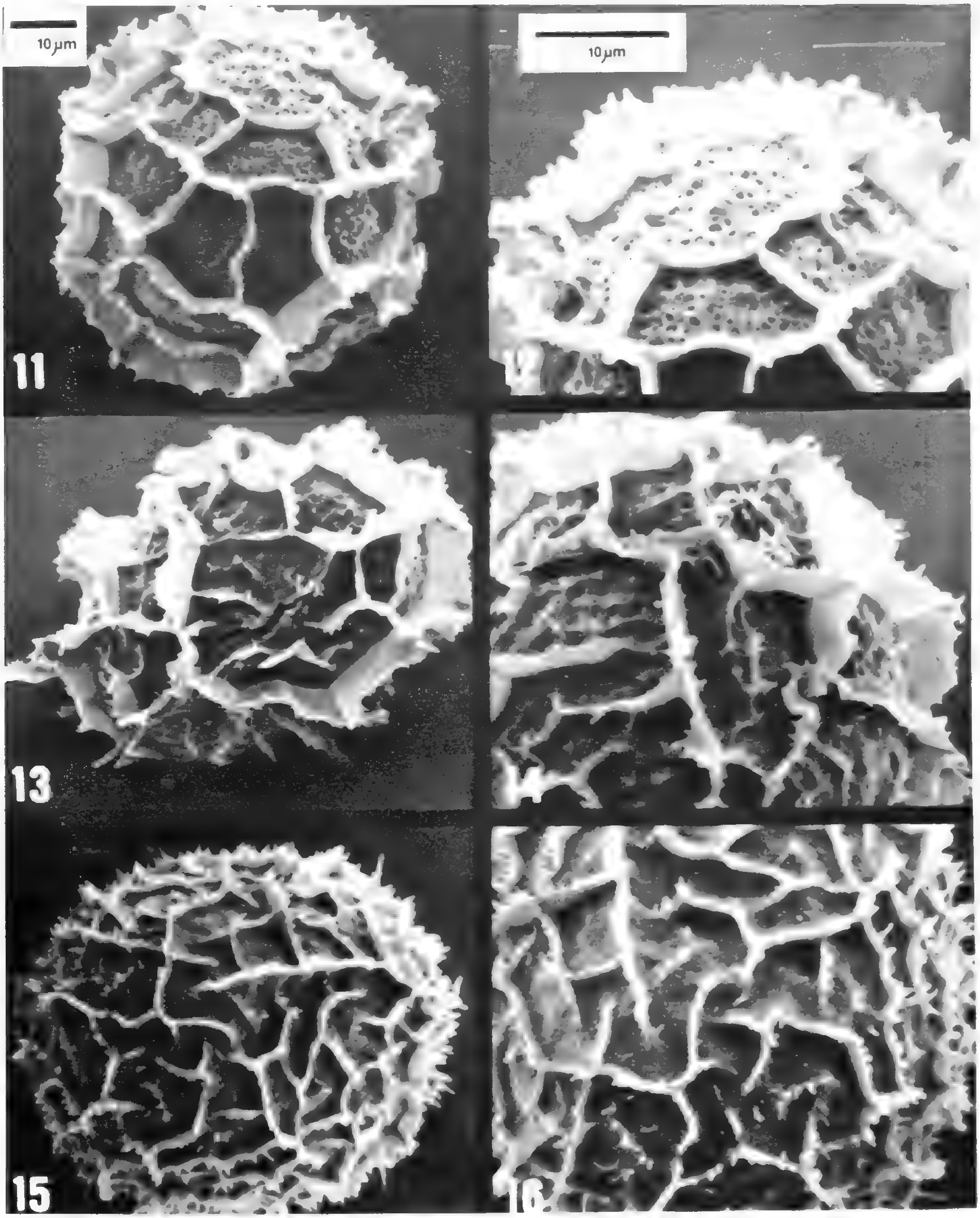
The morphological intermediacy, spore morphology, and meiotic irregularities fulfill the criteria for hybridity as outlined by Wagner and Chen (1965). Therefore recognition of this new hybrid is set forth in the following diagnosis and description.

**Woodsia × kansana R. E. Brooks, hybr. nov.** **Figs. 1–3, 7, 8.**
Laminae inter parentes *W. obtusam* et *W. oreganam* var. *oreganam*. Indusia 5–10 segmentis; composita segmentis pluribus cellulis latis, apicibus 2–3-furcatis vel irregulariter lobatis. Sporae abnormales et abortivae.



FIGS. 5–10. Photomicrographs and interpretive drawings of *Woodsia* indusia. FIGS. 5–6. *W. obtusa*. FIGS. 7–8. *W.* ×*kansana*. FIGS. 9–10. *W. oregana*.

Plants morphologically intermediate between *W. obtusa* and *W. oregana*. Rhizomes to 4 cm long, 2–4 mm in diam; scales brownish with a darker, thicker median stripe, lanceolate, 2–5 mm long, entire. Fronds 1–2 dm tall; blade coriaceous to subcoriaceous, lanceolate to narrowly ovate, pinnate-pinnatifid or bipinnate, 6.5–12 cm long, 2.5–4 cm wide, glabrous or sparsely glandular, apex acute; pinnae subopposite to alternate, deltoid to ovate, apex acute to obtuse, short petiolate or subsessile; ultimate segments oblong or ovate, apex obtuse to rounded, margins



FIGS. 11–16. Ornamentation of *Woodsia* spores. FIGS. 11–12. *W. obtusa*. FIGS. 13–14. *W.* ×*kansana*. FIGS. 15–16. *W. oregana*.

mostly slightly reflexed and entire to serrate; petiole dark reddish brown at the base and becoming stramineous above or infrequently all stramineous, scales few, pale brownish, lanceolate, and membranaceous. Sori medial, discrete, sometimes appearing confluent with age, roundish; indusium basal with 5–10 segments; segments several cells wide, apex 2–3-furcate or otherwise irregularly lobed; spores mostly abnormal and abortive.

TYPE: KANSAS. McPherson Co.: 2 mi west and 2 mi south of Marquette, east facing sandstone outcrops along a high prairie ridge, 25 June 1976, *Ralph Brooks 12259d* (KANU; isotypes MICH, NY).

Associated with its parents *W. obtusa* and *W. oregana* var. *oregana* on sandstone outcrops. Known only from central Kansas (McPherson and Ellsworth counties, perhaps others in vicinity).

PARATYPE: Wilson, Ellsworth Co., Kansas, 1928, *Clement Weber 2* (MO).

The habit drawing is the work of Carol Kuhn Teale, a graduate student in botany at the University of Kansas.

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## REVIEW

**The Genus Polypodium in Cultivation [Polypodiaceae],** by Barbara Joe Hoshizaki. Baileya 22:1–52, 53–99. June 1982.—This long work continues Barbara Joe's invaluable series on cultivated ferns. A key to subgenera and keys to the species in each subgenus lead to pertinent synonymy, a brief description, the native range, and horticultural notes for each species. Cultivated varieties are fully discussed under each species and also are illustrated. The taxa are illustrated by a silhouette of a frond or sometimes by a photograph. Occasionally a line drawing or silhouette of some detail is also provided, for instance, of a rhizome scale where that is diagnostic. Addenda and an index conclude the paper. In the addenda, the synonym *Pleopeltis revoluta* (Spreng. ex Willd.) A. R. Smith should be added to *Polypodium astrolepis*. Also, *Polypodium revolutum* C. Chr. appears to be a *nomen nudum;* the species apparently does not have a valid name. Under subgenus *Niphidium*, the name *Polypodium albopunctatissimum* Linden is mentioned as if it were a valid name, but it, too, is a *nomen nudum*. All who need to know or to identify cultivated polypodiums will make use of this paper constantly.—*D.B.L.*

# Polystichum lonchitis in Central Quebec–Labrador

MARCIA J. WATERWAY* and THOMAS T. LEI*, **

North American distribution maps for the Northern Holly Fern, *Polystichum lonchitis* (L.) Roth, show a disjunct range from alpine areas in the western United States and Canada to the northern Great Lakes region, the Gaspé Peninsula, Nova Scotia, Newfoundland, and Greenland (Fernald, 1935; Hultén, 1958, 1968; Wagner, 1979). One isolated station at Richmond Gulf on the eastern shore of Hudson Bay (Rousseau, 1974; Payette & Lepage, 1977) links the northern range of this species in Alaska, British Columbia, and Alberta with its distribution on the coast of Greenland. Rouleau (1956) reported *P. lonchitis* from Labrador but without locality data or specimen citation. Since a specimen has never been located to verify this report, the occurrence of the Northern Holly Fern in Labrador has been considered doubtful (Rousseau, 1974; Payette & Lepage, 1977) links the northern range of this species in Grenfell-Forbes Northern Labrador Expedition of 1931, noted that Rev. Hettasch had seen *P. lonchitis* growing on Ogualik Island (Cod Island) on the Labrador coast (57°47′N, 61°47′W) but had not collected it. This brief mention may have been the basis for Rouleau's including it in his list for Labrador.

Our recent collections from the Schefferville region (*Lei s. n.*, 20 July 1980, MTMG; *Waterway 2140, 30 July 1981, MTMG, CAN)* confirm the presence of *P. lonchitis* in the central interior of the Quebec-Labrador peninsula. In 1980, a specimen was collected from a population of about ten to fifteen individuals growing on a protected, east-facing slope of Geren Mountain in the saddle between Geren Mountain and Sunny Mountain (55°04′N, 67°14′W). The plants were small (10–15 fronds each) and separated from one another by distances of about 0.5 m. *Phegopteris connectilis, Carex scirpoidea, Salix vestita* and *Anemone parviflora* were observed at the same site.

An attempt to relocate this population in 1981 in order to gather more information about the habitat and associated species resulted in locating a second site in the same general area. This site is also on an east-facing slope of Geren Mountain, facing Sunny Mountain, at an elevation of approximately 740 m. Treeline occurs at about 585 m on this slope, but a few, very stunted *Picea marina* trees were found near the *P. lonchitis*. Both sites are in Quebec but located only 2 km from the provisional border with Labrador.

At the site found in 1981, a single clump of *P. lonchitis* with more than 100 fronds was found growing on a step-shaped dolomitic boulder located in a sheltered draw a short distance below a talus slope which still had a large snowpatch remaining in late July. Both hematite and dolomite occur in the vicinity. Most of the ground surface in the draw is moss-covered, giving the area a distinctly greener appearance than the surrounding dry, alpine tundra. Species diversity is greater in this protected area below the snowpatch than in the surrounding tundra vegetation.

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Co-occurring calciphilic species include *Carex scirpoidea, C. vaginata, Salix vestita, Anemone parviflora, Arabis alpina, Saxifraga aizoon, Dryas integrifolia, Bartsia alpina, Castilleja septentrionalis* and *Solidago multiradiata*. Several additional species usually found in damp, often forested habitats, including *Gymnocarpium dryopteris, Streptopus amplexifolius, Coptis trifolia, Viola adunca, Pyrola minor, Trientalis borealis, Linnaea borealis,* and *Viburnum edule* indicate the moist, protected nature of the site. Other tundra species growing in the immediate vicinity of the *P. lonchitis* are *Lycopodium alpinum, L. clavatum, Carex bigelowii, Poa arctica, Juncus trifidus, Salix herbacea, S. uva-ursi, Oxyria digyna, Cerastium alpinum, Ranunculus allenii, Cardamine bellidifolia, Rubus acaulis, Sibbaldia procumbens, Epilobium latifolium, Pyrola grandiflora, Phyllodoce caerulea,* and *Taraxacum lapponicum*.

Previously reported localities for *P. lonchitis* in eastern North America are either in the Great Lakes region, often associated with limestone or dolomite of the Niagara Escarpment (Fernald, 1935; Soper, 1954; Thompson, 1962; Marquis & Voss, 1981) or in coastal or oceanic regions including the Gaspé Peninsula (Rousseau, Wynne-Edwards & Dansereau, 1937; Scoggan, 1950), Cape Breton, Nova Scotia (Roland & Smith, 1969), Newfoundland, the east coast of Hudson Bay (Rousseau, 1974) and possibly the Labrador coast (Abbe, 1936). Habitat data for most of these coastal localities also suggest a calcareous substrate, either of limestone, dolomite, or gypsum. Most eastern habitats are talus slopes or other rocky areas and the majority are shaded. In western North America, *P. lonchitis* has a continental as well as a coastal distribution, and is usually found in the subalpine forest zone (Wagner, 1979).

The stations we have discovered represent the first report of *P. lonchitis* from a continental situation in northeastern Canada. Their location in the Labrador Hills, just north of the iron-mining district of Schefferville is more than 600 km east from the nearest station on Hudson Bay and more than 600 km north from the localities in the Gaspé Peninsula. The occurrence of two sites in the same area suggests that *P. lonchitis* can become established there when the spores land on a suitable substrate (dolomite) in a favorable microhabitat. Many other such lush, protected sites with dolomitic substrate occur in the Labrador Hills, and *P. lonchitis* very likely occurs in some of them. Further exploration in this and other subarctic regions of Canada may well result in the discovery of other such isolated localities, thus eliminating the apparent disjunctions in the North American range of *P. lonchitis*.

We would like to thank the curators of CAN, DAO, and MT for allowing us to examine specimens, Dr. D. E. Swales for identifying some of the associated species, and the McGill Subarctic Research Station for providing accommodation and transportation in Schefferville.

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# A Unique Type of Microsporangium in Selaginella Series Articulatae

PAUL SOMERS*

One of the most distinct taxonomic groups in the genus *Selaginella* is the series *Articulatae*, comprised of about 40 taxa endemic to Latin America, one species that is in South Africa, the Azores and Latin America, and several that are restricted to Southeast Asia. This heterophyllous group, first described by Spring (1850) and maintained in later classifications by Hieronymus (1901) and Walton and Alston (1938), takes its name from the articulations located just below each bifurcation of the stem. These appear either as dark-colored swellings in living material or as dark constrictions in some dried specimens. Other morphological characteristics that unify the group are: (1) each strobilus has only a single (or rarely two) basal megasporangia; (2) each enlarged fertile megasporophyll is subtended by one or more enlarged sterile leaves; (3) the megaspores are exceptionally large and have high crestoreticulate muri; (4) the microspores are pale (usually buff to tan) and have ornamentation of sharp spines on their exines; and (5) the aerial roots arise dorsally from the stem. Also, about three-fourths of the taxa in the series have bistelar or multistelar stem anatomy, a feature not found elsewhere in the genus.

During a taxonomic survey of the *Articulatae*, a previously undescribed type of microsporangium was found to be another unifying feature. A survey of nearly all of the articulate taxa and many non-articulate ones supported this generalization. An explanation of the survey and a description of the microsporangia follows.

## MATERIALS AND METHODS

Specimens of *Selaginella* with articulate stems from the following herbaria were examined: ENCB, F, FSU, G, GA, GH, H, K, MO, NY, P, PR, PRC, TENN, UC, UMEX, UPS, US and VT. A comprehensive survey of other *Selaginella* taxa was not undertaken, but representatives of many non-articulate taxa were examined during the course of the study.

The basic structural differences between articulate and non-articulate microsporangia were discernable to the naked eye, but in order to see anatomical details, slides were prepared using Hoyer's solution (Anderson, 1954). For even closer scrutiny, a few microsporangia were examined with a scanning electron microscope. Initially an AMR model 900 SEM was used, but later an ETEC autoscan model U-1 was employed. Samples were mounted on standard aluminum studs (Ladd Research Industries) using air-drying silver conductive paint (GC Electronics) or double-faced cellulose tape. The prepared studs were coated with vaporized carbon and gold in a Denton model 515 vacuum-coater with a randomly rotating head.

## RESULTS AND DISCUSSION

The microsporangia of typical non-articulate *Selaginella* are simple, bivalved structures. They are hinged at the base and split open along a lateral suture which runs from the apex down each side of the sporangium, forming two equal halves

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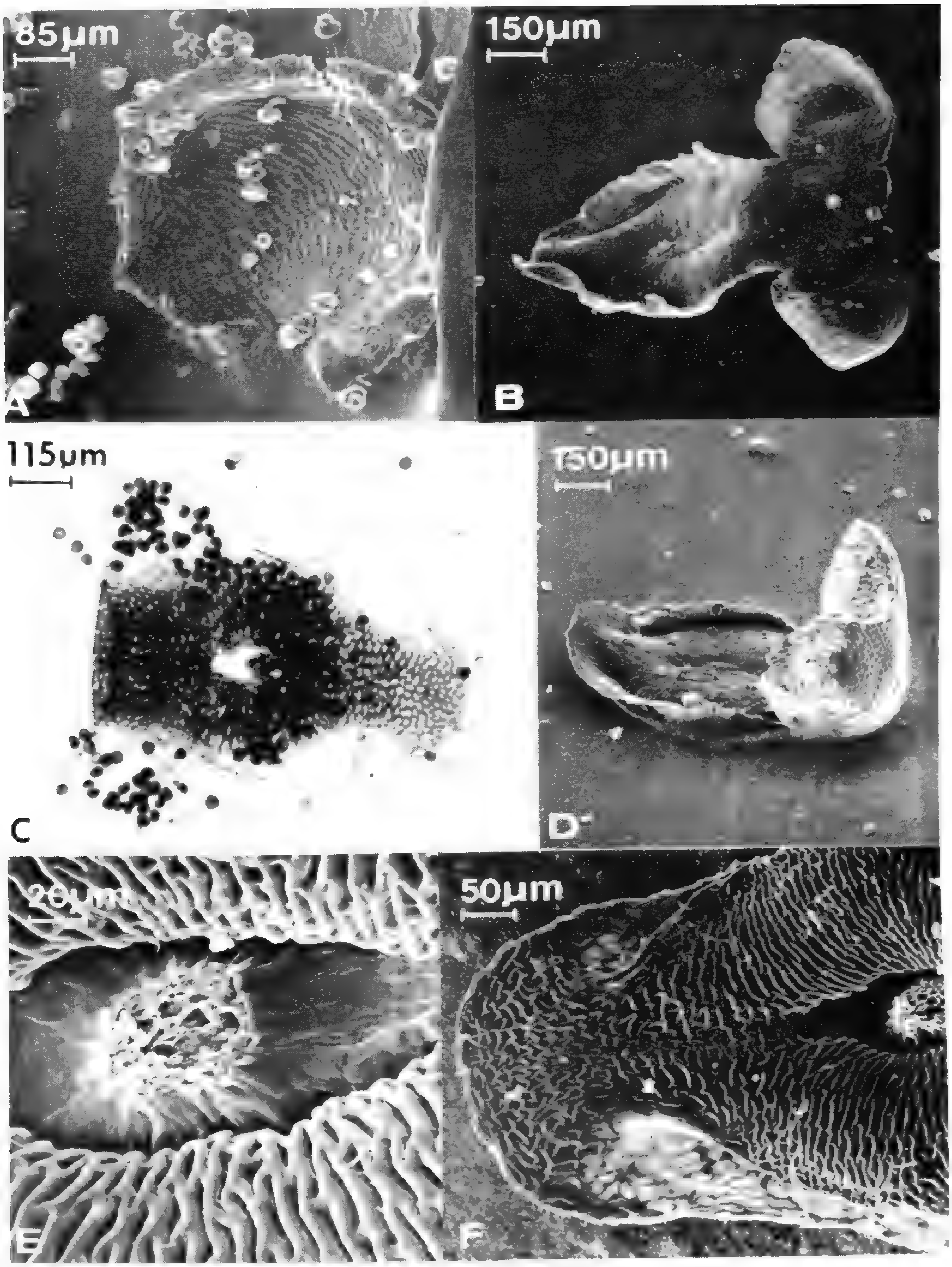

FIG. 1. Features of open microsporangia in non-articulate and articulate species of *Selaginella*. FIG. A One valve from microsporangium of non-articulate *S. oaxacana* (*Evans & Bowers 3223*, TENN). FIG. B. SEM view of completely opened microsporangium from *S. subarborescens* (*Hermann 11221*, US). FIG. C. Open microsporangium of *S. sertata* (*Allen 1959*, GH), with the abaxial end folded under. FIG. D. SEM view of open microsporangium of *S. fragilis* (*Lindeman 4007*, US). FIG. E. SEM view of basal portion of microsporangium of *S. fragilis* (*Lindeman 4007*, US) showing bands of annuloid cells on either side of sporangial stalk. FIG. F. SEM view of portion of microsporangium of *S. fragilis* (*Lindeman 4007*, US) showing annuloid bands of cells around sporangial stalk and cells forming suture line of dehiscence.

upon dehiscence. Each half is nearly hemispherical and consists of uniform cells (*Fig. 1A*). According to Goebel (1901), microsporangial cell walls in *S. flabellata* Spring, a non-articulate species, are differentially thickened, being thinner on their outer walls than on their inner tangential and radial walls. He described and illustrated microsporangia from a number of species, none of them articulate. Steinbrinck (1902) considered microsporangia to be much simpler in design than megasporangia; he described the former as "primitive" and "of unartistic origin." He based his judgement on material labeled *S. flabellata* sent to him by Goebel.

Microsporangia of the articulate species of *Selaginella* are more complex than those of non-articulate ones. They possess two distinct tissue types. At the base of each sporangium are two broad bands of relatively thick-walled cells. These bands converge on both sides of the short sporangial stalk (*Figs. 1C, E, F* and *2A, B, E*) and continue as broad annuloid bands up the curved faces of the sporangium. The adaxial and abaxial sides of the sporangia are not identical. Dehiscence occurs along a distinct suture line that leaves a tongue-shaped segment on the adaxial side and a larger, two-lobed portion, representing the remainder of the sporangium (*Fig. 1B-D, F*), on the abaxial side. The two lobes, which were the radial faces of the sporangium, are composed of flat, thin-walled cells (*Figs. 1B, D, F* and *2C, D*). These lobes remain concave on their inner faces and often carry masses of microspores upwards during dehiscence.

Goebel (1901) and Steinbrinck (1902) found that both mega- and microsporangia possessed cells with thick walls except on their outer faces. Goebel was uncertain about how the sporangia dehisced, but Steinbrinck strongly advocated the idea that cohesive forces of water played a major role. To support his hypothesis, Steinbrinck placed ripe megasporangia in absolute alcohol for 24 hours, and then dried them out in the air. Dehiscence did not occur. Then he placed the same sporangia in water until the cell lumina were filled with water. When they were allowed to dry the second time, they dehisced normally, demonstrating the importance of water in the dehiscence mechanism.

The same principles of cohesion and adhesion probably apply to the dehiscence of the unique microsporangia of the articulate species of *Selaginella*. When these microsporangia are immersed in water, they remain round and turgid; but when removed and allowed to dry, they gradually open. A combination of cohesive and adhesive forces during desiccation may cause the outer tangential walls of the cells in the thick walled regions to be pulled inward (*Fig. 1E*), thus causing tension along the suture line and the subsequent curling back of both ends of the banded region. My observations of excised microsporangia, when removed from water, show that they may curl completely inside out upon drying.

The annuloid banding is somewhat different than in ferns. A cross-sectional view through a microsporangium of *S. atirrensis* Hieron. (*Fig. 2A, B*) reveals that the cells are higher in the center of each band and taper in size laterally. Also, in this particular example the radial and inner tangential walls of the cells do not appear noticeably thicker than the outer tangential walls. In these respects they resemble the bulliform or "motor" cells described by Esau (1953, p. 145) as epidermal features of certain grasses that curl or fold their leaf blades.

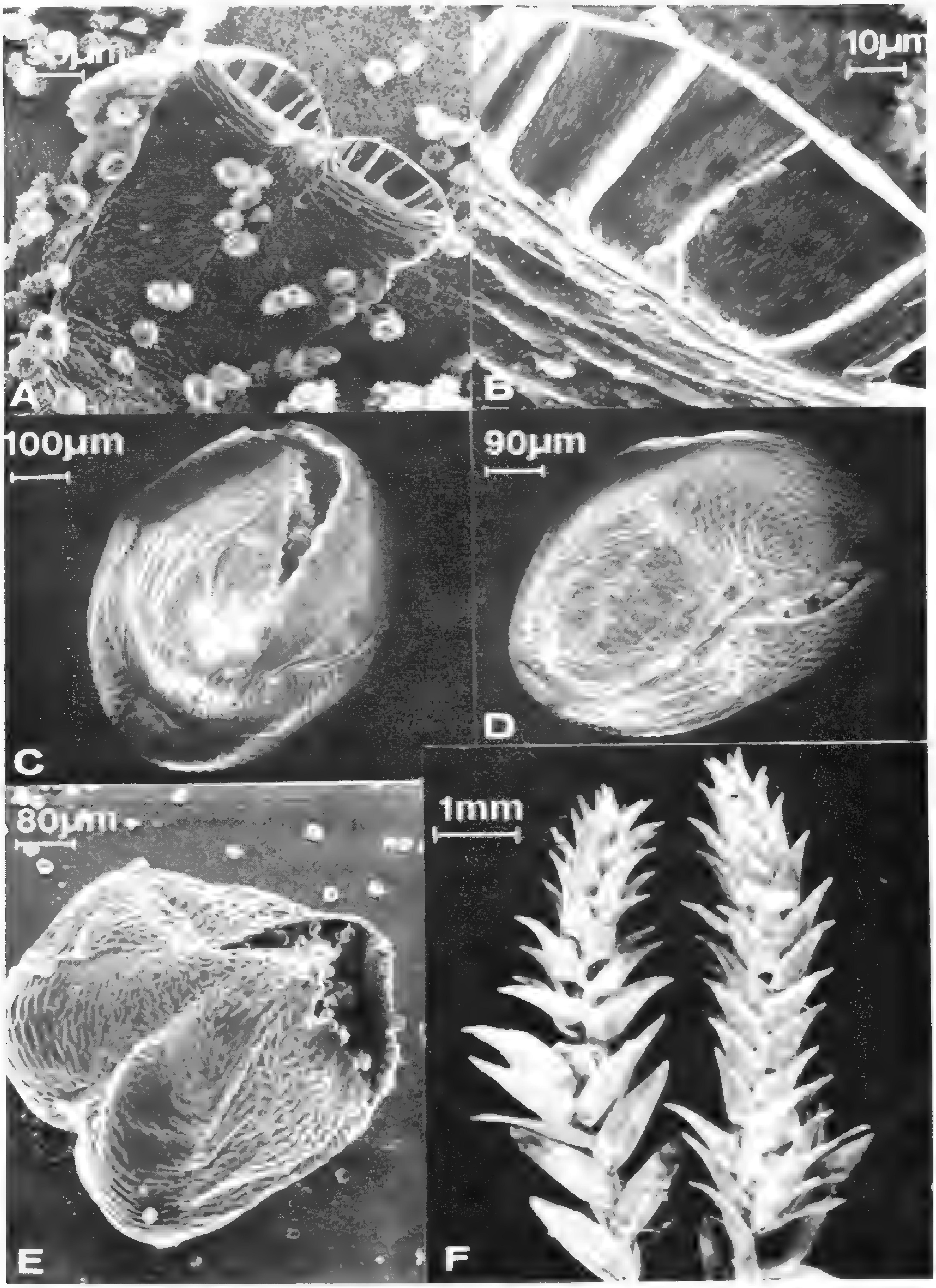

FIG. 2. Microsporangial features in articulate species of *Selaginella*. FIG. A. SEM view of portion of microsporangium with microspores of *S. atirrensis* (*Pittier 3638*, US) showing cross-section of annuloid bands of cells. FIG. B. Close-up SEM view of annuloid band of cells shown in Fig. A. FIG. C. SEM view of microsporangium of *S. kraussiana* (*cult. at Columbia Univ., NY*), showing split through region of thin-walled cells. FIG. D. SEM view of microsporangium from Fig. C, showing split along suture line. FIG. E. SEM view of microsporangium of *S. parkeri* (*Killip 37400*, US) showing split along suture line. FIG. F. Strobili from *S. atirrensis* (*Tonduz 14552*, US) showing open megasporangium at base of left strobilus and open microsporangium near top of right strobilus.

The opening of the microsporangium is not accompanied by a sudden recoiling of the annulus and catapulting of the spores. Instead, it breaks first at the apex along the suture line and then continues gradually downward along the border between the annuloid bands and the pockets of thin-walled cells. Each microsporangium is oriented so that its longer axis, with its pockets of thin-walled cells, is situated outwardly against the subtending sporophyll. When dehiscence occurs, the force of the uncurling annuloid bands may be exerted against the appressed sporophyll, forcing it downward. As the sporangium continues to curl back, it becomes exserted from the sporophyll (*Fig. 2F*), exposing the two concave lobes containing microspores. At this time the spores can be picked up by the wind, splashed away by rain, or washed down the sides of the strobilus, possibly into an open megasporangium at its base.

In summary, the *Articulatae* possess a type of microsporangium not found elsewhere in the genus and considered to be more advanced evolutionarily because of the presence of annuloid bands of cells that probably facilitate dehiscence. Unlike the explosive dehiscence in sporangia of ferns, the microsporangia of the *Articulatae* just slowly uncurl, breaking along a defined suture line of border cells and gradually lifting the masses of spores upward. While a hygroscopic mechanism is obviously responsible for dehiscence, the anatomical and physiological details are yet to be described.

The discovery of this unique and highly developed type of microsporangium within the *Articulatae* makes it more apparent than ever that the group is a well defined taxonomic unit within *Selaginella*. Combined with the other characteristics noted above, it can be argued that the group should be elevated to a subgenus. Existing classifications recognize 2–4 subgenera. Hieronymus (1901) split the genus into the homophyllous and heterophyllous taxa, and Walton and Alston (1938) followed Baker's (1887) basic classification, where the heterophyllous taxa were subdivided into three groups based mainly on whether the sporophylls were uniform or dimorphic. If one assumes equal weighting of taxonomic characters, the *Articulatae* should have, at least, as high a rank as any of the traditional subgenera.

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# Cystopteris tennesseensis in Illinois

ROBBIN C. MORAN*

*Cystopteris tennesseensis* Shaver is a fertile allotetraploid that presumably arose from an ancient cross involving *C. bulbifera* (L.) Bernh. and *C. protrusa* (Weath.) Blasdell. Shaver (1950) pointed out that *C. tennesseensis* is morphologically intermediate between *C. bulbifera* and *C. protrusa* and concluded that these were the two parental species. Morphological and cytological work by Blasdell (1963) supports this interpretation. Plants of *C. tennesseensis* are usually misidentified as either *C. bulbifera* or *C. protrusa*. As a result, the range and abundance of this fern are not precisely known. This paper presents the distribution of *C. tennesseensis* in Illinois and shows that it is much more common and widespread than generally realized.

Specimens of all Illinois *Cystopteris* from the following herbaria were examined: EIU, ILL, ILLS, ISM, MO, and SIU. Those specimens found to be *C. tennesseensis* were annotated as such and recorded. Locality data of individual collections are available from the author. In addition, numerous areas of suitable rock habitats were visited in the field, especially in southern Illinois and along the lower Mississippi and Illinois rivers.

Previously, this fern was reported from only three Illinois counties: Champaign, Jackson, and Will (McGregor, 1950; Mohlenbrock & Ladd, 1978); however, I was unable to locate specimens from Champaign County. *Cystopteris tennesseensis* occurs most frequently along major watercourses of the state, such as the Illinois, Mississippi, and Wabash rivers (*Fig. 1*). Along these major rivers, habitat for this fern is provided by the rocky escarpments and ravines that run along or into the river floodplains. The writer's field experience in these areas indicate that *C. tennesseensis* is commonly present in suitable habitats and is often abundant where found. *Cystopteris tennesseensis* is also present, although to a more limited extent, in the Driftless Area of northwestern Illinois and in the Shawnee Hills of southern Illinois.

In Illinois, *C. tennesseensis* grows on both limestone and sandstone; however, the great majority of specimens were collected from limestone, indicating a preference for calcareous habitats. Limestone outcrops in Illinois primarily occur along the Mississippi River, the lower Illinois River, and in portions of the Driftless Area in the northwestern corner of Illinois. Major sandstone outcrops where this fern occurs are the Shawnee Hills of southern Illinois and in north-central Illinois at Starved Rock State Park along the Illinois River. Observations in Illinois by the writer support the observations of McGregor (in Wagner & Hagenah, 1956, p. 144) that *C. tennesseensis* produces bulblets much more abundantly on limestone than on sandstone. Furthermore, the Illinois populations of this fern on limestone are more extensive and contain a higher density of individuals compared to sandstone populations where similar amounts of rock habitat exist. The preference of this fern for limestone as opposed to sandstone has been noted in other states (Cranfill, 1980; Shaver, 1950, 1954).

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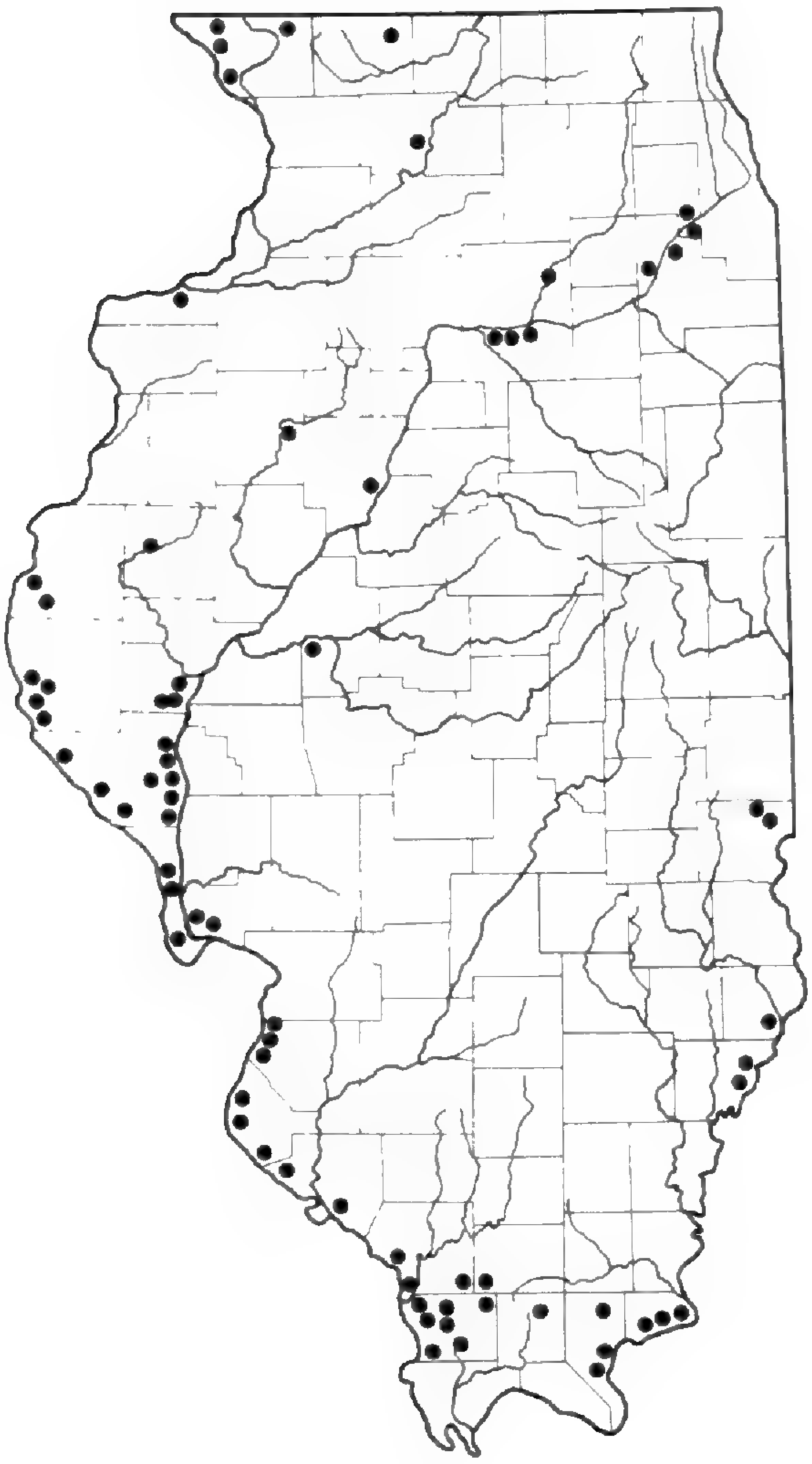

FIG. 1. The distribution of *Cystopteris tennesseensis* in Illinois.

All 90 herbarium specimens of *C. tennesseensis* examined for this study were originally misidentified. This is primarily due to the fact that *C. tennesseensis* is not keyed to in many commonly used floristic manuals and, in part, because the fronds are highly variable and confusingly intermediate between those of its parents. The qualitative characteristics of frond dissection are difficult to describe and to be appreciated by botanists unfamiliar with this fern. However, there is one quantitative character that can be used to distinguish this fern from both *C. bulbifera* and *C. protrusa:* spore size. In the genus *Cystopteris* polyploidy is correlated with spore size. Thus, *C. bulbifera* and *C. protrusa,* both diploids, have spores that are generally 27–32 μm in length, whereas *C. tennesseenis,* a tetraploid, has spores that are generally 32–42 μm in length (Blasdell, 1963). The writer has found spore size to be a reliable character and recommends its use if one is uncertain about identification based on frond morphology alone. Further discussion concerning the identification of this fern can be found in Cranfill (1980) and Shaver (1950, 1954).

*Cystopteris tennesseensis* is probably more common in many states than is generally realized. A careful search of other herbaria would add greatly to our knowledge of the frequency and occurrence of this fern elsewhere in its range.

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## DIETER E. MEYER (July 21, 1926–February 1982)

Dieter E. Meyer was born in Görlitz on 21 July 1926, son of Erich and Elisabeth Meyer. His primary and secondary schooling took place in Görlitz prior to and during World War II, and his early interest in natural history led to a volunteer position with a local natural history society. From 1946 to 1950 he studied botany, especially of the cryptogams, in Jena. In 1952 he earned a doctorate from the Free University of Berlin with a thesis on hybridization in *Asplenium*, which became a life-long interest. In 1954 he joined the staff of the Botanical Garden and Museum in Berlin-Dahlem; he was appointed a Keeper in 1964 and a Supervisory Keeper in 1969. His taxonomic interest in ferns was whetted by the excellent living and herbarium collections at Berlin. He himself made collections in Germany, Austria, Switzerland, England, and Canada, often searching for specimens of rare *Asplenium* hybrids that could be brought into cultivation for further study. He reorganized and restored the fern collections at Berlin, which had lain nearly untouched after Hieronymus' death and which fortunately had escaped destruction during World War II. In addition to his broadly based researches on *Asplenium*, Meyer published a variety of biographical, bibliographical, and floristic papers. Music was among his extra-botanical interests. A full biography and bibliography is to be published in Willdenowia, from which most of the foregoing comments have been taken.—*D.B.L.*

## SHORTER NOTE

**FLAVONOID CHEMISTRY OF THE NORTH AMERICAN LYCOPODIUM OBSCURUM COMPLEX.**—The Lycopodium obscurum complex is taxonomically difficult because of environmental effects on the subtle characters used to distinguish the taxa. A major problem has been whether to recognize as distinct the species *L. dendroideum* Michaux (Hauke, Bioscience 19:705–707. 1969). Using phyllotaxy, Hickey (Amer. Fern J. 67:45–48. 1977) re-defined *L. obscurum* L. var. *obscurum* and the problematic *L. dendroideum* and described another taxon, *L. obscurum* var. *isophyllum*. The current study of flavonoid chemistry was initially undertaken to provide an independent source of evidence regarding the status and relationships of these taxa.

Material for flavonoid analysis was collected from natural populations, and voucher specimens are on deposit at TENN. From each taxon, 50 g of vegetative tissue and 5 g of reproductive tissue (spores, sporophylls and strobilus axes) were extracted 2 or 3 times in 85% methanol for at least 24 hrs. Isolation by paper chromatography and identification by UV-spectral analysis for flavonoids followed the general procedures as outlined by Mabry, Markham and Thomas (The Systematic Identification of Flavonoids, 1970). The identity of the flavonoids was confirmed by co-chromatography with authentic compounds on cellulose-TLC.

Flavonoids were found to be absent in the vegetative material of all three taxa. In the reproductive tissue, however, chrysoeriol was uniformly present. Chrysoeriol has been found commonly throughout the genus *Lycopodium sensu lato*, according to Voirin and Jay (Biochem. Syst. Ecol. 6:95–97. 1978). Localization of flavonoids solely in reproductive tissues has not been previously reported for the fern allies. The function of this localization is unknown. Since all three taxa had identical flavonoid characteristics, flavonoid chemistry does not distinguish among them. Thanks are due to R. James Hickey for kindly confirming the identity of the voucher material.—*Frank Fusiak, Department of Botany, University of Tennessee, Knoxville, TN 37996-1100.*

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# Pteris ×delchampsii, a Spontaneous Fern Hybrid from Southern Florida

W. H. WAGNER, JR.* and CLIFTON E. NAUMAN**

The genus *Pteris* comprises over 200 tropical and subtropical species, and hybridization among its species is well known. Many of the species-groups, such as the *P. longifolia* and *quadriaurita* groups, include both Old World and New World endemics. The Chinese Ladder Brake, *P. vittata* L., which is a member of the *P. longifolia* group, has been introduced into the Americas, where it frequently grows with or near closely related native species. For instance, Maxon (1926, p. 436) wrote that *P. vittata* "has escaped from cultivation and become well established in St. Thomas, Bermuda, Dominica, Martinique, Barbados, Trinidad, eastern Brasil, Florida, Alabama, and Louisiana." It is with the Florida occurrences that we are concerned here.

This study began when C. E. Delchamps discovered some unusual brakes growing along the Coral Gables Canal in Miami in the late 1950's. He sent examples to Wagner, who found them to be intermediate between the Chinese Ladder Brake and the Bahama Ladder Brake, *P. bahamensis* (Agardh) Fée. In April 1966, Delchamps and Wagner visited the locality and found the two species and the intermediate growing togther. The intermediate, which we have found to have abortive spores, as would be expected in an interspecific hybrid, was surprisingly common at this locality. It is of special interest because it is a hybrid between a naturalized exotic species and an endemic species, which were brought together through man's activities. Recently Nauman made special searches for these plants in southern Florida and discovered several new localities for the hybrid, which is herewith described.

**Pteris ×delchampsii W. H. Wagner & C. E. Nauman, hybr. nov.**

Inter *P. bahamensem* et *P. vittatam* intermedia, sporis abortivis; squamae rhizomatis atrogriseae; squamae petioli pallido-brunneae; pinnae mediae frondis fertilis maturae (3)4(5) mm latae, remotae, 1.2–1.8 cm distantes; circumferentia pinnae ab imo ad summum gradatim decrescens; segmentum sterile margine denticulatum; coenosori maturi usque ad 1–2 mm a costa extensi.

TYPE: North bank of the Coral Gables Canal at 61st Ave. and Waterway Drive, Miami, Dade County, Florida, 17 April 1966, *W. H. Wagner 66013 & C. E. Delchamps* (MICH).

PARATYPES (All Dade County, Florida): Coral Gables Canal bank, SW 39th St. near 62nd Ave., *Delchamps* in 1960 (MICH); Ca. 30 ft from N bank of the Mowry Canal (C-103) at junction with Tennessee Road, plants in full sun, ca. 10 individuals, 28 June 1979, *C. E. Nauman & D. F. Austin 738* (MICH), *739* (FAU); Nixon-Lewis Hammock, W end of Avocado Road, 27 Feb 1979, *Nauman et al. 652* (FAU, MICH); Sweetwater, open field near 122 SW 127th Ave., 8 April 1979, *T. M. Thurmond 4b* (FAU, MICH); Fairchild Tropical Garden, Limestone Wall on SE side of Glade Lake, 22 Dec 1981, *Nauman 1490 A-D* (MICH).

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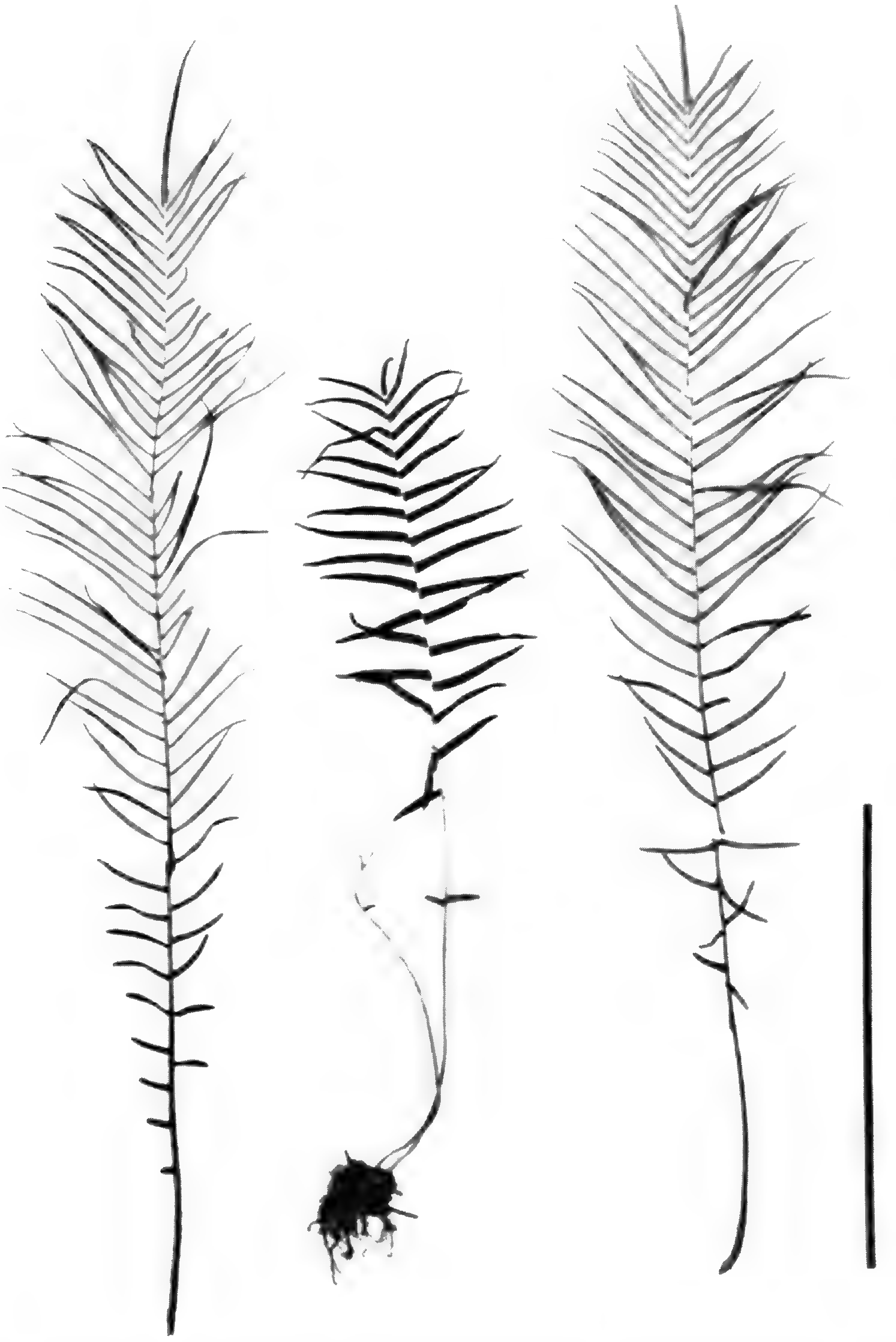

FIG. 1. Specimens from the type collection of *Pteris* ×*delchampsii* along the Coral Gables Canal, Miami, FL. Middle: Rhizome with sterile frond. Scale = 30 cm.

We name this fern for the late Dr. C. E. Delchamps, warm friend and field companion over many years, who took time out from his career as Chemistry Professor at University of Miami to explore southern Florida for rare and interesting pteridophytes. His guidance in the natural areas of Florida aided numerous researchers in their studies of problematic ferns. (See also the obituary by Mrs. C. E. Delchamps, 1978.)

At first sight, *P.* ×*delchampsii* resembles a narrow, somewhat skeletonized *P. vittata*. However, the rhizome scales are less conspicuous, shorter (2-3 mm long), and dark brown. The scales along the petiole are fewer than in *P. vittata*, but they do have the latter's pale tan color. The pinnae are more stiff, remote, and considerably narrower. The apical pinnae are less ascending, and the sterile pinna margins (wholly sterile pinnae, and tips of partially fertile pinnae) are not so coarsely or so sharply dentate as in *P. vittata*. The coenosori of *P.* ×*delchampsii* do not expand so much as do those of *P. vittata* when the sporangia have matured and discharged, probably due in part to abortion of the spores and failure of many sporangia to open, but the coenosori of the hybrid nevertheless come closer to the costa than do those of *P. vittata*.

Hybrids found in open, disturbed areas in full sun more closely resemble *P. bahamensis* in their stiffly erect habit and slightly revolute pinnae. Under shaded conditions, the fronds are more lax and arching and the pinnae are not revolute, and so closely resemble those of *P. vittata*.

Specimens suspected of being *P.* ×*delchampsii* can be confirmed as that by observing the extensively aborted spores, which are unlike the normal, uniform spores of the parents. A diagnostic key to the parents is given below as an additional aid in separating the hybrid from its parents and the parents from one another, as well as in detecting backcrosses. The key is based upon our Florida collections.

## KEY TO THE PARENTS OF PTERIS ×DELCHAMPSII

1\. Fronds stiff and nearly upright; rachises glabrous, shiny, wiry; rhizome scales relatively inconspicuous, dark brown to blackish, 1–2 mm long; stipes scaly only at the base; pinnae thick, leathery, 5–8 pinna widths distant, linear, round at the apex, the apical ones usually spreading, not strongly ascending, the sterile margins subentire to entire, lacking pointed teeth; middle fertile pinnae narrow, usually (2)3(4) mm wide; mature coenosori nearly touching the costa, thus exposing little lamina surface; old fronds persisting as naked rachises, the pinnae having disarticulated. *P. bahamensis*

1\. Fronds rather lax and spreading; rachises with more or less numerous, conspicuous, narrow, pale tan scales or fibrils; rhizome scales densely tufted, pale tan, 2–4 mm long; stipes scaly throughout; pinnae thin, chartaceous, 0.5–2 pinna widths distant, linear-lanceolate, narrowly pointed at the apex, the apical ones usually strongly ascending, the sterile margins coarsely and sharply toothed; middle fertile pinnae usually (4)6(9) mm wide; mature coenosori separated from the costa 1–3 mm, thus exposing much lamina surface; old fronds simply drying up and turning brown, the pinnae not disarticulating.................................................................................................*P. vittata*

*Pteris bahamensis* occurs in Broward, Collier, Dade, and Monroe counties in southern Florida. Outside of the United States, the species has been reported in the Bahamas, Cayman Islands and Cuba (Maxon, 1926, p. 433; Proctor, 1977, p. 141). In Florida, *P. bahamensis* occurs but infrequently in disturbed areas, and then only in or adjacent to pinelands. Typically it frequents rocky pinelands, growing in crevices of oolitic limestone, usually rooted in circumneutral to slightly acid marl and in pockets of humus. The canopy of these habitats is composed of Slash Pine, *Pinus elliottii*. The shrub layer varies in its dominant species but typically contains *Serenoa repens*, *Coccothrinax argentata*, *Metopium toxiferum*, *Guettarda scabra*, and a variety of other species. The herb layer is dominated by assorted grasses, of which *Schizachyrium rhizomatum* is a conspicuous example.

Plants of *P. bahamensis* may attain a height of over one meter in this habitat. Older specimens often have litter a decimeter or more deep at their bases composed of old fronds, pine leaves and other debris. Fires in these areas frequently destroy plants completely, but recolonization evidently occurs quickly, and within a period of a few months new plants appear.

The Chinese Ladder Brake, *P. vittata*, occurs scattered throughout Florida and other parts of the southeastern United States at least as far north as the Carolinas and as far west as Louisiana. The plants are frequent in disturbed locations on calcareous substrates, often on limestone ledges, walls, and sinks. The plants are generally more abundant and luxuriant (up to 1 m tall) in areas of high humidity, such as canal banks and limestone sinks with standing water. In dry places, the plants are sparser and dwarfed (usually less than 0.5 m tall).

The introduced species can be found together with its native relative in pinelands, particularly around small sinkholes. However, *P. vittata* is not common in these habitats. Conversely, the ledges and walls favored by *P. vittata* are seldom inhabited by *P. bahamensis*. Hybrids have not been found in the pineland habitats, but only in adjacent areas. The type locality in southwest Miami is a canal bank in an urban, residential area. The rocky sides of the canal had numerous weeds in addition to the brakes. The other ferns were: *Anemia adiantifolia* (*Wagner 66010*, MICH), *Sphenomeris clavata (66011)*, and *Thelypteris cf. augescens (66009)*. The canal bank had been widened and most of the ferns, including the parent and hybrid Ladder Brakes, had been destroyed when Nauman visited the locality in 1977. However, he found four new sites for the hybrid during the past five years. Three plants of *P.* ×*delchampsii* were found along a fringe of the Nixon-Lewis hammock in a border of *Schinus terebinthifolius*. The Glade Lake population at Fairchild Tropical Garden consisted of 11 plants. Two were terrestrial in a muddy substrate on the south bank of the lake; the remaining plants were confined to a small colony about 1.5 m in diameter on the westernmost portion of a rock wall. *Pteris bahamensis* was abundant on the north face of the wall, an atypical habitat for this species. *Pteris vittata* was also abundant near the site, but there were only three small, sterile plants within 50 m of the hybrid plants. The other sites (see specimen citations) were similar in being disturbed, open areas having loose, calcareous substrates covering oolitic limestone.

The presently known range of the hybrid in Florida is in Dade County from south Miami to Homestead. We predict that *P.* ×*delchampsii* may be discovered in Monroe and Collier counties. Because the habitat that the hybrid prefers is becoming more common in all of these counties, we expect that its range will increase in the future, although the available natural habitat of *P. bahamensis* is disappearing. Unless the hybrids develop some means of reproduction, the fate of *P.*

×*delchampsii* in years to come depends upon the success of *P. bahamensis* in surviving man-made changes. In all likelihood, the weedy *P. vittata* will be the ultimate survivor.

## BIOSYSTEMATICS OF PTERIS ×DELCHAMPSII

It is possible that *P.* ×*delchampsii* may develop a means of reproducing itself, in spite of its abortive spores. (The hybrid spores display all sorts of irregularities in size, shape, and exine development, and were illustrated by DeBenedictus, 1969, pl. 26.) Commonly the number of spores or spore-like bodies per sporangium in *P.* ×*delchampsii* is less than 64 because normal meiosis is interrupted and a number of large, presumably unreduced spores are formed, in addition to many tiny, aborted spores. The giant spores are evidently viable, as described below.

Both the hybird and its parents are tetraploid with $4x = 116$; the base number of *Pteris* is 29. In her studies of this plant, DeBenedictus was unable to obtain a precise count of *P. bahamensis*, but her evidence supported the conclusion that it is a tetraploid. It is interesting to note that *P. longifolia* L., of which *P. bahamensis* may be only a geographical variety, is reported by Walker (1966) also to have $4x = 116$, a number evidently characteristic of the Ladder Brake group. Unlike its sexual parents, *P.* ×*delchampsii* shows peculiar pairing behavior. Counts by W. H. Wagner, Jr., K. L. Chen, and V. M. DeBenedictus (vouchers in MICH) show ca. 32–35 bivalents, with the remaining chromosomes univalents.

DeBenedictus grew spores of *P.* ×*delchampsii* because of the possibility that it possessed a low-level expression of apogamy which enabled it to produce gametophytes that could proliferate directly into sporophytes. Such a mechanism would allow it to reproduce in its habitats. She found that gametophyte production from hybrid spores was much lower than in the parents. However, those gametophytes that did form bore many antheridia and archegonia on an especially well developed cushion region. Some gametophytes also produced peculiar growths of tissue on the wings. A few of the hybrid gametophytes became filamentous.

After flooding her cultures of *P.* ×*delchampsii* with water, DeBenedictus observed a few sporophytes developing. These arose from archegonia and appeared to be sexual in origin. Unlike *P.* ×*delchampsii*, the hybrid progeny gave $6x = 174$, which DeBenedictus explained as possibly resulting from backcrossing of *P.* ×*delchampsii* with one of its parents that was present as a contaminant. According to her, "Sperms produced by gametophytes of the hybrid would have 116 chromosomes. Fertilization of a parental gametophyte [with 58 chromosomes] would produce a sporophyte with $2n = 174$" (DeBenedictus, 1969, p. 70).

The phenomenon of apparent backcrossing between "sterile hybrids" and their parents in nature also has been suspected in *Asplenosorus* ×*ebenoides* × *Camptosorus rhizophyllus*, *Dryopteris (goldiana* × *intermedia)* × *intermedia* (Wagner, 1971), *Asplenium* ×*curtissii* × *abscissum* (Morzenti, 1967), and *Polystichum (acrostichoides* × *braunii)* × *acrostichoides* (Morzenti, 1962). It is possible that "sterile hybrid" ferns are especially likely to produce unreduced spores because of their faulty pairing behavior, and that the gametophytes produced by the unreduced spores are especially prone to backcrossing with their parents. We encourage field workers in southern Florida to make special efforts to discover new populations of *P.* ×*delchampsii* and its parents and to examine in detail those already known in order to find both hybrids and backcrosses. Because of its vigorous growth, *P.* ×*delchampsii* may become an ideal research tool, both in the wild and in the laboratory.

We wish to thank Katherine Lim Chen and Virginia Morzenti DeBenedictus for their contributions to this investigation. The University of Michigan Matthaei Botanical Gardens kindly grew cultures of the hybrid plants for our research. Most of the work described here was carried out under National Science Foundation Grant GB-3366, "Evolutionary Characters and Classification of Ferns."

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# *C*-glycosylxanthones in the Asplenium adiantum-nigrum Complex

P. MICK RICHARDSON and EUGENIA LORENZ-LIBURNAU*

The polyphenolics of the Appalachian *Asplenium* complex (Smith & Harborne, 1971; Harborne et al., 1973) confirmed in all respects the concept of reticulate evolution in the species complex which had been proposed by Wagner (1954) on the basis of morphology and hybridization and chromosome studies. For example, *A. montanum* Willd. contained four *C*-glycosylxanthone compounds which were present in all hybrids containing the *A. montanum* genome. It has now been discovered that a parallel situation occurs in the chemistry of a group of European spleenworts, namely the *Asplenium adiantum-nigrum* complex. *Asplenium adiantum-nigrum* L. is an allotetraploid derived from *A. cuneifolium* Viv. and *A. onopteris* L. (Shivas, 1969). *Asplenium onopteris* is also a diploid progenitor of the tetraploid *A. balearicum* Shivas, the other diploid parent being *A. obovatum* Viv. (Shivas, 1969; Lovis et al., 1972). Thus, *A. onopteris* is analogous to *A. montanum*, the diploid ancestor of the tetraploids *A. bradleyi* D. C. Eaton and *A. pinnatifidum* Nutt. The analogy is further supported by the presence of *C*-glycosylxanthones in *A. onopteris, A. adiantum-nigrum,* and *A. balearicum (Fig. 1).*

The European spleenworts are well known cytologically and morphologically (Lovis, 1977; Walker, 1979), but chemically they are virtually unknown. Several species have previously been surveyed for the presence of xanthones and proved negative: *A. adiantum-nigrum* (from Spain), *A. ruta-muraria* L., *A. septentrionale* (L.) Hoffm., *A. trichomanes* L., and the related species *Ceterach officinarum* DC. and *Phyllitis scolopendrium* (L.) Newm. (Smith & Harborne, 1971). A later reinvestigation of *A. adiantum-nigrum* indicated the presence of a xanthone-O-glycoside (Imperato, 1980). This particular compound had a 1,3,7,8-hydroxylation pattern in contrast to the 1,3,6,7-hydroxylation pattern of the *C*-glycosylxanthones found in the Appalachian spleenworts. It also had its sugar molecules attached by an oxygen linkage rather than by a direct carbon-carbon linkage as found in the *C*-glycosylxanthones. Imperato (1980) suggested that the absence of xanthones in the Spanish sample of Smith & Harborne (1971) may be due to phytogeographical factors.

A survey of ferns for the presence of *C*-glycosylxanthones is currently being undertaken at the New York Botanical Garden (Richardson, in press). The discovery of the *C*-glycosylxanthones mangiferin and isomangiferin in *Asplenium adiantum-nigrum* growing in the Enid A. Haupt Conservatory at NYBG led to a more intensive study of this plant and its related species. The possibility of geographic variation in xanthone production was examined by studying herbarium samples from almost the complete range of *A. adiantum-nigrum*. This led to the sampling of the diploid progenitors and ultimately to *A. balearicum*.

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## MATERIALS AND METHODS

Apart from the *A. adiantum-nigrum* plant (NYBG 2066/76) which initiated the study, all experimental work was performed on dried material. Dr. T. G. Walker (Department of Plant Biology, University of Newcastle upon Tyne) kindly provided the sample of *A. balearicum*. The other samples were all in the herbarium at NYBG.

*Asplenium adiantum-nigrum*.—Scotland, *Nicholson* in 1881; England, *Taylor et al. 1731;* Switzerland, *Morthier* in 1879; Yugoslavia, *Richter* in 1910; Gran Canaria, *Cook 308;* Tenerife, *Kuntze* in 1888; Madeira, *Wilkes 44;* Lebanon, *Stutz 3045;* Punjab, *Stewart 7881;* Kashmir, *Stewart 17448* and *21784;* Caucasus, *Radde* Ex herb. horti. Petropolitani; South Africa, Ex. herb. Mt. Holyoke Seminary; Colorado, *Bethel 270;* Hawaii, *Degener H186* and *Degener & Wiebbe 3889*.

*Asplenium cuneifolium*.—Germany, *Missbach 5591* and *Luerssen 5706;* Austria, *Werderman & Meyer 232;* Hungary, *Richter 5592*.

*A. onopteris*.—Switzerland, *Leroy;* Italy, *St. Lager* in 1894; Dalmatia, *Ronniger* in 1926.

Small amounts of plant material were extracted in 80% methanol using a Polytron Homogenizer (Richardson, 1982). The extracts were initially screened for the presence of *C*-glycosylxanthones by one-dimensional chromatography on Whatman No. 1 paper in both water and 15% acetic acid. *C*-glycosylxanthones are revealed as orange spots under ultraviolet light (360 nm), turning fluorescent yellow with ammonia vapor. Extracts which proved positive were further analysed by two-dimensional chromatography on Whatman No. 3 paper in TBA (t-BuOH: HOAC: $H_2O$, 3:1:1) and HOAc (15% acetic acid). The *C*-glycosylxanthone spots were eluted in 80% methanol and co-chromatographed with mangiferin and isomangiferin (isolated from *Asplenium montanum, Bozeman & Radford 11552*, NYBG) in TBA, BAW, 15% HOAc, and $H_2O$. Acid hydrolysis of the extract (2N HCl, 1 hr, 100°C), followed by two-dimensional chromatography, was performed on the one fresh sample of *A. adiantum-nigrum*. For further details of the chromatography solvents and methods, see Harborne (1973) and Markham (1982).

## RESULTS AND DISCUSSION

The two-dimensional chromatogram of the *A. adiantum-nigrum* from the conservatory revealed the presence of eleven polyphenolic compounds. Four were dark/yellow spots, typical of flavone and flavonol glycosides, with $R_f$ values in TBA and HOAc as follows: 14,40; 17,51; 23,51; and 27,58. Seven were orange/yellow spots, typical of xanthones, with $R_f$ values: 36,24; 37,49; 46,63; 20,72; 55,57; 55,68 and 70,64. The rutin marker was 39,68. After acid hydrolysis, the latter four xanthone spots disappeared and were replaced by a new xanthone spot at 48,26. This suggests that these latter four compounds were xanthone-O-glycosides, one of which was characterized by Imperato (1980). The other three xanthones were resistant to acid hydrolysis and were suspected to be *C*-glycosylxanthones. For two of the compounds this was confirmed by co-chromatography with mangiferin and isomangiferin, but the identity of the third *C*-glycosylxanthone remains unknown until larger quantitities of the compound become available for analysis.

Extracts from herbarium specimens of *A. adiantum-nigrum* produced either two or three xanthone spots on the two-dimensional chromatograms. In every case mangiferin and isomangiferin, and in some cases the unidentified *C*-glycosylxanthone, were readily visible and confirmed by co-chromatography. In no cases were the four dark/yellow or the four xanthone-O-glycoside spots visible. This may be due to the small amounts of herbarium material available for analysis. It was usual to use only ca. 10–20 mg per chromatogram, compared to a whole plant sometimes used by Smith & Levin (1963). It is also possible that some of the missing compounds have been oxidized since some of the herbarium specimens date from the late nineteenth century.

The three samples of *A. onopteris* yielded two-dimensional chromatograms which were identical to those of the 'three-spotted' herbarium material of *A. adiantum-nigrum*. Each sample contained mangiferin, isomangiferin, and the same unknown *C*-glycosylxanthone. The four samples of *A. cuneifolium* produced blank two-dimensional chromatograms, even when repeated with comparatively large amounts of material. It can be stated firmly that *C*-glycosylxanthones were absent from all four samples. Only one specimen of *A. balearicum* was available, and the two-dimensional chromatogram indicated the presence of mangiferin, isomangiferin, and the same unknown *C*-glycosylxanthone, as well as a large dark/yellow spot at 32,55. However, there was insufficient material to verify the three xanthones by co-chromatography with the compounds from the other species. It would be interesting to examine larger amounts of *A. onopteris* and *A. balearicum* chemically in order to determine if they contain the xanthone-O-glycosides which occur in *A. adiantum-nigrum*.

Samples of *A. adiantum-nigrum* from throughout its range contained *C*-glycosylxanthones. This contrasts sharply with the earlier negative report by Smith & Harborne (1971). Possibly there is a genuine geographical variation in xanthone occurrence (this could be revealed by more intensive sampling). Alternately, the plant examined by Smith & Harborne (1971) may have been misidentified and may actually be *A. cuneifolium*. Most of the *A. cuneifolium* plants at NYBG were found to be misidentified as *A. adiantum-nigrum*, presumably due to the great similarity between the two species.

*Asplenium onopteris* is the first diploid European *Asplenium* species which has been found to contain *C*-glycosylxanthones. The compounds are absent from *A. cuneifolium*. *Asplenium obovatum* may or may not contain the compounds, and this cannot be predicted by the occurrence of the compounds in *A. balearicum*. If *A. obovatum* actually contains *C*-glycosylxanthones, then the compounds can be predicted to be present in both *A. billotii* Schultz, the autotetraploid derivative of *A. obovatum*, and *A. foreziense* Heribaud, another allotetraploid derived from *A. obovatum*. An investigation of the whole European *Asplenium* complex for *C*-glycosylxanthones would perhaps confirm the relationships established by cytological studies. The occurrence of *C*-glycosylxanthones in the European *Asplenium* complex also may help to relate them to the Appalachian spleenworts. Smith & Harborne (1971) mention that the ocurrence of xanthones in other *Asplenium* species may possibly suggest a relationship to *A. montanum*. Experimental hybrids of *A. onopteris* and *A. montanum* would reveal any chromosomes held in common. Finally, the occurrence of *C*-glycosylxanthones in the diploid *A. onopteris* and its tetraploid derivatives helps to confirm the suggestion by Smith & Levin (1963) that chemical investigations have significant potential for evolutionary studies involving polyploidy.

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# Taxonomic Notes on Jamaican Ferns–IV

GEORGE R. PROCTOR*

This paper concludes my series of short papers on Jamaican ferns (Proctor 1965, 1968, 1981) written in conjunction with the preparation of a book about these plants, now essentially completed. For the sake of brevity, the rationale for new combinations will not be discussed at the present time. The reasons for these changes will become evident when the Jamaican fern volume is published.

I thank Dr. John Wurdack for his help in preparing the Latin descriptions, and Margi von Montfrans for drawing the two figures.

## LYCOPODIACEAE

**Lycopodium hippurideum var. montanum (L. M. Underw. & Lloyd) Proctor, comb. & stat. nov.**

*Lycopodium montanum* L. M. Underw. & Lloyd, Bull. Torrey Bot. Club 33:107. 1906. TYPE: Summit of Blue Mt. Peak, Jamaica; *Underwood 2537*, (NY; = *Maxon 1412*, isotype US).

## HYMENOPHYLLACEAE

**Trichomanes micropubescens Proctor, sp. nov.** **Fig. 1.**

Subg. *Didymoglossum*. A speciebus cetera subg. *Didymoglossi* laminis fertilibus anguste linearibus vel late oblanceolatis 6–13 mm longis 1–6 mm latis omnino integris vel distaliter inaequilateraliter lobatis, marginibus et paginae abaxialis venis pilis minutis simplicibus atrobrunneis compressis curvatis deciduis dense pubescentibus, marginibus pilis maioribus stellatis 3–5-ramosis remotis, soris solitariis terminalibus, involucro anguste obconico exserto, labiis abrupte expansis reflexis rotundis zona marginali fuscobrunnea ampla 5–8 cellulis lata differt.

Plants imbricate, forming mats; rhizome filiform, clothed with dark brown rhizoids. Fronds narrowly linear to broadly oblanceolate (except for irregularly roundish juvenile ones), 6–13 mm long, 1–6 mm broad above the middle, entire or the distal part expanded and irregularly lobed, sometimes subcordate and subsessile at the base, more often long-attenuate downward, filiform-stipitate or with no clear demarcation of the stipe; margins, and veins on abaxial side, at first densely pubescent with minute, simple, dark brown, flattened, curved or sometimes spirally twisted hairs, these eventually deciduous; margins also bearing larger, scattered, 3–5-branched stellate hairs. Fertile fronds costate, the costa running to the solitary apical sorus; sterile fronds also costate or sometimes with mostly flabellate venation; lateral veins flabellate, a few of them free in the very thin, membranous tissue. Sori always solitary; involucre narrowly obconic, 2–2.5 mm long, half or less immersed, the free distal portion marginate or very narrowly winged, at the apex abruptly flaring in two broadly rounded, usually reflexed lips, these with a wide, brown-darkened marginal zone 5–8 cells broad.

TYPE: Along the Drivers River above Soyo Falls, parish of Portland, Jamaica, on deeply shaded tree-trunks in wet forest near river, 400–500 ft (122–152 m), 23 Jan 1980, *Proctor 38554*. (IJ; isotype GH).

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This species is unique in its combination of minute, simple pubescence along the margins and abaxial side of veins and the very broad, darkened marginal band (up to 8 cells wide) on each lip of the involucre.

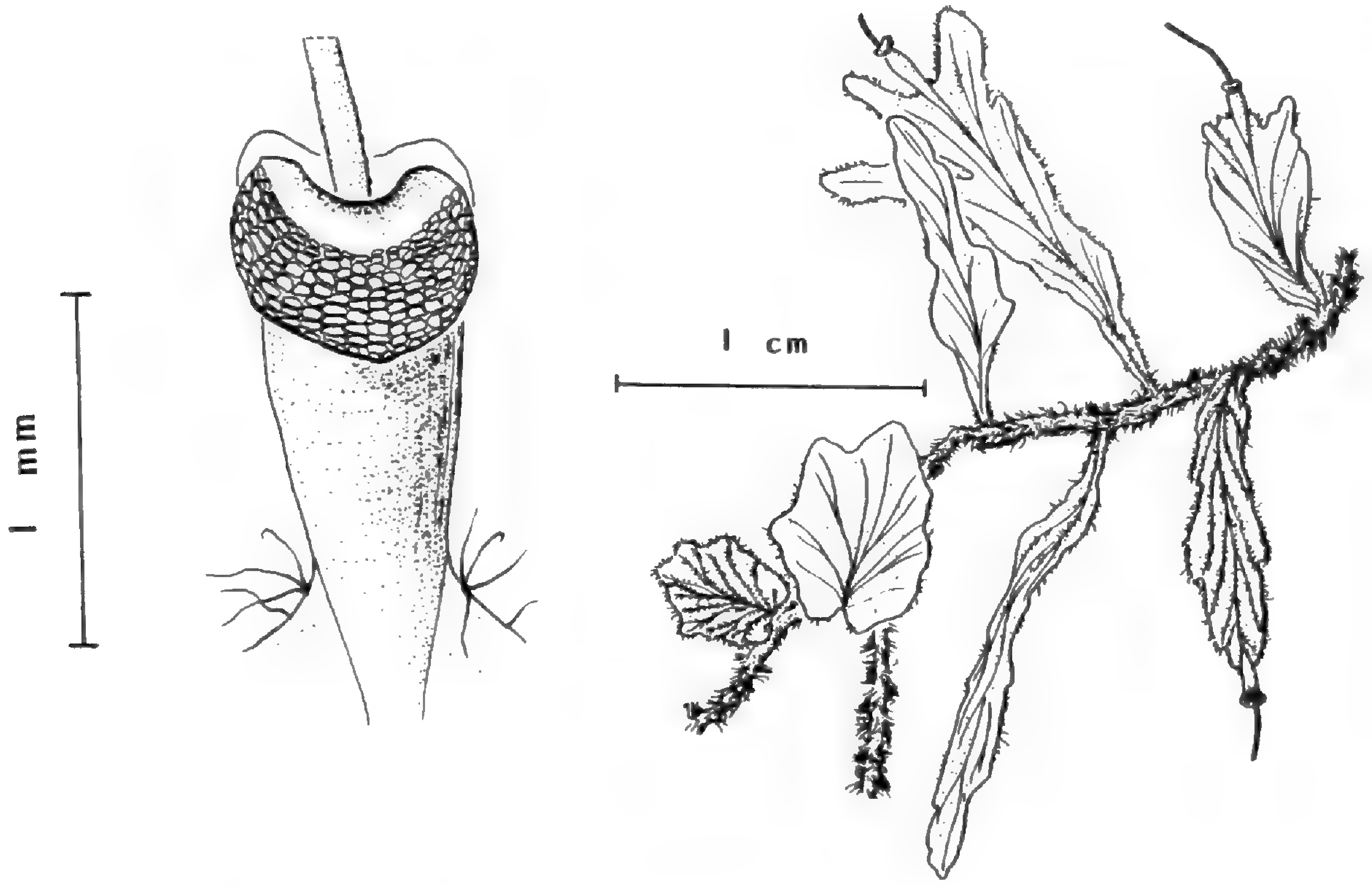

Fig. 1. Holotype of *Trichomanes micropubescens* Proctor

**Trichomanes radicans var. antillarum (v. d. Bosch) Proctor, comb. & stat. nov.** *Trichomanes antillarum* v. d. Bosch, Ned. Kruidk. Arch. 5:164. 1861. TYPE: "Woods above Fort Stewart", parish of St. Mary, Jamaica, Aug. 1843, *Purdie s.n.* (K).

## CYATHEACEAE

### Cyathea × bernardii Proctor, hybr. nov.

A *Cyathea* × *lewisii* stipitibus longioribus (50–70 cm vs. 20–35 cm), pinnis stipitatis (non subsessilibus), stipitibus 10–12 mm longis, caudicis stipitisque squamis fere omnino albidis solum bicoloribus ad basim apicemque, costulis abaxialiter squamis numerosis minutis albis bullatis armatis differt.

Caudex to 5 m tall, 6–10 cm in diameter, not spiny, densely clothed at the apex with whitish, satiny, concolorous (or faintly bicolorous at base and apex) scales, these up to 4 cm long. Fronds arcuate-spreading, 2.5–3.2 m long; stipes 50–70 cm long, pale brown, muricate with small, sharp spines not over 1 mm long and densely scaly with broad, whitish, nearly concolorous scales. Blades ovate, bright green, 2–2.5 m long, 0.9–1.3 m broad, 2-pinnate-pinnatifid, short-acuminate; rhachis remotely muriculate, sparsely hirsute with flexuous, pluricellular hairs in patches on the adaxial side; pinnae lance-oblong, 45–65 cm long, up to 22 cm broad, stalked, acuminate; costae densely hirsute on adaxial side, sparsely so beneath; pinnules up to 32 pairs, linear-oblong, up to 12 cm long, 1.7–2.5 cm broad, sessile, attenuate at the apex, cut nearly to the costule; costules and midveins more or less hirsute on both sides, abaxially bearing numerous, small, whitish bullate scales with hairlike tips; segments mostly 24–27 pairs, narrowly oblong-falcate, 10–15 mm long, 2–2.5 mm broad, the apex blunt, the margins crenulate-lobulate and more or less revolute;

veins mostly 12–15 pairs, chiefly 1- or 2-forked below the middle. Sori 4–10 pairs, inframedial or nearly medial; indusium flabelliform, irregularly lacerate or lobed, a few of the lobes often hair-pointed, brownish-hyaline; receptacle bearing small, golden-yellow, blunt-tipped paraphyses and much longer, colorless, sharp-pointed, hairlike ones, these exceeding the sporangia in length; spores often undeveloped or abortive.

TYPE: Corn Puss Gap, parish of St. Thomas, Jamaica, in lower montane rain forest, 2000 ft (610 m), 13 Feb. 1950, *Proctor 4001*. (US; isotypes IJ, MO).

This entity is postulated to represent the hybrid *Cyathea arborea* × *C. armata* (R. Tryon, 1976). It was formerly equated with *Cyathea* × *calolepis* (D. C. Eaton) Domin of Cuba, which is now thought to be a hybrid of *C. arborea* with a species other than *C. armata*, one not so far identified. Because the Jamaican plant has a rather wide local distribution (having been found at six localities in the parishes of St. Mary, St. Andrew, and St. Thomas), it has been provided with a specific epithet as a matter of convenience. It is named for Mr. C. Bernard Lewis, former Director of the Institute of Jamaica. The type specimens of *C.* × *bernardii* were collected from a plant growing beside the type plant of *C.* × *lewisii* (Morton & Proctor) Proctor, named for the same Mr. Lewis, and also having *C. arborea* as one of the parent species (*C. aspera* (L.) Swartz is the other).

## POLYPODIACEAE

### Arachniodes argillicola (Proctor) Proctor, comb. nov.

*Polystichopsis argillicola* Proctor, Amer. Fern. J. 51:147. 1961. TYPE: 2 miles NE of High Peak, above Murdock's Gap, parish of Portland, Jamaica, on shaded clay banks, 3500–4500 ft (1069–1372 m), *Proctor 5842* (IJ; isotype GH).

### Arachniodes chaerophylloides (Poiret) Proctor, comb. nov.

*Polypodium chaerophylloides* Poiret in Lam., Encycl. Méth. Bot. 5:542. 1804. TYPE: Puerto Rico, *Ledru s.n.* (P. Herb. Lam., photos GH, US).

*Polystichopsis chaerophylloides* (Poiret) Morton, Amer. Fern J. 50:155. 1960.

### Arachniodes lurida (Jenman ex L. M. Underw. & Maxon) Proctor, comb. nov.

*Dryopteris lurida* Jenman ex L. M. Underw. & Maxon in Slosson, Bull. Torrey Bot. Club 40:183, *t. 3, f. 1*. 1913. TYPE: Jamaica, *Jenman, "1874-79"* (NY; isotype US).

*Polystichopsis lurida* (Jenman ex L. M. Underw. & Maxon) Morton, Amer. Fern J. 50:155. 1960.

### Arachniodes macrostegia (Hooker) Proctor, comb. nov.

*Nephrodium macrostegium* Hooker, Sp. Fil. 4:148. 1862. TYPE: Rio Uaupés, Brazil, *Spruce 2245* (K; isotype US).

*Nephrodium ochropteroides* Baker, Ann. Bot. 5:325. 1891. TYPE: Fox's Gap, Jamaica, April 1886, *Hart s.n.* (K; isotype IJ).

*Polystichopsis ochropteroides* (Baker) Morton, Amer. Fern J. 50:155. 1960.

### Arachniodes pubescens (L.) Proctor, comb. nov.

*Polypodium pubescens* L. Syst. Nat. ed. 10, 2:1327. 1759. TYPE: Jamaica, *P. Browne s.n.* (LINN 1251.48).

*Polystichopsis pubescens* (L.) Morton, Amer. Fern J. 50:155. 1960.

### Asplenium erosum var. duale (Jenman) Proctor, comb. & stat. nov.

*Asplenium duale* Jenman (as *Adiantum* in error), Gard. Chron. III, 13:10. 1893. TYPE: Jamaica, *Sherring s.n.* (K ?, not seen).

**Asplenium gilbertii Proctor, sp. nov.** Fig. 2.

Ab *Asplenio sciadophilo* laminis deltato-oblongis minus quam 10 cm longis basiliter truncatis, divisionum ultimarum venis furcatis differt; ab *A. trichomanes-dentato, A. myriophyllo* et cetero laminis 2-pinnatis differt; et ab *A. clutei* laminis 2.5–4 cm latis (vs. minus quam 1.5 cm) et pinnarum plus quam 10 paria ferentibus differt.

Rhizome short, erect, 3–4 mm thick, clothed at apex with blackish, clathrate, narrowly deltate-acuminate or deltate-attenuate scales 1–3 mm long, these sometimes gland-tipped. Fronds few, erect or spreading, 15–20 cm long; stipes greenish or brownish, 8–11 cm long, longer than the blades, narrowly green-marginate, bearing scattered, minute, 2- or 3-celled gland-tipped hairs (similar hairs on abaxial side of rhachis and costae). Blades oblong or deltate-oblong, 6–9 cm long, 2.5–3.5 cm broad at the base, acuminate at the apex; rhachis green-marginate and bearing rather numerous, small, contorted, black, hairlike scales on the abaxial side; pinnae 9–12 pairs, short-stalked, slightly inequilateral, lance-deltate, 7–11 mm broad near base, pinnate in the basal half with 3 or 4 pairs of free pinnules, the basal acroscopic one the largest; distal portion of pinnae pinnatifid or lobate to an acute apex, the lobes simple or bidentate; pinnules ovate to obovate, pinnate-veined, cuneate at the base, the apex obtuse and crenate-dentate; tissue dark green, membranous. Sori elliptic, 1–1.5 mm long; indusium brown, firm, the margin entire; sporangia apparently mostly immature or abortive.

TYPE: Mandeville, Jamaica, *B. D. Gilbert s.n.* in 1895 (GH). The stated type locality is about 2000 ft (610 m) above sea level.

Known only from the type collection.

**Asplenium myriophyllum var. brevisorum Proctor, var. nov.**

A var. *myriophyllo* soris brevioribus (0.5–1.3 mm longis, vs. plerumque 1.5–2.5 mm longis), nullo modo diplazioideis, divisionibus ultimis plerumque angustioribus (0.4–0.8 mm latis, vs. 0.7–1.4 mm latis), textura aliquantum rigida et pallida vel dilute viridi differt.

Differs from var. *myriophyllum* in having shorter sori (0.5–1.3 mm long, vs. mostly 1.5–2.5 mm long), these never diplazioid; in having mostly narrower ultimate divisions (0.4–0.8 mm broad, vs. 0.7–1.4 mm broad); and in the rather stiff, pale to light green tissue of the blades.

The two Jamaican varieties of this species appear to be completely allopatric. Variety *brevisorum* occurs exclusively on limestone rocks and has been found chiefly in the central and western parts of the island; var. *myriophyllum*, on the other hand, occurs both on calcareous and non-calcareous rocks at somewhat higher elevations and is confined to the region of the Blue and Port Royal Mts. Both forms need to be investigated cytologically. Probably neither is endemic to Jamaica.

**Asplenium radicans var. tripinnatum (Hieron.) Proctor, comb. nov.**

*Asplenium flabellulatum* var. *tripinnatum* Hieron. Hedwigia 47:229. 1908. LECTOTYPE (chosen here): Ecuador, *Stuebel 851* (B, photo US). The other syntypes are: Colombia, *Stuebel 31* and *151* (both B, photos US) and Ecuador, *Stuebel 780* (B).

**Asplenium trichomanes-dentatum var. jamaicense (Jenman) Proctor, comb. & stat. nov.**

*Asplenium jamaicense* Jenman, J. Bot. Brit. For. 24:268. 1886. TYPE: Jamaica, *Sherring s.n.* (K, not seen).

Fig. 2. Holotype of *Asplenium gilbertii* Proctor

### Diplazium montediabloense Proctor, sp. nov.

*Diplazium brevisorum* John Smith, Cat. Kew Ferns 6. 1856, non John Smith, 1841. TYPE: A cultivated specimen originating from Jamaica (K, not seen).

A *Diplazio pectinato* magnitudine maiore, costis nudis et abaxialiter fere glabris, segmentis in quoque pinna paucioribus (minus quam 23, vs. plus quam 25 in quoque latere) et latioribus (8–10 mm latis, vs. 3–7 mm latis), differt.

Rhizome unknown, but plant stated to be "arborescent," i.e., with an erect caudex like a tree fern. Fronds evidently large, more or less oblong, of unknown length but probably between 1 and 2 meters; 35–50 cm broad, acuminate at the apex; rhachis and other vascular parts stramineous, glabrate, bearing but a few scattered pluricellular hairs chiefly at the base of costae abaxially. Pinnae lance-oblong, short-stalked, acuminate; segments ca. 19–22 pairs, opposite or alternate, oblong, 2–3.5 cm long (the lowermost pair of each pinna somewhat reduced), 8–10 mm broad, obtuse at the sharply serrate apex, the margins crenate- or bicrenate-lobulate, cut to 0.5–1.5 mm of the costa, the sinuses rounded; veins mostly forked below the middle, prominulous especially on adaxial side; tissue light green, thin-membranous. Sori inframedial, ca. 1.5 mm long; indusium thin, light brown, the margin more or less erose.

TYPE: "Near the top of Mt. Diablo," parish of St. Catherine (?), Jamaica, *R. C. Alexander s.n.* in 1849–50 (US). This specimen is marked "*Asplenium brevisorum* fid J. Sm."

Known only from the type collection. This species seems obviously related to *Diplazium pectinatum* (Fée) C. Chr., but differs in its much larger size, fewer segments per pinna, and almost entire lack of pubescence.

**Diplazium stokeyae Proctor, sp. nov.**

*Asplenium radicans* var. *pallidum* Jenman, Bull. Bot. Dept. Jamaica II, 2:88. 1894. TYPE: Second Breakfast Spring, parish of St. Andrew, Jamaica, *J. P. 549* (IJ).

A *D. expanso* et *D. fuertesii* pinnulis hebetibus vel rotundatis marginibus vix crenato-dentatis (non lobatis), soris longioribus (4–5 mm longis, vs. 2–4 mm longis), distanter uniseriatis in costulae quoque latere (non aggregatis ordinate cum lobis marginalibus), differt.

Rhizome erect, 0.5–1 cm thick, the apex bearing thick, dark brown, subclathrate, lanceolate scales ca. 3–5 mm long and 1–1.5 mm broad, the margins entire, the cell lumina parallelogramoid in outline, averaging 0.2 mm long and 0.1 mm wide, often deeper than wide. Fronds ca. 1 m long; stipes shorter than the blades, trisulcate adaxially, brown darkening to nearly black at base, the basal part bearing a few scales like those of rhizome, otherwise naked and glabrescent. Blades ovate-oblong, ca. 40 cm broad; rhachis light brown, glabrescent, slightly viscid-glandular; pinnae 8–10 pairs, subopposite to alternate, stalked, lance-oblong or oblong, acuminate, 6–8 cm broad, the lowermost 1 or 2 pairs slightly inequilateral with basiscopic pinnules a little longer than the acroscopic ones; free pinnules 3–5 pairs, the remainder of the ultimate divisions more or less adnate; costae very narrowly green-marginate; costae and costules brown and glabrescent to very sparingly puberulous with short pluricellular hairs, each costule subtended at the base by a single very small, pale brown, narrowly deltate-attenuate scale; pinnules and larger adnate divisions oblong, obtuse, 2.5–4 cm long, 1.3–1.6 cm broad, the margins crenate-serrate or crenate-biserrate to very shallowly lobulate; tissue pale green, membranous, glabrous on the adaxial side, sparsely puberulous abaxially with very minute white, erect, apparently unicellular hairs. Sori 5–7 pairs per division, inframedial on distal vein-branches, 4–5 mm long; indusium narrow, brown, with a subentire to slightly erose margin.

TYPE: Near the waterfall 0.5 mile N of Hardwar Gap, parish of Portland, Jamaica, ca. 3800 ft (1158 m), *Proctor 9849* (IJ).

Named for the late Alma G. Stokey in recognition of her valuable studies of fern gametophytes (based in part on Jamaican materials) and also in fond remembrance. Both of the cited localities for *Diplazium stokeyae* were sources of fern spores that she used in her work.

**Diplazium wilsonii var. brunneoviride (Jenman) Proctor, comb. & stat. nov.**

*Asplenium brunneo-viride* Jenman, J. Bot. Brit. For. 24:269. 1886. TYPE: Vicinity of Cinchona, parish of St. Andrew, Jamaica, *Jenman s. n.* (K).

**Grammitis minor (Jenman) Proctor, comb. nov.**

*Monogramme minor* Jenman, Bull. Bot. Dept. Jamaica II, 4:212. 1897. TYPE: Murray's Flat, Mt. Moses, parish of St. Andrew, Jamaica, *Jenman s. n.* in 1876 (NY; isotype US).

*Cochlidium minus* (Jenman) Maxon, Sci. Surv. Porto Rico Virgin Is. 6:407. 1926.

**Grammitis seminuda (Willd.) Proctor, comb. nov.**

*Blechnum seminudum* Willd. Phytogr. 13, *t. 8, fig. 2.* 1794. TYPE: Martinique, *Isert s.n.* in 1787 (B-*Herb. Willd. 19587).*

*Cochlidium seminudum* (Willd.) Maxon, Sci. Surv. Porto Rico Virgin Is. 6:407. 1926.

**Hypolepis fimbriata Maxon ex Proctor, sp. nov.**

A *H. stuebelii* magnitudine multo minore, pinnis oppositis vel suboppositis, costis costulis venisque essentialiter eglandulosis pilis paucis et grossioribus, differt.

Rhizome 2.5–4 mm in diameter, bearing numerous glistening, reddish-brown, contorted-articulate hairs often terminating in finely bristle-like tips. Fronds laxly ascending, up to 1 m or more long; stipes 40–45 cm long, lustrous brown, shallowly grooved adaxially, rough especially toward the basal end by the raised sclerotic bases of broken-off hairs, otherwise bearing a few narrowly conic spines 0.5–1.5 mm long, also minutely glandular-puberulous and with scattered, colorless, contorted, articulate hairs up to 1.5 mm long. Blades deltate, up to 60 cm or more broad at base, 2-pinnate-pinnatifid or -sect with lobed ultimate segments, acuminate at the apex, the vascular axes and veins on both sides with scattered, colorless, articulate hairs, the nonvascular tissue glabrous; rhachis with a few scattered spines like those of the stipe; pinnae spreading, opposite or subopposite, lance-oblong, with up to 18 pairs of pinnules, these narrowly deltate-oblong, the larger ones up to 10 cm long, 2.5 cm broad at base, mostly subsessile; ultimate segments lobed, the fertile lobes lobulate at the acroscopic base. Sori located on fertile lobules; indusium delicately membranous, densely ciliate with a tuft of colorless, hyaline acicular hairs.

TYPE: Lower slopes of Mt. Moses, parish of St. Andrew, Jamaica, 2000–2500 ft (610–762 m), 14 Apr 1903, *Maxon 1060* (US).

Known only from the type collection and an unlocalized specimen gathered by *Wiles* (BM, fragm. US) during the period 1793–1805.

**Hypolepis jamaicensis Maxon ex Proctor, sp. nov.**

A *H. bogotensi* stipite et rhachidi spiniferis costis costulisque eglandulosis differt; a *H. nigriscenti* laminis minus divisis (3-pinnato-pinnatifidis, vs. 4-pinnato-pinnatifidis vel 5-pinnatis), spinis multo minoribus (minus quam 1 mm, vs. usque ad 2 mm) rectis, costis costulisque pubescentibus differt.

Rhizome 2–5 mm in diameter, mostly naked, but on one or two sides toward the growing apex and near the bases of stipes bearing lustrous, yellowish-brown, articulate hairs, these with capillary-pointed tips. Fronds sprawling or vinelike, up to 5 m long, sometimes forming tangles; stipes 50–100 cm long, dull yellowish-brown, darker toward the base, grooved adaxially, finely muriculate or with scattered, small, sharp spines 0.5-1 mm long, glabrescent. Blades narrowly deltate-oblong, attenuate, up to 1 m broad at base, 3-pinnate-pinnatifid; rhachis and costae muriculate or finely spiny like the stipe; pinnae oblique or spreading, alternate or subopposite, deltate-oblong, acuminate, with up to 15 pairs of opposite to alternate primary pinnules, these oblong-acuminate, the larger ones up to 15 cm long and 6 cm broad at base, all but the most distal ones short-stalked; vascular parts on both sides pubescent with pluricellular, colorless hairs, these somewhat curved or flexuous but mostly not strongly articulate and not glandular; ultimate segments lobed or lightly crenate, pale-veined. Sori solitary at acroscopic bases of segment lobes; indusium pale-membranous, the margin (at least when young) coarsely toothed and sparingly septate-ciliate.

TYPE: Vicinity of New Haven Gap, parish of St. Andrew, Jamaica, ca. 5500 ft (1688 m), 21 June 1904, *Maxon 2610* (US).

Probably endemic in Jamaica, this species occurs rather widely in the Port Royal, Blue, and John Crow Mountains at elevations of 1200–6500 ft (366–1982 m). It is clearly related to *H. bogotensis* Karsten (which also occurs in Jamaica) and *H. repens* (L.) C. Presl (which does not).

By implication, A. R. Smith (1981) included this entity within his concept of *H. bogotensis*, at the same time rightly pointing out that true *bogotensis* does occur in our area. *Hypolepis jamaicensis* differs from *H. bogotensis* in its larger fronds and more rampant habit; its muriculate or finely spiny stipe, rhachis, and costae; the finer character of its pubescence; in its lack of glandularity; and in its pale (vs. dark) ultimate veins. *Hypolepis jamaicensis* seems most closely related to *H. repens* (with which it has often been confused), a species found widely in the West Indies and continental American tropics, but not so far authentically identified as occurring in Jamaica. *Hypolepis repens* is more spiny and less pubescent than *H. jamaicensis*, and its indusium is subentire and glabrous.

### Polypodium triseriale var. gladiatum (Kuhn) Proctor, comb. nov.

*Polypodium brasiliense* var. *gladiatum* Kuhn, Engl. Bot. Jahrb. 24:130. 1897. TYPE: "Interior" of Cuba, Sept 1822, *Poeppig s. n.* (LZ, destroyed; isotype BR, photo US).

*Polypodium gladiatum* Kunze, Linnaea 9:45. 1834, non Vell., 1827.

*Goniophlebium ampliatum* Maxon, Contr. U.S. Nat. Herb. 10:492. 1908.

*Polypodium ampliatum* (Maxon) Proctor, Bull. Inst. Jamaica Sci. Ser. 5:45.1953.

### Polytaenium lineatum var. intramarginale (Baker ex Jenman) Proctor, comb. & stat. nov.

*Vittaria intramarginalis* Baker ex Jenman, J. Bot. Brit. For. 15:266. 1877. TYPE: Jamaica, *Jenman 58* in 1877 (K).

*Polytaenium intramarginale* (Baker ex Jenman) Alston, Mutisia 7:9. 1952.

### Pteris arborea f. regia (Jenman) Proctor, comb. & stat. nov.

*Pteris regia* Jenman, Gard. Chron. III, 17:39. 1895. TYPE: Jamaica, *D. Morris s. n.*, ex herb. J. Hart (K, isotypes IJ, photos US).

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# Pelletixia amelguita, a New Species of Fossil Fern in the Potomac Group (Lower Cretaceous)

JUDITH E. SKOG*

A new species of the fossil fern *Pelletixia* Watson and Hill (1982) has been identified from fragments of pinnules discovered in sediments belonging to the Lower Cretaceous Potomac Group of Maryland. The locality was exposed in a stream bank at high flood stage during a tropical storm in 1972. Subsequently, material was collected from the site for several years until erosion by the stream completely destroyed the locality. The material described here is placed in a genus previously known only from the Wealden beds (Lower Cretaceous) of England. The Potomac Group and Wealden Formation have been shown to have many plants in common (Hueber, 1982), and so it is not surprising to find an additional example of a genus reported only from these two localities.

**Locality and Stratigraphy.**—*Pelletixia amelguita* was isolated as pinnule fragments from material brought to the U. S. National Museum of Natural History by Mr. Howard Hruschka. He had collected the material from a high, newly eroded bank along Paint Branch about one mile north of the University of Maryland campus in College Park, Maryland (Washington East Quadrangle 7.5 minute series topographic sheet, 39°00′ W lat., 76°56′ N long.). The plant-bearing strata are in Zone 1 of the Potomac as defined by Doyle (1969) and are probably of Barremian–Aptian age within the Lower Cretaceous. The stratum whence came the specimens described herein is probably the same which produced the rhizome of the fern *Loxsomopteris anasilla* J. Skog (1976). The age of the specimens is approximately 130 million years.

**Materials and Methods.**—The clay matrix was bulk macerated in 48% hydrofluoric acid. The residue was thoroughly washed with several changes of water until acid-free, sieved, and then sorted under a dissecting microscope for all sizes of material (Hueber, 1982). The specimens were examined under a Wild M-5 dissecting microscope, photographed, and then drawn using a camera lucida attachment. One specimen was air dried and mounted on the surface of a 12 mm cover glass that had been thinly coated with white glue. The cover glass was attached to a SEM stub with silver paint, coated with gold-palladium, and observed with a JOEL JSM-35C scanning electron microscope at the Palynology Laboratory, United States Geological Survey, Reston, Virginia. The specimen was cracked open on the stub and recoated to release some spores after the first viewing indicated the presence of sporangia and spores. Unfortunately, the inclusion of thymol granules in the water used for separating material did not prevent the second specimen from being destroyed by bacteria and fungi. This problem has also been noted by Hueber (1982) for material of the same age from a different locality. Photographs were taken with a Wild M-5 dissecting scope with 35mm camera attachment using Kodak Plus-X Pan film or with the SEM using Polaroid Type 52 positive-negative film.

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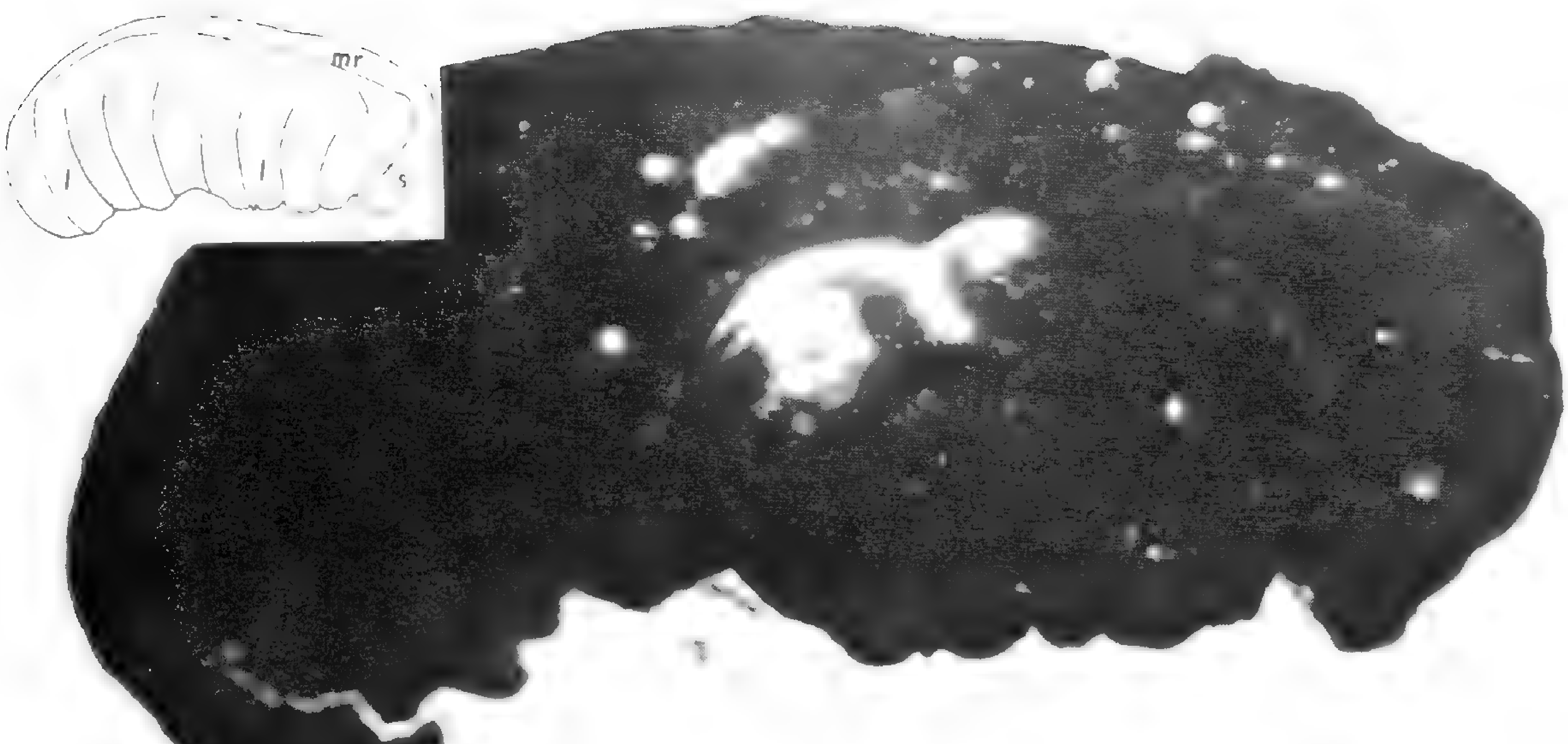

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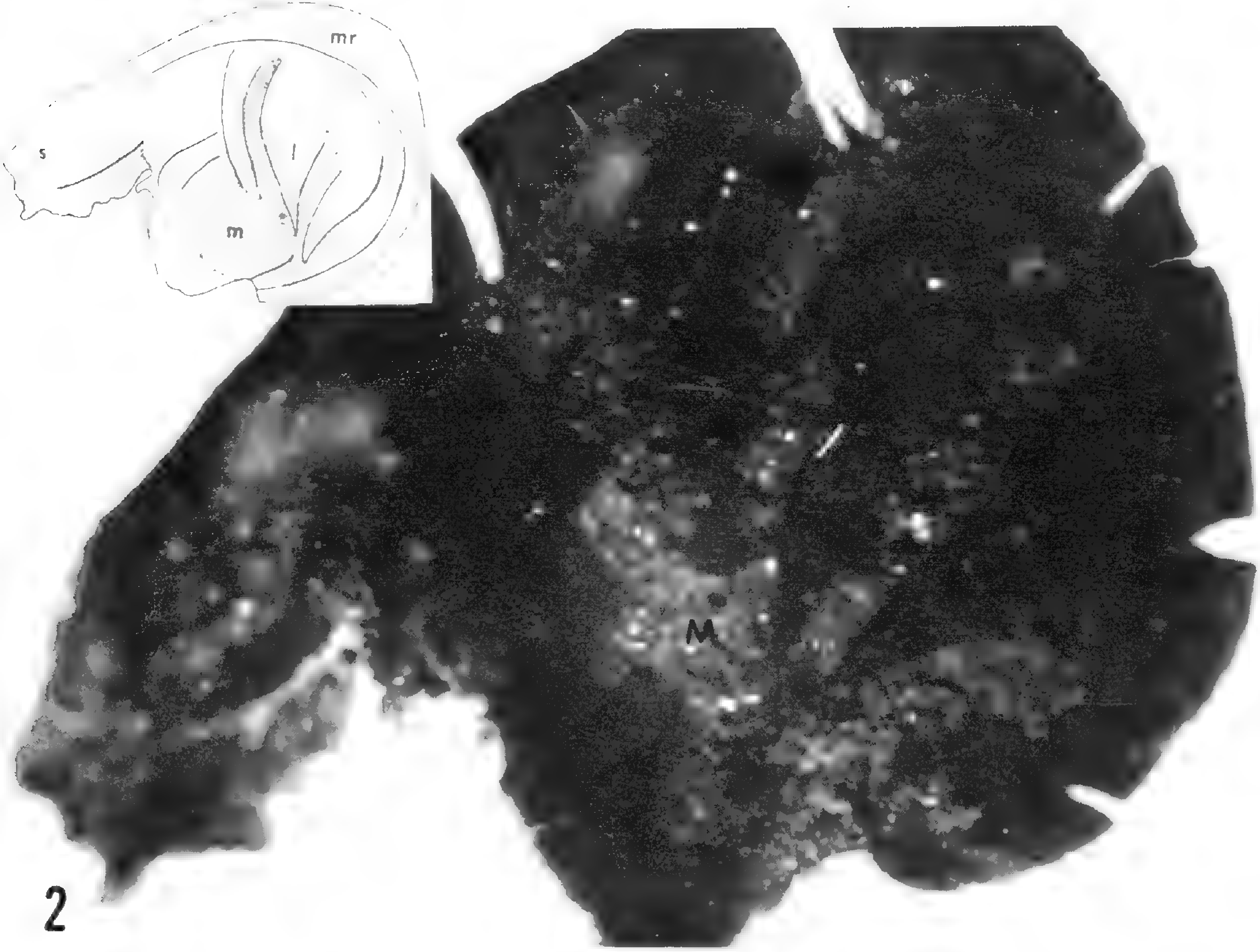

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FIG. 1. Pinnules of *Pelletixia amelguita*. ×26. FIG. 2. Pinnule of *Pelletixia amelguita*. Type specimen USNM 326733. ×52. The abbreviations are: l = lobe, m = matrix, mr = midrib, s = stalk.

**Pelletixia amelguita J. E. Skog, sp. nov. (Schizaeaceae) Figs. 1–12.**

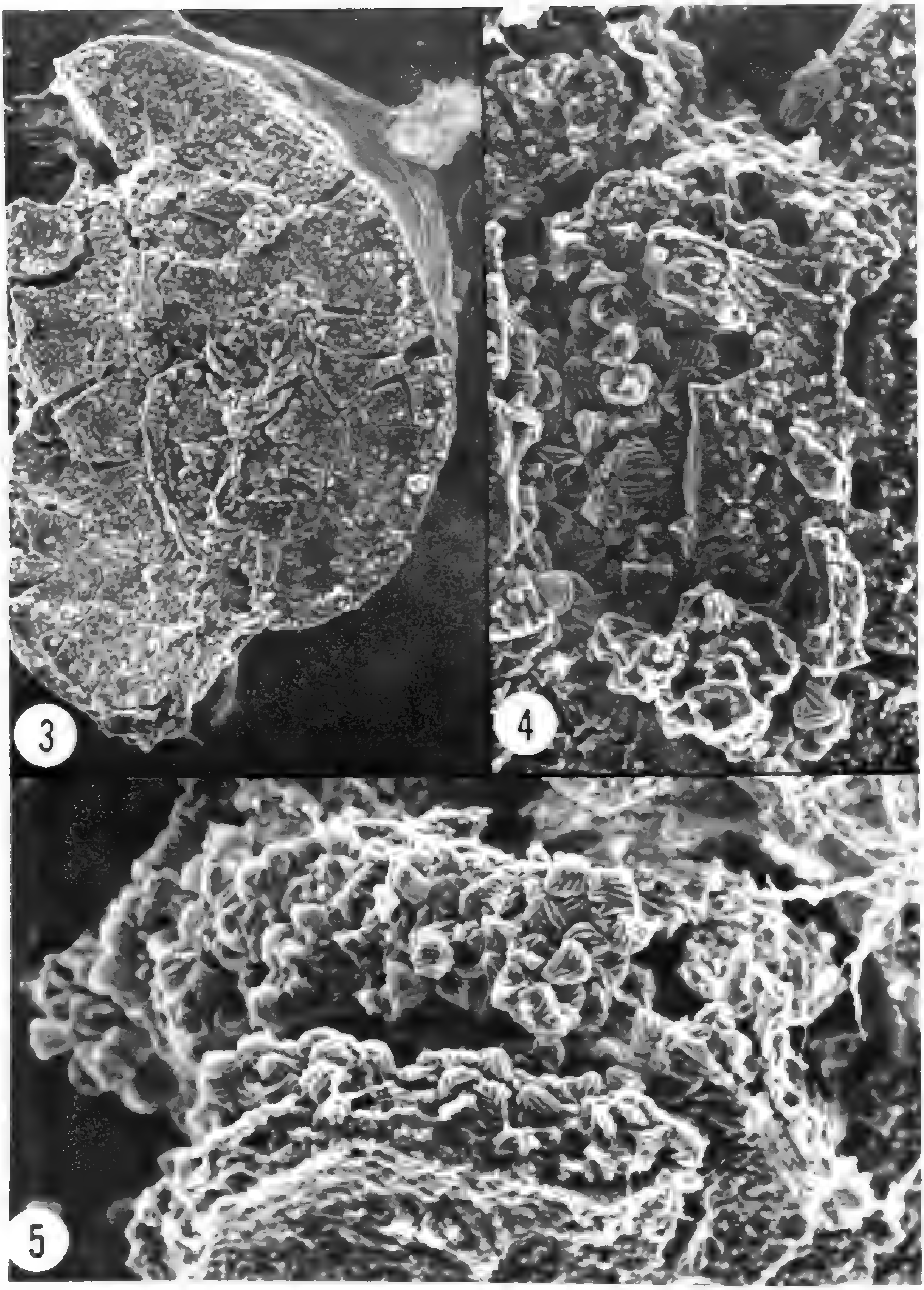
The fragments isolated from the matrix represent two tightly enrolled pinnules 1.5 to 2.5 mm long on short stalks 0.5 mm or less long (*Figs. 1* and *2*). The specimens are fractured, probably due to shrinkage as the matrix dried out in the laboratory (*Figs. 2* and *3*). Ridges and clay-filled grooves can be seen on both specimens and may represent veins or lobes of the pinnule. Such detail would be better defined were the pinnules unrolled. A definite midrib is seen along the adaxial surface of the pinnules (*Fig. 3*). Only one specimen (*Fig. 2*) remained for further study after general handling while studying; the additional characters described here are based on that specimen alone. When first viewed with the scanning electron microscope, the pinnule was clearly seen to be fertile (*Figs. 4* and *5*). The epidermis shows few cellular details other than it is composed of smooth, even cells. The sporangia were broken when the specimen was dissected, with the result that no details of the annulus can be described. Remnants of what may be an annulus can be seen in *Figs. 4* and *8*. At least 120 (128) spores can be counted in one area (*Fig. 5*), probably derived from a single sporangium. The spores are well-preserved and distinctive. They are trilete (*Fig. 6*), about 28–35 μm in diameter, and have raised lips around the laesura which seem to extend into a ridge that extends to the margin of the spore (*Fig. 7*). The spores are triangular with the margins at times slightly convex and the apices somewhat rounded. Two or three muri parallel the margins of the spore on both the proximal and distal surfaces (*Figs. 6* and *8*). These muri are narrow, 0.5–2 μm wide, 1–2 μm high and are separated by spaces 1.5–3.5 μm wide. On the distal surface the muri join at the pole to form a triangle about 5.0 μm in diameter. The shape of the triangular area is variable, ranging from sharply triangular (*Figs. 8* and *9*) to subdivided (*Figs. 10* and *11*), to circular within a triangle (*Fig. 12*). The outer muri extend to the apices.

TYPE: USNM 326733, Paleobotany Collections, U. S. National Museum of Natural History.

TYPE LOCALITY: East bank of Paint Branch, College Park, MD, U.S.A. Washington East Quadrangle 7.5 minute series, 39°00′ Lat. 76°56′ Long. Stratigraphy: Patuxent Formation, Potomac Group, Barremian–Aptian, Lower Cretaceous.

SPECIES NAME: Derived from the Spanish diminuitive of "amelga" meaning a ridge between valleys—to emphasize the smaller muri on the spores of this species in contrast to the spores of *Pelletixia valdensis* (Seward) Watson & Hill.

Seward (1913) described fertile pinnae or fronds from the Wealden (Lower Cretaceous) in England which he named *Pelletieria valdensis*. *Pelletieria* Seward, 1913, was shown by Watson and Hill (1982) to be a later homonym of *Pelletiera* St.-Hilaire, 1822, a member of the Primulaceae. They proposed the new generic name *Pelletixia* and formed the new combination *Pelletixia valdensis* for the monotypic species. Watson (1969) restudied Seward's type specimen for the species and determined that the fronds were quadripinnate, comprising slender axes without laminae. The fertile pinnules were tightly enrolled in this genus and there was little sterile tissue associated with the clusters of sporangia. The specimen discovered in the Potomac Group and described here exhibits the form of pinnule identical to the generitype. It is identified with the genus even though details of the morphology of the frond are not known for the new material. No other ferns of this age have been described with these very tightly revolute fertile pinnules. The spores of both species belong to the dispersed spore genus *Cicatricosisporites*. Those of *Pelletixia valdensis* have been well described and identified with *C. brevilaesuratus* (Hughes & Moody-Stuart, 1966). The spores of *P. amelguita* are closest in details of size and morphology to the dispersed spore species *Cicatricosisporites aralica* (Bolkhovitina) Brenner (see Brenner, 1963, Plate 7, fig. 4, 5; Phillips & Felix, 1971, Plate I, fig. 16). Brenner commented that these spores are similar to those in the fossil fern *Ruffordia goeppertii* Seward and that they occur commonly in Zone I of the Potomac



FIGS. 3–5. Morphological details of the holotype of *Pelletixia amelguita*. FIG. 3. Whole pinnule before breaking apart, ×54. Spores can be seen in upper center. FIG. 4. Area of spores enlarged. Remnant of sporangial wall and annulus can be seen at top center of photograph, ×200. FIG. 5. Area of spores after further breaking of specimen. Approximately 120 spores can be counted, ×200.

Group and are very common in the Wealden of England. He noted that similar spores are produced by extant species of *Anemia*. Both Hughes & Moody-Stuart (1966) and Watson (1969) commented that *C. brevilaesuratus*, the spore of *Pelletixia valdensis*, is comparable to the spores of *Ruffordia goeppertii*. The spores of *P. amelguita* are smaller than those of *P. valdensis*, actually about half the size, and the ridges are widely spaced, whereas in *P. valdensis* the ridges are quite close together. The spores of *P. amelguita* are certainly more similar to those of some specimens of *Ruffordia goeppertii* in size and spacing of muri, especially as described by Watson for specimen V 2192 of *R. goeppertii*. However, no specimen of *R. goeppertii* has been described with the tightly revolute pinnules of *Pelletixia*.

Thus, while the newly described pinnules are placed in the genus *Pelletixia*, I suggest that the genus may actually represent a stage in the development of the fertile frond. The open (unrolled), dispersing stage of the pinnules has been described and identified as a specimen of *Ruffordia goeppertii*. There is support for this interpretation within the modern genus *Anemia*. In modern affinities the fossil plants most closely resemble the genus *Anemia*, particularly plants found in the subgenus *Anemiorhiza*. *Anemia aurita* Swartz (endemic to Jamaica) has fertile pinnules that are at first tightly rolled and then unroll somewhat to release the spores (Mickel, 1981). The spores of this species and others within the subgenus resemble those of *Pelletixia* and also *Ruffordia*. Mickel (1981) considers this subgenus to be the most primitive of the genus.

The interpretation of the habitat of *Pelletixia* has been uncertain. Seward (1913) suggested it was possibly aquatic. Hughes and Moody-Stuart distinguished it from *Ceratopteris*, but suggested exploring the possibility that it was aquatic and not related to the rest of the family Schizaeaceae. Watson (1969) said that "the form of the fertile fronds cannot be matched" within the family Schizaeaceae and compared the structure of them to *Onoclea sensibilis* L. I suggest that there are comparable fertile pinnules within the Schizaeaceae, especially in tropical species of the genus *Anemia*, and that following further study, *Pelletixia*, *Ruffordia*, and *Anemia* may all prove to be congeneric.

The author acknowledges the aid of Mr. Howard Hruschka of College Park, MD, for collecting the matrix material; Mrs. Effie Shaw, Palynology Laboratory, U.S. Geological Survey, Reston, VA, for SEM assistance; and Mr. Jan Endlich, Department of Biology, George Mason Univ., for preparing photographs.

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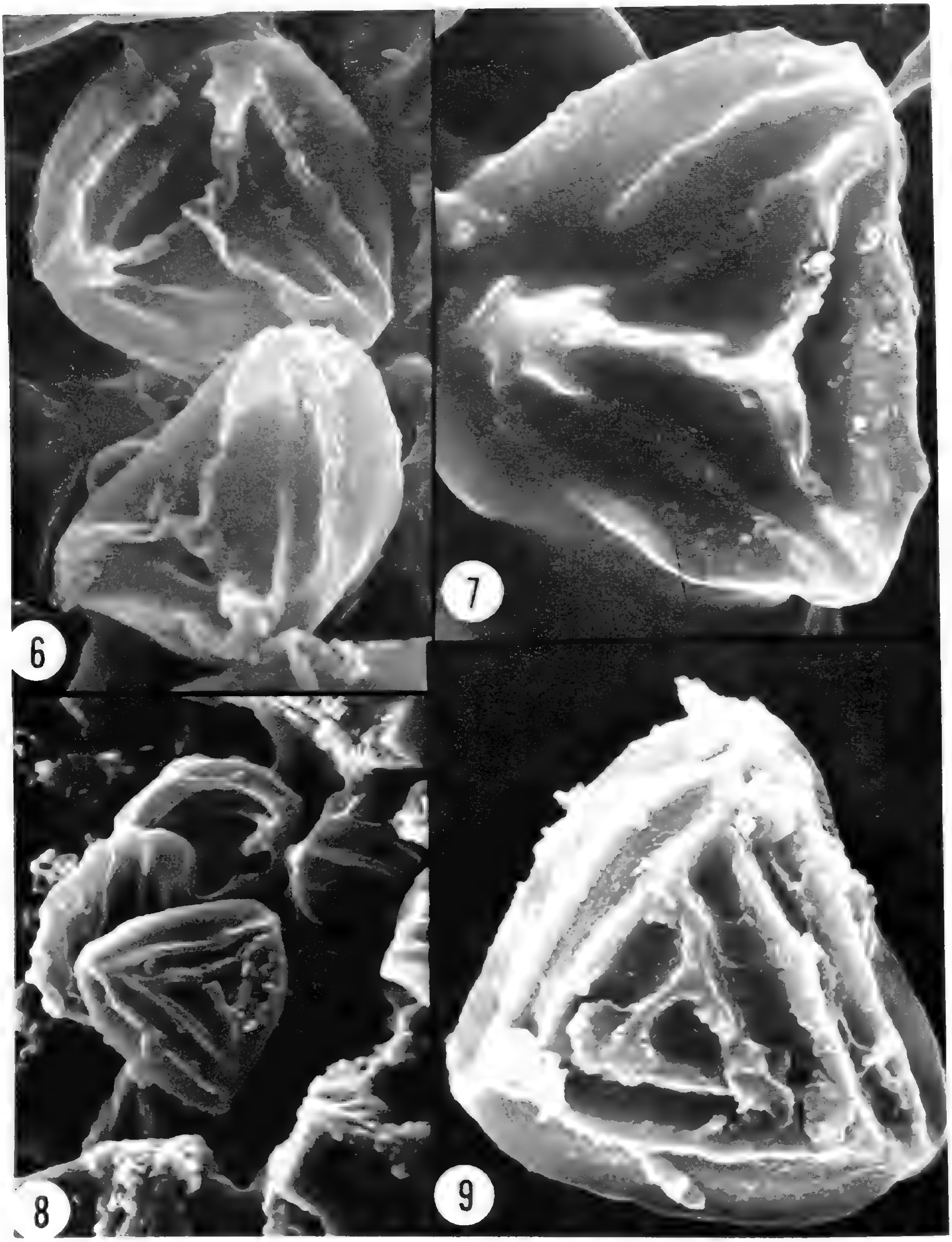
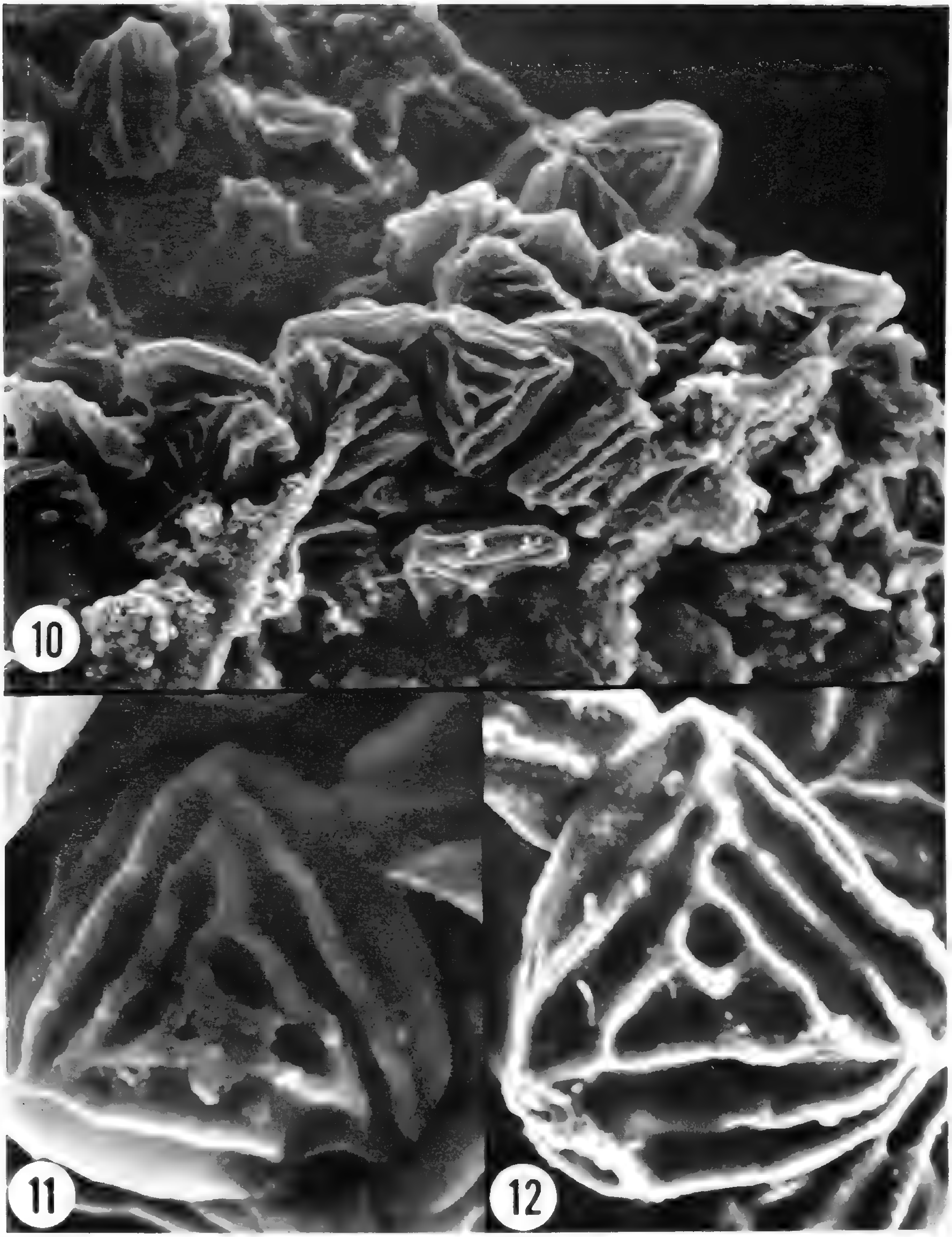


FIGS. 6–9. Spores of the holotype of *Pelletixia amelguita*. FIG. 6. Detail of spores showing proximal face with trilete mark and raised lips, ×1600. FIG. 7. Proximal face of spore, ×2200. Note that lips join with muri and extend to the margin. FIG. 8. Spores in sporangium showing distal face with irregular polar triangle. Possible remnants of annulus may be seen at edges of photograph, ×940. FIG. 9. Isolated spore with polar triangle and detail of muri on distal face, ×2200.



FIGS. 10–12. Spores of the holotype of *Pelletixia amelguita*. FIG. 10. Cluster of spores showing variability of polar triangle. ×618. FIG. 11. Spore with tripartite polar triangle (one section occluded). ×1854. FIG. 12. Spore with spherical depression in the polar triangle. ×1854.

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Manuscripts submitted to the JOURNAL are reviewed for scientific content by one or more of the editors, and, often, by one or more outside reviewers as well. During the past year we have received the kind assistance of C. Haufler, H. T. Horner, Jr., F. M. Hueber, E. E. Karrfalt, J. D. Montgomery, D. J. Paolillo, H. E. Robinson, J. E. Skog, R. G. Stolze, R. A. White, and D. P. Whittier, to whom we are deeply indebted. We welcome suggestions of other reviewers.—*D.B.L.*

## INDEX TO VOLUME 72

## ERRATUM FOR VOLUME 71 1981

Page 70, line 11: For ">" read "<".

## ERRATUM FOR VOLUME 82 1982

Page 27, line 15 should read: ". . . genera in the Dicksoniaceae, and concluded that both genera are more dicksonioid than cyatheoid on the basis. . ."

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