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# American Fern Journal

A QUARTERLY DEVOTED TO FERNS

Published by the

AMERICAN FERN SOCIETY

EDITORS

C. V. MORTON

R. C. BENEDICT IRA L. WIGGINS

A. C. SMITH

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# Contents

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# American Fern Journal

Vol. 50 JANUARY-MARCH, 1960 No. 1

FIFTIETH ANNIVERSARY

Invited Papers Contributed in Commemoration of the Fiftieth Volume of the American Fern Journal[1]

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[1]Other invited papers will appear in other issues during the year. The reports of the officers and other Society matters will appear in number 2. [C. V. M.]

## The Genesis of the American Fern Journal

RALPH C. BENEDICT

Officially, the American Fern Journal became the accepted publication of the American Fern Society in January, 1911, but actually the Journal was born some six months earlier during the summer of 1910, and the first two issues of Volume I had appeared before its formal adoption. By next summer, therefore, the Journal will have completed its fiftieth year of existence. So far as I recall, the background of its genesis has never been reported in its own pages. Such a report is the theme of this article.

The Fern Journal was born as a result of a difference of opinion: Should the American Fern Society own and control its official publication? At the beginning of the Fern Society's history, in 1893, the infant society had for a time exercised such control but the numbers of members was so small that maintenance of a journal was impractical and the Society arranged with Willard N. Clute to take over what had been called the "Linnaean Fern Bulletin" as a personal venture. A year or so afterward, Mr. Clute shortened the name to "The Fern Bulletin" as it remained through the rest of its twenty year existence. Part of the arrangement relating to the transfer of ownership called for the designation of the Bulletin as the "official" organ of the Fern Society. Each year the officers of the Society arranged with Mr. Clute for an agreed upon sum per member which the Society paid from dues received.

Willard Clute's contributions to the Fern Society were outstanding, both as the chief factor in its founding and for his successful development of the Fern Bulletin. For approximately the first ten years of its existence, there seems to have been an abundance of articles that were real contributions, many of which are well worth reading now. In fact there was so much original work being done by members that two substantial issues of papers read at two Society meetings in 1899 and 1900 were separately published as "Fernwort Papers."

During the first decade of the twentieth century, contributors of articles for the Fern Bulletin became fewer. Older members who had been chief contributors in earlier years were passing out of the picture. While the Fern Society continued a steady increase in numbers, there was a growing feeling that as a well-established, botanical society, it had become substantial enough to be represented by a publication owned and controlled by its members. Fern articles which might well have gone to the Fern Bulletin were published in other, more general botanical pournals.

Professor Clute's interpretation of the decline of contributors to the Fern Bulletin was that the Fern Society and the Fern Bulletin were coming to the end of a period of real need in the field of fern study. He announced that he would continue the Fern Bulletin to the end of a twenty year existence, even if he had to contribute all its pages himself. To a suggestion that he re-transfer the Bulletin back to the Fern Society, he returned a definite negative answer. If he had acceded we should now be entering upon the sixty-eighth year and volume of the Fern Bulletin instead of the fiftieth volume of the American Fern Journal.

Such in brief was the background of developments which led in 1910 to the birth of the American Fern Journal. During that year, a group of members set in motion two projects designed to determine whether the Fern Society should institute and publish its own official bulletin. Plans were made and carried out for the nomination of an independent slate of officers to be offered in competition with those nominated by the official nominating agency of the Society. The Constitution provided for such independent nominations then as now, and a single such nomination had been made for the secretaryship the preceding year. The independent nominee had received a majority of votes but the Society Council, as then constituted, had ruled that the official candidate should be declared elected. The second step undertaken was the preparation and printing of two issues of a fern publication to be supported by private contributions.

The first issue of the new publication made its appearance during the summer of 1910 and a second issue appeared in the fall of 1910.[1] The name chosen was the "American Fern Journal," the size and format followed that of the Fern Bulletin. The seven sponsors signed the Foreword in the first issue. These seven sponsors were: L. S. Hopkins, H. E. Ransier, E. J. Winslow, R. C. Benedict, Philip Dowell, W. C. Barbour, and Nellie Mirick. It was my privilege and responsibility to assemble the articles and to see to the printing of the first 16-page issue. Mr. Evelyn J. Winslow, of Auburndale, Mass., took charge of the distribution and continued to act as the business editor for over twenty years more, storing the increasing number of back issues in private facilities. Those first two issues were sent to all members of the Fern Society. Others among the seven made their contributions in other ways.

The following autumn, the other step in the program was carried out—the presentation of an independent slate of can-

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[1] Since this is an account of the birth of a new publication, it is appropriate to note the place as well as the date of the happy event. The New York Botanical Garden was the scene of the event and the venture was further suppposted by the accession of several Garden staff members as new members of the Fern Society during 1911.

didates for the four offices of members known to be favorable to a Society-owned and controlled publication. All four were elected by a good majority and in January, 1911, the following officers became the new Executive Council: President, Dr. Philip Dowell; Vice-President, Miss Nellie Mirick; Secretary, Mr. L. S. Hopkins; Treasurer, Mr. H. G. Rugg. One of their first acts was the adoption of the American Fern Journal as the Fern Society's official publication, with the incorporation of the two 1910 issues as parts of a six-number volume. Incidentally, 1911 proved to be a banner year in the number of new members received and in the growth of the membership of the Society.

Philip Dowell served as President for only one year, and was succeeded by C. H. Bissell, of Connecticut, for the two succeeding years. In those three years the basic policies by which the Society has been run ever since were established. The several accounts for "reserve funds" were established. Editors have been appointed by the elected Executive Council. Naturally, successive Councils have been very happy to maintain in office editors like C. A. Weatherby (1915-1940), William R. Maxon (1941-1947), and Conrad V. Morton (1948-1960), whose services as the "executive" and responsible editors-in-chief have meant so much to the Fern Journal and to the Fern Society. The Journal has never had an "editorial" page as did the Fern Bulletin. When the Editor writes for the Journal, he does so in his individual, not his official capacity. One desirable change was made some years back in the Editor-in-chief's position—he was made a non-elected member of the Executive Council.

185 HALL STREET, BROOKLYN 5, NEW YORK.

## What Is the Role of Spores in Fern Taxonomy?

CLAIR A. BROWN

Ferns are a group of plants that illustrate many changes in taxonomic concepts which are useful in establishing systems of classification and in the delimiting of genera and species. The Linnaean genera were distinguished on such gross morphological features as the shape, size, and placement of the sori. Later, stelar anatomy became an important criterion. Then such items as venation, origin of the sorus, indusium, development of the sporangium, scales, hairs, glands on the indusium, chromosome number, and, to a lesser extent, spore morphology were used to separate species. This is not a definitive paper on the use of spore morphology in fern taxonomy but rather an assessment of the role that may be attained by this much neglected field.

The concept of the structure and the terminology applied to different portions of the spore is quite varied. Douglas H. Campbell (1905) described spore structure as follows: "The young spores are thin-walled, but later the wall becomes thicker and shows a division into two parts, an inner layer, which generally shows a cellulose reaction and is called the endospore (intine), and an outer more cuticularized coat, the exospore (exine). In addition, a third outer coat (perenium, epispore) is very generally present." Structurally, the spore consists of a protoplast, the living portion encased in a thin layer, the intine, which is surrounded by the exine. This in turn is generally enclosed by one or more layers which have been termed perispore, epispore, perine, or sclerine by various authors. There is no unanimity of usage among those interested in spore morphology.

It was recognized early that differences in the number and orientation of cleavage planes gave rise to two types of spores from the spore mother cell, namely, the tetrahedral and bilateral spores. These were so named because, in the case of the former, three planes or faces were common to the proximal side of the spores tetrahedral or bilateral, and *Coniogramme* with spores four spores of a tetrad and at their junction developed a tetrad scar or Y-mark which was responsible for the term "trilete spore." The second type of spore, the bilateral spore, was formed from the division of the spore mother cell by two divisions so that the proximal edges touched each other along one line of contact. Visually this is equivalent to quartering a sphere with two longitudinal cuts at right angles to each other. The contact scar of this bilateral spore was a single line, slit, or opening which was called a monolete scar or aperture. The terms tetrahedral versus trilete and bilateral versus monolete are used more or less synonymously.

It is surprising that, in all the detailed studies on the ontogeny of the sporangium, the number of cells of the annulus, the number of spore mother cells, and the number of spores in a sporangium, a definitive answer has not been given to the following questions: Can both monolete and trilete spores be produced in one sporangium, in one sorus on one frond or in one species?

Selling (1944) compiled a list of species in the genera *Ophioglossum, Botrychium, Angiopteris,* and *Polybotrya* in which the leading type was the trilete spore and the occasional type was the monolete spore whereas this was reversed in species in the genera *Psilotum, Marattia, Schizaea, Dryopteris,* and *Mesochlaena.* He observed spores devoid of any dehiscence mark in some species of *Lycopodium, Psilotum, Ophioglossum, Cibotium,* and *Schizaea,* and mentioned that this condition has been reported in certain hybrids. Selling (1946) cited Goebel and Tammes as observing both monolete and trilete spores in the same sporangium of *Psilotum.* In his 1944 paper for the same observation, however, there is no specific mention for the species listed that both spore types came from the same sporangium. Also he apparently added mention of the trilete form for *Psilotum nudum* from the literature as he wrote specifically "I have seen no such cases."

Copeland (1947) characterized the spore types of monotypic genera such as *Hemipteris, Ochropteris,* and *Anopteris* with bilateral or tetrahedral. He characterized genera with several species in them, such as *Pteris*, with "spores tetrahedral or less commonly bilateral, smooth, tuberculate or sculptured."

The writer is inclined to question some of the observations that a species can possess both spore types *normally* for the following reasons:

First, the fundamental difference in methods of spore formation seems too distinctive to occur in the same species, although it is true that bilateral microspores and trilete megaspores are well known in *Isoëtes.*

Second, all the species the writer has examined (limited in number in relation to the world flora) had either trilete or monolete spores.

Third, contamination is so easy. Fresh, shedding sporophylls of *Osmunda regalis* were collected for spores. A microscopic examination of the spore mass showed it to be predominately *Osmunda* spores but there was a considerable quantity of pine and oak pollen. The same observation was repeated on *Osmunda cinnamomea.* Occasional spores of a dryopteroid type were also found. The writer has found more pine pollen in the sori of a herbarium specimen of *Angiopteris evecta* from Hongkong, China, than fern spores. It is not unusual to find herbarium specimens with a copious quantity of sporangia and spores that came from another sheet in the folder.

McVaugh (1935) published a study on fern spores with a key to the genera and species based upon spore morphology. He stated that his study was based upon herbarium material, thus indicating that he was cognizant of possible contamination. Erdtman (1958) illustrated the proximal face of a *Haplosoria* spore found in a slide made from *Serpyllopsis caespitosa* var. *densifolia.*

Palynologists such as Knox (1950), Selling (1944, 1946), Harris (1955), and Erdtman (1958) are much better acquainted with fern spores than are most fern taxonomists. Harris mentioned one clear-cut occurrence of both spore types in *Marattia* *salicina* in his detailed studies on the spores of New Zealand pteridophytes. Erdtman (1958) figured a general view of a monolete grain of *Phanerosorus major* whereas the detailed palynogram has a trilete aperture.

How many spores should be measured to give the size and range for distinguishing species? The philosophy of the investigator has a bearing. Some examine spores in several fields, pick out an average-sized spore visually, and then measure several. Then they look for smaller or larger spores in order to get the range of size variation. Others may measure a given number at random and average the spore sizes. Mrs. Knox measured 10 grains. Selling regularly measured 25 spores when he could find that number. Harris reported that he measured 10 spores but, when he wished a critical comparison between two species, he measured 50 of each. The larger the number of spore measurements, the greater the degree of accuracy in determining average size and amount of variation.

What effect does different processing methods and mounting media have upon spore size? Palynologists process peat by either of two methods. They boil the peat in 10% potassium hydroxide solution or in Erdtman's acetolysis mixture (9 parts acetic anhydride plus 1 part sulphuric acid). Reference slides are also prepared by the same reagent used in disintegrating the peat. This produces a "fossilized" grain. The protoplast and intine are removed and the resulting structure is more comparable to the grains found in processed peat. These reagents often destroy the perispore and leave a denuded exine. Many have interpreted these denuded exines as immature spores. Spores mounted in water tend to swell, and the perispores of the sensitive fern, *Onoclea sensibilis*, and of the ostrich fern, *Matteuccia pensylvanica*, are quickly shed. Potassium hydroxide and the acetolysis mixture often over-expand pollen grains with increases from 2 to 17% and, in some instances, up to 43%. B. B. Christensen (1948) found considerable variation between measurements at high dry versus oil immersion and between different observers of the same slides, as great as the expansion of the processing reagents. It is reported that pollen mounted in glycerin or glycerin jelly tends to swell. Freshly shed to dry spores have been mounted in Clarite (no longer available), Euparol, Permount, or Hoyers Mounting medium without dehydration. Unfortunately such mounts are rather opaque. The size and degree of wrinkling of the crests in *Dryopteris* spores depends upon the amount of moisture they absorb.

The writer prepares temporary slides from herbarium specimens as follows: The frond is searched under a 25-power binocular dissecting microscope and individual sori which contain spores are chosen. It should be mentioned that many herbarium specimens are deficient in mature spores and unopened sporangia are often filled with immature spores. Also, in the case of ferns like *Dryopteris serrata,* it is almost impossible to pick individual sori or sporangia because they form such a dense mass. Here scrapings must be used with caution. The sori or sporangia are picked with a moistened needle and placed on a slide in a drop of lactophenol or pure glycerin and then heated over an alcohol lamp until the liquid boils or steams in the case of glycerin. This drives out the air from the spores, expands them and makes them translucent. Lactophenol was used for many years but recently partial destruction of the perispore was observed in a few species. Pure glycerin was tried and found satisfactory. Slides so prepared last for years, if kept flat. A lactophenol slide dries out in a few weeks' time. It has been the practice to remove the cover glass and add a drop of glycerin jelly to make more permanent slides. If the cover glass is sealed with paraffin, the slides will keep even longer.

Erdtman's acetolysis mixture has become one of the chief reagents used in spore and pollen studies. It is used where-ever there is ample spore material. Acetolysis can be accomplished on the slide by gently heating a few sporangia in a drop of the fluid. If the slide is heated too long, the spores turn dark. The advantage of this process is that it removes the internal contents and renders the grain very translucent; it stains the perispore and exine a clear, brownish color. Fern spores which have been processed in potassium hydroxide or acetolysis and, to a lesser extent in lactophenol, show the exine distinct from the perispore. The perispore in some cases is very thin and adheres tightly to the exine, giving rise to the belief that spores lack a perispore.

Some measure the exine only; others measure the perispore as well. The reason for measuring the exine is that the perispore is often greatly distended by the processing.

There is no information on the relationship between spore size and the nutrition of the plant as there is for certain flowering plants. Thus there are many reasons for variation in spore measurements of the same species by different people and a small difference of two or three microns may be of little importance.

No one has studied the differences in spores from apogamous ferns as compared to those in which meiosis has occurred. Manton (1950) has shown that certain ferns have a polyploid chromosome series. She reported that the spores of the royal fern with a diploid chromosome compliment had a diameter of 80 microns whereas the tetraploid spore had a diameter of 90 microns. Although the chromosome compliment of spores of hybrid ferns has been investigated, their spore sizes are seldom mentioned. Manton reported abortive spores in the hybrid of *Dryopteris abbreviata* × *Filix-mas.* Erdtman (1958) illustrated abnormalities in *Aspleniopsis decipiens* and *Dipteris chinensis.* The first showed interesting modifications of the trilete aperture and the second had what can be interpreted as a monolete scar with a tiny fork near one end. Erdtman and Praglowski (1959) reported upon an anomolous condition in *Pityrogramma hybrida* var. *maxima* (= *P. calomelanos* × *chrysophylla*) in which the normal trilete aperture assumed a variety of shapes. Two of the trilete arms were irregularly forked; another spore had a monolete aperture; another a monoporate aperture, and the last was a grain without any dehiscence mark. Wagner and

Boydston (1958) illustrated the variation of spores of *Asplenium ebenoides, A. rhizophyllum,* and those of a hybrid between them. They showed several abnormally small grains with a perispore.

The above remarks show that there is a lack of detailed information and some pitfalls that must be taken into consideration in the use of spores in fern taxonomy. The present role can be shown by the following selected citations.

Christensen in Verdoorn (1938) outlined a classification of ferns with very little attention to spores. He mentioned spore types for certain orders, families, or subfamilies, along with the presence or absence of the perispore.

Selling (1946) presented keys for the identification of Hawaiian ferns by means of the spores.

Copeland (1947) gave the spore type for nearly every genus and occasionally mentioned the surface condition as smooth or tuberculate.

Makino (1949) included spore illustrations for about one-third of the Japanese ferns. Unfortunately, they are too small to be of diagnostic value.

Lawalrée (1950) briefly described the spores for most of the Belgian species and genera.

Reed (1953) was perhaps the first to include brief characterizations and photographs of non-cleared spores in a state fern book. Unfortunately, the internal contents obscured certain diagnostic features and the quality of the illustration suffered by the method of reproduction.

Madalski (1954) made excellent spore illustrations for every fern in the atlas of the Polish flora.

Holttum (1954) omitted the spore characteristics for many genera of the Ferns of Malaya. However, he used spore characteristics as a means to separate *Asplenium phyllitidis* and suggested that the spores of *Asplenium borneense* indicated probable relationships with *Asplenium scandens.* Mme. Tardieu-Blot (1954) considered that spores had good generic and specific diagnostic value and gave brief descriptions and good illustrations.

Harris (1955) published a manual of the New Zealand ferns based only upon spore characteristics. He presented keys to the families, genera, and for the species of many genera; for example, a key to the species of *Polystichum*. He reported that six species of *Adiantum* had similar spores with overlapping sizes and it was not possible to determine the species of *Adiantum* by their spores. He called attention to *Lindsaea viridis* with monolete spores in contrast to *L. cuneata* and *L. linearis*, which have trilete spores. He stated that the spore characteristics supported the removal of *Loxsoma* from the family Hymenophyllaceae.

Holttum (1957) indicated Nakai's proposal to place ferns with monolete spores in a distinct subfamily of the Gleicheniaceae apart from those with trilete spores was an unnatural arrangement because *Dicranopteris linearis* has trilete spores but the closely allied species *D. pubigera* and *D. curranii* have monolete spores.

The foregoing citations are sufficient to show that fern spores are becoming increasingly important in fern taxonomy. They have been used successfully to distinguish species in some genera, to differentiate genera and to characterize families. As studies progress and procedures are stabilized, spore data will be used also to distinguish polypoid races or strains and to indicate hybridity. Spores have as much diagnostic value as scales and hairs; the data should be considered as supplemental information, not the sole criterion. It is admitted that there are groups where spore data cannot be used to distinguish species.

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## The Endemic Pteridophytes of the California Floral Province

JOHN THOMAS HOWELL

Several years ago I advanced the idea that there is a natural California flora and proceeded to outline a California Floral Province, using as distinguishing criteria "the high endemism which is found in both genera and species and the distinctive associations in which these genera and species occur" (1957, pp. 133–138). Geographically, the province would extend from the vicinity of Coos Bay on the coast of Oregon southward along the California coast to northern Baja California south of Ensenada and to the islands off the coast, while the eastern boundary would be marked by the mountain ranges that extend northward from the Sierra San Pedro Mártir to the vicinity of Mount Shasta in California and thence northwestward to the Oregon coast, separating the Siskiyou-Klamath montane area from the Cascadian.

Although this proposal was based entirely on seed plants, I took occasion several months later to extend the idea to pteridophytes and outlined the results in remarks before the American Fern Society, at its meeting at Stanford University in August, 1957. At that time, I indicated that endemism among species of pteridophytes in the California Floral Province amounted to about 27%, using as a basis Maxon's and Pfeiffer's treatments in Abrams' Illustrated Flora of the Pacific States (1923). The impressiveness of this figure was shown by a comparison with the percentage of endemism indicated by Morton's account of the pteridophytes in Gleason's New Illustrated Flora (1952), in which endemic species constitute only about 7% of the entire fern population. Endemism as a mark of a California flora is thus not restricted to seed plants.

The present account of pteridophytes endemic to the California Floral Province is based chiefly on the above-mentioned treatments by Maxon and Pfeiffer (1923), as they have been accepted or somewhat modified by Munz in A California Flora (1959). I have altered Munz' total slightly (at points apparent in the following notes) and have of course applied the concept of endemism to a provincial, not a political, area. As accepted here the pteridophytes number 98 entities (86 species and 12 subspecies and varieties), of which 63 are "ferns" and 35 are "fern-allies." Of this total number, 27 entities (21 ferns and 6 fern-allies) are endemic, which by percentage amounts to 27.55% (ferns, 33.33%; fern-allies, 17.14%).[1]

The following notes give the name, distribution, habitat, etc. of the endemic pteridophytes in the California Floral Province as I now understand them. The phytogeographic affinity of two-thirds of the entities is strongly austral; only eight or nine show closer relations to plants of northern floras.

### SELAGINELLACEAE

SELAGINELLA ASPRELLA Maxon. On exposed dry slopes and in rock crevices, most common in the mountains of southern California from the San Gabriel Mountains, Los Angeles County, to the Laguna Mountains, San Diego County, at elevations of 5000–8000 feet. An outlying station reported by R. M. Tryon (1955, p. 76 and *map 51,* p. 73) is in the southern Sierra Nevada in the Kern River Canyon, Tulare County, where the plant grows at an elevation as low as 2800 feet (*Howell* 5031, 33100).

SELAGINELLA BIGELOVII Underwood. In gravelly or rocky soil or in shallow soil overlying rock surfaces; widespread and frequently common at elevations from sea level up to 6000 feet, from northern Baja California northward through southern California to Tulare County in the southern Sierra Nevada and to Sonoma County in the central Coast Ranges. R. M. Tryon (1955, *map 8,* p. 21), in mapping the distribution of the Bigelow

[1] It is interesting to compare these figures with the percentage of endemism in several other groups in the California Floral Province. Thus endemism in *Carex* amounts to 27.66%, in *Eriogonum* to 52.08%, in *Phacelia* to 52.58%, and in the "Tarweed Tribe" of the *Compositae*, the *Madiinae*, to 87.71%.

Endemism in pteridophytes in California in a strictly political sense is considerably reduced: Only 15 entities, or 15.30%, are restricted to the state.

mossfern, indicates two rather widely separated stations on the east side of Baja California that lie beyond the boundary of the California Floral Province as I have outlined it. It is to be expected that this species will be found to be rather common in central Baja California as the mountains there are more intensively explored. In 1956, George Lindsay and I found depauperate plants growing in rock crevices in the desert mountains 32.5 miles southeast of Rosario on the road to El Marmol (*Howell* 31012).

Selaginella cinerascens A. A. Eaton. *S. bryoides* Underwood. On packed clayey soil of open or brushy slopes in the coastal fog belt near sea-level, from San Diego County, California, southward to the vicinity of Ensenada, Baja California. Although this species is not uncommon within its highly restricted range, it is not frequently collected, perhaps because its delicate moss-like filagree over clay is overlooked by collectors of vascular plants.

Selaginella Hansenii Hieron. *S. Bolanderi* Hieron. *S. rupestris* (L.) Spring var. *Hansenii* (Hieron.) Jepson and var. *Bolanderi* (Hieron.) Jepson. Crevices and shelves of igneous and metamorphic rocks, 200–6000 feet elevation on west slope of the Sierra Nevada from Tulare County north to Butte County, with outlying stations on the Marysville Buttes (*Heller* 11802) and on Mount Shasta. I do not know of the Hansen moss-fern in the Coast Ranges, but R. M. Tryon (1955. *map 30*, p. 51) indicates two stations for the plant in the Inner Coast Range north and south of San Francisco Bay,[2] and Munz (1959, p. 24) credits it to the Santa Lucia Mountains.

Excluded species. Although *Selaginella leucobryoides* Maxon is found only in California, it is an endemic restricted to the higher mountains of the Mohave Desert that lie quite beyond the limits of the California Floral Province.

[2] The localities north of San Francisco Bay are Knights Valley, Napa County, *W. R. Dudley*, Feb. 23, 1895 (US, and Stanford 50231), and "Canyon northwest of Napa, July 30, 1913, *Suksdorf* 753 (US); both collections seem to be *S. Wallacei* Hieron., which is common in the region.—C. V. Morton.

ISOËTACEAE

ISOETES ORCUTTII A. A. Eaton. *I. Nuttallii* A. Braun var. *Orcuttii* (A. A. Eaton) Clute. Amphibious plants maturing on the drying beds of former rain pools ("vernal pools"); coastal mesas in northern Baja California and in California from San Diego County north through the South Coast Ranges and southern Sierra Nevada foothills to the Sacramento Valley in Sacramento County, 100–2000 ft. elevation.

OPHIOGLOSSACEAE

OPHIOGLOSSUM CALIFORNICUM Prantl. *O. lusitanicum* L. subsp. *californicum* (Prantl) Clausen. Moist flats and slopes at widely separated stations at elevations below 1000 ft. from central California to northern Baja California. The plant is rare or rarely detected, being known only from a few collections from Ione, Monterey, San Diego, and Ensenada. Published records from central Mexico are dubious. Munz (1959, p. 29) gives the habitat of the plant as "vernal pools." A collection I made in Balboa Park in San Diego in March, 1932 (No. 8232) came from a "moist grassy slope, growing up through a mat of *Selaginella bryoides*"; and Miss Eastwood told of making a collection at Ione (her No. 12413) on a grassy slope near a blue oak (*Quercus Douglasii*).

POLYPODIACEAE

ADIANTUM JORDANII C. Mueller. *A. emarginatum* D. C. Eaton. On shaded rocks or in rocky soil beneath trees or shrubs at elevations up to 4000 feet; northern Baja California north to the California Channel Islands and through the California Coast Ranges and Sierra Nevada to southwestern Oregon (lower Rogue River Canyon, acc. to Peck, 1941, p. 51). In the North Coast Ranges of California a hybrid between *A. Jordanii* and *A. pedatum* L. has been described: *A.* × *Tracyi* C. C. Hall *ex* Wagner (1956).

ASPLENIUM VESPERTINUM Maxon. *A. Trichomanes* L. var. *vespertinum* (Maxon) Jepson. Moist crevices of shaded rocks below 3000 feet elevation; San Gabriel Mountains, Los Angeles

County, south to the mountains of San Diego County in California and (acc. Maxon, 1923, p. 18) to Baja California.[3]

CHEILANTHES CALIFORNICA (Hooker) Mett. *Hypolepis californica* Hooker. *C. amoena* A. A. Eaton. *Aspidotis californica* Nuttall *ex* Copeland. Dry slopes in shallow or rockey soil below 4000 feet elevation, from southern California north through the Coast Ranges to Humboldt County and through the Sierra Nevada to Butte County, south to northern Baja California.

In treating the California lace-fern as a *Cheilanthes*, I am accepting what I believe to be the correct conservative interpretation of Maxon and of Weatherby, and more recently of Wagner and Gilbert (1957, pp. 741–743), rather than that of Copeland (1947, p. 68) or Munz (1959, p. 35).

CHEILANTHES CARLOTTA-HALLIAE Wagner & Gilbert. Shaded or sunny places around rocks in areas of serpentine; known only in the California Coast Ranges from Marin, San Benito, and San Luis Obispo counties. Mrs. Hall's lip-fern is intermediate between *C. californica* (Hooker) Mett. and *C. siliquosa* Maxon (*Pellaea densa* Hooker; *Onychium densum* Brack.), and perhaps it should have been named as indubitably a hybrid. Concerning this fern as I know it on Mount Tamalpais, Marin County, I recently remarked: ". . . in the vicinity of Bootjack (which is the type locality), there is to be found such a variety of plants intermediate between *C. californica* and *C. siliquosa* that it is not always possible to tell where one leaves off and the other begins, and it is well nigh impossible to delimit the proposed species [*i.e.*, *C. Carlotta-halliae*] from the numerous variations" (Howell, 1959, p. 53, 54). It would be enlightening to know if this lip-fern originated independently through hybridization in the three widely separated localities where it has been reported, or if those occurrences represent dispersal from a single cross. The field occurrence of the plant on Mount Tamalpais strongly suggests hybridization at that place.

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[3] San Rafael, Apr. 13, 1882, *M. E. Jones* 3749. [C.V.M.]

CHEILANTHES CLEVELANDII D. C. Eaton. Around rocks in dry brushy places below 5000 feet elevation; northern Baja California north in California to the northwestern borders of the Colorado Desert in Riverside County and northwest to Santa Barbara, Santa Barbara County, and to Santa Cruz and Santa Rosa islands.

CHEILANTHES COOPERAE D. C. Eaton. In moist shaded rock-crevices in summer-dry hills at elevations below 2000 feet, frequently on limestone (marble) or other metamorphic rocks, with an interrupted distribution from Shasta County, California, southward through the northern Sierra Nevada to Mariposa County and in southern California from Santa Barbara County southeastward to southwestern San Bernardino County.

CHEILANTHES FIBRILLOSA (Davenport) Davenport *ex* Underwood. *C. lanuginosa* Nuttall var. *fibrillosa* Davenport. California's rarest endemic fern, known only from the original collection made "by the brothers Parish well down in one of the passes that open out on the south side of the San Jacinto Mountains, in June 1882."[4] Actually the type locality is on the west side of the mountains and concerning it Munz and Johnston (1922, p. 113) wrote as follows: *Cheilanthes fibrillosa* is "known only from the type collection by Parish! made . . . in the San Jacinto Canyon at Oak Cliff at the point where the road to Strawberry Valley leaves the canyon bed.[5] The plant was found among rocks on a gravelly bench. An unsuccessful search for

[4]Bull. Torrey Club *12:* 21. 1885.

[5] I know of only three other ferns whose California records rest on single collections. Two are holarctic species of *Asplenium* of wide distribution. *Asplenium viride* Hudson in California is known only from the northern Sierra Nevada from a collection made by G. Ledyard Stebbins from crevices of a north-facing cliff on South Butte at 7500 feet in the Sierra Buttes, Sierra County (Madroño *12:* 128. 1953; Munz, 1959, p. 45). *Asplenium septentrionale* (L.) Hoffmann has been found in California only in the southern Sierra Nevada in Tulare County in crevices of a glaciated granitic rock between Columbine Lake and Sawtooth Pass, at an elevation of about 11,000 feet, *Howell* 17803, collected on Aug. 7, 1942 (cf. Howell, Base Camp Botany, 1942, p. 3; Ewan, Amer. Fern Journ. *33:* 29. 1943). The fourth fern known in California from a single collection is the widespread male-fern, *Dryopteris Filix-mas* (L.) Schott, which was collected in Holcomb Valley, San Bernardino Mountains in 1882 (cf. Munz, 1959, p. 42).

this fern was made at the type locality by Parish and Johnston in 1918; a similar one by the authors occurred in 1922 when the type locality and the water-shed above were examined.''

CHEILANTHES INTERTEXTA (Maxon) Maxon. *C. Covillei* Maxon var. *intertexta* Maxon. Shaded or partially shaded rock crevices and rocky slopes in the Coast Ranges and Sierra Nevada, and, according to M. E. Peck (1941, p. 51), to the ''Siskiyou Mountains of Oregon,'' from near sea-level to elevations of 9000 ft. Two stations just beyond the limits of the California Floral Province are: Dixey Mountains, Lassen County, California, and near Virginia City, Storey County, Nevada. Both on Mount Tamalpais and Mount Diablo in the central California Coast Ranges I have collected lip-ferns that I have determined as *C. Covillei* Maxon because of the scaly fronds and on both peaks this fern grew at a distance of less than a mile from *C. intertexta* (cf. Howell, 1959, p. 54, as to Mount Tamalpais plant). In both places, the scales of *C. Covillei* are somewhat more ciliate-fimbriate than are the scales of more typical *C. Covillei* from southern California coast or desert, but on both Tamalpais and Diablo I had no doubt but that I was dealing with two different lip-ferns. Although the two species grew rather close together in areas where habitats are uniformly alike, each was found restricted to its own particular rock-outcrops and no intergrades were observed on rocks situated between the two.

CHEILANTHES PARISHII Davenport. Known only from the region of the type locality on the rocky desert slopes of Andreas Canyon, on the east side of the San Jacinto Mountains near Palm Springs, Riverside County, California. Although included here as an endemic of the California Floral Province, the Parish lip-fern is found in the zone between the California flora and the Sonoran Desert flora and it could be considered a borderline endemic of the latter flora. However, from both morphological and phytogeographic relations to other California lip-ferns it seems preferable to regard the Parish lip-fern as Californian rather than Sonoran.

NOTHOLAENA CALIFORNICA D. C. Eaton subsp. NIGRESCENS Ewan. *Aleuritopteris cretacea* (Liebmann) Fournier subsp. *nigrescens* (Ewan) Munz. Rocky places in the chaparral, south side of the San Gabriel Mountains, Los Angeles County, California. This subspecies is not very distinct from variants in the typical subspecies and was placed in synonymy under *N. californica* by R. M. Tryon in his revision of the genus (1956, p. 73). Munz (1959, p. 35), after reducing *N. californica* to synonymy under *Aleuritopteris cretacea,* retains for his inclusive species the relatively restricted range of *N. californica* (southern California to Arizona and Baja California) rather than the truly extended range it should have had [at least to Puebla, Mexico, where the type of *N. cretacea* was collected, if not to Chile whither it ranges as *N. sulphurea* (Cav.) J. Smith (acc. R. M. Tryon, 1956, p. 71, *map 40*)]. *Notholaena candida* Hooker var. *accessita* Jepson (1923, p. 27) [*N. californica* f. *accessita* (Jepson) Ewan], described as a local California endemic of eastern San Diego County, is referred to the synonymy of *N. californica* D. C. Eaton by R. M. Tryon (1956, p. 73), a course that is followed here.

NOTHOLAENA NEWBERRYI D. C. Eaton. *Cheilanthes Newberryi* (D. C. Eaton) Domin. Dry rocky places at lower elevations from Ventura County to San Bernardino and San Diego counties and San Clemente Island in California and to northern Baja California and Guadalupe Island in Baja California.

PELLAEA ANDROMEDIFOLIA (Kaulfuss) Fée. *Pteris andromedifolia* Kaulfuss. *Pellaea rafaelensis* Moxley. (For extended synonymy see A. F. Tryon, 1957, p. 179.) Seasonally dry slopes, more or less shaded by brush or trees, on rocky ledges or in rocky soil, at elevations up to 3500 (or 4000) feet; southern California north through the Coast Ranges to Mendocino and Tehama counties and through the Sierra Nevada foothills to Butte County, west to the Channel Islands, and south to northern Baja California and Cedros Island (A. F. Tryon, 1957, *map 13*). A Thomas Jefferson Howell collection from Roseberg, Oregon, is regarded as doubtfully authentic by A. F. Tryon (1957, p. 182). *Pellaea andromedifolia* (Kaulfuss) Fée var. *pubescens* D. C. Eaton is a name applied to pubescent plants from the southern part of the range of the species.

PELLAEA BRACHYPTERA (Moore) Baker. *Platyloma brachyptera* Moore. *Pellaea Ornithopus* Hooker var. *brachyptera* (Moore) D. C. Eaton. *Allosorus brachypterus* (Moore) O. Kuntze. Dry rocky slopes, generally in areas of metamorphic rocks, 2500–8000 feet elevation; southwestern Oregon south in California to Lake County in the Coast Ranges and to Placer County in the Sierra Nevada.

EXCLUDED SPECIES AND VARIETY. Although *Pellaea mucronata* (D. C. Eaton) D. C. Eaton including its variety, var. *californica* (Lemmon) Munz & Johnston, is called a "California species" by A. F. Tryon (1957, p. 157), both var. *mucronata* and var. *californica* range too far and too commonly into the desert mountains of southeastern California for either to be regarded here as endemic to the California flora in the provincial sense of this paper. Var. *californica* is entered twice by Munz: Once as a synonym of *P. compacta* (Davenport) Maxon (1959, p. 35) and again (p. 36) as an accepted variety.

PITYROGRAMMA TRIANGULARIS (Kaulfuss) Maxon var. PALLIDA Weatherby. In California on dry rocky banks or in rocky soil, more or less shaded, Sierran foothills below 4000 feet, from Butte County to Kern County, and according to Munz (1959, p. 38) to Santa Clara County in the Coast Ranges.

PITYROGRAMMA TRIANGULARIS (Kaulfuss) Maxon var. VISCOSA (Nuttall *ex* D. C. Eaton) Weatherby. *Gymnogramme triangularis* Kaulfuss var. *viscosa* Nuttall ex D. C. Eaton. *Ceropteris viscosa* (Nuttall) Underwood. *Pityrogramma viscosa* (Nuttall) Maxon. Dry slopes, more or less shaded, in clayey or rocky soil; coastal southern California at low elevations in Los Angeles, Riverside, Orange, and San Diego counties and on the Channel Islands, south to northern Baja California.

POLYPODIUM CALIFORNICUM Kaulfuss. *P. intermedium* Hooker

& Arnott. *P. vulgare* L. var. *intermedium* (Hooker & Arnott) Fernald. In exposed or shaded places, terrestrial on rocky bluffs, in rock crevices, in rocky well-drained soil, or occasionally epiphytic on trees; widespread and common below an elevation of 4000 feet, northern Baja California (including Guadalupe Island) north in California to the Channel Islands and through southern California to Humboldt County in the Coast Ranges and to Butte County in the Sierra Nevada.

POLYPODIUM CALIFORNICUM Kaulfuss var. KAULFUSSII D. C. Eaton. A maritime form with coriaceous fronds which grows on exposed slopes of the California coast. Perhaps it is significant that, at least in central California, var. *Kaulfussii* is the form of *P. californicum* associated with the evergreen *P. Scouleri* Hooker & Greville.

POLYSTICHUM CALIFORNICUM (D. C. Eaton) Underwood. *Aspidium californicum* D. C. Eaton. *P. aculeatum* (Swartz) Roth var. *californicum* (D. C. Eaton) Jepson. On rocky slopes and bluffs of moist shaded canyon-sides in or near the redwood belt; Coast Ranges of central California from Santa Cruz County to Mendocino County. It has been suggested that plants which are intermediate between *P. californicum* and *P. munitum* (Kaulfuss) Presl and which are growing with those species are probably of hybrid origin (Howell, 1949, p. 51).

POLYSTICHUM DUDLEYI Maxon. *P. aculeatum* (Swartz) Roth var. *Dudleyi* (Maxon) Jepson. In deep shade on moist rocky slopes near the coast; central California Coast Ranges from San Luis Obispo County (acc. to Munz, 1959, p. 41) to Marin County.

POLYSTICHUM MUNITUM (Kaulfuss) Presl subsp. CURTUM Ewan. Dry rocky montane slopes below 8600 feet, Santa Lucia Mountains of the California Coast Ranges south through the mountains of southern California to San Diego County.

POLYSTICHUM MUNITUM (Kaulfuss) Presl subsp. NUDATUM (D. C. Eaton) Ewan. *Aspidium munitum* Kaulfuss var. *nudatum* D. C. Eaton. *P. munitum* (Kaulfuss) Presl var. *nudatum*

(D. C. Eaton) Gilbert. Rocky slopes and cliffs in the California mountains at elevations of 4000–7000 feet; Sierra Nevada from Tulare County to Plumas County. This variant and the preceding are not too readily distinguished from the wide-ranging *P. munitum* var. *imbricans* (D. C. Eaton) Maxon and may represent forms in a variable species rather than geographically distinct subspecies.

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## First Illustrations of Ferns from Peru and Chile

JOSEPH EWAN

Linnaeus recognized twelve genera of ferns in his *Species Plantarum* of 1753. The largest genus was *Polypodium* with fifty-eight species of which over sixty percent are American. Included in his genus "*Polypodium*" were species now known to be species of *Polystichum, Dryopteris, Cystopteris, Cyathea,* and other genera. Some eight authors were cited by Linnaeus in providing the bibliographies for the New World species. He cited his own works first, as elsewhere in his *Species Plantarum,* followed by references to the works of Plumier, Petiver, Gronovius, Plukenet, Morison, Hans Sloane, and John Ray. Though Linnaeus lists "Fewillaei *peruviana*" as one of his sources in the introduction to his classic, he does not refer to Feuillée in the pages devoted to "Cryptogamia Filices," evidently overlooking the fern descriptions contained in his work when writing the account of the several American species. This is more unusual since Feuillée illustrated two species based on Chilean observations not previously pictured. Father Luis Feuillée (1660-1732), explorer, astronomer, and botanist, was the author of the first herbal for Peru and Chile in which these fern drawings appeared.

Luis Econches Feuillée was born at Mane, near Forcalquier, in Provence, in the year 1660, of humble parents. In his twentieth year Luis joined the Order of the Minimi. At this time Europe was awakening to a lively interest in the sciences—the Royal Society was founded in London when Luis was two years old, and the Academie des Sciences was chartered by Louis XIV in 1666. Feuillée's taste for the sciences attracted attention in official circles and in 1699 he was sent to the Levant as an aide to Jacques Cassini on a hydrographic mission to determine the character of ports, to map offshore currents, and so forth. His mission to the Antilles in 1703 was an extension of this assignment; on this expedition he went ashore at Martinique, Caracas, and elsewhere, and returned to Brest in 1706. On Decem-

# JOURNAL DES OBSERVATIONS PHYSIQUES, MATHEMATIQUES ET BOTANIQUES.

Faites par l'ordre du Roy ſur les Côtes Orientales de l'Amerique Meridionale, & dans les Indes Occidentales, depuis l'année 1707. juſques en 1712.

*Par le R. P.* LOUIS FEUILLÉE, *Religieux Minime, Mathematicien, Botaniſte de* SA MAJESTÉ, *& Correſpondant de l'Académie Royale des Sciences.*

TOME SECOND.

A PARIS, RUE S. JACQUES,
Chez PIERRE GIFFART, Libraire Graveur du Roy, & de l'Academie Royale de Peinture & de Sculpture, à l'Image Sainte Therese.

M. DCC. XIV.
*AVEC APPROBATIONS ET PRIVILEGE DU ROY.*

Title Page of Feuillée's Rare Journal (1714) of His Travels on the Coasts of Peru and Chile


FEUILLÉE'S ORIGINAL ILLUSTRATION OF POLYPODIUM FEUILLEI BERT. OF CHILE ber 14, 1707, Feuillée again set sail for America, but was forced to return to Teneriffe by contrary winds in May, 1708; he succeeded in rounding the Horn in January and he reached Peru in April, 1709. For the next nine months he mapped the port of Callao and other smaller roadsteads, directed the artist Pierre Giffart[1] in the sketching of the city's skyline, described several of the animals he encountered, the distinctive *balsas* of Peru, and computed astronomical data before proceeding to Chile on the return voyage to France.

It was upon Feuillée's visit to Concepcion in January, 1711, that he observed, described, and illustrated the fern named *Polypodium feuillei* in 1829 by Bertero. Feuillée had identified the fern he found "au Nord de la Ville de Pinco" as "Polypodium radice squamosa. vulgo Pillabilcum," following the current practice of applying polynomials which were indeed short to long descriptive names for the plants in question. Elsewhere in his diary Feuillée more closely locates the habitat as the mountains to the east of the little valley called Pinco (1714: 545). Looser (1951: 41) corrected Pinco to "Penco" and located it on the Bay of Talcahuano. As Looser remarked this drawing (*Pl. 2*), which was *Plate 40* in Feuillée's work of 1714, is an excellent illustration of a sterile frond. Looser (1948: 85) says that *Polypodium feuillei* is "a very common epiphyte; also on walls" in the region of Corral, Niebla, and in the vicinity of Valdivia, where it ranges from 400 m. above sea level down to the shores of the Pacific. Kunkel (1959) recently published a paper on the nine infraspecific taxa of this fern. Feuillée's plate stands about intermediate between the var. *feuillei*, that is, the typical variety as interpreted by Kunkel, and var. *ibanezii* Loos. (cf. Kunkel's *plate 42*), but it will be noted that Looser's illustration of his var. *ibanezii* (*fig. 9*) shows a terminal lobe of the frond which is broad and irregularly toothed, being rather different from Kunkel's interpretation of that variety.

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[1] Giffart was also engraver for Plumier's great work *Nova Plantarum Americanarum Genera* (1703).


Feuillée's Original Illustration of Notholaena mollis Kunze of Chile

A second fern more briefly described by Feuillée and less accurately illustrated as well was *Notholaena mollis* Kunze. This second Chilean fern to be illustrated in botanical literature has a more obscure origin, for Feuillée fails to record where he observed this species. This fern is known from Coquimbo[2] and may have been observed there when he visited the port in April, 1710. The third volume of Feuillée's work, published in 1725, was illustrated by an unknown artist, Giffart having died in 1723. The xerophytic character of this *Notholaena* (*cf. Pl. 3*) doubtless engaged Feuillée's attention for he likely noticed the "resurrection habit" of alternately drying and reviving with wet and rainless periods. This fern was evidently not distinctive enough to be involved in early species descriptions as was *Polypodium feuillei*.

Feuillée's important contribution to the early knowledge of flowering plants has been sketched elsewhere by me (1959). Among the more notable of these were the genus *Fuchsia* and what has come to be called the "California Pepper Tree" (*Schinus molle*). Feuillée's later years included his election to the French Academy, his investigation of the island of Hierro in the Canaries in 1724, and the publication of the third volume of his *Journal*, already mentioned, in 1725. The only English translation of Feuillée's works was a much abridged treatise edited by Petiver entitled "The South Sea Herbal of Feuillée's Medicinal Plants," published in 1715 and including five plates. This seems to have been designed for sea captains. Father Feuillée died in Marseilles on April 18, 1732, the year of George Washington's birth.

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[2] W. T. Stearn remarks on the unusual opportunity among pre-Linnaean authors for locating the source of Feuillée's plants. Cf. his valuable Introduction to Linnaeus, *Sp. Pl.* (Ray Soc. reprint, London, 1957), p. 145.

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## Evergreen Grapeferns and the Meanings of Infraspecific Categories as Used in North American Pteridophytes

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In late years, work on the North American evergreen grapeferns (*Botrychium*, subg. *Sceptridium*) has led me to a taxonomic interpretation that deviates quite strongly from that of my predecessors. The plant I designate as *Botrychium oneidense* has been construed in the past mostly as a variety or form of *B. dissectum* or of *B. multifidum* or as their natural hybrid. The one now called *B. ternatum* (or its American representative) has been interpreted, if at all, as a form of *B. multifidum.* The occasion for this paper is to state briefly the philosophy on which these interpretations are founded, and, at the same time, to call attention to some of the usages of infraspecific categories to be found among other North American pteridophytes.

Estimates of the total of pteridophytic species that grow in North America north of Mexico range from roughly 340 to 380. We may never decide on the exact number of species, however, but not because of lack of exploration and research. In fact, I suspect that the next half-century will yield a tremendous expansion of our knowledge. The problem in estimating the number involves the taxonomic definitions themselves. There are no

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absolute, hard and fast applications of taxonomic categories in expressing plant relationships. But within certain boundaries they are meaningful.

The subject of infraspecific categories has been much discussed, and I have selected a few references (Emerson, 1955; Fuchs, 1954; Lewis, 1955; Mayr, Linsley, and Usinger, 1953; Rollins, 1952; Shinners, 1958; Simpson, 1958; and Weatherby. 1942) as a introduction to the vast literature on the subject. In the following, however, I wish to emphasize that the opinions are largely my own, even though the majority of them tend to agree with general practice. The major infraspecific categories applied to North American pteridophytes are *form, variety,* and *subspecies.*

I think that most of our *forms* are extremely minor categories at best—some even results of injuries. Forms are trivial variants, in my opinion, of no known consequence in the broad biology of the species, and they exist as scattered individuals. In *Plate 4,* I have tried to make a graphic representation of the category of form in comparison to subspecies and species. Forms may be induced by abnormalities or extremes of environment and development, or by single- or few-gene mutations. A good example of an environmentally induced form might be what has been designated as *Woodwardia virginica* f. *fertilis*—just an incompletely fertile leaf, with only a fraction of its sori developed. It tends to be found in deep, shady swamps. The same rhizome growing into sunny areas of the swamp will be normal, with fully fertile leaves. Abnormalities of development or ontogeny come usually from injuries or disturbance in growth. Transplanting rhizomes of *Onoclea sensibilis* into the greenhouse often results in the leaf form *hemiphyllodes,* one side sterile, the other fertile. The same transplanted rhizomes produce, in my experience, also imperfectly fertile leaves, f. *obtusilobata.* Both of these kinds of bizarre leaves are occasionally found in the wild, where they are produced by unknown factors (insects, injury by mammals, fire?). Taylor Steeves (1959) recently discussed *Osmunda cinnamomea* f. *frondosa* and f. *latipinnula,* giving a good, modern example of the causal approach to the study of forms.

In the category of genetic forms are probably most of the established crested forms of ferns, the skeletonized leaves, variegated forms, more or less sterile and divided variants (e.g., *Polypodium virginianum* f. *cambricoides, Asplenium platyneuron* f. *hortonae*), and so on. Some years age (1931), Andersson-Kottö established that certain of these are of simple genetic nature, but so far as I know such work has not been carried out in recent years. Many of the North American genetic forms deserve experimental study. In my opinion, however, no trivial "form" deserves a formal botanical name, no matter how peculiar-looking. In 99 out of 100 cases, I guess that their taxonomic significance is likely to be nil. Most are morphogenetic monstrosities, the naming of which seems to be a holdover from an earlier time and tradition, when the biology of plant species was poorly if at all understood.

In one recent manual of the northeastern American flora (Fernald, 1950) I estimate that there are 110 unnecessary Latin or Greek names of trivial forms of pteridophytes. If we persist in naming such sports the sky is the limit: We could name 150 more right now, for the eastern United States alone, and this would be just a beginning. (There must be at least 75 species, for example, for which no crested forms have been named; and many more for which we have no dwarfed forms named.)

When classification proceeds to the level of *variety, subspecies,* and *species,* it now has experimental and statistical methods of far more profound significance than were available a half-century ago. Such methods cannot be used, of course, in unexplored and remote areas of the tropics that are still in the alpha stage of knowledge, but they can surely be adopted for our native pteridophytes. Criteria of detailed anatomy (using clearing and sectioning techniques, as well as observation under high-powered microscopes), gametophyte morphology and biology, chromosomes, ecology and substratum, tests of characters in experimental cultures, and—above all—the nature of the breeding population under natural conditions—these provide us a much more concrete evaluation of diversity and its meaning.

The term *variety,* however, has been much confounded by different usages. Some botanists are inclined to drop it entirely. Some have used it to mean what others call "form." Others have used it for "subspecies." Still others have been inconsistent. To make matters worse, the term "variety" has been adopted widely and traditionally in horticulture. As I understand it, the general tendency now seems to be to continue the use of variety in more or less the sense of a "sub-subspecies." The subspecies, then, becomes a sort of "super-variety." The category of variety, then, may be used either as a lesser subspecies, i.e., a segregate of a species that is not sufficiently distinctive to be upheld as a subspecies; or as a segregate of a subspecies, where the species can be shown to be so constituted.

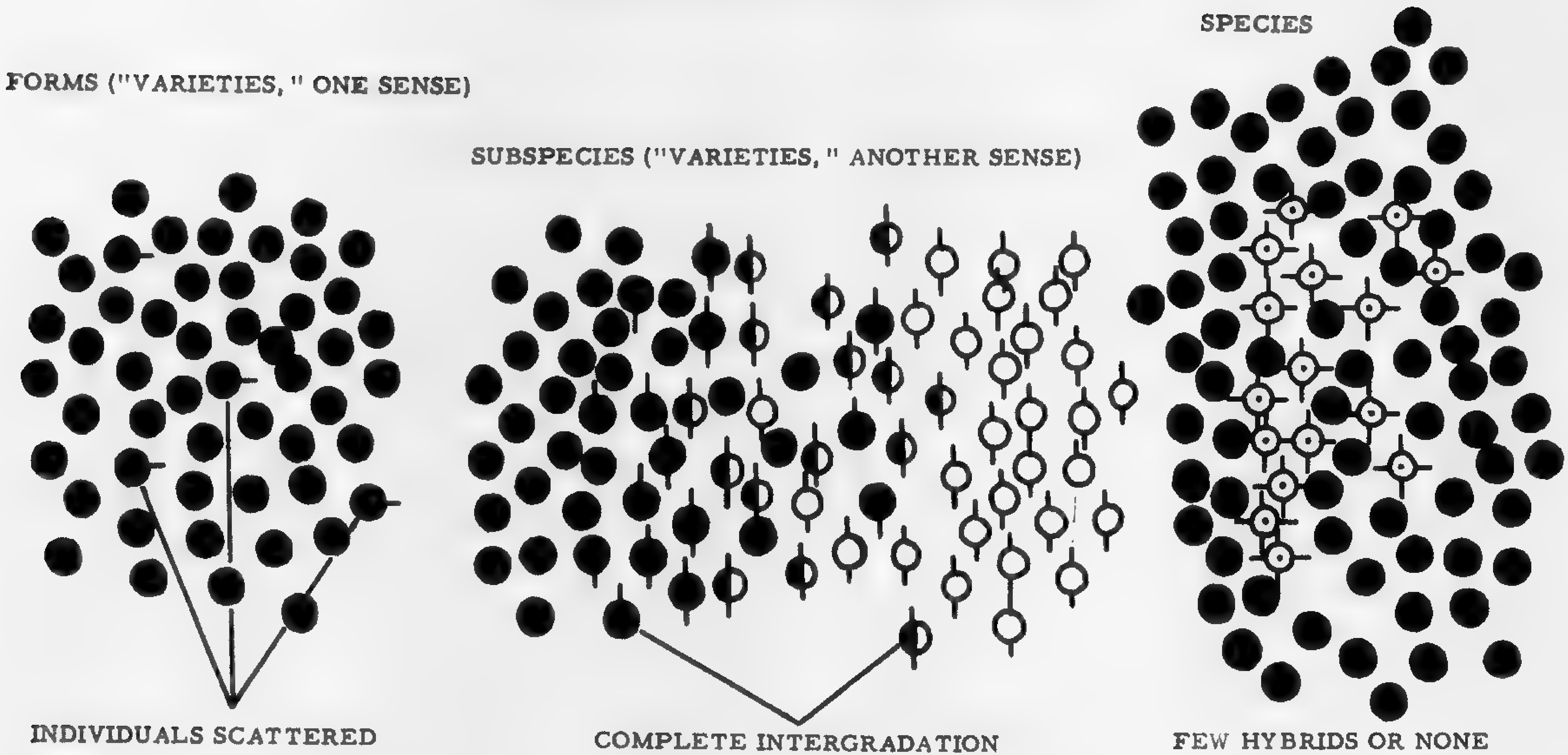
Therefore, it is upon the *subspecies,* that I should like to focus, with the understanding that *variety* is a similar, but more minor, category. An example of a zoological definition of subspecies is appropriate: "*Geographically defined* aggregates of local populations which differ taxonomically from other such subdivisions of a species" (Mayr *et al.*, 1953). The italics are mine. The botanist Fuchs recently (1954) defined a subspecies as follows, emphasizing another aspect (and I quote the original French):

"SOUS-ESPÈCE: Unité qui groupe les individus dont les différences morphologiques et anatomiques son bien établies et qui sont liés entre eux par des formes transitoires continues et non par des hybrides. C'est-à-dire que des 'espèces' liés entre elles d'une façon continue par des formes transitoires ne sont pas des espèces, mais des sous-espèces."

To Fuchs' definition, I know of only one exception so far in the study of ferns, namely the remarkable hybridization that occurs between species of *Pteris* in Ceylon (Walker, 1958)[2] producing complete intergradation between plants that are

[2] Reviewed, this JOURNAL *49:* 43, 44.

THREE IDEALIZED TAXONOMIC SITUATIONS



with little doubt good species. This single exception is not sufficient, I believe, to prevent us from combining three ideas in a definition of subspecies or variety that will apply to the vast majority of pteridophytes, viz. that, in general, subspecies or varieties (a) are morphologically distinct; (b) geographically defined, i.e., have distinctive ranges; and (c) if their ranges are in contact or overlap, freely and continuously intergrade, without sterility barriers. The middle picture in *Plate 4* endeavors to show this graphically.

Two subspecies or varieties, so defined, cannot have the same or overlapping ranges and at the same time co-exist in the same habits, for if they were shown to do so and still remained distinct from each other without intergradation their interpretation would then be questionable. If they did not intergrade and maintained their distinctions, there would have to be strong barriers to interbreeding. The taxa would therefore not be subspecies but species. I thus believe firmly that if two substantially different taxa do co-exist and extend together over large areas without interbreeding then they must be regarded as biological species. It would be a misuse of the concept of subspecies or variety to apply such categories to them. It would also be a misuse, in my opinion, if two undoubtedly distinct species of pteridophytes should form hybrids, sterile or fertile (by doubling of chromosome complements), and those hybrids are treated as subspecies or varieties of one of the parents; well marked interspecific hybrids that lack intergradation with their parental species may be expressed taxonomically by means, to be described below, other than the use of infraspecific categories.

Regarding the idea of breeding capacity within species, I do not mean, of course, to imply that there may not be intraspecific sectors which are incompatible, even in the same population, just as there are in animals. I shall not be surprised if there are all sorts of undetected biochemical mutants which are limited in their ability to breed with at least certain other members of the same species. In pteridophytes, the very little understood phenomenon of autopolyploidy—sectors of a species with different multiples of the chromosome number (*e.g.*, 42, 84, 126, 168, etc.)—probably divides a species into more or less separately breeding components (*e.g.*, *Polypodium vulgare, Asplenium trichomanes, Cystopteris fragilis s.s.*). Irene Manton and her group at the University of Leeds are studying such complexes. Autopolyploid isolation might lead over great spans of geological time to varieties, subspecies, and species. We do not really yet know, however, to what extent the so-called polyploid forms at their origins may be able to exchange genes anyway with their diploid progenitors, in spite of the chromosome number barrier. The various chromosome races may be, so far as we can tell, identical morphologically and ecologically, indicating that except for genome differences they are genetically alike and therefore sectors of the same taxon. Chromosome number by itself—at least at this stage of our knowledge—should not be used as the criterion of subspecies or varieties. These, instead, are more reliably defined upon suites of morphological characters and upon differences of range.

Current studies of the evergreen species of *Botrychium* involve such problems of interpretation. For a number of years I have been making mass collections of populations of these plants, and recently various members of this Society have very kindly made local population samples for me. All the evidence points to four distinct taxa in northern North America—*B. dissectum* (including many "forms"), *B. multifidum, B. oneidense,* and *B. ternatum* (or an American representative of it). All four taxa co-exist in what must be an unlimited number of localities across the large area running from Minnesota to Quebec and New England and downward to the southern Great Lakes region. I have attempted to obtain all my collections of the species growing side by side with one, two, or three of the others. In this study I have taken 4,627 specimens of *B. dissectum* in 82 localities; 640 of *B. multifidum* in 54 localities; 2,173 of *B. oneidense* in 66 localities; and 993 of *B. ternatum* in 35 localities. The chromosomes of all four taxa have been counted; and all show $n = 45$, so there is no chromosome number barrier to hybridiza-

*Segments small to large*

1 { ternatum
  { multifidum
2 dissectum
3 oneidense

*Tips undivided to divided*

1 dissectum
2 oneidense
3 { multifidum
  { ternatum

*Range: N. to S.*

1 multifidum
2 ternatum
3 oneidense
4 dissectum

*Vernation early to late*

1 multifidum
2 oneidense
3 ternatum
4 dissectum

*Segments angular to round*

1 ternatum
2 dissectum
3 multifidum
4 oneidense

*Young leaves green to red*

1 oneidense
2 multifidum
3 { dissectum
  { ternatum

*Spores smooth to rugose*

1 multifidum
2 ternatum
3 { dissectum
  { oneidense

*Margins smooth to dentate*

1 { multifidum
  { oneidense
2 ternatum
3 dissectum

*Mid-winter leaves green to bronze*

1 { oneidense
  { multifidum
2 ternatum
3 dissectum

tion. There is no obvious correlation of the character complex of one species with any of the others. The major variables are enumerated below, the species being arranged appropriately:

These character comparisons, some still incomplete, were made for the most part in mixed populations in the same habitats, and will be reported on in detail later.[3] There is overlap in practically all the characters, so that the arrangement is based on averages. Where two species are bracketed, the character is essentially identical in both. There is no question that all four species are very closely related. However, the point to be stressed regarding these grapeferns is that they do co-exist over a large range, yet maintain their distinctness. No one species is similar enough to any other in all the variables to be merged with it into one species. *Botrychium oneidense* and *B. ternatum* could be made varieties as well of *B. multifidum* as of *B. dissectum.* If we maintain two species, *B. dissectum* and *B. multifidum,* then we must maintain the two others by any "species standard" (*cf.* Rollins, 1952; Wagner, 1959).

The following illustrates the correlation of resemblances in nine variables:

| | *B. multifidum* | *B. dissectum* |
|---|---|---|
| *B. oneidense* | 5 | 4 |
| *B. ternatum* | 4 | 5 |

I believe that the taxonomic situation of these plants corresponds to the diagram on the right-hand side of *Figure 1.* Whether or not my treatment represents an ultimate taxonomic solution to the problem of inter-relationships of these evergreen grapeferns remains to be seen, but I think that this situation is a good illustration of a complex in which the infraspecific categories of subspecies or variety do *not* apply, in spite of the close resemblances that exist.

[3] The southern *Botrychium tenuifolium,* unfortunately, does not occur together with *B. multifidum* or *B. ternatum,* so far as I know; in fact their ranges do not overlap. However, Dale M. Smith has recently discovered both *B. oneidense* and *B. tenuifolium* in the same county of southern Indiana, though not yet in the same habitat. Our fitting of *B. tenuifolium* into the character spectra for these plants then will have to be based probably on comparison with *B. dissectum* which does grow with it.

Before going further, I should like to give some examples of taxa that I would regard as likely to be valid subspecies or varieties; the following list will be ample:

BOTRYCHIUM LANCEOLATUM var. LANCEOLATUM (Eurasia, western North America) and B. LANCEOLATUM var. ANGUSTISEGMENTUM (eastern North America).

PTERIDIUM AQUILINUM var. LATIUSCULUM (North America, northern Europe, eastern Asia), and P. AQUILINUM var. PUBESCENS (western North America, Mexico).

OSMUNDA REGALIS var. REGALIS (Eurasia) and O. REGALIS var. SPECTABILIS (North America, incl. Mexico).

PHYLLITIS SCOLOPENDRIUM var. SCOLOPENDRIUM (Europe) and P. SCOLOPENDRIUM var. AMERICANA (eastern North America).

CRYPTOGRAMMA CRISPA var. CRISPA (Europe, southwestern Asia) and C. CRISPA var. ACROSTICHOIDES (northeastern Asia, North America).

The example of bracken in the United States and Canada is a particularly good one because the two varieties grade into each other nicely where their ranges overlap (Tryon, 1941; Weatherby, 1942), and the picture is approximately like that of subspecies (or variety) in *Figure 1.* Most of the others are so well separated that their intergradation is unknown or absent.

In contrast to these there are some designated subspecies or varieties that should be considered quite skeptically and deserve research, because there is a real doubt as to whether these are taxonomically distinct at all. I am thinking especially of those taxa which are based upon characters strongly subject to environmental modifications. It goes almost without saying that a given fern genotype when grown in a deep swamp will produce plants of different aspect (larger, more divided leaves; petioles and petiolules attenuate; segments longer, more remote; texture thinner; sporangia fewer, if any) than in an open, dry field. By the same token, a mesophytic plant with certain characters in average habitats in Indiana and Michigan may be expected to have a different aspect if growing at very high latitudes or altitudes, e.g., Alaska (the plant smaller, simpler; petioles contracted; segments shorter, overlapping; texture firmer or more leathery; sori or sporangia abundant and confluent). These changes are so familiar to a field worker that he usually makes his taxonomic treatment accord, although it is true that ultimately the field observations should be confirmed experimentally, if there is any doubt, by uniform culture techniques. However, even without experiments, the probability that such changes are merely environmental is extremely high. Such taxonomic segregates as the following are questionable: *Botrychium simplex* var. *simplex* and *B. simplex* var. *tenebrosum*, *B. virginianum* subsp *virginianum* and *B. virginianum* subsp. *europaeum*, *B. multifidum* subsp. *multifidum* and *B. multifidum* subsp. *intermedium*, *Adiantum pedatum* var. *pedatum* and *A. pedatum* var. *aleuticum*, *Polystichum munitum* var. *munitum* and *P. munitum* var. *imbricans*.

A revision of the Ophioglossaceae by Robert T. Clausen (1938) has numerous examples of such subspecies and varieties, since the author depended so strongly on characters that students of these plants more interested in natural, biological populations recognize to be readily modified by environment. The examples cited above may not stand experimental tests and are probably mere forms. It is almost certain that individuals identified as different subspecies or varieties growing in the same regions belong to one basic genotype and do not warrant subspecific separation. For example, specimens of *B. virginianum* from Michigan identified as subsp. *europaeum* are with little doubt only dwarfed forms of the typical subspecies.

To set up subspecies or varieties for distinct taxa that grow side by side in abundance and maintain their distinctions defies any definition of species, in my opinion. If two taxa co-exist over a large range and maintain their characters, they should be interpreted as species. This means that not only do the taxa have diagnostic features of sufficient number and nature to be readily separated, but they do not interbreed to form fertile populations, or, if they do interbreed, it is to produce only occasional sterile hybrids or hybrids with decidedly diminished fertility. The varieties designated below would seem to represent, in actuality distinct species: *Lycopodium alopecuroides* var. *alo-*

*pecuroides* and *L. alopecuroides* var. *adpressum, Botrychium dissectum* var. *dissectum* and *B. dissectum* var. *oneidense, B. lunaria* var. *lunaria* and *B. lunaria* var. *minganense, Gymnocarpium dryopteris* var. *dryopteris* and *G. dryopteris* var. *robertianum, Dryopteris spinulosa* var. *spinulosa* and *D. spinulosa* var. *intermedia.*

The first of these pairs, involving the *Lycopodium inundatum* complex in North America, greatly needs research. C. V. Morton recently called to my attention that the *Athyrium filix-femina* complex is another that deserves careful investigation. The case of *Botrychium lunaria* vs. *B. minganense* was revived several years ago when we wrote a report (Wagner and Lord, 1956) to show that when these plants grow together in the same habitats, there may be detected at least 14 differences, including even those of juvenile plants and leaf primordia. They do not interbreed, and we therefore considered them as sympatric species, the range of *B. lunaria* completely overlapping that of *B. minganense* (the "species" of *Figure 1*). I believe that the same interpretation should be given to the other examples listed. With all the obvious differences between *Dryopteris spinulosa* and *D. intermedia,* species which flourish together in the same habitats intimately associated, it seems to me illogical to treat them as varieties of one species. Their common hybrid, *D.* × *fructuosa,* has abortive spores, indicating that, along with morphological differences, there is a clear-cut breeding barrier.

The mention of a hybrid brings us to the other use of the categories of subspecies or variety, which I would hold to be a misuse. It has been common in pteridophyte taxonomy to designate plants which are more or less obviously interspecific hybrids as varieties or subspecies of one of the two parents, as follows: A × B = AB, but AB is treated as A var. AB or B var. AB. None of the following are varieties, in my opinion: *Equisetum hyemale* × *kansanum* = *E. hyemale* var. *intermedium, Woodsia glabella* × *ilvensis* = *W. ilvensis* var. *alpina, Cystopteris bulbifera* × *fragilis* = *C. fragilis* var. *laurentiana, Dryopteris cristata* × *goldiana* = *D. cristata* var. *clintoniana, D. intermedia* ×

*spinulosa* = *D. intermedia* var. *fructuosa, Asplenium montanum* × *pinnatifidum* = *A. pinnatifidum* var. *trudellii.*

To be true, most of these were interpreted as subspecies or varieties before evidence leading to concepts of hybridity was adduced; the error, it seems to me, is to persist in treating plants as varieties of one of the parents, after the indications are presented that they are interspecific hybrids. In each of the cases, as has been shown with at least some assurance (in the work of R. L. Hauke, D. F. M. Brown, R. F. Blasdell, E. T. Wherry, S. Walker, and the writer, respectively), the "varieties" in question are actually not members of one species but are crosses, containing the heredities of two species. If they are to be made subspecies, or varieties, it could be of one parent just as well as the other. Some of these hybrids, of course, are fertile plants, well established in the biotic community, largely as "sexual species" through doubling of chromosomes (amphidiploidy), or as "asexual species" through some form of vegetative, nonsexual propagation such as apogamy (cf. Emerson, 1955). Other interspecific hybrids among pteridophytes are entirely sterile, and do not reproduce significantly by vegetative means. Hybrid taxa are best expressed either as a formula (e.g., *Dryopteris intermedia* × *marginalis,* the species arranged alphabetically), or as a binomial (*D.* × *pittsfordensis;* or, if a successful, sexual or asexual species, *D. pittsfordensis,* without the "×"). I do not believe that it is ever appropriate to designate them as varieties of one of the parents.

Having described the difficulties in the taxonomic interpretation of the evergreen grapeferns and having briefly reviewed in the light of my own bias the usages of the various infraspecific categories, I do not believe by any means that the conclusions of this short review are necessarily definitive for either problem. Mostly, I think, it should be re-emphasized that there are available today tools (such as techniques for studying anatomy, life-cycles, chromosomes, constancy of characters, and breeding ability) for making more objective analyses of taxonomic relationships than we have had previously. Under these conditions, perhaps, a certain conceptual solidarity among North American pteridologists in how they apply the infraspecific categories is more appropriate than ever before. Perhaps the notes presented here will call to the forefront some of the principles and problems we need to face.

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# The Ecology of Peruvian Ferns

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The Andes dominate Peru. They traverse its length and are responsible for the principal types of vegetation, their distribution patterns, and for the richness and the diversity of the flora as well. The Altiplano is the high central land from 10,000 to 14,000 feet elevation. It may be rather flat although usually it is broadly rolling; where it is penetrated by valleys there is considerable relief. It is bordered, except in the north, by a broken chain of high mountains many of which rise to 18,000 feet or more and support permanent snow fields and glaciers. These highlands are relatively cool and dry and the vegetation consists of grasslands, sedgelands, semi-desert shrubs, and cacti. Locally small woods, especially of *Polylepis,* may be found. Above the limit of agriculture, at about 13,000 feet up to the limit of vascular plant life at about 17,000 feet, is the Puna where the cold prevails and low cushion plants are the principal botanical feature.

Along the eastern slopes of the Andes there is a transitional climatic and vegetational band from about 11,000 down to 6,000 feet, and below this the tropical forest begins. This is the western edge of the largest forest in the world for it extends unbroken for some 1,700 miles through the Amazon Basin to the Atlantic Ocean. On the Pacific side, the slopes of the Andes become progressively drier, below 10,000 or 8,000 feet to the coast, and are usually barren or with a sparse desert vegetation. In the north of Peru, these desert conditions become less pronounced and at the northernmost tip there is a small forested area. This otherwise barren coastal zone is relieved only at intervals by green irrigated river valleys and by the naturally verdant lomas.

This paper is based primarily on the notes, collections, and observations made in Peru from July to November of 1956.[1] This

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trip was made for the purpose of providing a background for a taxonomic study of the ferns of Peru; I was accompanied by my wife Alice Tryon, to whom I am indebted for many of the results obtained. The principal places where we studied ferns are the following: The Montaña fern group at Iquitos, Tingo Maria, La Merced, and Potrero; the Ceja Thicket fern group at Carpish and Machu Picchu (the ruins); the Ceja Scrub fern group near Huacapistana; the Sierra fern group at Cuzco, Huancayo, and Tarma; and the Loma fern group at Amancaes and Lachay, in the Department of Lima. Our own material has been supplemented by that of others, largely taken from the publications listed in the bibliography. I am under particular obligation to Dr. Ramón Ferreyra, to Dr. César Vargas, and to Dr. Pedro Coronado for aid to my studies while in Peru.

In the ecological classification of the ferns of Peru, two fern vegetation types, the Forest Fern Vegetation and the Steppe and Scrub Fern Vegetation, are recognized on the basis of various characters of the plants. Each of these is subdivided into two ecological fern groups, primarily on the basis of environment and geography and secondarily on the basis of floristics. An intermediate between two of these groups is recognized because of its prominence. This classification is necessarily subject to local exceptions and transitions. However, it may be expected to portray the broad correlations between the plants and their environment.

I have included only the native Pteridophyta in their natural habitats. Such introduced species as *Adiantum Capillus-Veneris* and *Pteris vittata*, on the sea cliffs near Lima, and such native species as *Trismeria trifoliata*, *Equisetum bogotense*, and *E. xylochaetum*, along irrigation ditches and in similar habitats in the naturally dry coast and coastal valleys, will not receive further mention.

### I. THE FOREST FERN VEGETATION

The forest fern vegetation is characterised by the presence of more or less obligate epiphytes and, among the terrestrial ferns, by continuous growth throughout the year (or at least the leaves remain in a fresh condition), by sterile plants, by species with large leaves (5 feet long or more), some of which, having widely creeping rhizomes, form conspicuous colonies, and by species with some modification of the leaf for vegetative reproduction. In a given locality there is a relatively large number of species (about 50 to 100 within a mile radius) many of which are locally very rare. The area of this fern vegetation is that of the forest (Montaña) and moist Ceja de la Montaña (Ceja Thicket).

The following are some of the epiphytic ferns: *Polypodium duale, P. filicula, P. percussum, P. plumula, P. angustifolium, P. polypodioides* (var. *Burchellii*), *P. phyllitidis, P. pectinatum, Eschatogramme panamensis, Asplenium serratum, A. auriculatum, Ophioglossum palmatum,* and a number of species of *Elaphoglossum.* Some of these species may also grow on bare rocks, or may survive, at least for a time, on fallen branches. These species are biologically similar to the Sierra ferns. They may become dormant during the relatively mild dry season, especially if growing on the more exposed branches, and they have small leaves; the plants are usually fertile and none of the species have leaves modified for vegetative reproduction. When the plant is dormant, the leaves of most of the species curl and probably can revive after a brief dormancy; those of *Ophioglossum* die.

The following are some of the species with large leaves: *Nephrolepis biserrata* (to 12 feet), *Lygodium volubile* (to 40 feet), *Hemidictyum marginatum* (to 1 feet), *Hypolepis parallelogramma* (to 22 feet), *Adiantum pectinatum* (to 8 feet), and the tree ferns such as *Alsophila microdonta* and *A. elongata* (both to 10 feet). Others with large leaves frequently form conspicuous colonies: *Dennstaedtia cicutaria, Hypolepis hostilis, Pteris grandifolia, Gleichenia bifida, G. Bancroftii, Dicranopteris pectinata,* and *Pteridium aquilinum* (var. *arachnoideum*). The last species is the most aggressive and may occupy whole hillsides after they have been cleared for agriculture.

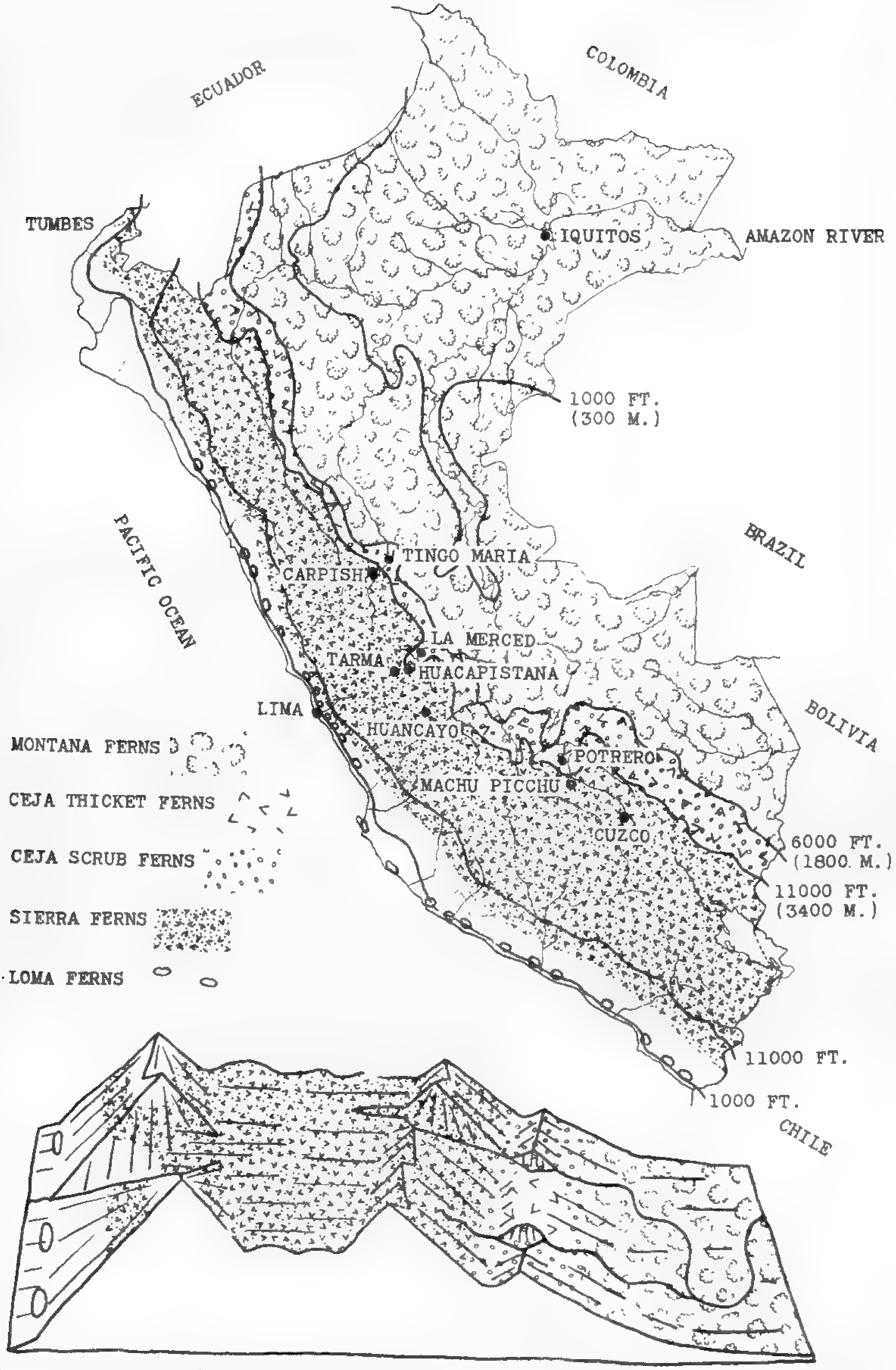
There are two kinds of modifications of the leaf for vegetative reproduction. The following species have buds on the lamina: *Polystichum platyphyllum, Thelypteris macrotis, Bolbitis crenata,* and *Diplazium cristatum* (all with buds along the rachis toward the apex of the lamina), *Doryopteris pedata* var. *palmata* (buds at the base of the lamina) and *Tectaria incisa* (buds at the base of the pinnae and along the pinna-rachises). In these species the buds are persistent and develop into plantlets, especially on the old leaves, while still attached to the leaf. In *Dennstaedtia arborescens* there are deciduous buds in the axils of the pinnae. Other species have a rachis-tip that roots to produce a new plant. In *Adiantum deflectens, Trichomanes diversifrons,* and *Asplenium radicans* the rachis-tip is elongate. In *Trichomanes Hostmannianum* it is greatly elongate and may produce roots at intervals before developing a new plant at the tip; while in *Danaea Moritziana* the tip is elongated but not otherwise modified. *Asplenium radicans* has all, or nearly all, of the leaves rooting, whereas all of the other species mentioned also have leaves with normal apices.

The reason for the considerable number of sterile plants in this fern vegetation needs investigation. The fertile leaves may be fugacious as in *Bolbitis crenata, B. Lindigii, Polybotrya caudata,* and *P. osmundacea,* and present only during a brief period of the year; or plants of some species may grow where the environment is not conducive to the formation of fertile leaves; or perhaps some species are not freely fertile, even in suitable habitats.

### IA. THE MONTAÑA FERN GROUP

This is the fern group of the forest which occupies the large area east of the Andes and a very small area in the Department of Tumbes that is an extension of the Gulf of Guayaquil vegetation. It is warmer than the Ceja Thicket and fog is not typical. There are some 60 to 140 inches of rain annually, most of it from October to April.

It is difficult to distinguish the group, by its species, from the Ceja Thicket ferns. Many of the species of the Montaña are not




DISTRIBUTION OF ECOLOGICAL FERN GROUPS IN PERU. MAP AND DIAGRAMMATIC PROFILE sufficiently common to be useful in defining the group and those that are may also grow in the Ceja Thicket. The best floristic distinction, perhaps, is the presence, only in the Montaña, of numerous and often rather common species of *Adiantum* with broad or dimidiate segments such as: *A. petiolatum, A. obliquum, A. latifolium, A. macrophyllum, A. anceps, A. peruvianum, A. platyphyllum, A. pectinatum, A. tetraphyllum, A. fructuosum. A. macrocladum, A. tomentosum, A. terminatum, A. pulverulentum,* and *A. villosum.*

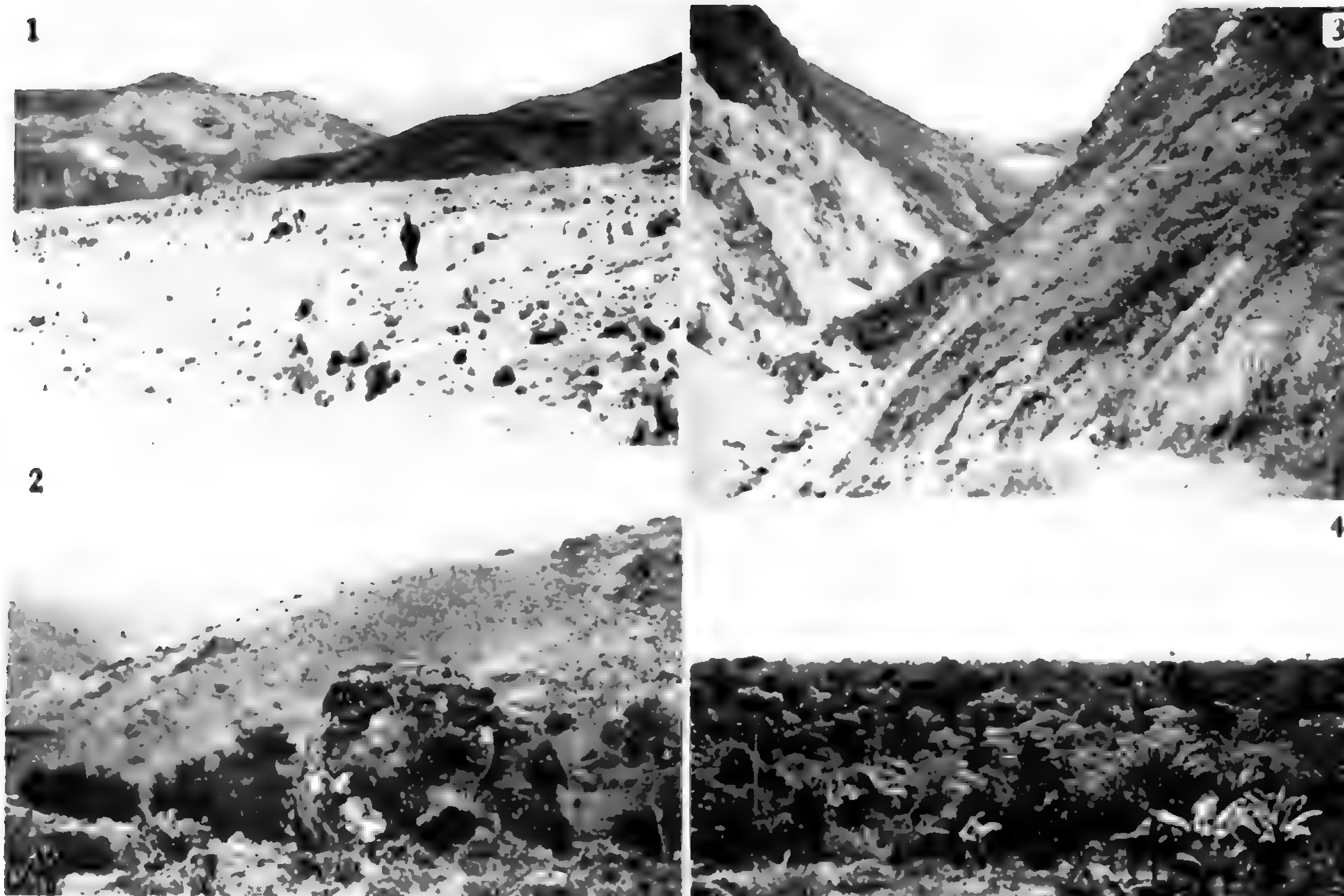
Furthermore it is difficult to distinguish floristic elements among the ferns of the Montaña, for the reasons mentioned above, although among its several hundred species there are some that are confined to the higher elevations and others to the lower ones.

### IB. THE CEJA THICKET FERN GROUP

The Ceja Thicket occupies locally favorable situations along the higher eastern slopes or low summits of the Andes at elevations of about 6,000 to 11,000 feet. These are moist, cool areas where clouds and fogs are present most of the year. Tree ferns and the bamboo *Chusquea* are the dominant elements in the landscape, both extending well above the dense shrubby growth. The best floristic distinction from the Montaña ferns is the absence of the Adiantums mentioned above and the presence of such species as *Hymenophyllum Ruizianum, Gymnogramma flexuosa, Lycopodium complanatum, L. clavatum, L. Jussiaei* and *L. pendulinum.*

### INTERMEDIATE BETWEEN IA AND IIA: THE CEJA SCRUB FERN GROUP

This fern group occurs in the same zone as the Ceja Thicket ferns but in drier situations (dry Ceja de la Montaña) where foggy conditions do not regularly occur. It is intermediate between the Sierra fern group and the Montaña fern group and forms a pronounced transition zone between them. Floristically, there is a mixture of species from the Sierra fern group and the Montaña group, especially of the more widely distributed ones. For example, *Pellaea ovata, P. sagittata,* and *Woodsia*




Habitats of Ecological Fern Groups in Peru. 1, Sierra Group (Near Tarma); 2, Loma Group (Loma Lachay); 3, Ceja Scrub Group (Near Huacapistana); 4, Montaña Group (Iquitos)

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*montevidensis,* typical Sierra ferns, may grow in the company of *Polypodium crassifolium, Pityrogramma tartarea, Nephrolepis cordifolia,* and *N. pectinata* which are typical Montaña species.

Most of the ferns have small leaves, are terrestrial, are usually fertile and do not have leaves modified for vegetative reproduction. In these characters, the group resembles the Steppe and Scrub fern vegetation. The plants grow more or less throughout the year or at least maintain leaves in fresh condition and in this respect it resembles the Forest fern vegetation. A few species such as *Pteridium aquilinum* and *Pteris muricata* have large leaves.

### II. THE STEPPE AND SCRUB FERN VEGETATION

The Steppe and Scrub fern vegetation is characterised by the absence of obligate epiphytes and by terrestrial plants with a definite dormancy during which the leaves either die or become curled, with fertile and small leaves (less than 2 feet long), and by the absence of species that form conspicuous colonies or have leaves modified for vegetative reproduction. In one locality there are relatively few species (about 5–15 within a mile radius) but most of these are frequent. This fern vegetation occupies the rather dry western portions of Peru. It has a mosaic distribution, for most of the coastal and adjacent Andean slopes are too dry for ferns, and in the Altiplano and the mountains it is mostly confined to rocky hillsides, cliffs, and similar habitats.

### IIA. THE SIERRA FERN GROUP

The Sierra ferns have a seasonal dormancy, but the dormancy may be intermittent due to infrequent rains during the dry season. The available moisture is largely in the soil or in rock crevices and there is a greater number of species where there is local seepage or perhaps conditions suitable for the condensation of water from the atmosphere. There is little information concerning this latter factor although it may be an important one. The rainfall, some 20 to 44 inches annually, is by no means deficient in itself but the very dry air, the winds and the strong insolation at the high altitudes combine to reduce its effectiveness.

Most of the Sierra ferns may be divided into two kinds. The xeric element is typical of the drier sites and these species curl and retain their leaves during the dry season; they may revive and continue activity during brief moist periods. Such species are: *Cheilanthes incarum*, *C. pruinata*, *C. myriophylla*, *C. scariosa*, *Polypodium pycnocarpum*, *Pellaea ternifolia*, *Selaginella peruviana*, *Notholaena nivea*, and *N. aurea*. The mesic element is typical of the locally moister habitats and in these species the leaves die during the dry season, unless in an unusually favorable place. *Adiantum Poiretii*, *A. digitatum*, *Cystopteris fragilis*, *Asplenium fragile*, *Thelypteris Rosei*, and *Woodsia montevidensis* are typical of this element. Two species of this element are exceptional in having proliferous buds on the leaf. These are *Asplenium fragile* and the closely related *A. Gilliesii*. A bud develops on the petiole which may become greatly elongate and act as a stolon. The petiole below the bud is persistent after the lamina has withered and the plantlet develops at what appears to be its tip.

### IIb. The Loma Fern Group

The loma fern group is part of the unique vegetation occurring at intervals along the coast of Peru (and Chile) north to about 8° S. Latitude. This vegetation develops in response to local physiographic conditions that, in winter, lead to more or less constant fog and guara (heavy mist) at certain hills and valleys. The summer months are continuously dry. Although a rather lush vegetation may be developed by the unusual moisture conditions, the flora, on the other hand, is evidently restricted by the long continuously dry season.

The loma ferns represent, almost wholly, a selection of species from the Sierra ferns. To my knowledge, only three of the species are not also among the Sierra ferns: *Ophioglossum nudicaule*, a *Polypodium* near *P. lasiopus*, and a *Dryopteris* near *D. patula*, but it is not certain that they do not also occur there.

Further study must be made before it will be known if the last two are perhaps endemic to the lomas. The most common species are: *Polypodium pycnocarpum, Adiantum subvolubile,* and *A. digitatum;* others are: *Ophioglossum petiolatum, Anogramma leptophylla, Woodsia montevidensis, Notholaena peruviana,* and *Adiantum Poiretii* (vars. *hirsutum* and *sulphureum*).

About 80 percent of the species of flowering plants on the lomas are endemic and the few, or no, endemics among the ferns is in striking contrast. This may be due to a slower rate of evolution among the fern species but I think that it is more likely that it reflects their superior means of dispersal. It is quite possible that, from the Andes, spores of these species reach the lomas with sufficient frequency to negate the effects of their geographic isolation.

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## Survival of Hart's-tongue Fern in Central New York

MILDRED E. FAUST

One hundred and fifty years after the hart's-tongue, *Phyllitis scolopendrium* (L.) Newm. var. *americana* Fern., was first reported in America, at Split Rock, New York, July 20, 1807, by Frederick Pursh, it is still persisting at least in the immediate vicinity. Trees which shaded it have been cut, a TNT explosion took place near by, and quarrying has destroyed many of the sheltering rocks. To be sure, the plants are not luxuriant but they will probably remain until man completely changes the habitat. When this station was rediscovered September 30, 1879, by the Syracuse Botanical Club, Charles Peck, who had been convinced that this station had long been destroyed, wrote then: "Pursh has been vindicated and botanists everywhere will rejoice. I regard this rediscovery of the *Scolopendrium* in its original locality after a lapse of more than seventy years as scarcely less important than the discovery of the *Epipactis.* It shows conclusively the persistence of species when left alone."[1]

Reports of the numbers, or more often of the thriftiness of the plants in the stations, have been given from time to time but not until 1916 was an organized census taken. Mabel Hunter (1922) fortunately chose the Jamesville Woods substation in Clark Reservation. In 1920 she repeated the census, found the plants increasing, and suggested that the census be a yearly one. Not until 1936 was another organized census taken in the Reservation by Lillian R. Sedgwick, David Caldwell, and myself. Since then this has been continued every five years with the assistance of botany students at Syracuse University and a number of members of the Syracuse Botanical Club—Lillian Sedgwick, Nettie M. Sadler, Mrs. Ellis Hinman, and Eleanore Porter. Because of the growth on talus we felt it would hinder survival to go into the area each year.

### DISTRIBUTION AND HISTORY

In central New York the native localities are still restricted to Onondaga and Madison Counties, where the ferns grow on talus slopes of glacial ravines and plunge basins. Coolness is the outstanding characteristic of all the ravines. The cool air pockets with the associated northern plants of the White Lake areas are well described by Petry (1918). The plants grow in the black humus of the beech, maple, hemlock, and yellow birch forests well below the overhanging ledges (largely of Onondaga lime-

[1]Letter (in Syracuse University) to Mrs. Myers, Oct. 3, 1879, Albany.

stone) on east- and north-facing slopes or in similar shaded areas.

A summary of the history as given by Maxon (1900) and Hunter (1922) is outlined below. The Roman numerals are used for Hunters' stations and colonies and capital letters for sub-stations.

I. GEDDES (SPLIT ROCK) (Pursh, 1807)
II. CHITTENANGO FALLS (Cooper, 1830?)
III. PERRYVILLE FALLS (Ledyard, 1898)
IV. JAMESVILLE
  A. HOWLETT'S GORGE (Foote, 1866)
  B. LITTLE LAKE (GREEN LAKE)
    I—Colony (Paine, 1866)
    II—Colony (Hunter, 1920?)
  C. GREEN POND (Paine, 1866)
  D. ROCK GORGE (Maxon, 1900?)
  E. WEST WHITE LAKE (Petry, 1918)
  F. EAST WHITE LAKE (Todd, 191?)
  G. EVERGREEN LAKE (Petry, 1920)
  H. JAMESVILLE WOODS (Maxon, 1900)
    I-VI Colonies
V. MUNNSVILLE (Stebbins, 1934) (Page?)
VI. BALDWINSVILLE (Larsen, 1959)

Stations I, IV and VI are in Onondaga and II, III and V in Madison County.

About 1900, H. D. House transplanted several of the plants from Chittenango Falls to a ravine near Munnsville. These persisted until at least 1920 (Hunter 1924) but probably disappeared soon afterwards and were not found in 1946.

By 1924, West White Lake was "covered with the blastings of quarrying operations" (Hunter 1924) and Green Pond, often called "Scolopendrium Lake" because of the abundance of the fern, was in the direct line of quarrying. In December united efforts were made to have this unusual White Lake area preserved and included in the Clark Reservation but when these failed the owners were persuaded to hold off operations until the hart's-tongue could be saved and many transplanted in the Reservation (Hunter 1924) (House 1926). Over 1000 plants were transplanted by the summer of 1925. Some 350 placed in a ravine east of the steps were washed out the spring of 1925; around 360 were planted in Colony VI of the Jamesville Woods substation and others in original or other ravines throughout the park. The Green Pond was destroyed in 1925. East White Lake was in the line of quarrying and was half filled in in the late thirties, and so no more hart's-tongues.

Through the efforts of the Syracuse Botanical Club an amendment to the State Law was passed in 1930 to protect the hart's-tongue in these two counties. During the thirties the trees around the Rock Gorge substation were cut, so that by 1942 there was only one mature and two young plants and these were gone before 1945. In 1934 Stebbins (1935) found two well-established plants in a ravine near Munnsville. For a while this was believed to be a native area and thus the region was extended to the east. Drs. House and Maxon had searched for the fern in this locality years before with no results. It was suggested by Dr. Robert Crockett that it was probably planted by the late Mr. Page. We consulted Dr. House and he consulted the son of Mr. Page, who said that his father did plant some in that vicinity. On November 15, 1946, Eleanore Porter, Nettie Sadler, and I found a very characteristic ravine, not with two, but with two groups of the ferns, one with nine and the other eleven mature plants. This is some distance west of the ravine where Dr. House planted some much earlier.

The most recently reported station VI was found by Michael J. Larsen in the vicinity of Baldwinsville, in October, 1959. There was one large plant with about twelve large leaves with many sori. It is on a north-facing bank of a cool ravine where many of us have botanized without seeing it. It is about ten miles northwest of the original Split Rock station.

## METHODS OF THE CENSUS

The census now taken every five years from 1936 through 1956 follows that of Hunter, in which the counts included three groups, mature plants which had at least one leaf with sori,

TABLE I

IV. JAMESVILLE STATION

H. JAMESVILLE WOODS SUBSTATION

| Colony | 1916 (After Hunter) | 1920 (After Hunter) | 1928 | 1936 | 1941 | 1946 | 1951 | 1956 |
|---|---|---|---|---|---|---|---|---|
| I | 159 | 197 | | 100 | 159 | 125 | 164 | 249* |
| II[1] | 109 | 115 | | | | | | |
| | | | | 53 | 159 | 130 | 253 | 783* |
| III | 17 | 8 | | | | | | |
| IV[1] | 119 | 206 | | | | | | |
| | | | | 129 | 258 | 307 | 583* | 272 |
| V | 29 | 20 | | | | | | |
| VI | 136 | 92 | 418[2]* | 108 | 91 | 73 | 110 | 89 |
| Totals | 569 | 638 | | 390 | 667 | 635 | 1110 | 1393* |

B. LITTLE LAKE (GREEN LAKE) SUBSTATION

| Colony | 1916 | 1920 | 1928 | 1936 | 1941 | 1946 | 1951 | 1956 |
|---|---|---|---|---|---|---|---|---|
| I | | 40+ | | 3 | 4 | 19 | 52* | 9 |
| II | | 50 | | 93 | 132 | 175 | 438* | 255 |
| Totals | | 90 | | 96 | 136 | 194 | 490* | 264 |
| Totals for Clark reservation | | 728 | | 486 | 803 | 829 | 1600 | 1657* |

* Highest count.

[1] Colonies II & III and IV & V combined in 1936 because of fluctuation of areas.

[2] About 360 transplanted to colony VI in 1925.

young plants (we consider those one inch and more in length and without sori, whereas Hunter considered leaf-shape), and sporelings and prothallia. Whenever possible the counts were made from the bottom toward the top of the ravines, as the young ones can be seen more readily and there is not as great a hazard for the plants. Counts were made during the late fall or early spring. The former is better, after the early frosts when the tall herbs, like *Impatiens*, are killed and before the snowfall.

## RESULTS AND DISCUSSION

Table I shows the census of mature plants in the ravines of Clark Reservation from 1916 until 1956. The fluctuation in counts is to be expected in a plant of such restricted range and the counts, having been made at five year intervals instead of yearly, show an incomplete picture of survival. Miss Hunter found an growth of 12.1% in the Jamesville woods substation in the years between 1916 and 1920. This shows a trend toward conservation since before this people were free to pick and distribute plants and areas were being cleared and burned. It is encouraging to see the gradual but fairly constant increase from 1936 through 1956. The history of the area will help to explain the 16 years between 1920 and 1936 with its general reduction in numbers. Certainly the destruction of half of the Jamesville stations would lower the count in general but the transplants should have aided the increase in the park. However, plants become established very slowly; the early Thirties were very dry, and many of those which had apparently become established could not endure this drought. For example, colony VI seemed to maintain its transplants at least until 1928. The very evident rise in numbers throughout the preserve from 1941 until the present can be due in large part to the passage of the 1930 law protecting the ferns and to the constant alertness of the park ranger, Mr. Ryan, during many years. Most of these canyons are out of the direct line of any of the paths in the park. With the moving of the steps farther away from colony I of Green Lake these plants seem to be increasing. We have noted, as did Miss

Hunter, that sometimes during dry seasons the prothallia will be more abundant when the mature plants, which are more exposed, are drying. Also there is a decided shift in the location from year to year or between counts. That is the reason we had to combine some of the colonies. They are in anastomosing canyons and it is almost impossible at times to separate the colonies. Occasional yearly counts have helped to show a slight correlation between the number of prothallia and mature plants the following year. In 1946, we had a cool rather dry summer with many cool nights and there were a large number of prothallia in most of the ravines. The highest number of plants for all the stations was in 1951. Not only are the numbers increasing but the plants are "thriving." In 1945, one plant in the park had 133 old leaves and with 127 new leaves unrolling in the spring. These were 3.5 inches wide and some 26 inches long. These ravines will probably never have the moisture and coolness accompanied by the rare northern plants of the White Lake area but they will thrive under the present protection of the park.

Survival outside of Clark Reservation is difficult to predict. In 1951, there were 216 plants in the stations outside as compared with 1600 in the park. Chittenango Falls is the only other station in a park. Unfortunately, a path was cut through one colony, which was destroyed by 1956. The other area is decreasing since a clearing was made near it. Perryville Falls has never had many plants and they are small with narrow leaves. It has improved since many of the raspberries are being replaced by trees. Munnsville remains the same. Howlett's which had 87 plants in 1925 had 3 in 1956 and 9 the following year. It is in one of the most exposed areas and near a path. Evergreen Lake, the only one left in the destroyed White Lake Area, is owned by people who are interested in preserving it. With a count of more than 50 when discovered by Dr. Petry in 1920 it had 73 in 1951. The original area at Split Rock continues to maintain itself, but the plants are small. However in 1951 there were 11 mature, 60 young, and 105 prothallia.

SUMMARY

1. Two new stations for hart's-tongue have been discovered in central New York since 1922. One is apparently a planted one and the origin of the other is unknown.

2. The number of plants in the stations in Onondaga and Madison counties have been counted at five year intervals from 1936 until 1956.

3. The number of mature plants in Clark Reservation as charted from 1916 until 1956 shows a decided increase.

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## Ferns and Allies in Kansas

RONALD L. MCGREGOR

Kansas is a state characterized by cycles of drought and good moisture years. Summers result in the drying of habitats to a point where only a few localized spots remain moist. In periods of drought, often lasting for a period of years, even the most protected habitats dry completely. Thus ferns have a very local distribution and only a few of the most common species are of somewhat general occurrence; a protected habitat insuring a moisture supply is a necessity. All habitats, whether limestone or sandstone, are neutral or above in ph. with the result that rock inhabiting species are found on both limestone and sandstone cliffs, except for *Cheilanthes feei* and *Pellaea dealbata*, which occur only on strictly calcareous sites.

In the eastern half of Kansas rocky wooded hillsides, particularly those with at least small rocky cliffs, have a fern flora.

Often only one or two species are encountered and these seldom in abundance. An average undisturbed site will have *Cystopteris fragilis* var. *protrusa*, *Botrychium virginianum*, and *Woodsia obtusa.* Rarely *Adiantum pedatum* and *Botrychium dissectum* var. *obliquum* will be found. Sandy oak-hickory areas, particularly if sandstone cliffs are present, generally have a greater diversity of species and a larger number of each species.

In the state 20 genera of ferns and fern allies are found, consisting of 32 species, 7 varieties and subspecies, and 5 forms. Most of these are species familiar to any student of ferns. In the following described locations will be found most of the species known for the state.

One interesting locality, and the only place in Kansas where such a place is found, is in NE¼ NE¼ Sec. 1, T. 35 S., R. 25 E., Cherokee County. This is in the small Ozark area in extreme southeastern Kansas where a 100 foot high steep north-facing bluff occurs for a short distance along Shoal Creek. The upland, above the bluff, is an open wooded area with *Quercus marilandica, Q. stellata, Q. Shumardii,* and *Carya tomentosa* as the dominants. The soil is shallow over surfacing cherty Boone limestone of Mississippian Age. In April and May scattered colonies of *Ophioglossum Engelmannii* occur in open places and *Isoëtes Butleri* is rare on shallow soil in depressions of surfacing limestone.

At the top of the bluff an abrupt outcrop of limestone averaging 15 feet in thickness occurs. A carpet of *Woodsia obtusa* is found just above this outcrop and is conspicuous until June at which time it dries and is not evident again until fall. Along the ledge of limestone are found a few species growing from crevices and pockets. These are: *Asplenium platyneuron, A. resiliens, Cheilanthes lanosa, Cystopteris fragilis* var. *simulans, Pellaea atropurpurea,* and *Pellaea dealbata.*

Below the ledge of limestone is found a moist, steep, talus slope on which grow *Quercus alba, Cornus florida, Lindera benzoin, Ilex decidua, Physocarpus opulifolius* var. *intermedius, Viburnum rufidulum,* and *Forestiera acuminata,* with *Betula* *nigra* along the stream at the bottom. Occurring on this slope as scattered individuals and colonies are: *Adiantum pedatum, Asplenium platyneuron, Botrychium virginianum, Camptosorus rhizophyllus, Cystopteris fragilis* var. *protrusa, Polystichum acrostichoides, Thelypteris hexagonoptera,* and *Woodsia obtusa.* On the flood-plain terrace at the foot of the slope is found *Equisetum hyemale* var. *pseudohyemale.*

A mile west of this site is another similar location but with less diversity. Here, however, occur two species known nowhere else in Kansas. These consist of a few plants of *Cheilanthes alabamensis* and *Pteridium aquilinum* var. *pseudocaudatum. Botrychium dissectum* var. *dissectum* was collected once at this location.

A second fern site in Kansas is located in the SW¼ NE¼ Sec. 36, T. 33 S., R. 11 E., Chautauqua County. This is an area where sandstone of the Douglas Group, Pennsylvanian Age outcrops or surfaces. A forest of *Quercus stellata* and *Q. marilandica* dominates the scene; but along sandstone cliffs are found *Carya texana, Amelanchier arborea, Viburnum rufidulum, Opuntia humifusa, Saxifraga texana,* and *Bouteloua hirsuta.* This site is characterized by a 10 to 20 foot sandstone cliff along the east side of a small creek. Above the cliff are a series of four barren sandstone flats 5 to 20 yards wide which merge with a gently sloping, sandy, oak-wooded upland area. On shallow soil around these bare areas is an abundance of *Selaginella rupestris* and our only known location for *Ophioglossum Engelmannii* on sandy soils. On shaded sandstone rocks are found *Cheilanthes lanosa, Woodsia obtusa,* and *Asplenium platyneuron.* On the upper edge of the cliff are masses of *Cheilanthes lanosa, Woodsia obtusa,* and *Selaginella rupestris.* On the vertical side of the partially shaded west-facing cliff are found: *Asplenium platyneuron, A. Trichomanes, Cheilanthes lanosa, Cystopteris fragilis* var. *tennesseensis, Dryopteris marginalis, Pellaea glabella,* and *Woodsia obtusa.* One small canyon cuts through this cliff and where it joins the creek are to be found *Onoclea sensibilis, Polystichum acrostichoides,* and *Thelypteris palustris.* On a large block of sandstone which has broken loose from the cliff is the only known Kansas colony of *Polypodium polypodioides* var. *Michauxianum*.

A little known habitat for ferns is to be found in the NE¼ NE¼ Sec. 5, T. 34 S., R. 15 W., Barber County. A few canyons in the area have small, shaded, outcrops of argillaceous, calcareous, dolomite associated with gypsum. On a few of these small rock outcrops occur colonies of *Cheilanthes Feei* and *Pellaea atropurpurea.* Small sandy rivulets in these canyons have colonies of *Equisetum laevigatum* subsp. *Funstonii* and *Marsilea mucronata.* The only trees present are *Populus Sargentii, Celtis reticulata,* and *Sapindus Drummondii.* At this location *Pellaea atropurpurea* has been found growing in a clump of *Opuntia.*

The High Plains topography of western Kansas is one of general monotony. The upland, however, is marked by thousands of depressions of various sizes. Most average but three to ten meters in diameter and a foot in depth. These depressions are known as buffalo wallows and their origin attributed to the wallowing of buffalo. Probably a number of factors account for their presence including wind scour, differential eolian deposition, differential compaction, solution-subsidence, and the wallowing of buffalo. These depressions in the buffalo grass prairies hold water in the spring until late June. In about 15% of these wallows *Marsilea mucronata* occurs as small plants only two or three inches high. As hot summers arrive the wallows slowly dry and sporocarps are produced in abundance. In such areas roadside ditches often are carpeted by *Marsilea* for miles along county roads. In early fall the numerous sporocarps appear as though thousands of small beans had been spread in the dried ditches.

In SE¼ SW¼ Sec. 14, T. 11 S., R. 4 W., Ottawa County is found an area known locally as Rock City. It consists of several clusters of round sandstone concretions four to twelve feet in diameter formed by erosion of Dakota Sandstone. These concretions are located at the lower slope of a hill and adjacent to a river valley plain. Several of these concretions have fissures from which grow *Cheilanthes Feei* and *Pellaea glabella.* Under the shaded side is found *Woodsia obtusa*. Though the small area is frequented by picnickers, these ferns have persisted for over 90 years.

The sand hill areas of central and western Kansas are not without a few interesting fern allies. In section 18, T. 22 S., R. 5 W., Reno County, are several small sand dune enclosed ponds. These invariably contain colonies of *Marsilea mucronata* but rarely are sporocarps produced unless the ponds dry completely by mid-summer. This is the only known site for *Pilularia americana* in Kansas, but it is relatively common around the margins of these ponds and regularly produces sporocarps. Scattered colonies of *Equisetum laevigatum* subsp. *laevigatum* occur in the area.

A few other species are found rarely in the state and may be briefly listed. *Azolla mexicana* is found in old oxbow swamps in the Kansas River Valley near Lawrence. *Isoëtes melanopoda* occurs in a moist swale in a nearly pure stand of *Eleocharis* three miles southwest of Neodesha, Wilson County. *Equisetum arvense* is known from a few moist sandy areas in eastern Kansas but is very local in occurrence.

Several species have been listed for Kansas but must be excluded. They were distributed from a fern garden to various herbaria and have been listed in manuals. These are: *Athyrium Filix-femina* (L.) Roth, *Athyrium pycnocarpon* (Spreng.) *Tidest.*, *Athyrium thelypterioides* (Michx.) Desv., *Cystopteris bulbifera* (L.) Bernh., *Dryopteris Goldiana* (Hook.) Gray, and *Osmunda regalis* L.

THE UNIVERSITY OF KANSAS, LAWRENCE.

## A Mule-train Trip to Sierra Mohinora, Chihuahua

DONOVAN S. CORRELL

Botanists of our day, similarly to botanists of yore, strive to use the most modern ways of transportation within their means to carry on their field work. Richard Spruce and others in South America, during the nineteenth century, used waterways wherever possible; Charles Wright and his contemporaries, in the early exploration of our own Southwest, used wagons, often belonging to the army, as did J. K. Small and his colleagues in exploring southern Florida at the turn of the twentieth century. Cyrus Pringle traveled mostly by train in his great Mexican exploratory work. Very few, with the exception of such eccentrics as Rafinesque, resorted primarily to walking.

Today, in the same tradition, we use some form of automotive transportation to take us within comparatively easy striking distance of most of our goals. Very seldom, and then only to reach otherwise inaccessible regions, is it necessary for one to have recourse to primitive and time-consuming means of travel, such as by mule- or pack-train.

In October of last year, Dr. Howard Scott Gentry and I decided to leave momentarily the comforts of modern conveniences and venture out into the remote areas of southwestern Chihuahua. Dr. Gentry hoped to satisfy a twenty year desire to attain the summit of Sierra Mohinora. He and his assistant, Juan Arguelles, were primarily interested in collecting seeds of wild plants for chemical analysis by the United States Department of Agriculture. I was hoping to obtain some additional fern collections for Dr. Irving W. Knobloch's and my work on the ferns and fern allies of Chihuahua which we expect to send to press later this year.[1]

After assembling our supplies in Parral, we started west in a Chevrolet Carryall for what we thought would be Ciénega Prieta. The narrow road we travelled is used primarily for hauling logs and raw lumber to Parral from San Juan and other points more than 100 miles away. As it winds through the mountains of northern Durango and southern Chihuahua, the road traverses some spectacular, as well as dangerous, and botanically fascinating country. The canyons and breaks of the Río San

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[1] I wish to acknowledge a Fellowship given me by the John Simon Guggenheim Memorial Foundation in support of this work. I also wish to acknowledge the help of Mr. C. V. Morton in identifying some of the more difficult collections.

Juan and Río Verde are especially rugged and botanically rich. The most hazardous stretch on the entire 120 mile trip is along the west side of the canyon formed by the Río Verde. On boulders and ledges of ravines sloping into this canyon were to be found such species as *Polypodium erythrolepis*, *Woodsia mexicana*, and *Asplenium monanthes*.

Because of the primitive nature of much of the road and our frequent botanical stops, we did not arrive in the sawmill town of San Juan until the afternoon of the third day. On the way over from Parral, however, we made a good haul of ferns, including the uncommon *Notholaena Aschenborniana* and *Pellaea allosuroides*, as well as *Asplenium Palmeri*, *Cheilanthes mexicana*, *Notholaena Grayi*, *Pellaea sagittata* var. *cordata*, and a peculiar *Polypodium* which appears to be a hybrid of *P. erythrolepis* and *P. thyssanolepis*.

Upon arrival in San Juan we were fortunate to find that a muleteer ("arriero") had just come in with a caravan from Guadalupe y Calvo. Since our contact in San Juan was at that time in Ciudad Chihuahua on business, we quickly engaged this muleteer for a trip of indefinite length but with his assurance that he would eventually place us on the summit of Sierra Mohinora.

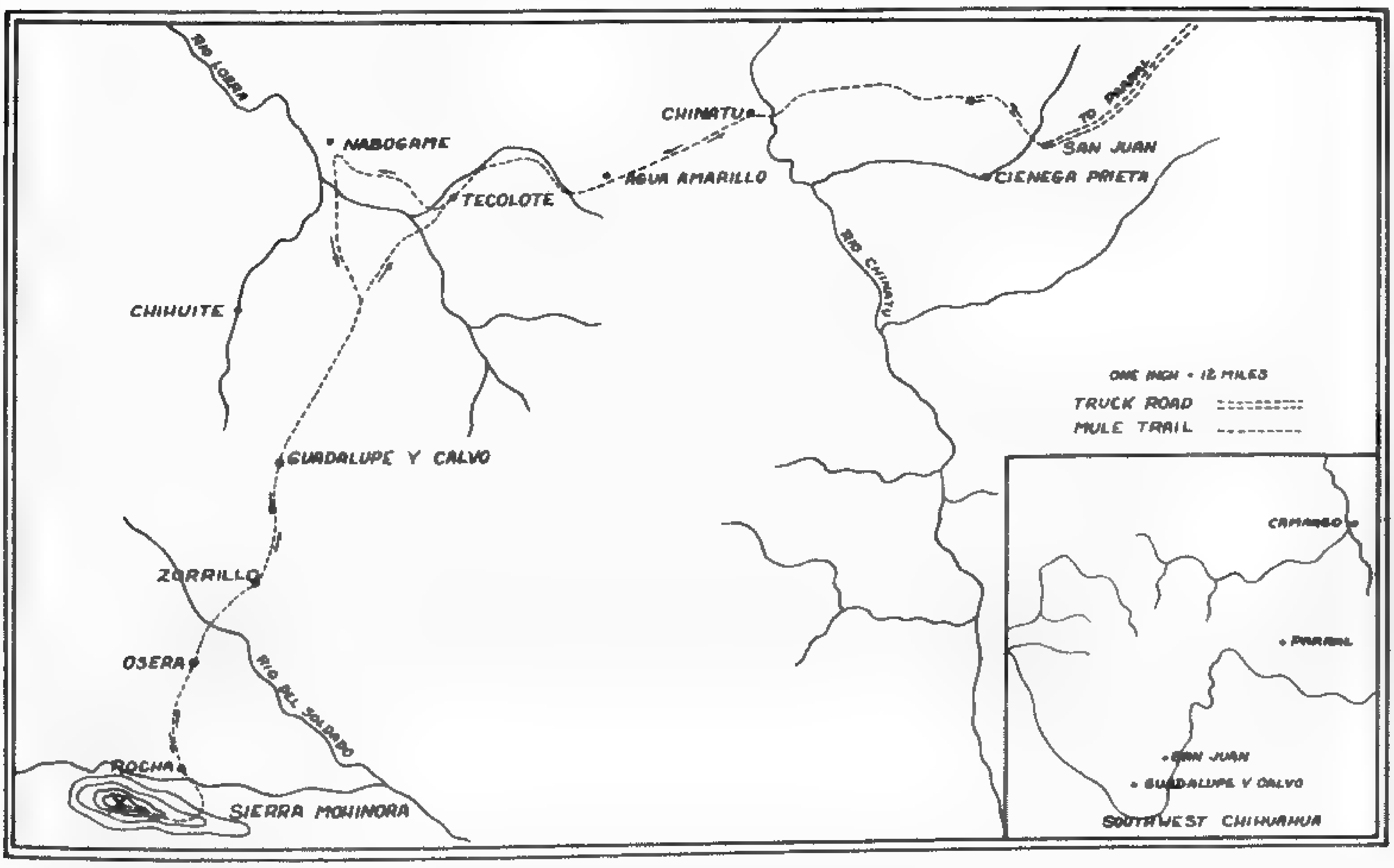
The next day, Friday, October 9, with our supplies loaded on pack animals and with Dr. Gentry astride a mule and me settled on a small mountain pony, we headed for adventure. We would share walking with Juan since our muleteer did not own another mount. It was amusing and at the same time chagrining that the muleteer, by his standards, considered me, a mere 170 pounder, to be a "fat man." When I mounted his small horse he winced.

The greatest inconvenience in traveling with a mule-train is that one must gear one's life to the needs and progress of the animals. Erratic lunches are conditioned on reaching a grazing spread, and the same holds for camping, plus the need for water. Looking down from the undulating back of a mule can also be frustrating when one sees what one takes to be *Cheilanthes pyra-*

*midalis* or, wait, is it *C. angustifolia;* or, is that *Polypodium guttatum* or *P. Hartwegianum* on that shaded boulder? Time and again this would happen and it would always be a case of clambering from the mule to verify, and usually collect, the species or of settling the question by mentally deciding that there were already abundant collections of that particular species.

A mule-train also has its virtue in that the slow pace gives one an opportunity to enjoy the gradual and ever-changing landscape. Each promontory revealed scenes that strikingly resembled those of woodcuts found in old travel-books.

Our trail (cf. map) left San Juan by way of Chinatú, with Ciénega Prieta lying to the south. It was either up or down, with very little level country for relief. On the floor of the




ABOVE: MULE-TRAIN ALONG STREAM NEAR TECOLOTE. BELOW: WATERFALLS ALONG TRIBUTARY OF RÍO DEL SOLDADO. PHOTOGRAPHS BY H. S. GENTRY.

mixed pine forest were many herbs among which were scattered plants of the tiny orchid *Malaxis Ehrenbergii,* with its inconspicuous spike of purplish brown flowers.

In spite of having to break into the routine of a mule-train we were able to pick up quite a few ferns while traveling over Sierra Chinatú during the day. We found *Cheilanthes lendigera* in the crevices of ledges and *Pellaea ternifolia, Polypodium peltatum,* and *Cheilanthes notholaenoides* on some large, shaded boulders.

Being slightly saddle-weary, to put it mildly, I, for one, was relieved to settle for a short first-day when our muleteer brought us to camp at Agua Amarillo, a few miles from Chinatú. During a quick foray here we found some of the finest colonies of another orchid, *Triphora mexicana,* that we had ever seen, as well as beautiful plants of *Cheilanthes pyramidalis* var. *arizonica* protruding from crevices of sheltered ledges.

The next day we traveled to the headwaters of Río Loera above Nabogame, country of the Tarahumare and Tepehuane Indians. At noon we stopped for lunch along a small stream at Tecolote (Owl). On these north-facing moist ledges and about the base of mammoth boulders were, among other species, luxuriant colonies of *Polypodium subpetiolatum* and *Adiantum Poiretii,* while on rather dry oak slopes were colonies of the uncommon *Cheilanthes angustifolia* and *C. Kaulfussii.* Downstream a little way, on a most unlikely ledge, were numerous plants of *Asplenium castaneum,* whose fronds were rooting near their tips, an unusual occurrence in this species.

At Nabogame, we set up a two-day camp on a small promontory overlooking Indian corn-fields. Through these fields a small stream meandered on its way from high mountains in the east to larger rivers in the north which eventually feed into Río Fuerte. About the base of boulders along its bank were extensive colonies of *Athyrium Filix-femina* var. *asplenioides.* The long, forested ravines that ran above camp and the tuffaceous bluffs that towered above all were rich in ferns. Twenty-one species were collected here, notably *Asplenium Adiantum-nigrum, A. resiliens, A. exiguum, Phanerophlebia auriculata, Woodsia mollis, Selaginella pallescens, Dryopteris patula* var. *Rossii* and a most unusual and rare *Asplenium, A. Pringlei.*

Early in the morning of our first day at Nabogame I was on the tuffaceous cliffs above camp jumping from ledge to ledge in search of good sporulating fronds of *Elaphoglossum pilosum* when, unaccountably, I jerked a ligament in my left knee. The remainder of our journey was, for me, accompanied by much agony. In riding an animal, the continuous knee-rolling motion was not only painful but not at all conducive to healing. After staying in the saddle for several hours I would literally fall off my mount and wobble about on my bad leg. With soft brown eyes looking at me our muleteers would solemnly wag their heads and say in doleful tones "muy malo." They didn't know the half of it! Philosophically, I considered that my condition was nothing more than the result of an occupational hazard.

As we sat around the fire that night several of the local inhabitants drifted in with some of their handiwork in the nature of thickly woven woolen blankets. Most were black or off-white in color, the wool having been taken from the animals and thence woven directly into blankets. Some of the "white" blankets had several irregular cross-lines of orange-brown wool dyed with vegetable dye. Although most were as soiled as the animals that contributed the wool, Dr. Gentry told me that the old man from whom I had purchased a blanket had assured him that it had been washed in a mountain stream, apparently at Agua Amarillo!

On the morning of October 12 we broke camp and followed the valleys lying east of Chihuite to the base of some high peaks that stood between us and Guadalupe y Calvo. As we struggled up along the open-wooded trail we saw a beautiful *Lobelia* with large indigo-blue flowers. Growing on boulders along the trail were *Polypodium guttatum, P. Hartwegianum*, and *P. thyssanolepis*. It was here, as my youngsters would say, that I made a real "boner." Riding above the edge of a steep ravine I could see arched and hanging from the opposite bank some fronds of a *Thelypteris* that were fully three feet long. With the thought in mind that I would collect specimens when I would undoubtedly see the plant later on, they were passed by. They were not

Above: In Gorge of Tributary of Río del Soldado, with the Author Standing Next to Colony of Blechnum stoloniferum. Below: Close-up of Colony of Blechnum stoloniferum Shown in Scene Above. Photographs by H. S. Gentry.

seen again. This is an all too common occurrence with field botanists.

After a day's stay in Guadalupe y Calvo, where Dr. Gentry and I enjoyed the luxury of a crude shower-bath, and a shave by a somewhat inebriated barber, we reassembled our scattered equipment and started on the last leg of our trip to reach our main objective—Sierra Mohinora. Climbing out of the rugged canyon that held Guadalupe y Calvo, we eventually reached a mountain stream in a rich coniferous forest. As we jogged along on our mounts I had been noting from a little distance large plants beneath the trees of what I took to be the common *Pteridium aquilinum* var. *pubescens* when, by chance, I saw standing above some exceptionally bright green fronds obese spikes of a *Botrychium*. Struggling from my horse, I quickly gathered some fine specimens of *B. cicutarium*. Who would have expected to find plants two feet tall!

Keeping a steady grinding pace, we passed through the Indian settlements of Zorrillo, Tahonas, and Osera, and late in the afternoon came out into a clearing which held the small colony of La Rocha, at an elevation of 7,500 feet on the northeast slope of Sierra Mohinora. We set up camp in a pine forest on a small tributary of Río del Soldado. Growing in pine needle duff on a large boulder at the edge of our camp was an extensive colony of the wild potato *Solanum polytrichon*.

The next day, October 15, I was in for one of the thrills of a lifetime. Following the small stream that ran by our camp I soon found myself quite abruptly in a wonderful gorge (Pl. 7). Although many rich areas had been and were still to be found, none were more fascinating than this gorge on the headwaters of Río del Soldado. It faced southwest and was sheltered by a dense forest of balsam and pine. The stream, in cutting through the rock substrata, had formed flumes and miniature falls from which an imperceptible and meliorative mist arose. Sheltered in this fern paradise were found 23 species of ferns, 6 of which were new to the known flora of Chihuahua.

This was the kind of place a fern enthusiast usually sees only

Route of Mule-train Trip from San Juan to Summit of Sierra Mohinora and Return, October 9-21, 1959.

in his dreams. Ferns, ferns everywhere! *Dryopteris cinnamomea*, in multitudinous forms, draped from every cliff and ledge, while several species of *Polypodium* formed large mats over great boulders. Following seams beneath dripping ledges were delicately green plants of the filmy fern *Trichomanes radicans*, while in mud at the base of dripping precipices were carpets of *Hymenophyllum tunbridgense*. Woodsias, Aspleniums and *Cystopteris fragilis* grew intermingled and entwined over mossy rocks, and *Plagiogyria semicordata* and *Thelypteris pilosa* luxuriated on the face of cliffs. Another rare fern, *Dryopteris parallelogramma*, rose in erect clumps alongside masses of Athyriums on the edge of the water, while *Blechnum stoloniferum* covered a seepage bank and climbed about the base of tree trunks (Pl. 7).

After I returned to camp completely laden with specimens, Dr. Gentry joined me and we went down stream several miles until we reached a series of waterfalls (Pl. 8). Growing on recessed walls behind the plunging water were glistening fronds of *Adiantum pedatum* and a small colony of *Polypodium vulgare* var. *columbianum*, both new to the State of Chihuahua. On nearby ledges were fine plants of *Notholaena incana* and *Cheilanthes farinosa*. Woodsias grew like grass on the steep slopes below the falls.

Ever since our leaving San Juan the weather had been unsettled and, at times, downright threatening. We had continuous difficulty drying blotters to keep ahead of our collecting. Consequently, most of our presses were in a state of semi-dryness when we left our camp at La Rocha and started for the summit of Sierra Mohinora. However, since it was cool and, at night, even cold, thus providing us a real natural refrigeration, we decided to simply bale up our "hay" while on the summit and wait until our descent to complete the necessary drying.

With a native of La Rocha as guide we had little difficulty in reaching the top. We found that the long plateau which forms the summit of Sierra Mohinora is covered with a fine forest of pines and on its upper north-facing slopes are dense stands of not only pines but also Douglas Fir and spruce (*Picea chihuahuana*). The ultimate summit, designated by a geodetic survey marker, is a grassy plot bordered by stunted weather-beaten pines. Here, our altimeter gave a reading of 10,300 feet altitude. Finding the herbaceous vegetation disappointingly sparse, we concluded that the herds of goats that have summer-grazed the region from time immemorial had doubtless exterminated most of these plants. Besides, the region had apparently already been heavily frosted.

From the very summit a breath-taking panorama spread westward to the Pacific. Range after range rolled across Sonora to engulf great barranca after great barranca in a seemingly endless repetition. In the immediate foreground, towers of stone fell precipitously to forested canyons below. Threaded across the face of these towers were scraggly plants of *Selaginella Underwoodii* and in shaded crevices below were delicately fragile plants of *Woodsia mexicana.*

We pitched camp just below the summit in the protection of a stand of pines. As dusk fell, great billowy clouds rolled in from the southwest to blanket our camp in an eerie twilight. The glow of our fire against massive trunks of the towering pines created an imaginary wall within which we slowly moved about. The gentle wheezing and munching of our animals in the shadows beyond lent an air of unreality to our surroundings. With what might be called "quiet efficiency," we fell to raising a makeshift shelter for the night. This was far from a waste of time and energy for we had no sooner begun than a sleety drizzle commenced to fall and continued doing so through most of the night. Snuggling down in our bags it was not too long before the color of our noses matched the red Mexican bandanas we were using for night-caps.

The next day, after thawing out and having collected every plant species in sight, we returned to our camp-site at La Rocha. On the way down from the summit one of the pack-mules got (*fide* our muleteer) a branch under his tail and away he went! The run-away results totaled up to a smashed "kitchen" with the resultant loss of all our coffee (after that the rest didn't count). We did retrieve a few scattered oats which later turned out to be mixed with an assortment of pulverized glass. A later incident which compensated somewhat for this tragic loss was the finding of a small colony of *Botrychium Schaffneri* on an open brushy slope near our camp at La Rocha.

Unfortunately, our head muleteer, who was unaccustomed to the rigorous life of a field botanist, had become increasingly more disgruntled and uncooperative. No amount of persuasion, even "mas dinero," could convince him to take us from La Rocha to San Rafael, on a lower tributary of Río Mohinora. We had been given glowing accounts of this essentially tropical region where bananas, coffee and oranges were said to be grown. We had visions of a profusion of tropical ferns draping from trees and hanging from the walls of cliffs. Here we were only a few hours journey away! Since I, the so-called "fat man," had already worn out a horse and was well on the way to wearing out a so-called "muy fuerte" mule, perhaps it was just as well we went no further; besides, after our loss from the run-away mule, we were running low on grub and my game leg was getting no better!

As we left La Rocha we noted that the beautifully clear morning had given way to a threatening day. The great ridge that formed the summit of Sierra Mohinora was already blanketed in clouds. It was a losing race with the elements. Within an hour a cold drizzle set in which soon turned into a steady chilling rain. We felt betrayed, but our spirits remained high. October in Chihuahua is supposed to be a month of crystal clear skies with weather feigning early spring. We were definitely not prepared for the rainy wintry weather we had been encountering. With these thoughts in mind, we trudged across mountain trails of slippery rock faces and open valleys that had become quagmires. As we entered Guadalupe y Calvo after dark, we felt thankful for the gregarious nature of man whereby he would congregate and build centers of habitation, no matter how humble or wretched they may be. A change of clothes along with a good mess of hot beans, washed down with unpalatable, but also hot, ersatz coffee put a new light on things.

The next morning, with little ado, we packed and started on the last lap of our trip. We were not only still intact, but we noted that our ranks had increased by the addition of a lone burro, which soon became the whipping-boy for the caravan.

After a night's stop at Tecolote (Pl. 8), we traveled on the next day to the upper slopes of Sierra Chinatú, within two hours of San Juan. The animals were, to put it mildly, completely fagged, so we made camp. Searching our meagre "kitchen" we came up with a handful of rice, along with a few scrawny potatoes and two eggs we had purchased from the Tarahumares. The eggs helped to thicken the greaseless stew which we gratefully consumed amid our thoughts.

Dr. Gentry and I got an early start the next day, Wednesday, October 21, and rode on into San Juan in search of some breakfast while the muleteers and Juan searched for a burro that had started back home during the night. With about fifteen pounds already shed from my frame and little twitches of hunger within, it is not at all strange that I recall those last two hours on the trail as the most fernless encountered during the entire trip.

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## Multicellular and Branched Hairs on the

ALMA G. STOKEY[1]

Hairs are a common feature on the sporophyte of ferns and are usually present on young parts if not on the mature. Bower (1923) made a sharp distinction between simple hairs and multicellular scales as indicators of phylogeny. As might be expected, hairs are not as highly developed or as numerous on the gametophyte. It remains to be seen if the types and distribution of hairs will be of any assistance in questions of phylogeny.

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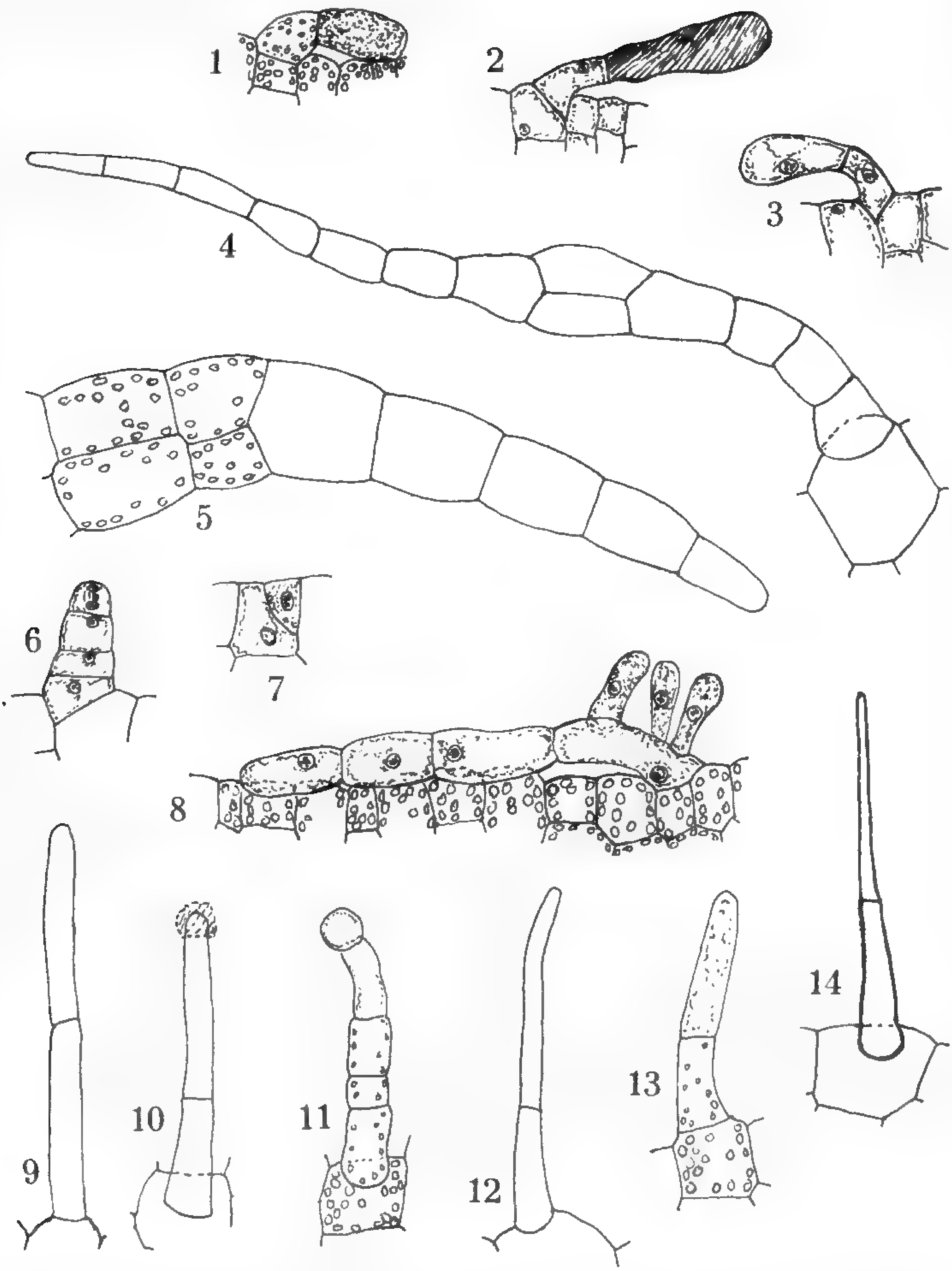
[1] This account is based on studies of cultures which have been maintained in connection with the investigations carried on in coöperation with Dr. Lenette R. Atkinson for the past ten years, and on my own earlier cultures.

There are many families, especially among the primitive ferns, in which hairs are entirely lacking on the gametophyte. They have not been found in the Marattiaceae, Osmundaceae, Hymenophyllaceae, Matoniaceae, Dipteridaceae, Plagiogyriaceae, Cheiropleuriaeceae, Dicksoniaceae, and Vittariaceae. (The Hymenophyllopsidaceae is the only family of which nothing is known of the gametophyte.) The most primitive families with gametophyte hairs are the Gleicheniaceae and Schizaeaceae; they are present, also, in the somewhat more advanced Cyatheaceae and Loxsomaceae.

In the Gleicheniaceae the hairs are never numerous, but have been described for several species (Campbell, 1908, Stokey, 1952). They are usually two-celled, less frequently three- or four-celled, and borne on the dorsal or ventral surface of the midrib. In the Gleicheniaceae, and also in the Cyatheaceae and Loxsomaceae, the hair arises from a special initial cell, a wedge-shaped cell on the anterior face of a young superficial cell near the apex of the thallus (*Figs. 6, 7*). Growth at this stage is rapid and the young hair soon projects above the surface, forms two cells, rarely more, and then curves towards the apex. A section of thallus of *Hicriopteris glauca* (Thunb.) Ching with a young hair is shown in *Fig. 3*, and an older hair of *Gleichenia vulcanica* Blume in *Fig. 2*. The terminal cell elongates, becomes slightly bulbous and filled with a heavily-staining substance, and the protoplasm disappears; the same process follows later in the basal cell.

In the Schizaeaceae the hair arises as a simple papilla on a marginal cell, less frequently on the surface (Bauke, 1878). When mature the hair is usually two-celled and curved towards the apex. The hair shown in *Fig. 1* was found on a thallus of *Anemia phyllitidis* (L.) Swartz only 46 days old. Hairs are not abundant in this family, and on *Lygodium palmatum* (Bernh.) Swartz they were found on only two prothalli (Rogers, 1923); they agreed in type with those of *Anemia* and *Mohria*.

In the Cyatheaceae and Loxsomaceae, the multicellular hairs arise not only from a special initial but are of a special scale-like

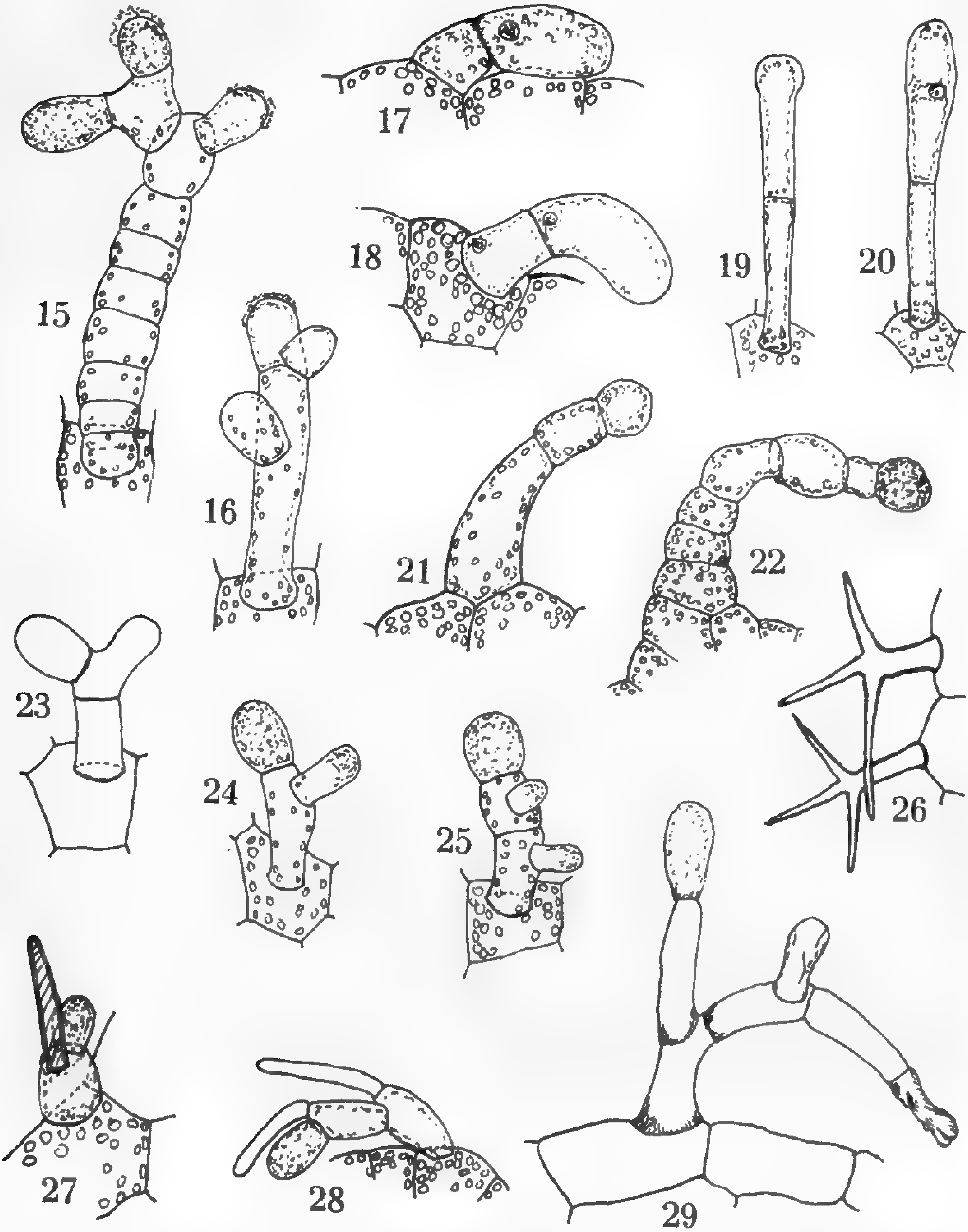



PROTHALLIAL HAIRS. FIG. 1, ANEMIA PHYLLITIDIS; 2, GLEICHENIA VULCANICA; 3, HICRIOPTERIS GLAUCA; 4, LOXSOMOPSIS COSTARICENSIS; 5-7, ALSOPHILA EXCELSA; 8, ARTHROPTERIS TENELLA; 9, 10, CYCLOPELTIS CRENATA; 11, NEPHROLEPIS CORDIFOLIA; 12, N. ACUMINATA; 13, OLEANDRA WALLICHII; 14, CYLOPELTIS PRESLIANA. FIGS. 1-3, 6-14, × 120; FIGS. 4, 5, × 75.

type (Bauke, 1876; Goebel, 1912; Stokey, 1930; Stokey & Atkinson, 1956). These hairs are one to several cells wide, many cells long, and usually have a tapering slender tip, as in *Loxsomopsis costaricensis* Christ (*Fig. 4*) and *Alsophila excelsa* R. Brown (*Cyathea Brownii* Domin) (*Fig. 5*), in which the hairs are often much longer. Bauke described them in his account of the Cyatheaceae as "Borsten." They arise, usually after archegonium production has begun, on or near the cushion on both dorsal and ventral surfaces, curving towards the notch and making a green brush-like growth large enough to be seen with the naked eye.

In the families formed in recent years by the breaking up of the old comprehensive family Polypodiaceae, hairs, unicellular, multicellular, and branched, are more abundant and varied than in the four families discussed. It is convenient to consider them on the basis of Copeland's classification (1947), with the addition of the Grammitidaceae which he recognized later (1951). It is in these higher families that the familiar type of papillate hair, unicellular and usually glandular, has developed in profusion. The multicellular hair, even when two-celled, is much less common and seldom present in abundance. A two-celled hair may properly be considered a multicellular hair; it seldom appears as a chance modification of a one-celled hair, and its variants are apt to be three- or four-celled.

In the Davalliaceae multicellular and even branched hairs are found occasionally. On the thallus of *Davallia denticulata* (Burm.) Mett. a few two-celled and branched hairs were found. On the gametophyte of *Oleandra* the abundant long unicellular hairs are often borne on extensions of marginal cells and suggest two-celled hairs; examples of true two-celled hairs were found in *O. wallichii* (Hook.) Presl (*Fig. 13*). In *Nephrolepis*, multicellular hairs were more abundant, especially on the thallus of *N. cordifolia* (L.) Presl, but less numerous and shorter on *N. acuminata* (Houtt.) Kuhn (*Fig. 12*). On *Humata heterophylla* (J. E. Smith) Desv., a marginal three-celled branched hair was found near the notch. On the thallus of *Arthropteris orientalis*




PROTHALLIAL HAIRS. FIG. 15, PLATYCERIUM ALCICORNE; 16, P. GRANDE; 17, LOXOGRAMME PARKSII; 18, BOLBITIS QUOYANA; 19, 20, PLEUROSORUS RUTIFOLIUS; 21, 22, CETERACH OFFICINARUM; 23, PALTONIUM LANCEOLATUM; 24, PYRROSIA CHINENSIS; 25, PESSOPTERIS CRASSIFOLIA; 26, THELYPTERIS BIOLLEYI; 27, XIPHOPTERIS DELITESCENS; 28, CTENOPTERIS JUBIFORME; 29. C. ASPLENIFOLIA. ALL × 120.

(Gmel.) C. Chr. several examples of three-celled simple hairs were found on the ventral surface near the archegonia. On that of *A. macrocarpa* (Cordem.) C. Chr. there were three-celled simple hairs on the dorsal and ventral surfaces, and branched hairs with as many as six cells appressed to the ventral surface. *Arthropteris tenella* (Forst.) J. Smith had more hairs, all appressed to the margin and curved towards the apex; some were simple and others elaborately branched (*Fig. 8*).

In the large and diverse assemblage of the Aspidiaceae, it is not unusual to find species in which multicellular hairs are borne on the gametophyte. On the prothallus of *Cyclopeltis crenata* (Fée) C. Chr. two-celled hairs were found on the surface but more abundantly on the margin, often with a glandular tip which gave a reaction for wax with Sudan IV (*Figs. 9, 10*); a few branched hairs were found on the surface. The same type of two-celled hair was found in large numbers on the thallus of *C. presliana* (J. Smith) Copel. even two or three on a single marginal cell. On the thallus of *Bolbitus quoyana* when eight weeks old there appeared on the margin two-celled hairs curving towards the apex (*Fig. 18*); at three months they were present on the margin in a close growth of curved colorless hairs of two or three cells with the terminal sometimes inflated; a few of the hairs were branched. Later branched hairs appeared on the dorsal surface. On the prothallus of *Phanerophlebia caryotidea* (Wall.) Copel. and on that of *Rumohra aristata* (Forst.) Ching a few short two-celled hairs were found. *Pteridrys australis* Ching had a liberal development of branched hairs with four to eight cells on both dorsal and ventral surfaces of the midrib. Two-celled hairs are not uncommon on the surface and margin of the gametophyte of *Pleocnemia conjugata* (Blume) Presl; branched hairs are relatively rare. The five species of *Tectaria* in our cultures showed multicellular or branched hairs or both: *T. incisa* Cav., *T. decurrens* (Presl) Copel., *T. irregularis* (Presl) Copel., *T. griffithii* (Baker) C. Chr., from Nepal, and *T. subtriphylla* (H. & A.) Copel. The hairs were mostly on the surface, rarely on the margin, usually three-celled but sometimes four- or five-celled. On a rather sparse culture of *Heterogonium pinnatum* similar branched hairs were found on several gametophytes. *Cyclosorus* is unusual in having acicular hairs on the gametophyte of several species usually one-celled but in the case of *C. parasiticus* occasionally two-celled (*Fig. 14*). *Thelypteris* (*Goniopteris*) *biolleyi* (Christ) Proctor has an unusual type of hair—branched stellate hairs similar to those found on the sporophyte, but there were no indications of apogamy. They appeared rather sparingly at three months on the ventral surface before archegonia had developed; they were present in great numbers on both margin and surface of cushion and wings when the cultures were nine months old, and archegonia were abundant (*Fig. 26*).

In the Aspleniaceae there is a considerable range in regard to hairs on the gametophyte, as was pointed out by Wagner (1953). A type of multicellular hair which ends in a gland was found on *Diellia* gametophytes, and also on those of *Ceterach dalhousiae* (Wagner, 1952); he found the same type on the thallus of *Asplenium leucostegioides* Baker (1953). The same type is present also on the prothallus of *C. officinarum* with considerable variation in length (*Figs. 21, 22*). It occurs also on the gametophyte of *A. flabelliforme* Cav., appearing when the prothalli are three to four months old, on the margin near the notch both before and after the production of archegonia. On some gametophytes of the same age and on some slightly older, apogamous sporophytic outgrowths associated with clathrate scales appeared. On the prothallus of *A. septentrionale* (L.) Hoffm. among the many long unicellular hairs there are occasionally two-celled and even branched hairs. The prothallus of a tetraploid *Phyllitis scolopendrium* var. *americana* Fernald (spores from a Michigan plant) when five months old had a considerable number of two- and occasionally three-celled hairs, straight or slightly curved, on both dorsal and ventral surfaces, as well as on the margin near the apex. There were only one-celled hairs in a culture of *Phyllitis scolopendrium*, presumably diploid, raised from spores collected in Mürren, Switzerland. The gametophyte of *Pleurosorus rutifolius* (R. Brown) Fée when less than four months old bore a considerable number of long two-celled hairs among and in front of the archegonia (*Figs. 19, 20*).

The description and figures by Klein (1881) of the prothallus of *Polypodium heracleum* Kunze [*Drynariopsis heraclea* (Kunze) Ching] is the classic account of branched hairs on a fern gametophyte. Recent work indicates that the Polypodiaceae *sensu stricto* is the group in which branched hairs appear on the gametophyte of the largest number of species, although the range in type is not known to be as great as in some other groups. Multicellular simple hairs are not unusual in young cultures which later produce branched hairs. The most common type of branched hair is usually three-celled, such as that of *Paltonium lanceolatum* (L.) Presl (*Fig. 23*), and that of *Pyrrosia lingua* (Thunb.) Farw. (*Fig. 24*), with the four- or five-celled, as in *Pessopteris crassifolia* (L.) Underw. & Maxon (*Fig. 25*) less frequent. This type of hair is usually found on the surface, on or near the midrib and rarely on the margin.

There is much variation in the age of thallus at which branched hairs appear, but it is regularly later than that for simple unicellar hairs. *Pleopeltis hastata* (Thunb.) Moore began the production of branched hairs at 75 days; *Pessopteris* had branched hairs with seven cells at three months; *Pyrrosia lingua* had branched hairs with three to six cells at 10 weeks. In *Phlebodium aureum* (L.) J. Smith, *Belvisia spicata* (L.) Mirb., and *Campyloneuron phyllitidis* (L.) Presl branched hairs were late in developing with some variation in different sets of cultures. They appeared sparingly in a culture of *P. virginianum* L. at seven to nine months. They were found on the following species of *Polypodium* at varying times: *P. chnoodes* Spreng., *P. pectinatum L., P. plebejum* Schlecht. & Cham., *P. repens* Aubl., and *P. vexatum* D. C. Eaton. They appeared also on *Aglaomorpha meyeniana* Schott, *Microsorium scolopendria* (Burm.) Copel., and *M. punctatum* (L.) Copel.; in addition to branched hairs, which appeared at six months, they also bore clathrate scales. Nayar (1957) has reported branched hairs on the prothallus of

*Drymoglossum piloselloides* (L.) Presl. The large branched hairs on the thallus of *Platycerium* (Straszewski, 1915; Stokey & Atkinson, 1954) are similar to the branched hairs described for other members of the family except that they are unusually large and abundant; the stalk cells are green and the tips of the branches glandular (*Figs. 15, 16*).

In *Loxogramme,* a genus whose systematic position is under question (Copeland, 1947; Holttum, 1949), multicellular hairs have appeared in two species. On the prothallus of *L. parksii* Copel. two-celled marginal hairs appeared sparingly at nine months; when two to six years old several two- or three-celled hairs could always be found towards the tip of a lobe or branch of the thallus usually on the margin (*Fig. 17*) but also on the surface. The same type of two-celled hair appeared sparingly. on *L. avenia* Presl at 13 months.

In the Grammitidaceae some species have a heavy growth of branched hairs with an occasional two-celled hair along the margin (Stokey & Atkinson, 1958). Some of the hairs have a slender spine-like branch, as in *Xiphopteris delitescens* (Maxon) Copel. (*Fig. 27*), or even two such branches as in *Ctenopteris jubiformis* (Klf.) J. Smith (*Fig. 28*) ; or all branches may have a glandular cell at the tip as in *C. suspensa* (L.) Copel. (*Fig. 29*). The hairs of the Grammitidaceae differ from those of the Polypodiaceae *s.s.* in arising regularly on the margin rather than on the surface.

The significance of multicellular and branched hairs on the fern gametophyte can hardly be considered apart from the larger question which would include the distribution and type of unicellular hairs. We need much more information about the occurrence and distribution of all types of hairs on both young and old gametophytes.

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## Progress in the Study of Dryopteris Hybrids

EDGAR T. WHERRY

In the course of searching for *Dryopteris* hybrids to send to Dr. Stanley Walker for the cytotaxonomic studies recently reported in this JOURNAL,[1] I felt a need for a diagram bringing out their inter-relationships. Now that data as to chromosome numbers can be added, it has seemed worth while to publish such a diagram. Before it can be presented, however, some considera-

[1] This JOURNAL *49*: 104–112. 1959.

[2] International Code of Botanical Nomenclature, Art. H 1. 1956.

tion of nomenclatorial matters is necessary.

For simplicity all parental taxa are here treated as species and designated by binomials, *Dryopteris* being abbreviated to "*D.*" and epithets uniformly decapitalized. According to standard procedure[2] the taxa forming hybrids are placed in alphabetical order, with the symbol × between; and when a hybrid has received an individual epithet, this is preceded by that symbol. Only basionyms—that is, name-bringing synonyms—are cited; additional synonyms can be found if desired in indexes.

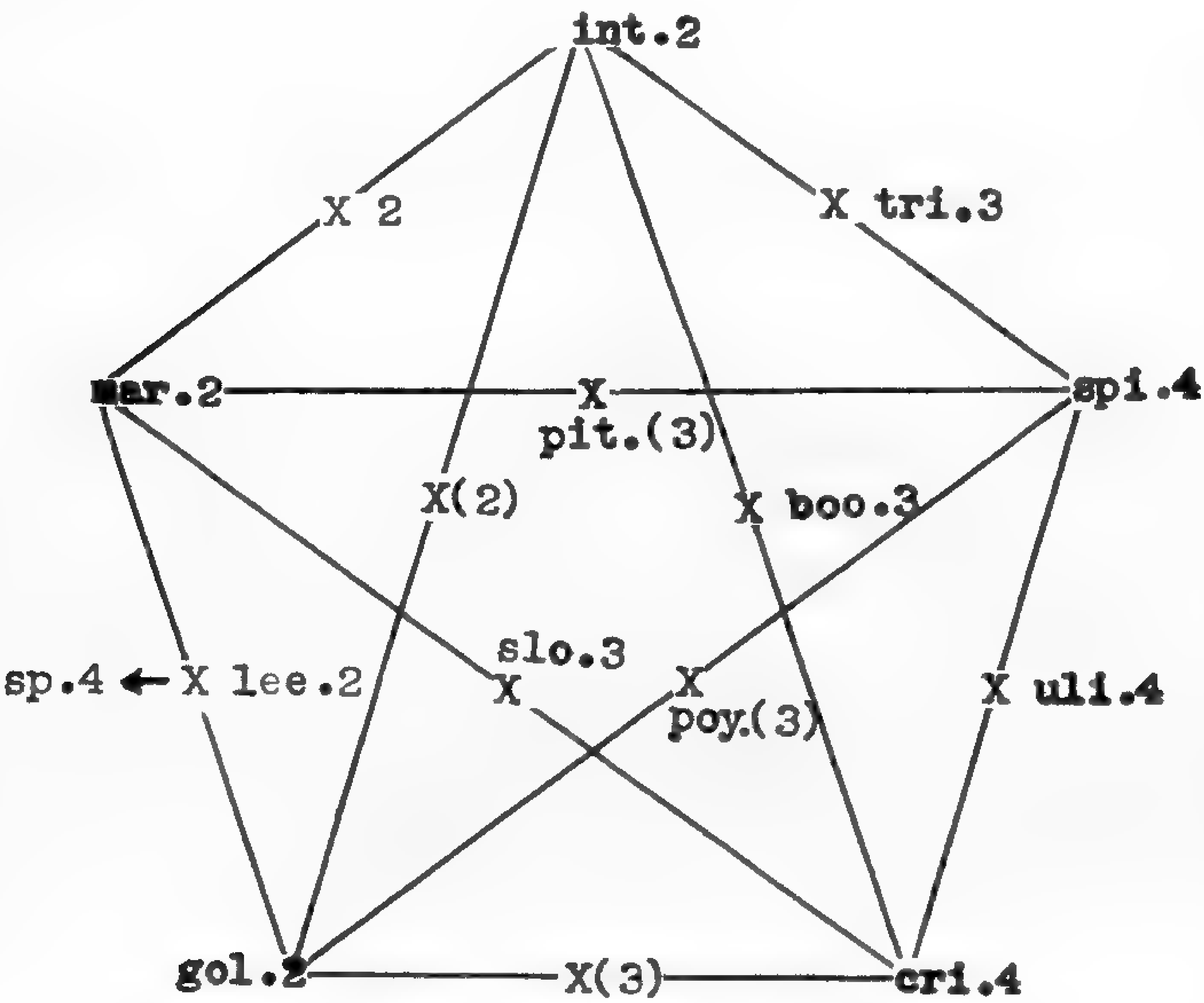


DIAGRAM OF DRYOPTERIS SPECIES AND HYBRIDS.
EXPLANATION IN TEXT ABOVE.

The diagram represents the five most widespread species in the northeastern United States—*D. cristata, D. goldiana, D. intermedia, D. marginalis,* and *D. spinulosa,* and the ten hybrids between them. Their epithets are abbreviated to three letters each. The ploidy is represented by numerals, placed in parentheses when inferred though not yet confirmed. These hybrids are as follows:

D. CRISTATA × GOLDIANA. Reported by Benedict[3] in 1909. It was inferred to be the same as *D. atropalustris* Small[4] by the writer[5] in 1942, but this is now realized to have been a mistake. As pointed out by Walker, *D. clintoniana* presumably arose from a clone of this inferentially triploid hybrid through chromosome-doubling.

D. CRISTATA × INTERMEDIA = D. × BOOTTII. This taxon, published as a species of *Aspidium* by Tuckerman[6] in 1843, was suggested to be a hybrid by several subsequent workers, and formally so treated by Dowell[7] in 1908.

D. CRISTATA × MARGINALIS = D. × SLOSSONAE. The first hybrid to be recognized as such in this country, by Davenport[8] in 1894. It was named as a species of *Nephrodium* by Hahne[9] in 1904, and transferred to *Dryopteris* by the writer[10] in 1942.

D. CRISTATA × SPINULOSA = D. × ULIGINOSA. Discovered in Europe, this was named *Aspidium spinulosum* var. *uliginosum* A. Braun,[11] and later *Lastrea uliginosa* by Newman[12] in 1849. Its hybrid nature was pointed out by Milde[13] in 1858, and the epithet was transferred to *Dryopteris* by Druce.[14]

D. GOLDIANA × INTERMEDIA. Reported by Dowell[15] in 1908. Guessed to be *D. separabilis* Small[16] by the writer[17] in 1942, but as pointed out by Walker such is not the case.

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3 Bull. Torrey Club *36:* 47. 1909.
4 Ferns SE. States 274. 1938.
5 Guide East. Ferns, ed. 2, 163. 1942.
6 Hovey's Mag. Hort. *9:* 145. 1843.
7 Bull. Torrey Club *35:* 136. 1908.
8 Bot. Gaz. *19:* 497. 1894.
9 Allg. Bot. Zeitg. *10:* 103. 1904.
10 Bartonia *21:* 15. 1942.
11 *ex* Doell, Rhein. Fl. 17. 1843.
12 Phytologist *3:* 679. 1849.
13 Nov. Act. Acad. Leop. Car. *26:* 533. 1858.
14 Cf. article by Ballard, this issue.
15 Bull. Torrey Club *35:* 138. 1908.
16 Ferns SE. States 284. 1938.
17 Guide East. Ferns, ed. 2, 161. 1942.

D. GOLDIANA × MARGINALIS = D. × LEEDSII. This hybrid was reported by Dowell[18] in 1908 and assigned the epithet *leedsii* by the writer[19] in 1942. The colony along the Susquehanna River yielding the specimen on which this was based has been reduced by road widening, but young plants are still appearing. These are more numerous than would be expected to be produced by a hybrid, but an explanation has now been found. Study by Mrs. C. W. Crane showed that many of the plants there are a normal-spored species; and as noted by Dr. Walker, this is a tetraploid, evidently resulting from chromosome-doubling in a clone of the diploid hybrid.

D. GOLDIANA × SPINULOSA = D. × **poyseri**, *nom. nov.* This was discovered by Poyser[20] and assigned the cumbersome name *Nephrodium cristatum clintonianum* f. *silvaticum* in 1908; it was indicated to be the present hybrid by Benedict[21] the following year. It is here assigned an epithet in honor of William Aldworth Poyser (1882-1928), noted Philadelphia fern student. The type specimen, from near Swarthmore, Pennsylvania, is preserved in the Academy of Natural Sciences, Philadelphia.

D. INTERMEDIA × MARGINALIS. Reported by Benedict[22] in 1909.

DRYOPTERIS **triploidea** Wherry, *hyb. nov.* (*D. intermedia* × *spinulosa*)

Plantae quam parentes majores, aspectu ei *D. spinulosae* similes, i.e. pinnis ascendentibus, pinnulis inferioribus basalibus longioribus quam sequentibus; rhachis sursum, venae, et indusia glandulas capitatas ferentia; sporae imperfectae; planta triploidea.

TYPE: Clayville, New York, collected by B. D. Gilbert, in the Gilbert Herbarium, Harvard University.

The tradition that *D. intermedia* and *D. spinulosa* grade into one another and are therefore only varietally distinct is manifestly based on the frequent occurrence of this hybrid, which

18 Bull. Torrey Club *35:* 139. 1908.
19 Bartonia *21:* 2. 1942.
20 Fern Bull. *16:* 13. 1908.
21 Bull. Torrey Club *36:* 47. 1909.
22 *Idem*, p. 48.

has commonly been known as *D. spinulosa* var. *fructuosa.* It was first noted in 1900 by B. D. Gilbert,[23] who identified his specimens with the European *Lastrea dilatata glandulosa* T. Moore, which he renamed *Dryopteris spinulosa glandulosa.* The next year he renamed the plant *Nephrodium spinulosum fructuosum*[24]; although the plant intended by Gilbert is the American hybrid, the name is technically based on *Lastrea dilatata glandulosa* Moore, which is stated unequivocally as a synonym. This English plant must presumably be different, since one of the parents of the American hybrid, *D. intermedia,* does not grow in England. Therefore, the American plant is in need of a new name. In any case, the epithet *fructuosum* is not available as a specific epithet under *Dryopteris* as the name is preoccupied. The new epithet here proposed refers to the interesting finding by Manton and Walker[25] that this hybrid, as is predictable by the first-named parent being diploid and the second tetraploid, is indeed triploid. It should be noted that most specimens in herbaria labelled "*fructuosa*" are merely luxuriant *intermedia.*

D. MARGINALIS × SPINULOSA = D. × PITTSFORDENSIS. First published as a species by Slosson,[26] and four years later interpreted by her[27] as this hybrid.

The foregoing diagram shows that order is at last appearing in the heretofore rather confused picture of inter-relationships in *Dryopteris* in the northeastern United States. No longer is there any excuse for shifting epithets around from one status to another under a multiplicity of species. Thanks to the observations of spores by Mrs. Crane and of chromosomes by Dr. Walker, hybrids can be recognized as such and their parentage established. Further progress can be made if members of the American Fern Society will keep on the lookout for additional material, especially of those hybrids which, as indicated in the above diagram, have not as yet been available for cytologic study.

23 Fern Bull. *8:* 11. 1900.
24 List N. Amer. Pterid. 37. 1901.
25 Nature *171:* 1116. 1953.
26 Rhodora *6:* 75. 1904.
27 Fern Bull. *16:* 99. 1908.

Special thanks are due to Mrs. C. W. Crane, without whose generous aid in checking the spores of specimens of the hybrids discussed the preparation of this article would not have been possible.

## Abnormal Nuclear Division in Fern Prothallia

WILLIAM J. CROTTY

The purpose of this paper[1] is to report the occurrence of abnormal nuclear divisions in the prothallia of three genera of ferns. Specifically, we have observed what we interpret as amitotic division and nuclear fragmentation in *Pteris vittata* L., the ladder-brake fern, *Matteuccia Struthiopteris* (L.) Todaro, the ostrich fern, and *Dryopteris* sp. Amitosis is usually defined as the simple constriction of the nucleus without the formation of condensed chromosomes or spindles; the term nuclear fragmentation is often used when more than two nuclei are so formed (5). Since amitosis or direct division has been a subject of recurring interest since nuclear division was first described, and, since the controversy over the significance of this process is still not satisfactorily settled, we feel it worthwhile to record these observations and suggestions for the use of the fern prothallia in the exploration of this problem. After describing our observations, we shall refer briefly to possible environmental conditions that might have stimulated the abnormal divisons.

The observations reported here were made on both living and fixed (in Navashin's or Carnoy's fixative) prothallia which were in either the early filamentous or later plate-like growth stages. They were stained with a pyronin-methyl green mixture. In no case was a single nucleus actually followed through the division described here; rather, the sequence was pieced together from the study of many isolated stages, a few of which are pictured in the figures. Since reports of amitosis have been regarded by some

[1] This investigation was aided by research grants from the National Science Foundation. Acknowledgments are gratefully made to Miss Nancy Coddington for technical assistance, and to Dr. Norman Marengo for the spores of the ostrich fern.

investigators as due to the fusion rather than to the constriction and separation of nuclei, anyone employing an indirect method, such as used here, must consider the possibility that he is reading the actual sequence of events backwards. In the discussion we shall consider why we favor amitosis as the interpretation for these observations.

A thallus cell is normally uninucleate unless the first nuclear division attendant upon differentiation into a rhizoid, antheridium or archegonium has occurred and the new cell wall has not yet formed. However, according to our experience acquired dur-

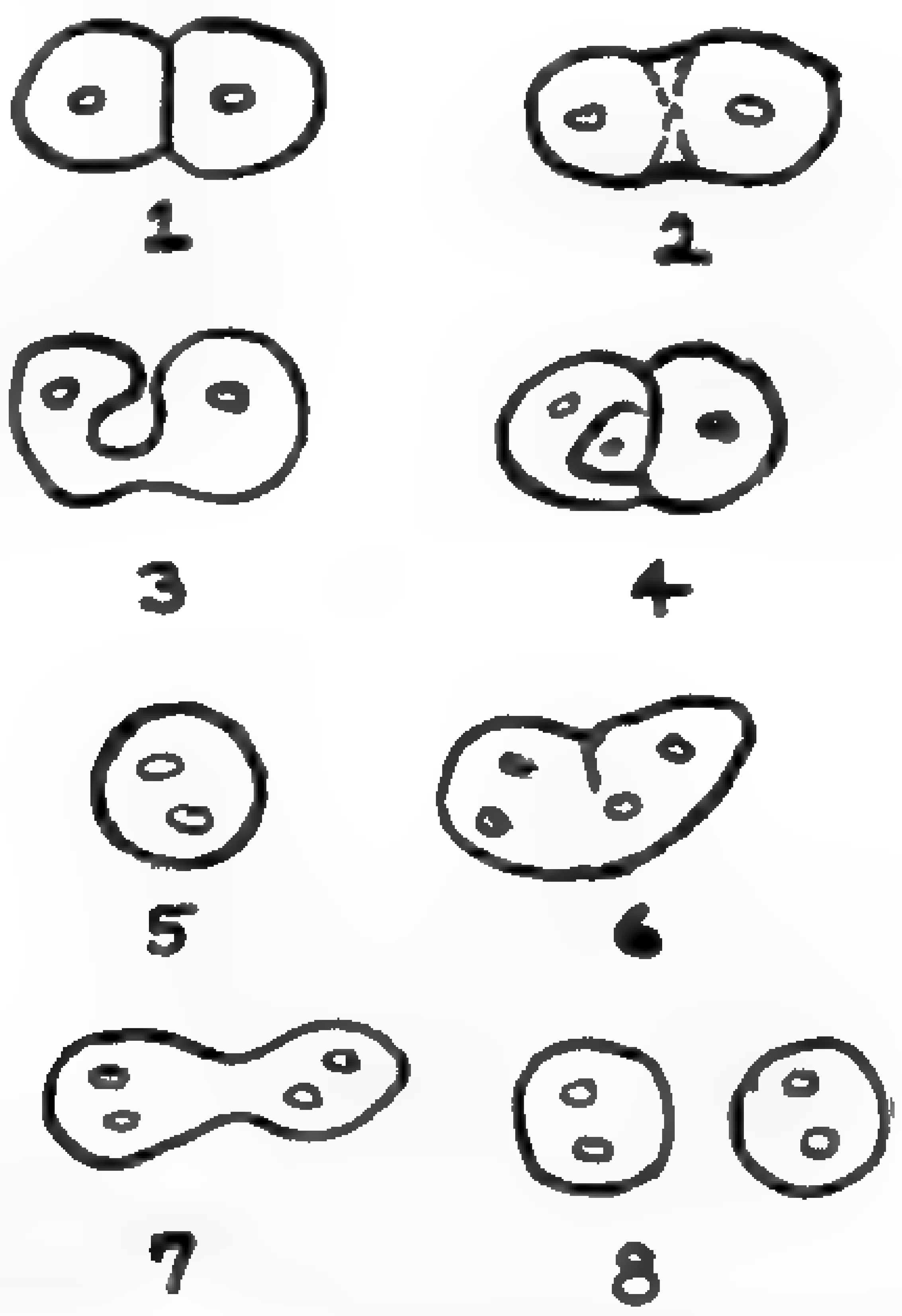
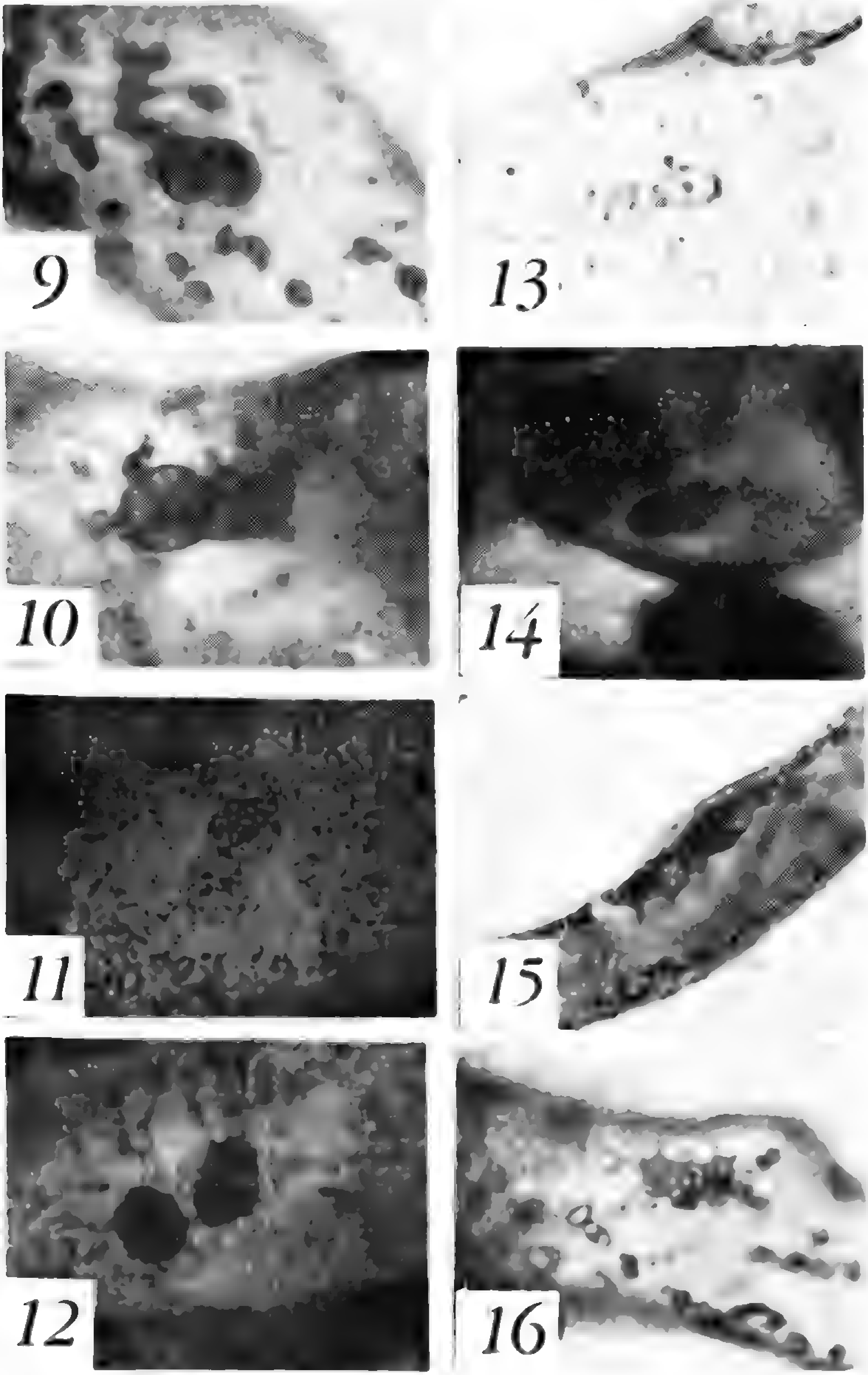



FIG. 1, CONSTRICTING NUCLEI SEEN AT ONE OPTICAL PLANE; 2, SAME NUCLEI AT DIFFERENT PLANE SHOWING CONTINUITY BETWEEN THEM; 3, INTERPRETATION OF FIGS. 1 AND 2 SEEN FROM THE SIDE INSTEAD OF FROM ABOVE; 4, THREE NUCLEI OF UNEQUAL SIZE; 5, NORMAL NUCLEUS; 6, ENLARGED, ELONGATE NUCLEUS SHOWING INCIPIENT CONSTRICTION LINE; 7, SEPARATING NUCLEI; 8, BINUCLEATE CONDITION

ing a cytochemical study (soon to be reported), we can detect such differentiation even before nuclear division has occurred, and certainly very shortly thereafter. Our interest was aroused, therefore, when we noticed a binucleate thallus cell for the first time several months ago. Thereafter, during a period of about five months, we found frequent binucleate and multinucleate




FIGS. 9, 10, OSTRICH FERN, CONSTRICTING NUCLEI; FIGS. 11-16, PTERIS VITTATA NUCLEI DIVIDING AMITOTICALLY; FIG. 14, THREE NUCLEI FORMED; FIG. 15, FRAGMENTED NUCLEI, SOME VESCICULAR; FIG. 16, FRAGMENTED NUCLEI cells in the prothallia germinated from several sowings of *Pteris vittata* spores and in one sowing each of *Matteuccia* and *Dryopteris*. No abnormal divisions have been seen in prothallia germinated in the last three or four months. A common abnormality resembled that sketched in *figure 1*. At one optical level (using apochromat oil immersion objectives) we saw what looked like two nuclei pressing against one another. At a different optical plane, however, it was apparent that the two nuclei were continuous (*figure 2*). *Figure3* is our interpretation of what *figure 1* would look like when viewed from the side instead of above and is similar to figures reported in the literature (4). Prior to these observations, we had assumed that the binucleate condition was the result of a regular mitosis. The finding of more and more of these closely associated nuclei, some of which were of unequal size (*figure 4*), indicated the possibility that amitotic divisions might be occurring. We therefore looked carefully for stages that might indicate either normal or aberrant mitosis (e.g. abortive spindle formation) or true amitosis. Even though spindle components are sensitive to the pyronin stain, we found no evidence of spindle formation. On the other hand, the occurrence of enlarged (*figure 6*) and constricted nuclei (*figures 1, 9, 10, 11, 13*) were very common, especially in cells adjacent to bi- and multinucleate ones. Incipient constrictions or plate-like ingrowths were fairly common is these elongated nuclei (*figure 6*) but they proved difficult to photograph satisfactorily. In multinucleate cells (*figures 4, 14, 15, 16*), the number of nuclei observed ranged from three to eight. Some of these multiple nuclei were little more than empty vesicles (*figure 15*) containing a pyronin-staining body (presumably a nucleolus) and a lightly-stained nuclear membrane. The conclusions that we have reached, therefore, are that these abnormal divisions are amitotic and that the sequence of events leading to the binucleate cell is illustrated by the following figures in the order given: *Figures 5, 6, 7* (or *3*) and *8* and *9, 10, 11* (or *13*) and *12*.

These observations had never been made by us before this period even though we had looked at literally thousands of prothallia with special attention focused on the nuclei of the cells. Nor as indicated above, have we found such abnormal divisions in sowings of the past three or four months. Since we used the same collection of spores of *Pteris* before, during, and after the period of these observations, it seems pertinent to consider possible environmental conditions that might have stimulated such divisions. The spores are sown in standardized amounts in 10 or 20 ml. of mineral nutrient media, in 50 ml. erlenmeyer flasks; some of the spores were disinfected with a chlorox solution, and others washed only with sterile water. The flasks are placed in a refrigerator-incubator under known conditions of light (65-85 footcandles from incandescent lamps) and temperature (25°C) for a given length of time (one, two weeks, etc.). After using some of the prothallia for specific experimental work, the remaining material in flasks was then shifted to other uncontrolled and unnoted light intensities to make room for new sowings. During the period of these observations, we experienced trouble with the temperature-regulating equipment so that the temperature was noted to vary from 18° to 30°C on a few occasions. All the prothallia with abnormal divisions showed evidence of some microbial contamination by the time the observations were made (or the material was fixed) since little attempt was made to maintain aseptic conditions in the original flasks beyond the time the prothallia were removed for other experimental purposes. Although the possible environmental variables listed above are numerous, we feel that it would be worthwhile to attempt to define the conditions that stimulate these abnormal divisions and we hope that others will also try to discover such conditions. Changes in temperature and light intensity seem to be possible factors. If infection is a factor, this might prove more difficult to reproduce. The fern prothallium strikes us as an ideal organism for studying such abnormal divisions *in vivo* but the first step will be to learn how to induce them.

There is a striking similarity between what we have observed in these fern prothallia and the pictures reported by Cutter, Wilson, and Freeman (1) as amitotic divisions in the developing endosperm of coconut. That amitosis does occur in both animal and plant cells has definitely been shown but there seems to be some controversy about: (1) whether specific reported instances are actually cases of amitosis or are really cases of fusing nuclei (which have previously been formed by normal mitosis); (2) whether or not amitosis is to be regarded as a degenerate, pathological condition; and (3) whether or not it is an unusual but "normal" situation which could be followed by normal mitosis (2, 3, 4, 5). Some discussion of our reasons for reading the sequence of stages as we do seems appropriate in view of the first of these questions. We can say nothing with assurance about the second and third of these controversies.

Essentially, our arguments for reading the sequence as we do are as follows: (1) Thallus cells are normally uninucleate. If amitosis has not occurred, we would have to postulate that normal mitosis (or mitoses in the case of multinucleate cells) had occurred and that the daughter nuclei had, or were in process of fusing. This in itself, seems more unusual and abnormal than amitosis. (2) In order to explain the appearance of three, unequal-sized nuclei in a cell (*figure 4*) by normal mitosis, we would have to assume either an unequal mitotic distribution of nuclear material, or else an unequal swelling of two nuclei with respect to the third, smaller one. Both of these alternatives seem much less probable than the amitotic explanation. (3) It is more difficult to explain the attitude of nuclei such as those shown in *figures 3, 7* and *13* as figures of fusion than as figures of constriction. One does not expect to see merging nuclei fusing in such a local manner as in *figure 13*. (4) The occurrence of many apparently empty nuclei in the multinucleate cells is more easily explained by amitosis than by normal mitosis.

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## On the Species of Dryopteris, Subgenus Pycnopteris

MOTOZI TAGAWA AND KUNIO IWATSUKI

In 1855, Thomas Moore described the genus *Pycnopteris*, which was characterized by having a hard coriaceous texture and the peculiarity of imparipinnate fronds with a free terminal pinna like the lateral ones. *Pycnopteris* was subsequently referred to the genera *Aspidium, Lastrea,* or *Nephrodium,* and finally recognized by Ching as a subgenus of *Dryopteris.* Ching also described a monotypic genus *Microchlaena,* which seems to the writers not particularly different from *Pycnopteris.* The seven species listed below may be referred to the subg. *Pycnopteris.*

DRYOPTERIS subg. PYCNOPTERIS (Moore) Ching, Bull. Fan Mem. Inst. Biol. *8:* 371. 1938.

*Pycnopteris* Moore, Gard. Chron. *1855:* 468. 1855. Type: *Aspidium sieboldii* van Houtte.

*Microchlaena* Ching, Bull. Fan Mem. Inst. Biol. *8:* 325. 1938. Type: *Aspidium yunnanense* Christ.

1. DRYOPTERIS SIEBOLDII (van Houtte) Kuntze, Rev. Gen. Plant. *2:* 813. 1891; Ogata, Icon. Fil. Jap. *3: t. 127.* 1930; Ching, Bull. Fan Mem. Inst. Biol. *8:* 396. 1938; H. Ito, in Nakai & Honda, Nov. Fl. Jap. Polypod. Dryopt. *1:* 25, *cum t. et fig.* 1939; Ohwi, Fl. Jap. Pterid. 83, *t. 41.* 1957; Tagawa, Col. Ill. Jap. Pterid. 92, 213, *fig. 182.* 1959.

*Aspidium sieboldii* van Houtte ex Mett. Fil. Hort. Lips. 87, *t. 20, fig. 1–4.* 1856.

*Pycnopteris sieboldii* Moore, Gard. Chron. *1855:* 468, *cum fig.* 1855.

*Nephrodium sieboldii* Hook. Fil. Exot. *t. 31.* 1859; Sp. Fil. *4:* 87. 1862.

This species was described from cultivated plants introduced from Japan to Europe by Siebold. As will be noted further on, the identification of the Chinese plants referred to *D. sieboldii* by Ching is dubious. The species is mainly restricted to southwestern Japan, where it is common in Kyushu; it occurs sporadically also in warm-temperate regions of Honshu and Shikoku.

2. DRYOPTERIS TOYAMAE Tagawa, Act. Phytotax. Geobot. *8:* 167. 1939; Ohwi, Fl. Jap. Pterid. 84. 1957; Tagawa, Col. Ill. Jap. Pterid. 93, 214. 1959.

Type: A plant cultivated in the Botanical Garden of the University of Kyoto, transplanted from Mount Kokuzoyama, Nagasaki Prefecture, Kyushu, Japan, *Tagawa* 2552 (KYO!).

When the senior writer described the present species, he made a comparison with *Dryopteris enneaphylla* only. As will be discussed under that species, *D. toyamae* is distinct by the crenation of the pinnae and the presence of teeth below the apex of the pinnae. Also the fact that the terminal pinna is more deeply dissected than the lateral ones was pointed out. The direct affinity of this species is no doubt with *D. sieboldii*, from which it may have been derived by some cytological variation. The pinnae are deeply pinnatifid near the base, thus forming one or two pairs of free pinnules; the sinuses become progressively shallower toward the apex of the pinna (*figs. 1, 2*).

*Tagawa* 3435 from Taiwan was referred to *D. toyamae* by the senior writer.[1] If *D. toyamae* is really derived from *D. sieboldii*, its occurrence in Taiwan, where genuine *D. sieboldii* is not found, is difficult to explain. It is conceivable that a plant like *Tagawa* 3435 was derived from the Taiwan *D. enneaphylla* in the same manner as *D. toyamae* from *D. sieboldii* in Japan. If this supposition is correct, the Taiwan plant must be segregated, for its alliance with *D. toyamae* would be unnatural.

3. DRYOPTERIS BODINIERI (Christ) C. Chr. Ind. Fil. 254. 1905; Ching, Bull. Fan. Mem. Inst. Biol. *8:* 398. 1938.

*Aspidium bodinieri* Christ, Bull. Acad. Géogr. Bot. Mans *1902:*

[1]Act. Phytotax. Geobot. *9:* 90. 1940.

248. 1902; *op. cit. 1906:* 115. 1906. Type: Tou-Chan, Kweichow, China, *Bodinier.*

A distinct, large species, attaining three meters in height, with 7 to 15 pairs of larger lateral pinnae. Known from Kweichow, Yunnan, and Szechwan, but rare.

4. DRYOPTERIS ENNEAPHYLLA (Baker) C. Chr. Ind. Fil. 263. 1905; Hu & Ching, Icon. Fil. Sin. *1: t. 6.* 1930; Ching, Bull. Fan Mem. Inst. Biol. *8:* 398. 1938.

*Nephrodium enneaphyllum* Baker, Journ. Bot. *1887:* 170. Type: Ichang, Hupeh, China, *Henry* 3217.

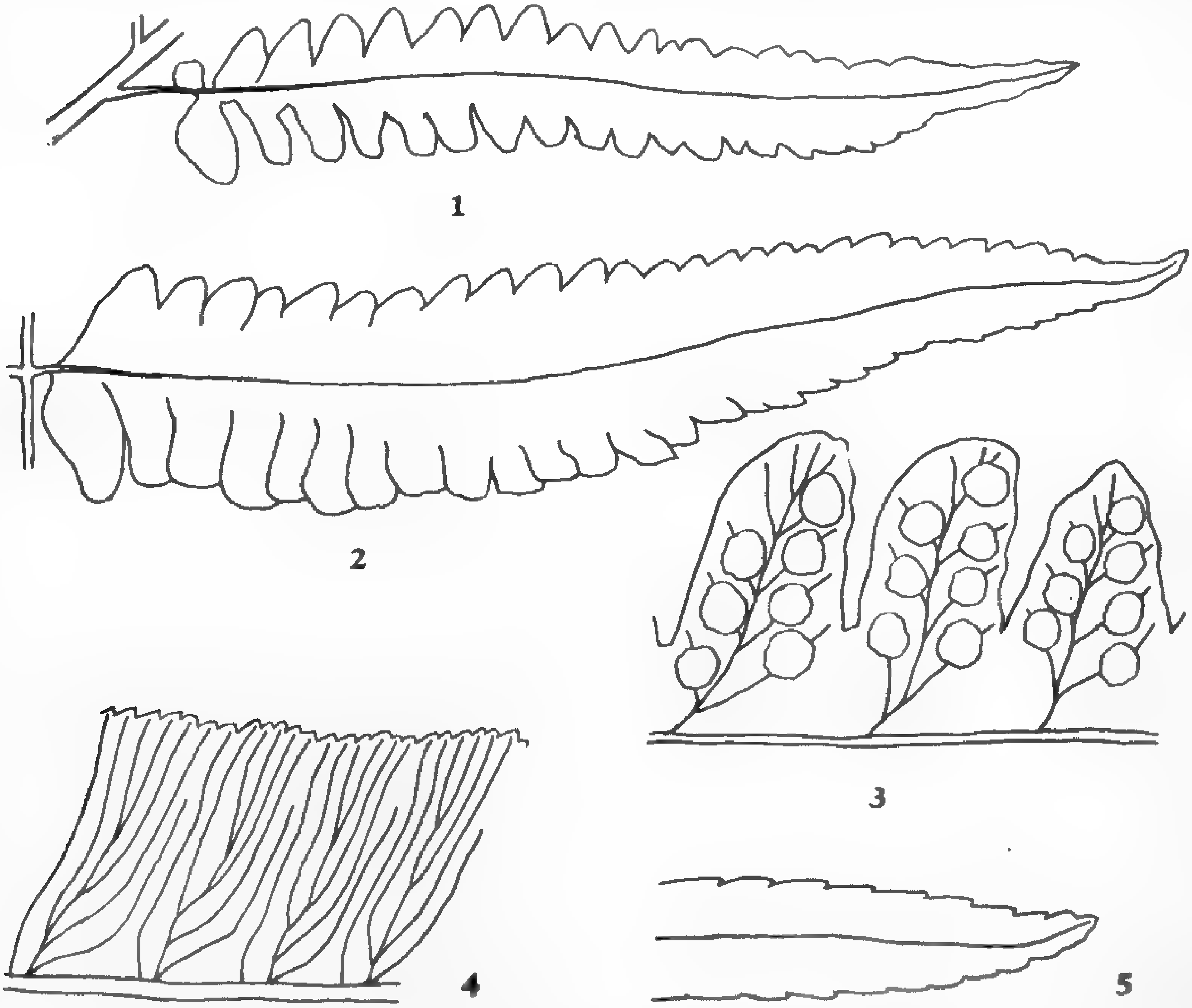
*Dryopteris sieboldii* var. *heteroneura* Tagawa, Journ. Jap. Bot. *12:* 487. 1936; H. Ito, in Nakai & Honda, Nov. Fl. Jap. Polypod. Dryopt. *1:* 26. 1939 (*pro form.*). Type: Between Miharashi and Miyama, Province of Taito, Taiwan, *Tagawa* 1034 (KYO!).

*Dryopteris heteroneura* Ching, Bull. Fan Mem. Inst. Biol. *8:* 398. 1938.

*Dryopteris heteroneura* differs from *D. sieboldii* in venation and in the serration of the margins of the pinnae (*Figure 4*). The margins are doubly-serrate, or broadly crenate with sharply toothed lobules. The basal posterior veinlets are usually apart from the insertion of the costules and arise directly from the costae, and between the first and the second basal posterior veinlets two basal anterior veinlets are borne. The other veinlets are borne in regular alternate sequence. Each veinlet runs to a sharp tooth. Although such a feature could be influenced by the breadth of the pinnae, it does not occur in Japanese *D. sieboldii*, even when the pinnae are broader than those of the type specimen of *D. heteroneura*. However, apart from the type specimen, this feature is not so typically developed. An additional peculiar feature is the doubly-serrate margins, the serration extending to the very apex of the pinnae. In *D. sieboldii*, the margins are almost entire at and below the apex. The same difference is seen between *Cyrtomium fortunei* and *C. falcatum*. Although the peculiar mode of venation is not common to all

Taiwan representatives, these may be considered conspecific.

The type specimen of *D. enneaphylla* has not been examined by the writers. In comparing this species with *D. heteroneura* and *D. pseudosieboldii*, the original description, the description and figure given by Ching, and the specimen *Henry* 7881 (TI)




FIGS. 1-3, DRAWN FROM TYPE OF DRYOPTERIS TOYAMAE. 1, A BASAL LATERAL PINNA OF A FERTILE FROND, × ½; 2, A BASAL LATERAL PINNA OF A STERILE FROND, × ½; 3, LOBULES OF A FERTILE PINNA, × 2. FIGS. 4 AND 5, DRAWN FROM TYPE OF DRYOPTERIS HETERONEURA (= D. ENNEAPHYLLA). 4, A PORTION OF A STERILE PINNA, × 1; 5, APICAL PART OF A STERILE PINNA, × 1.

have been taken into account. It appears that *D. enneaphylla* is quite identical with the species mentioned above except in the serration of the pinnae. However, in some specimens of *D. heteroneura* from Taiwan the pinnae are sometimes regularly lobate-crenate up to one-fourth down to the costa, *i.e.* to about the same degree as that shown in the figure of *D. enneaphylla* by Hu and Ching; *Tagawa* 3094, 3170, 3380 (all KYO) afford sufficient examples. In *D. pseudosieboldii* such crenations occur more typically, as seen in *Tagawa* 2054 (KYO). Similar crenations are also seen in some specimens of *D. sieboldii* from Japan, as for instance *N. Nakajima* (KYO) and *T. Baba* (KYO), and *Hiroshima H. N. School* 52 (TI), but they are usually irregular. A further study is necessary of the Chinese plants that have been identified as *D. sieboldii;* the materials available to us are inadequate.

4a. DRYOPTERIS ENNEAPHYLLA var. **pseudosieboldii** (Hayata) Tagawa & Iwatsuki, *comb. nov.*

*Dryopteris pseudosieboldii* Hayata, Icon. Pl. Formos. *4:* 171, *fig. 111.* 1914. Type: Mount Arisan, Province of Tainan, Taiwan, *Hayata & Sasaki* (TI!).

*Dryopteris sieboldii* var. *pseudosieboldii* Tagawa, Journ. Jap. Bot. *12:* 487. 1936.

Ching considered that *D. pseudo-sieboldii* was identical with *D. podophylla* (Hook.) Kuntze of southern China, but it may be that he did not see any authentic or topotypic specimens, for it is entirely different from *D. podophylla* in scales, in margins of the pinnae, and in the position of the sori. In *D. pseudosieboldii*, the scales are brown and lanceolate, being broadest near the base; each veinlet runs into a sharp tooth of the lobule except the anterior basal one, which stops a little beyond half-way; the sori are scattered and restricted to the marginal part of the pinnae, thus leaving a rather broad sterile space on each side of the costae. In *D. podophylla*, on the other hand, the scales are black and subulate; the margins of the lobules are subentire and neither the anterior nor the posterior basal veinlets reach to the margin; sterile bands occur in the fertile pinnae both along the costae and the margin. Thus, *D. pseudosieboldii* is clearly to be distinguished as a species distinct from *D. podophylla* by the characters noted above, in spite of the opinion of Ching.

The distribution of the sori in *D. pseudosieboldii* is characteristic; they are restricted to a marginal band, thus leaving a sterile band along each side of the costae. On the contrary, in *D. sieboldii* the sori are costal, thus leaving sterile marginal bands. *Dryopteris pseudosieboldii* has more than five pairs of pinnae, sometimes up to eight pairs, whereas *D. sieboldii* has usually four pairs or fewer (rarely five pairs). The two species may be discriminated by these characteristics. However, *D. pseudosieboldii* is quite identical with Taiwan plants of *D. enneaphylla* except in distribution of the sori; this difference is apparent but is hardly to be considered sufficiently important to segregate two species, and therefore *D. pseudosieboldii* is here regarded as a variety.

5. DRYOPTERIS PODOPHYLLA (Hook.) Kuntze, Rev. Gen. Plant. *2:* 813. 1891; Ching, Bull. Fan Mem. Inst. Biol. 8: 399. 1938.

*Aspidium podophyllum* Hook. Journ. Bot. *5:* 236, *t. 1.* 1853. Type: Hongkong, *M. Champion.*

*Nephrodium podophyllum* Hook. Sp. Fil. *4:* 87. 1862.

As mentioned above, this is another distinct species, which is restricted to southern China: Fukien, Kwangtung, Hongkong, and Hainan.

6. DRYOPTERIS NEOPODOPHYLLA Ching, Bull. Fan Mem. Inst. Biol. *8:* 401. 1938.

Type: Between Pin-fa and San Chouen, Kweichow, China, *Cavalerie* 2883.

The writers have not had the opportunity of studying this species.

7. DRYOPTERIS YUNNANENSIS (Christ) Copel. Gen. Fil. 122. 1947.[2]

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[2] The first renaming of the illegitimate *Polypodium elongatum* Wall. *ex* Hook. (*non* Aiton) was as *Phegopteris elongata* J. Smith (Hist. Fil. 233. 1875). By the International Code of Botanical Nomenclature, Art. 72, *Nota,* this is considered a new name by J. Smith and not a transfer. Therefore, the correct name for the species appears to be *Dryopteris elongata* (J. Smith) Kuntze, Rev. Gen. Plant. *2:* 811. 1891. An illegitimate nomenclatural synonym is *Dryopteris khasiana* (a superfluous name) and a taxonomic synonym is *D. yunnanensis* (Christ) Copel.—C. V. MORTON.

*Polypodium elongatum* Wall. ex Hook. Sp. Fil. *4:* 234. 1862, *non* Aiton 1789 *nec* Schrad. 1818.

*Aspidium yunnanense* Christ, Bull. Herb. Boiss. *6:* 965. 1898. Type: Mengtze, Yunnan, China, *Henry* 9038A.

*Dryopteris khasiana* C. Chr. Ind. Fil. 272. 1905; Contr. U. S. Nat. Herb. *26:* 276. 1931. [New name for *Polypodium elongatum* Wall. *ex* Hook., *non* Aiton]

*Microchlaena yunnanensis* Ching, Bull. Fan Mem. Inst. Biol. *8:* 325. *t. VI, fig. 1.* 1938.

Much impressed by the catadromous mode of venation, Ching described the new genus *Microchlaena,* which was based solely on this species. Copeland (1947) alluded to Ching's genus briefly and made it a synonym of *Dryopteris,* since *Dryopteris* as a whole has the catadromic plan of venation. A comparison with the type of venation in *D. heteroneura* is useful. As noted above, the sequence of veins is not always completely consistent, even within a single species. In an Assam specimen of *D. yunnanensis* collected by Gustav Mann (October, 1888, KYO), some veinlets are anadromic in sequence. Thus the venation is not a feature sufficient to discriminate the genus *Microchlaena.*

Besides the "peculiar" mode of venation, the lack of scales above the stipe base and the dark green colour of the frond were noted by Christensen (1931) and also by Ching (1938). As a matter of fact, the texture of *D. yunnanensis* resembles that of *D. dickinsii* or of *D. atrata.* However, small scales are, although rarely, found on the costae beneath, especially at the very base. Although the lateral pinnae are numerous (up to 20 pairs compared to 15 pairs at most, in *D. bodinieri,* otherwise the largest species of *Pycnopteris*), the imparipinnate blades are distinctive enough to allow us to consider *D. yunnanensis* also a member of the subgenus *Pycnopteris.*

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## The Correct Name for the Hybrid Dryopteris cristata × spinulosa

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A hybrid between *Dryopteris cristata* (L.) A. Gray and *D. spinulosa* (O. F. Muell.) Watt has been known in Europe for more than a hundred years. In Clapham, Tutin, and Warburg's Flora of the British Isles (p. 42, 1952) it is assigned the name "*Dryopteris uliginosa* (A. Braun) Kuntze," but since such a name is not listed in Christensen's Index Filicum and Supplements I have been asked to clarify its status.

The first use of the epithet *uliginosum* in this context was the description of *Aspidium spinulosum* b) *uliginosum* A. Braun in Doell's Rheinische Flora (1843), which reads as follows: "Moorliebender, kurzstachlicher Schildfarn. Strunk ziemlich kurz, mit wenigen, locker stehenden, breit-eiförmigen, kurz zugespitzten, braungelben Spreublättchen; Wedel doppeltgefiedert-fiederspaltig, Fiederchen genähert, an der Basis auf der unteren Seite etwas breiter, die an der Basis stehenden ein wenig kürzer als die folgenden; Zähne der Fiedertheilchen ziemlich kurz, stachelspitzig, anliegend. Diese noch weiter zu beobachtende Form wurder von A. Braun im Moos bie Freiburg mit der ersten Varietät und mit *Aspidium cristatum* gefunden." The "first variety" mentioned was var. *elevatum,* which is typical *spinulosum.*

Newman in proposing *Lastrea uliginosa* in 1849 made no reference to Doell's Rheinische Flora, but he did in fact adopt the epithet *uliginosum* from that work, as he explains in his "A History of British Ferns" (p. 163. 1854). He stated: "The first notice of this fern which I have seen is in Döll's 'Rhenish Flora,' pp. 17 and 18, but I believe it to be copied from a prior work or a MS. of Professor A. Braun. . . The next notice of this fern, and the first of its occurrence in England, is from my own pen; and, by a strange omission, subsequently amended by myself, no allusion whatever is made to the earlier description I have just cited." Newman assigned the common name "Lloyd's Fern" to this plant, in honour of a Mr. Lloyd, a gardener who had provided him with the material of it.

Druce in his various publications referred this plant to *Dryopteris* as *D. uliginosa* Ktze. Why Druce should have attributed the epithet to Kuntze I cannot imagine. It was probably just an error, which was copied by Clapham, Tutin, and Warburg. I think that we shall have to accept Druce's combination as validly published, since it is quite clear from his reference in the Comital Flora that he was referring to Newman's plant. The specimen he quotes is one of those quoted by Newman: "Wybunbury, Cheshire, *Mr. George Pinder.*" Druce's first use of the name was in 1908, although he prefixes the references with a question mark. Perhaps one should take the reference in Hayward's Pocket Book (1909).

In any case, the combination *Dryopteris uliginosa* (A. Braun *ex* Doell) Druce antedates *D. uliginosa* (Kunze) C. Chr. (Ind. Fil. Suppl. 3: 100. 1934). The important synonymy is as follows:

DRYOPTERIS ULIGINOSA (A. Braun *ex* Doell) Druce, List of Brit. Plants 87. 1908; Druce in Hayward's Bot. Pocket Book, ed. 13, 259. 1909; Comital Fl. Brit. Isles 383. 1932.[1]

*Aspidium spinulosum* var. *uliginosum* A. Braun ex Doell, Rhein. Fl. 17. 1843.

*Lastrea uliginosa* Newm. Phytol. *3:* 678. 1849.

*Lophidium uliginosum* Newm. Phytol. *4:* 371. 1851; Hist. Brit. Ferns 163. 1854.

*Aspidium uliginosum* Nyman, Consp. Fl. Eur. 866. 1884, *non* Kunze, 1847.

*Nephrodium uliginosum* Rouy, Fl. France *14:* 414. 1913.

*Polystichum uliginosum* P. Fourn. Quatre Fl. France 17. 1947.

ROYAL BOTANIC GARDENS, KEW, ENGLAND.

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[1] This cross, *Dryopteris cristata* × *spinulosa* has been reported from the United States a number of times (*e.g.* Bull. Torrey Club *35:* 136. 1908; Fern Bull. *17:* 35. 1909; Amer. Fern Journ. *1:* 13. 1911, Reed, Ferns and Fernallies of Maryland and Delaware 135. 1953), but is not well known. The name *D. uliginosa* for it has not come into the American literature, but it is now available. The corresponding cross of *cristata* × *intermedia* on the other hand is well known under the name *D. Boottii.*—C. V. MORTON.

# A New Equisetum[1]

Bernard Boivin

In the Canadian Arctic there occurs a plant that could easily pass as a small *Equisetum arvense* or, if fertile stems are collected, as its var. *arcticum* Rupr., [or f. *arcticum* (Rupr.) Braun], because, as in the latter, the fertile stems turn green and produce branches. However, closer examination reveals that the production of green branches is normal in this plant and not as in *E. arvense,* just an exceptional individual variation. Furthermore, there is some overlapping in the time of appearance of fertile and sterile stems and the behavior of the plant is in this respect, intermediate between that of *E. arvense* and *E. pratense.*

In this plant, which I am naming *E. calderi,* the fertile stems appear first but the sterile stems begin to appear while the fertile stems are still present and only in sporesis. Most, if not all, of the fertile stems soon turn green and produce green sterile branches. A number of morphological characters also set apart this new species from *E. arvense* var. *boreale.* The main ones may be briefly stated as follows: Central cavity very small (one-fifth to one-half of the diameter in *arvense*), about as small as the carinal cavities; sheaths from the middle of the stem with 4 or 5 (6) teeth (8–12 in *arvense*), these (0.6) 0.8–1.0 (1.3) mm. long (1.5–2.5 mm. in *arvense*); branches trigonous with teeth 0.4–1.0 mm. long (1–2 mm. in *arvense*); upper sheath of fertile stems 4–9 mm. long (16–19 mm. in *arvense*), with 4 to 5 teeth only, these very short, 1.5–3.0 mm. long. This Arctic vicariant of *Equisetum arvense* L. may be named and described as follows:

Equisetum **calderi,** sp. nov. Affine *Equiseto arvensi* L. et inter sectiones *Subvernalia* Braun et *Vernalia* Braun stans. Surculi annui dimorphi, fertiles praecoces vel subcoetanei, persistentes et ramulos serotinos proferentes. Surculus sterilis gracilis, 5–20 cm. alt., erectus vel decumbens, caudatus, 4–5 (6)-goniatus, vaginis 4–5 (6)-dentatis, dentibus (0.6) 0.8–1.0 (1.3) mm. longis,

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[1] Contribution No. 34 from the Plant Research Institute, Research Branch, Canada Department of Agriculture, Ottawa, Canada.

lacuna centrali minima. Frons simplex, sparsa, verticillis (3) 4–5 (7) in planta, ramis brevioribus solidis, internodiis (2) 3–5 (8) in ramo, dentibus vaginarum ternis, 0.4–1.0 mm. longis. Surculus fertilis 5–12 cm. longus, primo simplex, deinde ramosus et viridescens, internodiis pallide brunneis viridescentibus, vaginis pallide viridibus, vagina superiore 4–9 mm. longa, dentibus 4 vel 5 in vagina, 1.5–3.0 mm. longis.

FRANKLIN: *Senn & Calder* 3747, Frobisher Bay, Baffin Island, 63°45′N, 68°32′W, in stream 0.5 mile north of camp, upright in 3″–6″ of water, both fertile and sterile plants present, July 5, 1948 (DAO type); *Senn & Calder* 3798, from same locality, bed of dried up river, July 7, 1948 (DAO); *D. Coombs* 112, Erik Harbour, Baffin Island, 72°40′N, 76°36′W, Aug. 18, 1948 (DAO); *D. Coombs* 121, Eclipse Sound, Bylot Island, 72°55′N, 80°15′W, in sand, Aug. 23, 1948 (DAO); *P. F. Bruggemann* 221, northeastern Ellesmere Island, 82°28′N, 63°20′W, saddle 500′ between Egerton Lake and Hilgard Bay, marshy, mossy flat along small stream, sterile axes only, no trace of fertile axes found, axes prostrate with only their tips slightly ascending, July 26, 1951 (DAO); *P. F. Bruggemann* 186, northeastern Ellesmere Island, 82°31′N, 62°45′W, on small tussocks among mosses, grasses and willows, found only in a small area on a steep, wet, north-facing slope at foot of snow covered cliff, 15′ to 30′ above sea level, July 4, 1951 (DAO).

KEEWATIN: *W. J. Cody* 1077, Southampton Island, Coral Harbor, 64°09′N, 83°18′W, fairly common in gravelly muck in 0.5″–2″ water, July 1, 1948 (DAO); *Cody* 1674, from same locality, fairly common locally in moist gravel, July 30, 1948 (DAO); *Cody* 2019, locally common in limestone gravel stream-bed in shallow slow-flowing water, Aug. 11, 1948 (DAO); *Cody* 1997, from same locality, common in moist limestone gravel, Aug. 11, 1948 (DAO); *Cody* 1703, from same locality, fairly common in *Carex* meadow, July 31, 1948 (DAO); *Cody* 1554, from same locality, common, in water 1″, rooted in shallow muck over limestone gravel, July 25, 1948 (DAO).

MACKENZIE: *W. I. Findlay* 260, Coppermine, 67°50′N, 115°10′W, moist tundra, strobili very few, vegetative shoots quite common, Aug. 6, 1951 (DAO).

This species probably occurs also in Greenland, but the only collection at hand, *Sørensen* 202, from Scoresbysund, consists mostly of small fragments and is only doubtfully referable here.

The sterile shoots vary from erect to depressed, but all the fertile collections (*Bruggemann* 186, *Senn & Calder* 3747, *Findlay* 260, and *Cody* 1703 & 1077) show only erect sterile stems, the depressed phase being apparently sterile.

It is a pleasure to attach to this species the name of my friend and co-worker J. A. Calder.

Canada Department of Agriculture, Ottawa, Canada.

## Two Problem-species: Schizoloma cordatum Gaud. and Syngramma pinnata J. Smith

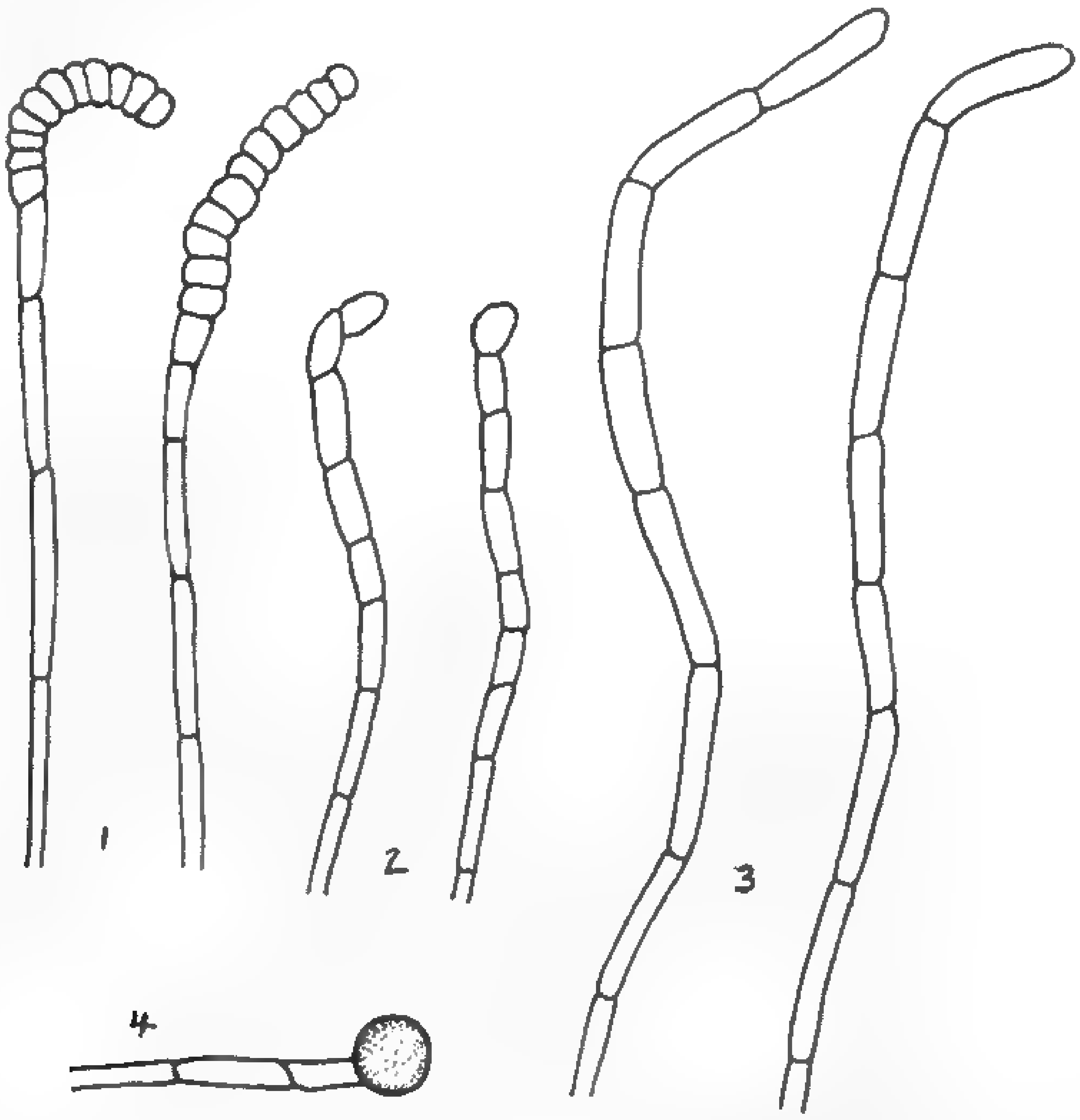
R. E. Holttum

It is clear from Copeland's Genera Filicum (pp. 55, 57) that he considers both *Schizoloma cordatum* and *Syngramma pinnata* to be nearly related to the genus *Taenitis*. I agree with this statement, and wish to present further evidence for it than that given by Copeland. My conclusion will be that both species should be transferred to *Taenitis*.

*Schizoloma cordatum* has a fairly wide distribution in Borneo, the Philippine Islands, Celebes, and the Moluccas, but has not been very frequently collected. I believe the reason to be that it is confined to limestone, and of very local occurrence, often in places not easily accessible. Certainly, the only locality from which it is known in Sarawak is the limestone hill at Bau, near Kuching. But before dealing with morphology, a note on nomenclature is necessary.

The genus *Schizoloma* was established by Gaudichaud in 1824, and in it he placed three very diverse species: *S. cordatum*, *S. guerinianum* and *S. billardieri*. Fée later removed *S. cordatum* to a new genus *Schizolepton* and *S. guerinianum* to *Isoloma*, leaving *S. billardieri* in *Schizoloma*. Copeland states that in so doing Fée misconstrued *Schizoloma*, but he does not explain what he means by that statement. Fée correctly construed *Schizoloma* Gaud. as a mixture, and had the right to choose how he would resolve that mixture. In so doing, he effectively chose *S. billardieri* as the type species of *Schizoloma*. *S. billardieri* (=

*Lindsaea ensifolia* Swartz) undoubtedly belongs to the genus *Lindsaea* as defined in the recent monograph of Kramer and as accepted by Copeland, and thus *Schizoloma* becomes a synonym of *Lindsaea*.[1] The correct name for *Schizoloma cordatum* is thus *Schizolepton cordatum* (Gaud.) Fée; there is no other known species of *Schizolepton*.




PARAPHYSES, ALL × 70: 1, TAENITIS BLECHNOIDES; 2, SYNGRAMMA PINNATA; 3, SCHIZOLEPTON CORDATUM; 4, SYNGRAMMA ALISMIFOLIA

*Schizolepton* differs from *Lindsaea* in having rigid cylindrical bristles, each consisting of a single series of cells, as a covering of the young parts of its rhizome. The rhizome of *Lindsaea* bears distinctly flat scales. In its sorus *Schizolepton* superficially resembles those species of *Lindsaea* (e.g. *L. ensifolia*) which have a continuous sorus all along the edge of each leaflet. But in *Lindsaea* the sorus is protected by a thin indusium which is quite distinct in substance from the true margin of the frond. In *Schizolepton* the sorus is in an apparently marginal groove, and the two edges of the groove are exactly alike in substance. I

[1] Cf. Kramer, Acta Bot. Neerl. *6:* 97–138. 1957.

think that the conclusion is inescapable that the sori in *Schizolepton* and *Lindsaea,* though superficially similar, have had quite different evolutionary origins. Thus, both in protective bristles on the rhizome, and in the nature of the protection of the sorus, *Schizolepton* is quite different from *Lindsaea.* Equally, it is distinct from *Isoloma* (it seems to me that Copeland is wrong in suggesting that *Isoloma* is related to *Schizolepton*). A third striking difference is the presence in *Schizolepton* of abundant rather thick hair-shaped paraphyses (*fig. 3*), as long as the sporangia, each consisting of a row of about eight cells, the lower cells gradually more slender, the apical one not of distinctive form; paraphyses in *Lindsaea* are much fewer and shorter, usually of two cells. (Fée gave a drawing of a paraphysis of *Schizolepton,* but omitted to show that it consists of a row of separate cells.)

Fée compared *Schizolepton* to *Vittaria,* and in my opinion the apparently marginal soral groove in the two genera is of exactly comparable structure, the two lips of the groove being of equal substance. But it is certain that *Schizolepton* and *Vittaria* are not closely related, and I believe the development of similar sori in the two cases is due to parallel evolution.

In his comments on *Schizolepton,* Copeland writes "related to *Taenitis,* in spite of being indusiate." As we have just noted, it is not indusiate. But it is certainly related to *Taenitis,* agreeing in rhizome-bristles, in venation, and in the nature of its paraphyses. Copeland states that *Taenitis* has "peculiar paraphyses which resemble abortive sporangia." But in fact the paraphyses of *Taenitis* are similar to those of *Schizolepton,* consisting of a single row of thin-walled cells (*fig. 1*); the difference is that in *Taenitis* there are more cells in each paraphysis (about 16) and the apical 10-12 cells are much shorter than the rest. In a dried specimen, the cells of a paraphysis collapse and turn brown, but if they are soaked in an alkaline bleaching solution they lose the brown colour and expand to their orginal shape. The paraphyses in *Taenitis blechnoides* develop before the sporangia, and their swollen ends form a very effective protection for the young sporangia.

It appears to me that *Schizolepton* differs from *Taenitis* only in having the sorus in an apparently marginal groove instead of in a superficial position between midrib and edge. If we take the parallel case of *Vittaria,* we find some species with sori in shallow superficial grooves lying between midrib and edge, and others with sori in apparently marginal grooves. Comparing *Vittaria* with the related genus *Antrophyum,* it seems probable that the elongate superficial sorus is primitive in *Vittaria,* and that the apparently marginal sorus is due to the upgrowth of the inner edge of a groove which at first is superficial. The sorus of *Schizolepton* bears the same relation to that of *Taenitis blechnoides* as the marginal type of sorus bears to the superficial type in *Vittaria.* As both kinds of sorus can occur in the one genus *Vittaria,* they could also occur in *Taenitis* (though here intermediate conditions are lacking); in fact, it would be quite a natural arrangement to transfer the species *Schizolepton cordatum* to *Taenitis,* and this I now do. The new combination is *Taenitis* **cordatum** (Gaud.) Holttum.[2]

Regarding *Syngramma pinnata* J. Smith, Copeland remarks "distinguished from *Taenitis* only by the sori and paraphyses." Here again therefore we have to look at paraphyses (*fig. 2*), and find that Copeland's statement is incorrect, because he did not know the true form of the paraphyses of *Taenitis* (though they were figured by Beddome in the Ferns of British India, *t.54,* in 1866). There is in fact close agreement between the paraphyses of *Syngramma pinnata* and *Taenitis blechnoides;* in *S. pinnata* the distal swollen cells are longer and fewer than in *Taenitis,* being about midway between those of *Taenitis blechnoides* and *Schizolepton cordatum.* But in other species of *Syngramma* the paraphyses are different; they have a glandular terminal cell which is quite different from the rest in shape, colour and contents (*fig. 4*).

[2] Basionym: *Schizoloma cordatum* Gaud. Ann. Sci. Nat. Paris *3:* 507. 1824.

The sorus in *Syngramma pinnata* is variable, a fact shown by Copeland in his *plate 1.* In what is regarded as the typical form of the species, the sori run along most of the veins, which form a network of oblique areoles (this venation is exactly as in *Taenitis*). In many specimens however the sori do not spread so much, and are more or less confined to the veins on a band about midway between the midrib of a leaflet and the margin, the sporangia more crowded than in the typical form and forming small patches. The sori in this variety occupy exactly the same position as the sori in *Taenitis blechnoides,* and if the gaps between them were filled they would be indistinguishable from the sori of *T. blechnoides.*

In shape of frond, and in venation, *S. pinnata* is exactly like *T. blechnoides;* sterile plants would be indistinguishable. The supposed difference in paraphyses is shown to be non-existent; in paraphyses *S. pinnata* resembles *T. blechnoides,* not the other species of *Syngramma.* On the other hand, there is no other *Syngramma* which has the frond-form and venation of *Taenitis.* To me, the conclusion is that *Syngramma pinnata* is properly a species of *Taenitis,* and I have transferred it to *Taenitis* in a recent paper.[3]

Prof. I. Manton has already recorded the chromosome number $n = 116$ $(4 \times 29)$ for *Syngramma quinata* (Hook.) Carr., as found in Malaya; this is probably not the true *S. quinata* of the Pacific, but a distinct Malaysian species.[4] She has recently found the number $n = 58$ $(2 \times 29)$ in a plant of *Syngramma alismifolia* (Presl) J. Smith brought to Kew from Sarawak; but another recent observation on *Taenitis blechnoides* gives a quite different chromosome number, $n = 44$. (Prof. Manton has informed me verbally of these two records, and I am grateful to her for permission to mention them here.) The chromosomes thus provide additional evidence that *Taenitis* and *Syngramma* are not closely related genera (though I believe that they are more closely related to each other than either is to *Lindsaea*).

[3] Kew Bull. *1958:* 453.
[4] Cf. Holttum, Ferns of Malaya, pp. 580, 627. 1954.

## Dryopteris borreri in Bavaria

J. POELT

The species *Dryopteris borreri* Newm., sometimes incorrectly called *D. paleacea* (Swartz) Hand.-Mazz., has attracted much attention in recent years since Doepp and Manton have shown that it is a distinct species. They have shown that it exhibits constant apogamy, in spite of funtioning antheridia. There are many connections with *D. filix-mas* through hybrids, which are also apomictic. Concerning these cytogenetic conditions we may refer to the publications of the above-mentioned authors. Wolf, v. Tavel, Rothmaler, Nordhagen, Reichling, Lawalrée, and others have dealt with its geographic distribution in Europe; they show that these plants are on the whole restricted to the oceanic regions of western and southern Europe.

In Bavaria, it was mainly Paul who drew attention to these beautiful ferns. Since the Bavarian region lies on the northeastern limit of the European area for this species, and since moreover the winters in this region are not mild but rather cold, it may be appropriate to deal briefly with this small but interesting part of the whole area.

As indicated on the accompanying map, *Dryopteris borreri* has been found on the lower ranges of the northern rim of the Alps, in north-exposed valleys of the Northern Limestone Alps, and in some places of the adjacent region to the north. It is always found in glens of the northern slopes of mountains or in the hilly region mostly in deep holes, that is, in places where there is a continually high humidity during the vegetative season. The protection against frost, which is necessary for an oceanic species, is provided by the long-lasting cover of snow, which in glens on northern slopes and in holes, continues far into the spring, rather than by a mild climate, as it is in western Europe. There is a close parallel with *Ilex aquifolium*, whose survival on the northern range of the Alps likewise depends mainly on the snow cover in winter.

On the other hand, these ferns are not bound to any special type of soil, since everywhere enough organic matter is formed to produce sufficient top-soil and the minerals contain enough lime to prevent the soil from turning acid.

As is true elsewhere, it is not quite easy to bring the different forms of *Dryopteris borreri* occurring in Bavaria into a system. This is the result of the special cytogenetic conditions prevailing. As Doepp has shown, the transitional forms, hybrids with *D. filix-mas* and derived forms, are generally in the majority on

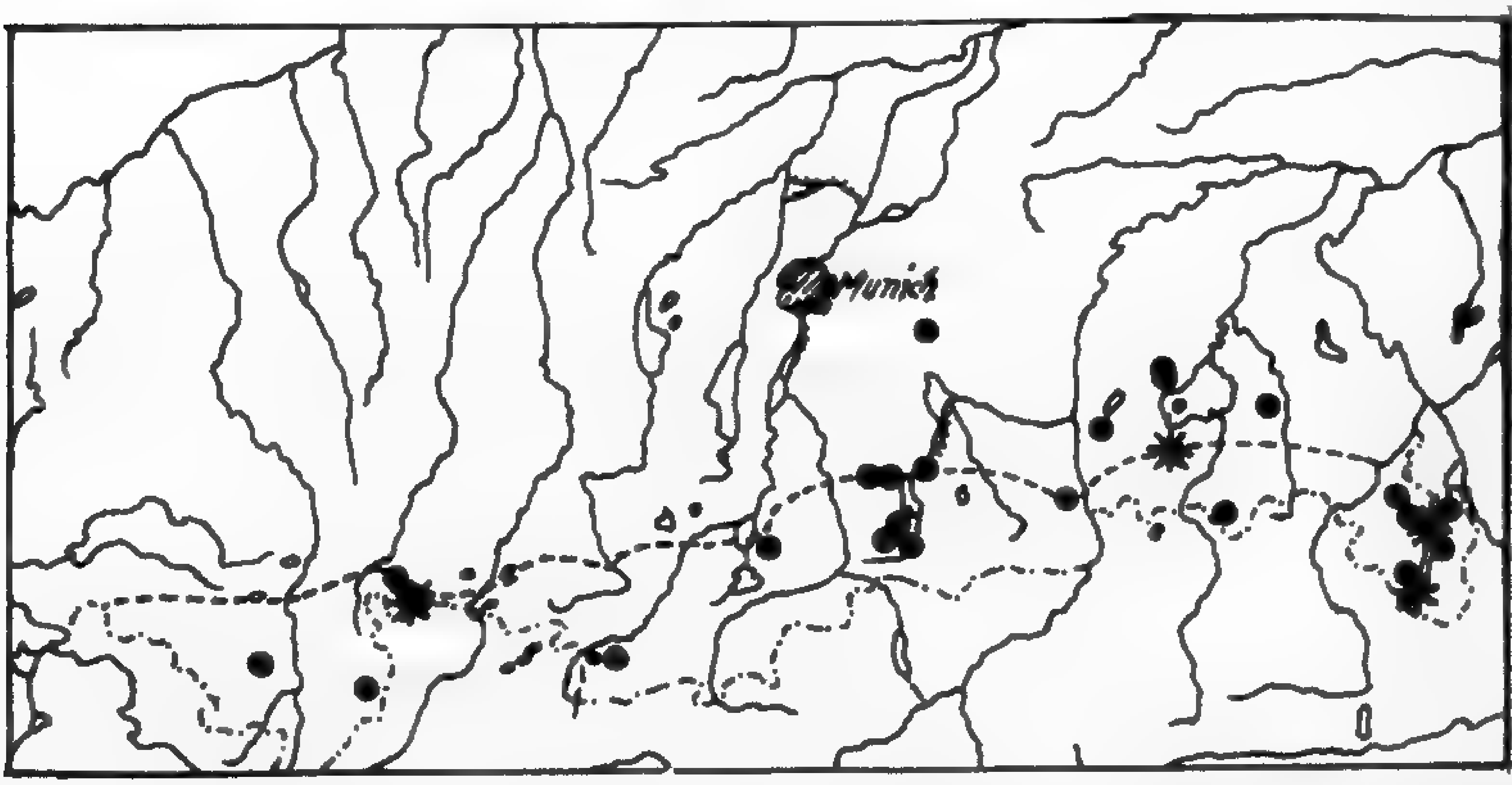



FIG. 1. ASTERISKS, LOCALITIES OF DRYOPTERIS BORRERI; DOTS, LOCALITIES OF D. X TAVELII AND UNCERTAIN FORMS; BROKEN LINE, NORTHERN BORDER OF THE ALPS; BROKEN AND DOTTED LINE, SOUTHERN BORDER OF BAVARIA

the borders of the area in which the species is found. This is especially true in southern Bavaria. It almost looked as if genuine *D. borreri* could not be found any longer in this region. Yet a few specimens found there have been proved to belong to this type both morphologically and in regard to the development of their spores. All these specimens are small plants with narrow, longish, pointed scales, with parallelogram-shaped pinnules, which are dentate at the apex but nearly smooth on the sides, and with brownish, strongly vaulted indusia. All the other specimens show definitely, though in different degrees, the influence of *Dryopteris filix-mas*, and must therefore have to be designated by the collective name *Dryopteris* × *tavelii* Rothmaler, which is the name applied to the cross *D. borreri* × *filix-mas.*

In some cases, it is quite impossible to arrive at an unambiguous decision. The reason is to be found in the facts stressed by Doepp that crossbreeds of *D. borreri* with *D. filix-mas* can hardly be distinguished from *D. borreri* by their appearance. A cytological examination of all specimens found in different regions is not possible. It is therefore the task of plant geography to fix the geographic distribution of all those forms that show the influence of *D. borreri.* This has in outline been done for Bavaria in the map in the present paper. We have to add that this species is not found in the other mountain ranges of Bavaria, like the Boehmerwald,[1] where a number of other oceanic species are found. The Bavarian area fits well into the general picture of the distribution of the species in the northern Alps, which extends from Switzerland to eastern Austria.

The few specimens of genuine *Dryopteris borreri* among an abundance of *D. tavelii* appear to prove that the present stock of specimens of the species in our region is a relic of an earlier climatically more favourable period, from which only the hybrids with *D. filix-mas* have managed to survive on a large scale down to the present time.

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[1] As has been shown by W. Freiberg, to whose kind help the author owes a great deal.

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## Notes on Pteridophytes from Australasia and New Caledonia, I

MARY D. TINDALE

Due to the impending publication of two new floras which will deal with pteridophytes occurring in southeastern Australia, it is necessary to publish the following two new combinations and a new species which will be either included in or mentioned in these books.

### BLECHNUM MINUS SUBSP. SCABRUM

BLECHNUM MINUS (R. Br.) Ettingsh. in Denkschr. Ak. Wien *23:* 63. 1864, subsp. **scabrum** (Domin) Tindale, *comb. et stat. nov.*

BASIONYM: *Blechnum capense* (L.) Schlecht. var. *scabrum* Domin, in Bibl. Bot. *85:* 116. 1913.

HOLOTYPE: Australia, Sieber Syn. Fil. exsic. No. 107. Domin does not state in which herbarium this specimen is located but I have examined isotypes bearing this label in the Natural History Museum, Paris, and in the Riksmuseum, Stockholm. Both specimens agree well with Domin's description.

A short description of *B. minus* ssp. *scabrum* is provided below:

*Rhizome* consisting of a short, erect caudex up to 5 cm. high and a horizontal, stoloniferous portion; caudex densely scaly, the scales long-acuminate, very thick, entire, very glossy, linear (more than 6:1) to narrowly lanceolate (6:1), chestnut or dark red-brown, brown or dark brown with light chestnut-coloured borders, up to 2.5 cm. long and up to 3 mm. broad, with a fibrillose, twisted apex. *Stipes* usually red-brown or black, strongly tuberculate. *Main rhachis* red-brown or black, rarely fawn towards the apex. *Fronds* up to 120 cm. in length including the stipes. *Sterile pinnae* gradually much smaller towards the base, thinly to thickly coriaceous, up to 25 cm. long and 3 cm. broad, closely spaced, often imbricate, prominently auriculate, the auricles up to 5 cm. long and up to 1.5 cm. broad, the apex of the pinnae acute or obtuse, the margin minutely serrulate. *Fertile pinnae* lomarioid. *Spores* bilateral, elliptical or subglobose, with a slightly reticulate perispore and a narrow, erosely dissected wing.

This variety is raised to subspecific rank on ecological and geographical grounds. It ranges from Fraser Island, south-eastern Queensland, to the South Coast region of New South Wales, where subsp. *scabrum* occurs in swampy, low-lying land not far from the sea. However, *B. minus* subsp. *minus* is usually found on the tablelands of New South Wales and Victoria along river banks and creeks in narrow mountain gorges, at the edge of waterfalls, along the banks of streams in eucalypt forests and in swampy creeks in cleared rain-forest areas. In Victoria and Tasmania the type subspecies is found in more coastal regions, *e.g.* there is a very old record (NSW. P4372) collected in 1853 on the banks of the River Yarra, Victoria, near Prince's Bridge, now in the heart of the present city of Melbourne. The type of subsp. *minus* was collected by Robert Brown in 1804 at Port Dalrymple at the mouth of the River Tamar, Tasmania (BM).

Some representative specimens of *B. minus* subsp. *scabrum* are as follows: QUEENSLAND: Fraser Island, Wide Bay District, *C. E. Hubbard* no. 4576, 17 Oct., 1930 (NSW. P8046). NEW SOUTH WALES: Wamberal, *T. Whitelegge*, 29 Dec., 1916 (NSW. P4343); Collaroy, *E. C. Chisholm*, 5 Dec., 1939 (NSW. P4348); Oatley, *J. H. Camfield*, Feb., 1897 (NSW. P4356); Kogarah Bay, *A. A. Hamilton*, June, 1901 (NSW. P4340); Kurnell, Botany Bay, *J. L. Boorman*, May, 1906 (NSW. P1245).

Many of the swampy sites in the George's River district of

Sydney, N.S.W., where *B. minus* subsp. *scabrum* was frequently collected at the turn of the century, have been reclaimed and are covered with houses, so that this fern has become very uncommon.

The following key will serve to distinguish the above-mentioned subspecies:—

A. Sterile and fertile pinnae not auriculate at the base or the lower pairs very slightly auriculate; scales of the rhizome dull, mostly concolorous, rarely with a paler border; stipes stramineous, sometimes mottled with brown, the base dark brown, smooth or slightly tuberculate. *B. minus* subsp. *minus*

A. Sterile and fertile pinnae very prominently auriculate at the base; scales of the rhizome glossy with a darker central band; stipes dark red-brown or black, very tuberculate ... ..... *B. minus* subsp. *scabrum*

### ADIANTUM CUNNINGHAMII

At my request the late Mr. A. H. G. Alston took photographs of the type of *Adiantum affine* Willd. in the Berlin Herbarium several years ago. These photographs left no doubt that this fern is the cosmopolitan *Adiantum Capillus-veneris* L., not the fern known as *A. affine* in New Zealand and Australia. The pinnules of the holotype of *A. affine* are cuneate-flabellate (see plate *12*) instead of rhomboidal as in the fern hitherto known by this name. The latter species must now be called *A. Cunninghamii* Hook. which was described[1] from a number of specimens collected in the North Island of New Zealand. After a comparison of material from Australia and New Zealand, I have concluded that the Australian material is not sufficiently different to be regarded as a separate species. With one exception (*i.e.* NSW. P2636, from Rockingham Bay, Queensland) the scales of the rhizome in the Australian specimens that I have examined are golden-brown instead of dark red-brown as in the New Zealand material; also the scales on the rhizomes of the latter tend to be slightly larger.

There are two varieties in *A. Cunninghamii*, one with glabrous

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[1] Spec. Fil. *2: 52. t. 86A.* 1858.

ADIANTUM AFFINE, TYPE. BERLIN HERBARIUM. PHOTOGRAPH BY A. H. G. ALSTON rhachises and another in which the upper surfaces of the main and secondary rhachises are clothed with dark brown, crisped hairs. I have seen no intermediates between the two types of rhachises in the Australian material, although specimens with the main rhachis glabrous and the upper surface of the secondary rhachises hirsute do occur amongst the New Zealand specimens according to Cheeseman,[2] but these may be hybrids with *A. fulvum* Raoul.

Hooker's original description of this species was drawn up from New Zealand specimens all of which had glabrous rhachises, so that this would now become the type variety, *i.e. A. Cunninghamii* Hook. var. *Cunninghamii.* The material with hirsute rhachises from eastern Australia may be placed in *Adiantum Cunninghamii* Hook. var. **intermedium** (Benth.) Tindale, *comb. nov.*, which is based on *A. affine* Willd. var. *intermedium* Benth.,[3] the type specimen of which was collected at Rockingham Bay, Queensland, Australia, by Dallachy, and is preserved in the Herbarium, Royal Botanic Gardens, Kew, England. Dr. A. C. Jermy very kindly examined this specimen and checked that there are dark brown, crisped hairs on the upper surface of the rhachises.

In the Australian material examined, specimens with glabrous rhachises are more common in northeastern Queensland but extend as far south as Bulgong Heights, North Coast, N.S.W. (e.g. NSW. P2624). In the southern part of its range in Australia the var. *intermedium* predominates especially on the North Coast, Central Tablelands, and Central Coast of New South Wales. Some typical examples from the latter state are as follows: NSW. P7017, Whian Whian State Forest, *E. F. Constable,* 15 Jan., 1953; The Dome, Dorrigo, *M. Tindale,* 24 Apr., 1944 (NSW. P1982), and Brittania Falls, Valley of the Waters, Blue Mountains, *Constable,* 7 Feb., 1949 (NSW. P5655), and similar specimens are found in southeastern Queensland and on the Atherton Tableland, North Queensland.

[2] Man. N. Zeal. Fl. 73. 1925.
[3] Fl. Austr. *7:* 725. 1878.

On the whole the specimens collected in the rainforests of New South Wales are larger, more robust and less glaucous than those from northeastern Queensland, although exceptions do occur such as NSW. P6721 collected at Linden, Blue Mountains, N.S.W., which is smaller and less branched, agreeing well with material from Queensland. NSW. P452 from the Cairns district, northeastern Queenland, is a very robust plant with hirsute rhachises.

### DICTYMIA MCKEEI

During several visits to New Caledonia between 1954 and 1958, Dr. H. S. McKee made a number of interesting collections of pteridophytes several of which have proved to be undescribed species, one of them being described below :—

DICTYMIA *McKeei* Tindale, *sp. nov.* Filix epiphytica. Rhizoma late repens 1.5–2 mm. crassum glaucum glabrescens, paleis fugacibus adpressis clathratis, e basi peltata suborbicularibus. in apicem longum acuminatum contractis, fimbriatis et brunneo-nigris. Stipites remoti basi ad rhizoma articulati, erecti straminei vel pallide fusci, 1.7–6.2 cm. longi, 0.5–1.2 mm. lati, praeter phyllopodium glabrati. Frondes simplices lineari-ellipticae subdimorphae glaberrimae subcoriaceae anguste cartilagineo-marginatae. Lamina fertilis 10–21 cm. longa, 1.2–1.6 cm. lata, integra, apicem versus subsinuata, basin versus breviter cuneata, apice acuminata vel subacuta. Lamina sterilis 7.5–13 cm. longa, 1–1.5 cm. lata, apice obtusa. Venae reticulatae obliquae, anastomosantes, seriem circa 4 areolarum formantes, areolis plerumque 4- vel 5-angulatis, raro venulis perpaucis liberis in areolis inclusis. Costa utraque facie prominens, pallide fusca, supra non sulcata. Sori 4–11 exindusiati superficiales orbiculares vel ovales, partem superiorem frondium occupantes, prope marginem dispositi, uniseriati, supra pustulati, 3–7 mm. longi, 2–5 mm. lati. Paraphyses nullae. Sporangia nuda; annulis ex 12–15 cellulis incrassatis, 6 cellulis tenuibus et stomio 2-cellulo; pedicellis elongatis, angustissimis saepe castaneis, sursum 2 cellulis latis, basi 1 cellulis latis. Sporae bilaterales reniformes hyalinae minime profunde reticulato-tuberculatae.

Epiphytic fern. *Rhizome* widely creeping, 1.5–2 mm. in diam., glaucous, glabrescent, paleaceous, the scales fugacious, appressed, clathrate, peltate-based, suborbicular, contracted into a long-acuminate apex, fimbriate, and brownish-black. *Stipes* remote, articulated at the base to the rhizome, erect, stramineous or fawn, 1.7–6.2 cm. long, 0.5–1.2 mm. broad, glabrous except the basal joint, this clothed with the same type of scales as on the rhizome. *Fronds* simple, linear-elliptical, subdimorphic, glabrous, subcoriaceous, narrowly cartilaginous-margined. *Fertile lamina* 10–21 cm. long, 1.2–1.6 cm. broad, entire, subsinuate towards the apex, shortly cuneate towards the base, the apex acuminate to subacute. *Sterile lamina* 7.5–13 cm. long, 1–1.5 cm. broad, the apex obtuse. *Veins* reticulate, oblique, anastomosing, forming a series of about 4 areolae, the latter usually 4- or 5-angled, rarely with a very few, free, included veinlets in the areolae. *Costa* prominent on both surfaces, fawn, not grooved above. *Sori* 4–11 on each frond, exindusiate, superficial, orbicular to oval, occupying the upper part of the frond, in a single row close to the margin, pustulate on the upper surface, 3–7 mm. long, 2–5 mm. broad. *Paraphyses* absent. *Sporangia* glabrous, the annulus with 12–15 indurated cells, 6 thin-walled cells and a 2-celled stomium, the pedicel elongated, very narrow, often castaneous, 2-celled above, 1 cell broad at the base. *Spores* bilateral, reniform, hyaline, shallowly reticulate-tuberculate.

HOLOTYPE: On the road to l'Hermitage, Nouméa district, New Caledonia, 400 m. alt., climbing on a tree trunk, in rain-forest, H. S. McKee No. 2126, 20 Feb., 1955 (NSW. P8036). The holotype is in the National Herbarium, Royal Botanic Gardens, Sydney, Australia; isotypes BM, US).

OTHER SPECIMENS EXAMINED:

NEW CALEDONIA: Mount Koghi, above l'Hermitage, 500–800 m. alt., on a tree trunk, on a forested slope, *H. S. McKee* 3941, 4 Feb., 1956 (NSW. P8037); Koghi, 400 m. alt., troncs et arbres vivantes, forêts, *Franc* 470, 2 Feb., 1909 (NSW. P8038).

*Dictymia McKeei* belongs to a small genus of three or possibly four species occurring in Australia, New Caledonia, and Fiji. It is closely related to *D. Mettenii* (Copel.) Copel., of New Caledonia, and *D. Brownii* (Wikstr.) Copel., of eastern Australia, but is distinguished readily by the linear-elliptical laminae which terminate rather abruptly in the stipes, whereas in the other two species the linear-loriform laminae taper very gradually into the stipes. In the two above-mentioned species from New Caledonia, the scales of the rhizome are very fugacious and the sori are almost marginal, whereas in *D. Brownii* the rhizome scales are persistent and the sori are half-way between the midrib and margin. In *D. McKeei* there are a few, free included veinlets in the areolae which breaks down a supposed generic characteristic of *Dictymia,* since they do not occur in any of the hitherto described species. I have seen no material of this genus from Fiji.

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In conclusion I should like to express my gratitude and appreciation for the facilities afforded by the directors and keepers of the following institutions: The Herbarium, Kew; the British Museum of Natural History, South Kensington; the Museum d'Histoire Naturelle, Paris; the Riksmuseum, Stockholm; the National Herbaria at Sydney and Melbourne, and the Botanic Museum and Herbarium, Brisbane. My thanks are also due to Dr. H. S. McKee, Dr. A. C. Jermy, Mr. L. A. S. Johnson, and the late Mr. A. H. G. Alston for their assistance in various ways.

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## The Nomenclature of a Japanese Ophioglossum

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In 1883, Carl Prantl (1883: 353) described a new species of Adder's-tongue as *Ophioglossum japonicum,* basing his description on material preserved in the herbarium of the Botanisches Museum, Berlin-Dahlem, that had been collected at Ujeno, Japan, by P. Hilgendorf[1] and near Tokyo by Wilhelm Doenitz, who collected in Japan during the period 1873–1879. Prantl overlooked or disregarded the existence of the earlier homonymous species *Ophioglossum japonicum* Thunb. (Thunberg 1784: 329). Although the latter species is now referred to the genus *Lygodium*, as *L. japonicum* (Thunb.) Swartz, it still renders the later homonym *O. japonicum* Prantl illegitimate.

Miyabé and Kudô (1916: 121) proposed the new name *Ophioglossum nipponicum*, which is clearly a renaming of *O. japoni-*

[1] According to this collection date, it seems that P. Hilgendorf collected in Japan as early as 1873. The dates "1874–1876" given by Lanjouw and Stafleu (1957: 275) should therefore be corrected.

*cum* Prantl (*non* Thunb.) from the synonymy cited and from the fact that it is indicated as a "*nomen novum.*" It seems likely that the specimens cited by Miyabé and Kudô from Hokkaido and Honshu belong taxonomically—at least in part—to *O. vulgatum* L. This is, however, irrelevant, for the type of *O. nipponicum* must be the same as the type of *O. japonicum* Prantl. Therefore, as a species the name *O. nipponicum* Miyabé & Kudô is correct.[2]

Overlooking the prior publication of *O. nipponicum* Miyabé & Kudô, William R. Maxon realized that *O. japonicum* Prantl was illegitimate and proposed the new name *O. angustatum* (Maxon 1923: 169). Two years later, Nakai (1925: 193) independently renamed *O. japonicum* Prantl as *O. nipponicum* Nakai, using the same specific epithet *nipponicum* by a coincidence. One year later, Nakai (1926: 375) became aware of the apparent conflict and renamed his *O. nipponicum* as *O. Savatieri.* All these later names are illegitimate, since they were superfluous when published, all being based ultimately on the same two syntypes cited by Prantl.

There is however a name based on another type that has to be considered. In 1915, O. A. and B. A. Fedtschenko described an *Ophioglossum vulgatum* L. var. *bucharicum,* based on a specimen collected by S. I. Korshinsky near Kabadiansk, in Bukhara, which is preserved in the herbarium of the Botanical Garden, Leningrad. Later, the same authors (1923: 8) raised their variety to specific rank, as *O. bucharicum.* Even though it is from quite a different locality, there is little doubt that this entity is conspecific with *O. nipponicum.* The illustration of Komarov (1934: *pl. 3, fig. 9*) matches perfectly material of *O. nipponicum* from Japan. Christensen (1934: 133) and Clausen (1938: 129) consider the names synonymous.

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[2] Specimens collected by Savatier (no. 1613) from the foot of Fudji-Yama and reported by Franchet and Savatier (1876: 252) as *O. vulgatum* belong to this species according to Nakai (1925: 193). The species was also reported (erroneously) as *O. nudicaule* L. f. by H. Christ (1896: 675) from specimens collected on the "Dunes de Sandai" by Père Urbain Jean Faurie (no. 4294).

Recently, the Japanese student of *Ophioglossum* M. Nishida has considered the plant in question as only varietally distinct from *O. thermale* Komarov, a species name dating from 1914 and therefore having two years' priority over *O. nipponicum*, and therefore has proposed the new combination *O. thermale* var. *nipponicum*. It seems likely that he is correct that *O. nipponicum* is only a morphologically slightly different form of *O. thermale*, which ranges from Kamtchatka through Japan south to Formosa and India and west through China into the Pamir-Alai region in central Asia. However, as a variety the epithet *bucharicum* has priority and therefore the following new combination is needed:

OPHIOGLOSSUM THERMALE Komarov, Repert. Sp. Nov. Fedde *13:* 85. 1914, var. **bucharicum** (O. A. & B. A. Fedtschenko) H. P. Fuchs, *comb. nov.*

*Ophioglossum japonicum* Prantl, Ber. Deut. Bot. Ges. *1:* 353. 1883; Jahrb. Bot. Gart. Berlin *3:* 327, *pl. 8, fig. 29.* 1884, *non* Thunb., 1784.

*Ophioglossum vulgatum* L. var. *bucharicum* O. A. & B. A. Fedtschenko in Fedtschenko, Rastitel'nost Turkestana 20. 1915.

*Ophioglossum nipponicum* Miyabé & Kudô, Trans. Sapporo Nat. Hist. Soc. $6^2$*:* 121. July, 1916 (*excl. coll. partim*).

*Ophioglossum bucharicum* O. A. & B. A. Fedtschenko, Not. Syst. Herb. Hort. Bot. Petrop. *4:* 8. Jan. 15, 1923.

*Ophioglossum angustatum* Maxon, Proc. Biol. Soc. Washington *36:* 169. May 1, 1923.

*Ophioglossum nipponicum* Nakai, Bot. Mag. Tokyo *39:* 193. 1925.

*Ophioglossum Savatieri* Nakai, *op. cit. 40:* 374. 1926.

*Ophioglossum thermale* var. *nipponicum* Nishida ex Tagawa, Journ. Jap. Bot. *33:* 203. July, 1958; Nishida, *op. cit. 34:* 45, 124, 125. 1959.

*Ophioglossum vulgatum sensu auctt., e.g.* Franch. & Sav. Enum. Pl. Jap. *2:* 252. 1879, *non* L.

*Ophioglossum nudicaule sensu auctt., e.g.* Christ, Bull. Herb. Boiss. *4:* 675. Oct., 1896 et Makino, Bot. Mag. Tokyo *12:* 376. 1897, *non* L. f.

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## A Synopsis of Sceptridium in Japan

MAKOTO NISHIDA

Lyon (1905) emphasized the presence of a suspensor in the embryo of *Botrychium obliquum* Muhl., which had been referred to the section *Phyllotrichium*, and took this up as the chief diagnostic mark for the new genus *Sceptridium,* to which he transferred all the species previously placed in the section *Phyllotrichium.* However, almost all pteridologists since (Eames, 1936, for example) have not recognized the character of the suspensor as a valid diagnostic feature, for the gametophyte had been examined only in the single species *B. obliquum.* Eames regarded it as a specific feature that is changeable, as it is in the order Marattiales within a genus or sometimes even within the same species, as in *Angiopteris evecta* Hoffm. I found a suspensor also in the embryo of *B. japonicum* and supported Lyon's proposal for using the suspensor as a generic character (Nishida

[3] Concerning the dates of publication, see Ohwi, Act. Phytotax. Geobot. *2:* 307, 308. November, 1933.

1954, p. 55). Moreover, I have reached the conclusion that the genus *Sceptridium* would be acceptable by the appreciation of the significance of the vascular anatomy of the phyllomophore, the so-called "common-stalk" (Nishida, 1952, p. 57).

It is natural, I think, from the viewpoints of vascular anatomy and sporangial structure, to divide the order Ophioglossales into two suborders, the Ophioglossineae and Botrychiineae, and three families—Ophioglossaceae, Helminthostachyaceae, and Botrychiaceae (Nishida, 1952, p. 59). The family Botrychiaceae contains the three genera *Sceptridium*, *Botrychium*, and *Japanobotrychium* (*Osmundopteris*).

KEY TO THE GENERA OF BOTRYCHIACEAE

Phyllomophore ("common-stalk") short; sterile blade with a long petiole, longer than or equal to the phyllomophore, producing a fertile blade from its basal part. Embryo endoscopic, with suspensor.
*Sceptridium* Lyon

Phyllomophore at least longer than the petiole of the sterile blade; sterile blade sessile or with a short petiole producing the fertile blade.

Small plant 5-20 (30) cm. high, with pinnately or bipinnately divided, coarsely herbaceous, brownish or dirty green, glabrous sterile blades; buds glabrous or glabrescent, developed endogenously in the tissue of the basal parts of the phyllomophore; vascular divisions in the phyllomophore typically dichotomous; embryo exoscopic, without suspensor ........ *Botrychium* Swartz

Larger plants 30-60 (80) cm. high, with 3- or 4-pinnately divided blades; sterile blades sessile, thin-herbaceous, yellowish or bright green, with scattered white hairs on the veins and veinlets on the dorsal (abaxial) surface; buds densely covered with white hairs, developed in crevices opening at the bases of the phyllomophores; vascular branch-traces arising extra-marginally;[1] embryo exoscopic, without suspensor.
*Japanobotrychium* Masamune[2]

SCEPTRIDIUM Lyon

Sceptridium Lyon, Bot Gaz. *40:* 457. 1905; Nishida, Journ. Jap. Bot. *27:* 257. 1952.

*Botrychium* sect. *Phyllotrichium* Prantl., Bericht. Deut. Bot. Ges. *1:* 349. 1883; Jahrb. Bot. Gart. Berlin *3:* 336. 1884; Copeland, Gen. Fil. 12. 1947.

[1] Chrysler, 1945; Nishida, 1957.
[2] Tagawa, 1958.

*Botrychium* subg. *Sceptridium* Clausen, Mem. Torrey Club *19:* 24. 1938.

Phyllomophores short, 1–5 cm. long (sometimes, in *S. daucifolium,* equal to the petiole of the sterile blade); medium-sized plants, (10) 15–40 cm. high, with rather thick-herbaceous, dark green, 2–3-pinnately divided sterile blades, more or less hairy or glabrescent, densely covered with deciduous, long, white hairs in juvenile stages; vascular traces to sterile and fertile blades isomarginal[3] or rarely and slightly extra-marginal (in *S. multifidum*); embryo endoscopic, with suspensor.

TYPE: *Sceptridium obliquum* (Muhl.) Lyon, Bot. Gaz. *40:* 458. 1905. *Botrychium obliquum* Muhl. ex Willd. in L. Sp. Plant. *5:* 63. 1810. *Botrychium dissectum* Sprengel var. *obliquum* Clute, Fern Bull. *11:* 89. 1903, *sec.* Clausen, Mem. Torrey Bot. Club *19:* 82. 1938.

KEY TO THE JAPANESE SPECIES OF SCEPTRIDIUM

Spores with echinate exine; terminal segments of principal pinnae and pinnules elongate; ultimate sterile segments of different sizes and shapes (Sect. *Sceptridium*).
- Fertile blades not conspicuously overtopping the sterile and about equalling the latter in length; phyllomophore more or less elongate, about equalling the stalk of the sterile blade ........ *S. daucifolium*
- Fertile blades much longer than the sterile; phyllomophore short, less than half the length of the stalk of the sterile blade ........ *S. japonicum*

Spores smooth; terminal segments of sterile pinnae and pinnules not elongate (or sometimes so); ultimate sterile segments all the same size and shape (Sect. *Multifida*).
- Sterile blades with longish (1–3 mm.), brownish hairs on the dorsal (abaxial) surface even in mature stages; sterile blades with the short stalks of the pinnae and pinnules not strongly ternate.
  - Terminal segments of the principal sterile pinnae elongate; ultimate segments minutely dentate or serrate ........ *S. minus*
  - Terminal segments obtuse or acutish, not elongate; ultimate segments entire or crenate, sometimes roughly serrate.
    - Plants small, 5–15 (20) cm. high, not strongly hairy; ultimate segments roundish or rhomboid (or rarely ovoid), entire or crenate. *S. multifidum* var. *multifidium*

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[3] Nishida, 1957.

Plants large, (15) 20–40 cm. high, sparingly hairy; ultimate segments acutish, oblong or ovoid, crenulate or serrate.
*S. multifidum* var. *robustum*

Sterile blades glabrous, rarely with a few, short (0.5-1 mm. long), white hairs on the costae of the pinnae and pinnules; sterile blades with the longer stalks of the pinnae and pinnules typically ternate.

Terminal segments of the principal pinnae and pinnules more or less elongate; ultimate segments acutish, with minutely serrate or cut margins; veinlets visible ........ *S. ternatum* var. *nipponicum*

Terminal segments obtuse or acutish, not elongate; ultimate segments ovoid or oblong, with entire or evenly crenulate margins; veinlets not visible ........ *S. ternatum* var. *ternatum*

A SYNOPSIS OF THE JAPANESE SPECIES

I. Sect. SCEPTRIDIUM. *Botrychium* sect. *Elongata* Clausen, Mem. Torrey Club *19:* 48. 1938 (as "*Elongatae*").

1. SCEPTRIDIUM JAPONICUM (Prantl) Lyon, Bot. Gaz. *40:* 457. 1905.

*Botrychium daucifolium β japonicum* Prantl, Jahrb. Bot. Gart. Berlin *3:* 340. 1884.

*Botrychium japonicum* Underwood, Bull. Torrey Club *25:* 538. 1898; Nakai, Bot. Mag. Tokyo *40:* 382. 1926.

NOM. JAP.: O-hanawarabi.

RANGE: Central and southern Japan, from Tanegashima Island, Kagoshima Prefecture, to Yamagata Prefecture; eastern China and Korea.

HABITAT: Shady bamboo thickets or forests.

2. SCEPTRIDIUM DAUCIFOLIUM (Wall.) Lyon, Bot. Gaz. *40:* 457. 1905.

*Botrychium daucifolium* Wall. ex Hook. & Grev., Icon. Fil. *t. 161.* 1829; Tagawa, Journ. Jap. Bot. *22:* 160. 1948; Nishida, Journ. Jap. Bot. *31:* 374. 1956.

*Botrychium formosanum* Tagawa, Act. Phytotax. Geobot. *9:* 87. 1940.

NOM. JAP.: Horai-hanawarabi.

RANGE: Yakushima Island, Kagoshima Prefecture, and Aogashima Island, Izu Islands. Aogashima is the northern limit for this species.

HABITAT: Rare, in evergreen forests.

II. Sect. MULTIFIDA (Clausen) Nishida, *comb. nov. Botrychium* sect. *Multifida* Clausen, Mem. Torrey Club *19:* 26. 1938 (as "*Multifidae*").

3. SCEPTRIDIUM MULTIFIDUM (Gmelin) Nishida in Tagawa, Journ. Jap. Bot. 33: 200. 1958.

Var. MULTIFIDUM.

*Osmunda multifida* Gmelin Nov. Comm. Acad. Petr. *12:* 517. 1768.

*Botrychium multifidum* Rupr. Beitr. Pfl. Russ. Reich. *11:* 40. 1859; Ohwi, Flora Jap. Pteridophyta 19. 1957.

NOM. JAP.: Yama-hanawarabi.

RANGE: Central and northern Honshu; *Fagus* and coniferous zones of the northern hemisphere.

HABITAT: Grassy open land and meadows, sometimes in deciduous *Fagus*-forests.

Var. ROBUSTUM (Rupr.) Nishida in Tagawa, Journ. Jap. Bot. *33:* 201. 1958.

*Botrychium rutifolium* var. *robustum* Rupr. ex Milde, Nov. Act. Nat. Cur. Caes. Leop. *26:* 763. 1859.

*Botrychium robustum* Underwood, Bull. Torrey Club *30:* 51. 1903.

*Sceptridium robustum* Lyon, Bot. Gaz. *40:* 458. 1905.

*Botrychium matricariae sensu* Miyabe et Kudo, Trans. Sapporo Nat. Hist. Soc. *6:* 124. 1916.

*Botrychium multifidum* subsp. *robustum* Clausen, Bull. Torrey Club *64:* 272. 1937; Mem. Torrey Club *19:* 34. 1938.

NOM. JAP.: Yezo-fuyuno-hanawarabi.

RANGE: Common in Hokkaido (Yezo) and rare in northern Honshu; North America, Alaska, Kamtchatka, and Siberia.

HABITAT: Shady woodlands in the *Fagus*-zone.

4. SCEPTRIDIUM MINUS (Hara) Nishida in Tagawa, Journ. Jap. Bot. *33:* 201. 1958.

*Botrychium japonicum* var. *minus* Hara, Journ. Jap. Bot. *9:* 127. 1933.

NOM. JAP.: Usui-hanawarabi.

RANGE: Usui-toge Pass, near Karuizawa, Gumma Prefecture, and Mount Hakone, Kanagawa Prefecture; endemic in central Japan.

HABITAT: Rare in *Fagus*-zone.

Inasmuch as the chief terminal segments of the pinnae and pinnules of this species are elongate, it would seem at first glance to belong to the section *Sceptridium.* However, the character of the spore-coat proves that it should be classed in section *Multifida.*

5. SCEPTRIDIUM TERNATUM (Thunb.) Lyon, Bot. Gaz. *40:* 458. 1905.

Var. TERNATUM.

*Osmunda ternata* Thunb. Fl. Jap. 329, *t. 32.* 1784.

*Botrychium ternatum* Swartz in Journ. Bot. Schrader 1800[2]: 111. 1801; Nakai, Bot. Mag. Tokyo *40:* 483. 1926.

NOM. JAP.: Fuyuno-hanawarabi.

RANGE: Central and southern Japan, ranging from Sendai, Miyagi Prefecture, to Tanegashima, Kagoshima Prefecture; Korea, Formosa, China, and the Himalaya Mountains.

HABITAT: Meadows, grassy open lands, and woodlands, at elevations of less than 500 meters.

Var. NIPPONICUM (Makino) Nishida, Journ. Jap. Bot. *34:* 137. 1959.
*Botrychium nipponicum* Makino, Journ. Jap. Bot. *1:* 5. 1916; Nakai, Bot. Mag. Tokyo *40:* 383. 1926.
NOM. JAP.: Aka-hanawarabi.
RANGE: Saitama, Chiba, Aichi, Gifu, Nara, and Okayama Prefectures; endemic in central Japan.
HABITAT: In woodlands in lowlands.

Dr. Makino indicated that *Botrychium nipponicum* was very closely allied to *B. japonicum,* differing in having a latericious-colored frond, conspicuous veins, and shorter and closer serration. Inasmuch as the chief terminal segments of the sterile pinnae are somewhat elongate, he considered that this species must be allied to *B. japonicum.* However, the former has the segment margins minutely serrate instead of roughly dentate as in *B. japonicum.* I take the character of the spore-coat as a diagnostic feature distinguishing this species from *B. japonicum.* Going on this spore-character, *B. nipponicum* is closely allied to *B. ternatum* and I consider it only varietally separable. *Sceptridium ternatum* itself is so closely similar to *S. multifidum* that the two are very difficult to distinguish. Although the former may be an ecological variant of the latter, I separate them tentatively by the diagnostic features mentioned in the key. In *S. multifidum,* the texture of the sterile blades is thick and coarsely herbaceous, rather than thin and more or less membranaceous as in *S. ternatum.* In *S. multifidum* there is a membranaceous sheath, the remnant of the withered phyllomophore of the preceding year, persistent at the base of the phyllomophore of the current year; such a sheath is lacking in *S. ternatum.*

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## The Identification of Aspidium distans Viv.

RODOLFO E. G. PICHI-SERMOLLI

*Aspidium distans* was described by Viviani[1] from specimens collected "in Corsicae sylvis *Allo Spedale*" by an old student of his, Dr. Stefano Serafini. Viviani gave a short description of his species and, following the conceptions of his time, properly referred it to the genus *Aspidium.* Nevertheless, his species was misinterpreted by succeeding authors since the first years of its publication.

In 1827, Sprengel[2] regarded *Aspidium distans* as a synonym of *Woodsia ilvensis* (L.) R. Brown, in spite of the fact that Viviani gave the dimensions of the fronds as two feet long or more. Bertoloni[3] studied a specimen sent to him from Viviani and treated *A. distans* as a good species; he described the fern more carefully and pointed out Sprengel's mistake too. Nevertheless, *Aspidium distans* continued to be referred to *Woodsia ilvensis* by Moore,[4] Milde,[5] Luerssen,[6] and other authors. Viviani's species was considered again by Cesati, Passerini, and Gibelli,[7] who regarded it as an independent species and proposed for it the new combination *Nephrodium distans.*[8] However, in a footnote, they observed that it remained to be seen if the species corresponded to *Aspidium paleaceum* Don.

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1 Appendix ad Florae Corsicae Prodromum 8. 1825.
2 Syst. Veg. *4*¹*:* 125. 1827.
3 Fl. Ital. Crypt. *1:* 53. 1858.
4 Ind. Fil. 90. 1858.
5 Fl. Europ. Atl. 165. 1867.
6 Farnpfl. in Rabenhorst, Krypt. Fl. Deutschl. ed. 2, *3:* 508. 1887.
7 Comp. Fl. Ital. 18. 1868.
8 This binomial was overlooked by Christensen in the "Index Filicum" (1906) and listed only in the first "Supplementum" (p. 51. 1913). It is a later homonym of *N. distans* Hook., from Madagascar.

Lectotype of Aspidium distans in Herb. Bertoloni, Bologna

A more careful study was carried out by Trevisan, who examined Viviani's type, kept at that time in the Genoa herbarium. In the part of his very interesting paper "Sylloge Sporophytarum Italiae,[9] dealing with this fern, Trevisan gave some information on the type material and on the identification of Viviani's species. He pointed out that Viviani's specimens in the Genoa herbarium, although very young, were fertile and that the sori were clearly smaller than those of *Polystichum filix-mas.* He regarded Viviani's fern as nearer to *Polystichum filix-mas* var. *borreri* (Newm.) Trevis. than to any other, differing in having the stipe very densely covered with scales, the blades longer, and lanceolate, the secondary segments obtuse and subcrenate, and the piliform scales of the under-surface and the edges of the segments longer and denser. He concluded that this fern belongs in the genus *Polystichum* (in his sense, i.e. *Dryopteris sensu* Christensen) and is an independent species for which he proposed the new combination *Polystichum distans.*[10] However, in a note added in proof after the study of some specimens in the herbarium of Comolli in Pavia with fronds more aged than those of Viviani, Trevisan clearly expressed some doubt that *P. distans* coud be kept distinct from *P. filix-mas.*

Probably influenced by the uncertainty shown by Trevisan in the above-mentioned note added in proof, Fiori[11] regarded Viviani's fern as a variety of the male fern, and proposed the new combination *Nephrodium filix-mas* var. *distans* (Viv.) Fiori. Some time later, the same author[12] treated this plant as a synonym of *Polystichum filix-mas* (L.) Roth, and still more recently he considered *Aspidium distans* Viv. as a doubtful species.[13] A different identification of the species was made by Briquet,[14] who

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[9] Atti Soc. Ital. Sci. Nat. *17*³*:* 213–258. 1875.

[10] *Polystichum distans* (Viv.) Trevis. was not listed in Christensen's "Index Filicum" (1906) but only in the first "Supplementum" (p. 64. 1913). It is a later homonym of *P. distans* Fourn. (1872).

[11] In Fiori & Paoletti, Fl. Anal. Ital. *4:* 3. 1907.

[12] Fiori, Nuov. Fl. Anal. Ital. *1:* 23. 1923.

[13] Fiori, Fl. Ital. Crypto. 5, Pterid. 103. 1943.

[14] Prodr. Fl. Corse *1:* 11. 1910.

regarded Viviani's fern as a synonym of *Dryopteris rigida* (Hoffm.) Underw. var. *australis* (Ten.) Briq. In more recent times, Wolf[15] regarded *A. distans* as doubtfully belonging to *Dryopteris borreri* Newm. Finally, Rothmaler[16] referred Viviani's fern to *Dryopteris paleacea* "(Sw.) Hand-Mazz."

In summation, *Aspidium distans* Viv. has been treated as follows in terms of modern nomenclature: (1) As an independent species of *Dryopteris* allied to *D. borreri;* (2) as a synonym of *Woodsia ilvensis;* (3) as an independent variety of *Dryopteris filix-mas;* (4) as a synonym of *Dryopteris filix-mas;* (5) as a synonym of *Dryopteris villarii* (Bellardi) Woynar var. *australis* (Ten.) Fiori; (6) as a synonym of *Dryopteris paleacea* "(Sw.) Hand-Mazz."; and (7) as a doubtful species.

Trevisan[17] informs us that Viviani received four specimens from Corsica, evidently collected by Dr. Serafini from the same rhizome. Two of these, those studied by Trevisan, were kept in the general herbarium of the Botanical Institute of the University of Genoa, but even in 1937, before the herbarium was completely destroyed during the war, these specimens were missing in the Genoa herbarium.[18] Another specimen was presented to Bertoloni by Viviani and is still present in the herbarium of the Botanical Institute of the University of Bologna (*pl. 13*). It bears the following label: "*Aspidium distant* Viv.—Bert. Fl. Ital. Crypt. p. 53, no. 4.—Dedit ipse Viviani Genuae 1827 augusto mense." The fourth specimen is preserved in Cesati's herbarium in the Botanical Institute of the University of Rome. It is labelled as follows: "*Aspidium distans* Viv. (Corsica)—(ex Herb. Viviani)—*Polystichum distans* Trev. in Atti Soc. Sc. Nat. Ital. vol. XVII, p. 227—Trevisan assicura di averne scoperto gli indusi minuti assai; del resto lo crede prossimo al *Polystichum Filix-mas* var. *Borreri.*—*Nephrodium*

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[15] Pollichia, ser. 2, *5:* 97, 106. 1936.

[16] Boissiera *7:* 168. 1943. cf. also, Reichling, Bull. Soc. Bot. Belg. *86:* 39–57. 1953.

[17] Atti Soc. Ital. Sci. Nat. *17*$^{3}$*:* 227, 228. 1875.

[18] Cf. Illario, Arch. Bot. *13:* 203. 1937.

*Viviani* mihi cum jam extet *N. distans* Hook, sp. IV. p. 76. Bak. syn. 288. No. 160 ex Madagascar.''[19]

I have examined both the species of the Bologna and the Rome herbaria. They agree with each other closely and consist of young fronds destitute of rhizomes. Contrary to the plants examined by Trevisan in the Genoa herbarium, both are sterile. In spite of the lack of sori, a careful examination of these specimens showed me clearly that they belong to that fern which is named *Dryopteris borreri*. Consequently, *Aspidium distans* Viv. and *Dryopteris borreri* are taxonomic synonyms. Since Viviani's epithet has priority over Newman's binomial, this species ought to change its name, and ought to be named *D. distans,* but unfortunately for the principle of priority but fortunately for the stabilization of nomenclature, the combination *Dryopteris distans* based on Viviani's epithet would be illegitimate owing to the existence of the earlier homonym *D. distans* (Hook.) Kuntze. Consequently, the well-known name *D. borreri* will still stand as the legitimate name of this fern. The synonymy to be added to that of *Dryopteris borreri* Newm. may be summarized as follows:

DRYOPTERIS BORRERI Newm. Hist. Brit. Ferns ed. 3, 189. 1854.

*Aspidium distans* Viv. App. Fl. Cors. Prodr. 8. 1825.

*Nephrodium distans* Cesati, Pass. & Gib. Comp. Fl. Ital. 18. 1868, *non* Hook, 1862.

*Polystichum distans* Trevis. Atti Soc. Ital. Sci. Nat. *17*[3]*:* 227. 1875. *non* Fourn. 1872.

*Nephrodium filix-mas* var. *distans* Fiori, in Fiori & Paol. Fl. Anal. Ital. *4:* 3. 1907.

*Dryopteris borreri* has been considered as an independent species by many authors, while it has been merged with *D. paleacea* by others, *e.g.* Rothmaler (*op. cit.*). I do not intend to go into the taxonomic value of *D. borreri* here, since I am not acquainted enough with its extra-European allies, but in any case, as already shown by Alston, the names *Dryopteris*

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[19] Evidently this note was written by Cesati after the publication of the part dealing with the ferns in the above-mentioned ''Compendio della Flora Italiana'' by Cesati, Passerini, and Gibelli. So far as I know, the name *Nephrodium viviani* was never published.

*paleacea* (D. Don) Hand.-Mazz., *Dryopteris paleacea* (Swartz) C. Chr., and *D. paleacea* "(Swartz) Hand-Mazz.," with "hybridized" authors as proposed by Rothmaler, must be rejected as illegitimate.[20] If the European *D. borreri* Newm., the American *D. parallelogramma* (Kunze) Alston [= *D. paleacea* (Swartz) C. Chr.], and the Asiatic *D. wallichiana* (Spreng.) Hyl. [= *D. paleacea* (D. Don) Hand.-Mazz.] are treated as a single species, the correct name for it is *D. wallichiana* (Spreng.) Hyl. If only two species are recognized, *D. borreri* would be better treated in some infraspecific category under *D. parallelogramma,* since it is nearer to the American species than the Asiatic one. However, as far as I am able to see from examination of some specimens, the Asiatic, the American, and the European appear to represent three distinct species.

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## Hybrids in the Genus Asplenium Found in Northwestern and Central Europe

D. E. MEYER

Hybrids in the genus *Asplenium* have been known for many years. Presumed parentages were at first purely speculative, but recent genetical and cytological work, including breeding and chromosome counts, have enabled us to determine the parentage with accuracy in many instances. The known hybrids are listed below, with some charts indicating the probable ancestry.

SPECIES

1. ASPLENIUM ADIANTUM-NIGRUM L., $2n = 72$, $2n = 144$.
2. A. ONOPTERIS L., $2n = 72$.
3. A. FORSTERI Sadler, $2n = 72$.
4. A. FISSUM Kit., $2n = 72$.
5. A. OBOVATUM Viv. *em.* Becherer, $2n = 144$.
6. A. FORESIACUM (LeGrand) Christ, $2n = ?$
7. A. FONTANUM L. $2n = 72$ (*A. halleri*).
8. A. LEPIDUM Presl, $2n = 144$.

[20] This JOURNAL *47*: 91, 92. 1957.

9. A. RUTA-MURARIA L., $2n = 144$.
10. A. SEPTENTRIONALE (L.) Hoffm., $2n = 144$.
11. A. SEELOSII Leyb., $2n = 72$.
12. A. MARINUM L., $2n = 72$.
13. A. TRICHOMANES L. em. Huds., $2n = 72$, $2n = 144$.
14. A. ADULTERINUM Milde, $2n = 144$.
15. A. VIRIDE Huds., $2n = 72$.
16. PHYLLITIS SCOLOPENDRIUM (L.) Newm., $2n = 72$.
17. CETERACH OFFICINARUM Lam. & DC., $2n = 144$.

HYBRIDS

1. ASPLENIUM × GERMANICUM Weis, Pl. Crypt. Fl. Goetting. 299. 1770, $2n = 108$. *Asplenium septentrionale* × *trichomanes* ($n = 36$). Figure: Eberle 1959b, pp. 72, 76.
2. A. × HEUFLERI Reichardt, Verh. Zool.-bot. Ges. Wien *9* Abh.: 95. 1859, $2n = 144$. *A. septentrionale* × *trichomanes* ($n = 72$). Figures: *op. cit. t. IV;* Eberle 1959b, pp. 73, 74, 75, 77).
3. A. × BAUMGARTNERI Doerfler, Oesterr. Bot. Zeitschr. *45:* 169. 1895, $2n = 144$. *A. trichomanes* ($n = 72$) × *septentrionale*. Figure: *Op. cit. t. IX.*
4. A. × MURBECKII Doerfler, Oesterr. Bot. Zeitschr. *45:* 223. 1895, $2n = 144$. *A ruta-muraria* × *septentrionale*. Figure: Lunds Univ. Arsskrift 27, *t. II.* 1892.
5. A. × SUEVICUM Bertsch ex Meyer, Ber. Deut. Bot. Ges. 72: 40. 1959, $2n = 144$. *A. septentrionale* × *ruta-muraria.* Figures: Veroeffentl. Wuertt. Landesst. f. Naturschutz (Stuttgart), Heft *19:* 83; Eberle 1959b, pp. 78, 79.
6. A. × CLERMONTAE Syme, Engl. Bot., ed. 3, *12:* 132. 1886. *A. ruta-muraria* × *trichomanes.* Figures: Verh. Zool.-bot. Ges. Wien *55:* 13. 1905; Alston 1940, p. 141, *fig. 2E.*
7. A. × LUSATICUM D. E. Meyer, Ber. Deut. Bot. Ges. *71:* 16. 1958, $2n = 108$. *A. trichomanes* ($n = 72$) × *trichomanes* ($n = 36$).
8. A. × BAVARICUM D. E. Meyer, Ber. Deut. Bot. Ges. *71:* 16. 1958, $2n = 108$. *A. trichomanes* ($n = 72$) × *viride.*

9. A. × POSCHARSKYANUM (Hofm.) Doerfl. Herb. Norm. no. 3670, Schedae 234. 1898, $2n = 108$. *A. adulterinum* × *viride*. Figure: Ber. Deut. Bot. Ges. *70:* 59. 1957.

TABLE I

X hybrids 22

0 not discovered till 1959 114

136

| | ono | fors | fiss | obo | fore | hall | lep | ruta | sep | seel | ma | tri | adu | vir | Phy | Cet |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cet | | | | | | | | | | | | | | | | |
| Phy | | | | | | | | | | | | | | | | X |
| vir | | | | | | | | | | | | | | | 0 | 0 |
| adu | | | | | | | | | | | | | | X | 0 | 0 |
| tri | | | | | | | | | | | | | X | X | X | 0 |
| ma | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 |
| seel | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 |
| sep | | | | | | | | | | 0 | 0 | X | 0 | 0 | 0 | 0 |
| ruta | | | | | | | | | X | 0 | 0 | X | 0 | 0 | 0 | X |
| lep | | | | | | | | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| hall | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 |
| fore | | | | | | 0 | 0 | 0 | X | 0 | 0 | X | 0 | 0 | 0 | 0 |
| obo | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 |
| fiss | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| fors | | | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | X | 0 | X | 0 | 0 |
| ono | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| adi | 0 | 0 | 0 | X | 0 | 0 | 0 | X | X | 0 | 0 | X | 0 | 0 | X | 0 |

*Hybrids between species of the Aspleniaceae in Northwestern Europe*

10. A. × TRICHOMANIFORME Woynar, Mitt. Naturwiss. Ver. Steiermark *49:* 153. 1913. *A. adulterinum* × *trichomanes*.
11. A. RUTA-MURARIA × VIRIDE D. E. Meyer, Ber. Deut. Bot. Ges. *71:* 19. 1958, $2n = 108$.
12. A. × GAUTIERI Christ in Burnat, Matér. Hist. Alpes Marit. 15. 1900, $2n = 54$? *A. fontanum* × *viride*. Figure: Ber. Deut. Bot. Ges. *70:* 59. 1957.
13. A. × CORBARIENSE Rouy, Fl. France *14:* 543. 1913. *A. fontanum* × *trichomanes*.

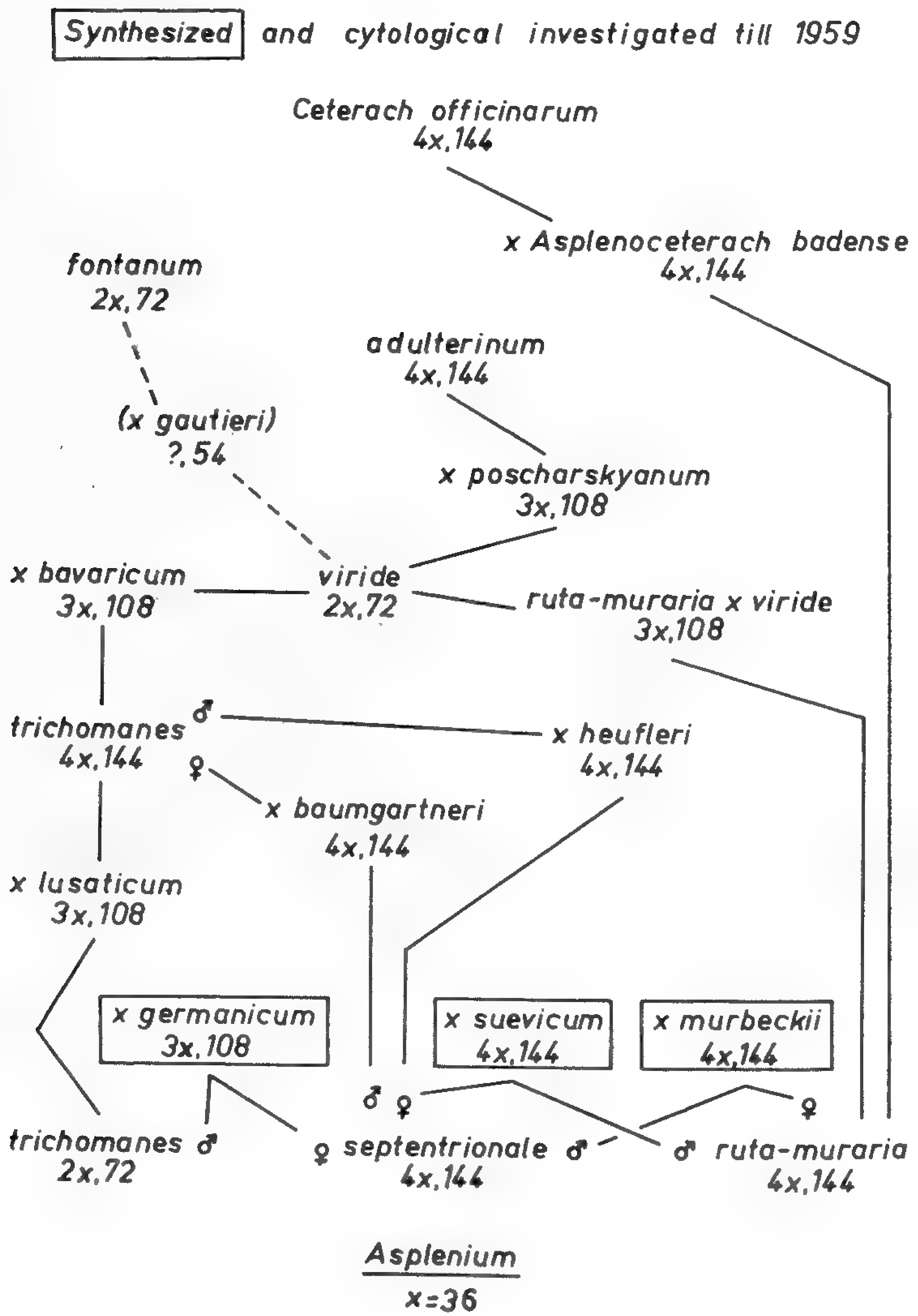
14. A. × REFRACTUM (Moore) Lowe, Ferns Brit. & Exot. *5:* 103. 1858. *A. obovatum* × *trichomanes.* Figures: Lowe, *op. cit. t. 35A;* Alston 1940, p. 141, *fig. 2A.*

FIG. 1: × ASPLENOCETERACH BADENSE D. E. MEYER. (ASPLENIUM RUTA-MURARIA × CETERACH OFFICINARUM.)

15. A. × PAGESII Litard. Bull. Géogr. Bot. (LeMans) *20:* 204. 1910. *A. foresiacum* × *trichomanes.* Figure: Brit. Fern Gaz. *6:* 307. 1935.
16. A. × COSTEI Litard. Bull. Géogr. Bot. (Lemans) *21:* 150. 1911. *A. foresiacum* × *septentrionale.*
17. A. × JAVORKAE Kuemm. Mag. Bot. Lapok. *21:* 1. 1923. *A. lepidum* × *ruta-muraria.*
18. A. × WOYNARIANUM Aschers. & Graebn. Syn., ed. 2, *1:* 126. 1913. *A. forsteri* × *viride.*
19. A. × WACHAVIENSE Aschers. & Graebn. Syn., ed 2, *1:* 125. 1913. *A. forsteri* × *trichomanes.* Figure: Verh. Zool.-bot. Ges. Wien *6: t. II, f. 1, 2.* 1856.

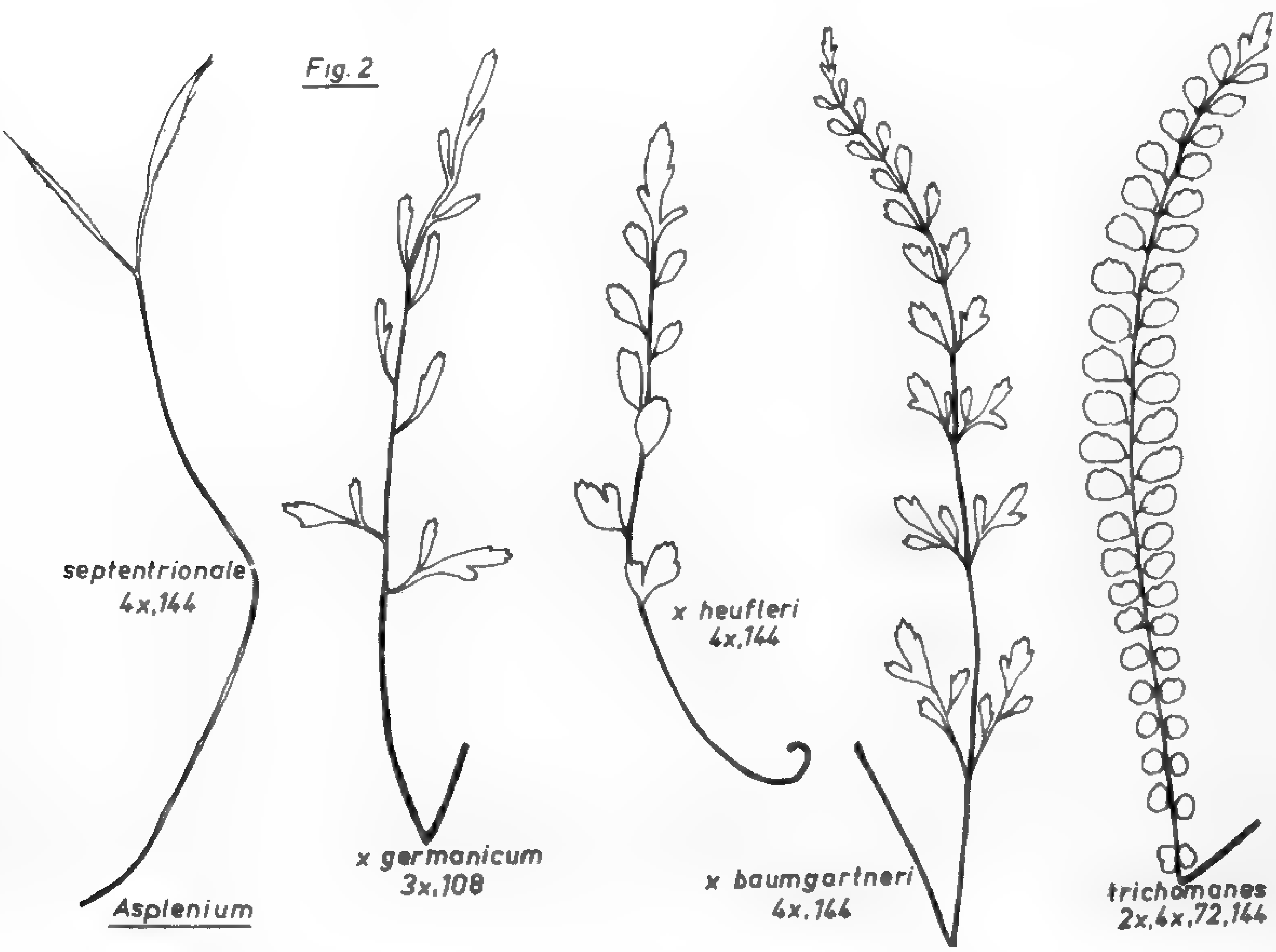
TABLE II

Species and hybrids in Central Europe



20. A. × MURARIAEFORME Waisbecker, Oesterr. Bot. Zeitschr. *49:* 63. 1899. *A. forsteri* × *ruta-muraria.*
21. A. × PERARDII Litard. Bull. Soc. Bot. Deux-Sèvres 1909-1910: 109. *A. adiantum-nigrum* × *ruta-muraria.*
22. A. × SOUCHEI Litard. Bull. Soc. Bot. Deux-Sèvres 1909-1910: 100, *t. 1, 2. A. adiantum-nigrum* × *septentrionale.*
23. A. × DOLOSUM Milde, Verh. Zool. Bot. Ges. Wien *14 (I):* 165. 1864. *A. adiantum-nigrum* × *trichomanes.* Figure: *op. cit. t. XVIII.*

Fig. 2




24. × ASPLENOPHYLLITIS JACKSONII Alston, Proc. Linn. Soc. London, Sess. *152 (2):* 142. 1940. *Asplenium adiantum-nigrum* × *Phyllitis scolopendrium.* Figure: *op. cit. fig. 2D.*
25. × ASPLENOPHYLLITIS CONFLUENS (Moore) Alston, Proc. Linn. Soc. London, Sess. *152 (2):* 139. 1940. *Asplenium trichomanes* × *Phyllitis scolopendrium.*
26. × ASPLENOPHYLLITIS MICRODON (Moore) Alston, Proc. Linn.

*tum* × *Phyllitis scolopendrium*. Figure: *op. cit. Fig. 2B.* Soc. London, Sess. *152 (2):* 140. 1940. *Asplenium obova-*

27. × ASPLENOCETERACH BADENSE D. E. Meyer, Ber. Deut. Bot. Ges. *70:* 61. 1857, $2n = 144$. *Asplenium ruta-muraria* × *Ceterach officinarum*. Figure: *op. cit.* p. 63.

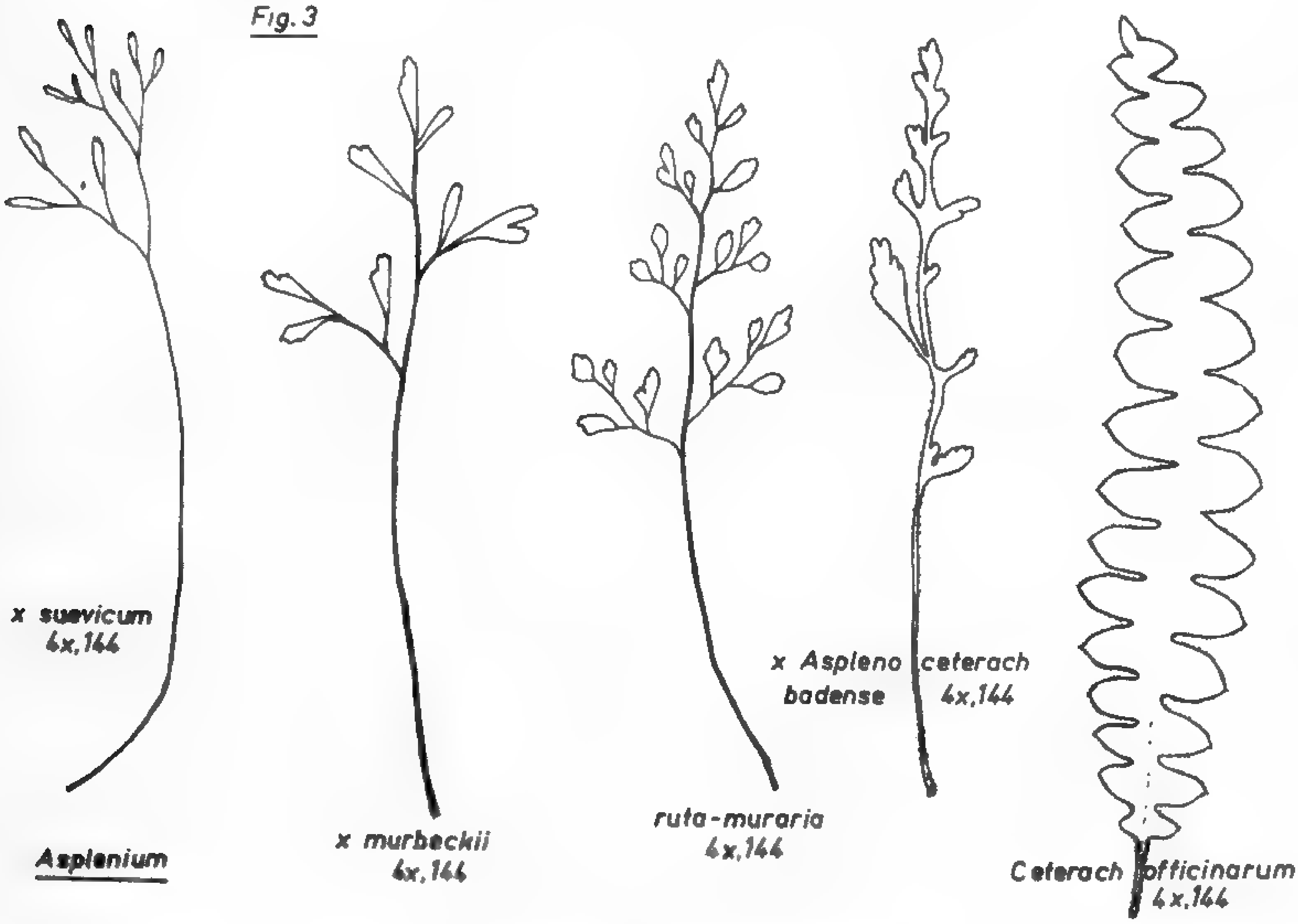



Fig. 3

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—, 1959b. Farne im Herzen Europas. Frankfurt a.M.

—, 1959c. Altes und Neues vom Schriftfarm (*Ceterach officinarum*). Natur u. Volk *89:* 229—236.

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—, 1958. *Ibid., op. cit. 71:* 11—20.

—, 1959. *Ibid., op. cit. 72:* 37—48.

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## Observations on Cultivated Ferns VI. The Ferns Currently Known as Rumohra

C. V. MORTON

In "Standardized Plant Names" (1942), Dr. Maxon and I assigned (or I should probably say invented) the common name "East Indian Holly-fern" to a plant that has usually been known as *Polystichum aristatum* (Forster) Presl. It is perhaps not uncommon in cultivation in greenhouses and in the open in southern California. A related species, which can conveniently be known as Standish's Holly-fern, was *Polystichum Standishii* (Moore) C. Christensen; it is less common, both in nature and in cultivation; it is however hardier, and I have a specimen at hand that is said by the collector, Mr. J. William Kingma, to have come from plants grown in the open in East Grand Rapids, Michigan.

These plants are rather large and coarse. They differ from *Polystichum* in some respects: The indusium is attached laterally, rather than peltately (i.e. centrally) as in *Polystichum;* the rhizome is creeping and the leaves are borne singly along it at intervals (rather close intervals, I might add), rather than being erect, with the leaves borne spirally in a crown as in *Polystichum;* the fronds are more or less broad and triangular, and tripinnate to quadripinnate, with the basal pinnae enlarged on the basal side (i.e. basiscopically developed), whereas the fronds of *Polystichum* are mostly elongate (oblong to linear in outline), only once- or twice-pinnate, and the basal pinnae are not basiscopically developed. More importantly, the structure of the blade is anadromous throughout, that is, the first basal pinnule to arise is that facing the apex of the blade, and the first secondary pinnule to arise is that facing the apex of the pinnae, and so forth down to the ultimate veins. *Polystichum* (and true *Dryopteris* generally) is at least partly catadromous, some of the first pinnules either facing the base or being opposite the anterior pinnules. Taken altogether, these differences are significant.

R. C. Ching, in a paper entitled "A Revision of the Compound Leaved Polysticha and other Related Species in Continental Asia Including Japan and Formosa"[1] decided that these two species and their allies could be separated generically from *Polystichum*, and he chose for them the generic name *Rumohra* Raddi.[2] The type of this genus is *Rumohra aspidioides* Raddi, a Brazilian species which is considered, I imagine properly, to be a synonym of *Polystichum adiantiforme* (Forster) J. Smith, a common species occurring in many widely-separated parts of the world. In cultivation and in dealers' catalogues, *P. adiantiforme* is often listed as "leather fern" under the synonymous names *Polystichum capense* and *P. coriaceum*, or sometimes even under the old and entirely incorrect name *Aspidium capense*. Copeland, in his Genera Filicum, followed Ching in uniting *aristatum* and its allies with *adiantiforme*, and even emphasized the "naturalness" of the resulting genus, but nevertheless such a conclusion is highly debatable.

*Rumohra adiantiformis* is primarily an epiphyte, with a long, stout, densely scaly, dorsiventral rhizome that climbs on tree-trunks, or occasionally on rocks. It has a strictly peltate indusium as in true *Polystichum*. It is very likely not phylogenetically close to *aristatum* and its allies. Dr. R. E. Holttum, in

[1] Sinensia *5:* 23–91. 1934.
[2] Raddi, Opusc. Sci. Bologn. *3:* 290. *pl. 12, fig. 1.* 1819.

his fine paper on the classification of leptosporangiate ferns,[3] came to the conclusion that true *Rumohra* is generically different from *aristatum*. He would ally it with *Davallia*, which seems a rather remote alliance. He states that the structure of the rhachis is of the davallioid type, that is that the two ridges of the rhachis are continuous with the leaf-margins. He may be right, for the structure does approach that of *Davallia*, but it is not quite so obvious; the ridges seem to arise from an intermediate area, neither from the margin as in *Davallia* nor from the margins of the costal groove as in *Polystichum*.

*Rumohra* should therefore be considered as a monotypic genus of uncertain alliance. Its geographic distribution shows that it is a very old type, for it occurs in widely separated parts of the world, as in New Zealand, South Africa, and Chile and Argentina; it has also spread far to the north. Its synonymy is as follows:

RUMOHRA ADIANTIFORMIS (Forster) Ching, Sinensia *5:* 70. 1934.

*Polypodium adiantiforme* Forster, Prodr. Fl. Insul. Austr. 82. 1786.
*Rumohra aspidioides* Raddi, Opusc. Sci. Bologn. *3:* 290. 1819.
*Polypodium coriaceum* Swartz, Prodr. Fl. Ind. Occ. 133. 1788.
*Aspidium coriaceum* Swartz, in Journ. Bot. Schrad. 1800[1]: 36. 1801.
*Aspidium capense* Willd. in L. Sp. Plant. *5:* 267. 1810, *non* Swartz, 1801.
*Polystichum coriaceum* Schott, Gen. Fil. *ad t. 9.* 1834.
*Polystichum capense* J. Smith, Bot. Mag. Comp. 35. 1846.
*Polystichum adiantiforme* J. Smith, Hist. Fil. 220. 1875.

Inasmuch as Holttum rejected *Rumohra* as an available name for *aristatum* and its allies, he was obliged to find another, and he chose *Polystichopsis*, calling the genus *Polystichopsis* (C. Chr.) Holttum, with a reference to Christensen in Verdoorn, Manual of Pteridology 543. 1938. Actually, Christensen recognized *Polystichopsis* as a genus at the place cited; it has a short description, and is listed in exactly the same manner as other genera discussed such as *Plecosorus* and *Papuapteris*. A reference is given to *Rumohra* of Ching, in part, and going back to Ching's paper we find the citation of *Dryopteris* subg. *Poly-*

[3] Journ. Linn. Soc. Bot. *53:* 137, 152. 1946.

*stichopsis* C. Chr., with a reference to Christensen's Monograph of the Genus Dryopteris, Part II.[4] In tracing this citation back, we find that Christensen's subgenus was based on *Lastrea,* sect. *Polystichopsis* J. Smith.[5] Therefore, the proper authority for the genus is *Polystichopsis* (J. Smith) C. Chr.

John Smith's section *Polystichopsis* was designed to include all the species of *Lastrea* (in his sense equalling *Dryopteris sens. lat.*) with decompound deltoid fronds, and thus included quite a number of species that may not be closely allied, such as *L. pubescens, L. hispida, L. decomposita,* and *L. funesta.* Christensen restricted the application of the name in his monograph to *L. pubescens* and its allies, and in Index Filicum, Supplementum Tertium,[6] he definitely cited *Dryopteris pubescens* (L.) Kuntze as the type of the section *Polystichopsis* (J. Smith). The type of the genus *Polystichopsis* is therefore the same species, *D. pubescens,* for Christensen's choice of lectotype can not be changed or even challenged, for this is one of the original species and it agrees with the original brief characterization and therefore qualifies as a lectotype on all counts.

The determination of the lectotype is of some significance, because *D. pubescens* and its near allies *D. chaerophylloides* and *D. lurida* diverge in some respects from the group of *aristatum.* Christensen was content to leave *D. pubescens* and *D. aristata* in the same section, and Ching (and also Copeland) regarded them as unquestionably both *Rumohra.* Still, there are differences.

*Polystichum* and *Dryopteris* are characterized by the absence of hairs in the channels of the upper leaf surface (and also elsewhere, except as capitate glands may be called hairs and reduced scales may be hair-like, as in *D. Filix-mas*) ; the fronds are usually evergreen, and of a coriaceous texture, shining on the upper surface and with mucronate or aristate teeth; the stipe bases are densely scaly. In all these characters *aristatum* agrees with *Polystichum.* On the other hand, *Dryopteris pubescens* has

[4] In Dansk. Vid. Selsk. Skr. Nat. Afd. VIII, *6:* 101. 1920.
[5] Hist. Fil. 217. 1875.
[6] P. 7, 1934.

abundant, long, silky, septate hairs on the blades; the texture is soft-herbaceous and the teeth are scarcely aristate; the stipe bases are abundantly hairy, as well as sometimes scaly. It seems that consistency necessitates the generic separation of *pubescens* and *aristatum;* the latter is unquestionably a near ally of *Polystichum* and *Dryopteris;* the former must have its origin elsewhere.

The group of *aristatum* is lacking an available generic name. The following is proposed.

**Byrsopteris** Morton, gen. nov.

Rhizoma crassum hypogaeum repens dense paleaceum, paleis magnis fibrosis elongato-lanceolatis, attenuatis, non ciliatis nec pilosis nec fimbriatis, subintegris, dentibus remotis ex cellulis duobus compositis, cellulis elongatis, parietibus lateralibus brunneis translucentibus modice crassis, parietibus exterioribus hyalinis tenuibus; folia sparsa distantia vel subfasciculata decomposita, longe stipitata, stipitibus stramineis crassis glabris sulcatis basi valde paleaceis, fasciculis vasorum robustis tribus vel pluribus; foliorum laminae deltoideae vel pentagonae tripinnatae usque ad quinquepinnatae, rhachibus stramineis glabris paleaceis, paleis integris vel denticulatis interdum basi dilatatis et fimbriatis, pinnis primariis saepe paucis, duobus inferioribus maximis deltoideis basiscopice dilatatis, pinnula basali inferiore elongata; pinnulae omnes anadromicae, i.e. anteriores quam posteriores rhachibus costis costulisque magis approximatae; frondium textura coriacea vel crasse papyracea, superficiebus nitidis glabris eglandulosis; segmenta ultima saepe deltoidea vel rhombica, marginibus saepe dentatis vel spinulosis; rhaches rachillae costaeque supra alte sulcatae, marginibus basiscopicis canalium decurrentibus in marginibus sulcorum rhachium ordinum inferiorum; venae liberae anadromicae saepe depressae obscurae et ex parenchymate tectae, furcatae, marginem non attingentes, apice saepe in hydathodis terminantes; sori globosi in venis terminales vel dorsales indusiati, indusiis crassis coriaceis subrotundis lateraliter in sinu clauso affixis glabris integris saepe persistentibus, parietibus interdum incrassatis glandulosis; sporangia numerosa longe pedicellata, cellulis induratis annuli 13 vel 14; paraphyses nullae; sporae bilaterales magnae 43—61 $\mu$ longae, evidenter cristatae, cristis interdum spinulosis.

Rhizome thick, hypogaeus, creeping, densely scaly, the scales large, fibrous, elongate-lanceolate, attenuate, not ciliate, pilose, nor fimbriate, subentire, the teeth remote, composed of two adjacent cells, the internal cells of the scales elongate, with thick, brown, translucent, lateral walls and thin, hyaline, brownish exterior walls; leaves relatively few, distant or adjacent on the creeping rootstock but not fasciculate, long-stipitate, the stipes straw-colored, thick, glabrous, sulcate, strongly scaly at base, the vascular bundles three or more; leaf-blades decompound, deltoid or pentagonal, tripinnate to 5-pinnate, the rhachises straw-colored, glabrous, scaly, the scales entire or denticulate, sometimes dilated at the base and there fimbriate; primary pinnae often few, the two lowest the largest, deltoid in outline, enlarged on the lower side, the lowest basal pinnule elongate; pinnae, pinnules, and veins all anadromous, i.e. the one pointing toward the apex arising closer to the rhachis, costae, or costules than the one pointing toward the base; fronds leathery or thick-papery in texture, mostly shining, eglandular or at least glands very sparse; ultimate segments mostly deltoid or rhombic, the margins dentate or mostly subspinulose; rhachises, rhachillae, and costae deeply channelled on the upper (adaxial) side, the basiscopic margins of the channels decurrent on the margins of the channels of the next lower order, these broken to receive them, the leaf-margins decurrent as wings and not as ridges; veins free, anadromous, furcate, mostly obscure and covered by parenchyma, not reaching the margins, terminating in rotund or elongate hydathodes; sori globose, terminal or dorsal on the veins, indusiate, the indusium thickly coriaceous, subrotund, laterally attached at a closed sinus and thus appearing centrally peltate, entire, the cell-walls thickened and sometimes apparently glandular; sporangia numerous, long-stalked, the annulus 13- or 14-celled; paraphyses none; spores monolete, large, 43–61 $\mu$ long,[7] obviously crested, the crests spinulose in some species.

*Typus: Polypodium aristatum* Forster.

The two species that are known in cultivation may be distinguished as follows:

Scales of the rhachis and rhachillae dark, broadened and fimbriate at the base, abruptly attenuate to an elongate, filiform apex, one cell thick; sori terminal on the veins; blade

[7] Not measured in all species.

BYRSOPTERIS ARISTATA (TYPE OF POLYPODIUM ARISTATUM FORST. BRITISH MUSEUM. PHOTOGRAPH BY C. V. MORTON.)

coriaceous, very thick in texture, with spinulose-toothed segments ........................ B. aristata

Scales of the blade pale, not much broadened or fimbriate at base, gradually attenuate, but two-celled almost or quite to the apex; sori dorsal on the veins; blades papyraceous, the segments mucronate but hardly spinulose ........ B. Standishii

✓BYRSOPTERIS **aristata** (Forster) Morton, *comb. nov.* (*Plate 14*).

*Polypodium aristatum* Forster, Fl. Insul. Austr. Prodr. 82. 1786.
*Aspidium aristatum* Swartz in Journ. Bot. Schrader 1800[2]: 37. 1801.
*Polystichum aristatum* Presl, Tent. Pterid. 83. 1836.
*Dryopteris aristata* Kuntze, Rev. Gen. Plant. *2:* 812. 1891.
*Rumohra aristata* Ching, Sinensia *5:* 50. 1934.
*Polystichopsis aristata* Holttum, Ferns Malaya 486. 1954.

BYRSOPTERIS **Standishii** (Moore) Morton, *comb. nov.*

*Lastrea Standishii* Moore, Gard. Chron. *1863:* 292. 1863.
*Dryopteris Standishii* C. Chr. Ind. Fil. 587. 1906.
*Rumohra Standishii* Ching, Sinensia *5:* 64. 1934.

The American species of *Byrsopteris* are:

BYRSOPTERIS **denticulata** (Swartz) Morton, *comb. nov.*

*Polypodium denticulatum* Swartz, Prodr. Fl. Ind. Occ. 134. 1788. Type from Jamaica, *Swartz.*
*Dryopteris denticulata* Kuntze, Rev. Gen. Plant. *2:* 812. 1891.
*Rumohra denticulata* Copel. Gen. Fil. 114. 1947.

BYRSOPTERIS **formosa** (Fée) Morton, *comb. nov.*

*Aspidium formosum* Fée, Gen. Fil. 296. 1852. Lectotype: Cuba, *Linden* 2115, selected by Christensen, Dansk. Vid. Selsk. Skr. Natur. Afd. VIII, *6:* 119. 1920.
*Dryopteris formosa* Maxon, Contr. U. S. Nat. Herb. *13:* 17. 1909 (*ad nom., excl. descr.*)

BYRSOPTERIS **leucostegioides** (C. Chr.) Morton, *comb. nov.*

*Dryopteris leucostegioides* C. Chr. Dansk. Vid. Selsk. Skr. Nat. Afd. VIII, *6:* 118. *fig. 28.* 1920. Type: Colombia, *Lindig* 234.

BYRSOPTERIS **rigidissima** (Hook.) Morton, *comb. nov.*

*Nephrodium denticulatum* var. *rigidissimum* Hook. Sp. Fil. *4:* 148. 1862. Type: Jamaica, *Wilson.*
*Dryopteris rigidissima* C. Chr. Dansk. Vid. Selsk. Skr. Nat. Afd. VIII, *6:* 118. *fig. 27.* 1920.

Some of the Old World species that I know are the following. A number of others which may or may not be distinct are recognized by Ching. Several species referred by Ching to *Rumohra* (*R. nipponica*, *R. sino-miqueliana*, *R. quadripinnata*, and *R. Miqueliana*) are variously hirsute. Examination of the rhachis structure in those species available to me for study (the two last named) shows that these species are not con-generic with *Rumohra* or *Byrsopteris*, as might be expected. Their real affinity (perhaps with *Ctenitis* ?) remains to be determined.

BYRSOPTERIS **amabilis** (Blume) Morton, *comb. nov.*

*Aspidium amabile* Blume, Enum. Pl. Jav. 165. 1828.
*Polystichum amabile* J. Smith, Ferns Brit. & For. 152. 1866.
*Dryopteris amabilis* Kuntze, Rev. Gen. Plant. *2:* 812. 1891.
*Rumohra amabilis* Ching, Sinensia *5:* 41. 1934.

BYRSOPTERIS **assamica** (Kuhn) Morton, *comb. nov.*

*Aspidium assamicum* Kuhn, Linnaea *36:* 108. 1869.
*Dryopteris assamica* Rosenst. Med. Rijks Herb. Leiden *31:* 6. 1917.
*Polystichum assamicum* Ching *ex* C. Chr. Ind. Fil. Sup. *III:* 162. 1934.
*Rumohra assamica* Ching, Sinensia *5:* 47. 1934.

BYRSOPTERIS **carvifolia** (Kunze) Morton, *comb. nov.*

*Aspidium carvifolium* Kunze, Bot. Zeit. *1843:* 283. 1843 (as *currifolium pro err.*)
*Polystichum carvifolium* C. Chr. Ind. Fil. 580. 1906.
*Dryopteris carvifolia* C. Chr. Act. Hort. Goth. *1:* 64. 1924.
*Rumohra carvifolia* Ching, Sinensia *5:* 60. 1934.

BYRSOPTERIS **coniifolia** (Moore) Morton, *comb. nov.*

*Aspidium coniifolium* Wall. ex. Kunze, Linnaea *24:* 293. 1851, *non* Presl, 1822. Type: Nepal, *Wallich* 341 (Isotype US).
*Lastrea coniifolia* Moore, Ind. Fil. LXXXVIII. 1857. A new name, by Int. Code Nomencl. (Art. 72, *Nota*)
*Rumohra Wallichii* Ching, Sinensia *5:* 56. August 1934. Based on *Aspidium coniifolium* Wall.
*Polystichum himalayense* Ching *ex* C. Chr. Ind. Fil. Sup. III: 163. Oct. 1934. Based on *Aspidium coniifolium* Wall.

As shown above, Article 72 of the present International Code of Nomenclature allows the use of the well-known epithet *coniifolia*. This Article is an extremely important one in stabilizing nomenclature, since it often results in the retention of well-known epithets, with merely a change in the parenthetical authorities, a minor matter so far as general usage is concerned.

BYRSOPTERIS **Hasseltii** (Blume) Morton, *comb. nov.*

*Polypodium Hasseltii* Blume, Fl. Jav. Fil. 195. *pl. 92.* 1829.
*Dryopteris Hasseltii* C. Chr. Ind. Fil. 269. 1905.
*Rumohra Hasseltii* Ching, Sinensia *5:* 61. 1934.
*Polystichopsis Hasseltii* Holttum, Ferns Malaya 487. 1954.

BYRSOPTERIS **Henryi** (Christ) Morton, *comb. nov.*

*Polystichum Henryi* Christ, Notul. Syst. *1:* 36. 1909. Type: China, *Henry* 13351 (Isotype US).
*Dryopteris Henryi* C. Chr. Contr. U. S. Nat. Herb. *26:* 282. 1931.
*Rumohra Henryi* Ching, Sinensia *5:* 57. 1934.

BYRSOPTERIS **Maximowiczii** (Baker) Morton, *comb. nov.*

*Nephrodium Maximowiczii* Baker, in Hook. & Bak. Syn. Fil. ed. 2. 499. 1874. Type: Japan, *Maximowicz* 98.
*Dryopteris Maximowiczii* Kuntze, Rev. Gen. Plant. *2:* 913. 1891.
*Rumohra Maximowiczii* Ching, Sinensia *5:* 72. 1934.

BYRSOPTERIS **mutica** (Franch. & Sav.) Morton, *comb. nov.*

*Aspidium muticum* Franch. & Sav. Enum. Pl. Jap. *2:* 240, 635. 1879. Type: Japan, *Savatier* 2418.
*Dryopteris mutica* C. Chr. Ind. Fil. 279. 1905.
*Rumohra mutica* Ching, Sinensia *5:* 65. 1934.

BYRSOPTERIS **speciosa** (D. Don) Morton, *comb. nov.*

*Aspidium speciosum* D. Don, Prodr. Fl. Nepal. 5. 1825.
*Polystichum speciosum* J. Smith, Journ. Bot. *4:* 195. 1841.
*Dryopteris speciosa* C. Chr. Act. Hort. Goth. *1:* 63. 1924.
*Rumohra speciosa* Ching, Sinensia *5:* 53. 1934.

Recently, Miss Mary D. Tindale[8] has revived the genus *Lastreopsis* Ching, which had been reduced to *Ctenitis* by Copeland. She appears to be justified, for the type of *Lastreopsis*. *L. recedens*, and a number of allied species, differ from *Ctenitis* in the rhachis structure. In these species the two prominent ridges of the rhachis and rhachillae are continuous with the leaf-margin (davallioid type), whereas in *Ctenitis* the rhachises

[8] Vict. Nat. *73:* 180–185. 1957.

are either not ridged at all or the ridges run to the center of the pinnules and not to the margins. Unfortunately, Miss Tindale includes in her enlarged genus *Lastreopsis* the species *pubescens, chaerophylloides,* and *lurida,* the first of which is the type of *Polystichopsis;* if she is right, then the proper name is *Polystichopsis,* which has priority over *Lastreopsis.* The matter needs to be investigated further, but it is my present opinion that both genera may stand. *Polystichopsis* has a rhachis structure of the dryopteroid type rather than the davallioid like *Lastreopsis.*

*Polystichopsis* appears to be a small, exclusively American genus. The species, none of which are in cultivation, are:

POLYSTICHOPSIS **pubescens** (L.) Morton, *comb. nov.*

*Polypodium pubescens* L. Syst. Nat. ed. 10, *2:* 1327. 1759.
*Dryopteris pubescens* Kuntze, Rev. Gen. Plant. *2:* 813. 1891.
*Rumohra pubescens* Ching, Sinensia *5:* 35. 1934.
*Lastreopsis pubescens* Tindale, Vict. Nat. *73:* 185. 1957.

POLYSTICHOPSIS **chaerophylloides** (Poiret) Morton, *comb. nov.*

*Polypodium chaerophylloides* Poiret in Lamarck, Encycl. Meth. *5:* 542. 1804.
*Dryopteris chaerophylloides* C. Chr. Dansk. Vid. Selsk. Skr. Nat. Afd. VIII, *6:* 105. 1920.
*Rumohra chaerophylloides* Ching, Sinensia *5:* 35. 1934.
*Lastreopsis chaerophylloides* Tindale, Vict. Nat. *73:* 185. 1957.

POLYSTICHOPSIS **lurida** (Underw. & Maxon) Morton, *comb. nov.*

*Dryopteris lurida* Underw. & Maxon in Slosson, Bull. Torrey Club *40:* 183. 1913.
*Rumohra lurida* Ching, Sinensia *5:* 35. 1934.
*Lastreopsis lurida* Tindale, Vict. Nat. *73:* 185. 1957.

POLYSTICHOPSIS **ochropteroides** (Baker) Morton, *comb. nov.*

*Nephrodium ochropteroides* Baker, Ann. Bot. *5:* 325. 1891.
*Dryopteris ochropteroides* C. Chr. Ind. Fil. 280. 1905.

This is the only species of *Polystichopsis* occurring outside the West Indies; it occurs in Jamaica, Panama, Colombia, and Surinam, everywhere extremely rare and mostly collected only once in each disjunct area. Habitally, it is not very close to *P. pubescens* and the other species, all of which have the same facies.

SMITHSONIAN INSTITUTION, WASHINGTON 25, D. C.

## Recent Fern Literature

FERNS OF ALBERTA.—With the publication of the book by Dr. E. H. Moss on the flora of Alberta,[1] one of the large gaps in our knowledge of the Canadian flora has been filled. In the Pteridophyta 55 species in 20 genera of seven families are considered. The author states that he has been conservative in his approach to taxonomy and a table claims treatment of only six subspecific entities. Actually 12 subspecific entities are considered.

The most disappointing aspect of this Flora is the lack of information regarding the distribution of species. There are no maps showing the occurrence of species (there are in fact no illustrations of any kind in the book) and phytogeographic information is of the sketchiest nature. For *Pellaea atropurpurea* (L.) Link var. *Bushii* Mack. we are told that it grows "on calcareous rocks"—nothing more. Actually, it has been collected only near the Bow Falls at Banff.[2] *Matteuccia Struthiopteris* (L.) Todaro is found in "damp woods," whereas *Polypodium vulgare* L. is found "on rocks, logs and banks." The author states in the Preface that Alberta affords features of exceptional botanical interest with steppes, forests, mountains, prairies, etc. It seems a pity that there is no correlation of the species with geography. This is surely a major deficiency in a regional work. Also there is little indication as to whether species are common or rare with few exceptions, such as *Asplenium Trichomanes* L., which is included although no Alberta plants have been seen by the author.

It seems a pity that in a $10.00 book of this nature that there could not be included a good colored map of Alberta. This would be useful in locating the few localities mentioned such as Waterton, Lake Athabasca, Drumheller, etc. Such a shortcoming is not uncommon, however, as the reviewer knows only too well

[1] Flora of Alberta, by E. H. Moss. 1959. University of Toronto Press, Toronto, Canada. 546 pp. $10.00.

[2] The plants from this locality are commonly considered to be var. *occidentalis* rather than var. *Bushii*.—C. V. MORTON

when gnashing his teeth over the lack of a map giving the names of the counties of Michigan in Billington's "Ferns of Michigan."

This reviewer was interested that both *Dryopteris dilatata* (Hoffm.) A. Gray and *D. spinulosa* (Muell.) Watt are included as separate species in the five species of *Dryopteris* considered. No subspecific categories are delineated for this genus. The inclusion of *D. Filix-mas* found on "wooded slopes" gives no information as to the range of this northern species.

*Cheilanthes Feei* Moore has evidently been added to the page proof in the introduction to the Polypodiaceae, as a species that was originally overlooked. It is not included in the alphabetical listing of genera. This species is stated to occur at Banff.

The keys and nomenclature are to a large extent based on C. V. Morton's treatment of the Pteridophyta in *The New Britton and Brown Illustrated Flora,* and are quite adequate. The paucity of fern species in the same genus will undoubtedly make the task of identification easier for the amateur. Of the 16 genera of ferns described, only *Botrychium* (6 spp.), *Dryopteris* (5 spp.) and *Woodsia* (4 spp.) have more than two species included.

This book will be of value as an intermediate manual for students of the flora of Alberta. For visitors to the province, or as a field guide, it has definite limitations.—DONALD M. BRITTON, ONTARIO AGRICULTURAL COLLEGE, GUELPH, ONTARIO.

FERNS OF CALIFORNIA.—The recently published "A California Flora"[1] treats all of the vascular plants of the state. The vascular cryptogams or Pteridophytes are included under three Divisions: Lepidophyta (*Lycopodium, Selaginella* and *Isoëtes*), Calamophyta (*Equisetum*) and Pterophyta (the ferns proper). A total of 28 genera and 86 species are recognized. These numbers compare with the 25 genera and 81 species of California in

[1] A California Flora. By Philip A. Munz in collaboration with David D. Keck. pp. 1-1681, *figs. 1-134*, 2 maps. University of California Press. 1959. $11.50.

Abrams[2] and the 26 genera and 79 species in Jepson.[3] The slight increase in genera and species is, I believe, a reflection of the fact that most of the kinds of ferns in California have been known for some time. Taxonomic revisions and range extensions have altered our knowledge of them in the last few decades but not to the significant extent that they have in many groups of the flowering plants.

Keys and diagnostic descriptions are provided for the families, genera, and species. The major groups of ferns and fern allies are illustrated by line drawings. The distribution in California is given for each species as well as a general statement of its entire range. An especially useful feature is that each species is related to the vegetation of the state by reference to the plant communities in which it grows. The twenty-nine plant communities that occur in California are described in the introduction.

The treatment of the Pteridophyta seems eminently usable and will undoubtedly provide, for most students, the standard treatment of this segment of the flora that the book itself will for the whole. For this reason it is unfortunate that, in following Copeland's Genera Filicum, the Flora does not always accurately reflect our present knowledge. There are no serious reasons, for example, for the segregation of Blechnaceae, Pteridaceae, Aspidiaceae, and Aspleniaceae from the Polypodiaceae. Also there are generic realignments that are not warranted by what we know, and do not know, about the species concerned. Some of the species of *Notholaena* are placed in *Cheilanthes* and one, *N. californica*, in *Aleuritopteris; Cheilanthes californica* is segregated as *Aspidotis;* and *Cheilanthes siliquosa* is placed in *Onychium.* This is not to say that the classification I would prefer (*Notholaena* and *Cheilanthes*) is wholly justified, but rather that detailed and serious study must provide the basis for improving it. As a matter of nomenclature, it is also unfortunate that the name *Lastrea* has been adopted rather than the correct name *Thely-*

[2] Illustr. Fl. Pacific States, vol. 1, 1923.
[3] Manual Fl. Plant. Calif. 1925.

*pteris.* The names for the two Californian species[4] are *Thelypteris puberula* (Baker) Morton (*Lastrea augescens*) and *Thelypteris nevadensis* (Baker) Clute (*Lastrea oregana*).

A few inaccuracies that I have noticed are mentioned here so that users of the Flora may correct them. In a work of such scope and actual length it is inevitable that, in spite of a successful effort to maintain high standards, a few errors will remain. The correct name for the variety of *Pteridium aquilinum* in California is var. *pubescens* Underw.; var. *lanuginosum* is a later homonym. *Pellaea compacta* and *Pellaea mucronata* var. *californica* are names for the same taxon; the recent revision of *Pellaea* treats it under the latter name. The var. *compositum* mentioned under *Botrychium multifidum* is a variety, not of that species, but of *B. simplex*. *Notholaena californica* (Ariz. and s. Cal. to Baja Cal.) is treated as *Aleuritopteris cretacea* (Liebm.) Fourn. but *Notholaena cretacea* Liebm. is a taxonomic synonym of the very distinct *Notholaena sulphurea* (Mexico to Chile). *Notholaena californica* has no name under *Aleuritopteris* and I hope one will not be made.

To complete the list of California ferns, two hybrids (or probable hybrids) should be mentioned: × *Adiantum Tracyi* Hall ex Wagner (Humboldt, Sonoma, and Marin counties) and *Cheilanthes Carlotta-halliae* Wagner & Gilbert (Marin, San Benito, and San Luis Obispo countries).—Rolla Tryon, Gray Herbarium.

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[4] Morton, This Journal *48*: 138, 139. 1958.

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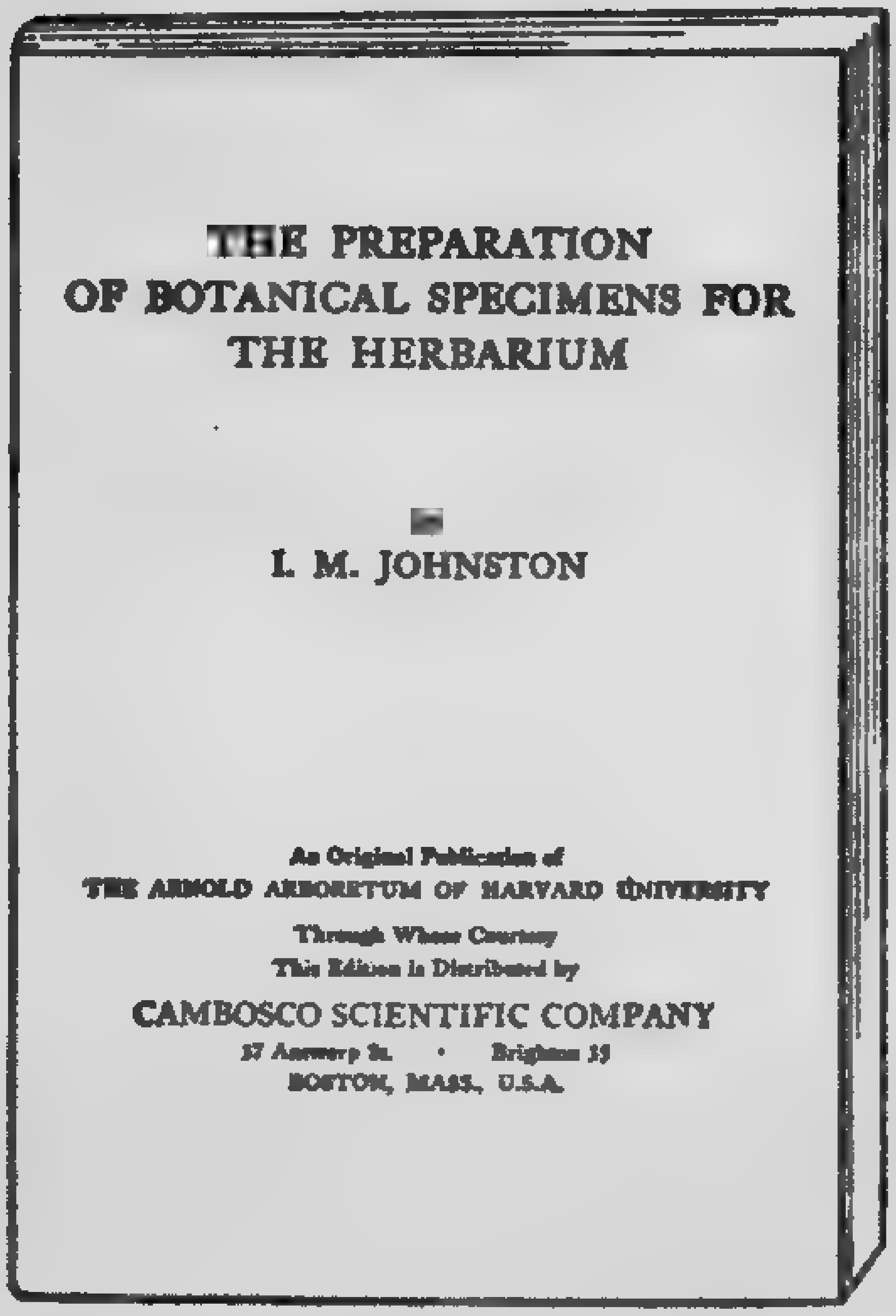


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# American Fern Journal

A QUARTERLY DEVOTED TO FERNS

Published by the

AMERICAN FERN SOCIETY

Editors

C. V. MORTON

R. C. BENEDICT IRA L. WIGGINS

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# American Fern Journal

Vol. 50 April-June, 1960 No. 2

## Hunting Ferns in the Barrancas of Chihuahua, Mexico[1]

Irving Knobloch

Those who travel down Highway 45 from Juarez to Chihuahua City and on to Mexico City are struck by the apparently endless desert on both sides of the highway that extends to the southern borders of the state. Few apparently know that the western half of the state contains high mountains covered with oaks and pines and generously provided with deep canyons or barrancas. There are ferns to be found on the mountains studding the desert but they do not compare in numbers or variety with those in the wetter and shadier parts of the state.

The writer has collected ferns in Chihuahua off and on since 1938. At the present count there are over 112 species and varieties of pteridophytes here. Many of these are confined to the western half of the state, such as *Pellaea Seemannii, Pellaea Skinneri* and *Notholaena Weatherbiana*. There are, of course, many others in the same category. Since some of the readers of this journal may be interested in Mexican ferns, we shall characterize some collecting grounds in the western part of the state and mention some of the more unusual ferns which are to be found there.

The Mojarachi-Maguarichi area is reached by driving (in a pick-up, jeep, or passenger car with high wheels and a second low gear) from Chihuahua City west to Cuauhtemoc, where one leaves the hard road. Then one follows the railroad to La Junta, Miñaca, and on to San Juanito. Here one leaves the better-travelled dirt road and drives on an old mining camp road

[1] Contribution No. 60-16 from the Department of Botany and Plant Pathology, Michigan State University.

Volume 50, No. 1, of the Journal, pp. 1–160, was issued April 25, 1960.

leading eventually to Maguarichi. Recent torrential rains in the state have damaged the road and bridges. This is really a bad road at best with the average speed being five to eight miles per hour. I do not recommend this trip except for the most experienced campers. One can get gas at San Juanito but there is not likely to be any from there on. Food should be taken along and meals prepared unless one is willing to eat in very poor restaurants. Water should be sterilized with iodine tablets and one should take two Entervioforme tablets every day to combat dysentery. At last reports, there was a new lumber camp beside the road, about two hours distance this side of Maguarichi. This locality is known as Las Lajas. There is an old road branching off to the left going to the abandoned mining camp of Mojarachi. Inquiries at Las Lajas will help one decide whether to attempt the road or to go on to Maguarichi. At the latter place, there are a few people living, one being an Austrian-American lady named Mrs. Zehtner who speaks very good English, as well as German and Spanish. She makes trips out quite often so one cannot be sure that she is there. Trinidad is the name of a local guide and mules can be rented from him for local trips or for the two hour trip to Mojarachi, south of Maguarichi. The latter place is about 4,900 feet above sea level and the latitude and longitude are approximately 27°–52′ N. and 108°–05′ W. respectively. Mojarachi is slightly south of Maguarichi and is at an elevation of about 7,200 feet. The latitude is about 27°–51′ N. and the longitude about 108°–00′ W. At last reports there was no one living in the place. Maguarichi is lower and really out of the pine belt. There are some scrub oaks and many species of flowering perennials. It is not rich in fern species. *Notholaena aurea*, *Notholaena sinuata* var. *sinuata* and *Asplenium Palmeri* can be found here quite readily. The dainty ***Bommeria hispida*** is also common. It should be mentioned that the ferns are at their best during the rainy season and this coincides, naturally, with the muddiest roads. July and August are good collecting months but poor travelling months. By the middle of September travel is best and the plants are still in good condition.

On the way to Mojarachi by mule, one may find, by searching, *Adiantum Capillus-veneris* and *Elaphoglossum pilosum.* These are found pendant on wet cliffs, the former usually in the sun and latter usually in the shade. Mojarachi is higher in elevation and while there are many species of oaks the pines are also there in variety and abundance. There is more duff on the ground and there is more shade. About 50 species and varieties of ferns can be found here in a radius of two miles, at the base of cliffs and boulders and rising from the duff on the forest floor. This is the only station in the state for *Selaginella Arsenei* (from Segorichi, within the two mile radius), and *Bommeria Knoblochii* was also first found at Segorichi. Other good finds in the Mojarachi vicinity are *Cheilanthes angustifolia, C. farinosa, Pellaea allosuroides, Pellaea sagittata*, vars. *sagittata* and *cordata, Asplenium exiguum, Woodsia mollis, Dryopteris augescens* var. *puberula, Plagiogyria semicordata, Polypodium aureum,* and *P. Hartwegianum.*

A second region worth seeing is the La Bufa-Rio Batopilas area. To reach this one returns to San Juanito and follows the railroad line south to the town of Creel. Here one can get gasoline and stock up with food supplies. There is a drug store here where one can get cold coca-cola. It is the drug store near the gasoline supply. One now is faced with a breath-taking five hour trip over a splendid but one-way road leading to the mining town of La Bufa, situated on the Batopilas river. If one speaks Spanish, one should go to the "Terminal" at the edge of town. This is an office of the Potosí Mining Company and here Señor Mendoza will tell you if the road is reasonably free of the diesel trucks that haul the ore from the mine to Creel. There are few turnouts on this road and one must give the right of way to the trucks by turning off or backing up. A Jesuit priest in Creel, Father Martinez, or Trompas as he is generally known, speaks good English and can be helpful. When everything is arranged, away you go through the pines, down into the Barranca de Cobre canyon, up out of this canyon, across a plateau, down into the Batopilas Canyon, and up the other side to the mine office itself. Here, at last reports, Mr. Robert Emmett was in charge and here reasonable accommodations can usually be had. My trip there in 1957 may now be described but yours may be better or worse.

I left Chihuahua on September 11 at about 9:30 a.m. in a station wagon through the courtesy of Mr. Martin Nesbitt, the manager of the Potosí Mining Company in the city of Chihuahua. We arrived in La Junta at 12:30 and ate at the Centro Viajero Hotel. I checked my baggage through to Creel, bought a ticket and got on the train from Chihuahua at 5:30 p.m. The train left La Junta at 7:30 p.m. and did not arrive in Creel until 4:30 a.m. The Hotel Chavez was open but no beds were available. One should telegraph ahead for accommodations if one really *wants* to stay in the Hotel. I dozed in a chair in the lobby until awakened by the truck driver sent from the mine to pick me up. We ate breakfast and waited around until 10:00 a.m. for the station to open in order to get my baggage, and then set out for the mine, arriving at 2:30 p.m. It was a most thrilling ride indeed. At the mine office I was introduced to Mr. Emmett and shown a two-bedroom cottage for my use and the lunch-room where I was to eat. The country is beautiful but very precipitous. Every day a house boy brought me two cold beers and two cold cokes as well as a pitcher of ice water. The second day, I added iodine tablets to the water and then had safe, ice-cold water. You see, it took me a whole day to wake up to the possibilities. Fresh figs from a tree nearby in a garden were also a treat.

Needless to say, I botanized from early morning until dark in all the side canyons near the mine. Sunday was a red-letter day for I was taken to the Basigochi Country Club, back down the road, at an elevation of 7,400 feet. Here we played 18 holes of golf with Tarahumare Indians as caddies, truly a unique experience. Returning to the mine in the evening, I collected a fine *Elaphoglossum* and a rattlesnake. Having read a great deal about Dr. Edward Palmer's travels in southwestern Chihuahua, I had a burning desire to visit one of his choice collecting grounds, namely Batopilas. The late Edward Goldman had also been there in the days when the silver mine was booming. Accordingly, I arranged for a guide and three mules and set out at 7 a.m. on September 18th. Batopilas lies down the canyon. Our cargo burros were slow and we did not arrive until 6 p.m., a long, hot, thirsty ride. One of the big men in this quaint town is Gregorio Bigler, to whom I had a letter of introduction and who, upon my arrival, immediately plied me with two cold bottles of Pepsicola. He kindly allowed me to sleep over the store on an army cot (which only proved comfortable after I had placed my air mattress upon it). The climate is hot and humid and malaria is prevalent despite governmental efforts.

We meet here plants belonging to tropical families. It is not at all the type of vegetation one would expect in a northern state like Chihuahua. Mingled with the figs, the kapok trees, and *Crescentia alata* trees are giant cacti towering 40–50 feet into the air. I was very anxious to see the Hacienda San Miguel, the headquarters of the old mine. What a sorry mass of ruins! The adobe buildings were rapidly returning to the soil from which they had come. Since I had sent my guide back to La Bufa for faster burros (for I had determined that the return trip would not take 11 hours), I hired an 80 years old native named Joaquin Vega and together we tramped around the ruins of the Hacienda and surrounding valleys for two days. It was not enough that I was thoroughly exhausted from the trip down here but the town band insisted on playing mournful airs practically all night long.

My explorations at Batopilas were only partially successful. I did relocate *Notholaena Weatherbiana* which Palmer had found around 1885, but I failed to find *Asplenium modestum.* However, there were huge clumps of *Notholaena Lemmonii* on the adobe walls, as well as large quantities of *Cheilanthes Pringlei* and *Selaginella pallescens.* Back in La Bufa, after a seven hour trip, we spent several weeks all told in obtaining such ferns as *Cheilanthes microphylla, Anemia anthriscifolia, Bommeria Knoblochii, Cheilanthes lendigera,* and other more common species. Since a flu epidemic started to rage through the mining community, I left there and settled back in Creel. Just at the edge of town, where the new railroad line begins to the Pacific coast, in pockets of a white-colored road cut, we found the prize fern of all, *Asplenium Adiantum-nigrum.* This had been found by Pringle and Dr. McVaugh before, but it is a very rare plant that we were very glad to obtain.

Incidentally, if one wishes to take a guided tour of the trip just described, one can contact "Wampler Trail Trips," Box 45, Berkeley, California. These trips go once a year to the place just described and once to the Basaseachi Falls in Chihuahua. I believe the cost is about $350 to $400 dollars from the border.

Describing trips further to the southwest, we might mention a trip we took in 1954. Five of us arrived in Creel in July. A small truck was hired here and we sped west on a new railroad grade being constructed. The road leads near the edge of the Urique Barranca in one place and we stepped out to take pictures here. This locale is known as the "Divisadero" and the canyon drops off 4,800 feet straight down to the river. Shortly thereafter we arrived in the head camp of the railroad engineers, a settlement known as Areponapuchi. Here we were kindly given accommodations. The next day we descended into this canyon by mule back but the trail was too slippery even for mules. Camping above the river, we collected many interesting plants, such as *Elaphoglossum pilosum* and *Cyrtomium auriculatum. Notholaeana Lemmonii* and *Pellaea Seemannii* were also taken. I was greatly pleased to find *Anemia anthriscifolia* growing in great abundance on the rocky slopes and in shade.

In 1958, a party of four of us came along this same railroad grade in a pick-up truck and went on down the road to Cuiteco, one of Rudolph Endlich's collecting grounds. Here we branched off onto a dirt road and traveled several hours to Cerocahui, situated on the rim above the town of Urique, our eventual destination. Cerocahui has about a dozen small houses and a magnificent catholic church. We bedded down on the floor of one of the houses and set out to explore the neighboring canyons. Ferns that are absent or uncommon in other parts of Chihuahua are common and luxuriant here. We might mention *Asplenium exiguum, Cheilanthes farinosa, Notholaena limitanea* var.

*limitanea*, and *Polypodium subpetiolatum*, the latter being very common at Cuiteco. The trip by mule to Urique consumed a back-breaking ten hours. Here we found another run-down mining town, all but in ruins. However, the people were as friendly as they usually are in Mexico and they did for us what they could. The weather was hot and humid; it rained every day and the air was malaria-ridden. Sanitary conditions were at a low ebb, to put it conservatively. We were in that unusual type of vegetation known variously as short-thorn or tropical deciduous forest where Acacias and Cacti mingle with representatives of tropical families, where some plants are covered with thorns and others devoid of them. My herpetological companions collected large numbers of subtropical species and obtained all sorts of interesting records. Here we found two rare fern-allies in great abundance, namely *Selaginella novoleonensis* and *Selaginella Wrightii*. *Notholaena candida* var. *candida*, rare elsewhere, was also in quantity. This, however, was only a starter. In shade and on rocks we obtained two species not hitherto found in the state—*Selaginella Sartorii* and *Pellaea Skinneri*. This Cerocahui-Urique area is one of the richest in ferns in the entire state and would be well worth further investigation. In a year or two at the most, the rails will be laid along the right-of-way and one will be able to get in here only by train or by air. If the new railway will operate like the present one from Chihuahua, it would not be advisable to go in by rail unless one is willing to be very patient and long-suffering. Flights from Chihuahua by light plane to Cerocahui (ten hours from Urique by mule) or to Naranja (four hours by mule from Urique) can be arranged.

The writer is completing with Dr. Correll a manuscript on the pteridophytes of the state. My experience has been similar to that of other explorers, namely, that more time is spent in travelling than in collecting. This is a very wasteful procedure but nothing can be done about it unless granting agencies are willing to be more generous with funds so that helicopters can be rented. In the long run this procedure, while apparently more expensive, might prove to be the most economical method yet. For example, one could sample dozens of areas in a state during a summer, areas that would take six to twelve summers to investigate by mule.

Although 60 per cent covered by desert and only one third the size of Texas, Chihuahua has more fern species than Texas, and the number grows with each trip. Someday we hope to describe for our readers the ferns of the drier parts of the state.

MICHIGAN STATE UNIVERSITY, EAST LANSING, MICHIGAN.

## Ferns in Cultivation, II

SYLVIA LEATHERMAN

Keeping potted ferns in good condition outdoors during hot summers has always been a problem. One solution is to actually plant them out in the garden, pot and all; the soil should be firmed closely around the pots. When the garden is watered regularly, the potted plants will also be watered, and the soil around the pots keeps them from drying out; this will, in all probability, save your prized ferns.

There are a few words of caution about using this method. First, one must select the correct spot in the garden for the specific fern, always away from winds, and with the correct sun element; most ferns will prefer a light shade. Secondly, remember that the roots will go down through the drainage hole in the pot and anchor themselves in the soil under the pot. When the pot is lifted, the plants then wilt and sometimes die. Using the lid off the top of a coffee can or a similar barrier placed in the bottom of the hole will prevent this for a short period of time. However, if the pots are to remain in the ground for weeks, they should be turned and twisted once a week, which will prevent the roots from becoming established in the soil. If the pots are sitting on a barrier, they will be easier to turn.

It is especially well to plant out the pots during a vacation period. Usually a person is hired to take care of the plants while the owner is away. Potted plants often suffer, since the hired persons do not understand them and do not devote enough time to them. Planting the pots out will save them, since the garden is watered regularly and plants in the ground almost always come through in good condition.

2637 North Lee Avenue, El Monte, California.

## Some Fern Books for Different Regions of the United States

C. V. Morton

Some, but not all, of the descriptive accounts of the ferns of various regions of the United States have been reviewed in the Journal. A number of readers have suggested a general listing of the best works, and such a summary is perhaps timely.

Dr. S. F. Blake's "State and Local Fern Floras of the United States"[1] is most useful, being almost complete and extremely accurate. The Supplement[2] brings this list up to 1950. The present list is not in any sense a second supplement, for I have made no attempt at completeness, and purely local lists are not noted at all.

General Works: M. L. Fernald's account of the ferns in Gray's Manual of Botany, Eighth edition,[3] is the most complete treatment, representing a lifetime of intense study by an outstanding botanist. The area covered is from Newfoundland west across Quebec and Ontario along the 49th parallel to the northwestern corner of Minnesota, southward along the western border of Minnesota and Iowa, and along the 96th meridian through Nebraska and Kansas to Missouri and then eastward along the southern borders of Missouri, Kentucky, and Virginia; thus all the northeastern and midwestern states are included, but the prairie regions of the Dakotas, Nebraska and Kansas are excluded. Fernald's work is topnotch and there is hardly a real

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[1] This Journal **31:** 81–90, 131–143. 1941.

[2] This Journal **40:** 148–165. 1950. These lists of Dr. Blake's were reprinted by the American Fern Society, and are still available for sale, at 25 cents for the two. Orders should go to the Treasurer.

[3] Pp. 1–1632. 1950. American Book Company, 55 Fifth Avenue, N. Y. $12.50. Reviewed, this Journal **40:** 229. 1950.

error in it, except the confusing and erroneous adoption of the name *Cheilanthes vestita* for the plant usually and properly called *C. lanosa* and the adoption of *C. lanosa* for the plant correctly called *C. tomentosa* Link. The name *Pteretis* for the ostrich-fern may have been correct when Fernald's work was published (although this is debatable) but it is definitely not correct now, since at the 8th International Botanical Congress in Paris in 1954 the name *Pteretis* was rejected and the name *Matteuccia* conserved.

The second large-scale work on the ferns of the eastern states is that of Morton in "The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada."[4] Although this was actually printed two years later than Gray's Manual, the manuscript had been prepared several years previously and was in press before the publication of the Manual. The area covered is essentially the same, and the treatment is quite similar in many ways, although there are some differences in nomenclature. Although, according to the general policy of this work, minor varieties and forms are not mentioned, as they are in Gray's Manual, the present work has the great advantage of fine drawings of all the species. Another complete work for the east is "A Field Guide to the Ferns,"[5] by Boughton Cobb; the illustrations in this work can be especially recommended for the natural way in which the plants are depicted.

An old standby, still available and to be recommended, is Herbert Durand's "Field Book of Common Ferns."[6] Other general works on eastern ferns are Dr. Edgar T. Wherry's ever-popular "Guide to Eastern Ferns,"[7] still as useful as ever to the beginner, Farida A. Wiley's "Ferns of Northeastern United

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[4] In three volumes. Published by the New York Botanical Garden, Bronx Park, New York 58, N. Y. Second, slightly revised printing, 1959. $30.00. Not reviewed in the JOURNAL.

[5] Published by Houghton Mifflin Company, 2 Park St., Boston, Mass. 1956. $3.95. Reviewed, this JOURNAL **46:** 161. 1956.

[6] Revised ed., pp. 1–219. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. $3.50.

[7] Ed. 2, pp. 1–251. 1942. University of Pennsylvania Press, Philadelphia, Pa. $2.00. Reviewed, this JOURNAL **33:** 76. 1943.

States,"[8] rather similar but not quite as good, and Willard N. Clute's "Our Ferns, Their Haunts, Habits, and Folklore,"[9] which is to be recommended highly for the amount of information not obtainable elsewhere.

The following older, much-loved books are now out of print but can sometimes be picked up from dealers in second-hand books: "Ferns; A Manual for the Northeastern States," by C. E. Waters (1903); "How Ferns Grow," by Margaret Slosson (1906); "Ferns and How to Grow Them," by Grace A. Woolson (1905, rev. ed. 1914); "The Fern Lover's Companion," by George H. Tilton (1922); and "American Ferns; How to Know, Grow and Use Them," by Edith A. Roberts (1935).

The states of North and South Dakota, Nebraska, Kansas, Minnesota, and Iowa, and the southern parts of Manitoba and Saskatchewan are treated in "Flora of the Prairies and Plains of Central North America,"[10] by P. A. Rydberg; this is not a region in which ferns are abundant, except in the easternmost part. The entire Rocky Mountain area is covered only in Rydberg's "Flora of the Rocky Mountains and Adjacent Plains,"[11] in which the ferns were treated by Margaret Slosson very capably. For the Far West there is only the treatment by William R. Maxon in Abrams, "Illustrated Flora of the Pacific States,"[12] a highly professional treatment, in fact a model in every way. A less elaborate work covering a part of the same area is "Ferns of the Northwest,"[13] by T. C. Frye.

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[8] Revised edition, pp. 1–108. 1948. Obtainable from the author, The American Museum of Natural History, New York, N. Y. Reviewed, this JOURNAL **39:** 61. 1949.

[9] Ed. 2, pp. 1–388. 1938. Frederick A. Stokes Company, New York, N. Y. Out of print. Reviewed, this JOURNAL **28:** 67. 1938.

[10] Pp. 1–969. Published by the New York Botanical Garden, Bronx Park, New York 58, N. Y., 1932. Out of print. Not reviewed.

[11] Pp. 1–1110. Published by the author, 1917. Reissued in facsimile edition, 1954, Hafner Publishing Co., 31 E. 10th Street, New York 3, N. Y. $15.00. Not reviewed.

[12] Vol. 1, pp. 1–557. 1923. Published by Stanford University Press, Stanford, California, $17.50.

[13] Pp. 1–177. 1934. Metropolitan Press, Portland, Oregon. Currently available from Binfords and Mort, 124 N. W. Ninth Avenue, Portland, Ore. $3.00. Reviewed, this JOURNAL **25:** 65. 1935.

The ferns of the southern states were treated by William R. Maxon, in J. K. Small's "Flora of the Southeastern United States,"[14] now somewhat out of date but still useful; the area covered includes all the region south of the northern boundaries of North Carolina, Tennessee, and Arkansas, and west to eastern Oklahoma and Texas, i.e. the northern boundary coincides with the southern boundary of Gray's Manual and Britton and Brown. A more recent, but in some ways eccentric treatment, is J. K. Small's "Ferns of the Southeastern States,"[15] which covers a similar area except that it extends west only to the Mississippi River. The southwest is more or less covered (unsatisfactorily) in "A Flora of Arizona and New Mexico,"[16] by I. Tidestrom and T. Kittell.

ALABAMA: No recent work.

ALASKA: "Flora of Alaska and Yukon,"[17] by E. Hultén, with keys but no descriptions; "Flora of Alaska and Adjacent Parts of Canada,"[18] by J. P. Anderson, with keys and descriptions, not altogether trustworthy, and with poor illustrations.

ARIZONA: "Arizona Flora,"[19] by T. H. Kearney and R. H. Peebles, the treatment of the ferns by C. V. Morton, with keys but no descriptions or illustrations.

ARKANSAS: No recent work.

CALIFORNIA: Maxon, in Abrams, mentioned above; "Manual of the Flowering Plants of California,"[20] by W. L. Jepson, the

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[14] Ed. 2, pp. 1–1394. 1913. Published by the author, now deceased. Out of print. Not reviewed.

[15] Pp. 1–517. 1938. Published by the author. Out of print. Reviewed, this JOURNAL **29:** 25. 1939.

[16] Pp. 1–897. 1941. Catholic University of America Press, Washington, D. C. Reviewed, this JOURNAL **32:** 119. 1942. Out of print.

[17] Lunds Univ. Arsskr. II. **37:** 1–108. 1941. Perhaps still available through Dr. E. Hultén, Naturhistoriska Riksmuseet, Stockholm, Sweden. Reviewed, this JOURNAL **32:** 74. 1942.

[18] Iowa State Coll. Journ. Sci. **18:** 137–175. 1943. Reviewed, this JOURNAL **34:** 64. 1944. Reprinted, Iowa State University, Ames, Iowa, 1959.

[19] Pp. 1–1032. 1951. University of California Press, Berkeley, California. Out of print. A new edition to be printed soon. Not reviewed in the JOURNAL.

[20] Pp. 1–1238, *fig. 1–1023.* 1925, 3rd printing. University of California Press, Berkeley, California. $6.50.

fern part out of date in concept and nomenclature and not on a par with the rest of the work. For southern California, "A Manual of Southern California Botany,"[21] by P. A. Munz, can be highly recommended for its accurate and careful treatment. A new treatment, by Munz & Keck, was reviewed in the last number of the JOURNAL.

COLORADO: "Colorado Ferns,"[22] by H. D. Harrington and L. W. Durrell, with keys, descriptions, and line drawings, mostly good. A similar but abbreviated treatment, without the drawings, is found in Prof. Harrington's "Manual of the Plants of Colorado."[23]

CONNECTICUT: No recent treatment.

DELAWARE: "Flora of Delaware and the Eastern Shore,"[24] by Robert R. Tatnall, an annotated list; see also Maryland, below. Still available from Greenwood Book Shop, 110 West 9th St., Wilmington, Del. $3.50.

DISTRICT OF COLUMBIA: see Maryland, below.

FLORIDA: "Ferns of Florida,"[25] by J. K. Small. See also the reference above to Small's larger book.

GEORGIA: "Ferns of Georgia,"[26] by R. McVaugh and P. H. Pyron, an altogether admirable treatment, that will be useful throughout the south.

IDAHO: "Contributions toward a Flora of Idaho,"[27] by Ray J.

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[21] Pp. 1–642. 1935. Claremont Colleges, Claremont, California. Out of print. Not reviewed in the JOURNAL.

[22] Pp. 1–91. 1950. Colorado Agricultural and Mechanical College, Fort Collins, Colorado, $1.00. Reviewed, this JOURNAL **41:** 93. 1951. Out of print.

[23] Pp. 1–666. 1954 (offset). Sage Books, Denver, Colo. Now available from The Swallow Press, 2679 So. York St., Denver 10, Colorado. $8.00. Not reviewed in the JOURNAL.

[24] Pp. 1–313. 1946. Published by the Society of Natural History of Delaware, Wilmington Institute Free Library, Wilmington 28, Delaware. Reviewed, this JOURNAL **38:** 95. 1948.

[25] Pp. 1–236. Illus. 1931, published by the author. Out of print. Not reviewed in the JOURNAL.

[26] Pp. 1–195. Illus. 1951. University of Georgia Press, Athens, Ga., $5.00.

[27] Leaflet 27, Pteridophytes, pp. 1–37. 1949. Published by the author, Dept. of Botany, University of Idaho, Moscow, Ida. Not reviewed in the JOURNAL. Probably obtainable from William C. Brown Company, Dubuque, Iowa.

Davis, the pteridophyte treatment by Seville Flowers, a mimeographed publication, useful but without illustrations.

ILLINOIS: "An Enumeration of Illinois Pteridophyta,"[28] by G. N. Jones, with keys and localities but no descriptions or illustrations; "Vascular Plants of Illinois,"[29] by G. N. Jones and G. D. Fuller, similar but with maps showing the distribution.

INDIANA: "Flora of Indiana,"[30] by Charles C. Deam, the most famous of the local floras of the eastern states, and deservedly so, representing as it does a lifetime of the most careful field and herbarium study by Dr. Deam.

IOWA: "Native Ferns of Iowa,"[31] by I. E. Melhus, with descriptions and maps but not the most trustworthy data.

KANSAS: No recent complete publication.

KENTUCKY: No recent publication.

LOUISIANA: "Ferns and Fern Allies of Louisiana,"[32] by Clair A. Brown and Donovan S. Correll, an admirable work, with fine photographs.

MAINE: "The Ferns of Maine,"[33] by Edith B. Ogden, by far the best work for New England, with good descriptions and drawings.

MARYLAND: "The Ferns and Fern-allies of Maryland and Delaware Including the District of Columbia,"[34] by Clyde F.

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[28] Amer. Midland Naturalist **38:** 76–126. 1947. The University Press, Notre Dame, Ind. Not reviewed in the JOURNAL. Out of print.

[29] Illinois State Museum Sci. Ser. **6:** 1–593. *Maps 1–1375*, 1955. Currently available from Univ. of Illinois Press, Urbana, Ill. $10.00. Reviewed, this JOURNAL **46:** 33. 1956.

[30] Pp. 1–1236. 1940. Department of Conservation, Division of Forestry, Indianapolis, Ind. Out of print. Not reviewed in the JOURNAL.

[31] Iowa State College Extension Circular 225. 1936. Reviewed, this JOURNAL **27:** 135. 1937.

[32] Pp. 1–186. 1942. Still available from Louisiana State University Press, Baton Rouge, La. $3.00.

[33] Maine Bulletin, vol. 41, no. 3 [University of Maine Studies no. 62], pp. 1–128. 1948. Still obtainable from University of Maine Library, Orono, Maine, $1.00. Reviewed, this JOURNAL **39:** 94. 1949.

[34] Pp. 1–286, *pl. 1–72, maps 1–58.* 1953. Published by the author, 10105 Harford Road, Baltimore, Md. $3.00. Reviewed, this JOURNAL **44:** 90. 1954.

Reed, interesting and unusual in some ways, especially by the inclusion of photographs of the spores.

MASSACHUSETTS: No recent work.

MICHIGAN: "Ferns of Michigan,"[35] by Cecil Billington; although not altogether adequate, still one of the better books that ought to be in fern students libraries.

MINNESOTA: "Ferns and Fern Allies of Minnesota,"[36] by Rolla M. Tryon, Jr., a fine, professionally executed book, notable also for the fine drawings and unusual silhouettes of fern fronds.

MISSISSIPPI: No recent work.

MISSOURI: "Ferns and Fern Allies of Missouri,"[37] by M. E. Pinkerton, a descriptive account (containing a number of errors); "Ferns and Fern Allies of Missouri,"[38] by E. J. Palmer and J. Steyermark, a check-list only, with commentaries.

MONTANA: No recent work.

NEBRASKA: No recent work.

NEVADA: "Flora of Utah and Nevada,"[39] by I. Tidestrom, the ferns contributed by William R. Maxon; a brief but authentic treatment, without descriptions or illustrations but with keys.

NEW HAMPSHIRE: "Ferns and Fern Allies of New Hampshire,"[40] by Edith Scamman, a careful treatment, with good drawings.

NEW JERSEY: "The Ferns of New Jersey,"[41] by M. A.

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[35] Cranbrook Institute of Science Bulletin 32, pp. 1–240, *pl. 1–16, fig. 1–79*. 1952. Available from Cranbrook Institute of Science, Bloomfield Hills, Michigan. $5.00. Reviewed, this JOURNAL **43:** 18. 1953.

[36] Pp. 1–166, *fig. 1–207, maps 1–85*. 1954. University of Minnesota Press, Minneapolis, Minn. Paper $2.75, Cloth $4.00.

[37] Annals Missouri Bot. Gard. **20:** 45–78, *map, pl. 1–5*. 1933. Reviewed, this JOURNAL **24:** 18. 1934. Available from Missouri Botanical Garden, 2315 Tower Grove Avenue, St. Louis, Mo., $0.70.

[38] This JOURNAL **22:** 105–122. 1933. Reviewed, this JOURNAL **24:** 18. 1934.

[39] Contr. U. S. Nat. Herb. **25:** 1–665. *pl. 1–15*. 1925. Out of print.

[40] New Hampshire Academy of Science Bull. 2, pp. 1–96. *pl. 1–18*. 1947. Obtainable from Dr. R. L. Blickle, Secretary-Treasurer, New Hampshire Acad. of Sci., Durham, N. H. $1.25. Reviewed, this JOURNAL **40:** 188. 1950.

[41] Pp. 1–201, *fig. 1–110, maps 1–76*. 1947. Rutgers University Press, New Brunswick, N. J. Out of print. Reviewed, this JOURNAL **38:** 95. 1948.

Chrysler and J. L. Edwards; especially notable for the fine photographs, both of habit and of individual fronds.

NEW MEXICO: "The Ferns and Fern Allies of New Mexico,"[42] by H. J. Dittmer, E. F. Castetter, and O. M. Clark, with keys, descriptions, and well-drawn illustrations.

NEW YORK: No general treatment, except "Annotated List of the Ferns and Flowering Plants of New York State,"[43] by Homer D. House, a list only, without keys, descriptions, or illustrations; a more local but better treatment is "Ferns of the Vicinity of New York,"[44] by J. K. Small, in which "vicinity" is broadly interpreted as being "within a hundred miles of Manhattan Island"; this is a complete manual, with fine descriptions and drawings.

NORTH CAROLINA: "Ferns of North Carolina,"[45] by H. L. Blomquist; a useful book, although not without some defects, some of which were corrected in a subsequent publication.[46]

NORTH DAKOTA: "Handbook of North Dakota Plants,"[47] by O. A. Stevens, a general manual in which the ferns are treated very briefly.

OHIO: "Ferns of Ohio,"[48] by H. H. Vannorsdall, an admirable and useful book, with fine photographs.

OKLAHOMA: "Ferns of Oklahoma,"[49] by H. I. Featherly and

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[42] Univ. of New Mexico Publ. Biol. **6**: 1–139. 1954. Available from Univ. of New Mexico Press, Albuquerque, New Mexico. $1.00. Reviewed, this JOURNAL **46**: 34. 1956.

[43] New York State Museum Bulletin 254, pp. 1–759. 1924. Not reviewed in the JOURNAL. Out of print.

[44] Pp. 1–285. Illustr. 1935. Published by the author. Out of print. Reviewed, this JOURNAL **26**: 16. 1936.

[45] Pp. 1–131, *fig. 1–79*. 1934. Duke University Press, Durham, North Carolina. Out of print. Reviewed, this JOURNAL **25**: 59. 1935.

[46] "A County Check List of North Carolina Ferns and Fern Allies," by H. L. Blomquist and Donovan S. Correll. Journ. Elisha Mitchell Sci. Soc. **56**: 63–105. 1940.

[47] Pp. 1–324, *fig. 1–319*. 1950. Available from North Dakota Institute for Regional Studies, State College Station, Fargo, North Dakota, $4.50. Not reviewed in the JOURNAL.

[48] Pp. 1–298, *fig. 1–215*. 1956. Obtainable from Curtis Book Store, Wilmington, Ohio, $3.09. Reviewed, this JOURNAL **47**: 116. 1957.

[49] Oklahoma Agr. & Mech. Coll. Exper. Station Circ. 80 (revised). pp. 1–24. Illustr. 1939. Reviewed, this JOURNAL **30**: 102. 1940. Out of print.

Clara Still Russell, is brief and inadequate.

OREGON: "A Manual of the Higher Plants of Oregon,"[50] by M. E. Peck, an adequate "manual-type" account; I understand that a new, revised edition is imminent.

PENNSYLVANIA: There is no descriptive manual. Dr. E. T. Wherry's "The Ferns and Lycosphens of Pennsylvania,"[51] is an annotated check-list; Elsie Deane Canan's "A key to the Ferns of Pennsylvania,"[52] is merely a key, although a rather full one, with rather primitive line-drawing illustrations.

RHODE ISLAND: No recent treatment.

SOUTH CAROLINA: No recent treatment.

SOUTH DAKOTA: No recent treatment. An annotated list in "Flora of South Dakota,"[53] by W. H. Over.

TENNESSEE: The finest of all state floras and a book that should be in every fern student's library is "Ferns of Tennessee,"[54] by Jesse M. Shaver; it is a model work, not easily imitated, since it represents many years of careful devoted work.

TEXAS: "Ferns and Fern Allies of Texas,"[55] by Donovan S. Correll, is one of the newest and best manuals, professionally executed.

UTAH: "Ferns of Utah,"[56] by Seville Flowers, with keys, descriptions, and accurate, tasteful drawings; to be recommended.

VERMONT: No recent specialized flora. An annotated list[57] is

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[50] Pp. 1–866. 1941. Published by the author, Willamette University, Salem, Oregon. Out of print. Not reviewed in the JOURNAL.

[51] Bartonia **21:** 11–37. 1942. Reviewed, this JOURNAL **32:** 117. 1942.

[52] Pp. 1–110, *fig. 1–59.* 1946. Published by The Science Press Printing Company, Lancaster, Pa., $1.50. Reviewed, this JOURNAL **36:** 124. 1946. Available from Miss Canan, 1023 Menoher Blvd., Johnstown, Pa., $1.50.

[53] Pp. 1–16. Illustr. 1932. Out of print.

[54] Pp. 1–502. *fig. 1–243.* 1954. Available from Bureau of Publications, George Peabody College for Teachers, Nashville 5, Tenn. $6.00. Reviewed, this JOURNAL **45:** 21. 1955.

[55] Pp. 1–188. *pl. 1–38, fig. 1–3.* 1956. [A reprinting of "Flora of Texas," vol. 1, part 1. 1955]. Texas Research Foundation, Renner, Texas. $5.50. Reviewed, this JOURNAL **47:** 79. 1957.

[56] Bull. Univ. Utah **35:** pp. 1–87, *fig. 1–164.* 1944. Reviewed, this JOURNAL **35:** 61. 1945. Still obtainable from the University of Utah Press, Salt Lake City, Utah. $1.00.

[57] 3rd rev. ed., pp. 1–353. 1937. Still obtainable from Dr. H. W. Vogelmann, Department of Botany, University of Vermont, Burlington, Vt., $1.50.

presented in "The Flora of Vermont," edited by E. J. Dole.

VIRGINIA: "The Ferns and 'Fern Allies' of Virginia,"[58] by A. B. Massey, a usable pamphlet.

WASHINGTON: No recent state treatment. See above the more general works of Maxon (in Abrams) and Frye.

WEST VIRGINIA: "The Pteridophytes of West Virginia,"[59] by M. G. Brooks and A. S. Margolin; a more recent treatment, in abbreviated style, is in "Flora of West Virginia,"[60] by P. D. Strausbaugh and Earl L. Core.

WISCONSIN: "The Ferns and Fern Allies of Wisconsin,"[61] by R. M. Tryon, Jr., D. W. Dunlop, N. C. Fassett, and M. E. Diemer, a fine work with beautiful photographs, somewhat diminished in effectiveness in the second edition (by offset).

WYOMING: "The Ferns and Fern Allies of Wyoming,"[62] by C. L. Porter, a mimeographed publication, showing thought and care; to be recommended.

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[58] 2nd ed., Virginia Polytechnic Institute Agricultural Extension Service Bulletin 256, pp. 1–78, *fig. 1–21*. 1958. Available gratis from Prof. Massey, Va. Polytechnic Institute, Blacksburg, Va. Reviewed, this JOURNAL **48:** 124. 1958. [The first edition reviewed this JOURNAL **34:** 128. 1944.]

[59] West Virginia University Bulletin, Series 39, no. 2, pp. 1–60, *pl. 1–16*. 1938. Reviewed, this JOURNAL **30:** 30. 1940. A few copies available for distribution gratis by E. L. Core, University of West Virginia, Morgantown, W. Va.

[60] Part 1. West Virginia Univ. Bulletin, Ser. 52, no. 12-2. 1952. Not reviewed in the JOURNAL. Available from University Bookstore, Morgantown, W. Va., $1.00.

[61] Ed. 2, pp. 1–158, *fig. 1–213, maps 1–76*. 1953. University of Wisconsin Press, Madison, Wis. $3.50. Reviewed, this JOURNAL **43:** 177. 1953. [First edition reviewed this JOURNAL **31:** 24. 1941.]

[62] Pp. 1–18. The Rocky Mountain Herbarium Leaflet 27. 1957. Not reviewed in the JOURNAL. To be obtained gratis on application to Prof. Porter, University of Wyoming, Laramie, Wyoming.

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## The Genesis of the American Fern Journal: Supplementary Data

RALPH C. BENEDICT

The article in the preceding number of the Fern Journal, "The Genesis of the American Fern Journal," was written at Pilot Knob, New York, without benefit of correspondence or Fern Society files. Reference to these files has not disclosed any factual errors in the earlier account, but it has added considerable data from official files which seem worth recording at this time. In particular, a circular, mimeographed letter sent to all members during 1909 by Mr. Evelyn J. Winslow, President of the Society for that year, makes very explicit the problem that faced the officers of the Fern Society with respect to a possible new, Society-owned publication. The letter, which follows, carries its own message. It may be noted here that Society members responded to this letter with a vote of sixty to ten in favor of a new journal.

"The Fern Bulletin has heretofore been furnished to members of the Fern Society for 60¢ per member. For the year 1910, the publisher [Willard N. Clute] offers it at 64¢ with a discount of 4¢ if the whole subscription is paid in advance by Jan. 1st. The Executive Committee is in doubt whether to accept these terms, and takes this way of getting the sentiment of the members.

"The proposition to issue a Society journal has been for some time under consideration and the contingencies involved investigated. The cost of printing and mailing a 30 page quarterly would be about $130.00. We should pay about $100.00 for the Bulletin [The Fern Bulletin] and $20.000 for the Annual Report, which could be included in the Society journal. This leaves a very small margin to be made up by advertising and outside subscriptions. Of course it would be the business of the publishing committee to keep the size of the paper within the means of the Society; but in case of a deficit, several members have already volunteered to make it good.

"We have several members who are entirely competent to do the editorial work, and one [Philip Dowell], who is associate editor of one of the leading botanical publications of the country [Bull. Torrey Botanical Club], has signified a willingness to assist in this way, if called upon to do so.

"By owning our publication we should gain immunity from the risk of being suddenly left without an official organ through no act of our own; freedom from the necessity, often embarrassing and sometimes humiliating, of periodically making terms with a publisher who has us at his mercy; the assistance of several of our ablest fern students, who, for reasons personal or otherwise, have long refused to contribute to the Bulletin; a stronger sense of common interest and responsibility among the members, increased growth, and an improved stature among the botanical organizations of the world.

"It is important that every member should vote, and do not forget to sign your name to the card."

*The President*

Officers' reports published during the next two years (1910 and 1911) provided considerable additional data for an understanding of the events that led to the institution of the Journal. As to its reception, while there is no information available about possible withdrawals from the Society, the first year of the Journal's adoption recorded a gain of some thirty in the total membership, to pass the 200 mark for the first time.

Now, fifty years later, perhaps a few reminiscent comments may be in order. From the first year, the editorial policy was to try to maintain a fair balance in the Journal between technical articles and those of special interest to members just starting fern study. William R. Maxon, a tower of strength to the Journal through the years, transferred his taxonomic "Notes on American Ferns" series to the Fern Journal. About the same time, he arranged for the series entitled "Notes of naturalist afloat" by Safford. During those early years, friendly amateurs used to write in occasionally asking for more articles of a popular nature. Anyone interested may decide whether a fair balance has been kept by reviewing the 198 quarterly issues and the 7,400 pages which constitute the Fern Journal up to 1960. There can be no question that in the many pages of the back numbers of the Fern Journal beginning as well as advanced fern students will find a wealth of significant articles.[1]

Now, to start the fiftieth volume we have the outstanding Golden Anniversary Number which is a tribute to the efforts of the editor in furthering the Fern Journal and the Fern Society. Although this first 1960 issue is predominantly technical, not a few of its articles will be of interest to members whose fern study is only a few years old. It is my hope, however, that this fiftieth volume may also see a plentitude of articles which will provide immediately interesting reading for the newest tyro among our members.

PILOT KNOB, NEW YORK.

## Isoetes melanopoda in Southern Illinois

ROBERT H. MOHLENBROCK, JR.

Just as the original collection of *Isoëtes melanopoda* Gay and Dur. by Elihu Hall in 1853 was accidental, so was the recent discovery of this fern ally in southern Illinois.

Engelmann in 1886 described the original discovery by Hall at Athens, Menard County, Illinois, ". . . Mr. Hall was accidentally led to the discovery of this plant on his farm in 1853 by finding its trunks and spores in turning up the soil for brick-making; . . ."

On June 13, 1955, the author made one of his frequent stops along Illinois Route 3 in western Jackson County to study the flora that occurs in the roadside ditches along that highway. On this particular date, the site selected was approximately three miles south of the junction of Illinois Routes 3 and 144, and

[1] See, Benedict, R. C. The American Fern Journal through Thirty Years. This JOURNAL **31:** 41–48. 1951, and also Wherry, E. T. Cumulative Index Volumes 1 to 25. [Available for sale from Treasurer, 25¢.]

about one mile south of Worthen Bayou. As I walked down the slope from the highway into the ditch, it was apparent that a fresh mowing had occurred along the length of the twenty-foot wide ditch. Grasses and sedges had been made destitute of their crowns. Many of the bunch-plants which had precarious anchorage because of the soggy character of the ground in which they grew fell easy prey to the mower and were knocked over, sometimes being detached completely from the soil. Thus was the case

FIG. 1. INUNDATED DITCH WITH ISOETES MELANOPODA. PHOTOGRAPH BY JOHN W. VOIGT

with the *Isoetes melanopoda*. Here staring at me with their blackish "eyes" were the megasporangia at the base of the megasporophylls or "leaves." Only ten reports have been recorded for this species in Illinois, most of them not since the turn of the century. And this was the farthest south in Illinois that the Black-based Quillwort has been found. On further examination, hundreds of specimens were observed.

[illegible] melanopoda from Southern Illinois; 3/5 Natural Size.
Photograph by John W. Voigt

The ditch is from one to six feet lower than the highway and averages nearly twenty feet wide (Figure 1). As much as one foot of water may stand in it for a short period each year, although the water depth is generally only a few inches. During the driest seasons of the year, there may be no standing water, although the ground always remains spongy underfoot.

A luxurious growth of vegetation occurs along the entire length of the ditch. Several rare species for Illinois are found here. Grasses and sedges abound, although the grasses seldom are allowed to grow large enough to flower. Spike rushes (*Eleocharis Smallii* and *Eleocharis tenuis*) and rushes (*Juncus bufonius* and *Juncus effusus*) are common. Species of *Carex* include *Carex caroliniana* (the only station for it in Illinois) and *Carex granularis*. The beaked rush (*Rhynchospora corniculata*) has its most northern station in Illinois along this ditch.

Dicotyledons are not uncommon. Clammy hedge hyssop (*Gratiola virginiana*), water primrose (*Jussiaea diffusa*), and water starwort (*Callitriche heterophylla*) occur in the more deeply inundated areas, while buttonweed (*Diodia teres*), *Ammannia coccinea,* and *Phyllanthus caroliniensis* are found in less moist situations.

Most of the specimens of *Isoëtes melanopoda* were robust (*Plate 15*). As many as eighty leaves were counted on some of the larger plants; these reached a length of 25 cm. The corms measured 2.5 cm. across in a few specimens, indicating a great age for these individuals. Growing with the very common dark-based plants were scattered individuals of forma *pallida* Fernald, with pale bases. In these specimens, the megasporangia were cream to pinkish in color, although in some, traces of black could be observed. Those referable to forma *pallida* were fully as robust as the darker ones.

Subsequent visits to the ditches along Highway 3 have led to the discovery of this species on both sides of the highway for a distance of two miles.

## REFERENCE

ENGELMANN, G. The genus Isoëtes in North America. Trans. St. Louis Acad. Sci. **4:** 358–390. 1886.

## The Smooth Scouring Rush and Its Complexities

RICHARD L. HAUKE

The smooth scouring rush, *Equisetum laevigatum,* is the only species of *Equisetum* endemic to North America and thus should have a special place in the affections of American pteridologists. Unfortunately, however, there has been so much confusion concerning this species that most botanists, amateur and professional, are uncertain about whether they actually know it. As part of a recently completed monographic study of the genus *Equisetum* subgenus *Hippochaete,*[1] I devoted special attention to this species, and wish to discuss the results of that study.

In 1840, Nicholas Riehl collected a smooth-stemmed scouring rush along the banks of the Mississippi river below St. Louis, which Alexander Braun named *E. laevigatum* in 1844. A fruiting specimen of Riehl's collection is to be found in the New York Botanical Garden herbarium and another is in Vienna. George Engelmann, having seen Braun's manuscript apparently, went out along the Mississippi banks to collect this new species. The specimens he collected in August, 1843, have since been mistakenly considered the type. They are without cones and show the autumnal condition of the species, with colored sheaths reminiscent of those in *E. hyemale.* However, all have the internal structure as well as the smooth stems characteristic of *E. laevigatum.*

In 1902, A. A. Eaton described a new *Equisetum* intermediate between *E. hyemale* and *E. laevigatum,* which he named *E. hyemale* var. *intermedium.* According to Eaton it had the external appearance of the former species and the internal structure of the latter species. He stated that Milde, certainly, and A. Braun, probably, based their descriptions of *E. laevigatum* partly on this plant. Eaton later (1903) described another new *Equisetum* of this alliance, *E. funstonii.*

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[1] Doctoral thesis, Department of Botany, University of Michigan, and available on microfilm from University Microfilms, Inc., Ann Arbor, Michigan, at moderate cost.

Willard N. Clute collected a plant at Joliet, Illinois, that he named *E. ferrissii* in 1904. He wrote to Eaton that it seemed much like the descriptions of *E. hyemale* var. *intermedium* but did not agree with the co-types of that variety, differing mainly in the very long internodes. Clute later (1928) stated that the spores of *E. ferrissii* appeared abortive. An isotype in the Gray Herbarium of Clute's species bears a close resemblance to *E. hyemale* var. *intermedium* and *E. ferrissii* is thus a synonym for Eaton's variety.

The most widely recognized American authority on *Equisetum*, John H. Schaffner, named a new species in 1912. He considered *E. hyemale* var. *intermedium* to be the same as *E. laevigatum* and segregated the plants with smooth, deciduous stems as *E. kansanum*. He did not study the internal structure, to which Eaton had paid careful attention, and consequently he misapplied Braun's name *E. laevigatum*. Unfortunately, Schaffner is the authority whom later workers have followed when compiling floras and manuals, and his interpretation has become the widely accepted one. Farwell (1917) protested that Braun's original description of *E. laevigatum* was clearly of the same species Schaffner was describing as *E. kansanum*, except for a misunderstanding of the annual nature, but Farwell's protest went unheard.

In a recently completed study (1958), Emily L. Hartman worked with plants identified as *E. laevigatum*, *E. hyemale* var. *intermedium*, *E. funstonii*, and *E. kansanum*, and reached the conclusion that the western American *E. funstonii* and the eastern *E. kansanum* were identical, that the two together form a subspecies, subsp. *funstonii*, of *E. laevigatum*, and that *E. hyemale* var. *intermedium* is a synonym of *E. laevigatum*. She separated the subsp. *funstonii* from subsp. *laevigatum* on the collenchyma ratio and cone apex. The first has carinal collenchyma (she called it sclerenchyma) equal to or less than vallecular collenchyma and the cone apices are blunt to acute. The latter has carinal collenchyma exceeding the vallecular collenchyma, and apiculate cones.

Dr. Hartman stated (p. 140): "The distribution of the three intergrading taxa throughout the same geographical range, and, more significantly, their occurrence in identical habitats alone invalidates the recognition of the entities in question as distinct species." However, it is just as difficult to conceive of sympatric subspecies. Partial isolation of a portion of the range of the species in question would be expected to precede the development of any discontinuous variation sufficient to be recognized as of subspecific importance. Stebbins (1950, p. 50) said: "The subspecies, on the other hand, is usually conceived of as a group of populations with a common origin and a more or less integral geographic distribution, which has acquired its distinctive morphological characteristics partly through the influence of similar environmental factors, but also to a large extent through partial isolation from other subspecies."

Perhaps if Dr. Hartman had studied all of the species of *Hippochaete* in North America and sought as many characters as possible, such as spore size and appearance, her conclusions might have been different. She might have suspected that the two groups of plants intergraded not necessarily because they are subspecies but possibly for some other reason. Even were these two really subspecies, it is impossible to understand how Dr. Hartman attached the name *laevigatum* to the group she did. The specimens she erroneously considered the type for this name all have the vallecular collenchyma reaching the vallecular canal, which is the key character for her subsp. *funstonii*. In fact one of the specimens of Engelmann's August 1843 collection was annotated subsp. *funstonii* by Dr. Hartman. Conversely, she annotated one of the specimens of the type collection of subsp. *funstonii* as subsp. *laevigatum*. Apparently she considered any specimen with the carinal collenchyma exceeding the vallecular by the slightest amount as subsp. *laevigatum* and any specimen with the vallecular collenchyma equal to the carinal as subsp. *funstonii*. Since within a single clone of *E. laevigatum* the depauperate stems and the upper portions of normal stems may have slightly greater carinal collenchyma, whereas the lower portions of the same stems may have slightly greater vallecular collenchyma—this is especially true of many specimens in the Southwest—this single variable character is insufficient for delimiting two subspecies.

Thus it appears that a misconception of the nature of speciation and a lack of sufficient information led Dr. Hartman to an erroneous conclusion. The consideration of *E. funstonii* and *E. kansanum* as synonymous is probably correct. The placing of this taxon as a subspecies of another taxon consisting of *E. hyemale* var. *intermedium* and *E. laevigatum* as synonyms is questionable.

The discovery of aborted spores and irregular meiosis in some specimens identified as *E. hyemale* var. *intermedium* and *E. laevigatum* first led me (1958) to the suspicion that hybridization between *E. hyemale* var. *affine* and *E. laevigatum* was a factor in the confusion attendant upon these species. I examined more than two thousand herbarium specimens of these plants collected in the United States. Specimens with aborted spores and those vegetative specimens resembling them were segregated into a group. A comparison of this group of suspected hybrids with the parents, involving statistical analysis of measurements from more than one thousand of the specimens examined, revealed that the suspected hybrids were intermediate between the parental types, as shown in Table 1.

TABLE 1

| Character | *E. hyemale* var. *affine* | Putative Hybrid | *E. laevigatum* |
|---|---|---|---|
| Stem diameter [1] | 7.80 | 5.80 | 4.90 |
| Stem height [2] | 7.84 | 7.46 | 5.80 |
| Ridge number | 30.14 | 22.04 | 21.97 |
| Sheath length [1] | 9.21 | 10.98 | 10.47 |
| Sheath width [1] | 8.34 | 6.74 | 5.90 |
| Sheath ratio l:w | 1.06 | 1.68 | 1.80 |
| Stomatal length [3] | 84.9 | 87.1 | 91.4 |
| Stomatal width [3] | 77.5 | 70.1 | 67.3 |
| Stomatal ratio l:w | 1.09 | 1.24 | 1.36 |
| Cone apex | apiculate | slightly apiculate | blunt |
| Stem duration | evergreen | bases only persistent | deciduous |
| Collenchyma ratio | (1:8)1:7–1:4(1:3) | (1:4)1:3–1:2(2:3) | (2:3)1–3:2 |

[1] In millimeters. [2] In decimeters. [3] In microns.

All values in Table 1 are means except the last. This is a range, with the extremes in parentheses being rare. The collenchyma, sometimes incorrectly called sclerenchyma, is the supporting tissue under the epidermis. It occurs in thick strands under the middle of the grooves (vallecular collenchyma) and ridges (carinal collenchyma). These strands extend radially toward the center of the stem. The collenchyma ratio is the ratio of the radial measurement (measured in an internode somewhat below the middle of the stem) of the vallecular collenchyma to the carinal collenchyma. Thus, *E. hyemale* has extensive development of the carinal collenchyma and slight development of the vallecular collenchyma, whereas in *E. laevigatum* they are both about equal or the vallecular exceeds the carinal.

Statistical analysis of herbarium specimens, as shown in Table 1, reveals the intermediacy in many characters of the specimens suspected of hybrid origin on the basis of their aborted spores. That the suspected parents, *E. hyemale* var. *affine* and *E. laevigatum,* could cross has been shown by culture of isolated gametophytes on an inorganic agar medium and controlled crossing of antheridial gametophytes of one species with archegonial gametophytes of the other. Sporophytes were produced but never survived longer than nine months, due to fungus attacks. Although the synthetically produced hybrids never grew large enough to be compared morphologically with the natural hybrids, it was demonstrated that the sperm from either species could fertilize eggs from the other with the production of viable sporophytes.

One fact which at first seemed inconsistent with the interpretation of the existence of a hybrid between *E. hyemale* var. *affine* and *E. laevigatum* was the presence of the supposed hybrids in areas where one or both parents were absent. Such is the case in New York, Pennsylvania, New Jersey, Connecticut, West Virginia, and Virginia. All specimens from these states identified as *E. laevigatum* appear to be of hybrid origin although the species *E. laevigatum* ranges only as far east as Ontario, Michigan, and Ohio. The answer is apparently distant dispersal by vegetative means, particularly by water transport of fragments of living plants. In Michigan, the sandy shores of many lakes are overgrown with various *Hippochaete,* providing an abundant supply of living stem fragments. Victorin (1927, p. 94) describes the vegetative dispersal of *E.* × *litorale* and *E. hyemale* var. *jesupii* (*E.* × *trachyodon*), two other hybrids, by ice action along the shores of the St. Lawrence river. Since most of the localities of the hybrid east of Michigan are in contact with the Great Lakes waterway it is quite conceivable that the plants were carried there by water. Many localities from central New York seem to be exceptions until it is noticed that they occur along a barge canal connecting Lake Erie to the Hudson River, and are thus also in contact with the Great Lakes waterway.

That vegetative propagation can readily occur was shown by an experiment in which over a hundred segments of green stems of the hybrid containing at least one node each were placed around the edge of an old gravel pit and more than twenty small plants were produced from them.

The occurrence of widespread hybridization between *E. hyemale* var. *affine* and *E. laevigatum* is therefore established. It has been shown that there are many specimens morphologically intermediate between those two species, and that these intermediate specimens have aborted spores. The ability of sperm from one species to fertilize eggs of the other has been demonstrated, as has also the ease of vegetative dispersal of the hybrid. Thus can be explained the presence of the sterile hybrid in cases where one or both parents are absent.

This knowledge of the existence of a hybrid between *E. hyemale* var. *affine* and *E. laevigatum* permits a clarification of the nomenclature of these widespread and long confused taxa. The correct name for the hybrid is *E.* × *ferrissii* Clute, the first legitimate binomial applicable to the hybrid. The name *E. hyemale* var. *intermedium,* given by Eaton, cannot be used because an interspecific hybrid can hardly be considered a variety of one parent. The synonomy of *E.* × *ferrissii* and its parents is as follows.

EQUISETUM HYEMALE VAR. AFFINE (Engelm.) A. A. Eat. Fern Bull. **11:** 111. 1903.

*E. prealtum* Raf. Fl. Ludovic. 13. 1817.

*E. laevigatum γ elatum* Engelm. Amer. Journ. Sci. **46:** 87. 1844.

*E. robustum* A. Br. *ibid.* 88.

*E. robustum β minus* Engelm. *ibid.*

*E. robustum γ affine* Engelm. *ibid.*

*E. hiemale* var. *californicum* Milde, Verh. Zool.-Bot. Ges. Wien **12:** 1264. 1862.

*E. hiemale* var. *iaponicum* Milde, Ann. Mus. Bot. Lugd.-Batavi **1:** 68. 1864.

*E. robustum* var. *drummondii* Milde, Equiset. 539. 1867.

*E. hiemale* f. *polystachyum* Prager *ex* A. A. Eat. in Gilbert, List N. Am. Pterid. 26. 1901.

*E. hiemale* var. *herbaceum* A. A. Eat. Fern Bull. **11:** 108. 1903.

*E. hiemale* var. *pumilum* A. A. Eat. *ibid.* 109.

*E. hiemale* var. *drummondi* (Milde) A. A. Eat. *ibid.* 111.

*E. hiemale* var. *affine* (Engelm.) A. A. Eat. *ibid.*

*E. hiemale* var. *robustum* (A. Br.) A. A. Eat. *ibid.*

*E. hiemale* var. *prealtum* (Raf.) Clute, Fern Bull. **16:** 18. 1908.

*Hippochaete hyemalis* var. *californica* (Milde) Farw. Mem. New York Bot. Gard. **6:** 464. 1916.

*H. prealta* (Raf.) Farw. *ibid.* 467.

*H. prealta* var. *affinis* (Engelm.) Farw. *ibid.*

*H. prealta* var. *pseudohyemalis* Farw. Amer. Fern Journ. **3:** 76. 1917.

*E. affine* Rydb. Fl. Rocky Mts. and Adj. Plains 1052. 1917.

*E. hyemale* var. *affine* f. *pumilum* Vict. Contr. Lab. Bot. Univ. Montreal **9:** 89. 1927.

*E. hyemale* var. *ramosum* Honda, Bot. Mag. Tokyo **47:** 435. 1933.

*E. komarovi* Iljin, Flora URSS **1:** 110. 1934.

*H. prealta* subvar. *neopolystachya* Farw. Amer. Fern Journ. **27:** 17. 1937.

*H. prealta* var. *pseudohyemalis* subvar. *polystachya* (Prager) Farw. *ibid.*

*E. californicum* (Milde) G. N. Jones, Univ. Wash. Pub. Biol. **7:** 23, 174. 1935.

*E. kansanum* f. *elatum* (Engelm.) Broun, Index N. Am. Ferns. 89. 1938.

*E. hyemale* var. *californicum* f. *herbaceum* (A. A. Eat.) Broun, *ibid.*

*E. prealtum* f. *drummondii* (Milde) Broun, *ibid.* 93.

*E. prealtum* var. *affine* (Engelm.) Broun, *ibid.*

*E. prealtum* var. *affine* f. *neopolystachyum* (Farw.) Broun, *ibid.*

*E. prealtum* var. *affine* f. *polystachyum* (Prager) Broun, *ibid.* 94.

*E. prealtum* var. *affine* f. *pumilum* (A. A. Eat.) Broun, *ibid.*

*E. prealtum* var. *affine* f. *ramosum* (A. A. Eat.) Broun, *ibid.*

*E. hyemale* var. *elatum* (Engelm.) Morton, Leafl. West. Bot. **16:** 156. 1951.

*E. hyemale* var. *pseudohyemale* (Farw.) Morton, in Gleason, New Ill. Fl. N. U. S. and Adj. Can. **1:** 16. 1952.

EQUISETUM LAEVIGATUM A. Br. Amer. Journ. Sci. **46:** 87. 1844.

*E. laevigatum β scabrellum* Engelm. Amer. Journ. Sci. **46:** 87. 1844.

*E. funstoni* A. A. Eat. Fern Bull. **11:** 10. 1903.

*E. funstoni* f. *caespitosum* A. A. Eat. *ibid.* 11.

*E. funstoni* f. *nudum* A. A. Eat. *ibid.*

*E. funstoni* f. *ramosum* A. A. Eat. *ibid.* 12.

*E. funstoni* f. *polystachyum* A. A. Eat. *ibid.*

*E. laevigatum* f. *ramosum* A. A. Eat. *ibid.* 42. 1903.

*E. laevigatum* f. *caespitosum* A. A. Eat. *ibid.* 43.

*E. laevigatum* f. *variegatoides* A. A. Eat. *ibid.*

*E. laevigatum* f. *polystachyum* A. A. Eat. *ibid.* 44.

*E. kansanum* Schaffn. Ohio Nat. **13:** 21. 1912.

*Hippochaete laevigata* (A. Br.) Farw. Mem. New York Bot. Gard. **6:** 469. 1916.

*H. prealta* var. *scabrella* (Engelm.) Farw. *ibid.*

*H. laevigata* var. *eatonii* Farw. *ibid.* 470.

*H. laevigata* var. *funstoni* (A. A. Eat.) Farw. *ibid.* 471.

*H. laevigata* var. *polystachya* (A. A. Eat.) Farw. *ibid.*

*E. funstonii* var. *caespitosum* Jeps. Man. Fl. Pl. Calif. 40. 1923.

*E. funstonii* var. *nudum* Jeps. *ibid.*

*E. funstonii* var. *ramosum* Jeps. *ibid.* 41.

*E. fontinale* Copel. Madroño **3:** 367. 1936.

*H. laevigata* var. *ramosa* (A. A. Eat.) Farw. Amer. Fern Journ. **27:** 17. 1937.

*H. laevigata* var. *caespitica* Farw. *ibid.*

*H. laevigata* var. *caespitosa* (A. A. Eat.) Farw. *ibid.*

*H. laevigata* var. *variegatoides* (A. A. Eat.) Farw. *ibid.*

*E. kansanum* f. *caespiticum* (Farw.) Broun, Index N. Am. Ferns 89. 1938.

*E. kansanum* f. *caespitosum* (A. A. Eat.) Broun, *ibid.*

*E. kansanum* f. *eatonii* (Farw.) Broun, *ibid.*

*E. kansanum* f. *polystachyum* (A. A. Eat.) Broun, *ibid.*

*E. kansanum* f. *ramosum* (A. A. Eat.) Broun, *ibid.*

*E. kansanum* f. *variegatoides* (A. A. Eat.) Broun, *ibid.*

*E. laevigatum* f. *scabrellum* (Engelm.) Broun, *ibid.* 90.

*E. laevigatum* subsp. *funstonii* (A. A. Eat.) Hartman, Trans. Kansas Acad. Sci. **61:** 144. 1958.

EQUISETUM × FERRISSII Clute, Fern Bull. **12:** 22. 1904. (*pro. sp.*).

*E. hyemale* var. *affine* × *laevigatum*

*E. hiemale intermedium* A. A. Eat. Fern Bull. **10:** 120. 1902.

*E. hiemale intermedium* f. *polystachyum* A. A. Eat. *ibid.* 122.

*E. hiemale* var. *suksdorfi* A. A. Eat. **11:** 109. 1903.

*E. fluviatile* L. var. *siccum* Lunell, Bull. Leeds Herb. **2:** 5. 1908.

*Hippochaete prealta* var. *intermedia* (A. A. Eat.) Farw. Mem. New York Bot. Gard. **6:** 468. 1916.

*H. prealta* var. *suksdorfi* (A. A. Eat.) Farw. *ibid.*

*H. laevigata* var. *eatonii* Farw. *ibid.* 470. (*pro. parte*).

*E. intermedium* Rydb. Fl. Rocky Mts. and Adj. Plains, 1053. 1917.

*E. laevigatum* f. *proliferum* Haberer, Bull. New York State Mus. **243–244:** 47. 1923.

*E. hyemale intermedium* f. *proliferum* Haberer, *ibid.*

*E. hyemale* var. *affine* f. *intermedium* Vict. Contr. Lab. Bot. Univ. Montreal **9:** 89. 1927.

*E. prealtum laevigatum* (A. Br.) Bush, Am. Midl. Nat. **12:** 111. 1930.

*E. laevigatum* auct. non A. Br.: Schaffner, Ohio Nat. **13:** 19–22. 1912; and most subsequent authors.

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## The Gametophyte and Young Sporophyte of Athyrium esculentum

B. K. NAYAR

*Athyrium esculentum* (Retz.) Copel. is one of the species of ferns that has suffered the most in nomenclature, having been by different authors attributed to at least eight different genera (*Hemionitis, Diplazium, Asplenium, Anisogonium, Microstegia, Callipteris, Digrammaria,* and *Gymnogramme*). It extends from Polynesia to India, growing as a straggling weed in marshy, or just moist, areas which are not necessarily shaded. *A. esculentum* lacks the elegance of most other species of *Athyrium* and consequently is not favoured as an ornamental fern, although it is comparatively easy to cultivate and is one of the most important of ferns as human food. The tender leaves of the plant are used as a vegetable in preparing tasty salads, pickles, etc.

Comparatively little is known regarding the gametophyte of *Athyrium esculentum* or for that matter any species of *Athyrium.* In view of this, spores were collected from plants growing at the National Botanic Gardens (Lucknow) and sown in September, 1955, on sand beds irrigated from below and maintained in a glass house. The technique followed is as described earlier (Kachroo & Nayar, 1953; Nayar, 1954).

The spores of *A. esculentum* (*Figs. 2, 3*) are bilateral,[1] anisopolar, with a single linear short proximal laesura, of medium size, monolete, concavo-convex in equatorial view, with one of the equatorial ends narrower than the other and with a brown scabrate exine (having small irregular elevated patches). The exine pattern (*Fig. 1*) is discernible only in acetolysed and bleached preparations. The average size of the spores is P 29.16 $\mu$, $E_1$ 44.00 $\mu$ and $E_2$ 30.24 $\mu$. The size variations are: P 25.00 to 32.50 $\mu$, $E_1$ 39.50 to 50.50 $\mu$ and $E_2$ 25.00 to 36.00 $\mu$.

In culture the spores germinate within a week. The first

[1] The acetolysis method (Erdtman, 1952) was used in the study of spores and the terminology used in spore description is after Harris (1955).

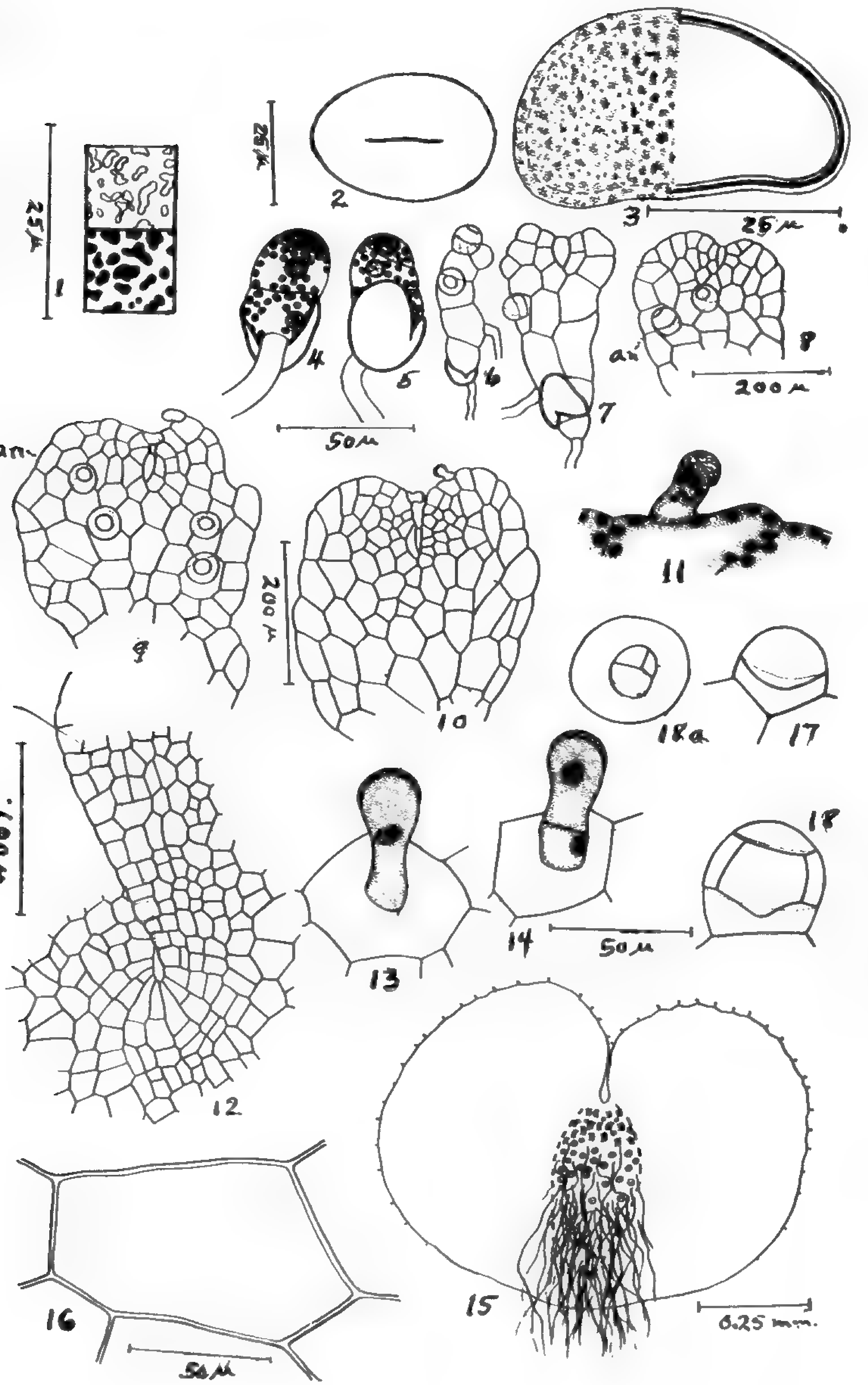
rhizoid protrudes as a papillose structure, the exine rupturing at the laesura, and is soon cut off from the body of the spore by a basal wall. The rhizoid in early stages may have a few included chloroplasts. The germinating filament originates laterally to the rhizoid towards the narrower end of the spores (*Figs. 4, 5*). As it grows the exine splits longitudinally into two and remains attached to the basal cell till very late in development. The germinating filament becomes 3 to 4 cells long before the formation of the prothallial plate begins (*Fig. 6*). The cells are broader than long and densely chlorophyllous. Rhizoids originate laterally. Some of the cells of the filament may form antheridia at this stage.

An obconical apical meristematic cell is established in the usual way and a spatulate prothallus is formed within a month after germination (*Fig. 7*). Soon the gametophyte develops a cordate apex with the meristematic cell lodged at the bottom of the apical notch (*Fig. 8*). Antheridia are formed continuously from the filamentous stage onwards and are both marginal and superficial.

The prothallus remains naked till it becomes distinctly cordate, when marginal unicellular, club-shaped hairs are formed (*Figs. 9, 10*). Each hair originates as a mammilliform protuberance, which is cut off by a basal wall from the parent cell. The protuberance elongates and the apex becomes highly vacuolate. Soon, a greenish-yellow extracellular cap is secreted (*Fig. 11*), which in older hairs may be shed.

As the gametophyte becomes distinctly cordate the apical meristematic cell becomes replaced by an apical meristem of conical cells (*Fig. 12*). Formation of a midrib is initiated by two months' old gametophytes and archegonia are produced continuously thereafter. Superficial hairs resembling the marginal ones but sometimes two cells long (*Figs. 13, 14*) are also developed sparsely over the midrib and wings.

The mature gametophyte (*Fig. 15*) is cordate, broader than long (ca. 10 mm in diameter) with a deep apical notch usually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15
16
50μ
0.25 mm.

overlapped by the lateral lobes and with a prominent midrib bearing sex organs on the ventral surface. The wing cells are uniformly thin-walled (*Fig. 16*) and densely chlorophyllous. The sex organs are of the usual type in higher ferns. Antheridia are globular and generally sessile (*Figs. 17, 18*). Occasionally the opercular cell is divided into two, three (*Fig. 18a*), or four cells. In liberating the sperms the opercular cell is entirely thrown off.

Gametophytes three months old produce sporelings. Generally only one sporophyte is formed per gametophyte (*Fig. 19*). The juvenile leaves are of the midribless type (terminology after Wagner, 1952b). The simplest cotyledonary leaf is cuneate (*Figs. 20, 21*) with a short petiole and a single vein forking equally twice. Their bases generally form an angle of less than 90° and the veinlets near the middle of the lamina run parallel to each other. The apex is usually truncate or shallowly notched.

Generally the second leaf (in some cases the first leaf itself) marks the next stage in development. It has a broader lamina with a distinct notch at the apex and a wider angle at the base. The veins fork three times (*Fig. 22*) with the branches towards the middle of the lamina more pronounced and sometimes forking once again in such a way as to give an appearance of pinnate branching (*Fig. 19–ii*). In such cases usually one side of the leaf is larger than the other (the right hand half in *Figs. 19–ii* and *22*).

The third stage is usually met with in the fourth or fifth leaf

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*Figs. 1–18.* Spore- and gametophyte-morphology of *A. esculentum. Fig. 1.* L. O. pattern of the spore exine; *Fig. 2.* Equatorial view of spore; *Fig. 3.* Proximal polar view of spore showing laesura; *Figs. 4, 5.* Origin of the germinating filament; *Figs. 6–10.* Early stages in the development of the prothallus; *Fig. 11.* Marginal hair on mature prothallus; *Fig. 12.* Apex of mature prothallus showing meristem and adjoining tissue; *Figs. 13, 14.* Superficial hairs on mature prothallus; *Fig. 15.* Mature prothallus (diagrammatic); *Fig. 16.* One of the wing cells showing thickenings at corners; *Figs. 17, 18.* Stages in development of antheridium (dotted line represents surface pattern); *Fig. 18a.* Surface view of mature antheridium showing a divided cap cell.


ii
iii
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200 μ

or in weak individuals even later. The lamina broadens and the apex becomes elongated giving an oval shape to the leaf. The main vein entering the leaf base instead of dichotomising proceeds towards the tip as a midrib and gives off lateral veins alternately. The lower lateral vein on each side dichotomises once or twice, the branches towards the middle being longer than the others (*Figs. 19–iii, 23*). The transition to the midribbed stage is rather sudden and no intermediate stages have been observed. The leaf margin is wavy, the depressions corresponding with the spaces between vein tips.

In the fifth or sixth leaf the lamina broadens considerably and becomes trilobed (*Fig. 24*), the midrib and its upper branches occupying the middle lobe and the basal pair of lateral veins occupying the lateral lobes. The lateral veins develop in the same manner as the midrib. Just below the sinus on either side are formed the first areoles, by the basal adaxial tertiary veinlet of the lateral lobes joining with the basal secondary veins of the middle lobe or a branch of it. After joining, the fused vein proceeds towards the base of the sinus.

In later formed leaves the middle lobe becomes more pronounced and the basal secondaries of it begin forming the next pair of lobes with an areole at the base of each sinus (*Fig. 25*). The sinuses separating the first pair of lobes become deeper and almost reach the midrib making the leaf pinnatisect. Consequently the areole at the base of the sinus is not formed.

Further expansion of the lamina is by a pronounced increase in length of the leaf and formation of successive lateral lobes on

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*Figs. 19–39.* Morphology of the juvenile leaves of *A. esculentum*. *Fig. 19.* Gametophyte with attached sporeling (growing apex of the sporeling not shown; *i*, *ii*, *iii*–the first, second and third leaves); *Figs. 20–26.* Leaf succession in the young sporophyte; *Fig. 27.* Portion of adult lamina showing venation pattern (*mr*– midrib, *lv*– lateral vein); *Fig. 28.* Portion of margin of first leaf showing hairs (*h*– club-shaped hair, *ah*– acicular hair); *Fig. 29.* Superficial hair on first leaf; *Fig. 30.* Multicellular hair on the fourth leaf; *Figs. 31, 32.* Superficial hairs on the sixth leaf; *Figs. 33, 34, 35.* Hairs on the petiole of the seventh leaf; *Fig. 36.* Palea on the petiole of the same; *Figs. 37, 38, 39.* Hairs on the lamina of adult leaf.

either side of the midrib (*Fig. 26*). Though areoles are formed on both sides of the midrib connecting successive secondary veins, they do not form later as the lobes become separated. Instead, areoles of the same pattern are formed on either side of the secondary veins in the lobes. The margins of the lobes remain wavy. The leaves pass on from the pinnatifid to the pinnate condition by gradual deepening and broadening of the base of the sinuses, until the lamina is reduced to inconspicuous wings on the midrib (now the rachis) and finally to a deep green line lodged in an inconspicuous groove on the sides . The leaf-lobes (now the pinnae) develop a narrow stalk-like base and the venation becomes more complicated.

Increase in the size of the leaf is more marked in the longitudinal plane until an oblong deeply pinnatifid lamina is obtained. The midrib becomes grooved on the upper surface. The lateral lobes elongate, become oblong with almost parallel sides and a tapering apex. The secondary lateral veins of the lobes produce alternating tertiary branches which run obliquely to the secondary veins. The first formed tertiaries from nearby secondaries fuse to form a single vein which runs parallel to the secondaries for a short distance and ends blindly. As the leaf-lobe expands, more tertiaries are produced by each secondary vein and the lower ones fuse in pairs. The fusion vein from each basal pair of tertiaries while proceeding towards the margin fuses with successive tertiaries on either side, thus forming two regular rows of obliquely placed areoles between the nearby secondaries (*Fig. 27*). Tertiaries formed towards the tips of secondaries are free. The fusion veins above the last pair of areoles either end blindly below the marginal sinus of the lamina or in some cases fork just below the sinus, the branches running parallel to the sides of the sinus for some distance.

Once-pinnate leaves characterize the young plants of *A. esculentum* for quite a long time, and adult plants may revert to this leaf form under adverse conditions of growth. The bipinnate leaves of the adult plants are formed by the pinnae of the juvenile leaves undergoing the same pattern of development as the main leaf itself.

The cotyledonary leaf bears unicellular, thin-walled, acicular hairs (*Fig. 28, ah*) all over the lamina and petiole. Mixed with them, unicellular club-shaped hairs (*Fig. 28, h; Fig. 29*) resembling those on the gametophyte, but without the caps, occur sparsely. The fourth leaf bears also club-shaped, uniseriate, multicellular hairs (*Fig. 30*) toward the base of the blade and on the petiole. These hairs are much bigger than the unicellular hairs and become pale brown when fully developed. The multicellular hairs become more numerous in succeeding leaves. The cell at the apex of the hairs becomes more prominent being globular, much bigger than other cells, and sharply marked off from the main body (*Figs. 31, 32, 33*).

The seventh or the eighth leaf is the first one to bear paleae. The multicellular, club-shaped hairs on these bear lateral unicellular glandular branches resembling gametophytic hairs (*Figs. 34, 35*). Later, the cells near the basal region of the hair expand and divide longitudinally, initiating the formation of a flattened base. The apical region in all cases remains narrow, uniseriate, and elongate, terminating in a globular or ovoid cell with very dense contents. Repeated longitudinal divisions of the cells of the basal half result in an oval palea with an attenuated hair-like tip and bearing superficial and marginal club-shaped hairs (*Fig. 36*). The adult leaf bears uniseriate, multicellular, club-shaped hairs with a prominent globular terminal cell having dense dark contents (*Figs. 37–39*).

### Comparison

Little is known regarding the gametophyte and much less about the young sporophyte of *Athyrium* and related genera, so much so that it is well nigh impossible to make many comparisons. Stokey (1951), Wagner (1952a) and others have shown the importance of characters of the gametophyte and the young sporophyte in assessing the phylogeny of the different genera of ferns. The author (Nayar, 1956) has shown the probable correlation between the gametophytic and sporophytic hairs in some of the polypodiaceous ferns and has suggested that it may be true for other ferns also. The study of *A. esculentum* lends further support to this statement. The acicular hairs on the young sporophyte seem from present observations to be entirely new structures, the paleae and hairs being comparable to gametophytic trichomes in their ontogeny and fundamental morphology.

Thickening of the walls at the corners of the cells of the mature gametophytes was reported in *Athyrium filix-femina* (L.) Roth by Stokey (1951). *Athyrium esculentum* differs from this in having uniformly thickened walls. Unicellular, club-shaped hairs of the *A. esculentum* type occur in *A. angustifolium* (Michx.) Milde but are reported to be absent in *A. filix-femina* and *A. alpestre* Rylands (Stokey, 1951). Unicellular, club-shaped hairs with an apical cap, mixed with two- to three-celled, elongate, acicular hairs (comparable to the acicular hairs on young juvenile leaves of *A. esculentum*) occur profusely on the prothallus of *Tectaria* spp. (Kachroo, 1956) and *Cyclosorus* spp. (Kachroo, 1957). The development and morphology of the gametophytes in these genera also are comparable to those of *A. esculentum.*

The first juvenile leaves in the related genera of ferns (*Dryopteris, Polystichum,* etc.) are usually dichotomous in plan and four- to eight-lobed (Wagner, 1952a). The early juvenile leaves of *A. esculentum,* though dichotomous in plan, have a cuneate, almost entire lamina, resembling in some respects the first leaf of some species of *Asplenium* (Slosson, 1906). The early leaves of those Aspleniaceae that are known have a tendency toward a simple, single vein pattern in the simplest frond condition and generally a more or less obcordate shape and a dichotomously divided vein in the first several fronds (Wagner, 1952b). All of them possess the ability to produce dichotomous vein patterns up to at least 4 to 6 vein termini. Among the Aspidiaceae, *Tectaria* alone, as far as known, is comparable to *A. esculentum* in the form of the juvenile leaves.

ACKNOWLEDGMENTS

Thanks are due to Prof. K. N. Kaul, Director, National Botanic Gardens, Lucknow (India), for the keen interest he has in this work.

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## Recent Fern Literature

CENTRAL EUROPEAN FERNS.[1]—In a collection of natural history books published by the Senckenberg Natural History Society, Georg Eberle has just written a book of high quality on the ferns of central Europe that is likely to attract new friends to these plants. It contains a summary on ferns in general—their organography and life cycle, a well-documented exposition on hybridity in central European ferns, taking account of the work of Manton and D. E. Meyer, an account of apogamy and apospory, and finally a treatment of the various species and their hybrids in the territory studied. The illustrations consist of two drawings and 92 magnificent photographs taken by the author between 1926 and 1958, showing the plants in their natural habitats.—A. LAWALRÉE.

[1] Eberle, Georg. Farne im Herzen Europas. pp. I–VIII, 1–116, ill. Obtainable from Verlag Dr. Waldemar Kramer, Frankfurt am Main, Germany, 1959. Price DM 8.50.

## Notes and News

MEMBERS OF THE OPHIOGLOSSACEAE WANTED FOR TRANSPLANT EXPERIMENTS.—Samples of from six to twelve whole living plants of Ophioglossaceae with roots and a clod of soil attached are desired, these to be sent in a plastic bag to the undersigned. These specimens will be carefully transplanted into various appropriate habitats to test whether or not the "distinguishing characters" are genetically fixed or are merely environmental modifications. The following are especially desired: *Botrychium multifidum* (Gmel.) Rupr. ssp. *multifidum* (=ssp. *typicum* Clausen); *B. multifidum* ssp. *californicum* (Underw.) Clausen; *B. australe* R. Brown; *B. dissectum* f. *elongatum* (Gilb. & Haberer) Weath.; *B. schaffneri* Underw.; *B. japonicum* (Prantl) Underw.; *B. simplex* var. *compositum* (Lasch) Milde; *B. simplex* var. *tenebrosum* (A. A. Eaton) Clausen; *B. matricariifolium* ssp. *hesperium* Maxon and Clausen; *B. lanceolatum* (Gmel.) Angstr. ssp. *lanceolatum* (=ssp. *typicum* Clausen); *B. virginianum* ssp. *europaeum* (Angstr.) Clausen; and *Ophioglossum vulgatum* var. *pycnostichum* Fernald.—W. H. WAGNER, JR., *Department of Botany, University of Michigan, Ann Arbor, Michigan.*

## American Fern Society

### Report of the President for 1959

Moderate growth in the membership of the American Fern Society continued through 1959, with applications for membership slightly exceeding our losses through death of members, resignations, and lapsing of dues. The membership stood at 764 on January 1, 1959, and 797 by the end of December. This increase is less than that of recent years, but it indicates that many of our members are still actively working in behalf of the Society and calling it to the notice of their friends. This type of growth is healthy and indicative of the esteem many hold for the ferns of this and other countries.

Growth in the number of members in good standing is gratifying, but in itself is not sufficient to insure long term benefits to the Society as a whole and to its individual members. Promotion of knowledge about ferns and expansion of awareness of their beauty and charm among green thumbers, gardeners, and householders does bring such benefits. That the members of the American Fern Society have fostered such studies and interest is shown by the continued flow of papers to the Editor of the American Fern Journal. These papers, a good sample of which have appeared in the Fern Journal's last four numbers, have been varied in scope, subject matter, style, and emphasis. Some of our members have lamented the small number that deal with the practical problems they meet in growing ferns in their own gardens, greenhouses, or homes. The large proportion of space devoted to articles dealing with the systematic position of certain ferns, with necessary changes in scientific names, and other technical subjects, is owing to the fact that most of the people who submit articles to the Editor are professional botanists. A member chiefly interested in growing, or just enjoying, ferns rarely wants to devote the necessary time and effort to preparing a paper for publication. To make the situation more difficult, the professional botanist all too often can not spare the energy required to grow many of his favorite ferns, so he seldom is in a position to write a gardening type of article.

During the year strong regional sub-organizations have functioned smoothly and effectively on both the Atlantic and the Pacific coasts. The "New England Section," under the capable leadership of such staunch supporters as Dr. R. C. Benedict, Dr. Benjamin Allison, Mr. Boughton Cobb, Miss Clara Hires, and others living in and near this area, has sponsored informal meetings to discuss ferns and to share information, arranged visits to gardens, negotiated with the Director of the New York Botanical Garden looking toward a fuller utilization of ferns in that justly famous garden. Owing to the distances between the New England-New York area and the official Society field-trip on the north shore of Lake Superior, the New England group sponsored an eastern fern foray during July. All of these activities have added to the prestige of the American Fern Society, and I sincerely believe the Society as a whole appreciates such excellent work.

Diagonally across the continent, members of the American Fern Society living in and near Los Angeles several years ago organized the Los Angeles Fern Society, open to anyone interested in ferns. But the founders stipulated that officers of that organization also must hold membership in the American Fern Society. These fern enthusiasts in the southwest have held regular monthly meetings for lectures on various aspects of fern taxonomy, ecology, structure, and culture, with vigorous discussion often following the presentation of papers. Their meetings have provided opportunities for the participating members to "swap" plants and to compare notes on the distribution of various native ferns, sources of supplies, and names of reliable dealers. Mrs. Sylvia Leatherman, who has been a member of the American Fern Society for a number of years, served as President of the Los Angeles Fern Society during 1959, succeeding Dr. W. C. Drummond, who was the first president of their organization.

In order to allow members planning to attend the Ninth International Botanical Congress in Montreal to participate in a fern foray just prior to the International meetings, Dr. Olga Lakela, Emeritus Professor of Botany at the University of Minnesota, led a two-day foray from Duluth, Minnesota, along the north shore of Lake Superior on August 7th and 8th. Eighteen members and friends enjoyed two fine days under Dr. Lakela's guidance. Several of those present went on to Montreal and took part in a fern excursion to the Rougemont area south of Montreal on August 21. This foray, although not officially sponsored by our Society, gave some of us a rare opportunity to become acquainted with pteridologists from England, Scandinavia, Italy, Belgium, France, India, China, and Africa. At least three of those on the Rougemont foray became members of the American Fern Society as a direct result of these contacts!

Negotiations with the American Institute of Biological Sciences, begun in 1958, continued into 1959 and resulted in our full affiliation with that organization. Henceforth, the American Fern Society will be able to hold its annual summer meeting in conjunction with those of the A.I.B.S. as an affiliate rather than a guest, and have the major portion of the local arrangements and provisions for the printing of the program handled by the staff of the A.I.B.S. The A.I.B.S. Bulletin, which will list the American Fern Society among the Affiliated Societies, reaches approximately 80,000 biologists in the United States and Canada five times each year.

Rising costs for publishing the American Fern Journal have been a source of much concern to the Editor and to the Council. Several times during the past five years the printers have served notice that the rates for printing the Fern Journal would be advanced. Each time the advance has been accepted, although without enthusiasm. Finally, in 1959, another such notice resulted in wide inquiry among various publishing houses by Mr. Morton, with the result that arrangements have been made to have the Fern Journal printed, beginning with the January-March number of Volume 50, by the Monumental Printing Company, of Baltimore, Maryland. The Council appreciates the many favors that the Business Press, Inc., extended to the Society during the 35 years it printed the Fern Journal. We hope that the association with the Monumental Printing Company may be as long and as free of difficulties.

It is a pleasure to commend the Council members and other representatives of the Fern Society for the loyal support each has accorded the President and the Society throughout 1959. When prompt action was required to carry through a project of importance to the Fern Society, each member of the Council has voted in accordance with his conviction on what was in the best interests of the Society. Our Representative to the Council of the American Association for the Advancement of Science, Dr. A. C. Smith, has attended each meeting, without cost to the Fern Society, and promptly furnished a resumé of the recommendations made and actions taken by that body. Dr. Rolla Tryon, representing us on the American Horticultural Council, called on the secretary of that organization to ascertain how our interests fitted in with the aims of the Horticultural Council. It appears that there are several spheres of interest held in common by our Society and the Horticulturalists. It is conceivable that their support in promoting protection and conservation of threatened fern localities might be of inestimable value.

Mrs. Boydston has prepared a report covering the Spore Exchange. I commend her for her faithful and efficient handling of that segment of the Society's activities!

Dr. Herbert Wagner continues to serve as Librarian of the Fern Society's collection of books and reprints on ferns, and to take care of the herbarium of dried and pressed fern specimens. (Permit me to call attention to the notice printed inside the front cover of the FERN JOURNAL, giving the terms on which loans and exchanges are conducted.)

As in past years, our Editor-in-Chief, C. V. Morton, works harder and longer each year on the affairs of the American Fern Society than any other member of the Council. It is he who reads all papers and articles submitted for publication in the FERN Journal, carries on correspondence with authors and the printers, makes the necessary editorial corrections and provides directions to the printers for the make-up of each issue of the American Fern Journal. Nor is his task finished when the galleys have all been read and the final printing completed. He still has to dispatch dozens of extra copies and back numbers to individuals and libraries requesting such material, a task that involves withdrawing the wanted items from the stock of reserve numbers stored where the temperatures soar in the summer time and approach or reach the freezing point in winter. So again, I am happy to extend to him the sincere thanks of the entire membership of the Fern Society.

Two of the Associate Editors, Dr. R. C. Benedict and Dr. A. C. Smith, have conscientiously aided the Editor-in-Chief with careful reading of galley proofs and in checking manuscripts on which he wished their respective advice. Their help is appreciated fully.

Finally, to every member of the Fern Society, please let me express gratification that he or she has continued to support the Society morally and financially during the period of the individual's association with our organization. Some of you have been members for over half a century, others for only a few months. The important point is that you have had, and continue to have, a genuine interest in ferns—in how to grow them, how to protect and conserve the wild ones still to be found in places of beauty and charm, and how to learn more about them through continued observation and study of this intriguing group of plants. It is my firm belief that each of you will provide Dr. Clair Brown, your new President, with the same steadfast support you have accorded me. May the fortunes of the American Fern Society and of its individual members, collectively and individually, continue to prosper.

Respectfully submitted,
IRA L. WIGGINS, *President*

**Report of the Treasurer for 1959**

The end of 1959 found our financial condition approximately the same as the preceding year. The balance on hand as of the first of the year was slightly less but still sufficient, so that we had no bank charges except for Unesco Coupons. Sale of back numbers continued to supply a substantial sum. The increase of postage rates, not anticipated when the 1959 budget was made out, caused some over-spending. No funds were withdrawn from the reserve accounts and the Society stands in good financial condition.

Subscription rates, both domestic and foreign, are scarcely sufficient to cover the cost of the Journal. Most of these subscribers require special attention and several letters for each transaction. I suggest that consideration be given to raising the subscription price to equal the membership fee. During the year we receive many checks for subscriptions from individuals which require special handling. The cost of back volumes could also be raised to the current annual value. These two raises would eliminate some of the current collection problems.

*Receipts*

| | Amount | Total |
|---|---|---|
| Cash on hand, January 1, 1959 | | $1,401.12 |
| 1958 Membership Arrears | $ 54.85 | |
| 1959 Membership Renewals | 1,053.79 | |
| 1960 Membership Advances | 109.35 | |
| 1959 Sustaining Members | 445.00 | |
| 1959 New Members | 200.35 | |
| 1958 Subscription Arrears | 13.65 | |
| 1959 Subscription Renewals | 200.40 | |
| 1960 Subscription Renewals | 267.05 | |
| 1961 Subscription Renewals | 6.35 | |
| Sale of Back Numbers | 236.20 | |
| Sale of Reprints | 165.65 | |
| Advertising | 40.00 | |
| Gifts | 14.00 | |
| Overpayment by Book Agent | 2.35 | |
| | | 2,808.99 |
| | | $4,210.11 |

*Disbursements*

| | | |
|---|---|---|
| A.F.J. Vol. 48, No. 4 | 612.78 | |
| A.F.J. Vol. 49, No. 1 | 785.49 | |
| A.F.J. Vol. 49, No. 2 | 366.11 | |
| A.F.J. Vol. 49, No. 3 | 397.34 | |
| Reprints | 357.31 | |
| Envelopes and Mailing | 106.70 | |
| Spore Exchange | 20.00 | |
| American Horticultural Council 1959 dues | 20.00 | |
| Dues to AIBS | 100.00 | |
| Overpayment to Book Agent | 2.35 | |
| Bank charge on Unesco Coupons | .51 | |
| Refund, Roy Bloemer—delay delivery back Nos. | 9.45 | |
| Expenses: | | |
| Secretary | 5.55 | |
| Treasurer | 199.37 | |
| Editor, 1958 and 1959 | 31.65 | |
| | | 3,014.61 |
| Cash in Southern Arizona Bank, January 1, 1960 | | $1,195.50 |

STATEMENT DECEMBER 31, 1959

*Assets*

| | | |
|---|---|---|
| Cash in Southern Arizona Bank | | $ 1,195.50 |
| Cash in Green Point Savings Bank (Bissell Herbarium Fund) | | 697.73 |
| Cash in Green Point Savings Bank (Life Membership Fund) | | 801.11 |
| Cash in Green Point Savings Bank (Reserve Fund) | | 1,910.04 |
| Cash in Green Point Savings Bank (Una Weatherby Fund) | | 3,125.75 |
| Inventory, American Fern Journal | | 3,150.08 |
| American Fern Society Library | | 396.00 |
| | | $11,276.21 |
| *Liabilities* | | |
| Advance Dues Collected | 382.75 | |
| Accounts Payable (Vol. 49, No. 4) | 487.43 | |
| | | 870.18 |
| *Fund Balances* | | |
| Bissell Herbarium Fund | | 697.73 |
| Life Membership Fund | | 801.11 |
| Reserve Fund | | 1,910.04 |
| Una Weatherby Fund | | 3,125.75 |
| General Fund | | 3,871.40 |
| | | $11,276.21 |

Respectfully submitted,
WALTER S. PHILLIPS, *Treasurer*

**Report of the Auditing Committee**

We hereby certify that we have seen the books and accounts of Dr. Walter S. Phillips, Treasurer of the American Fern Society, Inc., and have obtained confirmation of the correctness of the Society's balances on hand as set forth in detail in the accompanying report of the Treasurer.

*Auditing Committee*
CHARLES T. MASON, JR.
RICHARD H. HEVLY

**Report of the Secretary for 1959**

Your secretary has, he hopes, gotten through his first year at the post without seriously antagonizing anyone by his ineptness. At any rate, he has enjoyed the associations made and hopes that he is carrying out his duties satisfactorily.

The Society membership has continued to increase to 797, as compared with 764 at the beginning of 1959. California continues in the lead in number of members with 162. New York comes second with 90. Two possessions and 24 foreign countries are represented.

It is with great regret that I report the loss of several long-time members by death—Mr. Chauncey Jackson Newell (1902), Prof. Bremer W. Pond (1910), Mr. Peter Osterlund (1920), Mrs. Charles Tanger (1930), Mr. F. N. Irving (1940), and Mrs. F. G. Dunham (1941).

Due to the International Botanical Congress held in Montreal in August, the Society did not hold a meeting last year. It is hoped that this year's meeting in Stillwater, Oklahoma, will have a good representation of the membership and that a number of interesting and informative papers on ferns will be presented.

Respectfully submitted,
DONALD G. HUTTLESTON, *Secretary*

**Report of the Judge of Elections**

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

| | |
|---|---|
| For President | |
| Clair A. Brown | 331 |
| Ira L. Wiggins | 4 |
| Warren H. Wagner | 1 |
| For Vice-President | |
| Marcel Raymond | 335 |
| Rolla M. Tryon | 1 |
| Frieda L. Wertman | 1 |
| Hugh C. Cutler | 1 |
| For Secretary | |
| Donald G. Huttleston | 337 |
| For Treasurer | |
| Walter S. Phillips | 338 |

I therefore declare the following candidates elected to the several offices: President, Clair A. Brown; Vice-President, Marcel Raymond; Secretary, Donald G. Huttleston; Treasurer, Walter S. Phillips.

Respectfully submitted,
HUGH C. CUTLER, *Judge of Elections*

**Report of the Curator and Librarian for 1959**

Compared to the year 1958, in matters dealing with the Herbarium and the Library of the Society, the business has been very slow. The bulk of consultation of the collections, and such few loans as were made, involved persons in the local area of Michigan. Mr. David B. Lellinger, a graduate student in the Department of Botany of the University of Michigan, has provided much valuable assistance in routine work with the literature and specimens. I should like, once again, to call the attention of readers who have not yet utilized our collections to the description of the procedure given briefly in the bottom paragraph of the inner cover of the JOURNAL.

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

**Report of the Spore Exchange for 1959**

Contributions to the Spore Exchange during 1959 included five samples from Mr. L. J. Brass, who collected them on the Archbold Expedition to New Guinea, 22 from the University of California Botanical Garden, through Dr. Herbert Baker, who promises more, 38 from Mr. Jury, our member in New Zealand, 15 from Mr. Aarestup (Denmark), 5 from Mr. Fisher (London), 7 named and a number unnamed from Mrs. Faithful (New Zealand), through Mrs. Eva Alexander, Birmingham, Alabama, 7 from Japan contributed by Mrs. Barbara Joe Hoshizaki, 22 from Japan from Mr. Sekido (bearing names in Japanese but not English), and 164 from Fern Society members living in the United States. Among all these there were very few duplicates. Eighty-one were fresh supplies of species already listed; the others were new to the list.

These 1959 contributions to the Exchange have been sent in by 43 kind people, at the cost, no doubt, of considerable time and trouble. To each one goes the gratitude of the officers and members of the Fern Society. The exchange, of course, could not function without these faithful, interested people.

Though there have been well over a hundred notes and letters written about the exchange, only 22 members actually requested spores in 1959, and a total of 267 packets was mailed to them. Since the procedure for growing ferns from spores is easy (at least as this amateur does it anyway), it seems strange that more of our members do not take advantage of the Spore Exchange. Once in a while the results are disappointing, but far oftener are gratifying as well as enjoyable.

A new list of spores now available is in preparations and will be sent to all those who have requested or contributed spores or otherwise shown an interest in the Exchange. It will, of course, be sent also to any other member requesting it. The new list will contain only those species sent in during 1958 and 1959. From the old list, 41 have had to be omitted because they were sent in earlier or because the supply is exhausted. Of these, the ones that we are most anxious to receive and list again are: *Adiantum pedatum* var. *aleuticum*, *A. peruvianum*, *A. Wagneri*, *Asplenium fontanum*, *A. marinum*, *A. monanthes*, *A. resiliens*, *A. Trichomanes* (crested), *Cheilanthes alabamensis*, *Dryopteris viridescens*, *Lygodium japonicum*, *Polystichum acrostichoides* (bipinnate form), and *P. tripteron*. There have been requests for these. If you can supply these, please do so, or make a note to make collections when the 1960 spores ripen. Others often requested and nearly always in short supply are the Appalachian spleenworts, especially *Bradleyi*, *montanum*, *pinnatifidum*, and *Ruta-muraria*.

It would be fine if conservatories and botanic gardens generally could be interested in growing ferns, as are Longwood Gardens and the University of California Botanical Garden. Conceivably, an exchange, perhaps through the Fern Society, between such places with large areas under glass could be most interesting and worthwhile. We need finer and more comprehensive collections about the country for those of us who love to see and study the various warm-climate species but have no chance to grow them and no opportunity to travel and see them in their native haunts.

With sincere thanks to all for the past and future interest, we enter 1960 with high hopes for a bigger and better exchange program.

Respectfully submitted,
Kathryn E. Boydston
*Route 3, Niles, Michigan*

**Report on the 1959 Minnesota Field-trip**

The 1959 field-trip of the American Fern Society took place on the north shore of Lake Superior, Minnesota, on August 8 and 9. From Duluth to Grand Portage, a distance of some 160 miles, scheduled stops were made.

The attending members, with reservations for the night of August 7 in the Residence Halls of the Duluth University, were Dr. and Mrs. Ira Wiggins, Dr. and Mrs. Ralph H. Benedict, Mrs. George Gardner and a companion, Mrs. Frieda Wertman, Dr. Herbert Clarke, Dr. Robert Lommasson with four children, and Dr. J. W. Moore. Local personnel assisting with arrangements were Miss Mary I. Elwell, Miss Helen Heino, Dr. Paul Monson, and Dr. J. B. Carlson.

Saturday, the following morning, the enthusiastic group left the campus in six cars, heading for the North Shore drive. At Knife River, on Lake Superior, a stop was made on the property of Miss Olive Prine and Miss Jessie Wells to observe the relatively undisturbed crevice flora of the shore outcrops, and especially *Botrychium multifidum* and *B. simplex* on the shady upper terrace.

In the scenic gorge of Gooseberry River State Park, below the falls, on high cliffs of diabase, a search was made for crevice ferns, species of *Woodsia, Dryopteris,* and *Cryptogramma Stel-*

*leri. Cystopteris bulbifera* filled moist hollows of overhanging ledges near the river level.

The Palisade Head, one of the highest bluffs of a commanding view of the lake, is accessible by car. Field lunches with hot coffee were enjoyed there. Facing the cooling breezes under lowering clouds, those luscious tomatoes of the Benedicts, delectable in their colorful ripeness, seemed a bit exotic. The forested slopes and the sliding talus of porphyritic felsite, were explored for species of lycopods. Opportunities for collecting in general were not overlooked. Of special interest were the less common species, e.g. *Lycopodium Selago* and var. *patens.*

The remaining afternoon was absorbed in exploring Temperance River Gorge for woodland ferns. Among others, a fine colony of *Dryopteris spinulosa* var. *americana* was encountered. Due to impending rain and the late afternoon hours, it seemed advisable to proceed, without further stops, to Naniboujou Lodge where reservations for overnight lodging and meals had been arranged.

Fair skies and sunshine were in store for the Sunday morning trip to Grand Portage. One of the mountainous bluffs of slate, overlooking the historic portage trail and the lake, with shady, moist, ledges, and broad talus slopes, afforded opportunity for observing *Woodsia scopulina, W. Cathcartiana,* and the rarest of all, spotted by Dr. Benedict, *W. glabella.* There ended the foray with a list of 28 species of ferns, and eight species of fern-allies.

The writer is indebted to Dr. J. W. Moore for assisting in the identification of species in the field, and to each and all for gracious cooperation and enthusiasm in sharing the fern trails of Lake Superior coast.—OLGA LAKELA.

### Report on the Rougemont Field-trip

On Sunday, August 23, 1959, those who had registered for Field Trip 4 (Pteridology) of the Ninth International Botanical Congress climbed into a bus before 8 a.m. and waited expectantly to drive to Rougemont, Quebec, southeast of Montreal, Canada.

The trip was oversubscribed and two enthusiasts were forced to follow the bus in a private car. Some of the participants from abroad included Drs. Irene Manton, England; W. Zimmermann, Germany; Pierre Martens, France; R. E. G. Pichi-Sermolli, Italy; and E. A. Schelpe, South Africa. Those from the American Fern Society were Drs. Ira L. Wiggins, Alice and Rolla Tryon, Clair Brown, T. M. C. Taylor, Donald Huttleston, William Cody; Mrs. Lenette Atkinson, Mrs. Fern Crane, Miss Eva Sobol, and Miss Muriel Hegwood, among others.

The trip was ably conducted by Lionel Cinq-Mars who kindly supplied everyone with seventeen mimeographed sheets listing the vascular plants that he had collected at Rougemont from 1948 to 1959, two pages of descriptions of the various habitats and important species that we would encounter, and a one-page list of some interesting plants that have not been collected at Rougemont as yet, but that might logically occur there.

The first stop was a pine-wood in sand. Here we collected *Dryopteris marginalis, D. intermedia, Athyrium Filix-femina, Botrychium virginianum* and in a moist location, *Dryopteris Thelypteris, D. noveboracensis,* and *Osmunda Claytoniana. Lycopodium complanatum* var. *flabelliforme, L. lucidulum,* and *L. obscurum* were collected in these woods also, before we took a short walk down a hill to a dark, wet deciduous woods where we found *Dryopteris spinulosa, D. cristata, D. Phegopteris, D. disjuncta, Osmunda cinnamomea,* and *Athyrium thelypterioides.*

At the second stop we looked at a large clump of *Matteuccia* beside the road and then proceeded through a pleasant maple sugar bush up the north side of the mountain. There were some fine clumps of *Polystichum acrostichoides, Adiantum pedatum,* and a fine stand of *Dryopteris hexagonoptera.* It seemed a strange twist that this last fern should be growing on the *north* side of the mountain in perhaps its most northerly location in Canada, whereas *D. Phegopteris* was found on the *southern* slope.

After an enjoyable picnic lunch beside a duck pond near a local Quebec inn, we returned to Rougemont and one party of active oldsters climbed a steep limestone cliff while the other party of young laggards went up a less precipitous trail through rich deciduous woods alongside a small stream. Those who took the former course brought back *Woodsia ilvensis, Cystopteris fragilis,* and *Asplenium Trichomanes.* The others saw some fine specimens of *Dryopteris Goldiana,* and strong clumps of *Athyrium pycnocarpon. Polypodium virginianum* was collected along rocky ledges above the stream. One fern that eluded the collectors here was *Cryptogramma Stelleri*; presumably because of the drought of August it could not be found. *Dennstaedtia punctilobula* and *Onoclea sensibilis* were seen along a roadside near an orchard. In all 33 species were seen and collected and another twelve have been collected by Mr. Cinq-Mars in the last ten years. Unfortunately, we were unable to add any new species to his list of pteridophytes.

One further stop was made when our leader graciously offered us some apple juice and cider at his field-station in the center of the apple growing area. After this pleasant interlude we returned to Montreal with memories of a beautiful day and a fine field-trip.—D. M. BRITTON.

**Report of the 1959 Vermont Field-trip**

Under the leadership of Dr. Benjamin R. Allison, a New England field-trip of the American Fern Society was planned this summer to take place in Vermont, July 17 to 20. Wallingford Inn (Wallingford, Vermont) and St. Johnsbury House (St. Johnsbury, Vermont) were headquarters for the field-trip.

With Mr. Henry Potter of Clarendon as guide, 20 members and friends gathered at the Wallingford Inn for the Friday and Saturday trips which included an exploration of Proctorsville Gulf where 24 species of ferns were seen, 23 of which had been seen by the group two years ago and in addition, as a climax to the trip, several specimens of *Botrychium matricariifolium* in fruit.

After lunch, being assured by our guide that we were safe from the onslaught of a railroad train, we explored about half a mile down the tracks in a cut blasted out of solid gneiss by the Rutland Railroad in 1848. During the interval of 100 years many ferns had taken over on the banks and the rocks in the cut. The most exciting find was a good stand of *Cryptogramma Stelleri* clinging to the face of the solid rock in the cut. In addition, we saw quantities of *Cystopteris fragilis, Phegopteris connectilis* and some *Gymnocarpium Dryopteris.*

Friday evening Ralph C. Benedict joined us and during the evening gave an informal talk on fern nomenclature and numbers of fern species. Florida claims the largest number with 150 species; Texas comes next with 120; and Vermont and Michigan tie for third place with about 80 species each. Ralph's guess is that there may be 400 species in the United States. (These figures include the fern-allies.)

On Saturday morning we climbed to the ice-beds in White Rock Park to see quantities of *Dryopteris dilatata* growing in the cool air as a result of the huge cakes of ice still present in the open caves on a very hot July day. Also in this park we added several species of *Lycopodium* to our list as well as *Dryopteris spinulosa* and the hybrid *Dryopteris fructuosa.*

In the afternoon on a rugged hillside in Dorset we added seven other species of ferns to our list—*Pellaea atropurpurea, Asplenium Ruta-muraria* (very crisp because of the dry weather), *A. Trichomanes, A. platyneuron, Camptosorus rhizophyllus, Woodsia obtusa*, and a *Botrychium* (possibly *obliquum*).

With a visit to Mr. Potter's meadow to see *Ophioglossum vulgatum* in fruit, the Wallingford part of the Field Trip ended, and on Sunday 12 members of the group went to St. Johnsbury, so as to be ready to explore the Lake Willoughby area on Monday.

We were looking forward eagerly to the exploration of the Lake Willoughby area, having heard that this was the richest fern area in New England, but we suffered some disappointment in the number of species that we found. In explanation of this Mr. Potter reminded us that the area had been over botanized some years ago. However, the base of the cliff on Mt. Pisgah, on the east side of Lake Willoughby, yielded two rare species—*Woodsia glabella* and *Pellaea glabella.*

Two score or more years ago our guide, Mr. Henry Potter, was taken across Lake Willoughby by E. J. Winslow (former president and one of the founders of the FERN JOURNAL) to see *Asplenium viride* and *Dryopteris fragrans* on the West Cliff. We hoped to see these on the East Cliff but were not able to find them, and it was not possible for the group to explore the West Cliff.

All those present felt that the trip was a great success due to the planning of Dr. Allison and to the expert guiding of Mr. Potter, who knew where the ferns grew.

In all we identified 41 species of ferns, six species of *Lycopodium,* and three species of *Equisctum.* The following is a list of the ferns seen, the names taken from a check-list prepared by Ralph C. Benedict.:

*Dennstaedtia punctilobula*
*Pteridium aquilinum*
*Adiantum pedatum*
*Cryptogramma Stelleri*
*Pellaea atropurpurea*
*P. glabella*
*Polypodium vulgare*
*Matteuccia Struthiopteris*
*Onoclea sensibilis*
*Asplenium Ruta-muraria*
*A. Trichomanes*
*A. platyneuron*
*Camptosorus rhizophyllus*
*Athyrium Filix-femina*
*A. pycnocarpon*
*A. thelypterioides*
*Woodsia glabella*
*W. obtusa*
*Cystopteris bulbifera*
*C. fragilis*
*Thelypteris palustris*
*Thelypteris noveboracensis*
*Phegopteris connectilis*
*Gymnocarpium Dryopteris*
*Dryopteris marginalis*
*D. cristata*
*D. intermedia*
*D. spinulosa*
*D. dilatata*
*D. Goldiana*
*D. fructuosa*
*Polystichum acrostichoides*
*P. Braunii*
*Osmunda regalis*
*O. cinnamomea*
*O. Claytoniana*
*Ophioglossum vulgatum*
*Botrychium matricariifolium*
*B. virginianum*
*B. multifidum* (?)
*B. obliquum* (?)

The following members and friends were present at one or all of the sessions: Dr. and Mrs. Benjamin R. Allison, Mrs. Louise Adams, Dr. Ralph C. Benedict, Miss Alice Bristow, Miss Helen Bristow, Mrs. L. L. Delafield, Mr. and Mrs. Burton Dezendorf, Mrs. Dolt, Mr. and Mrs. Murray Evans, Mrs. H. E. Kincaid, Mr. Henry Potter, Miss Elsa Potter, Miss Anna E. Scudder, Dr. and Mrs. A. V. Smith, Miss Eva Sobol, and Miss Margaret Timpson.—ANNA E. SCUDDER.

## Obituaries

BREMER WHIDDEN POND, June 23, 1884–September 2, 1959.—Bremer Whidden Pond was born in Boston, the son of Charles Choate Pond and Annie Louise (Whidden) Pond. He received his high school education at Winchester, Massachusetts, and attended Dartmouth College, receiving his bachelor's degree in 1906. After spending a year studying in Germany, he began graduate work at Harvard, receiving in 1911 the degree Master in Landscape Architecture. For the next three years he served as secretary to Frederick Law Olmsted, thus rounding out the preparation for his life's work.

In 1914, Bremer Pond began his teaching career at Harvard. Except for a brief period during World War I when he served as Captain, then as Major, in the Construction Division of the Q. M. C. in Washington, he taught landscape architecture at Harvard until his retirement in 1950. He served as Chairman of the Department from 1928 on. His contribution to the profession was a very valuable one.

In addition to his teaching he maintained a private office which was very active until about 1940. There are many significant examples of his work. For fourteen years he served his professional society, the American Society of Landscape Architects, well as Secretary and Trustee. In addition, he performed invaluable service in many committees and helped solve many perplexing problems to insure a healthy growth of his profession.

Professor Pond was a member of the American Fern Society for almost fifty years, having joined in 1910, at about the time when the AMERICAN FERN JOURNAL was started. Although he was never a serious student of ferns, he maintained a lifetime interest in them.

Although Bremer Pond gave untiringly of himself to students and friends, his interest in nature was equal to his interest in mankind. In his earlier years there were many trips to Europe and in his later years much time was spent in the woods—tramping through the wild and unspoiled country at "Lost Horizon," his summer home in northern New Hampshire. Fishing was a major recreation and the artistry of his fly tieing has been the envy of many. His interests in life were wide and he was a most stimulating, friendly, and understanding companion who will be missed greatly by many of us for a long, long time.—WALTER L. CHAMBERS.

MRS. CHARLES Y. TANGER.—Members of the American Fern Society will regret to learn of the death on September 28, 1959, of Mrs. Charles Y. Tanger, of Lancaster, Pa. She joined the Society in 1930, and since that time welcomed many of its members to study the rarer species of that region, and to enjoy her small but fascinating back-yard fern garden.—EDGAR T. WHERRY.

CHAUNCEY JACKSON NEWELL.—We regret to note the passing of one of our oldest and most faithful members, Mr. Newell, a member for 57 years. An account of Mr. Newell and his interest in ferns was published in the JOURNAL some time ago under the heading "'Undistinguished' Fern Lover."[1]—C. V. MORTON.

FRANK N. IRVING.—Washington has lost one of its most avid fern lovers with the passing of Mr. Frank N. Irving. He was primarily a collector, and took great pride in the appearance of his specimens, justifiably so, for they are very likely the handsomest specimens ever prepared. Only material in absolutely top condition was collected, and each leaflet was carefully and

[1] This JOURNAL **46:** 169, 170. 1956.

separately pressed. His herbarium has been presented to the U. S. National Herbarium, through the kind offices of Mrs. Florence Skougaard. It is being especially prepared for preservation as a memorial to Mr. Irving.—C. V. MORTON.

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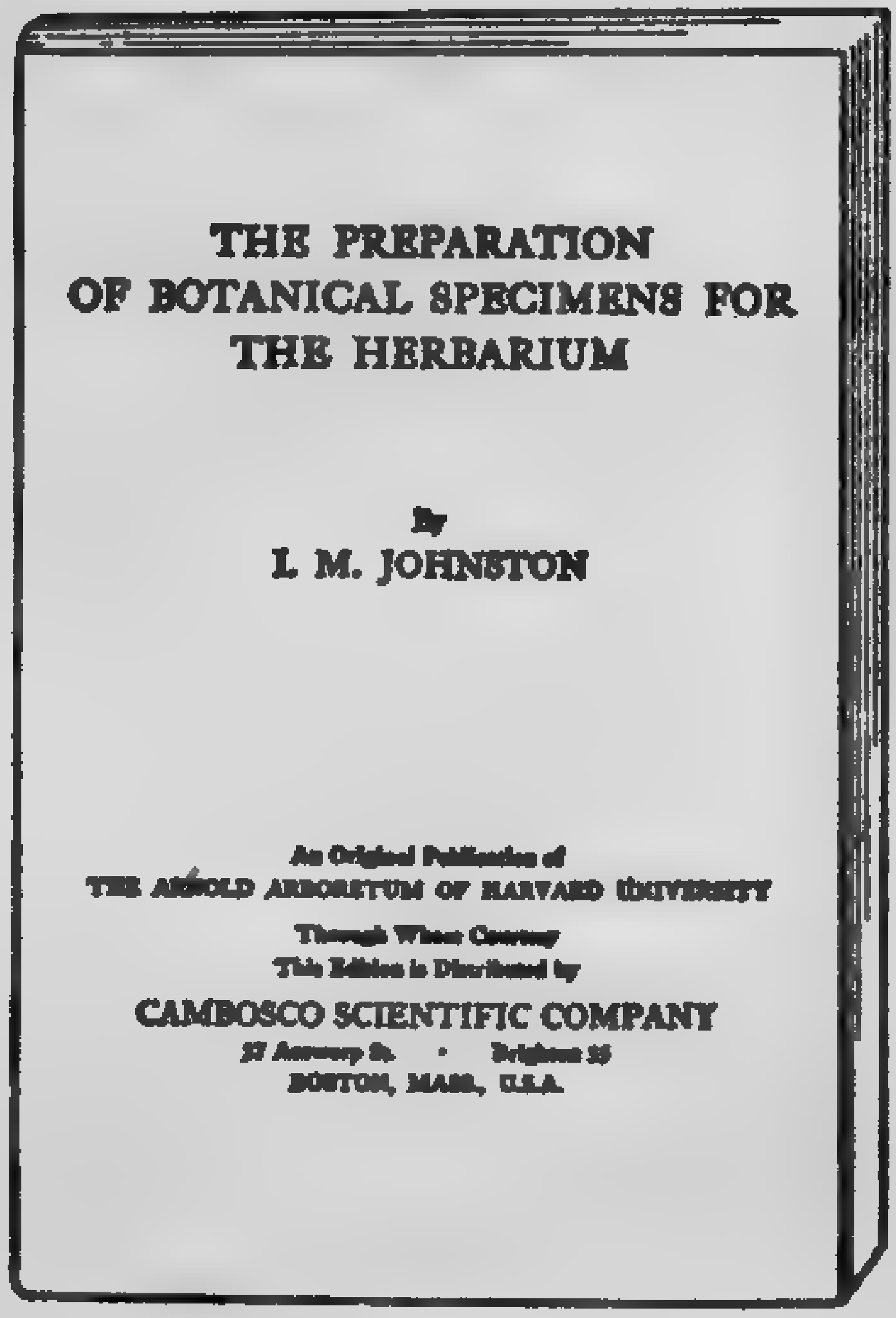


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# American Fern Journal

A QUARTERLY DEVOTED TO FERNS

Published by the

AMERICAN FERN SOCIETY

EDITORS

C. V. MORTON

R. C. BENEDICT IRA L. WIGGINS

A. C. SMITH

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# American Fern Journal

Vol. 50 JULY-SEPTEMBER, 1960 No. 3

## How I Became Interested in Ferns

EDGAR T. WHERRY

For some years my professional activities were in the fields of chemistry and geology, and my acquaintance with ferns was zero. Then in 1913 I was appointed Assistant Curator of Mineralogy in the U. S. National Museum. Having built a house on a large lot the next year, I decided to develop a wild flower garden there, and I made the acquaintance of amateur botanists who guided me to some of the notable plant localities around Washington. In a ravine along the Potomac I was shown a colony of Walking Fern growing on a gneissoid rock, although according to "the books" it was supposed to grow on limestone. Having in my laboratory work just become familiar with the then new conception of hydrogen-ion concentration, I wondered if this phenomenon might have a bearing on the habitats of such plants. So I started looking for Walking Fern on different rock formations, and found it on many kinds in the states within easy reach—Maryland, Pennsylvania, Virginia and West Virginia. Tests of the soil at the roots showed that on the average its reaction was indeed essentially neutral (as limestone is), and a paper on this subject was published in the Journal of the Washington Academy of Sciences in 1916.

Then it seemed of interest to study other ferns in like manner. and in order to learn the various kinds I bought a book called "Who's Who Among the Ferns," by W. I. Beecroft, of Boston. Whether this author ever did any scientific work on ferns I do not know, but at any rate his book—unlike too many more recent ones—was both simple and accurate, and made the recognition of species an easy matter. In doubtful cases I took specimens to a

Volume 50, No. 2, of the JOURNAL, pp. 161-224, was issued June 28, 1960.

EDGAR T. WHERRY, AGE 70, COURTESY OF ACADEMY OF NATURAL SCIENCES, PHILADELPHIA new acquaintance, Dr. William R. Maxon, then Associate Curator of the U. S. National Herbarium, who generously set me straight. He invited me to join the American Fern Society and to contribute articles to its journal, which I began to do in 1920. Travelling farther and farther afield, I gradually got to know in life most of the pteridophytes of the United States.

My writings on these plants having made me well known, the members of the American Fern Society elected me president of the Society for 1934. The finances of the Society were in bad shape, the Treasurer having used its reserve funds in business ventures which failed, and a committee was appointed to straighten things out. Its members—R. A. Ware, C. A. Weatherby, and myself—worked out plans for handling the Society's funds which have proved successful; we also had the Society incorporated. After being in office for five years I withdrew my name from renomination.

A cumulative index of the 20 volumes of the earlier Fern Bulletin had been published and proved useful, but there had been none of the American Fern Journal. As a result of the severe business depression, it was possible to obtain workers whose wages were paid by the government, and I accordingly employed a young lady to compile a 25-year index. The bill for printing this called for most of the Society's funds, and I fear gave the Society's then President, Dr. R. T. Clausen, and Treasurer, Dr. H. K. Svenson, considerable worry. However, the Society was soon in favorable financial condition again.

An inaccurate popular fern book having appeared in 1936, I decided to prepare a more realistic one based on my own observations in the field, herbarium and library. To illustrate this I was fortunate to obtain the services of Miss Olive Stoner and Mr. Cyrus Feldman, each of whom drew about 50 species. The book was published in 1937 under the title "Guide to Eastern Ferns." The first edition of 2000 copies was sold out in four years, and a second was then issued, containing some improved drawings, text changes, and a diagnostic key. Besides the 2000 printed copies of this, I had a like number copied by a photographic process and published by the University of Pennsylvania Press. The bulk of these issues have now been sold, but a few remaining copies have been deposited at the Academy of Natural Sciences of Philadelphia, which sells them at $2.00, plus 10c sales tax. It has been my pleasure to donate annually the small "profit" received from this sale to the American Fern Society.

BOTANICAL LABORATORIES, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, PENNA.

## Ferns in Oubangi, Congo

G. J. DE JONCHEERE

It was my good fortune to visit recently a part of the Belgian Congo that is hardly ever seen by tourists, especially those with an interest in ferns. I am speaking of the Gemena district, in the Province of Oubangi, in the northern part of Belgian Congo, east of the market town of Libenge, which is situated along the Oubangi River. This large stream is a tributary of the Congo and forms the border between Belgian Congo and French Equatorial Africa.

Thanks to the good offices of my host, Mr. Hans Kooiman, who is an agricultural advisor for several plantations there, I had the opportunity of making some extensive excursions in the neighbourhood of the plantations Bogbulu and Bala Bala. I made a collection of about 150 numbers of ferns, comprising about 40 species. The determination of the ferns was made easy by Madame Tardieu-Blot's beautiful publication "Les Pteridophytes de l'Afrique intertropicale française," in which the numerous plates are an example of good botanical illustration. I should like to thank Madame Tardieu also for her personal assistance in a few difficult identifications. Messrs. Adams and Alston's "List of the Gold Coast Pteridophyta" was useful also.

As far as the landscape around Gemena is concerned a certain monotony can not be denied. Mile after mile one travels through a slowly undulating peneplain, cut through by brooks and rivers and covered by grass fields and jungles. The deforested areas no doubt owe their origin to the intensive and repeated burnings by the primitive Negro tribes that populate the country. The transition from grass field to forest is immediate and with hardly any fringe area. Although the rainfall is certainly adequate, it strikes the observer that the rain-forest is not so lush and humid as the primeval forest in Java and Malaya, well-known to the writer. A certain scarcity of epiphytes and especially the infrequency of Hymenophyllaceae confirms this impression.

Although native agriculture is still on a very low level, and even near the settlements fruit trees are not often encountered, the oil-palm is frequently found in anthropogenic situations, always yielding a rich harvest of epiphytes, even in exposed places. It is interesting to notice that the ferns found on this palm really belong to the natural vegetation of sun-loving epiphytes that are found on the top branches of the giant jungle trees. During my stay, a small clearing was made on Bogbulu and on the branches of the fallen trees practically the same species were found as were previously collected on the *Elaeis* palm near the ground.

A list of the species collected in the area, subdivided according to habitat, is given below:

### SHADE-EPIPHYTES

(found on the bases of jungle trees in the shade of the primeval forest)

TRICHOMANES (MICROGONIUM) AERUGINEUM van den Bosch. This is the only hymenophyllaceous fern that was found in the area. It sticks out from the bark of old trees like little green shells. It has been regarded as only a variety of the well-known *T. erosum* Willd.

LOMARIOPSIS HEDERACEA Alston. Climbing vertically on mostly small trees, and also trailing on the ground in wet, shady places; common, but fertile fronds mostly absent.

LOMARIOPSIS GUINEENSIS (Underw.) Alston. Growing like the preceding species; remarkable for the diversity of its fronds: very young plants with simple lobed leaves, older plants with imparipinnate fronds; also common.

ANTROPHYUM MANNIANUM Hook. Growing on thick trunks of old trees in rain-forest.

ASPLENIUM BARTERI Hook. Found in the wettest localities, in deep shade; the "queue de rat" is a striking feature of the leaves, adorned with a bud.

### SUN-EPIPHYTES

(found on the top branches of large jungle trees and on single trees in the open, mostly *Elaeis*)

LYCOPODIUM STAUDTII (Nessel) Adams & Alston. Found only once, on *Elaeis,* but in a shady situation; certainly not typically a sun-epiphyte.

ARTHROPTERIS ORIENTALIS (Gmelin) Posth. A well-known tropical fern of wide distribution.

OLEANDRA DISTENTA Kunze. Apparently deciduous and just getting new leaves in September.

DAVALLIA CHAEROPHYLLOIDES (Poiret) Steud. One of the commonest epiphytes on *Elaeis,* and growing also on trees in Leopoldville and elsewhere.

VITTARIA GUINEENSIS Desv.

ASPLENIUM AFRICANUM Desv. Although often compared with the Bird's-nest Fern, *Asplenium nidus,* this species does not form real nests, and is hardly a humus collector. Common.

ASPLENIUM HEMITOMUM Hieron. Not common.

PLATYCERIUM ANGOLENSE Welw.

PLATYCERIUM STEMARIA (Beauv.) Desv. These common "staghorn" ferns are no doubt the most impressive in the sun-loving vegetation in the high jungle trees. Especially, the huge entire fronds of *P. angolense,* more than 50 cm. in circumference, dangling from the branches and surrounded by the erect brown nest-leaves, make an unforgettable impression.

PYRROSIA LANCEOLATA (L.) Farwell. Not common.

DRYNARIA LAURENTII (Christ) Hieron. Another interesting fern with nest- and foliage leaves.

MICROSORIUM PUNCTATUM (L.) Copel.

PHYMATODES SCOLOPENDRIA (Burm.) Ching. Well-known tropical epiphyte.

MICROGRAMMA LYCOPODIOIDES (L.) Copel. Extremely variable: Small and strongly dimorphic on high jungle-trees, much more lush in the shade in anthropogenic situations, sometimes covering whole stems of *Elaeis.*

## SHADE TERRESTRIAL FERNS

(in rain-forests and shady situations)

PTERIS ATROVIRENS Willd. Rhachises and costae spiny.

LONCHITIS CURRORI (Hook.) Mett. Huge fern, more than 2 meters high, in wet and shady situations. The young plants are completely different from full-grown specimens and have been described as a different species.

CTENITIS EFULENSIS (Baker) Tardieu

CTENITIS LANIGERA (Kuhn) Tardieu

CTENITIS PROTENSA (Afzel.) Copel. The two last-named species of *Ctenitis* are to be found on shady banks and well-drained situations in the forest; contrary to *C. efulensis,* they have the typical *Ctenitis* form and can not be mistaken.

CTENITIS JENSENIAE (C. Chr.) Tardieu. Found in several locations and apparently common in the primeval forest. The specimens found have been examined by Madame Tardieu, since they do not conform to the type in being less divided, not proliferous, and in having a slight anastomosis of the veins; they may represent a new species, but need further study.

LASTREOPSIS BARTERIANA (Hook.) Tardieu. The nomenclature of Madame Tardieu is followed here, although this fern is not a *Lastreopsis* in my opinion.

BOLBITIS GEMMIFERA (Hieron.) C. Chr. The interesting fertile leaves look a bit like those of *Lomariopsis*.

ATHYRIUM WELWITSCHII (Hook.) Tardieu

ATHYRIUM SAMMATII (Kuhn) Tardieu. The last two species belong to the *Diplazium* group.

ASPLENIUM SUBAEQUILATERALE Hieron. I compared my specimens (which have a bud below the upper pinnae) with the type of Hieronymus in Dahlem which is not proliferous, but otherwise identical. Alston calls the proliferous plants *Asplenium gemmascens* Alston. This fern is near *Asplenium hemitomum,* but terrestrial.

ASPLENIUM CEEI Pichi-Sermolli. Found in deep shade in the jungle, covering quite an area with deep green leaves; apparently common. The identification has been checked by Madame Tardieu.

SUN TERRESTRIAL FERNS

(found in open situations, secondary forest, and roadsides)

PTERIDIUM AQUILINUM (L.) Kuhn

HISTIOPTERIS INCISA (Thunb.) J. Smith

CYCLOSORUS DENTATUS (Forsk.) Ching

MICROLEPIA SPELUNCAE (L.) Moore.

DICRANOPTERIS LINEARIS (Burm.) Underw. The five preceding species are ubiquitous tropical species of weedy nature.

SWAMP TERRESTRIAL FERNS

(in open swamps and riversides)

LYCOPODIUM CERNUUM L.

SELAGINELLA MYOSURUS (Swartz) Alston

CYCLOSORUS STRIATUS (Schum.) Copel.

CYCLOSORUS GOGGILODUS (Schkuhr) Link

NEPHROLEPIS BISERRATA (Swartz) Schott. The two last named ferns are very common and sometimes cover entire swamps; *N. biserrata* is also a common epiphyte.

PTERIS SIMILIS Kuhn. This is an interesting fern, with short, thick ascending rhizomes and climbing fronds of indefinite growth, up to three meters long, and with spiny rhachises and costae. The proper name is not *P. spinulifera,* as adopted by Madame Tardieu, which is a synonym of *P. atrovirens Willd.* My specimens were kindly compared by Dr. D. E. Meyer with the type of *P. similis* Kuhn in the herbarium of the Botanisches Museum, Berlin-Dahlem.

BURCHARDSTRASSE 19, HAMBURG 1, GERMANY

## Ferns Cultivated in California: Sadleria

BARBARA JOE

Among the ferns arriving from the Hawaiian Islands is a group of tree ferns belonging to the genus *Sadleria*. Known to the Hawaiian natives as Amaumau and Amau, they have been known among some nursery dealers merely as dwarf tree ferns. Smaller than the true tree ferns, these "dwarfs" may still grow to a height of 12 feet beneath the shade of taller tree ferns in their native homes. The Hawaiians are said to have prepared a red dye from the trunks of Amaumau, and used the young leaves and pith of Amau for food.

Sadlerias are not entirely of recent introduction to this country, for large mature specimens have been known in Santa Barbara for some time. However, the majority of the cultivated specimens have arrived with the introduction of *Cibotium* trunks. When confronted with the usual selection of bare tree fern trunks, one can separate the Sadlerias by the protective covering of long narrow chaffy scales, which are distinctly different from the limp hairs of the *Cibotium*. Trunks bearing foliage are readily separated from each other. The fronds of *Sadleria* are oblong, and the pinnae are only pinnatifid, whereas the *Cibotium* fronds are broadly triangular, with pinnae two times further divided.

Ideal in tubs or other containers, Sadlerias are better than Cibotiums when a smaller plant with a more open crown is desired. The trunks are planted about 1/4 to 1/3 their length in well-drained and aerated soil. They may be set in a temporary rooting medium until new roots appear and then transferred to the permanent planting. The planting media must be kept moist; good drainage will help prevent rotting. Successfully rooted trunk specimens have the advantage of being large, mature plants in a relatively short time. Spore grown plants of *Sadleria* are also available in the trade. Though their trunks are not so developed, the foliage is usually more symmetrical than that of the trunk-grown specimens.

TOP: SADLERIA HILLEBRANDII, SEGMENTS; BOTTOM: SADLERIA CYATHEOIDES, HABIT.

The cultural requirements of *Sadleria* are very much like those of *Cibotium*. The plants are more tolerant of heat and dryness than many other tree ferns. Along the coastal areas they will endure almost full sun. The evergreen foliage is, however, more lush and green when light to medium shade is provided along with ample water. Their rate of growth is moderate. The extent to which these plants will endure freezing temperatures has not been determined. Short periods of temperatures slightly lower than 32°F have been borne without injury to the plants.

The genus *Sadleria* contains seven species which are native to the Pacific Islands. All are tree-like in habit with bipinnatifid or bipinnate fronds. The veins are netted to form meshes along the midvein; elsewhere they are free. The sori are linear and continuous, being borne on both sides of the midvein of the segment. The flap-like indusium is shaped like the sorus; it is attached to a vein of the areole (mesh) and opens toward the midvein of the segment. This genus is very closely related to *Blechnum*, from which it differs mainly in being tree-like.

At present only two species have been recorded in cultivation from Hawaiian shipments, but the introduction of the other species endemic to the Hawaiian Islands is to be expected. These two species may be separated by the following key:

A. Veins not conspicuous, immersed in the frond; leaf stalk naked except at the base ........ *S. cyatheoides*

AA. Veins raised and prominent on the underside of the frond; leaf stalk covered with scales ........ *S. Hillebrandii*

*Sadleria cyatheoides* Kaulf. Amaumau. Trunk 3–5 feet; leaf-stalk essentially naked except at the base, where densely covered with long-linear scales; midrib naked or with a few scattered scales; surface of frond essentially naked; veins immersed and inconspicuous. Hawaiian Islands, Sumatra. Semi-hardy; of easy culture; to 12 feet high.

*Sadleria Hillebrandii* Rob. Amau. Trunk 2–3 feet; leaf-stalk and midrib covered with scales; surface of frond bearing long hairs; veins raised and conspicuous; texture less rigid than that *S. cyatheoides*. Hawaiian Islands. Semi-hardy; presently not common in the trade; to 10 feet high.

*Sadleria* is easily separated from all other cultivated ferns by the small-tree-like habit and the presence of long-linear sori.

Department of Botany, University of California, Los Angeles, California.

## Ferns in Cultivation, III. Growing Fern Balls

Sylvia Leatherman

Living "fern balls," large baskets completely covered with beautiful billowing fern fronds, are spectacular, and always attract a great deal of attention. Fern growers may be interested in knowing how I obtain these specimen plants.

The best ferns for fern balls in southern California are the species of *Davallia*, commonly known as "rabbit's-foot fern" and "squirrel's-foot fern." The plants imported from Japan are the species *Davallia Mariesii;* the other common species in cultivation is *Davallia trichomanoides,* which is often sold under the incorrect name *D. canariensis,* which belongs properly to another species, also in cultivation, but not so common. Most people like to obtain small plants and grow these on to maturity. As the plants grow, they are shifted to larger pots. When they nicely fill a six inch pot, they are ready to transplant to baskets. The "foot" (rootstock) should be placed at an angle across the top of the pots and green sphagnum moss tucked under it. The "foot" is anchored to the moss by using hairpin-shaped wires; this encourages them to send out side "feet," which are also anchored down by wires. When the six inch pot is full of "feet," the plant is ready to be shifted to the basket. In the basket, the "feet" are trained across the top of the sphagnum on top of the basket and eventually down over the sides. It is amazing how fast the plants will grow when given this moss cushion.

The common Boston Fern (*Nephrolepis*) will respond also to this type of treatment. Many people cut away the runners (the long, wiry strands), as they think they are unslightly and unnecessary, and then they wonder why their ferns do not fill out. If these runners are wound around inside the top of the pot and anchored to the soil by using hairpin-shaped wires, they will take root and form small plants, and eventually completely fill the container. After the six inch pot contains a full plant, well-rooted, it can be shifted into a wire basket. The basket should be lined with green sphagnum moss. As the runners grow again, they can be wound around the soil on the top of the basket, and after an abundance of growth has been obtained on the top of the basket, the runners can be pinned down on the moss on the outside of the basket. After a period of time, the basket will be completely covered, and the result will be a spectacular living fern ball.

2637 NORTH LEE AVENUE, SOUTH EL MONTE, CALIFORNIA.

## A New Native Hardy Plant Area at the New York Botanical Garden

R. C. BENEDICT

An informal committee of the American Fern Society is happy to announce that plans are well advanced for the cooperation of members of the American Fern Society in the development of a hardy native plant area at the New York Botanical Garden. The background on which this cooperation is based may be outlined as follows:

Several members from the New York area who had been actively interested in the past in sponsoring field trips and local meetings came together to explore the possibilities of further activity in the New York area. Under the Chairmanship of Dr. B. R. Allison, Chairman of the New England Field Trip Committee of the Fern Society, with Miss Clara S. Hires and Messrs. Boughton Cobb and Ralph C. Benedict, the Committee got in touch with Dr. William Steere, who began his service as Director of the Botanical Garden in 1958. Two questions were asked: Could the Fern Society hold occasional meetings at the New York Botanical Garden? and Could the Fern Society be of assistance in building up the collections of living fern plants at the New York Garden?

To both questions a cordial affirmative was received. Regarding meetings, Dr. Steere said that with due notice and avoidance of conflicts, the Fern Society would be welcome to meet in the Museum Building. With respect to the living fern collections, Dr. Steere reported that the Garden had already in active work a special committee engaged in developing a native hardy flora area under the Chairmanship of Mrs. Percy Douglas, and the cooperation of the Fern Society in the assemblage of appropriate fern species would be immediately welcome.

The upshot of preliminary conferences with Dr. Steere was the calling of a meeting on May 23, 1959, at the Botanical Garden to set in motion actual plans by which the assembling of appropriate fern plants might be accomplished. Members of the Fern Society Committee had had two chances to visit the site of the hardy plant development, once with Dr. Steere and a second time with Mr. John Crawford, landscape architect in charge for the Botanical Garden Committee. Dr. Allison had asked Dr. Benedict to present a plan for Fern Society cooperation in the selection and assemblage of appropriate ferns. Such a list and a tentative plan of action were prepared and sent in advance to Dr. Steere and Mr. Crawford.

The meeting, under the auspices of a sunny but comfortable day, was held in three successive places: At the old Snuff Mill Restaurant, on a patio overlooking the Bronx River gorge, with a wooded bank, partly fern-clad opposite; in a classroom of the Museum Building; and in an inspection of the actual site of the new native plant area.

The Museum portion constituted the business meeting of the afternoon. Twenty-two were in attendance, including Dr. Steere, five members of the Botanical Garden special committee, and Mr. Crawford, landscape architect for the project. With Dr. Allison presiding, Dr. Steere outlined the Garden's interest in having a "living museum" of native plants and said that the Garden would provide staff for the actual planting of contributed specimens. Mrs. Douglas and Mrs. Donaldson of the Garden Committee spoke for that committee. Emphasis was placed on the avoidance of depleting native sources of rare species.

Dr. Benedict prefaced his remarks by noting that the Fern Society had a special connection with the New York Botanical Garden because it was there that the first two experimental privately financed issues of the American Fern Journal had been issued. These two were incorporated as part of Vol. 1 when the Fern Journal was officially adopted by the Fern Society in 1911.

As part of a plan by which the Fern Society might contribute the fern plants for the new native plant area, he suggested that the planting list of species should consist of some thirty to forty species, the successful installation of which could be reasonably certain. This would exclude the rarer species and others known to be difficult of transplanting and establishment. Some time in the future the rarer species might be added to the planting list, particularly if specially raised spore culture plants could be made available.

As a means of implementing the assembling of the proposed list, he suggested that a special committee be designated from the Fern Society to act in cooperation with Mr. Crawford and the Botanical Garden Committee. As appropriate areas in the hardy plant area become determined and well prepared, it would be the function of this Fern Society committee to arrange for the collection of plants contributed by Fern Society members. This would be a continuing program.

An irrigation system is about to be installed, but rock ferns would require special sites. At this time the best site for a Dryopteris species group requires the clearing of the big Japanese Polygonum.

Dr. Robert K. Lampton, 25 North Terrace, Maplewood, New Jersey, agreed to accept the appointment as chairman of the Fern Society committee the duty of which will be to carry forward in liaison with Mr. Crawford the actual process by which the desired fern plants will be obtained and transmitted to the Botanical Garden. Members of the Fern Society who are interested in helping are advised to get in touch with Dr. Lampton, and ask what they may contribute and tell him what they may have to offer. There will probably be definite days scheduled when such contributions can most readily be taken care of.

The final stage of the May 23rd meeting was held in the actual hardy plant area. At this time two members showed their readiness to start Fern Society contributions by bringing in actual plants. Miss Hires brought eight species; Dr. Allison brought in a large 'colony' of the narrow-leaved chain fern and others. These plants were heeled in until specific sites are ready.

The question of possible contributions of tropical plants for greenhouse collections was not dealt with specifically at the meeting, but the promise of a substantial source of such plants has recently come in a letter from Mrs. Sylvia Leatherman, President of the Los Angeles Fern Society. At a meeting of that Society recently, readiness was expressed to offer any species from their collective list of ferns which the New York Botanical Garden might wish to obtain. Meanwhile, Mr. L. P. Politi, Horticulturist of the New York Garden, has a very considerable collection of species under cultivation from spores obtained from various European and American Botanical Gardens.

The planning committee of the Fern Society, of which Dr. Allison is Chairman, hopes that a second meeting may be held to observe results of and to provide additional contributions of fern plants. Mr. Politi of the Botanical Garden promises to have individual fern plants from his spore cultures for those in attendance. Due notices will be sent.

In addition to the Architect-Engineer, Mr. John Crawford, the following members of the American Fern Society were in attendance: Dr. and Mrs. Benjamin R. Allison, Dr. Ralph C. Benedict, Mr. and Mrs. Burton Dezendorf, Dr. and Mrs. F. Gordon Foster, Mr. Robert Gaede, Miss Clara Hires, Dr. Robert K. Lampton, Dr. Elva Lawton, Mrs. Charlotte Learned, Miss Eva Sobol, Dr. William C. Steere, and Mr. and Mrs. George Tierney, and the following from the Wild Flower Group: Mrs. John W. Donaldson, Mrs. Percy Douglas, Chairman, Mrs. Marcus Fair, Mrs. Charles Hoffman, and Mrs. Martha Innes.

## Two New Georgia Stations for Lycopodium complanatum var. flabelliforme

THOMAS A. HUTTO

Although several species of *Lycopodium* occur in abundance in certain areas of the eastern United States, these plants have been reported infrequently in Georgia. This is particularly true for *Lycopodium complanatum* var. *flabelliforme*, which, according to Dr. Wilbur H. Duncan, Curator of the University of Georgia Herbarium, has been reported from only ten of Georgia's 159 counties.

In July, 1958, while on a botanizing expedition with Mr. Tom Jackson, of Rinehart College, I came across a small stand of *L. complanatum* var. *flabelliforme* in a wooded area at the base of Georgia's famous monadnock, Stone Mountain, in Dekalb County. According to Dr. Duncan this is the first report of this species from Dekalb County, so this raises the total to 11 counties.

More recently, on January 24 of this year, my father, Mr. Jim Hutto, accompanied me on a search for the grapefern *Botrychium dissectum* var. *obliquum* in a wooded area in Hall County about six miles south of Gainesville, Georgia. I had previously located an extensive growth of *B. dissectum* in this locality in 1958 and I was interested in reexamining it. Several feet from the bank of a small stream running through the area I came across a patch of *L. complanatum* var. *flabelliforme*. A search of the area revealed that this small patch was all that was present. Dr. Duncan informs me that this is a new station, although he has previously reported this *Lycopodium* from Hall County from a station about six miles further south.

It is my opinion that this and other species are probably more abundant in Georgia than we realize, particularly in the northern part of the state. With increased botanizing on the part of Georgia fern enthusiasts I believe the picture of the distribution will become more complete.

ROSWELL, GEORGIA.

## Vein Patterns in Microsorium scandens and Its Allies

MARY D. TINDALE

The following new combination is proposed:

MICROSORIUM **scandens** (Forst. f.) Tindale, *comb. nov.*

*Polypodium scandens* Forst. f., Prodr. 81. 1786; Benth. Fl. Austral. **7**: 770. 1878; Moore & Betche, Handb. Fl. New So. Wales 515. 1893. Lectotype: Without locality, labelled 275 and 437, *Polypodium scandens* (BM); "Society Islands" has been added to the label later.

*Phymatodes scandens* (Forst. f.) Presl, Tent. Pterid. 196. 1836; Pichi-Sermolli, Webbia **8**: 222. 1951.

*Drynaria scandens* (Forst. f.) Fée, Gen. Fil. 271. 1852.

Illustration: Domin, Bibl. Bot. **85**: 179, *fig. 40.* 1913, as *Polypodium pustulatum.*

In southeastern Australia there are only two species of *Microsorium,* namely *M. scandens,* which ranges from southeastern Queensland to Victoria, and *M. diversifolium* (Willd.) Copel., occurring in southeastern Queensland, New South Wales, Victoria, and Tasmania. Both species are quite common also in New Zealand.

Prof. R. E. Pichi-Sermolli has discussed in detail[1] the reasons why we should revert to the use of the epithet *scandens* for this Australasian fern. After an examination of the type specimens of *Polypodium scandens* Forst. f. and *P. pustulatum* Forst. f. in the British Museum of Natural History, London, I agree with Pichi-Sermolli that the common, sweet-scented species of polypody in the rain-forests of eastern Australia and New Zealand is identical with *Polypodium scandens* Forst. f. Unfortunately, Domin[2] adopted the name *P. pustulatum* Forst. f. for *Microsorium scandens* and used *Polypodium scandens* Labill. for the closely allied species *Microsorium diversifolium.* Following him, Copeland published the new combination *Microsorium pustulatum* (Forst. f.) Copel.

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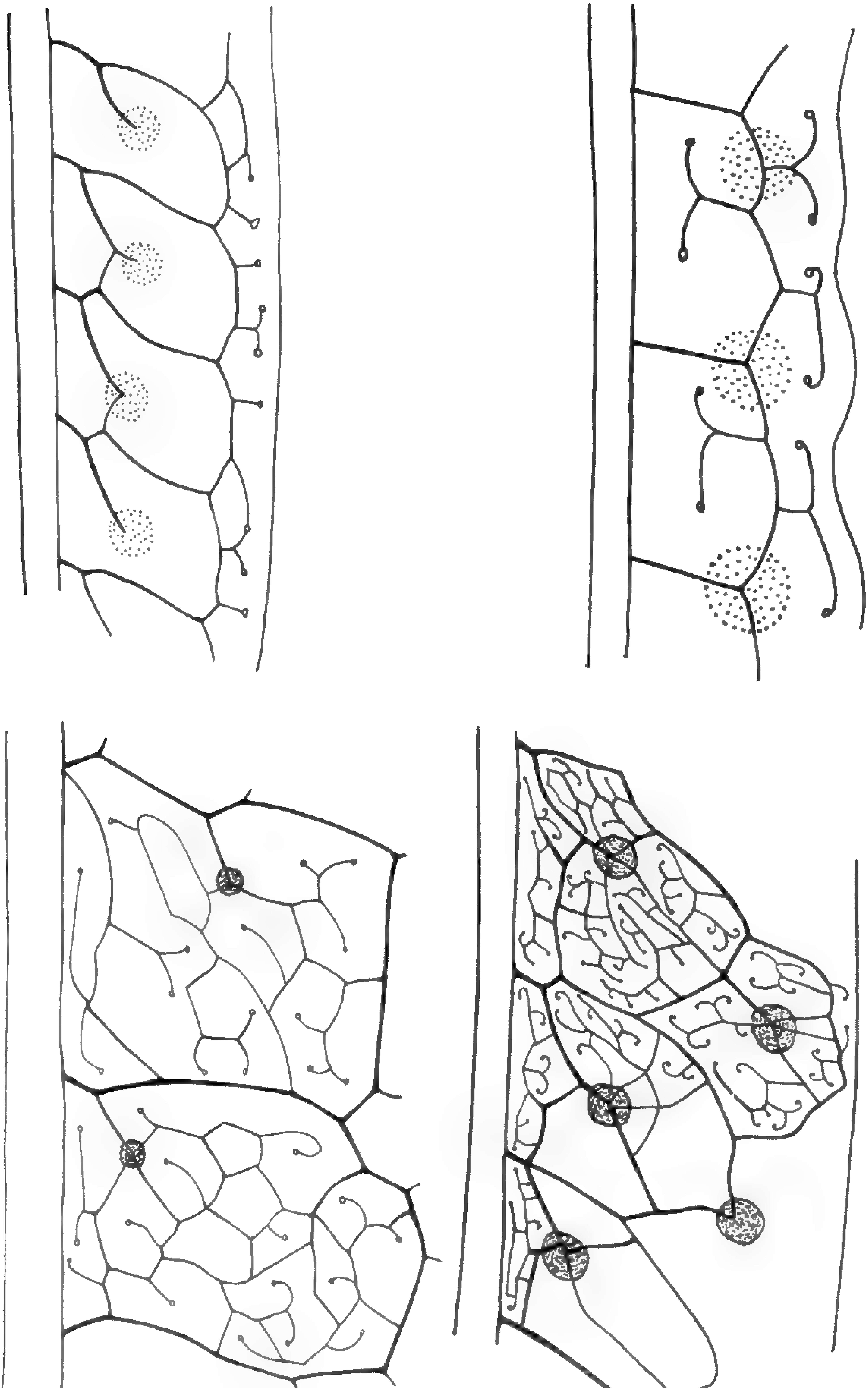
[1] Webbia 8: 212-222. 1951.
[2] Bibl. Bot. 85: 178. 1913.



The following key will serve to separate the two species found in southeastern Australia. They are closely allied to *M. novae-zealandiae* (Baker) Copel. of New Zealand, and *M. sibomense* (Rosenst.) Copel. of New Guinea. The latter species is characterized by a thin lamina with one or two rows of scarcely impressed sori.

Scales of the rhizome squarrose, persistent, dark brown or purplish brown, narrowly lanceolate to lanceolate; rhizome (when living) tough and wiry; lamina dark green, membranous to herbaceous, with a distinct musk scent when fresh or freshly dried; segments of the pinnatifid fronds 1.2–10 cm. long. *M. scandens.*

Scales of the rhizome appressed, deciduous, black, purplish-brown or dark to light grey, with a brown or light brown border, narrowly lanceolate or ovate; rhizome (when living) fleshy and often very glaucous; lamina light green, herbaceous to coriaceous, unscented; segments of the pinnatifid fronds 1.8–15 cm. long. *M. diversifolium.*

As Copeland[3] points out, the type species of the genera *Microsorium* and *Phymatodes* are very unlike each other, but it is impossible to draw a dividing line when all the species are considered. I concur with this view. I believe that the group of species allied to *M. commutatum* (Blume) Copel. form a connecting link between these two genera.

*M. scandens* has a very simplified vein-pattern in the lamina whereas in *M. diversifolium* the venation is essentially of the type characteristic of *Phymatodes,* i.e. the sori of the only (or in some species the lower) row are each borne at the junction of several minor veinlets and a strong acroscopic vein (arising from the base of or near the base of a main lateral vein). In *M. scandens* the sori are borne at or close to the junction of the main lateral vein or its acroscopic branch and the horizontal vein approximately parallel to the costa.

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[3] Gen. Fil. 195. 1947.

UPPER LEFT. POLYPODIUM FORMOSANUM; FERTILE LOBE WITH DETAILS OF VEINS AND SORI; HAMATE VEINS ABSENT IN AREOLE; x 6. UPPER RIGHT. MICROSORIUM SCANDENS; FERTILE LOBE; HAMATE VEINS IN AREOLES; x 4. LOWER LEFT. MICROSORIUM SYLVATICUM; FERTILE LOBE; SORAL ARRANGEMENT AS IN MICROSORIUM IN ONE AREOLE, AS IN PHYMATODES IN OTHER AREOLE; x 4.5. LOWER RIGHT. MICROSORIUM SCOLOPENDRIA; COMPLEX PHYMATODES-TYPE VENATION; x 3.

In some members of the *M. commutatum* group the sori are borne in box-like areolae which occur in alternating rows. The sori in the costal row are arranged as in *Phymatodes* but the upper row of sori are mostly irregularly placed. These points may be easily seen in the type of *Microsorium multijugatum* (Copel.) Copel., which was collected by Copland King, No. 228, at Goodenough Bay, New Guinea, in 1903 (NSW. P8078).

Specimens such as NGF. 6788, *Microsorium* sp. aff. *multijugatum*, collected at the Baiyer River, New Guinea, by Womersley and Floyd in November, 1954, appear to be midway between *Phymatodes* and *Microsorium*. The thickened vein on which the sorus is borne in the costal areolae arises in some cases from the costa in the middle of the areola but in others from the base of or close to the base of the lateral veins.

In *M. sylvaticum* (Brack.) Copel. the venation is somewhat similar except that the parallel lateral veins are more prominent and the cross-veins parallel to the costa are less pronounced than in *M. multijugatum*. The position of the sori is sometimes as in *Phymatodes*. A specimen of *M. sylvaticum* collected at Upolu, Samoa, by E. Betche, No. 57, in February, 1880, is characterized by a thin lamina with the sori not immersed in pits. Many of the species such as *M. scolopendria* (Burm.) Copel. and *M. alternifolium* (Willd.) Copel. that have been traditionally placed in *Phymatodes* have deeply impressed sori. Other species such as *M. sibomense* and *M. parksii* (Copel.) Copel. with the typical *Phymatodes*-type of venation have scarcely immersed sori.

The dividing line between *Polypodium sens. strict.* and *Microsorium*[4] may also be determined by their venation. In the latter genus the species usually placed in *Phymatodes* appear to be

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[4] As recently pointed out by W. A. Sledge, Bull. Brit. Mus. (Nat. Hist.) 2, No. 5: 142. 1960, the generic name was originally published by Link in Hort. R. Bot. Berol. 2: 110: 1833, both in the text and index as *Microsorum*, but later Link corrected this to *Microsorium* (Fil. Spec. Hort. Reg. Bot. Berol. Cult. Recens. 116, 135. 1841), as pointed out to me by C. V. Morton.

closer in affinity to *Polypodium* than those traditionally placed in *Microsorium.* The vein-pattern in *Polypodium formosanum* Bak., of Japan, is very similar to that of *Microsorium scandens* except that hamate and half-hamate veins are not given off from the basiscopic side of the cross-veins approximately parallel to the costa. In fact these cross-veins only occur in some of the areolae near the main rhachis, otherwise the sori are terminal on free veins in the areolae. These free veins arise at or near the base of the lateral veins on the acroscopic side. This type of venation is characteristic of the group of *P. loriceum* L. which includes the following species:—*P. plesiosorum* Kunze (Mexico), *P. chartaceum* Bak. (Ecuador), *P. falcaria* Kunze (Costa Rica), *P. limbatum* Brade (Brazil), *P. lachnopus* Wall. ex Hook. (Himalayas), *P. nipponicum Mett.* (Japan, China and Tibet), *P. punctulatum* Hook. (Ecuador) and *P. amoenum* Wall. ex Mett. (China and Tibet). I rarely observed cross-veins from the sori in any species of this group except *P. formosanum.*

Carl Christensen[5] discussed and illustrated many aspects of the vein-patterns in the groups of *Polypodium,* ranging from *P. vulgare* L. and its allies which have free-veins to *P. manmeiense* Christ. and *P. microrhizoma* Clarke, where areolae are formed to enclose the sori in some cases but the rest of the veins are free. He stated that this was just a step to the vein-pattern in the group of *P. loriceum.*

ACKNOWLEDGMENTS

I should like to express my appreciation for the facilities afforded by the directors and keepers of the following institutions: The Herbarium, Kew; the British Museum of Natural History, London, and the National Herbarium, Sydney. The writer also wishes to thank Dr. R. E. Holttum for a very helpful discussion on the subject of the above paper.

NATIONAL HERBARIUM, ROYAL BOTANIC GARDENS, SYDNEY, AUSTRALIA.

[5] Dansk. Bot. Arkiv. 5, No. **22:** 1-10. 1928.

## A New Station for Trichomanes Petersii in Georgia

HENRY BOOKOUT

In 1901, A. B. Seymour[1] collected *Trichomanes Petersii,* for the first time in Georgia, in a deep ravine at Tallulah Falls, Rabun County, of the Blue Ridge Mountain Province. Wilbur Duncan[2] made the second collection in Walker County of the Cumberland Plateau in 1952. On July 22, 1958, Frank Snyder and I discovered *Trichomanes Petersii* growing on rock cliffs in Butternut Cove of the Cedar Creek ravine, Stephens County, about ten miles south-southeast of the original site (now lost) at Tallulah Falls. The collection is *Bookout & Snyder* 82, ¼ mile off Yearwood Drive up the Cedar Creek ravine, elevation 825 feet. Specimens are in the University of Georgia Herbarium, the Harvard University Herbarium, and the author's private collection.

I had invited Mr. Snyder, an amateur botanist from Toccoa, out to Camp Mikell to see *Camptosorus rhizophyllus* (*Bookout* 81), which I had discovered three days before on July 19. The walking fern itself is not common in Georgia, and this new site was a new record for Stephens County and a considerable extension of its range southward for the eastern part of the state. Mr. Snyder and I were examining the nearby cliffs when I pulled off something that looked like a small liverwort or a flat-leaved moss, but noting the leafy rhizomes I said, "This looks like a filmy fern." When the fruiting bodies were discovered, the identity was assured. The fern is common below Cedar Fork in the Cedar Creek ravine at isolated stations on both slopes. It grows on siliceous cliffs and loose rocks where they are shaded and kept continually moist by seepage. There are several places where the filmy fern might have been found growing in the "spray of a waterfall," but not a single instance was noted. It seemed to prefer, instead, the protection afforded by overhanging rocks.

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[1] A. B. Seymour, 1903. *Trichomanes Petersii Found Anew.* Torreya **3:** 19–21.

[2] Wilbur Duncan, 1955. *New Records for Georgia Ferns.* This JOURNAL **45:** 1, 2.

On August 21, I revisited the site of *Camptosorus rhizophyllus* where I discovered something that originally had gone unnoticed —that on three different rocks the filmy fern and the walking fern were growing in close association. Since the filmy fern is always found on siliceous rocks[3] and the walking fern more commonly on calcareous rocks,[4] their association seemed at first sight to be remarkable. Dr. A. S. Furcron, the state geologist, identified one of the rocks as hornblende gneiss, a siliceous rock containing a calcium silicate. Perhaps this calcium silicate, Dr. Furcron suggested, releases sufficient calicum ions to make the walking fern at home. However, the other two rocks were muscovite quartzite with a granitoid appearance. In any case, the dry soil separated from the intertangled rhizomes of the filmy fern and the walking fern when tested with a Sudbury Soil Test Kit, model D, showed a rather strongly acidic pH of 4.5. The filmy fern, apparently, is typically located. The walking fern, however, here demonstrates its greater impartiality to environment in forming a self-perpetuating colony under relatively atypical conditions of an acidic soil.

ATLANTA, GEORGIA

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[3] E. T. Wherry, 1955. *The Substratum of Trichomanes Petersii.* This JOURNAL **45**: 93–95.

[4] Rogers McVaugh and Joseph Pyron, 1951. Ferns of Georgia, p. 72.

## Recent Fern Literature

POLLEN AND SPORE MORPHOLOGY.[1]—The first part of this volume is devoted to illustrations and legends for 57 genera of gymnosperms, 113 genera of pteridophytes, and 69 genera of bryophytes; the second part to a discussion of the ultra-microscopic structure of pollen and spore walls; and the third part to methods of preparation of ultra-thin sections.

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[1] Pollen and Spore Morphology/Plant Taxonomy. Gymnospermae, Pteridophyta, Bryophyta. (An introduction to Palynology, vol. 2.) G. Erdtman, Ed. Almquist & Wiksell, Stockholm; Ronald, New York, 1957. 151 pp. Illus. $8.

Readers of the American Fern Journal who are interested in fern spores will find illustrations of spores representing world-wide distribution of fern genera, but not a complete coverage of all the fern genera of the world. The arrangement of the illustrations is alphabetical by genera with a few exceptions when several genera of a family are illustrated in one figure. These figures usually include a view of the spore at a magnification of 250×, a palynogram with the distal face on the left and the optical section on the right at a magnification of 1000×, plus sketches to show the LO pattern at high and low focus. The LO pattern (L = light, O = obscuritas) is determined by critical focusing at the surface of the spore. The sculptural or structural elements of the sclerine appear as bright spots or areas in a slightly darker field; then, as the focus is moved downwards, the pattern reverses. Thus, through the differential absorption of light, details of the sclerine stratification are predicated.

Unfortunately the text to these illustrations is to be published in a separate volume that has not yet appeared. It is to be hoped that the descriptions will tell how other species of a genus differ from the one illustrated. One of the few instances in which more than one entity of a genus is illustrated is *Cystopteris fragilis* which is depicted by the typical, spiny spore and its forma *Dickieana* by a perine surface of irregular folds and crests like many species of *Dryopteris*. The taxonomists in the past have neglected characters of the spores which may be useful in classification and identification of ferns.

These questions may be asked: How reliable is the identification, in the absence of the citation of voucher specimens? How accurately do these palynograms represent the spores? The author had the privilege of studying in Professor Erdtman's laboratory. Most of the spores were secured from herbarium specimens. Although a record was kept of the data on the herbarium label and the herbaria which furnished samples, Professor Erdtman had to depend upon others for the reliability of the identification of specimens. Citation of voucher specimens is expected in the forth-coming volume of text. Slides of the spore material were prepared by the acetolysis process. Briefly, the dry spore sample was boiled for 1 minute in a mixture of 9 parts acetic anhydride plus 1 part of concentrated sulphuric acid, then centrifuged, washed, and mounted in glycerin jelly. This process removed the protoplasmic contents of the spore (also the perine at times), thus making it easier to study details of the wall structure. Professor Erdtman studied the slide, made a rough sketch to indicate the details he wanted the artist to illustrate, and mailed the slide to the artist who then made the illustration. The writer has studied some of these slides and has actually located the grain the artist drew. These stylized drawings are a faithful representation of the grains studied. The method of preparation is very important, inasmuch as spores boiled in potassium hydroxide or embedded directly in glycerin jelly, Permount, lactophenol, or other mounting media will and do look different from those prepared by acetolysis. There is a danger associated with removing spores from a herbarium sheet which should not be over looked—that is, the spores may be contaminated with those from other specimens. This is serious if only a few spores are taken from the specimen. Contamination is probably responsible for the opinion that a given species may produce both trilete and monolete spores.

This and its companion volumes will be necessary reference works for the palynologist.—CLAIR A. BROWN.

NEW GARDEN ENCYCLOPEDIA.—Under the editorship of T. H. Everett, of the New York Botanical Garden, the "New Illustrated Encyclopedia of Gardening, Unabridged" was published in April, 1960. It is in six volumes, bound in buckram and boxed. The work contains about 3,000 pages, well over 3,000 black and white pictures, and more than 600 colored illustrations. It is primarily a gardening rather than a botanical work. The publishers retail price of the set is $49.50, but it is being offered to members of the Fern Society at the special price of $33.00, plus $1.50 mailing charge. Dr. Ira L. Wiggins (Natural History Museum, Stanford University, Stanford, California) has agreed to handle orders.

SOME RECENT PAPERS ON CHINESE FERNS by R. C. Ching.—The well-known pteridologist R. C. Ching was inactive botanically for many years during and after the last war, but he is now at work again at the Academia Sinica, Peking, Peoples Republic of China. A recent letter from him will be quoted in the Notes and News section. Some of Ching's recent publications have been kindly shown to me by Dr. Egbert H. Walker and Dr. Clyde F. Reed. These are noted below. They are all in Chinese, with English summaries, and Latin descriptions of the novelties.

"Cyrtomidictyum Ching, A Yet Little Known Chinese Fern Genus."[1] The genus *Cyrtomidictyum* was proposed by Ching in 1940, but due to war conditions, it was not known to Copeland when he was preparing his Index Filicum. It was based on *Aspidium lepidocaulon* Hook., which was placed in *Polystichum* in the Index Filicum. It differs from *Polystichum* in being always simply pinnate, in exindusiate sori, borne dorsally on the veins, in the pinnae being entire and not aristate-serrate and not tipped with a spine, and in having the sterile blades prolonged and rooting at apex. All these characters occur occasionally in other species of *Polystichum* but are combined only in *Cyrtomidictyum*. The genus was originally monotypic, but three species are now added: *C. basipinnatum* (Baker) Ching, *op. cit.* 262 (based on *Aspidium basipinnatum* Baker (from Kwangtung), *C. conjunctum* Ching, *sp. nov., op. cit.* (type: *Hsiung Yao-Ko* 06466, from Hwang-Kan Shan, Kiangsi), and *C. Faberi* (Baker) Ching, *op. cit.* 265 (based on *Nephrodium Faberi* Baker, from Chekiang; occurs also in Taiwan). Also described is *C. lepidocaulon* (Hook.) Ching var. *incisum* Ching, *op. cit.* 265 (type: *Taquet* 2456, from Quelpaert, Korea).

"On the Genus Adiantum L. of China with Notes on Some Related Species from Neighbouring Regions."[2] Ching argues that *Adiantum* belongs to a distinct family, Adiantaceae, which ought not to be joined with the Pteridaceae following Copeland

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[1] Acta Phytotaxonomica Sinica **6**: 255–266. *pl. LI–LIV*, August, 1957.
[2] Acta Phytotax. Sin. **6**: 301–354. November, 1957.

or with the gymnogrammoid and vittarioid ferns as proposed by Holttum. He recognizes two genera, *Adiantum* and *Hewardia; H. olivacea* (Baker) Ching, *H. phyllitidis* (J. Smith) Ching, and *H. lucida* (Cav.) Ching are proposed as new combinations but not validly published by the Code, since the place of publication of the basionym is not given. A key in English is given to the 34 species of *Adiantum* recognized from China. If space is available in the FERN JOURNAL, perhaps we shall reprint this key, which should be more widely accessible.

"The Fern Genus Plagiogyria on the Mainland of Asia."[3] This paper is fortunately completely published both in Chinese and English. It discusses *Plagiogyria* in detail as to its history, its systematic position (as the representative of a monotypic family according to Ching), its origin and geographic distribution, its adaptive peculiarities, and its taxonomic division. The genus is divided into two sections termed *Carinatae* and *Euplagiogyriae,* the latter with the subsections *Euphlebiae, Adnatae,* and *Pycnophyllae.* Unfortunately, although these are carefully provided with Latin diagnoses they are not validly published by Art. 35 of the Code, since the nomenclatural types are not indicated. Altogether, 33 species are recognized from China, including a large number of new ones.

"A Revision of the Fern Genus Archangiopteris Christ & Giesenhagen."[4] *Archangiopteris* is said to be distinguished from *Angiopteris* by its smaller, simpler, slenderer habit, by having elongate, suberect dorsiventral rhizomes provided with thin-fleshy ovate-oblong bivalved persistent stipules, a stipe with a fleshy nodose swelling below the middle (or 4 or 5 nodes in *A. hokouensis* Ching), by the presence, especially on the lower part of the stipe, of elongate, clathrate, coarsely dentate, peltately affixed scales, by the simply-pinnate blades (bipinnate in *A. bipinnata* Ching), with few pairs of large, broadly lanceolate pinnae with inflated petiolules, by the longer sori, consisting of

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[3] Acta Phytotax. Sin. 7: 105–154, *pl. XXVIII–XL.* May, 1958.
[4] Acta Phytotax. Sin. 7: 201–224, *pl. XLIX–LII.* August, 1958.

many sporangia (40–240), which are not inframarginal but medial, by the numerous, articulate, freely-branched paraphyses, and by the echinate spores. Along with *Macroglossum,* these two genera constitute the family Angiopteridaceae, which Ching believes ought to be kept distinct from the Marattiaceae. Ten species of *Archangiopteris* are now known, confined to a small area in Yunnan, Kwangsi, Annam, and Tonkin, except for *A. tonkinensis* (Hayata) Ching, which has been found on Hainan, and *A. Somai* Hayata, of Taiwan.

"Materials for the Pteridophytic Flora of Hainan."[5] The text of this series of notes on the ferns of the island of Hainan is not translated into English, but the new species are given Latin diagnoses. Some of the species, *e.g. Dicranopteris ampla,* are not validly published because they are based on more than a single collection and the nomenclatural type is not indicated. The new species, both valid and invalid, are[6]: *Selaginella scabrifolia* Ching & C. H. Wang, *Angiopteris acutidentata, A. caudipinna, A. hainanensis, A. Howii* Ching & Wang, *A. neglecta* Ching & Wang, *A. oblanceolata* Ching & Wang, *A. remota* Ching & Wang, *A. subintegra, A. venulosa, Osmunda angustifolia, Dicranopteris ampla* Ching & Chiu, *Hicriopteris simulans, Mecodium hainanense, Hymenophyllum spinosum, Vandenboschia assimilis* Ching & Chiu, *V. hainanensis* Ching & Chiu, *Gonocormus australis, Crepidomanes dilatatum* Ching & Wang, *C. hainanense, C. Smithiae, Microlepia scyphoformis* Ching & Wang, *Hypolepis gigantea, Lindsaya neocultrata* Ching & Wang, *Oleandra hainanensis, Pteris crassiuscula* Ching & Wang, *P. hainanensis, Diplazium serratifolium, D. submettenianum, D. viridescens, Cyathea hainanensis, Dryopteris acutidens, D. caudifrons, D. livida* [as "*lividis*"], *Tectaria media, Lepisorus affinis, L. longifolius, Phymatodes lancea* Ching & Wang, *Colysis intermedia* Ching & Wang, *C. triphylla, Vittaria latifolia,* and *V. lauana.*—C. V. MORTON.

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[5] Acta Phytotax. Sin. **8:** 125–171, *pl. XVI–XXIV*. August, 1959.
[6] All by Ching unless otherwise specified.

## Notes and News

The LOS ANGELES FERN SOCIETY continued to meet regularly throughout the last year. The programs were devoted to discussions of ferns and their cultural requirements. Culture from fern spores was capably discussed and demonstrated by Frank Sobas and Frank Pauker, the Program Chairman and the Membership Chairman, respectively; this created more interest in the fern spore bank.

Dr. W. C. Drummond gave a series of lessons on the technical words used in describing ferns. He has prepared a mimeographed list each month for distribution to the members.

The Southern California Horticulture Society invited the Los Angeles Fern Society to present a program. The speaker, Sylvia Leatherman, discussed requirements as to light, soils, watering, and so forth, and gave ideas on the use of ferns in landscaping; her talk was illustrated by specimens.

During the year members have brought specimen plants to the meetings for exhibition. One of the most spectacular displays was Mr. Glen Scofield's huge specimen Platyceriums.

During the summer, meetings are held at members' gardens and also in the Fern Dell in Griffith Park, with pot luck dinners and a member participation program. These garden meetings are always a treat from the superb collections of living ferns on display.

The present officers are: Sylvia B. Leatherman, President; Dr. W. C. Drummond, Vice President; Mabel Anderson, Secretary, and Hertha Solmitz, Treasurer. Marie Zachau is the Librarian, and lends books to members.—SYLVIA B. LEATHERMAN.

EXCERPT FROM LETTER BY R. C. CHING TO CLYDE F. REED:—"... Mr. Morton is right in saying[1] that *Asplenium conmixum* Ching is an *err. script* for *A. commixtum*. I am not the author of the pteridophytes of north-eastern China. It was written by a group of young men of the Forestry and Soil Institute in Mukden. In the course of preparation for the book, they came to consult the fern specimens in our herbarium. I did not see

[1]This JOURNAL 49: 127. 1959.

their manuscript before going to the press. *Athyrium pachyphlebium* C. Chr., based upon Harry Smith no. 6130, from Shensi was published for the first time in Dansk Bot. Arkiv Vol. 3, no. 3, pp. 56, 1936, a fact which I failed to know until a few weeks after I had conveyed to Mukden my short Latin diagnosis; we have a cotype in our herbarium. So that the correct citation for this species should be: C. Chr. in Dansk Bot. Arkiv and not Fl. Herb. Bor-Orient. China. As indicated by Christensen, the type is now in Herb. Uppsala, Sweden. . ."

Letter from R. C. Ching.—Dr. R. C. Ching published a number of important papers on Chinese ferns and on fern classification during the thirties but was inactive botanically during and after the war. A recent letter from him may be of interest to others:

Dear Mr. Morton: November 5, 1959

We have known each other by name for many years. I remember I once received your papers on ferns, long ago. As you know, I am an old acquaintance of Dr. William Maxon of your Institution, and at one time we worked together in the herbarium at Kew. Since the outbreak of the war waged by the Japanese in 1937, we were cut off. Fortunately, I barely had time enough to return to your institution all the herbarium species of *Dryopteris* of the Himalayan and Chinese regions that Dr. Maxon had sent to me on loan for my monograph of the genus.

I did not publish much on ferns between the years 1942 and 1953, for in that period I was teaching at the University of Yunnan, as a professor of forestry, which was my original profession. Can you tell me where Dr. Maxon is now and also Dr. E. B. Copeland? I received his Genera Filicum in 1948 but I have heard from him no more since.

I am now engaged in preparation of the Fern Flora of China, which is a part of the Flora of China, which when completed will be in eighty volumes, of which five volumes are now in press. Volume 2, the first part of the Fern Flora, was published on the first of October, 1959. I am sending you under separate post a copy of it with my compliments.[1] There will be four more volumes on the ferns, containing in all about 2,300 species in China, to be published in the next few years.

With best regards, I am,
Sincerely yours,
R. C. CHING
DIVISION OF TAXONOMY AND PHYTOGEOGRAPHY
ACADEMIA SINICA, PEKING, CHINA

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[1]Now received, and to be reviewed later. C.V.M.

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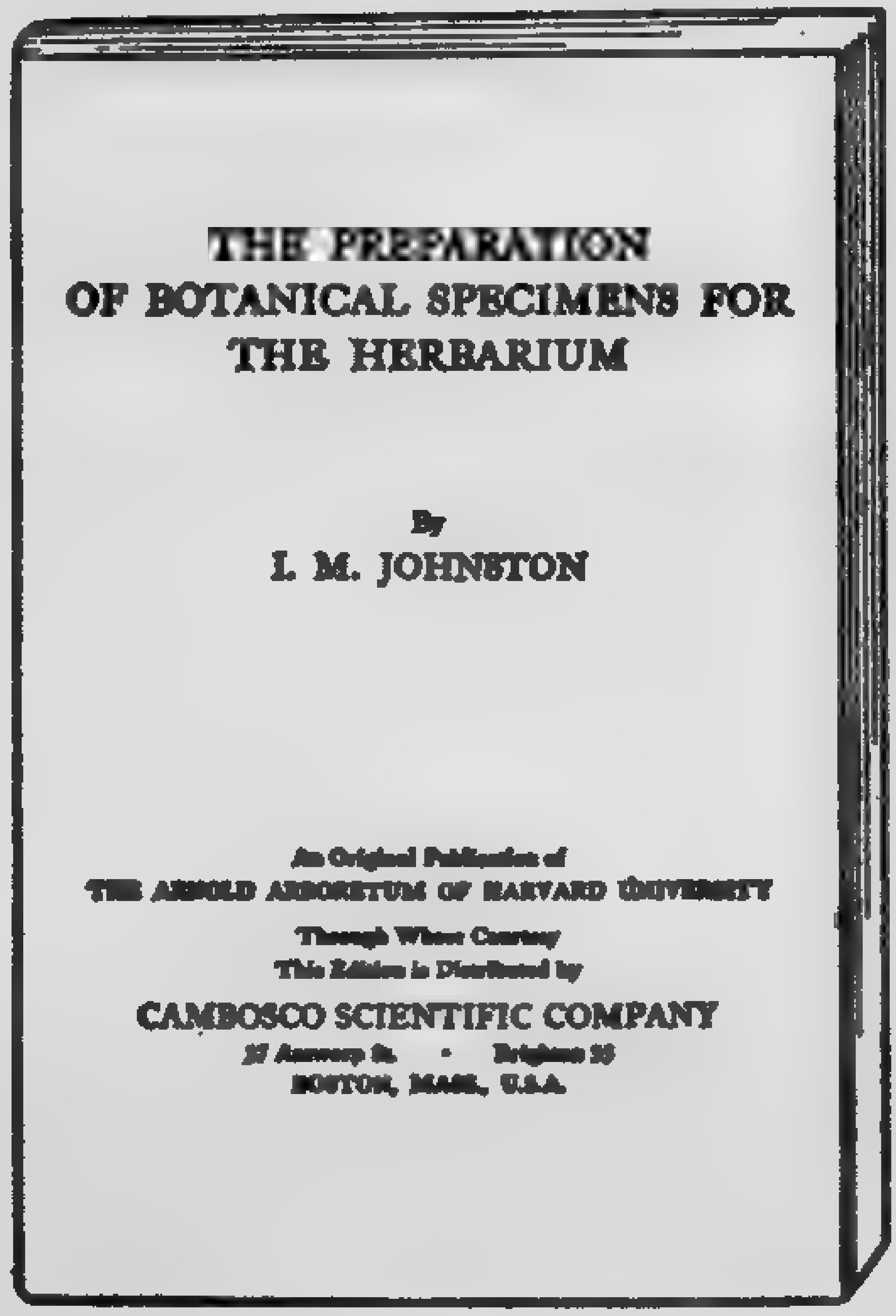


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American Fern Journal

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## On the Lava Fields of Rangitoto*

Marguerite Crookes

Surrounding the areas and "islands" of vegetation on Rangitoto Island, New Zealand, one encounters masses of black lava, treacherous to scramble over and ugly to behold. But a promising spot indeed is this "cinder heap" for a fern hunter. One would expect a few rock ferns and some of the hardy and ubiquitous species that range throughout the country, but little else. But actually on this unique volcanic island the most remarkable feature of a remarkable vegetation is the unexpected richness and variety of its fern flora, and the greatest surprise of all is the great quantity of filmy ferns (species of Hymenophyllaceae) which one associates with the shady forests and deep valleys of the mainland.

Exploring the islands one will find growing on them, right out on to the open lava, huge masses of Kidney Fern, *Cardiomanes reniforme* (Forster) Presl, with its beautiful clear green kidney-shaped fronds, fringed when fertile with tiny bright brown columns of sporangia. The kidney fern is also found completely covering the floor and rocky sides of small gullies where the lava has consolidated. Along with it is found in many places an abundance of Piri Piri, *Mecodium sanguinolentum* (Forst.) Presl, sometimes called the Scented Filmy fern because it scents the paper when drying. I well remember the astonishment of the late Sir Arthur Hill, Director of Kew, when he saw these exquisite delicate "filmies" flourishing on the open lava. "Good Heavens," he exclaimed, "Why at Kew we grow those things under three layers of glass!" Nor are the filmies confined to these two species. One sometimes meets with the handsome

*Invited paper for Fiftieth Anniversary Volume. [Ed.]

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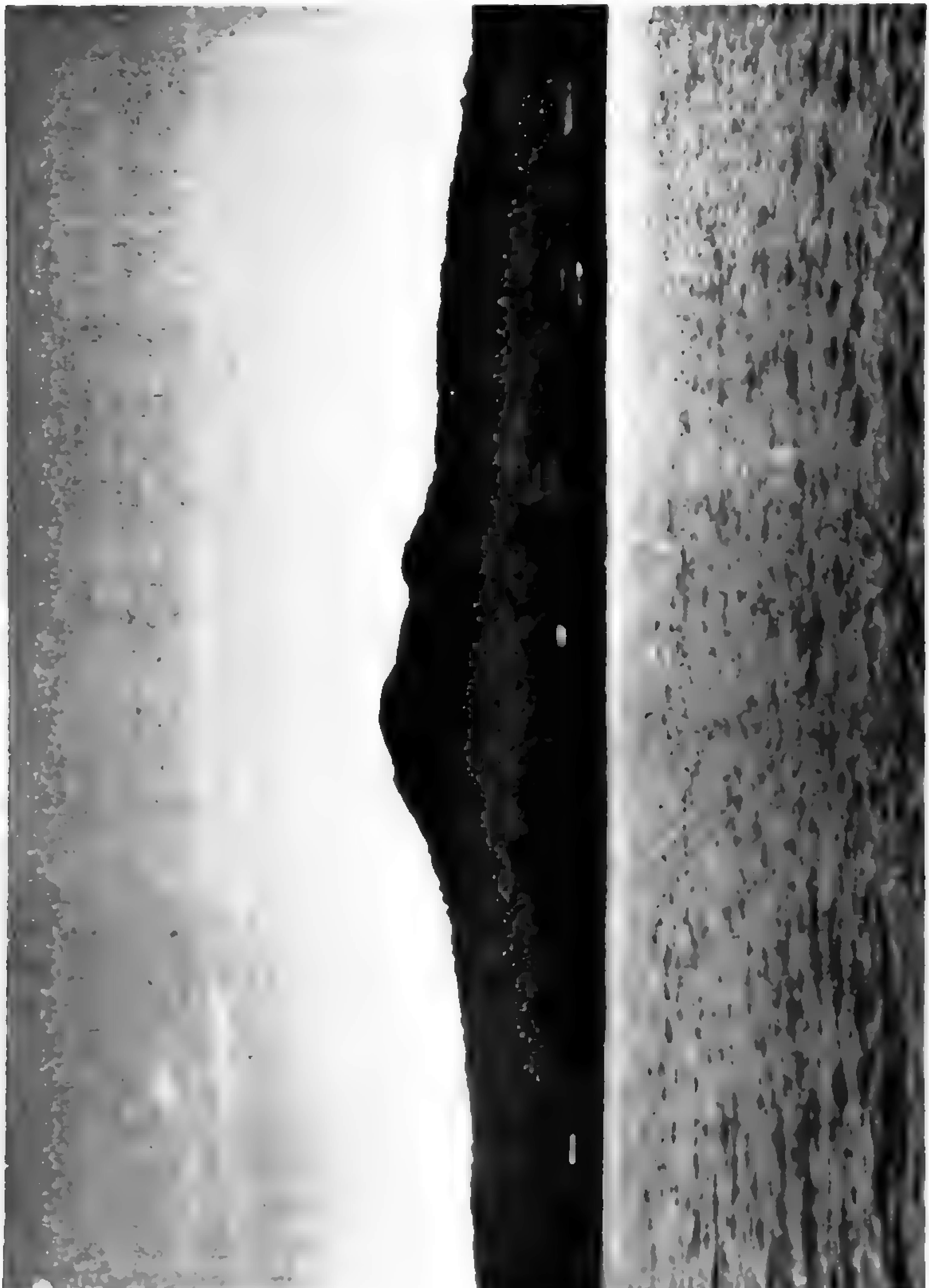

Rangitoto Island, at Entrance to Auckland Harbour, about 3 Miles Wide, 854 Feet High, Area 6400 Acres. Photograph by L. H. Millener

*Mecodium dilatatum* (A. Rich.) Copel. with its large bright green frond. This species is a tree climber, and so also is the occasionally met Hairy Filmy Fern, *Mecodium scabrum* (A. Rich.) Copel., with its rather bristly stipe and dark dull green frond, and less commonly, the finely cut *Meringium multifidum* (Forst.) Copel. with serrate edges. Occasionally, *Mecodium demissum* (Forst.) Copel., one of our larger filmy ferns, is also met. Smaller fry are not entirely absent though not common. Here and there we find the little dull green *Hymenophyllum revolution* Col. (long confused with the widespread Tunbridge fern, *Hymenophyllum tunbridgense*), the rather yellow-green fronds of *Mecodium flabellatum* (Labill.) Copel. and the small greyish-green *Mecodium rarum* (R. Br.) Copel.

But although the filmies are the most astonishing of its ferns, Rangitoto yields many others of great beauty and interest. Most attractive is the common *Microsorium diversifolium* (Willd.) Copel. with its shining bright green pinnatifid fronds often bearing large bright brown or orange sori. It climbs most energetically over rock and tree by means of its fleshy green rhizome, "spotted like a snake" owing to the presence of the black appressed scales. Of similar habit and catholic tastes is the little *Pyrrosia serpens* (Forst.) Ching, but its rhizome is more slender and its simple fleshy fronds have a whitish or buff coloured tomentum on the under side.

That large, complex and fascinating genus *Asplenium* is represented by four species. The beautiful tufts of the glossy bright green, simply pinnate fronds of the Shining Spleenwort (*Asplenium lucidum* Forst.) are to be seen, large and luxuriant in the shade and smaller, tougher and more yellowish-green in exposed places. The tufts of *Asplenium falcatum* Lam., also with simply pinnate fronds, are found in somewhat similar situations. But perhaps most fascinating of all is the Hanging Spleenwort, *Asplenium flaccidum* Forst., a most puzzling compound species which still poses many problems for the systematist. Much work has been done on it by the late David Knowlton, who was engaged in carrying out a detailed study

AN ISLAND OF VEGETATION, SHOWING SOME OF SURROUNDING LAVA FIELD AND CONSOLIDATED FOREST ABOUT BASE OF THE CONE. PHOTOGRAPH BY L. H. MILLENER of the New Zealand Aspleniums when he so tragically lost his life while fern hunting on the Little Barrier Island, Hauraki Gulf. The Hanging Spleenwort on Rangitoto seems quite normal, though as always varying greatly according to situation. In the forest it sends down long, pendent, thick fronds rather like green leather, sometimes reaching five feet, but when on the rocks it produces smaller stiffer tufts of a rather yellowish-green. The Hanging Spleenwort apparently hybridizes with several other species with considerable enthusiasm, but on Rangitoto I have only ever encountered one plant that looked at all suspicious.

The common bracken, *Pteridium esculentum* (Forst.) Diels, is encountered here and there, but as there is no room for it to run it presents a somewhat disgruntled appearance. Much more at home is its not distant relative sometimes called Trembling Bracken or Shaking Bracken, *Pteris tremula* R. Br., which, in spite of its timorous name, is hardy, and sends up its tall rather light green tufts of fronds in all sort of odd attractive corners. The more beautiful *Pteris macilenta* A. Rich. has also been encountered but only rarely. One might also see occasionally, though only where its rhizomes have room to run, the somewhat sticky Scented Fern, *Paesia scaberula* Kuhn, whose sun-loving tastes and exuberant growth make it extremely unpopular with the New Zealand farmer.

If one investigates suitable rocks where humus has accumulated in the crevices, two small Rock Ferns *Cheilanthes Sieberi* Kunze and *C. distans* R. Br. will be found. They are only a few inches high and are not at all easy to distinguish when mature, but the unrolled fronds of *C. distans* are very hairy giving a "cottonwool" effect to the young crook. Another Rock Fern rather larger and with a simply pinnate frond and rounded pinnae is *Pellaea rotundifolia* Hook., well calculated to make the most of unpromising situations. *Doodia media* R. Br., another fern loving the open spaces, also has a two-ranked frond, which when young has beautiful autumn colouring. Also to be seen on Rangitoto is our sole New Zealand member of the Comb Fern genus, *Ctenopteris* Blume. Our little New Zealand Comb Fern, *Ctenopteris heterophylla* (Labill.) Tindale, is a tough little tufted fern with deeply pinnatafid fronds. Two more little epiphytic tufted ferns are *Grammitis Billardieri* Willd. and *Anarthropteris Dictyopteris* (Mett.) Copeland. Both are sometimes to be found on rocks and tree trunks and have small undivided fronds. The *Grammitis* is rather an insignificant little thing with rather dull green fronds and not common. *Anarthropteris* on the other hand has long rather bright green fronds and is moreover stoloniferous, and so if it finds a suitable tree trunk or rock face can cover considerable areas. It is not particularly common on Rangitoto as it likes a certain amount of shade. The exact systematic position of this monotypic genus has been a matter of earnest debate among pteridologists. It has on occasion even been included among "jointed ferns" to the dismay of Copeland who very firmly named it *Anarthropteris* (an, not, and arthron, a joint) so that such unseemly errors should not again be committed.

A few odd species will crop up where the land has become more consolidated and more soil has collected. Two maidenhairs, *Adiantum affine* Willd. and *A. hispidulum* Swartz. have been recorded, and also a tree fern, *Cyathea dealbata* (Forst.) Swartz, and Shield Fern, *Polystichum Richardii* (Hook.) J. Smith, but these are not characteristic.

I feel I cannot conclude without some word of the "hidden ferns" of Rangitoto, which are a never-ceasing source of wonder to the visitor. One pursues a track through forbidding masses of black brittle lava rocks some quite small, some large or forming slabs, part of the cooled surface of the once molten flow, an area seemingly of complete and barren devastation. But if one steps aside on to the treacherous lava—carefully for it has an unmannerly habit of giving way and badly scored ankles are not hard to acquire—then bends down, moves aside a clump of rock, and peers into the miniature cavern below one will be astonished at what is seen. First is noticed the delicate green fronds of the Necklace Fern, *Asplenium flabellifolium*

Cav., which sends its little simply pinnate fronds from rock to rock; on finding suitable substrata these fronds will root at the end and continue on their fragile way. Tiny clumps of filmy ferns, probably *Mecodium sanguinolentum* (Forst.) Copel. may be encountered; the clump will never extend very far, but it is amazing to find it there at all. Liable to be found also are small plants of Shining Spleenwort, Hanging Spleenwort, and *Asplenium falcatum* Lam., and the Trembling Bracken may also put in an appearance. These ferns are not likely to grow very large and indeed some may not survive at all when they grow out into full sunlight. But they will gradually add their modicum of humus and in the meantime are a lasting source of delight to the wandering botanist.

Other areas in New Zealand may be found rich in the number of fern species but I know of no other spot that can rival Rangitoto with a fern wealth that is at one so beautiful and so entirely unexpected.

BROCKIS HOLT, MOUNTAIN ROAD, HENDERSON, AUCKLAND, NEW ZEALAND.

## Feeding Hardy Ferns: Wise, Safe, and Risky Methods[1]

A. J. MACSELF

The majority of our members are experienced cultivators of ferns who require no instruction from me, but so often, when friends have seen my ferns in their full dress, the question has been asked, "What do you feed them on?" that I am daring to place my views on the subject before readers in order that they may pull them to pieces, ruthlessly, if they wish, so long as they will offer alternatives from which we may all learn something.

Ferns, hardy or exotic, do not relish rank animal manure. That much I proved in the early days of my horticultural career, when I ruined a batch of several thousand market ferns by mixing cow and horse manure in the potting compost. I have since witnessed the torture and piecemeal murder of a plantation of hardy ferns which a gardener of the know-all type in-

[1]Reprinted from the British Fern Gazette, by permission.

sisted, despite all advice, upon planting in richly manured soil. Whilst my opinion is that they dislike rank manure such as we use in the preparation of rose beds and herbaceous borders, I would say that hardy ferns positively loathe and hate compound fertilizers if applied in the manner usually adopted in the feeding of flowering plants.

I am well aware that it is possible, when a fern in a pot has filled the receptable with roots, to compel it to produce extremely large fronds by gorging it with fertilizers diluted in water. When engaged in the commercial production of ferns to be sold in Covent Garden I had to use these stimulants by the hundredweight, but quick clearance when a batch of plants reached its zenith was compulsory, sometimes at heavily reduced prices. Why? Simply because it was well known at the nursery that they would soon be but lumber occupying space.

Thus far, it doubtless appears to the reader that my idea of feeding ferns is to starve them, but no; I want rather to urge that in dealing with hardy ferns dieting is a matter for careful consideration, and is very different from cramming, choking or giving one's plants dyspepsia. Ferns, like most plants, require potash, nitrogen, and phosphates, but the proportions of these which will make a well-balanced food for ferns is not on all fours with the perfect blends for a dahlia, chrysanthemum or an onion. Long before I learned of the existence of the British Pteridological Society I carried out a good many tests to ascertain the effect of various kinds of foods upon various kinds of ferns, and here are some of my findings.

Scolopendriums will assimilate and benefit from more liberal feedings than other kinds of ferns. They will make wonderful fronds if given light pepperings of a mixture consisting of two parts superphosphate of lime, one part sulphate of potash and one part sulphate of ammonia. Athyriums treated with the same mixture grow rapidly out of character, and become gross and coarse. The fronds of Polystichums fed thus are prone to irregular development, but by using a weak liquid made alternately with nitrate of soda and muriate of potash—not more than a teaspoonful of either salt to the gallon of water—Polystichums may be made to produce great fronds, even in development and rich bright green. Personally, I would adopt this feeding only in the case of plants to be grown as specimens for a particular purpose, such as for exhibition, and I would not continue the diet for two successive years unless I was prepared to throw the plant away after the second year. Polypodiums will gain strength and substance from superphosphate, but sulphate of ammonia soon causes rotting of the rhizomes.

Blechnums seems to turn sick at anything in the chemical line, and *Asplenium Trichomanes* say no to anything richer than charcoal, from which there is little obtainable in the way of soluble food although it serves a useful purpose in keeping compost open and sweet. Adiantums make big fronds if fed with nitrate of soda, but the texture is soft and flabby, and the centres of the crowns are disposed to die after a season's production of lush growth.

If I were bent upon growing a dozen assorted ferns in pots to show in great form, my first step would be to mix some bone meal and crushed oyster or cockle shell with the potting soil. If the potting were done in August or September, plain water only would be given until the following April. Thenceforward one watering would be with very dilute nitrate of soda and the next equally weak muriate of potash.

In the open ground, where I want plants to make good steady growth and to retain health and vigour year after year, my plan is to dig in bone meal when preparing the site. Thereafter all the feeding done is to spinkle old soot over the ground not more than once a year, and each winter to spread the ashes from a garden fire which has consumed a good deal of woody material. I do not object to a coating half an inch thick, for it never seems to do any harm, and supplies potash in the forms ferns seem to relish.

Once in about three years I have thrown a few crystals of sulphate of iron around my Lastreas and Polypodiums, and the fronds stand longer and take on a darker tone of green. A dust-ing of finely powdered lime once in a while is acceptable to the Lastreas (except *dilatata*), the Polypodiums, and the Scolopendriums, and that about sums up feeding ferns so far as I am concerned. I know some people use Blank's celebrated fertilizers according to the instructions on the tins, and I know they can boast about the length and breadth of fronds produced, but they also have frequent reason to complain that this plant or that was grand last year, but something has gone wrong with it and it looks like going home.

Occasionally I have had a Polystichum or a Scolopendrium which has gone hard and stubborn in the crown, refusing to send up new fronds. A drenching with water in which sulphate of ammonia, ½ oz. to the gallon, has been dissolved for six hours or more has been given, and growth has soon broken away, but having achieved that much no more has been given; it is all right to give a gentle fillip, but all wrong to whip and goad to second exhaustion.

## Azolla caroliniana Willd. in Georgia

WILBUR H. DUNCAN

*Azolla caroliniana* Willd. was reported by McVaugh and Pyron[1] from Camden, Chatham, Echols, and Liberty Counties. Additional specimens now in the University of Georgia Herbarium add stations in Decatur (*R. F. Thorne* 17105) and McIntosh (*Duncan* 19969 from Sapelo Island) Counties. These and the previous collections seem to indicate that this species occurs only in the counties along the southern boundary and the Atlantic Ocean.

It was, therefore, of considerable interest to find in the July-September 1958 issue of the American Fern Journal a statement that the original supply of *Azolla* used in physiological studies was collected in northern Georgia by R. A. Benedict.[2] I wrote to

[1] McVaugh, Rogers and Joseph Pyron. 1951. Ferns of Georgia. University of Georgia Press, Athens, Georgia. 195 pp.

[2] Nickell, Louis G. 1958. Physiological Studies with *Azolla* under Aseptic Conditions. Amer. Fern Journ. **48:** 103–108.

Dr. Nickell to obtain more precise information concerning the locality where the *Azolla* was obtained. He kindly sent dried specimens from the culture and stated (letter of 26 November 1958) that the original material was obtained from a roadside ditch near the main highway just before crossing the state line leaving Georgia. From additional correspondence it was learned that Mr. Benedict, to the best of his recollection (letter of 27 January 1959 from Dr. Nickell), obtained the *Azolla* about 20 miles before leaving Georgia on route #301. Examination of a highway map determines that the station in question is probably in Screven County of the central Coastal Plain.

For the present, therefore, it seems that this *Azolla* is not known from northernmost Georgia. Students should look for this species in northwestern Georgia, however, for it is reported by Shaver[3] from an adjacent county (Bradley) in Tennessee.

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[3] Shaver, Jesse M. 1954. Ferns of Tennessee. Nashville, Tennessee. 502 pp.

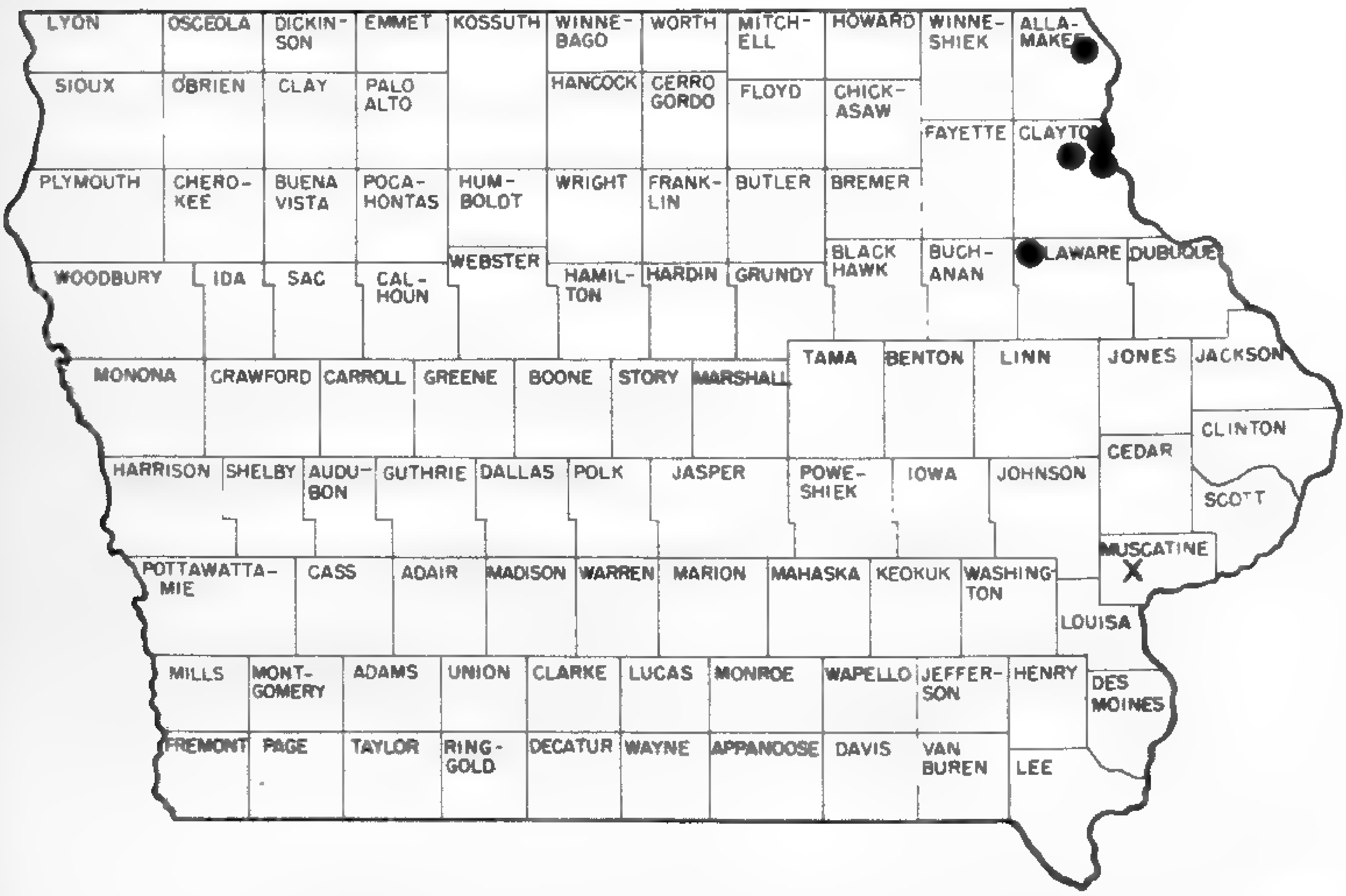
## The Lycopodiaceae and Selaginellaceae of Iowa

TOM S. COOPERRIDER

Until recently only four species of the Lycopodiaceae and one of the Selaginellaceae were known to be a part of the Iowa flora. None of these species is common in the state, but each has been collected at least once in the last decade. *Lycopodium clavatum* L. var. *clavatum* is known from three woodland stations in Johnson County, in the east-central part of the state.[1] *L. complanatum* L. var. *flabelliforme* Fern. has been collected from nine woodland stations in eastern Iowa. *L. lucidulum* Michx. has been collected from thirteen stations, most of them in wooded ravines and slopes in northeastern Iowa. *L. obscurum* L. var. *dendroi-*

[1] Statements of species distribution are based on specimens in the following Iowa herbaria: Davenport Public Museum, Grinnell College, Iowa State College, Iowa State Teachers College, and the State University of Iowa. Thanks are extended to their curators, Dr. L. F. Guldner, Dr. N. H. Russell, Dr. R. W. Pohl, Dr. M. L. Grant, and Dr. R. F. Thorne, respectively, for permission to study these specimens.

*deum* (Michx.) D. C. Eaton, is known but from a single station in White Pine Hollow State Forest, Dubuque County, in the northeastern part of the state. There, a vigorous colony grows among the branches of a dense stand of Canada yew on a cool, north-facing, limestone-talus slope.




MAP OF IOWA. CIRCLES INDICATE STATIONS FOR LYCOPODIUM SELAGO VAR. PATENS, CROSS STATION FOR SELAGINELLA APODA

Collections of *Selaginella rupestris* (L.) Spring have been made from twelve Iowa stations. Most of these are located in the northeastern part of the state. The plants grow on open fields of sand, in the crevices of sandstone exposures, and on talus from sandstone and quartzite exposures.

One more species of each of these families may now be reported. The writer recently re-examined the specimens identified as *Lycopodium lucidulum* in the herbaria of Iowa State College and the State University of Iowa. Two specimens from the former herbarium and four from the latter were found to be *L. selago* L. var. *patens* (Beauv.) Desv. Data on the labels indicate that these were collected from five different stations in the extreme northeastern corner of the state, usually on or near sandstone bluffs or ledges. The most recent of these collections was made in 1931.

The first known Iowa collection of *Selaginella apoda* (L.) Spring was made by R. F. Thorne and R. L. Hulbary, of the State University of Iowa, in September, 1958. An abundant stand of the species was discovered in a seepage bog at the foot of a sandy bluff along the Cedar River in Muscatine County.

The distribution of these two additions to the known Iowa flora is shown on the accompanying map.

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## Psilotum in Louisiana

WILLIAM D. REESE

Recently, after hearing Mr. John Lynch, of Lafayette, describe the area in southeastern Louisiana in which he gathers the fibrous bases of *Osmunda regalis* for use in his orchid houses, it occurred to me that the habitat he described must be very much like the ones in which I had seen *Psilotum nudum* in Florida. Subsequently, I took advantage of an offer to accompany Mr. Lynch and his sons on an *Osmunda*-gathering expedition to the area in question and did indeed discover *Psilotum* in the cypress swamps, at two stations approximately eight miles apart. The plants, although mostly rather small, were fairly vigorous and healthy in appearance, but all were sterile. They were not of general occurrence in the swamps but were locally abundant on mounds of pure humus which, emergent about 6 to 8 inches above the surface of the water, were well interlaced with roots of other species of plants. Growing with the *Psilotum* were a few plants of fruiting *Botrychium dissectum* var. *obliquum* and the mosses *Syrrhopodon texanus, Leucobryum albidum*, and *Climacium kindbergii.*

The collections, duplicates of which are deposited in the United States National Museum, Univ. of Southwestern Louisiana, Louisiana State University, Florida State University, and

Harvard University are the following: About 100 yards north of the Gibson-Schriever road, about 1.3 miles east of the junction with U.S. Highway 90, Terrebonne Parish, on hummock of humus at base of gum tree in cypress swamp, about 8 inches above water, Jan. 23, 1960, *Reese* (with John, Semmes, and Dick Lynch) No. 2576. About 0.5 mile west of U.S. Highway 90 bridge over Bayou Boeuf, about 0.25 miles north of the highway, St. Mary Parish, on hummock of humus in cypress swamp, about 6 to 8 inches above water, Jan. 23, 1960, *Reese* (*et al.*) No. 2577.

Dr. Clair Brown, of Louisiana State University, has informed me of one other record of *Psilotum* from the wild in Louisiana. According to Dr. Brown the name of the finder is unknown, and no specimen was preserved. The plants were found in the vicinity of Schriever, in the same general area dealt with in this note. *Psilotum* is otherwise known from Louisiana from specimens found at a nursery near New Orleans, and from Lynch's orchid houses in Lafayette, where it was recognized by Mr. Lynch after being found in the swamps. Doubtless it was brought in initially with the *Osmunda* bases and very likely is of rather wide occurrence in the state in greenhouses.

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## A Key to American Dryopteris Species Based on Characters of the Perispore[1]

FERN WARD CRANE

In 1954, Dr. Edgar T. Wherry collected a number of *Dryopteris* plants to be used specifically for cytological and palynological studies. Among the rhizomes sent to Dr. Stanley Walker,[2] University of Liverpool, there were some *D.* × *Leedsii* from the type locality in Maryland.[3] It was surprising to learn from him

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[1]Presented at the Ninth International Botanical Congress, Montreal, August, 1959.

[2]Walker, S. Cytotaxonomic Studies of Some American Species of *Dryopteris*. This JOURNAL **49**: 104–112. 1959.

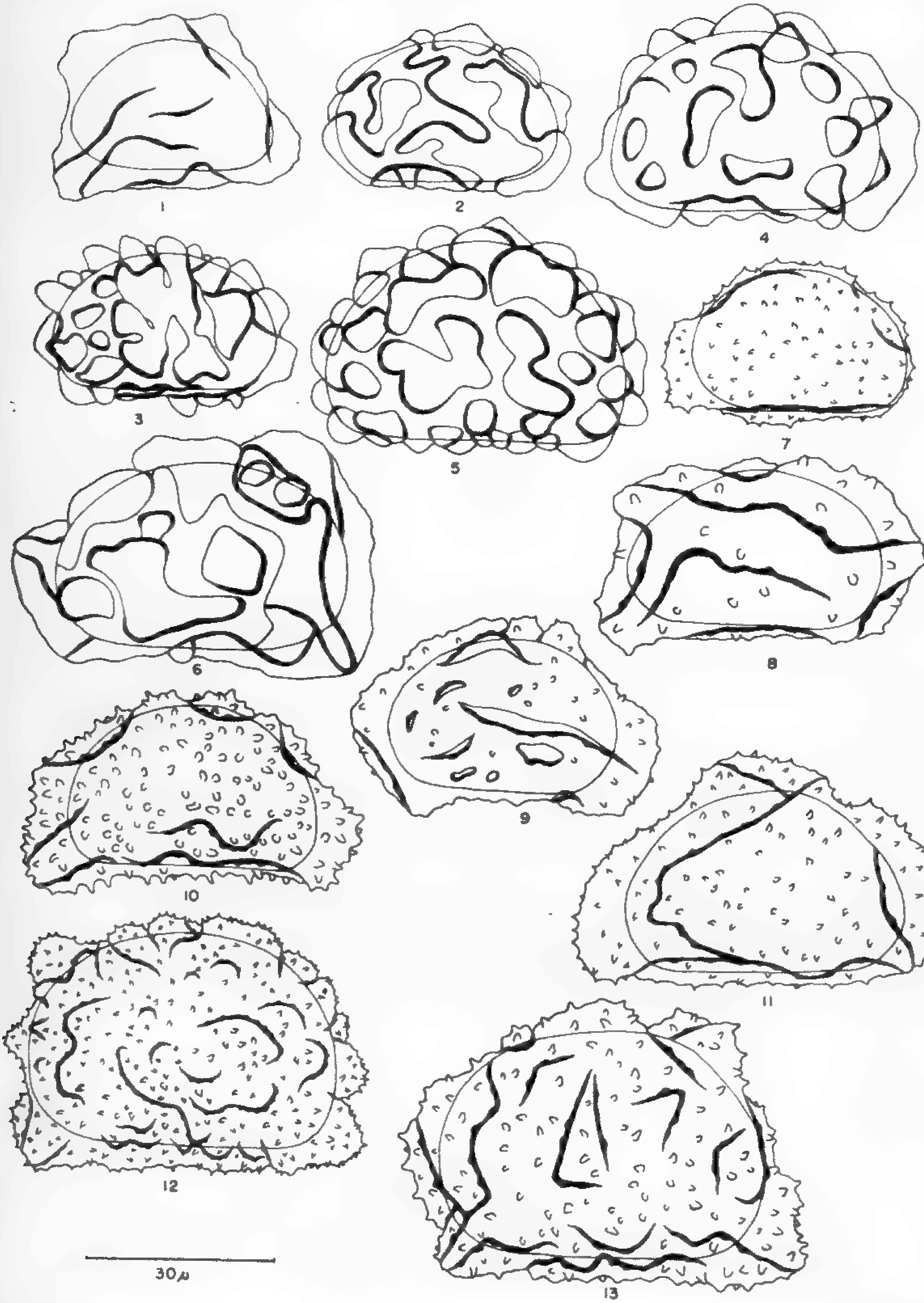
[3]Darling, Thomas Jr. Recent Field Notes. This JOURNAL **49**: 117–122. 1959.

that only half of these plants were diploid hybrids, the remainder being fertile tetraploids, but an examination of the spores confirmed this report. In another set of these ferns, collected in 1956, it was a simple matter to predict the results of chromosome counts when palynological evidence was considered. This tetraploid *Dryopteris* is the new species described below:

DRYOPTERIS **Wherryi** F. W. Crane, sp. nov.

Folia ca. 120–140 cm. longa, stipitibus ca. 30–40 cm. longis, 4–6 mm. diam., viridi-stramineis, basi compluribus paleis brunneis translucide late marginatis dense obtectis, eis sursum paucioribus et minoribus; laminae late lineari-lanceolatae, 90–100 cm. longae, 25–30 cm. latae, apice attenuatae, basin versus vix angustatae, pinnato-pinnatifidae, rhache colore stipitis, paleis capilliformibus ornata; pinnae 16–20-jugae, inferiores longe petiolatae, superiores subsessiles, alternatae, inferiores vix reductae, ca. 12–18 cm. longae, 3–5 cm. latae, longe lanceolatae, paulo distantes vel leviter sese tangentes, pinnatifidae, apice longe serrato-acutae, basales et apicales pinnatifido-serratae; pinnulae 2–3 cm. longae, 5–10 mm. latae, lineari-lanceolatae vel anguste triangulares, costam versus ampliatae, alas ± distincte formantes, oppositae vel suboppositae, regulariter serratae, dentibus acutis vel subacutis, in spinulos sensim replicatos coarctatis, supra olivaceo-virides, subtus griseo-virides; costa albido-virescens, ± late alata, paleis filiformibus translucentibus hic inde obtecta, supra canaliculata; sori usque ad 8-jugi, evidenter inframediales, indusio lato glabrato obtecti; sporae magnae, nigrescenti-brunneae, $28\mu \times 46\mu$, perisporio excluso; perisporium glabrum, saepius alis latis instructum, hinc inde alis angustioribus interspersis, ± continuis et qua de causa sculpturam formantibus. A Stanley Walker Universitatis Liverpoolensis mihi relatum filicem tetrapolideam esse, chromosomatibus normaliter conjungentibus. Orta, ut videtur, reduplicatione chromosomatium hybridae diploideae *Dryopteridis* × *Leedsii*. Detecta a Edgar T. Wherry, cui dedicata.

Leaf 120–140 cm. long; stipe 30–40 cm. long, 4–6 mm. wide, greenish-straw color, the base densely covered with brown scales with wide translucent margins, upwardly the scales smaller and rather fewer; blade broadly linear-lanceolate, 90–100 cm. long, 25–30 cm. wide, attenuate at apex, scarcely narrowed toward base, pinnate-pinnatifid, bearing hair-like scales; pinnae 16–20 pairs, the lower elongate-petiolate, the upper nearly sessile, alternate, the lower scarcely reduced, 12–18 cm. long, 3–5 cm.




SPORES OF DRYOPTERIS SPECIES, FIGURE NUMBERS CORRESPONDING TO SPECIES NUMBERS IN KEY; FIGS. 6, 9 PREVIOUSLY UNPUBLISHED wide, elongate-lanceolate, slightly spaced, pinnatifid, the tip long acute-toothed, the basal and terminal pinnatifid-serrate; pinnules 2–3 cm. long, 5–10 mm. wide, linear-lanceolate or narrowly triangular, enlarged toward costa, wing ± distinctly developed, opposite or subopposite, uniformly serrate, the teeth acute or subacute, the spinules distinctly folded back, olive-green above, beneath gray-green; costa whitish-green, ± broadly winged, covered with translucent filiform scales, grooved above; sori up to 8 pairs, manifestly inframedial, the indusium broad, glabrous; spores large, dark brown, $28\mu \times 46\mu$, excluding the perispore; perispore glabrous, usually furnished with wide wings interspersed with narrow wings, ± continuous so as to appear sculptured.

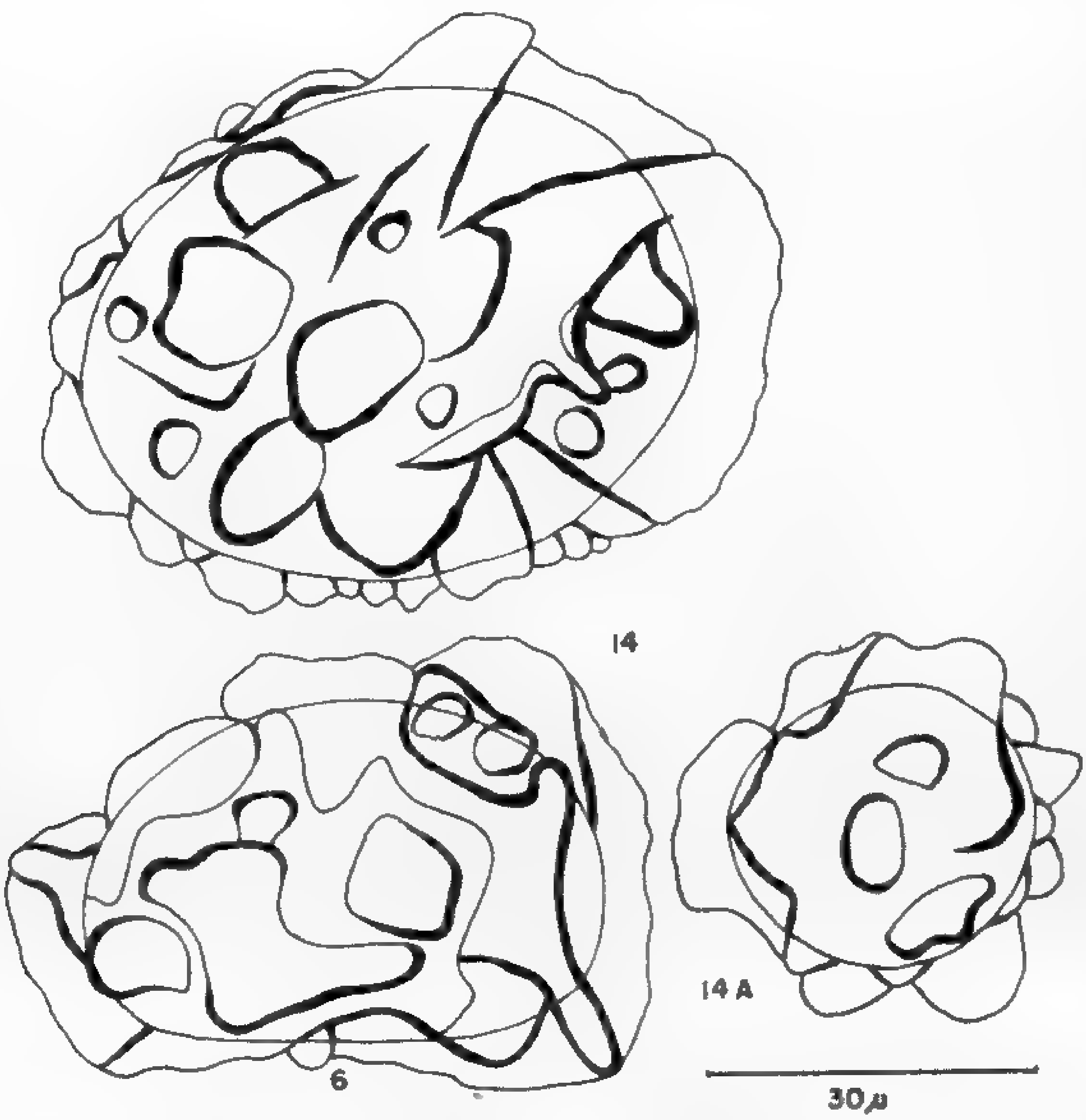



FIG. 6, DRYOPTERIS WHERRYI. FIGS. 14, 1a. DRYOPTERIS × LEEDSII; TYPICAL HYBRID SPORES, USUALLY A FEW LARGE AND MISSHAPEN, THE MAJORITY SMALL AND ABORTED

HOLOTYPUS in the United States National Herbarium, nos. 2,258,784 and 2,258,785, collected by Edgar T. Wherry, August 15, 1956, 3 miles below Conowingo Dam, Harford County, Maryland. (Herbarium F. W. Crane, no. 5615). Isotypus: Herbarium of the University of Pennsylvania.

This fern may be distinguished from *D.* ×*Leedsii* by the scales extending in abundance only to the mid-stipe, the lower segments of sterile pinnae little-spaced and the gap-width less than half the segment-width, the sori tending to lie nearer the midrib than the margin, and the spores being normal. Dr. Stanley Walker, University of Liverpool, reported to the author that the fern is tetraploid, the chromosomes pairing normally, and that apparently it has arisen through doubling of the chromosomes of the hybrid diploid, *Dryopteris* × *Leedsii* Wherry. It was discovered by Dr. Edgar T. Wherry, to whom it is dedicated.

*Dryopteris Wherryi* was illustrated by Dr. S. Walker recently as *Dryopteris "Leedsii"* (tetraploid); it is the left hand figure of *Plate 11* of his article,[4] which by a printer's error is marked "Fig. 10 (left): *Dryopteris celsa*" but which is actually fig. 8, *D. "Leedsii"* (tetraploid), the right hand frond being the true *D. Leedsii* (diploid). The correction is made in the Errata.[5]

The author wishes to thank Dr. E. T. Wherry and Dr. S. Walker for their cooperation, and Dr. H. P. Fuchs for the Latin version of the description.

KEY

A. Spinules absent.
  I. Spores small, 22–24$\mu$ x 32–37$\mu$.
    Wings simple, wide ........ 1. *Goldiana*
    Wings narrow, more or less continuous so as to produce a sculptured appearance.
      Wings few, continuous ........ 2. *marginalis*
      Wings many, smaller, less continuous ........ 3. *arguta*
  II. Spores large, 26–34$\mu$ x 41–50$\mu$.
    Wings small, rounded.
      Wings few, some wide ones interspersed ........ 4. *Filix-mas*
      Wings numerous, the appearance tuberculate ........ 5. *fragrans*
    Wings mostly wide, though with some smaller ones, continuous as in *marginalis* ........ 6. *Wherryi*
B. Spinules present.
  I. Spores small, 24–24$\mu$ x 36–41$\mu$.

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[4]Walker, S. Cytotaxonomic Studies of Some American Species of Dryopteris. This JOURNAL **49**: 104–112. 1959.

[5]This Journal, **49**: 160. 1959.

Wings few, simple.

Wings narrow, set with small sharp-tipped spinules ....7. *intermedia*

Wings wide, with a few large blunt-tipped spinules .... ..... 8. *celsa*

Wings more numerous, wide, simple; smaller wings also present; spinules blunt-tipped ..... 9. *ludoviciana*

II. Spores medium to large.

Size medium, 26–28$\mu$ x 42–45$\mu$.

Wings fairly wide; spinules mostly large, decidedly blunt-tipped ..... 10. *spinulosa*

Wings wider; spinules mostly small, sharp-tipped .... 11. "*dilatata*"[6]

Size large, 31–33$\mu$ x 48–52$\mu$.

Wings numerous, small, rounded; spinules many, sharp-tipped ..... 12. *cristata*

Wings fewer, wide, characteristically angular; spinules widely spaced, blunt-tipped ..... 13. *Clintoniana*

174 Summit Avenue, Summit, New Jersey.

[6]Proper name for eastern North American plant uncertain.

## Taxonomic Notes on Ferns, I

C. V. MORTON

ATHYRIUM **Lilloi** (Hicken) Morton, *comb. nov.*

*Nephrodium Lilloi* Hicken, Anal. Soc. Cient, Argent. **63**: 8. *tab.* [2]. 1907. Type: La Casita, Valle del Rio Canasorcona, Province of Tucumán, Argentina, 1700 meters altitude, Jan. 26, 1903, *M. Lillo* 2932.

*Drypopteris Lilloi* Hicken, Apuntes Hist. Nat. Buenos Aires **1**: 151. 1909.

This species has never been placed. In Christensen's "A Monograph of the Genus Dryopteris"[1] it is listed as dubious, said to be probably a valid species allied to *Dryopteris connexa*, following Hicken's original comparison. Hicken himself mentioned in his comments that the indusium appeared to be lateral, recalling that of *Asplenium* or *Athyrium*.

Material from Tucuman in the U. S. National Herbarium which agrees entirely with the original description and with the illustration (both the drawing and the photograph of the type) shows that this species really is an *Athyrium*, and not a *Nephro-*

[1]Part **2**: 125. 1920.

*dium* (or *Dryopteris*). The indusium is elongate and sometimes bent, where it runs past a forking of the vein on which it is borne, as is general in *Athyrium.* It is extremely broad and thin, and completely covers the sporangia when young: The sori are then "allantodioid" (sausage-shaped). The species thus belongs to Sect. *Allantodia,* and is allied to *Athyrium umbrosum* (Aiton) Presl, of Madeira, and *Athyrium australe* (R. Brown) Presl, of Australia. The latter is the type of the genus *Allantodia* R. Brown, which was characterized largely on the shape of the indusia. The section forms a link between *Athyrium* and *Diplazium,* and its affinities need to be investigated thoroughly. The peculiar distribution (Atlantic Islands, Australia, and southern South America) suggests an ancient origin; it is not exactly paralleled among ferns, although the distributions of the genera *Pleurosorus* and *Culcita* are somewhat similar.

## Cytological Observations on the Himalayan Species of Athyrium and Comments on the Evolutionary Status of the Genus*

P. N. MEHRA AND S. S. BIR

*Athyrium* Roth is one of the most widely distributed ferns in the Himalaya Mountains, where about 30 species occur,[1] out of a total of 180 species in the genus.[2] This number is bound to increase as the taxonomy of these ferns is better understood. Conspicuous disagreement among various authorities exists regarding the systematic position of *Athyrium,* as a survey of the various systems of classification proposed since the beginning of the present century reveals.[3] Recently, Copeland and Holttum have followed Milde[4] in uniting *Diplazium* Swartz with *Athyrium,* which has in fact added to the existing confusion, for *Athyrium* so construed (and also including *Deparia, Cornopteris,* and other segregates) is then a genus of about 600 species.

*Invited paper for the Fiftieth Anniversary Volume of the Journal. [Ed.]
[1]Clarke, 1880; Beddome, 1892; Hope, 1899–1904.
[2]Ching, 1940.
[3]Christensen, 1906, 1938; Bower, 1928; Ching, 1940; Dickason, 1946; Holttum, 1949; Copeland, 1947; Alston, 1956.
[4]Bot. Zeit. **1866:** 373.

In the present paper the genus is treated in the traditional sense as proposed by Roth[5] and followed by Diels, Christensen, Ching, Dickason, and others.

Some species of *Athyrium* are difficult to separate morphologically from those of *Diplazium*, as for instance *A. thelypterioides* (Michx.) Desv. and *D. japonicum* (Thunb.) Beddome; the role of cytology is significant here. Cytological information is available regarding 22 clear-cut species, of which eleven are from the Himalayas,[6] five from Ceylon,[7] three from Europe,[8] two from North America,[9] and one from South India.[10] Chromosome counts show that all are based on $x = 40$. Thus on cytological grounds *Athyrium* differs consistently from *Diplazium,* which has 41 as a base number;[11] this fully justifies the retention of *Diplazium* as a genus distinct from *Athyrium.*

The present paper deals with cytological observations on 16 previously unstudied species of *Athyrium,* and with the evolutionary status of the genus.

## MATERIALS AND METHODS

Fourteen species have been studied from the Eastern Himalayas, all from Sikkim State except *A. macrocarpum* (Blume) Beddome (from Darjeeling, 6,000 feet elevation[12]); the other two species are from the Western Himalayas. Material of *Athyrium pectinatum* (Wall.) Presl from both regions has been studied. The species show an altitudinal range from 3,000 to 14,000 feet. Two more species, *A. Schimperi* and *A. thelypterioides* that have already been studied from material from Darjeeling and Mussoorie respectively (Mehra and Verma, 1957) have been reinvestigated from cytogeographical considerations.

The material of four species came from the Western Himalayas. Two of these, *A. thelypterioides* and *A. dentigerum*

[5]Roem. Mag. 2[1]: 105. 1799.
[6]Mehra and Verma, 1957; Bir, 1959.
[7]Manton, 1953; Manton and Sledge, 1954.
[8]Manton, 1950.
[9]Britton, 1953; Wagner, 1955.
[10]Mahabale et al., 1953.
[11]Manton, 1954; Manton and Sledge, 1954; Brownlie, 1958; Bir, 1959.
[12]Observations by Mr. S. C. Verma.


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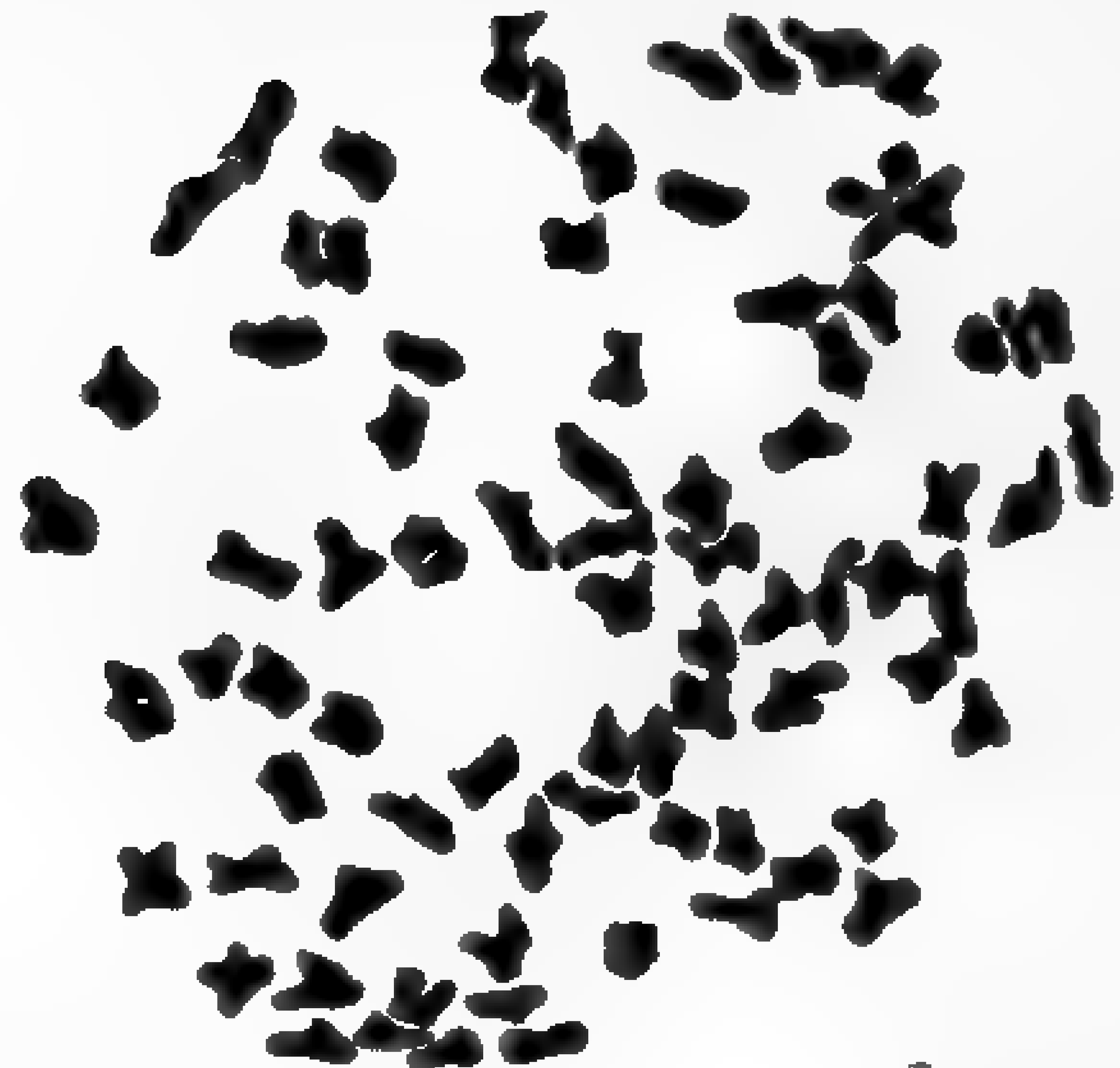
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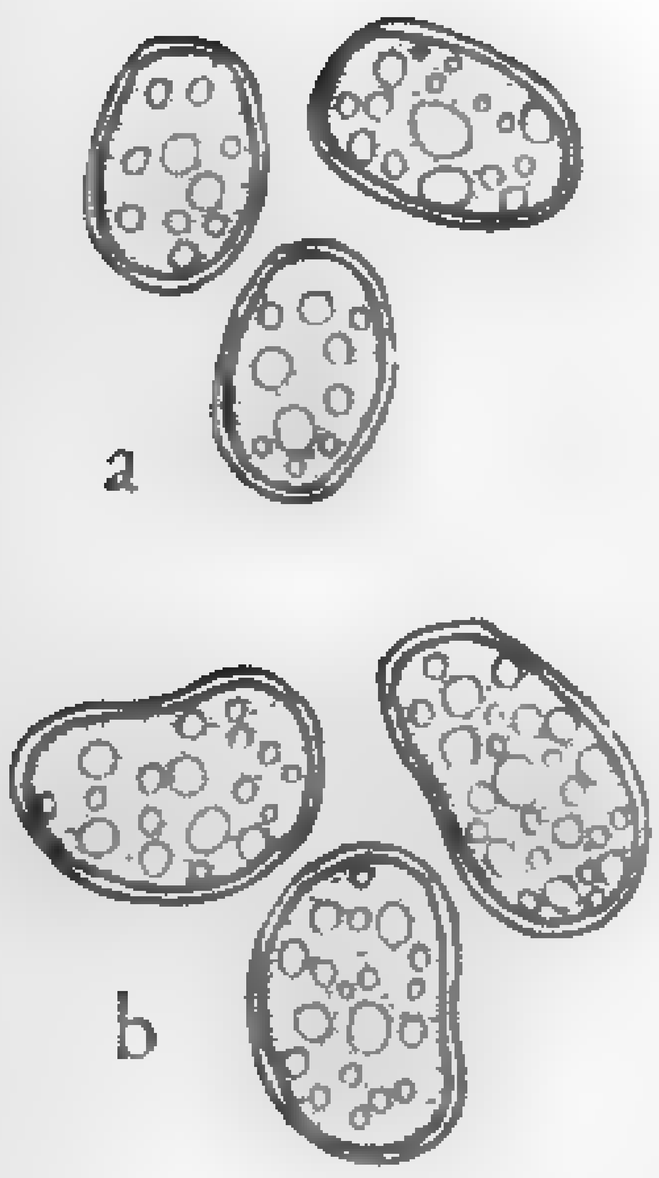
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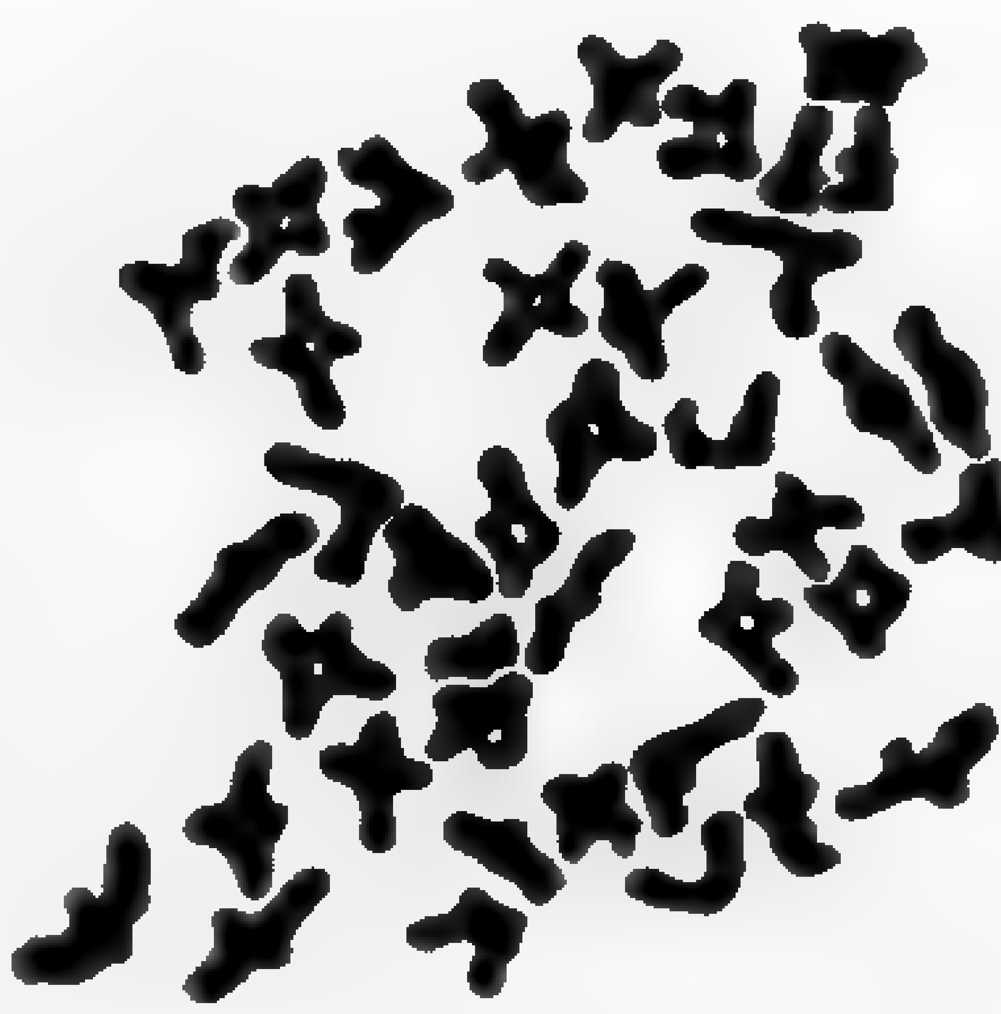
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FIG. 1, ATHYRIUM ATTENUATUM, DIPL., $n = 40$, $\times$ 500. FIG. 2, IBID., TETRAPL., $n = 80$, $\times$ 500. FIG. 3, IBID., SPORES $\times$ 150 (a, DIPL.; b, TETRAPL.). FIG. 7, DIAGRAM FROM FIG. 4. FIG. 8, DIAGRAM FROM FIG. 6. FIG. 9, SPORE MOTHER CELL, A. MEHRAE, 40 BIVALENTS, LATE DIAKINESIS, $\times$ 500. FIG. 10, A. SPINULOSUM, $n' = 80$, $\times$ 500

(Clarke) Mehra et Bir,[13] were collected near Dhanolti, along the Mussoorie-Tehri Road, at an altitude of 7,000 feet. *Athyrium thelypterioides* is a rather rare fern in this area and only a few plants were seen, growing in a clump; it is never so abundant here as in the Eastern Himalayas between 8,000 and 13,000 feet altitude. *Athyrium falcatum* Beddome is extremely rare at Nainital (7,000 feet). *Athyrium pectinatum* (Wall.) Presl is a comparatively low altitude fern; it is abundant near Mossy Falls (5,000 feet) and Sainji (3,000 feet) on the Mussoorie-Chakrata Road, where it forms extensive beds because of its creeping and branched rhizomes. Two individuals of another *Athyrium* were found near Magra (6,000 feet), on the way to Nag Tiba (Mussoorie) that are morphologically similar to *A. pectinatum;* they are suspected to be of hybrid origin, since they are cytologically abnormal, and are here designated *A.* × *pectinatum.*

The most beautiful of the Sikkim species is *A. Tsaii* Ching, which covers vast areas in the Lachen Valley at elevations between 10,000 and 12,000 feet, especially near Simdong (11,000 feet); the fronds and stipes are characteristically yellowish in colour. Another fern having almost the same distribution is *A. attenuatum* (Clarke) Tagawa. Two closely allied species with creeping rhizomes are abundant around Thangu (13,000 feet), namely *A. subtriangulare* (Hook.) Beddome, with a conspicuously yellowish lamina, and *A. spinulosum* (Maxim.) Milde, with chaffy and markedly pinkish stipes. Still higher up (14,000 feet), on the hill at the back of Thangu Dak Bungalow, *A. subtriangulare* var. *sikkimense* Bir grows occasionally under rhododendron trees in rather exposed situations. One of the rarest species is *A. Mehrae* Bir, which has very fragile fronds; only two plants were seen growing under the forest cover about two miles downwards from Thangu, at about 12,000 feet elevation, but a thorough search of the area may possibly

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[13] ATHYRIUM **dentigerum** (C. B. Clarke) Mehra et Bir, *comb. nov.* *Asplenium filix-foemina* var. *dentigera* C. B. Clarke, Trans. Linn. Soc. London, II, Bot. 1: 491. 1880.

reveal more individuals. The other species—*A. rupicola* (Hope) C. Chr., *A. parasnathense* (Clarke) Ching, *A. himalaicum* Ching, *A. Birii* Ching, *A. rubricaule* (Edgw.) Bir, *A. polysporum* (Clarke) Ching, and *A.* aff. *flabellulatum* (Clarke) Tardieu—grow at comparatively low elevations around Lachen, 8,000–9,000 feet altitude. In eastern Sikkim, *A. rupicola* attains much higher elevations, and some specimens were collected at Changu (about 13,800 feet). *Athyrium Schimperi* and *A. pectinatum* grow at still lower elevations than the other species from Sikkim reported here; they are common along the road between Chungthang and Lachen at about 6,000 feet. Full descriptions have been published only for *A. spinulosum, A. Schimperi, A. pectinatum, A. falcatum* and *A. macrocarpum*,[14] *A. attenuatum*,[15] *A. subtriangulare*,[16] and *A. rupicola*.[17] The taxonomic observations and complete descriptions of the others, which are either new species or varieties or new combinations, will be published separately.

The material was collected in July and August, 1958 and 1959, and fixed in 1:3 acetic alcohol and modified Carnoy's Fluid (1 part glacial acetic acid, 3 parts absolute alcohol, and 4 parts chloroform). Chromosome counts have been made from the spore mother cells entirely by the squash technique; the counts have been confirmed from a large number of cells in each case. All the photomicrographs are from permanent acetocarmine preparations. Voucher specimens are preserved in the Panjab University Herbarium.

## OBSERVATIONS

The course of meiosis in all cases is perfectly normal, except as mentioned below in *A. thelypterioides* and *A.* × *pectinatum*. All the species are sexual, since 64 normal and apparently viable spores were counted within a sporangium in each case except as noted below in *A. thelypterioides*, and apogamy has not been observed in any of them. Both perisporiate and

[14]Beddome, 1892.
[15]Tagawa, 1956, p. 177.
[16]Hooker and Baker, 1874, p. 225.
[17]Hope, 1899, pp. 531, 532.

non-perisporiate spores (cf. *Figs. 3* and *17d*) are present. The spores are broadly perisporiate in eight species, namely, *A. subtriangulare* (and var. *sikkimense*), *A. spinulosum, A. Mehrae, A. polysporum, A. dentigerum, A. falcatum, A. pectinatum,* and *A. macrocarpum.* The spores of *A. subtriangulare* ($n = 80$) are small; those of the rest are of the same general size. The spores of *A. attenuatum, A. Tsaii, A. parasnathense, A. rupicola, A. rubricaule, A. Birii,* and *A. himalaicum* are devoid of any clear-cut perisporium. The spores of *A. rubricaule* ($n = 40$) are the largest in this group.

The cytological results are summarized in Table I.[18] It is clear that 15 of these species are diploids, the haploid chromosome number being 40, and that three are tetraploids ($n = 80$). In the *Athyrium* species worked out here, polyploidy has been noted only up to the tetraploid level.

A previous report of the chromosome number of *A. thelypterioides* was by Mehra and Verma[19] who reported both diploid ($n = 40$) and tetraploid ($n = 80$) races. The authors have since studied several populations from the Lachen Valley, 8,000–12,000 feet, in northern Sikkim, also, and noted only the diploid race. Further scrutiny has shown that the tetraploid individuals differ from the true *A. thelypterioides* in the following characters and probably represent a different species:

(1) The individuals are smaller.

(2) The rhizome scales are smaller, and linear in outline, as compared with the larger, linear-lanceolate, broad-based scales of *A. thelypterioides.*

(3) The complete absence of uniseriate fibrillar hairs on the primary and secondary rachises, which is an important charac-

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[18]The names of the species marked * and ** are entirely on the authority of Prof. R. C. Ching.

[19]Mehra and Verma, 1957. The name here used, *Athyrium acrostichoides* (Swartz) Diels (1899), is illegitimate, being a later homonym of *Athyrium acrostichoideum* Bory ex Mérat (1836). The Greek form "*acrostichoides*" and the Latinized form "*acrostichoideum*" are orthographic variants and consequently homonyms; they are exactly comparable to "*pteroides*" and "*pteroideus,*" cited as examples of orthographic variants in the International Code of Botanical Nomenclature (Paris Edition, Art. 75, 1956).

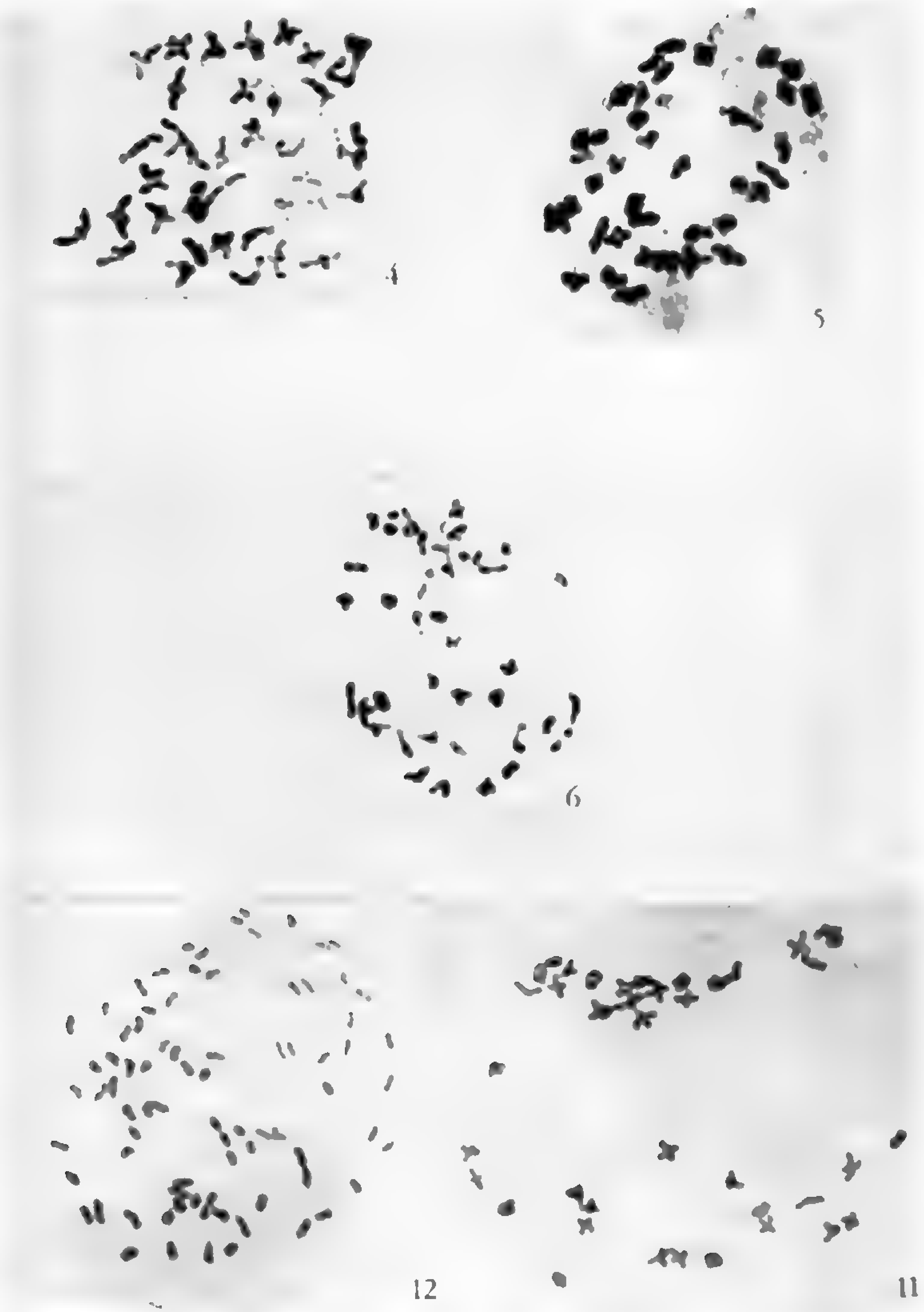



FIG. 4. A. DENTIGERUM. SPORE MOTHER CELL, 40 BIVALENTS. × 600. 5. A. SUBTRIANGULARE VAR. SIKKIMENSE, $n = 40$. × 600. 6. A. FALCATUM, $n = 50$. × 600. 11. A. TSAII. SPORE MOTHER CELL, 40 BIVALENTS. × 470. 12. A. THELYPTERIOIDES. SPORE MOTHER CELL, 80 UNIVALENTS. × 470.

ter of the species.

(4) The stipes and rachises are straw-coloured and almost naked, a few scales being present at the base only, in strong contrast to the dull-brown stipes, covered with hairs and scales, of *A. thelypterioides*.

(5) The lower pinnae are never reduced to mere auricles as in *A. thelypterioides*.

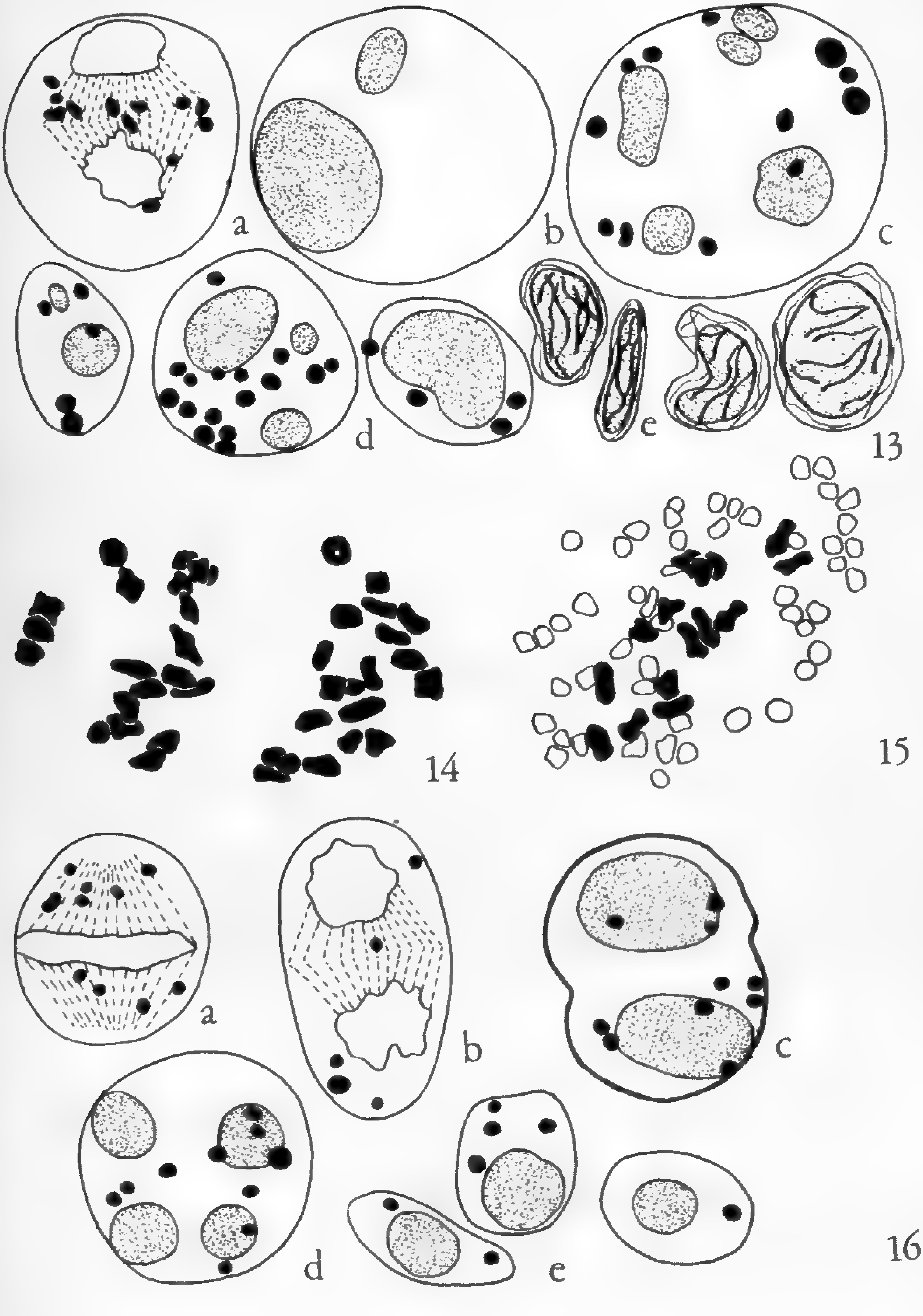
(6) The sori are typically "athyrioid" and not "diplazioid," as in *A. thelypterioides*.

(7) The spores are non-perisporiate rather than broadly perisporiate as in *A. thelypterioides*.

Therefore, in the authors' opinion the tetraploid individuals represent a different species; they are probably very near *A. MacDonellii* Beddome.

The diploid *A. thelypterioides* is morphologically variable. The individuals collected from Tonglu (8,500 feet) and near Thangu (12,000 feet) in the Eastern Himalayas differ from each other in the size of the pinnae and segments, the extent of the marginal crenations, the texture of the blade, and the amount of hairs and scales.

In the Mussoorie area the species is extremely rare and no sexual race has been found. All the individuals of *A. thelypterioides* growing near Dhanolti, 7,000 feet, Mussoorie, are cytologically abnormal. There are no signs of chromosome pairing in any of the spore mother cells, and at late diakinesis 80 univalents were clearly seen (*Fig. 12*). The chromosomes are longish and mitotic in appearance, and show median or submedian constrictions; soon, however, they become contracted and ovoid. The further course of meiosis is highly abnormal. The metaphase plate is seldom properly organized, and the univalents lie scattered in the cell. At A-I, the univalents divide longitudinally and the daughter chromatids reach either of the poles or may be left undivided and remain as laggards which are ultimately organized into micronuclei (*Fig. 13a*). The two nuclei resulting from the first meiotic division may be irregularly shaped and sometimes highly disproportionate,


a
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16

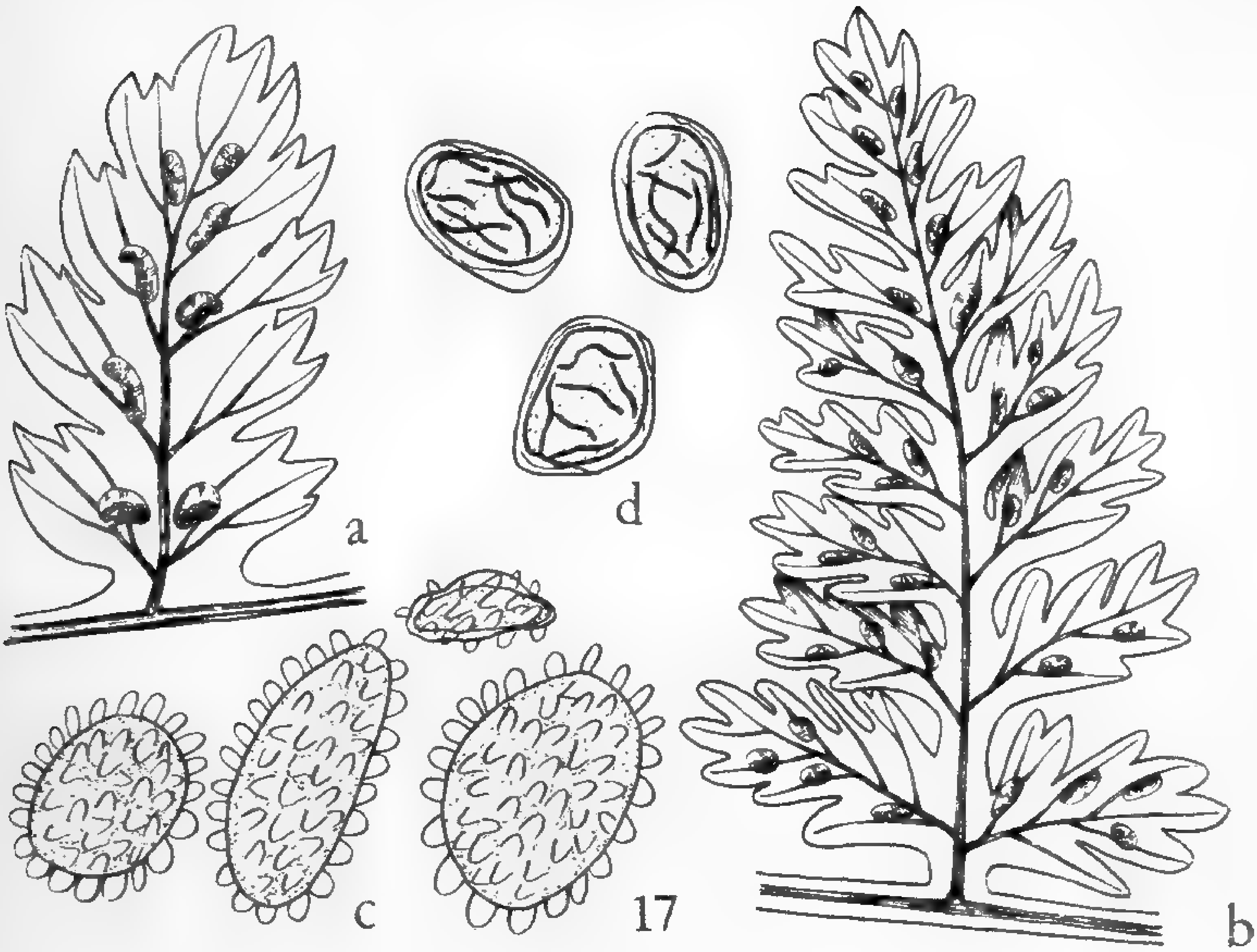
as a consequence of the unequal distribution of the chromatin material (*Fig. 13b*). The homoeotypic division is also irregular. All those univalents that divided in the first division being unable to divide for the second time are left as laggards; at the "tetrad" stage numerous micronuclei are present (*Fig. 13c*). The cytokinesis may be complete or incomplete. The young spores are of variable shapes and sizes and possess micronuclei (*Fig. 13d*). Obviously as a result of these irregularities, the mature spores are unequal in size, some even shrivelled up and abortive (*Fig. 13e*).

Although the Dhanolti (Mussoorie) specimens just mentioned that show abnormal meiosis differ markedly from those of Sikkim (diploid, $n = 40$) in the more elongate, deeply crenate, falcate segments, with a much broader sinus between them, they fall within the range of variation noticed in the species in various regions of the Himalayas. The differences mentioned are probably of little taxonomic importance, and the "sterile" specimens from Dhanolti can hardly be segregated as a variety or form. The almost complete similarity between the sexual and the "sterile" individuals of *A. thelypterioides* leads us to believe that the cytological abnormalities in the Mussoorie populations are not due to hybridity but are of genic origin.

The individuals of the fern designated as *A.* × *pectinatum* in Table I possess characteristically pinkish stipes when fresh. They differ from specimens of *A. pectinatum* from Sikkim, Nainital, and Mussoorie consistently in only two characters: Lamina only bipinnate, with lower pinnae more reduced (tripinnate in *A. pectinatum*) (*Figs. 17a, b*),[20] and spores tuber-

[20]It may be pointed out that these individuals exactly resemble the figure given by Beddome (1863, *t. 154*), for *A. Filix-foemina* from southern India, which later on (Beddome, 1892) was regarded as a small form of *A. Filix-foemina* var. *pectinatum.*

13, A. THELYPTERIOIDES, MEIOSIS; a, ANAPHASE I; b, TELOPHASE I, UNEQUAL NUCLEI; c, "TETRAD," MANY MICRONUCLEI; d, YOUNG SPORES, VARIABLE SIZE, WITH MICRONUCLEI; e, MATURE SPORES; a-d, × 535, e × 225. 15, A. PECTINATUM, $n = 40$, × 800. 15, A. × PECTINATUM, $2n = 80$, I.E. 15 (II) AND 50 (I), × 800. 16, IBID., MEIOSIS; a, METAPHASE I; b, ANAPHASE I; c, BINUCLEATE SPORE, MANY MICRONUCLEI; d, TETRAD, MICRONUCLEI; e, YOUNG SPORES, MICRONUCLEI; ALL × 540



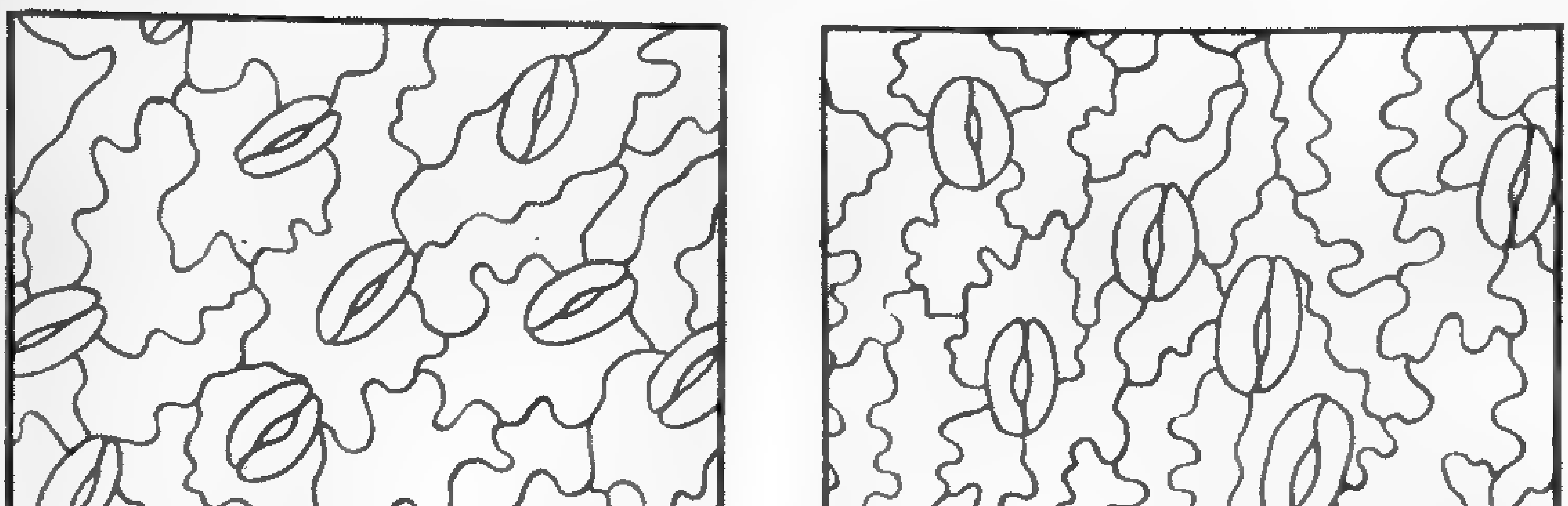




FIG. 17. a, b, PINNULES OF A. × PECTINATUM AND A. PECTINATUM, × 3. c, d, SPORES OF A. × PECTINATUM AND A. PECTINATUM RESPECTIVELY, × 220. 18. A. ATTENUATUM, LOWER EPIDERMIS WITH STOMATA, a, DIPLOID, b, TETRAPLOID, ×85

culate-thickened on the surface (smooth perisporium in *A. pectinatum*) (*Figs. 17c, d*). In this fern the course of meiosis is highly irregular. In the majority of the cells only a partial pairing of the chromosomes is noticed at diakinesis. One such cell is reproduced in *Fig. 15*, which shows $15_{II} + 50_{I}$, giving $2n = 80$. M-I and A-I are also abnormal and laggards are common (*Figs. 16a, b*). Very rarely, the second division fails and a binucleate spore results (*Fig. 16c*). The four nuclei at the tetrad stage are often unequal and numerous micronuclei are organized (*Fig. 16d*). The cytokinesis is irregular, resulting in spores of unequal size with micronuclei (*Fig. 16e*); these are abortive. Unlike other species of *Athyrium* from the Himalayas, these show tuberculate thickenings on the surface (*Fig. 17c*), in which character they resemble those of *Diplazium japonicum* (Thunb.) Beddome, although morphologicially there is no similarity whatsoever between *D. japonicum* and *A.* × *pectinatum*. Therefore at present nothing can be inferred regarding the other parent of this hybrid.

Only one species, *A. attenuatum*, shows intraspecific polyploidy. Diploid and tetraploid individuals grow side by side, but although the smallest individuals of the diploid race are shorter than the smallest tetraploids, morphologically the two races are similar in leaf outline; there are hardly any quantitative differences that could be detected, either in the size of the pinnae or their segmentation. The spores do show differences in size and in the quantity of stored food material, the diploids being smaller and less filled with food material than the tetraploids (*Figs. 3a, b*). There is a little difference in stomatal sizes, the stomata of the tetraploids being slightly bigger. The number of stomata per unit area in the tetraploid is lesser than in the diploid (*Fig. 18a, b*). The epidermal cells of the tetraploid are somewhat larger.

Another species that draws one's attention is *A. subtriangulare*. The typical variety ($n = 80$), with fronds 50–70 cm. long and 20–40 cm. wide, grows at lower elevations than var. *sikkimense*, which is diploid ($n = 40$), with fronds only up to

25 cm. long and 12 cm. wide. Curiously enough the variety, although only diploid, has spores somewhat larger than the typical variety, which may very well speak for its separate identity.

The phenomenon of apogamy, aside from the classical examples, *A. Filix-foemina* var. 'Clarissima Jones,' var. 'Clarissima Bolton,' and var. 'Uncoglomeratum' Stansfield,[21] has not been noticed in any of the 38 species worked out so far, which disproves Mahabale's observation that most species of *Athyrium* are apogamous. Both the examples of apogamous Athyriums worked out by Manton (1953) from Ceylon, *A. maximum* and *A. pinnatum,* are Diplaziums as that genus is now understood with the present day availability of chromosomal information. The names of these ferns are *Diplazium maximum* (Don) C. Chr. and *D. silvaticum* (Bory) Swartz respectively.

## DISCUSSION

A regional analysis of all the species thus far worked out is presented in Table II.[22] For the purpose of calculations, species with two cytological races have been counted on the higher side of ploidy. This Table shows that three sexual species have been found with different cytological races—*A. attenuatum* (2x and 4x, from the Himalayas), *A. gymnogrammoides* (4x and 6x, from Ceylon), and *A. macrocarpum* (2x from the Himalayas, 4x and 6x in Ceylon). No major morphological differences are evident in *A. attenuatum,* but the 4x and 6x individuals of *A. gymnogrammoides* are markedly different from each other, as has been illustrated by Manton and Sledge;[23] nothing can be said about *A. macrocarpum* until a thorough comparison of Himalayan and Ceylonese specimens is made.

[21]Farmer and Digby, 1907.

[22]The information included in this table and the subsequent ones is based on Manton, 1950, 1953, 1954; Britton, 1953; Manton and Sledge, 1954; Wagner, 1955; Mehra and Verma, 1957; Brownlie, 1958; Bir, 1959; and the present investigation.

[23]Manton and Sledge, 1954. It may be mentioned that the taxonomic status of *A. gymnogrammoides,* which belongs to a group of species allied to *A. solenopteris,* is confused, and it can not be said whether the 4x and 6x individuals fall within the boundaries of the species or not.

TABLE I.

| Name | Locality and altitude | *n* chromosome number | Fig. no. | Ploidy |
|---|---|---|---|---|
| *Athyrium attenuatum* (Clarke) Tagawa | Simdong, N. Sikkim, 11,000′ | 40 | 1 | Diploid |
| *Athyrium attenuatum* (Clarke) Tagawa | Simdong, N. Sikkim, 11,000′ | 80 | 2 | Tetraploid |
| **A. Birii* Ching (mss.) | Near Lachen, N. Sikkim, 8,000′ | 40 | | Diploid |
| *A. dentigerum* (Clarke) Mehra et Bir | Dhanolti, Mussoorie, 7,000′ | 40 | 4, 7 | Diploid |
| *A. falcatum* Beddome | Nainital, 6,000′ | 40 | 6, 8 | Diploid |
| *A.* aff. *flabellulatum* (Clarke) Tard. | Lachen, N. Sikkim, 8,500′ | 40 | | Diploid |
| **A. himalaicum* Ching (mss.) | Lachen, N. Sikkim, 8,500′ | 40 | | Diploid |
| *A. macrocarpum* (Blume) Beddome | Darjeeling, 7,000′ | 40 | | Diploid |
| *A. Mehrae* Bir | Near Thangu, N. Sikkim, 12,000′ | 40 | 9 | Diploid |
| ***A. parasnathense* (Clarke) Ching | Lachen, N. Sikkim, 8,500′ | 40 | | Diploid |
| *A. pectinatum* (Wall.) Presl | Sainji, Mussoorie, 3,000′ | 40 | 14 | Diploid |
| *A. pectinatum* (Wall.) Presl | Chungthang, N. Sikkim, 6,000′ | 40 | | Diploid |
| *A.* x *pectinatum* (Wall.) Presl | Magra, Mussoorie, 6,000′ | 15(II) + 50(I) | 15 | Diploid hybrid |
| ***A. polysporum* (Clarke) Ching | Lachen, N. Sikkim, 8,500′ | 80 | | Tetraploid |
| *A. rubricaule* (Edgw.) Bir | Lachen, N. Sikkim, 8,500′ | 40 | | Diploid |
| *A. rupicola* (Hope) C. Chr. | Near Lachen, N. Sikkim, 8,500′ | 40 | | Diploid |
| *A. Schimperi* Moug. | Near Chungthang, N. Sikkim, 6,000′ | 40 | | Diploid |
| *A. subtriangulare* (Hook.) Beddome | Thangu, N. Sikkim, 13,000′ | 80 | | Tetraploid |
| *A. subtriangulare* var. *sikkimense* Bir | Above Thangu, N. Sikkim, 14,000′ | 40 | 5 | Diploid |
| *A. spinulosum* (Maxim.) Milde | Thangu, N. Sikkim, 13,000′ | 80 | 10 | Tetraploid |
| **A. Tsaii* Ching (mss.) | Simdong, N. Sikkim, 11,000′ | 40 | 11 | Diploid |

* New species, discovered by S. S. Bir during the present investigation, as named by Prof. R. C. Ching.

** New combinations (Ching, ined.).

TABLE II. REGIONAL TABULATION OF DIPLOID, TETRAPLOID, AND HEXAPLOID ATHYRIUMS

| Himalayas | Ceylon | Europe | North America (Ontario and Michigan) |
|---|---|---|---|
| | **Diploid** | | |
| *thelypterioides* (syn. *acrostichoides*) | | *Filix-foemina* | *Filix-foemina* var. *Michauxii* |
| *Atkinsonii* var. *Andersonii* | | *alpestre* | *thelypterioides* |
| *attenuatum*, p.p. | | *flexile* | *pycnocarpon* |
| *Birii* | | | |
| *Boryanum* | | | |
| *dentigerum* | | | |
| *falcatum* | | | |
| *fimbriatum* | | | |
| *flabellulatum* | | | |
| aff. *flabellulatum* | | | |
| *foliolosum* | | | |
| *himalaicum* | | | |
| *macrocarpum* | | | |
| *Mehrae* | | | |
| *oxyphyllum* | | | |
| *parasnathense* | | | |
| *pectinatum* | | | |
| *proliferum* | | | |
| *rubricaule* | | | |
| *rupicola* | | | |
| *Schimperi* | | | |
| *setiferum* | | | |
| *Tsaii* | | | |
| *tenuifrons* (= *Clarkei*) | | | |
| *subtriangulare* var. *sikkimense* | | | |
| *sp.* (called *Leucostegia yaklaensis* Beddome) | | | |
| | **Tetraploid** | | |
| *attenuatum*, p.p. | *anisopterum* | | |
| *anisopterum* | *erythrorachis* | | |
| *polysporum* | *gymnogrammoides* | | |
| *spinulosum* | *macrocarpum*, p.p. | | |
| *subtriangulare* | | | |
| | **Hexaploid** | | |
| | *gymnogrammoides* | | |
| | *macrocarpum*, p.p. | | |

Only four instances where the same species occurs in different climates have been investigated. The temperate species *A. thelypterioides* (Himalayas and North America) and *A. Filix-foemina* (Europe and North America) show the same chromosome number, $n = 40$. *Athyrium anisopterum* has $n = 80$ in both the Himalayas and Ceylon, but *A. macrocarpum* shows a higher ploidy in Ceylon, being diploid ($n = 40$) in the Himalayas and tetraploid or hexaploid in Ceylon ($n = 80$ or ca. 120).

Table III, which gives a comparison of cytological data from various regions, shows that the three European and three North American species are all diploid, but that no Ceylon species are diploid, two being hexaploid, two tetraploid, and one a hybrid.

TABLE III. REGIONAL COMPARISON OF CYTOLOGICAL DATA

| Region | No. spec. counted | Dipl. | Tetrapl. | Highest polypl. | Hybr. | Percent of dipl. |
|---|---|---|---|---|---|---|
| Himalayas | 29[1] | 24 | 5 | 4x | — | 82.74 |
| Ceylon | 5 | — | 2 | Two 6x | 1 | 0 |
| Europe | 3 | 3 | — | — | — | 100 |
| No. Amer. | 3 | 3 | — | — | — | 100 |

[1] *A.* x *pectinatum*, from Mussoorie, not included.

In the Himalayas of the 29 species that have been studied, 24 are diploid (82.7%) and 5 are tetraploids. The highest grade of euploidy encountered in the Himalayas is only up to the tetraploid level (as compared with hexaploid in Ceylon), and the preponderance of diploids is significant. The Himalayas are similar to Europe and North America (Ontario and Michigan) in the temperate climate, whereas Ceylon has a tropical climate. Therefore, the above analysis of the situation in *Athyrium* appears to give support to Manton's (1953) observation that, "Evolution is proceeding faster in the tropics than in temperate latitudes."

Whether *Athyrium* has been placed in the subfamily Asplenioideae of the Polypodiaceae,[24] or in the tribe Athyrieae of the Aspleniaceae[25], or the subfamily Athyrioideae of the Dennstaed-

[24] Christensen, 1906, 1938.
[25] Ching, 1940; Dickason, 1946.

TABLE IV. COMPARISON OF CYTOLOGICAL DATA FOR ATHYRIUM WITH ALLIED GENERA

| Genus | No. of species | No. of species counted | Basic no. | Dipl. | Tetrapl. | Highest polypl. | Hybr. | Apogamy | Percent of dipl. |
|---|---|---|---|---|---|---|---|---|---|
| *Athyrium*[1] | 180 | 38 | 40 | 27 | 8 | Two 6x | 1 | — | 71 |
| *Diplazium*[2] | 380 | 27 | 41 | 11 | 8 | Two 6x | One 5x | Four 3x<br>One 5x | 40.74 |
| *Diplaziopsis*[3] | 2 | 1 | 41 | 1 | — | — | — | — | — |
| *Callipteris*[4] | 4 | 1 | 41 | 1 | — | — | — | — | — |
| *Cornopteris*[6] | 13 | 1 | 41 | — | 1 | — | — | — | — |
| *Cystopteris* | 17 | 10 | 42 | 2 | 4 | Two 6x<br>One 8x | One 3x | 1 | 22.25 |

[1]Data from Manton, 1950, 1953; Mahabale et al., 1953; Britton, 1953; Manton & Sledge, 1954; Wagner, 1955; Mehra & Verma, 1957; Bir, 1959, and present investigation.

[2]Manton, 1953, 1954; Manton & Sledge, 1954; Brownlie, 1958; Bir, 1959, and Bir ined.

[3]Bir, 1958.

[4]Manton, 1954 (under name *Athyrium accedens*).

[5]According to Copeland, 1947.

[6]Bir, ined.

[7]Manton, 1950; Britton, 1953; Wagner, 1955; Bir, ined.

tiaceae,[26] or in the family Aspidiaceae,[27] or recently in a separate family Athyriaceae,[28] it has usually been grouped with *Cystopteris* Bernh., *Diplaziopsis* C. Chr. *Diplazium* Swartz, *Cornopteris* Nakai, and *Deparia* Hook. & Grev. Kept separate by Ching, *Diplazium, Cornopteris,* and *Deparia,* were merged with *Athyrium* by Copeland, who on the other hand maintained Bory's genus *Callipteris,* which is not done by other authors. *Callipteris* was based on *C. prolifera* (Lam.) Bory, which is *Diplazium proliferum* (Lam.) Thouars [*Athyrium accedens* (Blume) Milde, of Holttum's treatment[29]]. The cytological data on these genera, which for the purposes of this discussion are treated separately, is presented in Table IV. The number of species referred to each genus follows Ching's estimate,[30] except for *Callipteris.*

The data in Table IV show that the basic chromosome numbers of these genera are 40, 41, or 42. The larger numbers may have evolved through aneuploidy. *Deparia,* a monotypic genus endemic to Hawaii, has not been studied yet. *Diplazium* seems to be actively evolving compared to *Athyrium,* because of the comparatively lower percentage of diploids, the greater number of hybrids and the consequent establishment of apogamy. The few hybrids recorded, the higher percentage of diploids, and the almost total absence of apogamy reveals that from an evolutionary viewpoint *Athyrium* is a static genus in this respect, and that evolution in it is principally by genic mutations.

## SUMMARY

Chromosome counts of 16 species of *Athyrium* from the Himalaya Mountains show that 13 species are diploid ($n = 40$), and 3 tetraploid ($n = 80$). All are sexual, apogamy being absent. Only one species, *A. attenuatum,* shows intraspecific polyploidy (diploid and tetraploid races). The counts of 29 species of the genus known from the Himalayas show that 82.74% are diploids and only 17.26% tetraploids, a significant abundance of diploids

[26]Holttum, 1949, 1954.
[27]Copeland, 1947.
[28]Alston, 1956.
[29]Holttum, 1954.
[30]Ching, 1940.

compared with data from Ceylon. From comparisons with allied genera, especially *Diplazium*, it is abundantly clear that *Athyrium* is a static genus as far as evolution by hybridization and polyploidy is concerned.

ACKNOWLEDGMENTS

The authors express their grateful thanks to Prof. R. C. Ching, of the Academia Sinica, Peking, for the identifications of many of the species. They are also thankful to Mr. R. S. Pathania for the photomicrographs and to Mr. B. Khanna for help with the drawings.

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BOTANY DEPARTMENT, PANJAB UNIVERSITY, AMRITSAR, INDIA.

## Notes and News

FERN PHOTOGRAPHS.—An article entitled "A Technique for Close-Up Photography of Freshly-Collected Fertile Fern Specimens," by Charles Neidorf, appeared in the August and September, 1960, numbers of Turtox News, published by the General Biological Supply House, Inc., Chicago, Illinois. Included as illustrations for the article are reproductions of two of the author's fern photographs. On a number of occasions[1] the American Fern Journal has published other examples of Mr. Neidorf's work. The photographs are notable for the amount of detail (some of it inevitably lost in the reproductions) revealed in the shape, arrangement and structure of the sori, indusia, sporangia, glands, scales, etc., details which are characteristic of the various species. Many of the photographs are quite striking in appearance and would be suitable for framing or would serve as useful adjuncts to herbarium specimens.

In addition to the article Turtox News includes a notice that sets of Mr. Neidorf's fern photographs are available for sale exclusively from Turtox Products. Initially, a set of 12 prints of familiar northeastern species is being offered. The prints are 8 inches by 10 inches in size, mounted on mats suitable for wall display or framing, priced at $36.00 per cet. It should be noted that while only twelve prints are being offered at this time Mr. Neidorf has photographed some 68 species of ferns and fern allies, as part of a project which is still in progress. Inquiries should be addressed to Mrs. Ruth L. Shepherd, editor of Turtox News, General Biological Supply House, Inc., 8200 South Hoyne Avenue, Chicago 20, Illinois.

[1]This JOURNAL, **37**: 74. 1947; **43**: 5, 59. 1953; **44**: 17, 67, 112. 1954; **45**: 18. 1955; **46**: 29. 1956.

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# Index to Volume 50

## ERRATA

Page 4, footnote, line 4: For "supposted," read "supported."
Page 6, bottom line: Transfer to become bottom line of p. 7.
Page 11, lines 20 and 22: For "compliment," read "complement."
Page 11, line 30: For "anomolous," read "anomalous."
Page 48, line 26: For "1 feet," read "7 feet."
Page 106, line 20: For "or," read "of."
Page 66, line 25: For "*Tidestr.*," read "Tidestr."
Page 69, on map: Change "One inch = 12 miles," to "One inch = 16 miles."
Page 69: Transfer legend under map to become legend under Plate 8, p. 74.
Page 74: Transfer legend under Plate 8 to become legend under map, p. 69.
Page 78, in title of paper by Alma G. Stokey: Add **"Fern Gametophyte."**
Page 82, line 5 of legend: For "JUBIFORME," read "JUBIFORMIS."
Page 112, line 19: For **"cordatum,"** read **"cordata."**
Page 114, line 7: For "funtioning," read "functioning."
Page 136, line 23: For "*distant*," read "*distans*."
Page 144: Interchange lines 1 and 2.

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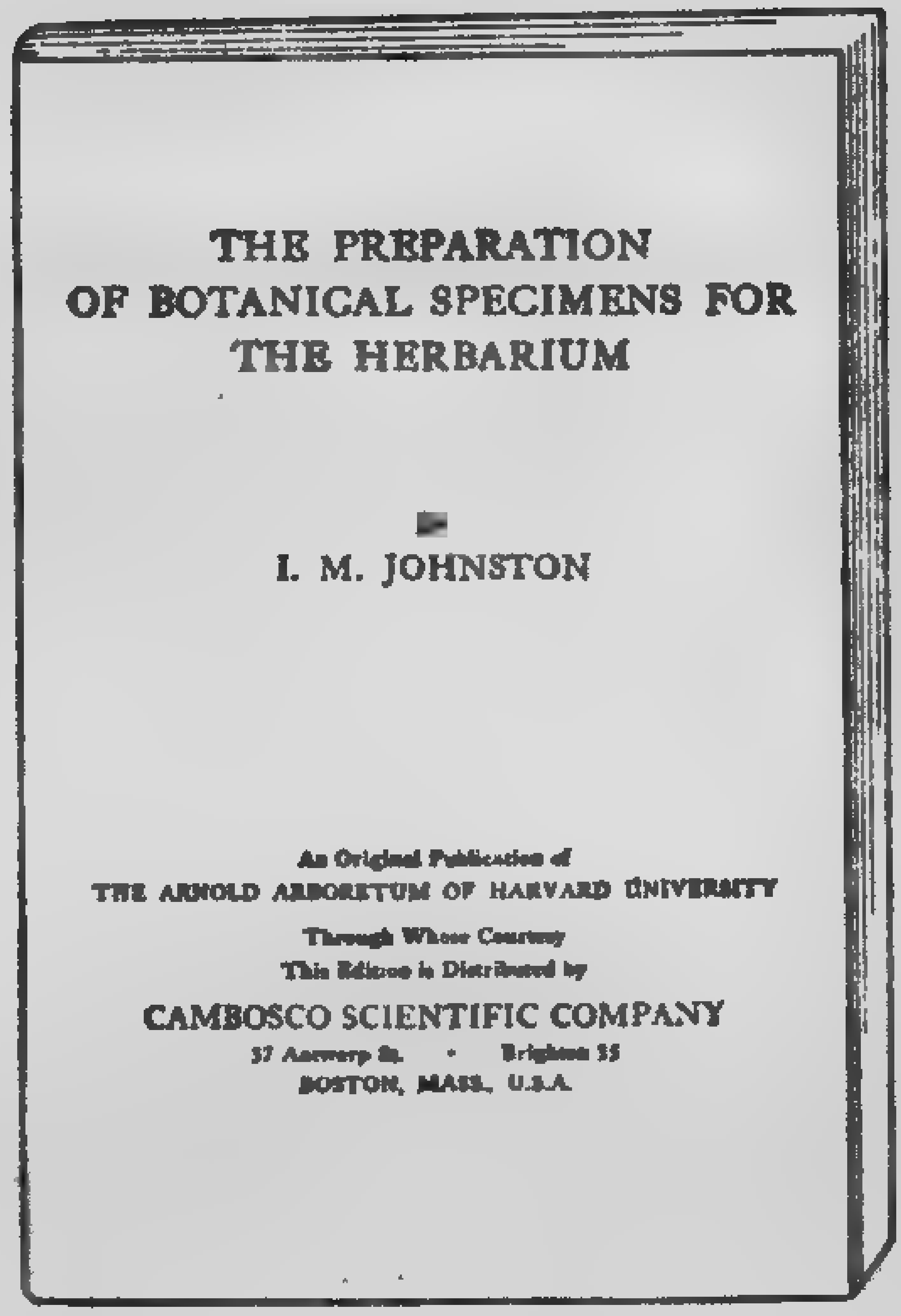


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Published by the

AMERICAN FERN SOCIETY

EDITORS

IRA L. WIGGINS

C. V. MORTON

ROLLA M. TRYON, JR.

JOHN H. THOMAS

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## Contents

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# American Fern Journal

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## Florida Rarities


Thomas Darling, Jr.


In April, 1941, I made my first trip to Florida, combining some casual fern hunting with other activities, mostly sightseeing. Since this was the period when the St. John brothers (Edward and Robert) were making their extensive studies of the fern flora of peninsular Florida, it is not surprising that I made a point of visiting them at Floral City, north of Tampa. More surprising, however, was the fact that Maurice Broun and his wife, having just returned from the West Indies, were visiting the St. Johns at that particular time. Maurice, noted ornithologist and curator of Hawk Mountain Sanctuary (Pennsylvania), and also known in the botanical field as the author of "Index to North American Ferns," had previously introduced me to some of the rarest ferns in Vermont when he was superintendent of nature activities at Long Trail Lodge, home of the Green Mountain Club, at Sherburne Pass.

The first day of my visit Maurice and I accompanied Edward and Robert St. John to certain areas near Floral City noted for unusual ferns. As a visitor familiar with only northern flora, this expedition was a liberal education. At the end of the day my mind was reeling with countless unfamiliar names. Surely Florida leads all other states in the number of ferns to be found within its boundaries. Because of the protective nature of lime sink formations, ferns are here to be found which otherwise are known only from the West Indies and other tropical regions.

Although I encountered many ferns new to me during that memorable field trip, as I now look back on the experience I find that we discovered few actual rarities with the exception of *Ophioglossum nudicaule* (*tenerum*), tiniest of the Adder's-tongues, near Homosassa Springs, and *Blechnum occidentale* in the vicinity of Brooksville. According to Dr. Small, the former is probably more overlooked than uncommon, but he lists the latter fern from only two hammocks in Florida. Following our return that evening an unexpected tragedy, the sudden death of Edward St. John's wife, cancelled our proposed field trips. The following day we had planned to visit Maynard's Cave at Lecanto to see three of the rarest spleenworts, *Asplenium plenum, A. scalifolium,* and *A. subtile,* believed to be Florida endemic species by the St. Johns, but more probably hybrids; they are still a subject of controversy. Unfortunately, I was not to see the St. John brothers again, nor to revisit Florida for many years.

Continuing to Miami along the Tamiami Trail, east of Monroe I stopped at dusk to look for *Asplenium serratum,* the Bird's-nest Fern. The Everglades swamps are most forbidding as darkness approaches. Weird bird calls mingle with the splash of unseen and unidentified animals and reptiles. Wading waist deep into the morass along the highway I was rewarded by finding *A. serratum* growing luxuriantly on mossy logs and vegetation together with the giant Strap Fern, *Campyloneuron phyllitidis.*

The late Professor Buswell, of the University of Miami, invited me to join him on an expedition along the Loop Road in the Everglades south of Monroe. Here, in addition to interesting epiphytic orchids, he showed me a fine display of the Vine Fern, *Phymatodes heterophyllum* (*Craspedaria serpens*) rooted in humus on the ground and climbing by rootstocks on the nearby shrubs and trees.

The next day we journeyed southward to Castellow Hammock, near Homestead, where we visited the amazing lime sinks of that region. Here I first encountered that fiendish subtropical vine known as Devil's Claws or Hold-back Vine, *Pisonia aculeata,* which literally can (and does) rip one's clothing to shreds. At Castellow Dr. Buswell showed me *Trichomanes punctatum,* one of the rare filmy ferns, along with *Tectaria minima* (Small Halberd Fern) and *Asplenium verecundum* (Lacy Spleenwort). He did not mention *Tectaria Amesiana* and *T. coriandrifolia,* two extremely rare ferns known from but a single location (Hattie Bauer Hammock) about three miles distant from Castellow Hammock. Whether these rarities were still to be found at Hattie Bauer as of that date is a matter of conjecture. Also at Castellow I saw the beautiful South Florida "tree fern," *Ctenitis ampla.*

On my return northward via Route 1 along the east coast, I stopped at Vero Beach to look for the rare Hand Fern, *Cheiroglossa palmata,* which grows as an epiphyte in humus at the bases of palmetto leaf-stubs higher than a man's head. Although Maurice Broun had given me a sketch map showing the approximate location one mile south of McKee Jungle Gardens, it took considerable searching before I finally discovered the prize in an area of canals and scattered cabbage palms. Although I never returned to the area, I understand that this unusual fern has been introduced into the Jungle Garden and may now be seen on trees there. It has also been reported from a few other localities including (surprisingly enough) along a busy highway south of Miami!

I did not visit Florida again until December 1955, when I flew down to Sarasota to stay with relatives on Longboat Key. Since then I have returned every autumn around Thanksgiving, and each time have included some fern hunting in the overall program.

In 1955, not having a car at my disposal, my activities were somewhat restricted. Fortunately John Beckner, a member of the American Fern Society from St. Petersburg, invited me to join him one Sunday in a search for rare Aspleniums.

First we drove to Maynard's Cave at Lecanto, which I had hoped to visit many years previously with the St. John brothers. Climbing down an iron ladder at the entrance, we found that a recent rock fall had unsettled part of the cave and made exploring hazardous. *Asplenium verecundum* was in evidence in places, and at one point John thought he detected *A. Curtissii* too far out of reach to be identified. Mature fruiting fronds of the three rarities *A. plenum, A. scalifolium,* and *A. subtile* have not been seen for many years. Tiny sterile specimens of what might have been immature forms of *A. scalifolium* (once termed "*A. suave*" by Edward St. John) were scattered along the cave wall. One sterile plant resembled *A. plenum,* but otherwise the cave was barren of interesting spleenworts.

In a lime rock area on high ground not far from the cave we found a limited occurrence of one of the rarer lip-ferns, *Cheilanthes microphylla.* Near Brooksville, we saw *Asplenium abscissum* and *A. heterochroum,* neither of them rare, but both new to me, as well as the relatively uncommon and highly decorative *Pteris cretica* var. *albolineata.*

The final object of our search was the epiphytic spleenwort *Asplenium auritum,* recently rediscovered by the Garrett brothers of Tampa. It grows southwest of Zephyrhills, in the Hillsborough River State Park area, usually appearing "on the north side of dead live-oaks leaning south." And before dusk, after considerable search and in just such a location, we came upon a thriving colony of this rare and intriguing fern.

Several days later I rented a car and drove to Lake Panasoffkee from Sarasota (about 300 miles round trip) in an attempt to find the strictly local Hemlock Spleenwort, *Asplenium cristatum,* known in the United States only in this general region. En route I stopped at a point south of Tampa to see the unique Floating Fern, *Ceratopteris pteridoides,* not uncommon in open ditches along the road. I had been told that at Lake Panasoffkee *A. cristatum* grew sparingly just south of the outlet on low boulders in an elevated portion of the hammock, but though I searched carefully for several hours until dark I could not find it. The long trip from Sarasota had proved a wild goose chase, and I would have to try again the following year.

In November, 1956, I again went to Florida by plane, this time going directly to Gainesville to explore that interesting rock formation west of the city known as Buzzards' Roost. Renting a car and consulting a sketch map given me by Dr. Erdman West of the University, I located this area without difficulty. At one time there was a profusion of rare spleenworts and other ferns on and around this cluster of lime rock ledges. Masses of *Asplenium Curtissii,* a Florida endemic formerly confused with *A. myriophyllum* of the West Indies, were described as forming dense mats or iridescent green cascading over the faces of these cliffs. Now, however, this fern has disappeared altogether from Buzzard's Roost, and even *A. verecundum* (Lacy Spleenwort) and the Creeping Fern (*Thelypteris reptans*), which also used to carpet these steep walls, have dwindled to an alarming extent. The damage has apparently been caused by a gradual leaching out of the lime, followed by an extensive drying and crumbling of the rock. Furthermore, cattle have been invading "The Roost" from pasture land above, and browse around at will. There has been talk recently of preserving this area as a nature sanctuary before it is too late.

Although unable to find *Asplenium Curtissii,* I was interested to renew my acquaintance with *A. verecundum* and *A. abscissum,* but the highlight of my visit was locating *A. pumilum* (Dwarf Spleenwort) on the very topmost ledges. This tropical fern is known from only a few stations in Florida.

The next use to which I put my rented car was another trip to Lake Panasoffkee, south of Ocala, where I had failed to locate *Asplenium cristatum* (Hemlock Spleenwort) the preceding year. This time, with the aid of a sketch map by John Beckner, I had better luck, finding a few plants on low boulders in that elevated part of the hammock south of the outlet. The fern was so scarce, however, it is not surprising that my "wild goose chase" from Sarasota in 1955 was doomed to failure. It is about this beautiful fern that Dr. Small wrote in his "Ferns of the Southeast," "As it is an attractive and rare fern, it might be the unfortunate victim of attempts to exploit it commercially."

Looking up John Beckner in St. Petersburg, I again joined him in an interesting expedition, this time to the Pineola grottoes near Istachatta. Along with Buzzards' Roost, this is one of the few localities once famous for a lavish display of *Asplenium Curtissii,* but here again the fern has practically disappeared, due largely to extensive quarrying operations. After many hours of search, we finally found one tiny plant halfway up a vertical rock wall, not at all representative of the species. But there were other interesting and beautiful ferns in the area including the luxuriant Brittle Maidenhair (*Adiantum tenerum*), the giant Bristly Shield Fern (*Thelypteris setigera*), the dimorphic Florida Shield Fern (*Dryopteris ludoviciana*), and the relatively uncommon *Thelypteris tetragona,* with its dark green fronds and pinna-like apical lobe of the leaf blade.

Following a brief visit with relatives near Sarasota, I flew back to Washington, stopping en route at Jacksonville to see Mrs. W. D. Diddell, a life member of the American Fern Society. There was time for a brief drive to Fort George Island, where I saw the odd-looking fern ally *Psilotum nudum* (Whisk Fern) growing beneath cedar trees near Rollins Sanctuary. The walls of the old slave houses on the island were covered with the tuberous form of the Sword Fern, *Nephrolepis cordifolia.*

In November 1957, instead of flying I decided to drive to Florida, to be more independent as far as fern exploration was concerned. Stopping at Jacksonville en route, I looked up Mrs. Diddell again and obtained information regarding rare Florida ferns, especially those in the Miami and Homestead areas.

At Gold Head Branch State Park I found the relatively uncommon *Hypolepis repens* (Spring, or Beaded, Fern) locally plentiful along the crystal clear stream at the bottom of the ravine.

Continuing to Gainesville, I spent a rainy morning examining herbarium sheets at the University of Florida, which proved to be time well spent, especially in locating the St. Johns' locality for ferns at Indian Fields Ledges in Sumter County.

At Orange Lake, south of Gainesville, I looked up Don McKay, who showed me the interesting Twin Sinks where formerly there was a fine display of *Asplenium Curtissii.* With the aid of ropes we ventured into the depths of these vertical shafts, and here for the first time I saw *A. Curtissii* approaching its typical form, although the plants were extremely scarce.

The next day, with the help of a local guide, I found my way to the Indian Field Ledges, north of Wahoo in Sumter County. Here on low boulders and ledges in an elevated portion of the hammock I encountered a profusion of ferns of the genus *Asplenium. A. abscissum, A. verecundum* and *A. heterochroum* were plentiful in this area, and at one point I felt confident that I had finally stumbled across a typical station for *A. Curtissii,* since the St. Johns had reported the latter from this locality. Later study of the specimens collected indicated that they were not typical *Curtissii,* but that the entire collection consisted of two apparent hybrid Aspleniums. One, the more finely cut of the two, closely resembled *A. Curtissii.* The other, less finely cut, resembled (rather surprisingly) the extremely rare *A. plenum* found many years ago at Lecanto Cave by Edward St. John.

At the time of my 1957 visit I was not aware of this distinction and supposed the entire lot to be *A. Curtissii.* Not until I revisited Indian Field Ledges in 1958 and collected more specimens of these ferns did I suspect that two different species of *Asplenium* were represented, John Beckner concurring in this supposition. On my return to Washington, I showed these plants to C. V. Morton at the Smithsonian Institution. Comparing the less finely cut form with the single specimen of *A. plenum* in the National Herbarium, he agreed that there was a resemblance. Sample specimens of both ferns were then sent to Dr. Warren H. Wagner at the University of Michigan and to Mrs. Charles W. Crane at Summit, N. J., for microscopic spore study. Their investigations and reports to date have indicated that *both* ferns reflect a condition of allopolyploidy and are probably hybrids. What parent ferns are represented presently remains a mystery, although a parent must almost surely be *A. verecundum*. This emphasizes the fact that at present little is known about Florida *Asplenium* hybrids, and this situation must prevail until a scientific cytological study can be made of living plants of all related species.

At Tampa, Ralph Garrett, local fern collector, one of two brothers who have discovered many new stations for Florida ferns, directed me by a sketch map to one of his brother Ray's recent "finds"—*Dicranopteris flexuosa* (Net Fern) about 15 miles southeast of the city. Although Dr. Small listed only one locality for this fern in the United States (Mon Louis Island, Alabama, where it was discovered in 1913),[1] Maurice Broun states that it was subsequently extirpated at this spot.[2] Miss Mary L. Singletary reported the first discovery from Florida (in 1947) at a point near Kissimmee, Osceola County. These plants were in poor condition and the station was described as a precarious one, exposed to storms and high water.[3] I found little difficulty in locating the colony of *Dicranopteris flexuosa* southeast of Tampa, where it forms a luxuriant thicket in a strictly local area.[4] Alongside it in profusion grows the handsome Staghorn Club Moss, *Lycopodium cernuum,* resembling a miniature Christmas tree.

Continuing southward, I traversed the Tamiami Trail to Miami to search for the rarer ferns of south tropical Florida. At Miami my efforts to find *Asplenium biscayneanum* in the vicinity of Brickell Hammock were unsuccessful. The entire area is now built up as an integral part of the city, and this rare fern (a probable hybrid between *A. dentatum* and *A. verecundum*) has disappeared from the lime rock formation along the sea wall where once it was found in limited quantities.

Along the Coral Gables Canal I found the grasslike *Sphenomeris clavata* locally plentiful under the banks of the south side, with *Thelypteris serra* (Parchment Fern) occasional, though rare, in the vicinity.

At Matheson Hammock, south of Miami, now a state park, I saw *Asplenium dentatum* growing sparingly along the sides of open lime sinks.

In the vicinity of Naranja, near Homestead, Mr. Fred Fuchs showed me some interesting ferns in Sykes Hammock, of which

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[1] Ferns of the Southeast; 329, 330. 1938.
[2] Index to North American Ferns, 60. 1938.
[3] THIS JOURNAL, **40**: 176. 1950.

he is the owner. Here I saw for the first time the decorative wavy-edged Filmy Fern, *Trichomanes Krausii.*

With Fred Fuchs, Jr., I explored Timms Hammock nearby in an effort to find the extremely rare *Stenochlaena Kunzeana* (Holly Fern). His teenage son asked for a description and promised to keep a sharp lookout inside the walls of the open lime sinks which honeycomb the area. Rougher going could scarcely be imagined! With *Pisonia* vines (Devil's Claws) clutching at you from all angles and giant spider webs whipping across your face at frequent intervals, the hammock floor would suddenly give way without warning and down you would go up to your armpits in a treacherous semi-covered lime sink. Although Fred had found the Holly Fern at Timms Hammock several years previously, no sign of it appeared after hours of search. We were about to give up when the bright-eyed youngster triumphantly called us over to a small sink where he had spotted half a dozen specimens of the prize!

With the same father and son as guides, I was shown dense masses of *Sphenomeris clavata* along the edges of lime sinks near the Homestead Air Base. We concluded the day searching for (and finding) a real rarity, *Trismeria trifoliata,* discovered as a genus new to the United States by Ray Garrett of Tampa in 1953. Along the Card Sound Road southeast of Florida City this fern grows luxuriantly in close proximity with *Blechnum serrulatum,* which the sterile fronds of *Trismeria* somewhat resemble.[5]

Before leaving the Homestead area I tried to unravel the mystery of the "Rare Tectarias," without success. This concerns the discovery many years ago, in Hattie Bauer Hammock, of the extremely rare *Tectaria Amesiana* and *T. coriandrifolia.* Dr. Wherry had written me that the lime sinks where these ferns used to grow had been taken over by the Fennell Orchid Jungle, and that the ferns had long since disappeared. John Beckner confirmed this, saying that the west end of the hammock, where

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[4] THIS JOURNAL **45**: 52. 1955.

the rare Tectarias were formerly found in a large sink, is now part of the Orchid Jungle, and that the ferns may have vanished in the 1930's following the effects of a long continued drought. This supposition, however, regarding the date of their disappearance is not strictly accurate, since there are on record (at Smithsonian) herbarium sheets of both Tectarias collected in November, 1940, by the late F. N. Irving of Washington, D. C. As far as I can ascertain, however, this is the last known collection. Mr. Irving once described to me his experience in collecting these ferns "in the middle of a dense jungle" and how he had tried to rediscover the locality at a later date, without success. Roy Woodbury of the University of Miami, now in Puerto Rico, wrote me that he had never been able to find these ferns after many years of search. Maurice Broun reported thriving colonies of both species in February 1935, of which he collected some fine representatives.

While visiting relatives on Longboat Key near Sarasota, I discovered gigantic specimens of *Psilotum nudum* (Whisk Fern) epiphytic on trees at the northern end of the island. Some of these plants measured approximately twenty inches long, greater than the upper limit given by Small and much larger than the terrestrial specimens I had seen on Fort George Island near Jacksonville.

On my return trip I had planned to join the Garrett brothers of Tampa for a full day of exploration. Unfortunately, heavy tropical storms earlier in the day prevented our leaving until afternoon. But even in this brief interval I had the pleasure of being shown at least two rare ferns by these amateur botanists who have made such amazing discoveries of new locations for Florida ferns. On a rocky abutment to a railroad bridge along the Hillsborough River near Zephyrhills I saw *Asplenium pumilum,* one of Ralph Garrett's surprising discoveries while looking for additional stations of *A. auritum,* Then, west of Dade City, in a swampy hardwood hammock we visited a typical location

[5] THIS JOURNAL, **45**: 10,11. 1955.

for the graceful *Thelypteris resinifera* (*T. panamensis*), one of the most beautiful of marsh ferns, which Dr. Small has termed one of Florida's rarer plants. The Garrett brothers have found a number of new locations for this uncommon fern.

Recently, in November 1958, I drove down to Florida once again. En route to Gainesville I stopped at Gold Head Branch State Park, finding the xerophytic *Selaginella arenicola* locally plentiful in high sandy locations around Sheeler Lake.

At Gainesville Dr. E. S. Ford, of the University of Florida, joined me in searching for a spot south of High Springs known to the St. John brothers as " Fern Cave," where they had found some rare Aspleniums identical (or at least similar) to those at Lecanto. A few specimens from this locality may be seen in the University herbarium. Stopping off at Buzzards' Roost we found the ferns there in poor condition due to the situation previously described. In this area Dr Ford pointed out the decorative *Pteris multifida,* the so-called Huguenot Fern, which I had overlooked in 1956. Our search for Fern Cave proved unsuccessful. Although we followed a number of leads and clues in the supposed general region, no local residents recognized a cave by that name, nor could we find any such formation after several hours of search.

Continuing southward I revisited Indian Field Ledges in Sumter County and found the unidentifiable Aspleniums still in evidence on the low boulders. This expediton was not without its hazards. A narrow wood road led to the spot, but recent rains caused soggy depressions in places where I nearly got mired down. At one point a herd of semi-wild bulls roaming the hammock land did not add to my peace of mind. Fortunately I was still driving, as I would not have cared to face these animals on foot. After I had left the bulls, however, the road became so impassable I had to travel the last part of the distance on foot. Arriving at Indian Field before dusk, I found a good-sized coral snake guarding the very ledges I wanted to examine. This is the poisonous reptile of the southland whose venom is similar to that of the cobra, affecting the nervous system and usually causing death within 24 hours. But these snakes are for the most part rather shy, and after this particular one had disappeared in a hole, I felt free to continue my search for Aspleniums with the results mentioned at the time of my 1957 visit.

Spending the night at Lake Panasoffkee, I arose early in the morning to renew my acquaintance with *Asplenium cristatum*, the Hemlock Spleenwort. A new road south of the outlet came perilously close to the limited stand of this fern which I had succeeded in finding after so much difficulty in 1956. It now appeared as if this station had been adversely affected by the road construction and felling of trees. In the vicinity a large cottonmouth moccasin raced across my path. Oddly enough, this was only the second poisonous snake which I had encountered during all my wanderings in Florida—two poisonous snakes in two successive days. I have yet to see the dreaded diamond-backed rattler.

Next I decided to explore the area north of the outlet, having heard just recently that *A. cristatum* had been found here also. Making my way across open shaded pasture land with masses of low boulders, I found nothing of interest for some distance. Suddenly I noticed *A. abscissum* on the rocks, and then, much to my amazement, *A. cristatum* too began to appear in considerable abundance. Sometimes these two ferns carpeted the same rocks, even occupying identical crevices on occasion, but after a careful search I could detect no sign of a hybrid. This is one place where *A. cristatum* appears to be locally plentiful.

At St. Petersburg John Beckner joined me on an all day trip halfway across the state in a search for *Meniscium* at Arbuckle Creek, Highlands County, northeast of Avon Park. After several hours of exploration along the low swampy areas bordering the sluggish stream bed, we encountered a considerable number of immature plants of *M. serratum*, but none of the strikingly conspicuous fertile fronds. Many of the ferns were broken and deformed, giving the appearance of having been eaten by cattle, thus possibly explaining the lack of mature plants. Finally, however, we did manage to find two typical fertile fronds of this rare and interesting fern. Once common in the Lake Okeechobee area, it has long since disappeared with the drainage of the swamps. All along the mud flats of Arbuckle Creek we saw many small fertile leaves of the Floating Fern, *Ceratopteris pteridoides,* sprouting out of the alluvial soil, the spores having been deposited when the waters receded after flood stage.

Before leaving St. Petersburg I paid a visit to the site about 25 miles north of the city where John Beckner in 1952 found a few tiny stems of the tropical Curly Grass, *Schizaea* (*Actinostachys*) *Germanii.*[6] My efforts to uncover this "needle in a haystack" were to no avail. Although Beckner returned to this spot a number of times folowing his original discovery, he was able to find only one additional plant.

Again I journeyed to Miami via "The Trail." This time, with directions from John Beckner, I located the small hammock near Rickenbacker Causeway in the very center of the city where he had found several plants of the almost extinct *Asplenium biscayneanum,* Sure enough, in one of the small sink holes in the dense woods on the flat limestone surface I saw a single specimen of this probable hybrid growing in company with *A. dentatum.*

On the grounds of the University of Miami, Dr. Taylor Alexander, head of the Department of Botany, showed me several thriving plants of *Pteris grandifolia,* a gigantic tropical bracken, found by Roy Woodbury near Cutler in 1952. Mr. Woodbury had written me about this discovery, mentioning that it was a fern new to the United States, but that it had not yet been officially reported or published.

Continuing to the Naranja area near Homestead, I once more looked up Mr. Fred Fuchs, Sr., who showed me *Thelypteris* (*Dryopteris*) *sclerophylla* in Sykes Hammock, a dark green leathery fern found in the United States only in this hammock.[7] In a nearby lime sink I saw two filmy ferns in close proximity

[6] THIS JOURNAL, **43**: 124,125. 1953.

—*Trichomanes punctatum* and *T. Krausii*—the former on the vertical rock wall, the latter on decayed logs at the edges. In his greenhouse, Mr. Fuchs showed me two of the rare epiphytic Strap Ferns, *Campyloneuron angustifolium,* originally from Timms Hammock close by, where it may now be extinct, and *C. costatum,* from the Big Cypress, near Deep Lake, in Collier County.

In the Naranja region I heard a rumor that someone had accidentally encountered a single plant of the Fragrant Maidenhair, *Adiantum melanoleucum,* in the Everglades National Park while searching for other plants. This rare maidenhair was believed to have become extinct in Florida many years ago. There was not sufficient time for me, however, to explore that distant area.

One of the rarest filmy ferns, *Trichomanes lineolatum,* has been discovered only in Castellow, Ross and Hattie Bauer Hammocks. With specific directions for the Ross Hammock location from Roy Woodbury in Puerto Rico, I carefully searched the area to no avail, nor did I see filmy ferns of any kind in this region.

On the return trip I visited the Deering Hammock near Cutler, south of Miami, having obtained permission to explore this interesting place, The head caretaker showed me about the vast wooded estate, with its many roads and trails. From a pteridological standpoint it is famous chiefly for the lavish and abundant display of *Asplenium dentatum* on almost every lime outcrop and lining the walls of the sinks. This protected sanctuary remains, except for Matheson Hammock and a few other restricted areas to a much lesser degree, the one place in the United States where this *Asplenium* still grows in abundance.

In a moist ravine at the Deering Estate, I happened to spot a few young and immature plants of the Giant Bracken, *Pteris* (*Litobrochia*) *tripartita,* the first time I had seen this fern in its native habitat. Although once common in many parts of Florida,

[7] THIS JOURNAL, **41**: 86,87. 1951.

it now appears extremely scarce. Previously, in Mrs. Y. C. Lott's garden in Miami I had seen a fully developed fruiting specimen of this handsome plant, taller than a man.

In conclusion, the above represents the story of random explorations by a northern visitor with limited time available. Local fern students are probably familiar with other places where some of these rarities may be found. Any information regarding these would be much appreciated by the author. With the advance of civilization, and all that it entails, many of the rarest Florida ferns may be doomed to extinction unless in some way they can be preserved for future generations to see and enjoy.

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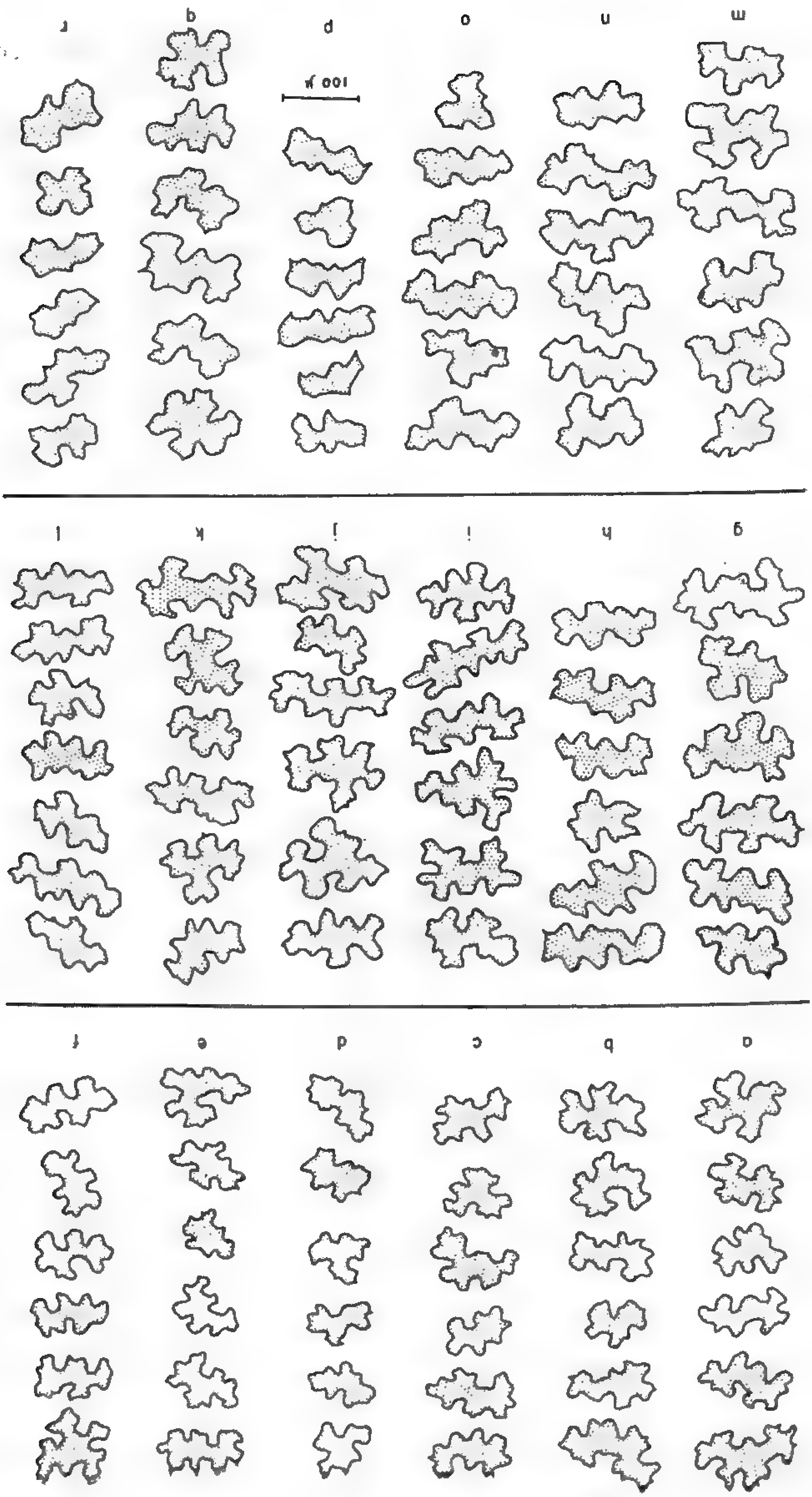
## Hybrids in North American Gymnocarpiums

ELIZABETH EICHSTEDT ROOT

The relationship between the two North American species of *Gymnocarpium, G. Dryopteris* and *G. Robertianum,* has long remained a topic of speculation.

These two circumboreal species occur together in many northern localities, though *G. Dryopteris* is often found alone at somewhat lower latitudes and in a greater variety of habitats. The less tolerant *G. Robertianum* most commonly grows in a limy situation, on talus slopes or in rocky woods, but it has also been collected in swamps, where there are no rocks. In some habitats, populations including both species frequently occur; it has been previously reported that within these populations are forms that are difficult to place with either species.

Lawalrée (1950) maintains that the presence of an intermediate form supports his view that *G. Robertianum* represents a variety of *G. Dryopteris*, being adapted to a calcareous habitat. He cites Koltz (1877-78) who, without proof according to Lawalrée, stated that the intermediate results from hybridization. Intermediates have also been turned up in North America. The intermediate characters found have concerned glandularity and leaf shape; *G. Dryopteris* has a very slightly glandular rachis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and a broadly triangular frond, whereas *G. Robertianum* is densely glandular on the rachis and lower leaf surface, and has a narrowly triangular frond. Hultén (1941) reports: "Some of the specimens of *G. Robertianum* referred to are very slightly glandular, and at the same time have a general appearance closely resembling tht of *G. Dryopteris,* while others are quite typical *G. Robertianum.* One specimen, *Anderson* 2609, from Circle Hot Springs, is very doubtful. The form of the frond approaches strongly that of *G. Dryopteris*, the first pair of pinnae being much larger than the rest. It has, however, scattered glands on the stipes and on the lower surface of the leaves as well as the dark green color of *G. Robertianum* . . ." The plant recognized by Tryon (1939) as *Dryopteris Linnaeana* forma *glandulosa* is more or less intermediate in glandularity also.

A few mixed populations of the *Gymnocarpium* complex have been found in Michigan, at the tip of the Lower Peninsula and, more commonly, in the Upper Peninsula. In July, 1957, such a population was found by Dr. W. H. Wagner, Jr., in Marquette Co. The plants were growing in woods on rock cliffs about six miles northwest of Ishpeming. A collection was made by the discoverer in company with E. G. Voss and D. J. Hagenah, and these plants were turned over to me for study. Of these twenty-six specimens, several, on the basis of frond shape, could not be placed with either species. Upon microscopic examination of these specimens, it was found that the degree of glandularity also varied according to frond shape. Further study of the variation was made possible through the help of C. V. Morton, of

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Microprojection drawings of upper epidermal cells of cleared pinnules, showing variations in size and shape: a–f, GYMNOCARPIUM DRYOPTERIS: a–c, *Voss* 4708, Marquette Co., Mich.; d, *Gorman* 132, Iliamna River, Alaska (US); e, *Gorman* 109, Lake Iliamna Region, Alaska (US); f, *Mackenzie & Griscom* 10013, Romaine Creek, Newfoundland (US); g–l, Intermediate: *Voss* 4707, Marquette Co., Mich.; m–r, G. ROBERTIANUM: m–p, *Voss* 4709, Marquette Co., Mich.; q, *Fernald, Long, & Fogg* 1130, Stanleyville, Newfoundland (US); r, *Fernald, Long & Fogg* 1131, Lord and Lady Cove, Newfoundland (US).

the United States National Herbarium, in lending to me additional materials and by his helpful suggestions.

The principal characters used to distinguish these species from one another have been those already mentioned of frond cutting and degree of glandularity. It is generally stated (Fernald, 1950, Morton in Gleason, 1952) that the fronds and rachises of *G. Dryopteris* range from glabrous to rarely very slightly glandular. However, upon close examination of specimens from various localities it was found that *every* individual of this species examined had glands. Though few, they were always present, at least in the axils of the pinnae. The degree of glandularity still remains a good distinguishing characteristic, however, as the fronds and rachises of *G. Robertianum* are much more

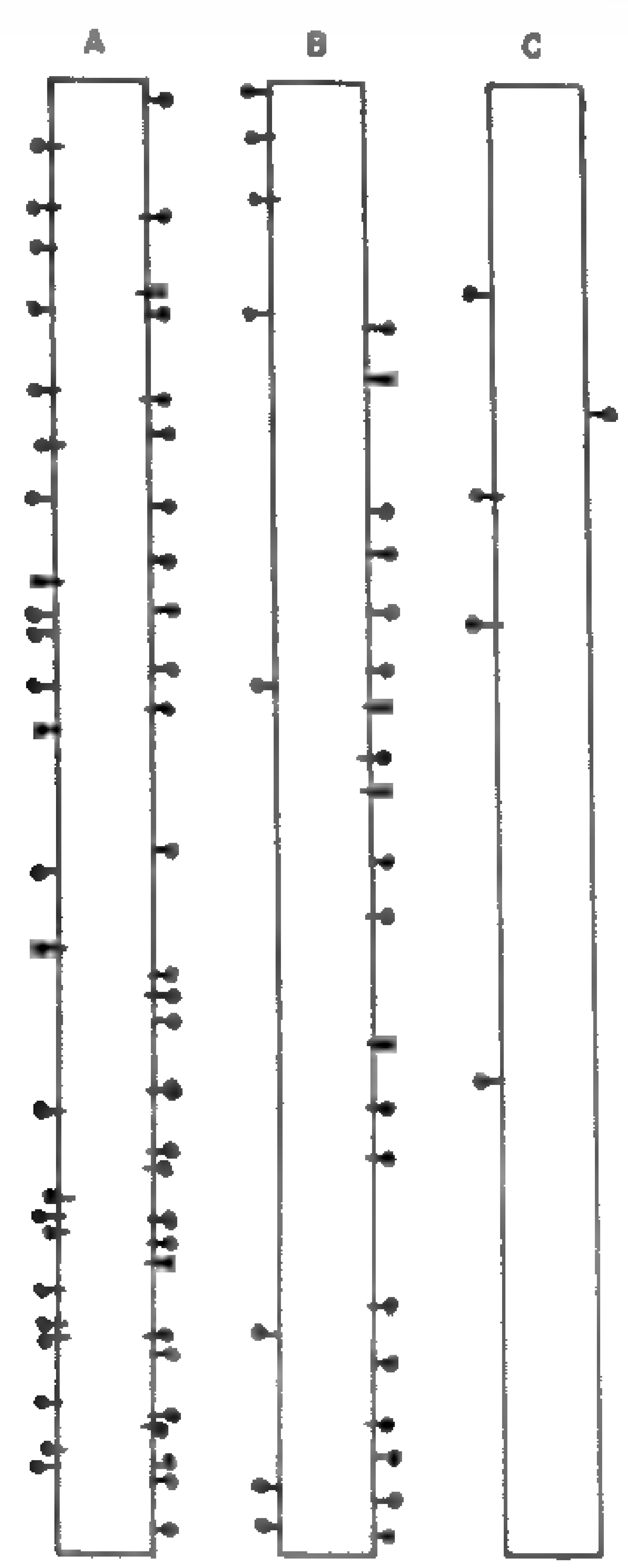


FIG. 1. DIAGRAM SHOWING THE SILHOUETTE OF A RACHIS SEGMENT BETWEEN THE FIRST AND SECOND PINNAE. EACH PROJECTION FROM THE RACHIS REPRESENTS A GLANDULAR HAIR. A: *G. Robertianum* (*E. G. Voss* 4709, MARQUETTE CO., MICHIGAN); B: INTERMEDIATE (*Voss* 4707, MARQUETTE CO., MICHIGAN); C: *G. Dryopteris* (*Voss* 4708. MARQUETTE CO., MICHIGAN)

densely glandular than those of *G. Dryopteris.* (*Fig. 1*) The difference in the frond cutting is due mainly to differences in the size and shape of the lowermost divisions of the blade. In *G. Dryopteris,* these are nearly as long as the terminal part of the blade; they are asymmetrical, the lower side having elongate pinnules. In comparison, those of *G. Robertianum* are about half as long as the terminal part, and they are more nearly symmetrical. As was mentioned earlier, specimens intermediate in these two characters were included in the Michigan collection, indicating the possibility of hybridization between these plants. Additional characters were required in order to substantiate this possibility. Therefore, a study of spores and epidermal cells was made. The Michigan specimens were divided into three groups, representing the two species and the intermediate. Microscope slides were made of the spores and cleared pinnules of each group. The latter were prepared by clearing in sodium hydroxide and then staining with tannic acid and ferric chloride.

Examination of the spores revealed only a subtle difference in structure, the perispore of *G. Robertianum* being a little more roughly sculptured than that of *G. Dryopteris.* Of major importance in the spore study is the fact that the majority of the spores of all intermediate specimens were found to be abortive. Subtle dissimilarities were noted also in the shape of the epidermal cells of the two species, those of *G. Robertianum* being longer, on the average, and with less sinuate margins than those of *G. Dryopteris.* Those of the intermediate were found to be large like *G. Robertianum,* but with the more sinuate margins of *G. Dryopteris* (*Pl. 1*).

## DISCUSSION

The fact that the spores of intermediate forms are abortive indicates that the two presumed parental plants are distinct species. If they are mere varieties, as has been claimed, their hybrids would most likely be fertile. The more roughly sculptured perispore of *G. Robertianum* provides a trait by which to separate the species.

Probable Hybrid, Gymnocarpium Dryopteris × G. Robertianum, Marquette Co., Michigan, Voss 4707

The intermediate character of the leaf cutting, glandularity, and epidermal cell shape and spore abortion provide a sound argument for the hybrid origin of these intermediate specimens. A summary of the intermediate characters is presented in Table I.

No other collections that I have seen from North America are clearly of the hybrid type. Several possible intermediates were examined from Alaska, Greenland, and Newfoundland, but the spore condition could not be determined because of the immaturity of the specimens or its loss of spores. Included in the National Herbarium specimens were three of *Dryopteris Linnaeana* forma *glandulosa* Tryon. These bore a resemblance in

TABLE I

| Character | *G. Dryopteris* | Intermediate | *G. Robertianum* |
|---|---|---|---|
| Frond Shape | Broadly triangular: two lower pinnae about three-fourths as long as remainder of frond or longer. | Two lower pinnae about one-half to three-quarters as long as remainder of frond | Narrowly triangular: two lower pinnae about one-half as long as remainder of frond. |
| Indument of frond and rachis | Very sparse | Moderate | Very dense |
| Size of epidermal cells (average greatest length) | 100 $\mu$ | 122 $\mu$ | 122 $\mu$ |
| Shape of epidermal Cells (average) | Margins deeply sinuate. | Margins moderately sinuate. | Margins shallowly sinuate. |
| Per cent abortion of spores | About 1 | 48–85 | About 5 |

leaf-cutting and glandularity to the Michigan hybrids, but the spores are immature, and the epidermal cells were not examined, and so the true position of this plant in the *Gymnocarpium* complex remains unknown.

There is a need for the investigation of additional collections of these species, in order to determine the frequency of hybridization between them. A more detailed analysis of the habitats of each may also shed further light on the problem. It is suggested that observers in regions where *G. Dryopteris* and *G. Robertianum* co-exist remain watchful for other hybrid populations.

I wish to express my appreciation to Dr. Warren H. Wagner, Jr., for his guidance in this work and for his generous extension of laboratory facilities.[1] My thanks go also to Mr. G. M. Christman for his helpful advice on the illustrations.

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[1] Since Mrs. Root's study, Olga Lakela and I have found an additional colony of an intermediate *Gymnocarpium* in June 18, 1959, on shaded cliffs below the observation tower at Ash River, St. Louis County, Minnesota (*Wagner* 9034.5a). The leaf shape and glandularity appear to be intermediate as described by Mrs. Root, and the spores are conspicuously irregular in form.

It might be mentioned that even though these plants are sterile, judging by spore abortion, they can still form large populations by vegetative reproduction, on account of their long, horizontal, underground rhizomes, similar to those formed by *Ambrosia* × *intergradiens* and *Equisetum* × *trachyodon*. On the other hand plants with only approximate offsets, such as *Polystichum acrostichoides* × *Lonchitis* and most *Dryopteris* hybrids, form only clumps of one or a few plants usually. Incidentally, the original living plant of *P. acrostichoides* × *Lonchitis* has been transplanted to his garden by Mr. Dale Hagenah because it was in danger of destruction by cattle and sheep; it will now be readily available for cytological study.
W. H. WAGNER, JR.

## The Problems of Variation in North American Dryopteris[1]

DONALD BRITTON

Recent cyto-taxonomic work has helped us considerably to understand the evolution and classification of the North American species of *Dryopteris.* The initial impetus for these studies came from Manton (1950). Later studies by Britton (1953), Manton and Walker (1953), Wagner (1955), and Walker (1959) have furthered our knowledge of this genus. It is now possible to exclude such species as *Thelypteris palustris, T. Phegopteris,* and *T. hexagonoptera* from *Dryopteris,* as is done in the New Illustr. Flora of Britton and Brown, both on the basis of their chromosome numbers departing from the basic number of 41 in the genus and also on their morphology (See Table). Having done this, it is then possible to focus attention on *Dryopteris.*

The novice soon learns to recognize *Dryopteris marginalis, D. Goldiana, D. cristata,* and *D. Clintoniana,* although together with the specialists he may be puzzled by intermediates between the latter two entities. *Dryopteris Filix-mas* and *D. fragrans,* for those who can find them, represent no problems in identification. The truly difficult plants to identify are those that belong to the *spinulosa* complex, and especially those forms which apparently have hybridized both within and without this complex. Examining the chromosome numbers of these entities (See Table) we find that *marginalis, Goldiana,* and *intermedia* all have 41 chromosomes, which is apparently the basic or monoploid number for the genus. These species all have a regular and normal meiosis and apparently reproduce sexually as one would expect. *Dryopteris spinulosa* var. *spinulosa* is in part a sexually reproducing tetraploid ($n = 82$), as is *D. cristata,* and *D. Clintoniana* is a hexaploid ($n = 123$). All these species have a regular meiosis with normal pairing of bivalents at meiosis I.

[1]The author wishes to acknowledge gratefully the support of this work by an award from the Sigma Xi RESA research grants, and to thank Dr. Rolla M. Tryon, Jr., and Prof. F. H. Montgomery for their interest and help in taxonomic matters.

For more than six years now, Dr. Stanley Walker, of the University of Liverpool, has been studying the cytology of this group and has been synthesizing hybrids between the different entities. The proof of the hypothesis that *D. Clintoniana* is an allopolyploid between *D. cristata* and *D. Goldiana* will have to await the publication of his results. Similar hybridization experiments together with some genome analysis will show how many basic genomes or sets of chromosomes are involved in the species of *Dryopteris*. The entities Dr. Walker has studied have been shipped to him from North America and hence are removed from their native habitat, and their natural morphology may have changed even if they are grown by experts under ideal conditions. Walker has not had the opportunity to examine his material growing in large numbers at any one location or over its natural range.

My own work has taken full cognizance of Walker's prolonged study of this group. I have attempted to examine and collect large numbers of these entities in an effort to delimit the genetic and ecological variation. Fortunately, there are many woods and swamps near Guelph that abound in *Dryopteris*, so I am well situated to study the variation in the genus.

One should make a distinction between occasional rare hybrids such as the one between *fragrans* and *intermedia* reported by Tryon (1942) and some of those entities that make up a substantial percentage of our fern flora. The latter group are extremely successful and are even "end-points" from an evolutionary standpoint, whereas the former tend to be curiosities such as some horticultural hybrids. The former can be plotted only as occurrences, whereas the latter may have a definite range.

The first observation that might be made is that although *D. marginalis* ($n = 41$) is one of our more common species and is usually found in association with other *Dryopteris* species (especially *intermedia*), it apparently has hybridized with the others very infrequently. Although six different *Dryopteris* hybrids involving *D. marginalis* are noted by Chandler (1948), this is not an indication that *marginalis* commonly hybridizes with other species of *Dryopteris.* More probably, it is an outcome of the broad distribution of *marginalis,* together with its distinctive phenotype which is expressed in a modified but recognizable form in its hybrids.

The second observation is the rather astonishing frequency of triploids that one encounters in the field. This is more apparent if one considers that each triploid has arisen from a separate fertilization and is a final product with no means of sexual reproduction. At one location, I collected seven specimens for cytological study; the three that looked like *intermedia* were diploid and the other four were triploids. At another location six specimens were collected; three were diploids and three triploids, which shows how frequently triploids may be encountered in this area.

Since typical *intermedia* is apparently a sexually reproducing diploid species with a normal meiosis, it would seem that if one looked at a very large number of entities that approached *intermedia* in morphology it might be possible to determine the extent of variation in this species. That is, instead of trying to key specimens down to *intermedia,* it should be possible to use diploidy as a basic criterion and group all diploids having an *intermedia*-like appearance as *intermedia,* since the only other diploids one encounters locally are *marginalis* and *Goldiana,* which will not be confused with *intermedia.* I have attempted to do this with a large number of plants and the only difficulty that I can visualize arising is that I may be putting another diploid species, e.g., a diploid var. *americana* (or *campyloptera*), in this grouping. However, I believe this possibility will be eliminated when all the specimens are examined critically and compared with one another.

Having conveniently lumped the diploids into *intermedia* for the taxonomists to determine the limits of variability, one is left with a large group of triploids and a large group of tetraploids. Considering the tetraploids next, these are apparently true *spinulosa.* The lower inner pinnules next to the rachis are longer than the next pinnules and, most important, the indusium is glabrous. None of the 29 local specimens for which I have determined the chromosome number could be considered to be var. *americana* (or *campyloptera*) on the basis of the spacing of the basal pinnules. It will be necessary to try to establish the limits of variation of this group also.

The last group are the triploids (including var. *fructuosa*) which as one would expect, are quite variable, although many approach *spinulosa*, except for the fact that the indusium is glandular. The chromosome numbers of 30 different specimens of these have been determined. As yet, it is too early to say whether the variability is due to reciprocal crosses exhibiting matrocliny, or of more than just the two entities *spinulosa* and *intermedia* being involved, as suggested by Manton and Walker (1953). From field studies, the hypothesis that only two paren-which, as one would expect, are quite variable, although many locations there is a preponderance of only one of the putative parents. In the dryer locations, especially rich deciduous woods in which *Adiantum pedatum* is present, *intermedia* and the triploid predominate, whereas in the wetter swamps *spinulosa* and the triploid are more frequent.

In some of the local swamps *Boottii* has been collected and, as Manton and Walker (1953) reported, this is a triploid hybrid with little or no pairing of the chromosomes. Presumably it has two sets of chromosomes from *cristata* (4x) and one set from *intermedia* (2x). Confirmation of this will have to await Dr. Walker's findings. Also found occasionally in these same swamps are some intermediates between *cristata* (4x) and *Clintoniana* (6x) which are pentaploid (5x) as one would expect.

Out of the hundreds of *marginalis* specimens looked at in the field only one putative hybrid was located between this and *intermedia*. As one would expect from such a cross, 82 unpaired chromosomes were seen at meiosis, 41 from *intermedia* and 41 from *marginalis*.

As far as possible in this study I have attempted to study the plants in the field as well as in the laboratory. To this end, I have placed Hartley Metal Labels with appropriate numbers in the ground beside certain selected plants so that I may return to the same plant another year if need be. Also, it will be possible to obtain four or five fronds in the Fall for herbarium specimens in addition to the one voucher frond collected in the Spring and used for determining the chromosome number. In this way, the plants will be disturbed as little as possible and their natural morphology preserved. The chief difficulty will be finding some of the labels in certain large clumps of ferns in inaccessible locations!

It would seem that var. *americana* (or *D. campyloptera*) is not present in the localities that this author has investigated so far, and that it has not been a factor in the production of the triploids. Both the author and Prof. F. H. Montgomery have made extended search for this entity.

Of the various characters used in keys for determining specimens, it would seem that if the innermost lower pinnules are shorter than the next succeeding pinnules that one is moving towards *intermedia*. The other good key character is whether the indusium is glandular or not. Further elaboration on these points will be required by competent taxonomists.

Chromosome numbers of 110 different plants have been determined. The onset of meiosis was on May 29 in this area and specimens suitable for cytological study were collected for the following two weeks. Studies on the variation in the genus were made both before and after suitable meiotic material was collected, and approximately 100 additional collections were made. The longer a student studies the different plants in the field the more discriminating he becomes about making collections because he knows which phenotypes are already represented in his material. Accordingly, the sample collected at any one location may be reduced to five or six plants although the investigator has looked at say a hundred intermedias at that one location. He rejects 94 of the intermedias as obviously falling into this species on the basis of his previous collections and previous chromosome number determinations, and consequently can conchromosome number determinations, and consequently can concentrate on the remaining six plants.

Since it is unlikely that triploid hybrids growing many yards apart, each arising from a separate fertilization, will arise in thick woods far removed from their parents, it is often necessary to return to the same locality to attempt to find the missing putative parent. If it cannot be found, as happened at one location, it would seem logical to assume that it has become extinct, although the age and longevity of the triploid hybrids is quite unknown to this investigator. Although unable to reproduce sexually the triploids can reproduce by vegetative means, but the speed of this vegetative colonization is unknown.

Another observation that might be made is that some plants that have only one or two fronds, in contrast to strongly growing plants with five or six fronds, show more variation in relation to the spacing of the innermost lower pinnules than do the latter in the same locality. There is also variation in different fronds of the same plant. Some intermedias will have a frond with the innermost lowest pinnules as long as, or longer than, the next succeeding pinnules, but this will not be true for all the fronds of the same plant. The cutting of the frond and the over all lacy appearance are certainly of help in field indentification.

The most variable character used in keys seems to be the spacing of the inner lower pinnules. For this general area, it would seem that the more remote spacing (over 0.5 cm.) is found on the diploids rather than the tetraploids. Some sterile fronds exhibit more variation in this respect than do the fertile fronds of the same plant; occasional sterile plants have wide spacing, but unfortunately their chromosome number is not known.

Further work is planned on these problems next year. It will be necessary to decide if all the diploids can be assigned to *intermedia*, and it will also be necessary to continue to search for var. *americana*. With the present specimens for reference, further collections can be made more and more critically.

CHROMOSOME NUMBERS OF EASTERN NORTH AMERICAN DRYOPTERIS[2]

| | | GAMETIC CHROMOSOME NUMBER | PLOIDY | AUTHORITY |
|---|---|---|---|---|
| 1. | D. Thelypteris var. pubescens | 35 | | Britton, 1953 |
| | Thelypteris palustris | 35 | | Wagner, 1955 |
| 2. | D. simulata | | | |
| | Thelypteris simulata | | | |
| 3. | D. noveboracensis | 29±2 | | Britton, 1953 |
| | Thelypteris noveboracensis | 27 | | Wagner, 1955 |
| 4. | D. disjuncta | 80–82 | | Britton, 1953 |
| | Gymnocarpium Dryopteris | 80 | | Manton, 1950[5] |
| 5. | D. Robertiana | 80 | | Manton, 1950[5] |
| | Gymnocarpium Robertianum | | | |
| 6. | D. Phegopteris | 90 | | Britton, 1953 |
| | Thelypteris Phegopteris | | | |
| 7. | D. hexagonoptera | 30 | | Wagner, 1955 |
| | Thelypteris hexagonoptera | | | |
| 8. | D. spinulosa | 82 | 4× | Manton & Walker, 1953 |
| | | | | Britton, 1960 |
| | D. austriaca var. spinulosa | 82 | 4× | |
| | | | | M. & W., 1953 |
| | D. spinulosa var. intermedia | 41 | 2× | Britton, 1960[3] |
| | D. austriaca var. intermedia | 41 | 2× | |
| | | | | M. & W., 1953 |
| | D. spinulosa var. fructuosa | pairs and singles | 3× | |
| | | | | Britton, 1960 |
| | D. austriaca var. fructuosa | | 3× | |
| | | | | Walker, 1959 |
| | D. spinulosa var. americana | 82 | 4× | |
| | D. austriaca var. austriaca | | | |
| | D. spinulosa var. concordiana | | | |
| | D. austriaca var. concordiana | | | |
| | | | | Britton, 1953[4] |
| 9. | D. × Boottii | | 4× | M. & W., 1953 |
| | | unpaired | 3× | Britton, 1960 |
| | | | 3× | |
| | | | | M. & W., 1953 |
| 10. | D. cristata | 82 | 4× | Britton, 1960 |
| | | 82 | 4× | |
| 10. | D. cristata var. Clintoniana | 123 | 6× | M. & W., 1953 |
| | D. Clintoniana | 123 | 6× | Britton, 1960 |

| | | | |
|---|---|---|---|
| 11. D. Filix-mas | 82 | 4× | M. & W., 1954[5]<br>Doepp, 1955[5] |
| 12. D. celsa<br>D. Goldiana subsp. celsa | 82 | 4× | Walker, 1959 |
| 13. D. Goldiana | 41 | 2× | M. & W., 1953 |
| 14. D. marginalis | 41<br>41 | 2×<br>2× | M. & W., 1953<br>Britton, 1953, and 1960 |
| 15. D. fragrans var. remotiuscula | | | |

[2]Number and name of each species following Fernald, in Gray's Manual, Eighth edition (1950); alternative names are those of Morton, in Gleason, The New Britton and Brown Illustrated Flora (1952).

[3]The count $n = 82$ of Britton, 1953, should be rejected; the material was not typical *intermedia.*

[4]The determination of the specimen is doubtful, and the cytological analysis was incomplete. This was presented merely to show some of the problems that arise in a first survey of this kind.

[5]Counts made from European plants, included here for interest.

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## Some New Data on the Vernation Differences of Botrychium dissectum and B. ternatum

W. H. WAGNER, JR.

No evidence has appeared thus far to indicate that the American grapefern that resembles *Botrychium ternatum* (Thunb.) Swartz of the Old World[1] is other than that species, so this name has been adopted for this plant. It has been discovered that the four northeastern North American species of evergreen grapeferns differ significantly from each other in periodicity of leaf development and sporangial maturation when growing together in the same habitat.[2] The first species to start growing in the spring (the last week of April and first week of May) is *Botrychium multifidum* (Gmel.) Rupr. and the last species to start is *B. dissectum* Spreng. (the first half of June). *Botrychium ternatum* and *B. oneidense* (Gilb.) House are intermediate, the former preceding the latter to some extent. The same periodicity differences between the species are also reflected in sporangial maturation in the late summer and fall. So far as we have been able to determine, these differences are found wherever two or more of the species co-exist.

Most of the data we have on time of early leaf development in these plants were obtained in 1959 during the period June 11–26 in various counties of southern Michigan. The differences in vernation between *B. dissectum* and *B. oneidense* were also examined on July 3, 1959, but no comparisons in the month of July of that year were made of *B. dissectum* and *B. ternatum*. Accordingly, the following year, on July 14, 1960, a now well known locality in Midland County, Michigan, where the last

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[1] American Grapeferns Resembling Botrychium ternatum: A Preliminary Report. THIS JOURNAL, **49**: 97–103.

[2] Periodicity and Pigmentation in Botrychium Subg. Sceptridium in the Northeastern United States. Bull. Torrey Bot. Club **87**: 303–325, 1960. This work has been continued as a study of periodicity differences between closely related species as a part of a National Science Foundation Research Project.

two species grow intimately together was visited (R.2E, T. 16N, Sect. 29, NW¼, south side of road, along edge of more or less open, sandy field with scattered trees and shrubs). In order to assure as accurate as possible a comparison, 22 pairs of plants were collected, each pair including one each of the two species in question, these taken anywhere from 0.3 to 5.0 feet apart. They were taken no further than 5.0 feet apart so that the habitat conditions were as nearly the same as we could get them.

The relative development, as in the earlier work cited above, was measured by the ratio of the length (to the nearest millimeter) of the 1960 leaf primordium to the length of the 1959 previous year's leaf, expressed as percentage. The measurements were made by Miss Virginia M. Morzenti. The results, as shown in the table, confirmed the previous conclusion, namely that *B. ternatum* develops significantly earlier than *B. dissectum.* In paired specimens of the two species, *B. dissectum* averaged only 55 per cent as far in development as *B. ternatum.*

*Botrychium multifidum* occurs scattered in the same habitat, associated here and there with the other two species. (No specimens at all of *B. oneidense* were found in 1960 at this locality, and only one was found in 1959.) The five complete specimens of *B. multifidum* (*Wagner 9257*) that were found on this date and in this habitat (though not in definite spatial relationship to the other two species) gave an average figure of leaf development of 109.8 per cent, and were thus much further developed than either *B. dissectum* or *B. ternatum.* This was entirely expected, however, as all previous studies have shown that *B. multifidum* matures its leaves considerably earlier than the other three species.

These investigations have been most interesting in supplying additional data for the interpretation of inter-relationships of these controversial species of evergreen grapeferns. We must credit Professor W. L. Dix[3] for calling attention to the need of

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[3] Observed Characteristics of Botrychium multifidum var. oneidense, THIS JOURNAL, **35**: 37–39. 1945.

making comparisons of subtle characteristics of these plants in the same habitats. It would be very desirable if our colleagues in Japan would make similar studies of *B. multifidum* and *B. ternatum* in habitats where these species grow together there.

| | *B. dissectum* | *B. ternatum* | *B. multifidum* |
|---|---|---|---|
| Collection no. | 9256 | 9258 | 9257 |
| Sample size | 22* | 22* | 5 |
| Average (%) | 37.4 | 67.6 | 109.8 |
| Standard Deviation (%) | 10.0 | 18.8 | 9.3 |
| Range (%) | 21.7–58.7 | 40.1–93.4 | 102.2–124.2 |

* Each specimen taken five feet or less from a specimen of the other asterisked species.

## Supplementary Note on Dryopteris Hybrids

EDGAR T. WHERRY

In a recent article on *Dryopteris* hybrids,[1] only five parent species were taken into account; two others are here discussed.

DRYOPTERIS CLINTONIANA. Since this taxon is now known to be hexaploid, its ability to cross freely with tetraploid and diploid ones is somewhat surprising, yet evidence from morphologic characters indicates that it does so. The following have been reported:

D. CLINTONIANA × CRISTATA. This was published[2] as *Aspidium cristatum* × *A. cristatum* var. *clintonianum*. The frequently expressed view that *D. clintoniana* and *D. cristata* intergrade and are therefore only varietally distinct is manifestly based on the manner in which this hybrid combines their features. It should prove on cytologic study to be pentaploid.

D. CLINTONIANA × GOLDIANA. In reporting the existence of this hybrid, Dowell[3] considered it to represent *D. goldiana* ssp. *celsa* W. Palmer. Although this view has been widely accepted, cytologic study by Dr. S. Walker[4] has shown it to be incorrect.

[1] THIS JOURNAL **50**: 87–92. 1960.
[2] Bull. Vt. Agr. Exp. Sta. **187**: 155. 1915.
[3] Bull. Torr. Club **35**: 137. 1908.
[4] THIS JOURNAL **49**: 104–112. 1959.

D. CLINTONIANA × INTERMEDIA = × *D.* **dowellii** (Farw.) Wherry, *comb. nov.* Reported by Dowell[5] and named *Filix* [×] *dowellii* by Farwell.[6]

D. CLINTONIANA × MARGINALIS. Reported by Davenport[7] in 1902.

D. CLINTONIANA × SPINULOSA = *D.* × **benedictii** (Farw.) Wherry, *comb. nov.* Reported by Benedict[8] and named *Filix* [×] *benedictii* by Farwell.[9]

DRYOPTERIS CELSA. While as above noted this taxon has often been considered a hybrid, the cytologic study by Dr. S. Walker (*op. cit.*) has shown it to be a tetraploid species. It is known from widely scattered stations from Dade County, Georgia, to Berks County, Pennsylvania, and is represented in many herbaria by specimens distributed as Plantae Exsiccatae Grayanae No. 1003 from one of its Virginia localities. It is herewith suggested to be one parent of three hybrids:

D. **celsa** × **intermedia** = *D.* × *separabilis,* new interpretation. This taxon was named as a species by Small[10] and inferred to be *D. goldiana* × *intermedia* by the writer;[11] as it grows in association with *D. celsa,* however, this is herewith proposed as one parent.

*D.* **celsa** × **ludoviciana** = *D.* × *australis,* new interpretation. The taxon named *D. clintoniana* var. *australis* by the writer[12] was raised to species status by Small.[13] That its imperfect spores indicate it to be a hybrid was pointed out by Brown and Correll,[14] and the cytologic study by Walker (*op. cit.*) favors

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[5] Bull. Torr. Club **35**: 136. 1908.
[6] Pap. Mich. Acad. Sci. **2**: 14. 1923.
[7] Rhodora **4**: 10. 1902.
[8] Bull. Torr. Club **36**: 45. 1909.
[9] Pap. Mich. Acad. Sci. **2**: 15. 1923.
[10] Ferns SE. States, 284. 1938.
[11] Guide East. Ferns, ed. 2, 163. 1942.
[12] THIS JOURNAL **27**: 2. 1937.
[13] Ferns SE. States, 279. 1938.
[14] Ferns. . .of La., 45. 1942.

the view of the origin proposed herewith.

D. CELSA × ? = *D. × atropalustris.* This taxon, named as a species by Small,[15] is known only from the inadequate type specimen, other occurrences listed by Small being doubtful. Until it is rediscovered, its parentage remains dubious.

In conclusion, attention may be called to the surprisingly close resemblance between some of the taxa discussed in this and the preceding article. In several cases distinction can be based only on spore studies, which Mrs. C. W. Crane has generously made for me. For example, while *D. clintoniana* normally has its lowest pinnae broadest at base, the material of it distributed in the Plantae Exsiccatae Grayanae series has them narrowed at base like *D. celsa;* this came, however, from New York state far north of the range of the latter, and its spores prove typical of *D. clintoniana.* On the other hand occasional plants of *D. celsa* have fairly broad-based lower pinnae, and Mrs. Crane finds these to have markedly different spore sculpture. The workers who have considered *D. clintoniana × goldiana* identical with *D. celsa* are not to be criticized, for the resemblance is striking, and only through the finding of imperfect spores can individual collections be identified as this hybrid. *D. clintoniana × marginalis* presents the same problem, as does indeed also *D. goldiana × marginalis* (*D. × leedsii*).

Two years ago Mr. Robert H. Gaede guided Mrs. Crane and me to a swamp in northern New Jersey that was being destroyed by the construction of a super-highway, where there grew hundreds of hybrid *Dryopteris* plants with no sign of any parents nearby. These showed combinations of the characters of various *Dryopteris* species, including *D. celsa,* which is not known to grow that far northeast, although it may formerly have done so. Mr. Gaede was fortunately able to rescue a considerable number of clumps. It is to be hoped that other similar occurrences will be discovered in places not endangered by human activities.

UNIVERSITY OF PENNSYLVANIA.

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[15] Ferns SE. States, 274. 1938.

## New Forms in Botrychium virginianum[1]

W. J. CODY

While conducting field work in preparation for the Southern Ontario Field Trip of the IX International Botanical Congress, the author came upon a Rattlesnake-fern (*Botrychium virginianum*) which in addition to the fertile panicle bore sporangia on some of the pinnae of the otherwise sterile part of the frond. An examination of some 175 specimens of var. *virginianum* in the herbarium of the Canada Department of Agriculture did not reveal any other specimens with sporangia disposed in this manner. There were, however, two specimens among 50 sheets of var. *europaeum* which displayed this phenomenon.

Although the occurrence of such forms has been known for a long time,[2,3] they have apparently not been formally named. The following names are proposed:

BOTRYCHIUM VIRGINIANUM (L.) Swartz var. VIRGINIANUM f. **anomalum**, n.f. Ramus sterilis sporangia aliquot gerens.

Ontario: Renfrew County, McNab Township, 2½ miles west of Braeside, June 19, 1959, *Cody & Dore* 11133 (DAO, TYPE). Growing with the typical form (*Cody* 11134) in cut-over clearing in mixed *Thuja occidentalis, Abies balsamea, Populus tremuloides* woods in rich black moist shallow soil over limestone.

BOTRYCHIUM VIRGINIANUM (L.) Swartz var. EUROPAEUM Ångstrom f. **heterodoxum**, n.f. Ramus sterilis sporangia aliquot gerens.

Rich woods, Saskatchewan, McKague, June 25, 1935, *A. J.*

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[1] Contribution No. 106 from the Plant Research Institute, Research Branch, Canada Department of Agriculture, Ottawa.

[2] Chrysler, M. A. The nature of the fertile spike in the Ophioglossaceae. Ann. Bot. **24**:1–18. 1910.

[3] Clausen, R. T. A monograph of the Ophioglossaceae. Mem. Torrey Bot. Club. **19**:1–177. 1938.

*Breitung s.n.* (DAO, TYPE); Bois tourbeux, Quebec, Vieux-Comptoir, 52° 37′ N, 78° 42′ W, *E. Lepage* 32,232 (DAO).

The type specimen of f. *anomalum* has one of the lower pinnules of each of the two outer segments of the ternate normally sterile portion of the frond almost completely fertile. In addition five other pinnae scattered over the normally sterile portion of the frond also bear sporangia. The single isotype bears only a few sporangia on lower pinnules of the outer segments of the normally sterile portion.

The type specimen of f. *heterodoxum*, in addition to the fertile panicle, bears scattered sporangia on the normally sterile portion of the frond. These sporangia are found mostly on the basal pinnules of the lower pinnae. The single paratype is one of two plants mounted on a sheet. One of the lower pinnules of a large outer segment of the ternate normally sterile portion of the frond is almost completely fertile. A few sporangia are also to be found on basal pinnules of the lower pinnae of the other two segments. The other specimen mounted on the sheet belongs to f. *europaeum*.

## Taxonomic Notes on Ferns, II

C. V. MORTON

THELYPTERIS subg. THELYPTERIS sect. **Glaphyropteris** (Presl) Morton, ***comb. nov.***[1]

Some years ago I published a paper entitled "New South American Species of *Dryopteris*, section *Glaphyropteris*,"[2] in which four new species were described and one variety raised to specific rank. The section *Glaphyropteris* is extremely close to the subgenus *Lastrea* of Christensen's Monograph of *Dryopteris*, differing only in the development of prominent aerophores at

[1] *Glaphyropteris* Presl, Abh. Boehm. Ges. Wiss. V, 5: 34. 1848. Typus: *Polypodium decussatum* L. *Dryopteris*, subg. *Glaphyropteris* C. Chr., Biolog. Arbeider Tilegnede E. Warming 80. 1911. *Thelypteris* subg. *Glaphyropteris* Alston, Jour. Wash. Acad. Sci. **48**: 234. 1958.

[2] Journ. Washington Acad. Sci. **28**: 525–530. 1938.

the base of the pinnae and also at the base of the costules in most species. This is a relative character, since some species classified as true Lastreas sometimes have minute aerophores, and doubtless is not of fundamental importance. *Glaphyropteris* can rank as no more than a section.

With the segregation of the large inclusive genus *Dryopteris* into smaller units, these plants fall in the genus *Thelypteris*. The following new combinations are necessary. Several species have already been transferred to *Thelypteris*—*D. canadasii* and *D. mapiriensis* by Alston and *D. Thomsonii* and *D. decussata* by Proctor. The others are:

THELYPTERIS **andina** (Morton) Morton, *comb. nov.*
*Dryopteris andina* Morton, Journ. Washington Acad. Sci. **28**: 526. 1938.

THELYPTERIS **boliviensis** (Morton) Morton, *comb. nov.*
*Dryopteris boliviensis* Morton, *op. cit.* 527.

THELYPTERIS **comosa** (Morton) Morton, *comb. nov.*
*Dryopteris comosa* Morton, *op. cit.* 528

THELYPTERIS **Tatei** (Maxon & Morton) Morton, *comb. nov.*
*Dryopteris Tatei* Maxon & Morton, Journ. Washington Acad. Sci. **28**: 529. 1938.

THELYPTERIS **brasiliensis** (C. Chr.) Morton, *comb. nov.*
*Dryopteris decussata* var. *brasiliensis* C. Chr. Dansk. Vid. Selsk. Skr. VII. **10**: 161. 1913.
*Dryopteris brasiliensis* Morton, *op. cit.* 529.

THELYPTERIS **polyphlebia** (C. Chr.) Morton, *comb. nov.*
*Dryopteris polyphlebia* C. Chr. Dansk. Vid. Selsk. Skr. VII. **10**: 161, *fig. 19.* 1913.

THELYPTERIS **macradenia** (Sodiro) Morton, *comb. nov.*
*Nephrodium macradenium* Sodiro, Rec. Crypt. Vasc. Quit. 47. 1883.
*Dryopteris macradenia* C. Chr. Ind. Fil. 276. 1905.

BLECHNUM PENNA-MARINA (Poiret) Kuhn

This attractive and characteristic species has been known from a number of widely separated localities—Australia, New Zealand, Chile and Patagonia, Tristan d'Acunha Island, Amsterdam Island, and Kerguelen Island. It is not reported from Madagascar in C. Christensen's Pteridophyta of Madagascar (1932), nor in Madame Tardieu's recent treatment,[1] but apparently it does grow there. Rather strangely, there are three sheets of the species in Christensen's home institution, the Universitetets Botaniske Museum, Copenhagen, that I discovered filed among the unidentified specimens of *Polypodium.*

Only one of the specimens is adequately ticketed, this one reading "Polypodium. *Commerson,* Madagascar, ded. Dr. Thouin, Hb. Vahlii," i.e. collected by Philibert Commerson in Madagascar, and presented by André Thouin, of the Muséum d'Histoire Naturelle, Paris, to Martin Vahl, Professor of Botany, University of Copenhagen, probably some time around the year 1800. If this were the only record, one might think of some mistake, but the other two collections also definitely say "Madagascar," and they are obviously from different collectors. One of them has no indication of the collector, but it is obviously an old sheet distributed from Paris. Some one will probably be able to recognize the handwriting, which is rather characteristic. The other sheet bears two initials indicating the collector, but these are not legible to me. [Can they refer to Pervillé?] It seems reasonable to conclude that *B. penna-marina* did grow in Madagascar 150 years ago and more. The absence of the species from recent collections is remarkable.

ASPLENIUM VARIANS Hook. & Grev.

Although common in India and China, this species has not been reported from Malaya. In the herbarium of the Universitetetes Botaniske Museum, Copenhagen, there is a specimen collected by C. W. Franck at "Gunung Pulae," Johore, April 20, 1924, that I so identify. It does not represent the divided form that is commonest, but a form that is merely deeply pinnate-pinnatifid, quite similar to a specimen in the U. S. National Herbarium from Yunnan, China (*Maire* 6108). This species has been known from Tonkin and Annam, and so its occurrence in Johore is not unreasonable.

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[1]In Humbert, Flore de Madagascar, 5th Fam. 2: 1–19. 1960.

## Some Records of Michigan Ferns and Fern Allies[1]

JARL K. HILTUNEN

In the western end of Chippewa County, Michigan, adjacent to Highway M-28, about 1.5 miles west of Hulbert, occurs a plant community with an unusual variety of plants. This part of the county is a swampland with intermittent, low, broad, sandy ridges, which are probably old glacial lakeshore deposits. The swampland is dominated almost exclusively by black spruce (*Picea mariana*), tamarack (*Larix laricina*), and white cedar (*Thuja occidentalis*), while the ridges support scattered pine trees, an abundance of bracken (*Pteridium aquilinum*), and blueberries (*Vaccinium* spp.). Information from the Michigan State Highway Department indicates that this segment of Highway M-28 was built in 1935. At that time, sand from some of the ridges was excavated for road construction, leaving a sandy, flat surface at the level of the surrounding swampland. This area remains moist most of the year, thus providing a suitable environment for a number of otherwise uncommon species of plants.

In the summer of 1954, I discovered this habitat and noted that, among other plants, certain species of club-moss were established there. These were mostly *Lycopodium clavatum, L. inundatum*, and *L. tristachyum*, together with another species which I did not recognize. I was unable to collect specimens, however, until the summer of 1956. In September of that year I revisited the area to collect a sample of the unknown club-moss[2]. The plant was relocated along the margin of the moist sand-flat, where the latter meets a bank of dry sand, a remnant of a partly removed ridge.

After a close examination, the plant was tentatively identified

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[1] Contribution No. 54 from the Department of Biology, Wayne State University, Detroit, Michigan.

[2] The author's collections are in the Herbarium, Biology Department, Wayne State University, Detroit, Michigan.

as *L. Selago*. Mr. Dale J. Hagenah, Cranbrook Institute of Science, and Dr. W. H. Wagner, Jr., Department of Botany, University of Michigan, agreed that it was this species or probably the variety *patens*. This proved to be an unusual find, for the only previous Michigan records of this species are from the western and central parts of the Upper Peninsula (Isle Royale, Keweenaw Peninsula, and Schoolcraft County). In July, 1957, however, I found the species in Ontario, along a margin of an upland lake, two or three feet from water's edge. This latter station, which is approximately 30 miles north of Sault Ste. Marie, is in a region that is mountainous and unlike that in Chippewa County. Judging from the above, *L. Selago* apparently is established in scattered moist habitats around the eastern end of Lake Superior.

On a third visit to the moist, sand-flat area in Chippewa County, in July, 1957, I found a few individuals of a previously overlooked club-moss that had the appearance of *L. tristachyum*. Among them was a variant with only four or five branches arising from one underground rhizome. Its specific determination was made more difficult by the fact that the plant was sterile. Further study showed, however, that the variant was not *L. tristachyum*, but that it appeared to be *L. sitchense* (*L. sabinifolium* var. *sitchense*). The specimen was sent to a student of the genus, Mrs. Joan H. Wilce, of the University of Michigan, who confirmed its identity. The only published Michigan records of this taxon are from Iron and Marquette Counties,[3] near the western end of the Upper Peninsula, so that this new record, as in the case of *L. Selago*, establishes a notable eastward range extension in Michigan.

Mr. Dale Hagenah recently visited the area described above and informs me that he has found the grape-fern *Botrychium simplex* in this habitat. The discovery of the grape-fern constitutes the third known record for the county, the first two being

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[3] Billington, Cecil. Ferns of Michigan. Cranbrook Institute of Science, Bull. 32, 1952.

those of Hagenah,[4] who found the species in a woodland habitat near Trout Lake.

Since the discovery of this community, it has been found to bear other vascular plants worthy of note: *Botrychium multifidum, B. virginianum, Carex flava, Gentiana rubricaulis, Habenaria clavellata, Juncus articulatus, Epigaea repens, Equisetum palustre, E. variegatum, Ophioglossum vulgatum, Scirpus hudsonianus,* and *Spiranthes cernua.*

WAYNE STATE UNIVERSITY, DETROIT, MICHIGAN.

## Shorter Notes

RECENT FERN DISCOVERIES IN WESTERN PENNSYLVANIA.—Although western Pennsylvania is relatively well known botanically, two interesting ferns have been discovered here recently:

LYGODIUM PALMATUM (Bernhardi) Swartz. Climbing Fern.

This fern has not previously, to our knowledge, been collected in western Pennsylvania, although it is known from northeastern Pennsylvania, southern Ohio, and West Virginia. In June, 1959, Mr. Robert Leberman, of Meadville, Pennsylvania, found a colony of Climbing Fern one mile north of Sugar Lake, Crawford County, in northwestern Pennsylvania. The plants were twining over cinnamon ferns and other vegetation in a mixed woods of red maple, yellow birch, and white pine.

WOODWARDIA AREOLATA (Linnaeus) Moore. Netted Chain-Fern.

Over fifty years ago, Dr. O. E. Jennings, Director Emeritus of the Carnegie Museum, collected this fern in the vicinity of Half-Moon Swamp, north of Mercer, in Mercer County, Pennsylvania. Until 1959, this was the only known collection in western Pennsylvania, although several efforts have been made to relocate this fern. Due to partial draining of the swamp, and other changes attendant on the passage of half a century, the plants could not be found and were suspected of being extinct. In June, 1959, however, the authors succeeded in finding a flourishing colony in a low wet woods in a part of the swamp not

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[4] Hagenah's collections are in the Herbarium of Cranbrook Institute of Science, Bloomfield Hills, Michigan.

previously investigated. With it grew such plants as wild calla and Virginia chain-fern—both rather rare in Pennsylvania so far south. Natives tell us that there was at one time a stand of American larch in this swamp.—L. K. HENRY and W. E. BUKER, *Carnegie Museum Herbarium, Pittsburgh, Pennsylvania.*

FERN MONSTER?—Our member Mr. George R. Proctor has sent a clipping from The Star, Kingston, Jamaica, with the headline "Asked to Fight Lake Monster," and the dateline September 20, 1960, Salisbury, Southern Rhodesia:

"The Federal Government of Rhodesia and Nyasaland has asked the United Nations to help fight a battle. It is asking for scientists to help conquer the 'Monster of Lake Kariba.'

"Although Kariba is the largest man-made lake in the world—it was officially opened by the Queen Mother earlier this year—90 square miles of its 1160 square mile surface has been covered by a fast-growing weed called *Salvinia auriculata,* known locally as 'The Monster.'

"Because the weed is so fast growing and cannot be controlled, the government is worried that before long it will cover the whole lake. This could bring the giant power supply engines to a standstill, partially crippling the Federation's economy.

As the problem is getting out of hand, the United Nation's Food and Agricultural Organization has been asked to send a scientific team to Kariba to find a way of controlling the weed."

CYSTOPTERIS TENNESSEENSIS Shaver.—In October, 1958, I collected one live plant of *Cystopteris tennesseensis* from Shaver's type station on the north-facing bluff below the quarry on Round Lick Creek near Highway US 70N. The station, I would say, is destroyed or nearly so by the quarry there, as I could only find one or two plants.

This plant was considered a hybrid by Dr. Shaver—*C. bulbifera* × *fragilis* var. *protrusa* (Ferns of Tennessee, p. 327). I planted the spores in October on sand plus peat-moss. They were fertile, for I now have typical plants bearing both spores and bulbils. The bulbils grow rapidly into nice plants. I would say that if *Cystopteris tennesseensis* is a hybrid, it is a fertile one and can be classed as a species.

I now have about fifty plants from the spores and will keep a colony growing, so that plants from the type station will continue to be available.—RALPH H. BENEDICT, *3106 Lapey Street, Rockford, Illinois.*

PELLAEA ATROPURPUREA.—The new edition of "Ferns and Fern Allies of Texas," by Donovan S. Correll, reviewed in an earlier volume of this journal,[1] gives on page 10 a schematic representation of the life cycle of a typical fern, using as an example *Pellaea atropurpurea*, as shown both by the drawing of the leaf and in the description of the figure. In the figure, *P. atropurpurea* is shown to have a sexual life cycle. This seems to be a noteworthy discovery, especially if sexual plants are as widespread as Mr. Correll indicates by choosing it to represent the prothallus of the entire fern flora of Texas. In fact, on page 116 in his book he says that this species "is perhaps the most widely distributed fern in Texas."

I have been interested for some time in the prothalli of *P. atropurpurea* and have grown them from spores collected by myself in the Ozarks and from spores kindly sent me from the Missouri Botanical Gardens by Mrs. Alice Tryon (original collection from Gray Summit, Missouri). Prothalli from both of these sources are apogamous.

That *P. atropurpurea* is apogamous has been known for some time. Reported first by Steil in 1911[2] and again in 1918,[3] it was studied in some detail by Manton[4] and discussed in her chapter on apogamy in "Problems of Cytology and Evolution in the Pteridophyta."[4] Miss Manton obtained spores (through the kindness of the late Mr. Alston of the British Museum) collected in the wild in California and found strong evidence of her material

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[1] THIS JOURNAL **47**: 79–81. 1957.

[2] Steil, W. N. Apogamy in *Pellaea atropurpurea*. Bot. Gaz, **52**: 400. 1911.

[3] Ibid. Studies of Some New Cases of Apogamy in Ferns. Bull. Torr. Bot. Club **45**: 96. 1918.

[4] Cambridge University Press (England) 1950, chap. 10, pp. 184, 185.

being triploid with a chromosome number'' of about or exactly 87.* This same number was obtained by Tryon and Britton for Mrs. Tryon's collection from Gray Summit, Missouri,[5] and for those who may be interested, my drawing of one of the apogamous prothalli appears in that paper.

That material of *P. atropurpurea* critically studied to date has been found to be apogamous does not, of course, preclude the existence of sexual plants of this species. The interesting case of *Asplenosorus ebenoides* immediately comes to mind—readers will remember Dr. Wagner's contribution in this journal.[6]

I should be happy to receive leaves of the Texan *P. atropurpurea* (in good fruiting condition, *i.e.*, leaves dropping spores) in order to grow the prothalli for points of comparison with those from Arkansas and Missouri which I have already studied. —LENETTE R. ATKINSON, *415 South Pleasant St., Amherst, Mass.*

## Recent Fern Literature

FLORA MALESIANA, Ser. II. PTERIDOPHYTA, vol. 1, pp. 1-64. 1959, by R. E. Holttum.[1]—Professor Holttum, having finished his magnificent job on the ferns of Malaya, has now turned his attention to the ferns of Malesia, that fern paradise in the South Seas consisting of Java, Sumatra, Borneo, New Guinea, and hundreds of smaller islands. This first part contains a brief general discussion of fern morphology, a key, admittedly tentative, to the genera, a bibliography, and a treatment of two families, the Gleicheniaceae and Schizaeaceae. The treatment is admirable—a model for other taxonomists—being usable and detailed, yet compact, in marked contrast to many contem-

* This ''evidence'' is suspect because *Pellaea atropurpurea* does not occur ''in the wild'' in California.—C. V. M.

[5] Tryon, Alice F. and Donald Britton. Cytotaxonomic Studies on the Fern Genus Pellaea. Evolution **12:** 137–145. 1958.

[6] Wagner, Warren H., Jr. A Cytological Study of the Appalachian Spleenworts. THIS JOURNAL **43:** 109–114. 1953.

[1] Available from P. Noordhoff, Ltd., Groningen, Holland, $2.65.

porary works, too many of which seem to be just skeletons, containing only the bare bones, or at the opposite extreme diffuse discussions in which it is hard to locate any definite or satisfying conclusions. Holttum's works are always contributions to knowledge, because they are original, in both senses of the word —they are never just compilations, composed of parrotings of other people's descriptions and ideas, and they always have new and stimulating ideas of their own; they are sure to remain indispensable to pteridologists. The many drawings deserve special mention, for they are models of botanical illustration. One can only wish Dr. Holttum an unusually long life, for a treatment of all the ferns of Malesia on the same scale as this beginning is a lifetime job.—C. V. MORTON

Recent publications of our Honorary Member GUALTERIO LOOSER that may be mentioned are: Los Helechos de la Isla de Pascua,[1] an account of the ferns of Easter Island, that isolated island in the South Pacific 2,000 miles west of Chile; and Clave de los Blechnum (Filicales) de Chile,[2] a supplement to a previous (1947) paper on Chilean Blechnums.—C. V. MORTON

NEW POLICIES FOR THE BRITISH FERN GAZETTE.—The most recent issue of the British Fern Gazette (Vol. 9, No. 1) makes very interesting reading for American Fern Society members. In a foreword, the new editor, Mr. A. C. Jermy,[3] explains changes in policy adopted by the Council of the British Pteridological Society. He notes that "An interest in fern variation has been foremost in the Society from its beginning and this interest has in later years resulted in two factions. One is the fern grower who is anxious to find new and attractive varieties for his collection; the other is the taxonomist, equally interested in finding varieties, but who is interested also in the conditions under which the plant is growing and its possible relationships

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[1]Revista Universitaria (Santiago, Chile) **XLIII**: 39–64, *fig. 1–16.* 1958.
[2]Revista Universitaria **XLIII**: 123–128. *fig. 1–17.* 1958.
[3] Mr. Jermy has succeeded to the post at the British Museum held by Mr. A. H. G. Alston, deceased. For the Gazette, he succeeds the Rev. E. A. Elliot, also deceased.

to other varieties and other species." The new policies of the Society provide for an extension of interest to fern allies and to pteridophytes from all parts of the world. It would appear that henceforth the Fern Gazette will have a much wider interest for fern students the world over and that the British Pteridological Society should find a greatly expanded membership. The ranks of British botanists, since the time of Bolton in 1795, have always included leaders in the study of ferns, both as to classification, in the fundamental field of morphology and phylogeny (Bower and Lang), and in genetics and cytogenetics (Anderson-Kötto, Manton and Walker).

This recent issue implements the new policy by its contents: A complete checklist of British pteridophytes carried down to counties and vice-counties by Mr. Jermy; a clearly and simply written account by R. E. Holttum of significant vegetative differences among common fern genera by which modern fern students supplement characteristics of fruiting structures formerly the chief reliance; and an article on the geographic affinities of New Zealand pteridophytes, by J. D. Lovis. There are shorter notes and also five pages which deal with the annual (1959) field excursion and other matters of Society activities.

A few comments on some of the articles follow. The Holttum discussion is a presentation by an expert taxonomist of data of real interest to amateurs, including beginners. I do not recall that the Fern Journal has ever published anything of this sort. The Jermy "Census" provides the best possible basis for a comparison of British fern flora with that of our own. That the British Isles offer fern species not found elsewhere has been noted before. Of the 73 species listed, two only are noted as aliens which have had limited establishment, the sensitive fern and the Pacific holly fern, *Cyrtomium falcatum*. A dozen hybrids furnish additional distinctive taxa to the species list. Only one is also found in the U. S., *Dryopteris uliginosa* (*D. cristata* × *spinulosa*). Among the others are two crosses between the hart's-tongue, almost ubiquitous in many parts of Great Britain, and two species of spleenwort; also several crosses involving the male fern and the mountain wood fern, *D. dilatata.* For the United States, I believe only one male fern cross has been reported, Winslow's find of *D. filix-mas* × *marginalis.* With us, *D. dilatata* has a higher altitudinal distribution, which usually keeps it out of much contact with our lowland species, among which many hybrids have been reported. I recall one Adirondack station with a good growth of *dilatata* and *D. intermedia* in which there were indications of possible crossing.

For the benefit of those who may wish to enroll as members of the British Pteridological Society, the following information is offered: The Society publishes at present one issue a year of the Gazette (the present issue is 32 pages). It conducts an annual summer excursion and holds one December meeting indoors. Members take part in plant exhibitions. The officers stand ready to provide information by correspondence. The dues are ten shillings per year and applications may be sent to the Secretary-Treasurer, Mr. J. W. Dyce, Esq., "Hilltop," 46 Sedley Rise, Loughton, Essex, England.—RALPH C. BENEDICT.

## Notes and News

ANNUAL MEETING:—The annual meeting of the American Fern Society will be held during the last week of August at Purdue University, Lafayette, Indiana, in connection with the meetings of the A. I. B. S. Will members desirous of reading papers at this meeting please send the titles and approximate length *immediately* to the Secretary, Dr. Donald Huttleston, Longwood Gardens, Kennett Square, Pennsylvania. The annual field-trip will be held in Kentucky just prior to the meeting. Members and friends interested should write for information to Mr. Thomas McCoy, Catlettsburg City Schools, Catlettsburg, Kentucky, who has kindly agreed to act as leader.

REPRINTS DESIRED.—Our member Dr. R. Pichi-Sermolli (Instituto Botanico "Hanbury," Via Balbi 5, Genova, Italy) is currently working on a new supplement to the Index Filicum. He asks that members of the American Fern Society, and other pteridologists, send him reprints of their taxonomic papers, especially those issued since 1933, the closing date for Supplement III. Papers published in the American Fern Journal are not needed.

Botrychium Transplanting?—In volume 48, number 4, of the American Fern Journal, Dr. Benjamin R. Allison asked the question why it is that botrychiums are so hard to transplant. I have five plants of *B. dissectum*, two of *B. multifidum*, and also several of *B. virginianum* that I moved three years ago. The multifidums have increased in size, the dissectums this year grew two fertile and two sterile leaves to each plant, and the virginianums have remained the same size. They are all in sandy soil on the north side of a building, well mulched with leaves at all times and kept well watered.—Ralph H. Benedict, *3106 Lapey Street, Rockford, Illinois.*

## American Fern Society

### Report of the President for 1960

The American Fern Society celebrated the fiftieth anniversary of the establishment of the American Fern Journal by printing over 300 pages, a new record. Although the cost of these extra pages exceeded the original budget for the year, it was deemed worthwhile to draw upon our reserve funds for this expense, and some members made contributions also. L. R. Bolton, President of the British Pteridological Society, sent hearty congratulations for the fiftieth year of publication of our Journal.

Last May witnessed the gala opening of the Fern Valley in the U. S. National Arboretum. This project, initiated in 1953 and supported by the National Capital Gardening League and others, has been under the supervision of one of our members, James W. Johnson. A full account will be published in a later number of the Journal. Plan to visit it the next time you are in Washington.

Your President was able to accept the invitation of Biological Abstracts to attend its symposium and house warming in celebration of its twenty-fifth anniversary and its move to new quarters.

The successful operation of the American Fern Society falls upon the shoulders of the other officers and members of the Council, and I wish to express my appreciation to them for their willing cooperation. Conrad Morton, as Editor, has had a very active part in soliciting papers and in the time-consuming task of preparing the Journal.

Walter S. Phillips, with the aid of his wife, has had the exacting fiscal duty of collecting membership dues and subscriptions to the Journal, and keeping the books, a task which has materially absorbed much of his time, leaving him very little opportunity for research or leisure.

Dr. R. C. Benedict's request to be relieved of his editorial duties was accepted with regret. The Society appreciates very much his interest and contributions over a period of 50 years. The resignation of Dr. A. C. Smith from the editorial board has also been accepted. Dr. Rolla M. Tryon, Jr., has accepted appointment to the editorial board.

Dr. Tom Cooperrider, Kent State University, Kent, Ohio, has been appointed Custodian of the back files of the Journal. At one time they were in the custody of Mr. E. J. Winslow; then transferred to Dr. Henry Svenson at the Brooklyn Botanical Garden; then in 1947 to Conrad Morton in Washington.

Dr. A. C. Smith has been the Society's representative on the AAAS Council for the past three years and has asked to be replaced. Each year he has submitted an excellent report on the activities of the Council.

Mrs. K. Boydson's enthusiasm and work has made the spore exchange a success.

Dr. Dwight W. Moore organized and led a highly successful field trip in northern Arkansas last August, the details of which will appear elsewhere.

Dr. Edgar T. Wherry kindly contributed the revenue derived from sales of his book "Guide to Eastern Ferns" to the American Fern Society, a gracious act showing his love and interest in the Society.

Our member Dr. W. H. Hodge, Chairman of the Editorial Committee of the American Horticultural Society, wrote me that his organization is interested in devoting a special issue of the National Horticultural Magazine to ferns. The Horticultural Society will assume the cost of publication if members of the Fern Society will undertake preparation of the manuscript. The proposed publication is to stress the horticultural importance of ferns; their propagation; how to grow them; kinds suitable for gardens in different sections of the United States; and kinds suitable for house plants. The exact scope is to be determined by an editorial committee which will have the problem of finding individuals who are willing to write on assigned topics. This project was discussed briefly at the meetings in Stillwater, and most of those present were in favor of it. It seems like a wonderful opportunity to prepare a much-needed publication. Several members have accepted appointment to this committee and are preparing lists of topics to be considered. After the scope of the publication has been approved, members will be asked if they will write on some phase in which they have had experience.

There has been some dissatisfaction with the procedure followed in selecting candidates for offices in the annual election. Although the procedure followed is that specified in our Constitution, it seems more democratic to present a dual slate so that members may have a choice. The constitution will be examined and, if necessary, steps will be taken to modify it if the members wish. I am ready for your suggestions.

Mr. Thomas N. McCoy, Catlettsburg, Kentucky, has kindly consented to lead the annual fern foray next August in the vicinity of Carter Caves, Natural Bridge, and Cumberland Falls, Kentucky.

In conclusion, I would like to say that, on my part, I have enjoyed being your President for the past year. You are a pleasant and wonderfully congenial group.

Respectfully submitted, CLAIR A. BROWN, *President*

**Report of the Secretary for 1960**

Due to the fact that a number of delinquent members were dropped from the rolls in July, the membership dropped for the first time in a number of years, from 797 to 749. By December, however, we had partially recovered from this drop and the present membership stands at 776. All are urged to persuade interested non-members to join so that we can resume our increase.

I am sorry to report the deaths of six members of long standing: Mrs. Walter Beck (1928), the Rev. E. A. Elliot (1939), Mr. F. N. Irving (1940), Dr. H. H. Bartlett (1944), Mr. H. B. Rust (1944), and Dr. S. F. Blake (1945). A note about Mr. Irving appeared in Volume 50, Number 2, 1960, of the Fern Journal.

The annual field trip, in the Ozarks of Arkansas, was well attended and is being reported upon elsewhere in the Journal.

The annual meeting of the Society was held in connection with the A.I.B.S. on the campus of Oklahoma State University, Stillwater, Oklahoma, on August 24, 1960. Since only seven papers were presented, there was only a morning session, but it was well attended by about 50 persons and considerable interest was shown. At the session, presided over by President C. A. Brown, the following papers were presented: "Ferns as Experimental Tools for the Study of Idioblast Differentiation—an Initial Report," by George S. Dehnel; "Spore Studies in the Genus *Cystopteris*," by Dale J. Hagenah (read by Warren H. Wagner, Jr.); "Banister's First Descriptions of Ferns from Virginia (1679)," by Joseph Ewan (read by D. G. Huttleston); "Spore Studies in the Genus *Anemia*," by John T. Mickel (read by Richard White); "The Species of Evergreen Grapeferns (*Botrychium*)," by Warren H. Wagner, Jr.; "Fern Spore Studies," by Clair A. Brown; and "Practical Checks to Microscopic Illusions," by Clara S. Hires. Miss Hires also had an exhibit of her work in the Exhibit Hall.

The luncheon at twelve o'clock was presided over by Dr. Brown and was attended by 35 members. At a brief meeting following the luncheon a suggestion by the American Horticultural Society that the Fern Society write a handbook on cultivated ferns, for future publication as a special issue of "The American Horticultural Magazine," was discussed and it was considered to be a worthwhile project. A committee to look into the feasibility of the undertaking is being appointed by Dr. Brown. The Fern Society is grateful to Prof. U. T. Waterfall for acting as the Society's local representative and for making the arrangements for the meeting rooms and luncheon.

The annual meeting for 1961 will be held as usual with the A.I.B.S. meetings at Purdue University, Lafayette, Indiana, August 27-31. It is hoped that all who can will plan to attend and that a number will present papers. We are hoping to arrange a field trip preceding the meetings.

Respectfully submitted,

D. G. HUTTLESTON, *Secretary*

**Report of Treasurer for 1960**

The balance on hand at the end of 1960 was much smaller than it has been for the last few years. However, most members will agree that the 1960 50th Anniversary numbers were well worth the extra cost, and in spite of the expense in printing the special number we still are in the black.

Sale of back numbers continues to aid in our yearly receipts, but it is my opinion that the back numbers ought to be raised to be at least as high as the yearly annual subscription cost. They are now selling at 50¢ a number or $2.00 for the volume, which is 50¢ less than the yearly subscription price. Reprinting out-of-print numbers has proven expensive and more reprinting must be done soon. I suggest that $3.00 per volume or 75¢ per number is a fair price and that old numbers be sold only when available as extras not needed for complete volumes.

Correspondence seems to increase each year. Libraries, institutions, both private and governmental, and especially foreign organizations are requiring extra invoices and receipts and usually by air mail. The 10¢ extra for foreign postage hardly covers the cost of the business dealings necessary in most cases.

Funds in reserve at the Green Point Savings Bank remain untouched and have shown yearly increases as the interest accumulates, but they do not show capital gains. Some of the funds ought to be invested in mutual funds so that capital gains can be appreciated.

The Treasurer and his wife want to express appreciation to those who answer our annual dues billings promptly and hope more members will follow suit. Last year we mailed out 700 first notices, 400 second notices, 100 miscellaneous back notices and answered some 250 miscellaneous requests for receipts, and so forth.

*Receipts*

| | Amount | Total |
|---|---|---|
| Cash on hand, January 1, 1960 | | $1,195.50 |
| 1959 Membership Arrears | $ 94.25 | |
| 1960 Membership Renewals | 1,130.67 | |
| 1961 Membership Advances | 93.85 | |
| 1962 Membership Advances | 5.00 | |
| 1960 Membership Sustaining | 460.00 | |
| 1960 Membership New | 227.15 | |
| 1958 Subscribers—Arrears | 2.35 | |
| 1959 Subscribers—Arrears | 2.35 | |
| 1960 Subscribers—Renewals | 177.07 | |
| 1961 Subscribers—Renewals (advance) | 245.42 | |
| 1962 Subscribers—Renewals (advance) | 4.50 | |
| Sale of Back Numbers | 231.21 | |
| Sale of Reprints | 404.32 | |
| Advertising | 50.00 | |
| Gifts | 200.01 | |
| A.I.B.S. subscription by member A.F.S. | 1.00 | |
| | | 3,329.15 |
| | | 4,524.65 |

*Disbursements*

| | |
|---|---|
| A.F.J. Vol. 49, No. 4 | 487.43 |
| A.F.J. Vol. 50, No. 1 | 1,521.86 |
| A.F.J. Vol. 50, No. 2 | 654.66 |
| A.F.J. Vol. 50, No. 3 | 459.48 |
| Reprints | 387.74 |
| Envelopes, mailing and postage | 202.55 |
| Shipping Back Numbers | 26.77 |

| | | | |
|---|---|---|---|
| A.I.B.S. 1960 dues | 100.00 | |
| A.I.B.S. 1960 Sub. by A.F.S. Member | 1.00 | |
| Refund to Book Agent for Cancellation | 2.50 | |
| Editor Expense—1959, $25.00—1960, $1.37 | 26.37 | |
| Secretary Expense—1959, $10.00—1960, $4.86 | 14.86 | |
| Treasurer Expense—1960 | 63.49 | |
| President's Expense—1959 | 40.00 | |
| Purchase of Filing Cabinet | 38.13 | |
| | | 4,026.84 |
| Cash in Southern Arizona Bank, January 1, 1961 | | $ 497.81 |

*Statement December 31, 1960*

*Assets*

| | | |
|---|---|---|
| Cash in Southern Arizona Bank | | $ 497.81 |
| Cash in Green Point Savings Bank (Bissell Herbarium Fund) | | 723.73 |
| Cash in Green Point Savings Bank (Life Membership Fund) | | 830.99 |
| Cash in Green Point Savings Bank (Reserve Fund) | | 1,981.15 |
| Cash in Green Point Savings Bank (Una Weatherby Fund) | | 3,240.33 |
| Inventory—American Fern Journal | | 3,046.68 |
| American Fern Society Library | | 396.00 |
| | | 10,716.69 |

*Liabilities*

| | | |
|---|---|---|
| Advance dues collected | $348.77 | |
| Accounts Payable (Vol. 50, No. 4) | 613.99 | |
| | | 962.76 |

*Fund Balances*

| | | |
|---|---|---|
| Bissell Herbarium Fund | | 723.73 |
| Life Membership Fund | | 830.99 |
| Reserve Fund | | 1,981.15 |
| Una Weatherby Fund | | 3,240.33 |
| General Fund | | 2,977.73 |
| | | $10,716.69 |

Respectfully submitted,

WALTER S. PHILLIPS, *Treasurer*

**Report of the Auditing Committee**

We hereby certify that we have seen the books and accounts of Dr. Walter S. Phillips, Treasurer of the American Fern Society, Inc., and have obtained confirmation of the correctness of the Society's balances on hand as set forth in detail in the accompanying report of the Treasurer.

CHARLES T. MASON, JR.
RICHARD H. HEVLY
*Auditing Committee*

**Report of the Judge of Elections**

Three hundred and fifty marked ballots were received. The tally of votes is as follows:

For President:

| | |
|---|---|
| Clair A. Brown | 346 |
| Boughton Cobb | 1 |
| R. Pichi-Sermolli | 1 |
| Rolla M. Tryon,Jr. | 1 |
| D. S. Correll | 1 |
| | 350 |

For Vice-President:

| | |
|---|---|
| Marcel Raymond | 346 |
| A. J. Sharp | 1 |
| Rolla M. Tryon, Jr. | 1 |
| Tom Cooperrider | 1 |
| K. U. Kramer | 1 |
| | 350 |

For Secretary:

| | |
|---|---|
| D. G. Huttleston | 348 |
| Mrs. Geoffroy Atkinson | 1 |
| Mme. Tardieu-Blot | 1 |
| | 350 |

For Treasurer:

| | |
|---|---|
| Walter S. Phillips | 349 |

I therefore declare the following officers elected: Clair A. Brown, President; Marcel Raymond, Vice-President; D. G. Huttleston, Secretary; Walter S. Phillips, Treasurer.

Respectfully submitted,
Clark T. Rogerson, *Judge of Elections*

**Report of the Curator and Librarian for 1960**

This has been an important year of organization and expansion of the herbarium. Much curating was done, and numerous contributions were made. In our herbarium, according to counts made during the summer, the total of mounted and filed specimens was 8,192. The Department of Botany of the University of Michigan contributed help to bring the collections up to date. Over a thousand specimens were mounted with plastic by Misses Patricia Deacon and Darleen Helmick, including a large backlog of unmounted materials plus 50 specimens contributed by Edgar T. Wherry and 31 specimens sent by Daniel B. Ward. A total of 1,051 specimens, mostly newly mounted on herbarium sheets, were inserted in the Herbarium. Mr. F. W. Hunnewell kindly contributed in addition three sets of specimens, these already beautifully mounted, from his collections, a total of 310 sheets altogether. The results of these contributions and the mounting and inserting program give the Society Herbarium a total of 9,675 specimens as of the end of 1960.

Also, during this year a number of books and pamphlets were contributed to the Society's Library by E. T. Wherry, D. M. Britton, Barbara Joe Hoshizaki, John Thomas Howell, and Thomas Darling, Jr. The use of the Herbarium and Library, except by people in and around Ann Arbor, has been low again this year, with only three requests to borrow literature.

Respectfully submitted,

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

**Report on the 1960 Arkansas Foray**

American Fern Society members gathered at the dormitory of Arkansas College, Batesville, Arkansas, during the afternoon and evening of August 24, 1960. By 9 p.m. about 20 members had assembled and were briefed for the trip by Professor Emeritus Dwight M. Moore, of the University of Arkansas. A well-planned itinerary which also included geological profiles of the Buffalo and White Rivers and a check list of 41 species and varieties of ferns which we might expect to see was distributed to the members.

Our first stop on August 25 was at the Blanchard Springs Recreational Area some 50 miles northwest of Batesville. A sizeable stream flowing out of and over the Everton limestone in a wooded valley provided the habitat for several ferns and other cryptogams such as *Rhodobryum, Thuidium, Conocephalum,* and *Dumortiera.* The latter was growing close to the spring falls where the water came from the rocks. By following the nearly empty stream bed above the spring we enjoyed the coolest and most unusual microclimate of the trip. A sinkhole from which issued cool moist air (ca. 64°F) allowed the rather lush growth of a number of ferns and sustained some flowering plants not otherwise found in Arkansas. Some of the ferns seen in this area were *Adiantum pedatum, Asplenium resiliens, Botrychium virginianum, Camptosorus rhizophyllus, Cystopteris fragilis, Dryopteris hexagonoptera, Osmunda Claytoniana, Pellaea atropurpurea, Polystichum acrostichoides, Pteridium aquilinum* var. *latiusculum,* and *Woodsia obtusa.* As we left the area a search was made along the roadside for *Cheilanthes alabamensis,* the smooth lip-fern, but it was not found.

During lunch time at the Barkshed Recreational Area considerable time was allowed for exploring the area on our own. Though many of the group were not too active after topping off our sack lunches with watermelon which Clair Brown and his family provided, several of the members discovered a nice stand of *Athyrium pycnocarpon* at the base of a tall limestone cliff. *Asplenium platyneuron* was growing in the grass at our picnic area.

A rest stop was made at the forest ranger station at the top of the surrounding hills. We had expected to see a young bobcat but had to be content to see the hounds which had played with it too hard and killed it. Back down at the stream level where we were tempted to go swimming the largest display of *Adiantum Capillus-veneris* some of us had ever seen covered the under side of an undercut rocky river bank. Close access was not possible and we had to be content with views from across the water by means of binoculars. Other ferns seen in this camp ground area were

*Athyrium asplenioides* and *Cystopteris bulbifera.* Near a small spring on the hillside there was an abundant growth of *Selaginella apoda* and a moss, *Fissidens.* The capture of a large copperhead snake which had been basking in the sun only a few feet from where most of the group had climbed a bank provided the excitement for the day.

Returning to an area across the White River from Calico Rock, we stopped at City Rock Bluff on top of a sandstone flat some 300 feet directly above the White River. Hanging several feet below the top of this sheer cliff were several plants of *Woodwardia areolata* protected somewhat in the crevice where they grew, but certainly out of their typical habitat in swamps 100 miles to the southeast. Besides this chain fern other ferns found here included *Polypodium virginianum* and *P. polypodioides, Dennstaedtia punctilobula,* rare in Arkansas, and *Asplenium Bradleyi* with small tapering fronds and stipes brown at base and green at tip. The mosses *Climacium, Grimmia,* and *Sphagnum* were conspicuous near the edge of the cliff. *Selaginella rupestris* grew abundantly in the open areas on this sandstone flat.

Descending to the White River our caravan crossed the river on a ferry which held 3 cars and was propelled back and forth by the current of the river.

One disappointment on the trip came as we discovered that the Bull Shoals Park Lodge, where we had planned to stop for supper and stay overnight, was temporarily without a supply of water. However some water was provided to wash off some of the day's accumulated dust and soon afterward a bounteous fried chicken dinner served family style restored us to amiable spirits. Mr. and Mrs. Charles Dear joined us during dinner and continued the rest of the trip with the group. The lodge manager called local motels and found rooms sufficient for the entire group.

Friday, August 26, on the way to Harrison, we made a roadside stop along the highway to observe the differences between *Juniperus virginiana* and *Juniperus Ashei.* Beyond Harrison the only car trouble which happened on the trip occurred. Dr. Jewel

Moore's car overheated and caused her to miss part of the trip. On the way in to Big Bluff, the roughest road on the trip, a protruding rock broke the exhaust manifold of Mrs. Blanche Dean's car. Mr. Dear was able to wire the parts approximately in place and Mrs. Dean went in to Fayetteville after lunch to have it repaired.

At Big Bluff the fern of most prominence was *Cheilanthes Feei* growing in the cracks of the limestone bluff. The top of the bluff is composed of Boone chert which showed numerous flint deposits in the limestone.

We ate lunch in a little private park adjacent to Scroggins Store, near Ponca. The store was a rather picturesque Ozark mountain general merchandise-grocery store where a variety of items could be purchased.

Friday afternoon we visited Lost Valley, a secluded area off the highway between Ponca and Boxley. Up the valley of a small stream a high, overhanging cliff gave a shaded place for resting to the few hardy members who scrambled up the rocky stream bed. Along the stream were several ferns, some growing quite luxuriantly. Those seen at Lost Valley were *Asplenium platyneuron, Asplenium Trichomanes, Asplenium resiliens, Adiantum pedatum, Botrychium virginianum, Camptosorus rhizophyllus, Cystopteris bulbifera, Dryopteris marginalis, Dryopteris hexagonoptera, Polypodium virginianum,* and *Polystichum acrostichoides.*

Before reaching Boxley we were shown an excellent display of *Adiantum Capillus-veneris* growing down the side of an undercut roadside embankment. From between the closely clustered fronds of this fern hung long slender strands of a soft lime material from which water dropped to the ditch below.

On a side road a few miles from Marble we stopped beside a limestone cliff of the Boone formation. Here we were able to see *Pellaea glabella* and *P. atropurpurea* growing close together, affording a nice comparison. *Cystopteris bulbifera* and *Asplenium Trichomanes* also grew along the cliff.

This was our last field stop for the day. A short while later we checked in at the Chief Motel in Fayetteville, where swimming, eating, and talking were all enjoyed after we were cleaned up from a dusty road trip.

Saturday morning the group congregated at the Union Building of the University of Arkansas for pictures and to get acquainted with new members of the foray. Later that morning on a trip west from Fayetteville we turned off the highway and proceeded through Savoy and on to a steep east-facing hillside of Boone chert. Near the top of this hill we were afforded the rare opportunity of seeing and photographing three species of *Cheilanthes* growing together, *C. alabamensis, C. lanosa,* and *C. tomentosa.* Also *Notholena dealbata, Pellaea atropurpurea,* and *Woodsia obtusa* were seen at this location. Further on at Lake Wedington we were priviledged to see an abundant growth of *Pilularia americana* (pillwort) and were told an absorbing story by our leader, Dwight Moore, of the rediscovery of *Pilularia* in Arkansas and of its distribution in new artificial lakes which are being created in the state.

On the way back to Fayetteville we investigated a poison ivy infested corner of a section north of Farmington. Most of us were turned back by the combination of Smilax and poison ivy. This poison ivy was the type that grew erect through the vegetation to about head height as a relatively unbranched young tree and then branched out forming a canopy that was hard to avoid. The three or four hardy members who braved the thicket were rewarded by finding *Botrychium dissectum* and *B. d.* var. *obliquum,* samples of which they brought out with them to show to the rest of the group.

Saturday afternoon our trip took us north of Fayetteville to Martin's Bluff. This was on a stream which was being dammed and the whole area was to be flooded. Collecting, therefore, was without limitation. Since many of us were heading toward Stillwater and the AIBS meetings, however, there was relatively little collecting done. There had been high water in the area but a number of ferns and other cryptogams were conspicuous and in plentiful supply. Many of the ferns which had been previously seen were found here also. In addition, we found *Onoclea sensibilis* and *Osmunda cinnamomea,* the latter peculiar in that it was growing as a cliff fern. A frond of *Dryopteris marginalis* found at this location was the smallest fertile marginal shield fern that I had ever seen.

We were able to see at least 36 of the 41 ferns on our list. All of us are indebted to Dr. Moore for his very capable leadership and for arranging such a fine trip.

Those attending the foray all or part of the time were Mr. and Mrs. Ralph H. Benedict, Mr. and Mrs. Clair A. Brown, Sarah Brown, Alan G. Cazart and daughters Cissy and Jeanie, Maxine Clark, Blanche E. Dean, Mr. and Mrs. Charles Dear, Elizabeth Eddy, Inez Hartsoe, Donald G. Huttleston, Sylvia B. Leatherman, Robert C. Lommasson, Amy Mason, Aileen McWilliam, Doris Milan, Jewel Moore, Dr. Dwight M. Moore, Marcel Raymond, Eva Sobol, and Mary Walker.—ROBERT C. LOMMASSON.

### NEW MEMBERS

Mrs. Elizabeth Arnold, Woodside Fernery, Route 2, Box 848, Jacksonville 7, Florida

Mr. M. Bange, 24 Rue Grenette, Lyon 2, France

Mr. Henry S. Blethen, 47 Federal St., Reading, Mass.

Miss Nona Ford Boeck, 4702 Dietrich Road, San Antonio 2, Texas

Mrs. M. Quince Bullock, 5915 S.W. 4th St., Miami 44, Florida

Mr. William E. Bulmer, 8427 Bird Road, Miami, Florida

Mrs. E. M. Carroll, Paradise, California

Mrs. R. Granville Curry, River Road, Rockville, Md.

Angie Estill, 153 Navarre Drive, Miami Springs, Florida

Mrs. Brooks Evert, 430 Thomas Avenue, Riverton, New Jersey

Mr. Miles T. Garber, Jr., R. D. 1, Carlisle, Penna.

Mrs. Ronald S. Gray, 64 North St., North Reading, Mass.

Mrs. Edward I. Griffith, 135 Athania Place, Metairie, Louisiana

Mr. Edward N. Hallman, 2308 Coventry Avenue, Lakeland, Florida

Mrs. David E. Harris, 713 E. Orange St., Lakeland, Florida

Mr. N. Keith Harrison, Dept. of Botany and Bacteriology, Montana State College, Bozeman, Mont.

Mr. David W. Hutchings, Science Department, Cazenovia Junior College, Cazenovia, New York

Miss Alice C. Jones, 218 High St., Mt. Holly, New Jersey

Dr. Alan Johnston, Route 6, Martinsville, Indiana

Mr. E. W. Johnson, 15 Elinor Avenue, Mill Valley, Calif.
Mrs. John N. Keers, Sr., 4290 Ristow Drive, La Canada, Calif.
Miss Ethel E. King, 129 South Buena Vista Drive, Dunedin, Florida
Mrs. Helen B. Krechiak, Ozone, Tennessee.
Mr. Charles Lapetina, 310 West 18th St., Houston 8, Texas
Mrs. J. L. Linkenhoger, 45 Carolane Trail, Houston 24, Texas
Mr. D. A. MacInnes, Rockefeller Institute, New York 21, N. Y.
Mr. Harry F. Malone, P.O. Box 1333, Cocoa, Florida
Miss Norma A. Maloney, 1600 N. Rodney St., Wilmington 6, Delaware
Mrs. Lee B. Marshall, 25 Farmingdale Road, East Brunswick, New Jersey
Mrs. James H. Mason, Box 251A, Route 1, West Terre Haute, Indiana
Mr. Frank F. Morr, 830 Sheridan Road, Evanston, Illinois
Mrs. Martha H. Mosier, 490 West Washington St., Martinsville, Indiana
Mr. Clarence Muhlick, Botany Department, University of Washington, Seattle 5, Washington
Mr. W. P. Murray, 249 Seaview Avenue, San Rafael, Calif.
Mrs. Franz D. Nagel, P.O. Box 2615, Juneau, Alaska
Mrs. Claire A. Nail, 1555 33rd Ave., San Francisco 22, Calif.
Mrs. Jacintha S. Paschal, Fernbrook Farm, Route 4, Charlottesville, Va.
Mr. S. N. Patnaik, Botanical Survey of India, Eastern Circle, Shillong, Assam, India
Mr. James D. Perry, Dept. of Botany, University of Georgia, Athens, Ga.
Mr. George Postma, 847 Courtney St. N.W., Grand Rapids 4, Michigan
Mr. L. G. Ragsdale, P.O. Box 17, Craig, Florida
Mrs. Arno Reddel, Harbert, Michigan
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Mr. Dean H. Ross, Route 4, Box 128, Johnstown, Penna.
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Mr. Charles E. Stevens, 615 Preston Place, Charlottesville, Va.
Mr. Donald E. Tate, 314 E. Garland St., West Frankfort, Illinois
Mr. William Carl Taylor, 8914 Francis Court, St. Louis 23, Missouri
Dr. Edmund A. Turnau, 20329 Lakeshore Road, Baie d'Urfe, Quebec, Canada
Mrs. P. E. Votaw, P.O. Box 516, Brazoria, Texas
Mrs. E. O. Williams, 2601 Acacia Court, Fort Lauderdale, Florida
Mr. David L. Woolsey, Route 1, Box 140, Ione, Calif.

## Changes of Address

Dr. Ralph D. Ade, 2805 26th St., Moline, Illinois
Mrs. Lenore Alexander, 2104 Grant Ave., Redondo Beach, Calif.
Mr. Walter S. Allen, 2 Pool Road, New Haven, Conn.
Mr. Oscar J. Byers, Jr., 563 28th St., Oakland 9, Calif.
Mr. Thomas O. Carlson, 1627 Peachtree St., N.E., Atlanta 9, Georgia

Mrs. Ruth W. Cotton, 13 High St., Beverly Farms, Mass.
Miss Ione Covert, 1105 Elizabeth St., South Norfolk 6, Va.
Mrs. Lewis L. Delafield, Piermont Road, Hewlett, L. I., New York
Dr. Charles E. DeVol, 65 Wan Shen St., Chingmei, Taipei, Taiwan, Free China
Mr. Michael K. Eosefow, 83 Salem St., Andover, Mass.
Mr. Austin M. Evans, Dept. of Botany, University of Michigan, Ann Arbor, Michigan.
Mrs. Alexandra T. Filer, 12665 Highview Lane, Redlands, Calif.
Mrs. George N. Gardiner, Pikes Hill Road, Weston, Vermont
Mr. Arnold Hall, Box 511, Sandy Hook, Conn.
Miss Muriel P. Hegwood, 402 Randolph St., Radford, Va.
Mr. E. F. Heim, Jr., 5216 Locust Ave., Carmichael, Calif.
Mrs. Herman Heinlein, Route 2, Box 92, Homestead, Florida
Mrs. Ralph Linfoot, 6886 Farm Brook Drive, Cincinnati 30, Ohio
Mr. Ray McAdams, Apt. E-4, Harold Apts., 1130 Woodward Heights Blvd., Hazel Park, Michigan
Mrs. Juanita S. McCoy, Biology Dept., Salem College, Salem, West Virginia
Dr. Jewel Moore, Box 915, Arkansas State Teachers College, Conway, Ark.
Dr. E. W. Murphy, % Timberly, 801 Norwood Road, Silver Spring, Md.
Mr. David N. Perry, 276 Shorewood Drive, Webster, New York
Mr. & Mrs. Eugene Peterson, 1140 South Spruce Drive, Bozeman, Mont.
Mr. John T. Reynolds, 12 E. Scott St., Chicago 10, Illinois
Dr. Howard F. L. Rock, Dept. of Biology, Vanderbilt University, Nashville 5, Tenn.
Mr. George A. Schlanert, 13611 Wheeler Place, Santa Ana, Calif.
Mrs. Maxine B. Sites, P.O. Box 562, Sweet Home, Oregon
Mrs. John Stephan, Route 2, Box 744, Pinson, Alabama
Mrs. Leslie B. Stevens, Plantsville, Conn.
Mrs. Carl Sybertz, South Millie Road, Route 1, Box 298, Valrico, Florida
Mr. Albert R. Tenney, Box 45, R. D. 1, Toronto, Ohio
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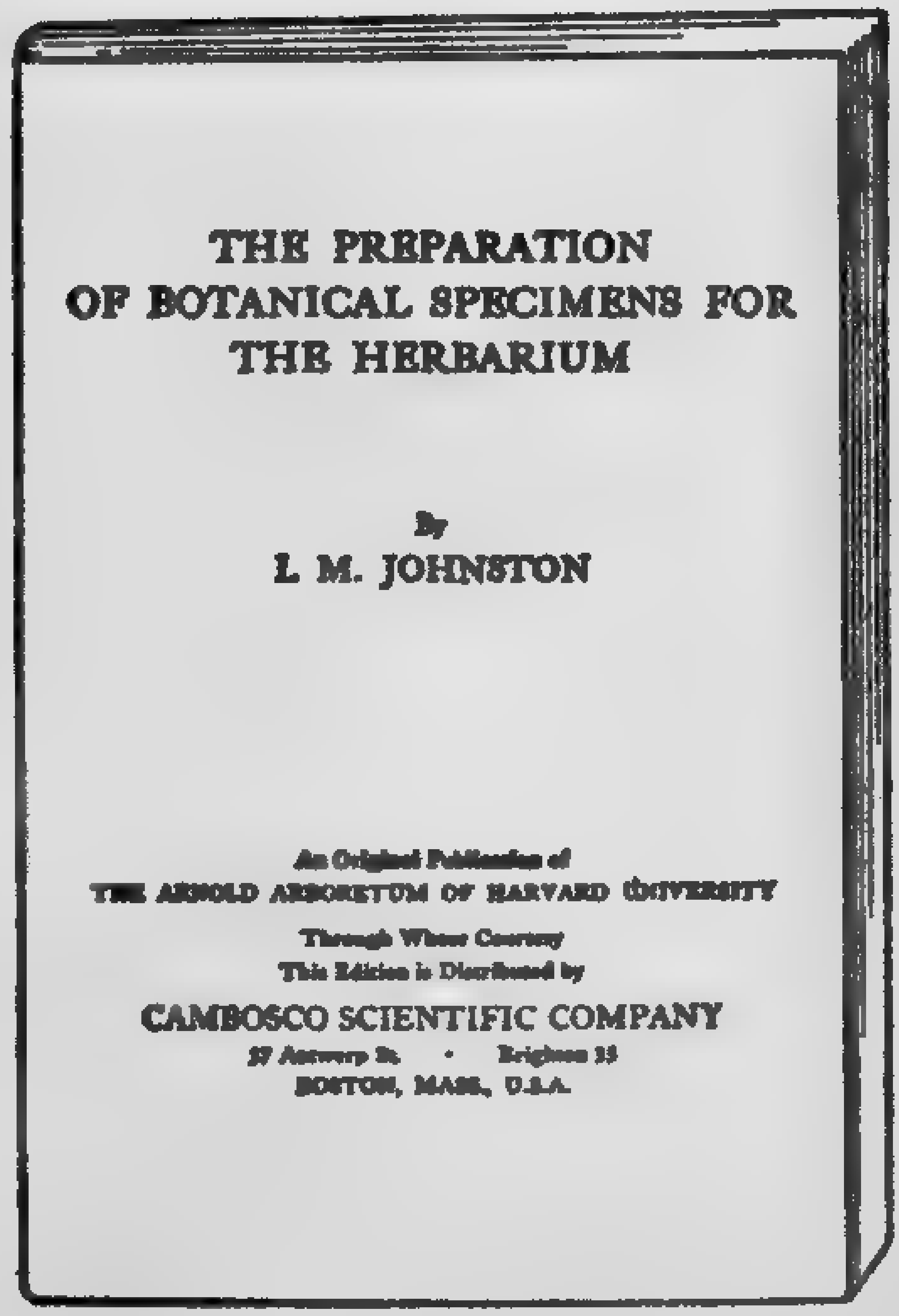


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American Fern Journal

VOL. 51 APRIL-JUNE, 1961 NO. 2

# My Lath House for Ferns

FAY MACFADDEN

My early married years were spent in British Columbia, where I first became interested in ferns. Later we moved to Los Angeles. When in 1935 we eventually found a house on two lots, a lath house started to go up almost before we got settled. The first one was not large, only 16 by 20 feet with a roof eight feet high, but built so that it could grow in time. The uprights, redwood four by fours, were cemented into the ground, and the framework was constructed of two by fours, with laths for the roof. It is better to have a small lath house well conditioned than a larger one poorly cared for. After the small one is established, you can always add to it.

This part of Los Angeles had once been swampland and salt grass grew everywhere. Salt grass roots are ropelike and go very deep, forming a sort of impenetrable mass of roots that sometimes completely cuts off drainage. Storm drains had not yet come and the water table was high in those years and the soil full of salt. Such a situation was mine, and so I eventually dug up the soil on the two lots two to four feet deep. I had a little grass and a mountain of roots to dispose of. But it was necessary to establish good drainage.

A foundation of six inches of rocks was laid down. Every time we went for a drive, the old Hupmobile came home groaning with the weight of rocks. And we made many trips to the mountains for leaf mold. Our home was not far from peat beds at the foot of Baldwin Hills which used to catch fire and burn for months. Eventually the city controlled the fires and used the spot as a dumping ground for city sweepings. Over the years a

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great quantity of leaves were deposited there and a bed of leaf mold several feet thick had been formed. The city was letting builders dump earth there so that it could be reclaimed; and so we got a truck and sacks and anything that would carry leaf mold and worked feverishly to get quantities before the big earth-loaded trucks began to roll. I feel that much of my success with ferns is due to the leaf mold that I acquired at that time.

The leaf mold was mixed with peat moss, not the finely ground kind that is now sold and which is soon gone but the fibrous peat that used to come baled from Europe and which we can not get now; the fibrous peat really built the soil and lasted for years. Over the years I've used many bales of peat moss. If you are buying moss at most nurseries in Los Angeles they will try to sell you Oregon green moss and tell you it is the same as sphagnum. However, this is not so. The green moss can be used for lining baskets but must have soil put in to make a growing medium. However, there are a few nurseries that will get baled sphagnum for you, and this can be used as the growing medium. It holds about seven times its weight in water. It is much cheaper than Oregon green moss.

In the lath house I planted several small Japanese maple trees. One of these, a four-pronged tree, is huge now. Due to its deciduous habit it allows sun in the winter and shade in the summer. It comes into leaf in early April. The leaves fall in November and I have them to mulch the ferns that grow underneath. In spite of the network of tree roots, the ferns thrive. However, if one wants to move a fern it has to be cut out, and unfortunately some ferns have to have their location changed many times before the right spot is found for them.

Between the trees we built a fish pond, which is ornamental and also provides moisture for the atmosphere. Basket ferns hang from the maple trees over the water. In a few years we added to the lath house and eventually had 2000 square feet under lath, except that now we do not use lath but old fluorescent tubes. These are to be had free. They provide a light shade, have the advantage of lasting indefinitely, and are also ornamental. The back end of the lath house is a stucco wall, now covered with ivy, where originally there was a beautiful old pepper tree. In recent years, with the construction of storm drains, the water table has gone down and after several drought years all the old and beautiful pepper trees in the neighborhood died, including ours.

In the completed lath house we laid out brick walks and constructed a little ravine where some rock ferns could be grown. I also planted an English yew tree, to satisfy my desire for the woods. In the center of the area I planted a *Woodwardia radicans* at the time the house was enlarged. It is tremendous now. The arching fronds produce buds which root and form new plants in the winter and late spring. These I cut away and hope I can find someone who wants them. The central area has several tree ferns also.

The design for a lath house planting, or any other kind of garden for that matter, is a personal matter, like painting a picture: Two can't do it. Really, if you want a fern garden, it is because you love ferns. It is the gardener who hasn't much money to spend but has lots of love to give his plants who has the best luck with ferns, for every fern must be studied and loved for itself alone.

In future articles I shall write about the kinds of ferns suitable for a lath house in the Los Angeles area and about some of the problems to be solved in growing them.

5450 CARLIN ST., LOS ANGELES 16, CALIFORNIA.

## A Parcel of Ferns from Stephens County, Georgia

GLADSTONE W. McDOWELL AND FRANKLIN D. SNYDER

Recent explorations in the valleys of two streams tributary to the Tugaloo River in Stephens and Habersham Counties, northeast Georgia, have resulted in the finding of several ferns previously unreported in that region or which are rare in Georgia. The streams, Panther and Toccoa Creeks and their tributaries, lie partly in deep gorges that are not easily accessible. Perhaps the more spectacular gorge of the Tallulah River has diverted the attention of botanists from these gorges which are only a few miles to the south.

Several years ago we became interested in the area south of the Tallulah River because of published reports of limestone outcrops in the Brevard schist through which Panther Creek has cut deeply. It was not until 1957, however, that any field work was done. In January of that year the authors searched part of Panther Creek. The precipitous sides of the gorge made walking difficult, and at times it was necessary to wade the creek. Sheer cliffs rose from the water at our stopping place, and a sharp bend prevented a view farther upstream. A few species of ferns were seen, but none that would indicate the presence of limestone. One was *Asplenium montanum*, a first record for Stephens County. The most unusual plant observed was *Carex plantaginea*, a striking sedge reported previously in Georgia only from Rabun County.

Subsequent trips were confined mostly to the portions of the streams in Stephens County, and the ferns mentioned hereafter are from that county. The second trip to Panther Creek, which was made in January, 1958, a year later, resulted in the finding of *Asplenium resiliens* on a small outcrop of limestone. This fern was new to northeast Georgia, the nearest station in Georgia being about 60 miles to the west.

On March 22, 1959, larger exposures of limestone were discovered in the Panther Creek gorge, where we found *Cheilanthes alabamensis*, *Pellaea atropurpurea*, and *Camptosorus rhizophyllus*. The Alabama lip-fern seems to be rare in Georgia and had been reported only in the Appalachian Valley of northwest Georgia. Also, *C. tomentosa* was collected in the gorge, and *C. lanosa*, though not seen there, occurs elsewhere in Stephens County. The walking fern was abundant, and forma *auriculata* R. Hoffm. was collected. Some of the leaves of this form had only the right or left lobe elongated.

The glade fern, *Athyrium pycnocarpon*, and the brittle fern, *Cystopteris fragilis*, were found on May 16, 1959. The glade fern was abundant in one of the numerous small ravines tributary to the gorge. This collection added a third county in which it has been reported. The brittle fern, which fits the description of the variety *protrusa* Weath., grew with the glade fern and in several other places on cool, north-facing slopes. It has been reported from five other counties, only one of which is south of Stephens County.

In the summer of 1958, Mr. Henry W. Bookout found the first station for the walking fern in Stephens County in the deep ravine of Cedar Creek, a tributary of Toccoa Creek. A few days after that discovery, he and Snyder collected *Trichomanes Petersii* at the same locality. In October, 1958, Snyder collected *Adiantum Capillus-veneris* in the ravine. The southern maidenhair has previously been known in north Georgia only from one station in Habersham County.

On March 21, 1959, we visited Cedar Creek to see *T. Petersii* and to look for additional specimens of the southern maidenhair. None was found, but a thorough search was prevented by bad weather. One additional fern for Stephens County, *Asplenium Trichomanes,* was found on cliffs in the ravine. On June 21, 1959, McDowell made another visit to Cedar Creek and found a number of plants of the southern maidenhair growing among the more abundant northern maidenhair.

Much of the whole area remains to be explored, and we do not yet know what lies beyond the sharp bend in Panther Creek where the cliffs rose from the water. The two streams rise on the divide between the Gulf and Atlantic drainage systems formed by the Chattahoochee Ridge and the Tallulah Mountains. The maximum elevation reached is about 2,800 feet. All the ferns mentioned were found at elevations of about 900 feet. The previous records given in this paper are based on Pyron and McVaugh's Ferns of Georgia and a mimeographed list of additional records prepared in 1957 by Dr. Wilbur H. Duncan, of the University of Georgia.

328 HEARD STREET, ELBERTON, GEORGIA, AND 198 VALLEY ROAD, TOCCOA, GEORGIA.

## Another Asplenium Hybrid from Kentucky

DALE M. SMITH, TRUMAN R. BRYANT, and DONALD E. TATE

Intensive collection of Aspleniums in the Cumberland Plateau region of eastern Kentucky during the past two years has yielded much material of the species and hybrids comprising the "Appalachian Spleenwort complex" (Wherry, 1925, Wagner, 1954). All the basic species are present in this area; the most commonly encountered hybrids are *A.* × *trudellii* Wherry, and A. × *gravesii Maxon* (Smith, Bryant and Tate, 1961). It seems quite likely that all the possible hybrid combinations in the complex may eventually be found in this limited area.

One of the most elusive hybrids in the complex is that involving *A. Bradleyi* D. C. Eaton, and *A. montanum* Willd. The first record of this hybrid was that of Wherry in 1935, based upon a specimen collected by him in New Jersey. This was followed by the publication of a line drawing of two lower pinnae of a rather large frond with the statement, "Exactly intermediate between parents" (Wherry, 1937). No additional information about this hybrid was given by Wherry in 1942, nor was mention made of this hybrid by either Fernald (1950), or Morton (in Gleason, 1952). Wagner (1954) mentioned the hybrid briefly and predicted that the plant would be a triploid. Evidently no additional material of the hybrid has been detected since Wherry's original discovery.

It was our good fortune to find two plants of this hybrid in a dry sandstone crevice, along with both putative parents, near Bear Track Lookout Tower, Lee County, Kentucky. These plants were quite small individuals, and were unfortunately overlooked as possible hybrids until the pressed material was studied later. Consequently, it was impossible to verify Wagner's prediction of the triploid chromosome number for these plants, but the spores were abortive as in many other Asplenium hybrids.

In consideration of the paucity of information about this hybrid it seems well to give it a binomial and a more complete description. It is a pleasure to name this fern in honor of one of


FIG. 1. ASPLENIUM × WHERRYI, WHOLE PLANT FROM LEE CO., KENTUCKY; FIG. 2. A. × WHERRYI, SINGLE FROND FROM TYPE SPECIMEN FROM NEW JERSEY; FIGS. 3–5. A. × WHERRYI AND PUTATIVE PARENTS TAKEN FROM SAME ROCK CREVICE, LEE CO., KENTUCKY; FIG. 3. A MONTANUM; FIG. 4. A. × WHERRYI; FIG. 5. A. BRADLEYI. ALL NATURAL SIZE.

the foremost students of American ferns. Dr. Edgar T. Wherry, of Philadelphia.

ASPLENIUM × **Wherryi**, *hybr. nov. (A. bradleyi × montanum).* Stipitibus fuscis, usque ad 2 cm. longis, laminis foliorum sempervirentibus, lanceolatis, basi bipinnatis, sursum bipinnatifidis, apice pinnatifidis, pinnis 10–16, alternis, rachibus viridibus, sporis abortivis.

TYPE: Sandstone cliff 4.5 miles northwest of Blairstown, Warren County New Jersey, *Edgar T. Wherry*, September 1, 1935, no. 725,248 (PH).

This sterile, probably triploid hybrid is, as pointed out by Wherry, essentially intermediate between the putative parents in several characteristics. The stipe as well as much of the rachis is darkened in *A. Bradleyi*, but only the stipe bases are darkened in *A. montanum*. In *A.* × *Wherryi*, the darkening extends only to the base of the frond blade, the rachis being entirely green. The overall shape of the frond in *A. Bradleyi* is typically narrowly lanceolate, in *A. montanum* decidedly triangular, often nearly deltoid, and in *A.* × *Wherry* lanceolate. The extent to which the fronds of both parental species are cleft is quite variable, but in *A. Bradleyi* only the basal pinnae are regularly deeply cleft. In *A. montanum* it is not uncommon to find bipinnate fronds, or those which are occasionally subdivided to an even greater extent. The type specimen of *A.* × *Wherryi* is bipinnate in the lower half, grading gradually near the tip to bipinnatifid, and at the apex it is pinnatifid.

In eastern Kentucky, and perhaps elsewhere, *A. Bradleyi* and *A. montanum* occur rather abundantly in crevices of sandstone, often in contiguous clusters. Consequently, it is surprising that more specimens of *A.* × *Wherryi* have not been found. If ecological differences exist they are slight, with *A. Bradleyi* occupying slightly drier crevices, and *A. montanum* occurring in more moist or shaded places. More often than not the two parental species occur together, and perhaps with more careful searching additional hybrid individuals will be found.

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UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS.

## Some Forms of Polypodium californicum

C. V. MORTON

Mr. Donald Branscomb, of Willits, California, an amateur member of the American Fern Society, has been enthusiastically studying and growing the ferns of northern California. He has recently sent me a frond of a *Polypodium californicum* that he found in Humboldt County in which the lower segments are deeply lobed rather than merely serrate as they usually are. This is the sort of variation that is to be expected in species of the *vulgare* alliance, of which many forms have been described in Europe. No such form has ever been described in *P. californicum*, and no other specimens seem to have been collected, so far as the rather abundant material in the National Herbarium shows. It is perhaps worth while giving this form a name:

POLYPODIUM CALIFORNICUM Kaulf. forma **Branscombii** Morton, *f. nov.*

A forma typica segmentis inferioribus perspicue lobatis lobis latis obtusis serratis 3–8 utrinque latere differt.

Type in the U. S. National Herbarium, no. 2,257,987, collected on the Redwood Highway, 2.8 miles south of Trinidad, Humboldt County, California, December 25, 1958, by Donald Branscomb.

While looking through the material of *Polypodium californi-*

*cum* in the National Herbarium, I came across another peculiar form which has lain undescribed in the collections for the last 64 years. It is a form with the segments deeply laciniate and is a dead ringer for *P. vulgare* f. *cambricum,* the well-known English fern, except this plant is surely *P. californicum.* It was found in one of the canyons coming down from Mount Tamalpais, in Marin County, California, in 1895, by Miss Mary Elizabeth Parsons. Miss Parsons sent additional material to Dr. Maxon eight years later, writing as follows:

San Rafael, California
September 14, 1903

Dear Dr. Maxon:

Several years ago I found in one of our canyons a peculiar form of *Polypodium falcatum*[1] in which the pinnae, at least most of the lower ones, were divided again to the rachis and much enlarged—in fact each pinna looked like a small fern in itself. The following year I found it again in the same locality but have never seen it anywhere else.

I brought home a plant, which has been growing since in our greenhouse. I am sending you one of the fronds produced by this plant this summer. I am sorry my attention was not claimed by it until it had become badly discolored and ready to fall away. Even in this condition it will serve to show you the form if not the color, which however does not differ from the ordinary form of *P. falcatum.* I am not able to visit the canyon this year to hunt for more, and at any rate there would be none now at this dry season. Perhaps next spring I may be able to examine the spot again.

Will you please name and publish this form if you think it worthy of doing so? If you do publish it, I should be glad to know of it. The canyon where this fern was found is on the property of Mrs. A. E. Kent (my aunt), Kentfield Station, on the North Shore Railway about two or three miles north of the Corte Madera tunnel. The canyon is one of those channeled out by one of the little streams making down from Mount Tamalpais. The altitude was probably not over 100 feet, if that.

Yours truly

MARY ELIZABETH PARSONS

[1] Actually *P. californicum.* C. V. M.

POLYPODIUM CALIFORNICUM Kaulf. forma **Parsonsiae** Morton, *f. nov.*

A forma typica lamina bipinnatifida, segmentis, saltem inferioribus, fere usque ad costulam partitis differt.

Type in the U. S. National Herbarium, no. 434,989, from a plant cultivated in a greenhouse in California, collected by Mary Elizabeth Parsons, September 14, 1903, originally transplanted from a canyon near Kentfield, Marin County, California. A paratype in the U. S. National Herbarium, no. 469,766, is a similar specimen collected from the wild at Kentfield by Miss Parsons, in March, 1895.

## On the Relative Development of the Fertile Segments in Botrychium dissectum and B. oneidense

W. H. WAGNER, JR.[1]

The taxonomically controversial *Botrychium oneidense* (Gilb.) House differs from *B. dissectum* Spreng. in a number of characteristics, including the average shape and size of the segments, the pigmentation and periodicity of the primordial and mature leaves, the root diameter, and the geographical range. It has been considered a distinct species, a variety of *B. dissectum*, a variety of *B. multifidum*, or, possibly, the hybrid of *B. dissectum* and *multifidum*. *Botrychium oneidense* is said to produce fertile segments less commonly than *B. dissectum*, and this has been adduced as an argument for the theory that *B. oneidense* may be an interspecific hybrid of the two species with which it has been associated. The present paper adds new data on the relative development of the fertile segments, and discusses briefly some of the implications.

Some years ago it was pointed out by Robert T. Clausen[2] that

[1] Research supported by a grant from the H. H. Rackham School, University of Michigan.

[2] On the status of *Botrychium dissectum* var. *oneidense*. THIS JOURNAL, **34**: 55–60. 1944.

"In central New York var. *oneidense* is fairly common. Around Utica it apparently fruits as freely as do any of the other varieties of *B. dissectum.* In the section around Ithaca and the southern tier of counties in New York this is definitely not the case, for the plants develop fertile panicles only rarely." His survey of his collections showed that only 15% of a total of 72 specimens of *oneidense* possessed these structures; but in "*obliquum*" (*B. dissectum*) 54% of a total of 148 had fertile segments, i. e., fertile segments were, relatively, over three and a half times as common. Clausen did not say, however, whether or not his materials were comparable, i.e., from the same localities. In the Cornell University herbarium, his count showed that 66% of a total of 72 *oneidense* were fertile; and 88% of 217 specimens of *obliquum* were fertile. He suggested the hypothesis "that var. *oneidense* may be an interspecific hybrid, only more or less fertile," on the basis of "a marked tendency toward lower fertility" plus some morphological and geographical observations. It is only with the "marked tendency toward lower fertility" that I am concerned here. There are two questions involved: (a) If *B. oneidense* were truly an interspecific hybrid, would this necessarily lead to the expectation that formation of fertile leaf parts would be influenced by its hybrid nature?; and (b) Are the data used for demonstrating the lower fertility of *B. oneidense* reliable? The latter question will be discussed first.

Comparative materials of different taxa of evergreen grapeferns should be taken in the same localities, where soil conditions, climate, and associated plants are alike. It would be best if we could grow these plants together in routine greenhouse culture, but grapeferns are notoriously difficult to grow in pots and they usually die. The data reported here are from mass collections made by the author, assisted by one to five other collectors, and from each locality every leaf, young and old, seen during the time available was taken. The counts were made by Misses V. M. Morzenti and Therese Signaigo. The leaves were plucked at ground level and pressed. There is the possibility of occasional errors in rare cases where the leaf separated above the insertion of the fertile segment or the fertile segment was completely destroyed by some natural agent.

All of the 14 localities from which the samples were taken are in southeastern Michigan, roughly 350 miles west of the areas in which Clausen found such sharp differences in the relative production of fertile spikes. Table 1[3] gives a comparison of successive mass collections from three of our best localities for *B. oneidense.* Locality 2 showed a consistently low percentage of fertile spikes for both species in the years 1958 and 1959, not more than 5% of either species bearing fertile segments either year. However, localities 1 and 3 had higher percentages: In 1958, locality 1 produced approximately half the percentage of fertile leaves that it did in 1954 and 1959. Locality 3 had a greater percentage of fertile leaves in *B. dissectum* than in *B. oneidense* in 1958, but in the following year the proportion was reversed. These data suggest that the number of fertile leaves per species may vary from locality to locality and from year to year.

Table 2 compares the averages of localities 1, 2, and 3 with mass collections from 11 additional localities. One point will be immediately evident to persons familiar with *B. dissectum,* as it grows, for example, in meadows and fields—in this table *B. dissectum* shows a surprisingly low percentage of fertile spikes, and, with one exception, considerably lower than the 54% reported by Clausen. This may be explained, I believe, by the fact that the localities listed in Table 2 are all low, swampy, acid woods, the usual habitat of *B. oneidense,* with very rare exceptions. But *Botrychium dissectum* is a much more common and generally distributed plant, with indications of a much wider amplitude of habitat and range tolerances, for it grows not only in localities where *B. oneidense* occurs, but in widely different habitats, often in much more open and exposed situations where it becomes much more freely sporangiferous.

The average percentages of fertile segments in all 14 locali-

[3] All collection numbers of the writer's will be reported with locality data by Dale J. Hagenah in the near future as part of a report on the geographical distribution of Ophioglossaceae in Michigan.

ties show that there is indeed a difference between *B. dissectum* and *B. oneidense,* the average of *B. dissectum* being greater. However, seven out of 14 localities gave a difference of less than 5% in the production of fertile leaves, and, in fact, in four localities, *B. oneidense* exceeded *dissectum* in the percentage of fertile leaves. I would not call this a "marked tendency toward lower fertility." The data suggest that in Michigan the condition is like that stated to be true around Utica, New York, *i.e.,* *B. oneidense* fruits almost as freely as the varieties of *B. dissectum.* Studies should be made to determine why *B. oneidense* is more sterile in the area around Cornell University.

TABLE I. COMPARISON OF SUCCESSIVE MASS COLLECTIONS FROM THE SAME LOCALITIES

| | *B. DISSECTUM* | | | | *B. ONEIDENSE* | | | |
|---|---|---|---|---|---|---|---|---|
| | Coll. | No. lvs. | Fert. lvs. | % | Coll. | No. lvs. | Fert. lvs. | % |
| Loc. 1 | 4–29–54a (1954) | 90 | 9 | 10.00 | 4-29–54b | 25 | 4 | 16.00 |
| | 8521 (1958) | 29 | 2 | 6.89 | 8522 | 50 | 3 | 6.00 |
| | 9109 (1959) | 154 | 21 | 13.63 | 9110 | 50 | 7 | 14.00 |
| | | | av. | 10.17 | | | av. | 12.00 |
| Loc. 2 | 8599 (1958) | 28 | 1 | 3.57 | 8600 | 156 | 5 | 3.21 |
| | 9124 (1959) | 60 | 1 | 1.66 | 9125 | 114 | 4 | 3.52 |
| | | | av. | 2.62 | | | av. | 3.37 |
| Loc. 3 | 8631 (1958) | 70 | 20 | 28.57 | 8630 | 132 | 18 | 13.64 |
| | 9059 (1959) | 55 | 11 | 20.00 | 9061 | 60 | 17 | 28.33 |
| | | | av. | 24.29 | | | av. | 20.99 |

W. L. Dix pointed out in 1945[4] that "var. *oneidense* [which he considered a variety of *B. multifidum*] is a plant of the woods and is seldom found in fields" and that "insufficient sunlight is a common cause of sterility among most plants." He wrote further that, according to his evidence, when *B. dissectum* occurs in shady places ("woods and thickets") it too has reduced fertility. The data reported here from southern Michigan tend to support Professor Dix's idea that the "theoretical sterility of

[4] Observed Characteristics of Botrychium multifidum var. oneidense. THIS JOURNAL, 35: 37–39.

. . . *oneidense* may be due to environment rather than to hybridity or a juvenile condition."[5]

If *Botrychium oneidense* were an interspecific hybrid, which I do not believe it is, might we expect that the formation of fertile parts of the leaf would be arrested or curtailed by factors associated with hybridity? Among the many sterile interspecific hybrids known among ferns, there is no reason known to me why leaf axes or parts of leaves that bear sporangia should become aborted. The leaf blade and its fertile parts tend to develop normally in sterile hybrids. The sporangia themselves also develop in the usual way after the fertile axes or fertile laminae mature.

TABLE II. COMPARISON OF VARIOUS COLLECTIONS FROM 14 LOCALITIES

| | *B. DISSECTUM* | | | | *B. ONEIDENSE* | | | |
|---|---|---|---|---|---|---|---|---|
| | Coll. | No. lvs. | Fert. lvs. | % | Coll. | No. lvs. | Fert. lvs. | % |
| 1. | See Table 1 | ---- | ---- | 10.17 | ---- | ---- | ---- | 12.00 |
| 2. | See Table 1 | ---- | ---- | 2.62 | ---- | ---- | ---- | 3.37 |
| 3. | See Table 1 | ---- | ---- | 24.29 | ---- | ---- | ---- | 20.99 |
| 4. | 8374 | 114 | 15 | 13.15 | 8373 | 79 | 8 | 10.13 |
| 5. | 8394 | 40 | 4 | 10.00 | 8393 | 18 | 2 | 11.11 |
| 6. | 8403 | 48 | 15 | 31.25 | 8401 | 63 | 8 | 12.69 |
| 7. | 8519 | 106 | 7 | 6.60 | 8517 | 68 | 0 | 0.00 |
| 8. | 8631 | 70 | 20 | 28.57 | 8630 | 132 | 18 | 13.64 |
| 9. | 8641 | 73 | 6 | 8.21 | 8640 | 108 | 14 | 12.96 |
| 10. | 8648 | 57 | 16 | 28.07 | 8647 | 123 | 19 | 15.45 |
| 11. | 8676 | 43 | 6 | 14.00 | 8675 | 53 | 4 | 7.55 |
| 12. | 9068 | 56 | 3 | 5.35 | 9069 | 28 | 1 | 3.57 |
| 13. | 9101 | 252 | 171 | 67.85 | 9102 | 64 | 31 | 48.44 |
| 14. | 9119 | 46 | 12 | 26.08 | 9120 | 117 | 16 | 13.67 |
| | | | av. | 19.73 | | | av. | 13.26 |

Only at the time of meiosis, when spore production takes place do irregularities in chromosome distribution and other factors become apparent that tend to produce abortive spores. Often the failure of the spores to develop within their sporangia is so severe and early that the sporangia themselves become more or less

[5] It would be interesting to transplant *B. oneidense* from its ordinary woodland habitats to open fields and meadows where *B. dissectum* (as well as *B. multifidum* and *B. ternatum*) tend to be highly fertile, and thus determine whether the woodland species can be made to react as does *B. dissectum* and produce more fertile structures. Such studies are planned by the present author; it is possible, however, that *B. oneidense* with its narrow habitat requirements may not tolerate or survive such conditions.

arrested, and they may even fail to undergo the normal dehiscence process.

The fertile structures of *Botrychium* pass through an extensive growth period prior to the maturation of the spore-mother cells prior to meiosis. How any irregularities in meiosis could affect the ontogeny of the fertile part of the leaf, a process taking at least several years, is by no means clear to me. The only plant I have thus far found in this genus that seemed to be an interspecific hybrid (*B. matricariifolium* × *simplex*) had an entirely normal fertile structure; the spores, however, were extremely irregular, mostly dwarfed and distorted but some of them very large, suggesting the failure of cytokinesis. The idea that leaf axes or parts of a leaf that bear sporangia would be aborted in a hybrid in addition to the spores themselves lacks any basis in experience, to the best of my knowledge.

That the average low percentage of production of fertile structures in *B. oneidense* could be a result of abortion associated with hybridity finds even less support in a study of the meiotic process itself in this species. As I reported several years ago[6] cytological studies of materials of *B. oneidense* from three localities showed that there was no evidence of hybridity, either in irregular pairing or polyploidy.

In conclusion, then, the relative development of fertile segments in plants of *Botrychium dissectum* and *B. oneidense* growing in the same localities tends to show what appear to this author as only minor differences. The percentage of fertile leaves evidently varies from locality to locality and from year to year; it is imperative, therefore, in making comparisons to take materials from the same habitats and at the same times. The area around Ithaca and the southern tier of counties of New York, where very profound differences have been found in production of fertile spikes between the two species, should be examined carefully. However, even if there are areas where there are marked differences in the relative development of fertile structures in

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[6] Cytotaxonomic Observations on North American Ferns. Rhodora 57: 219–240.

these two species, I do not believe that this can, without further knowledge, be taken as evidence in support of an idea that *B. oneidense* originated as the hybrid *B. dissectum* × *multifidum*.
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## Another Genus of Ferns New to the United States

C. V. MORTON

Mr. Joseph Monachino, of the New York Botanical Garden, has been working recently in curating some of the collections of Dr. J. K. Small, with the assistance of Mr. George Cooley. He has sent me two sheets of a fern collected in Deering Hammock, Florida, in December, 1921, which was left unnamed by Dr. Small. It represents *Maxonia apiifolia* (Swartz) C. Chr., a genus not hitherto known from the United States. It occurs in Cuba (rarely) and is not uncommon in Jamaica. Mr. Monachino has suggested that this specimen may have been from a cultivated plant, and this is certainly possible. Still, this species has never been known in cultivation. Very probably it is a natural occurrence but a recent introduction. It seems that the prevalence of hurricanes is having an effect, and quite a number of West Indian species are being blown across to Florida, where some of them become acclimatized. The leaf collected by Dr. Small is from a large, vigorous specimen, and must have been from a well-established plant several years old. Still, it may not have been persistent, since no one else has found it in the last 38 years. One factor against its survival is that it is an epiphyte, and even in southern Florida the climate is not altogether the best one for large epiphytes.

The genus *Maxonia,* named in honor of the late William R. Maxon, cannot be regarded as a very "strong" genus, which is to say that it has no characters that are absolutely different from allied genera, unless it is the peculiar method of development of the indusium, as described by Christensen. It belongs to the general group of *Dryopteris* and *Polystichum,* and it has been referred to both genera. The indusium which is large, vaulted, and conspicuous, is apparently peltate, but it is actually of the reniform type, being laterally attached in the early stages; in development, some large basal lobes grow out and overlap, thus making the point of attachment apparently medial. The type is that of *Dryopteris* rather than *Polystichum*.

The rhizome provides perhaps the most distinctive generic character. It is elongate and climbing, unlike that of species of *Dryopteris,* which are terrestrial. It is thick and cordlike and with its dense covering of bright brown scales suggests strongly the genus *Polybotrya*. The general shape of the blades is also rather like *Polybotrya,* and there may be a real relationship. However, in *Polybotrya* the sporangia are "acrostichoid," i.e. distributed all over the fertile segments, without an indusium and not grouped into sori. The closest relationship of *Maxonia* is with some of the species grouped by Christensen in *Dryopteris* sect. *Polystichopsis*. The relationships remain to be worked out. The rhizome character and epiphytic habit can be considered characteristic for the present. Another, probably less important, character, is that in *Maxonia* the fronds are somewhat dimorphic. Sometimes the fertile blades are strongly contracted, with reduced leaf tissue, and then resemble *Polybotrya;* again, only certain pinnae are contracted and fertile. *Polystichopsis* species have fertile and sterile fronds that are essentially uniform.

The synonymy is as follows:

MAXONIA C. Chr., Smiths. Misc. Coll. **66**[9]: 3. 1916. Type: *M. apiifolia* (Swartz) C. Chr.

*Dryopteris* subg. *Peismapodium* Maxon, Contr. U. S. Nat Herb. **13**: 39. 1909.

MAXONIA APIIFOLIA (Swartz) C. Chr., Smiths, Misc. Coll. **66**[9]: 3. 1916.

*Dicksonia apiifolia* Swartz, Journ. Bot. Schrad. **1800**[2]: 91. 1801.

*Dryopteris apiifolia* Kuntze, Rev. Gen. Plant. **2**: 811. 1891.

*Polystichum apiifolium* C. Chr. Ind. Fil. 578. 1906.

FLORIDA: Deering Hammock, Cutler, December, 1921, *John K. Small, George K. Small, John B. DeWinkeler,* coll. (NY).

CUBA: Batabanó, Prov. Habana, in patch of royal palms, Dec. 10, 1920, *Ekman* 11599 (US). Moist woods between Ojo de Agua del Baño and Laguna de Piedra, Pinar del Río, March, 1937, *León* 16817 (US). In palm grove, Caibarien, Las Villas, Apr. 10, 1921, *H. Fernando* 592 (US). In wet palm jungle in swamp at end of road due north of Hotel Isla de Pinos, Nueva Gerona, Isla de Pinos, Feb. 18, 1955, *Killip* 44829 (US); *ibid.*, Feb. 6–10, 1956, *Morton & Killip* 9971 (US). Without special locality, *De la Sagra* (B), cited by C. Chr.

JAMAICA: Vicinity of Troy, Hollymount, Moneague, Tiddenham, and elsewhere, various collectors.

MAXONIA APIIFOLIA var. DUALIS (Donn. Smith) C. Chr., *op. cit.* 4.

*Nephrodium duale* Donn. Smith, Bot. Gaz. **15**: 20. *pl. 4.* 1890.

GUATEMALA: Pansamalá, Dept. Alta Verapaz, *von Tuerckheim* 1408 (US, typus). Dense wet limestone forest near Chirriacté, Dept. Alta Verapaz, alt. 900 m., Apr 9, 1941, *Standley* 91664 (US).

PANAMA: Barro Colorado Island, C. Z., *Standley* 31401 (US), *Kenoyer* 22 (US), *Taylor* 1330 (US). Juan Diaz River, C. Z., *Killip* 2610 (US). Trail from Campana to Chica, Cerro Campana, Prov. Panama, 600–800 m., *Allen* 2658 (US).

ECUADOR: Vicinity of Quininde, alt. 50–150 m., *Holdridge* 1640 (US). This is the first report of this species in Ecuador, in fact the first record of the genus in South America at all.

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## Isoetes echinospora Durieu in North America[1]

BERNARD BOIVIN

The North American variants of *Isoëtes echinospora* Durieu are generally distinguished by the presence of stomata on the leaves, whereas typical European plants lack stomata. This character is scarcely a practical one, but in view of its geographical value it may be retained to separate the American and European phases of this species. As the presence or absence of stomata does not appear to be linked with any other character, specific rank for the American phases appears to be hardly justifiable, but our plants may be conveniently regarded as a subspecies as follows:

ISOETES ECHINOSPORA Dur. subsp. **muricata** (Dur.) Boivin, stat. nov.

*Isoëtes muricata* Dur., Bull. Soc. Bot. France **11**: 100,101. 1864.

The type locality of *I. muricata* is Woburn, Massachusetts.

[1] Contribution No. 33 from the Plant Research Institute, Research Branch, Canada Department of Agriculture, Ottawa, Canada.

[2] THIS JOURNAL **35**: 84. 1945.

Live specimens collected by Boott were sent to Durieu and cultivated in the botanical garden at Bordeaux.

ISOETES ECHINOSPORA Dur. subsp. MURICATA var. MURICATA.

Leaves rather long, 15–40 cm. long, flaccid and often twisted.

Specimens have been examined from Nova Scotia, New Brunswick, Maine, New Hampshire, Massachusetts, and New York; also reported from New Jersey. The New Hampshire plants have been referred to var. *robusta,* to which they are somewhat intermediate, but they appear to be closer to var. *muricata.*

ISOETES ECHINOSPORA Dur. subsp. MURICATA var. ROBUSTA Engelm. Trans. St. Louis Acad. Sci. **4**: 380. 1882.

Somewhat intermediate between var. *muricata* and var. *Braunii.* Plants stouter with leaves numerous, usually 20 or more, and 15–25 cm. long as in var. *muricata,* but more rigid and mostly strongly arched as in var. *Braunii.* Specimens of this variety resemble luxuriant plants of var. *Braunii.* However, as they are roughly distributed around the old Champlain Sea, they may be retained as a geographical variety. Specimens have been examined from Ontario (Marmora, *Gillett* 6765; Deux-Rivières, *Dore* 10235), Quebec (Wakefield, *Calder, Cody & Gillett* 1746; Templeton, *Calder* 1222; La Tuque, *Marie-Anselme;* Saint-Jean, *Raymond* 1762), and Vermont (Isle LaMotte, *Pringle*). The type is from Isle La Motte, Lake Champlain, Vermont.

ISOETES ECHINOSPORA Dur. subsp. MURICATA var. Braunii (Dur.) Engelm. ex Gray, Manual, ed. 5, 676. 1867.

*Isoëtes Braunii* Dur., Bull. Soc.. Bot. France **11**: 101,2. 1864.

*Isoëtes echinospora* var. *Boottii* Engelm. ex Gray, Manual, ed. 5, 676. 1867.

*Isoëtes maritima* Underw., Bot. Gaz. **13**: 94. 1888.

*Isoëtes echinospora* var. *truncata* Eaton ex Gilbert, List N. A. Pter. 10, 27. 1901.

Plants smaller, with 5 to 20 leaves, these 3–15 cm. long, rigid, at first straight, soon becoming arched. Megaspores about 0.5 millimeter across, varying from 400 $\mu$ to 600 $\mu$.

This plant is disjunct-transcontinental, ranging from Nova Scotia and the northeastern United States to southern Mackenzie, then along the Pacific Coast from the Aleutian Islands to Vancouver Island. The western specimens have been segregated on the basis of their blunt spines on the megaspores, but this character does not appear to be convincing. Type in Berlin, from Lake Winnipiseogee, New Hampshire.

I have not seen any material of *I. muricata* var. *hesperia* Reed,[2] but from the original description this variety should belong here.

ISOETES ECHINOSPORA Dur. subsp. MURICATA var. **Savilei** Boivin, var. nov.

Parva, foliis 5–10 (15) in planta, (2) 5–10 (12) cm. longis, rigidis, strictis vel saepius arcuatis; megasporae 300–400 $\mu$.

The spores are smaller than in any of the other varieties, mostly averaging about ⅓ mm. in diameter.

GREENLAND: Tjørn ved Ivigtut, August 17, 1937, *J. Grøntved* 606 (DAO).

QUEBEC: Great Whale River, 1.5 miles northeast of Post, Ungava, 55°17′N, 77°47′W, in rock pool with black organic mud bottom, numerous in this pool, not in adjacent ones, September 8, 1949, *D. B. O. Savile* 792 (DAO, type); same locality *Savile* 553 & 738 (DAO); Fort Chimo, Ungava, 58°07′N, 68°23′W, in muddy-bottomed stream between 2 lakes about 3 miles west of base, common locally, rare in area, August 17, 1948, *J. A. Calder* 2668 & 2669 (DAO).

ONTARIO: Shores of Lake Attawapiskat, Patricia, 52°14′, 87°53′, August 28, 1952, *Dutilly, Lepage & Duman* 30,714 (DAO).

In all the varieties enumerated above the size of the sporangium varies concurrently with the size of the leaf. For a more complete synonymy of the varieties listed above, see C. F. Reed, Amer. Fern Journ. **35**: 77–86. 1945. Incidentally I may mention that among the material at hand is a collection of *W. J. Eyerdam* (No. 3373), collected in 1939 at Prince William Sound, Alaska, and distributed as *I. Braunii* var. *maritima* and as *I. Nuttallii* A. Braun. This specimen apparently belongs to *I. asiatica* Makino, new to North America.

# A Hawaiian Thelypteroid Fern with Peltate Indusia

KUNIO IWATSUKI

Natural groups of species are defined by a combination of characters. However, some of these diagnostic characters are sometimes overestimated, so as to result in unnatural groups, for there is no single feature that can circumscribe the higher taxonomic groups.

ASPIDIUM BOYDIAE,[1] an interesting but little known Hawaiian species described by D. C. Eaton, has long been considered as a representative of the genus *Cyrtomium* because of the presence of a peltate indusia, though its affinity has also been thought to be with *Aspidium* (*Cyclosorus*) *cyatheoides.* In *A. Boydiae,* the indusia are round and peltate; the fronds are impari-pinnate, with narrowly triangular-lanceolate, papyraceous pinnae with reticulate venation. On account of these features, this species was placed in *Cyrtomium.* A peltate indusium is a convenient key character to define the polystichoid ferns within the dryopteroid group of genera. Still, the similarity of such a character may be relatively unimportant, and in this case the most intimate alliance of *A. Boydiae* is found in *A. cyatheoides,* a species undoubtedly thelypteroid. Because of its interesting characteristics, *A. Boydiae* has been investigated from the phylogenetic point of view, comparisons having been made especially with *Cyrtomium,* a genus of the polystichoid series, and with the thelypteroid series of ferns.

The rhizome of *A. Boydiae* is ascending and radially constructed, as in both the series. In *A. Boydiae,* the stipes are terete, stramineous, and subpubescent. The scales are very sparse near the base of stipe only, as is usual in almost all of the thelypteroid ferns. In *Cyrtomium,* the stipes are often densely

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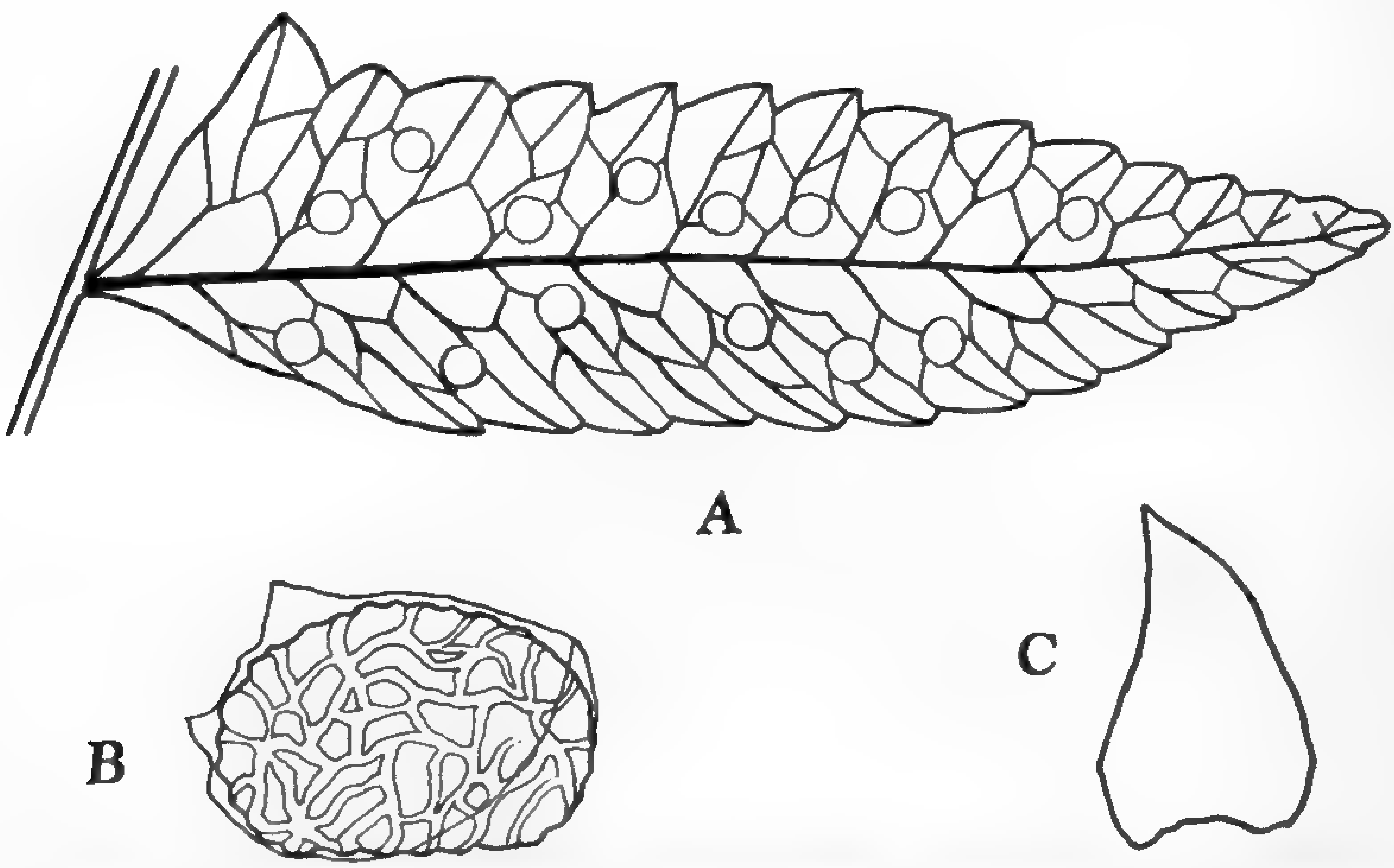
[1] *Aspidium Boydiae* D. C. Eaton, Bull. Torrey Bot. Club **6:** 361. 1879; type from Oahu, Hawaiian Islands.

*Aspidium cyatheoides* var. *depauperatum* Hilleb. Fl. Haw. Isl. 572. 1888.
*Dryopteris cyatheoides* var. *Boydiae* C. Chr. Ind. Fil. 66. 1905.
*Cyrtomium Boydiae* W. Robinson, Bull. Torrey Bot. Club **40:** 204, *pl. 10.* 1913; C. Chr. Ind. Fil. Suppl. **II:** 11. 1917; Bull. B. P. Bishop Mus. **25:** 10, 25. 1925.

covered, with the scales lacerate-fimbriate on the margin. The internal structure of the stipe of *A. Boydiae* indicates more evidently its thelypteroid nature; two vascular strands are present in the base of stipe, which are united upwards to a single strand, U-shaped in cross section, a feature typical of the thelypteroid and athyrioid ferns. In the polystichoid ferns, on the contrary, the stipe contains several separate vascular strands.



FIGS. A–C, ASPIDIUM BOYDIAE, DRAWN FROM FAURIE 352. A, A LATERAL PINNA, SHOWING THE VENATION AND THE POSITION OF SORI, × 1.5; B, A SPORE, × 300; C, A SCALE AT BASE OF STIPE, × 7.5.

The form of frond varies in both series. Impari-pinnate blades are also found in both of them, as observed in most species of *Cyrtomium* and of *Abacopteris*. There is, however, a distinct difference in the anastomosis of the veins between these two series. In the polystichoid species having reticulate venation, the veins anastomose to form irregular areoles, which usually contain one or more veinlets. On the contrary the venation of the thelypteroid ferns is, when anastomosing, typically goniopteroid or meniscioid, and a sinus-membrane usually develops. The venation of *A. Boydiae* is goniopteroid in pattern, but somewhat irregular, a sinus-membrane being also found. On the abaxial surface of the fronds of *A. Boydiae* occur sparsely some setiform hairs, and no scales are found on the laminar surface, both characters of thelypteroid ferns. In the polystichoid ferns, scales are usually present on laminar parts and no setiform hairs.

With the exception of the indusia, the sori of the polystichoid and thelypteroid ferns exhibit no fundamental differences. The indusia of *A. Boydiae* are, as mentioned above, round-peltate in construction. Except for this aberrant feature, *A. Boydiae* may be considered as a member of the thelypteroid group on the basis of the brief discussion given above. In the thelypteroid ferns in general the indusia are reniform to round-reniform, rarely somewhat asymmetrical, but peltate indusia or ones intermediate between reniform and peltate have been recorded. The peltate indusia of *A. Boydiae* are so constant in their construction that there is no clue as to their probable origin. At present, only the morphological presumption that the peltate indusia of *A. Boydiae* have been derived from the basifixed reniform ones may be admitted. This is supported by the generally accepted assumption that the various types of indusia found in the athyrioid ferns have been derived from a reniform type.

The thelypteroid relationship of *A. Boydiae* may be assumed from the facts mentioned above, but its final taxonomic position is still in question. According to the current delimitation of the thelypteroid genera, this species might be included in *Cyclosorus*, if only the indusia were not peltate. The similarity between *A. Boydiae* and *Cyclosorus cyatheoides* is apparent, but the difference in their indusia seems to be evidence that the position of *A. Boydiae* is fairly distant from *Cyclosorus* proper. It appears to be necessary not to include this species in *Cyclosorus*, but, as *Cyclosorus* itself is not yet completely studied, no new taxon or combination is proposed here. The proper systematic position of *A. Boydiae* may be clarified when *Cyclosorus* is better known.

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# Observations on Microsporocarpic Material of Azolla caroliniana

R. K. GODFREY, GRADY W. REINERT, and RICHARD D. HOUK[1]

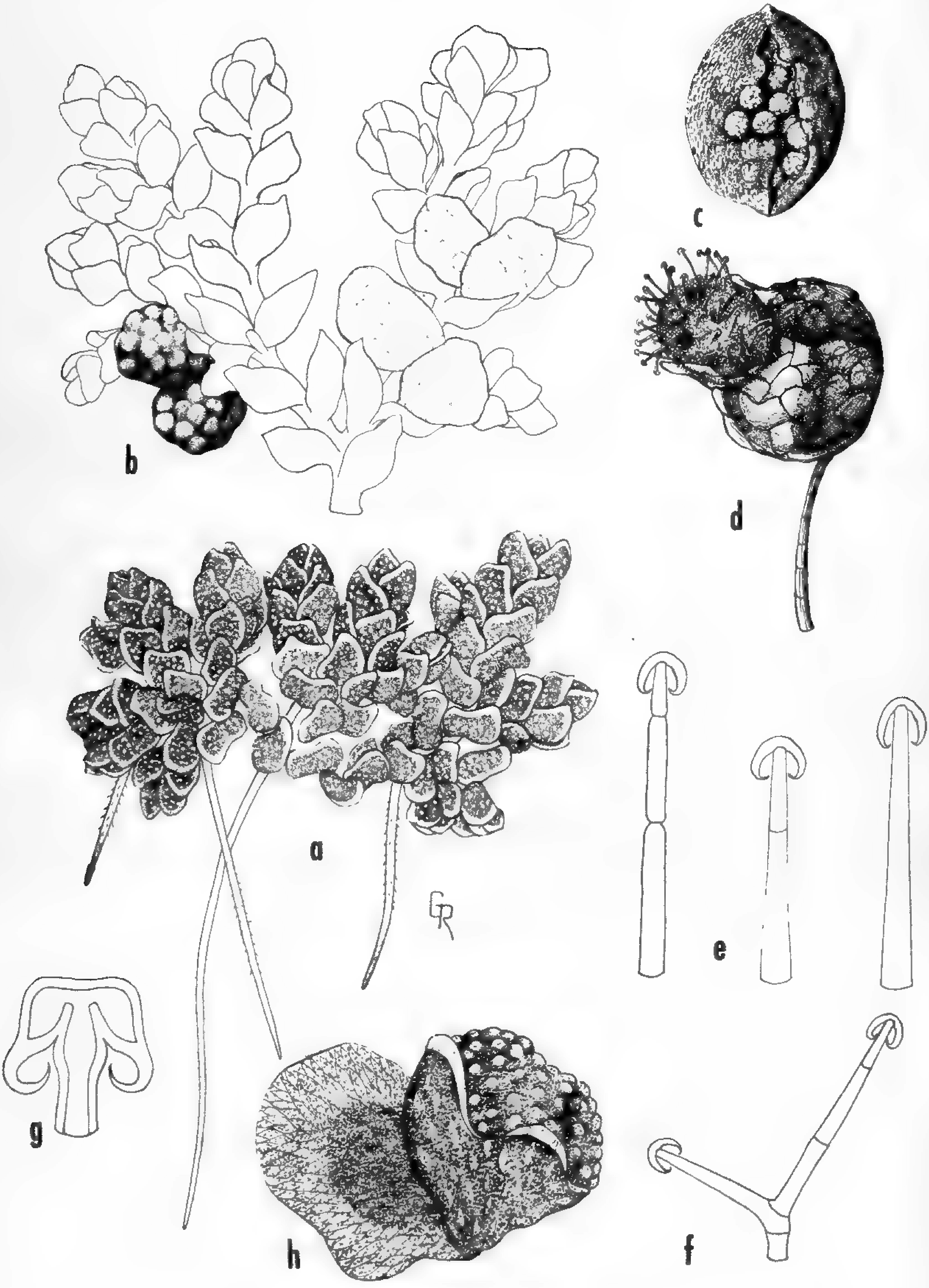
Svenson (1944), in reference to *Azolla caroliniana* Willd., wrote that diligent search by him revealed but two herbarium collections in which microsporocarps were present and implied that he saw no megasporocarps. For several years the senior author has been collecting and examining plants of this species in the hope of obtaining "fruiting" material. Only recently has this met with limited success. On October 8, 1960, about 6 miles south of Perry, Taylor County, Florida, a small collection was made, subsequent examination of which revealed the presence of microsporocarps. Since no megasporocarps could be found amongst the meagre amount of material collected, we revisited the locality and procured a larger quantity. In this, although microsporocarps were bountifully present, still no megasporocarps were seen.

Neither Svenson (*ibid.*) nor Mason (1957) appear to be overly confident about the characters by which the species of *Azolla* are to be distinguished, particularly vegetatively. Both authors use the septation, or lack of it, of the glochidia of the microsporangic massulae as primary characters. Svenson indicates that the character of the surfaces of the megaspores is distinctive for three of the four species with which he was concerned, the megaspores of *A. caroliniana* being unknown.

*Azolla caroliniana* is the only species of the genus reputedly occurring in Florida. Plants of the collection here discussed appear to be not unlike those that the senior author has observed during his years of botanical work in the southeastern states and it is assumed that they represent this species.

Microscopic examination of the microsporangic massulae of our

[1] This investigation was supported (in part) by a PHS research grant, RG-6305, to the senior author from the Division of General Medical Sciences, Public Health Service. Illustrations were prepared by Mr. Reinert.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recent collection shows that the glochidia of a given massula are both septate and nonseptate without exception. A single instance was observed in which a glochidium was branched, one branch being septate, the other nonseptate. According to Svenson the glochidia of *Azolla caroliniana* are not septate; those of *A. filiculoides* are not septate or rarely have 1 or 2 septae at their apices; *A. mexicana* and *A. microphylla*, on the other hand, have many-septate glochidia. We are not suggesting that *A. caroliniana* and *A. filiculoides* are not, therefore, distinguishable for we have insufficient material for comparison. We simply question the use of the nature of the glochidia as distinguishing characters for these two plants. And we encourage collectors to keep a weather eye out for sporocarpic material of *Azolla*, particularly *A. caroliniana*, so that in time there may be more ample and more suitable material for comparative study.

It is difficult in our material to ascertain the number of sporangia in each sporocarp because some sporangia apparently do not develop at all and gradually disintegrate. Of those which do mature, not all mature at the same rate. Svenson gives the number per microsporocarp of *Azolla caroliniana* as 8 to 40. For the record, counting all microsporangia in a given sporocarp which could be distinguished regardless of stage of development, these are the counts for thirty-four microsporocarps: 23, 24, 45, 24, 50, 60, 66, 44, 29, 64, 60, 23, 24, 45, 24, 19, 45, 24, 50, 60, 44, 29, 64, 60, 19, 32, 30, 39, 16, 49, 52, 22, 19, 48.

Svenson, in his key to the species, gives the number of massulae per microsporangium as 4 to 6 in *Azolla filiculoides*, and four in *A. mexicana*. In discussion of *A. microphylla* he reports an earlier investigator's count as six for this species. He gives no count for *A. caroliniana*. The number of massulae in virtually all of the numerous microsporangia examined in our material

FIG. 1. AZOLLA CAROLINIANA: A, HABIT, UPPER SURFACE OF STERILE PLANT; B, LOWER SURFACE, PLANT WITH MICROSPOROCARPS; C, MICROSPOROCARP; D, MICROSPORANGIUM WITH MASSULA BEING DISCHARGED; E, GLOCHIDA TYPES FROM A SINGLE MASSULA; F, THE ONLY BRANCHED GLOCHIDIUM OBSERVED; G, TIP OF A GLOCHIDIUM AS SEEN UNDER OIL IMMERSION; H, THE TWO-LOBED LEAF.

was three; only one of those examined contained four.

Specimens of our microsporocarpous material have been distributed to some herbaria as *Godfrey* 60394 and *Godfrey & Houk* 60474. Some material has been preserved in F A A and is available should anyone wish to see some.

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## Adaxial Sori in Polypodium hesperium

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While collecting ferns and fern allies in the Gunnison National Forest, in central Colorado, in June, 1959, two colonies of a *Polypodium* were discovered which were unique in that the fronds had distinct sori on both the adaxial and abaxial surfaces (*Fig. 1*). The plants readily keyed to *Polypodium hesperium* Maxon, the taxonomic status of which is somewhat uncertain as evidenced by the fact that Maxon in Abrams[1] and Harrington[2] regard it as a distinct species, whereas Broun[3] listed it as a variety of *Polypodium vulgare* L. and Fernald[4] considered it a synonym of *Polypodium vulgare* L. var. *columbianum* Gilbert. Without attempting to decide the taxonomic status discrepancy, the collections here reported will be referred to as *P. hesperium*.

The two colonies were growing in the crevices of rocks on mountain slopes covered with a piñon-juniper association at an altitude a little over 7680 feet. Although the habitats were quite similar, they were separated geographically by over 30 miles.

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[1] Illustrated Flora of the Pacific States **1**: 8. 1926.
[2] Manual of the Plants of Colorado 15. 1954.
[3] Index to North American Ferns 144. 1938.
[4] *Polypodium virginianum* and *P. vulgare*, Rhodora **24**: 125–142. 1922.

Polypodium hesperium with Adaxial Sori
(Colorado, Hartman 1653)

The presence of adaxial and abaxial sori was widespread throughout both colonies, occurring on more than 50% of all the plants present. In general, a single plant would have this tendency developed to some extent on all of its fronds. The plants of one colony were about twice the size of those in the second colony, but within each of the colonies the individual plant size was fairly uniform. The larger fronds averaged 15.0 cm. in total length and there was some occurrence of arrested pinna-development, in which case the pinnae were either reduced to slight protuberances, mere laminal flanges of the rachis, or were totally absent. There was no apparent distributional pattern of these abnormalities. Mohlenbrock,[5] in reporting an unusual form of *Asplenium pinnatifidum* Nutt., mentions abaxial sori being visible from the adaxial side. This occurred on three specimens of a population, and in each case there was extreme suppression of laminal development.

The abaxial sori were large and located about one-half way between the margin and the midrib or submarginal. The adaxial sori were smaller and definitely marginal, suggesting in some cases a dorsal continuation of the normal ventral sori. Although superficial examination of the pinnae would lead one to this conclusion, microscopic study of microtomed sections showed that there were two distinct sites of sori initiation, one definitely abaxial and one definitely adaxial. Thus what appears to be a confluency of sori is merely due to the bushy development of sporangia within a sorus. It should also be pointed out that there was not an adaxial counterpart of every abaxial sorus. The ratio between viable and non-viable spores was essentially the same in both sori. Approximately 15–20% of the adaxial and abaxial spores were non-viable. Viable spore size was also essentially the same, ranging from 60–65 $\mu$ in length $\times$ 38 $\mu$ in width.

A specimen is on deposit in the herbarium of the U. S. National Museum. Specific collection data is as follows: Crevices

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[5] An Unusual Form of *Asplenium pinnatifidum,* THIS JOURNAL, **46:** 91. 1956.

of large rocks on piñon-juniper covered mountain slopes, Spring Creek Camp Ground, Gunnison National Forest, 26 miles northeast of Gunnison, Gunnison County, Colorado, June 28, 1959, elev. over 7,680 feet, *Hartman* 1653.

DEPARTMENT OF BIOLOGY, KANSAS STATE TEACHERS COLLEGE, EMPORIA, KANSAS.

## Heat Resistance of Sporocarps of Marsilea quadrifolia

WILLIAM W. BLOOM

In an earlier paper[1] the author reported on the comparable viability of sporocarps of *Marsilea quadrifolia* L. in relation to age. The same paper summarized some of the reports in the literature on the unusual resistance of sporocarps of the Marsileaceae to aging, drying, alcohol, and herbarium poisons. The present paper deals with the unusual resistance to moist heat of sporocarps of *M. quadrifolia.*

On November 21, 1953, sporocarps of *M. quadrifolia* were collected at the botany pond of Eastern Illinois State College. A similar collection was made on November 3, 1953, by Dr. W. N. Stewart at the Kikapoo State Park in Illinois and forwarded to Dr. Paul D. Voth, of the University of Chicago, under whom the author was working at the time.

When attempts were made to germinate sporocarps from each lot soon after collection, the results were poor. Few of the sporocarps opened typically, and relatively few spores were released. Few sporophytes were produced. However, when sporocarps were placed in a 65°C oven in a study of their moisture content, excellent germination results were obtained after two days of drying. Both lots of sporocarps were stored in a steam-heated room in the Barnes Laboratory of Botany at the University of Chicago during the fall and winter. These sporocarps showed normal germination behavior by early spring.

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[1] Bloom, William W. Comparative Viability of Sporocarps of *Marsilea quadrifolia* L. in Relation to Age: Ill. Acad. Sci Trans. **47**: 72–76. 1955.

Early in the spring of 1954, when the normal sporocarps were giving good germination results, it was decided to check their resistance to boiling. Sporocarps boiled for two hours showed normal germination. Numerous gametophytes developed and later sporophytes were produced.

The writer thought it would be desirable to repeat the experiment in the fall of 1957 and extend it by determining whether the spores within the sporocarps could withstand autoclaving at 15 lbs. pressure for 15 minutes as well as boiling. The results of this repetition were somewhat surprising. At this time the spores within the sporocarps were unable to resist even the five minutes of boiling.

Since the sporocarps might have taken up considerable moisture during the humid summer of 1957, selected sporocarps were subjected to drying at 65°C to a constant weight. The weight of 100 sporocarps decreased from 1.895 grams to 1.745 grams for a loss of 0.15 grams or 7.9%. The weight loss of a control lot was negligible during the same period.

Sporocarps from the dried lot and the control lot were boiled for 15, 30, 90 and 120 minutes. Similar numbers of sporocarps were autoclaved at 15 pounds pressure for 15 minutes. Following this heat treatment, sporocarps were scarified with a file and placed in individual vials containing about 20 ml of tap water each. The dried and boiled sporocarps that were germinated contained viable spores which developed into good gametophytes and later sporophytes developed, similar to those of a set of controls. The spores from undried sporocarps that were boiled failed to develop into gametophytes. The undried sporocarps that were autoclaved also lacked viable spores. Some of the sporocarps that were dried and autoclaved contained no viable spores, some had viable megaspores, and some had both viable megaspores and microspores which resulted in the production of sporophytes. In a series of 20 dried and autoclaved sporocarps, 1 did not open, 9 contained no viable spores, 7 had viable megaspores only, and 3 had viable megaspores and microspores which resulted in sporophyte development.

It is interesting to note that the microspores were much more susceptible to the autoclaving, as they were to aging, as was pointed out in the earlier paper cited previously. This greater resistance of the megaspores to autoclaving is a handy tool for hybridizing attempts with the Marsileaceae. Since megaspores are readily visible, it is possible to mix microspores from one source with megaspores of another, making it possible to work with thousands of megaspores with a minimum of labor as compared to that required for the manual separation of megaspores and microspores.

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## Peltapteris in Costa Rica

CLYDE F. REED

*Peltapteris* Link is a small genus of wide-creeping, epiphytic ferns, with slender-branching rhizomes and dimorphic fronds. The more or less dissected, flabellate sterile fronds tend to separate this genus from *Elaphoglossum*, to which it is nearly related. The fertile fronds are smaller and roundish, cordate, crenate-dentate or lobed, with the sporangia covering the fertile surfaces.

Morton[1] made transfers of the species and varieties to *Peltapteris* Link from *Rhipidopteris* Schott. There are two species, each with one or more varieties or forms, found in Costa Rica.

In addition to the many specimens of the following species and forms in the United States National Museum, collections in the Reed Herbarium, purchased through grants to H. E. Stork and C. K. Horich, give an idea of the distribution of the genus *Peltapteris* in Costa Rica. The general distribution for each will also be given based on the specimens in the United States National Museum. I wish to thank C. V. Morton for helping in the identification of the specimens in the Reed Herbarium.

PELTAPTERIS FLABELLATA (H. & B.) Morton. Atlantic rainforest

[1] THIS JOURNAL **45:** 11–14. 1955.

of Tapanti, dense jungles at base of the northern Cordillera de Talamanca, along the upper headwater area of Río Reventazon and Río Macho, south of Orosí, alt. 1100-1200 m., *Horich* 193 (Reed Herb. 33487-88); Santa Clara de Cartago, alt. 1950 m., *Maxon & Harvey* 8238 and *Lankester* 662 (US); vic. of El General, Prov. San José, alt. 1680 m., *Skutch* 3043 (US). Also Panama, Colombia, Peru, and Ecuador.

PELTAPTERIS FLABELLATA forma STANDLEYI (Maxon) Morton. Creeping in moss on tree in wet forest, vic. of Tilarán, Prov. Guanacaste, alt. 500–600 m., *Standley & J. Valerio* 44454 (US); also collections in US from Los Ayotes, La Palma, Pejivalle, Quebrada Serena, La Tejona, and El Silencio. This form is usually at lower elevations than the typical one. Also Panama, Venezuela, and Ecuador.

PELTAPTFRIS PELTATA (Swartz) Morton forma PELTATA. Peralta, *Stork* 493 (Reed Herb. 19936). West Indies, Mexico to Panama.

PELTAPTERIS PELTATA forma FOENICULACEA (Hook & Grev.) Morton. Highest Carpintera, alt. 6000 ft., *Stork* 1372 (Reed Herb. 19937); Carpintera, cloud forests, mountains near San Ramón de Tres-Ríos, alt. 1700–1880 m., *Horich* 20 (Reed Herb. 32809). This is the most divided form, with the sterile fronds up to 6-times divided and the ultimate segments filiform, making them about one-half as wide as those in the typical form. Also south to Venezuela and Ecuador.

PELTAPTERIS PELTATA forma **potentillifolia** (Christ) Reed, *comb. nov.* Based on *Acrostichum* (*Rhipidopteris*) *peltatum* Swartz var. *potentillaefolium* Christ, Bull. Soc. Belg. **35**: 242. 1896. La Palma. Costa Rica, alt. 1550 m., Dec. 18, 1888, *Pittier* 704 (Isotype, US 833,938). Cloud forests of Montaña del Cedral, south of San Antonio de Escazú, crest section and ridges at 2000–2400 m. alt., Nov. 1959–Jan. 1960, *C. K. Horich* 52 (Reed Herb. 33039-40). The lamina is several times dichotomous, with 6 to 8 segments which are decussate-dentate at their apices and from 0.3–0.5 cm. wide, making the segments about twice as wide as those of the typical form. Only known from Costa Rica.

REED HERBARIUM, 10105 HARFORD ROAD, BALTIMORE 34, MD.

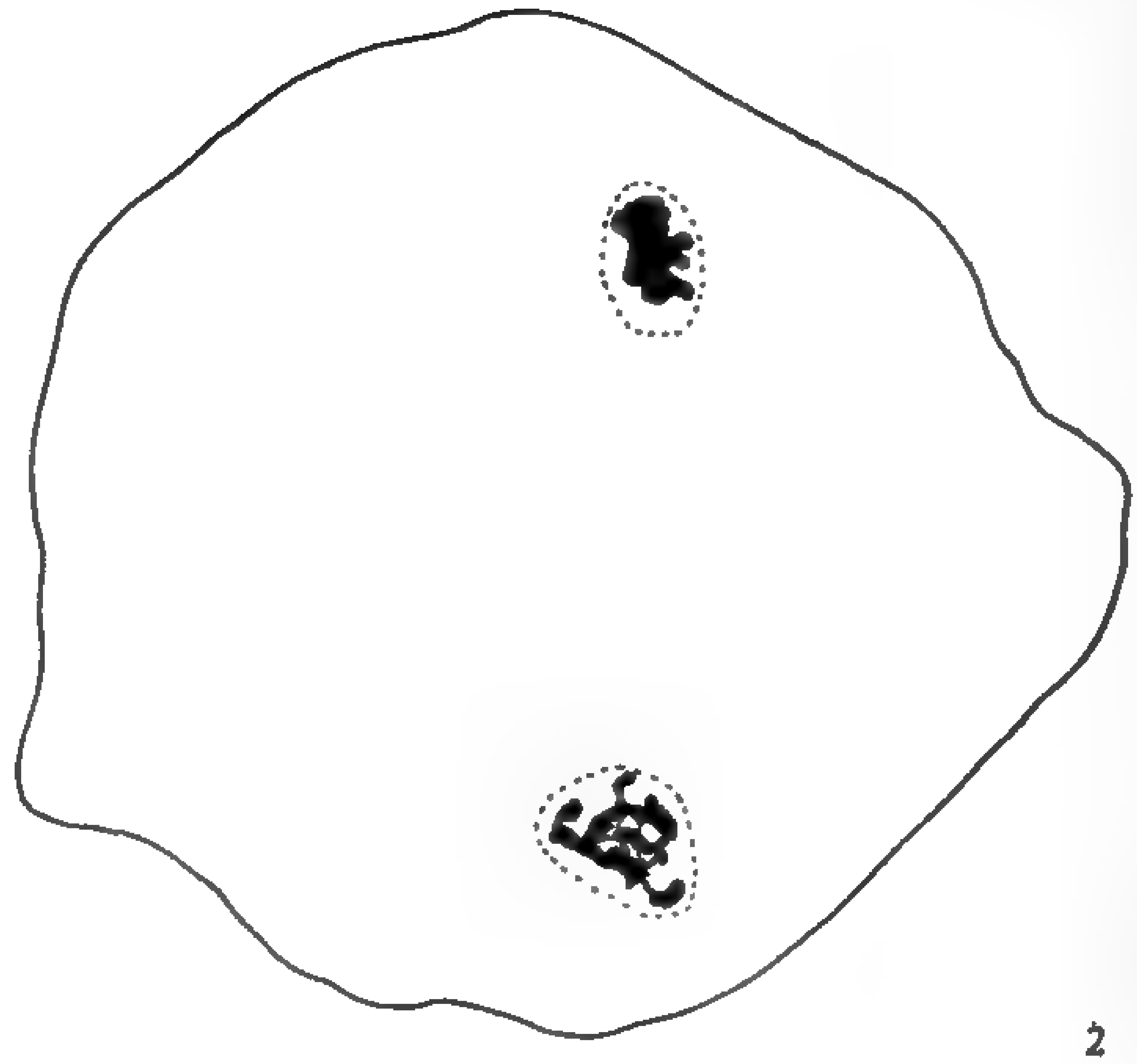
## Cytology of Isoetes coromandelina

S. C. VERMA

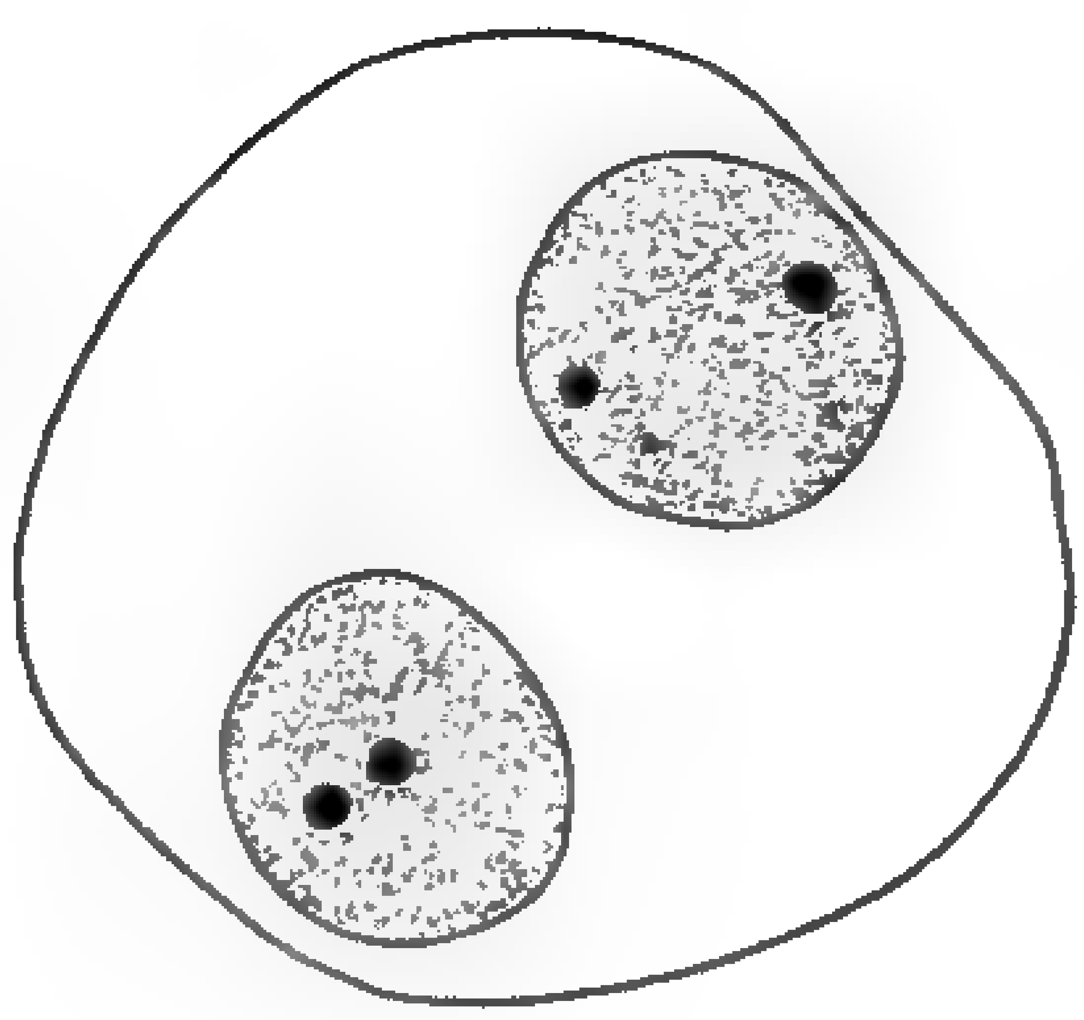
*Isoëtes coromandelina* L. is a native of India (cf. Reed, 1953) and is most commonly met with in South Indian localities along with three other species, namely: *I. dixitei* Shend., *I. sahyadrii* Mahabale and *I. sampathkumaranii* Rao. Apart from South India, *I. coromandelina* has been reported to occur in Serampur (Bengal, cf. Ekambaram and Venkatanathan, 1933), Bombay (McCann, 1934), Banaras (Bhardwaja, 1935) and Baroda (Gaekwad and Deshmukh, 1956) from where a new variety has been described. Recently Bhambie (1957) has reported its wild occurrence at Meerut (N. India), the exact location being about four to five miles north of Meerut, on the Meerut-Mowana road, where it is fairly common on field margins during the monsoons and dries up in winter. The present cytological observations concern only the Meerut gatherings. The morphology of the genus as a whole is being dealt with by Dr. S. N. Bhambie; the cytology was investigated by the writer in August and September 1956, 1957, and 1958 with the kind permission of Prof. V. Puri. Almost all the fixations of the wild as well as the material kept in the greenhouse were made in 1:3 acetic-alcohol by Dr. S. N. Bhambie, to whom the writer is very grateful.

Extensive examination of the material has revealed the presence of only megasporangiate plants at Meerut. Curiously enough, Bhambie (1957) too, who has studied many more individuals, has only recorded the megasporangiate material thus far. As Prof. Puri tells me, microsporangia have so far not been observed in any of the individuals studied at Meerut. Therefore, the present account is limited to only the megaspore-mother-cells. The number of megaspore-mother-cells per sporangium is usually very small, which evidently renders this difficult cytological material. The usual acetocarmine squashes (cf. Manton, 1950) have been obtained and made permanent by McClintock's (1929) technique.

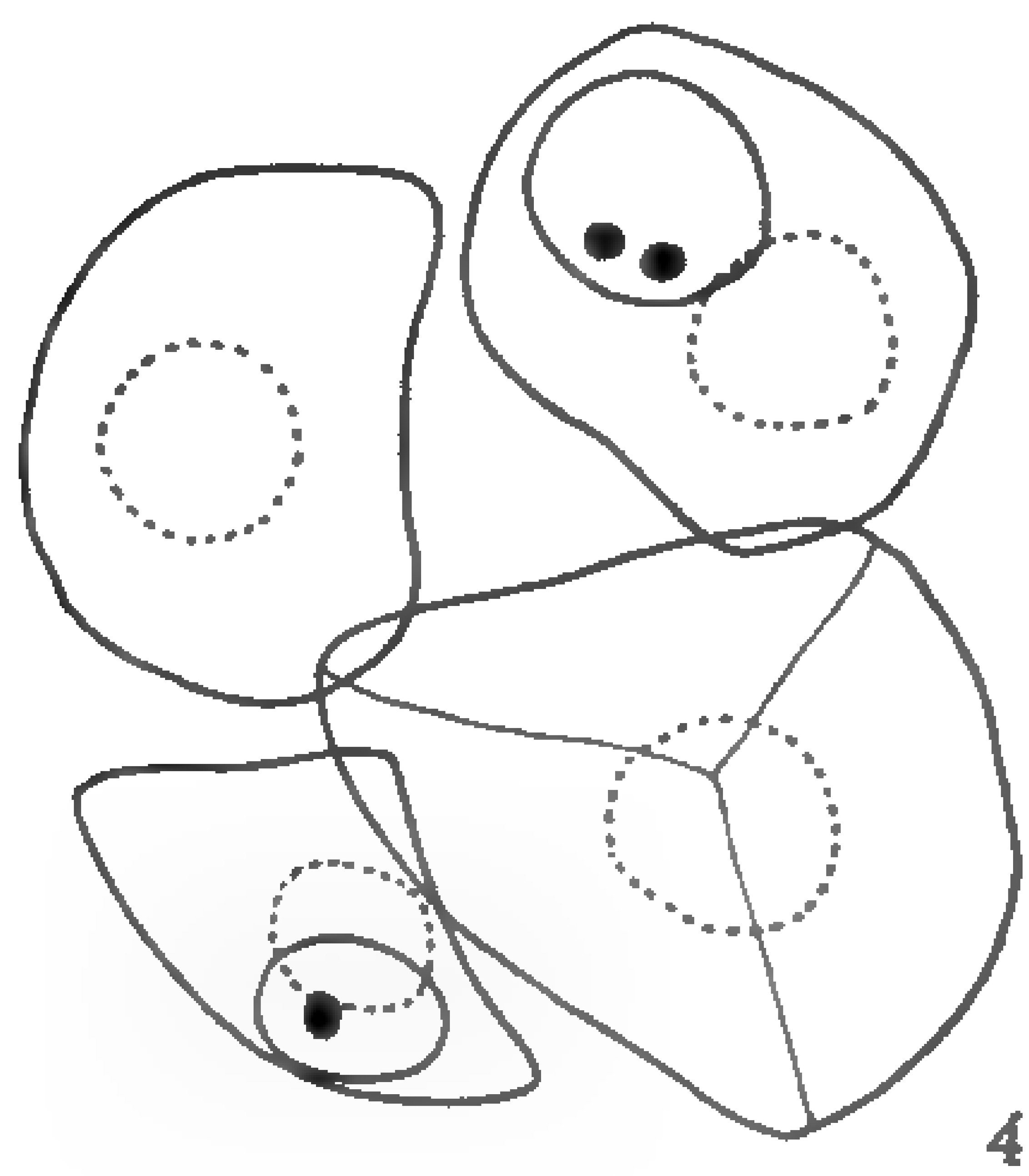
1



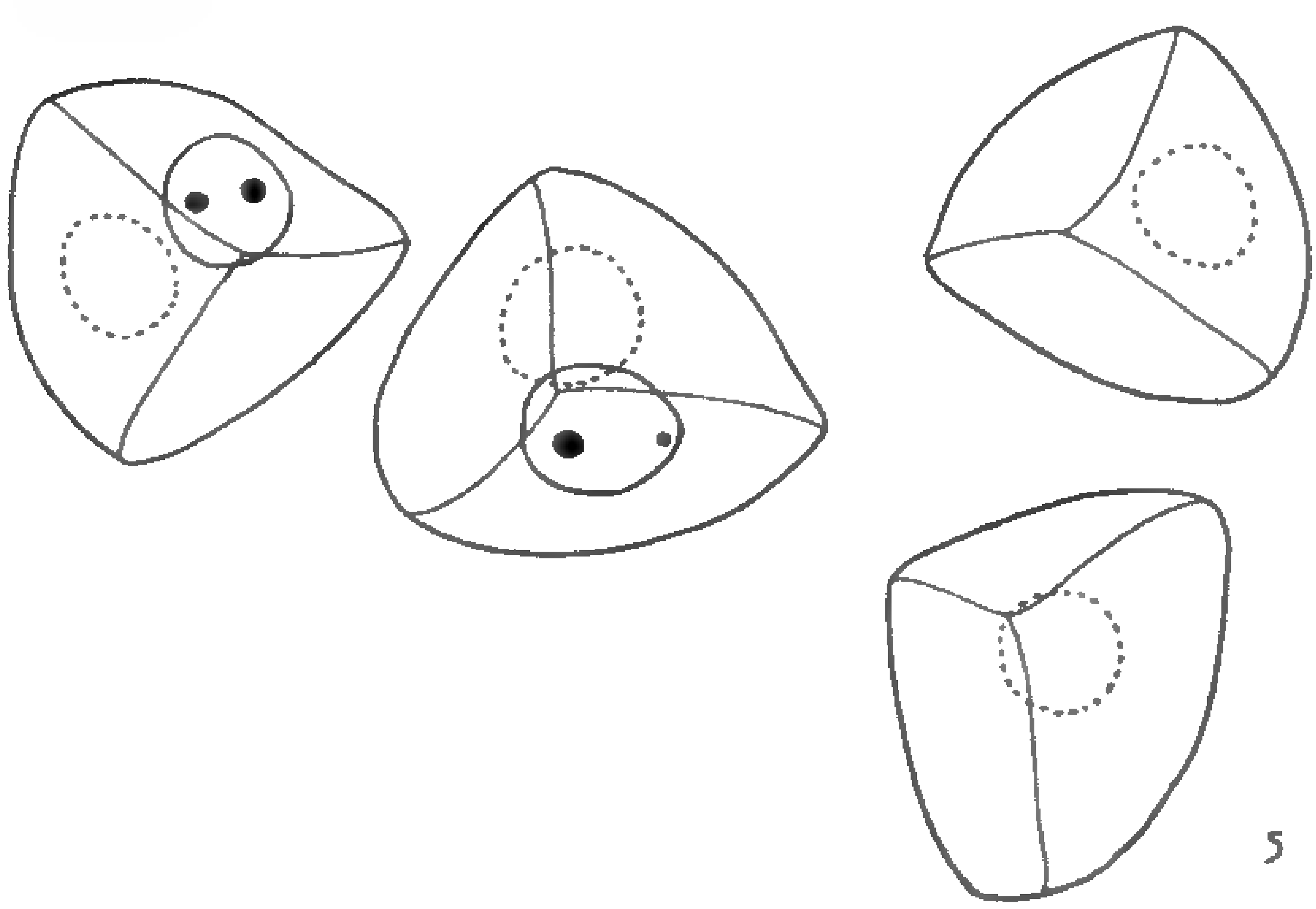
2



3



4



5

The sequence of meiosis in the megaspore-mother-cells is interesting. Early prophase stages have not yet been critically followed, but the evidence seems to be convincing that mostly the chromosomes remain unpaired during prophase. In a very few mother-cells, the univalent chromosomes are associated in groups of three or more. There is no regular division in such cells and depending upon the groups micronuclei are organized, or in some cases there is one mitotic division of the chromosomes followed by an irregular anaphase separation, which results in abortive spores. Rarely the entire contents, first distributed in groups, get included into a single large nucleus and result in a "monad." However, in 95% of the cells examined there is complete asynapsis and at the first meiotic phase 33 univalents and a small fragment (marked 'f') are clearly discernible (*Fig. 1*). Three to five chromosomes are usually observed to be associated with the nucleolus where some of them may show end to end associations, observed only in a few preparations). The small fragment has invariably been noticed and is therefore believed to be centric. It is further supported by a similar count in two squashes of root tips which were pre-treated with 8-hydroxyquinoline (cf. Tjio and Levan, 1950) There is an equational division of the chromosomes with a regular anaphase separation and subsequent organization of two nuclei with the unreduced chromosome number (*Figs. 2* and *3*). There is no indication of a second meiotic division. Tetrad nuclei are therefore absent and the dyads are the end products of "meiosis." This type of meiotic behavior is in general agreement with hybrid species where almost all the chromosomes appear at metaphase I as univalents (cf. Darlington, 1958). Complete details of the process will appear elsewhere.

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FIG. 1. Total asynapsis in a megaspore-mother-cell of Isoëtes coromandelina Linn. showing 33 + 1 frag. chromosomes (all univalents) at the first meiotic phase, × 430; FIG. 2. A megaspore-mother-cell at telophase I, × 430; FIG 3. A megaspore-mother-cell showing dyad nuclei, × 430; FIG. 4. Tetrahedrally partitioned megaspore-mother-cell showing two nucleate and two enucleate spores, the nucleate ones with prominent nucleoli; × 430; FIG. 5. Tetrahedrally partitioned spore-mother-cell showing two nucleate and two enucleate spores, × 430.

The dyads with the unreduced nuclei now undergo cytokinesis in a tetrahedral manner, like the ferns with tetrahedral spores, resulting in two nucleate and two enucleate spores (*Figs. 4* and *5*). The latter shrivel and ultimately abort. Mature megaspores are invariably tetrahedral, which supports the present observations and also confirms that this type of wall formation is the rule in the Meerut plants. Evidently the suppression of one meiotic division has not affected the cytokinetic behavior, which occurs here as it would take place in a normal tetrad. It may be pointed out that in other ferns such as *Ophioglossum vulgatum* L. (forma) (Verma, 1956) and *Trichomanes insigne* (v.d.B.) Bedd. var. *B* (Mehra and Singh, 1957) where dyad formation has been reported, there is only one wall laid down to separate the dyads. Sometimes, however, here in *Isoëtes coromandelina* (in Meerut) incomplete walls may be laid and the whole mass containing two nuclei remains a single structure with the impression of walls on it. This part of the study and the probable explanation of the events has appeared separately (Verma, 1960). It may be pointed out here that to the writer's knowledge there have been no previous reports of such a type of cytokinesis: The laying down of more than one wall when dyads are developed either by the suppression or failure of one meiotic division. This appears to be the first report in plants. The conclusion well supports the general view expressed by Swanson (1958), that "the two processes—karyokinesis and cytokinesis are distinct and have arisen independently in evolution."

Only the nucleate spores seem to be capable of germination. Furthermore, in the absence of any microsporangiate plants or an accessory mode of reproduction, it is inferred that the unreduced megaspores develop parthenogenetically (apogamously). Spore germination studies are in progress.

Abraham and Ninan (1958) have recently reported on the cytology of two of the South Indian species, *Isoëtes sampathkumaranii* and *I. coromandelina.* The latter was studied from Kovalam, Veli, Quilon, and Crangannore, in Kerala state and from Waltair, in Andhra Pradesh. All these gatherings were shown to be diploid asynaptic with 22 + 1 frag. chromosomes at meiosis in the megaspore-mother-cell and also in root-tip squashes. One of the plants collected from Kovalam was, however, a triploid, 33 + 1 frag. chromosomes having been observed in its root-tips. The Meerut populations of *I. coromandelina* are, in contrast, all triploids, and are thus of perhaps some cytogeographic interest. Like the South Indian material, the Meerut plants also possess an additional (centric) fragment. Abraham and Ninan also suggested the apogamous reproduction of the South Indian material. Furthermore, since Ekambaram and Venkatanathan (1933) observed bivalents and regular meiosis in both mega- and microsporangia in Coromandel coast as well as Madras material, the search for a sexual population is likely to be rewarded in South India which may perhaps give a clue to the origin of the triploid taxon. Such a probability is further indicated by Abraham and Ninan's statement that in the diploid race "asynapsis is probably the result of accumulation of structural hybridity rather than the consequence of hybridization," which means its origin from a previously sexual species.

Abraham and Ninan's results corroborate the earlier findings of the lowest monoploid number in *Isoëtes echinospora* Dur. ($n = 11$, Ekstrand, 1920) and *I. asiatica* Makino ($2n = 22$, Takamine, 1921). The chromosome number in the Meerut population of *I. coromandelina* lends additional support to the monoploid number of 11. Polyploid series based on 11 have earlier been reported in *I. japonica* A.Br. ($2n = 43$–$45$, Takamine, *l.c.;* $n = 33$, Yuasa, 1935) and *I. lacustris* L. ($n = 54$–$56$, Manton, 1950). It is believed that the rest of the numbers in *Isoëtes* reported by various authors (cf. Delay, 1953) and also in *I. coromandelina* in all probability may have been derived from the number 11.

The writer wishes to express his sincere thanks to Prof. P. N. Mehra for suggestions and encouragement, to C. V. Morton for some literature, to Prof. V. Puri (Meerut) for allowing him to work out the cytology and for laboratory facilities, and to Dr. S. N. Bhambie for the fixation of the material.

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## Recent Fern Literature

THE FERNS AND OTHER PTERIDOPHYTES OF IOWA, by Tom S. Cooperrider[1] is the latest addition to state fern floras, and a commendable one. All the species are keyed; localities are given for the rare ones, and all have county distribution maps. Five species reported from Iowa by various authors are not included since they are not represented by specimens seen by the writer; they are *Adiantum Capillus-veneris, Dryopteris Filix-mas, Equisetum palustre, Thelypteris noveboracensis,* and *Woodsia scopulina.* One of these can definitely be added on the basis of a specimen in the National Herbarium—*Thelypteris noveboracensis,* which was collected in a ravine in Tom Range,[2] Iowa, July 22, 1921, by B. Shimek (distributed by the University of Texas with the number 152). The other species mentioned should be searched for; the *Adiantum* would hardly have been misidentified, and probably not the *Dryopteris,* but the *Equisetum* and *Woodsia* could have been errors of determination. This *Thelypteris* brings the number of Iowa pteridophytes to 55; and *Equisetum scirpoides,* first collected in Iowa in 1959, in Winneshiek and Allamakee Counties by Thomas Hartley, according to a letter from Cooperrider, makes the total 56.—C. V. MORTON.

THE GOLDBACK FERNS OF CALIFORNIA.—To those familiar with the California flora it is perhaps a wonder that the conspicuous and variable goldback ferns, *Pityrogramma triangularis sensu lato,* have not long ago been investigated by biosystematists. Karen S. Alt and Verne Grant of Rancho Santa Ana Botanic Garden at Claremont have now given us the first investigation of this complex using modern cytogenetic techniques.[3] Although the study is not yet complete, the results are of substantial interest both to pteridologists and general vascular-plant taxonomists.

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[1]State University of Iowa Studies in Natural History, vol. 20, no. 1, pp. 1–62. Undated, but published July 22, 1959, according to a letter from Cooperrider, September 21, 1959.

[2]Thus far, I have been unable to identify this locality, which is unknown to Dr. Cooperrider also.

[3]Cytotaxonomic observations on the goldback fern. Brittonia 12 (no. 3): 153–170, *figs. 1–9, tab. 1–3.* 1960.

*Pityrogramma triangularis* was treated by C. A. Weatherby in 1920 as comprising, in addition to the widespread typical variety that ranges from Baja California to the southeastern edge of Canada, several other varieties, namely *pallida, viscosa,* and *Maxonii,* each with much more local and southern distribution patterns. The results of Alt and Grant show that "typical" *P. triangularis* itself comprises at least three population systems—two diploids (a large, coarse one with long segments, "A," and a small, more herbaceous one with short segments, "B") and a tetraploid with $n = 60$ chromosomes. They consider "A" and "B" to be best regarded as poorly separated "semispecies" because of the many intermediates that exist. But they interpret the tetraploid populations as representing possibly a distinct, sibling species.

The "varieties" *pallida* (of the Sierra foothills of Central California) and *viscosa* (of maritime southern region) are sympatric with *P. triangularis.* They retain their distinctness where they overlap, in spite of evidences of some hybridization in certain localities, and the authors therefore propose that *pallida* and *viscosa* be treated as species coordinate with *triangularis.* The primarily desert-inhabiting var. *Maxonii* is still so little known that the authors have made no suggestions in regard to its status.

These cytotaxonomic studies have revealed, according to Alt and Grant, "an unsuspected heterogeneity within this small assemblage," and they interpret the traditional taxonomic fern species *Pityrogramma triangularis* as a complex of biological species, not unlike a number of taxonomic species of Californian flowering plants such as *Artemisia tridentata, Elymus glauca,* and others which are similarly constituted.—W. H. WAGNER, JR.

## American Fern Society

### Report of the Spore Exchange, 1960

The activities of the spore exchange, consisting of receiving and filing contributions of spores and of filling requests for them, seem to follow a seasonal pattern, the peak load coming in the fall when spores in most of the country have recently ripened and folks are returning from summer vacations. The next busiest time is in early winter—no doubt when things are being cleared away and put in order after the Christmas rush is over. The period of least activity is in the spring, although people in warm places and those who have greenhouses may request or send in spores at any time. Letters and replies go on more or less all the year. In 1960 there were many more of these than in the previous year, considerably over a hundred.

As to spores, 146 packets were received from 27 kind members and of these about 40 were species new to our list, already numbering 239 kinds available to members. During the year, 1,173 packets were sent to 48 members requesting them.

At the present time, our supply of mimeographed lists of available spores is exhausted. A new revised and up-to-date list is planned for the fall of 1961; it will be sent to any who in the past two years have shown interest in the exchange either by inquiries or by contributions or requests for spores. It will be sent also to any member of the Society requesting one.

In order to make this new list as inclusive as the last, an urgent request is made to all members to send in spores or fertile fronds by September 10 or sooner. Even if the ferns you have or the ferns you see on your trips seem to you too common, remember they are not common in another part of the country or the world. We have a good many requests, now, from other countries. Also, even if you have sent the same ones before, remember the supplies must be kept fresh each year and many species with spores that are now two years old will have to be dropped from the present list.

Preparing a new spore list is a task requiring a considerable amount of time, and so if it is to reach you in the fall, spores *must* be on hand in earliest September. Your cooperation in this will be sincerely appreciated.

Before closing this report a more or less personal note should be added. Because of other full time commitments from October 15 through Christmas, it will be impossible for letters to be answered or spore requests filled during that time. It was a source of real concern when this proved true in 1960, and many letters of apology had to be written in January.

So, please, your spore contributions before September 10 and your spore requests before October 15. Thank you.

Respectfully submitted,

KATHRYN E. BOYDSTON,
*Fernwood, Route 3, Niles, Michigan*

# CONSTITUTION OF THE AMERICAN FERN SOCIETY, INC.[1]

## ARTICLE I. NAME

Section 1. The name of this society shall be THE AMERICAN FERN SOCIETY, INCORPORATED.

## ARTICLE II. OBJECTS

Section 1. The objects of the Society shall be to affiliate those who are interested in the study of ferns and allied plants, to foster such an interest, to encourage correspondence and exchange of specimens between members, and the publication of matter pertaining to this group of plants.

## ARTICLE III. MEMBERSHIP

Section 1. Any person interested in the objects of the Society shall be eligible to membership.

Section 2. Application for membership accompanied by the required fee of two dollars and fifty cents may be made at any time to the Secretary, and when so received, approved by two members of the Council, and acknowledged, the applicant shall be considered a member for the current year.

Section 3. The admission fee shall be two dollars and fifty cents payable when application for membership is made. This fee shall also constitute the dues for the current year.

Section 4. The annual dues shall be two dollars and fifty cents, payable on January first of each year. Sustaining membership is credited to any person upon the annual payment of five dollars.

Section 5. Any eligible person may become a life member on payment, at any one time, of a fee of fifty dollars, and shall thereafter be subject to no dues nor assessments. All such fees shall be held and invested as a permanent fund, the principal of which shall not be expended, but the income from which may be used for the purposes of the Society on vote of the Council. Contributions for the purpose and other available moneys may be added to this fund at the discretion of the Council.

Section 6. Honorary members may be chosen when unanimously nominated by the Council, and their names submitted to the members at the next succeeding annual election. Three-fourths of the votes cast on the question shall be required for election, and the total number cast must

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

be at least twenty. Honorary members shall be entitled to all the privileges of the Society without payment of dues. The number of such members shall not exceed five at any one time.

Section 7. Every member in good standing is entitled to all the privileges of the Society including its publications.

Section 8. Members one year in arrears for dues who have been twice notified of their indebtedness shall be considered not in good standing and shall forfeit all privileges of the Society including its publications. Any such member may be reinstated at any time durng the succeeding year by the payment of arrears to the Treasurer. If at the expiration of this second year and without justifying cause his dues shall remain unpaid, he shall cease to be a member of the Society, provided, however, that the Council shall have the power to remit any dues for reasons which it considers sufficient.

## ARTICLE IV. OFFICERS

Section 1. The officers of the Society shall be a President, Vice-President, Secretary, and Treasurer. Their term of office shall begin January first and they shall serve for one year, or until their successors are duly chosen.

Section 2. The President shall be in immediate charge of the general interests of the Society; he shall appoint all committees not otherwise provided for, and shall report annually to the Society. On or before December 31 of each year, he shall appoint one who is not an officer, and need not be a member of the Society, who shall audit the accounts of the treasurer for that year and who shall report to him as soon after the close of the year as possible.

Section 3. The Vice-President shall act in the absence or disability of the President.

Section 4. The Secretary shall keep the records of the Society, including the official list of members, and conduct the correspondence pertaining to his office. He shall turn over to the Treasurer all money received and shall report annually to the Society.

Section 5. The Treasurer shall receive and hold all moneys belonging to the Society subject to the direction of the Council, receipt for dues, pay bills when approved in the manner prescribed by the Council, make an annual report to the Society, and at the end of his term of office shall deliver to his successor all money and other property of the Society in his possession.

At such times as the Council shall direct, he shall furnish the Council with a statement showing his financial transactions since the date of his previous report, any outstanding indebtedness, the cash balance in hand,

and such other simple facts as shall enable the Council to know clearly the financial condition of the Society at the time. He shall close his accounts for the year promptly as of December 31 of each year, and as soon as practicable thereafter shall place in the hands of the auditor such records, vouchers, etc., as shall make possible a proper auditing of his accounts.

Section 6. The unexpired term or vacancy in any office shall be filled until the ensuing election by appointment by the Council.

### ARTICLE V. COUNCIL

Section 1. The President, Vice-President, Secretary, Treasurer, and Editor-in-Chief shall constitute a standing committee to be known as the "Council."

Section 2. The Council shall have general charge of the affairs of the Society; of its publications and property; shall have power to expend the Society's money and to act upon all questions not requiring a vote of the Society.

### ARTICLE VI. ELECTIONS

Section 1. Before the first day of September of each year, the President, with the approval of the Council, shall appoint a nominating committee, consisting of a chairman and two other members, none of whom shall be an officer of the Society.

Section 2. This committee shall nominate officers for the ensuing year and forward the list of nominees to the President before October fifteenth. Any other nominations, if endorsed by three members in good standing and received by the Secretary not later than October fifteenth, shall be incorporated in the ballot for that year.

Section 3. The President shall immediately thereafter appoint some member not a candidate for office to act as Judge of Elections, and shall forward his name together with the list of nominees to the Secretary.

Section 4. The Secretary shall before November first send to each member of the Society a notice of the election, giving a list of the nominees and the name and address of the Judge of Elections, to whom each member shall send his ballot.

Section 5. Balloting shall begin November first and end December first. Immediately after election the Judge of Elections shall send to the Secretary a true statement of the ballots cast and shall send the ballots to the chairman of the nominating committee. The candidate receiving the largest number of votes shall be declared elected, and shall be notified of his election by the Secretary. In case of a tie the nominating committee shall cast the deciding vote and shall notify the Secretary of its action.

## ARTICLE VII. AMENDMENTS

Section 1. Proposed amendments to this Constitution must be presented to the Secretary in writing before October first, signed by three members. The Secretary shall publish such proposed amendments with the notice of the next annual election and they shall be voted upon at that election. If two-thirds of the vote cast for any proposed amendment are in favor of its adoption, and provided that not less than twenty votes are cast on the question of its adoption, the amendment shall be declared adopted.

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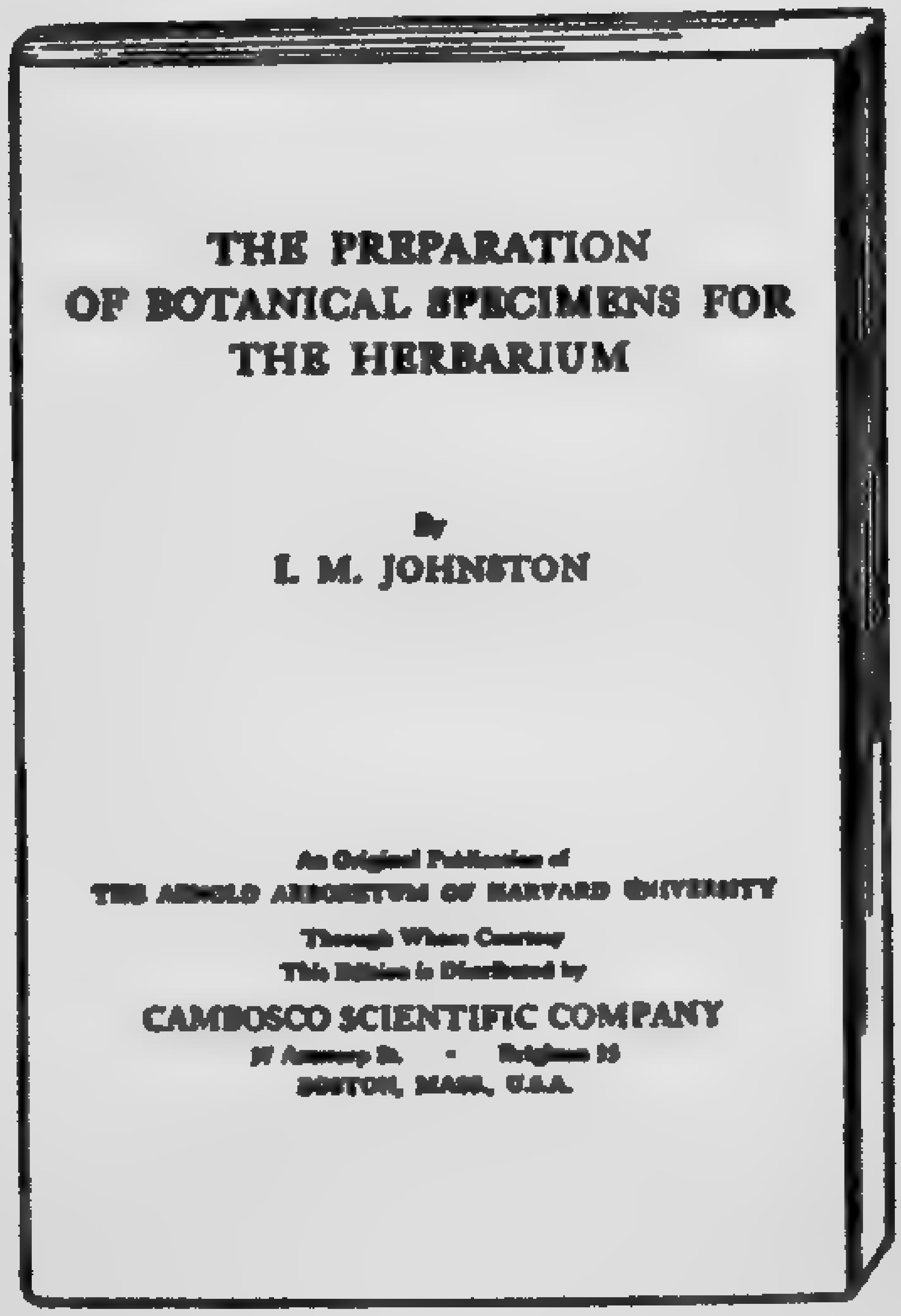


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# American Fern Journal

A QUARTERLY DEVOTED TO FERNS

Published by the

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C. V. MORTON IRA L. WIGGINS JOHN H. THOMAS ROLLA M. TRYON, JR.

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# American Fern Journal

Vol. 51 — July-September, 1961 — No. 3


## Growing Ferns from Spores


Thorleif Fliflet


### Introduction

Some years ago I acquired a small wooded area next to my garden and to make it more interesting, I began planting ferns there. At the same time a friend, Mr. Thomas Carlson, who is a local pteridologist, introduced me to the American Fern Society, and I was all set for a new hobby. Later I became acquainted with the late Mr. M. D. Mann, Jr., then Treasurer of the American Fern Society. Many will remember his interest in the Society and its members, his beautiful fern garden and his "give away" department. Being a conservationist rather than a botanist, I began growing ferns from spores, doing some experimenting in order to find the most practical methods for the amateur fern grower. Of course, I did some reading, too.

This review was originally intended only to cover the development of spores into prothallia, ending the process with the first leaf or leaves of the young sporophytes or fernlets, a process which, in the case of viable spores, requires only that the spores be surrounded by an atmosphere at or close to the point of saturation (of moisture), while resting on a moist surface and subject to favorable light and temperature conditions. However, the amateur who sows fern spores does so in order ultimately to produce ferns for his garden. So it appeared logical to pursue the subsequent development of the tiny sporophytes or fernlets through transplanting, and so forth. This article covers only the growing of ferns by the amateur not possessing a greenhouse. Commercial methods are not considered.

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## GENERAL DESCRIPTION OF METHODS FOR GROWING FERNS FROM SPORES

The amateur gardener who wishes to grow ferns from spores has two simple methods available to him, the flowerpot method and the method using clear plastic containers. Both methods employ organic soil for the cultures and require only easy means of sterilization. Methods involving a high degree of sterilization or the use of crocks, stones, peat, or agar will not be considered. However, reference is made in the appendix to articles in the AMERICAN FERN JOURNAL covering this subject and generally employing more highly sterile conditions.

The process of growing a mature fern from a spore involves the following steps:

a. Collecting and sowing of the spores.

b. Germination of the spores as indicated by the green emerging prothallia.

c. Period of growth of the prothallium (first stage) during which it attaches itself to the surface of the medium and develops its characteristic shape and size.

d. Fertilization, a process which depends on the waterborne movement of the sperm cells and their fusion with egg cells. However, many species of ferns reproduce without recourse to the fertilization process.

e. Development of the sporophyte or fernlet by the grower until mature enough to be planted in the garden.

The entire process, commencing with spores, involves one and one half to two and one half years.

Assuming that the spores are sown in the fall, the miniature ferns must be transplanted from the cultures in the following spring and kept indoors another year enclosed in a propagation box, "window greenhouse," or a terrarium. By then the ferns are one and one half years old (counting from sowing of the spores) and may still be too fragile for the garden, in which case they should go into a cold frame or possibly into a lathhouse. The cold frame will require attention as to shading, ventilation, and watering in the warm season. Protection against freezing during the following winter should be provided so far as this is practical. After the third winter, when the ferns are two and a half years old, they are set out in the garden, where they usually make rapid growth. All transplanting is done with the soil adhering to the roots and vigorous watering should be delayed until they are well anchored so as to avoid disturbing the root system.

The time schedule given above will be affected to some extent by the temperature and light available by the method employed, the propagation box described below resulting in a faster growth than the other method. The rate of growth also varies with the species of fern. The above period of two and a half years is based on planting young ferns outdoors in the spring only, avoiding fall planting. However, in some instances the grower may find that a year and a half period may be sufficient.

### THE FLOWER POT METHOD FOR GROWING PROTHALLIA

a. Equipment. Unglazed earthenware flower pots, 3″ to 5″ size with drainhole, each provided with a piece of windowglass on top and a saucer underneath. Several pots may be placed in an aluminum or tinned iron pan. The pots should have a piece of crock in the bottom.

b. Material. Water, which must be boiled. Drainage material, preferably vermiculite, which should be washed so as to remove soluble salts. Soil, principally or entirely humus, screened through one sixteenth inch mesh.

c. Procedure. The washed pots are half filled with vermiculite and soil is then added up to three-fourths inch below the top and pressed slightly down to a smooth surface. The pots and the covers are then heated in an oven (the pots without the covers on) for an hour or so at 250°F together with the saucers and the pan. After cooling the covers are put on and the pots partly submerged in water to moisten the contents. When the surface of the soil appears moist (not muddy) and the pots cooled to room temperature, the spores are sown without touching them with the fingers. The cultures are then placed in a warm room, near a window but well shaded against direct sunlight. The pan or saucer will require watering once or twice a week to replace the loss from evaporation. A slight loss of moist air from the pots will also occur. The cultures should not be exposed to frost.

The prothallium obtains and utilizes the soil water through its hairlike rhizoids. After fertilization and the emergence of the sporophyte, the prothallium disappears. The organic soil contains the necessary nutrients, although the microbial life has been temporarily destroyed by the sterilization process. Condensation of water on the glass creates somewhat of a problem as large drops of water falling down in the pot may wash spores down into the soil. It is advisable to remove condensation occasionally, for instance by tilting the whole culture. After germination, however, drops falling on the prothallia may even be of some advantage in facilitating the movement of the sperm cells in the case of sexual species that follow the normal process of reproduction.

### Variations of the Flower Pot Method

There are, of course, many variations of this method as regards use of drainage material and sterilization of the soil. Some growers sterilize a flower pot in an oven, and then put in their own soil mixture, with or without drainage material. Next the soil is packed down and saturated with boiling water, and then a thin layer of charcoal and ground crocks passed through a screen and heated in an oven, is placed on top. The surface is then moistened by a fine spray. This arrangement corresponds to the use of sand over a seedflat, and is intended to avoid attacks by "damping off" fungi. The use of such an inert surface is said to hasten the germination of the spores by providing a medium of neutral reaction. Other growers, again, may sterilize the soil to some extent by holding a bag of soil in a pail and pouring boiling water over it; the weight of the water used must be at least twice the combined weight of the pail and the soil. However, there is no doubt that a higher degree of sterilization is obtained by heating the soil in an oven as described above.

### PLASTIC CONTAINER METHOD

The use of plastic containers already has been discussed by Dr. Benedict (1). I have used plastic jars for several years and believe they are well suited to the amateur. They are four inches in diameter and two and three-fourths inches high and made of clear plastic with clear plastic covers. They do not always withstand boiling water so I wash them in water not hotter than my hands can stand. After rinsing them I dry them with paper towels. Mild solutions of some household disinfectant, such as Chlorox, unquestionably would be of some help in the cleaning of the jars.

I fill the jars an inch and a half deep with washed vermiculite which is still wet, add some water (about an inch and a half above the bottom) and then three-fourths inch of woods soil (leafmold) which has been screened through a sixteenth inch mesh mosquito netting or kitchen strainer and then heated. The heating of the soil can be done outdoors over an open fire or in the kitchen oven. The pan containing the soil should have some water in the bottom and, if an open fire is used, the soil must be stirred to avoid carbonization. The oven should be set at 250°F and the pan of soil kept at this temperature for an hour or so, resulting in a dry powder.

Considering now the jars with vermiculite, water, and soil, the surface of the soil is leveled off and the jars are left to stand for a while with covers on until the excess water which may have floated some of the vermiculite has sunk down sufficiently to permit the surface of the soil to be pressed gently down to the proper density and made smooth. Due to its dryness the oven-heated soil has difficulty in absorbing water by capillary action and it may take a day's time before the surface is moist and ready for the sowing of the spores. Dry spots in the surface must be avoided. Builders sand could be used instead of vermiculite; it must be washed and then rinsed in boiling water. However, sand is much heavier and absorbs only half as much water as the vermiculite does.

Plastic jars are much handier to deal with than are regular flower pots and their appearance does not usually conflict with the decor of a room. The covers are sufficiently tight to obviate any further watering. As wild growth (mosses and fungi) does not occur to any serious extent, I have found the method satisfactory. Occasionally "damping off" fungi have appeared, sometimes introduced perhaps with the spores themselves. Airborne spores of such fungi and of mosses may enter the cultures later in the process.

### THE WARDIAN CASE (TERRARIUM)

In 1836, Dr. N. B. Ward, a Londoner, invented the case that bears his name, a glass-walled and -covered container provided with a layer of moist soil over drainage materials on the bottom for growing plants. His invention was considered important enough at the time to be made a subject of a lecture by the great physicist Michael Faraday at the Royal Institution in April, 1838, and thereafter the invention became generally known (2).

The Wardian case was at one time much used for ferneries in the home but was probably of greater value in transporting living plants to botanic gardens. Today, the case is most often found in the form of a plant terrarium. The principle involved is that moisture-loving plants are protected against dry air and that only infrequent watering is required. There are various forms of the Wardian case, an interesting one being the "Wonderglobe" described in "Wildflowers for Your Garden" by Helen S. Hull.

It should be noted that ordinarily the Wardian case is not airtight around the cover, so that some air leaks in and out. The air leaking out is moist and the air coming in is comparatively dry, and accordingly there is a loss of water which, in the case of a terrarium with a volume of five gallons amounts to a few teaspoonfuls a month.

### METHODS FOR GROWING PROTHALLIA AND FERNS IN THE WARDIAN CASE

#### a. FLOWER POTS IN THE TERRARIUM

The equipment for this method is easily obtainable. A five-gallon aquarium with a glass cover, used as a terrarium, provides space for eight three-inch flower pots. Such a terrarium may be built in a home workshop, using glass for the two sides and the cover and one by ten inch lumber for the ends and the bottom. The bottom should be covered with heavy roofing paper bent up a couple of inches along the edges to form a watertight bottom. The boards and bottom should be painted with white lead. The dimensions of the case can vary; I like them ten inches high and 24 inches long. For cultures use three- or four-inch flower pots without glass covers or saucers. Spread one inch of vermiculite on the bottom of the case and begin with a half-inch depth of water. This case will give room for 12 three-inch pots, each of which may contain four small ferns after transplanting from the cultures. However, a two-foot square box with ten-inch sides and with glass only used for the cover may be easier to make and is twice as roomy. The glass pane should be divided in the middle and be double thick sheet glass (one-eighth inch).

#### b. FLOWER POTS IN PROPAGATION BOX WITH FLUORESCENT LIGHT

The various forms of the Wardian case described above can be used where daylight is available but they may also be placed under a fluorescent light and kept out of way, say in the cellar. However, if greater capacity is desired, a larger propagation case made from transite boards is recommended. The case used so successfully for spore cultures and small ferns by Mr. Mann has been described and illustrated by Dr. Benedict (1). This method gives results more quickly than other methods since the illumination and temperature are under full control.

This box may be 30 inches wide, 60 inches long, and 30 inches high, with two doors forming the front. Two 48 inch fluorescent lights in a reflector are placed in a recess in the top of the box. At the ends of this recess should be a few ventilating holes. The bottom of the box is covered with an inch of vermiculite, kept wet by an inverted bottle of water such as is used for supplying water to a small trough in a chicken-house. Additional space is available by a ten-inch shelf placed 20 inches above the bottom. The total capacity is probably 130 three-inch pots. A soil-heating cable and a breeder thermostat may be provided as well as a time switch for the electric light, which may be kept on at least 20 hours a day. Cultures are kept in this box as well as plants, although the most common practice is to keep cultures in subdued light until after germination. Mr. Mann used washed vermiculite as drainage material in the pots with a soil two-thirds "hyperhumus" and one-third screened peatmoss. He sterilized only the pots. He recommended a temperature of 70 to 75°F and also that the cultures be sprayed with water when the prothallia were well developed.

Mr. William S. Johnston employs a similar box and method except that he does not require the heating cable. His soil mixture is "hyperhumus," sand, and garden soil. He also referred me to an English writer, A. J. Macself, who recommended temperatures in the 60's so as to get hardier plants, although this would result in much slower growth. The above propagation box if requiring heat beyond that furnished by the fluorescent lamps could be supplied with one or two ordinary light bulbs rather than a soil-heating cable.

c. PLASTIC CONTAINERS IN "WINDOW-GREENHOUSE"

A "window-greenhouse" consists of a case holding a set of shelves with clear plastic cloth in the back and provided with a removable cover in front also covered with clear plastic cloth. When held together, the case is fairly airtight and forms a Wardian case built in several stories. This "greenhouse" depends on room heat, but as the nights may be quite cold in the ordinary dwelling, the growth will be much slower than in the case of a propagation box. The advantage of the "greenhouse" is that everything is visible; on the other hand, the capacity is rather limited.

The frame and the shelves are built of one- by four-inch boards for holding the four-inch plastic jars or alternatively three-inch flower pots with their saucers. Two intermediate shelves are placed eight to ten inches apart making the height of the case 24 to 30 inches. The plastic cloth is held by half-inch halfrounds (such as used for holding the screencloth to the frame of a window screen) against the rear edge of the boards. The front cover is made up by a frame of one- by two-inch boards set on edge, braced at the corners, and provided with a vertical board in the middle to hold the plastic cloth better. The length of the case could be equal to the width of an ordinary window. Plants should be kept away until the paint solvents have evaporated. The case can be supported from the floor by extending the sides downward to provide legs which can be secured to the floor by a small angle iron and screws. For stability, the top of the case should be braced to the window casing and, accordingly, the sides should be continued upward to permit headroom under the braces. Placing the case 18 inches away from the wall will permit access to the window. The case could be supported from the windowsill and braced higher up but this would make the window inaccessible. A 24 by 36-inch wooden kitchen table can also be used to support the case. With such an arrangement the bottom of the case should be 6 inches above the table and the sides extended downward accordingly. In order to supply stability two feet should be provided made from one by four-inch lumber 18 inches long and fastened to the sides. These feet should probably also be held to the tabletop by angle irons and screws. The table-top should be at the same level as the window-sill. The capacity of this "table model" is 21 four-inch containers, but it will hold 28 if made of 12-inch lumber, the case then being 30 inches high but with only one intermediate shelf, assuming that the case is to be 36 inches long.

This "greenhouse" provides a safe place for keeping the season's supply of cultures with their covers on, but it is principally built to hold the small ferns after they are transplanted into four-inch diameter and 3-inch high plastic jars. These will have an inch and a half of wet vermiculite on the bottom and an inch of soil. Four plants may be used in a jar. Using containers that have no drainhole may seem unusual but when properly used there will be no stagnant water in the soil and watering will only be required at intervals of several weeks. Paper may be used on the shelves. Some condensation will occur on the woodwork and it will be subject to mildew in the long run. Empty shelves may have jars filled with just water to help moisten the air. The case may also hold three-inch flower pots with their saucers, but the additional weight may have to be considered.

## MISCELLANEOUS COMMENTS

a. DRAINAGE MATERIAL.

In fern literature one often sees references to drainage and drainage material. As is well known, the root system of a fern must have access to oxygen and soil in order to make nutrients available to the plant. At the same time, water must be supplied at the required rate. Considering the ordinary flower pot the common practice is either to place broken pieces of crock in the bottom or gravel covered with a layer of dead sphagnum moss. The watering is done from above and a saucer collects the excess water. One finds at times, an expression of the idea of supplying air to the roots by the lugs that are sometimes found on special saucers or flower pots.

In nature, plants receive their water as rain from above or through capillary action from below. Ferns have shallow roots and may be planted in flower pots which are filled one-third with vermiculite. The pots should be placed inside a container reaching half way up the pot. Such an arrangement is suitable for houseplants requiring much water. Watering can then be done from below and at greater intervals as a storage of water is provided. Submergence of the roots in water is easily avoided and proper aeration of the roots is obtained. The use of the plastic jars for small ferns in the "window greenhouse" as described above also necessitates the same drainage material for water storage; watering is done from the top, and care must be taken to keep the water level below the roots.

b. SOIL USED FOR CULTURES.

The use of organic soil as a medium for the growing of spores appeals to the amateur as well as to the commercial grower, as transplanting is easily done. Each grower has his own preference as to a soil mixture, which generally is made up from good loamy garden soil, humus, and builder's-sand in equal amounts or with the humus predominating. Soil recently manured must be avoided. After the soil has been screened it is sterilized.

Soil taken from gardens or woods contains insects, insects' eggs, earthworms, and so forth and it is also alive with spores of fungi and mosses. Accordingly, the soil must be sterilized, which will also destroy the nematodes that cause browning of the leaves.

c. SPORES.

If a fertile blade of fern is taken at the time of maturity and pressed between two sheets of absorbent paper, an outline of the blade will appear. This configuration is made up of empty sporecases, free spores, and in certain cases also pieces of indusia. Unopened sporangia also may be present. By depositing this powder on a black surface and removing the larger pieces of debris a brown colored powder remains, part of which consists of pieces which are visible to the naked eye. The other, only visible as a fine dust, is comprised mostly of spores. By applying a 10x magnifying glass, the spores become individually visible. It is not necessary to separate the spores from the empty or full sporecases, but the mixture should be examined to judge the number of spores available for sowing. It is important to scrape the spores off from the paper of the envelope where they have been kept, because an inspection will often reveal a surprisingly small number of free spores. Sometime it is possible to see the sporangia exploding while resting on a black surface, scattering the spores around; some of these are carried away by the air-currents. As a sporangium contains normally 64 spores, the individual spore is so small that it is practically invisible to the naked eye, which led to the belief, in folklore that the spores were actually invisible and so useful in witchcraft.

The first problem confronting the fern grower is the collecting of spores in the woods or in the garden, which requires a close inspection of the fronds with at least a 10x hand lens (3). When collecting spores from small ferns an entire frond may be taken, but in the case of a large fern only a few pinnae need to be gathered. The harvest is taken home, dried to release the spores and finally cleaned of such debris as is easily removable. A frond in a bag or envelope of ordinary paper will dry to a degree depending on the temperature and the amount of moisture in the air in the bag. It is a slow process; the paper soaks up moisture on one side and lets it evaporate on the outside, assisted by the movement of air through any opening available. After the house heating system starts up in the fall, the drying process speeds up. However, if the frond has been picked at the proper time the spores will fall off in a few days.

In my own experience the collecting of spores is the weakest link in the process of fern growing by amateurs. The owner of a greenhouse is able to catch the spores as soon as they begin to ripen under his watchful eye, and he may enclose the frond with a paper bag before he removes it.

The second problem concerning spores is that of their viability. Most viable spores will germinate visibly to the naked eye within a period of a few days or weeks depending on the species and the degree of dryness. The temperature of the culture is also a factor. In most of the species dealt with by the amateur it is probably a matter of a couple of months. The life of a spore kept at ordinary temperatures will in most cases span several months or even years. Spores of the Osmundaceae are quite short-lived, however, unless kept in cold storage (4). Spores of some hybrid ferns are practically sterile and may not germinate, but the amateur will only meet such cases very rarely.

The third problem when growing ferns from spores involves germination of the spore and fertilization of the prothallium which leads to the development of the sporophyte and the young fern. There are at the present no data available as to the percentage of germination of fern spores. Before germination, very little can happen to the culture except that spores may have been washed down by drops of condensation. After germination prothallia growing too closely together will have to be thinned out in order to provide space for further growth. Also, close spacing appears to interfere with the fertilization process.

The prothallium will keep growing and reach the stage when fertilization is to take place. At this point some growers recommend the use of free water, either as a fine spray or by submerging the prothallia for a short time so as to encourage the movement of the waterborne sperm cells. In nature, there is a great difference between day and night temperatures, resulting in dew, a phenomenon similar to the condensation taking place in the spore cultures when they are subjected to cooling. At a uniform temperature no condensation occurs, but it is most probable that the sperm-cells will find their way through the water-film covering the prothallia and the surface of the soil without recourse to spraying. Cultures are generally subject to a daily variation in temperatures resulting in condensation on the culture.

Through the fertilization of the prothallium the second generation, the sporophyte, is initiated, which thereupon develops into a fern. In a culture, however, there may be a long interval of time between the appearance of the first and the last sporophyte and my patience runs out when a dozen are ready to be transplanted and the remaining prothallia are then abandoned.

Now, a word of encouragement to the amateur fern grower. He should know that the spores he takes home and sows have a much greater chance of producing ferns than if he had left them on the plant, and, also that the professional grower only grows ferns which propagate very readily and, in many cases, asexually, which is the easy way for a prothallium to turn into a sporophyte. Readers interested in the scientific study of spores will find much material published in the American Fern Journal.

d. ILLUMINATION.

In nature there is a daily cycle of light and darkness during which time plants grow continuously. In an article describing the forcing of ferns in a greenhouse for the 1938 International Flower Show, Dr. and the late Mrs. E. D. Thurston, Jr., made the observation that the growth was greater during the night than during the daylight hours (5). This observation has been confirmed by growers of flowering plants under natural light. Dr. R. C. Benedict (1), in discussing the use of fluorescent light by Mr. M. D. Mann, refers to the period of light as 20 hours a day and also mentions some cases of continuous illumination. His discussion dealt with spore cultures rather than ferns however. In greenhouses, some flowering plants may have the electric light on during the night while other plants may be kept in continuous darkness for a time to accelerate the time of flowering. Information regarding artificial illumination for growing ferns in a propagation box is incomplete.

CONCLUSION

The above article is rather lengthy. It has been written on the assumption that a reader interested in a hobby is able and willing to make an effort to explore the basic elements of his hobby. In Great Britain the study and growing of ferns has always been popular, especially among people living in retirement but who continue to seek happiness in their surroundings, gardens, or woodlands nearby. People confined to indoor living may well enjoy a "window-greenhouse." It is hoped articles in the American Fern Journal for the use of the layman will stimulate the interest of American garden-lovers in ferns, native and foreign. Although most fern gardeners will appreciate the botanical features of their ferns, there is pleasure also in developing attractive landscape effects.

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## Some Chromosome Numbers of Icelandic Ferns and Fern-allies

ÁSKELL LÖVE AND DORIS LÖVE

In connection with the collection of material for a cyto-taxonomic review of the higher plants of Iceland (Löve & Löve, 1956), the present writers also made fixations of Icelandic pteridophytes. The results obtained from the Lycopsids have already been reported (Löve & Löve, 1958), but chromosome numbers determined from other groups still remain unpublished. More exhaustive investigations based on this material are not possible in the near future. Since the observations already made have a certain interest, there seems to be justification in making them available without further comments. All the counts here reported were made on somatic material fixed and treated in the same way as the root tips of the higher plants studied by Löve & Löve (1956). For previous reports on the same species and races, the list of European chromosome numbers by Löve & Löve (1961) can be consulted. If no exact locality is given below, the material originated from several places in the regions mentioned. The authors wish to thank Dr. M. S. Chennaveeraiah for assistance with some of the chromosome number determinations.

| SPECIES | $2n$ | LOCALITY |
|---|---|---|
| SELAGINELLA SELAGINOIDES (L.) Link | 18 | SW. & N. Iceland. |
| EQUISETUM ARVENSE L. | | |
| ssp. ARVENSE | 216 | SW. Iceland. |
| ssp. BOREALE (Bong.) Löve | 216 | SW. & N. Iceland. |
| EQUISETUM PRATENSE Ehrh. | 216 | SW. Iceland. |
| EQUISETUM FLUVIATILE L. | 216 | SW. Iceland. |
| HIPPOCHAETE HYEMALIS (L.) Börner | 216 | N. Iceland. |
| HIPPOCHAETE VARIEGATA (Schleich.) Börner | 216 | SW. Iceland. |
| OPHIOGLOSSUM VULGATUM L. ssp. AMBIGUUM (Coss. & Germ.) Warb. var. ISLANDICUM Löve & Löve | 480 | SW. & W. Iceland. |
| BOTRYCHIUM BOREALE (Fr.) Milde | 90 | Eyjafjördur, N. Iceland. |
| BOTRYCHIUM LANCEOLATUM (Gmel.) Ångstr. | 90 | Hengill, SW. Iceland. |
| BOTRYCHIUM LUNARIA (L.) Swartz | 90 | SW. & N. Iceland. |
| PHEGOPTERIS CONNECTILIS (Michx.) Watt | 90 | SW. Iceland |
| GYMNOCARPIUM DRYOPTERIS (L.) Newm. | 160 | SW. & W. Iceland. |
| ASPLENIUM VIRIDE Huds. | 72 | Fagurhólsmýri, S. Iceland. |
| ATHYRIUM FILIX-FEMINA (L.) Roth | 80 | SW. Iceland. |
| ATHYRIUM DISTENTIFOLIUM Tausch | 80 | Hafnarfjördur, SW. Iceland. |
| WOODSIA ILVENSIS (L.) R. Br. | 82 | SW. Iceland. |
| WOODSIA ALPINA (Bolton) S. F. Gray | 164 | Hredavatn, W. Iceland. |
| CYSTOPTERIS FRAGILIS (L.) Bernh. | 168 | SW. Iceland. |
| POLYSTICHUM LONCHITIS (L.) Roth | 82 | Kapelluhraun, SW. Iceland. |
| DRYOPTERIS ABBREVIATA (DC.) Newm. | 82 | Búdahraun, W. Iceland. |
| DRYOPTERIS DILATATA (Hoffm.) A. Gray | 164 | SW. & N. Iceland. |
| BLECHNUM SPICANT (L.) J. E. Smith | 68 | Kaldársel, SW. Iceland. |
| POLYPODIUM VULGARE L. | 148 | Hvalfjördur, SW. Iceland. |

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## Ferns for a Lath House

Fay MacFadden

A great many kinds of ferns can be grown in small lath houses in Los Angeles, California. Many prefer sun in their native haunts, but most of them prefer shade in southern California, at least the kind of light shade provided by a lath house of the kind described in my last article in this Journal. Very near the coast, where the air is moister, the sun-loving ferns will stand lots of sun, but inland they want less sun; in the interior valley, where conditions approximate desert conditions, lots of shade and artificial humidity is a necessity. In southern California all ferns look better in some shade. There are plenty of other kinds of sun-loving plants for full sun.

When I started growing ferns in Los Angeles in the early thirties, Mr. Baldwin had been growing ferns from spores for the wholesale and retail trade, although only a few nurseries sold them. My first ferns from the Baldwin Nursery were species of *Pteris* and some of the cultivars of *Pteris cretica.* Most of these I still have, such as *P. dentata*, *P. quadriaurita*, and *P. cretica* cv. *Drinkwateri* and *Childsii.* I also got *P. tremula* and *P. quadriaurita* cv. *argyraea*, both beautiful for two or three years, but which have to be replaced frequently. Most *Pteris* ferns are rugged and compact, and are among the easier subjects for cultivation.

One of the interesting ferns sold by Baldwin was listed as "Nephrodium K. O. Sessions," evidently introduced by the horticulturist Miss Kate O. Sessions, but the botanical indentity of which has been in doubt until C. V. Morton recently indentified it as the Japanese species *Thelypteris acuminata.* It is an ornamental fern, so well adapted to conditions in southern California that it has escaped from cultivation at least casually.

Among the larger ferns suitable for a lath house are the Microlepias. In a corner *M. platyphylla* is good; it is tall-growing and rather coarse. *Microlepia strigosa*, mistakenly sold as *M. speluncae*, is even more ornamental, but is perhaps better outside if the lath house is small, because it eventually takes considerable space. A peculiar cultivated form that I have grown for many years, probably obtained originally from Baldwin, has been described as *M. strigosa* forma *MacFaddeniae*. *Woodwardia radicans* is another suitable large, decorative fern for the lath house. These Microlepias and Woodwardias do well outside under trees or on the north or east sides of houses, where they get some protection from sun and wind. Another fern that may eventually get too large is the leather fern, *Rumohra adiantiformis*, but it is good for several years.

Some large ferns should be grown with caution. *Hypolepis punctata* and the other species are a constant care in keeping the old fronds cut. The common bracken, *Pteridium aquilinum*, has long, running rhizomes that will make such a jungle that it will be difficult to get rid of; it should probably never be planted, except perhaps outdoors in places where space is no problem.

The native southern maidenhair fern, *Adiantum Capillus-veneris*, is easily grown when once started, and in fact it became a weed in my lath house, but many people have a difficult time in starting it. It likes lime and if it is put next to a limestone rock or the foundation of a house it starts with ease; good soil and oyster shells help. After it is started it seems to grow anywhere. On the other hand, the northern maidenhair, *Adiantum pedantum*, only grows outside or in lath houses in southern California for a short time; although it may be possible to keep it alive for a few years its beauty is soon gone. It grows naturally along streams and in deep moist woods; it is too hot and dry in southern California. However, it does well in a greenhouse, if given good soil, oyster shell, good drainage, and lots of water. The other maidenhairs such as *A. hispidulum*, *A. formosum*, and the cultivars of *A. cuneatum* I have been unable to establish outdoors due to drying winds and low humidity.

I grow successfully a great many other attractive ferns. Among these are *Rumohra aristata, Asplenium bulbiferum, Poly-*

*stichum Dudleyi, Blechnum occidentale, Dennstaedtia rubiginosa,* and *D. glauca.*

Of course, a fern lath house need not contain ferns exclusively. Fuchsias, begonias, and azaleas like the same growing conditions and give needed color. Camellias are good, although they eventually get too large for the average lath house, and they may get too much shade. *Helxine* is beautiful, of course, but it is better not to be planted, as it eventually gets in the roots of all your ferns, and is one thing that makes fern growing difficult.

Once ferns are established, they are the easiest kind of gardening. Let a hand-lens be your constant companion in the garden and you will be surprised at all the things you are going to find out about your ferns. Growing ferns is very rewarding. To watch a fern develop from spore into a beautiful plant, even though this takes a long time, does something to the gardener spiritually.

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## A Resume of the Taxonomic Reorganization of Equisetum, Subgenus Hippochaete, I.

Richard L. Hauke

In a recently completed study of *Equisetum*, subgenus *Hippochaete* (the scouring rushes, snake grasses, or joint grasses), I developed a taxonomic system that varies from that presently accepted for this group of plants. I wish to present a résumé of this system in the American Fern Journal that it may be read, criticized, and possibly used by people working with the vascular cryptograms.

The study was monographic in scope, involving field experimentation, garden culture, gametophyte culture, and study of over 6,000 herbarium specimens, and including the statistical analysis of measurements from more than 2,000 specimens and observations of microscopic anatomy of over 400 specimens. I concluded that because of frequent interspecific hybridization, clinal variation, and extensive morphological variability resulting from traumatic injury or environmental stress, an excessive number of infraspecific taxa have been described and named. Most of these do not warrant formal taxonomic recognition.

Perhaps the best known work on *Equisetum* is Milde's *Monographia Equisetorum* (1867). In this, *Hippochaete* is regarded as a separate genus, containing the following infrageneric groups:

A. Equiseta pleiosticha[1]
  a. Equiseta planifolia
    E. xylochaetum
    E. martii
  b. Equiseta angulata
    E. giganteum
    E. pyramidale
    E. schaffneri
B. Equiseta ambigua
  E. ramosissimum
  E. sieboldii
C. Equiseta monosticha
  a. Equiseta debilia
    E. debile
  b. Equiseta mexicana
    E. myriochaetum
    E. mexicanum
  c. Equiseta hiemalia
    E. hiemale
    E. robustum
    E. laevigatum
  d. Equiseta trachyodonta
    E. trachyodon
    E. variegatum
    E. scirpoides

Milde never made any specific combinations under *Hippochaete*. Baker (1887) called *Hippochaete* a subgenus, and listed *E. myriochaetum*, *E. mexicanum*, and *E. schaffneri* as synonyms of *E. giganteum*, but maintained *E. xylochaetum* as a separate species. He never mentioned *E. martii* or *E. pyramidale*. Boerner (1912) and Farwell (1916) independently recognized *Hippochaete* as a separate genus. Farwell divided it into two sections, sect. *Euhippochaete*, containing *H. hyemalis*, *H. variegata*, *H. scirpoides*, and *H. prealta*, and sect. *Ambigua*, containing *H. laevigata* and *H. nelsonii*. Rothmaler (1944) followed Boerner in treating *Hippochaete* as a genus, and recognized the following subdivisions:

[1] "Equiseta pleiosticha," and similar group-names, being in binomial form, must be considered as descriptive phrases, and are not validly published subgeneric, sectional, or subsectional names. The same applies to Schaffner's groupings such as "Equiseta Primitiva."

Sect. *Stichopora* (A. Br.) Rothm.
  Subsect. *Hiemalia* (A. Br.) Rothm.
    *H. hiemalis*
    *H. trachyodon*
  Subsect. *Homocormia* (Pfitzer) Rothm.
    *H. variegata*
Sect. *Univaginata* (Pfitzer) Rothm.
    *H. scirpoides.*

Schaffner (1921, 1925, 1930a, 1930b) developed a radically different classification of the genus *Equisetum*. He did not accept *Hippochaete* as a taxon, but rather put the species of *Hippochaete* into four groups:

I. Equiseta Primitiva
  E. xylochaetum, E. giganteum.
II. Equiseta Hiberna
  E. myriochaetum, E. ramosissimum, E. debile, E. laevigatum, E. prealtum, E. hiemale.
III. Equiseta Ambigua
  E. kansanum, E. funstonii.
IV. Equiseta Pusilla
  E. nelsonii, E. trachyodon, E. variegatum, E. scirpoides.

Although not a comprehensive review of the taxonomic treatments of the scouring rushes, this should illustrate the disagreement about the proper classification of this group of plants. It should also serve as a background against which I can place the system of categories I believe most accurately reflects the relationship of the various taxa of *Hippochaete*. This system follows:

*Equisetum*, subgenus *Hippochaete*

A. Section *Incunabula*
  1. *Equisetum giganteum*
B. Section *Ambigua*
  2. *Equisetum ramosissimum*
    2a. Subspecies *ramosissimum*
    2b. Subspecies *debile*
  3. *Equisetum myriochaetum*
  4. *Equisetum laevigatum*

C. Section *Hippochaete*
  Ca. Subsection *Perennantia*
    5. *Equisetum hyemale*
      5a. Var. *hyemale*
      5b. Var. *affine*
  Cb. Subsection *Homocormia*
    6. *Equisetum variegatum*
      6a. Var. *variegatum*
      6b. Var. *alaskanum*
    7. *Equisetum scirpoides*

Hybrids
*Equisetum* × *schaffneri* (*E. giganteum* × *myriochaetum*)
*Equisetum hyemale* × *myriochaetum*
*Equisetum* × *moorei* (*E. hyemale* × *ramosissimum*)
*Equisetum* × *ferrissii* (*E. hyemale* × *laevigatum*)
*Equisetum* × *trachyodon* (*E. hyemale* × *variegatum*)
*Equisetum* × *nelsonii* (*E. laevigatum* × *variegatum*)
*Equisetum ramosissimum* × *variegatum*

Descriptions of all taxa will be included in this résumé but only the most important synonyms will be given. Complete lists of synonyms and citations of specimens examined can be obtained by writing University Microfilms Inc., Ann Arbor, Michigan, for a microfilm of the thesis, entitled *A taxonomic monograph of the genus Equisetum, subgenus Hippochaete.*

In the descriptions that follow reference is made to the collenchyma and the endodermal patterns. These are determined from a cross-section of an internode from below the middle of the stem. The collenchyma is the supporting tissue under the epidermis; it occurs in thickened strands under the ridge (carinal collenchyma) and under the groove (vallecular collenchyma). The endodermis is a distinctive layer of cells in the vicinity of the vascular bundles, and it occurs in three patterns. If each vascular bundle is encircled by an endodermis it has an individual pattern; if there is one endodermis surrounding the ring of vascular bundles, it is called the outer common endodermis; and if there is one endodermis surrounding the ring of vascular bundles and another internal to the ring of vascular bundles, that is called the double common endodermis.

Subgenus HIPPOCHAETE (Milde) Baker, Fern Allies 3. 1887.

*Equisetum* II *Homophyadica* A. Braun, Flora **22**:308. 1839 (pro parte).

*Equisetum* II *Sclerocaulon* Döll, Flora des Grossherz. Baden **1**:65. 1857.

"*Equisetum* II *Equiseta cryptopora*" Milde, Abh. Schles. Ges. **2**:138. 1861. (Invalid.)

*Equisetum* subg. *Cryptostoma* Milde, Verh. Zool.-Bot. Ges. Wilen **14**:526. 1864. (Pro syn.)

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*Equisetum* sect. *Cryptopora* Milde ex Grintescu in Salvulescu, Flora Republicae Popularis Romanicae **1**:67. 1952. [Sectional name may have an earlier valid publication!]

Although I am aware of a body of opinion by botanists past and present that *Hippochaete* should be maintained as a genus separate from *Equisetum,* I shall nevertheless continue to treat it as a subgenus. There are, indeed, absolute and apparently inviolable differences between the two groups in stomatal structure, the chromosomes have some distinctions, so far as they are known (Manton, 1959), and hybrids between these groups are probably never formed. These differences, however, are few when compared to the great similarities in general morphology, anatomy, and reproductive structure. The contrasts of deciduous stems with blunt cones in *Equisetum* vs. evergreen stems with apiculate cones in *Hippochaete,* though usually distinctive, are violated by *E. laevigatum* and *E. ramosissimum* subsp. *ramosissimum.* The stomatal arrangement of *E. arvense* is matched by that of *E. giganteum.* Thus the differences between *Equisetum* and *Hippochaete* are far outweighed by the similarities between them. To reflect this taxonomically, they should be included within a single genus. Since a few distinct differences do exist between all of the species in one group and all of those within the other group, the groups may be maintained as subgenera. The type for this subgenus is *Equisetum hyemale.*

DIAGNOSTIC KEY TO SECTIONS, SUBSECTIONS, SPECIES, SUBSPECIES AND VARIETIES OF SUBG. HIPPOCHAETE

Stems with regular verticils of branches; stomata in bands of two or more lines; individual endodermises in stem ........ Sect. *Incunabula*
1. *E. giganteum*

Stems with regular verticils of branches, irregularly branched, or unbranched; stomata in single lines, sometimes in bands of two or more lines; individual, outer common, or double common endodermis in stem. Characters never in combination found in sect. *Incunabula*.

Stems branched and evergreen or deciduous, or unbranched and deciduous; stomata in one to several lines; ridges convex.
Sect. *Ambigua*

Stem with individual endodermises; stomata in single lines; teeth regularly breaking off; stems branched and evergreen.
2b. *E. ramosissimum* subsp. *debile*

Stem with double common endodermis; stomata in one to several lines; teeth persisting or breaking off; stems branched or unbranched, evergreen or deciduous.

Stomata in one to several lines; teeth persistent; lower sheaths usually tan ........ 2a. *E. ramosissimum* subsp. *ramosissimum*

Stomata always in one line; teeth breaking off; lower sheaths green.

Stems evergreen, with regular verticils of branches.
3. *E. myriochaetum*

Stems deciduous, unbranched ........ 4. *E. laevigatum*

Stems unbranched, evergreen; stomata always in one line; ridges rarely convex, mostly bituberculate ........ Sect. *Hippochaete*

Rhizome with individual endodermises; sheaths with black girdles, white above; teeth articulated ........ Subsect. *Perennantia*

Teeth persistent to falling; ridges convex to bituberculate; plants of North America and easternmost Asia.
5b. *E. hyemale* var. *affine*

Teeth soon falling; edges always bituberculate; plants of Eurasia ........ 5a. *E. hyemale* var. *hyemale*

Rhizome with an outer or double common endodermis; sheaths green, rarely black above; teeth not articulated, always retained ........ Subsect. *Homocormia*

Sheath with four or more teeth; stem and rhizome with double common endodermis.

Teeth incurved, with narrow white margins or all black.
6b. *E. variegatum* var. *alaskanum*

Teeth straight, with wide white margins.
6a. *E. variegatum* var. *variegatum*

Sheath with three teeth; stem and rhizome with outer endodermis only .......... 7. *E. scirpoides*

N. B.: Intermediates between 1 and 3, 2a and 5a, 2a and 6a, 3 and 5b, 4 and 5b, 4 and 6a, and 5a or 5b and 6a are probably hybrids, especially if they have abortive spores. Seeming intermediates are sometimes produced under unusual growth conditions or as a result of injury.

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(*To be continued*)

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## An Interesting Ecological Niche Involving Salvinia rotundifolia Willd.

THOMAS A. HUTTO

Early in February of this year I accompanied Dr. Wilbur H. Duncan and a group of students from his advanced taxonomy class at the University of Georgia on a field trip to Sapelo Island off the Georgia coast. When Dr. Duncan extended an invitation to take this trip I readily accepted because Sapelo Island is privately owned by Mr. R. J. Reynolds and is not open to the public. The University of Georgia Institute of Marine Biology, which is financed by Mr. Reynolds, is located on the island.

Sapelo is one of a chain of barrier islands just off the coast of Georgia. It is bounded on the east by the Atlantic Ocean and on the west by an extensive salt marsh. The island is in view of the famous "Marshes of Glynn" about which Georgia poet Sidney Lanier wrote. The vegetation of the area is interesting and varied, and so Dr. Duncan is preparing a flora of it.

During the course of our trip the group visited a large, fresh-water lake at the north end of the island to see the water fern *Salvinia rotundifolia* Willd., which Dr. Duncan had collected in 1956 (*Duncan* 20,111). The plants were abundant in the water near the edge of the lake and I collected a quantity in a plastic bag.

After returning to Athens, I placed the *Salvinia* in a container of water in a window. It was then that I noticed that the plants were covered with green objects which appeared to be insects. With a microscope I saw that they were aphids which were abundant along the veins of the leaves; they had penetrated the veins with their mouthparts, and were so firmly attached that attempts to remove them with forceps proved difficult. Cast skins of the aphids were scattered about the surface of the leaves.

Aphids Feeding on Salvinia rotundifolia Willd.

While observing the aphids feeding I found an unidentified insect of the order Hemiptera feeding on the aphids. This tiny predaceous bug apparently kept the prolific aphid population in check. Several of these bugs were located, all busily feeding on the aphids by piercing their soft bodies and sucking the fluids. After consuming an aphid a bug would turn to another aphid on the same plant or would stride across the surface of the water to a different plant. I did not observe any of the aphids moving from plant to plant across the water surface and I assume that they were unable to do so. Apparently the aphids were at the mercy of the more maneuverable bugs. However, considering the rapidity with which aphids are known to reproduce it was obvious that the bugs were quite busy keeping the population in check.

Finding the aphids feeding on *Salvinia* aroused my curiosity, because, to my knowledge aphids do not occur on other ferns. For that matter, the ferns as a group seem to be generally free of insect pests, although Durand (1949) states that ferns grown as house plants may become infested with insects and Boydston (1958) mentions that ferns grown from spores may be attacked by thrips. It might prove interesting to make a future study of the insect pests of the ferns.

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## The Occurrence of Mecodium wrightii in Canada

Kunio Iwatsuki

I have recently received from Mr. C. V. Morton a notice of the occurrence of an interesting filmy fern in British Columbia. Complying with my request, he kindly lent me the specimen in the United States National Herbarium, and suggested that I should prepare a note on it. The specimen examined is labelled as *Mecodium wrightii,* an identification of E. B. Copeland, It was collected by Dr. H. Persson in Canada in the summer of 1957, the locality being: North end of Dawson Inlet, off Skidegate Channel, Graham Island, Queen Charlotte Islands, British Columbia, on west exposed shady vertical precipice, ca. 10 m.s.m. There is no question that this filmy fern is *Mecodium wrightii* (v. d. Bosch) Copeland.

*Mecodium wrightii* was originally described by van den Bosch[1] on the basis of a specimen collected by C. Wright at Hakodate, in Hokkaido. The known range of distribution has been from Saghalien[2] and the southern Kuriles[3] to Kyushu and southern Korea. The headquarters of its distribution lie in the central and northern districts of Honshu, usually at altitudes lower than 1500 meters. In Shikoku and Kyushu it is found, rarely, at 500 to 1000 meters elevations. In the regions where *M. wrightii* is most abundantly found, it is usually growing on the bases of the trunks of large trees, especially of aged *Cryptomeria japonica* (*Pl. 8, 9*), in humid dense mountain forests. These substrata are in general moist and mossy. In northern Honshu and Hokkaido, it grows mostly on mossy rocks or cliffs in shade and usually in places with high humidity. Viewed in the vertical distribution, it grows, even in Hokkaido, at altitudes higher than 1000 meters, but it has never been collected in the alpine regions of central Honshu, where *M. polyanthos* is occasionally found. Thus, *M. wrightii* has more limited habitats and distri-

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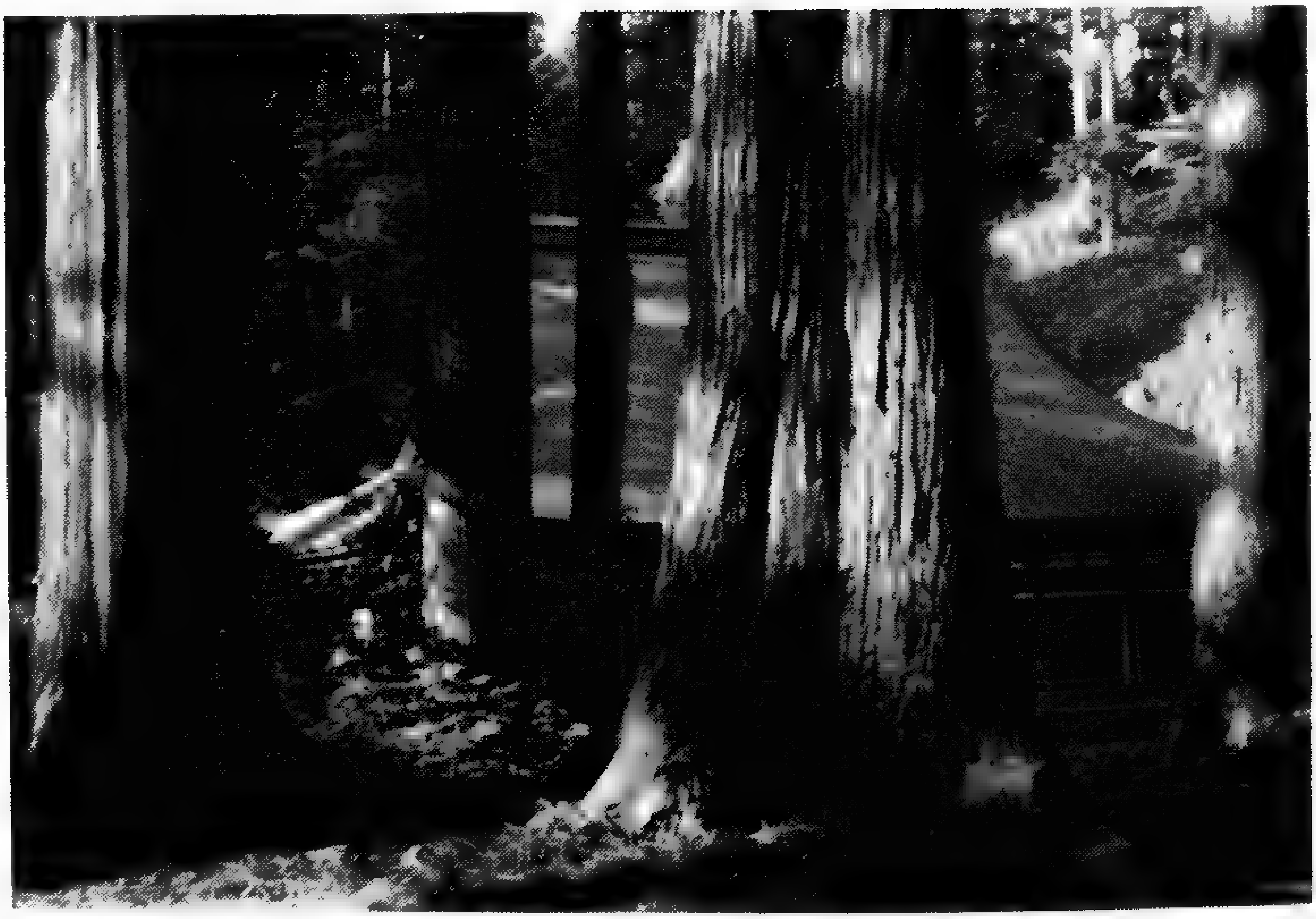
[1] Nederl. Kruidk. Arch. **4:** 391. 1859.
[2] Fomin, Fl. Sib. Or. Extr. **5:** 217. 1930.
[3] Kunashiri Island, Kuriles, *Y. Matsumura* (KYO). New to the Kuriles.

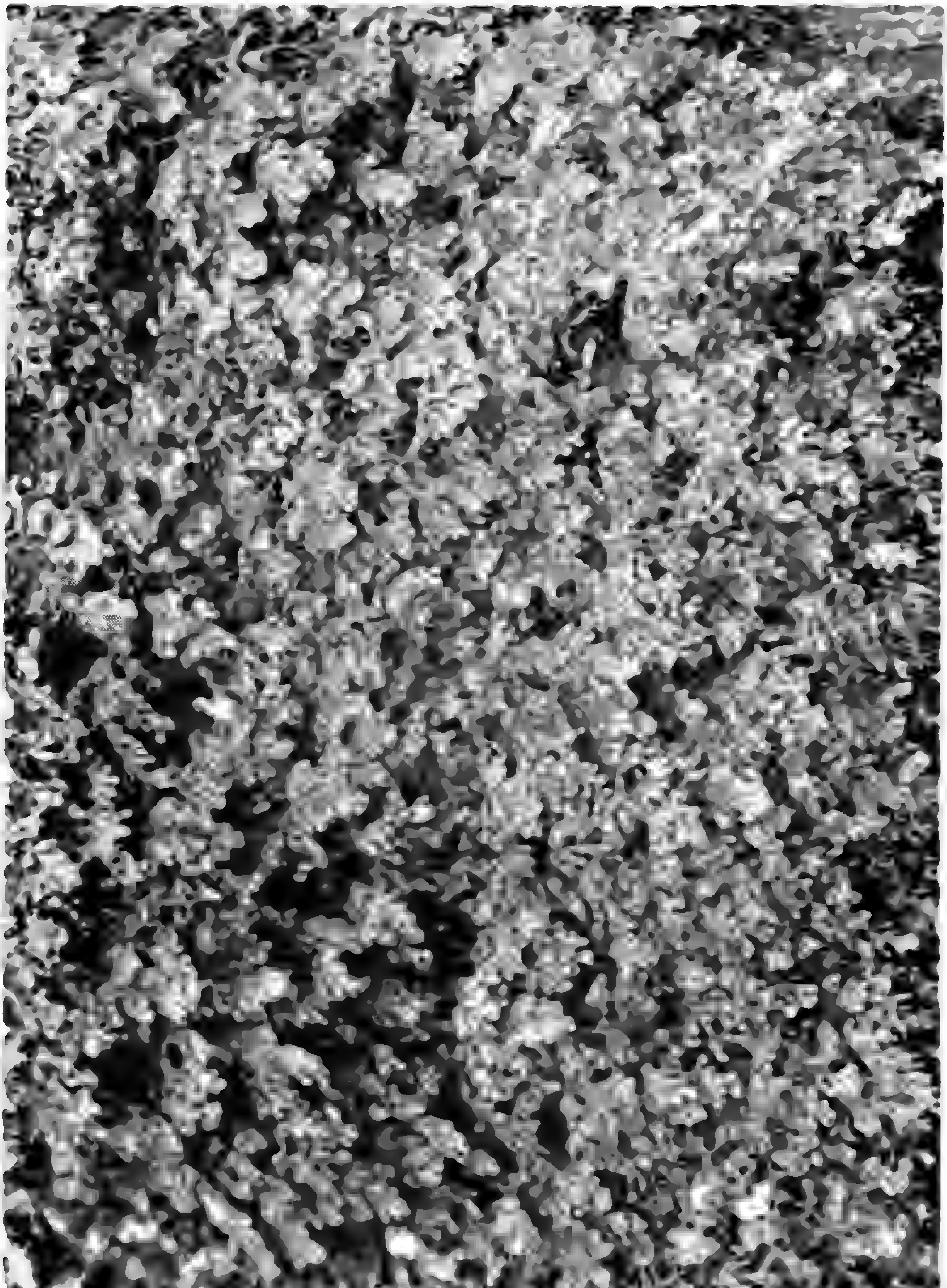


FOREST OF CRYPTOMERIA JAPONICA AT SHAKADÔ ON MOUNT HIEIZAN NEAR KYOTO, WITH THE SHAKADÔ TEMPLE AT THE BACK

bution than its close relative, *M. polyanthos*, of world-wide distribution.

The collection in British Columbia is, therefore, a remarkable range extension. Moreover, it is a notable fact that this is the first record of any filmy fern in western North America. Among true ferns there is no known example of such a pattern of distribution as the occurrence in northern Japan and in western Canada. But an example is seen in the hepatic *Takakia lepidozioides* S. Hatt. et H. Inoue[4], an interesting liverwort occurring only in the alpine regions of central Honshu, Japan, and in British Columbia. Dr. Persson[5] first discovered it in British Columbia, in the same station as *Mecodium wrightii*. I am not certain why they have such distinct gaps in their distribution. Contrary to *Takakia*, which is taxonomically isolated

[4] Journ. Hattori Bot. Lab. **19:** 137. 1958; **20:** 296. 1958.
[5] Bryologist **61:** 359. 1958.



CLOSE-UP OF COLONY OF MECODIUM WRIGHTII SHOW[illegible] enough to merit a monotypic family or even an order, *Mecodium wrightii* is closely allied to the variable cosmopolitian fern *M. polyanthos*. The distinctive features between these two were briefly summarized by Copeland[6] and by Iwatsuki.[7] As *M. wrightii* is considered to be a direct northern derivative of *M. polyanthos*, it may be that this species became dispersed from the Far East through the north coast of the Pacific Ocean to western Canada. It may be growing now in the North Pacific Islands or along the north coast of the Pacific Ocean, but there has been no record as yet.

The problem of generic delimitation in the Hymenophyllaceae has been questioned since the time that Copeland[8] reclassified the family after his extensive study of Old World species. I adopted his generic classification wholly in my investigation on the species of Japan and the neighbouring regions. This is only due to the fact that *Trichomanes* and *Hymenophyllum* in the older sense are not natural when numerous intermediate species groups and characters are taken into account. It is endorsed also by recent investigations by cytotaxonomists. However, as the taxonomic characters have not been precisely studied from the viewpoint of comparative morphology, the evaluation of characters for giving the definition of the genera of filmy ferns depends chiefly upon the experience of the specialists. For the present, I follow conveniently Copeland's classification, because his system seems to be the most natural one among those given until now.

In closing, I wish to express my best thanks to Mr. C. V. Morton for his kindness in lending me the Canadian material, and to Mr. N. Kitagawa, a specialist in hepatic taxonomy in our institute, and Dr. M. Tagawa, who were kind enough to review my manuscript.

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[6] Phil. Journ. Sci. **64:** 152. 1937.
[7] Acta. Phytotax. Geobot. **17:** 66. 1958.
[8] Phil. Journ. Sci. **67:** 1, 1938; Gen. Fil. 31. 1947.

## Notes on Polystichopsis

GEORGE R. PROCTOR

In a recent paper, C. V. Morton (1) has presented a discussion of *Rumohra* and some related fern genera, including the small, chiefly West Indian one now to be known as *Polystichopsis*. The purpose of the present publication is to offer some additional data on this group.[1]

Mr. Morton recognizes 4 species (*P. pubescens, P. chaerophylloides, P. lurida,* and *P. ochropteroides*) only the last of which occurs outside the West Indies. However, within the group there exist several other West Indian entities, including two which I consider valid species, not dealt with by Mr. Morton. A re-enumeration of the whole genus is herewith presented.

POLYSTICHOPSIS PUBESCENS (L.) Morton

The typical form occurs in Jamaica, Cuba, and Hispaniola. On the latter island also occurs a distinct variety, as follows:

POLYSTICHOPSIS PUBESCENS var. **haitiensis** (C. Chr.) Proctor, *comb. nov.*

*Dryopteris pubescens* var. *haitiensis* C. Chr. Monogr. Dry. **II**:105. 1920 (Dansk. Vid. Selsk. Skr. VIII. **6**(1):105).

This variety was based on *Picarda* nos. 277 & 733. A duplicate of No. 277 at the Institute of Jamaica shows a plant with very long-attenuate fronds, and sori bearing large, persistent, hairy indusia. The rhizome-scales, not mentioned by Christensen, are shorter, relatively broader, and more noticeably clathrate than those of typical *pubescens* from Jamaica. In other respects, a close relationship to *P. pubescens* is obvious.

Another form of *P. pubescens*, with somewhat broader, more divided blades, occurs in Jamaica. This was confused by Christensen (2) with the Lesser Antilles plant now recognized as *P. muscosa*, but it is my belief that they have nothing in common.

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[1] Some of the data used in this paper were obtained through field work in the Lesser Antilles supported by Grant No. G-4441 from the National Science Foundation, in cooperation with Dr. R. A. Howard, Arnold Arboretum, Harvard University.

The Jamaican form may not be taxomically distinguishable from typical *P. pubescens.*

POLYSTICHOPSIS **muscosa** (Vahl) Proctor, *comb. nov.*

*Polypodium muscosum* Vahl, Eclog. Amer. **3**: 54. 1807.

*Aspidium muscosum* (Vahl) Swartz, Adnot. Bot. 68. 1829.

*Phegopteris villosa* Fée, Mém. Foug. **11**: 53. 1866.

*Dryopteris pubescens* var. *muscosa* (Vahl) C. Chr., Mon. Dry. II: 105. 1920.

The type of *Polypodium muscosum* was collected in Montserrat by Ryan. The species has since also been found in Guadeloupe, Martinique, and St. Lucia (*Proctor 21652*) in the Lesser Antilles. Christensen cited specimens from Jamaica, Trinidad, and Margarita Island (Venezuela), but the Jamaican material, at least, is really a larger, more divided form of typical *P. pubescens,* as noted above. The Lesser Antillean population differs significantly from *P. pubescens* by having longer, paler rhizome-scales, very much larger fronds (to 60 cm. long, or more, the deltoid-subpentagonal blades up to 30 cm. broad) with densely pale-villous stipes, and larger sporangia (averaging ca. 207 $\mu$ in diameter vs. ca. 175 $\mu$ for *P. pubescens*). *P. muscosa* is described as being without an indusium, and this seems to be true for much of the material, but some specimens from Guadeloupe (*Proctor 20384*) bear small, pale, suberect indusia which are fimbriate at the apex. These are quite different from the brownish, more or less entire, orbicular-reniform indusia of *P. pubescens.*

POLYSTICHOPSIS CHAEROPHYLLOIDES (Poir.) Morton

Christensen recognized a variety *sericea* (first described as *Phegopteris sericea* in 1860 by Mettenius). Aside from slightly greater hairiness, this form seems to have no distinguishing characters by which it can be separated from typical *chaerophylloides.* The type of var. *sericea* came from Cuba (*Wright 1054*), and similar hairier forms have also been collected in Hispaniola. The type of *P. chaerophylloides* was collected in Puerto Rico by *Ledru.* This species is known to occur on all four of the Greater Antilles.

POLYSTICHOPSIS LURIDA (Underw. & Maxon) Morton

Typical *P. lurida* is localized in the Mt. Diablo area of central Jamaica, where it has been collected repeatedly. A slightly different form, orginally described as a distinct species, occurs farther west, where it is rare. It can be recognized as a form:

POLYSTICHOPSIS LURIDA forma **leucochaete** (Slosson) Proctor, *comb. nov.*

*Dryopteris leucochaete* Slosson, Bull. Torrey Club **40**: 184, *pl. 3, fig. 2.* 1913.

*Dryopteris lurida* f. *leucochaete* (Slosson) C. Chr., Mon. Dry. **II**: 107. 1920.

*Thelypteris lurida* f. *leucochaete* (Slosson) Proctor, Bull. Inst. Jam. Sci. Ser. 5: 61. 1953.

POLYSTICHOPSIS OCHROPTEROIDES (Baker) Morton

No further comments are here offered on this seldom-collected species. The type is a *Hart* specimen from Jamaica.

POLYSTICHOPSIS **argillicola** Proctor, *sp. nov.*

Rhizoma breviter repens ca. 0.5 cm. crassum apice paleis lanceolato-attenuatis integris 0.5–1 cm. longis nitidis rufo-brunneis translucentibus dense vestitum. Stipes 15–25 cm. longus ad basin dense pilosus aliter glaber fere sine vel sine paleis. Lamina deltoidea, plerumque 12–20 cm. longa, basi 9–12 cm. lata, tripinnata, chartacea vel subcoriacea, supra atrovirens, subtus pallidior, rhache et costis pubescentibus, pilis longis et brevibus, venulis ultimis etiam subtus sparse setosis. Forma pinnularum et segmentorum *P. ochropteroidei* similis. Sori indusiis magnis reniformibus tenuibus marginibus subtiliter undulatis tecti.

Rhizome short-creeping, about 0.5 cm. thick, densely clothed at apex with glossy, red-brown, translucent, lance-attenuate, entire scales 0.5–1 cm. long. Stipes 15–25 cm. long, densely soft-pilose toward base, otherwise glabrous and nearly or quite devoid of scales. Blades deltoid, mostly 12–20 cm. long, 9–12 cm. broad at base, tripinnate, chartaceous or subcoriaceous, dark green above, paler beneath; rachis and costae pubescent with long and short hairs, the costules of the ultimate divisions also sparsely setose beneath. Shape of pinnules and segments about as in *P. ochropteroides*. Sori covered by large, reniform, thin, glabrous indusia with finely undulate margins.

TYPE: Jamaica; Parish of Portland, on ridge 2 miles northeast of High Peak, above Murdocks Gap, on shaded clay banks at 3500–4500 feet elevation, *Proctor* 5842, collected May 2, 1951. Holotype in herbarium of the Institute of Jamaica.

Differs from the somewhat similar *P. ochropteroides*, with which it was included in the writer's "Checklist" (3), by its very much smaller size, non-scaly stipes, setose ultimate costules, and non-ciliate indusia.

It is interesting to note that five of the six known species of *Polystichopsis* occur in Jamaica, and that two of them are confined to that island. Although a relatively minor example, this can be added to the impressive list of genera for which Jamaica is a center of speciation.

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## The Genus Grammitis in Japan, with Description of a New Species

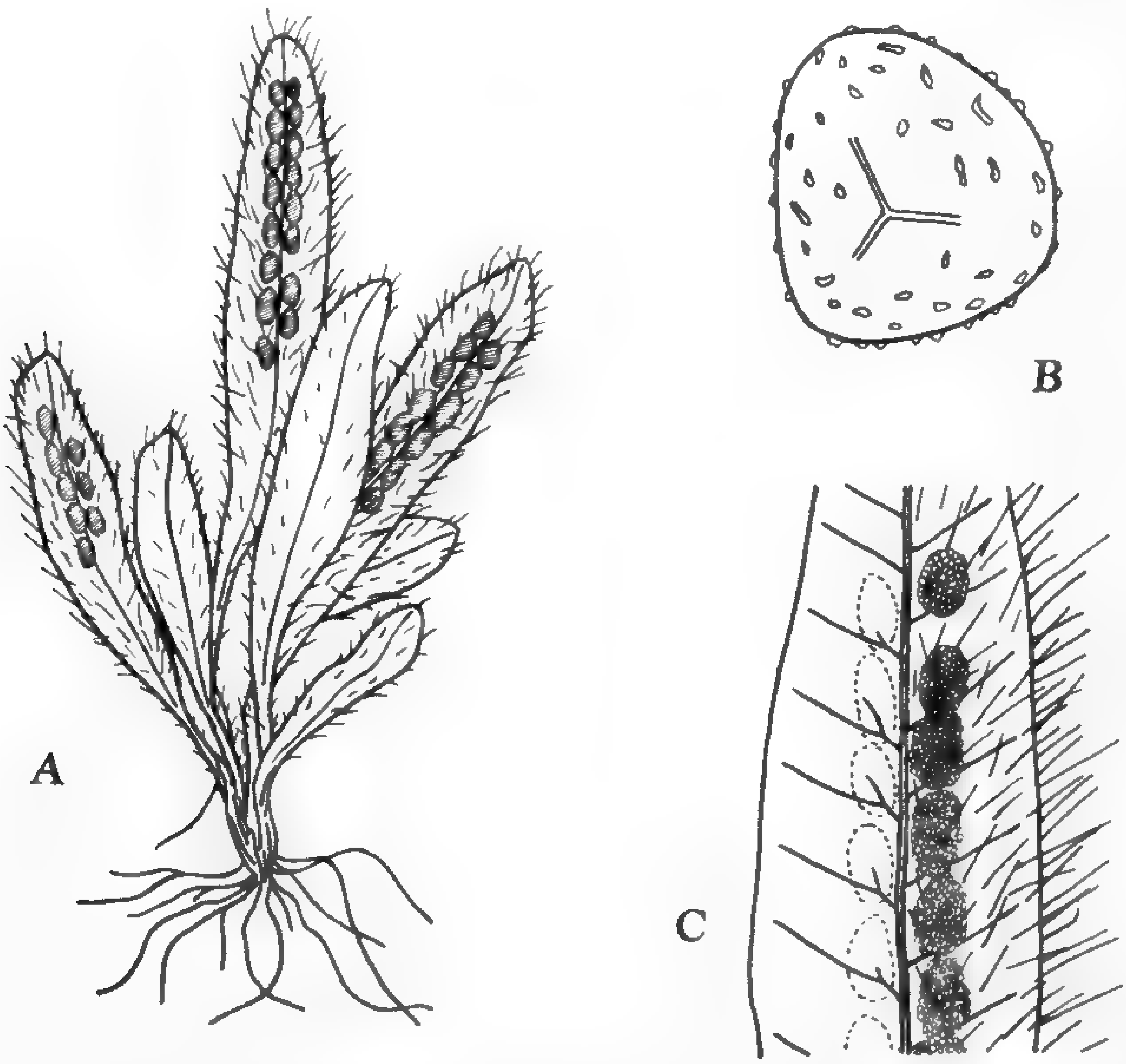
MOTOZI TAGAWA AND KUNIO IWATSUKI

The ferns of southern Japan and of the northern Ryukyu Islands have recently been studied rather minutely by the writers both in the field and by using herbarium specimens, including in the course of their investigation the genus *Grammitis.*

In 1954, the senior author published a revision of grammitoid ferns in Japan, the Ryukyus, and Taiwan[1], in which only one species of *Grammitis, G. dorsipila*[2] was credited to Japan. At

[1] Tagawa, Acta Phytotax. Geobot. **15:** 182–191. 1954.
[2] *Grammitis dorsipila* (Christ) C. Chr. et. Tard., Not. Syst. **8:** 179. 1933; Tagawa, *l. c.* 183.
*Polypodium asahinae* Ogata, Icon. Fil. Jap. **5:** *pl. 243.* 1933.

that time, this species was known to occur rarely from the southern extremity of Kyushu and the northern Ryukyus and in South China and Cambodia. Since then several collections have been added to the herbarium of the University of Kyoto from the same regions, where *G. dorsipila* is fairly common on mossy tree trunks or on mossy rocks near the very summit of




FIGS A-C, HOLOTYPE OF GRAMMITIS NIPPONICA, SP. NOV. A, A WHOLE PLANT, × 1.5; B, A SPORE, × 300; C, A PART OF FROND, × 5.

higher mountains (alt. 500-1,000 meters) where there is constant moisture from the daily mists. These additional specimens are:

KYUSHU: Mount Hoyoshi-dake, south of Kanoya-shi, Pref. Kagoshima, at 900 meters elevation, *Tagawa & Iwatsuki* 1141. RYUKYU ISLANDS: Mount Yuwan dake, Amami-Oshima, at 690 meters elevation, *Tagawa & Iwatsuki* 2919, *ibid.*, *T. Shin s.n.*; Mount Inokawa-dake, Tokunoshima Island, at 640 meters elevation, *Tagawa & Iwatsuki* 2778, *ibid.*, *T. Shin s.n.*

In 1950 our associate, Mr. G. Murata, collected an interesting *Grammitis* at Nachi, in Wakayama Prefecture in southern

Honshu. Recently Prof. S. Hatusima, of Kagoshima University, sent a specimen of *Grammitis* to the writers for determination, which was collected by his student, Mr. K. Kawanabe, on the island of Yakushima. These two specimens are identical and so distinct as to warrant a description of a new species as shown below. It is distinct from *G. dorsipila* by its broader, harsher, more strigose lamina, with larger and subcostal sori. The difference in the breadth of lamina makes a difference between the two species in the relative position of their sori. In addition of these features, the two species are ecologically distinct from each other, *G. dorsipila* being found only in a cloud zone near the summit of mountains, and the present new species, on the contrary, growing at low elevations near the coast. Japanese specimens of *Grammitis*[3] have usually been referred to ***Polypodium hirtellum*** Blume of western Malesia, which is, however, distinct from the two Japanese species by its larger lamina with more sparse hairs less than 1.5 mm long, and by the smaller rhizome scales.

GRAMMITIS **nipponica** Tagawa et Iwatsuki, *sp. nov. **Figs. A-C**,*

*G. dorsipilae* affinis, frondibus ubique setis longioribus ad 2 mm. longis densiore obsitis distincta; frondibus 2–3.5 cm. longis linearibus vel lineari-lanceolatis; venis fere ad marginem prolongatis; soris costalibus, ellipticis, in maturitate saepe plus minus confluentibus.

Rhizome very short, ascending to almost erect, usually immersed in mosses on rocks, densely covered with scales at the apex; rhizome scales narrowly lanceolate, up to 1.7 mm. long, 0.7 mm. broad, acuminate to attenuate at the apex, entire, glabrous, pale brownish, subclathrate. Stipes terete, short, less than 1 cm. long, ca. 0.3 mm. in diameter, stramineous, rather densely covered with shining, ebeneous-brown setiform hairs less than 0.5 mm. long. Leaves tufted, suberect; lamina linear or linear-lanceolate, gradually attenuate and long-decurrent

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[3] *e.g. Polypodium hirtellum sensu* Makino, Bot. Mag. Tokyo **15**: 60. 1901; Phan, Pter. Jap. Ic. Ill. **1**: *pl. 87.* 1902.

into the short stipe, (1.5) 2–3.5 (4.5) cm. long, 3.5–4.5 (6) mm. broad, rounded to moderately acute at the apex, entire or very slightly undulate, subcoriaceous and rather thick in texture, both surfaces rather densely covered with ebeneous-brown, stiff hairs up to 2 mm. long, more densely so on the costa and the margin; veins entirely hidden, simple or furcate above the base in fertile condition, the acroscopic veinlet very short, the basiscopic veinlet nearly reaching the margin. Sori elliptic, dorsal on simple veins or on anterior veinlets, arranged in a row close to costa, usually more or less confluent at maturity; sporangia naked or bearing a long seta; spores nearly spherical, trilete, minutely tuberculate.

HONSHU. San-no-taki Falls, at Nachi, Pref. Wakayama, on riverside mossy rocks in constant spray of a waterfall in dense mountain forests at about 400 meters elevation, *G. Nakai* 5052 (type KYO), *ibid., Iwatsuki* 2510 (KYO). KYUSHU. Along the Suzu-kawa, Yakushima Island, in thickets at about 50 meters elevation, *Kawanabe* 4991 (KAG).

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## Concerning Azolla imbricata

EUGENE YU-FENG SHEN

*Azolla* is a very common fern in Eastern Asia. Diels (1901) listed the plants from Central China (Hupeh) that were collected by Henry as *Azolla pinnata* R. Brown, and Matthew (1911) in his Enumeration of Chinese Ferns used the same name. Dunn and Tutcher (1912) called the plant from Hongkong *Azolla caroliniana* Willd. In 1925 Nakai suggested that the correct name for the fern that is found from India to Japan is *Azolla imbricata* (Roxb.) Nakai, stating that it is a species resembling *Azolla africana*, differing from that by the shorter papillae of the leaves and less pointed leaf-apex. Ching (1933) accepted Nakai's name and used it in his list of the Pteridophyta of Kiangsu, as did DeVol (1945) in his Ferns and Fern Allies of Eastern Central China, and most botanists have been calling this fern by this name since that time. However, we have often

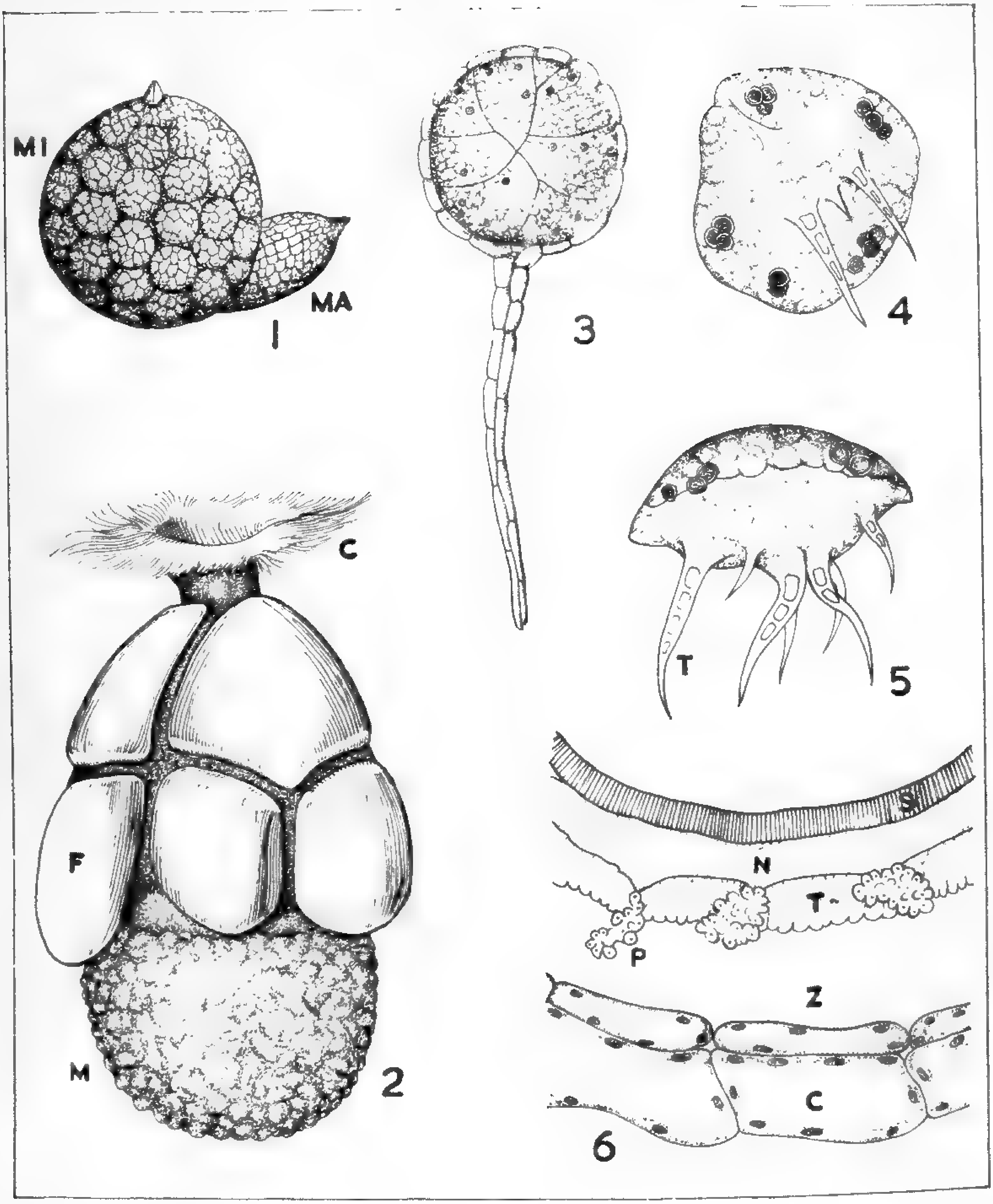


FIG. 1, A MICROSPOROCARP (MI) AND MEGASPOROCARP (MA); 2, MEGASPOROCARP WITH WALL REMOVED, SHOWING FUNNEL-LIKE CILIA (C), FLOATS (F), AND MEGASPORANGIUM (M); 3, MICROSPORANGIUM CONTAINING MASSULAE; 4, MASSULA, VENTRAL VIEW; 5, MASSULA, SIDE VIEW, WITH VACUOLATED TRICHOMES (T); 6, SECTION OF MEGASPOROCARP, WITH MEGASPOROCARP WALL (C), ZONE BETWEEN MEGASPOROCARP WALL AND MEGASPORANGIUM (Z), OUTER LAYER OF MEGASPORANGIUM WALL (T), WITH VERMIFORM PAPILLAE (P), INNER, NON-CELLULAR LAYER OF MEGASPORANGIUM WALL (N), AND MEGASPORE WALL (S).

wondered about the status of this species, for the real distinction between species of *Azolla* rests on the nature of the massulae and structure of the megasporangium and not merely on the papillae or shape of the leaves. So Charles DeVol suggested that we make a detailed study of the fruiting bodies of this aquatic fern with the object of finding out whether *A. imbricata* is really distinct from *A. pinnata* or not.

Genkei Masamune (1936) in his "Short Flora of Formosa" had called this plant *A. japonica* Fr. et Sav., which was an error in determination, for true *A. japonica* has never been collected in Taiwan. In Masamune's 1954 revision of his list of Taiwan plants he lists two species *A. africana* and *A. imbricata.* It has been thought that *A. africana* from Madagascar and many parts of Africa was distinct from *A. pinnata* of Australasia, but Christensen (1906) was correct in reducing it to a synonym. *Azolla kiangsiensis* is also no doubt the same fern. Specimens collected by L. H. Bailey in Kiukiang, Kiangsi, now in the U. S. National Herbarium are small sterile plants which appear the same as our Taiwan plants. The original descriptions of these four species are too brief to be of much value. The detailed structure of the sporocarps of *Azolla africana* and *Azolla imbricata* have not been previously reported.

Vegetative characters alone cannot be used as the sole criteria to distinguish the species of *Azolla.* It is more correct and reliable to determine the species by using their fruiting structures. The morphology of the massula and its trichomes, the structure and the contents of megasporocarp, including the character of its ciliated apex, the number of floats, the presence or absence of a collar, and the structure of the megasporangial wall are all important.

Last year the writer had a chance to get fruiting specimens of *Azolla* from Nanching, Chiayi Hsien. By carefully studying their morphological structures he found them to be similar to Strasburger's drawings of *Azolla pinnata.* We do not know where Strasburger got his material but his drawing shows it to be from a plant like ours. Both have massulae with trichomes attached on one surface and without glochidia. The anastomosing appearance of the trichomes of the massulae in Strasburger's drawing of *Azolla pinnata* may be due to the over-lapping of some of the endings of the trichomes. The structures contained within the megasporocarp and the vermiform papillae on the wall of the megasporangium shown in the Strasburger's drawing are also similar to ours, and the shape of the massulae appears similar to our species. Therefore, it seems safe to conclude that these taxa may be just a single species, and if so, then the correct name for the fern from Eastern Asia should be *Azolla pinnata* R. Brown. Specimens received from Australia sent by Ilma G. Stone and from Singapore sent by Hsuan Keng have been examined and found to be similar to ours.

### A Description of the Important Structures

The plants found in Taiwan are triangular in shape. They fragment easily, and therefore vegetative multiplication is very rapid. The leaves are alternate and stand on the dorsal surface of the rhizome in two rows. They are each divided into a dorsal aerial and a ventral submersed lobe. The dorsal lobe is several cells thick in the central region and is photosynthetic, with papillae on the upper surface. The ventral lobe is thin, one cell layer thick through most of its extent, and is non-photosynthetic. The leaf-lobes are broader near the apex, being trapezoidal and 1.2 to 1.4 mm long. Unbranched roots on the lower side of the plants extend a short distance into the water. They are enveloped with a sheath and cap when young. The sheath and cap are sloughed off and the root hairs spread out when the root is fully mature.

The sporocarps containing microsporangia or megasporangia are different in size and shape. The microsporocarp is large and globular and the megasporocarp is smaller and ovoid in shape (*Pl. 10, Fig. 1*). The wall of the sporocarp, which is the indusium, is two cells in thickness with an opening at the apex. Within the microsporocarp are many long-stalked spherical microsporangia (*Fig. 3*) borne laterally on a receptacle. The order of development of the sporangia within the sorus is gradate. There are four or more "massulae" in each microsporangium. The shape of the massulae of our species is almost like a hat with a dorsal and ventral face; it is not isodiametric (*Figs. 4, 5*). Three to eight trichomes hang from the ventral side, these not being glochidia-like. The contents of the trichomes are highly vacuolate and thus may appear to be septate, but they are not branching and not anastomosing. The microspores are 13–18 $\mu$ in diameter.

Embedded in the megasporocarp wall at the base is a spherical megasporangium, above which are nine floats arranged in two tiers, with three floats above and six floats below. There is no collar between the spore and floats. Above the floats there is a funnel-like tuft of long cilia. A single large megaspore is formed within the megasporangium (*Fig. 2*). The wall of the megasporangium of our species has two layers, just like that illustrated by Strasburger (Strasburger, *Fig. 103b*); the inner layer is non-cellular and appears homogeneous; the outer layer is finely tuberculate and covered with scattered vermiform papillae. The megaspore wall has close striations (*Fig. 6*).

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DEPARTMENT OF BOTANY, NATIONAL TAIWAN UNIVERSITY,
TAIPEI, TAIWAN, CHINA

## Shorter Notes

AN ADDITION TO THE LIST OF FERNS FOUND GROWING NATURALLY IN TENNESSEE.—During the Annual Wildflower Pilgrimage to the Great Smoky Mountains National Park, in the third week of April, 1957, a fern was discovered along the Huskey Gap Trail by Dr. Frank Barclay and the writer. This specimen could not be readily identified in the field, but upon further study proved to be *Botrychium matricariifolium* A. Br. An unusual feature of this plant was that a few sporangia had developed on the sterile frond. A specimen has been deposited in the Herbarium of the Great Smoky Mountain National Park.

A detailed description of this plant is given in *Gray's Manual of Botany.* Its range is given as extending from Newfoundland south to West Virginia. Westward, it is found in Michigan, Wisconsin, and Idaho. No mention of this species is to be found in any of the excellent works dealing with the flora of Tennessee, such as those of Anderson and Shaver. This find then represents a new addition to the ferns of Tennessee as well as to the unique flora of the Great Smokies.

The southernmost stations for this plant previously known were in Maryland and West Virginia. Professor Ogden, of Alfred University, New York, tells me that he has collected specimens in the mountains of West Virginia. — HERMAN O'DELL, *East Tennessee State College, Johnson City, Tennessee.*

OBITUARY: ALBERTO CHIARUGI, 1901–1960.—The botanical world suffered a loss with the death of Alberto Chiarugi on February 25, 1960. Founder of the serial "Caryologia," he directed its publication for 12 years. His wife Emilia is now undertaking the continuation of the publication. Botanists will be interested in perusing volume 13, no. 1, of "Caryologia" for a list of Dr. Chiarugi's publications, which number 174 and attest to a long and active career. Of particular interest in this volume and number is a posthumous article on ferns entitled, "Tavole Cromosomiche Delle Pteridophyta," in which paper of 123 pages is discussed the cytological situation in the pteridophytes, with lists of all known chromosome numbers in this group. The list of numbers is by far the most complete attempt existing, and lacks only the more recent papers (such as an article by Mehra and Loyal 1959 in which *Marsilea brachypus* is listed as having $n=20$ and a new number of $n=20$ is given for *M. quadrifolia*). Since accurate chromosome counts in ferns with numerous chromosomes is only possible with the squash technique, it is necessary to evaluate individually counts made prior to 1950. Dr. Chiarugi's list will serve as an important reference point for many years to come.—IRVING W. KNOBLOCH, *Michigan State University, East Lansing, Michigan.*

## News and Notes

A FERN PROJECT WINS A SCIENCE FAIR AWARD. — In the Plainfield, New Jersey Courier-News for March 31, 1961, there was published a photograph of a young lady receiving a certificate, with the caption:

"HER FERNS ARE TOPS—Emily Anne Carver, a junior at the Watchung Hills Regional High School, in Warren Township, received an award last night for the best project submitted by a girl in the Central New Jersey Science Fair at Rutgers University."

The text notes that as a grand prize winner she will enter the National Science Fair in Kansas City May 8 and 9. Miss Carver's project consisted of a study of the ferns and fern allies of Somerset County, New Jersey, listing for each the known localities, the geological formation, the climate, the soil acidity, etc.—E. T. W.

The Society for Economic Botany is interested in stimulating scientific studies of plants useful to man, by annual meetings, and the publication of "Economic Botany," the official journal of the Society, which publishes monographs, review articles and original studies on economic plants. The Society welcomes new members (annual dues, including subscription to journal, $7.50). Inquiries to Richard M. Klein, New York Botanical Garden, Bronx Park, New York 58, N. Y.

A MASS COLLECTION OF POLYSTICHUM.—Two members of the Fern Society, Mr. Harry K. Roberts and Mr. Donald L. Branscomb, of Guerneville and Willits, California, respectively, have made mass collections of Polystichums native in the California Coast Ranges between Santa Cruz and the Oregon state line. Fronds were taken from populations of *P. munitum, P. californicum,* and *P. Dudleyi.* The specimens exhibit amazing variations and intergradations, and suggest that these "species" may be a polymorhic complex within which introgression occurs freely.

Several hundred unmounted fronds, ranging from 3 decimeters to 1.5 meters in length, are stored at the Dudley Herbarium, Stanford University. Anyone interested in studying this material inquire of the Editor.—I. L. W.

ONOCLEA SPORES AVAILABLE:—Dr. Ralph C. Benedict, Pilot Knob, New York, has a quantity of fresh spores of the sensitive fern, *Onoclea sensibilis,* available, if college teachers or others wish them for demonstrations or laboratory work.

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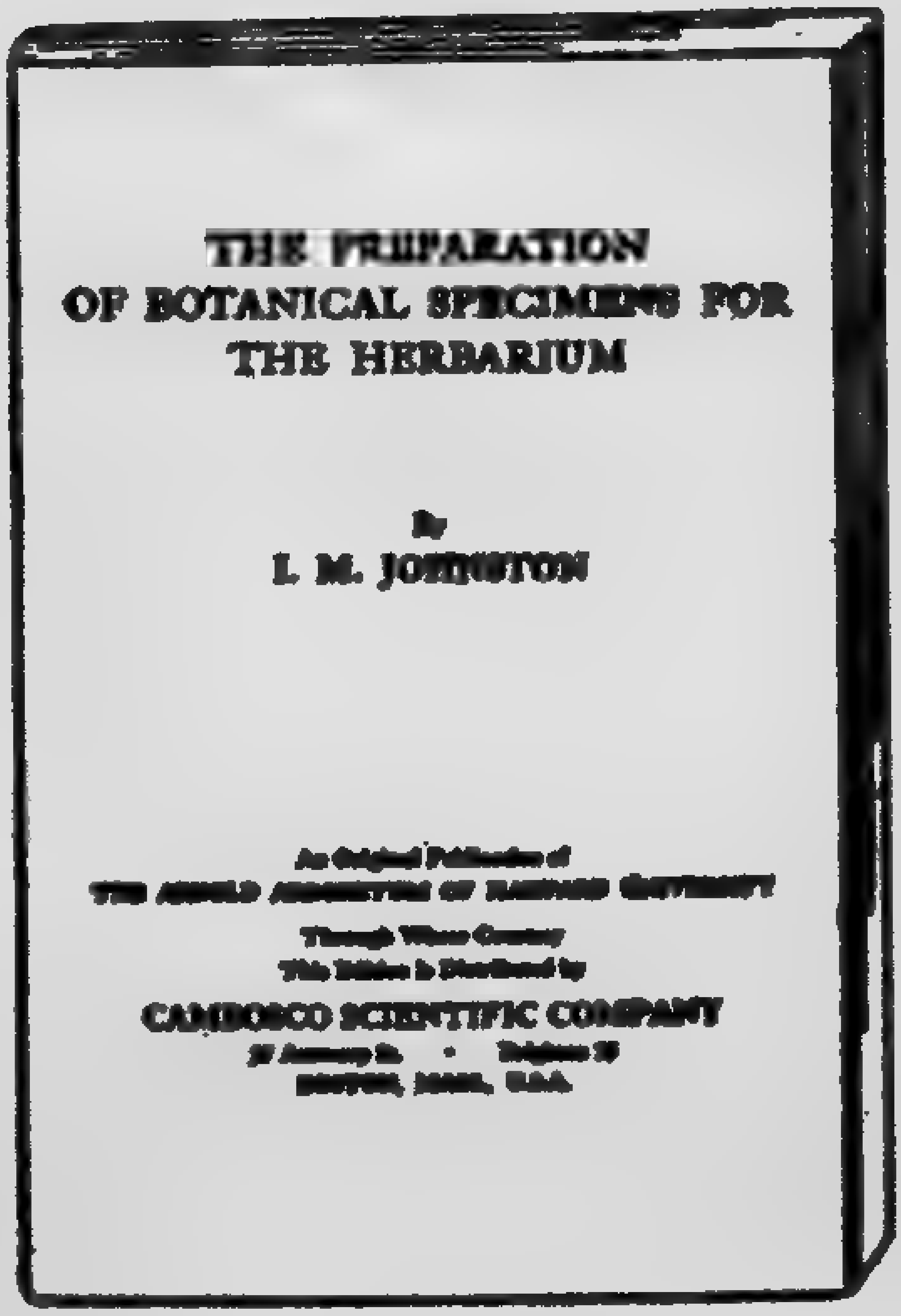


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VOL. 51 OCTOBER-DECEMBER, 1961 No. 4

# American Fern Journal

A QUARTERLY DEVOTED TO FERNS

Published by the

AMERICAN FERN SOCIETY

IRA L. WIGGINS

C. V. MORTON ROLLA M. TRYON, JR.

JOHN H. THOMAS

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An illustrated quarterly devoted to the general study of ferns, published quarterly by the American Fern Society, 3110 Elm Ave., Baltimore 11, Md. Second-class postage paid at Baltimore, Md.

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# American Fern Journal

VOL. 51 OCTOBER-DECEMBER, 1961 No. 4

## The Fern Valley at the United States National Arboretum

EDITH BITTINGER

"The U. S. National Arboretum was established by Act of Congress on March 4, 1927. The purpose of the Arboretum is to conduct research with woody plants, and to further public education with respect to trees and shrubs susceptible of cultivation in the climate prevailing in the Washington, D. C., area. . . . The strategic location of the Arboretum enables it to serve as a national institution in a very real sense. It is in an intermediate climatic zone enabling the cultivation of plants from a wide range of habitats."[1]

The Arboretum consists of 400 acres in the northeast section of the District of Columbia.[2] Before the government acquired it for an Arboretum it was rolling farm land with two hills. One hill, named Mount Hamilton, is the site of the Arboretum's magnificent collection of azaleas. In the midst of the fields was a valley, undoubtedly called a gulch or a gully, of no use except as a dump for farm trash. It was a nuisance, a useless piece of land, so fortunately for its later use, the trees were not cut nor the gully filled. For this we are eternally grateful. This is Fern Valley.

Fern Valley is 900 feet long and 150 feet wide, and has an area of about four acres. It runs east and west, and has a spring-

---

[1] Quoted from a folder on the National Arboretum published by the United States Department of Agriculture.

[2] Directions: From the Capitol northeast on Maryland Avenue to its terminus, the main entrance to the Arboretum. Open Monday through Friday 8 a.m. to 4:30 p. m.; week-ends mid-April to mid-May, 10 a.m. to 7 p.m. and late October to early November, 10 a.m. to 5 p.m.

Vol. 51, No. 3, of the JOURNAL, pp. 113-160, was issued October 4, 1961.

fed rivulet winding down the center. It is pleasantly wooded with magnificent old tulip, beech, oak, hickory, and some scrub-pine trees. The soil is a thick layer of leaf mold on a rather acid clay loam. Since it drains the surrounding area, the brooklet is subject to quick rises, sometimes as much as three feet during the flash summer rains, and storm debris was deposited above an

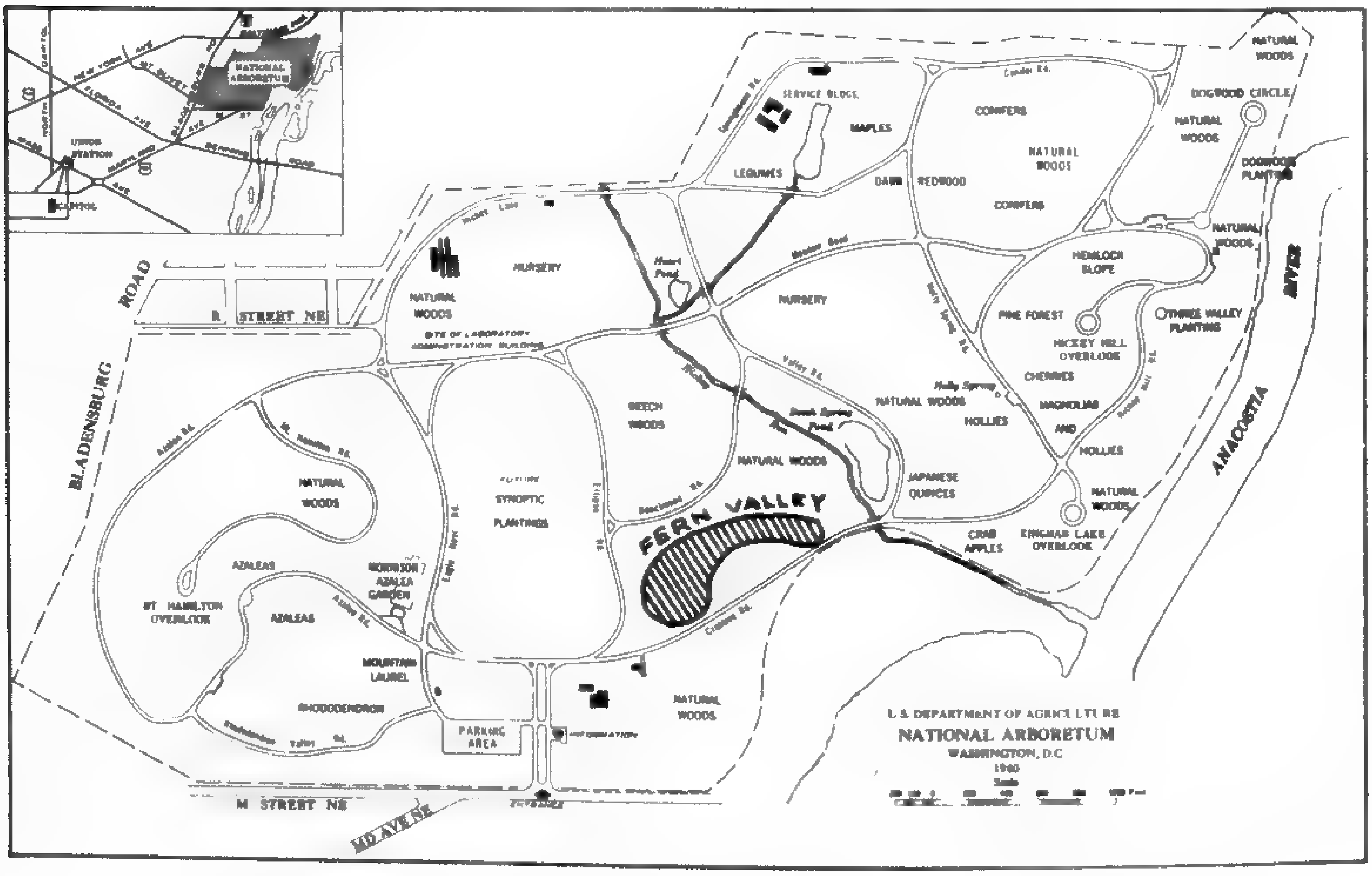


FIG. 1. MAP OF THE UNITED STATES NATIONAL ARBORETUM

unsightly six-foot sewer pipe which crosses the valley. At the lower end was a swampy area, where the ground was covered with Japanese honeysuckle intertwined with poison ivy. This was Fern Valley as I first saw it in 1957.

In 1950 Dr. James W. Johnston, Jr., Professor of Physiology at Georgetown University, visited the National Arboretum with Mr. Oliver M. Freeman, then Botanist of the Arboretum and author of "Annotated List of Plants Growing at the National Arboretum," as a guide. At that time Mr. Freeman pointed out the valley. Dr. Johnston had been interested in ferns for many years, and with no place to plant them himself he thought of the

Fern Valley When Work Began

Arboretum valley as a possible fern garden. In 1953 he met with Mr. Matthew Mann and Dr. Ralph C. Benedict, then Treasurer and President respectively of the American Fern Society, and suggested that the American Fern Society start a fern collection at the National Arboretum. As a result of this meeting Dr. Benedict authorized Dr. Johnston to seek a conference with Dr. Skinner, Director of the Arboretum, who approved of the proposed garden. Thus the Fern Society could make a start at planting under a special committee with Dr. Johnston as chairman. I quote from Dr. Johnston's notes:

"May, 1953. Dr. Johnston discussed the project with Dr. Skinner and Dr. de Vos, Assistant Director of the Arboretum. They approved the use of the valley. . . . It was planned initially as a series of pilot plantings since intensive garden culture was not possible then. . . . Three species of ferns occur naturally in the valley.

"July-October, 1953. Dr. Johnston collected and planted certain native species and received and planted ferns from Cyrus Darling, Mrs. Charlotte Learned, Gerald Lynch, and Matthew D. Mann, Jr. Dr. R. C. Benedict and Dr. Edgar T. Wherry also gave ferns and advice.

"October, 1953. Dr. Benedict wrote a letter to Dr. Skinner on behalf of the American Fern Society expressing appreciation for the cordial welcome given the fern project.

"May, 1954. About 20 members of the American Fern Society and friends met at Fern Valley, where they were greeted by the Arboretum Staff and taken on a tour of the area by Dr. Johnston.

"May 28, 1954. Mr. James Benedict led several local members of the Fern Society along the Virginia Side of the Potomac. The purpose was to collect the more abundant species for planting in the garden.

"The pilot plantings at Fern Valley were five to ten plants that were put in prepared pockets. The adjacent weeds and honeysuckle were eliminated and the ferns entrusted to nature. Dr. Johnston built a non-calcareous rock wall for the smaller species. The late summers of 1953 and 1954 were very hot and dry, so some of the plantings failed. By 1955 it was clear that the initial phase was ended, and that what was needed was intensive garden culture and vigorous volunteer labor before any serious plantings were carried out.

"Partial success was obtained, however, in the cases of the fine red-dotted shield ferns of Japan given by Matthew D. Mann, Jr., the goldie ferns from Cyrus Darling, and the Leedsii ferns from Dr. Edgar Wherry, which are still growing well where they have been for five or six years.[3]

The list of Dr. Johnston's ferns is as follows:

| | | |
|---|---|---|
| 10 Lady ferns | 2 Ebony spleenworts | 5 *D. intermedia* |
| 9 Hay-scented ferns | 15 Walking ferns | 1 *D. cristata* |
| 14 Maidenhair ferns | 3 Cinnamon ferns | 1 *D. Boottii* |
| 15 Polypodies | 8 Oak ferns | 1 *D. spinulosa* |
| 11 Resurrection ferns | 6 New York ferns | 1 *D. clintoniana* |
| 1 Christmas fern | 3 *Dryopteris marginalis* | 1 Ostrich fern |
| 7 Royal ferns | | |

During the winter of 1957 and 1958 the National Capital Garden Club League[4] sponsored a course in Tree Identification. This course was held at the National Arboretum with Dr. de Vos as lecturer, and the class walked all over the Arboretum on field-trip demonstrations. At the last lesson I asked, by chance, if there was a fern collection at the Arboretum, so Dr. de Vos took us into the valley they hoped to develop into a fern and wild flower sanctuary.

I later asked Dr. Skinner and Dr. de Vos if they would like to have ferns sent in, and then learned of the previous planting undertaken by the American Fern Society, by that time inactive.

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[3] In the summer of 1959 I received a note from Mrs. Donnald, our planting chairman, reporting progress. She wrote: "When I checked the lower end of Fern Valley yesterday I found that Dr. Johnston had been much more successful than he thought. . . . I found over two dozen individual ferns growing there!"

[4] The National Capital Garden Club League is to the greater metropolitan area of Washington, D. C., what a State Federation of Garden Clubs is to each State. There are 107 member clubs, approximately one-third each from Maryland, Virginia, and the District of Columbia.

The Directors thought nothing should be attempted without consulting the Fern Society and gave me Dr. Benedict's address. I wrote to him and quote from his reply:

"May 26, 1958. I am delighted to know of your interest in developing representative fern plantings at the National Arboretum. The Fern Society made a start at such planting just about four years ago, after consultation with authorities. A special committee, with Prof. James Johnston, of Georgetown University, as chairman was appointed. . . . I recommend that you get in touch with Dr. Johnston and with Mr. James Benedict, Vice-President of the Fern Society at this time. . . . These suggestions are in no way intended to indicate any prior claim or rights in the activity for the Fern Society; rather to express gratification that fern planting at the Arboretum is going to progress under favorable auspices. I think your planting plans well conceived. As time goes on I am sure Fern Society members will be ready to aid in further steps for expanding the plantings."

Dr. Benedict's reply reached me after I had left Washington for the summer, and I was unable to contact Dr. Johnston and Mr. Benedict until autumn, but on the basis of Dr. Benedict's letter, I began a summer project of collecting ferns for the Arboretum. My plan was to make a basic collection of our common native ferns and such rarer ones as I could find. Knowing from experience how inadequate a planting of only three or four ferns of a kind is, and also aware of the characteristics of the area to be planted, I decided on units of 25 specimens of a species if possible. To this basic collection more could be added as needed, and rare ferns provided later by gift, purchases, or field-work.

I had much plasant cooperation in my project. My sister, Miss Mary Gay, a friend, Miss Irene Walker, and I, long addicted to fern-hunting, searched our own countryside, eastern Massachusetts, and made trips to western Massachusetts, New Hampshire, and Vermont. In the latter state we discovered, sadly but approvingly, that a law had just been passed prohibiting the removal of some rarer ferns. The late Mr. Donald Wyman, of Bay State Nurseries, allowed me his professional discount in purchasing ferns; Mr. Abbey, of Gardenside Nursery in Shelburne, Vermont procured for me two native Scolopendriums from a friend in New York; my own town Tree Warden, Mr. Roy Parks gave me a double handful of *Libelia cardinalis* seeds, which gave us beautiful blooms in the summer of 1960.

In October, 1958, I sent to the Arboretum nearly 1,000 ferns of 38 species. I did not include any of our weedy ferns—bracken. hay-scented fern, and sensitive fern, and I made no effort to collect Christmas ferns, *Woodsia obtusa*, and ebony spleenworts, which grow in quantity in the Washington area. My ferns were heeled in at the Arboretum as they arrived. A list of the species sent to the National Arboretum is:

LIST OF FERNS SENT TO ARBORETUM IN OCTOBER, 1958

| | | | |
|---|---|---|---|
| 150 | *Adiantum pedatum* | 25 | *Gymnocarpium Dryopteris* |
| 25 | *Asplenium Trichomanes* | 25 | *Lygodium palmatum* |
| 25 | *Athyrium Filix-femina* (upland) | 25 | *Osmunda cinnamomea* |
| 25 | *A. Filix-femina* (lowland) | 25 | *O. Claytoniana* |
| 25 | *A. pycnocarpon* | 30 | *O. regalis* |
| 25 | *A. thelypterioides* | 25 | *Pellaea atropurpurea* |
| 25 | *Camptosorus rhizophyllus* | 15 | *Polystichum Braunii* |
| 25 | *Cystopteris bulbifera* | 30 | *Polypodium vulgare* |
| 20 | *C. fragilis* | 25 | *P. polypodioides* |
| 25 | *Dryopteris Boottii* | 25 | *Matteuccia Struthiopteris* |
| 25 | *D. Clintoniana* | 10 | *Scolopendrium* (2 native, 8 English) |
| 25 | *D. cristata* | 25 | *Thelypteris hexagonoptera* |
| 25 | *D. Filix-mas* | 25 | *T. Phegopteris* |
| 25 | *D. Goldiana* | 25 | *T. palustris* |
| 25 | *D. intermedia* | 25 | *T. noveboracensis* |
| 25 | *D. marginalis* | 25 | *Woodsia ilvensis* |
| 25 | *D. spinulosa* | 25 | *Woodwardia virginica* |
| 15 | *D. dilatata* | | |

Up to this time it was a "one man project," but in the summer of 1958 the Board of Trustees of the National Capital Garden Club League voted to make Fern Valley a League project.[5] To bring it to general attention, a fern screen for exhibition at garden shows, was made by Mrs. Donnald and Mrs. Grant.

Dr. de Vos expressed a wish that a committee be appointed for the development of the valley. This was done with Mrs.

[5] The League also maintains a guide service for the National Arboretum.

Map Shelter in Fern Valley

Morrill Donnald, Chairman for planting, Mrs. Frederick Lee, Mrs. Clifton Luce, Mrs. Benjamin Thoron, Mrs. Benjamin Powell, for wild flowers, Dr. James Johnston, for the American Fern Society, and Mrs. Charles Bittinger, Chairman.

As some money is essential for any kind of program, we gave a benefit and the proceeds were deposited with the "Friends of the National Arboretum." Gifts have been added to this fund from time to time, from individuals and clubs. Some gifts were for specific purposes, for example the entrance planting with a stone bench and map shelter, where a map of the valley and a list of workers and donors is displayed.

In November, 1958, the Committee met at the Arboretum with the Directors to formulate plans. It was obvious that before any planting could be done much basic word had to be accomplished, and Dr. Skinner offered to arrange for this. The Arboretum has operated for many years on rather limited appropriations from Congress. With roads and bridges to build in order to open the various sections, there was little money or labor available for other projects. It was our good fortune that when the League began its plans the Arboretum was able to undertake a basic landscaping and clean-up task that the League would have been unable to accomplish or afford.

It was agreed that the honeysuckle and poison ivy should be removed, that a main path five to six feet wide should encircle the valley, that the debris from flash floods should be cleared out, and that outlets from the main water system be installed.

Under the able and artistic direction of Dr. de Vos work went on through the winter and summer of 1958 and 1959. The landscaping was not finished but the results far exceeded our hopes. The ugly sewer pipe was camouflaged and made into a bridge across the stream, the rivulet was cleared, dammed, and widened, making miniature waterfalls, pools, swamp, and marsh areas; the honeysuckle was nearly eliminated. We, the League's Fern Valley Committee, were ready to begin.

Garden tools, hose, and soil testing equipment were bought, and five tons of lime soil and ten tons of lime rock were brought

[illegible]

from Leesburg, Virginia. Mrs. Donnald sent out a notice for workers and the planting began. It seemed to us that a limestone wall was essential for the lime-loving ferns. Once again Dr. Skinner came to our assistance by asking if he might supervise its construction. Dr. de Vos knew of a limestone wall in Frederick, Maryland, part of the fortifications built by Braddock in the French and Indian war. Sixty tons of this we bought and trucked in. Our limestone "cliff" is ten feet high and sixty-five feet long, built against a dirt bank and filled with lime soil. It faces north but, following the contour of the bank, has some slight east and west exposures. The Arboretum has planted many hemlocks in this area.

During the summer of 1959 Dr. de Vos asked if we could buy a collection of wild flowers. We agreed and he ordered and transported 750 plants of 45 varieties which were planted by our workers. Mrs. Donnald collected the ferns and planted the bank which we had envisioned as "dripping with Christmas ferns" with 375 plants. The season ended with 3,000 ferns and 2,500 wild flowers planted.

The winter of 1959 and 1960 saw the construction of two bridges completing the circuit of the valley, thus bringing the path back to the entrance. A small pine woods was added where *Cypripedium acaule* grows naturally; a non-calcareous wall was built; many native shrubs and trees, including two cypress trees, were planted by the Arboretum.

We planned the formal opening of Fern Valley for May 24, 1960. Early spring found every one at work, more ferns were brought in from the Washington area, more ferns were bought, and some rare ferns donated. By this time the original hope that rare ferns would be added to the basic planting was being fulfilled. Dr. Wherry sent ferns (*Athyrium* hybrids) and gave advice. Dr. Laura Barnes brought *Dryopteris chrysoloba* and *D. viridescens*.

At the opening ceremonies Mrs. Donnald reported 4,000 ferns, of 47 species, and 2,000 wild flowers representing 90 species had been planted. Seventy workers from 21 garden clubs had con-

FERN VALLEY TODAY

tributed 326 man-days of work. Gifts of plants and money had come from 61 individuals and clubs.

When we began all ferns were welcome, even the weedy ferns for restricted areas, but by the summer of 1960 it was decided to limit planting in Fern Valley to native ferns and wild flowers. We wished to have a group of foreign ferns for comparison and study, so a planting of exotic ferns was started in an adjoining ravine. Dr. Johnston was in charge of this section, and used exotics from his pilot planting as a nucleus.

The exotic ferns transplanted to this section included *Athyrium Goeringianum* var. *pictum*, an *Athyrium* hybrid (*A. angustum* × *Goeringianum* var. *pictum*?), *Dryopteris chrysoloba*, and *D. viridescens*. Dr. Meyer donated three each of *Dryopteris Filix-mas* cv. *'Daedalea,'* cv. *'Eroso-crenata,'* cv. *'Furcans,'* cv. *'Polydactyla,'* and cv. *'Subintegra,' D. pseudomas* cv. *'Polydactyla,' Athyrium Filix-femina* cv. *'Frizelliae,'* cv. *'Montrosum,"* cv. *'Multidentatum,'* cv. *'Pseudo-Victoriae,'* and some others.

We still welcome gifts, for work continues on this long-term project. Anyone wishing to send ferns write to Mrs. Morrill Donnald, 3703 Jones Road, Chevy Chase 15, Maryland, and ask about species desired and for shipping instructions.

I shall go ferning again, for the search is the spice of life, and the acquisition of new and rare ferns, in order that our National Arboretum may have as complete as possible representation of our native ferns in its climate, is our satisfaction. Our success to date is due to the interest, help and encouragement of the entire Arboretum staff, its Directors, Botanists, Plant Propagators, Secretaries, Workmen and Truck-drivers; to Mrs. Donnald and her husband, to the 75 women diggers and their husbands, but most of all to Mrs. Donnald, whose endless enthusiasm, devotion, and hard work has made Fern Valley what it is.

So here is Fern Valley today; a lovely shady valley with its beautiful old beech and tulip trees, sloping hillsides, rivulets, pools, ferns and flowers, a joy to all, a dream come true.

3403 O STREET, N. W., WASHINGTON 7, D. C.

## Ferns in Cultivation, IV. Some Wall Ferns

SYLVIA LEATHERMAN

A wall is a straight harsh line, which we all try to soften in order to have an attractive setting. Ferns are good for overcoming these straight lines. One I like to use is *Microlepia platyphylla,* a common fern in cultivation which seems to lack a common name. Here in southern California it will grow to seven or eight feet tall and is therefore an ideal background fern for landscaping along a wall that faces east or north. Good specimens with graceful arching fronds develop only with some sun. I have tried it in a shady corner, but the stipes become soft and do not have the sturdiness to hold up the large heavy fronds.

*Microlepia strigosa* is another popular fern that can be used along a wall to create a soft, graceful effect. I have grown this one successfully where it receives the early morning sun or the late afternoon sun, and also where it receives filtered sunlight, or even in a location where it received no sun at all but had good light. It has been satisfactory in all these locations. In the sun the fronds are yellow-green and have a thick texture, whereas the ones in the shade with good light are greener and thinner.

The Leatherleaf Fern, *Rumohra adiantiformis* (sometimes erroneously called *Polystichum capense* or *Aspidium capense*), also called Iron Fern, is popular with flower arrangers, because the fronds will last as long as three weeks after being cut. To have good texture and fronds that will stand up, the ferns must have a good deal of sun. Inland where I live is not considered a good location for ferns, for we are far enough away from the ocean to have dry heat in the summer and frost in the winter. However, *Rumohra* will grow well with me if given care. It desires morning sun until about eleven o'clock or the afternoon sun from three thirty p.m. on. Along the coast, where there is better humidity, it will taken even more sun. This fern is often called a "buffer" plant; when planted at the windy end of a wall it will break the wind and protect other ferns planted along the wall.

2637 NORTH LEE AVENUE, EL MONTE, CALIFORNIA.

## Southern Distribution of Botrychium oneidense and B. multifidum

F. R. FOSBERG

The resemblance of a plant collected for *Botrychium dissectum* in Greenbrier Cove, Sevier County, Tennessee (*Fosberg* 40332) to one found in Quebec (*Fosberg* 40154) a few weeks previously and called *B. multifidum* by botanists there directed my attention to differences between this Smoky Mountains plant and two other collections from the Smokies near the Chimneys Campground, Sevier County (*Fosberg* 40334, 40336). The aberrant collection, representing a small colony, has short stubby ultimate segments, rounded to acute at the tips, but the fronds are not as dissected as those of plants of *B. multifidum* from Shenandoah National Park. It corresponds well with the description of *B. dissectum* var. *oneidense* (Gilb.) Farw. as given by Fernald in the 8th edition of Gray's Manual. When W. H. Wagner expressed an interest in seeing this collection I sent it, along with a number of others of the *Sceptridium* group of *Botrychium*. He confirmed my identification, but prefers to regard *B. oneidense* as a separate species. So far as we know this constitutes a new record for Tennessee and for the Great Smokies. Another collection, *Fosberg* 23958b, from Little Hunting Creek just east of Mount Vernon, on the Potomac River, Fairfax County, Virginia, as well as the one from Quebec, three miles west of Napierville (*Fosberg* 40154), also proved to be *B. oneidense*.

The Virginia and Tennessee records rather amplify the known distribution of *B. oneidense* in the southeastern United States. It has previously been reported from Rockingham County, Virginia, by Clausen (1944); Yellow Creek, Graham County, North Carolina, by Clausen (1938); from Roan Mountain, Mitchell County, North Carolina, by Clausen (1943); and from Gatewood Switch, Pendleton County, West Virginia, by Strausgbaugh and Core (1952). The latter specimen has been verified by Dr. Wagner as *B. oneidense* (*in litt.* Aug. 7, 1960).

The only localities south of Pennsylvania in eastern North

America in which *B. multifidum* grows are in the Virginia Blue Ridge. Besides the well-known colony at Big Meadows (see Wagner, 1946), two others have turned up not far away, one just to the north, at Old Rag View Overlook, on the Skyline Drive, Madison, County (*Fosberg*, 36135a), the other a little to the south, at Milam Gap, also on the Skyline Drive, Madison County (*Fosberg*, 41088). All of these Blue Ridge collections are from meadows resulting from the abandonment of ridge-top farms when the land was bought for the Shenandoah National Park. There was undoubtedly a swamp at Big Meadows, even in the farming days, and a surprising number of plants otherwise rare or absent in the area found refuge and persisted there. Among these are such otherwise northern species as *Caltha palustris*, *Menyanthes trifoliata*, and *Betula populifolia*. *Botrychium multifidum* may well have existed there as a relict from a colder period, and with the new availability of the meadow habitats, may now have started to spread into them, north and south, exactly as has *Betula populifolia*.

If there is anything to the hypothesis that *Botrychium oneidense* is a hybrid between *B. multifidum* and *B. dissectum* (see Clausen 1944) it could be expected to turn up at Big Meadows and Old Rag View, where these species grow side by side. It has not been found there as yet, but it has not been specially sought. Furthermore, the existence of *B. oneidense* at five localities in the Appalachians and one on the Coastal Plain all well out of the present range of *B. multifidum*, make it seem unlikely that any such hybridization is taking place at present in this southern part of its range.

On the other hand, though these three plants are distinguishable, they seem pretty close together to be regarded as distinct species. The fact that these three, with their several other close relatives, all now being studied critically by Dr. Wagner, seem to require statistical methods to be discriminated with certainty, suggests that in *Botrychium* taxonomy we are almost getting to the field mouse stage. It may be that the suggestion (Clausen 1944, p. 59) that *B. multifidum* and *B. dissectum* might be "only subspecies of a polytypic species" has merit and should not be abandoned altogether.

I am familiar with Wagner's (1960) discussion of infra-specific categories in this and other groups of pteridophytes, in which he maintains, among other points, that "if two taxa co-exist over a large range and maintain their characters, they should be interpreted as species." I find this statement a little hard to reconcile with that which immediately follows it: "This means that not only do the taxa have diagnostic features of sufficient number and nature to be readily separated. . . ." As I read Wagner's article it seems to be an attempt to place the category "subspecies," at least, on an objective basis. However, the words *sufficient* and *readily* in the above quotation place us right back where we were before, as these involve purely subjective judgments. It is evident that so long as we employ the present linear hierarchy of categories in which, because of the complex character of natural phenomena, we must include many kinds of taxa in each category (see Camp and Gilly 1943) any hope of placing these categories on a really objective basis is illusory.

Since I have been interested for many years in the taxonomic treatment of infra-specific categories, I would like to comment a little more fully on Wagner's discussion. Although it is of considerable value to consider the range of usage of given categories among students of pteridophytes as well as of other plants, it does not seem that we should allow preponderance of usage to influence our judgment unduly. We have a definite and limited series of categories available under the International Code of Nomenclature, and there seems to be no point in discarding any of them merely because other botanists have misused them. The purpose of having such a series is quite simply to indicate the degree of divergence between the discernible groups of plants, giving a number of levels at which they can be discussed and, hopefully, to indicate in some measure the evolutionary relationships of the populations concerned. The extremely diverse nature of the populations, at any one level of differentiation (or rank), would seem to make a single objective definition of any category impossible.

The category of *forma* should, in my opinion, be limited to what Wagner calls "genetic forms," as there is certainly no place for non-genetic accidental or environmental modifications in the taxonomic system. Probably this rank should comprise both the sporadic but conspicuous genetically different individuals that occur among populations of ordinary individuals and the geographically limited populations of individuals which differ only very slightly from the rest of the species. I cannot agree at all with Wagner's opinion that "no trivial form deserves a botanical name." Whether or not such entities should be named depends on whether we need to refer to them by name.

Although admitting that *variety* has been variously misused I could not countenance dropping it altogether or even de-emphasizing it. I expressed myself on this matter some years ago (1944) and have as yet found no reason to change my mind about it. My principal difference from Wagner's conclusions on this is that I regard *varietas* as the ordinary geographical subdivision of a species, rather than assigning to this the term *subspecies* as is done by the zoologists. It is certainly very likely that varieties, in this sense, will intergrade with each other, especially where their ranges come together, but on the other hand, this intergradation does not seem to me a necessary criterion. There are sterility and other barriers, even between populations that are morphologically indistinguishable or almost so, that prevent any gene exchange. It still seems to me to be a matter for the judgment of the individual taxonomist, preferably based on experience with many groups of plants, to decide how distinct these should be before they should be called varieties or species. The same is true of intergrading populations, some of which certainly merit the rank of species, though most are of lower rank.

The category subspecies should, I think, in general be reserved for groups of closely related varieties within species, but there seems no inherent reason why the term should not also be applied to well separated single entities where this serves the purposes of clarity or emphasizes evolutionary diversity.

It is easy to agree with Wagner that hybrids should not be regarded as varieties or subspecies of either of their parents so long as we are dealing with ordinary hybrids, either sterile $F_1$ or the segregating "pleomorphic" hybrids whether sporadic or forming swarms. There seems no reason why these should not be designated by a formula, or if a name is desirable, it should be a binomial preceded by × if between species. The difficulties arise where such plants give rise to populations by vegetative or apomictic reproduction, and where they give rise to relatively true-breeding populations by amphidiploidy. In either of these two cases the hybridity is merely a matter of the origin or putative origin of the population, and its taxonomic disposition should not be determined by this, but by its morphology and behavior as a population, just as with any other entity. It may very well have characters that place it much closer to one parent than the other. Such populations should be spoken of as *of hybrid origin* rather than as hybrids.

In any event, it is obvious that the *Sceptridium* group of grapeferns should be much more carefully studied in the field, and that observations should be reported to Dr. W. H. Wagner, Jr., Curator of Pteridophytes of the University of Michigan, whom I sincerely thank for his determinations and information pertaining to the plants discussed in this note.

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212 HOLMES RUN ROAD, FALLS CHURCH, VIRGINIA.

## Dryopteris x Tavelii in the Valley of Chamonix, France

ANDRÉ AND ANNE-MARIE LAWALRÉE-COLLARIS

In August, 1960, we spent several days collecting between Servoz and Chamonix, at the foot of Mont Blanc, in the Department of Haute-Savoie, a region with a luxuriant vegetation and a rich flora. *Dryopteris* × *Tavelii* Rothmaler is abundant in this region, although the little work on the ferns of the environs of Mont Blanc by Venance Payot[1] mentions only typical *D. Filix-mas*. In 1959, the senior author in outlining the distribution in France of *D.* × *Tavelii*[2] had not at that time seen a single specimen from Haute-Savoie. Probably Christian Bange, of Lyon, was the first to observe this fern in this region. He wrote to us September 10, 1960, that he had found it in 1958 in the gorges of Diosaz, and later in several localities in Savoie and Haute-Savoie, among others in the environs of Chamonix. He believes that he has discovered *D. Borreri* Newm. also, on the left lateral moraine of the Glacier of Argentières. In collaboration with M. Berthet, M. Bange communicated his first discoveries to the Societé Linnéenne de Lyon in June, 1960, and an account has now been published.[3]

The specimens of *D.* × *Tavelii* from the valley of Chamonix differ from those of Belgium and Luxemburg. They have the

[1] V. Payot. Les fougères des environs du Mont Blanc, in Florule du Mont-Blanc, ou Guide du botaniste et du touriste sur les Alpes Pennines, deuxieme partie II + 22 p., Trembley, Genève. 1881.

[2] A. Lawalrée. Répatition en France et présence en Autriche et en Yougoslavie de Dryopteris x Tavelii Rothm. Bull. Res. Council Israel, Sect. D., Bot. **7D**: 181–183. 1959.

[3] P. Berthet and C. Bange. Notules d'herborisations ptéridologiques: IV. Bull. Mens. Soc. Linn. Lyon **29**: 227–231. 1960.

blades often narrower and more coriaceous, doubtless because of the more severe climate. Sometimes they have the pinnules almost entire and separated by narrow sinuses, thus being so similar to *D. Borreri* that we have consulted with Léopold Reichling, of Luxemburg, who after a full study has replied (10 October 1960): "Specimens of true *Borreri* such as those that I have collected here in Luxemburg and in Spain have characters and a general aspect that I have not found in any of your specimens from Haute Savoie. It will be necessary to establish by cytological research the nature of these forms of the Alps that leave us undecided before being able to judge their specific relationship."

We identify therefore all our plants as *D. × Tavelii,* although no. 11,120 is however very near to *D. Borreri.*[4] Moreover, Reichling has indicated that numbers 11,128, 11,137, and 11,141 are practically identical with two specimens (nos. 18,829 and 18,830) collected in the Swiss cantons of Uri and Tessin by a collaborator of F. von Tavel, E. Oberholzer, and determined by the latter as *D. Borreri* var. *insubrica* von Tavel.[5] It is true that von Tavel slassified his var. *insubrica* among his typical *Borreri* forms, but is not this plant related rather to *D. × Tavelii?*

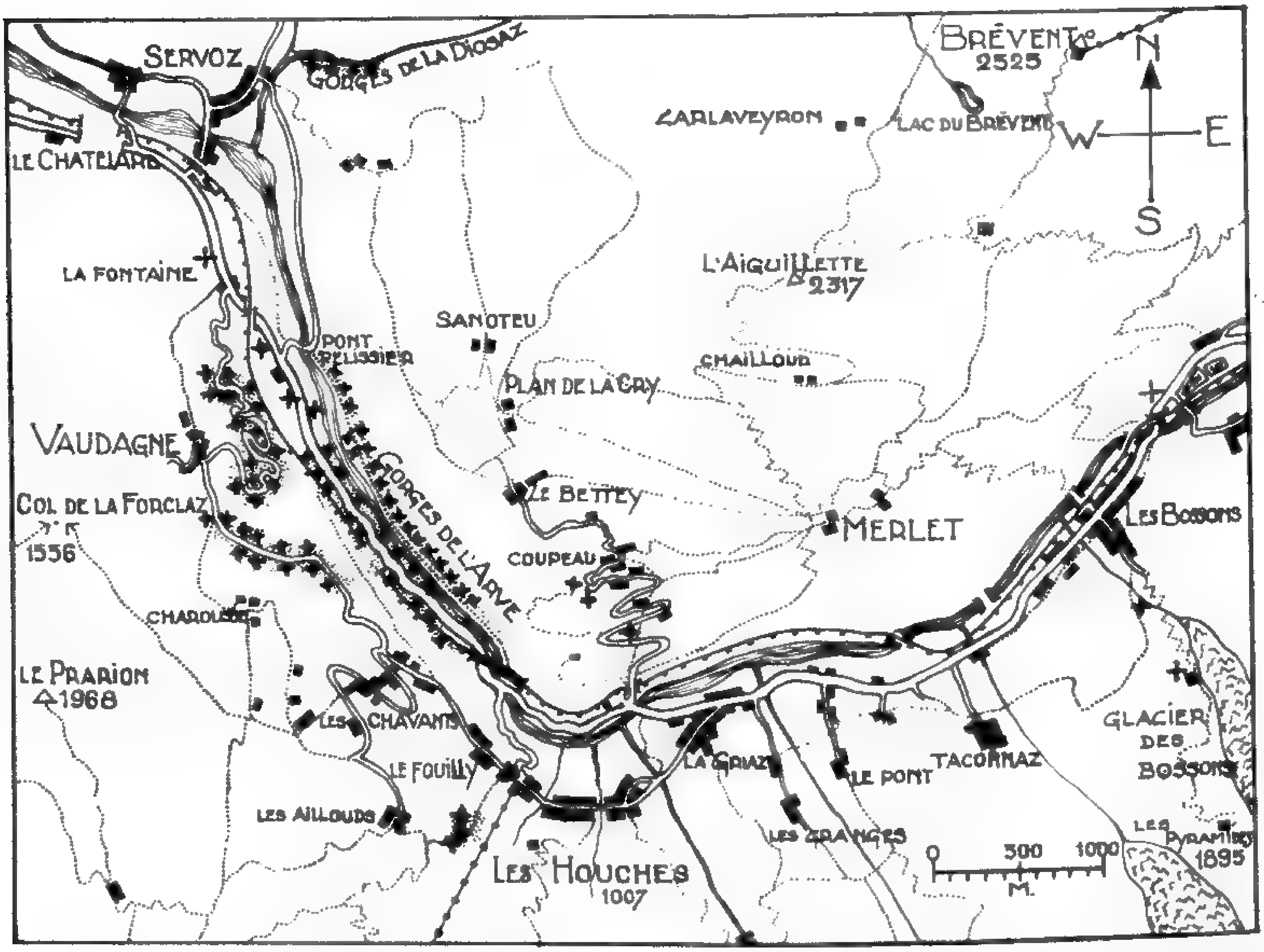
Poelt[6] speaks of his difficulties in sorting his Bavarian specimens into *D. Borreri* and *D. × Tavelii,* and our specimens present the same problem. Does *D. × Tavelii* behave in the valley of Chamonix like it does in Bavaria, on the northern slopes of the Alps, where Poelt studied it? Both regions have a very cold winter and a rather high humidity during the growing season. In the valley of Chamonix it grows on all exposures and far from being restricted to the bottom of the valley it climbs the slopes at least 400 meters higher near the Glacier of Bossons on western exposures and 200 meters near Vaudagne on northern

[4] Our collection numbers 11,113 to 11,142 of August, 1960, from Chamonix are in the herbarium of the Jardin Botanique de l'Etat, Bruxelles.

[5] F. von Tavel. *Dryopteris Borreri* Newm. und ihr Formenkreis. Verh. Schweiz. Naturf. Ges., 118 Jahresversamml: 153–154. 1937.

[6] J. Poelt. *Dryopteris Borreri* in Bavaria. THIS JOURNAL **50**: 114–117. 1960.

exposures. One finds it in shade and in full sun, generally in a deep soil, although it sometimes accompanies *Asplenium septentrionale* on almost vertical schistose rocks that very likely the snow does not cover in winter; but in this habitat the plants are weak, for example no. 11,139 (see no. 5 below).




MAP OF THE VALLEY OF CHAMONIX WITH THE LOCALITIES WHERE THE AUTHORS HAVE FOUND D. × TAVELII, MARKED WITH A CROSS; ALTITUDES IN METERS. CHAMONIX IS JUST OFF THE MAP TO THE EAST.

Here going from lower to higher elevations, are the places where we have observed *D.* × *Tavelii*:

A. On the right bank of the Arve River:

1. Gorges of the Lower Diosaz River: A little above the monument to Frédéric Auguste Eschen, left bank (no. 11,122); under the falls of the Porte River on the left bank in a little side ravine (no. 11,121); steps above the Barme Rousse Bridge, left bank;

under the falls of the Aigle River, left bank; at the Achille Cazin Bridge, right bank.

2. Gorges of the Arve River: Abundant from the Pelissier Bridge to the viaduct of Sainte-Marie-aux-Houches, e.g. no. 11,141.

3. Along the Coupeau road, on wooded slopes at two places.

4. Between Les Gaillands and Les Bossons, on wooded slopes 200 meters above the railway bridge over the Arve River (no. 11,116), two tufts in company with *D. Filix-mas, D. carthusiana,* and *Athyrium Filix-femina.*

B. On the left bank of the Arve River:

5. Sides of National Highway 506: A little below La Fontaine (no. 11,139), on schistose rocks on the south side of the road with *Asplenium septentrionale;* between La Fontaine and Pelissier Bridge, on the south side; at 100 meters above Pelissier Bridge, on the south side, on schistose rocks; at 500 meters above Pelissier Bridge (no. 11,133), on the north side, with *Alnus incana;* higher, on both sides of the road, rather frequent up to the road to Les Houches (no. 11,134), for example in a wood of *Picea Abies,* with galls of *Chortophila signata* (Brischke) de Meijere.

6. Along the road between Vaudagne and Highway 506: In a forest of *Picea Abies* and *Fagus sylvatica,* where the road winds frequently (no. 11,130) often with *Pilystichum aculeatum* (no. 11,131); on schistose rocks beside the road, with *D. Filix-mas, Athyrium Filix-femina, Veronica latifolia* L. em. Scop. (= V. *urticifolia* Jacq.), *Hieracium* gr. *murorum* L. em. Huds., *Saxifraga cuneifolia, Deschampsia flexuosa, Prenanthes purpurea, Vaccinium Myrtillus, Melampyrum pratense, Epilobium montanum, Chaerophyllum hirsutum, Solidago Virgaurea, Asplenium Trichomanes, Polypodium vulgare, Thelypteris Phegopteris, Rhabdoweisia fugax, Bartramia pomiformis, Hypnum cupressiforme, Dicranum scoparium, Rhytidiadelphus triquetrus, Rhacomitrium aquaticum, R. heterostichum, Hylocomium splendens, Fissidens cristatus, Polytrichum juniperinum, Schistidium apocarpum, Tortella tortuosa, Diplophyllum albicans, Lophozia*

*quinquedentata,*[7] *Peltigera horizontalis,*[8] and other species.

7. Between Vaudagne and Les Chavants, frequent in hedges and talus (no. 11,120) and in the forest (nos. 11,128 and 11, 129). Here is a phytosociological record of 70 square meters of this light forest, 50 meters south of the Vaudagne-Les Chavants road, at about 100 meters elevation, on a 20% slope exposed to the east.

| | |
|---|---|
| Arboreal stratum, attaining 30 m. in height and a covering of 40%: | |
| *Picea Abies* (L.) Karst. | 3—5 |
| Shrubby stratum, attaining 4 m. in height and a covering of 30%: | |
| *Corylus avellana* L. | +—1 |
| *Alnus incana* (L.) Moench | 1—2 |
| *Populus tremula* L. | +—1 |
| Herbaceous stratum, attaining 1 m. in height and a 100% covering: | |
| *Agrostis tenuis* Sibth. | 4—4 |
| *Vaccinium Myrtillus* L. | 4—4 |
| *Melampyrum pratense* L. | 3—3 |
| *Rubus* sp. | 2—2 |
| *Potentilla erecta* (L.) Raeusch | 1—2 |
| *Dryopteris Filix-mas* (L.) Schott | +—2 |
| *Dryopteris* × *Tavelii* Rothm. | +—2 |
| *Dryopteris dilatata* (Hoffm.) Gray | +—1 |
| *Athyrium Filix-femina* (L.) Roth.[9] | +—2 |
| *Blechnum Spicant* (L.) Roth | +—2 |
| *Thelypteris limbosperma* (All.) H. P. Fuchs | +—2 |
| *Carex pallescens* L. | +—1 |
| *Prenanthes purpurea* L. | +—2 |
| *Viola* sp. | +—1 |
| *Hieracium* gr. *murorum* L. em. Huds. | +—1 |
| *Orchis maculata* L. | +—2 |
| *Fragaria vesca* L. | +—1 |
| *Anthoxanthum odoratum* L. | +—1 |
| *Holcus mollis* L. | +—1 |
| *Epipactis Helleborine* (L.) Crantz | +—1 |
| *Veronica officinalis* L. | +—1 |
| *Prunella vulgaris* L. | +—1 |

[7] E. Castague, of Tervueren, and F. Demaret, of Bruxelles, have identified the bryophytes cited in this paper.

[8] Identified by J. Lambinon, of Namur.

[9] The gall of *Chortophila signata* (Brischke) de Meijere is abundant in the wood on *Athyrium Filix-femina.*

| | |
|---|---|
| *Ajuga reptans* L. | +—1 |
| *Vaccinium Vitis-idaea* L. | +—2 |

Mossy stratum covering about 80%:

*Cirriphyllum piliferum* (Hebw.) Grout
*Dicranum scoparium* Hedw.
*Entodon Schreberi* (Brid.) Moenkem.
*Hylocomium splendens* (Hedw.) Bruch & Schimp.
*Ptilidium crista-castrensis* (Hedw.) DeNot.
*Rhodobryum roseum* (Hedw.) Limpr.
*Rhytidiadelphus loreus* (Hedw.) Warnst.
*Rhytidiadelphus triquetrus* (Hedw.) Warnst.
*Lophocolea bidentata* (L.) Dumort.
*Lophozia barbata* (Schmidel) Dumort.
*Plagiochila asplenioides* (L.) Dumort.

8. Les Houches, on the road to Les Aillouds (no. 11,126), wooded slopes facing west, with the following species: *Alnus incana, Acer Pseudoplatanus, Sorbus aucuparia, Fraxinus excelsior Fagus sylvatica, Picea Abies, Larix decidua, Prenanthes purpurea, Oxalis Acetosella, Deschampsia cespitosa, Rubus idaeus, Chaerophyllum hirsutum, Solidago Virgaurea, Fragaria vesca, Maianthemum bifolium, Athyrium Filix-femina, Dryopteris Filix-mas, Polystichum aculeatum, Prunella vulgaris,* and various bryophytes.

9. Along the path to the Glacier des Bossons up to 1415 meters elevation (no. 11,137), the highest altitude where we have observed *D.* × *Tavelii,* a little below the chalet of the Glacier des Bossons (alt. 1425 m.), on a slope forested with *Picea Abies,* with a sub-story characterized by an abundance of *Prenanthes purpurea,* mixed with *Veronica latifolia, Thelypteris limbosperma, T. Phegopteris, Dryopteris dilatata, D. Filix-mas, Athyrium Filix-femina,* and other species.

SAN MINIATO, 3 AVENUE VAN ELDEREN, BRUXELLES 16, BELGIUM.

## Basket Ferns for Southern California

FAY MACFADDEN

In southern California ferns may be easily grown in baskets which may be hung from the branches of trees, from the rafters of a porch, or from the roofs of lath houses.

The best medium for growing plants in baskets I have found to be pure sphagnum moss; it is light in weight when dry and can be easily moved. Baskets lined with Oregon green moss are good too, but then the baskets must be filled with a soil adapted to the growth of epiphytes; these are then heavy to lift. Each spring I tuck more sphagnum in the holes where the birds have stolen it to build nests, and around the edge and top of the basket Otherwise baskets require little care. They may be watered with a hose or by soaking them in a tub of water.

*Polypodium aureum* (also known as *Phlebodium aureum*) and some of its cultivars, such as *'Mandaianum,'* make huge baskets. The fronds turn yellow and fall eventually. I cut them off as the new fronds appear. Like many other epiphytes they can be grown in soil, where they are beautiful when planted in good soil at the base of trees and posts. I usually plant them in sphagnum at first, but eventually they spread out to whatever soil they find.

The most commonly grown basket-fern in southern California is *Polypodium subauriculatum* cv. *'Knightiae'*, which is tough and resistant. The old fronds are ready to drop off in April, when the new fronds begin to show, peeking through the basket, are black before they unroll. These fronds cover the whole basket and a well-grown plant is a beautiful sight. In this form the margins of the leaves are deeply and irregularly cut. Plants of the botanical species *P. subauriculatum,* with the margins uncut, are also grown in southern California, but they are very tender; they grow only during the summer months, and must be protected when the days get really cold.

Another fern that may be grown in baskets is *Polypodium vulgare* and its varieties. They are at their best in early spring.

Among the most unusual ferns for baskets are the rabbit's-foot-ferns, *Davallia* and *Humata,* which creep over logs and rocks in nature as well as growing as epiphytes in trees. *Humata Tyermannii,* a native of southeastern Asia, has long-creeping rhizomes, covered with white scales, which completely cover a basket. The faster-growing *Davallia trichomanoides,* sold in the local trade erroneously as *D. canariensis,* is similar but has tawny rhizome scales. Both these ferns have deciduous fronds. *Humata Tyermannii* is beautiful when its fronds mature. These are quite thick; some time before they fall they turn various shades of yellow and eventually brown, but never dry until they fall. The fronds are jointed to the rhizome, and thus these ferns prune themselves, as do some species of *Polypodium.* An attempt to pull a frond off even a few hours before it is ready to fall is of no avail. *Davallia trichomanoides,* on the other hand, is inconspicuous in its ripening process; the fronds when withering and drying up may be pulled loose easily without damaging any new growth. In the fall most fronds of the *Humata* usually fall off, leaving the basket a mass of rhizomes, and the same thing may happen at other times if the plant becomes too dry. No doubt this is nature's way of carrying these ferns through periods of drought. Late winter or early spring will bring new growth; the new fronds do not really develop well until summer arrives and the ripening takes place in late summer.

Another rabbit's-foot-fern, *Davallia feejeensis,* is a fern that maintains a good appearance all year, although it does not grow in the winter. Whether one is conscious of it or not, most ferns, even the tropical and subtropical ones, have a period of rest. Some may grow half-heartedly during part of the winter, some go completely dormant, like this *Davallia,* even though the fronds of the preceding summer remain green, and some disappear entirely, like *Polypodium californicum,* which sends forth fronds in winter and spring and which dies down completely in summer. The fern gardener shold take note of where such things are planted, to avoid digging around them when they have ceased to show. The fronds of *D. feejeensis* are even more ornamental than those of the other Davallias, being finer cut and lacier. In summer this species grows luxuriantly, but in winter it should be grown under glass. The frond usually withers and dies; the old stipe is left on and can be pulled out. I never wait for self-pruning in *D. feejeensis,* but remove the worst-looking fronds; still, the old fronds do protect the rhizomes somewhat. These rhizomes grow either upright or horizontal, but although they can cover the basket they do not wrap themselves around the basket in the complicated manner of *D. trichomanoides.*

Suitable for baskets in the shade are the staghorn-ferns, *Platycerium bifurcatum* and other species, which form huge, exotic-looking plants. Other good basket ferns are *Polypodium polycarpon* (sold as *P. punctatum* or *P. irioides*) and *Pyrrosia lingua.*

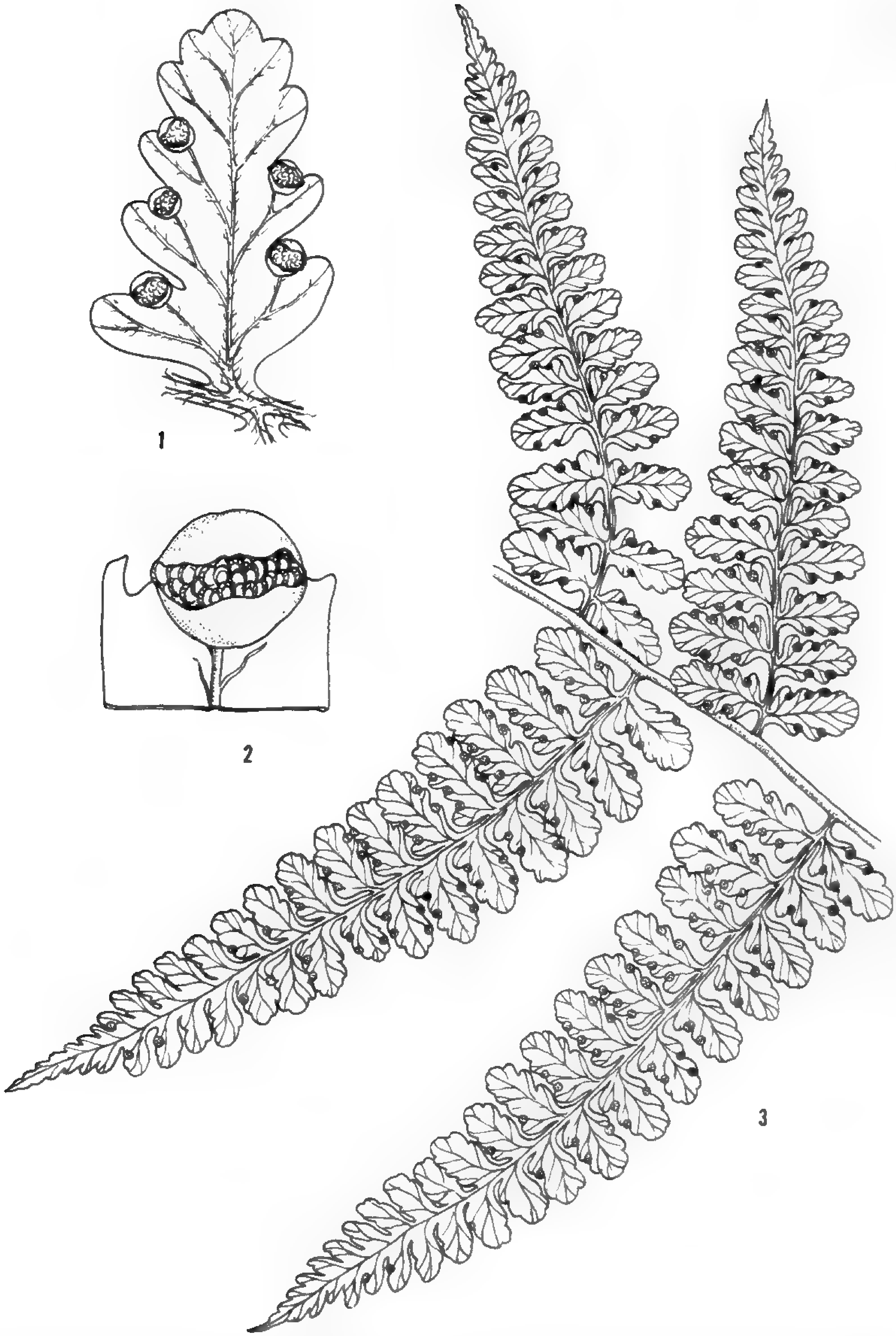
5450 CARLIN STREET, LOS ANGELES 16, CALIFORNIA.

## Shorter Notes

DENNSTAEDTIA GLOBULIFERA (POIR.) HIERON. IN TEXAS (Pl. 15). Recently the writer reported the occurrence of *Dennstaedtia globulifera* in Texas (WRIGHTIA **2**(2):108-110, *fig. 20.* 1960). This species is not only new to Texas but also to the United States. In order to call the attention of members of the Fern Society to this discovery, who might otherwise not see the WRIGHTIA report, Mr. Morton suggested a reprinting of the illustration and this note.

*Dennstaedtia globulifera* was collected in Fern Cave, 18 miles north of Comstock in Val Verde County, Texas, by Larry Hoffman (s.n.) on November 2, 1958. The plant or plants grew in a cave 50 feet in depth and had fronds which were said to be 13 feet in length.

This species is now known to occur throughout the West Indies and from northern South America northward in the tropical and subtropical regions of Central America and Mexico, with a disjunct station in Val Verde County, Texas. It is usually found in moist thickets and partially shaded places.—DONOVAN S. CORRELL, *Texas Research Foundation, Renner, Texas.*




DENNSTAEDTIA GLOBULIFERA (POIR.) HIERON.: 1, PINNULE, SHOWING SORI, ABOUT × 3; 2, SORUS, × 20; 3, TWO PAIRS OF SECONDARY PINNAE, × ⅔. ILLUSTRATION BY PHOEBEJANE HORNING.

PTERIDOLOGICAL TROGLODYTES.—It is well known that many ferns flourish in caves, or in limestone sink-holes, often well below the surface of the ground; the plants adjust to available natural light. But ferns that depend almost entirely upon artificial light and survive unnatural conditions, as real troglodytes, are rare.

For several years two clumps of ferns have been putting on a brave show deep in the limestone recesses of Crystal Cave, three miles west of Kutztown, Pennsylvania. The ferns were shown to me in early June, 1961, by Ralph B. Lutz, one of the Cave guides, who has taken a special interest in these misplaced members of the fern community.

The plants, sadly depauperate specimens, barely exist without benefit of soil; they cling to thin, moist limestone ledges about 200 feet back from the Cave entrance, and 110 feet below the surface of the ground, where the mean average annual temperature is 56°. Clump #1, a Christmas Fern, *Polystichum acrostichoides,* had five fronds the longest of which was seven inches. It enjoys more ample light than its neighbor, an Ebony Spleenwort, *Asplenium platyneuron*—just barely recognizable as such. (At the time of my visit I added a generous handful of rich humus to the Christmas Fern. Two months later Mr. Lutz informed me that this clump developed two additional fronds, and that the plant had become healthier, more vigorous with the addition of soil.

Illumination for these plants is derived from single 75-watt projection lamps, part of the lighting system of the Cave. In the case of the Christmas Fern, the lamp is 27 inches from the plant and, when illuminated, the temperature at the fern is 78°. The lights are on for 5 hours daily from mid-February to late May and from early September to December 1, and 8 hours daily from Memorial Day to early September—approximately 1,780 hours of the year.

The fern spores could easily have been introduced into the Cave via human visitors, or by bats; but it is remarkable that the ferns could develop under a light intensity of 8 foot-candles an indicated by a photoelectric meter.—MAURICE BROUN, *Hawk Mountain Sanctuary, Kempton, Pennsylvania.*

MARSILEA QUADRIFOLIA L. IN INDIANA AGAIN.—Recently while collecting ferns and fern-allies in Indiana, I came upon a large colony of *Marsilea quadrifolia* L. in Cooley's Pond, a farm pond given over to *Nuphar advena* and *Marsilea.* This pond is on a farm one and one-quarter miles south of Bordens on route 60 in Clark County. The pond varies from 150 to 200 feet in diameter. The *Nuphar* grows out in the center of the pond, while *Marsilea* grows from along the shore, where some plants are actually emersed, to ten feet into the pond where the water is at least two feet deep. One end of the pond is entirely covered by the *Marsilea.*

Deam (in Flora of Indiana, p. 1021, 1940) excluded *Marsilea quadrifolia* L. from the flora of Indiana because he was unable to find the species in 1937 in the area reported by Grimes in 1911, that is, from an old mill pond on the south side of the Vandalia Railroad in Greencastle, Putnam County, Indiana.

Therefore, finding *Marsilea quadrifolia* L. in Cooley's Pond near Bordens, in Clark County, reestablishes its existence in Indiana. Many specimens were collected from this locality Aug. 16, 1961 (*Reed* 52412). Some plants have one sporocarp and some bear pairs of sporocarps. Representative specimens have been placed in the United States National Herbarium.—CLYDE F. REED, *Reed Herbarium, Baltimore 34, Maryland.*

## Notes and News

July 18, 1961

Dear Sir:

In Volume 51 of the Journal, Mrs. MacFadden suggests the use of old fluorescent tubes in lath-house construction. Although modern tubes may be safe for such use, older tubes are dangerous and should never be used. They contain various salts of beryllium in a fine, powdery form. Leaking and broken tubes permit escape of this material, which, if it gains entry into lung or injured skin, is capable of producing unsightly, painful, and even fatal granulomatous lesions.

I feel that readers of the Journal should be apprised of the very real danger involved in the proposed use of the tubes. If the age and contents of fluorescent tubes are in doubt they should not be used, but should be disposed of in the manner recommended by the Public Health Department.

Please refer to Flint, Thos. *Emergency Treatment and Management* (Saunders, 1958), pp. 220-221.

Sincerely,
J. V. Gilkey, M. D.

San Leandro, California

## American Fern Society

### Report on the Cumberland National Forest Foray

Participants gathered for the foray at the Seven Gables Motel, Burnside, Kentucky, during the afternoon and evening of August 23, 1961. A short briefing was given by Dr. Clair Brown, President of the American Fern Society, and by Mr. Thomas McCoy, leader of the foray.

During the morning of August 24th two stops were made in Cumberland Falls State Park. The first was above the Falls where the group walked up the river to observe the ferns on cliffs and talus slopes. The next stop was at the Falls, where we ate lunch and looked for ferns in the immediate vicinity. The notable find at that station was *Trichomanes radicans* (*T. boschianum*) made by Conley Webster. He guided three different groups to the colony of this attractive little fern.

The drive to Natural Bridge State Park, the only long one of the foray, took most of the afternoon. The night was spent at Hemlock Lodge in the Park.

During the next morning and early afternoon we made several short trips in the area, visiting Natural Bridge, Nada Tunnel, Sky Bridge, and Devil's Kitchen. Spectacular scenery furnished attractive backgrounds for the many ferns observed. In the late afternoon we drove to Morehead College, where we stayed over night in the college dormitories.

On August 26 we drove to Carter Cave State Park where we spent the forenoon and ate lunch. In addition to several ferns, the Crane-fly Orchid (*Tipularia discolor*) and the Three Birds Orchid (*Triphora trianthophora*), both in flower, attracted a great deal of attention although a few persons had seen both at Cumberland Falls. After lunch the group began to break up, but a few went on to explore Sandy Hook.

The 33 persons who participated in all or part of the foray were indebted to Mr. McCoy, "the only McCoy who got away from the Hatfields," for his careful planning, meticulous arrangements, and able leadership.

Those attending the foray were Robert G. Aborn, Earl Bishop, Dr. R. F. Blasdell, Dr. and Mrs. Clair A. Brown, Mrs. Muriel P. Brown and daughter and grandson, Dr. and Mrs. Lewis Dickinson, Frederick Dunlap, David L. Emory, Mr. and Mrs. Edward G. Heinzelman, Dr. and Mrs. L. K. Henry and two sons, Dr. Donald G. Huttleston, Mr. and Mrs. J. W. Kunneke, Mr. and Mrs. John T. Laitsch, Mr. and Mrs. T. E. Landry, Thomas N. McCoy, Miss Lillian McKee, Mr. and Mrs. G. H. Peters, Dr. Elizabeth L. Sawyer, Miss Mabel Slack, Miss Eva Sobol, and Conley Webster. Special mention should be made of Earl Bishop who, although a 1961 high school graduate, was more familiar with the native ferns of the area than were most of the participants, including this reporter.

The following 46 species, varieties, and forms of ferns were seen during the foray: *Adiantum pedatum, Asplenium bradleyi, A. cryptolepis, A. montanum, A. pinnatifidum, A. platyneuron, A. platyneuron* var. *incisum, A. resiliens, A. trichomanes, Athyrium filix-femina* var. *asplenioides, A. filix-femina* var. *michauxii, A. pycnocarpon, A. thelypterioides, Botrychium dissectum* f. *obliquum, B. virginianum, Camptosorus rhizophyllus, Cystopteris bulbifera, C. fragilis* var. *protrusa, Dennstaedtia punctilobula, Dryopteris goldiana, D. hexagonoptera, D. marginalis, D. noveboracensis, D. spinulosa* var. *intermedia, D. thelypteris* var. *pubes-*

*cens, Equisetum arvense, E. hyemale* var. *affine, Lycopodium complanatum* var. *flabelliforme, L. lucidulum, L. obscurum, L. porophilum, L. tristachyum, Lygodium palmatum, Onoclea sensibilis, Osmunda cinnamomea, O. claytoniana, O. regalis* var. *spectablis, Pellaea atropurpurea, P. glabella, Polypodium polypodioides, P. virginianum, Polystichum acrostichoides, P. acrostichoides* f. *incisum, Pteridium aquilinum* var. *latiusculum, Selaginella apoda,* and *Trichomanes radicans.*

It was undoubtedly the aspleniums that received the greatest amount of attention, with a considerable bit of discussion—almost argument—over species and hybrids.—DONALD G. HUTTLESTON, *Longwood Gardens, Kennett Square, Penn.*

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# Index to Volume 51

## ERRATA

Vol. 50, no. 4.

Page 277, line 26: For "from Darjeeling and Mussoorie respectively," read "from Mussoorie and Darjeeling respectively."
Page 278, Magnification for figures 1, 2, 7, 8, 9, 10: For "500," read "1000," and for fig. 3, for "150," read "300."
Page 282, legend, figure 6: For "$n = 50$," read "$n = 40$."
Page 286, legend, figure 18: For "85," read "100."
Page 296, line 7: For "cet," read "set."

Vol. 51.

Page 5, line 5: For "or," read "of."
Page 9. Transfer footnote 4 to page 8.
Page 10. Transfer footnote 5 to page 9.
Page 14. Transfer footnote 7 to page 13.
Page 16. Plate is upside down.
Page 17, line 6: For "tht," read "that."
Page 20. For "Gymnocarpiune," read "Gymnocarpium."
Page 26, line 16: For "which, as one would expect are quite variable, although many," read "tal entities are involved is strongly favored, because in many."
Page 28. Omit line 1.
Page 29. Lines 10 to 22 of last column should be lowered one line.
Page 70, line 7: For "*Maxon,*" read "Maxon."
Page 71. Add to legend of plate: "The arrows indicate farthest extent of darkening of stipe or rachis."
Page 148. Item 2 in Bibliography: For "Christeneen," read "Christensen."
Page 150, line 10: For "of," read "to."

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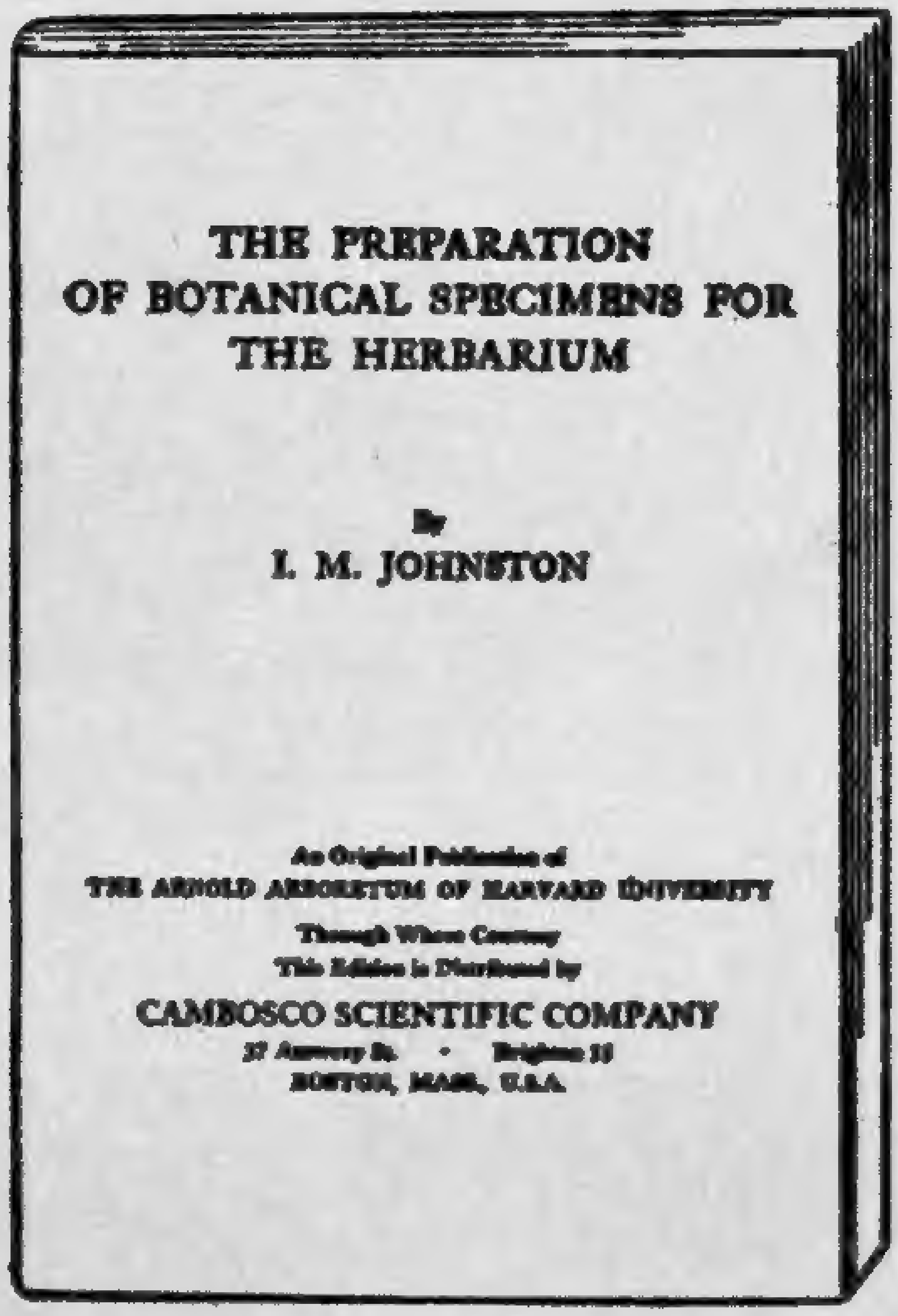


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