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NEW YORK ACADEMY OF SCIENCES



SCIENTIFIC SURVEY  
OF

Porto Rico and the Virgin Islands

VOLUME VII—Part 3

Paleobotany of Porto Rico

BY

*Arthur Hollick*



NEW YORK:  
PUBLISHED BY THE ACADEMY  
1928

[Issued October 31, 1928]





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# PALEOBOTANY OF PORTO RICO

ARTHUR HOLLICK

## INTRODUCTION

The earliest published references to fossil plant remains in Porto Rico were by Hodge,\* who mentioned (*loc. cit.* (a), p. 278) the presence of a bed of limestone, and an adjacent bed of hematite containing fossil leaves, in the northeastern part of the region discussed. The beds were inferred to be lower Cretaceous, by reason of a characteristic species of coral found in the limestone, and from the general facies of the flora as indicated by a few plant remains found in the hematite bed.

In the author's second paper the subject was discussed at greater length and more in detail, in connection with a description of an unconformity between the Barranquitas-Cayey series of rocks and the Sierra de Cayey series, in the course of which discussion he remarked (*loc. cit.* (b), pp. 192-193): "A short distance below this unconformable contact two calyxes of a coral were found in a limestone, which have been identified as *Cladophylla furcifera* . . . . Its presence here should indicate that the rocks are at least of Comanche age. Below the limestone occurs a thin bed of bog iron ore and in it were some leaves. Dr. Edward W. Berry and Dr. F. H. Knowlton identified these leaves as follows:

*Nelsonia* [= *Nilssonia*], an old Mesozoic order [= genus] of cycads.

*Protorhipis*, a fern with the same range as above.

Another species of Mesozoic fern.

A dicotyledon.

The above authorities stated that these plants were not critical for the Comanche, but that they tended to support the evidence of the corals—at least they indicate Mesozoic age."<sup>†</sup>

\* Hodge, E. T. (a) Geology of the Coamo-Guayama region, Porto Rico [Secretary's abstract]. New York Acad. Sci., Annals vol. 27, pp. 277-278. 1917. (b) Geology of the Coamo-Guayama district. New York Acad. Sci. scientific survey of Porto Rico and the Virgin Islands, vol. 1, pt. 2, pp. 111-228. 1920.

<sup>†</sup> Incidentally it may here be pertinent to remark that I took occasion to refer to and to discuss the identifications above mentioned, with both Professor Berry and Doctor Knowlton, and that each merely recalled, rather vaguely, having seen the specimens, but could furnish no additional information in regard to them. I also made diligent effort to locate the specimens, in order to examine them personally, but without success.



The bed of iron ore, and the associated strata, were investigated and critically examined by Dr. N. L. Britton and me in 1926, and again by Doctor Britton in 1927 and 1928; but except for a few small fragments and impressions of stems or branches and disintegrated vegetable tissue, and some obscurely defined seed- and fruit-like organisms, the rocks appeared to be barren of plant remains. None of this material is identifiable further than as above mentioned.

The matrix in which the remains are included consists in part of thinly bedded black shale and in part of ferruginous shaly sandstone, which are exposed on the side of the Aibonito-Barranquitas Road in the vicinity of Kilometer 3, and on the Aibonito-Coamo Road between K. 86.5 and K. 90; and, more recently, an investigation by Dr. H. N. Coryell, of fossiliferous limestone from K. 89.8, on the road about half way between Aibonito and Coamo, has revealed remains of coralline algae of the genus *Lithothamnium* in that rock; and in this connection it is of interest to note that Hodge (*loc. cit.* (b), p. 155, fig. 15; p. 156, fig. 16; p. 158, fig. 18), in his discussion of the Coamo Springs limestone, described and figured remains of *Lithothamnion* (= *Lithothamnium*) as constituents of the rock which he apparently regarded as Eocene in age.

During the years 1915-16 Hubbard\* was engaged in the geological survey of the Lares district, during the prosecution of which he made a considerable collection of fossil plants in the San Sebastian or Collazo shales, on the Collazo River, and a few in the Lares limestone, on the Guajataca River; but the only published mention of these remains was a brief reference, in connection with the discussion of the stratigraphy of the shales, where he remarked (*loc. cit.*, p. 39) that "many of the lignitic clays contain fossil leaves and fresh or brackish water mollusca." The original locality labels that accompany the specimens from the locality last mentioned read: "Guajataca River, south bank, about one-fourth mile north of town of Lares ('Collazo shales, uppermost of the series')." Only three identifiable specimens were included in the collection from this locality, which were described and figured by me† under the following names:

\* Hubbard, Bela. The geology of the Lares district, Porto Rico. New York Acad. Sci. scientific survey of Porto Rico and the Virgin Islands, vol. 2, pt. 1, pp. 1-115. 1923.

† Hollick, Arthur. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, pp. 259-323, pls. 1-15. Sept. 13, 1924.

*Coccoloba* (?) sp. (*loc. cit.*, p. 297).

*Anona* [= *Annona*] *saraviana* Berry? (*idem*, p. 298).

*Aniba portoricensis* Hollick (*idem*, p. 300).

These three species represent the only published record of the flora of the particular geological horizon in which they were found.

The fossil plant locality on the Collazo River is designated by Hubbard, on the labels, as "Collazo River, near (or "at") base of second falls below Carretera bridge." The collection made by Hubbard at this locality included twenty species that were described and figured by me in the paper cited; and these will be found included, in their proper systematic sequence, with the descriptions of new species, in the present volume.

In the meantime, and subsequently, a considerable number of specimens were collected at or near to Hubbard's locality on the Collazo River, by Don Narciso Rabell, of San Sebastian, which were transmitted to me for examination.

During the winter of 1926 Dr. N. L. Britton was in Porto Rico, and took advantage of the opportunity to confer with Señor Rabell in regard to the material transmitted. The locality where the specimens were collected was visited, in company with Mr. W. D. Noble of San Juan, and a brief period of examination and collecting yielded such gratifying results that I was called upon to come to Porto Rico and assist in the investigation. During the month of March of that year the ravine of the Collazo River, from the falls above the Lares-San Sebastian Road bridge to a distance of about a kilometer below was explored, and fossil plant remains were collected at four localities. At two of these localities, viz, at the base of the first falls below the bridge (designated "station B"), and at the base of the second falls (designated "Station A") well defined fossil plant remains were collected in abundance. The latter station is apparently identical with Hubbard's locality, previously mentioned. Plant remains found at the other two stations in the Collazo ravine consist mostly of twigs and branches, disintegrated woody tissue, and fragments of bark and leaves, none of which was identified. An exposure of lignitic clay was also discovered in the ravine of Media Luna Creek, parallel with and a short distance to the east of the Collazo River ravine. A bed of finely comminuted lignitic debris is a prominent feature at this locality. Specimens of this material were collected, but they yielded nothing that was identifiable.

A brief account of the explorations made in 1926 was included by Doctor Britton\* in a report upon the general investigations prosecuted in Porto Rico during that year, together with one by me (*idem*, pp. 102-104) issued under the title Paleobotanical exploration in Porto Rico.

During the year 1924,<sup>a</sup> Señor Adriano Gonzales, of Arecibo, collected specimens of lignitic debris, including well defined nuts of *Juglans*, in the valley of the Guajataca River near Quebradillas, in deposits of recent (probably Post-Pliocene) age. This material was subsequently submitted to me for examination and was made the subject of a paper,<sup>†</sup> in which the nuts were described and figured under the name *Juglans archaeoantillana*.

The species described and listed in the following pages were all collected in the ravine of the Collazo River, either by Dr. Bela Hubbard in 1915, by Don Narciso Rabell in succeeding years, or personally and by other members of the expedition headed by Dr. N. L. Britton in 1926.

The figures of leaves and other parts of existing species of plants, introduced for comparison on the plates of this volume, all represent specimens in the herbarium of the New York Botanical Garden.

\* Britton, N. L. Further botanical investigation in Porto Rico. New York Bot. Gard., Journ. vol. 27, No. 317, pp. 97-102. May, 1926.

† Hollick, Arthur. Fossil walnuts and lignite from Porto Rico. New York Bot. Gard., Journ. vol. 27, No. 322, pp. 223-227, text figs 1a, a', 1b, b', 1c, c'. Oct. 1926.

## DESCRIPTIONS OF SPECIES

### Phylum **THALLOPHYTA**

#### Class ALGAE

#### Order DICTYOTALES

#### Family DICTYOTACEAE

#### Genus **CHONDRITES** Sternberg

#### **Chondrites dictyotoides** n. sp.

#### Plate 51, Figure 1.

Fronde or thallus, irregularly branched; main branches about 1 millimeter in maximum width, proximad; each successive series of branches narrower than its supporting series; all ligulate in shape; ultimate ramifications truncate (?), about .25 millimeter in width; costae not discernible.

Fragmentary remains of this species, including those figured, are scattered over the surface of a shaly layer of matrix about 7.5 by 10 centimeters in extent. They evidently represent dismembered parts of a thallophyte that bears a close surficial resemblance to existing marine algae included in the family Dictyotaceae, and may be especially compared with certain forms of *Dictyota Bartayresii* Lamouroux—an existing species common in the West Indian region.

The fragmentary condition of our specimen renders impossible any satisfactory concept either of its size or of its exact system of branching, in its entirety. In places the branches are alternately disposed, and in others dichotomy is apparent, and the spacing of the branches and their angles of divergence appear to be more or less irregular. It is possible, however, that a specimen complete in all its parts might show certain of these apparent characters to be due to imperfection of preservation and to the fragmentary condition of the remains.

About twenty species and varieties, surficially similar to our specimens, have been described and figured under the fossil algal genus *Chondrites*, especially by Heer,\* from the Eocene (Flysch) of Switzerland, among which *Chondrites Targioni arbuscula* (Fischer-Ooster) Heer (*op. cit.*, p. 155, pl. 61, fig. 9; pl. 62, figs. 1-7; pl. 63, figs. 12-17), and *Chondrites intricatus* (Brongniart) Sternberg, in its several forms (*idem*, p. 157, pl. 63, figs. 1-10), may be regarded as those that are most closely comparable with ours. A tracing of one of the figures of the former species, representing Heer's figure 1, plate 62 (*op. cit.*), is reproduced in our Figure 2, Plate 51, to facilitate comparison. The same author† also described similar remains from Alaska, designating them "*Chondrites* sp." (*op. cit.*, p. 21, pl. 10, fig. 5); but in as much as the specimen upon which the description and figure was based is stated to have been found "*in lapide erratico*," or as "float rock," its geological age was not satisfactorily determined. Incidentally also, comparison may be made with *Sphaerococcus crispiformis* (Schlotheim)

\* Heer, Oswald. *Flora fossilis Helvetiae*, pt. 5 (Die Eocene flora der Schweiz), pp. 147-182, pls. 59-69 in part. 1877.

† Heer, Oswald. *Flora fossilis Arctica*, vol. 2, pt. 2 (Flora fossilis Alaskana). 1871.

Heer,\* from the Miocene of the Old World, a tracing of which is reproduced in our Figure 3, Plate 51.

Fragmentary remains of an alga from the Tertiary of Wyoming, that is evidently of the same general type as those previously mentioned, were described and figured by Lesquereux† under the name *Fucus lignitum*, and it is interesting to note that he compared it with *Sphaerococcus crispiformis*; and Ward‡ described and figured similar remains from the same region and referred them to Lesquereux' species, together with mention of its resemblance to *S. crispiformis* and also to "some forms of *Chondrites*."

Locality: Station A.

## Phylum PTERIDOPHYTA

### Class FILICINAE

### Order POLYPODIALES

### Family CYATHEACEAE

#### Genus HEMITELIA R. BROWN (CNEMIDARIA Presl)

#### HEMITELIA BRANNERII Hollick & Berry?

Plate 51, Figure 4

*Hemitelia Branneri* Hollick & Berry. Johns Hopkins Univ. Studies in Geology No. 5 (A late Tertiary flora from Bahia, Brazil), p. 46, pl. 1, figs. 3-6. 1924.

A single median fragment of a pinnule, or a pinnatifid division of a pinna, is all that we have thus far found to represent ferns in the fossil flora of Porto Rico; otherwise the specimen here described and figured would probably have received but little attention. The nervation is poorly defined, and it is impossible to determine if the veinlets are forked or simple. The sori appear to be round and to occupy a position about midway between the midvein and the margin. The margin is minutely denticulate.

In its general characters, as far as these are discernible, the specimen is highly suggestive of certain existing species in the genus *Hemitelia*, and it bears so close a resemblance to the fossil species *H. Brannerii* (*op. cit.*), from the Tertiary of Brazil, that I have referred it, tentatively, to that species—the only apparent difference between them being that the specimen from Porto Rico is narrower and the sori are somewhat larger, as may be seen by comparison with Figures 5 and 6, Plate 51, which represent figures 5 and 4, respectively, of the work cited.

The species, based upon the specimen from Brazil, was compared by the authors with the existing *Hemitelia grandifolia* (Wildenow) Sprengel; and illustrations of pinna lobes of the existing species *H. subglobosa* (Underwood) Maxon (Figure 7, Plate 51) and *H. Imrayana* Hooker (Figure 8, Plate 51) are introduced for generic comparison with our specimen.

Locality: Station A.

\* Heer, Oswald. Flora Tertiaria Helvetiae, vol. 1, p. 23, pl. 4, fig. 1. 1855.

† Lesquereux, Leo. U. S. Geol. Survey Terr., Rept. vol. 7 (The Tertiary flora), p. 42, pl. 61, figs. 24, 24a. 1878.

‡ Ward, L. F. Synopsis of the flora of the Laramie group. U. S. Geol. Survey, Sixth Ann. Rept. 1884-85, p. 549, pl. 31, figs. 1, 2. 1885. Types of the Laramie flora. *Idem*, Bull. No. 37, p. 13, pl. 1, figs. 1, 2. 1887.

## Class LYCOPODINAE

## Order ISOÉTALES

## Family ISOÉTACEAE

## Genus ISOÉTES Linnaeus

**ISOÉTES (?) incerta** n. sp.

Plate 52, Figures 1, 2

Organism apparently consisting of a bundle of linear leaves, united or closely compacted at their bases; leaves about 1 to 1.5 millimeter in width by 6 or more centimeters in length.

The two figures that serve to illustrate this organism represent counterparts of one and the same specimen; but the impression of only the upper portion of the specimen is represented by Figure 2. In the specimen represented by Figure 1 the base consists of a relatively thick, more or less disintegrated mass of carbonaceous material, impossible to differentiate, visually, into any definite form or structure. It was examined and studied from the viewpoint of its possibility as a sheath, as in *Pinus*, and as an aggregation of ligulae, as in *Isoëtes*, but without arriving at any satisfactory conclusions. Another possibility appeared to be indicated by its general surficial resemblance to a partly disintegrated monocotyledonous leaf that had split and separated longitudinally along the lines of the nervation, thus presenting an appearance simulating several narrow, linear leaves. However problematic its taxonomic position might be, the specimen, nevertheless, could not be ignored or disregarded in any illustrated, descriptive list of the flora in which it was an element; but its reference to the genus *Isoëtes* is to be regarded as tentative.

For purposes of generic comparison I have introduced (Figure 3, Plate 52) a drawing of a herbarium specimen of the existing *Isoëtes riparia* Englemann, the resemblance of which, to the figures of our specimen, is as remarkable as it is interesting.

Only one fossil species, *Isoëtes brevifolia* Lesquereux,\* from the mid-Tertiary of Florissant, Colorado, has been heretofore recorded from anywhere in the New World, as far as I am aware; but unfortunately it was not figured. The author, however, mentioned its resemblance to *Isoëtes Braunii* (Unger) Heer†; and comparison between our figures and certain of those by Heer, especially his figure 6 (*op. cit.*), reproduced in our Figure 4, Plate 52, may be seen to be quite striking.

*Locality*: Station B.

*Type specimen*: Figure 1.

## Phylum SPERMATOPHYTA

## Class GYMNOSPERMAE

## Order CYCADALES

## Family CYCADACEAE

\* Lesquereux, Leo. U. S. Geol. Survey Terr., Rept. vol. 8 (The Cretaceous and Tertiary floras), p. 136. 1883.

† Heer, Oswald. Flora Tertiaria Helvetiae, vol. 1, p. 44, pl. 14, figs. 1-7. 1855.

Genus *ZAMIA* Linnaeus*Zamia collazoënsis* n. sp.

Plate 53, Figures 1, 3, 5, (7?)

Leaflets broadly spatulate-obovate, truncate and more or less constricted at the base, 3.5 to 4 centimeters in length by 2 to 3.5 centimeters in maximum width; margins entire laterally, obscurely finely notched-dentate apically; nervation sub-parallel, somewhat flabellate, closely approximated or confluent at the base, more widely spaced above, uniform and apparently simple throughout, about fifteen per centimeter, measured across the widest parts of the leaflets.

These specimens apparently represent proximal leaflets of a cycad that may be compared with certain existing species of *Zamia* native in the West Indies and adjacent regions, such as *Z. integrifolia* Jacquin (= *Z. latifoliolata* Preneloup), represented by Figure 2, Plate 53, and *Z. salicina* Britton, represented by Figures 4 and 6, Plate 53, introduced for comparison.

Figure 1 may be regarded as representing a normal, average sized specimen, comparable with the leaflet of *Z. integrifolia* depicted in the adjacent Figure 2; Figure 3 with the leaflet of *Z. salicina* shown in Figure 4; Figure 5 with a distorted leaflet of the latter species shown in Figure 6; and Figure 7 with the leaflet of an unnamed species from Cuba, represented by Figure 8. I am somewhat in doubt as to whether or not the specimen represented by Figure 7 should be included in the same species with the others, as it is obviously more flabelliform in shape, and has a system of nervation that is spaced somewhat more widely than is apparent in the other specimens; but the shape of the leaflet differs but little more from the average normal type than do many of the leaflets that might be selected from among those of the existing species utilized for comparison.

It may be noted that in all of our specimens the bases are broader, and not so conspicuously constricted as they appear to be in connection with the leaflets of species of *Zamia* in general, thus simulating, in this particular, a feature that is more characteristic of certain other genera—*Microcyas*, *Dioon*, etc. Whether or not this feature has any generic or morphologic significance, however, is not apparent.

Only two New World species of Tertiary cycads have heretofore been described and figured, viz. *Zamia tertiaria* Engelhardt\* from Chile, and *Zamia* (?) *Wilcoxensis* Berry†, from Louisiana. The figure of the former is reproduced, for comparison, in our Figure 12, Plate 53, and the figure of the latter in our Figure 13, Plate 53.

Engelhardt's discussion of his species indicates that he regarded it as allied to the same foliar type of cycad as that with which ours appears to be most closely comparable. Thus he remarked that "es ist nur ein Fiederblättchen vorhanden, das jedoch so sehr mit denen von *Zamia integrifolia* Ait. [= *Z. floridana* De Candolle ?], übereinstimmt, das ich nicht zögere, diese Pflanze als nächste Verwandte anzusehen, wenigstens so lange, bis uns vollständig erhaltenes Material eines Besseren belehrt." His figure is more or less conventionalized, with parallel nervation; but it appears as if meant to represent a leaflet very similar to our specimens.

\*Engelhardt, Hermann. Ueber Tertiärpflanzen von Chile. Senckenb. Naturf. Gesellsch., Abh. vol. 16, No. 4, p. 646, pl. 2, fig. 16. 1891.

†Berry, E.W. The lower Eocene floras of southeastern North America. U.S. Geol. Survey, Prof. Paper 91, p. 169, pl. 114, fig. 2. 1916.

The specimen described and figured by Berry (*loc. cit.*) obviously represents a cycad leaflet, but it is too fragmentary for any but tentative generic identification. It appears to represent the basal portion of a longer and narrower leaflet than any that I have included under *Zamia collazoënsis*, and it may, perhaps, be more nearly comparable with leaflets of the species next described.

In the existing flora the genus *Zamia* includes about thirty recognized species, all of them natives of tropical and sub-tropical regions in the New World, extending northward into Florida.

*Locality*: Station B.

*Type specimen*: Figure 1.

### ***Zamia Noblei* n. sp.**

Plate 53, Figures 9, 10; Plate 54, Figures 1, 3a; Plate 55, Figures 1-3, 4a, 5a.

Leaflets linear-obovate or clavate in shape, 5 to 9 centimeters in length by 1.25 to 2.25 centimeters in maximum width; margin entire throughout and, for the most part, apparently, involute; nervation sub-parallel; nerves closely approximated or confluent at the base, more distinctly separated and spaced above, uniform and, apparently, simple throughout, approximately fifteen per centimeter, measured across the widest parts of the leaflets.

The relationship of the specimens above described to the Cycadaceae appears to be obvious, and some of them bear such a close resemblance to leaflets of certain existing species of *Zamia* that this generic relationship appears to be reasonably certain.

For purposes of comparison I have introduced a drawing of a leaflet of the existing *Zamia pumila* Linnaeus (Figure 11, Plate 53), which may be compared with our Figure 9 on Plate 53; and one each of *Z. integrifolia* Jacquin (= *Z. latifoliolata* Preneloup) (Figure 2, Plate 54), and *Z. umbrosa* Small (Figure 5, Plate 54), which may be compared, respectively, with our Figures 1 and 3a on Plate 54. I am in some doubt as to whether or not the specimen represented by Figure 1 on Plate 54 should be included in the same species with the others, as it appears to possess a somewhat coarser nervation; but otherwise their respective features appear to be identical.

Other fragmentary remains, represented by Figure 10 on Plate 53, and by Figures 1, 2, 3, 4a, and 5a, on Plate 55, may or may not all belong to one and the same species; but they are not sufficiently complete for satisfactory differentiation.

As previously remarked only two species of cycads of Tertiary age have been heretofore recorded from the New World; and of these *Zamia* (?) *Wilcoxensis* Berry,\* appears to be the only one that might, possibly, be inferred to be identical with *Z. Noblei*. Berry's figure (*loc. cit.*) is reproduced in Figure 13, Plate 53, and it may be seen that it might, perhaps, be regarded as representing the proximal part of a leaflet, comparable in its general characters with a similar foliaceous fragment of *Z. Noblei*.

It may also be noted that, as mentioned in connection with *Zamia collazoënsis*, in all of our specimens the bases are broader and are not as constricted as they are in existing species of *Zamia*; but this feature may be more apparent than real, and attention is called to the fact merely in order that it may not be overlooked in connection with the study of any further material that may be brought to light in the future.

\*Berry, E. W. U. S. Geol. Survey, Prof. Paper 91, p. 169, pl. 114, fig. 2. 1916.

Incidentally, also, it may be of interest to compare certain figures of our specimens, such as Figure 4a, Plate 55, with a similar one of a specimen from the Tertiary of Chile, figured by Engelhardt,\* designated "Monokotylar Blattrest" (*loc. cit.*, p. 687), and described as follows (*loc. cit.*, p. 686): "Taf. I, Fig. 4 bilde ich einen Pflanzenrest ab, der auf eine monokotyle Pflanze hinweist; doch dürfte es kaum möglich sein, ihn in eine bestimmte Familie einzureihen, weshalb ich ohne Namen lasse. Vielleicht dass spätere Funde Klarheit über ihn zu bringen vermögen." And in this connection it is interesting to note that Berry† described and figured specimens of cycad-like leaflets from the Tertiary of Chile, which he identified as *Zamia tertiaria* Engelhardt,‡ and under that name included also Engelhardt's "Monokotylar Blattrest" above mentioned. In no instance, however, is a leaflet depicted intact; and in those figures in which the missing extremities are restored these are indicated as tapering and acute, which characters alone would serve to differentiate them from our specimens from Porto Rico. In order to illustrate the preceding citations and remarks one of Berry's figures is reproduced in our Figure 1, Plate 88. It represents the initial figure (not numbered) on his plate 2.

Lesquereux¶ and Ward§ also described and figured somewhat similar remains, from the Eocene of Montana, and referred them to *Phragmites alaskana* Heer. Certain of these figures compare quite closely with certain of ours; but the descriptions, and enlarged details of the nervation, show the nerves to consist of a major and a minor series, whereas in ours all the nerves appear to be of equal rank.

The specific name is in honor of Mr. W.D. Noble, to whom we are indebted for valuable assistance in connection with the work of collecting the specimens.

*Locality:* Station B (Figures 9, 10, Plate 53; Figures 1, 3a, Plate 54; Figures 3, 4a, 5a, Plate 55). Station A (Figures 1, 2, Plate 55).

*Type specimen* = Figure 3a, Plate 54.

Class ANGIOSPERMAE

Sub-Class MONOCOTYLEDONAE

Order ARECALES

Family ARECACEAE [PALMACEAE]

Genus BACTRIS Jacquin

**Bactris Pseudocuesco** n. sp.

Plate 56, Figures 18, 19

Fruits spheroidal or slightly oblate-spheroidal in shape, about 1.75 centimeter in diameter; nut apparently marked with obscurely defined, longitudinal striae; exocarp relatively thick, apparently originally coriaceous or chitinous in texture.

\*Engelhardt, Hermann. Ueber Tertiärpflanzen von Chile. Senckenb. Naturf. Gesellsch., Abh. vol. 16, No. 4, pl. 1, fig. 4. 1891.

†Berry, E. W. Contributions to the paleobotany of Peru, Bolivia and Chile. Johns Hopkins Univ. Studies in Geol. No. 4<sup>3</sup> (The flora of the Concepcion-Arauco coal measures of Chile. George Huntington Williams Memorial Publication No. 17.), p. 120, pl. 1, fig. 4; pl. 2, figs. 1-3 [not numbered on plate]. 1922.

‡Engelhardt, Hermann. Ueber Tertiärpflanzen von Chile. Senckenb. Naturf. Gesellsch., Abh. vol. 16, No. 4, p. 646, pl. 2, fig. 16. 1891.

¶Lesquereux, Leo. U. S. Geol. Survey, Terr., Rept. vol. 7 (The Tertiary flora), p. 90, pl. 8, figs. 10-12. 1878.

§Ward, L. F. Synopsis of the flora of the Laramie group. U. S. Geol. Survey, Sixth Ann. Rept. 1884-85, p. 550, pl. 32, figs. 1-3. 1885. Types of the Laramie flora. *Idem*, Bull. No. 37, p. 17, pl. 3, figs. 1-3. 1887.

These two specimens—one (Figure 18) with a portion of the exocarp attached, and the other (Figure 19) with the exocarp entirely gone—resemble so closely the fruit of certain species of the existing genus *Bactris* that generic relationship appears to be definitely indicated; and specifically they can hardly be distinguished from the fruit of *Bactris Cuesco* Crueger, as may be seen by comparing Figures 18 and 19, respectively, with Figures 20 and 21 on the same plate, the latter representing specimens of *B. Cuesco* from the island of Trinidad. They may also be compared with *Palmocarpon* (?) *globosum* Lesquereux,\* from the Tertiary (Oligocene) of Colorado (See our Figure 22, Plate 56, reproduced from Lesquereux' figure), and with certain of the specimens from the Tertiary (Eocene) of Wyoming, referred by the same author† to "*Carpites lineatus*?, Newby." (= *Carpolithes lineatus* Newberry)‡ (from the Eocene of Dakota—a reference, however, which does not appear to be justified by comparison between the figures).

It may also be of interest to refer, in connection with the several species above mentioned, to one from the Tertiary of the island of Trinidad, originally described and figured by me¶ under the name *Palmocarpon bactrioides*, and subsequently found in the same locality by Berry.§ Reference is here made to this species merely in order to facilitate comparison by those who may be interested in the subject, especially in view of the remark by the latter author (*loc. cit.*) that "it might well be suggested that the fossil should be referred directly to this genus [*Bactris*]."

*Locality*: Station B (Figure 18); Collazo River. Collected by Don Narciso Rabell (Figure 19).

*Type specimen* = Figure 18.

#### Genus IRIARTEA Ruiz & Pavon

#### *Iriartea collazoënsis* n. sp.

Plate 56, Figure 1.

Nut rounded, unsymmetrically oblong-spatulate or balloon shaped, about 4 centimeters in length by 1.5 centimeter in maximum width; surface of the endocarp marked by relatively coarse, longitudinally extended reticulations.

This specimen possesses characters that closely simulate those of certain species in the existing genera *Arenga* and *Iriartea*, as may be seen by comparing the figure of our fossil with Figure 2, on Plate 56, representing a nut of *Arenga saccharifera* Labillardiere, and with Figure 3 on the same plate, representing a nut of *Iriartea setigera* Martius. Such comparison shows so close a resemblance, in the shape and external markings of the nuts, between the fossil and these two existing species that generic relationship between it and one or the other of them would appear to be satisfactorily indicated. The species first mentioned is more

\*Lesquereux, Leo. U. S. Geol. Survey Terr., Rept. vol. 8 (The Cretaceous and Tertiary floras), p. 144, pl. 24, fig. 3. 1883.

†Lesquereux, Leo. U. S. Geol. Survey Terr., Rept. vol. 7 (The Tertiary flora), p. 302, pl. 60, figs. 1 (in part), 1b, 1c, 1d. 1878.

‡Newberry, J. S. U. S. Geol. Survey, Mon. vol. 35 (The later extinct floras of North America), p. 138, pl. 40, fig. 1. 1898.

¶Hollick, Arthur. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 286, pl. 1, fig. 4. Sept. 13, 1924.

§Berry, E. W. Johns Hopkins Univ. Studies in Geology, No. 6<sup>2</sup>. (The Tertiary flora of the island of Trinidad, B. W. I. George Huntington Williams Memorial Publication No. 22), p. 79, pl. 1, fig. 1. 1925.

nearly comparable with it in size, but this species, as well as the genus to which it belongs, is exclusively of Old World distribution, whereas *Iriartea* is a New World genus. The factor of geographic distribution would seem to demand more serious consideration and inference than that of mere difference in size, and therefore I have thought it more logical to regard our fossil as belonging to *Iriartea* rather than to *Arenga*. If any trace of a germ pore were discernible its location might serve to identify the generic relationship of the fossil more definitely.

A fossil palm fruit, from the Tertiary of the Canal Zone, was described and figured by Berry\* under the name *Iriartites Vaughanii*. The reference of the fruit to the fossil genus *Iriartites* was stated by the author to be on account of its resemblance to the fruit of certain existing genera in the tribe Iriarteae; but, unfortunately, no specific examples were cited, although the genera *Iriartea* and *Astrocaryum* were mentioned. Incidentally, also, it may be pertinent to remark that the original generic description of the genus *Iriartites* was based by the author† exclusively upon fragmentary remains of palm leaves, described and figured under the name *Iriartites tumbezensis*. In any event, however, no generic relationship is apparent between our specimen and *Iriartites Vaughanii* Berry, as may be seen by comparison between Figure 1, Plate 56, representing our specimen, and Figure 23 on the same plate, representing a reproduction of Berry's figure 2 (*loc. cit.*), which is described as one half the natural size.

*Locality:* Collazo River. Collected by Don Narciso Rabell.

#### Genus MANICARIA Gaertner

#### **Manicaria portoricensis** n. sp.

Plate 56, Figures 24a, 24b.

Fruits globose and 2.5 centimeters in diameter, or oblong-globose and 3 centimeters in length by 2 centimeters in width; nut marked with fine, thread-like striae on the surface of the endocarp; exocarp apparently thick and rugose.

These two specimens may have been, originally, more nearly alike in shape than their actual appearance might seem to indicate. The one represented by Figure 24b, for example, may be seen to be fractured and, apparently, is more or less distorted, and may have been, in its entirety, more globose-oblong than oblong-globose in shape. The surficial striae on the endocarps may be assumed to have a proximad-distad direction; but such assumption, in the absence of any visible indication of a pore or hilum, does not assist in locating either extremity.

Comparison of our specimens with the fruit of the existing genus *Manicaria* shows such a close resemblance between them that generic identity appears to be satisfactorily indicated. Figure 25, Plate 56, represents a fruit of the West Indian species *Manicaria sacchifera* Gaertner, with the exocarp partly removed, exposing the smooth, finely striated surface of one side of the nut, with the rough broken edge of the exocarp surrounding it—the figure as a whole, except for its larger size, showing a striking resemblance to the figures of the fossils.

*Locality:* Station A.

*Type specimen* = Figure 24a.

\*Berry, E. W. A palm nut from the Miocene of the Canal Zone. U. S. Nat. Mus., Proc. vol. 59 (No. 2356), pp. 21–22, figs. 1–3. 1921.

†Berry, E. W. Miocene fossil plants from Northern Peru. U. S. Nat. Mus., Proc. vol. 55 (No. 2270), p. 285, pl. 14. 1919.

## Genus PALMOCARPON Lesquereux

## PALMOCARPON ACROCOMIOIDES Hollick

## Plate 56, Figure 4.

*Palmocarpon acrocomioides* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 287, pl. 13, fig. 4. Sept. 13, 1924.

This specimen appears, superficially, to be generically identical with the one described and figured by me (*loc. cit.*) under the above name, from the Tertiary of Santo Domingo, island of Hispaniola; and no characters are discernible that might serve to differentiate them specifically, one from the other. They resemble compressed, globose fruits of certain species of the existing genus *Acrocomia*, with the exocarp more or less fractured, as may be seen by comparison with Figure 5, Plate 56, which represents a fractured specimen of *Acrocomia crispata* (Humboldt, Bonpland, and Kunth) C. F. Baker.

Somewhat similar fossils, but more elongated in shape, from the Tertiary of Switzerland, were described and figured by Heer\* under the name *Palmacites* [*Antholithes*] *Martii* (see our Figure 7, Plate 56, representing Heer's figure 3, *loc. cit.*); but beyond the superficial mutual resemblance to palm fruits with thin, brittle exocarps, the apparently near relationship between the specimens from Switzerland and those from the West Indies need not be further discussed.

It may also be pertinent here to refer, incidentally, to certain fruits from the Tertiary of Chile, described and figured by Engelhardt† under the name *Carpolithes cycasiformis*, which he regarded as suggestive of the genus *Cycas*. The largest one, described as "rundlich, etwas zuzammengedrusst," may be seen to bear more or less of a resemblance to our figures of *Palmocarpon acrocomioides*, and to simulate, perhaps a little more closely, Heer's *Palmacites Martii* previously cited.

*Locality*: Station A.

**Palmocarpon cetera** n. sp.

## Plate 56, Figure 10.

Fruit rounded, oblong-ovate in shape, somewhat compressed or flattened, 2.5 centimeters in length by 1.75 centimeter in maximum width, at about the middle; endocarp obscurely and finely roughened or wrinkled latitudinally and marked longitudinally with faintly defined striae.

It is possible that this specimen might be regarded as specifically identical with *Palmocarpon exemplare*, the species next described (see Figures 8, 9, Plate 56). It may be seen that they present a similar mutual resemblance; but minor characters serve to differentiate the specimen under discussion from the two upon which the species mentioned is based.

Relationship is superficially indicated with either one or the other of the existing genera *Astrocaryum* or *Cocos*, but the absence of any trace of a germ pore in our specimen renders accurate or satisfactory comparison impossible. In connection with the former genus the pores are distad, as shown in Figure 16, Plate 56, which represents a decorticated fruit of the Brazilian species *Astrocaryum Javarii* Martius, while in *Cocos* they are proximad, as shown in Figure 17, Plate

\*Heer, Oswald. Flora Tertiaria Helvetiae, vol. 1, p. 97, pl. 41, figs. 1-4. 1855.

†Engelhardt, Hermann. Ueber Tertiärpflanzen von Chile. Senckenb. Naturf. Gesellsch., Abh. vol. 16, p. 685, pl. 13, fig. 1. 1891.

56, which represents a specimen of *Cocos eriospatha* Martius, with its exocarp partly removed.

In the same general category with the fossil and existing species above discussed we may be justified in including a specimen from the lower Tertiary of New Mexico, described and figured by Lesquereux\* under the name *Palmocarpum mexicanum*, reproduced in our Figure 14, Plate 56, which he apparently represented with the distal extremity downward, as may be seen by comparison with Figure 15, Plate 56, representing a fruit of *Cocos Datil* Grisebach & Drude with the distal extremity upward. From the foregoing discussion it may be appreciated that surface markings which might be indicative of pores in any specimens of fossil palm nuts might well be of considerable importance as generic indices.

*Locality*: Station A.

### **Palmocarpum exemplare** n. sp.

Plate 56, Figures 8, 9.

Fruits rounded, ovoid in shape, about 2.5 centimeters in length by 2 centimeters in maximum width; exocarp apparently relatively thin and smooth; nut apparently smooth.

These fruits, as in the case of the species last described, might be more or less satisfactorily compared with those of certain existing genera, such for example, as *Astrocaryum* and *Cocos*. It is not possible, however, to determine which is the distal and which is the proximal extremity in either one of our specimens, nor is there any indication discernible of the location of any germ pores; and whether the consistency of the exocarp was originally either coriaceous, or chitinous, or fibrous is not apparent. In view of these conditions I have deemed it best to include our specimens, for the time being, in the comprehensive genus *Palmocarpum*, pending the possible future discovery of specimens with better preserved and more clearly defined characters which might serve to identify them, generically, in a more satisfactory manner.

For purposes of comparison I have introduced (Figure 6, Plate 56) a drawing representing a fruit of the Brazilian species *Cocos Inarjai* Trail, with exocarp intact and the proximal extremity downward, which, except for its somewhat larger size, may be seen to bear a suggestive similarity to our specimens. Also, further reference may not be here out of place to Figure 7, Plate 56, representing the fossil species *Palmacites* [*Antholithes*] *Martii* Heer,† from the Tertiary of Switzerland, introduced primarily for purposes of comparison with *Palmocarpum acrocomioides* Hollick, described on page 189.

*Locality*: Station B (Figure 8); Station A (Figure 9).

*Type specimen* = Figure 9.

### **Palmocarpum opinabile** n. sp.

Plate 56, Figure 24c

Impression of a broadly spatulate or balloon shaped fruit, about 3 centimeters in length by 2.5 centimeters in maximum width, apparently with a fibrous or shreddy exocarp.

\*Lesquereux, Leo. U. S. Geol. Survey Terr., Rept. vol. 7 (The Tertiary flora), p. 119, pl. 11, fig. 5. 1878.

†Heer, Oswald. Flora Tertiaria Helvetiae, vol. 1, p. 97, pl. 41, fig. 3. 1855.

It is with a feeling of more or less uncertainty that I have included this specimen under the generic name that implies relationship with the palms; but that it was originally represented by some thick, rounded organism, such as a nut-like fruit, appears to be certain, as indicated by the pronounced concavity of the impression; and in this connection the fact that it occurs in the same piece of matrix, and in close proximity to the fruits previously described on page 188 under the name *Manicaria portoricensis*, may possess a certain significance.

It is also suggestive of a specimen from the Eocene Tertiary of Mississippi, figured by Berry\* and referred to *Nipadites umbonatus* Bowerbank—an Old World Tertiary species, supposed to be allied to the existing Old World genus *Nipa*. Reference to this species, however, should be here regarded merely as suggesting surficial resemblance, and in order to facilitate comparison for those who might be interested in the further study of similar fossil remains.

*Locality:* Station A.

### **Palmocarpon Rabellii** n. sp.

Plate 56, Figure 11

Nut unsymmetrically ovate in shape, 1.8 centimeter in length by 1.4 centimeter in maximum width, marked by widely spaced, longitudinal striae.

I have been unable to arrive at any satisfactory conclusion in regard to the probable generic relationship of this specimen. Resemblance to the genus *Elacis* may be noted, but this genus, in our existing flora, is of Old World distribution. In order, however, that the interesting resemblance may be visualized I have introduced (Figure 12, Plate 56) a figure of a nut of *Elacis guineënsis* Jacquin. In this genus the pores are distad, and in the figure the distal extremity of the nut is represented as downward. A New World genus with which comparison may be made is *Copernicia*, and for this purpose I have introduced (Figure 13, Plate 56) a figure that represents a nut of *Copernicia cerifera* Martius, with the distal extremity upward. In this genus the nuts are without pores. Any indication of pores are not apparent in our specimen, nor is there any trace of a hilum, hence it is impossible to determine or even to infer, satisfactorily, which is the distal and which is its proximal extremity. In the circumstances it would not seem to be justifiable, therefore, to suggest, through the medium of a name, an assumed relationship of our specimen with any existing genus or species. The generic appellation *Palmocarpon* is indicative of its general taxonomic and morphologic status, and the collector may properly be recognized in connection with the specific name.

*Locality:* Collazo River. Collected by Don Narciso Rabell.

### Genus PALMACTES Brongniart

#### **Palmacites alius**, n. sp.

Plate 57, Figure 1.

Fragment of a finely striated woody part of a monocotyledonous plant, surficially resembling a flattened piece of a petiole of a palm leaf.

This fragmentary specimen may not appear to be worthy of description and illustration; but similar remains of Monocotyledonae are so few, in the col-

\*Berry, E. W. U. S. Geol. Survey, Prof. Paper 91 (The lower Eocene floras of south-eastern North America), p. 176, pl. 112, fig. 13. 1916.

lections of fossil plants from Porto Rico, that every fragment is of interest, and may be of value in eventually piecing out and building up more or less complete specimens of the plants of which they are parts.

A somewhat similar fragment, from the same region, was described and figured by me\* under the name "*Palmophyllum* sp. (fragment of petiole)?" but it would be hazardous to infer specific or generic identity between them.

*Locality:* Collazo River. Collected by Don Narciso Rabell.

### ***Palmacites conformis* n. sp.**

Plate 57, Figure 2

Fragment of a relatively coarsely striated culm or leaf of a monocotyledonous plant; dimensions not known.

This specimen may represent merely a smaller part of a plant of the same species as the one next described (*P. sparsistriatus*), in as much as they are both from the same station, and the only apparent difference between them, as may be seen by comparison of the two figures, is that of size.

Possibly future discoveries may bring to light additional material that will enable us to determine, more satisfactorily, the taxonomic position and the morphologic characters of the remains.

*Locality:* Station A.

### ***Palmacites sparsistriatus* n. sp.**

Plate 58

Fragment of a trunk, stem, or other part of a monocotyledonous plant, apparently palmaceous, coarsely striated longitudinally, the interspaces varying in width from 2 to 3 millimeters.

Beyond the fact that this fragment evidently represents remains of the woody part of a monocotyledonous plant its taxonomic status is problematic, and the generic name under which it is placed may be regarded merely as indicative of its assumed family relationship, and as indicating close similarity in appearance to certain other fossil plant remains that have been described and figured under the generic name *Palmacites*, such as *P. canaliculatus* Heer,† from the Miocene of Switzerland, in connection with which the author discusses the general resemblance of the striated surface to that of the Paleozoic genera *Sigillaria* and *Calamites*, but also remarks upon the impossibility of generic or family relationship with either, by reason of the absence, in the Tertiary species, of both leaf scars and nodes.

*Locality:* Station A.

### Genus PALMOPHYLLUM Conwentz

PALMOPHYLLUM sp. Hollick<sup>1</sup>

*Palmophyllum* sp. Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 285, pl. 9, fig. 1. Sept. 13, 1924.

\*Hollick, Arthur. A review of the fossil flora of the West Indies, with the descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 286, pl. 9, fig. 2. Sept. 13, 1924.

†Heer, Oswald. Flora Tertiaria Helvetiae, vol. 1, p. 95, pl. 40, figs. 2a-2d, 3a, 3b. 1855.

*Locality:* Collazo River, near base of second falls below Carretera bridge. Collected by Bela Hubbard.

PALMOPHYLLUM sp. (fragment of petiole)? Hollick

*Palmophyllum* sp. (fragment of petiole)? Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 386, pl. 9, fig. 2. Sept. 13, 1924.

*Locality:* Collazo River, near base of second falls below Carretera bridge. Collected by Bela Hubbard.

## Order SCITAMINALES

### Family MUSACEAE

#### Genus MUSOPHYLLUM Goeppert

#### MUSOPHYLLUM SP.

#### Plate 61, Figure 1.

Leaf of unknown shape and dimensions, with a thick midrib and fine, parallel secondary nerves, about 5 millimeters distant from each other, that subtend angles of about 65° with the midrib.

This leaf fragment almost certainly represents the genus *Musophyllum*, although only a few of the secondary nerves are discernible. The probability is that the leaf, in its entirety, possessed a major and a minor series of secondary nerves and that no traces of the latter were preserved. The specimen apparently represents the median or lower part of a leaf, where the nerves subtend more obtuse angles with the midrib than do those toward the apex. It is comparable with *Musophyllum trinitense* Hollick,\* from the Tertiary of the island Trinidad; *M. elegans* Engelhardt,† from the Tertiary of Colombia; and a specimen of the latter species from the Tertiary of Venezuela, described and figured by Berry‡ under the name *Heliconia elegans* (Engelhardt) Berry, in connection with which he remarked: "Aside from the actual resemblance between these fossil American forms and the existing *Heliconias*, it seems to me that general considerations point to the conclusion that the genus *Musa* was never present in the Western Hemisphere [in Tertiary time], despite the fact that it flourishes so greatly under cultivation in the American Tropics at the present time." Engelhardt (*loc. cit.*, pp. 25-26) also expressed doubt in regard to the actual relationship of his species with the genus *Musa* in the following words: "Die Stücke entstammen jedenfalls einer Art der Gattung *Heliconia* L., welche Südamerika eigenthümlich ist, wenigstens liefs sich aus der Nervatur trotz vieler Vergleichen nicht nachweisen, ob sie zu dieser oder zu *Musa* L. zu rechnen sei, weshalb ich mich der provisorischen Bezeichnung [*Musophyllum*] bediente."

In my discussion of the probable generic relationship of *Musophyllum trinitense* (*loc. cit.*, p. 288) I commented as follows: "This specimen . . . has so close a superficial resemblance to leaves of the existing genus *Musa* that I would have

\*Hollick, Arthur. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 288, pl. 1, fig. 2. Sept. 13, 1924.

†Engelhardt, Hermann. Ueber neue Tertiärpflanzen Süd-Amerikas. Senckenb. Naturf. Gesellsch., Abh. vol. 19, p. 25, pl. 4, figs. 1-3; pl. 5, fig. 1. 1895.

‡Berry, E. W. Tertiary fossil plants from Venezuela. U. S. Nat. Mus., Proc. vol. 59 (No. 2385), p. 560, text fig. 1 (p. 561). 1921.

but little hesitation in so referring it were it not for the doubt that is generally entertained, and the uncertainty that obtains, in regard to the New World nativity of the genus."

It may be recalled, however, that Alexander von Humboldt argued for the probable American nativity of *Musa*; and, more recently, Cook\* discussed the matter in a favorable vein. Definite proof was lacking, however, until the discovery of undoubted banana seeds in Tertiary (Oligocene?) coal beds in Colombia, which were described by Berry† and commented upon as follows: "The present discovery shows that *Musa* was an undoubted member of American Tertiary floras; and although it does not prove that the native banana was brought into cultivation by the aborigines in the Western Hemisphere, it lends probability to such a belief, and in a measure serves to substantiate the statement of the Peruvian author Garcellasso de la Vega (1530-1568) that the banana was one of the staples of the aborigines before the discovery of America; and that of Montesinos (1527), as quoted by the historian Prescott, that the natives of Tumbez brought bananas as an offering to Pizarro when he disembarked."

Finally, Bassler‡ described a seed-bearing species of *Musa*, found growing in eastern Peru, which may represent a heretofore unrecorded species, native to the region.

In any event we no longer need hesitate to consider the possibility, if not the probability, of the generic relationship between *Musa* and *Musophyllum*, and the probable presence of the former as an element in the Tertiary flora of America.

*Locality:* Station A.

Sub-Class DICOTYLEDONAE

(CHORIPETALAE)

Order URTICALES

Family MORACEAE

Genus *FICUS* [Tournefort] Linnaeus

***Ficus hyphodroma* n. sp.**

Plate 57, Figure 3.

Leaf apparently elliptical-lanceolate in shape and coriaceous in texture, about 14 centimeters in length, including the short, thick petiole, by 5.5 centimeters in maximum width, at about the middle, tapering below to a narrow, cuculate base, and apparently tapering or curved to the apex; margin entire, undulate, or incurved in places, probably inflexed; midrib strong, terminating below in a short, thick petiole about .5 centimeter in length; nervation, other than the midrib, not discernible.

This specimen evidently represents a leaf that was of thick, coriaceous texture, in which all traces of the secondary and finer nervation is lost to view. In shape and marginal characters it is strikingly suggestive of a leaf from the

\*Cook, O. F. The American origin of agriculture. Pop. Sci. Monthly, vol. 61, pp. 492-505. Oct. 1902. Food plants of ancient America. Smithsonian Inst., Rept. 1903 (No. 1515), pp. 481-497. 1904.

†Berry, E. W. A species of *Musa* in the Tertiary of South America. Nat. Acad. Sci. U. S. A., Proc. vol. 11, No. 6, pp. 298-299, June 1925.

‡Bassler, Harvey. *Musa* in tropical America. New York Bot. Gard., Journ. vol. 27, No. 315, pp. 49-54, pls. 301, 302. March 1926

Tertiary (Eocene) of Arkansas described and figured by Berry\* under the name *Ficus eolignitica*; but the absence of any trace of nervation in our specimen prohibits satisfactory identification.

*Locality*: Station B.

FICUS SCHIMPERI Lesquereux

Plate 57, Figure 4.

*Ficus Schimperi* Lesquereux. On species of fossil plants from the Tertiary of the State of Mississippi. Amer. Philos. Soc., Trans. vol. 13, art. 14, p. 417, pl. 18, figs. 1-3. 1867.

The fragmentary condition and imperfectly defined minor characters of our specimen render accurate comparison somewhat unsatisfactory; but its general shape, and the characters of the secondary nerves, as far as they are discernible, are so closely similar to those of Lesquereux' figures that mutual specific identity appears to be reasonably certain. Lesquereux' descriptions and illustrations were based upon specimens of Tertiary (Eocene) age collected in Mississippi; and subsequently Berry† described and figured other specimens from the same region and horizon, which he identified with Lesquereux' species. The specific identity of our specimen with those figured by Berry, especially in comparison with his figure 3 (*loc. cit.*), can also hardly be doubted.

*Locality*: Station B.

Ficus vexativus n. sp.

Plate 59, Figures 1-4

Leaves varying greatly in size, apparently obovate in shape, narrowed and abruptly constricted to a bluntly apiculate or somewhat decurrent base; margin entire; nervation simply pinnate, camptodrome; midrib and main secondary nerves robust; secondary nerves irregularly disposed and spaced, subtending angles of various degrees with the midrib, more or less flexuous, ultimately ascending and curving upward, following the general contour of the adjacent margin, and thinning out into a series of irregular loops that constantly decrease in size and ultimately coalesce; occasional minor intermediate secondary nerves extend from the midrib and merge into the tertiary cross nervation, where they are connected by nervilles of minor rank, forming a fine reticulated network of oblong and polygonal areolae.

These specimens are all so fragmentary that it is impossible to visualize the exact appearance of a perfect leaf, but it may be assumed that the shape was pyriform-obovate, and that the characters of the nervation indicate close relationship with the foliar type represented by the Tertiary species *Ficus comparabilis* Hollick,‡ from the island of Trinidad; and more perfect specimens of each might indicate that the several variable forms now regarded as representing two species should be included under a single specific name.

*Locality*: Station A (Figures 1, 2); Station B. (Figures 3, 4).

*Type specimen* = Figure 2.

\*Berry, E. W. The lower Eocene floras of southeastern North America. U. S. Geol. Survey, Prof. Paper 91, p. 203, pl. 31, fig. 4. 1916.

†Berry, E. W. The lower Eocene floras of southeastern North America. U. S. Geol. Survey, Prof. Paper 91, p. 204, pl. 31, figs. 1-3. 1916.

‡Hollick, Arthur. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 293, pl. 3, figs. 1a, 1b, 2; pl. 4, figs. 2a, 2b; pl. 5, figs. 2-4. 1924.

## FICUS sp.

Plate 87, Figures 1, 2.

The specimens represented by these two figures are, obviously, too fragmentary for satisfactory identification, or even comparison; but the probability appears to be that they might be tentatively referred to *Ficus vexativus*, the species last described.

*Locality:* Collazo River. Collected by Don Narciso Rabell (Figure 1); Station A (Figure 2).

## Order RANALES

## Family ANNONACEAE

## Genus ANNONA Linnaeus

***Annona cetera* n. sp.**

Plate 60, Figure 1; Plate 76, Figures 2a, 2b; Plate 85, Figure 1b; Plate 86, Figure c.

Leaves ovate-oblong in shape, about 14 centimeters in length by 5 centimeters in maximum width, broadest about 2 centimeters below the middle, tapering above, rounded below; margin entire; nervation simply pinnate, camptodrome; midrib relatively thick; secondary nerves irregularly spaced and disposed, subtending angles of  $45^{\circ}$ - $75^{\circ}$  with the midrib, ascending, curving upward and continuing close to the margin where they ultimately coalesce in a series of successively smaller and smaller loops and fine connecting cross nervilles.

These specimens appear to be comparable with the foliar type represented by the existing species *Annona squamosa* Linnaeus, which is native in the West Indies and adjacent regions. A figure of a leaf of the latter (Figure 2, Plate 60) is introduced for comparison.

A number of Tertiary species of the genus *Annona* have been described and figured, but they all, apparently, represent the foliar type with more regular and less ascending secondary nerves than in ours; although, in several instances individual figures in certain species are difficult to differentiate from certain ones of ours, as in connection with *Annona Wilcoxiana* Berry,\* from the Tertiary of Tennessee, and *Annona lignitum* Unger,† from the Tertiary of the Old World.

*Locality:* Station A (Plate 60, Figure 1); Station B (Plate 76, Figures 2a, 2b; Plate 85, Figure 1b; Plate 86, Figure c).

*Type specimen* = Figure 1, Plate 60.

***Annona pseudoglabra* n. sp.**

Plate 54, Figure 3b.

Leaf ellipsoidal in shape, slightly curved to one side, tapering to an acutely cuneate base and apex, 7 centimeters in length by 3.2 centimeters in maximum width, entire; nervation simply pinnate, camptodrome; secondary nerves subtending obtuse angles with the midrib, consisting of a major series widely and irregularly spaced, and a minor series irregularly disposed between and connected with and merging into the tertiary cross nervation.

\*Berry, E. W. U. S. Geol. Survey, Prof. Paper 91 (The lower Eocene floras of southeastern North America), p. 216, pl. 41, figs. 1, 2. 1916.

†Unger, Franz. K. Akad. Wissensch. [Wien], math.-naturwiss. Cl., Denkschr. vol. 19, (Sylloge plantarum fossilium, pt. 1), p. 25, pl. 10, figs. 1-7. 1860.

These leaves compare so closely with those of the existing species *Annona glabra* Linnaeus that their generic relationship appears to be assured and their near specific relationship to be indicated. A tracing of a leaf of the latter species, from Cuba (Figure 4, Plate 54), is introduced for comparison.

Incidentally it may be of interest to note that Berry\* included *Annona glabra* in his descriptive list of Pleistocene plant remains from Florida, based upon the identification of a single seed.

*Locality:* Station B.

Order THYMELEALES

Family LAURACEAE

Genus ACRODICLIDIUM Nees

***Acrodictidium pseudosalicifolium* n. sp.**

Plate 61, Figure 2

Leaf oblong lanceolate-ovate in shape, 9.5 centimeters in length by 3.5 centimeters in maximum width, broadest below the middle, tapering above to an apiculate apex, rounded below to a convex-cuneate base; margin entire; nervation simply pinnate, camptodrome; midrib slightly curved to one side at base and apex; secondary nerves irregularly spaced and disposed, subtending angles of 45° to 75° with the midrib, curving upward and becoming camptodrome in a series of successively finer and finer connecting loops in the marginal region.

This specimen is so closely similar, in all of its surficial features, to certain leaves of the existing West Indian species *Acrodictidium salicifolium* (Swartz) Grisebach that it is practically impossible to differentiate one from another, as may be seen by comparison between Figure 2, Plate 61, representing the fossil, and Figure 3, Plate 61, representing a leaf of *Acrodictidium salicifolium*, introduced for the purpose.

The genus is represented by about a dozen species in the existing flora of the West Indies and tropical South America, but has not heretofore, as far as I am aware, been recorded in paleobotanical literature.

*Locality:* Station B.

***Acrodictidium Pseudocanelo* n. sp.**

Plate 62

Leaf oblong-elliptical in shape, apparently about 19 centimeters in length by 6 centimeters in maximum width, at about the middle; margin entire; nervation simply pinnate, camptodrome; secondary nerves irregularly spaced and disposed, leaving the midrib at obtuse angles, bending or curving rather abruptly upward and then ascending and continuing upward in the marginal region, where they thin out, approach one another, and ultimately coalesce in a series of progressively lessening loops and finer and finer connecting nervilles.

This specimen is so closely comparable with certain leaves of the existing South American species *Acrodictidium Canelo* Rose that they appear to be absolutely identical in all discernible features. It is unfortunate that both base and apex are missing in our specimen; but the marginal curves, where they are broken, indicate tapering both proximad and distad, as in leaves of the existing species.

\*Berry, E. W. The fossil plants from Vero, Florida. Fla. State Geol. Survey, Ninth Ann. Rept., p. 26. 1917.

For purposes of comparison I have introduced a tracing of a leaf of *Aerodictidium Canelo* (Plate 63).

It may also be compared with *Ocotea pseudomartinicensis* Hollick,\* from the Tertiary of the island of Trinidad, from which it appears to differ only in its more oblong shape. Incidentally it may here be remarked that surficial differences between leaves of many species included in the lauraceous genera *Aniba*, *Aerodictidium*, *Ocotea*, *Nectandra*, *Persea*, etc., are often so slight that accurate or satisfactory generic identification, based upon foliar characters alone, is impossible.

*Locality:* Station B.

Genus ANIBA Aublet

**Aniba collazoënsis** n. sp.

Plates 64, 65

Leaves entire, broadly falcate and inequilaterally oblong-ellipsoidal in shape, about 18 to 19 centimeters in length by 6.2 centimeters in maximum width, tapering and ultimately contracted to an acute cuneate base; nervation simply pinnate, camptodrome; midrib thick and conspicuously curved below, becoming slenderer and straighter above; secondary nerves irregularly disposed and spaced, subtending angles of various degrees with the midrib, the basilar ones more acutely divergent than those above, all curving gently upward, ultimately extending in a series of irregular loops, and thinning out near the margin.

The two specimens that represent this species were selected from a number in our collection, all of them closely similar in general surficial appearance, but varying in minor details of nervation. They might be compared more or less satisfactorily with leaves of existing lauraceous species in the genera *Aniba*, *Ocotea*, *Nectandra*, *Persea*, etc. They are also comparable, except for their larger size, with *Nectandra curvatifolia* Engelhardt,† as identified by Berry‡ from the Tertiary of Trinidad, which species was compared by Engelhardt with the existing South American species *Nectandra amazonum* Nees. It may also be found of interest to compare them with *Nectandra Woodringii* Berry,§ from the Tertiary of Costa Rica, which he compared with the existing West Indian species *N. antillana* Meissner. Finally, for still further comparison, I have introduced (Plate 66) a tracing of a leaf of the existing species *Aniba riparia* (Nees) Mez, which appears to match our specimens about as satisfactorily as do any of the numerous ones, existing and fossil, with which they have been compared.

*Locality:* Station B.

*Type specimen* = Plate 65.

Genus HUFELANDIA Nees

HUFELANDIA PORTORICENSIS (Hollick) n. comb.

Plate 67, Figures 1-3, 5, 6

*Aniba portoricensis* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 300, pl. 9, figs. 4, 5. Sept. 13, 1924.

\*Hollick, Arthur. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 299, pl. 7. 1924.

†Engelhardt, Hermann. Ueber neue Tertiärpflanzen Süd-Amerikas. Senckenb. Naturf. Gesellsch., Abh. vol. 19, p. 28, pl. 9, fig. 3. 1895.

‡Berry, E. W. The Tertiary flora of the Island of Trinidad, B. W. I. Johns Hopkins Univ. Studies in Geology No. 6<sup>22</sup>, p. 116, pl. 9, fig. 6. 1925.

§Berry, E. W. Tertiary fossil plants from Costa Rica. U. S. Nat. Mus., Proc. vol. 59 (No. 2367), p. 177, pl. 26, fig. 1. 1921.

The specimens here figured are apparently specifically identical with certain fragmentary foliar remains from Porto Rico previously described and figured by me (*loc. cit.*) under the name *Aniba portoricensis*, in connection with the discussion of which species I remarked that "The remains might be more or less satisfactorily compared with any one of a dozen or more existing lauraceous species in the genera *Mespilodaphne*, *Oreodaphne*, *Ocotea*, *Ampelodaphne*, *Aniba*, etc. The reference to the genus *Aniba* is, therefore, to be regarded as representing their family rather than their definite generic relationship."

This additional material has now made possible the following more extended description and illustration of the species:

Leaves oblong-elliptical to oblong-falcate in shape, 6 to 8.5 centimeters in length by 2.5 to 3.5 centimeters in maximum width, abruptly narrowed above to a blunt acuminate apex, and below, to a narrow, more or less inequilateral base; margin entire, sinuous or wavy; nervation pinnate, camptodrome; midrib curved; secondary nerves irregularly spaced and disposed, subtending various angles with the midrib, mostly flexed, curved upward, the extremities conforming to the contours of the adjacent margin and ultimately becoming camptodrome.

A more satisfactory comparison with existing genera and species than was originally feasible was also rendered possible, and in consequence I am now inclined to regard the specimens as comparable with the genus *Hufelandia* (= *Beilschmidia*) Nees rather than with *Aniba*; and as an example of one of the numerous specific comparisons made I have introduced tracings of two leaves of the existing species *Hufelandia pendula* (Swartz) Nees (Figures 4, 7, Plate 67). Leaves of this species, even on an individual branch, may, and often do show as great a variation in shape and dimensions as may be seen in connection with the fossil specimens.

Comparison may also be made with certain fossil specimens, from the Tertiary of Ecuador, described and figured by Engelhardt\* under the name *Trigonia varians*. Whatever may be thought of the specimens represented by his figures 4-6, in plate 7, the one represented by his figure 9, on plate 9, is so strikingly similar to our Figures 1 and 2, on Plate 67, that they all might be regarded as specifically identical, as far as fragmentary specimens may be compared.

*Locality* = Station B (Figures 1-3); Station A (Figures 5, 6).

#### Genus MISANTECA Chamisso & Schlechtendahl

MISANTECA DUBIOSA (Hollick) n. comb.

Plate 68, Figures 1-6; (Plate 70, Figure 6b?)

*Laurophyllum dubiosum* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 300, pl. 12, figs. 1-3. Sept. 13, 1924.

The specimens upon which this species was originally based were recognized as belonging to the Lauraceae, but were relegated to the comprehensive fossil genus *Laurophyllum*. Recent critical examination of additional material, however, has resulted in more or less satisfactory comparison with leaves of certain existing species in the genus *Misanteca*, and particularly with those of *Misanteca*

\*Engelhardt, Hermann. Ueber neue Tertiärpflanzen Süd-Amerikas. Senckenb., Naturf. Gesellsch., Abh. vol. 19, p. 35, pl. 7, figs. 4-6; pl. 9, fig. 9. 1895.

*triandra* (Swartz) Mez, tracings of which are represented by Figures 7 and 8 on Plate 68.

*Locality:* Station A (Figure 1, Plate 68); Collazo River. Collected by Don Narciso Rabell (Figures 2, 4, 5, Plate 68); Station B (Figures 3, 6, Plate 68, and Figure 6b, Plate 70).

Genus OREODAPHNE Nees

OREODAPHNE MISSISSIPPIENSIS Berry?

Plate 67, Figures 8-10

*Oreodaphne mississippiensis* Berry. U. S. Geol. Survey, Prof. Paper 91 (the lower Eocene floras of southeastern North America), p. 303, pl. 82, figs. 3-5. 1916.

*Laurus primigenia* Unger. Hollick, Arthur. A report on a collection of fossil plants from northwestern Louisiana. Special Rept. No. 5, [in] Harris, G. D., and Veatch, A. C., Geol. Survey La., Prelim. Rept., 1899, p. 284, pl. 41, fig. 1 [excl. fig. 2]. 1900.

These three specimens are too fragmentary to serve as the basis for a specific description; but they may be satisfactorily identified as belonging in the Lauraceae, and may be tentatively referred to *Oreodaphne mississippiensis* Berry (*loc. cit.*), from the lower Tertiary of the southern United States. Berry's figure 4 (= Hollick's fig. 1, *loc. cit.*) appears to be specifically identical with our Figure 9, Plate 67; and our Figure 10 on the same plate appears to be merely a smaller specimen of the same species. Our Figure 8 may or may not be referable to it.

The difficulty of identifying, generically, leaves of the general type represented by these specimens was commented upon by Berry (*loc. cit.*, p. 304) as follows: "Numerous existing species of the American Tropics and sub-tropics in this and allied genera approach closely to this type. In fact, though there may be differences among students of fossil floras, as there are among students of the existing flora regarding the proper generic limits of the genera of the Lauraceae, no one can dispute the correctness of the family reference of these . . . species. The present species [*Oreodaphne mississippiensis*] is very similar to . . . the existing *Persea pubescens* (Pursh) Sargent . . . I have also seen unnamed specimens of *Ocotea* (*Oreodaphne*) from New Grenada identical with it."

In the circumstances, therefore, I have deemed it best to regard our fragmentary specimens as tentatively referable to the species described and figured by Berry, pending the possible future discovery of more perfect specimens that might or might not confirm the identification.

*Locality:* Station A (Figures 8, 9); Station B (Figure 10).

Order ROSALES

Family LEGUMINOSAE (MIMOSACEAE)

Genus INGA [Plumier] Scopoli

**Inga curta** n. sp.

Plate 69, Figure 1.

Leaflet oblong (or oblong-lanceolate?) in shape, apparently about 6 centimeters in length by 1.8 centimeter in maximum width; base inequilateral, broadly cuneate on one side, apparently narrowed on the other; margin entire; midrib

flexuous, bent in opposite directions at base and apex; nervation simply pinnate; secondary nerves rather widely spaced.

The imperfect condition of this specimen renders satisfactory description or comparison impossible. It apparently represents a leaflet of a compound leaf, and the outline and basilar contours are so suggestive of certain species of *Inga*, both existing and fossil, that I have ventured to refer it to that genus; and for comparison I have introduced a drawing of a leaflet of the existing species *Inga affinis* De Candolle (Figure 2, Plate 69). Comparison may also be made with *Inga mississippiensis* Berry\*, from the Tertiary of Mississippi, and with *Leguminosites clastroides* Heer,† from the Tertiary of Switzerland. If the specimens that represent these last two species and ours had been found associated together all three would probably have been regarded as specifically identical.

*Locality:* Station B.

### *Inga pseudinsignis* n. sp.

Plate 79, Figures 1b, 2b

Leaflets oblong or oblong-lanceolate, inequilateral, entire, apparently about 8 centimeters in length by 3 centimeters in maximum width; base rounded on one side, cuneate on the other; nervation pinnate; secondary nerves irregularly spaced and disposed, subtending angles of approximately 45° with the midrib, curving upward and ultimately extending close along the margin; tertiary nervilles fine, obscurely defined.

These two figures represent counterparts of one and the same specimen, and although neither of them is complete they bear such a close resemblance to leaflets of certain existing species of *Inga* that their reference to that genus appears to be justified; and for comparison I have introduced (Figure 3, Plate 88) a tracing of a leaflet of *Inga insignis* Kunth, with which our Figure 1b, Plate 79 may be seen to compare very satisfactorily.

*Locality:* Station B.

*Type specimen:* Figure 1b.

### INGA PSEUDONOBILIS Hollick

Plate 70, Figure 6a; Plate 76, Figure 1a

*Inga pseudonobilis* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 301, pl. 5, fig. 6; pl. 10, fig. 7. Sept. 13, 1924.

It is unfortunate that the original specimens on which this species was based, and also those subsequently collected, are all imperfect and in a similar manner—only the basal parts of the leaflets being preserved.

Existing species with which these fragmentary remains may be compared include *Inga Bourzoni* De Candolle, and *Inga nobilis* Willdenow; and a tracing of a leaflet of the latter species, represented by Figure 3, Plate 76, is introduced for this purpose.

*Locality:* Station B.

\*Berry, E. W. U. S. Geol. Survey, Prof. Paper 91 (The lower Eocene floras of southeastern North America), p. 222, pl. 45, fig. 1. 1916.

†Heer, Oswald. Flora Tertiaria Helvetiae, vol. 3, p. 125, pl. 139, fig. 43c. 1859.

**Inga pseudospuria** n. sp.

Plate 69, Figure 3

Leaflet oblong-lanceolate in shape, slightly unsymmetrical, one side rounded or obscurely convex, the other almost flat, 4.75 centimeters in length by 1.5 centimeter in maximum width, entire, rather abruptly narrowed to an acuminate apex and rounded to a blunt base; midrib slightly curved distad and bent in the direction of the flat side of the leaflet; nervation simply pinnate; secondary nerves irregularly spaced and disposed, those on the rounded side of the leaflet diverging from the midrib at angles more obtuse than those on the opposite side.

This specimen resembles so closely certain of the leaflets of the existing *Inga spuria* Humbolt & Bonpland that they might well be regarded as specifically identical, one with the other; and a drawing of a leaflet of this species (Figure 4, Plate 69) is introduced for comparison.

It may also be suggested that this leaflet merely appears like a small form of *Inga pseudinsignis*, as represented by our Figure 1b, Plate 79; but unless they should be found actually associated together on one and the same leaf stalk they may be regarded as specifically different.

*Locality:* Collazo River. Collected by Don Narciso Rabell.

INGA (?) sp. Hollick

*Inga* (?) sp. Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 301, pl. 12, fig. 5. Sept. 13, 1924.

*Locality:* Collazo River, near base of second falls below Carretera bridge. Collected by Bela Hubbard.

Genus PITHECELLOBIUM [= PITHECOLOBIUM] Martius

**Pithecellobium** (?) **imperfectum** n. sp.

Plate 69, Figure 5

Leaflet apparently about 3 centimeters in length by 1.1 centimeter in maximum width, inequilateral, oblong (?) in shape; base rounded-cuneate on one side, concave-cuneate on the other; margin entire; midrib fine; secondary nervation not discernible.

This imperfect leaflet is tentatively referred to the genus *Pithecellobium*, and it may be compared with the existing *P. gracilliflorum* Blake (Figure 6, Plate 69), as far as the shape of the lower part of the leaflet is concerned; but the absence of the upper part of the fossil and also of any indication of secondary nervation, render further comparison useless.

Somewhat similar leaflets, from the Eocene of the southern United States, were described and figured by Berry\*, under the name *Caesalpinia Wilcoxiana*, which he compared with *Cassia longifolia* Engelhardt,† from the Tertiary of Ecuador, and with several Old World Tertiary species described under the genera *Caesalpinites*, *Leguminosites*, etc. In view, however, of the fragmentary condition of our specimen and the lack of essential diagnostic characters, any further

\*Berry, E. W. U. S. Geol. Survey, Prof. Paper 91 (The lower Eocene Floras of southeastern North America), p. 235, pl. 50, figs. 9-12. 1916.

†Engelhardt, Hermann. Ueber neue Tertiärpflanzen Süd-Amerikas. Senckenb. Naturf. Gesellsch., Abh. vol. 19, p. 19, pl. 2, figs. 15, 16. 1895.

discussion of its probable generic relationship would not be likely to lead to conclusions of any value.

*Locality:* Station B.

PITHECELLOBIUM PSEUDOTRAPEZIFOLIUM Hollick

*Pithecolobium pseudotrapezifolium* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 302, pl. 10, fig. 8. Sept. 13, 1924.

*Locality:* Collazo River, near base of second falls below Carretera bridge. Collected by Bela Hubbard.

PITHECELLOBIUM VEXATIVUM Hollick

Plate 71, Figure 3

*Pithecolobium vexativum* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 303, pl. 11, fig. 4. Sept. 13, 1924.

This specimen appears to be specifically identical with the one upon which the species was originally based. Unfortunately each one lacks the distal portion, hence a full specific description is impossible.

In many respects these specimens resemble leaflets of certain other fossil species in the Leguminosae, such as *Cynometra Rabellii* (Figures 1a, 2, Plate 71), collected in the same locality; but that species is narrower, and may be further distinguished by its smaller size and more rounded cuneate base. Whether or not these characters may properly be considered sufficient to constitute specific difference, however, should be regarded as a matter of personal opinion. *Pithecellobium vexativum* Hollick may also be compared with *Leguminosites copaiiferaeoides* Engelhardt,\* from the Tertiary of Chile, and with the existing species *P. ligustrinum* (Jacquin) Klotzsch.

*Locality:* Collazo River. Collected by Don Narciso Rabell.

Family LEGUMINOSAE (CAESALPINIACEAE)

Genus CASSIA [Tournefort] Linnaeus

CASSIA (?) DUBIOSA Hollick

*Cassia (?) dubiosa* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 304, pl. 10, fig. 4. Sept. 13, 1924.

In the original discussion of this species (*loc. cit.*) I remarked that "the systematic position of this specimen has not been satisfactorily determined. The apex is missing and the nervation is obscurely defined and incomplete." It was compared, incidentally, with *Cassia Glennii* Berry,† from the Tertiary of the southern United States. It may also be compared with *Pithecellobium vexativum* Hollick, the species last described (Figure 3, Plate 71); but in connection with either species the specimens are too fragmentary for satisfactory comparison.

\*Engelhardt, Hermann. Ueber Tertiärpflanzen von Chile. Senckenb. Naturf. Gesellsch., Abh. vol. 16, No. 4, p. 682, pl. 9, fig. 11. 1891.

†Berry, E. W. U. S. Geol. Survey, Prof. Paper 91 (The lower Eocene floras of southeastern North America), p. 233, pl. 45, figs. 15, 16, 17a, 18; pl. 52, fig. 6. 1916.

*Locality:* Collazo River, near base of second falls below Carretera bridge. Collected by Bela Hubbard.

***Cassia evidens* n. sp.**

Plate 69, Figure 8

Leaflet unsymmetrically oblong-obovate in shape, entire, about 3.25 centimeters in length by 1 centimeter in maximum width, rounded-cuneate at the base on one side, narrowly-cuneate on the other; midrib straight; nervation simply pinnate; secondary nervation fine.

There can hardly be any doubt in regard to the generic relationship of this specimen, and for comparison I have introduced a drawing of a leaflet of the existing species *Peirania* [*Cassia*] *biflora* (Linnaeus) Britton & Rose (Figure 9, Plate 69). Leaflets of several other species of the genus might, however, have been utilized for the same purpose, and it would be hazardous to infer closer specific relationship to any particular one than to any of the others.

The genus is well represented in Tertiary deposits of both the Old World and the New, and several of the species that have been described and figured are more or less suggestive of the general type of leaflet represented by our specimen, as for example *Cassia dimidiato-linearis* Engelhardt,\* from the Tertiary of Ecuador.

*Locality:* Station B.

***Cassia imitativa* n. sp.**

Plate 70, Figures 1, 2a, 2b

Leaflets ovate-lanceolate to ovate-elliptical in shape, slightly unsymmetrical, about 5 to 6 centimeters in length by 2.25 to 2.8 centimeters in maximum width, rounded or curved below to a cuneate base, narrowed more or less abruptly above to an acuminate apex; margin entire; nervation pinnate; secondary nerves irregularly spaced and disposed, subtending obtuse angles with the midrib.

It is difficult to decide if these leaflets should be described as representing a new species, or if they should be regarded merely as foliar variants of a heterophyllus species, such as *Cassia Glennii* Berry,† from the Tertiary of the southern United States, in connection with which the author remarked (*loc. cit.*): "It may be matched by a number of the abundant existing species of *Cassia* from the American tropics. Among fossil forms it shows great similarity to certain European Tertiary species, especially to the abundant and wide spread *Cassia Berenices* Unger (Unger, Franz. Die fossile flora von Sotzka, p. 58, pl. 43, figs. 4-10, 1850), and *Cassia hyperborea* Unger (*idem*, pl. 43, figs. 1-3), both so common in the Oligocene of Southern Europe."

In the circumstances, therefore, it may be regarded as an open question whether or not specific differentiation of our specimens from one or another of the species cited may be justified. Incidentally it may also be pertinent to here remark that equal difficulty would be experienced in connection with the determination and differentiation of existing species of the genus if scattered leaflets were the only material available for study.

*Locality:* Station B.

*Type specimen:* Figure 1.

\*Engelhardt, Hermann. Ueber neue Tertiärpflanzen Süd-Amerikas. Senckenb. Naturf. Gesellsch., Abh. vol. 19, p. 18, pl. 1, fig. 25. 1895.

†Berry, E. W. U. S. Geol. Survey, Prof. Paper 91 (The lower Eocene floras of south-eastern North America), p. 233, pl. 45, figs. 15, 16, 17a, 18; pl. 52, fig. 6. 1916.

***Cassia imparilis* n. sp.**

Plate 70, Figure 5

Leaflet oblong or oblong-lanceolate in shape, entire, about 5 to 5.5 centimeters in length by 2 centimeters in maximum width, rounded below to a convex cuneate base, narrowed distad; nervation pinnate; secondary nerves widely spaced, irregularly disposed, subtending angles of about 45° with the midrib.

This leaflet may be compared more or less satisfactorily with any one of several different existing species of *Cassia*, and also with certain individual figures of *Cassia emarginata* Berry (not *C. emarginata* Linnaeus) and *C. Wilcoxiana* Berry,\* from the Tertiary of the southern United States. In our specimen, however, the apex is missing and hence any satisfactory comparison is not feasible. In connection with a genus such as *Cassia* it is as easy to discern differences as it is to recognize resemblances between leaflets of many of the species, and satisfactory conclusions in regard to specific relationships, based entirely upon leaflets are well nigh impossible.

*Locality:* Station B.

***Cassia ordinaria* n. sp.**

Plate 69, Figure 10

Leaflet ovate-lanceolate in shape, entire, about 5 centimeters in length by 2.2 centimeters in maximum width, tapering above to an acuminate apex and rounded below to a convex-cuneate base; midrib straight; nervation simply pinnate; secondary nerves fine, irregularly spaced and disposed, leaving the midrib at angles of approximately 45°.

This specimen represents a type of leaflet that is common to several different species of the genus *Cassia* in our existing flora, and also to certain fossil species that have been referred to the genus. For general generic comparison I have introduced a drawing of a leaflet of the existing *Cassia leptocarpa hirsuta* Bentham (Figure 11, Plate 69), which may serve to represent the type of leaflet mentioned; and as an example of a closely related fossil species, comparison may be made with *Cassia Glennii* Berry,† from the Tertiary of Tennessee and Mississippi, especially with his figure 15, plate 45, and figure 6, plate 52 (*op. cit.*). Our specimen might also be regarded merely as a small leaflet of *Cassia imitativa*, previously described (page 204, Figures 1, 2a, 2b, Plate 70), from the same locality and station.

*Locality:* Station B.

**CASSIA PURYEARENSIS Berry**

Plate 70, Figures 3, 4

*Cassia puryearensis* Berry. U. S. Geol. Survey, Prof. Paper 91 (The lower Eocene floras of southeastern North America), p. 230, pl. 51, figs. 13, 14. 1916.

There do not appear to be any discernible characters in our specimens that might serve to differentiate between them and those figured by Berry (*op. cit.*) from the Tertiary of Tennessee, which he compared with the existing species

\*Berry, E. W. U. S. Geol. Survey, Prof. Paper 91 (The lower Eocene floras of southeastern North America), pl. 45, fig. 17b; pl. 48, fig. 5 (= *C. emarginata*); pl. 50, fig. 2 (= *C. Wilcoxiana*). 1916.

†Berry, E. W. U. S. Geol. Survey, Prof. Paper 91 (The lower Eocene floras of southeastern North America), p. 233, pl. 45, figs. 15, 16, 17a, 18; pl. 52, fig. 6. 1916.

*Adipera* [Cassia] *laevigata* (Willdenow) Britton & Rose and *Cassia corymbosa* Lamarck.

*Locality:* Station B (Figure 3); Station A (Figure 4).

**Cassia visibilis** n. sp.

Plate 69, Figure 12

Leaflet ovate-acuminate in shape, entire, 2.75 centimeters in length by 1.5 centimeter in maximum width; apex slightly flexed or bent toward one side; midrib slightly bent distad; nervation simply pinnate; secondary nerves fine, leaving the midrib at angles of approximately 60°.

This specimen may possibly represent one of the lower leaflets of *Cassia ordinaria*, previously described (Figure 10, Plate 69). Leaflets on individual leaves of any one of several different existing species of *Cassia* differ between themselves, in shape and size, far more than do the two fossil specimens under consideration; but in the absence of any definite evidence on either side I have deemed it best to describe the leaflet in question under a distinct specific name, and to compare it with the existing species *Ditremeza* [Cassia] *occidentalis* (Linnaeus) Britton & Rose (Figure 13, Plate 69). In this connection it is of interest to note the great diversity of leaf forms included by Heer\* under the Old World Tertiary species *Cassia Berenices* Unger, and incidentally to compare his figure 42 (*op. cit.*) with the figure of our specimen. As far as this particular figure of Heer's is concerned it might well be regarded as representing a specimen very difficult of specific differentiation from ours.

*Locality:* Station B.

Genus COPAIVA Jacquin

**Copaiva oligocenica** n. sp.

Plate 71, Figure 5.

Leaflet inequilateral, the broader side expanded distad, the opposite, narrower side expanded proximad, 3.75 centimeters in length by 1.8 centimeter in maximum width, entire, abruptly narrowed to an obtuse apiculate apex, rounded below to an inequilateral curved-cuneate base; midrib curved, convex toward the broader side of the leaf; nervation simply pinnate; secondary nervation fine, consisting of irregularly disposed and spaced major and minor nerves, those on the convex side of the midrib subtending angles more acute than those on the opposite, concave side, all curving upward, approaching and merging together in the marginal region through the connecting tertiary nervilles.

This leaflet is so closely comparable with lateral leaflets of *Copaiva chiriquensis* Pittier, that from selected specimens it would be difficult to differentiate the fossil form. A tracing of an average leaflet of the above species (Figure 6, Plate 71), is introduced for comparison.

*Locality:* Station A.

Genus CYNOMETRA Linnaeus

**Cynometra Rabellii** n. sp.

Plate 71, Figures 1a, 2.

Leaflets inequilateral, 3.5 to 4.5 centimeters in length by 1.5 to 1.8 centimeter in maximum width, broadest distad, abruptly narrowed to an apiculate

\*Heer, Oswald. *Flora Tertiaria Helvetiae*, vol. 3, p. 118, pl. 87, figs. 42-56. 1859.

apex, rounded to the base on the broader side, cuneate on the narrower side, entire; midrib curved, convex toward the broader side; nervation pinnate-reticulate, delicate, apparently consisting of a major and a minor series that are irregularly disposed and spaced, leaving the midrib at various angles of divergence, bent, flexed, curving upward and connected by tertiary nervilles that form a series of irregular reticulations.

These specimens certainly represent lateral leaflets of a compound leaf, apparently belonging to the Leguminosae. Comparison with leaflets of a number of different genera having similar foliage finally resulted in matching our specimens most satisfactorily with leaflets of certain species of the genus *Cynometra*; and, as an example, I have introduced (Figure 4, Plate 71) a tracing of a lateral leaflet of the existing species *Cynometra trinitensis* Oliver. Comparison may also be made with *Pithecellobium vezativum* Hollick, discussed on page 203, and illustrated by Figure 3, Plate 71, which differs from the former, however, in its larger size and also, apparently, in the more uniform convexity of its sides. Possibly their mutual generic identity, at least, might be regarded as a matter of individual opinion.

Identifications of the leaflets of leguminous plants are frequently not entirely satisfactory. In many instances they differ but little in surficial characters, and certain species are exceedingly heterophyllous, as far as individual leaflets are concerned; hence isolated fossil leaflets in which important diagnostic characters are lacking, or only obscurely defined, may be identified as representing any one of several genera; and subsequent discovery of specimens, in a better state of preservation, might result in indicating that the original identification was erroneous.

*Locality:* Collazo River. Collected by Don Narciso Rabell (Figure 1a); Station B (Figure 2).

*Type specimen:* Figure 2.

#### Family LEGUMINOSAE (PAPILIONACEAE)

Genus *Lonchocarpus* Humboldt, Bonpland, and Kunth

#### *Lonchocarpus praelatifolius* n. sp.

Plate 71, Figure 7a

Leaflet lanceolate-ellipsoidal in shape, inequilateral, entire, 6 centimeters in length by 2.5 centimeters in maximum width, tapering rather abruptly to a constricted apiculate apex, rounded to an inequilateral cuneate base; midrib slightly flexuous; nervation simply pinnate; secondary nerves irregularly disposed and spaced, leaving the midrib at acute angles of divergence on the narrower side of the leaf and at more obtuse angles on the opposite, broader side, all curving upward, thinning out and approaching closely in the marginal region and connected by tertiary cross nervation.

The general appearance of this specimen at once suggests that it represents a lateral leaflet of a compound leaf; and critical examination suggests generic relationship with the genus *Lonchocarpus*. For comparison I have introduced (Figure 8, Plate 71) a tracing of a leaflet of *Lonchocarpus latifolius* (Willdenow) Humboldt, Bonpland, and Kunth, which may be seen to resemble our specimen very closely—so closely, in fact, that specific relationship might almost be implied.

*Locality:* Station B.

## Genus SOPHORA Linnaeus

## SOPHORA (?) SUSPECTA Hollick

## Plate 69, Figure 7

*Sophora (?) suspecta* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 304, pl. 10, fig. 3. Sept. 13, 1924.

The identity of our specimen with this species can hardly be questioned, despite the absence of any trace of secondary nervation. In shape the agreement is perfect; also our specimen and the one above cited, on which the specific type was based, both came from the same locality. It may be compared with the existing species *Sophora affinis* Torrey & Gray.

*Locality:* Station A.

## Order GERANIALES

## Family MELIACEAE

## Genus GUAREA Allamand; Linnaeus

**Guarea opinabilis** n. sp.

## Plate 86, Figure d

Leaf apparently oblong lanceolate in shape, about 15 centimeters in length by 4 centimeters in maximum width; margin entire, sinuous; nervation pinnate, camptodrome; secondary nerves irregularly spaced and disposed, subtending obtuse angles with the midrib, curving upward and thinning out in the marginal region, where they approach and join in a series of successively smaller loops.

This may not be regarded as a satisfactory specimen upon which to base a new specific description; but it may be compared so closely with certain existing species of the genus *Guarea* that I have ventured to so refer it, and to compare it with an unnamed species from South America, a tracing of a leaf of which is represented by Figure 2, Plate 88.

It may also be compared with a fossil specimen, from the Tertiary of Ecuador, described and figured by Engelhardt\* under the name *Tapiria* [= *Tapirira*] lanceolata, which he compared with the existing species *T. guianensis* Aublet.

*Locality:* Station B.

## Genus TRICHILIA P. Browne; Linnaeus

**Trichilia evidens** n. sp.

## Plate 72, Figure 7

Organism consisting of a tripartite, loculicidal capsule; divisions ovate-lanceolate in shape, about 1.8 centimeter in length by about .9 centimeter in maximum width, varying somewhat in size between themselves, thick and coriaceous in texture, dorsal surfaces channeled medianly from base to apex.

This specimen evidently represents three confluent valves or divisions of a loculicidal capsule that was split open, flattened out and compacted. Apparently it is the exterior that is exposed, as indicated by the clearly defined linear depression in the median region of each division, extending from the proximal to the distal extremity.

\*Engelhardt, Hermann. Ueber neue Tertiärpflanzen Süd-Amerikas. Senckenb. Naturf. Gesellsch., Abh. vol. 19, p. 15, pl. 9, fig. 4. 1895.

It is so closely comparable with capsules of certain existing species of *Trichilia* that I have no hesitation in referring it to that genus; and for purposes of comparison I have introduced two drawings of a dried capsule of *Trichilia odorata* Andrews, from Jamaica,—one representing the interior (Figure 8, Plate 72), and one the exterior (Figure 9, Plate 72). In the former the median lines represent, ridges or fins. In the latter they represent dorsal depressions.

*Locality:* Collazo River. Collected by Don Narciso Rabell.

### ***Trichilia Pseudobakerii* n. sp.**

Plate 72, Figure 5

Leaflet obovate-elliptical in shape, entire, about 12 centimeters in length by 5 centimeters in maximum width, tapering to a narrow, elongated base and, apparently, to a more or less abruptly constricted apex; nervation pinnate, camptodrome; secondary nerves irregularly spaced and disposed, subtending obtuse angles with the midrib, mostly flexed and more or less angled and curved, or bent abruptly upward toward their extremities, where they join in a series of angled loops; tertiary nervation all more or less flexed, forming irregular polygonal areolae.

There can hardly be any doubt that our fragmentary specimen represents a species very close to the existing *Trichilia Bakerii* C. De Candolle (Figure 6, Plate 72), and we may infer that our specimen, in its entirety, would have possessed basal and apical characters comparable with those of the specimen of *T. Bakerii* represented by Figure 6, in as much as the parts that are available may be matched so satisfactorily.

A fossil species, from the Tertiary of the island of Trinidad, that resembles our species closely, was described and figured by me\* under the name *Geissanthus Brittonii*. The resemblance of this species to *Trichilia Pseudobakerii* is so marked that the differences between them appear to be almost negligible; but the former may be seen to be smaller in size and of a more obovate or spatulate shape. If they should ever be proved to be specifically identical, however, it might yet be a difficult matter to determine the genus to which they should be referred. It would not be inconsistent to regard the figures of the two species as generically identical, and as possibly representing leaflets of a compound leaf of one and the same species.

*Locality:* Station B.

### ***Trichilia pseudohirta* n. sp.**

Plate 72, Figure 1

Leaflet lanceolate in shape, entire, about 4.5 centimeters in length by 2 centimeters in maximum width, rounded below, constricted above to an acuminate apex; nervation pinnate, camptodrome; secondary nerves rather widely and uniformly spaced, subtending approximately uniform angles of 45° to 55° with the midrib, extending almost straight, or curving slightly upward, and joining in the marginal region in a series of angled loops.

Leaflet lanceolate in shape, entire, about 4.5 centimeters in length by 2 centimeters in maximum width, rounded below, constricted above to an acuminate apex; nervation pinnate, camptodrome; secondary nerves rather widely and

\*Hollick, Arthur. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 312, pl. 2, figs. 2, 3. Sept. 13, 1924.

uniformly spaced, subtending approximately uniform angles of 45° to 55° with the midrib, extending almost straight, or curving slightly upward, and joining in the marginal region in a series of angled loops,

This specimen is so closely comparable with certain leaflets of the existing species *Trichilia hirta* Linnaeus that it would be difficult to differentiate between equivalent fragmentary remains, as may be seen by comparing Figure 1, Plate 72, representing the fossil, with Figure 2, on the same plate, representing a leaflet of the species mentioned. The figure of the fossil matches the upper part of the leaflet so perfectly that we may assume the basal part of the former to have been identical in its contour with the equivalent part of the latter, as indicated in Figure 2.

Our figure may also be seen to closely resemble, except in its smaller size, that of a leaf from the Tertiary (Pliocene) of Bolivia, described and figured by Berry\* under the name *Anona* [= *Annona*] *cochambensis*, and compared with the existing species *A. acutiflora* Martius — all of which indicates the difficulties experienced in endeavoring to satisfactorily compare and identify Tertiary fossil floras of tropical regions with the flora now in existence in the same regions.

*Locality:* Station B.

### ***Trichilia spatulata* n. sp.**

Plate 72, Figure 3

Leaflet apparently spatulate in shape, slightly inequilateral, entire, about 3.75 centimeters in length by 1.25 centimeter in maximum width; nervation pinnate; secondary nerves numerous, fine, leaving the midrib at angles of approximately 45°, curving upward and becoming camptodrome in the marginal region.

This leaflet appears to be comparable with those of the existing species *Trichilia trifolia* Linnaeus, of which a tracing of a specimen, represented by Figure 4, Plate 72, is introduced in order to facilitate comparison. Although the apical portion of the fossil, represented by Figure 3, is lacking, the basal portion matches the equivalent part of Figure 4 so closely that it would seem justifiable to infer that they were also alike in their apical parts.

*Locality:* Station B.

### Order SAPINDALES

#### Family SAPINDACEAE

#### Genus MELICOCCA Linnaeus

### ***Melicocca immutata*, n. sp.**

Plate 73, Figures 1-4

Leaflets inequilaterally obovate, oblong or oblong-lanceolate in shape, 6 to 7.5 centimeters in length by 3 to 3.5 centimeters in maximum width, entire, tapering to the apex or rounded and abruptly acuminate, turned to one side, unsymmetrically rounded or curved-cuneate at the base; midrib curved, turned to one side distad, conforming in general to the trend of the adjacent marginal contour; nervation pinnate, reticulate-camptodrome; secondary nerves numerous, consisting of a major series, with a minor series interspersed between, all fine, closely approximated, irregularly spaced and disposed, subtending mostly obtuse

\*Berry, E. W. Johns Hopkins Univ. Studies in Geol. No. 4<sup>1</sup> (Pliocene fossil plants from eastern Bolivia. George Huntington Williams Memorial Publication No. 18), p. 172, pl. 8, fig. 4. 1922.

angles with the midrib, connected by numerous fine tertiary nervilles that form an irregular reticulated network of elongated and polygonal areolae throughout, with rounded and angled loops in the marginal region.

The figures representing these specimens were compared with leaflets of several different existing species in the Sapindaceae—the family to which they appear to be referable. A species that matches them very closely in general surficial characters, as well as in minor variations of size and shape, is *Melicocca bijuga* Linnaeus. Tracings of two typical leaflets of this species are represented by Figures 5 and 6, Plate 73. Figure 5 may be most satisfactorily compared with Figures 1 and 3, and Figure 6 with Figures 2 and 4.

It is possible that a fragmentary specimen originally described and figured by me\* under the name *Apocynophyllum pseudowillughbya*, may properly belong in the same generic, and possibly in the same specific category with them. They were all collected in the same locality; but the specimen in question is too fragmentary and too imperfectly preserved for accurate comparison, and the resemblance had best be regarded merely as suggestive.

*Locality:* Station B (Figures 1-3); station A (Figure 4).

*Type specimen:* Figure 1.

MELICocca sp.

Plate 87, Figure 4

This imperfectly preserved foliar fragment is, apparently, closely related to the specimens previously described and figured (page 210, Plate 73, Figures 1-4) under the name *Melicocca immutata*; and the similarity between them might be regarded as sufficient for specific recognition. The particular one of the above figures with which it may be most nearly matched is Figure 3, from which it appears to differ merely in its somewhat larger size.

*Locality:* Station B.

Genus SAPINDUS [Tournefort] Linnaeus

**Sapindus Brittonii** n. sp.

Plate 55, Figure 5d; Plate 74, Figures 1, 2; Plate 75, Figure 5; Plate 76, Figure 1b; Plate 78, Figures 3a, 3b; Plate 79, Figures 1a, 2a; Plate 86, Figure e; (Plate 87, Figure 3?)

Leaflets curved, unsymmetrically obovate-elliptical in shape, short petiolate, 9 to 12 centimeters in length by 4 to 5 centimeters in maximum width; margin entire, more or less sinuous or flexuous; midrib curved, bent to one side and flexuous in conformity with the contour of the adjacent margin; nervation pinnate; secondary nerves irregularly disposed and spaced, consisting of a major series with others of minor rank interspersed between, subtending obtuse angles with the midrib on the convex side and angles more acute on the concave side, mostly curved or bent abruptly upward and becoming camptodrome in the marginal region, where they join in a series of loops successively diminishing in size.

Most of our specimens compare closely with certain leaflets of the existing species *Sapindus Saponaria* Linnaeus. This species is one in which the leaflets vary in size and shape to an unusual extent, and the general type with which our specimens may be most satisfactorily matched is indicated by Figure 3, Plate

\*Hollick, Arthur. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 318, pl. 11, fig. 3. Sept. 13, 1924.

74, representing a tracing of a leaflet of *Sapindus Saponaria* which may be regarded as an example of an average broad-type leaflet of the species.

A considerable variation may be noted among the specimens included under *Sapindus Brittonii*, but the differences in size and shape of the leaflets are negligible in comparison with the differences that may be seen among leaflets of *Sapindus Saponaria*.

A fossil species from the Tertiary of Brazil, which might be regarded as merely a small form of *Sapindus Brittonii*, was described and figured by Hollick & Berry\* under the name *Sapindus praesaponaria*, by reason of its close resemblance to *S. Saponaria*. All of our specimens, however, appear to be representative of a larger type of leaf.

*Locality:* Station B (Figure 5d, Plate 55; Figure 5, Plate 75; Figure 1b, Plate 76; Figures 3a, 3b, Plate 78; Figures 1a, 2a, Plate 79; Figure e, Plate 86; (Figure 3, Plate 87?). Station A (Figure 1, Plate 74). Collazo River. Collected by Don Narciso Rabell (Figure 2, Plate 74).

*Type specimen:* Figure 1, Plate 74.

### *Sapindus gracilentus* n. sp.

Plate 75, Figure 3

Leaflet curved, unsymmetrically linear-lanceolate, sub-falcate in shape, entire, apparently about 8.5 centimeters in length by 1.75 centimeter in maximum width, tapering to a narrow, inequilateral, cuneate base; midrib curved in conformity with the curvature of the leaflet; nervation pinnate; secondary nerves irregularly disposed and spaced, numerous, fine, including obscurely defined series of major and minor rank, subtending angles of approximately 45° with the midrib, becoming camptodrome-reticulate in the marginal region.

This leaflet is apparently comparable with the ordinary narrow type of leaflets of the existing species *Sapindus Saponaria* Linnaeus, a tracing of one of which is represented by Figure 4, Plate 75. The specimen of *Sapindus* represented by *S. gracilentus*, and those last described, under the name *S. Brittonii* differ so greatly in size and shape that, superficially, they may not at first appear to be generically related; but, as a matter of fact they do not differ, one from the other, any more strikingly than do the leaflets on different individual trees of *S. Saponaria*, with which species both of the two fossil ones might be compared.

A number of narrow leaved Tertiary species of the genus have been described, from both the Old World and the New; but in no instance does there appear to be a resemblance to ours sufficiently striking to definitely indicate specific identity. Interesting comparisons, however, may be made with *Sapindus falcifolius* Alex. Braun as depicted by Heer,† from the Tertiary of Switzerland, and *Sapindus angustifolius* Lesquereux,‡ [not *S. angustifolius* Blume] from the Tertiary of the western United States, which was subsequently split up into several different species (*S. coloradensis* Cockerell, *S. Iconis* Cockerell, *S. mississippiensis* Berry, etc.)—an example of the confusion that obtains in connection with efforts to identify and to differentiate between leaf forms referred to this genus.

*Locality:* Station A.

\*Hollick, Arthur, & Berry, E. W. Johns Hopkins Univ. Studies in Geology No. 5 (A late Tertiary flora from Bahia, Brazil), p. 82, pl. 8, figs. 6, 7. 1924.

†Heer, Oswald. Flora Tertiaria Helvetiae, vol. 3, pl. 119; pl. 120, figs. 2-8; pl. 121, figs. 1, 2. 1859.

‡Lesquereux, Leo. U. S. Geol. Survey Terr., Rept. vol. 7 (The Tertiary flora), pl. 49 figs. 2-7. 1878.

## SAPINDUS OBESUS Hollick

*Sapindus obesus* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 307, pl. 10, figs. 1, 2. Sept. 13, 1924.

This species may be compared with certain short lower leaflets of the existing species *Sapindus Saponaria* Linnaeus, and with *Sapindus obtusifolius* Lesquereux\* from the Eocene of the western United States.

*Locality:* Collazo River, near base of second falls below Carretera bridge. Collected by Bela Hubbard.

**Sapindus pseudomarginatus** n. sp.

Plate 73, Figure 7

Leaflet slightly unsymmetrically oblong-ovate and broadly falcate in shape, 5.25 centimeters in length by 2.3 centimeters in maximum width, rounded at the obscurely inequilateral base, abruptly constricted to a blunt acuminate apex; margin entire, wavy or sinuous; midrib curved or bent in conformity with the contour of the adjacent margin; nervation pinnate; secondary nerves widely spaced, irregularly disposed, subtending acute angles with the midrib on the concave side and obtuse angles on the convex side, all curved and extending upward in the marginal region.

This specimen closely resembles certain lower leaflets of leaves of the existing species *Sapindus marginatus* Willdenow, as may be seen by comparison with Figure 8, Plate 73, which represents a tracing of a leaflet of that species.

*Locality:* Station B.

## Order RHAMNALES

## Family RHAMNACEAE

## Genus ZIZYPHUS [Tournefort] Miller

**Zizyphus Pseudochloroxylon** n. sp.

Plate 77, Figures 1-4.

Leaves apparently oblong-ovate in shape, entire, 3-nerved from the base; midrib straight; lateral primaries curved outward, apparently acrodrome; tertiary nervation fine, obscurely defined, the inner ones subtending obtuse angles with the midrib and bent or flexed in extending to the inner sides of the lateral primaries, the outer ones subtending somewhat more acute angles with the lateral primaries and joining in the marginal region in a series of flattened and angled curves, with obscurely defined nervilles extending from the angles outward and upward.

It is unfortunate that in no instance has a perfect specimen of this species been found. The basal outline is revealed, however, and the general shape of the leaf is clearly indicated, as are also the essential characters of the nervation, and I have but little hesitation in referring it to the genus *Zizyphus* and in comparing it with the existing West Indian species *Z. Chloroxylon* (Linnaeus) Oliver, a drawing of a leaf of which is introduced for comparison (Figure 5, Plate 77.). The close similarity between the fossil specimens and the leaf of the existing species is so striking that it may not be ignored in any comparison or discussion of the extinct and existing floras.

\*Lesquereux, Leo. U. S. Geol. Survey Terr., Rept. vol. 7 (The Tertiary flora), p. 266, pl. 49, fig. 10 [excl. figs. 8, 9, 11]. 1878.

A leaf that approaches it in appearance, as far as general characters are concerned, is *Miconia Ettingshausenii* Hollick & Berry,\* from the Tertiary (Pliocene?) of Brazil; but critical examination of the secondary nervation, especially in the marginal region, clearly indicates that this species possesses a true marginal vein, characteristic of the genus *Miconia* and the Melastomataceae in general, which appears to be lacking in our specimens; but specimens in which critical minor characters may be more clearly defined, if discovered at any time in the future, might result in change of opinion as to the generic and family relationship of the specimens under consideration.

Several other fossil species, under the genera *Miconia* and *Melastomites*, have been described and figured from America and from the Old World, but it would be of no value to cite or to discuss them here, in connection with our specimens, in view of the fragmentary and unsatisfactory condition of the latter. Also, the same may be said in regard to the many fossil species of *Zizyphus* that have been published; and the best we can do in the circumstances is to compare our specimens with the existing species of the region that appears to resemble them most closely.

*Locality:* Station B.

*Type specimen:* Figure 1.

#### Order MALVALES

#### Family MALVACEAE

Genus **Malvocarpon** n. gen.

**Malvocarpon clarum** n. sp.

Plate 75, Figure 6

Fruit globose-oblong in shape, about 1.5 centimeter in length by 1.25 centimeter in width, consisting of an aggregate of what appear like elongated, apiculate carpels arranged around a common center.

Relationship of this specimen with the Malvaceae can hardly be questioned, and generic relationship with *Abutilon* is strongly indicated by the shape and arrangement of the carpels. The fruit as a whole, and also the individual capsules, are more or less broken and distorted, so that original minor features have probably been destroyed; but comparison with a mature fruit of the existing species *Abutilon texense* Torrey & Gray—an illustration of which is introduced for comparison (Figure 7, Plate 75)—may serve to show their close mutual resemblance.

*Locality:* Collazo River. Collected by Don Narciso Rabell.

#### Order MYRTALES

#### Family RHIZOPHORACEAE

Genus RHIZOPHORA Linnaeus

**Rhizophora (?) doctrinalis** n. sp.

Plate 70, Figure 6c; Plate 71, Figure 7b; Plate 82, Figure 5b.

Leaf elliptical-oblong, entire, about 8 centimeters in length by 3 centimeters in maximum width, with rounded or curved-cuneate base and convex-cuneate

\*Hollick, Arthur, & Berry, E. W. Johns Hopkins Univ. Studies in Geol., No. 5 (A late Tertiary flora from Bahia, Brazil), p. 95, pl. 12, fig. 1. 1924.

apex; texture coriaceous; midrib well defined, somewhat abruptly thickened proximad; nervation hypohdrome.

These are very unsatisfactory specimens upon which to base a generic identification and a specific description, and their reference to the genus *Rhizophora* is therefore questioned. For comparison, however, I have introduced a tracing of a leaf of the common Mangrove of the tropics, *Rhizophora Mangle* Linnaeus (Figure 4, Plate 78), which may be seen to resemble our specimens very closely, as far as shape and marginal contour are concerned. In neither is there any visible trace of secondary nervation. Berry\* described and figured a species from the Eocene Tertiary of Georgia under the name *Rhizophora eocenica*, and two specimens from the Pleistocene of the island of Trinidad which he† referred to *Rhizophora Mangle*. These are both suggestive of the general type of leaf to which our specimens belong; but the figures are as unsatisfactory for definite generic identification as are those representing our specimens. Apparently these are the only specimens of the genus *Rhizophora* as a fossil thus far recorded from America; but it is possible that certain species of fossil leaves, in which secondary nervation is lacking or obscurely defined, that have been identified under other generic names, might all be included under one and the same generic category. This matter was discussed by Berry (Prof. Paper 84, *loc. cit.*, p. 145), especially in connection with specimens from the Eocene of Mississippi, described and figured by Lesquereux‡ and identified as *Quercus chlorophylla* Unger. Also it may be pertinent to refer in this connection to a specimen from Cuba which was described and figured by me§ under the name *Mimusops Leonii*. A comparison of our Figure 5b with these several figures cited may serve to demonstrate the difficulty of arriving at satisfactory conclusions in regard to the generic identity of fossil specimens in which essential or critical characters are obscure or lacking.

*Locality*: Station B.

*Type specimen*: Figure 5b, Plate 82.

#### Family COMBRETACEAE

#### Genus COMBRETUM Linnaeus

#### **Combretum Pseudojacquinii** n. sp.

Plate 55, Figure 4b; Plate 78, Figure 1; Plate 79, Figure 3a.

Leaves elliptical-lanceolate in shape, entire, about 8.5 centimeters in length by 4 centimeters in maximum width, broadest at about the middle, contracted to an apiculate apex and tapered to an acute cuneate base; midrib straight; nervation pinnate, camptodrome; secondary nerves rather widely spaced, irregularly alternately arranged, subtending approximately uniform angles of about 50° with the midrib, connected in the marginal region by a series of more or less angled loops.

As far as may be inferred from the fragmentary specimens upon which the above description is based the general resemblance to leaves of certain existing

\*Berry, E. W. U. S. Geol. Survey, Prof. Paper 84 (The upper Cretaceous and Eocene floras of South Carolina and Georgia), p. 144, pl. 29, figs. 1, 2. 1914.

†Berry, E. W. A Pleistocene flora from the island of Trinidad. U. S. Nat. Mus., Proc. vol. 66, Art. 21, p. 5, pl. 2, figs. 2, 4. 1925.

‡Lesquereux, Leo. On species of fossil plants from the Tertiary of the State of Mississippi. Amer. Philos. Soc., Trans. vol. 13, art. 14, p. 416, pl. 17, figs. 5, 6, 7. 1867.

§Hollick, Arthur. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 314, pl. 14, fig. 10. Sept. 13, 1924.

species of the genus *Combretum* is too close to be ignored. Unfortunately, however, any of the finer nervation is lacking in our specimens; but a tracing of a leaf of *Combretum Jacquinii* Grisebach (Figure 2, Plate 78) is introduced for comparison. Very slight variations in minor characters, however, are frequently essential for satisfactory generic differentiation between leaves possessing the general shape and nervation represented by the specimens under consideration, as may be seen by comparison with the specimen described and figured under the name *Trichilia Pseudobakerii* (Figure 5, Plate 72) and compared with the existing *Trichilia Bakerii* De Candolle (Figure 6, Plate 72). The discovery of a perfect leaf of such general type, with well-preserved minor characters, might result in its reference to either of the above genera, or even to some other genus.

*Locality:* Station B.

*Type specimen:* Figure 1, Plate 78.

#### Family MYRTACEAE

##### Genus EUGENIA Linnaeus

##### EUGENIA COMPARABILIS Hollick

Plate 55, Figures 5b, 5c; Plate 79, Figures 3c, 3d; Plate 80, Figure 1.

*Eugenia comparabilis* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 310, pl. 8, figs. 2-5, 6b. Sept. 13, 1924.

The original specimens upon which this species was based came from the Tertiary of the island of Trinidad; and Berry\* also referred other specimens from the island to the same species. A considerable range of variation may be noted between the figures cited, but it would be difficult to recognize any differences that might be satisfactorily recognized as of specific value.

*Locality:* Station B.

##### *Eugenia pseud aeruginea* n. sp.

Plate 80, Figure 3

Leaf apparently slightly inequilateral, oblong-elliptical or slightly obovate in shape, entire, 7 centimeters in length by 2.5 centimeters in maximum width, rather abruptly narrowed or constricted to an acuminate apex and apparently tapered to an acute cuneate base; midrib slightly curved; nervation pinnate; secondary nerves numerous, fine, irregularly spaced and disposed, consisting of a major series with others of minor rank interspersed between, subtending various angles of divergence with the midrib, all more or less curved or flexed.

This leaf is closely comparable with those of the existing species *Eugenia aeruginea* De Candolle, a tracing of a leaf of which (Figure 4, Plate 80) is introduced for comparison. Our specimen, and the one with which it is compared, represent, in their general characters, a common foliar type that is difficult to differentiate and identify satisfactorily. As far as discernible, however, the generic identity of our specimen appears to be reasonably assured.

*Locality:* Station B.

\*Berry, E. W. Johns Hopkins Univ. Studies in Geol. No. 6<sup>3</sup> (The Tertiary flora of the island of Trinidad. George Huntington Williams Memorial Publication No. 22), p. 119, pl. 9, figs. 1-5. 1925.

## Genus MYRCIA De Candolle

**Myrcia denuntiativa** n. sp.

Plate 80, Figure 5

Leaf apparently inequilaterally ellipsoidal in shape, entire, about 10 centimeters in length by 4 centimeters in maximum width, curved on one side and tapering on the other to an inequilateral cuneate base; midrib curved in conformity with the curvature of the leaf; nervation pinnate-marginal; secondary nerves sub-parallel, irregularly disposed, widely and irregularly spaced, subtending angles of 75° to 85° with the midrib, extending almost straight until close to the margin, where they connect with a slightly wavy marginal nerve.

This fragmentary specimen is suggestive of certain leaves of the Myrtaceae, and, as far as may be seen, it resembles those of the existing genus *Myrcia* more or less closely. For purposes of comparison I have introduced a tracing of a leaf of an unnamed species of the genus, from the island of Antigua (Figure 6, Plate 80), the lower part of which may be seen to simulate our specimen quite closely. Apparently there is an obscurely defined minor series of secondary nerves in both specimens, and if this series had been better preserved in the fossil its similarity to the other would, probably, have been more pronounced.

*Locality:* Station A.

## MYRCIA EUGENIOIDES Hollick

*Myrcia eugenioides* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 310, pl. 9, figs. 6, 7. Sept. 13, 1924.

This species was based upon leaf form alone—no trace of nervation, other than the midrib, being discernible. It was compared with the existing species *Myrcia sylvatica* De Candolle.

*Locality:* Collazo River, near base of second falls below Carretera bridge. Collected by Bela Hubbard.

## Genus PSIDIUM Linnaeus

**Psidium dissimile** n. sp.

Plate 81, Figure 1

Leaf elliptical in shape, entire, about 7.5 centimeters in length by 3.5 centimeters in maximum width, tapering or narrowed to the apex, curved and tapering below into an obscurely inequilateral cuneate base; nervation pinnate; midrib almost straight; secondary nerves relatively numerous, rather evenly spaced at distances of 5 to 7 millimeters, sub-parallel, subtending angles of approximately 30° with the midrib, extending almost straight until reaching the marginal region where they bend upward and become camptodrome in connecting series of upward diminishing loops.

This leaf may be compared more or less satisfactorily with those of certain existing species of *Psidium*, such as *P. Guajava* Linnaeus, a tracing of one of which is represented by Figure 2, Plate 81. The simple, comparatively uniform character of the secondary nervation—a somewhat unusual type—may be seen to be common to both.

*Locality:* Station A.

PSIDIUM (?) sp. Hollick?

Plate 81, Figures 3, 4, 5a

*Psidium* (?) sp. Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 311, pl. 12, fig. 4. Sept. 13, 1924.

As far as may be determined from comparison between these fragmentary specimens and the similar one (*loc. cit.*) to which they are referred, reproduced in Figure 4, Plate 81, they apparently belong at least in the same generic category, and might be regarded as specifically identical. The original generic identification was based upon the general resemblance of the fragment to the basal portions of certain leaves in the existing species *Psidium Guajava* Linnaeus and *P. pomiferum* Linnaeus.

*Locality*: Station B (Figure 3); collected by Bela Hubbard (Figure 4); station A (Figure 5a).

(GAMOPETALAE)

Order PRIMULALES

Family MYRSINACEAE

Genus MYRSINE Linnaeus

***Myrsine pseudoferruginea* n. sp.**

Plate 82, Figures 1-5a; Plate 85, Figure 1a

Leaves linear-oblong in shape, slightly curved to one side, about 9 centimeters in length by 2 to 2.4 centimeters in maximum width, narrowed to an acute apex and tapering to the base; margin entire; midrib more or less curved or slightly flexuous; nervation simply pinnate; secondary nerves numerous, delicate, consisting of a major series with finer nerves between, all more or less flexed and angled, irregularly disposed and spaced, leaving the midrib at various angles of divergence; tertiary nervation forming with the secondaries a series of irregular reticulations that apparently become camptodrome close to the margin.

These leaves are apparently referable to the Myrsinaceae, and they simulate very closely, in general shape and in nervation, those of certain existing species of *Myrsine*, such as *M. ferruginea* Sprengel and *M. myricoides* Schlechtendahl, illustrations of which are represented, respectively, by Figures 6 and 7, Plate 82.

A fossil species which may not properly be ignored in connection with any discussion of our specimens is *Hancornia minor* Hollick,\* a species based upon an imperfect fragmentary leaf, with nervation very similar to that of *Myrsine pseudoferruginea*, and collected at the same locality. That all of these specimens mentioned belong to one and the same species appears to be possible, and with *Myrsine* rather than *Hancornia* as the mutual generic relationship.

*Locality*: Station B (Figures 1, 3-5a, Plate 82; Figure 1a, Plate 85); station A (Figure 2, Plate 82).

*Type specimen*: Figure 2, Plate 82.

\*Hollick, Arthur. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 316, pl. 11, fig. 6. Sept. 13, 1924.

## Genus ICACOREA Aublet

## ICACOREA PRISCA Hollick

*Icacorca prisca* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 312, pl. 11, fig. 5. Sept. 13, 1924.

This species was originally compared (*loc. cit.*) with the existing species *Icacorea (Ardisia) latipes* Martius.

*Locality:* Collazo River, near base of second falls below Carretera bridge. Collected by Bela Hubbard.

## ICACOREA (?) sp.

## Plate 87, Figure 5

A fragmentary leaf specimen, of unknown shape and dimensions, with entire margin and weak, pinnately arranged secondary nervation, apparently referable to the Myrsinaceae and possibly to the genus *Icacorea*.

It is possible that this specimen may represent a leaf of *Icacorea prisca*, the species next preceding, but this suggestion is to be regarded as merely incidental. Comparison may also be made with *Chrysophyllum ficifolium* Berry,\* from the Tertiary of Tennessee, in connection with the discussion of which (*loc. cit.*) he mentions its resemblance to leaves of *Brosmium*, *Ardisia* and *Icacorea*, and *Ficus*.

In the circumstances the problem of the generic identity of our specimen may best be regarded as an open question.

*Locality:* Station A.

## Genus STYLOGYNE A. De Candolle

## STYLOGYNE (?) FRAGMENTA Hollick?

## Plate 85, Figure 2

*Stylogyne (?) fragmenta* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 313, pl. 10, fig. 6. Sept. 13, 1924.

It is unfortunate that the original specimen upon which this species was based (*loc. cit.*), and the specimen represented by Figure 2, Plate 85, should each be so fragmentary that they can not be satisfactorily compared, one with the other, or with other species. Even their common reference to the genus *Stylogyne* should be regarded as tentative only. As a possible measure of assistance, however, I have introduced (Figure 3, Plate 85) a tracing of a leaf of the existing species *Stylogyne lateriflora* (Swartz) Mez, which may serve as a suggestion of the possible specific relationship of our specimens.

*Locality:* Station B.

## Order EBENALES

## Family SAPOTACEAE

## Genus CHRYSOPHYLLUM Linnaeus

\*Berry, E. W. U. S. Geol. Survey, Prof. Paper 91 (The lower Eocene flora of south-eastern North America), p. 335, pl. 100, fig. 7. 1916.

**Chrysophyllum comparabile** n. sp.

Plate 84, Figure 1

Leaf of unknown size and shape, tapering distad, terminating in a blunt apiculate apex; margin entire, sinuous; nervation pinnate; secondary nerves numerous, fine, sub-parallel, subtending angles of about  $45^\circ$  with the midrib.

It is possible that this foliar fragment may belong with *Chrysophyllum pseudargenteum*, the species next described. It appears, however, to be narrower distad and to have somewhat finer, more uniform secondary nervation. I am also inclined to give it distinct specific rank by reason of its close similarity to the existing species *Chrysophyllum Cainito* Linnaeus, a tracing of an apical portion of a leaf of which species (Figure 2, Plate 84) is introduced for comparison.

*Locality:* Collazo River. Collected by Don Narciso Rabell.

**Chrysophyllum pseudargenteum** n. sp.

Plate 83, Figure 1

Leaf apparently obovate in shape and about 10 centimeters in length by 5.4 centimeters in maximum width, entire, terminating above in a short, blunt, constricted apiculate apex; midrib straight; nervation pinnate, camptodrome; secondary nerves numerous, subtending mostly obtuse angles with the midrib, consisting of a major series with a minor series in between that merge together in the marginal region into a network of angled and curved areolae of various shapes and dimensions, ultimately forming an irregular, wavy, marginal nerve.

It is unfortunate that we have only the upper part of this leaf from which to try to visualize what it was probably like in its entirety. It may, however, be satisfactorily compared with similar parts of broad leaf forms of the existing species *Chrysophyllum argenteum* Jacquin, a tracing of a specimen of which (Figure 2, Plate 83) is introduced for the purpose.

*Locality:* Collazo River. Collected by Don Narciso Rabell.

**Chrysophyllum pseudargenteum oblongum** n. var.

Plate 83, Figures 3, 4, 5

Leaves that differ from the specific type merely in their, apparently, oblong rather than obovate shape.

It is with some hesitation that I have decided to recognize these three fragmentary specimens as varietally distinct from *Chrysophyllum pseudargenteum*, the species last described. They might well be included in one and the same specific category, especially as the leaves of *Chrysophyllum argenteum*—the existing species with which the fossil species was compared—differ between themselves far more than do the fossil species and variety.

The latter might be regarded as a relatively narrow, and oblong form, and the former as a relatively broad, and obovate form of one and the same species. Recognition of the varietal difference may, however, be more convenient at the present time.

*Locality:* Station B.

*Type specimen:* Figures 3 and 4 (composite).

Genus DIPHOLIS A. De Candolle

**Dipholis pseudoleiantha** n. sp.

Plate 84, Figure 3

Leaf narrowly oblong-elliptical in shape, slightly curved, entire, somewhat inequilateral, apparently about 4.5 to 5 centimeters in length by 1.5 centimeter in maximum width, tapering proximad to a narrow, slightly inequilateral, cuneate base; midrib curved in conformity with the curvature of the leaf; nervation pinnate; secondary nerves numerous, fine, subtending angles of about 45° with the midrib.

It is with some hesitation that this fragmentary leaf is referred to the genus *Dipholis*, although it may be seen to compare quite satisfactorily with leaves of the existing species *Dipholis leiantha* Standley, a tracing of a specimen of which (Figure 4, Plate 84) is introduced for comparison. My hesitation is due to the fact that species in several other genera might have been utilized for the same purpose, as it represents a foliar type which, in general characters, is common to several families as well as genera, and the preservation of every detail of outline and nervation would be necessary for critical comparison and thoroughly satisfactory generic determination.

*Locality:* Station B.

Genus SAPOTA [Plumier] Miller

**Sapota agnitionalis** n. sp.

Plate 75, Figure 1

Leaf oblong-ovate in shape, entire, rounded proximad to a broad convex-cuneate base; nervation pinnate; midrib curved or bent to one side, proximad; secondary nerves numerous, fine, subtending mostly obtuse angles with the midrib.

The secondary nervation in this specimen, upon the details of which its generic identification is dependant, is very obscurely defined. As far as discernible, however, the foliar characters in general agree best with those of certain leaves of *Sapota Achras* Miller, a tracing of a specimen of which (Figure 2, Plate 75) is introduced for comparison.

Comparison may also be made with a fragmentary specimen collected at the same locality, which was described and figured by me\* under the name *Hancornia pseudopubescens*, and with one from a supposed Tertiary deposit in Cuba, described and figured by me (*idem*, p. 314, pl. 14, fig. 10) under the name *Mimusops Leonii*. The weight accorded to resemblances or to differences would, probably, represent the personal factor in determining the generic reference of each of these fossil specimens.

*Locality:* Collazo River. Collected by Don Narciso Rabell.

Genus SIDEROXYLON [Dillenius] Linnaeus

**Sideroxylon aequale** n. sp.

Plate 84, Figures 5, (6?)

Leaf irregularly oblong in shape, entire, apparently about 8 to 9 centimeters in length by 3.5 centimeters in maximum width; nervation pinnate; secondary

\*Hollick, Arthur. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 316, pl. 11, fig. 7. Sept. 13, 1924.

nerves numerous, consisting of a major series with others of minor rank interspersed between, all subtending obtuse angles with the midrib, curving upward and becoming reticulate-campitodrome in the marginal region.

I have compared these leaves with those of the existing species *Sideroxylon foetidissima* Jacquin more or less satisfactorily, at least as to their generic relationship. A tracing of a leaf of that species (Figure 7, Plate 84) is introduced to serve as an example of their close mutual similarity in shape and nervation.

The specimen represented by Figure 6 is so imperfect and the nervation is so obscurely defined that its specific identity is somewhat doubtful and is, therefore, questioned.

*Locality:* Station B.

*Type specimen:* Figure 5.

### Order GENTIANALES

#### Family APOCYNACEAE

#### Genus APOCYNOPHYLLUM Unger

#### APOCYNOPHYLLUM PSEUDOWILLUGHBYA Hollick

*Apocynophyllum pseudowillughbya* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 318, pl. 11, fig. 3. Sept. 13, 1924.

This species was originally (*loc. cit.*) compared with leaves of the existing apocynaceous species *Willughbya* [*Willughbeia*] *scandens* Willdenow.\* The only specimen figured is fragmentary, however, and the nervation is scanty and obscurely defined. In its entirety it might have presented a different appearance, one more nearly comparable with certain forms of *Melicocca immutata*, described and figured in this volume (page 210, Plate 73, Figures 1-4), especially if compared with Figures 2 and 4.

*Locality:* Collazo River, near base of second falls below Carretera bridge. Collected by Bela Hubbard.

#### APOCYNOPHYLLUM WILCOXENSE Berry?

#### Plate 85, Figure 4

*Apocynophyllum Wilcoxense* Berry. U. S. Geol. Survey, Prof. Paper 91 (The lower Eocene flora of southeastern North America), p. 342, pl. 103, figs. 2, 3; pl. 108, fig. 4. 1916.

It would be of little use, and might be misleading, if any effort were made to definitely identify this leaf fragment with any existing or fossil species. In its entirety the leaf was, apparently, ligulate in shape with hypodrome, or perhaps very delicate secondary nervation.

It may be compared with certain fossil species that are generally regarded as referable to the Apocynaceae, such as *Apocynophyllum Wilcoxense* Berry (*op. cit.*) from the Tertiary of the southern United States, which he mentioned as being similar to *Nerium bilanicum* Ettingshausen, † from the Tertiary of the Old World.

\*The specific name adopted was an unfortunate one, as it might be thought to imply relationship with *Willughbaeya scandens* (Linnaeus) Kunze (= *Mikanta scandens* (Linnaeus) Willdenow), a species belonging to the Compositae.

†Ettingshausen, Constantin von. K. Akad. Wissensch. [Wien], math.-naturw. Cl., Denkschr. vol. 28 (Die fossile flora des Tertiär-Beckens von Bilin, pt. 2), p. 218 (30), pl. 36, fig. 20; pl. 37, fig. 2. 1868.

In the circumstances the provisional reference of our specimen to Berry's species would appear to be all that is advisable in the matter of identification and discussion.

*Locality:* Station B.

Genus ASPIDOSPERMA Mattiuis & Zuccarini

ASPIDOSPERMA COLLAZOËNSIS Hollick

*Aspidosperma collazoënsis* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12. No. 45, p. 317, pl. 11, figs. 1, 2. Sept. 13, 1924.

This species was originally compared with leaves of the existing species *Aspidosperma polyneuron* Mueller.

*Locality:* Collazo River, at base of second falls below Carretera bridge. Collected by Bela Hubbard.

Genus ECHITES P. Browne

**Echites pseudostellaris** n. sp.

Plate 85, Figure 5

Leaf roughly ovate-lanceolate in shape, about 6 to 6.5 centimeters in length by 3.5 centimeters in maximum width, abruptly contracted distad to a blunt, slightly curved or bent apiculate apex, rounded proximad; margin entire, irregular and wavy; midrib curved or bent distad, in conformity with the curvature of the apex; nervation pinnate, camptodrome; secondary nerves few, widely and irregularly spaced, subtending mostly obtuse angles with the midrib, connected in the marginal region in a series of angled loops of diverse dimensions.

This specimen represents a leaf that is strikingly similar in appearance to those of the existing species *Echites stellaris* Lindley, a tracing of one of which (Figure 6, Plate 85) is introduced for comparison.

Leaves of this genus and of the allied fossil genus *Echitonium* have been described and figured in paleobotanical literature, but none, apparently, with which our species is likely to be confused.

*Locality:* Station B.

Genus ECHITONIUM Unger

ECHITONIUM (?) sp.

Plate 79, Figure 3b

This fragmentary leaf is manifestly too imperfect to serve as a basis for either specific or generic description, or for satisfactory identification in connection with any described or figured specimen. It may, however, be referred provisionally to the fossil genus *Echitonium*, and be compared with *E. lanceolatum* Ettingshausen, as identified and figured by Berry,\* from the Tertiary of Tennessee, and with *Apocynophyllum chilense* Engelhardt,† from the Tertiary of Chile—especially the specimen represented by his figure 11 (*loc. cit.*).

*Locality:* Station B.

\*Berry, E. W. U. S. Geol. Survey, Prof. Paper 91 (The lower Eocene floras of southeastern North America), p. 345, pl. 103, fig. 1. 1916.

†Engelhardt, Hermann. Ueber Tertiärpflanzen von Chile. Senckenb. Naturf. Gesellsch., Abh. vol. 16, No. 4, p. 659, pl. 5, figs. 9, 11. 1891.

## Genus HANCORNIA Gomez

## HANCORNIA MINOR Hollick

*Hancornia minor* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 316, pl. 11, fig. 6. Sept. 13, 1924.

This species was based upon a fragment of a median part of a leaf, which was described and figured under the above name by reason of its apparent surficial similarity to narrow leaf forms of the existing species *Hancornia pubescens* Nees & Martius, and *H. speciosa* Gomez; and incidentally it may now be compared with certain of the leaves described and figured by me (page 218, Plate 82, Figures 1-5a; Plate 85, Figure 1a) under the name *Myrsine pseudoferruginea*—especially Figure 5a, Plate 82.

The possibility of the specific or generic identity of *Hancornia minor* with *Myrsine pseudoferruginea* may, perhaps, be regarded as an open question. The specimen upon which the former species was based is too fragmentary to serve as a basis for any positive conclusion.

*Locality:* Collazo River, at base of second falls below Carretera bridge. Collected by Bela Hubbard.

## HANCORNIA PSEUDOPUBESCENS Hollick

*Hancornia pseudopubescens* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species. New York Bot. Gard., Bull. vol. 12, No. 45, p. 316, pl. 11, fig. 7. Sept. 13, 1924.

This species, as in connection with *Hancornia minor*, the one last discussed, was based upon a median fragment of a leaf that was compared with broad leaf forms of the existing species *Hancornia pubescens* Nees & Martius, and *H. speciosa* Gomez. Whether or not this generic reference was justified may, perhaps, be regarded as an open question, especially if the figure of *Hancornia pseudopubescens* is compared with the leaf described and figured in the present work (page 221, Plate 75, Figure 1) under the name *Sapota agnitionalis*. It is always unfortunate when generic identifications are attempted, and specific descriptions are published, on fragmentary material that fails to convey an adequate idea of the species in its entirety; and yet such material may represent all that may ever be known about the species, and a description and illustration, however inadequate they may be, accompanied by an appropriate name, would always seem to be warranted.

*Locality:* Collazo River, at base of second falls below Carretera bridge. Collected by Bela Hubbard.

## Genus PLUMIERA Linnaeus

## PLUMIERA EVIDENS Hollick

*Plumiera evidens* Hollick. A review of the fossil flora of the West Indies, with descriptions of new species, New York Bot. Gard., Bull. vol. 12, No. 45, p. 315, pl. 10, fig. 5. Sept. 13, 1924.

This species was based upon a foliar fragment that was compared with leaves of the existing species *Plumiera bracteata* A. De Candolle, *P. rubra* Linnaeus, and *P. Sucuuba* Spruce.

*Locality:* Collazo River, near base of second falls below Carretera bridge. Collected by Bela Hubbard.

Order RUBIALES

Family RUBIACEAE

Genus GUETTARDA Linnaeus

**Guettarda intercalaris** n. sp.

Plate 81, Figure 5b

Leaf oblong medianly, tapering proximad to a narrow cuneate base, entire, apparently about 12 to 13 centimeters in length by 3.5 to 4 centimeters in maximum width; midrib straight; nervation simply pinnate; secondary nerves relatively numerous, irregularly spaced and disposed, sub-parallel, subtending approximately uniform angles of about 45° to 50° with the midrib, extending almost straight, or gently curved, to the marginal region, where they bend rather abruptly upward.

This foliar fragment is referred to the genus *Guettarda* by reason of its resemblance to basal parts of certain leaves that belong to existing species of the genus. For comparison I have introduced (Figure 4, Plate 88) a tracing of a lower part of a leaf of the genus, from Cuba.

A figure of a specimen that is somewhat suggestive of ours is *Tapirira lanceolata* Engelhardt, as identified and figured by Berry,\* from the Tertiary of Peru. The resemblance to Engelhardt's† figure that represents a specimen from the Tertiary of Ecuador is not, however, particularly striking, and anything more than casual reference to the species, in connection with our specimen from Porto Rico, would not have occurred to me as pertinent had it not been for Berry's identification.

*Locality:* Station A.

PLANT REMAINS OF UNDETERMINED TAXONOMIC  
RELATIONSHIP

RAMULUS gen. et sp.?

Plate 71, Figure 1b

Specimen consisting of a branch or twig, flattened, broken across at intervals, thus presenting an appearance of a series of nodes and internodes, the surface cracked and fractured latitudinally and longitudinally, forming a mesh of irregular quadrilaterals.

The specimen possesses no apparent features of any diagnostic value, and it is included merely because of its connection with the leaf with which it is intimately associated in the matrix. This association, however, does not appear to be of any special taxonomic significance or interest.

*Locality:* Collazo River. Collected by Don Narciso Rabell.

\*Berry, E. W. Miocene fossil plants from Northern Peru. U. S. Nat. Mus., Proc. vol. 55 (No. 2270), p. 291, pl. 15, fig. 1. 1919.

†Engelhardt, Hermann. Ueber Tertiärpflanzen Süd-Amerikas. Senckenb. Naturf. Gesellsch., Abh. vol. 19, p. 15, pl. 9, fig. 4. 1895.

## DISCUSSION OF THE FLORA

## BOTANICAL DISCUSSION

The flora listed in the introductory part of this volume may be seen to consist of ten elements, all of which, with two exceptions, are of unknown or doubtful specific or generic identity, viz:

*Juglans archaeoantillana* Hollick.

*Aniba portoricensis* Hollick.

*Annona saraviana* Berry?

*Coccoloba*?

A dicotyledon (gen. et sp.?).

*Nilssonia* (sp.?).

*Protorhipis* (sp.?).

A Mesozoic fern (gen. et sp.?).

*Lithothamnium* (sp.?).

*Lithothamnium* (sp.?).

It is manifest that the tentatively identified elements are of little value in determining the exact stratigraphic position or age of the rocks in which they occur; and any attempt to include them in a critical discussion of either the botanical or the geological aspects or significance of the extinct flora of Porto Rico might lead to erroneous conclusions. They include, however, certain generic elements (*Protorhipis* and *Nilssonia*) which, if correctly identified, indicate the presence of a Mesozoic (apparently Lower Cretaceous) flora on the island, and as such they should serve as an incentive toward further exploration and search for additional equivalent material.

The two species definitely identified (*Aniba portoricensis*, and *Juglans archaeoantillana*) are of particular interest for the reason that the former is the only specific element identified without question from the upper or youngest member of the Collazo shale series of deposits, and because the latter represents the only described species from a horizon very much younger or more recent than any member of the Collazo shales. As suggested in connection with the Cretaceous specimens, the two species above mentioned should act as a stimulus to further exploration and search in the localities where they were, respectively, found.

The present discussion, therefore, in the circumstances, will be restricted in its scope to the flora of the Collazo shales; and, to facilitate comparison, the specific elements of this flora, together

with superficially similar elements in the existing flora of the world, are arranged in taxonomic sequence in the following parallel columns:

FLORA OF THE COLLAZO SHALES.	EXISTING SPECIES OF CLOSE SURFICIAL RESEMBLANCE.
<i>Chondrites dictyotoides</i> n. sp. . . . .	† <i>Dictyota Bartayresii</i> Lamoroux.
<i>Hemitelia Brannerii</i> Hollick & Berry.*	<i>Hemitelia subglobosa</i> (Underwood) Maxon <i>Hemitelia Imrayana</i> Hooker.
<i>Isoëtes</i> (?) <i>incerta</i> n. sp. . . . .	<i>Isoëtes riparia</i> Engelmann.
<i>Zamia collazoënsis</i> n. sp. . . . .	† <i>Zamia integrifolia</i> Jacquin. (= <i>Z. latifoliolata</i> Preneloup). <i>Zamia salicina</i> Britton.
<i>Zamia Noblei</i> n. sp. . . . .	<i>Zamia integrifolia</i> Jacquin. <i>Zamia pumila</i> Linnaeus. <i>Zamia umbrosa</i> Small.
<i>Bactris Pseudocuesco</i> n. sp. . . . .	* <i>Bactris Cuesco</i> Crueger.
<i>Iriartea collazoënsis</i> n. sp. . . . .	<i>Iriartea setigera</i> Martius.
<i>Manicaria portoricensis</i> n. sp. . . . .	<i>Manicaria sacchifera</i> Gaertner.
<i>Palmocarpum acrocomioides</i> Hollick. . . . .	† <i>Acrocomia aculeata</i> Lodd. <i>Acrocomia crispa</i> (H. B. K.) C. F. Baker.
<i>Palmocarpum cetera</i> n. sp. . . . .	<i>Astrocaryum Jauarii</i> Martius. <i>Cocos Datil</i> Grisebach & Drude. <i>Cocos eriopatha</i> Martius.
<i>Palmocarpum exemplare</i> n. sp. . . . .	<i>Cocos Inarjai</i> Trail.
<i>Palmocarpum opinabile</i> n. sp. . . . .	<i>Manicaria</i> sp.?
<i>Palmocarpum Rabellii</i> n. sp. . . . .	<i>Copernicia cerifera</i> Martius.
<i>Palmacites alius</i> n. sp. . . . .	?
<i>Palmacites conformis</i> n. sp. . . . .	?
<i>Palmacites sparsistriatus</i> n. sp. . . . .	?
<i>Palmophyllum</i> sp. Hollick. . . . .	?
<i>Palmophyllum</i> sp. (fragment of petiole) ? Hollick. . . . .	?
<i>Musophyllum</i> sp. . . . .	<i>Musa</i> sp?
<i>Ficus hyphodroma</i> n. sp. . . . .	* <i>Ficus elastica</i> Roxburgh.
<i>Ficus Schimperii</i> Lesquereux. . . . .	<i>Ficus ferruginea</i> Desfontaines. <i>Ficus populiformis</i> Schott. <i>Ficus velutina</i> Willdenow.
<i>Ficus verativus</i> n. sp. . . . .	<i>Ficus</i> sp.?
<i>Ficus</i> sp. . . . .	<i>Ficus</i> sp.?
<i>Annona cetera</i> n. sp. . . . .	† <i>Annona squamosa</i> Linnaeus.
<i>Annona pseudoglabra</i> n. sp. . . . .	† <i>Annona glabra</i> Linnaeus.
<i>Acrodiclidium pseudosalicifolium</i> n. sp. . . . .	† <i>Acrodiclidium salicifolium</i> (Swartz) Grisebach.
<i>Acrodiclidium Pseudocanelo</i> n. sp. . . . .	<i>Acrodiclidium Canelo</i> Rose.
<i>Aniba collazoënsis</i> n. sp. . . . .	* <i>Aniba riparia</i> (Nees) Mez.

\*Indicates genera represented in the native flora of Porto Rico.

†Indicates species represented in the native flora of Porto Rico.



- Eugenia pseudoaeruginea* n. sp. . . . . †*Eugenia aeruginea* De Candolle.  
*Myrcia denuntiativa* n. sp. . . . . \**Myrcia* sp.?  
*Myrcia eugenoides* Hollick. . . . . *Myrcia sylvatica* De Candolle.  
*Psidium dissimile* n. sp. . . . . †*Psidium Guajava* Linnaeus.  
*Psidium* (?) sp. Hollick. . . . . *Psidium pomiferum* Linnaeus.  
*Myrsine pseudoferruginea* n. sp. . . . . *Myrsine ferruginea* Sprengel.  
*Myrsine myricoides* Schlechtendahl.  
*Icacorea prisca* Hollick. . . . . \**Icacorea* [*Ardisia*] *latipes* Martius.  
*Icacorea* (?) sp. . . . . *Icacorea* sp.?  
*Stylogyne* (?) *fragmenta* Hollick. . . . . †*Stylogyne* [*Ardisia*] *lateriflora* (Swartz) Mez.  
*Chrysophyllum comparabile* n. sp. . . . . †*Chrysophyllum Cainito* Linnaeus.  
*Chrysophyllum pseudargenteum* n. sp. †*Chrysophyllum argenteum* Jacquin.  
*Chrysophyllum pseudargenteum oblongum* n. var. . . . . *Chrysophyllum argenteum* Jacquin.  
*Dipholis pseudoleiantha* n. sp. . . . . \**Dipholis leiantha* Standley.  
*Sapota agnitionalis* n. sp. . . . . †*Sapota Achras* Miller.  
*Sideroxylon aequale* n. sp. . . . . †*Sideroxylon foetidissima* Jacquin.  
*Apocynophyllum pseudowillughbya* Hollick. . . . . *Willughbya scandens* Willdenow.  
*Apocynophyllum Wilcoxense* Berry? . . . *Nerium* sp.?  
*Aspidosperma collazoënsis* Hollick. . . *Aspidosperma polyneuron* Mueller.  
*Echites pseudostellaris* n. sp. . . . . \**Echites stellaris* Lindley.  
*Echitonium* (?) sp. . . . . *Echites* sp.?  
*Hancornia minor* Hollick. . . . . *Hancornia pubescens* Nees & Martius.  
*Hancornia speciosa* Gomez.  
*Hancornia pseudopubescens* Hollick. . . *Hancornia pubescens* Nees & Martius.  
*Plumiera evidens* Hollick. . . . . *Plumiera bracteata* A. De Candolle.  
†*Plumiera ruba* Linnaeus.  
*Plumiera sucuba* Spruce.  
*Guettarda intercalaris* n. sp. . . . . \**Guettarda* sp.?  
*Ramulus* gen. et sp.? . . . . ?

A numerical analysis of the above listed flora of the Collazo shales shows it to consist of 91 specific elements or entities—using these terms in the broadest sense—included in 51 genera, 24 families, and 20 orders, grouped, taxonomically, as follows:

	Species	Genera	Families	Orders
Thallophyta . . . . .	1	1	1	1
Pteridophyta . . . . .	2	2	2	2
Gymnospermae . . . . .	2	1	1	1
Monocotyledonae . . . . .	14	7	2	2
Dicotyledonae . . . . .	71	39	17	13
Undetermined . . . . .	1	1	1	1
	91	51	24	20

The single representative of the Thallophyta (*Chondrites dictyotoides*) in the flora, which apparently represents a marine or brackish-water alga, is of ecological interest as indicating lagoon or estuary conditions under which the sediments were deposited in which it and its associated land plant remains were entombed and preserved; and such conditions are further indicated by the presence of fresh- and brackish-water molluses, crustaceans, and other animal remains in the same series of sediments. *Chondrites dictyotoides* may be compared with certain species of the existing cosmopolitan genus *Dictyota*, especially with *D. Bartayresii* Lamouroux, a marine alga native in Porto Rican waters and in tropical and subtropical waters elsewhere along the Atlantic coast. The generic name *Chondrites*, representing a fossil algal genus, has been rather loosely applied; but it is largely associated with species of Tertiary age, from both the Old World and the New.

The only fern in the flora, *Hemitelia Brannerii* Hollick & Berry, is, apparently, specifically identical with specimens previously described from the Tertiary of Brazil, and not recorded from elsewhere until found in Porto Rico. The genus *Hemitelia*, in our existing flora, is cosmopolitan and tropical in its geographical distribution; and three of its approximately forty recognized species are native in Porto Rico.

The genus *Isoetes* includes several fossil species, of Tertiary age, and some fifty existing species of tropical and temperate distribution, in the Old World and in North and South America, Mexico and Cuba. It is not, however, an element in the existing flora of Porto Rico. The species from the Callazo shales (*Isoetes* (?) *incerta*), if correctly identified generically, is, therefore, of interest by reason of its geographical location, in addition to its purely botanical interest as the second one of the only two known representatives of the Pteridophyta in the flora of the shales, and, incidentally, as one of the only two recorded fossil species of *Isoetes* from the New World.

The Gymnospermae are represented by two more or less well defined species of *Zamia* (*Z. collazoënsis* and *Z. Noblei*) and, possibly, by one or more additional species or varietal forms, which might be differentiated from them. Their remains are, relatively, abundant, and it is apparent that the genus was an important element in the flora. Cycads in general, although well represented in rocks of Mesozoic age throughout the world, are very rare as

Tertiary fossils, either in the Old World or the New, and the discovery of these abundant and well defined remains in the Collazo shales is of considerable interest. In the existing flora the genus *Zamia* is represented by about thirty species, all of which are confined to the tropical and subtropical regions of the New World. Three of these are native in Porto Rico, one of which (*Z. integrifolia* Jacquin) is so clearly comparable with *Z. collazoënsis* as to be almost indistinguishable from it, as far as surficial foliar characters are discernible.

The Monocotyledonae are well represented by a number of species referable to the Arecales. Stem and leaf fragments and fruits of palms are abundant, both relatively and actually. The number of genera included is six, and the number of described species is thirteen; but certain of these may or may not represent distinct genera or species, in as much as some are based wholly upon fragments of woody parts, others on foliar remains, and others on fruits. The comprehensive fossil genera *Palmocarpon*, *Palma-cites* and *Palmophyllum*, and the species included under them cannot, therefore, be properly utilized in any enumeration in connection with either category. They indicate however, that the palms were an abundant and important element in the flora. The genus *Bactris* is represented in the existing native flora of Porto Rico by one species, and *Iriartea* and *Manicaria* are tropical American genera. How many other existing genera may be represented in the other fruits and fragmentary remains could be inferred, approximately; but any such inference would be of no statistical value.

The Scitaminales are represented by a single genus, *Musophyllum*, the identification being based upon a single leaf fragment which might almost equally well be referred to the existing genus *Musa*. Definite and satisfactory identification of any fossil remains of *Musa* in the flora of the Collazo shales would be of great interest, in view of the doubt that yet obtains in regard to the nativity of the genus in the New World, even though the identity of banana seeds, found in Middle Tertiary deposits in South America, has not been questioned, as far as I am aware.

An analysis of the list of the Dicotyledonae shows that the twenty-five genera of the Choripetalae include fifty-two species, or over fifty-seven per cent of the entire flora. Nine orders and eleven families are represented in the group, of which the Rosales, with one family (Leguminosae), seven genera, and nineteen species

is the most extensive of the entire flora, in both generic and specific elements; and the genus *Cassia*, with seven species is the largest of the genera. Furthermore, all of the genera, with three exceptions (*Oreodaphne*, *Malvocarpon*, and *Combretum*) are represented by one or more species each in the existing flora of Porto Rico.

The Gamopetalae are represented by fourteen genera and nineteen species, included in four orders and four families, of which the Gentianales, with one family (Apocynaceae), six genera, and eight species, contains the largest number of generic and specific elements. Two of the fourteen genera (*Apocynophyllum* and *Echitonium*) are fossil genera. Three (*Myrsine*, *Aspidospermum*, and *Hancornia*) are not represented in the native flora of Porto Rico, although all are represented in the flora of the adjacent mainland. The remaining nine genera are elements in the native flora of the island.

If the flora as a whole is analysed, in connection with its existing generic elements, certain salient facts are obvious. Every genus is tropical, or tropical and subtropical in its distribution. Some, such as *Ficus*, *Cassia*, *Eugenia*, *Myrsine*, etc., are cosmopolitan; others, such as *Zamia*, *Bactris*, *Iriartea*, *Manicaria*, *Acroclidium*, *Inga*, *Hancornia*, etc., are exclusively American genera. Thirty-five of the genera are elements in the present flora of Porto Rico; and a number of the species such as *Zamia collazoënsis*, *Z. Noblei*, *Annona cetera*, *Acroclidium pseudosalicifolium*, *Lonchocarpus praelatifolius*, *Trichilia pseudohirta*, etc., are so closely comparable with certain existing species in the flora of the island that any differences between them are not obvious, and it would be practically impossible to differentiate between them in any descriptions based upon surficial foliar characters alone.

#### GEOLOGICAL DISCUSSION

The flora of the Collazo shales is of limited value as an index of the exact geological age of the shales, in as much as it is, for the most part, composed of heretofore undescribed species, nearly all of them closely similar to certain ones now in existence. Of the ninety-one recognized floral entities, sixty-four, or about seventy per cent., represent new species. These, therefore, are not available for the purpose of critical stratigraphic identification; and, of the remaining twenty-seven, which represent previously described species, twenty-two are from the Collazo shales, and consequently

they also are negligible for the same purpose. The genera, however, are clearly indicative of the major stratigraphic position of the flora, and from these we may be justified in assuming that its Tertiary age will not be questioned; but whether it may properly be regarded as Eocene, Oligocene, Miocene, or even Pliocene represents a legitimate subject for discussion.

Those who have studied the stratigraphic relations of the shales in the field, and those who have studied the included fauna, are not entirely in agreement in their inferences and conclusions as to the exact age of the shales; but the range of difference is so slight as to be of little consequence—the extremes being upper Eocene to lower Miocene.

Only five extra-territorial elements have been recorded in the flora, and it would be hazardous to deduce any critical conclusions, or even inferences, based upon species that represent such a small percentage of the whole. It may be pertinent, however, to list them, together with data relating to their stratigraphic status and geographic distribution, as far as known, viz:

- Hemitelia Brannerii* Hollick & Berry. Upper Miocene or Pliocene? Brazil.
- Ficus Schimperii* Lesquereux. . . . . Eocene (Wilcox formation), southern United States; (Raton formation), Colo., N. Mex.
- Oreodaphne mississippiensis* Berry. . . . . Eocene (Wilcox formation), southern United States.
- Cassia puryearensis* Berry. . . . . Eocene (Wilcox formation), southern United States.
- Apocynophyllum Wilcoxensis* Berry. . . . . Eocene (Wilcox formation), southern United States; (Raton formation), Colo.

From the above data it may be seen that the species listed are in substantial agreement with the stratigraphy of the shales as interpreted by other observers.

In the tabulation that follows an effort has been made to compare certain of the elements of the Collazo shales flora with described fossil species that appear to simulate them most closely:

FLORA OF THE COLLAZO SHALES	FOSSIL SPECIES OF SURFICIAL RESEMBLANCE
<i>Chondrites dictyotoides</i> n. sp. . . . .	<i>Chondrites Targione arbuscula</i> (Fischer-Ooster) Heer.
	<i>Chondrites intricatus</i> (Brongniart) Sternberg.
<i>Hemitelia Brannerii</i> Hollick & Berry?	
<i>Isoetes</i> (?) <i>incerta</i> n. sp. . . . .	<i>Isoetes Braunii</i> (Unger) Heer.
<i>Zamia collazoensis</i> n. sp. . . . .	<i>Zamia tertiaria</i> Engelhardt.

- Zamia Noblei* n. sp. . . . . *Zamia* (?) *Wilcoxensis* Berry.  
*Bactris Pseudocuesco* n. sp. . . . . *Palmocarpon* (?) *globosum* Lesquereux.  
*Iriartea collazoënsis* n. sp. . . . .  
*Manicaria portoricensis* n. sp. . . . .  
*Palmocarpon acrocomioides* Hollick. . . . . *Palmacites* [*Antholithes*] *Martii* Heer.  
*Palmocarpon truncatum major* Lesquereux.  
*Palmocarpon cetera* n. sp. . . . . *Palmocarpon mexicanum* Lesquereux.  
*Palmocarpon exemplare* n. sp.  
*Palmocarpon opinabile* n. sp. . . . . *Nipadites umbonatus* Bowerbank.  
*Palmocarpon Rabellii* n. sp.  
*Palmacites alius* n. sp.  
*Palmacites conformis* n. sp.  
*Palmacites sparsistriatus* n. sp. . . . . *Palmacites canaliculatus* Heer.  
*Palmophyllum* sp. Hollick.  
*Palmophyllum* sp. (fragment of petiole)? Hollick.  
*Musophyllum* sp. . . . . *Musophyllum trinitense* Hollick.  
*Musophyllum elegans* Engelhardt.  
*Ficus hyphodroma* n. sp. . . . . *Ficus cölnitica* Berry.  
*Ficus Schimperii* Lesquereux . . . . . *Ficus monodon* (Lesquereux) Berry.  
*Ficus cuspidata* Watelet.  
*Ficus vexativus* n. sp. . . . . *Ficus comparabilis* Hollick.  
*Ficus* sp.  
*Annona cetera* n. sp. . . . . *Anona* [*Annona*] *Wilcoxiana* Berry.  
*Anona* [*Annona*] *lignitum* Unger.  
*Annona pseudoglabra* n. sp.  
*Acrodiclidium pseudosalicifolium* n. sp.  
*Acrodiclidium Pseudocandlo* n. sp. . . . . *Ocotea pseudomartinicensis* Hollick.  
*Aniba collazoënsis* n. sp. . . . . *Nectandra curvatifolia* Engelhardt.  
*Nectandra Woodringii* Berry.  
*Hufelandia portoricensis* (Hollick) n. comb. . . . . *Trigonía varians* Engelhardt.  
*Misanteca dubiosa* (Hollick) n. comb.  
*Oreodaphne mississippiensis* Berry? . . . . . *Nectandra Glennii* Berry.  
*Laurus attenuata* Watelet. *Litsaca expansa* Saporta & Marion.  
*Inga curta* n. sp. . . . . *Inga mississippiensis* Berry.  
*Leguminosites cclastroides* Heer.  
*Inga pseudinsignis* n. sp.  
*Inga pseudonobilis* Hollick.  
*Inga pseudospuria* n. sp.  
*Inga* (?) sp. Hollick . . . . . *Inga sanchezensis* Berry.  
*Pithecellobium* (?) *imperfectum* n. sp. . . . . *Caesalpinia Wilcoxiana* Berry.  
*Cassia longifolia* Engelhardt.  
*Pithecellobium pseudotrapezifolium* Hollick . . . . . *Pithecolobium tenuifolium* Engelhardt.  
*Pithecellobium vexativum* Hollick . . . . . *Laguminosites copaisferoides* Engelhardt.



<i>Dipholis pseudoleiantha</i> n. sp.	
<i>Sapota agnitionalis</i> n. sp. . . . .	<i>Hancornia pseudopubescens</i> Hollick. <i>Mimusops Leonii</i> Hollick.
<i>Sideroxylon aequale</i> n. sp.	
<i>Apocynophyllum pseudowillughbya</i> Hollick . . . . .	<i>Melicocca immutata</i> n. sp.
<i>Apocynophyllum Wilcoxense</i> Berry? . . . . .	<i>Nerium bilanicum</i> Ettingshausen. <i>Nerium sarthacense</i> Saporta.
<i>Aspidosperma collazoënsis</i> Hollick.	
<i>Echites pseudostellaris</i> n. sp.	
<i>Echitonium</i> (?) sp. . . . .	<i>Echitonium lanceolatum</i> Ettingshausen. <i>Apocynophyllum chilense</i> Engelhardt.
<i>Hancornia minor</i> Hollick . . . . .	<i>Myrsine pseudoferruginea</i> n. sp.
<i>Hancornia pseudopubescens</i> Hollick . . . . .	<i>Sapota agnitionalis</i> n. sp.
<i>Plumiera evidens</i> Hollick . . . . .	<i>Apocynophyllum mexicanum</i> Berry.
<i>Guettarda intercalaris</i> n. sp. . . . .	<i>Tapiria</i> [ <i>Tapirira</i> ] <i>lanceolata</i> Engelhardt.
<i>Ramulus</i> gen. et sp.?	

An analysis of the data included in the above tabulation might be utilized to deduce various inferences or conclusions; but they would not be likely to result in anything that could alter the point of view previously outlined. In other words the general facies of the flora of the Collazo shales, compared with that of a flora composed of fossil species most closely similar, would be indicative of lower-middle Tertiary age.

Incidentally it may also be of interest to compare this Tertiary flora of a tropical region with approximately contemporaneous floras northward, and to infer from their elements the climatic conditions that probably prevailed in the region where each flora was growing. Specific comparisons would be too few to be of any value; but comparisons based upon the generic elements in each may be utilized to advantage.

As previously outlined, the forty-two existing genera included in the flora of the Collazo shales are all representative of tropical and subtropical environment. The flora, in its general facies, is essentially 100 per cent. tropical.

The Eocene (Wileox and Lagrange) flora of the southern part, or Gulf region of the North American Continent, is composed of about 130 generic elements, of which ninety-four are identified as existing genera; and of these about eighty are of tropical distribution, and the others might be classed a subtropical and warm temperate. Among the former may be noted *Zamia*, *Ficus*, *Annona*, *Oreodaphne*, *Inga*, *Pithecellobium*, *Cassia*, *Sophora*, *Sapindus*, *Zizyphus*, *Combretum*, *Eugenia*, *Myrcia*, *Ikacorea*, *Chryso-*

*phyllum*, *Sideroxylon*, and *Guettarda*—all of which are represented in the flora of the Collazo shales—and *Pistia*, *Chamaedorea*, *Sabalites* [= *Sabal*?], *Canna*, *Artocarpus*, *Coccolobis*, *Pisonia*, *Chryso-balanus*, *Dalbergia*, *Canavalia*, *Simaruba*, *Carapa*, *Cedrela*, *Vantanea*, *Banisteria*, *Sterculia*, etc. About a dozen genera, however, are indicative of cooler climatic conditions, among which may be noted *Hicoria*, *Juglans*, *Quercus*, *Planera*, *Rhamnus*, *Cornus*, and *Fraxinus*. It may be regarded as a flora that is about eighty-five per cent. tropical—certain of the genera indicating climatic conditions warmer than now obtain except in the extreme southern part of the region.

The Eocene (Lance and Fort Union) flora of the Rocky Mountain region includes, approximately, 108 generic elements, of which eighty-five are identified as existing genera. If these genera are analyzed it may be seen that only about ten, or approximately eleven per cent., would be classed as strictly tropical, viz, *Ottelia*, *Sabal*, *Artocarpus*, *Laurus*, *Cabomba*, *Parrotia*, *Bauhinia*, *Acacia*, *Sapindus*, and *Zizyphus*; and about ten others as subtropical or warm temperate, such as *Taxodium*, *Pistia*, *Ficus*, *Nelumbo*, *Magnolia*, *Grewia*, etc. The flora is one that would be representative of the North American temperate zone today, with about twenty-two per cent. tropical and subtropical generic elements included in it, which indicate warmer climatic conditions than those that now prevail in the same latitude.

If the Eocene floras of the Arctic region are analyzed and compared in a similar manner the fact will be apparent that although they include a few tropical and subtropical genera, such as *Taxodium*, several cycads and palms, *Artocarpus*, *Ficus*, *Laurus*, *Magnolia*, etc., their general facies suggests a temperate zone flora, evidencing mild instead of the arctic climatic conditions that now prevail throughout almost the entire region.

The essential fact of geologic interest that the identification and analysis of the floral elements of the Collazo shales have emphasized is that, although mild climatic conditions evidently prevailed throughout the northern hemisphere during early Tertiary time, zonal differentiation was already established to a limited extent. There was a distinctly southern or tropical flora in the equatorial region, and a northern flora in which the tropical elements became fewer and fewer in regions successively further and further north, as temperate zone elements supplanted them.

Old generic types were eliminated and new generic types were evolved in the northern regions as a result of changing climatic conditions; but the flora of the southern regions underwent a barely perceptible change during the same period and subsequently. Whatever new types may have been evolved were the result of factors other than those of climatic change or fluctuation.

#### SUMMARY AND CONCLUSIONS

The flora of the Collazo shales represents one of tropical environment; its habitat was in the vicinity and on the borders of lagoons or estuaries, in which brackish water was present; it is typically New World in its general facies; it is almost identical, generically, with the existing flora of Porto Rico and adjacent regions; it is Tertiary in age and is referable to the lower-middle part of that period.

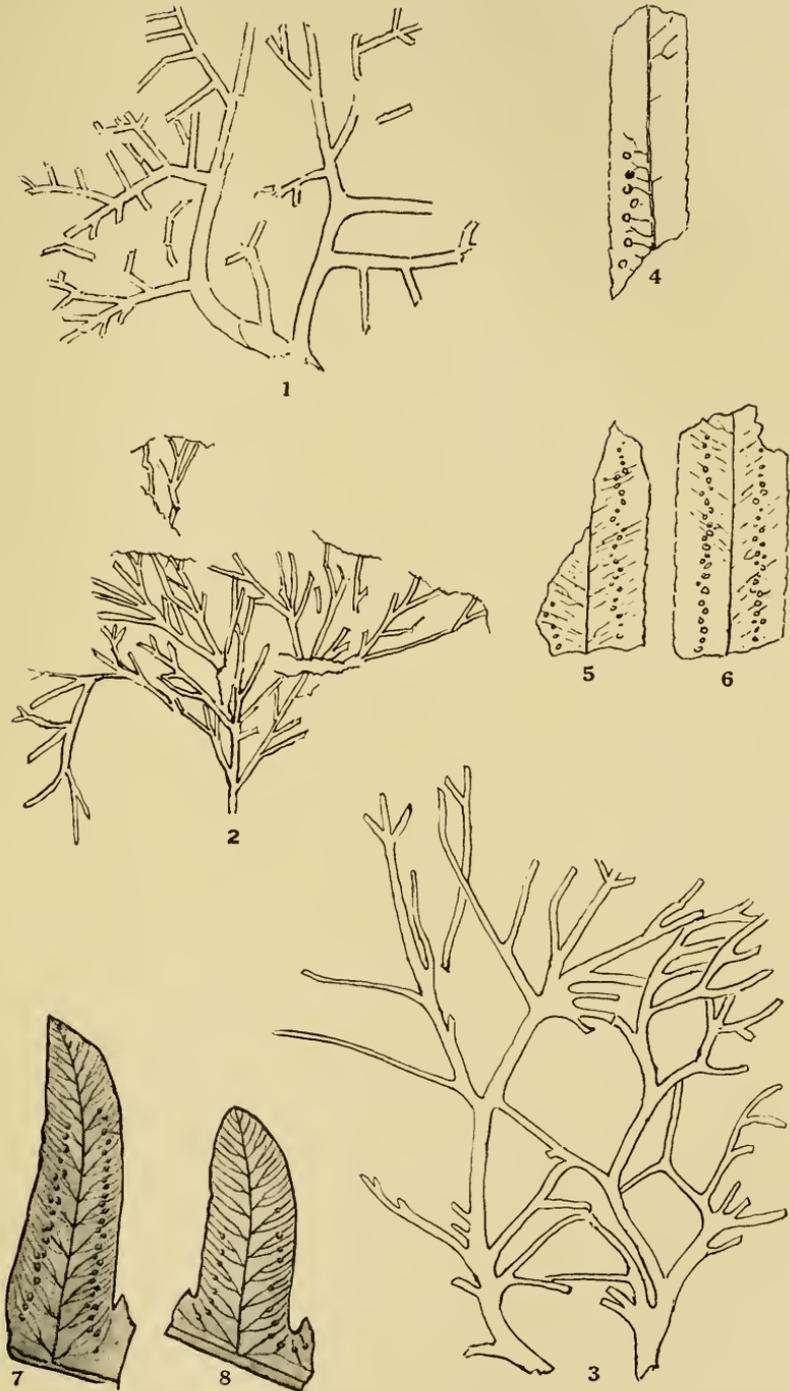
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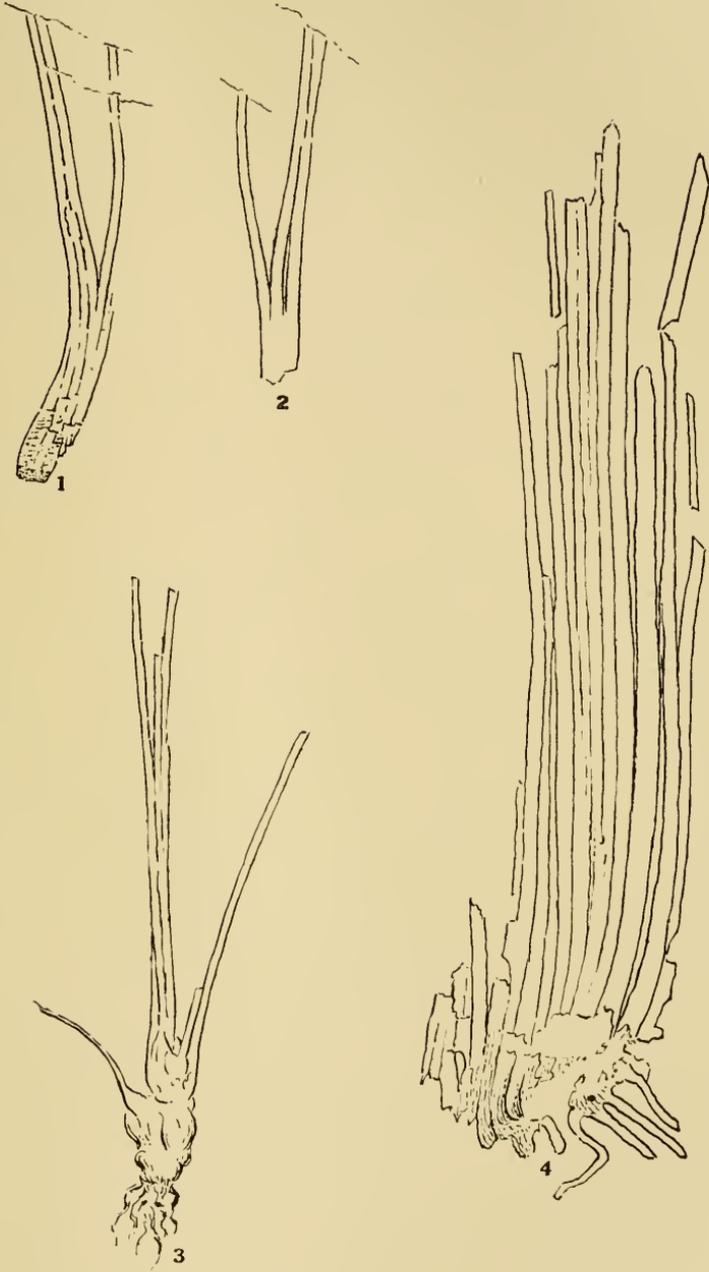
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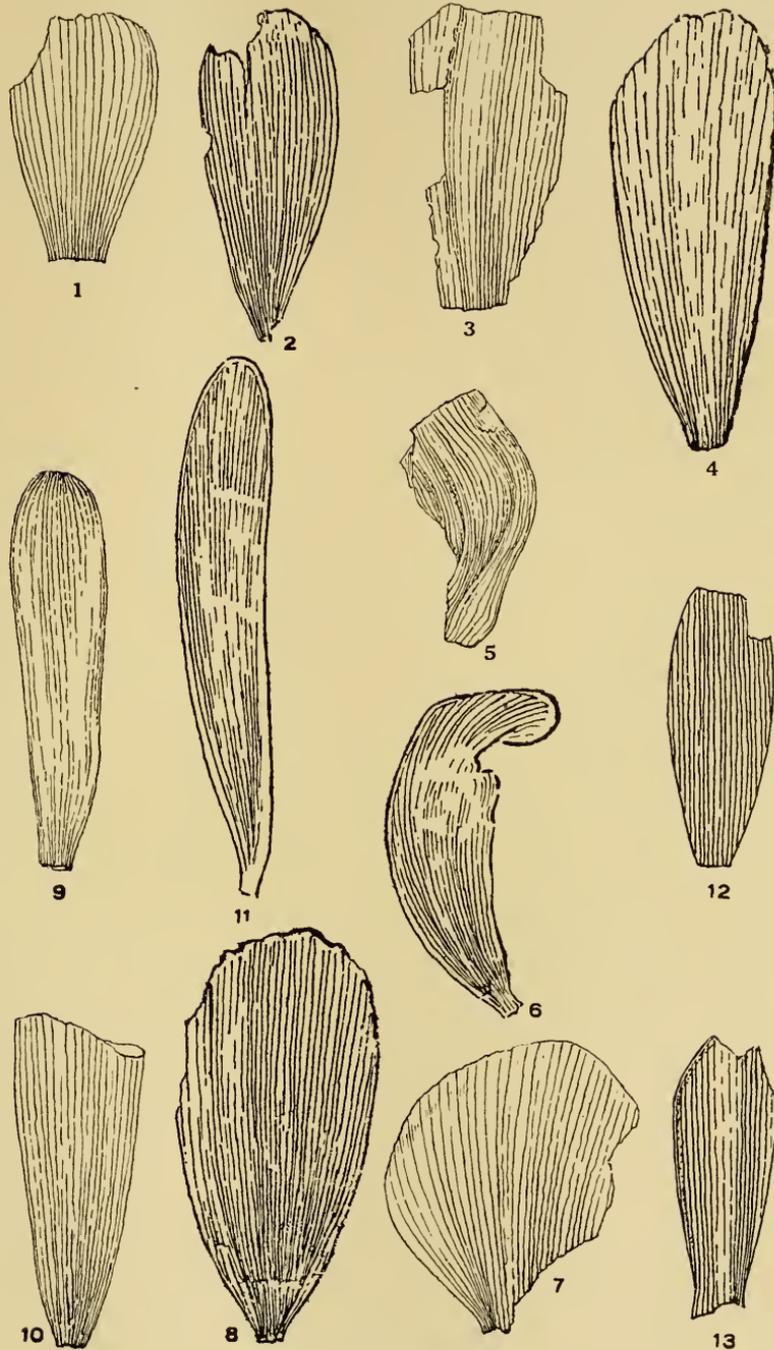
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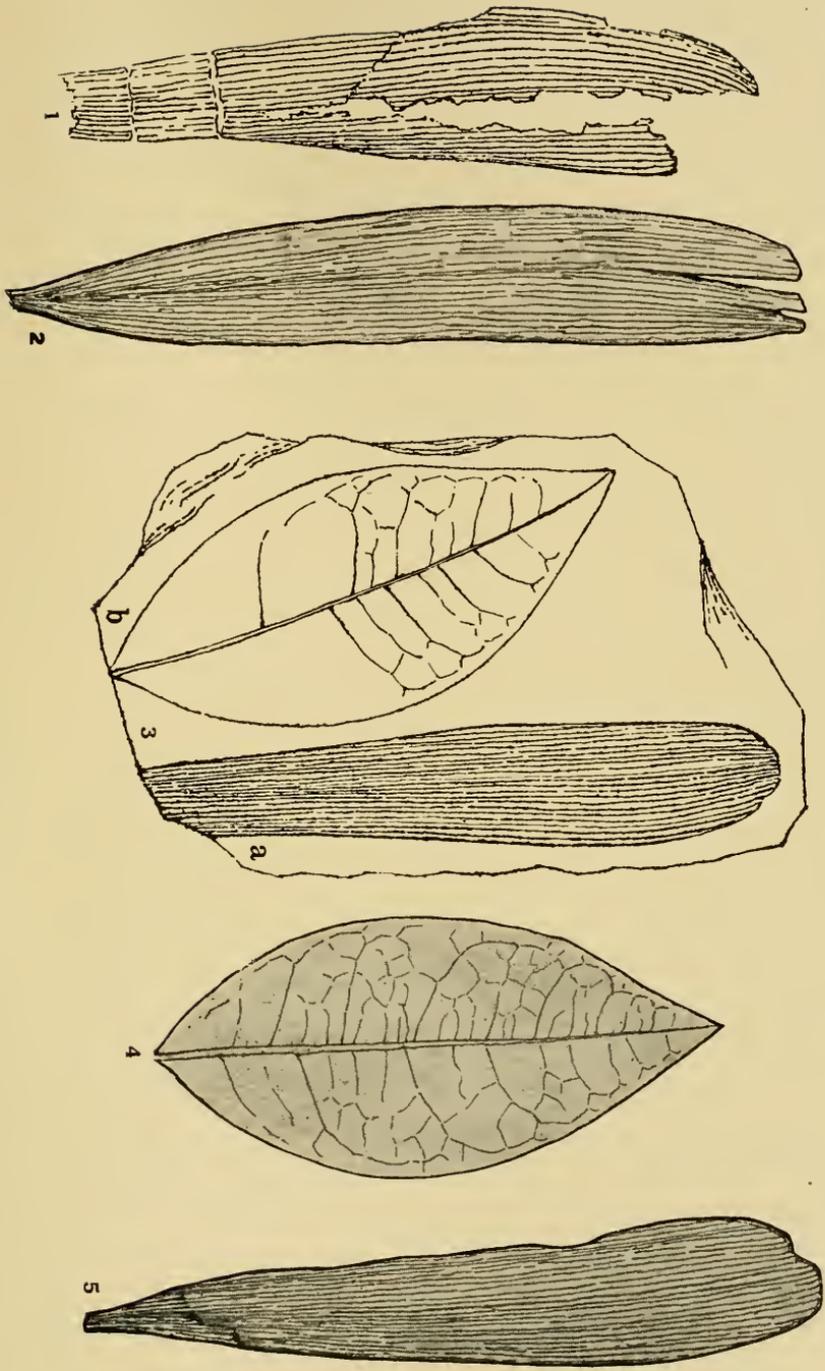
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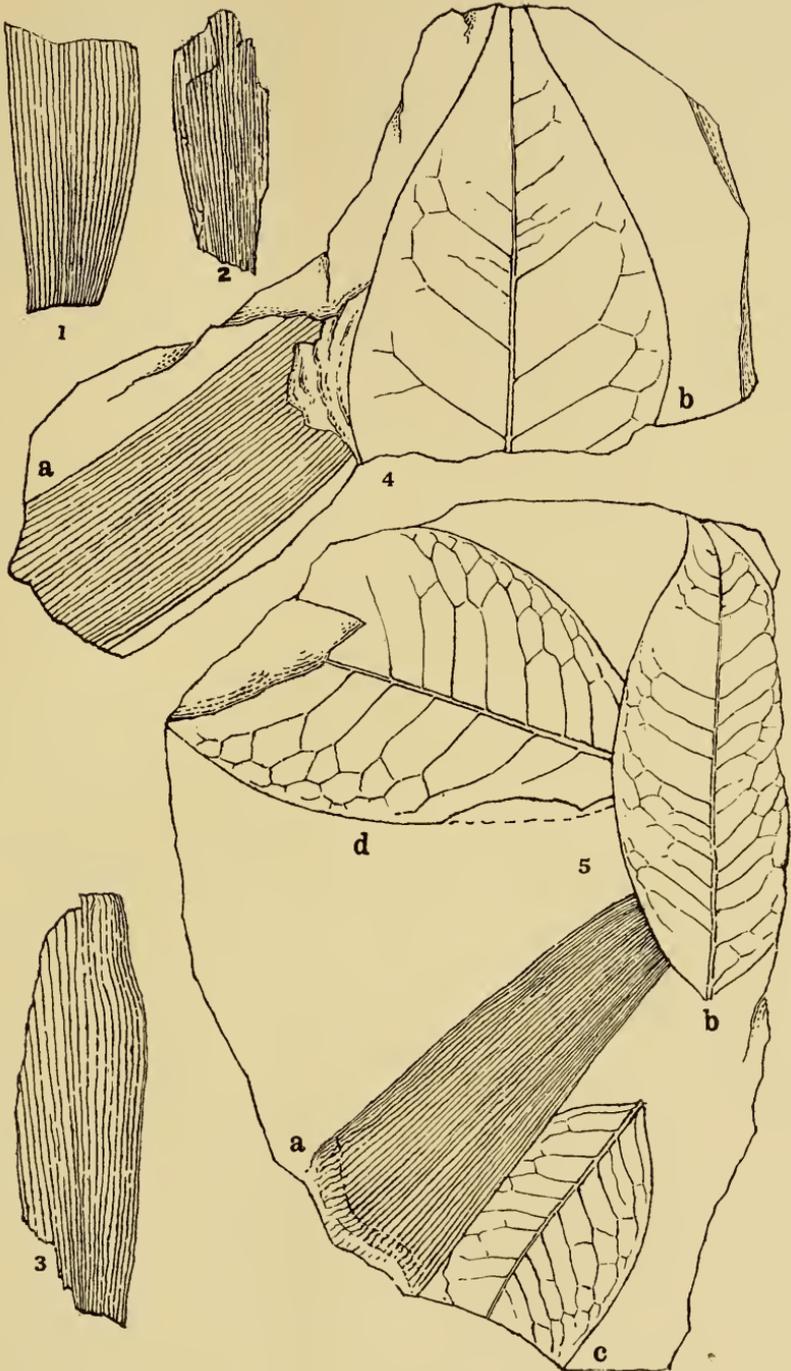
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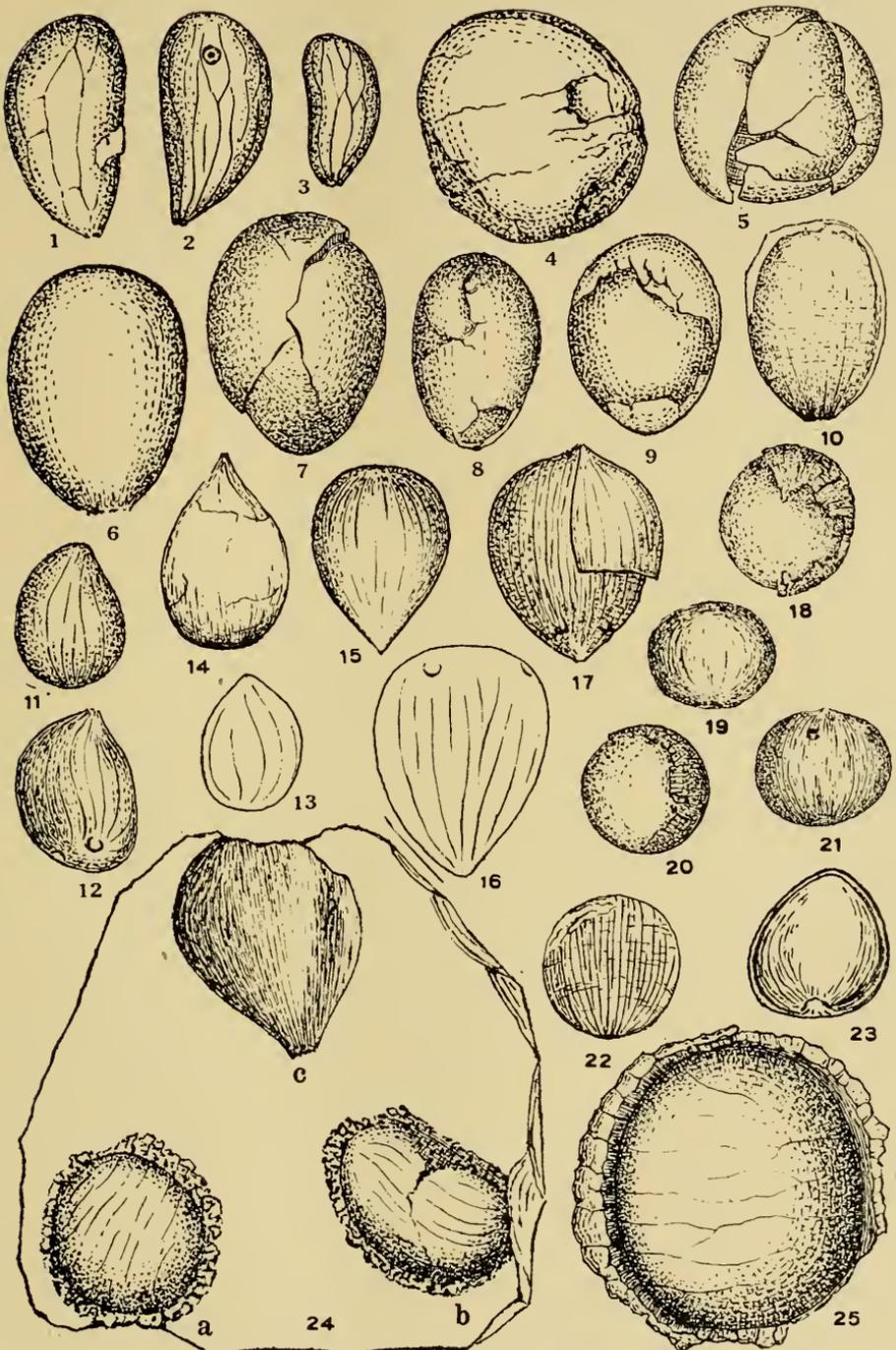
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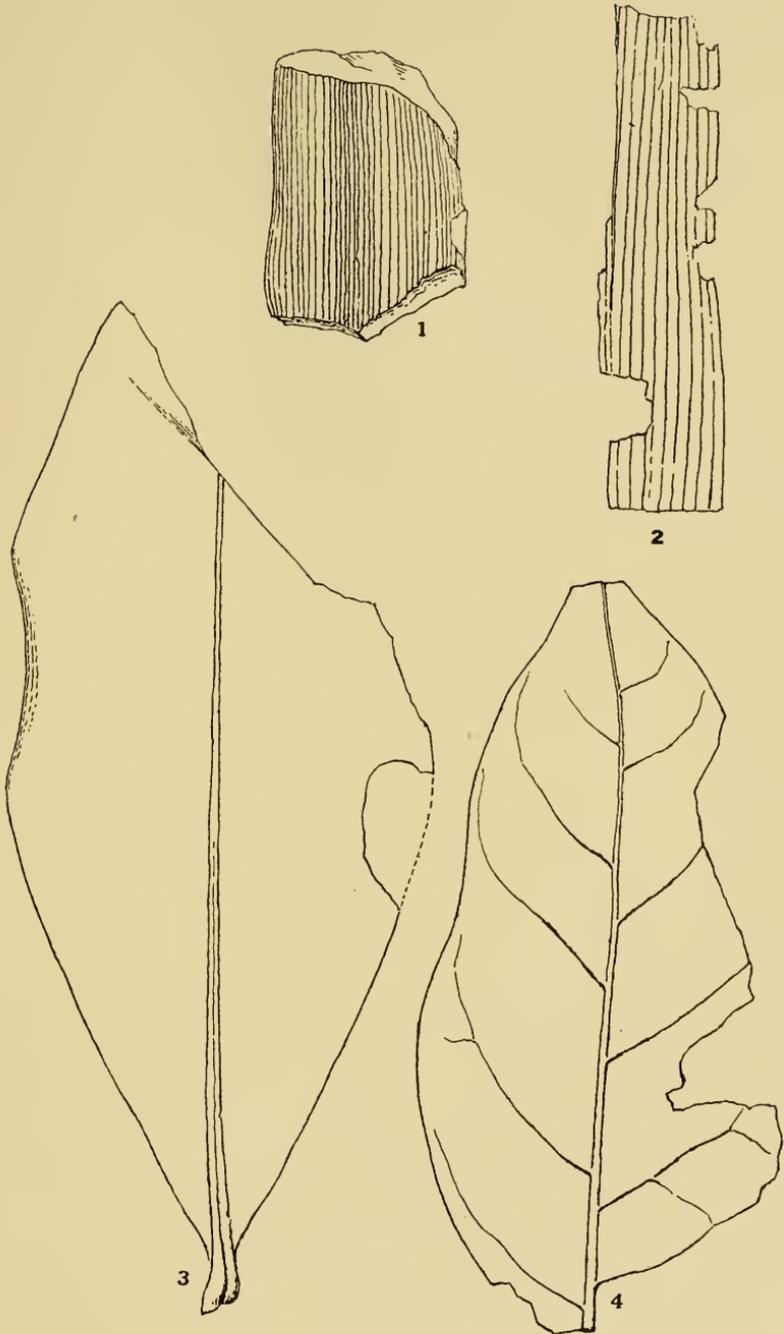
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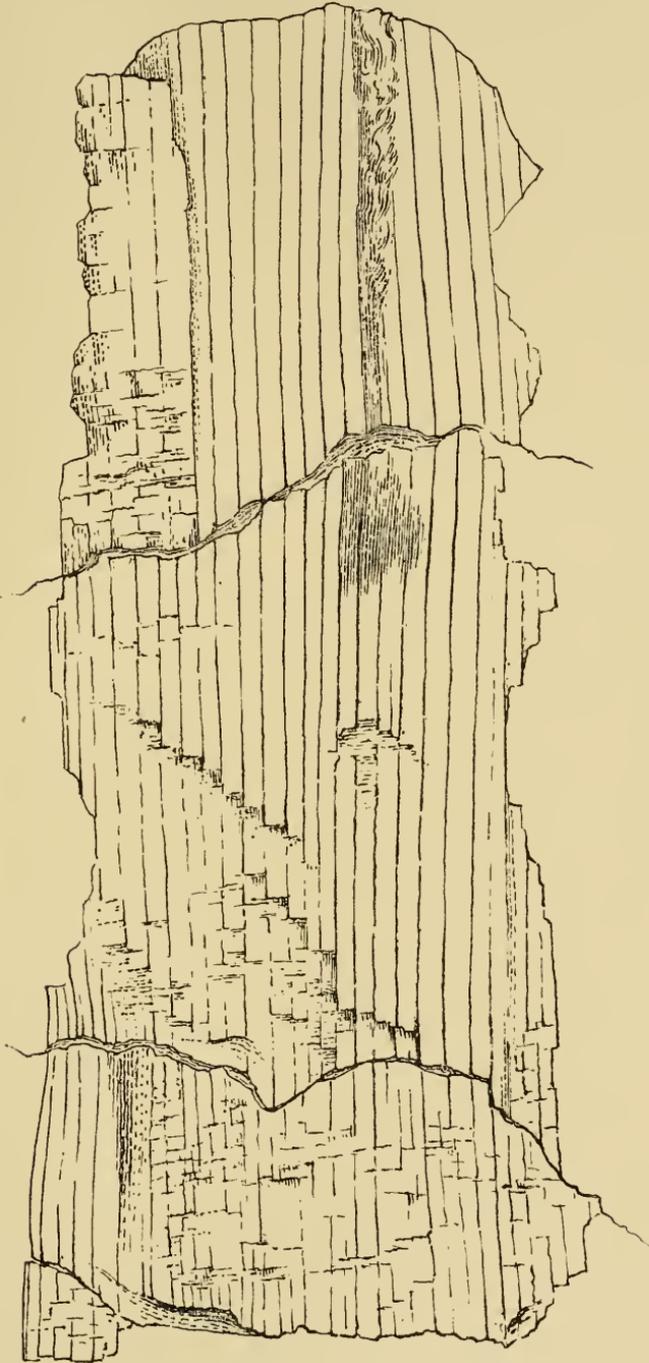
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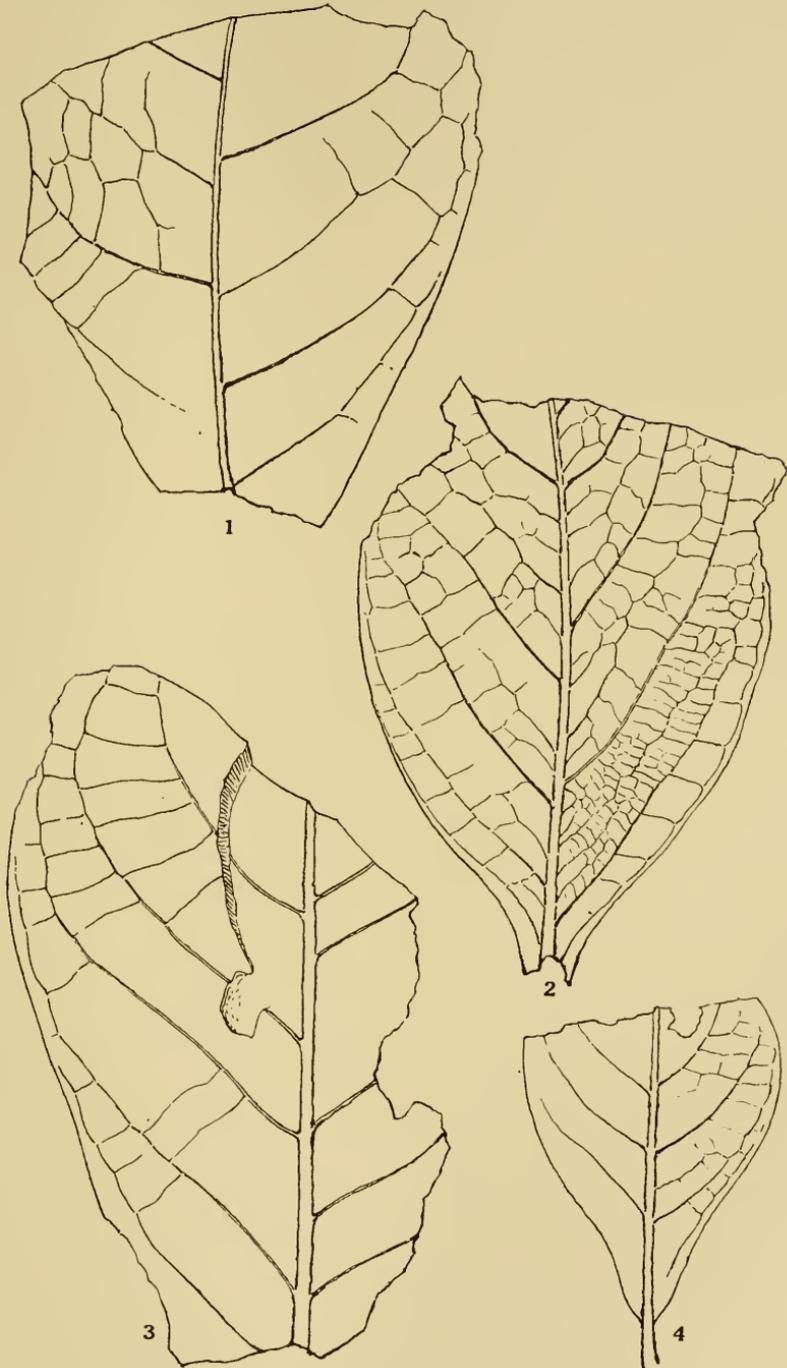
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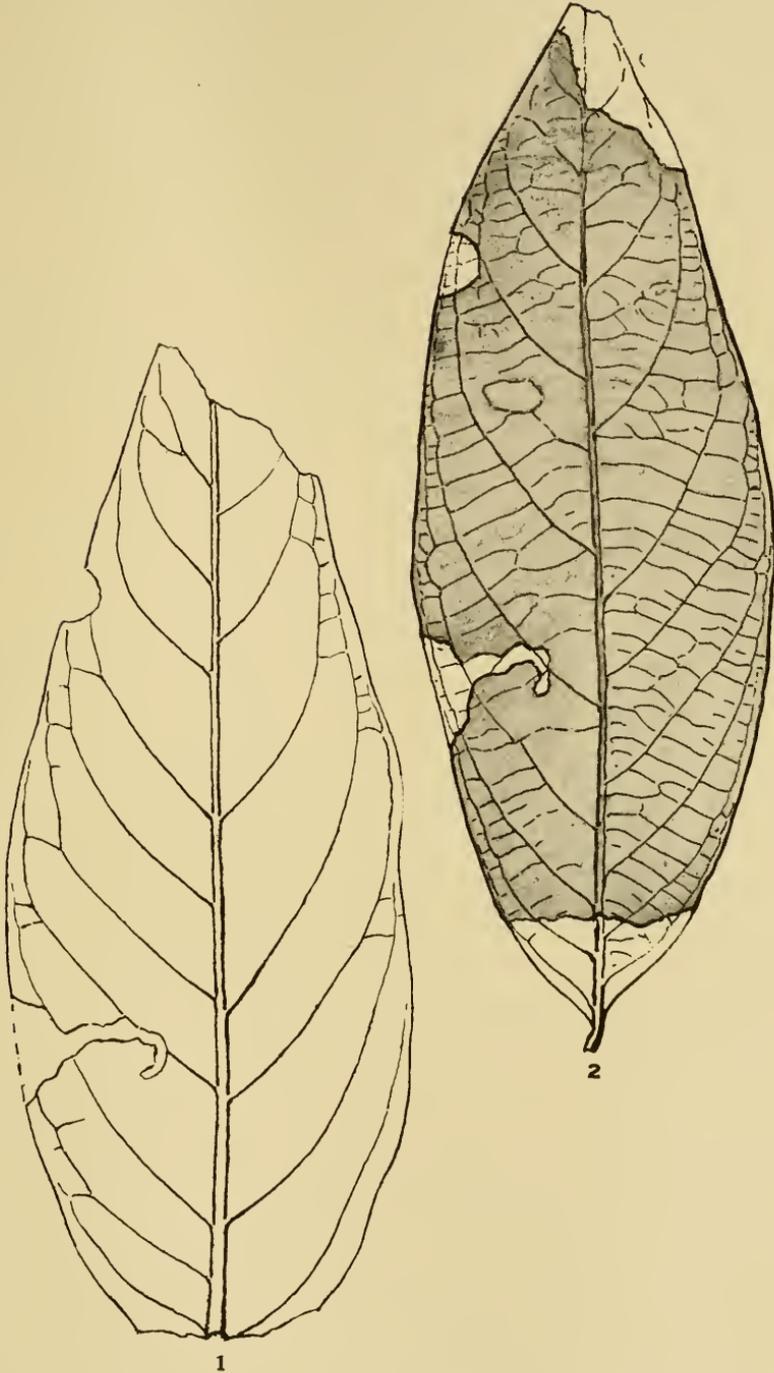
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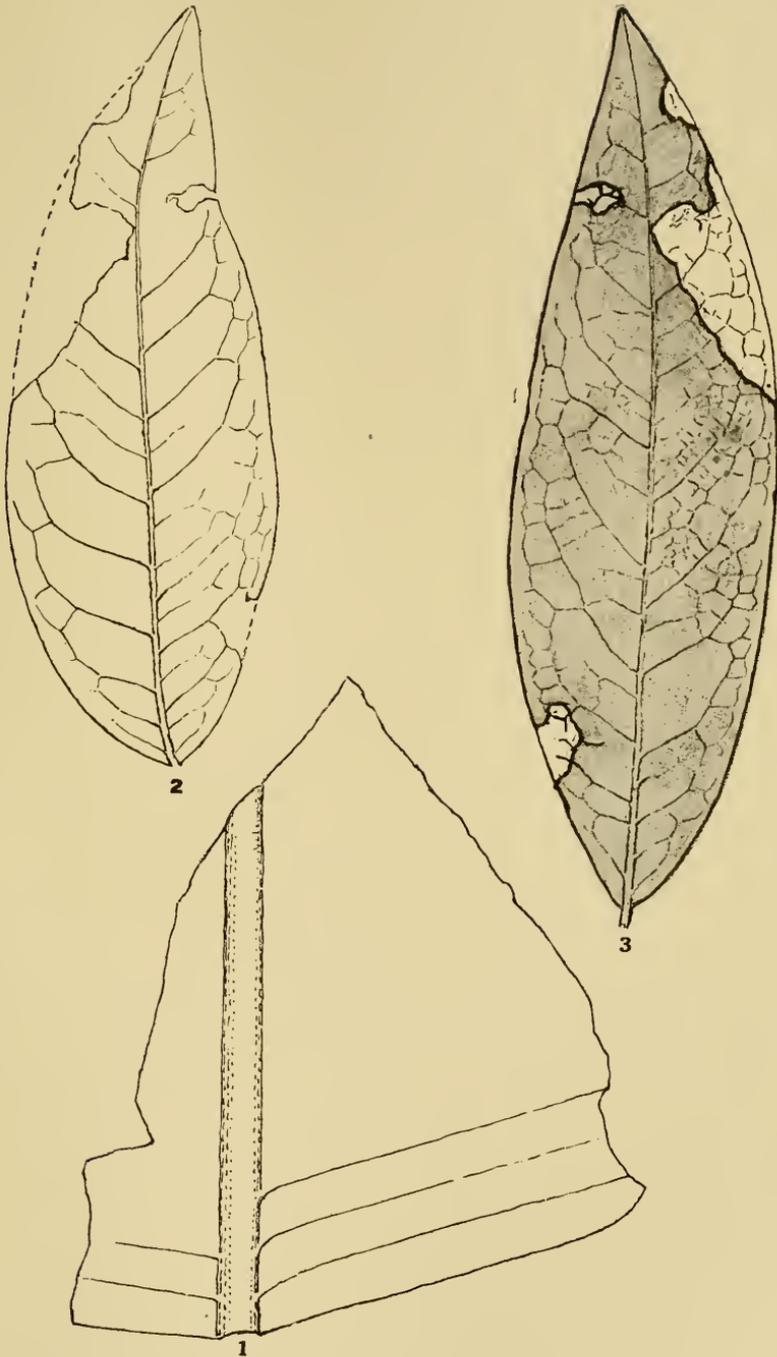
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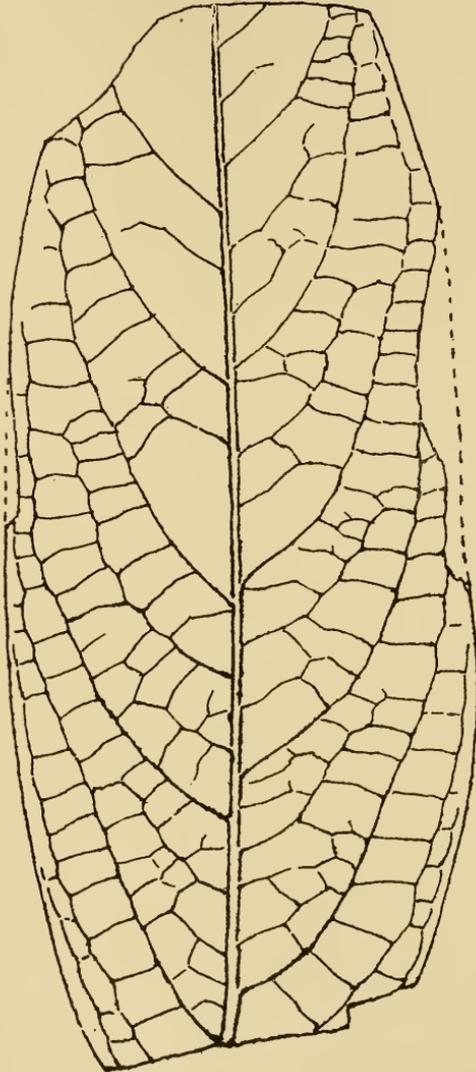
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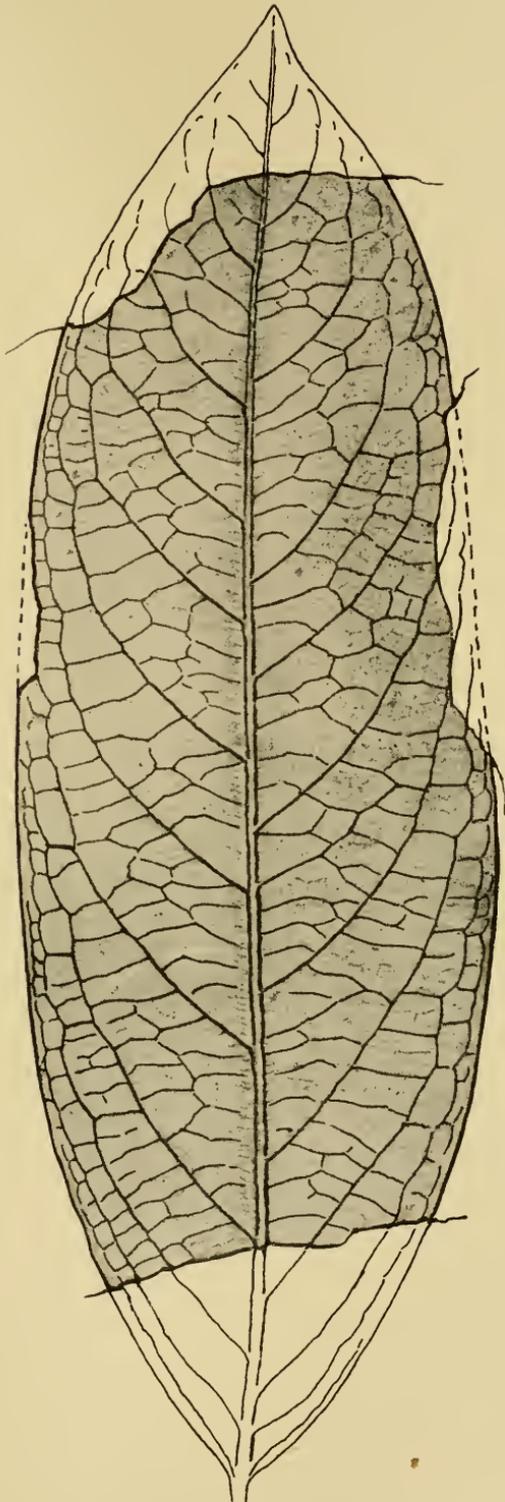
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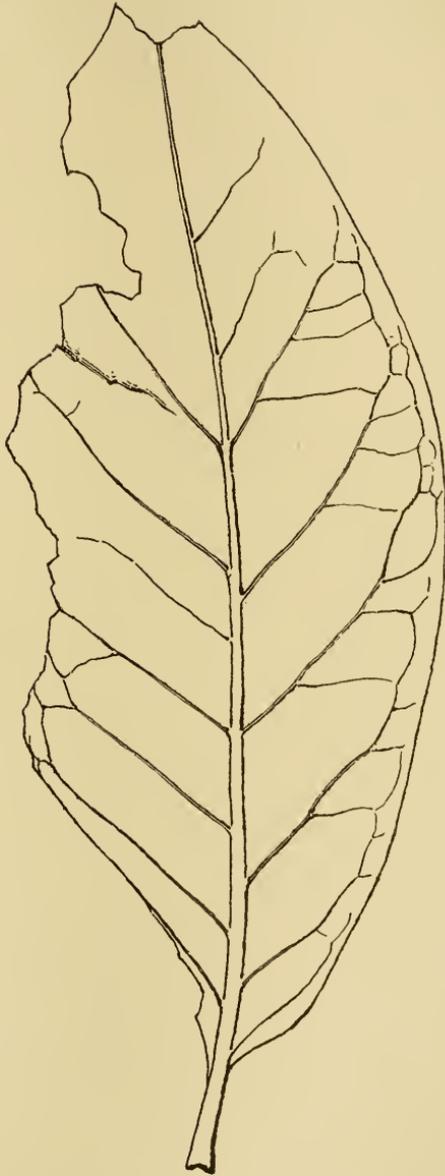
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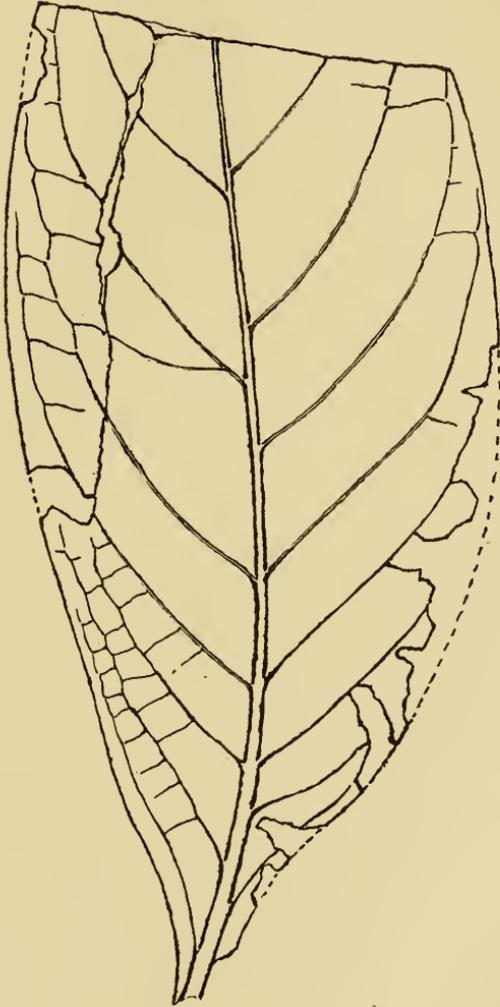
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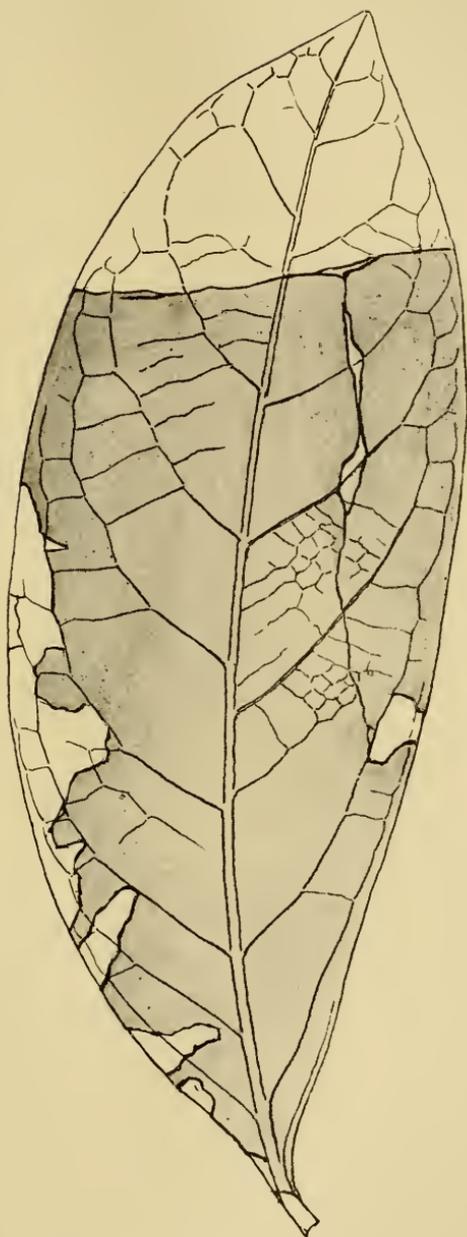
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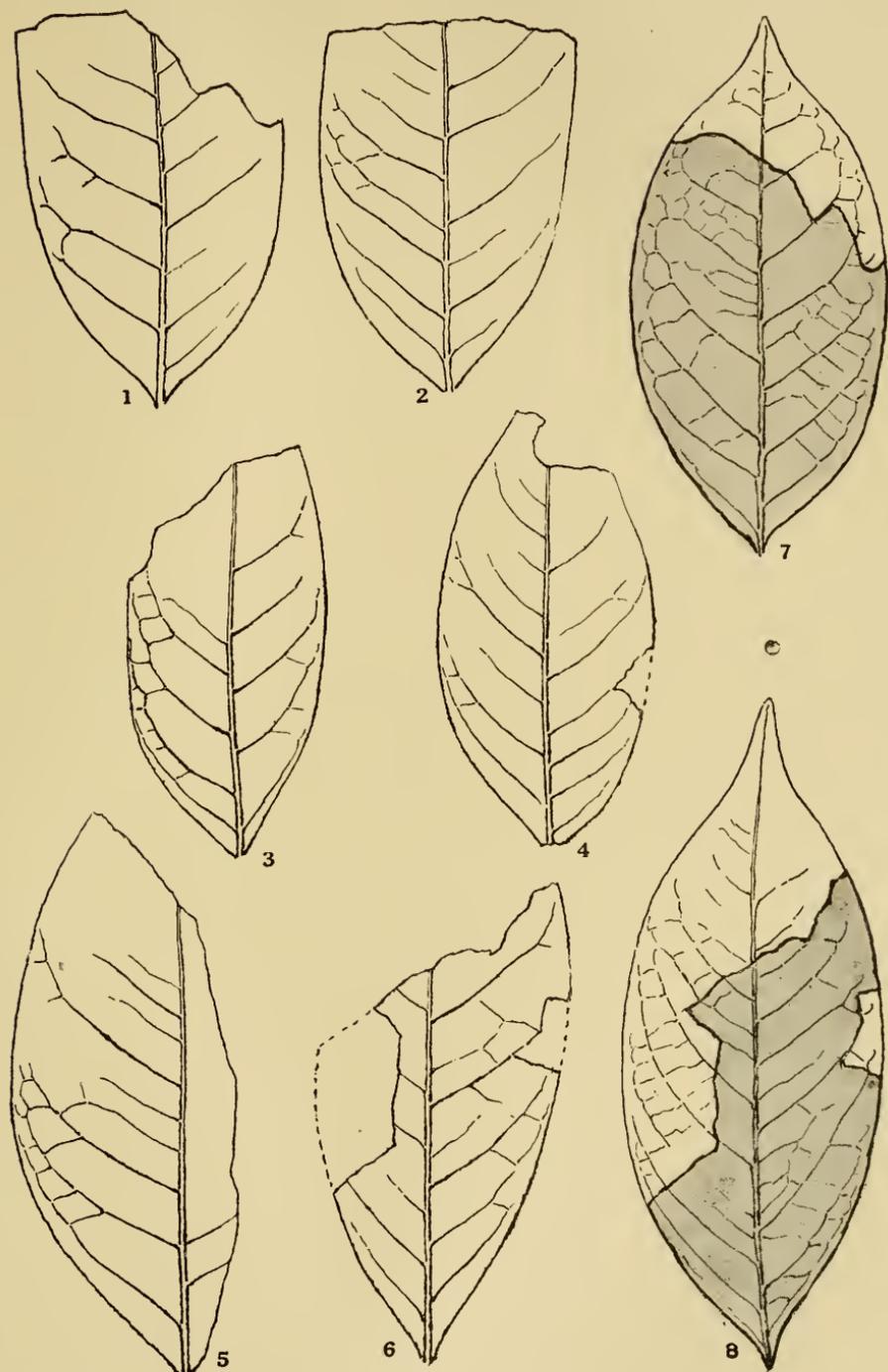
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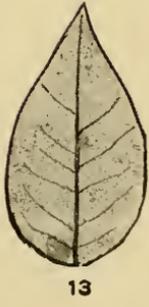
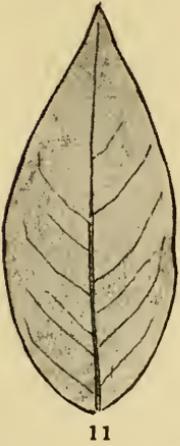
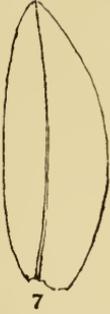
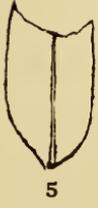
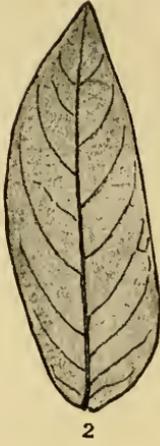
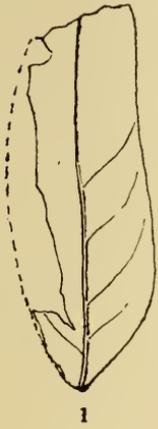
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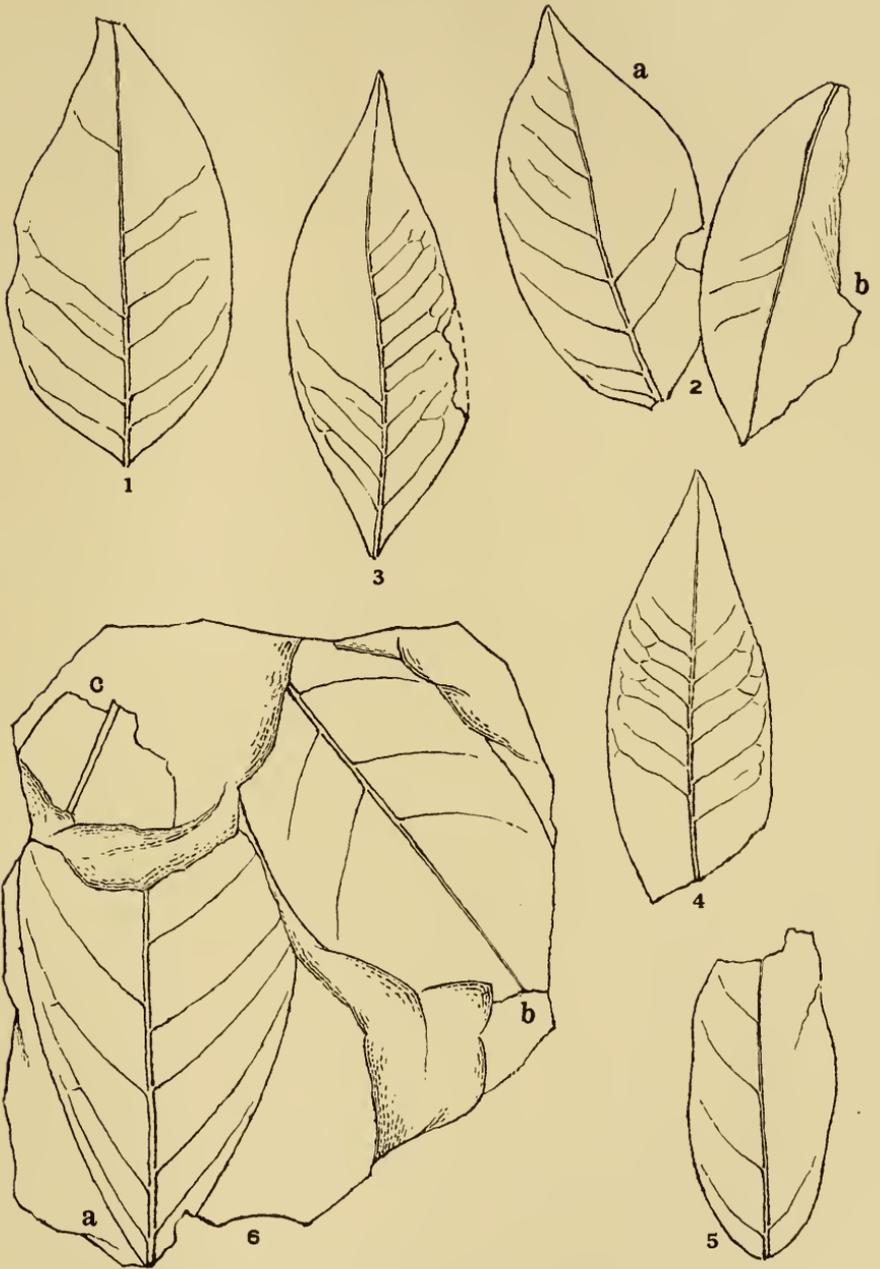
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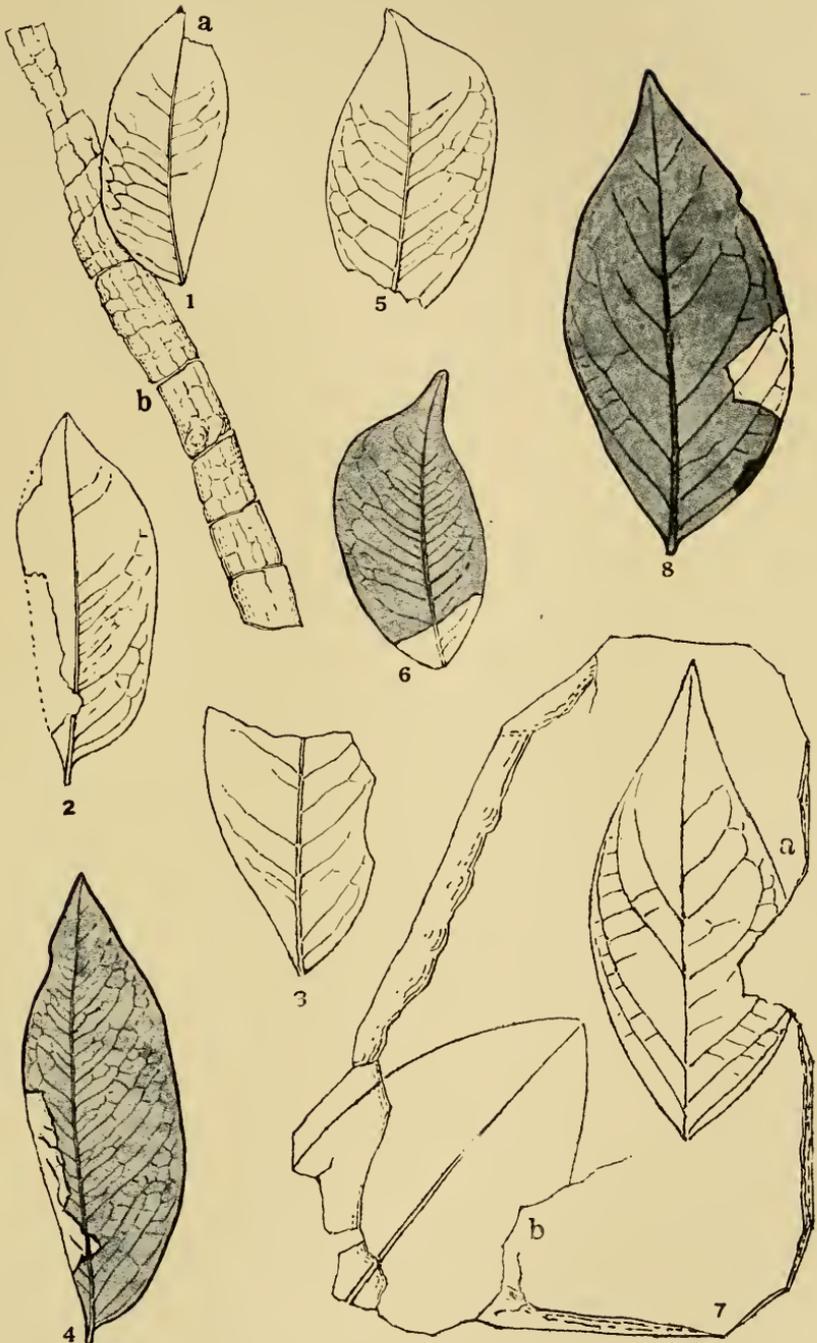
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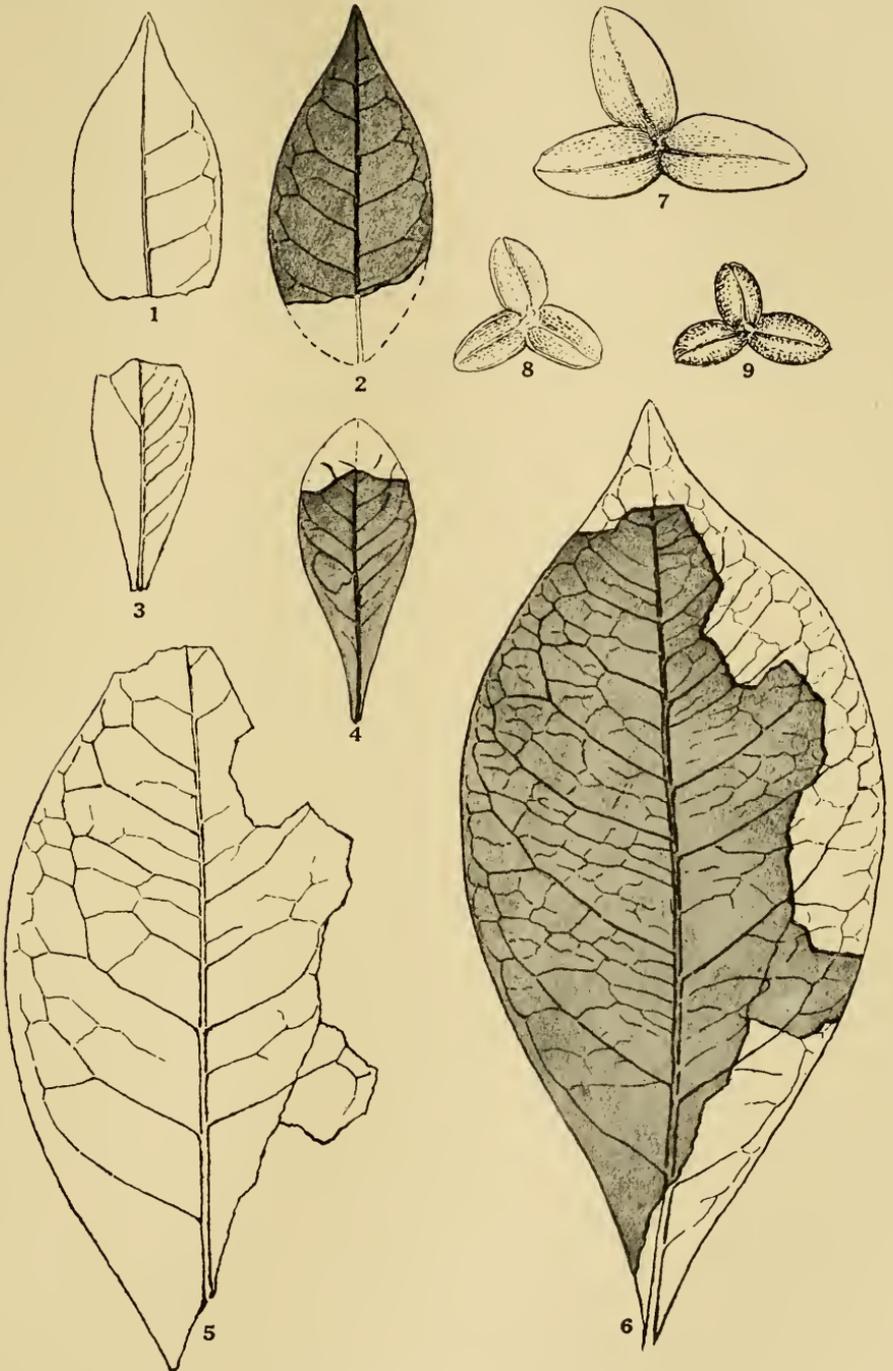
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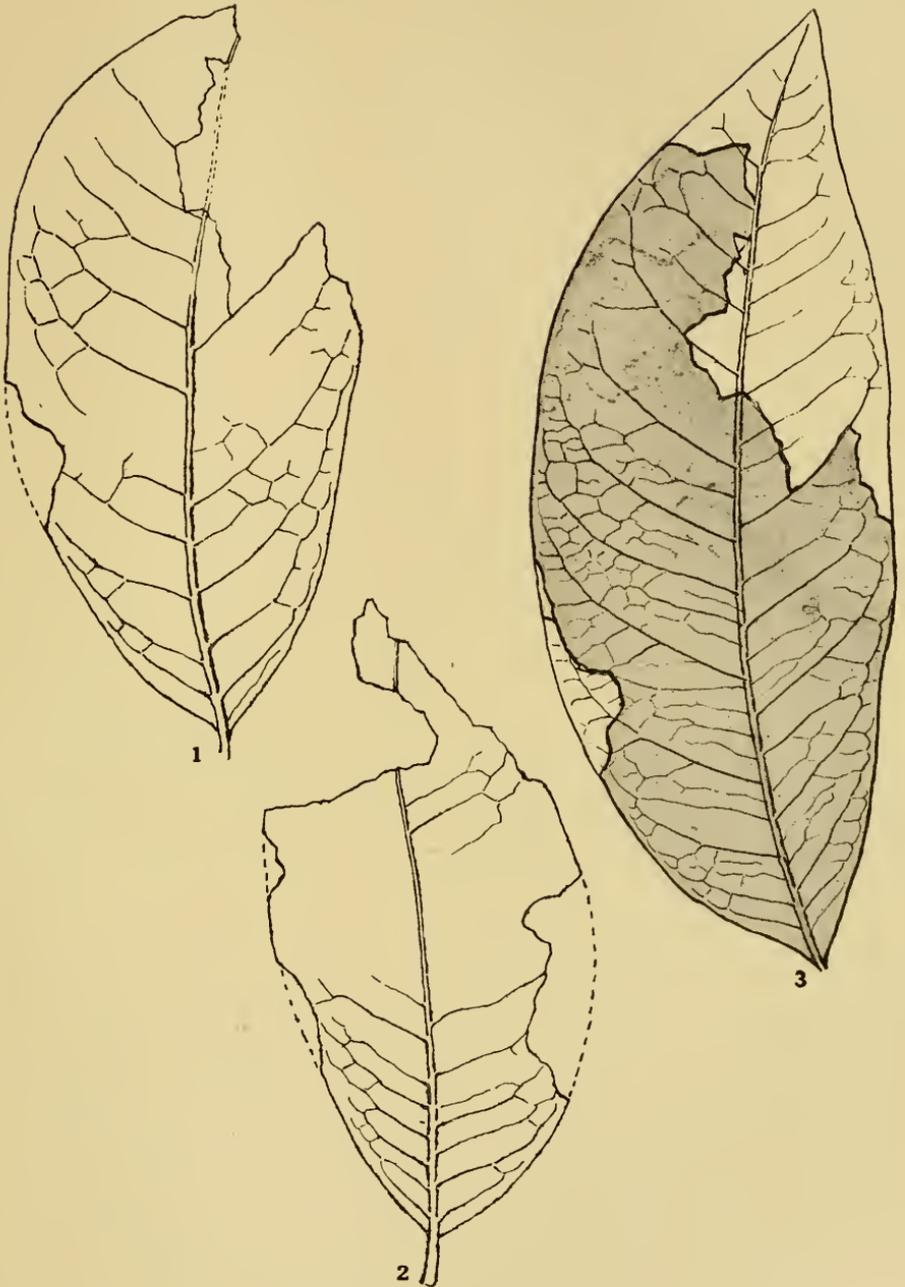
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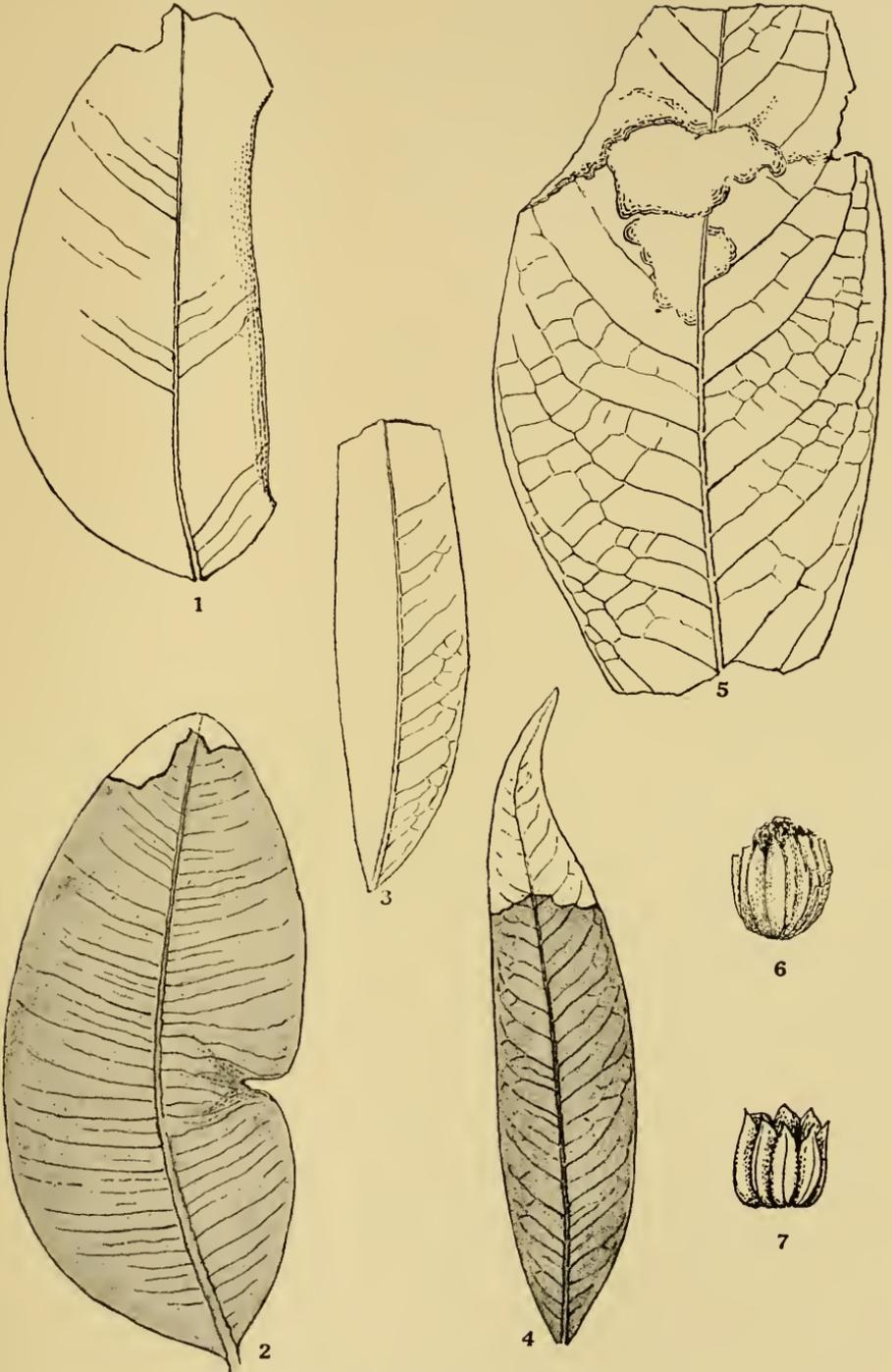
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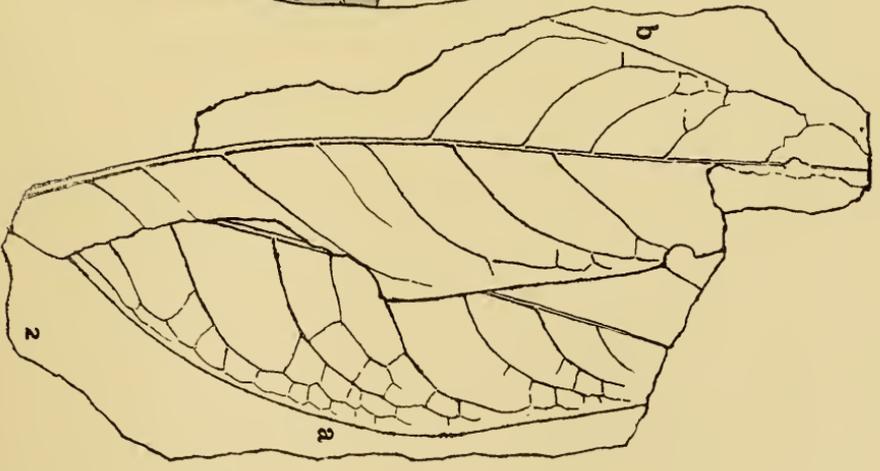
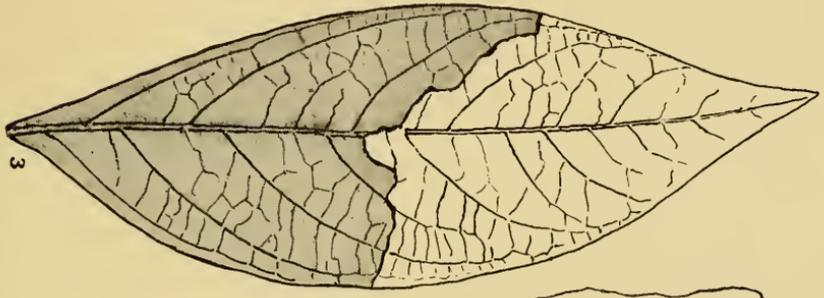
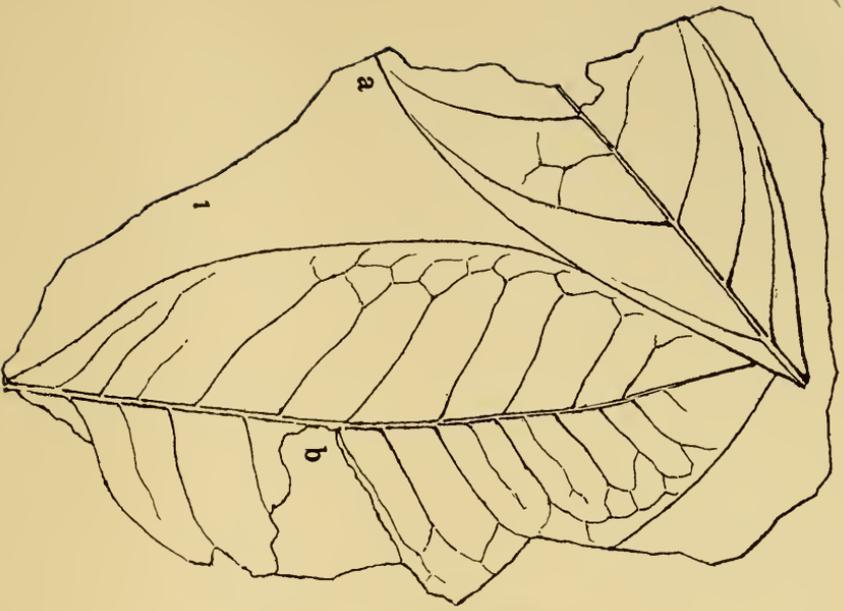
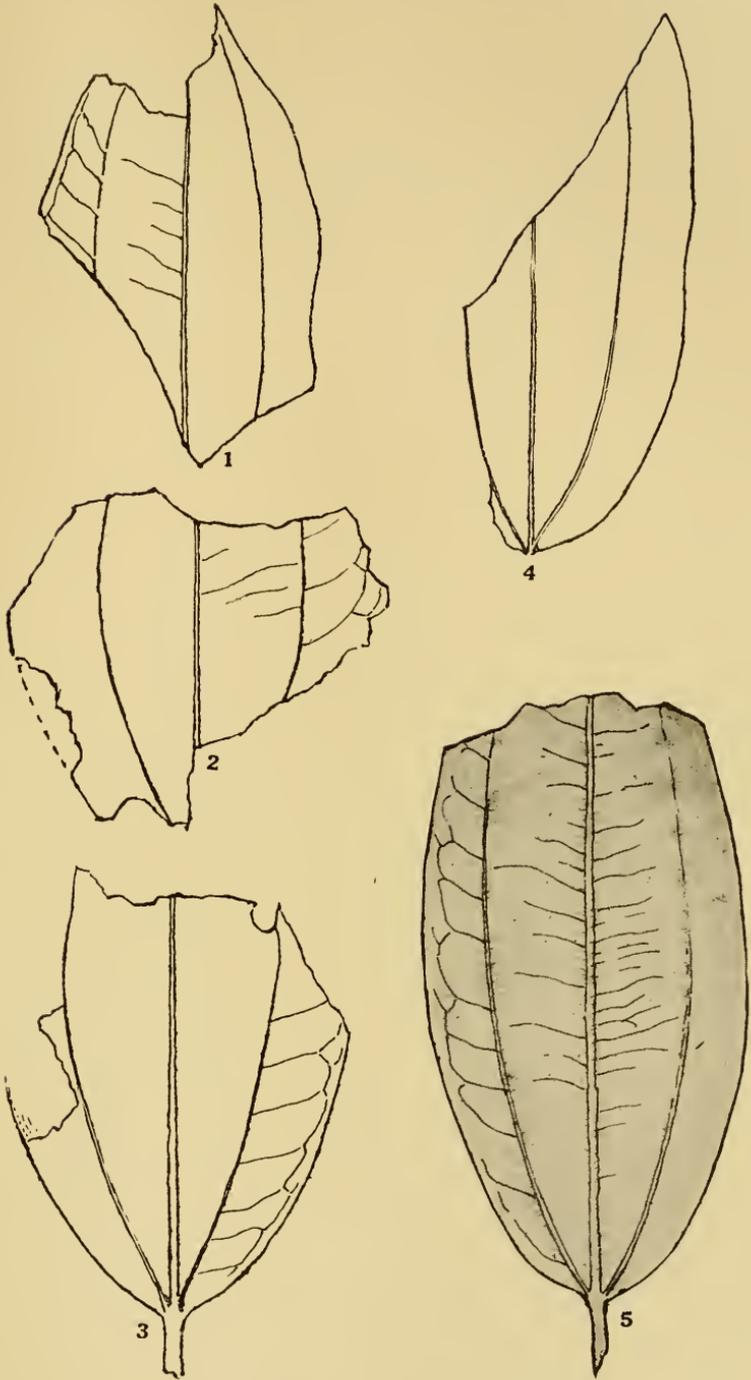






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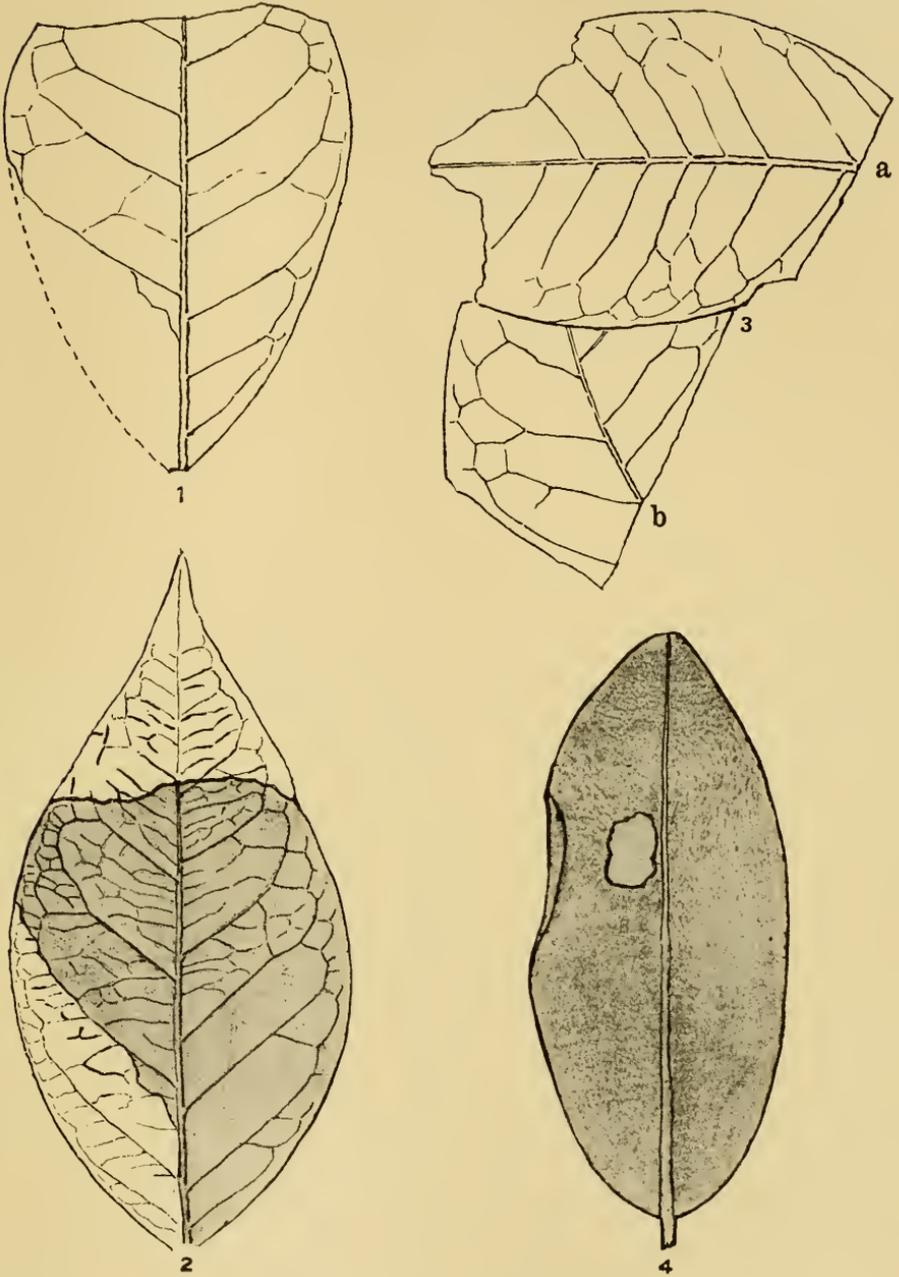
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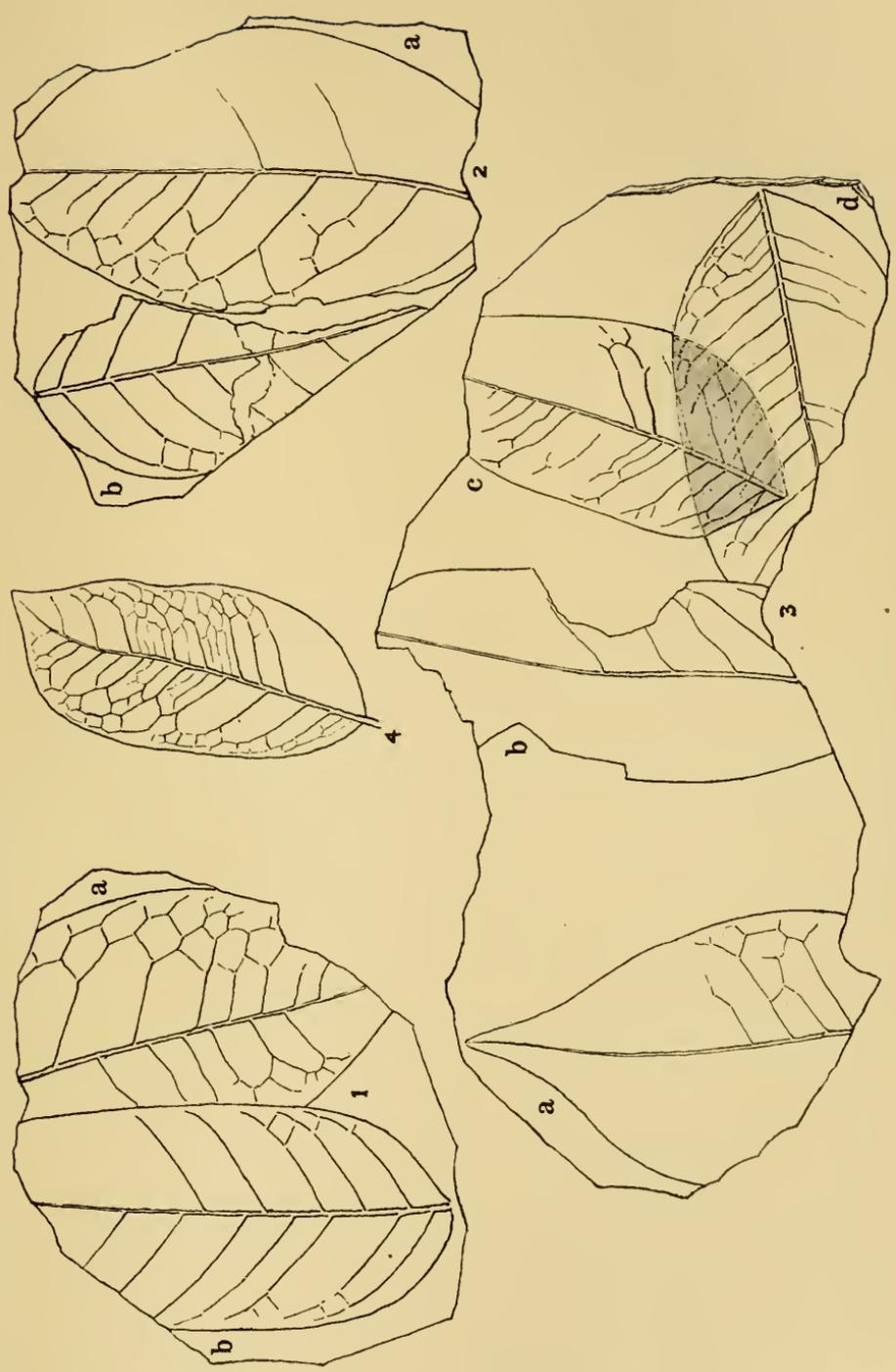
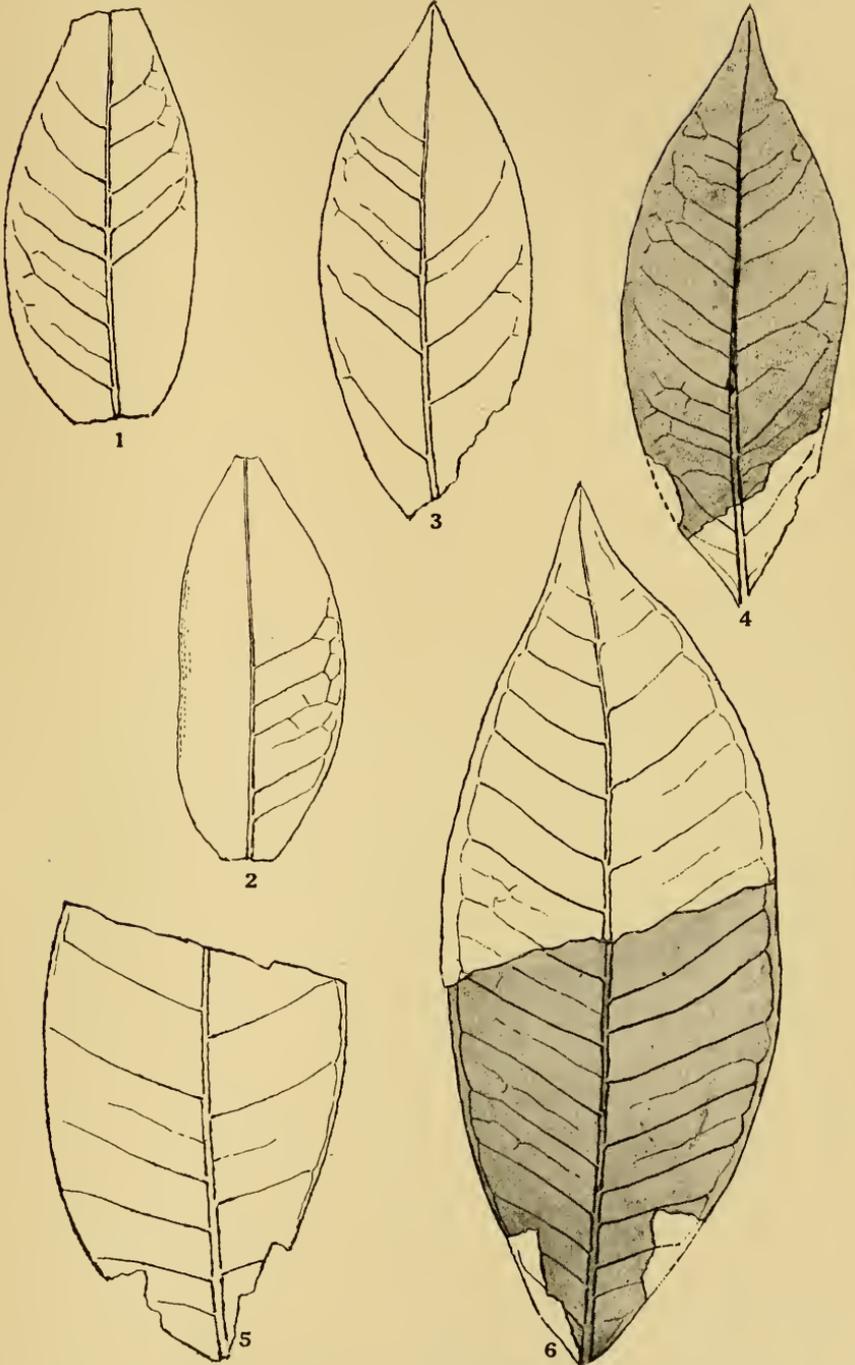






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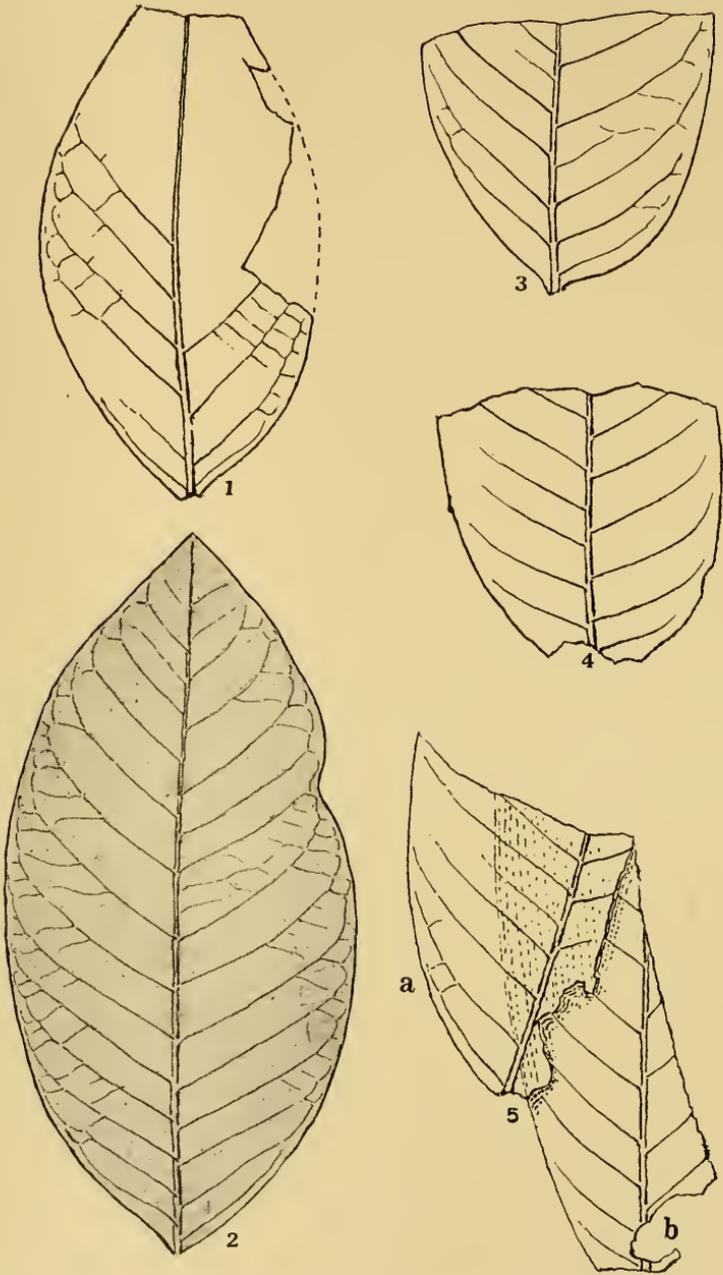
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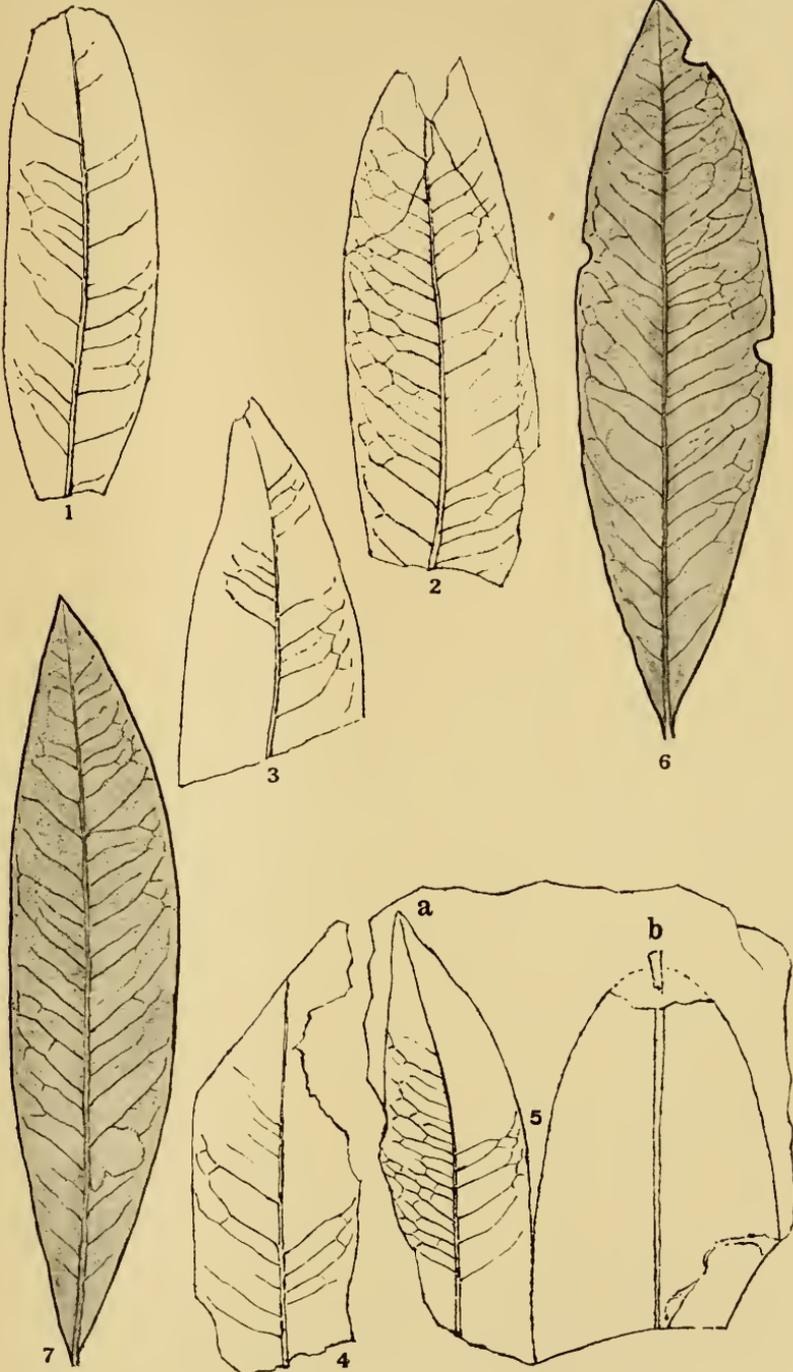
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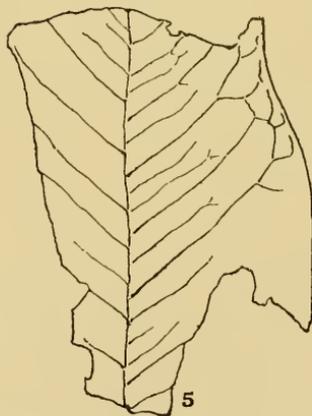
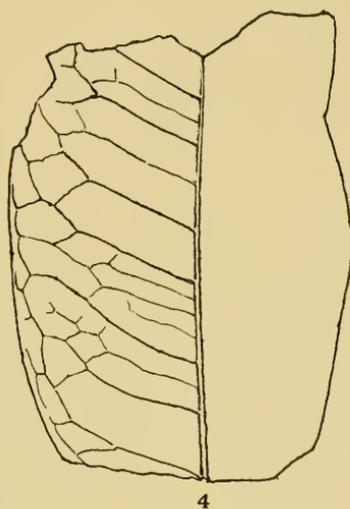
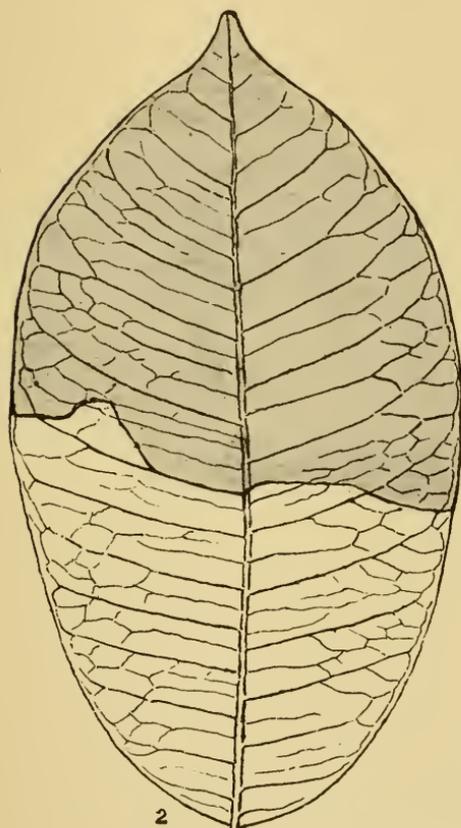
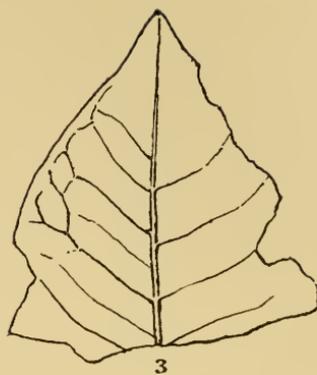
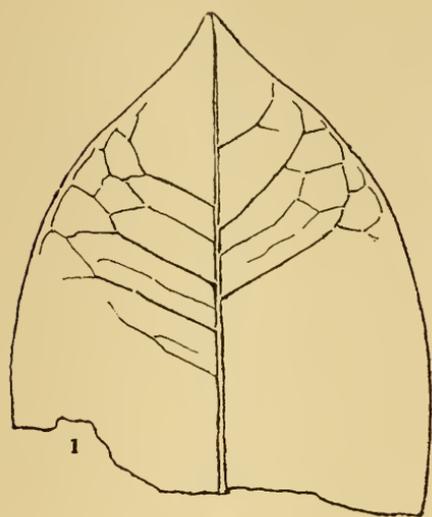






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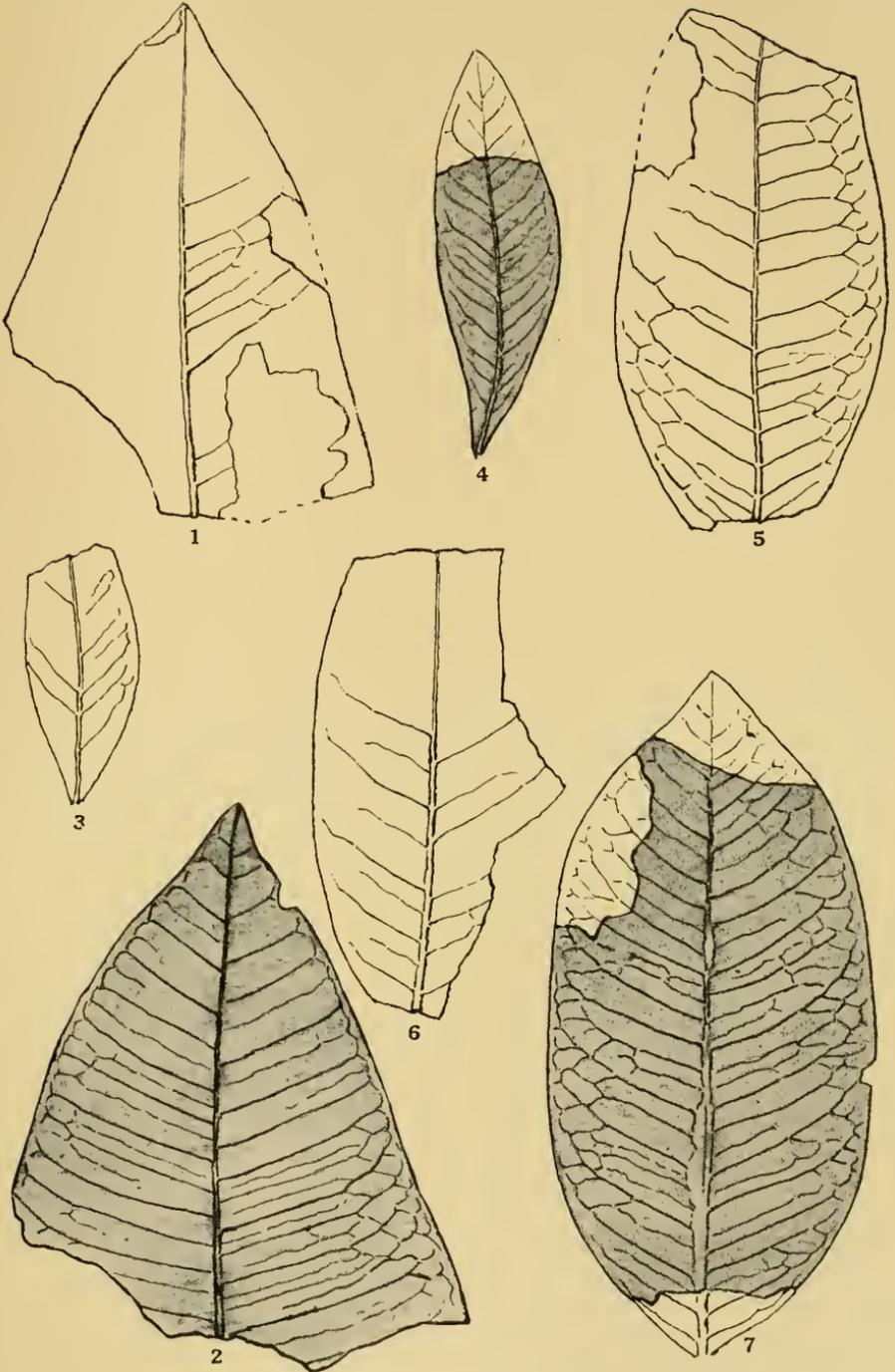
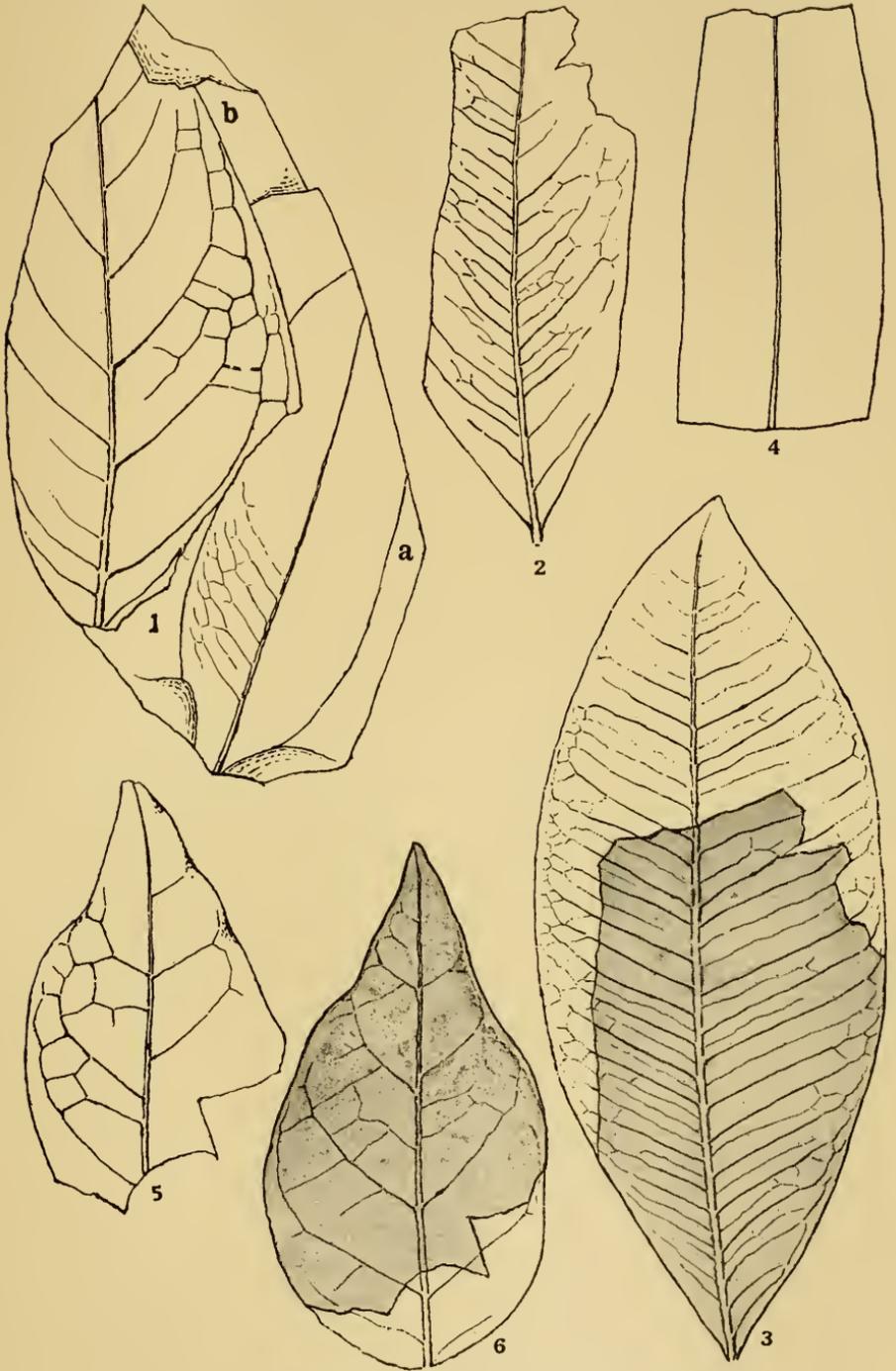






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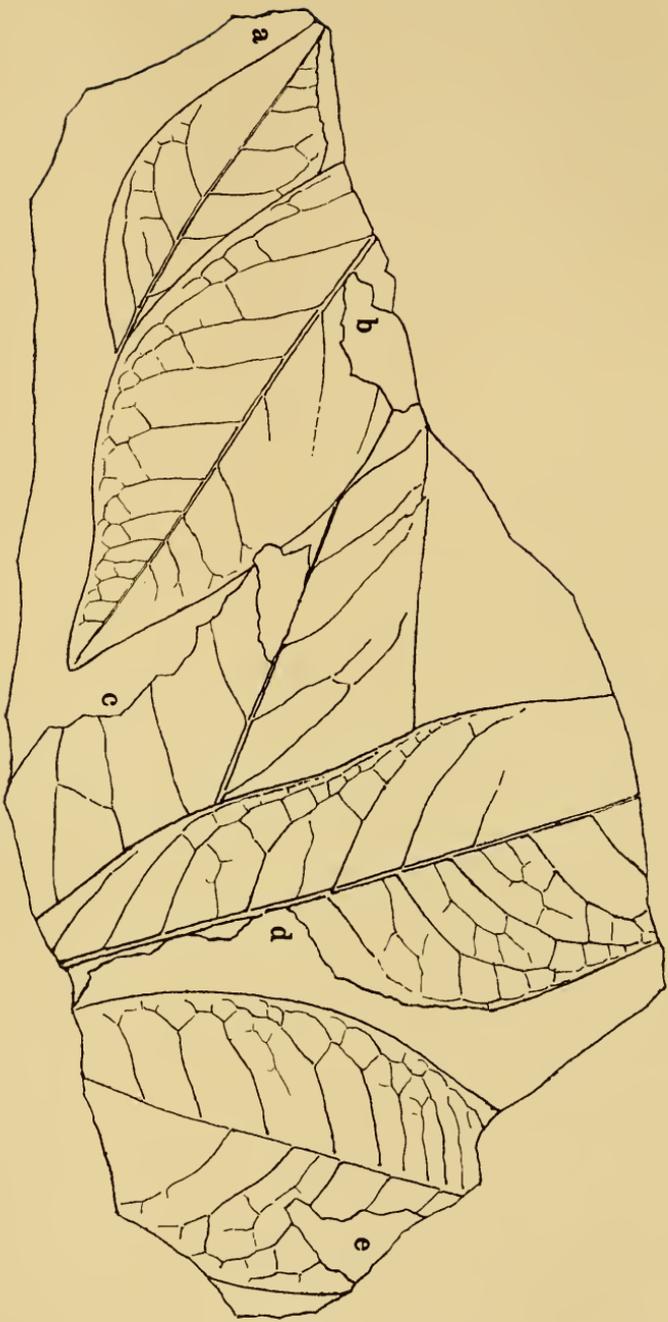
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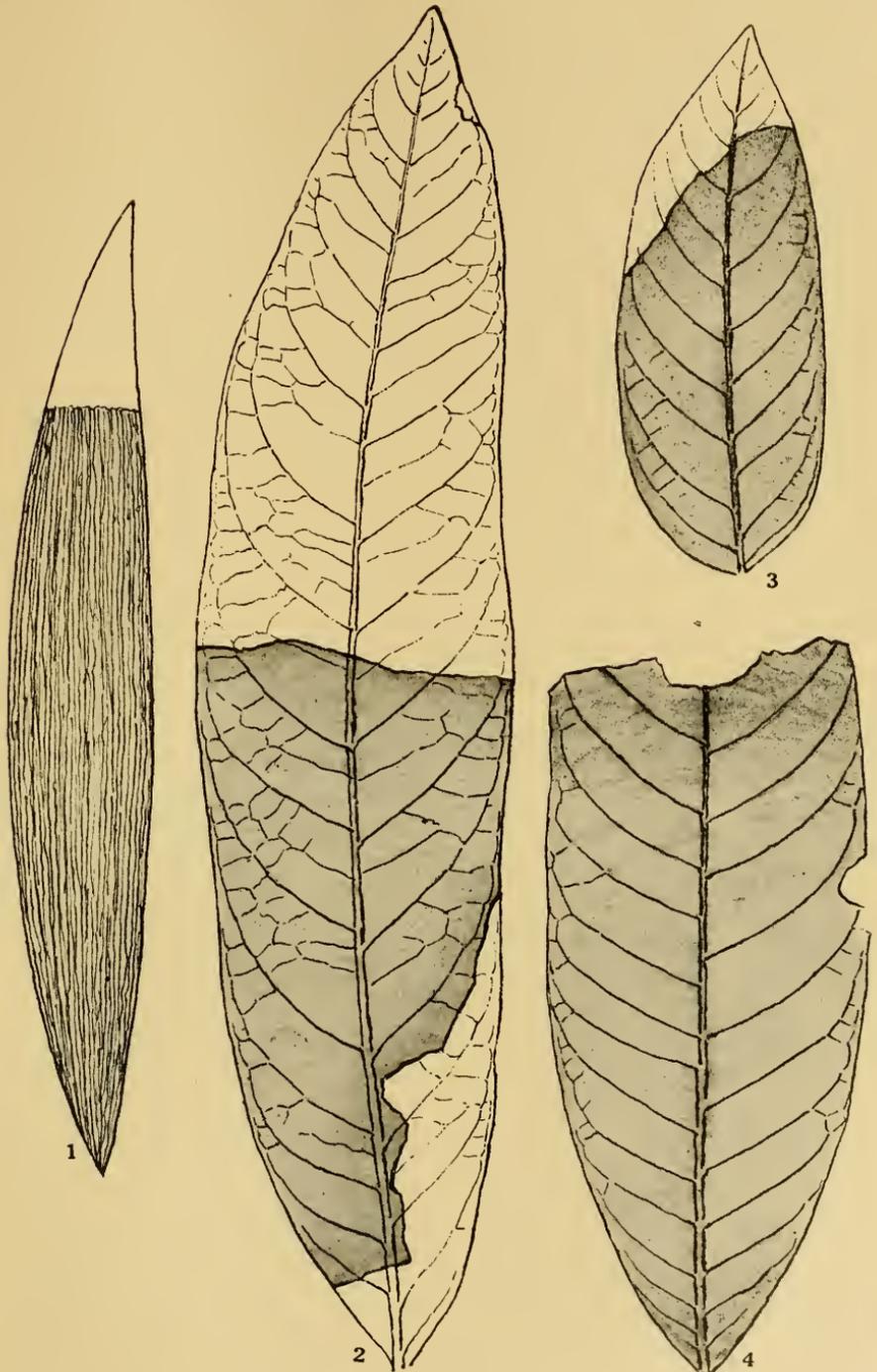
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SCIENTIFIC SURVEY  
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VOLUME VII—Part 4

THE MOSSES OF PORTO RICO AND THE VIRGIN ISLANDS

H. A. Crum and W. C. Steere



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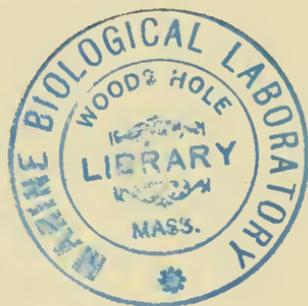
SCIENTIFIC SURVEY  
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VIRGIN ISLANDS

*This natural-history survey of Porto Rico and the Virgin Islands, conducted by The New York Academy of Sciences, was established in 1913 and carried out with the cooperation of the Porto Rican government. The results of this survey have appeared from time to time as investigations by specialists have been completed.*

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# THE MOSSES OF PORTO RICO AND THE VIRGIN ISLANDS\*

By H. A. Crum and W. C. Steere

## INTRODUCTION

The phanerogamic flora of Puerto Rico is more fully known than that of any other West Indian island. Literally dozens of botanists have collected and studied Puerto Rican plants. This intensive botanical exploration is reflected in the literature by three separate, relatively complete treatments of the phanerogamic flora in three different languages—Spanish, German, and English. In surprising contrast to the abundance of published material on the floras of Puerto Rico, however, stands the fact that no other West Indian island has even one complete published treatment of its phanerogamic flora.

When bryophytes are considered, the situation is strikingly reversed. One to several catalogues or extensive treatments of the known Musci have been published for nearly every major West Indian island but Puerto Rico. The physician-botanist Olof Swartz, a student of Linnaeus, spent several years (1783 to 1787) in a botanical exploration of Jamaica and Hispaniola, and his publications thereon are now classics (1788 and 1797 to 1806). Additional important studies of Jamaican mosses have been published more recently by C. Müller (1897), Elizabeth G. Britton (1912a and many other short papers), E. B. Bartram (1928 and 1936), and H. Crum and E. B. Bartram (in press). The bryological flora of Cuba was set forth in excellent fashion by C. Montagne (1845 to 1856) in the publication of Ramón de la Sagra's *Historia Física, Política, y Natural de la Isla de Cuba*. Later publications of W. S. Sullivant (1861), Brother León (1928) and I. Thériot (1939 to 1941) bring our knowledge of the Cuban moss flora completely up to date. Thériot (1944) contributed a lengthy paper on the mosses of Hispaniola. Several thorough studies of the bryophytes of Martinique and Guadeloupe have been made by various botanists, including É. Bescherelle (1876 and 1902), T. Husnot (1870), and V. F. Brotherus (1903). In view of the many competent and extensive publications on West Indian mosses, of which some examples have just been cited, and in view of the extensive botanical collections made in Puerto Rico, it is almost incredible that no comprehensive treatment of Puerto Rican mosses has ever appeared. The present contribution to the bryology of Puerto Rico constitutes an attempt to remedy this lack.

Early collections of Puerto Rican bryophytes, still unstudied, are doubtless buried in European herbaria, especially in Spain. The extensive plant collections made in Puerto Rico by M. Sessé and J. M. Moçino between 1795 and 1804 must have included bryophytes, although none has been cited in the

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literature. The first Puerto Rican mosses cited in bryological literature were collected during 1818 and 1819 by C. Bertero, an Italian physician. Both Bertero and K. Sprengel studied the mosses and appended manuscript names to some of them, but the majority were named by S. E. Bridel-Brideri. In his *Bryologia Universa*, the first attempt to compile descriptions of the world moss flora, Bridel (1826 to 1827) attributed eighteen species to Puerto Rico, all collected by Bertero. Bertero's collections are also cited in Müller's *Synopsis Muscorum Frondosorum* (1848 to 1851), where *Hypnum subdenticulatum* C. M. is added to the flora of Puerto Rico.

In 1852 E. Hampe reported a small collection of Puerto Rican mosses collected by Carl Schwanecke in the years from 1847 to 1850 and added the names of thirty-five species, a large number of which have been subsequently revised in accordance with a more nearly perfect knowledge of tropical American mosses.

Carl Müller supplemented and expanded our list; in 1855 he substituted *Syrrhopodon schwaneckeanus* C. M. for Hampe's report of *S. flavescens*, and in 1858 he described *Hypnum schwaneckianum* C. M. to replace the *Leskea congesta* of Hampe's list. In 1898 Müller added fifty-eight species to the flora, mostly described as new. Unfortunately Müller had developed a habit of manufacturing new species on the slightest provocation, so that most of them were really old species under new names.

In 1904 Renauld and Cardot, in the tenth installment of their "Musci Exotici Novi vel minus cogniti," described nine new species of Puerto Rican mosses from the collections of A. A. Heller. Heller's were the first collections made under occupation by the United States after the Spanish-American War. From then on, the interest of The New York Academy of Sciences and The New York Botanical Garden, New York, N. Y., further stimulated moss collecting. Many experienced bryologists, including A. W. Evans, L. M. Underwood, M. A. Howe, and Mrs. N. L. Britton, visited the island. Mrs. Britton spent many winters in Puerto Rico and, accompanied by Dr. Britton, friends, and students, made numerous collecting trips to all parts of the island and to the Virgin Islands. Because mosses were her special interest, the collection of Puerto Rican Musci at the New York Botanical Garden gradually became the largest in existence. Both Mrs. Britton (1906, 1912, 1912a, 1913, 1914, 1915, 1918, 1922, 1924, 1924a and 1924b) and R. S. Williams (1920, 1927, and 1929), also of the New York Botanical Garden, published papers establishing a number of additions to the local flora, and Britton and Williams together contributed a few other records (1914 and 1915).

Other important but incidental references to Puerto Rican mosses are to be found in publications by the following authors: N. L. Britton (1916), N. L. Britton and C. F. Millspaugh (1920), G. Dismier (1910), M. Fleischer (1922), T. C. Frye and M. E. Duckering (1946), J. García-Díaz (1938), A. J. Grout (1941, 1943, and 1946), C. Müller (1901), R. Schornherst (1944), W. C. Steere (1945 and 1946), and P. Wilson (1917).

The extent of bryological collecting in Puerto Rico and the Virgin Islands can be judged from the following list of collectors and their dates of collec-

tion, as taken primarily from the labels of the specimens examined: Breutel, I. C., 1841 and 1843 (Virgin Islands); Britton, Elizabeth G., March 1906, February to April 1913, March 1914, February to March 1915, February 1923, January and March to April 1925 and January and March 1926; Britton, E. G. and Margaret S. Brown, March 1922; Britton, E. G. and Delia Marble, March 1906 and February and March 1913 (St. Thomas); Britton, Nathaniel L., January and March 1926; Britton, N. L., and K. Boynton, February 1925; Britton, N. L., and E. G. Britton, January to March 1923, February to March 1924, February to March 1927, December 1929, and January and March 1930; Britton, N. L. and S. Brown, February to March 1915; Britton, N. L. and J. F. Cowell, March 1914 and February 1915; Britton, N. L., J. F. Cowell, and S. Brown, February to March 1915; Britton, N. L., J. F. Cowell, and W. E. Hess, February 1913 (Mona and Desecheo Islands); Britton, N. L. and W. E. Hess, April 1913 and March 1914; Britton, N. L. and J. A. Schafer, February 1912 and February 1913 (St. Jan); Britton, N. L. and W. M. Wheeler, March 1906; Britton, N. L., E. G. Britton, and M. B. Brown, February and March 1922; Britton, N. L., E. G. Britton, and C. E. Chardón, February 1927; Britton, N. L., E. G. Britton, and J. F. Cowell, March 1914; Britton, N. L., E. G. Britton, and F. S. Earle, February to March 1922; Britton, N. L., E. G. Britton, and F. W. Horne, February 1923; Britton, N. L., E. G. Britton, and S. E. Jelffe, February 1927; Britton, N. L., E. G. Britton, and J. F. Kemp, March 1923 (Virgin Islands); Britton, N. L., E. G. Britton, and Delia Marble, February 1913; Britton, N. L., E. G. Britton, and J. A. Schafer, February 1913; Britton, N. L., B. A. Dutcher, and S. Brown, March 1915; Britton, N. L., J. Matz, and C. E. Chardón, March 1922; Colón, Wildo F., 1939 to 1949; Cook, O. F., 1900; Cowell, J. F., March 1906; Dale, E. E., February 1923; Earle, F. S., May 1903; Fishlock, W. C., May 1913 and 1919 (Tortola); Goll, G. P., November to December 1899; Grout, A. J., April 1940; Heller, A. A., January to February 1900 and January 1903; Heller, A. A., and Mrs. Heller, April to May 1899; Hess, W. E., August and December 1913 and April 1914; Hioram, Bro., April and July to August 1911, March 1912, and January 1913; Howe, M. A., N. L. Britton, and J. F. Cowell, March 1906; Johnston, J. R., March 1912, February 1913, and March 1914; Johnston, J. R. and J. A. Stevenson, January and March 1914; Laubengayer, R. A., March 1929; Marqués, A., August 1911; Masters, María H. R., 1939 to 1940; Moore, Rufus, 1937; Muller, A., October 1928; Ostefeld, C. H., January 1914 (St. Thomas); Otero, José I., February 1923; Pagán, F. M., 1936 to 1939; Romig, A. B., December 1913 (Virgin Islands); Rose, J. N., February 1913 (St. Croix); Rose, J. N., W. R. Fitch, and P. Russell, February 1913 (Virgin Islands); Sain, F., August 1911; Schafer, J. A., March to August 1914; Schwanecke, 1847 to 1850; Sintenis, P., December 1884, March and July 1885, 1886, and March 1887; Steere, William C., September 1939 to May 1940; Stevens, F. L., July 1915; Stevens, F. L. and W. E. Hess, August 1913; Stevenson, J. A., February 1914, March and July 1915, and January and April 1915; Underwood, L. M., and R. F. Griggs, May 1899 and June to July 1901; Wheeler, W. M., March 1906; Whetzel, H. H., March to April

1916; Wille, N., February 1915; Wilson, Percy, July 1902; and Wolcott, G. N., July 1915.

As a result of cooperation between the University of Michigan, Ann Arbor, Mich., and the University of Puerto Rico, Río Piedras, Puerto Rico, the junior author, W. C. Steere, was able to spend the academic year of 1939 to 1940 in Puerto Rico. Having already examined and listed all the collections of Puerto Rican mosses in the New York Botanical Gardens, he was able to recognize novelties in the field and to collect them in quantity. Approximately 3500 bryophytes were collected; among them were many that were new to Puerto Rico, as well as a substantial number that were new to science.

This work does not pretend to be absolutely complete or, in nomenclature, inflexible. More intensive collections will doubtless turn up more novelties, and monographic treatments of any larger genus will possibly result in a revision of the names used herein. The lists of synonymy particularly are not to be taken as authoritative and final, but rather as tentative solutions to problems that can be solved only by badly needed monographic revisions. A total of 268 species and varieties of Musci has been recognized in this manual.

#### *Acknowledgments*

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### SYSTEMATIC ACCOUNT

#### PHYLUM 3. BRYOPHYTA (MOSESSES AND LIVERWORTS)

Plants terrestrial, epiphytic or aquatic, with life cycle of 2 sharply defined, alternating generations: haploid (sexual gametophyte) and diploid (asexual sporophyte). Gametophyte is green and independent, differentiated into stem and leaves or consisting of simple, flattened thallus. Sexual organs multicellular, superficial, or embedded in tissue of gametophyte; antheridia spherical to elongate, usually stalked, producing great numbers of biciliate antherozoids; archegonia flask-shaped, stalked, or sessile, producing single egg, fertilized egg developing directly into sporophyte, which is protected at least during early development by all or part of archegonial wall, which may become greatly modified as calyptra. Sporophyte usually less conspicuous

than gametophyte, wholly dependent on gametophyte, or chlorophyllose for part of its life. In simplest form, the sporophyte consists of spherical, spore-bearing capsule, but more commonly also possesses basal absorbing organ, the foot, and more or less elongate stalk or seta. Structure of capsule may be very complex, with photosynthetic tissue, stomata, and specialized structures for discharge of spores. Spores uniform or sometimes indistinctly of 2 sizes and sexually differentiated, producing on germination usually inconspicuous and more or less ephemeral thalloid or filamentous protonema, which produces gametophyte directly or through buds.

Leaves not lobed or divided, 3- to 8-ranked, rarely 2-ranked; costa usually present; seta usually persistent, never hyaline; capsule nearly always operculate; elaters absent.

Plants thallose or leafy, leaves often lobed or divided, ecostate, 2-ranked or, if 3-ranked, third row of very small leaves; seta ephemeral, hyaline; capsule not operculate; elaters usually present. . . . . Class I. Musci  
 . . . . . Class II. Hepaticae

**CLASS I. MUSCI**

Plants on soil, rocks, or bark, rarely aquatic, gametophyte differentiated into stem, leaves, and rhizoids; produced from usually filamentous protonema arising from 1-celled spore, monoicous or dioicous, multicellular sex organs borne apically (acrocarpous) or laterally (pleurocarpous). Sporophyte consisting of foot, elongate seta, and capsule. Capsule usually with columella derived from endothecium, around which spore sac may be dome-shaped or cylindrical, derived from outer layer of endothecium (Bryales and Andreaeales) or from inner layer of amphithecium (Sphagnales); capsule wall often chlorophyllose and stomatose, derived from amphithecium. Capsule operculate or cleistocarpous; if operculate, mouth is naked (gymnostomous) or surrounded by peristome consisting of 1 or 2 rows of hygroscopic teeth that aid in spore discharge. Upper part of archegonium usually torn off and borne upward as calyptra over developing capsule.

Branches fascicled, crowded at stem tip in dense heads; leaf cells unistratose, of 2 kinds: large, fibrillose, hyaline cells in meshes of network of linear, green cells

Branches not fascicled or crowded in dense heads; cells usually not dimorphous or, if so, multistratose, never fibrillose. . . . . Order 1. Sphagnales

Capsule dehiscing by valves; seta lacking; sporophyte elevated by prolongation of gametophyte. . . . . Order 2. Andreaeales

Capsule usually operculate, not valved; seta usually present; sporophyte never borne on prolongation of gametophyte. . . . . Order 3. Bryales

**Order 1. Sphagnales**

Protonema normally thalloid. Gametophyte leafy, developing from 1 edge, at first branchless, later developing branches in fascicles of 3 or more. Archegonia and antheridia on separate branches. Calyptra irregularly ruptured by maturing capsule, leaving at its base an inconspicuous sheath. Capsule nearly sessile, globose, on very short seta with bulbous foot, at maturity raised above perichaetial leaves on prolongation of perichaetial branch, the pseudopodium, dehiscent by small operculum. Peristome lacking. Endothecium giving rise only to columella, which is overarched by dome-shaped spore sac derived from inner layer of amphithecium. Spores tetrahedral. Single family and 1 genus of wide distribution.

## SPHAGNACEAE

(1) *Sphagnum* L., Sp. Plant. 1106. 1753.

Large or small, erect or floating mosses, generally found in peat bogs or other wet places. Gametophyte developing apically, with rhizoids only in initial stage. Stem lacking central strand, with 1 or more layers of thin-walled, parenchymatous cortical cells. Branches usually in fascicles disposed spirally about stem, densely crowded into head, or capitulum, at apex. Leaves of stem and branches arranged spirally, consisting of single layer of 2 kinds of cells: narrow, linear, chlorophyll cells forming meshes of network enclosing large, rhomboidal, hyaline cells, with walls reinforced by ring-shaped or spiral fibrils, pores large, round to elliptic. Stem leaves more or less differentiated in size and shape, less crowded than branch leaves. Plants monoicous or dioicous, antheridia and archegonia on separate branches; antheridia long-stalked, subglobose, each borne at margin of perigonal leaf, paraphyses lacking; archegonial branches single or rarely paired, bearing at apex 1 to 5 archegonia without paraphyses; perichaetial leaves much larger than other leaves, enclosing capsule until maturity. Capsule globose, operculate, gymnostomous, usually bearing numerous pseudostomata in the outer wall. Spores yellow, tetrahedral, with a large convex face and 3 smaller, plane faces.

Cortical cells of stems and branches without spiral fibrils; branch leaves lanceolate, moderately concave.....(c) *S. cuspidatum* var. *serrulatum*  
 Cortical cells of stems and branches reinforced by spiral fibrils; branch leaves ovate, very concave

Cortical cells of branches funnel-shaped at base.....(b) *S. portoricense*  
 Cortical cells of branches plane or slightly receding, not funnel-shaped at base  
 (a) *S. erythrocalyx*

- (a) *Sphagnum erythrocalyx* Hampe ex C. M. Syn. Musc. Frond. 1: 92. 1848.  
*S. perichaetiale* Hampe ex C. M. *Op. cit.* 93.  
*S. peruvianum* Mitt. Journ. Linn. Soc. London, Bot. 12: 625. 1869.  
*S. guadalupense* Schimp. ex Besch. Ann. Sci. Nat., Bot. VI. 3: 264. 1876.  
*S. husnoti* Schimp. ex Besch. *Ibid.*  
*S. guyoni* Warnst. Deutsch. Bot. Monats. 2: 17. 1884.  
*S. wrightii* C. M. Flora. 70: 411. 1887.  
*S. cymbifolium* var. *ludovicianum* Ren. & Card. Rev. Sphaignes d'Amér Nord. 4. 1887.  
*S. paucifibrosus* Warnst. Hedwigia. 30: 152. 1891.  
*S. carneum* C. M. & Warnst. Hedwigia. 36: 145. 1897.  
*S. ouropretense* C. M. & Warnst. *Ibid.* 172.  
*S. sintenisii* C. M. Hedwigia. 37: 219. 1898.  
*S. subbrachycladum* C. M. ex Warnst. Bot. Jahrb. 27: 255. 1899.  
*S. brevicaule* Warnst. Hedwigia. 39: 108. 1900.  
*S. harperi* Warnst. Beih. Bot. Centralbl. 16: 250. 1904.  
*S. macroporum* Warnst. Allgem. Bot. Zeitschr. 11: 98. 1905.  
*S. pauloense* Warnst. Beih. Bot. Centralbl. 20(2): 136. 1906.  
*S. earlei* Warnst. In Engler, Pflanzenreich: Sphagn. Univ. 449. 1911.  
*S. glaucovirens* Warnst. *Op. cit.* 501.

- S. allionii* Warnst. *Op. cit.* 502.  
*S. bahiense* Warnst. *Op. et loc. cit.*  
*S. tijucae* Warnst. *Op. cit.* 503.  
*S. huntii* Warnst. *Op. cit.* 521.

Cortical cells of stem in 3 to 4 layers, thin-walled, fibrils distant, pores rounded, 1 to 2 per cell. Stem leaves small to large, broadly lingulate to lingulate-spatulate, with a denticulate border of conspicuously eroded cells. Branches usually short, in fascicles of 4 or 5, with 2 spreading, cortical cells in a single layer; cell walls reinforced by fibril bands that may be much reduced; outer wall frequently showing a pore in upper end. Branch leaves imbricate or slightly spreading, ovate, with a broad apex, strongly concave; chlorophyll cells in section subrectangular or lenticular, equally exposed on either surface or, rarely, somewhat included on outer surface; hyaline cells strongly fibrillose, slightly convex on inner surface, somewhat more so on outer surface but not bulging more than  $\frac{1}{4}$  diameter of cell. Dioicous. Perichaetial leaves large, long-lingulate.

In ditches and wet, sandy places, north central coast of Puerto Rico; throughout West Indies; Atlantic coastal plain of United States from New Jersey to Louisiana; British Honduras; South America.

(b) *Sphagnum portoricense* Hampe. *Linnaea*. 25: 359. 1852.

- S. sullivanianum* Aust. *Amer. Journ. Sci.* II. 35: 253. 1863.  
*S. herminieri* Schimp. ex Besch. *Ann. Sci. Nat., Bot.* VI. 3: 265. 1876.

Cortical cells in 3 to 4 layers, thin-walled, fibrillose, with 1 to 4 irregularly rounded pores. Stem leaves medium-sized, lingulate, denticulate, with broad, hyaline border of conspicuously eroded cells. Branches in fascicles of 4 or 5, with 2 turgid, clavate, horizontal, or decurved, others pendent and appressed to stem, their cortical cells in a single layer, increasing in size toward branch tip, each cell inserted by a funnel-shaped base into the cell beneath. Cell walls with numerous fibrils, the outer surface without pores. Branch leaves broadly ovate, concave, denticulate; chlorophyll cells triangular in section, exposed on the inner surface of the leaf; hyaline cells bulging as much as  $\frac{1}{2}$  diameter of cell on outer surface.

On swampy ridges and hillsides at higher elevations, Sierra de Luquillo, Puerto Rico; West Indies; Mexico; British Guiana; Atlantic coastal plain of United States from New Jersey to Florida.

(c) *Sphagnum cuspidatum* Ehrh. var. *serrulatum* (Schlieph.) Schlieph. *Irmischia*. 2: 67. 1882.

- S. trinitense* C. M. *Syn. Musc. Frond.* 1: 102. 1848.  
*S. laxifolium* var. *serrulatum* Schlieph. *Verh. k.-k. zool.-bot. Ges. Wien.* 15: 397. 1865.  
*S. serratum* Aust. *Bull. Torrey Bot. Club.* 6: 145. 1877.  
*S. helleri* Warnst. *Allgem. Bot. Zeitschr.* 11: 100. 1905.

Cortical cells of stem in 2 to 3 layers, lacking fibrils, of 2 kinds: large retort cells with a pore and an inconspicuous neck and smaller cells without

pores. Stem leaves small, triangular-ovate, concave, toothed at apex; hyaline cells narrow, with or without fibrils in apical part of leaf. Branches mostly in fascicles of 4, with 2 spreading and others drooping, their cortical cells in 1 layer. Branch leaves lanceolate, somewhat concave, toothed at apex and serrulate at margins by projecting ends of narrow border cells; hyaline cells fibrillose, only slightly convex on inner surface; chlorophyll cells trapezoidal in section with broader exposure on outer surface. Dioicous. Perichaetial leaves broadly ovate, obtuse and entire at apex.

In ditches and wet, sandy places, north-central coast of Puerto Rico; Bermuda; the Atlantic Coastal plain of the United States from Maine to Louisiana; South America; also reported from Europe.

### Order 2. Andreaeales

Protonema normally thallose. Gametophytes small, dark brown or reddish, brittle, usually growing on rocks. Stems without central strand, cells uniform and stereid with large oil globules. Leaves also bearing oil globules in cells, costate or ecostate; cells incrassate and sinuose, often densely papillose. Perichaetial leaves often large and convolute. Seta lacking; sporophyte consisting of foot and capsule, elevated at maturity on projection of gametophyte, called pseudopodium; spore sac dome-shaped, overarching columella; both spore sac and columella derived from endothecium; wall of capsule without spongy photosynthetic tissue; dehiscence by 4 to 8, or rarely 10 valves.

Small order of 1 family and 2 genera not represented in flora of Puerto Rico.

### Order 3. Bryales

Protonema normally filamentous. Gametophyte leafy, minute to large. Stems erect or creeping, often with central strand. Branches not fascicled. Leaves in 2 to many ranks, costate or ecostate. Perichaetial leaves often differentiated. Seta usually present, persistent, green and independent at least when young, never hyaline; capsule usually operculate, peristome usually present, single or double; loose photosynthetic tissue normally present between spore sac and capsule-wall; spore sac usually cylindrical, not overarching columella; both spore sac and columella derived from endothecium.

### FISSIDENTACEAE

Plants minute to large, gregarious or tufted. Stems erect or prostrate, sparsely branched, usually with central strand. Leaves narrow, distichous and equitant, adaxial side of base apparently split into 2 vaginant laminae that sheath stem; costa ending below apex to excurrent, rarely lacking; cells usually unistratose, rather uniform, rounded-hexagonal, sometimes irregularly rhomboidal, smooth, mammillose or papillose; marginal cells sometimes linear in 1 to several rows. Calyptra cucullate, narrow, usually smooth, rarely lobed at base. Sporophyte terminal or lateral. Seta generally, elongate, usually straight and erect; capsule erect to horizontal, symmetric or somewhat

arcuate; annulus usually lacking; peristome inserted below mouth, rarely rudimentary. In *Fissidens* teeth divided to middle or below into 2 or sometimes 3 forks, outer surface papillose or vertically striate, tips often spirally ridged, operculum rostrate.

(1) *Fissidens* Hedw. Sp. Musc. 152. 1801.

Small to medium-sized plants with leaves distichous and complanate, split to costa on inner side at base, forming 2 vaginant laminae that clasp the stem, remainder of leaf consisting of 2 expanded lamellae: apical, making up upper portion of leaf; and dorsal, opposite vaginant laminae on abaxial side of costa. Cells mostly unistratose, small, hexagonal or rounded, smooth to mammillose or papillose; costa usually well developed, single or rarely lacking. Sporophyte lateral or terminal; seta usually much longer than perichaetial leaves, sometimes paired; capsule small, erect or inclined; peristome single, consisting of 16 teeth, usually forked.

Plants aquatic; lamina more than 1-cell thick.....(a) *F. rochensis*  
Plants not aquatic; lamina unistratose.

At least the perichaetial leaves bordered, entirely or in part.

Leaves bordered nearly to apex of apical lamina.

Leaves soft, shriveled when dry; cells large and lax.

Costa ending  $\frac{1}{2}$ - $\frac{1}{3}$  up apical lamina.....(b) *F. reticulosus*

Costa ending 5 to 10 cells below apex.

Border vanishing at or near apex; upper cells up to  $15 \times 30 \mu$

(c) *F. dissitifolius*

Border distinct to apex; upper cells up to  $22 \times 40 \mu$ .....(d) *F. mollis*

Leaves merely contorted when dry; cells small, not particularly lax.

Upper cells about  $8 \mu$  in diameter, scarcely enlarged in vaginant laminae

(e) *F. repandus*

Upper cells 9 to  $14 \mu$ , clearly enlarged in vaginant laminae.

Cells unipapillose.....(f) *F. yucatanensis*

Cells smooth.

Leaves linear-lanceolate.....(g) *F. angustifolius*

Leaves oblong-lanceolate.....(h) *F. kegelianus*

Border ending far below apex of leaf.

Leaves entire or nearly so; cells smooth.....(i) *F. pseudexilis*

Leaves crenulate to dentate; cells papillose.

Border strong, reaching apex of vaginant laminae or beyond.

Border scarcely exceeding vaginant laminae.....(j) *F. elegans*

Border extending well up apical and often dorsal laminae.....(k) *F. weirii*

Border confined to base of vaginant laminae of upper leaves or of perichaetial leaves only.

Border intramarginal near base.

Leaves linear-lanceolate, acuminate; cells bulging or unipapillose

(l) *F. densiretis*

Leaves oblong-lanceolate, acute; cells not bulging, pluripapillose

(p) *F. ravenelii*

Border marginal.

Cells sharply unipapillose.....(m) *F. muriculatus*

Cells pluripapillose.

Leaves obtuse or rounded at narrow tip; only perichaetial leaves bordered

(n) *F. garberi*

Leaves acute; upper leaves also bordered.....(o) *F. leptopus*

Leaves not bordered.

Cells pluripapillose; dorsal lamina very narrow, vanishing well above leaf base

(q) *F. stenopteryx*

Cells various, not pluripapillose; dorsal lamina border, extending to or almost to leaf base.

- Cells coarsely unipapillose.  
 Leaves linear-lanceolate, acute. . . . . (r) *F. vardei*  
 Leaves oblong-lanceolate, rounded-obtuse to broadly acute. . . . (s) *F. donnellii*  
 Cells smooth or bulging.  
 Plants minute, usually less than 5 mm. high, rarely 10 mm.  
 Costa ending 6 to 11 cells below apex. . . . . (t) *F. radicans*  
 Costa longer, sometimes ending 2 to 3 cells below apex, or percurrent.  
 Stems 1 to 2 mm. high; vaginant laminae very abruptly narrowed to dorsal lamina; cells longer than broad. . . . . (u) *F. inaequalis*  
 Stems higher; vaginant laminae gradually narrowed; cells nearly isodiametric.  
 Cells up to 5  $\mu$ , bulging, thin-walled. . . . . (v) *F. cylindraceus*  
 Cells up to 15 or 20  $\mu$ , smooth, incrassate. . . . . (w) *F. pellucidus*  
 Plants medium-sized to robust, 1 to 5 cm. high.  
 Leaves entire or slightly denticulate at extreme apex; cells 10 to 15  $\mu$ , incrassate; setae lateral. . . . . (x) *F. polypodiioides*  
 Leaves crenulate or serrulate; costa ending below apex; cells 5 to 10  $\mu$ , thin-walled; setae terminal.  
 Leaves oblong-ligulate, broadly obtuse and sometimes apiculate; costa ending many cells below apex. . . . . (y) *F. asplenioides*  
 Leaves lanceolate, acute; costa ending just below apex. . . . . (z) *F. similiretis*

(a) *Fissidens rochensis* Broth. *In Urban, Symb. Antill.* 3: 421. 1903.

Dull, dark green, aquatic plants in dense, rigid cushions. Stems up to 1.5 cm. long, usually simple. Leaves rigid, in many pairs, 1.1 to 1.2 mm. long, narrowly oblong-lanceolate, broadly acute, entire or nearly so, bordered nearly to apex by long, narrow cells; costa strong, vanishing below apex; vaginant laminae unequal, about  $\frac{1}{2}$  of leaf length; dorsal lamina narrow, reaching stem, unbordered below; apical lamina at least 2 layers thick except at margins; cells 5 to 6  $\mu$ , irregularly rounded, smooth, incrassate. Sporophyte unknown.

On rocks in stream, known in Puerto Rico only from Mt. Morales (*E. G. Britton & Delia Marble*, March 15, 1898); Jamaica, Santo Domingo, Dominica, and Guadeloupe.

(b) *Fissidens reticulosus* (C. M.) Mitt. *Journ. Linn. Soc. London, Bot.* 12: 603. 1869.

*Conomitrium reticulosum* C. M. *Syn. Musc. Frond.* 2: 525. 1851.

*Fissidens sphagnifolius* Sull. *Proc. Amer. Acad. Arts and Sci.* 5: 275. 1861.

*Conomitrium acutifolium* Lindb. ex C. M. *Bot. Zeit.* 22: 374. 1864, non *F. acutifolius* Mitt. 1859.

*Fissidens lindbergii* Mitt. *Journ. Linn. Soc. London, Bot.* 12: 602. 1869, nom.

*Conomitrium palmatum* Besch. *Rev. Bryol.* 18: 50. 1891.

*C. hookeriaceum* C. M. *Bull. Herb. Boiss.* 5: 173. 1897.

Plants small, up to 2 mm. high. Leaves in 4 to 9 pairs, soft, shriveled and twisted when dry, flexuose and palmately spreading when moist, up to 3.0 mm. long, lanceolate, acuminate, entire or slightly irregular at apex, narrowly and indistinctly bordered nearly to apex; costa ending far below leaf apex, extending only  $\frac{1}{2}$  to  $\frac{2}{3}$  length of apical lamina; dorsal lamina narrowed to base; cells of apical lamina oblique, rhomboidal or elongate-hexag-

onal, lax and thin-walled, about  $30 \times 15 \mu$ , basal cells up to  $80 \mu$ , parallel with costa. Seta terminal, 5 to 10 mm. long; urn of capsule nodding or horizontal, asymmetric, less than 1 mm. long; operculum conic-rostrate; peristome spirally thickened above. Spores smooth, yellow.

On clay, Laguna Tortuguera and Sierra de Cayey, Puerto Rico; West Indies; Mexico to Panama; Brazil.

(c) *Fissidens dissitifolius* Sull. Proc. Amer. Acad. Arts and Sci. 5: 274. 1861.

Small plants sometimes producing multicellular brood bodies on filaments at leaf-bases. Leaves up to 8 or 12 pairs, shriveled when dry, up to 2 mm. long, oblong-lanceolate, acute or apiculate; border narrow and indistinct, disappearing near the apex about opposite tip of costa; costa ending  $\frac{3}{4}$  or more the length of apical lamina, usually within 4 to 10 cells of apex; dorsal lamina tapering to base, ending rather abruptly or slightly decurrent; apical cells in oblique rows, oblong-hexagonal, up to  $15 \times 30 \mu$ , those of vaginant lamina up to  $65 \mu$ , parallel with costa. Dioicous. Seta terminal, 5 to 6 mm. long; urn of capsule cylindrical, 1 to 1.5 mm. long; operculum long-rostrate; peristome-teeth spirally thickened above. Spores smooth, 8 to  $10 \mu$ .

On stone, especially limestone, at middle altitudes, Puerto Rico; Cuba, Haiti and Jamaica; Mexico and Guatemala.

(d) *Fissidens mollis* Mitt. Journ. Linn. Soc. London, Bot. 12: 600. 1869.

*F. macrophyllus* Mitt. *Ibid.*

*Conomitrium bryodictyon* Besch. Rev. Bryol. 18: 50. 1891.

*C. flexifrons* Besch. *Ibid.* 51, p. p.

Small plants, up to 1 cm. long, but usually less, sometimes producing brown, septate brood bodies on filaments at leaf bases. Leaves in 10 to 20 pairs, laxly spreading when moist, contorted when dry, 3 to 5 mm. long, narrowly lanceolate to oblong-lanceolate, blunt to acute, more or less apiculate, strongly bordered all around, sometimes weakly toothed; costa usually ending 5 to 8 cells below apex, rarely percurrent, variable even on same plants; vaginant lamina  $\frac{1}{2}$  or more of leaf-length; dorsal lamina slightly tapering and bordered to stem, sometimes abruptly rounded at or above base; apical cells lax and thin-walled, oblong-hexagonal, 15 to  $22 \times 40 \mu$ , basal cells up to  $60 \mu$ . Dioicous. Seta terminal, 5 to 8 mm. long; urn of capsule erect or inclined, about 1 mm. long; operculum long-rostrate; peristome teeth spirally thickened above. Spores 13 to  $16 \mu$ .

On clay and rocks at middle elevations, Puerto Rico; Cuba, Jamaica, Haiti, Guadeloupe, and Martinique to Trinidad; Mexico, Guatemala, Costa Rica, and Panama; western South America.

(e) *Fissidens repandus* Wils. ex Mitt. Hooker's Journ. Bot. 3: 52. 1851.

*F. tortilis* Hampe & C. M. Bot. Zeit. 22: 340. 1864.

*F. reclinatulus* C. M. ex Ren. & Card. Bull. Soc. Roy. Bot. Belg. 31(1): 153. 1892.

*F. carionis* C. M. Bull. Herb. Boiss. 5: 171. 1897.

*F. fasciculatobryoides* C. M. *Ibid.* 172.

*F. aequalis* Salmon. *Ann. Bot.* 13: 120. 1899.

*F. pringlei* Card. *Rev. Bryol.* 36: 69. 1909.

*F. reclinatulus* var. *brevifolius* Card. *Ibid.*

*F. heribaudii* Broth. & Paris ex Card. *Rev. Bryol.* 40: 35. 1913.

*F. arsenei* Broth & Paris ex Thér. *Smiths. Misc. Coll.* 78(2): 8. 1926.

*F. tortilis* var. *cubensis* Thér. *Mem. Soc. Cubana Hist. Nat.* 13: 205. 1939, nom.

Small plants with up to 12 pairs of leaves, somewhat crisped when dry, oblong-lanceolate, broadly acute and apiculate, with whitish or yellowish, subentire border, usually vanishing just below apex but sometimes confluent with costa; costa vanishing in mucro; dorsal lamina tapering to base, often not reaching stem; cells smooth, thin-walled, hexagonal, 6 to 8  $\mu$  wide, little or not at all enlarged in vaginant laminae. Sporophyte terminal; seta short; capsule small, erect, and symmetric.

On clay, middle altitudes, Cordillera Central, Puerto Rico; United States (Florida); West Indies; Mexico to South America.

This widely ranging species is quite variable in relative width of leaves and in strength of leaf-border. The Puerto Rican specimens reported by Grout as *F. bryoides* Hedw. include a number of variations, none of which seems to differ specifically from *F. repandus*. Likewise, the plants that Grout named *F. limbatus* Sull. seem to belong in this species. It is difficult to understand why they were named as they were, since no indication of a border of green cells at the base of the leaves was found.

(f) *Fissidens yucatanensis* Steere. *Amer. Journ. Bot.* 22: 397. 1935.

Small plants, rarely 8 mm. high. Leaves in 4 to 12 pairs, oblong-lanceolate, broadly or narrowly acute, sometimes slightly apiculate, bordered nearly to apex; vaginant laminae slightly more than  $\frac{1}{2}$  leaf length; dorsal lamina scarcely tapered, broad and crenate at insertion; costa flexuose above, subpercurrent; upper cells hexagonal, thin-walled, unipapillose, 8 to 12  $\mu$ ; basal cells near costa greatly enlarged, oblong, 11 to 16  $\times$  32 to 40  $\mu$ . Dioicous. Sporophyte unknown (FIGURE 1).

On soil over limestone, at 500 to 1000 ft. above sea level, known in Puerto Rico from only 2 localities; Jamaica and Haiti; Yucatán (Mexico).

As compared with the type collection, the leaves of these plants are somewhat less strongly papillose and more sharply acute. In the type the upper cells measure only 10 to 12  $\mu$ , rather than 24 to 32  $\mu$ , as stated in the original description and in Grout's description in the *North American Flora* (1946).

(g) *Fissidens angustifolius* Sull. *Proc. Amer. Acad. Arts and Sci.* 5: 275. 1861.

*F. bernoullii* Schimp. ex C. M. *Bull. Herb. Boiss.* 5: 173. 1897.

*F. lindigii* var. *latifolius* Varde & Thér. *Mem. Soc. Cubana Hist. Nat.* 13: 207. 1939.

Stems short or nearly lacking, 1 to 5 mm. long. Leaves in 2 to 10 pairs, linear to linear-lanceolate, gradually tapering to an acute, entire, or slightly

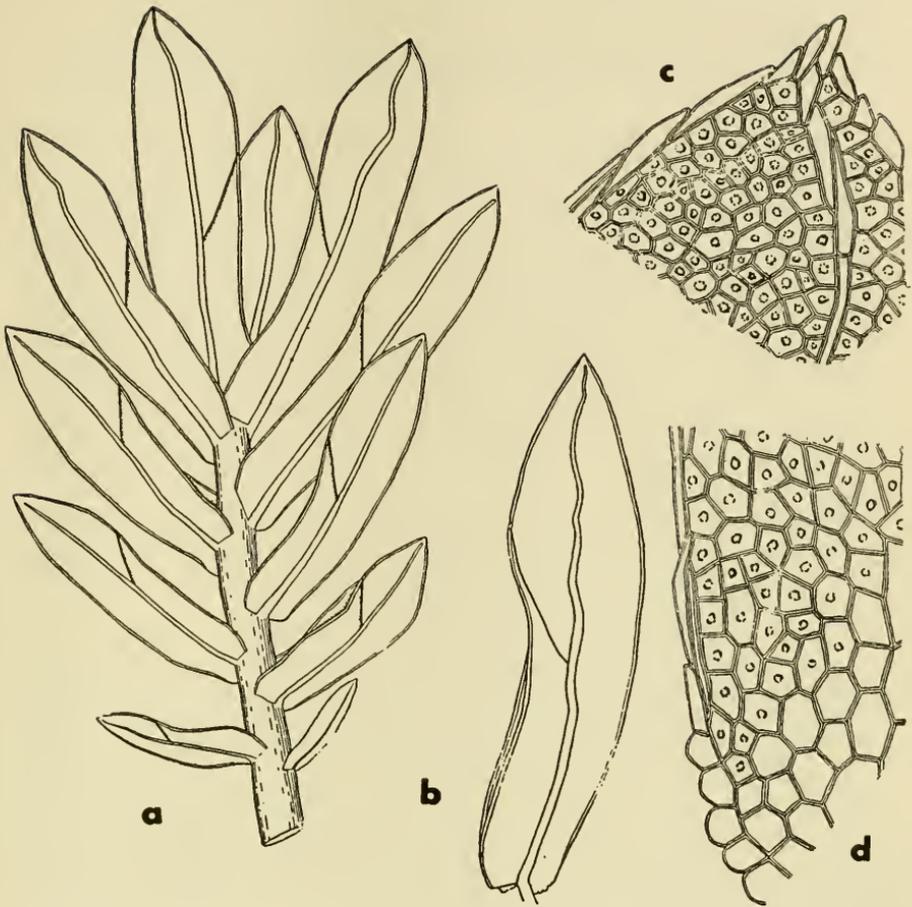


FIGURE 1. *Fissidens yucatanensis*: (a) plant, (b) leaf, (c) apex of leaf, and (d) base of dorsal lamina (Steere, 1935).

toothed apex, upper and perichaetial leaves 1.5 to 2.5 mm. long; vaginant laminae reaching  $\frac{1}{2}$  of leaf length; dorsal lamina attenuate to base; border yellow, strong, especially on vaginant laminae, vanishing not far below leaf apex; costa percurrent; cells smooth, thick-walled, irregularly hexagonal in apical lamina, 9 to 12  $\mu$  in diameter, noticeably enlarged in vaginant laminae, especially toward base, oblong-hexagonal or rectangular, reaching  $35 \times 12 \mu$ . Autoicous. Seta red, 4 to 7 mm. long; urn of capsule small, erect or somewhat inclined, symmetric, ovoid-cylindric, about 0.5 mm. long; operculum as long as urn or longer; peristome teeth red, divisions with spiral thickenings. Spores obscurely punctate, 10 to 12  $\mu$ .

On soil and rock, widespread at middle altitudes in Puerto Rico; Cuba, Jamaica, and Haiti; Trinidad; British Honduras and Guatemala.

(h) *Fissidens kegelianus* C. M. Syn. Musc. Frond. 1: 49. 1848.

*F. pseudobryoides* Schlieph. Bot. Zeit. 13: 424. 1855.

*F. clavipes* Sull. Proc. Amer. Acad. Arts and Sci. 5: 475. 1861.

*F. monandrus* Mitt. Journ. Linn. Soc. London, Bot. 12: 498. 1869.

*F. trinitensis* Hampe ex Jaeg. Ber. St. Gall. Natur. Ges. 1874-75: 123. 1876, nom.

*Conomitrium flexifrons* Besch. Rev. Bryol. 18: 51. 1891, p. p.

*C. crassicolle* Besch. *Ibid.*

Stems usually less than 3 mm. high. Leaves in 4 to 6 pairs, narrowly oblong-lanceolate and slenderly acuminate, uppermost 2 to 3 mm. long; margins strongly bordered to or nearly to apex, often finely but sharply toothed near apex, sometimes nearly entire; costa strong, subpercurrent to short excurrent; vaginant laminae reaching about  $\frac{1}{2}$  leaf length; cells isodiametric, irregularly polygonal, 10 to 14  $\mu$  in diameter, those of vaginant laminae much larger toward costa, up to 30 or 35  $\mu$  long. Sporophyte terminal; urn of capsule erect and symmetric or somewhat arcuate, 0.4 to 0.6 mm. long, obconic-cylindric; operculum rostrate, sometimes as long as urn. Spores smooth, about 9  $\mu$ .

On clay, very common at low altitudes, especially in calcareous areas in Puerto Rico; St. Thomas, St. Jan, and St. Croix; United States (Florida); West Indies; Mexico to northern South America.

(i) *Fissidens pseudexilis* Thér. Smiths. Misc. Coll. 78(2): 13. 1926.

Plants minute, about 2 to 3 mm. high. Leaves up to 7 pairs, oblong-lanceolate, acute, about 1 mm. or less in length, entire or faintly toothed near apex; vaginant lamina about  $\frac{1}{2}$  or more of leaf length, weakly bordered at base of perichaetial leaves; dorsal lamina tapered to the stem or ending above leaf base; upper cells irregularly hexagonal, often slightly longer than broad, 7 to 10  $\mu$  in longest diameter; costa ending 2 to 3 cells below leaf apex. Dioicous? Seta straight, 3 mm. long; urn of capsule erect, 0.6 to 0.8 mm. long; operculum conic, short-rostrate, about  $\frac{1}{3}$  length of urn; peristome vertically striate below, forks spirally thickened.

On rock; single Puerto Rican collection comes from middle slopes of Mt. Guilarte near Adjuntas; also in Mexico.

Based on a single specimen (*Steere 7225*) already reported by Grout as *F. exiguus* Sull., this report is made with reservation. Until this perplexing species complex is more satisfactorily resolved it seems more logical to use a name first applied to a Mexican collection than one given to a poorly understood species, supposedly ranging from King Oscar Land in the far north to Bermuda and British Honduras in the American tropics. We have not seen the type of *F. pseudexilis*.

(j) *Fissidens elegans* Brid. Musc. Recent. Suppl. 1: 167. 1806.

*F. intermedius* C. M. Linnaea 21: 181. 1848.

*F. cuspidatulus* Sull. Proc. Amer. Acad. Arts and Sci. 5: 274. 1861.

*Conomitrium hemiloma* Besch. Rev. Bryol. 18: 52. 1891.

*Fissidens* (?) *flavifrons* Besch. *Ibid.* 54.

*F. acicularis* C. M. ex Broth. Bih. K. Sv. Vet.-Akad. 21 (III, 3): 12. 1895.

?*F. nicholsoni* Salmon. Ann. Bot. 13: 123. 1899.

*F. hemicraspedophyllus* Card. Rev. Bryol. 37: 120. 1910.

*F. hancockianus* Steere. Hancock Pacific Exped. 3(1): 2. 1936.

*F. willisiae* Bartr. Bryol. 42: 152. 1939.

Fertile stems to 5 mm. high with 3 to 10 pairs of leaves, sterile stems to 1 cm. with 15 to 25 pairs. Leaves usually distant and somewhat secund at tips when dry, oblong-lanceolate, acute, about 1 mm. long, strongly bordered usually to apex of vaginant laminae, rarely less, often extending a short distance up dorsal lamina, often toothed on border, minutely crenulate at margins of dorsal and apical laminae; vaginant laminae about  $\frac{2}{3}$  leaf length; dorsal lamina extending to or nearly to leaf base, ending abruptly; costa pellucid, stout, percurrent or shortly excurrent, rarely ending slightly below apex; upper cells obscure, irregularly polygonal, 5 to 7  $\mu$  in diameter, those of vaginant laminae hexagonal to short-rectangular, up to 10  $\mu$ , finely pluri-papillose. Dioicous or autoicous. Perichaetial leaves with vaginant laminae very unequal. Sporophyte terminal; seta erect or bent at base, 3 to 5 mm. long; operculum rostrate; annulus narrow; capsule oblong to ovoid, erect or inclined, nearly symmetric, 1 mm. long, or less; peristome teeth spreading when moist. Spores minutely punctate, 10 to 12  $\mu$  (FIGURE 2).

On soil and rock, especially limestone, common at lower and middle altitudes in Puerto Rico; West Indies; Mexico to South America.

(k) *Fissidens weirii* Mitt. Journ. Linn. Soc. London, Bot. 12: 602. 1869.

*Conomitrium lefebvrei* Besch. Rev. Bryol. 18: 53. 1891.

*F. howelli* Bartr. Proc. Calif. Acad. Sci. IV. 21: 78. 1933.

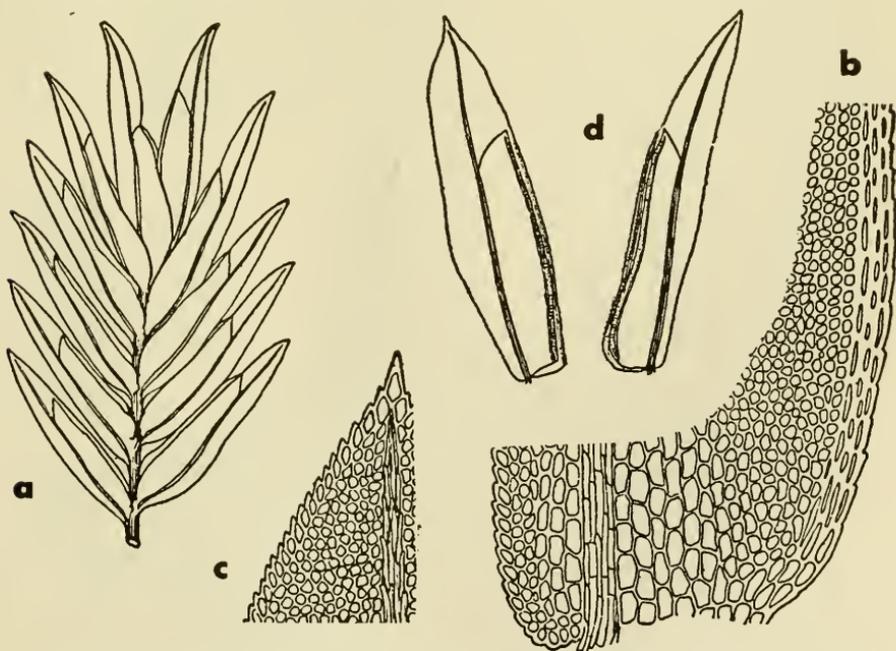


FIGURE 2. *Fissidens elegans*: (a) part of plant, (b) cells at leaf base, (c) cells at leaf tip, and (d) leaf shapes (Grout, 1943).

*F. eckmani* Thér. Mem. Soc. Cubana Hist. Nat. 13: 205. 1939.

*F. bizoti* Thér. *Ibid.*

*F. acunae* P.-V. & Thér. *Ibid.* 206.

Plants about 4 to 5 mm. high, rarely 1 cm. Leaves usually in 6 to 10 pairs, sometimes many more on sterile stems, somewhat curled at tips when dry, about 1.3 to 1.5 mm. long, oblong-lanceolate, acuminate and apiculate, crenulate except where bordered; border strong, of variable length, ending well below apex of dorsal lamina, often entirely lacking from abaxial margin of leaf or, if present, ending well above truncate base of dorsal lamina; vaginant laminae unequal, obliquely narrowed to costa,  $\frac{1}{2}$  leaf length; costa pellucid, bent at junction of vaginant and apical laminae, ending in apiculus or shortly excurrent; upper cells opaque, densely and finely papillose, small and dense, 6 to 8  $\mu$  wide, rounded-quadrate. Autoicous. Sporophyte terminal; seta 2 to 3.5 mm. long; urn of capsule erect, 0.5 to 0.7 mm. long; operculum rostrate; annulus present; peristome teeth spirally thickened above. Spores up to 8 to 10  $\mu$  (FIGURE 3).

On rock and at base of trees in wet forest at high altitudes, Puerto Rico; West Indies; Guatemala; Brazil and the Galapagos Islands.

*Fissidens weirii* var. *insertus* Grout. No. Amer. Fl. 15(3): 179. 1943.

Leaves oblong, more broadly acute; border of vaginant laminae marginal, border of dorsal and apical laminae intramarginal, or sometimes lacking or marginal in dorsal lamina.

Although distinct from any other collections of *F. weirii* that we have seen and readily recognizable because of the narrow border of green papillose cells outside the smooth linear cells in the dorsal and apical laminae, the var. *insertus* is probably nothing more than a freak of nature. Until further collections have been made to indicate whether it is geographically or geneti-

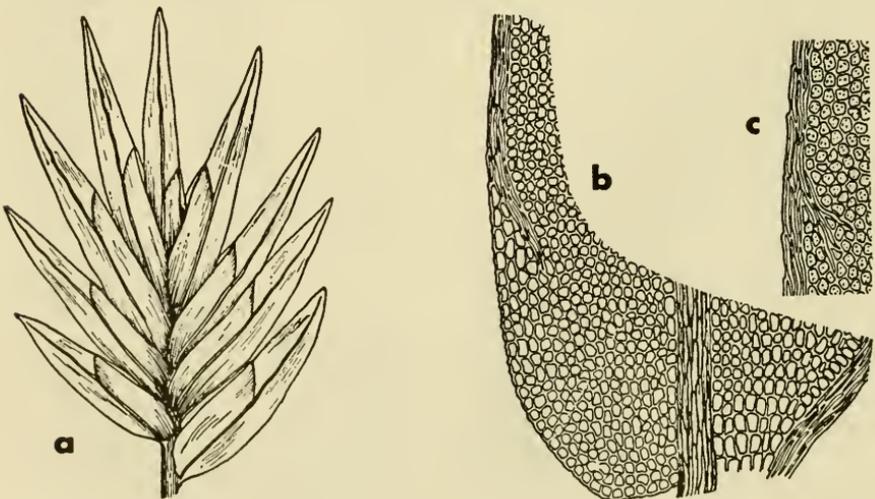


FIGURE 3. *Fissidens weirii*: (a) part of plant, (b) cells at leaf base, and (c) cells at margin near leaf middle (Grout, 1943).

cally distinct from the species proper, its claim to a varietal status may be open to question.

On clay bank, known only from type locality on trail to Mt. Britton, El Yunque, Sierra de Luquillo; endemic to Puerto Rico.

The position of *F. weirii* in the section *Pycnothallia* is rather doubtful, because the leaf border is scarcely thickened and consists of linear, smooth cells. It seems awkward to relegate a species so closely related to *F. elegans* to an entirely different section of the genus.

(1) *Fissidens densiretis* Sull. Proc. Amer. Acad. Arts and Sci. 5: 274. 1861.

Stems slender, usually less than 1 cm. high. Leaves in 20 to 25 pairs, secund at tips when dry, linear-lanceolate, narrowly acuminate, sharply acute or rather blunt at narrow tip, 1 to 1.2 mm. long, crenulate all around; vaginant lamina  $\frac{1}{2}$  or  $\frac{2}{3}$  leaf length, upper and perichaetial leaves bordered, border intramarginal toward base; dorsal lamina not markedly attenuate, usually somewhat rounded to stem at base; costa pellucid, ending a few cells below leaf apex; cells rounded, 6 to 8  $\mu$ , bulging, not or very faintly unipapillose. Dioicous. Seta terminal, 2 to 3 mm. long; urn of capsule erect, 0.6 to 0.8 mm. long; operculum long-rostrate, shorter than urn; peristome teeth spirally thickened above (FIGURE 4).

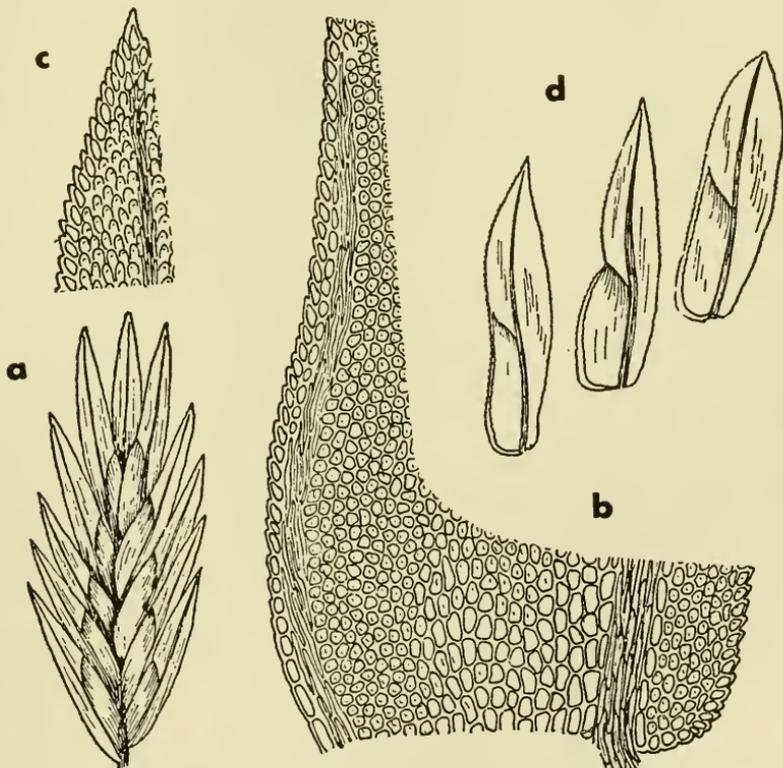


FIGURE 4. *Fissidens densiretis*: (a) part of plant, (b) cells of leaf base, (c) cells at leaf tip, and (d) leaves (Grout, 1943).

On rock and tree bases, not common, at middle and upper altitudes in Puerto Rico; Cuba, Haiti, and Guadeloupe.

The 2 Puerto Rican specimens cited as *F. densiretis* var. *latifolius* by Grout, including the type collection, are not clearly related to this species but differ in having much broader leaves with irregular, angular cells covered with numerous minute and indistinct papillae. These plants do not differ in any essential way from *F. ravenellii* Sull. We have not seen the third specimen cited by Grout (*Marie 114*, from Guadeloupe).

(m) *Fissidens muriculatus* Spruce ex Mitt. Journ. Linn. Soc. London, Bot. 12: 593. 1869.

*F. diplodus* Mitt., *ibid.* 589.

*F. corticola* Schimp. ex Besch., Ann. Sci. Nat., Bot. VI. 3: 191. 1876.

Plants small, up to 5 or 8 mm. long. Leaves somewhat secund at tips when dry, oblong-lanceolate, broadly acute and often apiculate, about 1 mm. long, rarely more, crenulate; vaginant laminae  $\frac{1}{2}$  or more of leaf length, those of perichaetial leaves indistinctly bordered at base; dorsal lamina ending abruptly at or near leaf base; costa percurrent or nearly so; cells rounded-hexagonal, rather incrassate, bluntly unipapillose, about 6 to 10  $\mu$  wide. Monoicous. Seta terminal, 1.5 to 2 mm. long, often bent at base; capsule suberect, up to 1 mm. long; peristome teeth irregular. Spores 16 to 20  $\mu$ , rough (FIGURE 5).

On tree trunks, more rarely on rock, especially limestone, at middle altitudes in Puerto Rico; West Indies; Mexico and Guatemala; northern South America.

(n) *Fissidens garberi* Lesq. & James. Proc. Amer. Acad. Arts and Sci. 14: 137. 1879.

Small plants; fertile stems rarely 5 mm. long, with 4 to 8 pairs of leaves, sterile stems taller, with as many as 20 pairs. Leaves more or less secund when dry, crowded, oblong-lanceolate or lingulate, broadly acute, blunt, or rounded at narrow tip, serrulate all around, about 0.6 to 0.8 mm. long, rarely 1 mm., obscurely bordered at base of vaginant laminae of perichaetial leaves; vaginant laminae about  $\frac{1}{2}$  leaf length; dorsal lamina rather broad, truncate at leaf base; costa pellucid, ending a few cells below leaf apex; cells of apical lamina irregularly rounded-quadrate, 5 to 8  $\mu$  in diameter, obscure, finely papillose. Sporophyte terminal; seta 1.5 to 2 mm. long; urn of capsule erect, 0.5 to 1.0 mm. long; operculum long-rostrate; peristome teeth spirally ridged except at papillose tips. Spores 10 to 13  $\mu$ , smooth or nearly so.

On soil, rock, wood and bark, common at lower and middle altitudes in Puerto Rico; United States (Florida to Louisiana); West Indies; Bermuda; Mexico to northern South America; Cocos Island.

(o) *Fissidens leptopus* Card. Rev. Bryol. 37: 120. 1910.

*F. michoacanus* Thér. Smiths. Misc. Coll. 78(2): 12. 1926.

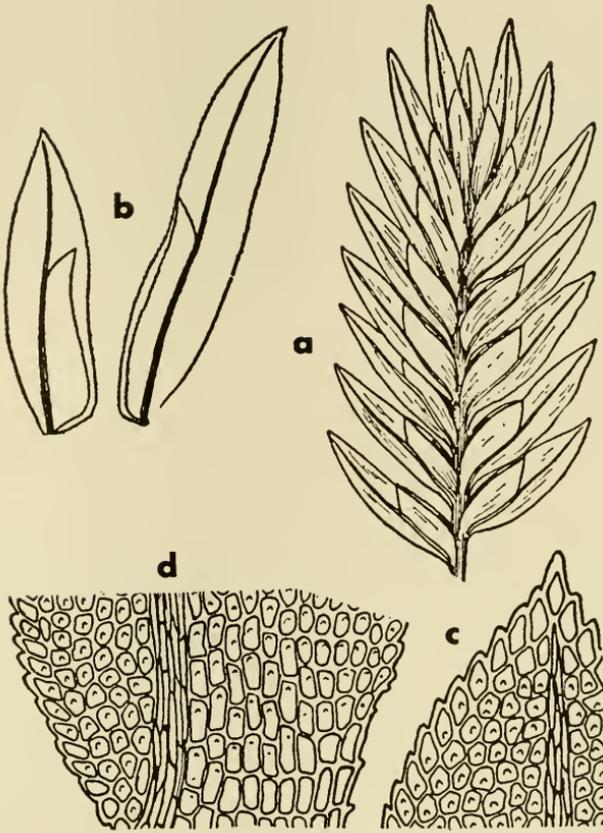


FIGURE 5. *Fissidens muriculatus*: (a) part of plant, (b) leaves, (c) cells at leaf tip, and (d) cells at leaf base (Grout, 1943).

Small plants, about 3 mm. high. Leaves in 7 to 20 pairs, somewhat curled at tips when dry, oblong-lanceolate, sharply acute, 1.0 to 1.25 mm. long, crenulate at margins, upper and perichaetial leaves bordered at base of vaginant laminae; dorsal lamina reaching stem, ending rather abruptly; costa percurrent or nearly so, ending in a pale, sharp mucro; upper cells obscure, densely papillose, irregularly rounded-quadrangle, thin-walled, 5 to 8  $\mu$ . Seta terminal, 3 to 4 mm. long; capsule small, erect to inclined; operculum long-rostrate; peristome teeth spirally thickened.

On limestone at middle altitudes in Puerto Rico; Haiti, Cuba, and Trinidad; Mexico, British Honduras, and Guatemala.

(p) *Fissidens ravenelii* Sull. Mem. Amer. Acad. Arts and Sci. N. S. 4: 171. 1849.

*F. densiretis* var. *latifolius* Grout. No. Amer. Fl. 15(3): 181. 1943.

Small plants, up to 5 mm. high. Leaves up to 10 pairs, somewhat secund at tips when dry, oblong-lanceolate, gradually acute, finely serrulate, about

1 mm. long, upper and perichaetial leaves bordered at base of vaginant laminae, border intramarginal near base; vaginant laminae about  $\frac{1}{2}$  leaf length; dorsal lamina tapered to stem or often ending abruptly at leaf base; costa ending 2 to 4 cells below apex; upper cells rather obscure, faintly roughened with 1 to several minute papillae, irregularly rounded-quadrate, incrassate, 5 to 8  $\mu$ . Seta terminal, 3 to 5 mm. long; urn of capsule erect, about 0.7 to 0.8 mm. long; operculum conic-rostrate, more than  $\frac{1}{2}$  length of urn; peristome teeth spirally thickened above. Spores 7 to 9  $\mu$ .

At western end of Cordillera Central, above Maricao, Puerto Rico; southeastern United States from North Carolina to the Gulf of Mexico: West Indies.

(q) *Fissidens stenopteryx* Besch. Rev. Bryol. 18: 54. 1891.

Stems up to 1 cm. long, with as many as 22 leaf-pairs, usually shorter. Leaves incurved and twisted when dry, crowded and overlapping at base, oblong-lanceolate, acute and apiculate, papillose-crenulate, up to 1 mm. long; vaginant lamina about  $\frac{1}{2}$  leaf length; dorsal lamina very narrow and gradually tapered to a vanishing point well above the leaf base; costa pellucid, disappearing 3 to 4 cells below leaf apex in pale, smooth cells of apiculus, more or less sinuose above; upper cells obscure, densely and finely papillose, rounded-quadrate, 5 to 6  $\mu$  wide. Rhizautoicous or autoicous. Seta terminal, flexuose, 0.8 to 1 mm. long; urn of capsule about 0.8 mm. long; operculum conic-rostrate; peristome teeth spirally thickened. Spores minutely punctate, 18 to 20  $\mu$  (FIGURE 6).

On rock and tree trunks, a few collections from an altitude of about 1000 feet, Puerto Rico; also Guadeloupe.

(r) *Fissidens vardei* Thér. Mem. Soc. Cubana Hist. Nat. 13: 208. 1939.

Plants minute; stems up to 0.5 mm. high. Leaves in 3 to 6 pairs, 1 to 1.5 mm. long, linear-lanceolate, acute, sharply dentate all around; dorsal lamina

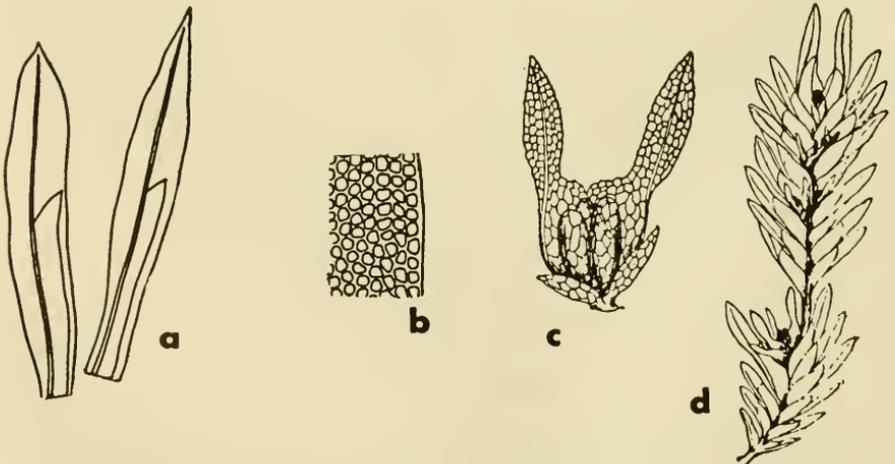


FIGURE 6. *Fissidens stenopteryx*: (a) leaves, (b) upper cells of leaf, (c) antheridial bud, and (d) antheridial plant (Grout, 1943).

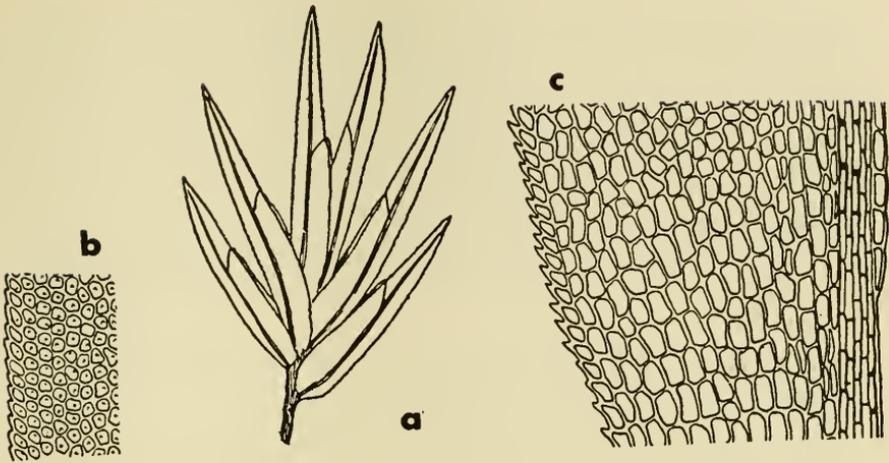


FIGURE 7. *Fissidens vardei*: (a) plant, (b) upper cells of leaf, and (c) cells of leaf base (Grout, 1943).

narrow, tapered to leaf base or ending somewhat above it; costa ending, at most, 2 to 3 cells below apex; upper cells hexagonal, 8 to 10  $\mu$ , coarsely unipapillose. Dioicous or pseudautoicous. Seta terminal, 2 to 5 mm. long; urn of capsule erect, less than 0.5 mm. long; operculum rostrate, about as long as urn; peristome teeth spirally thickened above. Spores 10 to 12  $\mu$  (FIGURE 7).

On rock, at altitudes above 3000 ft. in Cordillera Central, Puerto Rico; Cuba, Jamaica, and Haiti.

(s) *Fissidens donnellii* Aust. Bot. Gaz. 4: 151. 1879.

*F. tenerrimus* C. M. ex Broth. Acta Soc. Sci. Fenn. 19(5): 10. 1891.

*F. crenatoserrulatus* Card. Rev. Bryol. 36: 70. 1909.

Plants minute. Stems up to 2 to 3 mm. high, with 6 to 7 pairs of leaves. Leaves oblong-lanceolate, rounded-obtuse to subacute, dentate all around, coarsely toothed on vaginant laminae, up to 1.25 or 1.5 mm. long; vaginant laminae more than  $\frac{1}{2}$  leaf length; dorsal lamina broad, only slightly tapered to stem, or ending abruptly at leaf base; costa ending 3 to 5 cells below apex, bent at junction of vaginant and apical laminae; cells hexagonal, 7 to 10  $\mu$  wide, coarsely unipapillose. Seta terminal, 2 to 3 mm. long; urn of capsule erect, 0.7 to 0.8 mm. long; operculum conic-rostrate, about as long as urn; peristome teeth spirally thickened. Spores 13 to 21  $\mu$ .

On rock, rotten wood and soil at middle altitudes in Puerto Rico; United States (Florida); West Indies; Mexico; British Honduras and Guatemala.

(t) *Fissidens radicans* Mont. Ann. Sci. Nat., Bot. II. 14: 345. 1840.

*F. santaclarensis* var. *obtusifolius* Bizot & Thér. Mem. Soc. Cubana Hist. Nat. 13: 210. 1939.

Stems 2 to 5 mm. high. Leaves in 8 to 12 pairs, crowded, not or slightly contorted when dry, lingulate, gradually or abruptly narrowed to an obtuse

or rounded-obtuse apex, 1 to 1.5 mm. long, crenulate all around, not more strongly crenulate on vaginant laminae; vaginant laminae longer than apical lamina; dorsal lamina not conspicuously narrowed below, sometimes ending above leaf base; costa ending 4 to 11 cells below leaf apex, pellucid; upper cells 8 to 9  $\mu$ , rounded, bulging. Seta terminal, 3 to 5 mm. long; urn of capsule oval, up to 1 mm. long; operculum rostrate; peristome teeth short. Spores finely papillose, about 20  $\mu$ .

Usually on calcareous rock, more rarely on rotten wood or tree trunks, at lower and middle altitudes in Puerto Rico; United States (Florida); West Indies; Mexico, Guatemala, and Panama; Colombia, British and French Guiana, and Brazil.

(u) *Fissidens inaequalis* Mitt. Journ. Linn. Soc. London, Bot. 12: 589. 1869.

*Conomitrium latiusculum* C. M. Flora. 83: 328. 1897.

Plants minute. Stems 1 to 2 mm. high, with 2 to 3 pairs of leaves. Lower leaves very small; perichaetial leaves lanceolate from an abruptly differentiated base, gradually narrowed to a slenderly acute apex, entire or nearly so, up to 1 or 1.5 mm. long; vaginant laminae less than  $\frac{1}{2}$  leaf length, truncate or retuse at junction of vaginant and apical laminae; dorsal lamina attenuate to stem, sometimes ending above leaf base; costa percurrent or nearly so; cells smooth, thin-walled, oblong-hexagonal, somewhat oblique above, about 30 to 35  $\mu$  wide, mostly smaller, narrower and rectangular at margins. Seta terminal, up to 3 or 5 mm. long; urn of capsule about 0.6 to

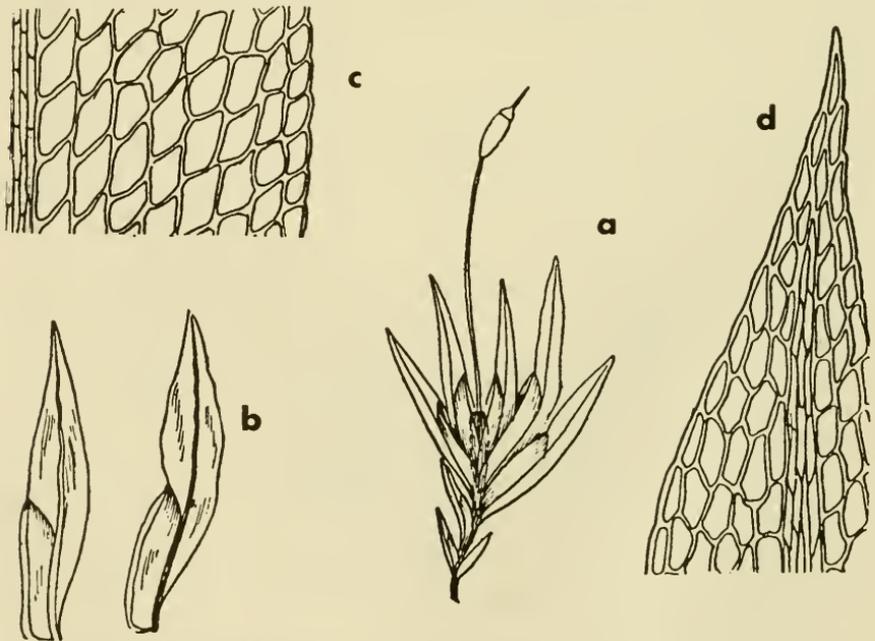


FIGURE 8. *Fissidens inaequalis*: (a) plant, (b) leaves, (c) upper cells of leaf, and (d) cells at leaf tip (Grout, 1943).

0.8 mm. long; operculum long-rostrate; peristome teeth spirally thickened. Spores smooth, 10 to 12  $\mu$  (FIGURE 8).

On clay banks, at lower altitudes, known in Puerto Rico from only 2 collections (*W. C. S.* 6382, 6919); also in Brazil.

Grout's report of *F. closteri* Aust. from Puerto Rico (1946) is based on specimens identical to those he had named *F. inaequalis*. The 2 species appear to be closely allied, but the longer stems and abruptly narrowed vaginant laminae of *F. inaequalis* seem to be of specific importance.

(v) *Fissidens cylindraceus* Mitt. Journ. Linn. Soc. London, Bot. 12: 590. 1869.

Plants small. Stems up to 7 mm. long. Leaves slightly secund at tips when dry, up to about 1.5 mm. long, oblong-lanceolate, acute, finely crenate, except for sharply serrulate margins of vaginant laminae; vaginant laminae about  $\frac{1}{2}$  leaf length; dorsal lamina broad, abruptly rounded at leaf base; costa usually ending 2 to 3 cells below apex; upper cell rounded-hexagonal, bulging, about 5  $\mu$  wide. Seta terminal, about 1.5 mm. long or sometimes more; urn of capsule erect, subcylindric, about 1 mm. long; operculum short-rostrate; peristome teeth papillose. Spores smooth or nearly smooth, 13 to 15  $\mu$  (FIGURE 9).

On tree trunks and rock, at middle altitudes in Puerto Rico; Martinique; Mexico; Ecuador.

(w) *Fissidens pellucidus* Hornsch. Linnaea 15: 146. 1841.

*Conomitrium asterodontium* C. M. Syn. Musc. Frond. 2: 527. 1851.

*Fissidens subcrenatus* Schimp. ex C. M. *Op. cit.* 531.

*F. rufulus* Sull. Proc. Amer. Acad. Arts and Sci. 5: 275. 1861, non Schimp. 1851.

*F. wrightii* Jaeg. Enum. Gen. et Spec. Fissid. : 12. 1869, nom.

*F. pyrenocystis* Card. Rev. Bryol. 37: 121. 1910.

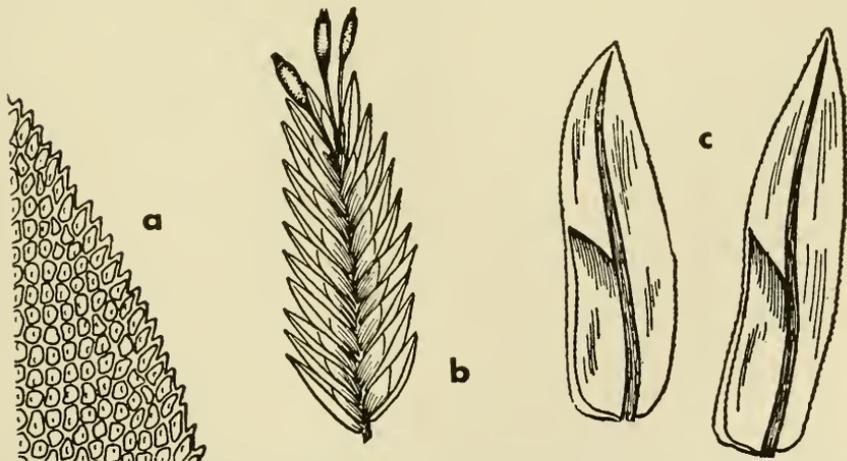


FIGURE 9. *Fissidens cylindraceus*: (a) cells at leaf tip, (b) part of plant, and (c) leaves (Grout, 1943).

Plants small, tinged with red-brown. Stems 2 to 5 mm. long, rarely more. Leaves in 3 to 8 pairs, rarely 10 or 12, slightly curled at tips when dry, oblong-lanceolate, up to 1.5 mm. long, obtuse to sharply acute, entire to crenulate; vaginant lamina about  $\frac{1}{2}$  leaf length; dorsal lamina rather broad, usually tapering to the stem; costa brown, usually ending 2 to 3 cells below leaf apex, but sometimes percurrent or even short-excurrent; cells smooth and pellucid, with thick, brownish walls, hexagonal, up to 15 or 20  $\mu$  wide. Seta terminal, 2 to 5 mm. long; urn of capsule erect, up to 1 mm. long; annulus falling with operculum; peristome teeth spirally thickened. Spores smooth, up to 10  $\mu$ .

Usually on soil, more rarely on rock and tree trunks, common, at lower and middle altitudes; United States (Georgia and Florida); West Indies to Brazil; Mexico and Guatemala.

The distinctions between *F. pellucidus* and its allies, *F. flexinervis* Mitt. and *F. validicostatus* Sull., seem at best rather tenuous. The angle of the leaf apex, the relative length of the costa, and the marginal crenulation are all characters of great variability in this complex. Intergradations among the local collections seem to indicate that only 1 variable species, *F. pellucidus*, can be recognized, at least in Puerto Rico.

(x) *Fissidens polypodioides* Hedw. Sp. Musc. 154. 1801.

Large plants with stems 2 to 8 cm. high. Leaves in many pairs, not crowded, curved at tips when dry, oblong-lingulate, rounded or broadly obtuse and bluntly apiculate at apex, entire or sometimes slightly irregular at apex, 3 to 5 mm. long; vaginant laminae  $\frac{1}{2}$  or more of leaf length, variable, often subequal or one more or less rounded to costa on same plants; dorsal lamina wide, truncate at leaf base; costa strong, percurrent or nearly so; cells smooth, incrassate, rounded-hexagonal, 8 to 15  $\mu$ , larger near costa and smaller at margin. Dioicous. Seta lateral, about 1 cm. long; urn of capsule inclined, obconic-cylindric; operculum rostrate,  $\frac{1}{2}$  length of urn; annulus large; divisions of peristome teeth nodulose. Spores minutely punctate, 12 to 15  $\mu$ .

On soil and rock, at middle and higher altitudes in Puerto Rico; southeastern United States; West Indies; Mexico to South America.

(y) *Fissidens asplenioides* Hedw. Sp. Musc. 156. 1801.

*F. flabellatus* Hornsch. In Mart. Fl. Brasil. 1(2): 91. 1840.

*F. turbinatus* Tayl. London Journ. Bot. 7: 190. 1848.

*F. ligulatus* H. f. & W. Fl. Nov. Zeland. 2: 63. 1854.

*F. nigricans* Schimp. ex Besch. Ann. Sci. Nat., Bot. VI. 3: 192. 1876.

*F. barbaemontis* C. M. ex Ren. & Card. Bull. Soc. Roy. Bot. Belg. 31(1): 152. 1892.

*F. costaricensis* Besch. Bull. Herb. Boiss 2: 390. 1894.

*F. santaclarensis* Thér. Mem. Soc. Cubana Hist. Nat. 13: 209. 1939.

Rather robust, dark green or yellowish plants, usually 1 to 2 cm. high, sometimes up to 5 cm. Leaves in 10 or more pairs, crowded, with tips strongly secund when dry, recurved even when moist, ligulate, rounded-obtuse,

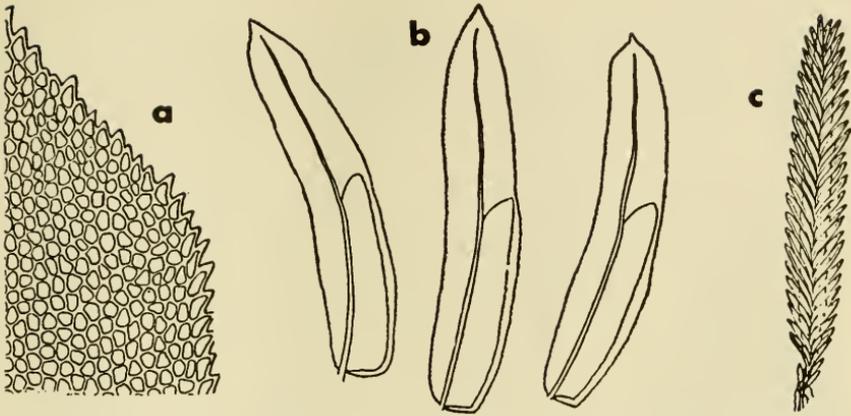


FIGURE 10. *Fissidens asplenioides*: (a) cells at leaf tip, (b) leaves, and (c) plant (Grout, 1943).

often slightly apiculate, finely crenulate, 2 to 3 mm. long; vaginant laminae over  $\frac{1}{2}$  leaf length, unequal, 1 rounded nearly to costa; dorsal lamina usually rather wide, ending rather abruptly above leaf base; costa ending many cells below apex, bent at junction with vaginant lamina; cells often bulging, not incassate, irregularly hexagonal, 5 to 10  $\mu$ . Dioicous. Seta terminal, 4 to 8 mm. long; urn of capsule erect to inclined, oblong, up to 1.5 mm. long; operculum rostrate, as long as urn; annulus present; divisions of peristome teeth long and slender, papillose in more or less oblique lines (FIGURE 10).

On soil and rocks, widespread at middle and higher altitudes in Puerto Rico; widespread in tropical and austral latitudes throughout world.

(z) *Fissidens similiretis* Sull. Proc. Amer. Acad. Arts and Sci. 5: 274. 1861.

*Conomitrium firminusculum* Besch. Rev. Bryol. 18: 53. 1891.

*Fissidens helleri* Ren. & Card. Bull. Soc. Roy. Bot. Belg. 41(1): 49. 1905.

Plants 1 to 3 cm. high. Leaves in 10 to 20 or more pairs, curled at tips when dry, ligulate-lanceolate, 2 to 3 mm. long, broadly acute or obtuse, irregularly serrulate at tips, crenulate below; vaginant laminae about  $\frac{2}{3}$  leaf length, unequal, 1 usually rounded above nearly to costa; dorsal lamina somewhat tapered to base or ending abruptly at or above insertion; costa ending below apex, flexuose above; cells rounded-hexagonal, smooth, thin-walled, 8 to 10  $\mu$ . Seta terminal, 3 to 4 mm. long; capsule 0.5 mm. long; operculum rostrate; peristome teeth spirally thickened above. Spores up to 18  $\mu$  (FIGURE 11).

On soil and rocks, northern coastal plain of Puerto Rico; West Indies; Guatemala (as var. *guadalupensis*).

#### DICRANACEAE

Plants small to robust, usually densely tufted. Stems erect, simple or forked, densely foliate, radiculose or tomentose below. Leaves straight and erect, or curved and secund, or crisped, lanceolate; costa single, usually

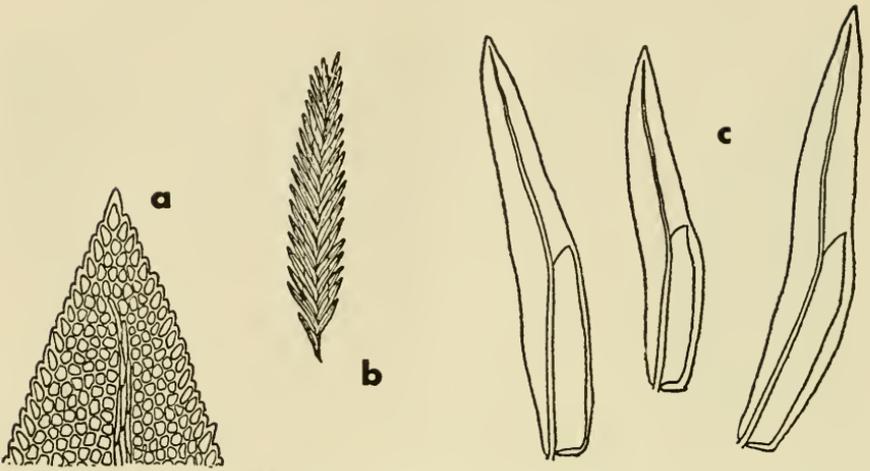


FIGURE 11. *Fissidens similiretis*: (a) cells at leaf tip, (b) plant, and (c) leaves (Grout, 1943).

stout, often ribbed at back; upper cells usually rounded-quadrate, smooth to mammillose or papillose, often incrassate and porose, the lower cells mostly pale and rectangular, often clearly differentiated at basal angles. Calyptra cucullate, not plicate or hairy, often rough above, entire or ciliate at base. Seta elongate, erect or curved; capsule erect or curved, ovoid to cylindric, often ribbed; operculum usually conic-rostrate; peristome single, rarely lacking, the 16 teeth mostly divided to or below middle and usually vertically striate on outer surface below, papillose above.

- Neck of capsule slender, as long as urn or longer . . . . . 4. *Trematodon*
- Neck short and inconspicuous, much shorter than urn.
- Alar cells not conspicuously differentiated.
- Seta stout, strongly curved when moist . . . . . 3. *Campylopodium*
- Seta slender, erect.
- Leaves lingulate, rounded at apex; cells lax and rhomboidal; peristome teeth split to base into 2 short, terete, spirally ridged forks . . . . . 5. *Wilsoniella*
- Leaves linear, narrowly pointed; cells oblong or linear; peristome teeth undivided or split about halfway down, papillose or striate.
- Capsule stomatose; peristome 250 to 450  $\mu$  high; leaves strongly clasping
- 1. *Anisothecium*
- Capsule without stomata; peristome rarely 300  $\mu$  high; leaves not conspicuously clasping . . . . . 2. *Dicranella*
- Alar cells clearly differentiated.
- Leaves bordered by narrow, hyaline cells . . . . . 8. *Leucoloma*
- Leaves not bordered.
- Costa narrow, less than  $\frac{1}{3}$  width of leaf base; perichaetia very large
- 7. *Holomitrium*
- Costa  $\frac{1}{3}$  or more leaf base; perichaetia not conspicuously enlarged . . . . . 6. *Campylopus*

(1) *Anisothecium* Mitt. Journ. Linn. Soc. London, Bot. 12: 39. 1869.

Leaves sheathing at base and gradually to abruptly narrowed to a spreading, lanceolate or subulate limb, or lanceolate, nonsheathing and erect-spreading to secund; costa single, not merging with lamina toward base. Dioicous, rarely autoicous; male inflorescence small and gemmiform. Seta red; capsule generally symmetric, erect, or sometimes inclined, smooth or

striate when dry and empty; exothecial cells isodiametric, incrassate, with straight walls; annulus none, or rarely small and persistent; stomata present; peristome teeth large, 250 to 450  $\mu$  high, usually divided scarcely half way down into 2 or 3 forks, dark red, vertically striolate below, usually papillose above.

*Anisothecium brachydontium* Crum & Steere. Bryol. 59: 247. 1956.

Plants rather slender to medium-sized, yellowish, caespitose. Stem erect, about 1 to 2 cm. high, simple or branched by innovations, slightly radiculose below. Leaves 3 to 4 mm. long, the lowermost ovate and subsheathing at base, gradually acuminate, the others abruptly contracted to a linear-lanceolate, acute, erect-spreading limb from a broad, strongly sheathing obovate base, entire-margined; costa percurrent, 65 to 70  $\mu$  wide below; upper cells rectangular, smooth and pellucid, 8  $\mu$  wide, 2 or 3: 1, basal cells longer and laxer. Dioicous? Calyptra cucullate, smooth, naked. Seta 10 to 20 mm. high, slender, erect, flexuose when dry, pale yellow becoming somewhat reddish with age; urn of capsule 1 to 1.3 mm. long, suberect and slightly asymmetric, elliptic, reddish-brown becoming dark, irregularly wrinkled when dry; operculum obliquely long-rostrate, as long as the urn; exothecial cells rectangular or oblong-hexagonal, small and hexagonal in a few rows below mouth; annulus small, persistent; peristome teeth 230 to 265  $\mu$  high, dark red and vertically pitted-striate below, hyaline and papillose above, divided about half way down into 2 slender, papillose forks. Spores bluntly and coarsely papillose, 27 to 29  $\mu$  in diameter.

Endemic. On clay in trail westward from El Toro to Ciénaga Alta, Sierra de Luquillo, *W. C. Steere* 6500, Feb. 10, 1940. On roadside cliff at km. 15.3, Mameyes—Río Blanco, Sierra de Luquillo, *W. C. Steere* 6556, Feb. 17, 1940. On roadside bank, south of San Lorenzo, km. 11.2, unfinished road to Patillas, *W. C. Steere* 6808, March 9, 1940, type.

*Anisothecium jamesonii* (Tayl.) Mitt. of South America and Cuba is similar in general appearance but clearly differs from *A. brachydontium* in having a longer peristome, more typical in size of *Anisothecium*, and obscure, papillose upper leaf cells and crenulate upper leaf margins. The nearest relative of this species appears to be *A. hioramii* Thér. of Cuba, which also has smooth upper leaf cells and a small, persistent annulus. According to the description, however, *A. hioramii* has only comal and perichaetial leaves that are clasping at the base, a much narrower costa, and longer upper leaf cells.

(2) *Dicranella* Schimp. Coroll. Bryol. Eur. : 13. 1855.

Small plants in loose, dull, yellowish or brownish tufts. Stems erect, simple or sparsely branched, sparsely radiculose below. Leaves crowded above, usually smaller and more remote below, erect-spreading or secund, rarely squarrose, gradually to rather abruptly subulate from an oblong, half-sheathing, or a lanceolate, nonsheathing base; costa single, ending at or near apex, sometimes filling most of subula; cells smooth, subquadrate to linear, not differentiated at basal angles. Dioicous; perichaetial leaves similar to upper

stem leaves. Seta erect, slender, yellow to reddish; capsule erect or somewhat inclined, symmetric, subglobose to oblong-cylindric; operculum long-rostrate; annulus present; peristome teeth 16, up to 300  $\mu$  high, not or only shortly and irregularly forked, or split  $\frac{2}{3}$  to  $\frac{3}{4}$  down into 2 slender, papillose forks, papillose throughout, or sometimes vertically striolate on outer surface below.

Peristome teeth entire, or divided into short, irregular forks.

Peristome teeth vertically striate on outer plates; capsules short-oval, more or less nodding and strumose; leaves narrowed to a nearly subulate apex

(a) *D. guadelupensis*

Peristome without striae; capsules erect and symmetric; leaves blunt.

Capsules oval; spores coarsely papillose. . . . . (b) *D. longirostris*

Capsules spheric; spores minutely papillose. . . . . (c) *D. sphaerocarpa*

Peristome teeth divided to middle or below, pitted-striolate below.

Most leaves rounded-obtuse; costa vanishing well below apex.

Seta reddish, rather stout and erect; capsule contracted below the mouth when dry; median leaf-cells 6 to 7  $\mu$  wide. . . . . (d) *D. subinclinata*

Seta yellowish, weak and flexuose; capsule usually not contracted below mouth.

Leaf cells lax and thin-walled, upper and median short, irregular or subquadrate

(e) *D. hilariana*

Leaf cells somewhat incrassate, median 2 to 6:1, 4 to 5  $\mu$  wide. . . . . (f) *D. herminieri*

Most leaves acute; costa percurrent or excurrent.

Leaves clearly squarrose; blade distinct to apex; seta pale. . . . . (g) *D. reticulata*

Leaves not squarrose, often secund; seta yellowish or becoming reddish with age.

Capsule short-oval to oblong, nodding, not furrowed. . . . . (h) *D. perrolletii*;

Capsule oval, erect, furrowed when dry. . . . . (i) *D. harrisi*;

(a) *Dicranella guadelupensis* Mitt. Journ. Linn. Soc. London, Bot. 12: 37. 1869.

*D. cespitans* Besch. Ann. Sci. Nat., Bot. VI. 3: 183. 1876.

*D. homomalla* Besch. *Ibid.* 184.

Yellow-brown plants in compact mats. Stems up to 2 cm. high, often branched. Lower leaves erect, slightly curved when dry, upper secund, nearly subulate from a lanceolate base, about 2 mm. long; costa about  $\frac{1}{3}$  leaf base, 80 to 100  $\mu$  wide below; leaf cells narrowly rectangular with thickened, colored walls. Perichaetial leaves up to 4 mm. long, denticulate at apex, abruptly narrowed to limb, which is 3 to 4 times length of clasping base. Seta 10 to 12 mm. long; capsule short-oval, more or less nodding and strumose; annulus broad; peristome teeth irregular, scarcely 125  $\mu$  high, vertically striate and papillose nearly throughout. Spores rough, up to 16  $\mu$ .

On bare soil in trails and on banks, collected in several localities at middle altitudes in Luquillo Mountains, northeastern Puerto Rico; Guadeloupe and Martinique.

(b) *Dicranella longirostris* (Schwaegr.) Mitt. Journ. Linn. Soc. London, Bot. 12: 30. 1869.

*Trematodon longirostris* Schwaegr. Suppl. Sp. Musc. I. 2: 343. 1876.

*Microdus crispulus* Besch. Ann. Sci. Nat., Bot. VI. 3: 179. 1876.

*Dicranella pseudolongirostris* Card. Rev. Bryol. 36: 68. 1909.

Brownish-green plants in low compact mats; stems mostly unbranched and less than 1 cm. high, with leaves more or less erect-appressed or some-

what curved. Stem leaves short-lanceolate, entire, narrowly obtuse, 1 mm. long or slightly more; costa nearly percurrent, about  $70 \mu$  wide below; leaf cells rectangular, with walls somewhat thickened throughout, lower about 6:1, upper 1 to 1.5:1; perichaetial leaves up to 2.5 mm. long, scarcely clasping, gradually acuminate to a limb not much longer than base, entire or nearly so at apex. Seta about 7 mm. long; capsule oval, erect, and symmetric, 1.25 mm. long; annulus large; peristome teeth mostly less than  $120 \mu$ , not striate, irregularly divided or perforated. Spores very coarsely papillose, up to  $18 \mu$ .

On clay, several localities in Luquillo Mountains, at altitudes of 1000 to 3000 ft., Puerto Rico; St. Jan (*Breutel*); West Indies; Mexico; Brazil (*Bescherelle*).

(c) *Dicranella sphaerocarpa* Card. Rev. Bryol. 36: 69. 1909.

Plants in loose, low, green mats. Stems up to 5 mm. high, branched. Leaves erect-flexuose when dry, upper stem leaves about 2 mm. long, lanceolate or oblong-lanceolate, usually narrowly obtuse and crenate at apex; margins recurved above; costa 50 to  $60 \mu$  wide below and about  $\frac{1}{7}$  to  $\frac{1}{5}$  width of base, vanishing in or below apex; cells thin-walled, mostly rectangular, 5 or 7:1 below, 1 or 2:1 above; perichaetial leaves scarcely clasping, similar to upper stem leaves. Seta about 5 mm. long; capsule erect, subglobose, 0.6 mm. in diameter; annulus large; peristome teeth less than  $100 \mu$  high, not striate, irregularly or not divided. Spores minutely papillose, up to  $17 \mu$ .

On clay banks, a few localities in Central Cordillera at altitudes of 3000 to 4000 ft., Puerto Rico; United States (Florida); Mexico.

(d) *Dicranella subinclinata* Lor. Moosstudien. 160. 1864.

*Dicranum caespitans* Schimp. ex Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg. 16: 164. 1872.

*Dicranella stenocarpa* Besch. Ann. Sci. Nat., Bot. VI. 3: 182. 1876.

*D. martinicae* Broth. In Urban, Symb. Antill. 3: 421. 1903.

Plants in rather loose, dull green or brown tufts. Stems usually simple, about 1 cm. high. Leaves erect-appressed and somewhat curled when dry, erect-spreading when moist; stem leaves gradually larger upward, about 1.5 mm. long, lanceolate with more or less recurved margins, narrowly obtuse and crenate at apex; costa not quite percurrent, 60 to  $70 \mu$  wide at base; upper cells rectangular, 6 to  $7 \times 12$  to  $18 \mu$ , mostly not more than twice as long as wide, larger below and mostly narrow, with colored, scarcely thinner walls to near base; perichaetial leaves about 2.5 mm. long, scarcely clasping, gradually narrowed to a lance-linear limb about twice as long as base. Seta reddish, at least when old, straight or somewhat flexuose, 1 to 1.5 cm. long; capsule oval, smooth, erect or inclined, symmetric, more or less contracted under the mouth when dry; peristome teeth 250 to  $275 \mu$  high, divided more than  $\frac{2}{3}$  down. Spores finely papillose, 15 to  $20 \mu$ .

On soil and disintegrating rock, especially on roadside banks, very common and widespread at middle altitudes in Puerto Rico; West Indies; Mexico and Central America.

- (e) *Dicranella hilariana* (Mont.) Mitt. Journ. Linn. Soc. London. **12**: 31. 1869.

*Dicranum hilarianum* Mont. Ann. Sci. Nat., Bot. II. **12**: 52. 1839.

*Angstroemia liebmanniana* C. M. Syn. Musc. Frond. **2**: 605. 1851.

*Campylochaetium mexicanum* Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg. **16**: 168. 1872.

*Angstroemia trematodontifolia* C. M. Linnaea. **38**: 630. 1874.

*Dicranella leptorhyncha* Ren. & Card. Bull. Soc. Roy. Bot. **31**(1): 143. 1893.

*Angstroemia pseudodebilis* C. M. Hedwigia. **37**: 229. 1898.

?*A. wrightii* C. M. *Ibid.*

Plants in loose, pale green mats. Stems simple or branched, 2 to 5 mm. high. Stem leaves erect-spreading or sometimes slightly secund when moist, ovate-lanceolate and about 0.5 mm. long below, reaching about 2 mm. above, narrowly lanceolate, gradually narrowed to a blunt, serrulate apex, not clasping at base; costa stout, ending below the apex, prominent at back and sometimes rough above; cells lax and thin-walled, subquadrate to short-rectangular above, much larger and clearer below; perichaetial leaves similar to upper stem leaves. Seta weak and flexuose, 5 to 12 mm. long, yellowish, becoming brownish with age; capsule ovoid to short-oblong, erect or nearly so, smooth, urn about 1 mm. long; peristome teeth about 200  $\mu$  high, divided  $\frac{2}{3}$  to  $\frac{3}{4}$  down. Spores finely papillose, 15 to 18  $\mu$ .

Not common; on soil and disintegrating rock in mountains at altitudes of 1000 to 3000 ft.; southeastern United States; West Indies; Mexico to South America.

- (f) *Dicranella herminieri* Besch. Ann. Sci. Nat., Bot. VI. **3**: 180. 1876.

*Trichostomum pyriforme* Lesq. & James. Manual. 109. 1884.

*Dicranella tonduzii* Ren. & Card. Bull. Soc. Roy. Bot. Belg. **31**(1): 144. 1893.

*D. leptotrichoides* Ren. & Card. Bot. Gaz. **19**: 237. 1894.

*Angstroemia hydrophila* C. M. Hedwigia. **37**: 230. 1898.

*Dicranella substenocarpha* Ren. & Card. Bull. Soc. Roy. Bot. Belg. **41**(1): 11. 1905.

Plants mostly in loose, dull green mats. Stems usually simple, 4 to 6 mm. high, rarely reaching 2.5 cm. Leaves erect-appressed and slightly curved when dry, erect-spreading when moist, short, ovate-lanceolate to lanceolate, gradually narrowed to an obtuse, entire or subentire apex; costa stout, about  $\frac{1}{5}$  leaf base, scarcely percurrent; cells slightly incrassate nearly to base, median mostly rectangular, 4 to 7  $\mu$  wide, usually 2 to 6 times as long, broader and longer below; perichaetial leaves up to 3 mm. long, gradually narrowed from an ovate base to a narrow limb about twice as long, obtuse or acute. Seta usually yellowish, flexuose, 6 to 8 mm. long; capsule ovoid, erect, and symmetric; peristome teeth more than 200  $\mu$  high, divided  $\frac{2}{3}$  down or more. Spores papillose, 16 to 18  $\mu$ .

On soil and soft rock, very common in upper coastal plain and lower

mountain slopes in Puerto Rico; the coastal plain of southeastern United States; West Indies; Mexico, Honduras, Costa Rica, and Panama.

(g) *Dicranella reticulata* (C. M.) Paris. Index Bryol. Suppl. 118. 1900.

*Angstroemia reticulata* C. M. Hedwigia. 37: 228. 1898.

Plants in loose green tufts. Stems simple or branched above, up to 1.5 cm. high. Stem leaves 1 to 1.5 mm. long, abruptly narrowed from clasping base to squarrose limb, lower leaves narrower and less clasping at base, entire or denticulate at apex; costa percurrent; cells of leaf blade distinct to apex or nearly so, rectangular, up to 2:1 above; perichaetial leaves up to 3 mm. long or somewhat more, abruptly narrowed from clasping base to flexuose limb 3 or 4 times as long. Seta pale, up to 12 mm. long; capsule oval, more or less furrowed when dry, erect, urn 1.5 mm. long; peristome teeth about 250  $\mu$  high, divided about  $\frac{2}{3}$  down; operculum obliquely and slenderly long-rostrate. Spores warty, 20 to 23  $\mu$ .

On soil, especially on roadside banks, known from a few localities at middle elevations in Puerto Rico; Cuba, Jamaica, and Guadeloupe.

(h) *Dicranella perrottetii* (Mont.) Mitt. Journ. Linn. Soc. London. Bot. 12: 35. 1869.

*Dicranum perrottetii* Mont. Ann. Sci. Nat., Bot. II. 19: 241. 1843.

*Dicranella flava* Besch. Ann. Sci. Nat., Bot. VI. 3: 181. 1876.

Plants in yellowish or brownish-green tufts. Stems up to 2.5 cm., rarely 4 cm. high, often branched. Stem leaves erect-spreading, often secund, lower gradually narrowed from lanceolate base to stout, subentire, acute point, with narrow blade extending to apex, upper and perichaetial leaves larger, more clasping and more abruptly narrowed above, with leaf blade very narrow or indistinct upward; costa about  $\frac{1}{2}$  width of base, 80 to 100  $\mu$  wide below, vanishing just below apex in lower leaves, often slightly excurrent in upper leaves; lower cells elongate-rectangular, colored, upper shorter, about 2:1. Seta yellowish, about 12 mm. long; capsule short-oval to oblong, more or less nodding, not furrowed; peristome teeth 225 to 275  $\mu$  high, mostly divided more than  $\frac{2}{3}$  down into 2 unequal forks. Spores minutely papillose, to 16  $\mu$ .

On clay, especially on vertical banks, in mountains, at altitudes of 1000 to 4000 ft. in Puerto Rico; West Indies.

(i) *Dicranella harrisii* (C. M.) Broth. In E. & P., Nat. Pfl. 1(3): 309. 1901.

*Angstroemia harrisii* C. M. Bull. Herb. Boiss. 5: 554. 1897.

Plants in rather compact, dull, yellow-green cushions. Stems mostly simple, about 8 mm. high. Stem leaves rather distant, gradually larger above, rather abruptly narrowed from ovate, scarcely clasping base to somewhat incurved-spreading limb, with blade indistinct or lacking above, mostly denticulate at acute apex; costa 60 to 100  $\mu$  wide at base; cells colored and narrowly elongate and slightly incrassate below, much smaller and indistinct above; perichaetial leaves up to 4 mm. long, abruptly nar-

rowed from broad, clasping base to slender, flexuose limb without a distinct lamina above. Seta yellow, or finally reddish, about 8 mm. long; capsule oval, about 1 mm. long, nearly erect and symmetric, sometimes slightly strumose at base, slightly furrowed when dry and empty; peristome teeth 250 to 350  $\mu$  high, divided  $\frac{3}{4}$  down. Spores rather coarsely papillose, 20 to 22  $\mu$ .

On clay banks, from a few localities at rather high altitudes (3000 to 4000 ft.) in Puerto Rico; Cuba; Jamaica.

(3) *Campylopodium* (C. M.) Besch. Ann. Sci. Nat., Bot. V. 18: 189. 1873.

Plants small, gregarious or laxly tufted, yellow-green. Stems simple and erect, radiculose at base. Leaves more or less clasping at base and abruptly narrowed to a flexuose, spreading subula; margins plane and entire; costa sharply differentiated at leaf base, excurrent, and often filling subula; cells of blade rectangular, with little-thickened, unpitted walls, cells longer in basal portion, not differentiated in alar region. Dioicous. Seta elongate, stout, twisted, and irregularly contorted when dry, geniculate to recurved when moist; capsule symmetric to slightly curved, smooth or more or less striate, stomatose; annulus present; operculum obliquely rostrate from conic base; peristome usually present, the 16 teeth more or less irregularly divided about halfway into 2 subulate forks, vertically striate below and papillose above.

*Campylopodium pusillum* (Schimp.) Williams. No. Amer. Fl. 15(2): 94. 1913

*Campylopus pusillus* Schimp. ex Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg. 16: 165. 1872.

*Angstroemia sartorii* C. M. Linnaea. 38: 629. 1874.

*A. pilopogon* C. M. *Ibid.* 630.

*Dicranum magnirete* C. M. Bull. Herb. Boiss. 5: 186. 1897.

*D. tuerckheimii* C. M. *Ibid.*

Stems to 1 cm. high. Lower leaves short, ovate-lanceolate, not clasping; upper leaves to 4 mm. long, with ovate, clasping bases and subulae 2 to 3 times as long, usually slightly denticulate at apex, crenulate at shoulders; costa about 80  $\mu$  wide near base,  $\frac{1}{3}$  to  $\frac{1}{2}$  width of leaf base; lower cells rectangular, shorter and irregular at shoulders, linear in narrow blade. Calyptra entire at base, smooth, split on 1 side to above middle. Seta up to 6 mm. long; capsule oval, ribbed when dry, 1 to 1.5 mm. long; peristome teeth 200  $\mu$  or more high. Spores coarsely papillose, 20 to 24  $\mu$ .

On clay banks in high mountains from very few localities in Puerto Rico; Jamaica; Mexico, Guatemala, and Costa Rica; northern South America.

(4) *Trematodon* Michx. Fl. Bor. Amer. 2: 289. 1803.

Small, gregarious, light green or yellowish plants with erect, usually simple stems. Leaves tapering to lanceolate or subulate point from oblong-ovate, clasping base; costa with or without stereids, ending below apex to excurrent; cells smooth. Calyptra cucullate. Seta elongate; capsule erect or curved, cylindric, narrowed to neck equal to or longer than urn; annulus single or double; operculum long-rostrate; peristome lacking or single, with 16 undivided, perforate or bifid teeth, vertically striate on outer surface. Spores roughened.

*Trematodon longicollis* Michx. Fl. Bor. Amer. 2: 289. 1803.

*T. reflexus* C. M. Syn. Musc. Frond. 1: 459. 1848.

*T. squarrosus* C. M. Bot. Zeit. 15: 381. 1857.

*T. uncinatus* C. M. Linnaea. 38: 628. 1874.

*T. tenellus* Schimp. ex Besch. Ann. Sci. Nat., Bot. VI. 3: 178. 1876.

*Trichodon flexifolius* Ren. & Card. Rev. Bryol. 15: 70. 1888.

*Trematodon cubensis* C. M. Hedwigia. 37: 228. 1898.

Stems 2 to 8 mm. high. Leaves clasping at base, spreading-flexuose at tips when moist, curled when dry, about 2 to 2.5 mm. long above, abruptly narrowed from ovate or oblong, clasping base to linear, obtuse limb; margins more or less recurved, entire except for blunt teeth at apex; cells short-rectangular above, more elongate below. Autoicous. Seta about 1 cm. long, yellow; capsule cylindrical, curved and inclined, urn about 1 to 1.5 mm. long, neck variable, usually about 3 mm. long, stomatose throughout and strumose at base; annulus revoluble; peristome teeth fused at base, red, irregularly perforate, vertically striate below, papillose above. Spores 17 to 23  $\mu$ .

On clayey soil, widespread at all altitudes but the lowest in Puerto Rico; eastern United States; West Indies; Mexico to South America; Europe; Ceylon; New Guinea; Philippine Islands; Hawaii.

(5) *Wilsoniella* C. M. Bot. Zentralbl. 7: 345. 1881.

Plants small, soft, loosely tufted. Leaves narrowly lingulate to linear-lanceolate, usually very blunt or rounded at apex, plane at margins; costa thin, ending well below leaf apex; cells lax and thin-walled, elongate-rhomboidal or oblong-hexagonal. Seta elongate, erect, slender, yellow; urn of capsule oblong-cylindric, short-necked, usually contracted below mouth when dry and empty; annulus present; operculum slenderly rostrate from a conic base; peristome teeth erect, split to base into 2 terete, papillose, or spirally ridged forks.

*Wilsoniella subvaginata* Crum & Steere. Bryol. 59: 248. 1956.

Plants small, brownish green, loosely tufted. Stems sparsely branched, about 0.5 cm. high, radiculose at base. Leaves spreading and contorted when dry, widely spreading when moist, 1.5 to 2 mm. long, oblong-lanceolate or long-lingulate, concave, subsheathing at base, rounded and crenulate at apex, entire below, plane at margins; costa slender, ending well below apex; cells smooth, lax, and thin-walled, elongate-rhomboidal in median region, shorter and rhombic or hexagonal at apex, laxly rectangular at base, not differentiated at basal margins. Calyptra mitrate-rostrate, lobed at base, smooth and naked. Autoicous; perichaetial leaves similar to stem leaves; inner perigonal leaves similar but about half as long; both inflorescences with paraphyses. Seta 8 to 13 mm. long, thin and flexuose, smooth, yellow; urn of capsule erect and symmetric, narrowly cylindrical when dry, oblong and contracted to short neck when moist, including neck 1.5 to 2 mm. long, not contracted below mouth; exothecial cells oblong-hexagonal, shorter in few rows at mouth; annulus large, revoluble; operculum slenderly long-rostrate from low-conic base, straight, about 0.5 to 1 mm. long; peristome teeth 140

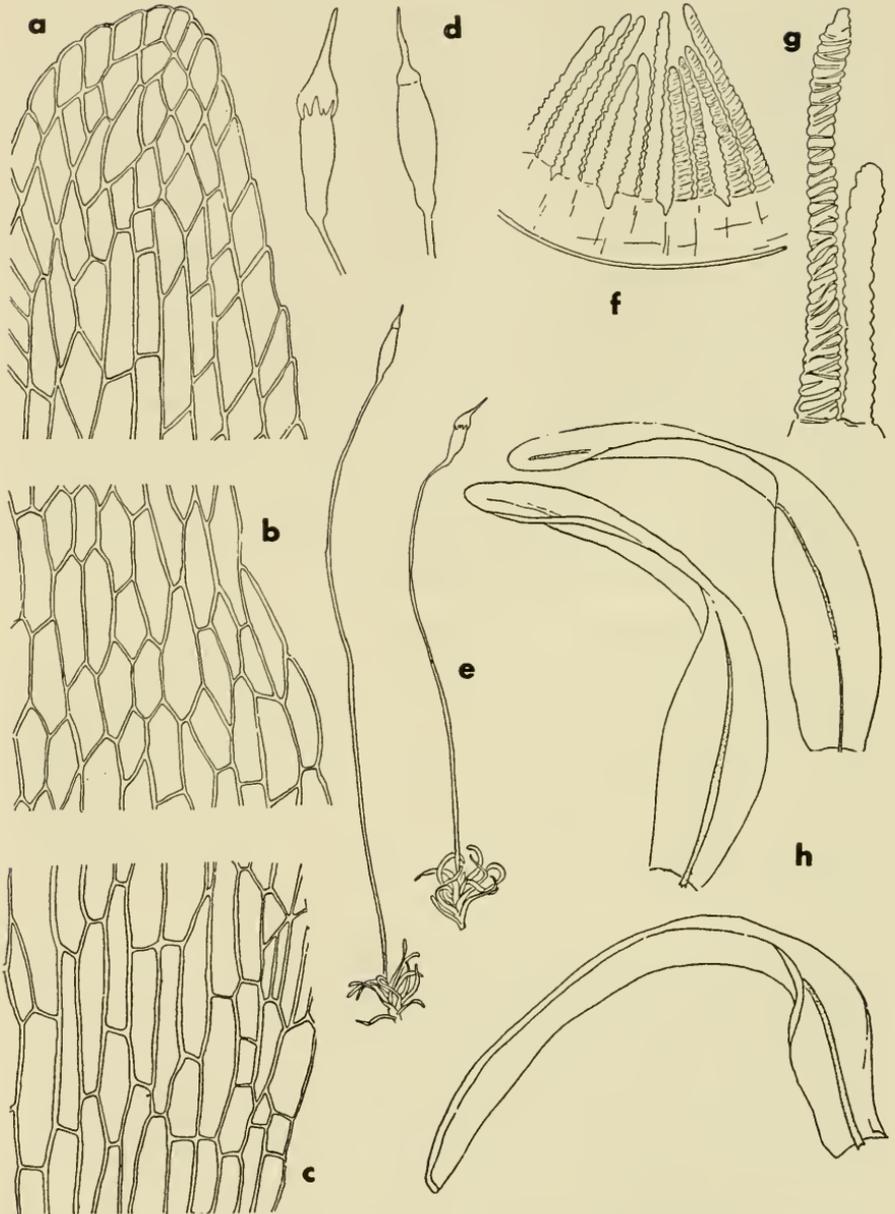


FIGURE 12. *Wilsoniella subvaginans*: (a) cells at leaf tip, (b) cells at upper third of leaf, (c) cells of leaf base, (d) 2 capsules, one with calyptra, (e) 2 fruiting plants, (f) portion of peristome, (g) pair of peristome teeth, and (h) leaves.

to 160  $\mu$  high, erect, split nearly to base into 2 short, terete, spirally ridged forks. Spores spheric, densely and finely papillose, 24 to 27  $\mu$  (FIGURE 12).

In crevices of shaded cliff along old trail above river, from Maricao south to Maricao Insular Forest, *W. C. S.* 5623, Dec. 29, 1939. On roadside bank

at shelter, high ridge, km. 14.4, road between Maricao and Sabana Grande, Maricao Insular Forest, *W. C. S.* 5823 (type), Dec. 31, 1939. On clay bank along trail east of Cerro de la Punta, Cordillera Central, south of Jayuya, *W. C. S.* 6184 (with *Rhamphidium borinquense*, Jan. 20, 1940).

Closely related to *Wilsoniella flaccida* (Williams) Broth. of Bolivia, this species differs in its somewhat shorter, less toothed, subclasping leaves, longer capsules and larger spores.

(6) *Campylopus* Brid. Musc. Recent. Suppl. 4: 71. 1819.

Mostly coarse, compactly tufted plants with radiculose or tomentose, branching stems. Leaves straight or curved, often secund, usually rigid, ovate or ovate-lanceolate at base, narrowed to channeled, subulate, usually dentate point, rarely hyaline tipped; costa very broad, usually filling most of upper leaf, percurrent or excurrent, more or less ribbed or lamellose at back; upper cells mostly rhomboidal to short-rectangular, at lower margins sometimes pale, very narrow and thin-walled, forming an indistinct border, inner basal cells often incrassate and pitted, alar conspicuously differentiated, usually extending to costa. Dioicous. Calyptra cucullate, usually ciliate at base, sometimes entire. Seta usually strongly cygneous; capsule usually deeply furrowed when dry; annulus large, compound; operculum rostrate, peristome teeth rarely solid or more or less divided, but usually divided about  $\frac{1}{2}$  down and vertically striate below.

Leaves ending in hyaline tips or hair-points.

Costa strongly ridged at back; basal cells thin-walled. . . . . (a) *C. introflexus*

Costa smooth or faintly ridged; basal cells incrassate and porose. . . . . (b) *C. richardii*

Leaves ending in short to long, concolorous tips.

Costa with 2 stereid bands; basal cells incrassate and porose.

Plants slender, silky; leaves in interrupted tufts. . . . . (c) *C. porphyreodictyon*

Plants medium-sized to large, coarse; leaves not tufted.

Stems up to 6 cm. high; leaves 6 to 9 mm. long; costa up to 275  $\mu$  wide above alar cells, ribbed above. . . . . (d) *C. cubensis*

Stems up to 12 cm.; leaves 12 to 18 mm.; costa to 400  $\mu$  wide above alar group, lamellose. . . . . (e) *C. tortuosus*

Costa with 1 stereid band; basal cells various.

Cells in lower part of leaf with straight, thin walls.

All or nearly all cells of leaf base more or less inflated and hyaline; alar cells scarcely differentiated. . . . . (f) *C. fragilis*

Only cells of lower  $\frac{1}{2}$  or  $\frac{1}{3}$  of leaf base enlarged or inflated; alar cells clearly differentiated.

Cells of upper lamina linear-flexuous, incrassate, somewhat pitted

(g) *C. angustiretis*

Cells of upper lamina short-rectangular to oblong or rhomboidal

(h) *C. gracilicaulis*

Cells in basal portion of leaf incrassate and more or less pitted.

Plants very robust; stems up to 24 cm. high; leaves 10 to 12 mm. long; costa about 800  $\mu$  wide at base. . . . . (i) *C. praealtus*

Plants much smaller; stems to 4 cm.; leaves 5 to 7 mm.; costa 300  $\mu$  or less wide below.

Leaves about 17 mm. long; costa about 300  $\mu$  wide; calyptra ciliate at base (j) *C. cygneus*

Leaves about 5 mm. long; costa about 250  $\mu$  wide; calyptra not ciliate

(k) *C. saxatilis*

(a) *Campylopus introflexus* (Hedw.) Brid. Bryol. Univ. 1: 472. 1826.

*Dicranum introflexum* Hedw. Sp. Musc. 147. 1801.

*Campylopus polytrichoides* De Not. Syll. Musc. 222. 1838.

- Dicranum liebmanni* C. M. Syn. Musc. Frond. 2: 601. 1851.  
*D. lamellicosta* C. M. *Op. et loc. cit.*  
*D. lutescens* C. M. *Op. cit.* 602.  
*D. proliferum* C. M. *Op. et loc. cit.*  
*Campylopus leucotrichus* Sull. & Lesq. Icones Musc. 28. 1864.  
 ?*C. vitziliputzli* Lor. Moosstudien. 158. 1864.  
*C. strictus* Schimp. ex Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg. 16:  
 167. 1872.  
*C. luridus* Schimp. ex Besch. *Ibid.* 168.  
*C. pilosissimus* Schimp. ex Besch. *Ibid.*  
*C. subproliferus* C. M. ex Ren. & Card. Bull. Soc. Roy. Bot. Belg. 31(1):  
 149. 1893.  
*Thysanomitrium jamaicense* C. M. Bull. Herb. Boiss. 5: 552. 1897.  
*Campylopus cinchonae* Paris. Index Bryol. Suppl. : 90. 1900, nom.  
*C. pachycomus* Besch. ex Paris. *Op. cit.*(Ed. 2). 2: 321. 1904, nom.

Rigid plants in dense tufts, greenish or yellowish above, dark below. Stems tomentose below, equally foliate or comose at intervals, up to 4 cm. or more. Leaves laxly appressed or erect-spreading, oblong-lanceolate, 5 mm. or more long, ending in a hyaline, toothed point of variable length, or sometimes ending abruptly in a few hyaline teeth; blade gradually tapered, scarcely reaching base of awn, entire or nearly so; costa with dorsal stereids only, excurrent, about 300  $\mu$  wide or more near base and about  $\frac{1}{2}$  to  $\frac{3}{5}$  width of base, strongly ridged at back with serrate lamellae 2 to 6 cells high; cells rather inconspicuous to inflated, hyaline or reddish in alar region, narrowly rectangular, hyaline and thin-walled just above, thick-walled, colored and short-rhomboidal higher up. Calyptra ciliate at base. Setae often aggregated, scabrous above, 6 to 9 mm. long; capsule rugose at base, furrowed when dry; peristome teeth red-brown, 45 to 60  $\mu$  wide at base. Spores rough, up to 13  $\mu$ .

On rock and soil, at middle altitudes in central cordillera of Puerto Rico (much less common than its abundance elsewhere would lead one to expect); West Indies; southeastern United States; throughout Mexico, north to Arizona and Texas, south to Central and South America; Europe; Pacific islands and New Zealand.

(b) *Campylopus richardii* Brid. Musc. Recent. Suppl. 4: 73. 1819.

*Thysanomitrium richardii* (Brid.) Schwaegr. Suppl. Sp. Musc. II. 1(2): 61. 1823.

*Dicranum laevigatum* C. M. Syn. Musc. Frond. 1: 413. 1848.

*Thysanomitrium yunqueanum* C. M. Hedwigia. 37: 225. 1898.

Coarse, moderately robust plants, yellow-green at tips, brown or black below. Stems up to 8 cm. long, uniformly foliate, or comose in fertile plants. Leaves up to 6 or 8 mm. long, oblong-lanceolate, subtubulose above, entire, usually ending in short, hyaline, toothed point; costa broad, only slightly ribbed at back, excurrent, with 2 stereid bands below, none above; basal cells rectangular to oblong-linear, pitted and incrassate, narrower and paler

toward margins forming an indistinct border, alar cells red or brown, incassate, upper and median cells obliquely rhomboidal, incassate. Calyptra ciliate; inflorescences aggregated and sporophytes numerous. Seta 6 to 8 mm. long, sinuose or cygneous, slightly rough above; capsule regular, elliptic, somewhat furrowed, rough at base, 1.5 to 2.5 mm. long; operculum conic-rostrate, about 0.4 mm. high; peristome teeth solid or more or less divided, densely papillose nearly to base.

On bark rock, restricted to summits of peaks in Luquillo Mts., Puerto Rico; West Indies; Mexico to Chile and Juan Fernández.

(c) *Campylopus porphyreodictyon* (C. M.) Mitt. Journ. Linn. Soc. London, Bot. 12: 75. 1869.

*Dicranum porphyreodictyon* C. M. Syn. Musc. Frond. 1: 395. 1848.

*Campylopus tenuissimus* Sull. Proc. Amer. Acad. Arts and Sci. 5: 279. 1861.

Yellowish, loosely caespitose plants. Stems ascending, sparsely tomentose, of 2 forms: (1) fertile stems low, with short proliferations, nearly bare below, falcately comose above; or (2) sterile stems simple, elongate, curved, apically-foliate. Leaves of fertile plants lanceolate, subulate, denticulate on margins and back of upper  $\frac{1}{3}$  or more; costa with dorsal and ventral stereids, rather broad, strongly furrowed; alar cells showy, purple, cells elongate in lower part of leaf, thick-walled and porose, at least toward costa, becoming small, dense, green, elliptic in upper leaf. Leaves of sterile plants broader, shorter, more acute. Calyptra fringed with a few yellow, flexuose hairs. Capsule slightly strumose, sulcate.

On soil, rocks, and tree trunks, abundant in all mountainous areas, at altitudes of 3000 to 4000 ft., Puerto Rico; West Indies; Trinidad, Brazil, Colombia, and Ecuador.

The report of *Thysanomitrium filifolium* (Hornsch.) Hampe (1852) may be based on a misidentification of material belonging to this species.

(d) *Campylopus cubensis* Sull. Proc. Amer. Acad. Arts and Sci. 5: 278. 1861.

Plants green and rather loosely tufted. Stems more or less branched, tomentose to apex, uniformly leafy or somewhat comose, up to 6 cm. high. Leaves 6 to 9 mm. long, flexuose, spreading, lanceolate, stout apex formed by short-excurrent, dentate costa; blade 4 to 6 cells wide on either side of costa shortly below its termination, serrulate nearly  $\frac{1}{2}$  down; costa with stereid bands above and below, about  $\frac{1}{3}$  width of base, 225 to 275  $\mu$  wide near base, ribbed and serrulate above; alar cells usually forming large, red auricles, cells just above thick-walled, pitted toward costa, smaller, narrower, and unpitted toward margin, becoming obliquely oval, with thickened, nonpitted walls, not in straight rows in upper leaf. Calyptra ciliate at base. Seta flexuose, nearly smooth, 12 to 16 mm. long; capsule arcuate, furrowed when dry, not quite smooth at base; peristome teeth 50 to 60  $\mu$  wide at base. Spores rough, up to 14  $\mu$ .

On soil, in mountains at and above 2000 ft., known from only 3 localities in Puerto Rico; Cuba, Jamaica, and Haiti.

(e) *Campylopus tortuosus* (Hampe) Paris. Index Bryol. Suppl. 98. 1900.

*Dicranum tortuosum* Hampe. Linnaea. 25: 361. 1852.

*Campylopus giganteus* Sull. Proc. Amer. Acad. Arts and Sci. 5: 278. 1861.

Plants in deep, soft, loose tufts. Stems robust, up to 12 cm. high, simple or forked. Leaves spreading-recurved, ovate-lanceolate, gradually long-subulate, 12 to 18 mm. long, narrow leaf blade extending to near apex and serrulate in upper  $\frac{1}{2}$ ; costa with dorsal and ventral stereids, about 400  $\mu$  wide just above alar cells, covered on back with numerous serrulate lamellae mostly 2 cells high; alar cells forming large, auriculate, hyaline or reddish group, lower cells very narrow and elongate, incrassate at margins, becoming larger and pitted toward costa, somewhat obliquely elongate, not seriate high up, gradually merging into small, oval, oblong or angular, incrassate, nonpitted upper cells.

On soil, at high altitudes in mountains, 3000 to 5000 ft., type locality in Puerto Rico; Cuba, and Haiti.

(f) *Campylopus fragilis* (Turn.) Bruch & Schimp. Bryol. Eur. fasc. 41. 1847.

*Dicranum flexuosum* var. *fragile* Turn. Musc. Hib. 74. 1804.

Plants in compact, pale, rather glossy, green tufts. Stems tomentose below, equally foliate, branching above, up to 4 cm. high. Leaves up to 5 mm. long, suberect and slightly flexuose when dry, erect-spreading when moist, narrowly lanceolate from a pale, oblong base, serrulate in upper  $\frac{1}{3}$ ; costa short-excurrent, about  $\frac{1}{2}$  width of base, somewhat ribbed on back above; alar cells not differentiated, nearly entire basal portion of leaf made up of large, oblong, thin-walled cells, narrower toward margins, shorter and subrhomboidal toward shoulders, short-rhomboidal in upper leaf. Calyptra ciliate at base. Seta 5 to 8 mm. long; capsule ribbed. Spores finely papillose, 14 to 16  $\mu$ .

On tree trunks and rotting logs, at altitudes of 3000 to 4000 ft., Cerro de la Punta, Cordillera Central, Puerto Rico; United States (Florida); Cuba, Jamaica, and Haiti; Mexico and Guatemala; Europe; Asia; Africa.

(g) *Campylopus angustiretis* (Aust.) Lesq. & James. Manual. 80. 1884.

*Dicranum angustirete* Aust. Bot. Gaz. 4: 150. 1879.

Plants in fairly lax, green to brownish tufts. Stems mostly simple, 1 to 3 cm. high, with leaves nearly straight, laxly imbricate below, often crowded above. Leaves increasing in size up stem, upper leaves reaching 5 mm. or more, long-lanceolate; costa with dorsal stereids only, 150  $\mu$  wide or more just above alar cells and about  $\frac{1}{3}$  to  $\frac{1}{2}$  width of leaf base, short-excurrent as a dentate point, slightly ribbed on back; alar cells inflated, reddish in older leaves; lower cells broad, short-rectangular, thin-walled, becoming narrower and smaller toward margins and narrowly oblong to vermicular, about  $30 \times 4$  to 6  $\mu$ , with somewhat porose, incrassate walls in upper leaf.

On soil, rock, and rotting log, altitudes of 2000 ft. and up, Cordillera Central of Puerto Rico; United States (Florida); Haiti.

- (h) *Campylopus gracilicaulis* Mitt. Journ. Linn. Soc. London, Bot. 12: 83. 1869.

Slender, loosely tufted plants. Stems up to 3 cm. high, upper stem-leaves and those of very short, subterminal branches forming large, compact tuft. Comal leaves up to 6 mm. long, oblong-lanceolate, serrulate nearly  $\frac{1}{3}$  down; blade often extending nearly to apex, 6 to 10 cells wide on either side of costa  $\frac{1}{2}$  up; costa short- or long-excurrent, with dorsal stereids only, about  $\frac{1}{3}$  width of base, rough above with low, serrulate ribs; alar cells more or less distinctly differentiated, reddish to hyaline, lower cells mostly large, oblong, pale, and lax, becoming narrower toward margins, somewhat incrassate, smaller and rhomboidal above. Calyptra fimbriate at base. Seta about 9 mm. long; capsule rough at base.

On soil, at altitudes of about 3000 ft., Cordillera Central of Puerto Rico; United States (Florida); Cuba, Jamaica; British Guiana, Colombia, and Brazil.

- (i) *Campylopus praealtus* (C. M.) Paris. Index Bryol. Suppl. 96. 1900.

*Dicranum praealtum* C. M. Hedwigia. 37: 227. 1898.

Very stout, glossy, yellow plants in loose tufts. Stems radiculose nearly to apex, simple or forked and terminating in more or less penicillate tufts, up to 24 cm. high. Leaves 10 to 12 mm. long, older stem leaves bristly-spreading, younger more or less imbricate, gradually narrowed to acute, sharply dentate apex from ovate-lanceolate base; costa with dorsal stereids only, about 800  $\mu$  wide below; cells of blade just above alar group and toward costa broadly oblong with much thickened and pitted walls, narrower and paler at margins, forming fairly distinct border, becoming more or less obliquely oblong-linear above, with walls much pitted in broad part of leaf blade.

In wet places, on rock and soil, restricted to summits of highest peaks, 2000 to 4000 ft. altitudes, in Puerto Rico; type locality Puerto Rican; Brazil and Venezuela.

- (j) *Campylopus cygneus* (Hedw.) Brid. Bryol. Univ. 1: 475. 1826.

*Dicranum cygneum* Hedw. Sp. Musc. 148. 1801.

*Campylopus jamaicensis* Mitt. Journ. Linn. Soc. London, Bot. 12: 82. 1869.

Plants rather loosely tufted. Stems slender, more or less branched, sparsely radiculose, rather equally foliate or somewhat comose above, up to 4 cm. high. Upper leaves about 7 mm. long, nearly straight when moist, somewhat appressed or spreading and flexuose when dry, gradually narrowed to long subula from ovate-lanceolate base, slightly hyaline and denticulate at apex; blade very narrow, slightly serrulate, extending well above midleaf; costa with dorsal stereids only, nearly  $\frac{1}{2}$  width of leaf base and up to 300  $\mu$  wide just above alar cells; alar cells large, inflated, auriculate, red or hyaline, marginal cells just above alar group narrow and pale, inner basal cells broad, short, thick-walled, sometimes colored or pitted, 1 to 2:1. Calyptra copiously ciliate at base. Seta flexuose, smooth, 8 to 12 mm. high; capsule oval, curved,

furrowed, slightly strumose when dry; peristome teeth red-brown, about 60  $\mu$  wide at base. Spores rough, up to 14  $\mu$ .

On moist rock and soil, rarely on wood, at high altitudes in Luquillo Mountains, northeast Puerto Rico; Cuba, Jamaica, and Haiti.

(k) *Campylopus saxatilis* Williams. No. Amer. Fl. 15(2): 137. 1913.

Plants in rather pale green tufts. Stems tomentose, about 3 cm. high, equally foliate. Leaves erect-spreading, flexuose, ovate or lanceolate and slenderly tapering to long, slender, serrulate apex, about 5 mm. long; blade narrow, extending far above midleaf; costa with dorsal stereids only, about 250  $\mu$  wide below and  $\frac{1}{2}$  width of leaf base; cells red to hyaline in alar region, hyaline and narrowly rectangular on margins just above, broader and short-oblong with incrassate, slightly pitted walls within, those farther up shorter, rather obliquely oblong to rhomboidal with thickened walls. Calyptra not ciliate. Seta smooth, flexuose, 10 mm. long; capsule nearly smooth at base, furrowed when dry, distinctly strumose; peristome teeth about 55  $\mu$  wide at base. Spores rough, up to 16  $\mu$ .

On rock and soil in Cordillera Central at and above 2000 ft., Puerto Rico; Cuba, Jamaica, Haiti, and Dominica.

(7) *Holomitrium* Brid. Bryol. Univ. 1: 226. 1826.

Plants medium-sized, growing in dense, tomentose tufts. Stems erect, branched, sometimes flagelliferous. Leaves crisped when dry, lanceolate from broader base, often subtubulose, usually serrate; costa usually percurrent, with dorsal and ventral stereid bands; upper cells rectangular to subquadrate, incrassate, often pitted, elongate below and clearly differentiated at basal angles. Pseudautoicous; male plants minute and resting on tomentum of female plants; perichaetial leaves convolute, with long, setaceous points often extending to or beyond mouth of capsule. Calyptra cucullate, smooth. Seta erect, smooth; capsule erect, cylindrical, smooth, stomatose at base; operculum rostrate; peristome inserted well below mouth, teeth red, papillose, not striate, entire or more or less divided along median line.

*Holomitrium arboreum* Mitt. Journ. Linn. Soc. London, Bot. 12: 58. 1869.

*H. macrocarpum* C. M., Nuov. Giorn. Bot, Ital. N. S. 4: 36. 1897.

Plants 2 to 3 cm. high, or rarely 5 cm., yellow-green, becoming brown below. Leaves crowded, crisped when dry, 4 to 6 or 7 mm. long, gradually acuminate from an oblong-clasping base, serrate above middle; costa percurrent or slightly excurrent; upper cells subquadrate, basal cells long-linear with thick, pitted walls, alar group brown, very distinct. Perichaetial leaves  $\frac{1}{2}$  length of seta, or sometimes reaching base of capsule. Seta 1 to 2 cm. long; capsule cylindrical, 4 to 6 mm. long; operculum subulate-rostrate. Spores about 16  $\mu$ , slightly roughened.

On tree trunks and decaying logs at high altitudes, ca. 4000 ft., and at mountain summits, Puerto Rico; Mexico to British Guiana and Bolivia.

(8) *Leucoloma* Brid. Bryol. Univ. 2: 218. 1827.

Plants pale to dark green, silky, in soft, lax mats. Stems branched, sparsely radiculose, wiry, usually dark colored and roughened by projecting bases of fallen leaves. Leaves flexuose-spreading or secund, gradually lanceolate-subulate from an ovate base, subtubulose, grooved above, entire except at apex, plane or slightly incurved at margins; costa narrow; upper cells, except at border, mostly roughened on back with crowded papillae: marginal cells smooth, narrow, and hyaline, forming distinct border; alar group large, often auriculate. Dioicous; perichaetial leaves abruptly narrowed to subulate point from short, broad, sheathing base. Calyptra mostly rough above, base nearly entire, sometimes irregularly slit. Seta erect; capsule erect and symmetric or nearly so, cylindrical; operculum long-rostrate; annulus lacking; peristome teeth divided to middle or nearly to base into 2 forks.

Upper leaf cells all elongate, 3 to 6 times as long as wide.....(a) *L. mariei*  
Upper leaf cells mostly short, or partly elongate, up to 3 times as long as wide.

Leaves with distinct median band of short, papillose cells extending to or near base  
(b) *L. serrulatum*

Leaves without a median band of short cells in basal part.

Leaves smooth at back throughout or slightly rough at apex... (c) *L. schwaneckeanum*

Leaves densely papillose at back to below middle.

Leaves about 6 mm. long, with a distinct, hyaline border extending nearly or quite to base, 8 to 12 cells wide shortly above base.....(d) *L. album*

Leaves 4 to 5.5 mm. long, border narrow above, not or scarcely distinct from inner cells in lower part of leaf.....(e) *L. cruegerianum*

(a) *Leucoloma mariei* Besch. Journ. de Bot. 5: 145. 1891.

Plants rather red-green, with more or less branched stems 1 to 2 cm. high. Leaves somewhat curved-secund, up to 5 mm. long, rather densely covered at back with low papillae to below midleaf except on poorly defined border that is very narrow above, gradually widened below, and composed of narrower but scarcely paler cells than within; costa mostly somewhat excurrent; cells of blade all elongate, upper 3 to 6 times as long as wide, with slightly incrassate walls, becoming longer, incrassate, and more or less pitted toward base; alar cells forming large, reddish-brown groups extending nearly to costa. Sporophyte unknown.

On tree trunks and on rock, collected only in Luquillo Mts., at altitudes of 3000 ft. and over, Puerto Rico; Guadeloupe.

(b) *Leucoloma serrulatum* Brid. Bryol. Univ. 2: 752. 1827.

*Dicranum bridelianum* C. M. Syn. Musc. Frond. 1: 354. 1848.

*Poecilophyllum vincentinum* Mitt. Journ. Linn. Soc. London, Bot. 12: 93. 1869.

*Dicranum cryptocarpum* C. M. Linnaea 38: 626. 1874.

*Leucoloma riedlei* Besch. Journ. de Bot. 5: 146. 1891.

*Dicranum longicapillare* C. M. Bull. Herb. Boiss. 5: 553. 1897.

Branching stems up to 10 cm. high. Leaves wide-spreading, often nearly straight or somewhat curved, secund at stem apex, sharply serrulate about  $\frac{1}{5}$  down; costa excurrent; border hyaline, scarcely evident near apex, 2 to

3 cells wide about  $\frac{1}{3}$  down, gradually widened below and merging with lower leaf cells; green cells of upper leaf oblong, 6 to  $12 \times 5 \mu$ , minutely papillose at back, gradually becoming somewhat larger below with slightly sinuose, unequally thickened walls and extending in broad band along costa nearly to base, other cells much more elongate, with unequally thickened, somewhat pitted walls; alar groups brownish, extending nearly to costa, not auriculate. Seta about 1.5 mm. long; capsule about 1.0 mm. long, oblong, mouth mostly exceeded by tips of perichaetial leaves; peristome teeth divided nearly to base into 2 slender forks, distinctly and regularly articulate more than  $\frac{1}{2}$  up, upper parts papillose. Spores smooth, up to  $18 \mu$ .

A common and abundant moss of wet mountain forests, on tree trunks, hanging from branches and twigs, or on rocks, from altitudes of 2000 ft. up to summits, widespread in Puerto Rico; West Indies; Mexico, Central America, and northern South America.

(c) *Leucoloma schwaneckeanum* (Hampe) Britt. *In* Williams, No. Amer. Fl. 15(2): 112. 1913.

*Dicranum schwaneckeanum* Hampe. *Linnaea*. 25: 361. 1852.

*D. portoricense* C. M. Hedwigia. 37: 226. 1898.

Stems erect and flexuose, often branched, up to 4 cm. high. Leaves mostly falcate-secund with point variously curved and twisted, up to 8 mm. long, smooth or slightly papillose at back just below apex; costa excurrent; hyaline border extending from near apex to base, very narrow above, becoming 10 to 12 cells wide  $\frac{3}{4}$  down, then mostly narrowed to base; very pale, green cells of upper leaf subquadrate to short-oblong, about 4 to  $6 \times 4 \mu$ , gradually lengthening below to about  $12$  to  $25 \times 6 \mu$ , with somewhat thickened, smooth walls; alar cells brownish to hyaline, often inflated and forming auricles.

On tree trunks, rotting logs, and rock, especially abundant in Luquillo Mts., but common elsewhere above 2000 ft. altitude in Puerto Rico, type locality; Cuba; Dominica.

(d) *Leucoloma albulum* (Sull.) Jaeg. *Ber. St. Gall. Natur. Ges.* 1870-71: 412. 1872.

*Dicranum albulum* Sull. *Proc. Amer. Acad. Arts and Sci.* 5: 278. 1861.

Plants green, whitish-tinged by leaf borders. Stems often branched, 1 to 4 cm. high. Leaves falcate-secund, about 6 mm. long, densely papillose on back in upper half or more, less papillose on inner surface; costa excurrent; hyaline border extending from near apex to base, very narrow above, about 12 cells wide  $\frac{3}{4}$  down, then narrowed to base; cells green, rounded to oblong, 4 to  $6 \times 4 \mu$ , gradually becoming longer and smooth below, about 20 to  $40 \times 6 \mu$  with somewhat thickened but not or slightly pitted walls at base; alar group brown, not or scarcely auriculate. Seta red, up to 18 mm. long; capsule about 2.5 mm. long; peristome teeth reddish, smooth or slightly papillose above, indistinctly striate below, divided  $\frac{1}{2}$  to  $\frac{3}{4}$  down, articulations prominent on outer surface below. Spores slightly roughened, up to  $16 \mu$ .

On tree trunks, known in Puerto Rico from only 2 localities—Mt. El Toro in Luquillo Mts. and Mt. La Torrecilla in central cordillera; West Indies.

(e) *Leucoloma cruegerianum* (C. M.) Jaeg. Ber. St. Gall. Natur. Ges. 1870-71: 412. 1872.

*Dicranum cruegerianum* C. M. Syn. Musc. Frond. 2: 588. 1851.

*D. asperrimum* C. M. Linnaea. 42: 472. 1879.

Stems fragile, short, with few branches. Leaves flexuose and wide-spreading when dry, 3 to 5 mm. long; costa percurrent to slightly excurrent; border of narrow, elongate cells in 1 row above, gradually widened downward and merging with cells of lower leaf; cells in upper part of blade irregularly subquadrate, about  $6\ \mu$  wide and up to 3 times as long as wide, sharply papillose at back in upper half or more of leaf, gradually longer below, with unequally thickened, slightly porose walls near base; alar group brownish, not or scarcely auriculate. Seta red; peristome teeth red, divided to middle into 2 subulate-lanceolate forks, trabeculate below

Widespread but not common in all mountainous areas of Puerto Rico, at and above an altitude of 1500 ft.; West Indies; Mexico to Panama; Venezuela and Ecuador.

#### LEUCOBRYACEAE

Small to large, whitish-green plants in dense cushions. Leaves ligulate or lanceolate, consisting of narrow lamina at base and a broad costa showing in section 2 or more rows of large, hyaline, thin-walled leucocysts enclosing row of small, green chlorocysts. Calyptra cucullate. Seta single, erect; capsule erect and regular, or nodding and asymmetric, often strumose; peristome usually inserted below mouth, consisting of 8 or 16 lanceolate, usually strongly articulate teeth.

Leaves with dorsal stereid band.....(2) *Leucophanes*  
Leaves without stereids.

Leaves grooved on upper side; capsules nodding, curved; peristome striate below

(1) *Leucobryum*

Leaves flat on upper side; capsules erect and symmetric; peristome not or scarcely striate.....(3) *Octoblepharum*

(1) *Leucobryum* Brid. Bryol. Univ. 1: 763. 1826.

Plants medium-sized to large, in dense whitish-green cushions. Leaves crowded, unaltered on drying, erect-spreading or curved-secund, narrowed from ovate base to subtubulose point, composed of 2 to 8 rows of leucocysts enclosing single row of small chlorocysts; lamina reduced to narrow, hyaline border at leaf base. Fragile or reduced, deciduous leaves commonly serving in propagation. Dioicous; male plants minute and epiphytic on larger female plants. Seta elongate; capsule inclined, asymmetric, often strumose, 8-ribbed; annulus mostly lacking; operculum obliquely long-rostrate; peristome teeth inserted at mouth, split to middle into 2 slender forks, vertically striate below, papillose above.

- Leucocysts in 2 layers throughout..... (a) *L. martianum*  
 Leucocysts in more than 2 layers at thickest part of leaf base.  
 Very large plants; leaves 14 to 22 mm. long, with 4 or often 6 layers of leucocysts at base, except along middle..... (b) *L. giganteum*  
 Smaller plants; leaves rarely 14 mm., usually much less.  
 Leucocysts in 5 to 6 layers at thickest part of leaf base.  
 Leaves 5 to 10 mm. long, tip longer than base..... (c) *L. antillarum*  
 Leaves less than 5 mm., tip about same length as base..... (d) *L. polakowskyi*  
 Leucocysts usually in 4 layers on either side of middle at leaf base.  
 Leaves 8 to 14 mm. long, with ovate base about 2 to 3 mm. long... (e) *L. albicans*  
 Leaves less than 8 mm. long, with ovate base about 1 mm. long... (f) *L. crispum*

(a) *Leucobryum martianum* (Hornsch.) Hampe ex C. M. Linnaea. 17: 317. 1843.

*Dicranum martianum* Hornsch. In Mart., Fl. Brasil. 1(2): 11. 1840.

Plants up to 2 or 3 cm. high, in loose mats. Leaves 5 to 6 mm. long, crowded, usually falcate-secund, gradually narrowed from ovate base to slender point; apex denticulate; leaf base not thickened, consisting of 2 rows of leucocysts enclosing chlorocysts between them, chlorocysts closer to dorsal surface in upper leaf; lamina 5 to 6 cells wide. Seta 1.5 to 2 cm. long; urn of capsule about 1.5 mm. long, curved and strumose. Spores rough, up to 16  $\mu$ .

On tree trunks and rotting wood in wet forests, collected only in Luquillo Mts., at and above 2000-ft. altitude, in Puerto Rico; West Indies; Mexico to northern South America.

(b) *Leucobryum giganteum* C. M. Syn. Musc. Frond. 1: 79. 1848.

*L. robustum* Sull. Proc. Amer. Acad. Arts and Sci. 5: 279. 1861.

Usually very robust plants with branching stems, up to 15 cm. high. Leaves crowded, rather wide-spreading from erect base, 14 to 22 mm. long, gradually narrowed from ovate base to long, often twisted limb, acute and slightly toothed at apex; leucocysts in 4 to 6 layers at thickest part of leaf base. Seta up to 3.5 cm. long; urn of capsule about 2 mm. long. Spores nearly smooth about 16  $\mu$ .

On soil and rotten wood, known in Puerto Rico only from 2 localities at west end of central cordillera, near Maricao; West Indies; Costa Rica and Panama; northern South America.

(c) *Leucobryum antillarum* Schimp. ex Besch. Ann. Sci. Nat., Bot. VI. 3: 190. 1876.

*L. costaricense* Besch. Journ. de Bot. 11: 153. 1897, nom.

*L. jamaicense* C. M. Bull. Herb. Boiss. 5: 547. 1897.

*L. subglaucum* C. M. *Ibid.* 548.

*L. sciuroides* C. M. Hedwigia. 37: 221. 1898.

*L. eggersianum* C. M. *Ibid.*

*L. glaucovirens* Card. Rev. Bryol. 36: 69. 1909.

*L. flaccidulum* Card. Rev. Bryol. 37: 119. 1910.

Plants up to 8 cm. high. Leaves flexuose-spreading, sometimes secund, 5 to 10 mm. long, gradually narrowed from ovate base about 1.5 to 2 mm.

long to limb varying from slightly longer to 2 to 3 times as long; apex denticulate; leucocysts usually in 6 layers at thickest part of leaf base; lamina about 6 to 8 or 10 cells wide.

On soil, humus or, rarely, rock, in rain- or fog-swept areas at and above 1000-ft. altitude, widespread but not common in Puerto Rico; the United States (Florida); West Indies; Central and northern South America.

- (d) *Leucobryum polakowskyi* (C. M.) Card. Mém. Soc. Nat. Sci. Natur. Cherbourg. 32: 82. 1900.

*Ochrobryum polakowskyi* C. M. ex Besch. Journ. de Bot. 11: 151. 1897.

*Leucobryum minusculum* C. M. Hedwigia. 37: 220. 1898.

Densely tufted plants with stems about 1 cm. high. Leaves 3.5 to 4.5 mm. long, flexuose-spreading, gradually narrowed from narrowly obovate base to limb slightly longer than base; leucocysts in 5 to 6 layers at thickest part of leaf base; lamina 8 to 10 cells wide. Seta about 1 cm. long; capsule not strumose, 1.25 mm. long.

On rotting wood and humus, rarely on rock or tree trunks, widespread in mountainous areas of Puerto Rico, especially in Cordillera Central; West Indies; Trinidad; Mexico and Central America.

- (e) *Leucobryum albicans* (Schwaegr.) Lindb. Öfv. K. Sv. Vet.-Akad. Förh. 20: 402. 1863.

*Dicranum albicans* Schwaegr. Suppl. Sp. Musc. II. 2(2): 122. 1827.

*Leucobryum longifolium* Hampe ex C. M. Linnaea. 17: 317. 1843.

Plants rather large, up to 4 cm. or more. Leaves 8 to 14 mm. long, flexuose-spreading, often somewhat secund, gradually tapering from ovate base to limb 2 to 4 times as long; apex entire or denticulate; leucocysts mostly in 4 layers at thickest part of leaf base; lamina 6 to 9 cells wide. Seta 1.5 to 2.5 cm. long; annulus well developed. Spores minutely roughened, 12 to 14  $\mu$ .

On humus, rotten logs, and tree bases in mountain forests at altitudes of 2000 ft. and higher, apparently restricted to Cordillera Central in Puerto Rico; West Indies; Costa Rica; South America.

- (f) *Leucobryum crispum* C. M. Syn. Musc. Frond. 1: 78. 1848.

*L. subulatum* Hampe. Linnaea. 25: 359. 1852.

*L. tenuifolium* Sull. Proc. Amer. Acad. Arts and Sci. 5: 279. 1861.

Loosely tufted plants with stems 2 to 3 cm. high. Leaves 5 to 7 mm. long, irregularly flexuose-spreading, narrowed from ovate base about 1 mm. long to limb 3 to 6 times as long; apex entire or slightly toothed; leucocysts in 4 to 5 layers at thickest part of leaf base; lamina 7 to 10 cells wide. Seta about 2 cm. long.

On tree trunks, rotting logs, and humus, rarely on rock, in wet mountain forests at 1000-ft. altitude and above, common and abundant in Luquillo Mts. but very rare elsewhere in Puerto Rico; West Indies; Costa Rica; northern South America.

(2) *Leucophanes* Brid. Bryol. Univ. 1: 763. 1826.

Medium-sized plants in pale, greenish or yellowish compact mats. Stems erect, branching, usually without radicles. Leaves rather stiffly erect-spreading or wide-spreading, narrowly or rather broadly lanceolate, sometimes producing gemmae or radicles at leaf tips, showing in section a layer of small, green cells enclosed on either side by large hyaline cells and median dorsal and marginal stereid bands. Seta elongated, slender; capsule sub-cylindric, erect, usually somewhat ribbed when dry and empty; teeth of peristome lanceolate, without median line or distinct articulations, not striate, papillose on both surfaces.

*Leucophanes millenii* Card. ex Paris. Index Bryol. (Ed. 2) 3: 192. 1905.

*Octoblepharum angustifolium* Mitt. Journ. Linn. Soc. London, Bot. 12: 110. 1869, non *Leucophanes angustifolium* Ren. & Card., 1895.

*Leucophanes calymperaceum* C. M. Malpighia. 10: 512. 1896, non C. M. ex Dusén. 1896.

Small, pale, grayish-green plants. Leaves 2.5 to 4.5 mm. long, erect-spreading, gradually narrowed from narrowly elliptic base to linear, keeled limb; apex broadly acute to obtuse, serrulate, sometimes bearing septate, fusiform gemmae or radicles; leaves showing in section at midleaf 1 layer of leucocysts on either side of chlorocysts and 2 marginal and 1 median dorsal stereid bands, median band smooth at back and extending to apex or nearly so, marginal bands forming rather obscure border from apex nearly to base, usually recurved in lower half of leaf; median leaf cells short-rectangular to elongate-hexagonal, about  $20$  to  $40 \times 12 \mu$ , larger and rectangular below. Sporophyte unknown.

On tree bases and rotting logs in wet mountain forests at altitudes of 1500 ft. and higher, known only from Luquillo Mts. of northeastern Puerto Rico; Guadeloupe; Nicaragua; British Guiana, Trinidad, and Ecuador.

(3) *Octoblepharum* Hedw. Sp. Musc. 50. 1801.

Whitish-green plants often tinged with brown or red, usually growing in compact cushions. Stems branching, 1 to 3 cm. high. Leaves erect-spreading to widely spreading, often fragile, fleshy, ligulate from a hyaline base tapering to insertion, consisting primarily of costa with 3 to 4 layers of leucocysts above and 2 to 3 below a median row of small, triangular chlorocysts; lamina very narrow, restricted to leaf base. Autoicous. Calyptra cucullate, entire at base. Seta erect; capsule erect and symmetric, cylindric; operculum obliquely long-rostrate; peristome teeth pale or golden brown, 8 or 16, slightly roughened.

Leaves suberect, slender and very fragile; 16 peristome teeth . . . . . (a) *O. pulvinatum*  
Leaves wide-spreading, fleshy, not fragile; 8 peristome teeth.

Leaf apex acute or gradually apiculate, subentire; seta 10 to 20 mm. long

(b) *O. cylindricum*

Leaf apex broadly obtuse or rounded, abruptly apiculate and serrate. . (c) *O. albidum*

(a) *Octoblepharum pulvinatum* (Dozy & Molk.) Mitt. Journ. Linn. Soc. London, Bot. 12: 109. 1869.

*Arthrocormus pulvinatus* Dozy & Molk., Prodr. Fl. Bryol. Surinam. 6. 1854.

*Octoblepharum juruense* Broth. Hedwigia. 45: 263. 1906.

Whitish-green plants about 0.5 to 3 cm. high, growing in compact tufts. Leaves erect-spreading, very fragile, 5 to 7 mm. long, ligulate from broader base, abruptly rounded, apiculate and usually entire or sometimes irregular at apex. Seta 10 mm. or more in length; capsule about 2 mm. long; 16 peristome teeth, in pairs, nearly smooth. Spores rough, up to 16  $\mu$ .

On tree bases, especially on winged, buttress roots, on rotten wood, humus and, rarely, on rock, in mountain forests from altitudes of 1000 to 2000 ft., widespread in Puerto Rico; West Indies; Guatemala and British Honduras to Costa Rica; northern South America.

(b) *Octoblepharum cylindricum* Schimp. ex C. M. Syn. Musc. Frond. 1: 87. 1848.

Pale greenish or brownish-white plants up to 4 cm. high, growing in compact tufts. Leaves 5 to 6 mm. long, widely spreading, ligulate from broader base; apex acute, subentire, sometimes gradually apiculate. Seta 10 to 20 mm. long; capsule 1.5 to 2 mm. long; 8 peristome teeth, bluntly and obscurely papillose. Spores finely papillose, up to 16  $\mu$ .

On moist, shaded sand, known from single locality in Puerto Rico—Laguna Tortuguera, on northern coastal plain; Jamaica and Santa Domingo; British Honduras; northern South America.

(c) *Octoblepharum albidum* Hedw. Sp. Musc. 50. 1801.

*O. pallidum* Besch. ex Card. Mém. Soc. Nat. Sci. Natur. Cherbourg. 32: 41. 1900, nom.

*O. martinicense* Mitt. ex Card. *Ibid.*, nom.

*O. minus* Hampe. Dansk Naturh. Foren. Vidensk. Meddel. 1879-80: 83. (1879?).

*O. ekmani* Thér. Mem. Soc. Cub. Hist. Nat. 13: 220. 1939.

Plants in pale, dense cushions. Stems 0.5 to 3 cm. high. Leaves 6 mm. or more long, widely spreading to recurved, ligulate from short, broader, erect base; apex rounded or obtuse, apiculate and serrulate. Seta usually single, 4 to 7 mm. long; capsule oblong, 1 to 1.5 mm. long; 8 peristome teeth, faintly striate. Spores finely papillose, about 16 to 20  $\mu$ .

Weedy species growing in great abundance on tree trunks, rocks, and soil throughout coastal plain and lower mountain slopes of Puerto Rico; pan-tropical; north to southern Florida.

#### CALYMPERACEAE

Slender to fairly robust, erect, tufted plants, usually growing on trees or logs. Leaves lanceolate from pale, sheathing base, often narrowly bordered

with hyaline or yellowish cells, more rarely unbordered, or with thickened, concolorous margins; costa with 2 stereid bands, usually strong, ceasing near apex to short-excurrent, sometimes bearing brood-bodies at apex; leaf base including cancellinae, or areas of inflated, hyaline cells sharply set off from much smaller, usually papillose or mammillose, green cells of upper leaf. Calyptra reaching at least to base of capsule, cucullate or campanulate. Seta erect, usually elongate; capsule erect, cylindrical; annulus lacking; operculum usually subulate; peristome of 16 papillose teeth inserted below mouth, or lacking.

Leaves almost always with narrow, intramarginal bands of transparent, linear cells 2 to 12 cells from margin, sometimes extending only short distance above base; calyptra persistent, campanulate, clasping base of capsule.....(1) *Calymperes*  
 Leaves without intramarginal band of elongate cells, unbordered or bordered at margins only with pale, elongate cells or with serrated wings; calyptra cucullate, not clasping  
 (2) *Syrhodon*

(1) *Calymperes* Swartz ex Weber. Tab. Calypt. Operc. Musc. Frond.  
 Gen. 3. 1813.

Plants small to medium-sized. Stems erect, often branched. Leaves usually strongly incurved or crispate from sheathing, conspicuously white base, limb linear or lanceolate to ligulate; costa subpercurrent to short-excurrent, often thickened at apex and bearing clusters of propagula; margins usually more or less thickened and serrate; narrow intramarginal bands (teniolae) consisting of elongate, yellowish or greenish cells conspicuous at shoulders and frequently extending well into leaf blade, rarely lacking. Dioicous. Calyptra persistent, plicate, rough above, embracing base of capsule and split on sides only part way to base.

Leaves without cancellinae at base; teniolae distinct.....(b) *C. fluviatile*  
 Leaves with distinct cancellinae; teniolae usually present.

Upper hyaline cells of cancellinae mammillose on upper surface. (a) *C. mammilliferum*  
 Upper hyaline cells smooth.

Leaves up to 15 or 18 mm., blade usually curled but rarely crisped, 10 to 15 times as long as base; upper cells wider than long.....(c) *C. lonchophyllum*

Leaves less than 5 mm. long; upper cells not wider than long; blade more or less crisped when dry, not more than 3 to 4 times as long as base.

Margins entire, or slightly serrulate at apex.

Teniolae short but usually distinct near shoulders; costa smooth or nearly so  
 (d) *C. guildingii*

Teniolae lacking; costa rough on both sides to below midleaf.....(e) *C. nashii*  
 Margins of base or blade serrulate; teniolae to midleaf or beyond.

Upper cells about 4  $\mu$  in diameter; teniolae 6 to 12 cells from margin at shoulders; cancellinae acute.....(f) *C. donnellii*

Upper cells up to 7 or 8  $\mu$ ; teniolae 2 to 3 cells from margin at shoulders; cancellinae rounded above.....(g) *C. richardii*

(a) *Calymperes mammilliferum* Crum & Steere. Bryol. 59: 248. 1956.\*

\* Wm. D. Reese has demonstrated recently (in lit.) that *C. mammilliferum* can be included in the variations of *C. emersum* C. M., which is known also from Florida, Jamaica, Mexico to South America, and (probably) northern South America as well.

Plants robust, dull, yellow-brown, densely tufted. Stems 2 to 4 cm. high, sparsely branched, radiculose at base. Leaves appressed and clasping at base, with tips erect-contorted and tubulose when dry, erect-spreading when

moist, 3 to 4.5 mm. long, obovate base  $\frac{1}{4}$  to  $\frac{1}{3}$  leaf length and broader than lingulate-lanceolate limb; costa strong, excurrent as a stout, terete, rough point bearing a terminal cluster of brown, clavate propagula, rough on ventral surface, usually smooth at back except near tip, showing in section 2 stereid bands and 6 to 7 median guide cells; upper cells distinct, rather thin-walled, subquadrate or short-oblong, 5 to  $8 \times 8$  to  $11 \mu$ , ventrally mammillose, dorsally smooth; teniolae slender, yellow, extending from near base almost to base of excurrent costa, 4 to 6 cells in from margins at shoulders, 1 cell in from margins of upper leaf; cancellinae filling most of base, ending shortly above shoulders in  $\pm$  obtuse or acute angles, smaller hyaline cells marginal to upper angles ventrally conic-mammillose. Sporophyte unknown (FIGURE 13).

On wet lower surface of overhanging rock, south of Yabucoa, km. 102.9 on road to Maunabo, W.C.S. 4965, Nov. 20, 1939 (type).

The ventral protuberances formed by the small, hyaline cells bordering the upper angles of the cancellinae are the most distinctive features of this species, which is closely related to *C. disciforme* C. M. and *C. emersum* C. M. It seems to differ from both those species, however, in having the costa excurrent as a rough, terete point in all the leaves, rather than in the upper-

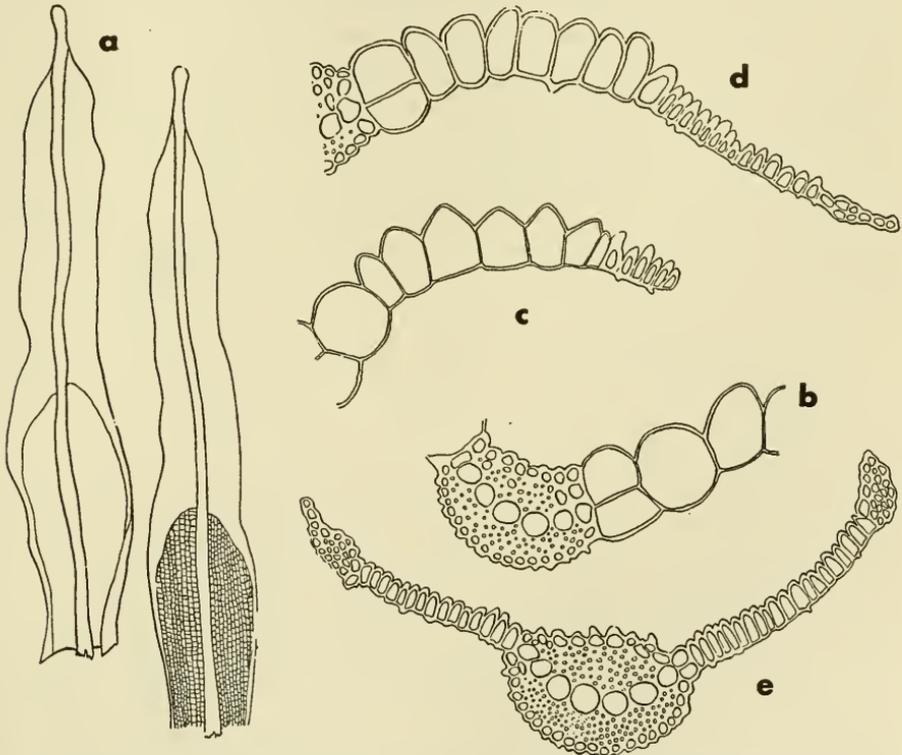


FIGURE 13. *Calymperes mammilliferum*: (a) 2 leaves, with cancellinae shown at right, and (b) to (e) cross sections at various successive levels from base of leaf upward.

most leaves only. The limb is longer and narrower than that of *C. emersum*, and the teniolae are closer to the margins than in *C. disciforme*.

(b) *Calymperes fluviatile* Williams. Bull. Torrey Bot. Club. 47: 394. 1920.

Stems simple, 2 to 3 cm. long. Leaves subtubulose and incurved or crisped when dry, oblong-ligulate, broadly pointed, entire, 3 to 3.5 mm. long; costa subpercurrent; cells rounded or slightly elongate, 6 to 7  $\mu$ , mammillose on upper surface, gradually elongate toward base, a few basal cells rectangular and colored but not forming distinct cancellinae; teniolae very distinct almost from base nearly to apex, 3 to 6 cells in from margins. Sporophyte unknown.

On wet rocks in stream, known in Puerto Rico from only 2 collections— from La Juanita near Las Marías and from vicinity of Utuado, type locality. Endemic.

(c) *Calymperes lonchophyllum* Schwaegr. Suppl. Sp. Musc. I. 2: 333. 1816.

*Calymperes asperipes* Besch. Ann. Sci. Nat., Bot. VIII. 1: 277. 1895.

Stems radiculose, up to 5 mm. high. Leaves flexuose, rarely crisped, up to 15 or 18 mm. long, ligulate from narrowly oval, serrulate base, up to 1.5 mm. long, margins thickened, doubly serrulate or entire, serrulate at acute apex and along basal portion of leaf; costa subpercurrent, smooth on both sides, without propagula; leaf blade often bistratose, cells transversely elongate, mostly 4 to 5  $\times$  6 to 8  $\mu$ , smooth; teniolae distinct to lacking, not extending into blade; cancellinae nearly filling leaf base, truncate or rounded above. Seta 10 to 12 mm., slightly roughened above; capsule about 2 mm. long; lid long-rostrate. Spores rough, up to 20  $\mu$ .

Usually on tree trunks, but also on rotten logs and on rock, widespread in Puerto Rico and often abundant in mountain forests, 1000- to 2000-ft. altitudes; Central America; northern South America; West Indies.

(d) *Calymperes guildingii* Hook. & Grev. Edinb. Journ. Sci. 3: 223. 1824.

*Syrrophodon badius* Schimp. ex Besch. Ann. Sci. Nat., Bot. VI. 3: 197. 1876.

*Calymperes guadalupense* Broth. In Urban, Symb. Antill. 3: 423. 1903, non Besch., 1895.

Rather rigid, brownish plants up to 4 cm. high. Leaves 4 to 5 mm. long, flexuose or crisped when dry, narrowed to linear-lanceolate point from broader oblong or obovate base; margins entire, strongly thickened above; costa subpercurrent, smooth on both sides, often bearing propagula on upper side near apex; cells distinct, mammillose on upper side, rounded or slightly elongate, 6 to 8  $\times$  8 to 10  $\mu$ ; teniolae usually distinct near shoulders, 4 to 8 cells from margin, soon disappearing in thickened border above; cancellinae extending about  $\frac{1}{4}$  up leaf, usually acutely angled above, but sometimes rounded or truncate. Seta 4 to 5 mm.; capsule cylindric, 2 mm., with short-rostrate operculum.

On tree trunks and vertical rock faces in wet mountainous areas, at

altitudes of 1000 to 3000 ft., common and abundant in Luquillo Mts., apparently very rare in Cordillera Central of Puerto Rico; Jamaica, St. Kitts, St. Vincent, Guadeloupe, and Martinique.

(e) *Calymperes nashii* Williams, Bull. Torrey Bot. Club. 47: 391. 1920.

Stems 2 to 3 mm. high. Leaves about 2.5 mm. long, strongly incurved or crisped when dry, oblong-linear, slightly or not at all broader at base; margins entire, with thick border of short-rectangular, green cells from leaf shoulder to near apex, teniolae wanting; costa usually short-excurrent, papillose on both sides to shoulders, bearing numerous short, septate propagula at apex; cells of limb mostly not elongate, 4 to 6  $\mu$ , mammillose on upper side, more or less papillose on under side; cancellinae extending about  $\frac{1}{4}$  up leaf, mostly 4 to 6 cells wide, truncate or rounded above. Sporophyte unknown (FIGURE 14).

On tree trunks, apparently not collected in Puerto Rico proper but known

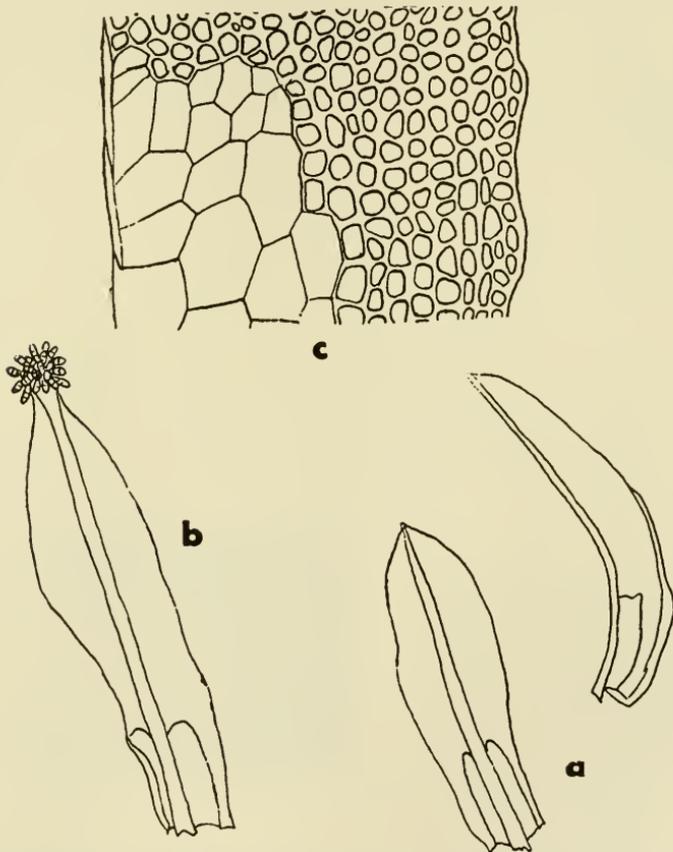


FIGURE 14. *Calymperes nashii*: (a) 2 lower leaves, (b) upper leaf with propagula, and (c) cells near shoulder of leaf (Grout, 1937).

in region from single collection from Mona Island (co-type); United States (Florida); Haiti.

(f) *Calymperes donnellii* Aust. Bot. Gaz. 4: 151. 1879.

*C. rufescens* Besch. Ann. Sci. Nat., Bot. VIII. 1: 302. 1895.

*C. brittoniae* Besch. *Ibid.* 278.

*C. smithii* Besch. ex Paris. Index Bryol. 1255. 1898, nom.

*C. portoricense* Ren. & Card. Bull. Soc. Roy. Bot. Belg. 41(1): 57. 1904.

Stems up to 1 cm. high. Leaves incurved or crisped when dry, lower 2.5 to 3.0 mm. long, upper reaching 5 mm., oblong-linear from slightly broader, ovate or oblong base, broadly acute at apex, propaguliferous leaves usually abruptly narrowed to stout, rough point of varying length; margins incurved, thickened, irregularly double-serrate above, serrulate below; costa stout, often very rough on both sides in limb; upper cells mammillose and papillose, roundish, 4 to 5  $\mu$ ; teniolae distinct to leaf base, 6 to 12 cells from margins at shoulders, disappearing in thickened border about  $\frac{1}{2}$  up leaf; cancellinae extending about  $\frac{1}{4}$  to  $\frac{1}{3}$  up leaf, acute above. Seta 5 mm. long; capsule cylindrical, about 2 mm. long. Spores rough, about 18  $\mu$  (FIGURE 15).

On tree trunks, at lower altitudes, widespread in coastal plain of Puerto Rico; United States (Florida); Mexico to northern South America; Cocos Island; West Indies.

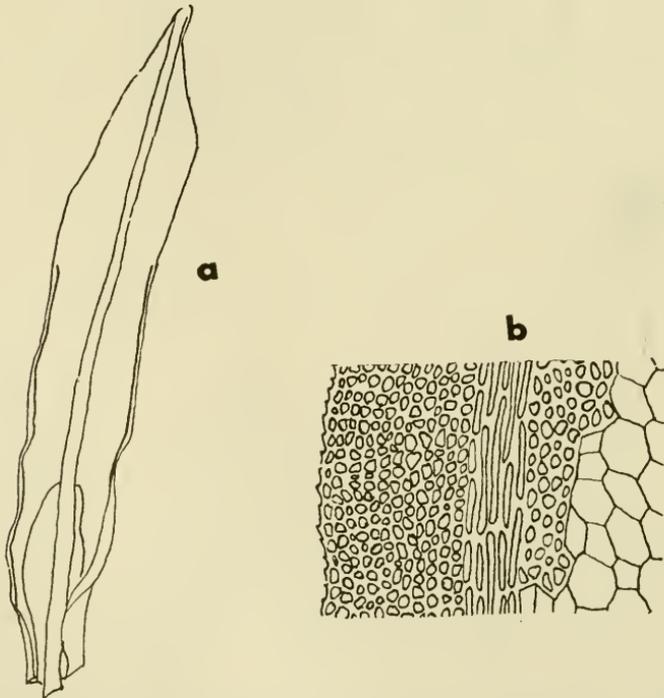


FIGURE 15. *Calymperes donnellii*: (a) leaf that will bear propagula at its tip, and (b) cells at leaf shoulder (Grout, 1937).

(g) *Calymperes richardii* C. M. Syn. Musc. Frond. 1: 524. 1849.

*C. breutelii* Besch. Ann. Sci. Nat., Bot. VIII. 1: 278. 1895.

*C. guadalupense* Besch. *Ibid.* 285.

*C. hexagonum* Besch. *Ibid.* 286.

*C. hookeri* Besch. *Ibid.* 287.

*C. panamae* Besch. *Ibid.* 298.

Rather slender plants, sometimes as high as 2 cm. Leaves strongly incurved or crisped when dry, short and ovate below, upper 3.0 to 4.5 mm. long, ovate or obovate, base varying from much wider than blade to scarcely as wide, broadly obtuse at apex; margins irregularly serrulate in upper part of clasping base; upper cells mammillose, rounded, 6 to 8  $\mu$ ; teniolae 1 to 5 cells from margin at shoulders, extending into thickened border toward leaf tip; cancellinae extending  $\frac{1}{4}$  to  $\frac{1}{3}$  up leaf, rounded above. Modified leaves bearing septate propagula narrower, rounded at apex. Seta about 3 mm. long; capsule narrowly oval, 1.5 mm. long; operculum short-rostrate. Spores rough, up to 35  $\mu$  (FIGURE 16).

On tree trunks and on rock, common and abundant species in coastal

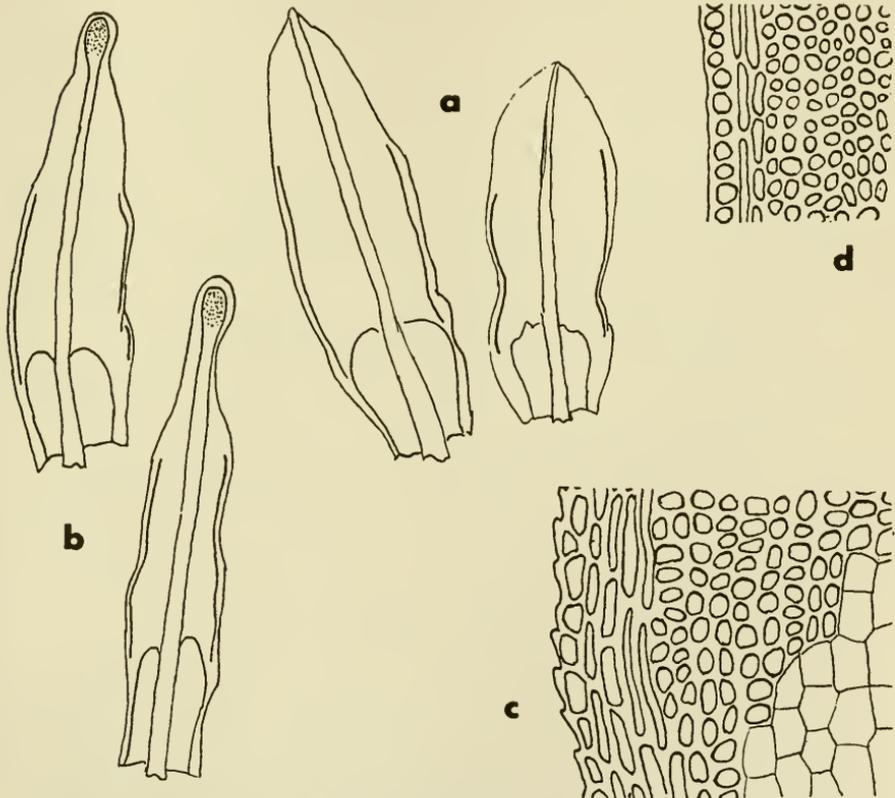


FIGURE 16. *Calymperes richardii*: (a) 2 lower leaves, (b) 2 upper leaves, (c) cells near leaf shoulder, and (d) cells of upper part of leaf (Grout, 1937).

plain of Puerto Rico; Mona Island; St. Thomas; Tortola; United States (Florida); Mexico to northern South America; West Indies.

(2) *Syrhophodon* Schwaegr. Suppl. Sp. Musc. II. 1(2): 110. 1824.

Small to rather large, green, brownish or whitish, tufted plants. Stems erect, more or less radiculose and branched. Leaves crowded, lanceolate to ligulate from an appressed, often conspicuously white base, with hyaline or thickened, concolorous border; costa strong, subpercurrent to excurrent, often spinose above. Propagula often borne on upper side of leaf or at tip of costa. Calyptra cucullate, entire or somewhat split at base, often roughened at apex. Operculum often rostrate. Peristome usually present, the 16 teeth mostly lanceolate and undivided, sometimes irregular, usually golden-brown and papillose.

Leaf borders thickened, brownish or concolorous, serrate.

Leaves 4 to 7 mm. long, abruptly narrowed from erect base; upper cells small, 5 to 7  $\mu$  wide.

Leaves 5 to 7 mm. long; border oval in section. . . . . (a) *S. berterianus*

Leaves 4 to 5 mm. long; border triangular. . . . . (b) *S. incompletus*

Leaves more than 7 mm. long, gradually narrowed from erect base; upper cells oblong, 7 to 10  $\times$  12 to 17  $\mu$ . . . . . (c) *S. rigidus*

Leaf borders consisting of linear, hyaline, yellowish or brownish cells.

Plants robust, coarse; leaves coarsely toothed; border yellow or brown

(d) *S. lycopodioides*

Plants smaller and delicate; leaves less strongly toothed, with hyaline or pale-yellow border.

Leaves mostly unbordered in upper third, or border sometimes lacking on some leaves.

Leaves ligulate, rounded at apex; cancellinae broadly rounded above

(e) *S. ligulatus*

Leaves lanceolate or ovate, acute; cancellinae acute. . . . . (f) *S. parasiticus*

Leaves bordered to apex or nearly so.

Leaves serrulate in upper quarter, ciliate-dentate or serrate at midleaf; cells mammillose. . . . . (g) *S. borinquensis*

Leaves entire except at apex; cells papillose.

Leaf points crispate when dry, 1 to 2 times as long as base. . (h) *S. gaudichaudii*

Leaf points usually not crispated, 2 to many times as long as base.

Costa without accessory guide cells; stems usually shorter than longest leaves (i) *S. tenuifolius*

Costa with 1 to 3 accessory guide cells; stems usually much longer than longest leaves.

Leaves rather wide-spreading from erect base; costa smooth below denticulate apex. . . . . (j) *S. husnotii*

Leaves erect-spreading from sheathing base; costa mostly papillose at back

(k) *S. prolifer*

(a) *Syrhophodon berterianus* (Brid.) C. M. Syn. Musc. Frond. 1: 539. 1849.

*Dicranum berterianum* Brid. Bryol. Univ. 1: 445. 1826.

*Syrhophodon laevidorsus* Besch. Rev. Bryol. 18: 75. 1891.

Pale to brownish green, robust plants, 2 to 8 cm. high. Stem leaves 5 to 7 mm. long, abruptly narrowed from obovate base to linear, acute point that is flexuose-spreading when dry, erect-spreading when moist; margins slightly serrulate at shoulders, thickened and distantly serrate above, oval in section; costa subpercurrent or short-excurrent as yellow spine, smooth; upper cells oval, 7 to 10  $\times$  6 to 7  $\mu$ , distinct, more or less bulging on upper

surface, smooth on lower; cancellinae hyaline, rounded or truncate above, filling  $\frac{1}{2}$  to  $\frac{2}{3}$  base. Dioicous. Seta 9 to 13 mm. long; capsule oval, about 2 mm. long; operculum conic-rostrate, up to 2 mm. long; peristome teeth united in pairs, irregularly roughened, projecting about  $75 \mu$  above mouth. Spores rough, about  $20 \mu$ .

On tree trunks in wet mountain forests, especially in sierra palm zone, about 2000-ft. altitude, most common in Luquillo Mts., rare elsewhere in Puerto Rico; West Indies; Trinidad; Costa Rica; northern South America.

(b) *Syrrhopodon incompletus* Schwaegr. Suppl. Sp. Musc. II. 1(2): 119. 1824.

*Calymperes hobsonii* Grev. Ann. Lyc. N. Y. 1: 271. 1825.

*Syrrhopodon semicompletus* Schwaegr. Suppl. Sp. Musc. II. 2(2): 97. 1827, nom.

*S. mohri* C. M. Linnaea. 38: 633. 1874.

*S. brachystelioides* C. M. Nuov. Giorn. Bot. Ital. II. 4: 48. 1897.

*S. decolorans* C. M. Bull. Herb. Boiss. 5: 188. 1897.

Rather robust, brownish-green plants with more or less curved and branching stems, 1 to 5 cm. high. Leaves 4 to 5 mm. long, abruptly narrowed from obovate base to linear-lanceolate limb with thickened, doubly serrulate margin, triangular in section; apex broadly acute or somewhat rounded, sometimes bearing clusters of propagula; costa subpercurrent, denticulate at apex, papillose at back, especially in upper half; upper cells subquadrate or slightly longer than wide, 5 to  $6 \mu$  wide, mammillose on lower surface; cancellinae filling  $\frac{2}{3}$  to  $\frac{3}{4}$  base, rounded above. Calyptra rough above. Seta 6 to 7 mm. long; urn oblong, small-mouthed, about 2 mm. long; peristome short, pale membrane. Spores rough, 16 to  $18 \mu$  (FIGURE 17a).

On tree trunks and on rock, in coastal plain, and in lower slopes of mountain areas in Puerto Rico; United States (Florida); West Indies: Mexico to northern South America.

(c) *Syrrhopodon rigidus* Hook & Grev. Edinb. Journ. Sci. 3: 226. 1824.

*Calymperes androgynum* Mont. Ann. Sci. Nat., Bot. II. 3: 195. 1835.

*Syrrhopodon longisetaceus* C. M. Syn. Musc. Frond. 1: 535. 1849.

Brownish-green plants. Stems red-tomentose, 1 to 3 cm. high. Stem leaves 7 to 10 mm. long, gradually narrowed from narrowly ovate base to linear-lanceolate, acute, or acuminate limb 7 to 8 times as long; apical propaguliferous leaves longer, to 12 mm.; leaf base sharply toothed, upper leaf with thickened, doubly serrate border that is triangular in section; costa percurrent to excurrent, bearing septate propagula at apex, usually rough on both sides above, smooth below; upper cells distinct, oblong,  $12$  to  $16 \times 7$  to  $10 \mu$ , mammillose on upper side; cancellinae more or less golden or red-brown, usually acute above. Dioicous. Seta 2 to 2.5 cm. long; urn 1.5 to 2.0 mm. long, oval; operculum conic-rostrate, up to 1.5 mm. long; peristome a low membrane, 50 to  $75 \mu$  high. Spores punctate-roughened, about  $20 \mu$ .

On tree trunks and on vertical rock faces, in wet mountain forests at altitude of about 3000 ft., apparently restricted to Luquillo Mts. in north-

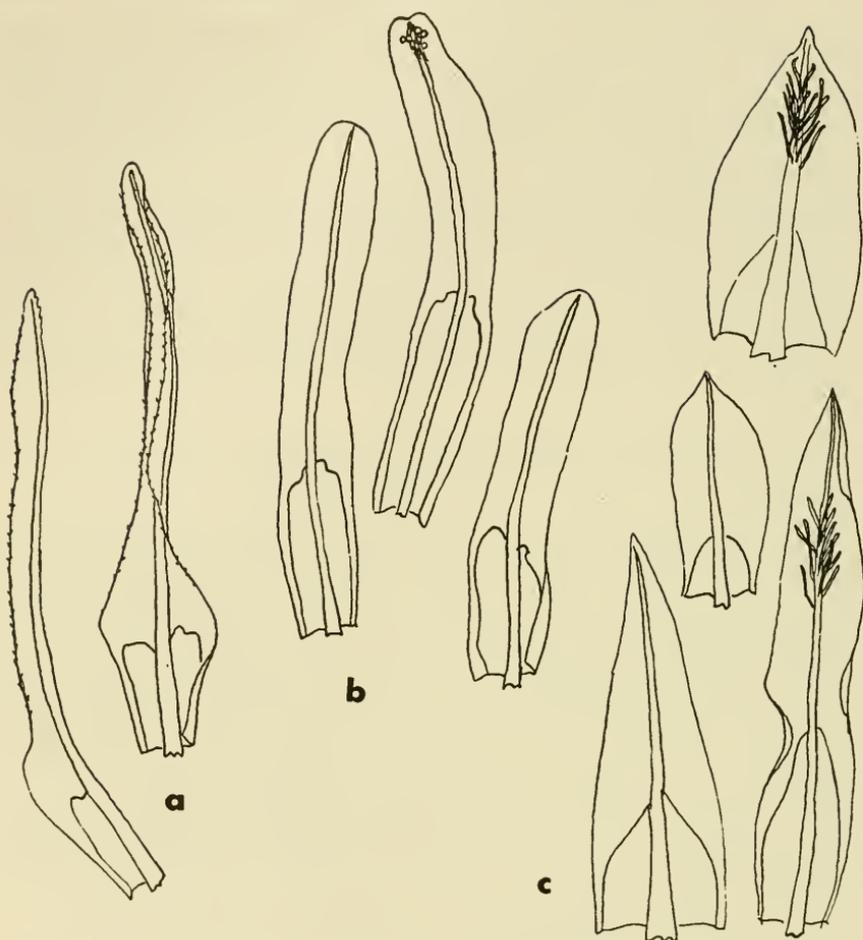


FIGURE 17. (a) Two leaves of *Syrrhopodon incompletus*; (b) leaves of *Syrrhopodon ligulatus*; and (c) leaves of *Syrrhopodon parasiticus*, 2 with propagula (Grout, 1937).

eastern Puerto Rico; Lesser Antilles; Trinidad; British and French Guiana; Cocos Island.

(d) *Syrrhopodon lycopodioides* (Swartz) C. M. Syn. Musc. Frond. 1: 538. 1849.

*Dicranum lycopodioides* Swartz. Prodr. Fl. Ind. Occ. 3: 1766. 1806.

Large brownish plants with yellowish tips. Stems occasionally branched, 8 to 15 cm. high. Stem leaves 7 to 10 mm. long, gradually narrowed from scarcely wider, oblanceolate or obovate base to flexuose-spreading linear-lanceolate, acute or acuminate limb, conspicuously bordered by linear cells in thickened, brown, doubly serrate rim; costa subpercurrent to short-excurrent, smooth; upper cells smooth, distinct, rounded-quadrangle, 10 to 14  $\mu$ ; cancellinae broadly rounded above, filling  $\frac{1}{2}$  to  $\frac{2}{3}$  the base. Dioeous.

Seta 6 to 10 mm. long; capsule cylindric, 2.5 to 3 mm. long; operculum long-rostrate, to 2 mm. long; peristome teeth very irregular, projecting about 75  $\mu$  above mouth. Spores rough, about 20  $\mu$ .

On sierra palm, near summit of Mt. Britton, El Yunque, and Luquillo Mts., the only locality known for this species in Puerto Rico; West Indies; Guatemala and Costa Rica; northern and western South America to Bolivia.

(e) *Syrrhopodon ligulatus* Mont. Syll. Gen. Spec. Crypt. 47. 1856.

*S. crispus* Aust. Bot. Gaz. 2: 109. 1877.

*S. anomalus* Broth. Bih. K. Sv. Vet.-Akad. Handl. 21(III, 3): 19. 1895.

Small greenish to brownish plants with simple or branched stems, 1 to 1.5 cm. high. Stem leaves crisped when dry, 2 to 3 mm. long, ligulate or lingulate from scarcely broader, oblong base, limb 1 to 1.5 times as long as base; apex rounded-obtuse to truncate or emarginate, sometimes minutely apiculate; margins papillose-crenulate, bordered with very narrow hyaline border only on upper part of leaf base, or sometimes unbordered; costa percurrent or occasionally slightly excurrent as a minute yellow apiculus, somewhat serrulate at back near apex; upper cells isodiametric, 6 to 8  $\mu$ , obscure, mammillose and papillose on both sides; cancellinae nearly filling leaf base, broadly rounded above. Seta 3 to 4 mm. long; capsule ovate, scarcely 1 mm. long; teeth of peristome rather rough. Spores rough, 12 to 15  $\mu$  (FIGURE 17b).

On tree trunks and decaying logs in mountain forest, at altitude of 1000 to 2000 ft., known only from Luquillo Mts. in Puerto Rico; United States (Georgia and Florida); West Indies; Mexico and Guatemala; northern South America.

(f) *Syrrhopodon parasiticus* (Swartz) Besch. Ann. Sci. Nat., Bot. VIII. 1: 298. 1895.

*Ecalypta parasitica* Swartz, Prodr. Fl. Ind. Occ. 3: 1759. 1806.

*Calymperes disciforme* C. M. Linnaea. 21: 183. 1848.

Plants rather large, up to 2 cm. high. Stem leaves usually 4 to 5 mm. long, linear-lanceolate from rather narrow base, upper leaves much shorter and broader, lanceolate to ovate, acute, subtubulose and erect when dry, subsquarrose when moist, often bearing filiform septate propagula on upper surface on either side of costa at midleaf; margins with narrow, irregular, entire or serrulate, pale border extending about  $\frac{2}{3}$  leaf length, sometimes lacking in comal leaves; costa subpercurrent, smooth at back or denticulate at apex; upper cells irregularly hexagonal, about 8  $\mu$  wide, mammillose on upper side, smooth or unipapillose on lower side; cancellinae acutely angled above. Dioicous. Seta about 3.5 mm. long; capsule erect, cylindric, less than 2 mm. long; peristome consisting of 16 irregular teeth barely exceeding rim of urn. Spores oval, minutely roughened (FIGURE 17c).

On tree trunks and twigs, rarely on living leaves and rotten wood; at lower levels, in wet mountain forests; widespread in Puerto Rico; United States (Florida); West Indies; Mexico; Central America; Galapagos Islands.

(g) *Syrhropodon borinquensis* Crum & Steere. Bryol. 59: 249. 1956.

Small, scattered or loosely tufted plants, green above, brownish below. Stems subsimple, usually less than 5 mm. high. Leaves 2.5 to 4 mm. long, flexuose-spreading to crispate when dry, wide-spreading when moist, consisting of erect, oval to obovate base,  $\frac{1}{3}$  to  $\frac{1}{2}$  leaf length, and somewhat involute, oval-lingulate point wider than base; apex broadly acute; margins bordered from base nearly to apex with narrow band of elongate, hyaline cells, serrulate in upper quarter, entire in lower quarter, but ciliate-dentate or serrate with 1-celled teeth along middle half of leaf; costa percurrent or nearly so, smooth throughout on both sides, upper cells distinct, angular, rather irregular, 9 to 12  $\times$  6 to 9  $\mu$ , bulging on upper side, smooth or nearly so on lower side; cancellinae filling most of base, ending about  $\frac{1}{2}$  up leaf in acute angles beside costa. Sporophyte unknown (FIGURE 18).

On buttress roots and trunks of large trees in wet mountain forests, at altitudes of 1000 to 2000 ft.; apparently restricted to Sierra de Luquillo and Sierra de Cayey, in eastern Puerto Rico. On buttress roots of great tree along trail, northern Guavate Purchase Unit, Sierra de Cayey, W. C. S. 4851, 4855, Nov. 10, 1939. On large tree, along trail up east slope of El Toro range via Río Sabana, Sierra de Luquillo, W. C. S. 5333, Dec. 21, 1939.

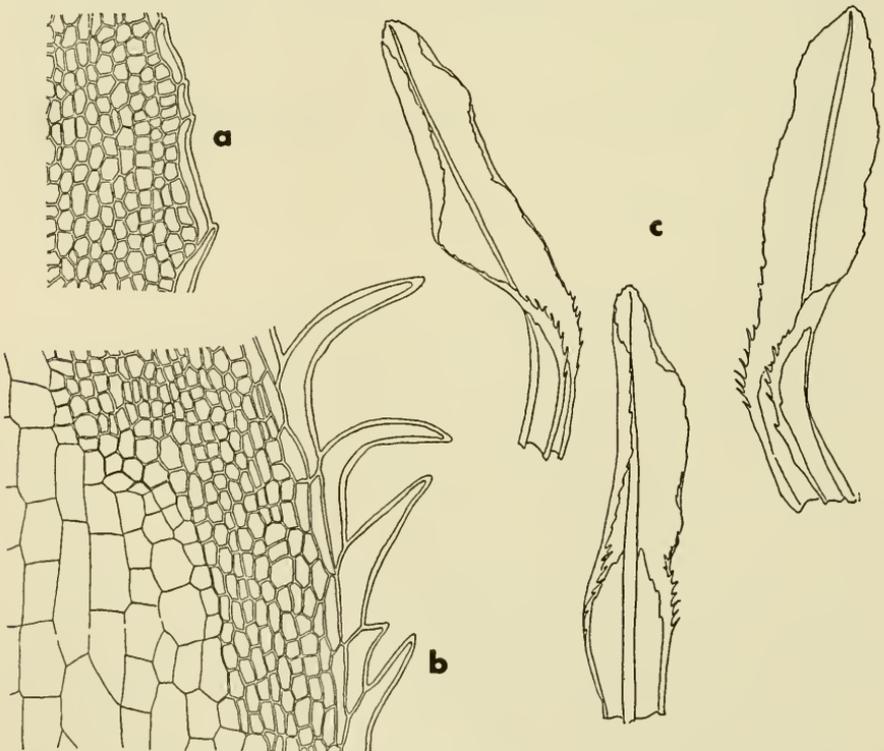


FIGURE 18. *Syrhropodon borinquensis*: (a) upper leaf cells, (b) cells at leaf shoulder, and (c) leaves.

On trunk of tree along upper Río Baño, north slope of Sierra de Luquillo, *W. C. S.* 5386, Dec. 23, 1939. On trunk of tree, above Verde, northeast side of El Yunque Range, Sierra de Luquillo, *W. C. S.* 6260, 6277, Jan. 26, 1940. On tree along trail through northernmost part of Guavate Purchase Unit, Sierra de Cayey, *W. C. S.* 6733, March 1, 1940. On base of large tree, forest along Coco River, above falls, Sierra de Luquillo, *W. C. S.* 7027 (type), May 3, 1940.

Similar to *S. erubescens* Bartr., this species differs in its smaller size and less strongly toothed margins in the upper quarter of the leaves, as well as in the acute rather than rounded cancellinae.

(h) *Syrrhobodon gaudichaudii* Mont. *Ann. Sci. Nat., Bot.* II. 2: 376. 1834.

*S. sartorii* C. M. Linnaea. 38: 633. 1874.

Plants in extensive green or brownish mats. Stems branched, 1 to 3 cm. high. Leaves crowded, twisted-crispate when dry, 1.5 to 3 mm. long, abruptly narrowed from oval to oblanceolate base to linear-lanceolate, broadly acute, grooved limb, 1 to 2 times as long as base, margins entire except at spinose apex, with white or yellowish border nearly throughout; costa subpercurrent to slightly excurrent, smooth except at apex; upper cells oval to isodiametric, about 6  $\mu$  in diameter, densely papillose on both sides; cancellinae filling most of base, rounded or truncate above. Dioicous. Seta 5 to 6 cm. long, slightly roughened above; capsule oblong-cylindric, about 1.5 to 2 mm. long; operculum conic-rostrate, about 1 mm. long; peristome teeth slightly roughened. Spores rough, 12 to 14  $\mu$ .

On tree trunks, decaying logs, and humus in mountain forests at higher altitudes, apparently known only from Cordillera Central in Puerto Rico; United States (Florida); West Indies: Mexico; Costa Rica; Brazil; Ecuador; Galapagos Islands.

(i) *Syrrhobodon tenuifolius* (Sull.) Mitt. *Journ. Linn. Soc. London, Bot.* 12: 117. 1869.

*Calymperes tenuifolium* Sull. *Proc. Amer. Acad. Arts and Sci.* 5: 280. 1861.

Plants small, pale green to red-brown. Stems up to 1 cm. but usually less than 5 mm. high. Stem leaves extremely variable in length, from few millimeters to more than 4 cm. long, largest usually at stem tips, slightly narrowed from narrowly oblong base about 2 mm. long to filiform limb; apex acute, apiculate, spinose; margins entire except at apex, with narrow hyaline or yellowish border throughout; costa percurrent or nearly so, spinose at apex, showing in section 1 to 3 guide cells below median guide cells; upper cells subquadrate to short-rectangular, 8 to 12  $\times$  6 to 7  $\mu$ , bearing spinose or compound papillae on both sides; cancellinae acute above, almost filling leaf base. Sporophyte unknown.

On tree trunks, roots, rotten wood, and humus in mountain forests, at middle altitudes, known only from Cordillera Central of Puerto Rico; Cuba, Jamaica, Dominica and St. Kitts; British Honduras.

(j) *Syrrhodon husnotii* Besch. Ann. Sci. Nat., Bot VI. 3: 195. 1876.

Pale brownish plants with fragile, somewhat branched stems up to 4 cm. high. Leaves about 4.5 mm. long, narrowed from oblong-linear to oblanceolate base to rather widely spreading, twisted-flexuose, setaceous point, 2.5 to 3 times as long as base; margins entire except at apex, with pale, cylindrical border; costa subpercurrent, smooth except at denticulate apex, with median guide cells only; upper cells about 8 to 10  $\times$  6  $\mu$ , rather obscure, papillose on both surfaces; cancellinae filling most of base, usually acute above. Sporophyte unknown.

On tree trunks and bases and on rotten wood, in mountain forests at middle altitudes (2000 ft.), apparently widespread in Puerto Rico, but known from few localities; Guadeloupe and Martinique.

(k) *Syrrhodon prolifer* Schwaegr. Suppl. Sp. Musc. II. 2(2): 99. 1827.

*S. flavescens* C. M. Syn. Musc. Frond. 1: 541. 1849.

*S. parvulus* Schimp. ex C. M. *Op. cit.* 544.

*S. schwaneckeanus* C. M. Bot. Zeit. 13: 763. 1855.

*S. scaber* Mitt. Journ. Linn. Soc. London, Bot. 12: 119. 1869.

*S. calypteridianus* Besch. Ann. Sci. Nat., Bot. VI. 3: 195. 1876.

*S. subviridis* Besch. *Ibid.* 196.

*S. scaber* var. *breviligulatus* C. M. Hedwigia. 87: 235. 1898.

*S. dussii* Broth. In Urban, Symb. Antill. 3: 422. 1903.

Pale green or yellowish plants with fragile, branched stems 1 to 2 cm. long. Leaves nearly erect, flexuose and somewhat twisted when dry, variable in length, usually 3 to 6 mm. long, sometimes reaching 12 mm., gradually narrowed from oblong base to linear, acute limb 3 to 8 times as long; margins entire except near apex, with narrow border of hyaline or yellowish cells extending to apex or nearly so; costa subpercurrent, more or less spinose at tip on both sides, showing only median guide cells in section; cells obscure, papillose on both sides, about 6  $\times$  6 to 8 or 10  $\mu$ ; cancellinae nearly filling leaf base, usually narrowly acute above, sometimes broadly rounded. Seta 5 to 8 mm.; capsule cylindrical, up to 1.5 mm.; peristome teeth yellowish, papillose. Spores minutely roughened, about 12  $\mu$ .

A common, abundant, and extremely variable species growing on tree trunks, decaying wood, humus, and rock at all altitudes, but best developed at about 1000 to 3000 ft.; United States (Florida); Mexico to South America; West Indies.

#### POTTIACEAE

Small to moderately large plants usually growing in dense mats on soil or rock. Stems erect, often branched. Leaves several-ranked, usually contorted when dry; costa strong, usually subquadrate, incassate, papillose and obscure, rarely smooth, basal cells rectangular, usually thinner-walled and pellucid. Calyptra cucullate. Seta smooth, erect, usually elongate; capsules mostly erect and symmetric, subcylindric, smooth; operculum mostly conic-rostrate; peristome of 16 erect or spirally twisted teeth from

low to high basal membrane, entire or divided into 32 slender, papillose forks, sometimes rudimentary or lacking.

- Archegonial inflorescences lateral. . . . . (1) *Anoetangium*  
 Archegonial inflorescences terminal.  
 Costa with dorsal and ventral stereid bands.  
 Hyaline basal cells extending upward along margins as V-shaped border. . (8) *Tortella*  
 Basal margins not bordered.  
 Leaves involute at margins, at least above.  
 Peristome lacking; capsule closed by membrane for some time after dehiscence  
 (2) *Hymenostomum*  
 Peristome present; capsule not closed by membrane after dehiscence.  
 Peristome inserted well below mouth of capsule; teeth usually undivided and  
 poorly developed. . . . . (3) *Weissia*  
 Peristome inserted at mouth; teeth split to base into 32 filiform divisions  
 (7) *Trichostomum*  
 Leaves plane or recurved at margins.  
 Peristome lacking.  
 Leaves lanceolate; margins sometimes recurved on 1 side; operculum attached  
 to columella, sometimes persisting after dehiscence. . (4) *Gymnostomum*  
 Leaves broadly oblong or spatulate; margins inrolled when dry; operculum  
 not united to columella. . . . . (9) *Hyophila*  
 Peristome present.  
 Leaves obovate and sheathing at base; operculum very long and needlelike  
 (5) *Rhamphidium*  
 Leaves not sheathing; operculum often rostrate, but not needlelike or re-  
 markably long.  
 Peristome strongly twisted. . . . . (10) *Barbula*  
 Peristome erect.  
 Margins of leaves revolute, irregularly dentate near apex; basal cells  
 large and lax. . . . . (11) *Bryoerythrophyllum*  
 Margins plane (somewhat inrolled when dry), entire; basal cells not  
 markedly differentiated. . . . . (6) *Tuerckheimia*  
 Costa consisting of homogeneous cells, or with dorsal stereids only.  
 Leaves strongly bordered all around by firm, colored cells. . . . . (13) *Tortula*  
 Leaves unbordered, or bordered only at base by upward extension of hyaline basal  
 cells.  
 Hyaline basal cells extending upward along margins as short, V-shaped border;  
 green cells conspicuously bulging. . . . . (14) *Luisierella*  
 Basal cells not forming border below; cells not bulging.  
 Leaves obtuse and mucronate, entire; cells obscure and papillose; capsules im-  
 mersed; operculum lacking. . . . . (12) *Phascum*  
 Leaves rounded and crenulate at apex; cells lax and pellucid, whether smooth or  
 papillose; capsule exserted; operculum present.  
 Cells smooth; peristome present. . . . . (15) *Splachnobryum*  
 Cells papillose; peristome lacking. . . . . (16) *Gymnostomiella*

- (1) *Anoetangium* Bruch & Schimp. Bryol. Eur. fasc. 29-30. 1846, nom.  
 conserv., non *Anoetangium* Schwaegr., 1811, nec *Anictangium*  
 Hedw., 1801.

Slender plants in dense, pale green or yellowish green mats. Stems radicu-  
 lose, reddish below. Leaves erect-spreading when moist, appressed or  
 spirally twisted when dry, keeled, narrowly lanceolate or oblong; costa  
 strong, subpercurrent, with ventral guide cells, stereids variously disposed:  
 basal leaf cells quadrate or short-rectangular, pellucid, upper cells small,  
 hexagonal or rounded, densely papillose on both surfaces. Calyptra long-  
 rostrate, cucullate. Dioicous. Seta lateral, elongate, erect; capsule oblong;  
 operculum obliquely long-rostrate; peristome lacking.

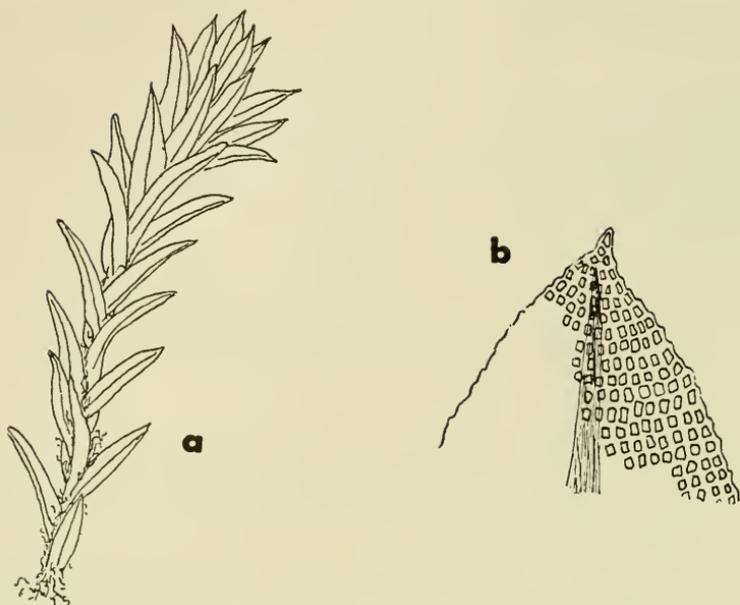


FIGURE 19. *Anoeclangium incrassatum*: (a) habit, and (b) cells at leaf tip (Børgesen, 1919).

*Anoeclangium incrassatum* Broth. In Børg. Bot. Tidsskr. 36: 278. 1919.

Plants slender, green above, yellow and matted with reddish radicles below, growing in dense sods. Stems up to 3 cm. high, or much shorter, erect, forked, densely foliate. Leaves erect-spreading when moist, appressed and spirally twisted around stem when dry, oblong-lanceolate or lingulate, keeled, acute, ending in hyaline apiculus; margins erect, entire except for marginal papillae; costa stout, subpercurrent, rough at back; upper cells rounded-quadrate, often broader than long, very incrassate, densely papillose on both sides but distinct, neatly arranged in rows, basal cells short-rectangular, incrassate, smooth (FIGURE 19). "Perichaetium erect, 1.1 mm. high, about 6 broadly ovate, acuminate leaves sheathing at the base, the outer a little shorter; upper cells incrassate, quadrate to 3 or 4 times as long as broad, more elongate and hyaline toward concave hyaline base; costa percurrent or ending just below apex; seta yellow, 5-7 mm. long, flexuose, twisted to right when dry; capsule (old and empty) erect, pale brown, ovoid, about 1 mm. high, gradually contracted to short neck; spores smooth,  $10\ \mu$  in diameter. Lid and calyptra unknown" (Bartram, 1928).

On vertical shaded cliff above Río Maricao, only locality known in Puerto Rico; Cuba, Jamaica, and Haiti.

(2) *Hymenostomum* R. Brown. Trans. Linn. Soc. London. 12: 573. 1819.

Small plants forming loose to compact cushions on soil. Leaves larger toward stem apex, erect or wide-spreading when moist, crisped when dry,

linear-lanceolate to ligulate-lanceolate, mostly incurved or inrolled at margins; costa strong, excurrent as a mucro; upper cells small, rounded or quadrate, densely pluripapillose on both sides, elongate-rectangular and usually hyaline below. Calyptra cucullate, reaching middle of capsule. Seta long, straight, slender, yellow; capsule symmetric, erect or somewhat inclined, ovate to ellipsoid; annulus lacking; operculum long-rostrate; peristome lacking, narrow mouth of capsule usually covered by fugacious membrane developed from columella.

*Hymenostomum breutelii* (C. M.) Broth. *In* E. & P., *Nat. Pfl.* 10: 254. 1924.

?*Gymnostomum micaceum* Schlecht. *Linnaea.* 10: 443. 1836.

?*Hymenostomum subglobosum* Hornsch. *In* Mart., *Fl. Brasil.* 1(2): 5. 1840, non Nees, Hornsch. & Sturm, 1823.

*H. cylindricum* B. S. G. *Bryol. Eur. fasc.* 33-36. 1846, nom.

*Weissia breutelii* C. M. *Syn. Musc. Frond.* 1: 664. 1849.

*W. senocarpa* (sic) C. M. *Op. cit.* 2: 633. 1851.

*W. pabstiana* C. M. *Bot. Zeit.* 15: 383. 1857.

*W. edentula* Sull. *Proc. Amer. Acad. Arts and Sci.* 5: 273. 1861, non Mitt., 1859.

*W. cubensis* Hampe ex C. M. *Hedwigia.* 37: 235. 1898, nom.

Small plants in green or yellowish, loose to dense tufts. Stems simple, sparsely branched, about 0.5 cm. high, or less. Leaves widely spreading from erect base when moist, curved to contorted when dry, 1.5 to 2 mm. long, narrowly lanceolate, acuminate, cucullate and apiculate at apex; margins entire, involute above; costa about 60  $\mu$  wide at base, excurrent as a small yellow mucro; upper cells small, irregularly subquadrate, green, densely papillose, and somewhat obscure, toward base short-rectangular and pelucid. Probably autoicous. Seta rather long, slender, yellow; capsule erect, or nearly so, oblong-cylindric, brownish.

On calcareous soil in coastal plain and at lower altitudes in mountains; apparently common in Virgin Islands; West Indies; Costa Rica; Brazil.

It is suspected that this species and many others in tropical America will prove to be synonymous when the genus is critically studied.

(3) *Weissia* Hedw. *Sp. Musc.* 64. 1801.

Small plants in rather thin, yellowish-green to green cushions on soil. Leaves larger toward stem apex, spreading, crisped when dry, narrowly lanceolate from broader base, acute or acuminate, keeled; upper margins inrolled or incurved; costa usually excurrent as a mucro; upper cells small, rounded, opaque, densely covered on both sides by low papillae, lower cells rectangular, hyaline. Seta straight, slender, elongate; capsule erect and symmetric, ovate to cylindric, smaller at mouth; annulus persistent; operculum obliquely long-rostrate; peristome inserted well below mouth, teeth variable in form, short and narrow, often rudimentary, not forked, smooth or papillose.

*Weissia controversa* Hedw. var. *australis* (Aust.) Schornh. Bryologist 43: 63. 1940.

*W. viridula* Hedw. var. *australis* Aust. Musci Appal. Suppl. 1. No. 466. 1878, nom.; Bull. Torrey Bot. Club. 7: 4. 1880.

*W. longiseta* Lesq. & James. Proc. Amer. Acad. Arts and Sci. 14: 125. 1879.

Stems erect, sometimes branched, up to 5 mm. or more. Leaves erect-spreading when moist, strongly crisped when dry, up to 3 mm. long, lanceolate, sharply pointed; margins strongly involute above, plane below, entire; costa 35 to 45  $\mu$  wide at base, excurrent as sharp, pale mucro; upper cells rounded-hexagonal, 6 to 7  $\mu$ , papillose and obscure. Seta up to 15 mm. long, usually bright yellow; capsule oblong-cylindric, dark brown and shiny, somewhat plicate when empty; peristome teeth sometimes perforate or bifid. Spores papillose.

On calcareous soil and limestone, widespread in coastal plain and at lower altitudes in mountainous area; St. Jan; southeastern United States, north to North Carolina; probably widely distributed in Caribbean area.

(4) *Gymnostomum* Smith. Fl. Brit. 3: 1158. 1804, nom. conserv., non Hedw., 1801.

Plants densely caespitose, rusty-red below. Stems rounded or triangular in section, with or without central strand. Leaves gradually increasing in size toward stem apex, erect and more or less contorted when dry, linear-lanceolate, somewhat keeled; margins entire, plane or somewhat recurved, at least on 1 side below; costa strong, ending below apex, with 1 or 2 stereid bands or sometimes nearly homogeneous; upper cells small, rounded-quadrate, papillose, smooth and short-rectangular below. Dioicous; archegonia terminal; perichaetial leaves scarcely larger than stem leaves, somewhat sheathing at base. Calyptra narrowly cucullate. Seta elongate; capsule ovoid or oblong; peristome lacking; operculum obliquely long-rostrate, falling easily or remaining attached to columella.

*Gymnostomum recurvirostrum* Hedw. Sp. Musc. 33. 1801.

*Weissia stillicidiorum* Mitt. Journ. Linn. Soc. London, Bot. 12: 134. 1869.

*Gymnostomum orizabanum* Schimp. Mém. Soc. Nat. Sci. Natur. Cherbourg. 16: 159. 1872.

*Pottia glauca* C. M. Bull. Herb. Boiss. 5: 555. 1897.

*P. nanangia* C. M. *Ibid.* 556.

*Trichostomum crustaceum* C. M. Hedwigia. 37: 235. 1898.

*Zygodon eggersii* C. M. *Ibid.*

*Hymenostylium longopulvinatum* Dusén. Ark. f. Bot. 6(8): 7. 1906.

*Gymnostomum uvulum* Card. Rev. Bryol. 36: 70. 1909.

Bright to yellow-green, densely tufted plants, sometimes glaucous. Stems branched, up to 3 to 4 cm. or more, sometimes very robust. Leaves crowded, slightly contorted when dry, erect or erect-spreading when moist, 1 to 2 mm. long, lance-acuminate, acute, keeled; margins recurved on 1 or both

sides below; upper cells rounded to angular, 7 to 10  $\mu$  wide, incrassate, often porose, bluntly pluripapillose but distinct; costa prominent at back, disappearing below apex. Seta 8 to 10 mm. long; capsule erect, dark red-brown, about 1 mm. long; operculum attached to columella after dehiscence and finally falling with it.

On moist to dripping limestone cliffs, 2 localities in northern coastal plain and 1 near summit of Mt. Britton, El Yunque range, Luquillo Mts., Puerto Rico; Labrador to Alaska, south in United States to South Carolina in East and to California and Arizona in West; Mexico and Guatemala; West Indies; South America; also Europe, Asia, and New Zealand.

(5) *Rhamphidium* Mitt. Journ. Linn. Soc. London, Bot. 12: 45. 1869,  
non *Rhamphidia* Lindb., 1840.

Small, green or yellow-green, gregarious plants with simple or forked stems. Leaves lanceolate or ligulate and spreading when dry; apex broadly obtuse; costa strong, subpercurrent, sometimes rough at back; upper cells small, subquadrate or slightly elongate, usually smooth, rarely bulging and papillose, basal cells elongate or linear, smooth, hyaline. Dioicous. Perichaetial leaves similar to stem leaves but larger. Calyptra cucullate. Seta erect, elongate; capsule elliptic to cylindrical, inclined; annulus deciduous; operculum subulate-rostrate, often as long as urn; peristome inserted at mouth, the 16 teeth long, erect, or sometimes slightly twisted, split nearly to base into 2 slender, roughly papillose forks densely covered with spicules or lamellae.

Upper leaf cells smooth.....(a) *R. dicranoides*  
Upper cells bulging and papillose.....(b) *R. borinquense*

(a) *Rhamphidium dicranoides* (C. M.) Bartr. Bryol. 49: 112. 1946.

*Leptotrichum dicranoides* C. M. Syn. Musc. Frond. 2: 612. 1851.

*Trichostomum dicranelloides* Schimp. ex Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg. 16: 175. 1872, nom.

?*T. hyophilaceum* C. M. Bull. Herb. Boiss. 5: 191. 1897.

*T. macrostegium* Sull. Proc. Amer. Acad. Arts and Sci. 5: 276. 1861.

*Dicranella belangeriana* Besch. Ann. Sci. Nat., Bot. VI. 3: 183. 1876.

Slender, yellowish, erect plants 6 to 12 mm. high. Stem leaves crisped when dry, spreading when moist, scarcely 1 mm. long, lanceolate from short, oblong-obovate, sheathing base, spreading blade very concave, often subtubulose, obtuse; margins erect, entire, or distantly and minutely crenate-dentate above middle; costa ending below leaf apex, toothed at back above; upper cells somewhat incrassate, subquadrate to short-rectangular, about 8  $\mu$  wide. Perichaetial leaves longer than stem leaves, 2 mm. or more in length. Seta 1 mm. or less, slender, reddish; urn of capsule oblong-ovoid, suberect to inclined, slightly wrinkled when dry and empty, 1.0 to 1.8 mm. long; annulus narrow; operculum with needlelike beak longer than urn; peristome teeth fused at base, roughly papillose throughout, and spirally ridged above.

On soil and disintegrating rock in all mountainous areas, from altitudes of 1000 ft. to 3000 ft. in Puerto Rico; West Indies; Mexico to northern South America (also reported from Alabama and Louisiana in United States).

(b) *Rhamphidium borinquense* Crum & Steere. Bryol. **59**: 250. 1956.

Fertile stems reaching 5 mm., sterile stems somewhat longer. Leaves crisped and usually incurved when dry, erect-spreading to wide-spreading when moist, becoming larger toward stem apex, about 1 mm. long, the obovate, sheathing base about  $\frac{1}{2}$  leaf length, limb linear-lanceolate or lingulate, deeply concave; margins sometimes incurved, entire or crenulate below, crenate-dentate above, and often irregularly serrate at somewhat cucullate, blunt apex; costa strong, percurrent in lower leaves, shorter in upper leaves; upper cells irregularly quadrate, 7 to 10  $\mu$ , mammillose and papillose, becoming elongate below, smooth at base and up to 50 $\mu$  long near costa. Seta straight, red, about 1 cm. long; capsule inclined, symmetric, elliptic to cylindrical, about 1 mm. long, somewhat swollen at stomatose neck; annulus 1 to 2 cells wide, not revolute; operculum long-rostrate from conic base, reaching 1.5 mm., as long as or longer than urn; the 16 peristome teeth orange-red, bifid to short basal membrane, densely papillose and covered with dense, high, platelike or spicular, spiral processes. Spores smooth, 12 to 15  $\mu$  (FIGURE 20).

On clay in trail to West Peak, El Duque Range, Sierra de Luquillo, *W. C. S.* 5983, type, on rock, 5932, Jan. 9, 1940. On clay bank along trail, upper slopes of Mt. Guilarte, west of Adjuntas, *W. C. S.* 7212a, c. fr. On soil, bottom of Mt. Britton trail, Sierra de Luquillo, *W. C. S.* 5989a, Apr. 27, 1940, c. fr. On steep rock ledges along road from Mameyes to Luquillo Mountain National Forest at km. 9.8, *W. C. S.* 5204, Dec. 15, 1939. On clay bank, along trail, ridge north of Río Dona Juana, Toro Negro Purchase Unit, north of Villalba, *W. C. S.* 6059, and on boulder, 6043, Jan. 18, 1940. On rocky bank along trail from Toro Negro reservoir to Jayuya, *W. C. S.* 6877, March 20, 1940. On steep rock ledges along road from Mameyes to Luquillo Mountain National Forest, at km. 9.8, *W. C. S.* 5201a, Dec. 15, 1939. On soil, at high altitude, Tres Picachos, *P. A. Laubengayer*, March 30, 1929. On clay bank along trail east of Cerro de la Punta, Cordillera Central, south of Jayuya, *W. C. S.* 6184 (with *Wilsoniella subvaginans* Crum & Steere), Jan. 20, 1940.

*Rhamphidium borinquense* appears to be the only known species of the genus with papillose leaf cells. The leaf shape and aerolation and the characteristics of the sporophyte, particularly the long operculum and the markings of the peristome teeth, are very similar to those of *R. dicranoides*.

(6) *Tuerckheimia* Broth. Öfv. F. Vet.-Soc. Förh. **52**: 2. 1910.

Very small plants in loose green tufts on limestone. Stems very short and simple. Leaves crowded, flexuose-incurved when dry, erect-spreading when moist, linear-lanceolate or ligulate, scarcely broader at base, keeled; margins entire, incurved when dry, plane when moist; costa strong, ending below apex, covered ventrally with green, papillose cells, with 2 stereid bands; cells small, incrassate, rounded-quadrate, finely papillose on both sides, basal cells oblong, smooth, hyaline. Dioicous; inner perichaetial leaves sheathing at base. Seta elongate; capsule small, cylindrical; peristome inserted

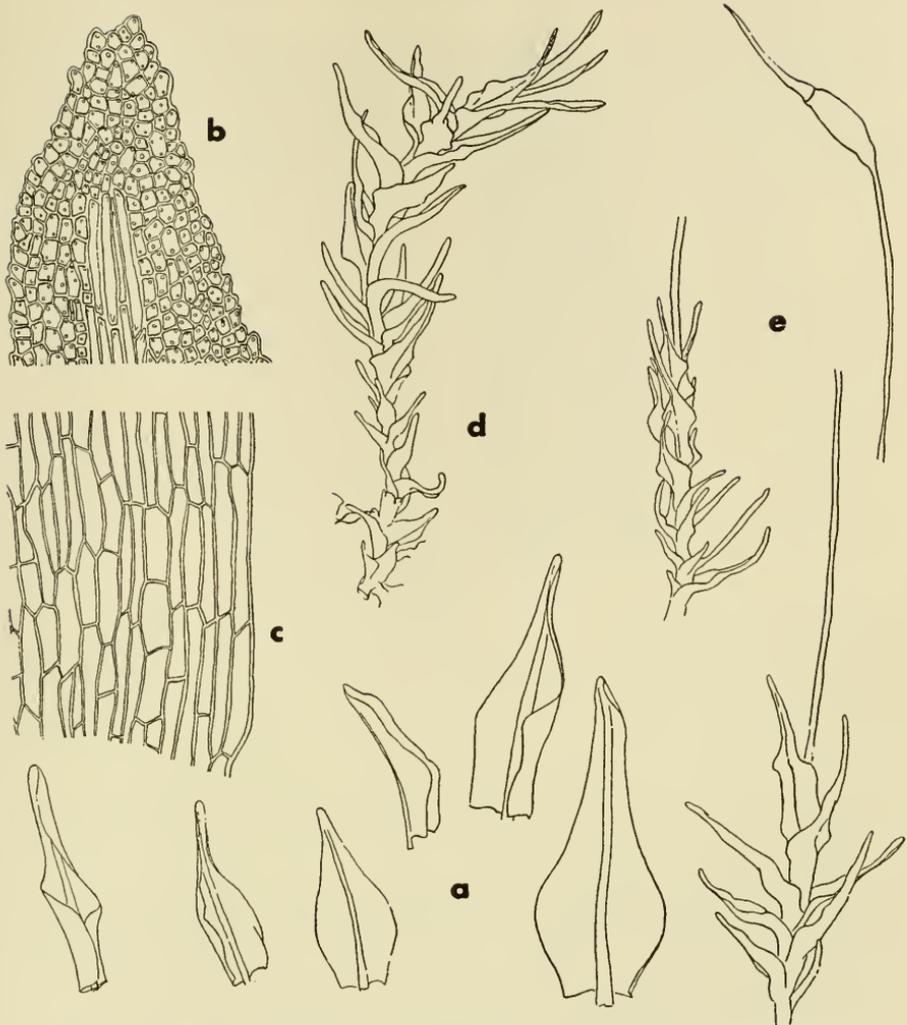


FIGURE 20. *Rhamphidium borinquense*: (a) leaves, (b) cells at leaf tip, (c) cells at leaf base, (d) sterile plant (moist), and (e) 2 fruiting plants (dry at left, moist at right), with sporophyte at right.

at mouth, teeth erect, usually divided to base into 2 filiform forks, sometimes rudimentary or lacking.

*Tuerckheimia linearis* (Swartz) Britt. Bull. Torrey Bot. Club. 40: 675. 1913.

*Tortula linearis* Swartz. Prodr. Fl. Ind. Occ. 3: 1765. 1806.

Small, dull, green, gregarious plants. Leaves erect with curled and contorted tips when dry, erect-spreading when moist, about 2 to 2.5 mm. long, narrowly ligulate, acute, scarcely broader at base, moderately keeled; costa subpercurrent; upper cells 6 to 8  $\mu$ , somewhat incrassate, finely papil-

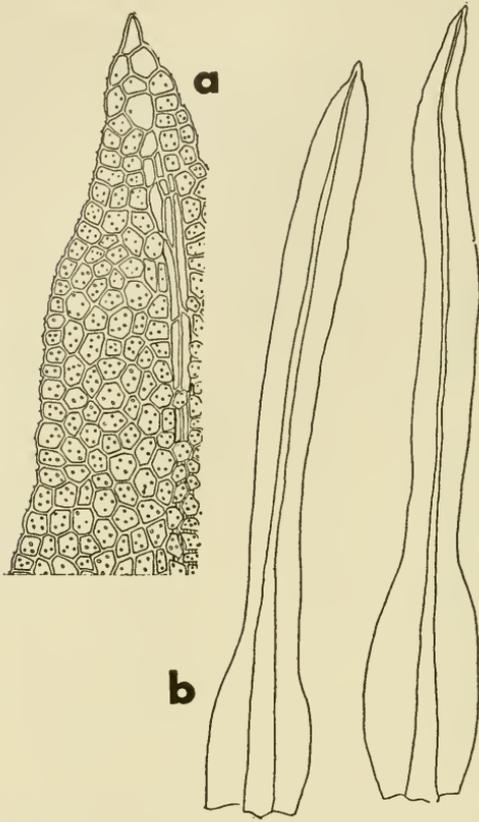


FIGURE 21. *Tuerckheimia linearis*: (a) apex of leaf, showing upper cells and costa covered with green, papillose cells; and (b) 2 leaves.

lose on both sides, not bulging, basal cells laxly oblong, hyaline, thin-walled. Inner perichaetial leaves abruptly enlarged and sheathing. Seta 3 to 7 mm. long, slender, erect; urn of capsule 1 to 1.25 mm. long; annulus large; operculum long-rostrate, 0.6 mm. high; peristome teeth about  $220\ \mu$  high, split nearly to base into 2 filiform, papillose forks (FIGURE 21).

On soft limestone, known in Puerto Rico from a single locality, at Río Abajo Planting Project, south of Arecibo (*W. C. S.* 6677); Cuba, Jamaica, and Haiti.

(7) *Trichostomum* Bruch. *Flora.* 12: 393. 1829, nom. conserv., non Hedw., 1801.

Small to moderately robust, rigid, usually dull, tufted plants. Leaves narrow, longer toward stem apex, strongly contorted when dry, spreading when moist; margins usually involute above, rarely plane throughout, usually entire; costa strong, percurrent or excurrent as a hyaline or yellow mucro; cells small and densely papillose above, rectangular and pellucid below. Dioicous. Seta elongate, erect; capsule cylindrical, usually erect; annulus mostly lacking; operculum conic-rostrate; 16 peristome teeth, erect, smooth or papillose, undivided or split nearly to base, sometimes rudimentary.

- Leaf margins plane.....(a) *T. portoricense*  
 Leaf margins involute.  
 Plants shiny, dark-brown; basal cells of leaf very incrassate; costa 100 to 110 $\mu$  wide below  
 (b) *T. sublamprothecium*  
 Plants dull, green or yellow-brown; basal cells only moderately incrassate; costa 80  $\mu$   
 or less wide.  
 Leaf limb linear-lanceolate.....(c) *T. jamaicense*  
 Leaf limb broadly lanceolate.....(d) *T. involutum*

(a) *Trichostomum portoricense* Crum & Steere. Bryol. 59: 250. 1956.

Very small, rigid, dark green plants, sometimes tinged with brown, in loose tufts. Leaves flexuose-spreading, with tips contorted when dry, 1.5 to 3 mm. long, narrowly linear, scarcely broader at base, obtuse or broadly acute, abruptly mucronate, entire or irregularly notched above, channeled at costa; margins erect; costa strong, about 40 to 45  $\mu$  wide, about  $\frac{1}{4}$  width of upper leaf, prominent at back, yellow, in section showing 2 well-developed stereid bands with row of median guide cells, not covered ventrally with green, papillose cells, excurrent as stout, yellowish mucro; cells rounded-hexagonal, 6 to 8  $\mu$ , dark-green, obscure, bulging and densely papillose on both sides, basal cells short-rectangular, hyaline, smooth, incrassate. Dioicous; archegonia produced terminally (FIGURE 22).

This curious species is distinct from any other *Trichostomum* known from the Caribbean area in its small size, its very narrow leaves, scarcely broader at the base and, most notably, its erect leaf margins. It bears a strong resemblance to *Tuerckheimia linearis* (Sw.) Britt., but can be distinguished from that species by the fact that the costa is not covered by green, papillose cells, apparently a generic character of *Tuerckheimia*. The nearest relative of this species appears to be *Trichostomum apophysatulum* Herz., known only from rather high altitudes in the Bolivian Andes. *T. portoricense* has been collected on limestone rocks at Hato Arriba near Arecibo by E. G. Britton (*s.n.*, March 1, 1915 and 2019, March 3, 1914) and south of Arecibo at the Río Abajo Planting Project by W. C. Steere (6601, February 22, 1940, type, distributed as *Tuerckheimia linearis*).

(b) *Trichostomum sublamprothecium* Paris. Index Bryol. 1331. 1898, nom.

*T. lamprothecium* C. M. Bull. Herb. Boiss. 5: 556. 1897, non C. M., 1874.

Plants rigid, shiny, dark brown below, yellow-green at tips, in extensive, low tufts. Stems 1 to 1.5 cm. high, slender, subsimple. Leaves about 3 mm. long, erect and strongly curled when dry, spreading when moist, gradually narrowed to lance-acuminate, subtubulose limb from short, ovate, appressed base; margins strongly involute to apex, entire; costa strong, 100 to 110  $\mu$  wide below, brown, exerted as sharp mucro at acute apex; cells subquadrate, 5 to 8  $\mu$ , obscure, densely papillose, rectangular toward base, very incrassate, deep yellow, a few rows at margins paler and thinner-walled. Perichaetial leaves similar, more slenderly acuminate. Seta yellow, short, flexuose; urn erect, small, cylindrical, shiny brown; operculum conic-subulate, straight; peristome teeth short, rough, reddish, irregularly divided nearly to base. Sporophyte not seen.

On vertical rock faces, only known locality in Puerto Rico on cliffs just

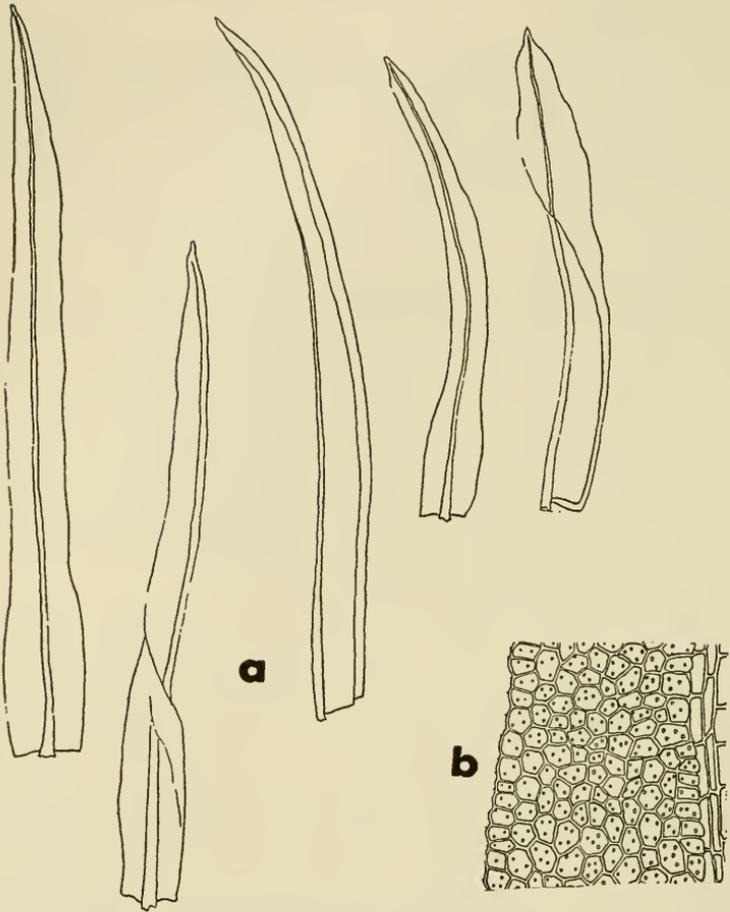


FIGURE 22. *Trichostomum portoricense*: (a) series of 5 leaves, and (b) cells of upper third of leaf and costa.

below summit of Mt. Britton, El Yunque range, Luquillo Mts.; Jamaica and Haiti.

(c) *Trichostomum jamaicense* (Mitt.) Jaeg. Ber. St. Gall. Natur. Ges. 1871-72: 397. 1873.

*T. canaliculatum* Hampe ex Sull. Proc. Amer. Acad. Arts and Sci. 5: 276. 1861, nom., non *Tortula canaliculata* Mitt. 1869.

*Tortula jamaicensis* Mitt. Journ. Linn. Soc. London, Bot. 12: 147. 1869.

*T. rivalis* Mitt. *Ibid.*

*Trichostomum lamprothecium* C. M. Linnaea. 38: 637. 1874.

*T. purpusi* Card. Rev. Byrol. 36: 73. 1909.

Rather coarse plants up to 1 cm. or more high. Leaves 2.5 to 3.5 mm. long, strongly curled at tips when dry, linear-lanceolate from oblong-ovate,

hyaline or yellowish base, acute or obtuse, cucullate and mucronate at apex; margins strongly involute; costa strong, 65 to 80  $\mu$  wide near base, excurrent as a mucro; cells small, dense, opaque, densely papillose, 5 to 8  $\mu$ , basal cells rectangular, incrassate or rather thin-walled, smooth. Seta 8 to 15 mm. long; capsule cylindric, 2 to 2.5 mm. long; peristome teeth perforated or irregularly divided nearly to base into 32 forks. Spores densely and finely papillose, 19  $\mu$  (FIGURE 23).

Very common and abundant on calcareous soil and rock, especially in coastal plain of Puerto Rico, but also occasional on lower mountain slopes; United States (Oklahoma, Texas, and Arizona); south to Guatemala; West Indies.

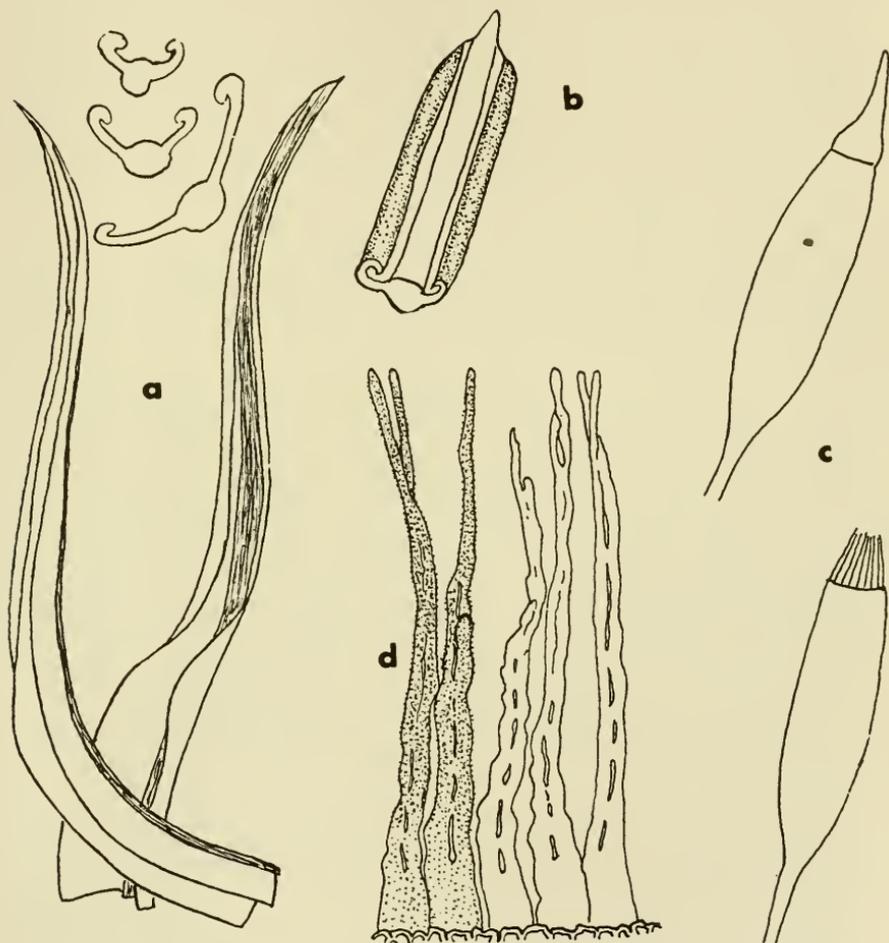


FIGURE 23. *Trichostomum jamaicense*: (a) leaf and cross sections from upper portion, (b) apex of leaf, showing involute margins, (c) 2 capsules, and (d) portion of peristome (Grout, 1938).

- (d) *Trichostomum involutum* Sull. Proc. Amer. Acad. Arts and Sci. 5: 277 1861, non Broth., 1922.

*Tortula canaliculata* Mitt. Journ. Linn. Soc. London, Bot. 12: 148. 1869, non *Trichostomum canaliculatum* Hampe ex Sull. 1861, nom.

Stems about 1 cm. or less high, simple or forked. Leaves crisped and curled at tips when dry, erect-spreading above appressed base when moist, 1.5 to 2.5 mm. long (perichaetial leaves sometimes 3 mm.), broadly lanceolate and subtubulose above, gradually narrowed from oblong, sheathing base; margins involute from shoulders to apex, cucullate and abruptly mucronate; costa yellow, 45 to 60  $\mu$  wide near base, excurrent as a stout, smooth, yellow mucro; cells irregularly subquadrate, 5 to 7  $\mu$ , firm-walled, obscure and densely papillose, cells of base rectangular, hyaline or pale yellow, rather thin-walled, 8 to 9  $\mu$  broad, 2 to 4:1. Seta short and slender, 6 to 7 mm. long; capsule yellow-brown, red at mouth, smooth, cylindrical, 1.5 mm. long; operculum conic-rostrate; peristome teeth short, irregularly cleft or bifid. Sporophyte described from type collection.

On calcareous soil and rock, at somewhat higher altitudes than *T. jamaicense*, usually in sierras, apparently most common at 1000 to 2000 ft.; Bermuda; West Indies.

Typically, this species can be distinguished from *T. jamaicense* (Mitt.) Jaeg. by the broader leaf tips, but intergradations between the 2 extremes make it seem doubtful whether there is any valid distinction between the species.

- (8) *Tortella* (C. M.) Limpr. Laubm. Deutsch., Österr., Schweiz. 1: 599. 1888.

Plants small to fairly robust, in wide, compact, green or yellowish cushions. Stems erect, simple or sparsely branched, more or less radiculose below. Leaves larger and crowded above, usually strongly crisped when dry, spreading when moist, long-lanceolate or linear-lanceolate; margins plane or inflexed, especially when dry; costa strong, usually shiny and conspicuous when dry, percurrent to excurrent; cells small, rounded-quadrate and densely papillose, basal cells laxly long-rectangular, delicate, smooth and hyaline, sharply set off from upper cells in V-shaped region extending up margins as a usually distinct border at shoulders. Seta erect, elongate; capsule cylindrical, erect or nearly so; annulus none; operculum narrowly high-conic; peristome inserted below mouth, split to low basal membrane into 32 filiform, papillose, spirally twisted teeth.

Small plants; leaves more or less glaucous, not clearly bordered at shoulders, very narrowly linear.....(a) *T. mollissima*

More robust plants; leaves not glaucous, clearly bordered at or above shoulders, broader, linear to lanceolate.

Leaves long-linear, fragile at tips.....(b) *T. subfragilis*

Leaves oblong-lanceolate, not fragile.....(c) *T. humilis*

- (a) *Tortella mollissima* Broth. ex Bartr., Bryol. 50: 203. 1947.

Dull, often glaucous, yellowish or brownish green, rigid, slender plants in low, dense tufts. Stems about 1 cm. high or less. Leaves rigidly erect-spreading with tips usually curled when dry, 5 to 8 mm. long, very narrowly linear,

rarely more than 0.22 mm. wide, gradually narrowed to channeled or subtubulose tips from narrowly oblong base, slenderly acuminate and mucronate; margins erect or somewhat incurved above, entire or obscurely notched above, not undulate; costa strong, short-excurrent; lamina very narrow, upper cells small, about 6 to 8  $\mu$  in diameter, subquadrate to rounded-hexagonal, densely papillose and obscure, basal cells rectangular, hyaline, delicate and thin-walled, usually extending slightly higher up margins but not forming distinct border. Dioicous. Seta about 13 mm. long, reddish, slender; urn of capsule erect, cylindrical, 2 mm. long; peristome teeth insufficiently known. Sporophyte not seen (FIGURE 24).

On limestone, collected abundantly in 2 areas—in high mountains south of Maricao and in Río Abajo area south of Arecibo, not known elsewhere in Puerto Rico; Cuba and Jamaica; Trinidad; Mexico, Guatemala, and British Honduras.

The more or less subtubulose upper leaves and the absence of any well-defined border at the leaf shoulders are very suggestive of a relationship to *Trichostomum* rather than to *Tortella*. This problem can be resolved only by the discovery of sporophytes with peristomes in good condition.

(b) *Tortella subfragilis* Crum & Steere. Bryol. 59: 250. 1956.

Plants robust, dull, green or yellow-brown, rigid, in compact tufts. Stems erect-flexuose, sparsely branched, slightly radiculose below, up to 3 cm. high. Leaves very fragile, up to 9 mm. long, erect-spreading with tips curled and contorted when dry, erect- or wide-spreading when moist, very narrowly long-linear from oblong-lanceolate, sheathing base, channeled above, strongly mucronate at slender, acute apex; margins entire or nearly so, erect; costa strong, yellow, excurrent as a mucro; cells rounded-hexagonal, 8 to 10  $\mu$ , densely papillose and obscure, basal cells laxly rectangular, hyaline or brownish-yellow, sharply set off from upper cells in V-shaped region and extending well above shoulders as narrow but distinct border.

On moist cliff, along old trail above river, from Maricao south to Maricao Insular Forest, *W. C. S.* 5606, Dec. 29, 1939; same, on exposed bank, 5646, Dec. 30, 1939. On exposed soil along new trail (CCC No. 1) from Maricao south to Maricao Insular Forest, *W. C. S.* 5581, Dec. 29, 1939. On limestone cliff, Igartua trail, Río Abajo planting project, south of Arecibo, *W. C. S.* 6672, Feb. 23, 1940. On cliff, Mt. Britton peak, Sierra de Luquillo, *W. C. S.* 7083, 7084, 7091 (type), May 11, 1940. On moist cliff, "The Pinnacles," El Yunque Range, Sierra de Luquillo, *W. C. S.* 7111, May 14, 1940. Maricao, *F. M. Pagán* 227, July 14, 1937.

The fragile leaves are suggestive of *T. fragilis* (Hook. & Wils.) Limpr., but the very narrow, long leaf points, the border ending far above the shoulders, and the flexuose, laxly foliate stems with points spreading and contorted when dry are highly distinctive.

(c) *Tortella humilis* (Hedw.) Jenn. Manual Mosses West. Penna. 96. 1913.

*Barbula humilis* Hedw. Sp. Musc. 116. 1801.

*B. caespitosa* Schwaegr. Suppl. Sp. Musc. I. 1: 120. 1811.

*B. pallidoviridis* C. M. Hedwigia. 36: 103. 1897.

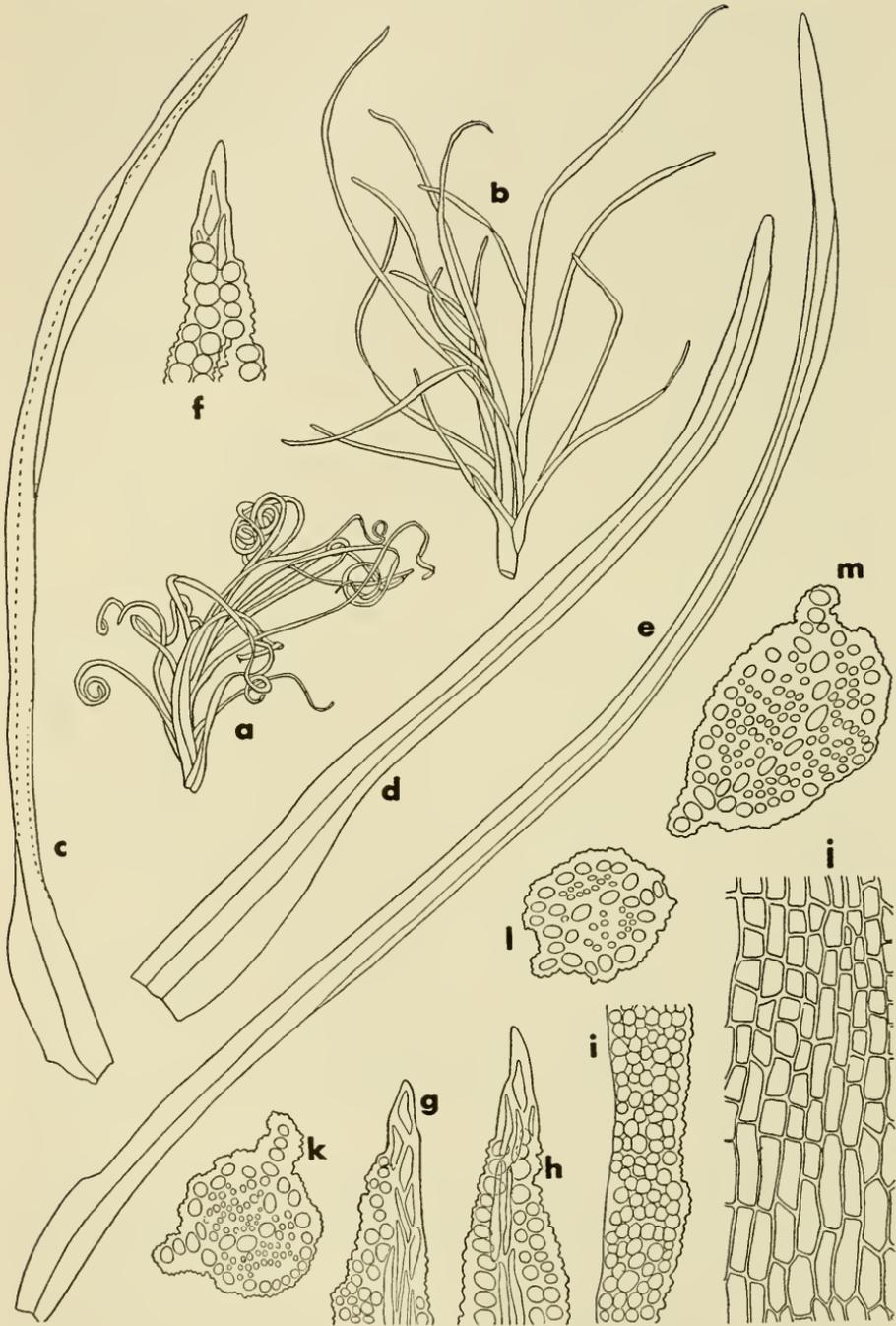


FIGURE 24. *Tortella mollissima*: (a) dry plant, (b) moist plant, (c to e) leaves, (f to h) cells at leaf tip, (i) cells of upper third of leaf, (j) cells of leaf base, and (k to m) cross sections of upper part of leaf.

Plants dark or yellow-green. Stems about 5 mm. high. Leaves crisped when dry, about 3 mm. long, oblong-lanceolate, concave, broadly acute to acuminate, mucronate; costa yellow, excurrent as a mucro; margins crenulate, more or less undulate; upper cells subquadrate, 8 to 9  $\mu$  wide, densely papillose and obscure, lower cells abruptly differentiated, delicate and hyaline, clearly extending higher at margins than near costa. Autoicous. Seta reddish, 1 to 1.5 cm. long; capsule light brown or reddish; peristome teeth pale red, twisted 2 to 3 times. Spores smooth, 8 to 9  $\mu$ .

On calcareous soil and limestone, known in Puerto Rico only from high mountains south of Maricao, at altitudes of 1500 to 2500 ft.; eastern United States, and south from Arizona to Guatemala; Jamaica and Haiti; South America and Galapagos Islands; also Europe and North Africa.

(9) *Hyophila* Brid. Bryol. Univ. 1: 760. 1826.

Rather small, dark-green plants becoming brownish or reddish with age. Leaves larger and crowded above, flat and spreading when moist, incurved with inrolled margins when dry, oblong or spatulate, acute or obtuse; costa subpercurrent to short-excurrent; upper cells subquadrate, papillose, or rarely smooth, basal cells rectangular. Calyptra cucullate. Seta elongate; capsule erect; annulus well developed, deciduous; operculum conic or long-rostrate; peristome lacking.

Leaf cells densely papillose, obscure; seta 2 to 3 mm. long; urn of capsule scarcely 1 mm. long. . . . . (a) *H. microcarpa*  
 Leaf cells only slightly papillose, distinct; seta 5 to 10 mm. long; urn up to 2 mm. long  
 . . . . . (b) *H. tortula*

(a) *Hyophila microcarpa* (Schimp. ex Besch.) Broth. In E. & P., Nat. Pfl. 1(3): 403. 1902.

*Trichostomum microcarpum* Schimp. ex Besch. Ann. Sci. Nat., Bot. VI. 3: 198. 1876.

*Hyophila guadalupensis* Broth. In Urban, Symb. Antill. 3: 424. 1903.

Stems less than 5 mm. high. Leaves crowded, incurved and contorted when dry, 1.5 to 2 mm. long, lingulate or oblong-lanceolate, broadly acute or obtuse, mucronate; margins erect or slightly inflexed above; costa percurrent or excurrent as a small, yellow mucro; upper cells small, 8 to 9  $\mu$ , hexagonal or subquadrate, densely papillose and very obscure, papillae often C-shaped, cells toward base yellowish, smooth, regularly quadrate or short-rectangular, longer, lax and pellucid at insertion. Dioicous. Seta 2 to 5 mm. long; urn of capsule short-ovoid or subglobose, scarcely 1 mm. long; operculum obliquely rostrate, 0.5 mm. long. Sporophyte not seen.

On limestone and serpentine, known from several localities in coastal plain of Puerto Rico; Virgin Islands; Haiti, Montserrat, Guadeloupe, and Martinique; Trinidad; Mexico, Guatemala, and Venezuela.

(b) *Hyophila tortula* (Schwaegr.) Hampe. Bot. Zeit. 4: 267. 1846.

*Gymnostomum tortula* Schwaegr. Suppl. Sp. Musc. II. 2(1): 78. 1826.

?*Pottia oerstediana* C. M. Syn. Musc. Frond. 2: 622. 1851.

*P. contermina* C. M. *Op. cit.* 623.

*P. riparia* Aust. *Musc. Appal.* 112. 1870.

*Trichostomum bescherellei* Schimp. ex Besch. *Mém. Soc. Nat. Sci. Natur. Cherbourg.* 16: 177. 1872.

*Tortula donnellii* Aust. *Bot. Gaz.* 3: 31. 1878.

*Hyophila martinicae* Ren. & Card. *Bull. Soc. Roy. Bot. Belg.* 29(1): 173. 1890.

*H. subcontermina* Ren. & Card. *Ibid.* 31(1): 154. 1892.

*Pottia denticulata* C. M. *Bull. Herb. Boiss.* 5: 190. 1897.

*P. subcrenulata* C. M. *Ibid.*

*P. reflexifolia* C. M. *Ibid.*

*P. perrobusta* C. M. *Hedwigia.* 37: 233. 1898.

*P. perconvoluta* C. M. *Ibid.*

*P. wrightii* C. M. *Ibid.* 234.

*Hyophila mollis* Broth. *In Urban, Symb. Antill.* 3: 424. 1903.

*H. elata* Card. *Rev. Bryol.* 36: 76. 1909.

*H. subdenticulata* Card. *Ibid.*

*H. dentata* Card. *Ibid.* 40: 36. 1913.

Stems simple or branched, up to 3 cm. high, usually less. Leaves crowded in rosulate tufts, tubulose and crisped when dry, 2 to 3 mm. long, oblong-lingulate to spatulate, obtuse, mucronate; margins plane below, inflexed above, subentire to coarsely and irregularly dentate above; costa stout, brown, subpercurrent or ending in short mucro; cells rounded-quadrate, 8 to 12  $\mu$ , clearly arranged in transverse rows above, bulging ventrally, slightly papillose, basal cells smooth, oblong. Polymorphous, stalked brood-bodies frequently produced in axils of comal and perichaetial leaves. Dioicous. Seta 5 to 10 mm. long, reddish; urn of capsule cylindrical, about 1.5 mm. long.

On rock, masonry, and calcareous soil, rarely on trees and wood, common and weedy species in calcareous areas throughout coastal plain of Puerto Rico, in mountains only on lowermost slopes; Virgin Islands; widespread in eastern North America, and south from Arizona to northern South America; West Indies.

(10) *Barbula* Hedw. *Sp. Musc.* 115. 1801.

Small or medium-sized, rather rigid, tufted plants. Leaves usually larger at stem apex but rarely rosulate, usually contorted when dry, narrowly lanceolate to ovate or lingulate, widest at or near base; margins entire, recurved to revolute at least in part; costa usually subpercurrent to excurrent; upper cells small, rounded-quadrate, usually papillose and obscure, becoming smooth and more elongate near insertion. Calyptra cucullate. Dioicous. Seta elongate; capsule cylindrical, erect or nearly so; annulus usually present and persistent; operculum long-rostrate; peristome inserted below mouth, papillose, divided to low basal membrane into 32 filiform, spirally twisted forks.

Upper cells rounded or angular, papillose and obscure. . . . . (a) *B. cruegeri*

Upper cells subquadrate, smooth and pellucid.

Leaves broadest near middle, broadly acute, mucronate. . . . . (b) *B. agraria*

Leaves narrow, lanceolate-subulate, broader at base, bluntly acute. . . . . (c) *B. subulifolia*

(a) *Barbula cruegeri* Sond. ex C. M. Syn. Musc. Frond. 1: 618. 1849.

*B. cancellata* C. M. Flora. 56: 483. 1873.

*B. jooiana* C. M. Bull. Torrey Bot. Club. 5: 49. 1874.

*B. closteri* Aust. Bot. Gaz. 1: 29. 1876.

*B. ravenelii* Aust. *Ibid.* 2: 89. 1877.

?*Desmatodon bushii* Card. & Thér. Bot. Gaz. 37: 366. 1904.

*Hyophila uliginosa* Britt. Bull. Torrey Bot. Club. 42: 4. 1915.

Small, yellowish or brownish, loosely caespitose plants. Stems red, usually less than 1 cm. high, simple or with terminal innovation, usually bearing small, red-brown, stalked propagula in leaf axils. Leaves contorted when dry, spreading to recurved when moist, 1 to 2 mm. long, oblong-lanceolate, obtuse, with minute, hyaline mucro; margins more or less revolute below, plane above, rarely plane throughout; costa percurrent or slightly excurrent, rough at back above; cells very small and opaque, densely papillose, papillae often C-shaped, basal cells rectangular, smooth. Perichaetial leaves slightly longer, acuminate, somewhat sheathing at base. Seta red; capsule small, oblong-cylindric, erect; annulus none; operculum long-rostrate; peristome teeth red, closely twisted. Spores very small, smooth (FIGURE 25).

Common on calcareous soil and rock throughout coastal plain of Puerto Rico; Virgin Islands; New Jersey to Texas in eastern United States; West Indies; Mexico to northern South America.

(b) *Barbula agraria* Hedw. Sp. Musc. 116. 1801.

*B. domestica* Brid. Musc. Recent. Suppl. 4: 89. 1819.

*B. rauei* Aust. Bull. Torrey Bot. Club. 6: 43. 1875.

?*B. subagraria* C. M. Bull. Herb. Boiss. 5: 193. 1897.

Very small, nearly stemless, gregarious plants. Leaves crowded in rosette, scarcely contorted when dry, spreading when moist, about 2 mm. long, concave, ovate-lanceolate, acute and mucronate; margins plane, or sometimes slightly recurved; costa stout, ending in mucro; upper cells subquad-

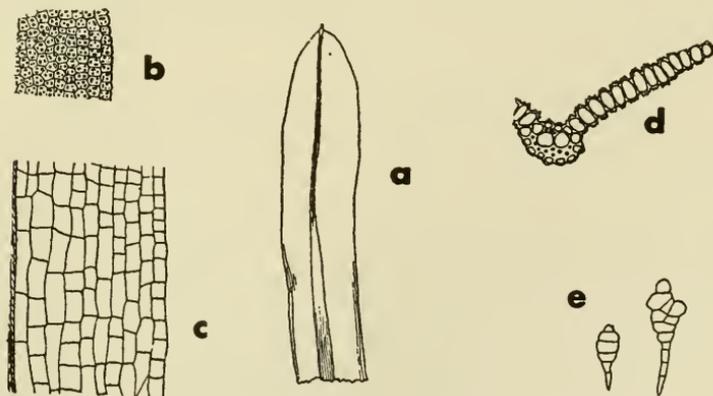


FIGURE 25. *Barbula cruegeri*: (a) leaf, (b) upper leaf cells, (c) basal cells of leaf, (d) cross section of upper part of leaf, and (e) propagula (Britton, 1915, as *Hyophila uliginosa*).

rate, ventrally mammillose, basal cells oblong, smooth and pellucid. Perichaetial leaves somewhat clasping. Seta reddish, about 1 cm. long; capsule cylindrical, striate when dry; annulus revoluble; operculum long-rostrate, about as long as urn; peristome pink to red, basal tube short but well-developed. Spores smooth, 6 to 8  $\mu$ .

On calcareous soil and rocks in all limestone areas of Puerto Rico, especially common and abundant in coastal plain, but also ascending to an altitude of 1000 ft.; United States (Florida, Louisiana, and Texas); West Indies; Mexico, Guatemala, and northern South America.

(c) *Barbula subulifolia* Sull. Proc. Amer. Acad. Arts and Sci. 5: 227. 1861.

*B. ferrinervis* C. M. Bull. Herb. Boiss. 5: 557. 1897, non C. M., Nuov. Giorn. Bot. Ital. N. S. 4: 255. 1897.

*Trichostomum setifolium* C. M. Hedwigia. 37: 234. 1898.

Plants densely tufted, yellow-green above, brown below. Stems red-brown to red, simple or sparsely branched, up to 2.5 cm. long. Leaves contorted when dry, erect-spreading when moist, 1 to 3 mm. long, subulate-lanceolate, narrowly but bluntly pointed and dentate at apex, sometimes acute and apiculate; margins narrowly recurved from base nearly to apex, or sometimes only in lower half; upper cells irregularly quadrate or short-rectangular, 6 to 8  $\mu$  wide, pellucid, smooth, basal cells short-rectangular. Dioicous. Seta red, 12 to 18 mm. long; capsule cylindrical, 1 to 2 mm. long; peristome teeth red, spirally twisted, sometimes as long as urn; operculum long-rostrate, about as long as urn.

On calcareous soil and rocks in streams and on wet cliffs in mountains throughout Puerto Rico, at altitudes of 1000 to 2500 ft.; West Indies; Mexico, Guatemala, and Costa Rica; Ecuador.

A close ally of *B. subulifolia* Sull. is *B. stillicidiorum* Card. of Mexico and Guatemala, which differs in having more gradually tapered leaves and broader, more clearly rounded leaf tips. The Puerto Rican plants show considerable variability with respect to size of plants and length of leaves, but the smooth upper leaf cells and the characteristically narrow but blunt, dentate apices, together with the tuft-forming habit of growth, seem to be reliable diagnostic features. *Barbula lurida* Hornsch. is also closely related to and may intergrade with *B. subulifolia*.

(11) *Bryoerythrophyllum* Chen. Hedwigia. 80: 4. 1941.

Plants slender to robust, loosely to densely tufted, green, or usually brownish-red. Stems erect, simple or branched, radiculose below, with central strand. Leaves crowded, erect-spreading, more or less keeled, lanceolate or broadly lingulate from broader base; margins revolute, more or less toothed toward apex, sometimes bordered by pale, smooth cells; costa strong, showing in section well-developed ventral and dorsal stereid bands; upper leaf cells small, densely papillose, papillae often C-shaped, basal cells conspicuously enlarged, rectangular, thin-walled and hyaline. Calyptra cucullate, smooth. Seta elongate, erect; capsule erect and straight or inclined and curved, cylindrical, not striate; annulus revoluble (at least, in *B. re-*

*curvirostre*); operculum conic and rostrate; 16 peristome teeth, erect or slightly twisted, fused at base and inserted at mouth, divided nearly to base into 2 (or 3) filiform branches or undivided and perforate:

*Bryoerythrophyllum recurvirostre* (Hedw.) Chen. Hedwigia. 80: 5. 1941.

*Weissia recurvirostra* Hedw. Sp. Musc. 71. 1801.

*Trichostomum aeneum* C. M. Syn. Musc. Frond. 2: 628. 1851.

*T. leucodon* C. M. Bull. Herb. Boiss. 5: 192. 1897.

*Didymodon recurvirostris* (Hedw.) Jenn., Manual Mosses West Penna. 97. 1913.

Slender plants in bright to yellow-green tufts, reddish below. Stems erect, branches 1 to 4 or 5 cm. high, radiculose below. Leaves flexuose to crisped when dry, widely spreading from pale, appressed base when moist, linear-lanceolate, mucronate, denticulate to dentate at apex; margins revolute nearly to apex; costa ending near apex to short-excurrent; basal cells large, rectangular, smooth, and hyaline or red-brown, upper cells small, quadrate, densely papillose, obscure. Monoicous. Seta 15 to 18 mm. long, slender, red; capsule erect, oblong-cylindric, smooth, red-brown at maturity, the urn up to 3 mm. long; annulus fragile, revoluble; operculum obliquely conic-rostrate; peristome teeth red, minutely roughened, only rarely divided along median line.

Known in Puerto Rico from single collection (*Heller 1340*) without locality data; Europe, Africa, and Asia; North America south to Mexico and Guatemala; northern South America.

(12) *Phascum* Hedw. Sp. Musc. 19. 1801.

Very small, budlike plants growing scattered on bare soil. Stems simple or branched. Leaves usually ovate to lanceolate; margins entire, revolute; costa excurrent; upper cells quadrate or hexagonal, warty-papillose except in 1 species, larger, rectangular and hyaline below. Monoicous. Seta very short, straight or curved, sometimes 2 from same perichaetium; capsule subglobose to ovoid, bluntly apiculate, generally immersed; annulus, operculum and peristome lacking.

*Phascum brittoniae* Crum & Steere. Bryol. 59: 251. 1956.

*P. sessile* Britt. Bull. Torrey Bot. Club. 42: 4. 1915, non Bruch & Schimp. 1844.

Plants small, gregarious. Stems 1 to 2 mm. high, simple or branched at base. Leaves crowded in rosettes, inrolled with conspicuous, pale costa when dry, spreading and bright green when moist, oblong-obovate, obtuse, mucronate, 1 to 1.25 mm. long; margins entire or crenulate-papillose; costa percurrent to short-excurrent; upper cells hexagonal, up to 13  $\mu$ , with 1 to 3 papillae on each surface, basal cells oblong, smooth, hyaline. Paroicous. Calyptra small, conic, split, slightly roughened above. Seta lacking or nearly

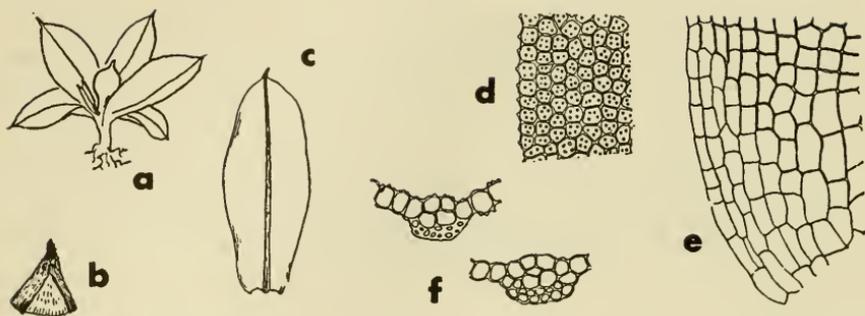


FIGURE 26. *Phascum brittoniae*: (a) plant, with sporophyte, (b) calyptra, (c) leaf, (d) cells of upper part of leaf, (e) cells of leaf base, and (f) cross sections of the costa, at (above) upper portion of leaf, and at (below) leaf base (Britton, 1915, as *P. sessile*).

so; capsule immersed, globose, about 0.5 mm. long. Spores brown, slightly roughened, 27 to 30  $\mu$  (FIGURE 26).

On soil, still known only from St. Thomas Island in Virgin Islands.

(13) *Tortula* Hedw. Sp. Musc. 122. 1801, p. p.

Plants small to robust, bright or glaucous green, often tinged with brown or red. Leaves often larger and crowded at stem apex, usually erect and regularly twisted when dry, widely spreading to squarrose when moist, usually revolute at margins; costa strong, mostly percurrent to excurrent; upper cells small, hexagonal, usually strongly papillose, rarely smooth, basal cells usually much larger in hyaline or colored groups on either side of costa. Capsule exserted, erect; annulus persistent or deciduous; operculum usually long-rostrate; peristome inserted below mouth, divided to basal membrane of varying length into 32 filiform, papillose teeth, spirally twisted in 1 to 2 turns.

*Tortula mniifolia* (Sull.) Mitt. Journ. Linn. Soc. London, Bot. 12: 167. 1869.

*Barbula mniifolia* Sull. Proc. Amer. Acad. Arts and Sci. 5: 277. 1861.

Small, brownish-green, gregarious plants, less than 5 mm. high. Leaves crowded, strongly crisped when dry, soft and spreading when moist, 3 to 4 mm. long, oblong-lingulate, rounded-obtuse or minutely mucronate, concave and moderately keeled; margins entire, or denticulate at apex, strongly bordered all around by narrow, thickened band of brownish, elongate cells; costa brown, slender, ending below apex in lower leaves but confluent with margin at apex of upper leaves; upper cells rounded-hexagonal, thin-walled, smooth, about 22  $\mu$  wide, gradually becoming laxly rectangular below. Sporophytes not seen.

On calcareous soil, usually on moist shaded banks, several localities in higher parts of northern coastal plain of Puerto Rico; West Indies; Trinidad; Mexico, Guatemala, and Costa Rica; western South America to Bolivia and northern Peru.

Although the stems and leaves are shorter and the leaf cells slightly narrower, these plants are structurally almost identical to those found on the

mainland of tropical America. This species is curiously atypical of the genus and might easily be mistaken for a *Mnium*, which it resembles not only in leaf shape and areolation, but also in the characteristic manner of shriveling when dry. *Tortula domingensis* Thér. of Santo Domingo, said to grow on the branches of trees, seems doubtfully distinct from this species.

(14) *Luisierella* Thér. & P.-V. Bull. Soc. Bot. France. **83**: 73. 1936.

Plants very small, dark green, scattered to gregarious. Leaves crowded in rosulate tufts, contorted to crispate when dry, narrowly lingulate from narrower base, broadly rounded at apex, keeled; margins plane, entire below, more or less irregularly crenate above; costa broad, ending below leaf apex, dorsal stereids more or less differentiated; cells unistratose, hyaline at base, thin-walled and inflated, extending farther up margins than near costa, green cells of upper leaf smaller, rounded-hexagonal, bulging-mammillose, obscure. Calyptra cucullate. Seta erect, red, 4.5 to 10 mm. long; capsule ellipsoid, erect and symmetric; annulus narrow, persistent; operculum high-conic, obtuse; peristome teeth short, erect, narrowly lanceolate, entire or unequally cleft or perforate.

*Luisierella barbula* (Schwaegr.) Steere. Bryol. **48**: 84. 1945.

*Gymnostomum barbula* Schwaegr. Suppl. Sp. Musc. II. 2(1): 77. 1826.

*Tortula melanocarpa* Mitt. Journ. Linn. Soc. London, Bot. **15**: 60. 1876.

*Gyroweisia cubensis* Broth. In E. & P., Nat. Pfl. 1(3): 389. 1902, nom.

*Luisierella stenocarpa* Biz. & Thér. Mem. Soc. Cubana Hist. Nat. **13**: 273. 1939.

Stems scarcely reaching 1 mm. Leaves crowded, contorted when dry, spreading when moist, about 2 to 2.5 mm. long, narrowly lingulate, keeled, rounded to broadly acute at apex; margins crenate above because of bulging cells; costa ceasing shortly below leaf apex, covered ventrally with dorsal stereid band; upper cells bulging, irregularly rounded-hexagonal, not papillose, basal cells abruptly inflated, rectangular, hyaline, extending farther up margins than at costa. Dioicous. Seta 4 to 8 mm. long; urn of capsule narrowly cylindrical, 1 to 2 mm. long, dark brown; annulus well developed; operculum about  $\frac{1}{2}$  length of urn; 16 peristome teeth, very short and irregular, densely papillose. Spores smooth about 7 to 9  $\mu$  (FIGURE 27).

On limestone, sometimes forming small pits in rock surface; several localities in northern coastal plain of Puerto Rico; Cuba, Jamaica, Haiti, New Providence, and Abaca; Bermuda; United States (Florida and Texas); British Honduras.

This interesting species might be readily overlooked because of its small size. The bulging upper leaf cells and the hyaline, inflated cells of the basal margins are highly distinctive. The peristome teeth (at least in local material) are rudimentary, or sometimes apparently lacking.

(15) *Splachnobryum* C. M. Ver. k.-k. zool.-bot. Ges. Wien. **19**: 503. 1869.

Plants small, pale green, simple or slightly branched, radiculose at base. Leaves larger and crowded above, lingulate to spatulate or suborbicular,

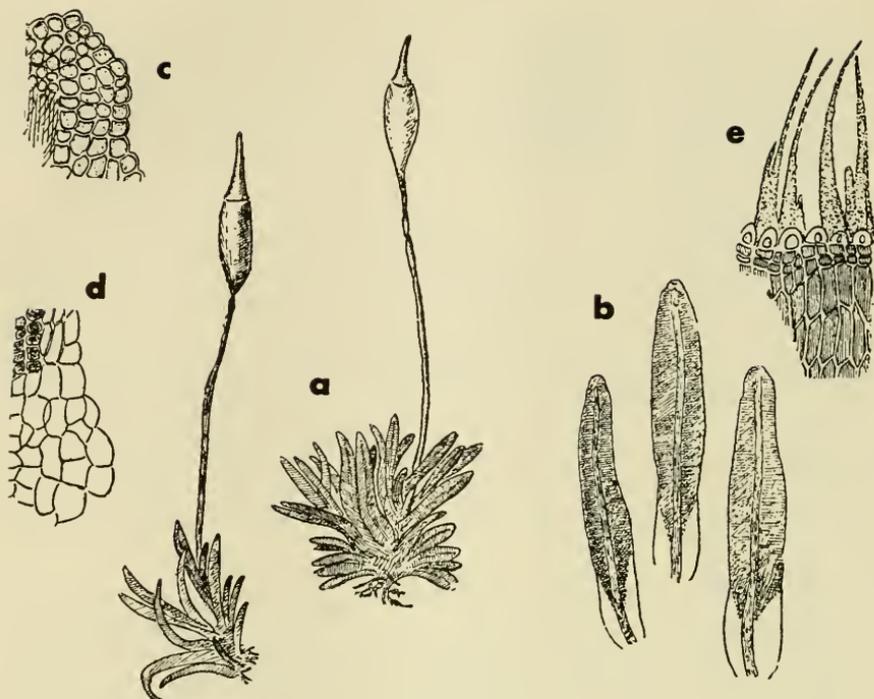


FIGURE 27. *Luisierella barbula*: (a) 2 habit sketches, (b) leaves, (c) apical cells of leaf, (d) basal marginal cells of leaf, and (e) peristome and exothecial cells (Potier de la Varde, 1936).

rounded to broadly pointed at apex, entire or crenulate above; costa slender, ending below leaf apex; cells laxly rhomboidal, smooth. Dioicous. Seta slender, elongate; capsule cylindric, erect; operculum conic; peristome inserted well below mouth, teeth narrow, irregularly cleft, papillose.

Leaves ligulate or obovate, 2 to 4:1.....(a) *S. splachnifolium*  
 Leaves nearly as broad as long, or up to 2:1.....(b) *S. obtusum*

(a) *Splachnobryum splachnifolius* (Hook.) Thér. Mem. Soc. Cubana Hist. Nat. 13: 275. 1939.

*Didymodon splachnifolium* Hook. Musci Exot. 1: pl. 76. 1818.

*Splachnobryum wrightii* C. M. Ver k.-k. zool.-bot. Ges. Wien. 19: 505. 1869.

Small, somewhat rigid plants. Stems 1 to 3 mm. high, pale reddish below. Leaves lingulate to oblong-obovate, larger above, 2 to 4:1, 0.5 to 1.3 mm. long, broadly rounded at crenulate apex; margins plane in lower leaves, in upper and perichaetial leaves slightly to distinctly recurved, sometimes nearly to apex; costa slender, usually ending 2 to 4 cells below leaf apex; cells oblong-hexagonal, about 2.5:1, arranged in oblique rows and becoming smaller and subquadrate at upper margins, laxly hexagonal except for about 7 suboral rows of smaller, oblate cells with rather thick red walls; peristome

teeth red-brown, barely projecting above mouth, a hyaline, smooth preperistome of short, irregular segments external to teeth. Spores smooth, about 11  $\mu$ .

On soil and rock, known in Puerto Rico from sea level to summit of Mt. El Yunque, in Luquillo Mts., at altitude of over 3000 ft.; West Indies.

The application of the names of some of the Caribbean species of *Splachnobryum* will remain troublesome until the original collections have been studied with a view to revising the genus. According to a manuscript note by Dixon (1920) in the New York Botanical Garden, plate 76 of Hooker's *Musci Exotici* was drawn from 2 different specimens, one from the Antilles, collected by Richard (fig. 3), and another from Santo Domingo, collected by Coulon (fig. 2). We have not seen the specimens, but the pictures referred to above suggest the same species.

The phylogenetic position of *Splachnobryum* and *Gymnostomiella* is a matter of some question. We have tentatively followed Andrews' suggestion (1949) that they may belong here rather than in the Splachnaceae although, like him, we feel that there may be sufficient reason to put both genera in a family of their own. The preperistome of some, and perhaps all species of *Splachnobryum*, is curiously unlike any structure found in either the Splachnaceae or the Pottiaceae.

(b) *Splachnobryum obtusum* (Brid.) C. M. Verh. k.-k. zool.-bot. Ges. Wien. 19: 504. 1869.

*Weissia obtusa* Brid. Musc. Recent. Suppl. 1: 118. 1806.

*Splachnobryum julaceum* Besch. Rev. Bryol. 18: 76. 1891.

Plants minute, soft. Stems 1 to 1.5 mm. high, pale reddish below. Leaves suborbicular to shortly obovate, larger above, 1 to 2:1, 0.3 to 0.9 mm. long, broadly rounded at entire or slightly crenulate apex, plane at margins; costa slender, usually ending 2 to 5 cells below apex; cells oblong-hexagonal, about 2:1, arranged in oblique rows, smaller and subquadrate at margins in upper half, longer and rectangular toward base. Sporophyte not seen.

On soil in calcareous areas, not uncommon, known from several localities on northern coastal plain of Puerto Rico; West Indies; Costa Rica (according to Bartram).

The local plants assigned to *S. obtusum* are nearly identical to the small, sterile plants often found among fruiting specimens of *S. splachnifolium*. At least in so far as the Puerto Rican collections are concerned, it seems possible that *S. obtusum* is no more than a juvenile or sterile form of *S. splachnifolium*. Only sterile and male plants were found.

(16) *Gymnostomiella* Fleisch. Laubmoosfl. v. Java. 1: 309. 1904.

Very delicate, minute plants forming dense, felted mats or intermingled with other mosses. Stems filiform, rhizoidous at base, with leaves small and distant below, larger and crowded in comal tufts above, erect to wide-spreading, concave, oblong-spatulate, rounded at apex; margins erect, entire to papillose-crenulate; costa slender, ending below leaf apex or near midleaf; cells lax, thin-walled, 4 to 6-sided and papillose to mammillose above,

rectangular and nearly smooth at base. Dioicous; perichaetial leaves sheathing, larger than stem leaves, innermost nearly smooth and more or less toothed at apex. Calyptra narrow, mitrate. Seta up to 5 or 6 mm. long; capsule exerted, erect, oval, firm-walled, brown or red-brown; operculum subulate-rostrate from conic base; peristome lacking.

*Gymnostomiella orcuttii* Bartr. Jamaica Nat. 1: 15. 1928.

Stems 2 to 3 mm. long, simple or branched by innovations, frequently bearing small, brown propagula. Upper leaves 0.3 to 0.4 mm. long, somewhat shriveled when dry, erect-spreading from narrow, subclasping base when moist; margins papillose-crenulate to below midleaf; upper cells hexagonal, 2- to 3-papillose on either surface, smooth and rectangular at insertion. Antheridia in terminal buds; perichaetial leaves similar to upper stem leaves, up to 1 mm. in length. Seta brown, 4 to 6 mm. long; urn of capsule rounded ovate, brown, 0.6 to 0.8 mm. long; operculum about 1 mm. long, flat-conic with slightly curved, subulate beak; no annulus; exothelial cells rectangular and transversely elongate in 2 to 3 rows below mouth, larger and hexagonal below, without stomata. Spores smooth, 7 to 8  $\mu$  (FIGURE 28).

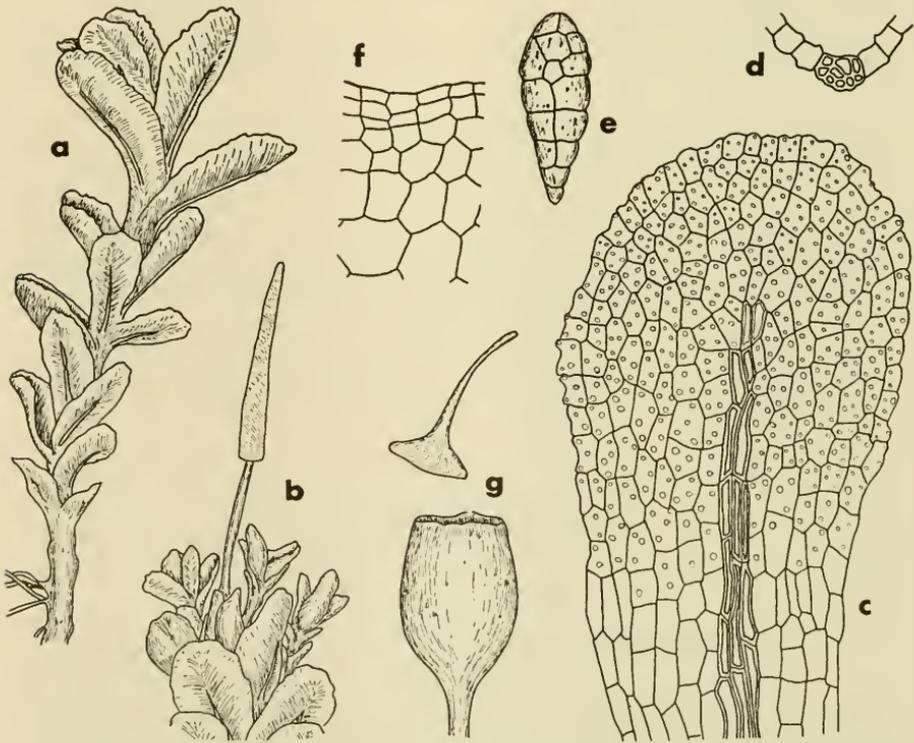


FIGURE 28. *Gymnostomiella orcuttii*: (a) sterile plant, (b) portion of fertile plant, showing proliferations at base of young sporophyte, (c) leaf, (d) cross section of costa, (e) propagulum, (f) exothelial cells, and (g) mature capsule and operculum.

On shaded limestone, locally abundant in calcareous hills south of Arecibo, Puerto Rico; United States (Florida); Jamaica and Haiti; eastern Mexico.

## FUNARIACEAE

Gametophytes usually small, light green. Leaves broad, soft, larger above and crowded in comal tufts; costa strong, nearly percurrent to short-excurrent; cells large, lax and thin-walled, smooth, rhomboidal above, rectangular below. Calyptra smooth, cucullate, often inflated below, long-beaked. Capsules emersed to long-exserted, erect or curved, smooth or plicate; operculum not beaked, sometimes apiculate; peristome sometimes lacking, or single, or double with segments opposite the 16 obliquely directed teeth, endostome lacking basal membrane or cilia.

Capsules curved and asymmetric. . . . . (1) *Funaria*  
Capsules erect and symmetric. . . . . (2) *Entosthodon*

(1) *Funaria* Hedw. Sp. Musc. 172. 1801.

Medium-sized, gregarious plants with short, simple, or sparsely branched, erect stems. Lower leaves small and distant, upper larger, erect and crowded in budlike cluster, obovate, concave, acute to short-acuminate, unbordered; costa strong, ending below apex to short-excurrent; cells laxly oblong-hexagonal. Autoicous. Calyptra inflated. Seta elongate, often strongly curved and twisted when dry; urn of capsule elongate-pyriform, long-necked, usually inclined to pendent, sulcate, usually asymmetric and curved, oblique at mouth; annulus usually present, large; operculum flat to convex; peristome mostly double, 16 teeth, lanceolate, curved and directed obliquely to right, segments of endostome opposite teeth, sometimes rudimentary or lacking.

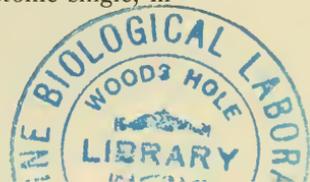
*Funaria calvescens* Schwaegr. Suppl. Sp. Musc. I. 2: 77. 1816.

Pale green plants. Stems up to 1 cm. high, simple or branched. Upper leaves somewhat contorted when dry, 2 to 4 mm. long, oblong-lanceolate, concave, acute to short-acuminate, entire or weakly toothed above; costa subpercurrent to short-excurrent; upper cells oblong-hexagonal, 1 to 2:1, longer below. Seta 1 to 5 cm. long, flexuose; capsule widest at mouth when dry, suberect to inclined, curved and asymmetric, sulcate; peristome teeth dark-red, segments well-developed, shorter than teeth.

Although this is a weedy plant in most tropical areas, it is not common in Puerto Rico, where it occurs on soil at all altitudes from sea level to over 3000 ft. Common in warmer latitudes throughout the world.

(2) *Entosthodon* Schwaegr. Suppl. Sp. Musc. II. 1(1): 44. 1823.

Plants small to rather robust, loosely or densely caespitose. Leaves oblong, ovate or spatulate, sometimes bordered. Calyptra inflated. Capsule exserted, erect and symmetric or nearly so, short- to long-pyriform; annulus lacking; operculum flat to conic, sometimes apiculate; peristome single, inserted well below mouth, sometimes lacking.



*Entosthodon bonplandii* (Brid.) Mitt. Journ. Linn. Soc. London, Bot. 12: 245. 1869.

*Gymnostomum bonplandii* Brid. Bryol. Univ. 1: 101. 1826.

?*Entosthodon microcarpus* C. M. Bull. Herb. Boiss. 5: 174. 1897.

*E. paucifolius* C. M. *Ibid.* 548.

Plants small, green or brownish, gregarious. Stems about 2 to 6 mm. high. Lower leaves small and remote, upper larger and moderately crowded, few, contorted when dry, 2 to 2.5 mm. long, oblong-spatulate to obovate, concave, acute or short-acuminate, denticulate in upper half; costa ending well below apex; cells lax and thin-walled, oblong-hexagonal, about 2 to 3:1, narrower in several rows at margins, sometimes forming distinct, pale yellow border. Seta 6 to 10, sometimes 14 mm. long, reddish; urn of capsule erect, oblong-pyriform, typically becoming urceolate and wide-mouthed when old and empty, 1.5 to 2 mm. long (including neck); operculum small, flat; peristome teeth lacking, or sometimes short, hyaline, and truncate (according to Bartram). Spores finely papillose, about 20 to 22  $\mu$ .

On moist soil, usually on steep banks, in mountainous area, at altitude of 1000 ft. and over; West Indies; Mexico, Guatemala, and Costa Rica; South America; Trinidad.

#### EPHEMERACEAE

Very minute plants consisting mainly of budlike cluster of leaves arising from persistent, branched protonema. Leaves few, small and narrow; costa usually weak or lacking. Calyptra small, mitrate-campanulate, usually persistent. Seta very short or lacking; capsule spheric or ellipsoid; columella usually resorbed at maturity; operculum sometimes not differentiated; no peristome. Spores usually large.

*Nanomitrium* Lindb. Notis. Sällsk. Fauna et Fl. Fenn. 13: 408. 1874

Leaves erect to erect-spreading, ovate-lanceolate to linear, long-acuminate, ecostate, or rarely costate; margins plane, entire or serrulate; cells thin-walled, smooth, rectangular below, rhomboidal above. Perichaetial leaves smaller. Seta lacking; capsule spheric, not apiculate, thin wall consisting of large, loose cells; stomata lacking; operculum differentiated; no peristome. Spores relatively small.

*Nanomitrium capituligerum* (C. M.) Broth. *In* E. & P., Nat. Pfl. 1(3): 515. 1903.\*

*Ephemerum capituligerum* C. M., *Hedwigia* 39: 235. 1900.

Plants less than 1 mm. high, light green, scattered. About 7 or 8 leaves, crowded, narrowly lanceolate, broadly acuminate, faintly and bluntly toothed in upper  $\frac{1}{3}$  or  $\frac{1}{2}$ , or subentire, 0.8 to 1.3 mm. long, ecostate; cells laxly oblong-rectangular, about 16 to 19  $\times$  80 to 130  $\mu$ , not differentiated

\* L. E. Anderson and Virginia S. Bryan have found recently (in manuscript) that *N. capituligerum* is a synonym of *N. austinii* (Sull.) Lindb., which was known previously only from the eastern United States.

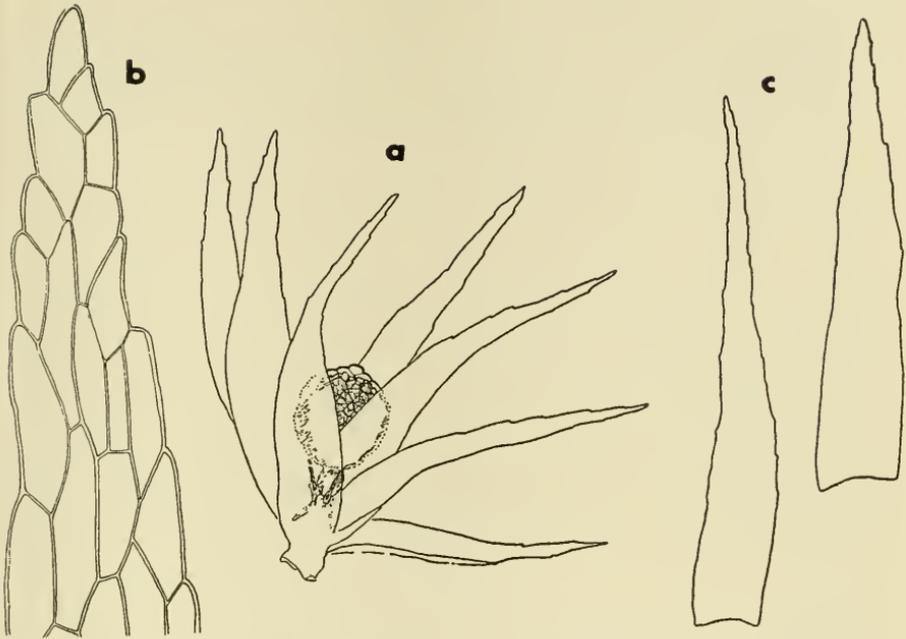


FIGURE 29. *Nanomitrium capituligerum*: (a) plant, (b) cells at leaf tip, and (c) 2 leaves

at base. Dioicous. Seta very short and globular, only about 70 to 100  $\mu$  high; capsule immersed, spheric, about 230 to 300  $\mu$  high, tipped until maturity by small, smooth calyptra, dehiscing along middle of urn. Spores about 32 to 34  $\mu$  in diameter, somewhat reniform, showing faint triradiate markings, finely papillose, brownish. Type seen (FIGURE 29).

On moist shaded soil, found in single locality in Puerto Rico, in hill-top clearing at Jajome Alto between Cayey and Guayama (*W. C. S.* 7250); Brazil and Panama.

Contrary to Roth's description in *Die aussereuropäischen Laubmoose* (1911), the leaves of the type collection from Brazil are often clearly toothed, rather than entire.

#### BRYACEAE

Small to robust, usually tufted plants. Stems erect, simple or branching by subfloral innovations, often matted with radicles below. Leaves lanceolate to ovate or obovate, often bordered, larger and often clearly tufted at stem apex; costa strong, usually percurrent or excurrent; cells linear to laxly rhomboidal, often narrower at margins. Calyptra cucullate, generally small. Capsule exserted, inclined to pendulous, rarely erect, usually elongate and tapering to distinct neck; stomata numerous, confined to neck; operculum convex and apiculate; peristome sometimes lacking, or consisting only of exostome or endostome, but usually double, the 16 teeth alternating with the keeled segments, usually rising from high, keeled basal membrane, cilia often present.

- Leaves in 3 to 4 rows, dimorphous, dorsal smaller. . . . . (1) *Epipterygium*  
 Leaves uniform, in many rows.  
 Capsules erect or nearly so; segments of endostome lacking or rudimentary; leaves closely imbricate. . . . . (2) *Brachymenium*  
 Capsules inclined to pendent, segments well developed; leaves erect or spreading.  
 Stems producing rhizomelike stolons; sporophytes clustered. . . . . (3) *Rhodobryum*  
 Stems not stoloniferous; sporophytes single. . . . . (4) *Bryum*

(1) *Epipterygium* Lindb. Öfv. K. Sv. Vet.-Akad. Förh. 19(1862): 599. 1863.

Rather small and delicate plants, sometimes aggregated in dense, pale-green to whitish, radiculose tufts, often tinged with pink or red. Leaves small and distant, upper not crowded, complanate, somewhat dimorphous, especially on sterile stems, lateral leaves ovate, flatly spreading, widely decurrent, dorsal leaves erect, smaller and narrower; margins entire or somewhat denticulate at apex, sometimes bordered with narrower, reddish cells; costa reddish, ceasing far below leaf apex; cells large, very lax and thin-walled, hexagonal to elongate-rhomboidal, narrower at margins. Dioicous. Seta red, elongate, bent above; capsule small, ovoid, pendulous; annulus deciduous; operculum mammillate; peristome complete, teeth yellow, papillose, segments thin, from high basal membrane, with well-developed, nodose cilia.

*Epipterygium wrightii* (Sull.) Lindb. Öfv. K. Sv. Vet.-Akad. Förh. 19(1862): 604. 1863.

*Mnium wrightii* Sull. Proc. Amer. Acad. Arts and Sci. 5: 282. 1861.

*Epipterygium jamaicense* Lindb. Öfv. K. Sv. Vet.-Akad. Förh. 19(1862): 603. 1863.

*Anisostichium pictum* Mitt. Journ. Linn. Soc. London, Bot. 7: 119. 1864.

*A. bakeri* Mitt. Journ. Linn. Soc. London, Bot. 12: 319. 1869, ut syn.

Rather small to medium-sized, pale green plants becoming tinged with red. Stems erect, about 1 to 2.5 cm. high, complanate-foliate. Lateral leaves to 3 mm. long, broadly obovate, abruptly apiculate, entire or bluntly serrulate near apex; costa ceasing about  $\frac{3}{4}$  leaf length; cells lax and thin-walled, elongate-rhomboidal, 2 to 3:1, longer and narrower at margins forming usually distinct reddish border. Dorsal leaves much smaller, narrowly lance-acuminate, in 2 rows. Dioicous. Seta about 6 to 8 mm. long; capsule 1 to 1.5 mm. long, pyriform, pendulous; operculum low-convex.

Common and abundant on soil and disintegrating rock on vertical banks in wet mountainous areas at altitude of 1000 ft. and higher; Cuba, Jamaica, Santo Domingo, and Veraguas; Venezuela.

No mature sporophytes were found in Puerto Rican collections. Sullivant described the setae as  $\frac{3}{4}$  to 1 inch long, occasionally 2 from perichaetium.

(2) *Brachymenium* Schwaegr. Suppl. Sp. Musc. II. 1(2): 131. 1824.

Densely tufted, medium-sized plants, usually tomentose below. Leaves imbricated or contorted when dry, oblong-lanceolate to ovate, not decurrent, sometimes bordered, often piliferous; costa usually strong, often long-excurrent; cells smooth, rhomboidal above, short-rectangular below. Seta elongate, rather stiff, rarely bent; capsule erect and symmetric or nearly so,

ovate to cylindrical; annulus deciduous; operculum small, convex, apiculate; peristome inserted near mouth, teeth normally developed, hyaline above, more or less papillose, endostome imperfect, consisting of irregular basal membrane with segments lacking or rudimentary.

*Brachymenium bulbiferum* Bartr. Journ. Wash. Acad. Sci. 24: 472. 1934.

*B. viviparum* Bartr. Contr. U. S. Nat. Herb. 26(3): 77. 1928, non Ren. & Card., 1898.

Plants slender, dull, dark or yellow-green, often tinged with brown or red, gregarious or loosely tufted. Stems erect, reddish, simple or sparsely branched, sparsely radiculose at base, 0.5 to 2 cm. high, bearing large, reddish, oblong or ovoid propagula, with 2 to 5 incurved, ecostate leaf primordia at tips. Leaves loosely erect and moderately contorted, often spirally twisted when dry, erect-spreading when moist, 1 to 2 mm. long, ovate, obtuse or broadly acute, abruptly cuspidate because of yellow, excurrent costa; margins erect, entire, in older plants clearly bordered by 1 to 2 rows of linear cells, border indistinct or often lacking in younger shoots; costa excurrent as short, stout, smooth point; cells oblong-hexagonal, 2 to 3:1, thin-walled, becoming short-rectangular toward base.

On tree trunks, especially of sierra palm, in mountain forests at altitude of about 2000 ft., widespread in Puerto Rico; Costa Rica.

(3) *Rhodobryum* (Schimp.) Hampe. Linnaea. 36: 517. 1870.

Robust, stoloniferous plants in loose mats. Leaves small and distant below, often crowded in rosettes above, often appearing whorled at intervals on stem, spatulate, usually bordered, serrate above; costa stout, more or less percurrent; upper cells very large, rhomboidal, basal cells rectangular. Seta stout, very long, single or aggregated; capsule large, pendulous; annulus differentiated; peristome double, complete, cilia usually appendiculate.

*Rhodobryum domingense* (Brid.) Besch. Journ. de Bot. 15: 384. 1901.

*Mnium dominghense* Brid. Musc. Recent. Suppl. 3: 51. 1817.

*Bryum swartzianum* C. M. Journ. Museum Godeffroy 3(6): 63. 1874.

*B. antillarum* Schimp. ex Besch. Ann. Sci. Nat., Bot. VI. 3: 206. 1876.

Plants large, dark green tinged with red. Erect stems 2 to 8 cm. high, slightly radiculose below, branched by innovations. Lower leaves very small, upper reaching 11 or 12 mm. long, more or less crowded, or short-acuminate; margins slightly recurved at extreme base, densely spinose-serrate above; costa strong, percurrent; cells oval-hexagonal, lax and thin-walled, 2 to 3 rows at margins elongate forming narrow hyaline or pinkish border. Apparently dioicous. Sporophyte not seen.

On soil and over rocks on mountain peaks, relatively abundant at La Torrecilla, near Barranquitas, but known in Puerto Rico from only 1 other locality; widespread in West Indies and possibly throughout American tropics under variety of synonyms, possibly *R. beyrichianum* (Hornsch.) Par. among them.

- (4) *Bryum* Schimp. Syn. Musc. Eur. 344. 1860, nom. conserv., non Hedw., 1801.

Small to robust, tufted plants. Stems branching, often by subfloral innovations, radiculose below. Leaves usually larger and crowded above, usually ovate-lanceolate, rarely lanceolate or spatulate, often bordered by narrow cells, entire or serrulate; costa strong, subpercurrent to excurrent; cells rhomboidal above, larger and rectangular below. Seta elongate; capsule usually pendent, generally clavate or pyriform with conspicuous neck; annulus large, deciduous; operculum convex, more or less mammillate; peristome double, teeth lanceolate, endostome varying considerably, but generally with high basal membrane bearing 16 keeled, split segments, cilia often appendiculate.

- Plants silvery-white. . . . . (a) *B. argenteum*  
 Plants green, often tinged with red, brown, or yellow.  
 Capsule short, neck thick, rounded, spongy, abruptly contracted to seta  
 (b) *B. coronatum*  
 Capsule elongate, with narrow, tapering neck.  
 Leaves narrow and acuminate. . . . . (c) *B. capillare*  
 Leaves bluntly acute to rounded, sometimes apiculate.  
 Leaves suborbicular, obtuse to rounded at apex; upper cells short-hexagonal  
 (d) *B. limbatum*  
 Leaves not suborbicular, acute, often apiculate; cells elongate-rhomboidal.  
 Branches usually julaceous; leaves less than 1 mm. long; cilia short or lacking  
 (e) *B. leptocladon*  
 Branches not julaceous; leaves more than 1 mm. long; cilia better developed.  
 Small, pale green or yellowish plants with red stems; leaves erect-spreading  
 when dry, not crowded in rosulate tufts, unbordered; cells linear-rhomboidal  
 (g) *B. cruegeri*  
 Coarse, dark green or reddish-tinged plants; leaves crowded in rosulate tufts  
 and more or less twisted when dry, bordered; cells rhombic-hexagonal  
 (f) *B. truncorum*

- (a) *Bryum argenteum* Hedw., Sp. Musc. 181. 1801.

*Mnium lanatum* P.-B. Prodr. 75. 1805.

?*Bryum liebmannianum* C. M. Syn. Musc. Frond. 2: 575. 1851.

*B. minutulum* Schimp. ex Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg. 16: 197. 1872.

*B. argenteum* var. *corrugatum* Hampe ex Besch. *Ibid.* 197.

*B. brevicaule* Schimp. ex Besch. *Ibid.* 198.

?*B. subcorrugatum* C. M. Bull. Herb. Boiss. 5: 182. 1897.

?*B. lagunicolum* C. M. *Ibid.* 183.

?*B. arsenei* Thér. Smiths. Misc. Coll. 78(2): 16. 1926.

Small, silvery plants, scattered to densely tufted. Stems red, branched, fragile, julaceous. Leaves closely imbricated, concave, broadly ovate, abruptly apiculate to acuminate; margins entire, plane or slightly reflexed below; costa ceasing below apex to excurrent, reddish at base, green above; upper cells narrow, thin-walled and hyaline, basal cells quadrate, green or reddish. Dioicous. Seta slender, red, about 1 cm. or more high; capsule pendulous, oblong, short-necked, red or brownish, about 1.5 mm. long; operculum convex or low-conic; peristome brownish-yellow, orange at base, finely papillose, with prominent lamellae at back, endostome pale, papillose,

with well-developed basal membrane, perforate segments and appendiculate cilia. Spores nearly smooth, 14 to 18  $\mu$ .

On disturbed soil, often a weed following man's activities, widespread in Puerto Rico at all altitudes from sea-level to high mountain summits; cosmopolitan.

(b) *Bryum coronatum* Schwaegr. Suppl. Sp. Musc. I. 2: 193. 1816.

Plants rather low, tufted, green, radiculose below. Stems green, rarely reaching 1 to 1.5 cm. high, branching from base. Leaves rather distant below, larger and more crowded above, erect and scarcely contorted when dry, erect-spreading when moist, concave, ovate to ovate-lanceolate, acuminate, slightly decurrent; margins entire, revolute in lower  $\frac{2}{3}$ ; costa green, percurrent to excurrent; cells lax and thin-walled, rhomboidal above, up to 50  $\mu$  long, about 3:1, narrower and paler toward margins, shorter and broader toward base. Dioicous; antheridial inflorescence terminal, conspicuous when mature. Seta slender, red, up to 2 cm. or more; capsule red, pendent, 2 to 2.5 mm. long, oblong-cylindric, neck short and rounded, often wider than urn when dry; peristome dark yellow-brown below, papillose, lamellae distinct but projecting only slightly at back, endostome yellowish, papillose, with high basal membrane, perforate, rather narrow segments and 2 to 3 clearly appendiculate cilia. Spores nearly smooth, about 10  $\mu$ .

On soil and wood, known in Puerto Rico from single locality—limestone hills south of Arecibo (*W. C. S.* 6693); pantropical; north to United States (Florida).

(c) *Bryum capillare* Hedw. Sp. Musc. 182. 1801.

*B. flaccidum* Brid. Bryol. Univ. 1: 665. 1826.

*B. domingense* C. M. Linnaea. 17: 594. 1843.

?*B. pohliaeforme* Schimp. ex Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg. 16: 198. 1872, non Brid. 1826.

?*B. botteri* C. Mohr ex C. M. Linnaea. 38: 622. 1874.

*B. sawyeri* Ren. & Card. Rev. Bryol. 15: 71. 1888; Bot. Gaz. 14: 95. 1889.

?*B. bernoulli* C. M. Bull. Herb. Boiss. 5: 183. 1897.

*B. vulcanicolum* C. M. *Ibid.* 184.

Green or brownish, usually densely tufted plants. Stems usually 1 cm. or less high, brown or red, radiculose at base, branched by innovations. Leaves small and distant below, larger and crowded above, contorted when dry, erect-spreading when moist, broadly ovate to ovate-lanceolate, cuspidate or gradually acuminate, about 3 mm. long; margins subentire to serrulate above, recurved below, sometimes indistinctly bordered; costa generally ceasing below apex, often rather long-excurrent; upper cells elongate-rhomboidal, lax and thin-walled, up to 70  $\mu$  long above, about 4:1, usually narrower toward margins, basal cells rectangular. Dioicous, or sometimes synoicous. Seta red-brown, sometimes as long as 3 to 4 cm.; capsules horizontal or inclined, up to 4 mm. long, clavate, often curved at neck; operculum low-conic or convex and bluntly mammillose; peristome teeth yellow, papillose, not especially lamellose at back, endostome pale yellow, papillose,

with high basal membrane, rather broad, perforate segments and appendiculate cilia. Spores rough,  $10\ \mu$  or more.

On soil and rock, widespread in mountains of Puerto Rico at 1000 to 3000 ft.; nearly cosmopolitan, but more frequent in temperate latitudes.

(d) *Bryum limbatum* C. M. Syn. Musc. Frond. 2: 573. 1851.

*Webera mnioides* Schimp. ex Besch. Ann. Sci. Nat., Bot. VI. 3: 204. 1876.

Plants fragile, delicate, sordid green, loosely tufted. Stems up to 2 cm. high, loosely foliate, sometimes bearing brownish, septate filaments in upper leaf axils. Leaves contorted when dry, widely spreading when moist, sub-orbicular, broadly acute or obtuse to rounded at apex, decurrent, 1.5 to 1.8 mm. long; margins erect, subentire; costa strong, brown, ending below apex; upper cells short-hexagonal, thin-walled, 3 to 5 rows at margins linear with brown, incrassate walls, basal cells rectangular. Seta slender, elongate, curved at tip; capsule small, oblong-clavate, horizontal to nodding; exostome teeth short, yellowish, with prominent lamellae; segments of endostome equal to teeth, cilia single, or double and cohering, well developed. Sporophyte not seen.

On rocks in mountain streams, often submerged, at altitudes of 1000 ft. and above, widespread in Puerto Rico; Mexico, Guatemala, and Costa Rica; Cuba, Haiti, Grenada, and Guadeloupe.

(e) *Bryum leptocladon* Sull. Proc. Amer. Acad. Arts and Sci. 5: 282. 1861.

*Brachymenium bordazii* Ren. & Card. Bull. Soc. Roy. Bot. Belg. 29(1): 178. 1890.

Slender green or yellowish, loosely caespitose plants, 5 to 7 mm. high. Stems short, red, freely branching by innovation; branches slender, usually julaceous. Leaves crowded or remote, appressed, ovate-lanceolate, acute and apiculate, concave, 0.5 to 0.7 mm. long; margins erect, entire; costa yellow, strong, subpercurrent; cells elongate-rhomboidal, lax and thin-walled, gradually becoming quadrate or short-rectangular below. Dioicous; perichaetial leaves erect, up to 0.9 to 1.0 mm. long, more laxly areolate. Seta slender and flexuose, red, 1 cm. long; capsule oblong-pyriform, asymmetric, slightly inclined to horizontal, about 1 mm. long; annulus revoluble; operculum convex, blunt; peristome teeth fused at base, pale brown and finely papillose below, hyaline and coarsely papillose at tips, endostome keeled, lightly papillose, as long as exostome, basal membrane about half as high as teeth, segments narrowly perforate, cilia short and single, or lacking. Spores smooth, about  $16\ \mu$ .

On soil and disintegrated rock, common on banks along mountain trails and roads in Puerto Rico, at 1000 ft. and above; Cuba, Jamaica, Haiti, Guadeloupe, and Martinique.

Brotherus (1924) included this species in *Anomobryum*, which it sometimes resembles in aspect because of the slender, julaceous branches. The strong costa and the lax, thin-walled leaf cells, however, indicate a more natural relationship to *Bryum*.

(f) *Bryum truncorum* Brid. Musc. Recent. Suppl. 3: 50. 1817.

*Bryum andicola* Hook. In Kunth, Syn. Pl. Aequin. 1: 58. 1822.

*B. cygnopelma* C. M. Bull. Herb. Boiss. 5: 550. 1897.

Medium-sized plants, usually in dense tufts, green or yellowish above, brown and radiculose below. Stems to 3 cm. high, often bearing brown, papillose, septate filaments in upper leaf axils. Leaves appressed and more or less twisted when dry, small and distant below, larger and crowded in rosulate tuft above, 3 to 3.5 mm. long, obovate, short-acuminate; margins recurved below, denticulate toward apex; costa strong, short-excurrent; cells rhomboid-hexagonal, distinctly bordered above by 2 to 3 rows of narrow, incrassate cells. Dioicous. Seta 2 cm. or more in length, sometimes paired; capsule large, subpendulous; peristome teeth yellow, orange at insertion, finely papillose; endostome pale yellow, slightly roughened, basal membrane moderately high, segments perforated, cilia usually paired, not very strongly developed, nodulose or slightly appendiculate. Spores slightly papillose, 10 to 15  $\mu$ .

Usually on rock or moist cliffs, or on boulders in rivers, widespread in mountains of Puerto Rico at middle and upper altitudes; rather generally distributed in southern hemisphere and particularly in Americas (Tennessee, and southwestern United States to Guatemala); Panama; South America; West Indies.

(g) *Bryum cruegeri* Hampe ex C. M. Syn. Musc. Frond. 1: 300. 1848.

*B. landsbergii* Dozy & Molck. Prodr. Fl. Bryol. Surinam. 40. Pl. 4. 1854.

*B. sintenisii* C. M. Hedwigia. 37: 225. 1898.

*B. ovalifolium* Sull. Proc. Amer. Acad. Arts and Sci. 5: 282. 1861.

*B. ripense* C. M. Bull. Herb. Boiss. 5: 551. 1897.

Plants small, pale green or yellowish, often tinged with red, slightly glossy, gregarious to loosely tufted. Stems red, branched, usually less than 2 cm. high. Leaves erect-spreading when dry, wide-spreading when moist, oblong-lanceolate, concave, broadly acute to slightly apiculate, 1.5 to 2 mm. long; margins plane, unbordered, entire or slightly denticulate above; costa percurrent or slightly excurrent; cells elongate-hexagonal, thin-walled, 60 to 80  $\mu$  long, 6 to 8:1, narrower near margins, lax and broad at base. Dioicous. Seta slender, more or less curved, red, 1.5 to 2 cm. long; capsule suberect to pendulous, clavate with tapering neck sometimes as long as urn; operculum conic-apiculate; peristome teeth dark red-brown, with prominent lamellae; endostome pale yellowish, minutely papillose, with high basal membrane, segments broadly perforate and cilia appendiculate. Spores smooth or nearly so, about 14  $\mu$ .

On soil and disintegrating rock, on masonry and rarely on wood, a weedy moss common and abundant in most parts of Puerto Rico from sea level to high mountain summits; United States (Georgia and Florida); West Indies; Mexico to South America; Trinidad.

*Excluded Species*

*Bryum decursivum* C.M. Hedwigia. 37: 224. 1898, non C. M. 1899.

No specimen available for study.

*Bryum microdecurrens* Britt. Bull. Torrey Bot. Club. 42: 4. 1915.

This species, known only from sterile material, has been excluded because of its uncertain relationship. According to A. LeRoy Andrews (1949) it belongs "somewhere in the *Brachymenium* complex."

## RHIZOGONIACEAE

Medium-sized, densely tufted plants. Stems erect, evenly foliate, radiculose below. Leaves narrow, spreading, strongly serrate with single or paired teeth; costa strong; cells small, rounded, smooth, incrassate. Calyptra cucullate. Seta elongate, produced laterally near base of stem; capsule erect, or inclined to horizontal, short-necked, curved; annulus present; operculum mostly oblique-rostrate; peristome double and complete (except in *Hymenodon*).

*Rhizogonium* Brid. Bryol. Univ. 2: 663. 1827.

Stems stiff, erect, elongate, simple or branched. Leaves incurved when dry, spreading when moist, narrowly lanceolate, gradually acuminate, usually thickened at serrate margins; costa percurrent or excurrent, usually toothed at back above. Peristome teeth lanceolate, acuminate, yellow-brown, segments pale yellow, papillose, cilia not appendiculate.

*Rhizogonium spiniforme* (Hedw.) Bruch. Flora. 29: 134. 1846.

*Hypnum spiniforme* Hedw. Sp. Musc. 236. 1801.

Usually 3 to 4 cm. high, yellow-green, matted below with brown radicles. Leaf border thickened, doubly serrate; costa yellowish, percurrent, toothed at back above; cells rounded-quadrate, about 10 to 15  $\mu$ , with thick, smooth walls. Synoicous. Seta up to 5 cm. or more long; capsule yellow-brown, urn about 3 mm., gradually narrowed to short neck; operculum obliquely rostrate; peristome teeth closely set, bordered, segments narrow and fragile, basal membrane high, generally with 2 nodose cilia. Spores about 18  $\mu$ , finely papillose.

On moist soil, over rocks, on tree trunks and decaying logs, common in wet mountain forests at higher altitudes and especially abundant in sierra palm zone; pantropical, reaching north to Georgia, Florida, and Louisiana in the United States.

## BARTRAMIACEAE

Small to large, tufted plants, often densely tomentose below. Stems branched, often with whorled subfloral innovations. Leaves mostly narrow and acute, serrate; costa strong; cells narrow, papillose at or near end walls, rarely smooth. Seta short to long; capsules mostly globose and cernuous,

typically strongly ribbed when dry; operculum convex or conic; peristome normally double or imperfect, with 16 teeth, segments shorter, often poorly developed. Spores rough.

Leaves plicate at base; basal cells linear; stems somewhat pinnately branched

(1) *Breutelia*

Leaves not plicate at base; basal cells rectangular to isodiametric; stems not pinnate

(2) *Philonotis*

(1) *Breutelia* Schimp., Coroll. Bryol. Eur. 85. 1856.

Robust, densely tufted, green or yellowish-green plants. Stems branched, usually densely tomentose below. Leaves lanceolate, slenderly pointed, usually plicate at base; costa narrow, percurrent to excurrent; cells linear to rectangular, incrassate, papillose. Perichaetial leaves smaller, not papillose. Dioicous; male inflorescence discoid. Seta stout, usually elongate; capsule inclined or drooping, rarely suberect, globose or ovoid, furrowed when dry; operculum very small, convex; peristome double, cilia rudimentary or lacking.

Upper cells nearly smooth; alar cells subquadrate in 4 to 6 rows . . . . . (a) *B. scoparia*  
Upper cells clearly papillose; alar cells scarcely differentiated, 2 or 3 somewhat larger and oblong . . . . . (b) *B. tomentosa*

(a) *Breutelia scoparia* (Schwaegr.) Schimp. ex Paris. Index Bryol. 154. 1894.

*Bartramia scoparia* Schwaegr. Suppl. Sp. Musc. III. 1(2): pl. 241. 1828.

Robust yellow-green or brownish, laxly tufted plants. Stems up to 10 cm. long, freely branched, tomentose below. Leaves spreading from insertion, 3 to 5 mm. long, narrowly lanceolate from short, ovate, lightly plicate base, slenderly acuminate; margins narrowly recurved below, serrulate above; costa slender, excurrent; cells linear, nearly smooth, becoming longer below, colored at insertion and short and lax, especially at basal angles where they are irregularly subquadrate in 4 to 6 rows. Seta 2.5 to 3 cm. long; capsule inclined or nodding, at least when young, 3 mm. long. Sporophytes from St. Vincent.

On wet cliffs near mountain summits, known in Puerto Rico only from 2 localities—in Luquillo Mts. and in Cordillera Central; Jamaica, Haiti, and Santo Domingo; St. Vincent, St. Kitts, Martinique, and Guadeloupe; British Guiana.

(b) *Breutelia tomentosa* (Swartz) Schimp. ex Paris. Index Bryol. 155. 1894.

*Bryum tomentosum* Swartz. Prodr. Fl. Ind. Occ. 3: 1837. 1806.

Robust yellow-green to golden brown, laxly tufted plants. Stems up to 10 or sometimes 16 cm. long, freely branched, matted with reddish tomentum below. Leaves spreading from insertion, or occasionally subclasping at base, 3 to 5 mm. long, lanceolate from short, ovate, lightly plicate base, slenderly acuminate; margins narrowly recurved below, serrulate above; costa slender, excurrent; cells linear, incrassate, clearly papillose at proximal ends above,

smooth and longer below, long and narrow and colored across insertion except for marginal row of 2 or 3 oblong, pellucid cells at basal angles. Seta 1 to 2 cm. long; capsule nodding, ovoid, 3 mm. long. Sporophytes not found in Puerto Rico.

On wet rocks, high mountain peaks, known in Puerto Rico from Cordillera Central and Luquillo Mts.; West Indies; Mexico to northern South America.

(2) *Philonotis* Brid. Bryol. Univ. 2: 15. 1827.

Pale, light green or yellowish, often glaucous plants, usually in compact, tomentose cushions. Stems erect, with whorled, subfloral branches, or rarely irregularly branched. Leaves usually appressed when dry, erect-spreading to secund when moist, mostly lanceolate; costa usually subpercurrent to excurrent; cells oblong-linear, or short-rectangular, papillose at 1 or both ends. Seta elongate; capsule subglobose, inclined to horizontal, striate, furrowed when dry; peristome double, teeth generally conspicuously barred by interlamellar thickenings, segments from high basal membrane, cilia usually well developed.

Leaves obtuse to rounded; costa ending below apex. . . . . (a) *P. gracillima*  
Leaves acute or acuminate.

Stems slender, elongate and flexuose, irregularly branched. . . . . (b) *P. elongata*

Stems stout and erect, branched by subfloral innovations in whorls.

Autoicous. . . . . (c) *P. longiseta*

Dioicous.

Stems hooked at tips; costa of perigonal leaves long-excurrent. . . . (d) *P. uncinata*

Stems not hooked; costa of perigonal leaves ending at or below apex, rarely short-excurrent.

Costa long-excurrent; leaves straight, sharply serrate . . . . . (e) *P. sphaerocarpa*

Costa percurrent; leaves straight or subfalcate, bluntly toothed.

(f) *P. glaucescens*

(a) *Philonotis gracillima* Ångstr. Öfv. K. Sv. Vet.-Akad. Förh. 33(4): 17. 1876.

*P. evanescens* Broth. In Urban, Symb. Antill. 3: 425. 1903.

?*Bartramia ligulata* C. M. Hedwigia. 37: 231. 1898.

Slender, bright green plants. Stems up to 1 or 1.5 cm. high. Leaves erect-spreading, oblong-ovate, bluntly pointed, 0.5 to 1 mm. long; margins plane or slightly recurved, crenate; costa ending below apex; upper cells oblong-linear to rhomboidal, weakly papillose at upper ends at back, lower cells somewhat enlarged, shorter and laxer. Dioicous; perigonia small, gemmiform. Seta about 2 cm. long; capsule ovoid, horizontal, red-brown, mouth small and slightly oblique; peristome teeth reddish, papillose, endostome yellowish, vertically papillose-striate. Spores reniform, coarsely papillose, 20 to 26  $\mu$ .

On moist soil and rock, usually in calcareous habitats, common in coastal plain of Puerto Rico; southeastern United States; West Indies; Mexico to northern South America.

(b) *Philonotis elongata* (Dism.) Crum & Steere. Bryol. 59: 251 1956.

*P. tenella* var. *elongata* Dism. Bull. Soc. Bot. France. 2(17): 14. 1910.

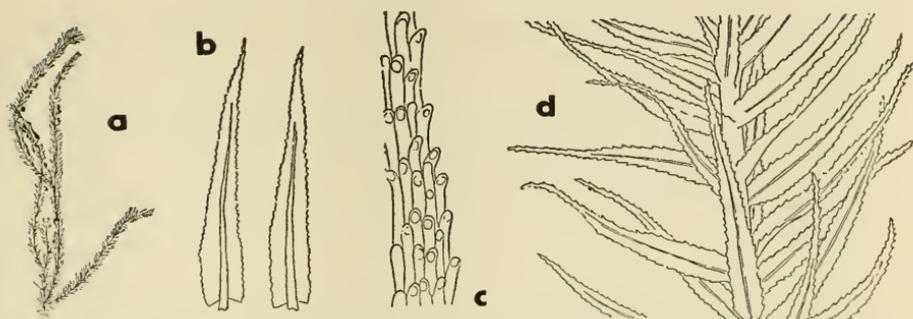


FIGURE 30. *Philonotis elongata*: (a) habit, (b) leaves, (c) upper leaf cells, and (d) portion of branch.

Delicate, graceful plants in loose, green or yellowish, somewhat glossy mats. Stems red, elongate and flexuose, 2 to 4 cm. high, reddish-radicleose below, irregularly but sparsely branched. Leaves erect-spreading or widely spreading moist or dry, tips sometimes subsecund when dry, 0.7 to 1.2 mm. long, narrowly lanceolate and slenderly acuminate; margins narrowly recurved, sharply serrulate all around; costa percurrent or shortly excurrent; cells oblong-linear, thin-walled, clearly papillose at upper ends, scarcely differentiated at base (FIGURE 30).

On moist shaded rocks and occasionally on trunks of sierra palms in wet mountain forests at upper altitudes; widespread in Puerto Rico; Martinique; Ecuador and Peru.

The elongate, flexuose stems, the irregular branching, and the widely spreading, slenderly acuminate leaves with excurrent costae give this plant such a characteristic appearance that it can be recognized by gross aspect alone. The characters mentioned above seem to justify the recognition of a species distinct from the widespread *P. tenella* (a synonym of *P. glaucescens*).

(c) *Philonotis longiseta* (Michx.) Britt. Bryol. 14: 44. 1911.

*Bartramia longiseta* Michx. Fl. Amer. Bor. 2: 301. 1803.

*B. radicalis* P.-B. Prodr. 44. 1805.

*Philonotis orizabana* Schimp. ex Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg. 16: 202. 1872.

*Bartramia graminicola* C. M. Linnaea. 38: 632. 1874, non C. M. 1890.

Plants green or yellowish, up to 2 or 2.5 cm. high. Leaves spreading or erect-spreading, often crowded, 1 to 1.5 mm. long, lanceolate, acuminate; margins revolute, serrate; costa percurrent to rather long-excurrent; cells strongly papillose throughout, linear and papillose at upper ends above, lower cells gradually enlarged, not or rarely inflated. Autoicous; perigonia small, lateral, gemmiform. Seta 1.5 to 2.5 cm. long; capsule inclined to nodding, ovoid, 2 mm. long, mouth small, slightly oblique; peristome teeth reddish, papillose, endostome yellowish, papillose-striate. Spores reniform, papillose, 22 to 26  $\mu$ .

On soil and rock, apparently rare in Puerto Rico, known from only 2 localities at high altitudes—on summit of El Yunque in Luquillo Mts. and

near Villalba, in Cordillera Central; eastern United States; Mexico to Guatemala.

(d) *Philonotis uncinata* (Schwaegr.) Brid. Bryol. Univ. 2: 22. 1827.

*Bartramia uncinata* Schwaegr. Suppl. Sp. Musc. I. 2: 60. 1816.

*B. scabrida* Schwaegr. *Op. cit.* 57.

*B. berteriana* C. M. Linnaea. 17: 590. 1843.

*B. berteriana* var. *flaccida* C. M. Syn. Musc. Frond. 1: 485. 1849.

Pale green or yellowish plants, 2 to 3 cm. high. Leaves crowded, subfalcate at stem tips, imbricate when dry, erect-spreading when moist, 1 to 1.5 mm. long, oblong-lanceolate, acuminate; margins revolute, serrulate; costa short-excurrent; cells rough throughout with papillae at upper ends, linear above, broader and oblong below. Dioicous; perigonia gemmiform. Seta 1 to 2.5 cm. or more long; capsule oblong-ovoid, yellow-brown, inclined to cerenuous, 1.5 to 2 mm. long; teeth of peristome red-brown, papillose, endostome yellowish, papillose-striate. Spores ovoid to reniform, bluntly papillose, 23 to 26  $\mu$ .

On rock, especially on moist cliffs in mountains, generally at middle and upper altitudes in Puerto Rico; southeastern United States; West Indies; Mexico to South America.

(e) *Philonotis sphaerocarpa* (Hedw.) Brid. Bryol. Univ. 2: 25. 1827.

*Mnium sphaericarpum* Hedw. Sp. Musc. 197. 1801.

?*Bartramia chrysoblata* C. M. Bull. Herb. Boiss. 5: 188. 1897.

Plants light green or yellowish, 2 to 3 cm. high. Leaves imbricated, erect or nearly so, oblong-lanceolate, slenderly acuminate; margins revolute, sharply serrulate; costa rather long-excurrent as a spinulose point; cells linear to oblong, papillose at upper ends, broader and oblong below. Dioicous; perigonia small and gemmiform. Seta 1.5 to 2.5 cm. long; capsule red-brown, inclined to cerenuous, subglobose, small-mouthed; peristome teeth reddish, papillose, endostome yellowish, papillose-striate. Spores reniform, papillose, 23 to 26  $\mu$ .

On soil and rock, occurring in Puerto Rico at all elevations from sea level to mountain summits, but most abundant at middle altitudes in mountainous areas; United States (Florida); West Indies; Mexico to South America.

(f) *Philonotis glaucescens* (Hornsch.) Paris. Index Bryol. 923. 1894.

?*P. humilis* Brid. Bryol. Univ. 2: 17. 1827.

*Bartramia glaucescens* Hornsch. In Mart. Fl. Brasil 1(2): 40. 1840.

*B. minuta* Tayl. Lond. Journ. Bot. 6: 335. 1847.

*B. tenella* C. M. Syn. Musc. Frond. 1: 481. 1849.

*B. pabstiana* C. M. *Op. cit.* 486.

*Philonotis brachyclada* Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg 16: 203. 1872.

*P. caespitulosus* C. M. ex Ångstr. Öfv. K. Sv. Vet.-Akad. Förh. 22(4): 16. 1876.

*Bartramia defecta* C. M. Linnaea. **43**: 419. 1882.

*B. versifolia* Hampe. Ann. Sci. Nat. Bot. V. **3**: 371. 1865.

*Philonotis nanodendra* C. M. Bull. Soc. Roy. Bot. Belg. **31**(1): 160. 1892.

*Philonotula oreades* C. M. Hedwigia. **36**: 99. 1897.

*Bartramia scobinifolia* C. M. Bull. Herb. Boiss. **5**: 188. 1897.

*B. minutissima* C. M. Nuov. Giorn. Bot. Ital. N. S. **4**: 43. 1897.

*Philonotis riograndensis* Broth., Bih. K. Sv. Vet.-Akad. Handl. **26**(III, 7): 27. 1900.

Small, pale green plants. Stems 1 to 2 cm. high. Leaves crowded, often more or less curved and secund, oblong-lanceolate, acuminate; margins plane or recurved, bluntly serrate; costa percurrent; upper cells oblong-linear, papillose at upper ends at back, lower cells larger and oblong, sometimes lax and inflated. Dioicous; perigonia small, gemmiform. Seta 1 to 1.5 cm. long; capsule inclined or cernuous, ovoid, 1.5 to 2 mm. long, mouth small and slightly oblique; teeth of peristome red-brown, papillose; endostome papillose-striate. Spores reniform, bluntly papillose, 22 to 26  $\mu$ .

On calcareous rock and soil, at all altitudes from sea level to high mountain tops, but especially abundant and widespread at middle elevations in mountains of Puerto Rico; widespread in American tropics; southeastern United States north to Kansas.

#### ERPODIACEAE

Small, delicate plants with slender, prostrate, irregularly branched stems consisting of large, loose cells. Leaves more or less closely and uniformly arranged, spreading when moist, imbricate when dry, broad, ecostate, unbordered; cells parenchymatous, usually papillose. Autoicous; perichaetial leaves longer, erect. Calyptra mitrate to campanulate, lobed at base, incised on 1 side, usually plicate. Sporophyte borne at ends of short, lateral

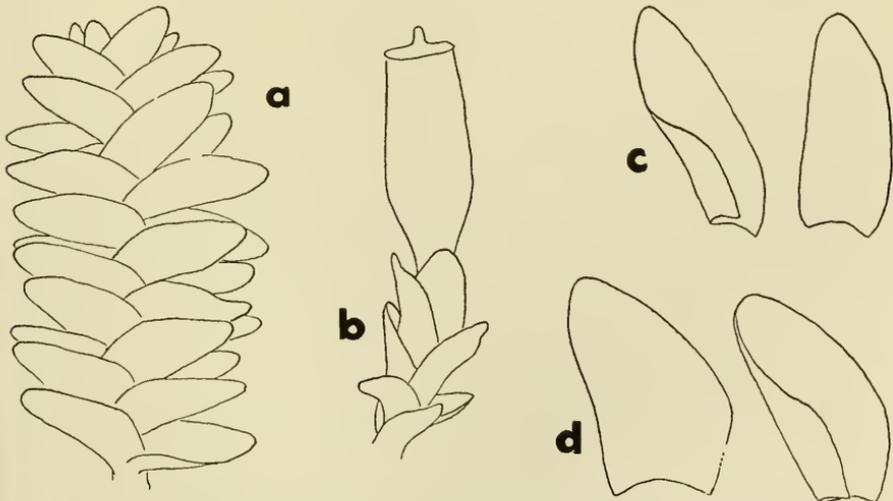


FIGURE 31. *Erpodium domingense*: (a) dorsal view of plant, (b) female branch, with sporophyte, (c) ventral leaves, and (d) dorsal leaves (Grout, 1935).

branches; seta very short; capsule erect and symmetric, thin-walled, pale; annulus usually present; peristome generally lacking, or single, consisting of 16 red, papillose, lanceolate teeth.

*Erpodium* (Brid.) C. M. Bot. Zeit. 1: 774. 1843.

Stems prostrate, more or less elongate, freely branched; branches short, horizontal, flattened. Leaves ovate to nearly lanceolate; cells oval or rounded-hexagonal, smaller and quadrate at margins, quadrate or oblate in several rows at leaf angles. Perichaetial leaves pale. Calyptra mitrate, plicate, scabrous on folds. Capsule elongate, immersed or exserted; annulus wide, persistent; peristome lacking.

*Erpodium domingense* (Spreng.) C. M. Bot. Zeit. 1: 774. 1843.

*Anoetangium domingense* Spreng. Neue Entdeckungen 3: 3. 1822.

Yellowish-green plants in close mats. Leafy stems up to 1.5 mm. wide. Rhizoids very numerous. Leaves imbricate when dry, widely spreading when moist, complanate, overlapping half their length, rounded at apex, entire except for marginal papillae, more or less dimorphous, dorsal somewhat asymmetric, ovate, 0.75 to 0.9 mm.  $\times$  0.4 to 0.5 mm., the ventral symmetric, lanceolate-ligulate to oblong, 0.6 to 0.9 mm.  $\times$  0.2 to 0.3 mm., both kinds widely inflexed at lower margins; cells densely papillose, 14  $\times$  18  $\mu$ , marginal cells 11 to 12  $\mu$ , basal somewhat larger, smooth, quadrate. Seta less than 0.5 mm. long; capsule cylindrical, 1.0 mm. long, pale yellow, darkening with age, contracted below mouth when dry. Spores green, smooth, 25 to 30  $\mu$  (FIGURE 31).

On rocks and tree trunks, known from 3 localities on south slope of Puerto Rico, at elevations of less than 1000 ft.; also from Cayo Muertos and Virgin Islands (St. Thomas); West Indies; southwestern United States (Texas) to Guatemala; Panama.

#### ORTHOTRICHACEAE

Plants rather small to robust, densely tufted. Stems erect, or creeping with erect-secondary stems. Leaves crowded, often crisped, usually oblong or lanceolate, concave or keeled, often bearing septate brood-bodies; costa strong, percurrent or nearly so, rarely excurrent; upper cells rounded, incrassate, usually papillose or mammillose on both sides, basal cells elongate, not differentiated at basal angles. Calyptra usually hairy, mostly mitrate or campanulate. Sporophytes terminal or lateral; capsules immersed to exserted, erect, smooth or plicate; peristome usually present, the 16 teeth often united in pairs, 8 or 16 segments, alternate with teeth, often lacking.

Leaves bordered at base by linear cells; other basal cells short . . . . . (1) *Groustiella*  
Leaves not bordered below; basal cells all elongate.

Calyptra mitrate, plicate, often shorter than capsule. . . . . (2) *Macromitrium*  
Calyptra campanulate, not plicate, almost or wholly covering capsule

(3) *Schlotheimia*

(1) *Groustiella* Steere. Bryol. 53: 145. 1950.

Slender to moderately robust plants in dense, brownish-green mats, similar in aspect to *Macromitrium*. Primary stems creeping; secondary

stems numerous, erect, simple or more or less branched. Leaves crowded, contorted when dry, oblong-lanceolate to lingulate; costa strong; leaf cells isodiametric, nearly uniform throughout except for border of linear cells extending well up margins from leaf base. Calyptra mitriform, usually small, sometimes covering capsule, plicate, lacinate at base, naked. Seta elongate, smooth; capsule smooth, subcylindric, erect; operculum long-rostrate; peristome reduced to 1 or 2 short membranes, sometimes lacking.

Border extending nearly to leaf apex.....(a) *G. husnotii*  
 Border extending only half leaf length or less.....(b) *G. apiculata*

(a) *Groutiella husnotii* (Schimp. ex Besch.) Crum & Steere. *Bryol.* 53: 147. 1950.

*Macromitrium husnoti* Schimp. ex Besch. *Ann. Sci. Nat., Bot.* VI. 3: 200. 1876.

Small, brownish-green plants. Secondary stems 1 cm. high, or less. Leaves crowded, contorted, and often spirally twisted around stems when dry, erect-spreading when moist, up to 2.5 mm. long, ligulate, abruptly rounded at apex and strongly apiculate because of excurrent costa, carinate, entire; cells nearly uniform throughout, rounded, smooth or slightly bulging, about 5  $\mu$  in diameter above, larger and more incrassate below, but short nearly to insertion; border of linear cells extending nearly to leaf apex. Seta 8 to 10 mm. long; urn of capsule oblong-cylindric, smooth, 2 to 3 mm. long; peristome single, consisting of a fragile, papillose membrane. Spores finely papillose, 20 to 30  $\mu$ .

On trunks of trees, especially sierra palm, occasionally on rotten wood or rock, in wet mountain forests at higher altitudes in Puerto Rico; Cuba, Haiti, and Martinique; Venezuela.

(b) *Groutiella apiculata* (Hook.) Crum & Steere. *Bryol.* 53: 146. 1950.

*Orthotrichum apiculatum* Hook. *Musci Exot.* 1: pl. 45. 1818.

*Macromitrium macrostomum* Schwaegr. *Suppl. Sp. Musc.* II. 2(2): 132. 1827.

*M. brevipes* C. M. *Syn. Musc. Frond.* 1: 728. 1849.

Small plants, yellowish-green above, brown below. Secondary stems short, crowded, erect. Leaves crowded, tubulose, and spirally twisted around stem when dry, slightly concave and spreading when moist, 1.5 to 2 mm. long, lingulate, obtuse and abruptly narrowed to a stout apiculus composed of excurrent costa; margins strongly incurved when dry, entire; cells small, 7 to 9  $\mu$ , irregularly rounded, more or less bulging, becoming incrassate below and elongate and sinuose at insertion, 6 to 10 rows of linear cells forming distinct, pale border to about  $\frac{1}{2}$  leaf length. Autoicous. Seta 5 to 8 mm. long, smooth; urn of capsule ovoid, about 1.5 mm. long, smooth; operculum conic-rostrate; peristome lacking, or reduced to a low membrane.

On bark of trees and on rock, a very abundant and conspicuous moss in moist places in Puerto Rico, at all altitudes from sea level to highest peaks; West Indies; Mexico to South America; Galapagos Islands.

*Groutiella mucronifolia* (Hook & Grev.) Crum & Steere, often confused

with this species, can be distinguished by its broadly rounded leaf apices, often retuse, with a minute mucro, as well as by the shorter border at the leaf base.

(2) *Macromitrium* Brid. Musc. Recent. Suppl. 4: 132. 1819.

Plants slender to robust, in compact, reddish or dark green mats. Stems long and creeping, producing numerous more or less branched, densely foliate, erect or ascending secondary stems. Leaves oblong to linear-lanceolate, more or less plicate at base; costa strong; upper cells small, thick-walled, lower cells linear, often tuberculose. Calyptra large, mitriform, plicate, laciniate at base. Capsule usually exserted, erect, ovoid; usually no annulus; operculum mostly rostrate; peristome lacking, single or double, inserted below mouth, teeth papillose, lanceolate to truncate, often more or less united, endostome membranous, divided into segments or merely lobed.

Leaves truncate or emarginate and strongly apiculate, often appearing tridentate at apex

(a) *M. perichaetiale*

Leaves obtuse to acuminate, not truncate or retuse.

Upper cells oblong-linear, 2 to 4:1, those at margins somewhat longer and narrower in indistinct border.....(b) *M. scoparium*

Cells short; leaves not bordered.

Cells at leaf base smooth.

Leaves broadly acute to obtuse and apiculate; upper cells bulging and papillose

(c) *M. richardii*

Leaves acuminate; cells smooth.....(d) *M. stratosum*

Cells at leaf base tuberculate.

Stem leaves up to 2 mm. long, broadly acute; cells mammillose on both sides.

(e) *M. portoricense*

Stem leaves 2.5 to 4 mm. long, acuminate; cells not mammillose.

Upper cells clearly elongate, more or less sigmoid.....(f) *M. schwaneckeanum*

Upper cells irregularly subquadrate.....(g) *M. cirrosium*

(a) *Macromitrium perichaetiale* (Hook. & Grev.) C. M. Bot. Zeit. 3: 544. 1845.

*Orthotrichum perichaetiale* Hook. & Grev. Edinb. Journ. Sci. 1: 127. 1824.

*Macromitrium truncatum* C. M. Linnaea. 17: 383. 1843.

Plants brownish or reddish, fairly robust when well developed. Secondary stems 1 to 2 cm. long. Leaves closely appressed and somewhat flexuose, but scarcely contorted when dry, erect-spreading when moist, about 3 to 4.5 mm. long, lanceolate, truncate or deeply retuse at apex, ending in stout point caused by excurrent costa; margins entire, usually recurved on 1 side below; cells linear throughout, very incassate and porose, basal cells not tuberculate. Dioicous; perichaetial leaves up to about 7 mm. long, hair-pointed because of long-excurrent costa. Calyptra hairy. Seta smooth, about 12 to 15 mm. long; urn of capsule oblong or ovoid, 1.5 to 2 mm. long; exostome teeth truncate, somewhat united at base, papillose; segments of endostome longer than teeth, linear, consisting of single row of cells, basal membrane narrow. Spores smooth, up to 60  $\mu$  in diameter.

On tree trunks and branches, rarely on rock, in wet mountain forests throughout Puerto Rico, but most abundant in Sierra de Luquillo; West Indies; Trinidad.

(b) *Macromitrium scoparium* Mitt., Journ. Linn. Soc. London, Bot. 12: 206. 1869.

*M. trichophyllum* Mitt. *Ibid.* 207.

Plants golden-green or brownish above, dark brown or reddish below. Secondary stems up to 3 cm. or more in length, often forked. Leaves crowded, erect at base with erect-spreading to widely spreading tips, spirally twisted when dry, 4 to 6 mm. long, narrowly lanceolate, long and slenderly acuminate, keeled; margins serrulate in upper half, sometimes indistinctly so; costa excurrent; upper cells oblong-linear, 3 to 4:1, usually about 20 to 23  $\mu$  long, incrassate, seriate, usually longer and narrower at margins, forming an indistinct, yellowish border, basal cells narrowly linear, very incrassate and porose. Perichaetial leaves somewhat shorter, abruptly acuminate, cells linear throughout. Calyptra naked. Seta 8 to 13 mm. long, smooth or obscurely to distinctly roughened above; urn of capsule globose, smooth, nearly 2 mm. long; peristome double, teeth truncate, more or less joined, papillose, endostome as long as teeth, an irregularly divided, papillose membrane. Spores finely papillose, 21 to 27  $\mu$ .

On trunks and branches of trees, rarely on rock, at altitudes of 2000 ft. and higher, apparently restricted to Luquillo Mts. in northeastern Puerto Rico; Jamaica, Martinique, and St. Kitts; Brazil.

In his recent treatment of the American Orthotrichaceae, Grout (1946) reported 2 Puerto Rican collections (*Grout 63* and *Schafer 3060*) as *M. williamsii* Bartr. Schafer's collection at least is no different from *M. scoparium*. From such few specimens of *M. williamsii* and *M. dubium* Schimp. as have been available for study, it seems doubtful that either species should be maintained separate from *M. scoparium*.

(c) *Macromitrium richardii* Schwaegr. Suppl. Sp. Musc. II. 2(1): 70. 1826.

*M. didymodon* Schwaegr. *Op. cit.* 2(2,2): 138. 1827.

*M. goniopodium* Mitt. Journ. Linn. Soc. London, Bot. 12: 198. 1869.

*M. rhabdocarpum* Mitt. *Ibid.* 199.

*M. insularum* Mitt. *Ibid.* 200, non Sull. & Lesq. 1859.

*M. leptophyllum* Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg. 16: 190. 1872.

*M. domingense* Jaeg. Ber. St. Gall. Natur. Ges. 1872-73. 149. 1874.

*M. tenellum* Card., Rev. Bryol. 36: 109. 1909.

Small, yellow-green plants. Secondary stems crowded, usually 1 to 1.5 cm. high, or less. Leaves erect with inrolled points when dry, erect-spreading to incurved when moist, 2 to 2.5 mm. long, narrowly oblong-lanceolate, broadly acute to obtuse-apiculate, keeled; margins papillose-crenulate above, plane or recurved on 1 side below; costa subpercurrent to short-excurrent; upper cells slightly incrassate, rounded, bulging and papillose, about 8  $\mu$ , basal cells oblong to linear, incrassate and smooth. Autoicous; perichaetial leaves longer, broader at base, with cells smooth and more or less elongate throughout. Calyptra sparsely hairy. Seta smooth, 8 to 12 mm. long; capsules ovoid, puckered below mouth; operculum subulate; peristome single,

consisting of 16 short, pale, papillose, paired teeth, often broken. Spores finely papillose, up to 25  $\mu$  (according to Grout).

On trees, known in Puerto Rico from only 2 localities near western end of Cordillera Central at an altitude of over 2000 ft.; United States (Florida); West Indies; Mexico to South America.

(d) *Macromitrium stralosum* Mitt. Journ. Linn. Soc. London, Bot. 12: 199. 1869.

*M. cacuminicolum* C. M. Bull. Herb. Boiss. 5: 559. 1897.

*M. acunae* Thér. Mem. Soc. Cubana Hist. Nat. 14: 353. 1940.

Plants small, brownish-green; secondary stems numerous, short, usually less than 1 cm. long, more or less branched. Leaves crowded, erect with incurved points when dry, erect-spreading when moist, lanceolate, acuminate, keeled, about 2 mm. long; margins plane and entire; costa percurrent to short-excurrent; upper cells small, 5 to 6  $\mu$ , irregular, rounded, smooth, incrassate, becoming linear toward base and very incrassate, porose, smooth. Autoicous; perichaetial leaves broader, abruptly narrowed to hairpoint formed by excurrent costa. Calyptra naked. Seta 10 to 16 mm. long, smooth; urn of capsule about 1.5 mm. long, ovoid, narrowed at mouth and puckered when dry and empty; operculum long-rostrate; peristome single, consisting of 16 short, blunt teeth, densely papillose. Spores finely papillose, 39 to 48  $\mu$  in diameter.

On shrub, known in Puerto Rico from single locality near highest part of island, over 4000 ft., south of Jayuya (*W. C. S.* 6866); West Indies; Guatemala and Costa Rica.

(e) *Macromitrium portoricense* Williams. Bryol. 32: 69. 1929.

Secondary stems up to 1.5 cm. high, crowded, bearing short branches. Leaves crisped when dry, erect-spreading when moist, up to 2 mm. long, lanceolate to oblong-lanceolate, keeled, broadly acute; margins plane, crenulate above; costa subpercurrent to short-excurrent; cells incrassate, rounded, 10  $\mu$ , mammillose on both sides, basal cells linear and tuberculate, short and broad in marginal row, and sometimes dentate toward base. Dioicous; perichaetial leaves shorter and broader, consisting of elongate, smooth cells except near apex. Calyptra naked, somewhat scabrous above. Seta about 6 mm. long, smooth; urn of capsule ovoid, smooth, about 1.5 mm. long; peristome present. Spores smooth, 16 to 20  $\mu$  (FIGURE 32).

On rock, still known only from type locality at Monte Alegrillo, south of Maricao. Endemic.

(f) *Macromitrium schwaneckeanum* Hampe. Linnaea. 25: 360. 1853.

Small to moderately robust, yellow-brown plants. Secondary stems usually 1 to 2.5 cm. high, simple or forked. Leaves crowded, crisped and flexuose-spreading when dry, widely spreading when moist, 3 to 4 mm. long, linear-lanceolate, gradually acuminate, keeled, serrulate to serrate usually in upper half; costa subpercurrent to short-excurrent; upper cells irregularly elongated and sigmoid, incrassate, 11 to 20  $\mu$  long, clearly seriate and furrowed between

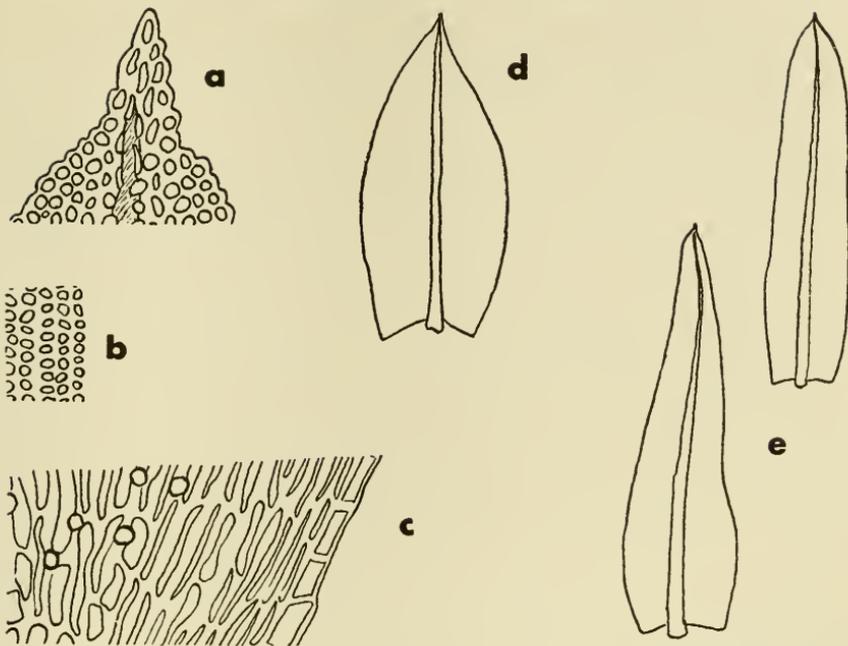


FIGURE 32. *Macromitrium portoricense*: (a) cells at leaf tip, (b) median leaf cells, (c) basal leaf cells, (d) perichaetial leaf, and (e) 2 stem leaves (Williams, 1929).

rows, smooth, longer and narrower at extreme apex, linear, strongly incresate, sinuose and tuberculate at base. Perichaetial leaves as long as stem leaves, somewhat narrower. Calyptra smooth, deeply lobed. Seta smooth, 8 to 12 mm. long; urn of capsule ovoid, smooth, about 1 to 1.5 mm. long; annulus lacking; operculum long-rostrate; teeth of exostome obtuse, more or less united, densely papillose; endostome papillose, the segments narrow and irregular from a high membrane. Spores smooth, 21 to 30  $\mu$ .

On trees, shrubs, rotting logs, and on rock, in wet mountain forests at altitudes usually above 2000 ft.; in all high mountain areas of Puerto Rico; Cuba, Jamaica, Haiti, Santo Domingo, Santa Lucia, Dominica, and Guadeloupe; probably more widely distributed under some of the names included by Grout (1946) in the synonymy of *M. cirrosium*.

This species is clearly related to *M. cirrosium*, but it has been segregated here because of the characteristic elongate, more or less sigmoid upper leaf cells that are arranged in distinct longitudinal rows separated by pronounced furrows.

(g) *Macromitrium cirrosium* (Hedw.) Brid. Bryol. Univ. 1: 316. 1826.

*Anictangium cirrosium* Hedw. Sp. Musc. 42. 1801.

*Hypnum cirrhatum* Brid. Musc. Recent. 2(2): 185. 1801.

*Macromitrium praelongum* Mitt. Journ. Linn. Soc. London, Bot. 12: 207. 1869.

*M. microtheca* Mitt. *Ibid.* 208.

*M. barbense* Ren. & Card. Bull. Soc. Roy. Bot. Belg. 31(1): 157. 1892.

- M. erectopatulum* C. M. Nuov. Giorn. Bot Ital. II. 4: 124. 1897.  
*M. cubensicirrhosum* C. M. Hedwigia. 37: 236. 1898.  
 ?*M. pseudocirrhosum* C. M. Ibid. 237.

Yellow-brown plants, small, or moderately robust when well developed. Secondary stems 0.5 to 3 cm. high, usually 1 cm. or less, simple or forked. Leaves crowded, crisped-flexuous when dry, erect-spreading when moist, 2.5 to 3.5 mm. long, linear-lanceolate, gradually acuminate, keeled, serrulate at apex, or sometimes to midleaf; costa subpercurrent to short-excurrent; upper cells subquadrate or rounded, typically incrassate, about 6  $\mu$ , usually in rows, smooth or somewhat bulging, longer and narrower at extreme apex, linear, strongly incrassate and sinuose, tuberculate at base. Perichaetial leaves as long as stem leaves, 3 to 4 mm. long, somewhat narrower, gradually acuminate. Calyptra naked, deeply lacinate. Seta smooth, 6 to 8, rarely 12 mm. long; urn of capsule ovoid, smooth (or more or less ribbed), about 1 mm. long; annulus lacking; operculum long-rostrate; teeth of exostome obtuse, more or less united, strongly papillose; endostome papillose, segments narrow and irregular from a high membrane. Spores smooth, 17 to 24  $\mu$ .

On tree trunks, more rarely on rock, in mountain forests above 1000-ft. altitude throughout Puerto Rico; West Indies; Mexico, Guatemala, British Honduras, and Costa Rica; South America.

The synonymy is essentially that given by Grout in the *North American Flora* (1946), except that *M. schwaneckeanum* Hampe has been recognized as distinct from the complex of variable forms perforce included in *M. cirrosum* because of the clearly elongate sigmoid cells of the upper leaf. A careful study of the entire *cirrosum*-complex in tropical America will doubtless result in the segregation of a number of regional races and ecologic forms that cannot be adequately investigated in a local study such as this. Two varieties of *M. cirrosum*, neither free of intergradations with each other or with more typical *M. cirrosum*, have been recognized.

*M. cirrosum* var. *jamaicense* (Mitt.) Grout. Bryol. 47: 9. 1944.

*M. jamaicense* Mitt. Journ. Linn. Soc. London, Bot. 12: 209. 1869.

*M. allipes* C. M. Bull. Herb. Boiss. 5: 559. 1897.

*M. werckleanum* Thér. Réc. Soc. Havraise d'Études Div. 1921(4): 307. 1921.

Stem leaves 3 to 4 mm. long; upper leaf cells rather irregular in shape, isodiametric, 5 to 7  $\mu$ , arranged in irregular longitudinal rows, sometimes furrowed. Perichaetial leaves somewhat shorter than stem leaves, abruptly short-acuminate, serrate, with cells elongate throughout. Seta about 10 mm. long.

On trees and rocks in wet mountain forests of Luquillo mountains and Cordillera Central of Puerto Rico; Cuba, Jamaica, and Haiti; Guatemala.

*M. cirrosum* var. *stenophyllum* (Mitt.) Grout. Bryol. 47: 9. 1944.

*M. stenophyllum* Mitt. Jour. Linn. Soc. London, Bot. 12: 215. 1869.

*M. laevisetum* Mitt. Ibid. 214.

Very close to var. *jamaicense*; typically with leaf cells more plainly seriate than those of *M. cirrosum*; costa more excurrent; perichaetial leaves somewhat shorter than stem leaves, abruptly short-acuminate, serrate, with cells elongate throughout. Seta about 15 to 22 mm. long; capsule often somewhat plicate.

On trees, known from a few localities in Puerto Rico in wet forests on high mountains; Cuba, Jamaica, and Haiti; Guatemala.

(3) *Schlotheimia* Schwaegr. Suppl. Sp. Musc. I. 2: 39. 1816.

Medium-sized plants in dense, usually reddish-brown mats, sometimes green at tips. Primary stems elongate, creeping; secondary stems crowded, suberect, tomentose, bearing short, stout branches above. Leaves crowded, erect and often spirally twisted around stem when dry, lanceolate or ligulate, often rugose, entire and unbordered; costa strong; cells small and rounded or oblate above, incrassate, elongate below. Calyptra campanulate, large, covering capsule, usually smooth except at apex, not plicate, lobed at base. Capsules mostly exserted, erect, subcylindric, smooth or somewhat ribbed; annulus lacking; operculum long-rostrate; peristome teeth narrowly lanceolate, papillose, reddish; segments shorter, or rudimentary.

Leaves not or obscurely rugose; perichaetial leaves broadly acute and short-apiculate

Leaves finely rugose above; perichaetial leaves slenderly acuminate, not apiculate

(a) *S. jamesonii*

(b) *S. torquata*

(a) *Schlotheimia jamesonii* (Arn.) Brid. Bryol. Univ. 1: 742. 1826.

*Orthotrichum jamesoni* Arn. Mem. Wern. Nat. Hist. Soc. 5: 201. 1824.

*Schlotheimia hansenii* C. M. Hedwigia. 37: 238. 1898.

Secondary stems crowded, up to 10 mm. high, sparsely branched. Leaves crowded, appressed and spirally twisted around stem when dry, erect-spreading when moist, about 2 mm. long, lingulate, rounded-obtuse and mucronate, not rugose above; costa short-excurrent; upper cells smooth, rounded or oblate and incrassate toward margins, oval and about 2:1 near costa, becoming oblong-linear, very incrassate, and porose toward base. Perichaetial leaves not rugose, broadly acute and short-apiculate, about 2 times as long as stem leaves. Seta about 7 or 8 mm. long; urn 2 to 3 mm. long. Calyptra slightly scabrous above.

On tree trunks and rock in mountain forests, known from single localities in Luquillo Mts. and Cordillera Central; Jamaica; Galapagos Islands; Brazil, Venezuela, Ecuador, and Bolivia.

(b) *Schlotheimia torquata* (Hedw.) Brid. Bryol. Univ. 1: 323. 1826.

*Hypnum torquatum* Hedw. Sp. Musc. 246. 1801.

*Neckera torta* Swartz. Prodr. Fl. Ind. Occ. 1800. 1806, nom.

*Schlotheimia nitida* Schwaegr. Suppl. Sp. Musc. II. 2(1): 51. 1826.

*S. sprengelii* Hornsch. In Mart., Fl. Brasil. 1(2): 34. 1840.

*S. pabstiana* C. M. Bot. Zeit. 13: 764. 1855.

*S. unguiculata* Mitt. Journ. Linn. Soc. London, Bot. 12: 226. 1869.

*S. sartorii* Schimp. ex Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg. **16**: 191. 1872.

*S. pellucida* C. M. Bull. Herb. Boiss. **5**: 561. 1897.

*S. undatorugosa* C. M. Hedwigia. **37**: 238. 1898.

*S. macrospora* C. M. Bull. Herb. Boiss. **6**: 103. 1898.

Secondary stems crowded, 0.5 to 2 cm. high, sparsely branched. Leaves crowded, appressed and spirally twisted around stem when dry, erect-spreading when moist, about 1.5 mm. long, lingulate, rounded-obtuse and mucronate, rugose above; costa subpercurrent to short-excurrent; upper cells smooth, rounded or oblate and incrassate toward margins, 6 to 8  $\mu$ , oval, about 2:1 near costa, becoming oblong-linear, strongly incrassate and porose toward base. Perichaetial leaves not rugose, slenderly acuminate, about twice as long as stem leaves. Seta 4 to 6 mm. long; urn about 2 mm. long. Calyptra slightly scabrous above.

On trees and shrubs in wet forests of high mountains, both in Luquillo Mts. and in Cordillera Central of Puerto Rico; West Indies; Mexico, Guatemala, British Honduras; South America.

#### HELICOPHYLLACEAE

Plants in extensive, flat, yellowish or glaucous green mats. Stems stiff, strongly flattened, elongate, creeping, irregularly branched, densely tomentose. Leaves strongly dimorphous, lateral in 2 opposite rows, spreading at right angles to stem, strongly inrolled when dry, lingulate, broadly rounded at apex, plane and entire at margins and narrowly bordered by yellow cells; costa strong, ceasing near leaf apex; cells rounded-hexagonal, very green, unipapillose on either surface. Ventral leaves in 2 rows, much smaller, erect, lanceolate, yellowish and transparent, cells rectangular, mostly faintly bipapillose on each surface. Dioicous; perichaetial leaves erect, pale, resembling ventral leaves but larger; costa excurrent. Seta short; capsule immersed, erect, oblong, smooth; no annulus; operculum flat, umbonate; no peristome.

Monotypic family, represented throughout tropical and subtropical America by single species.

*Helicophyllum* Brid. Bryol. Univ. **2**: 771. 1827.

With characteristics of family.

*Helicophyllum torquatum* (Hook.) Brid. Bryol. Univ. **2**: 771. 1827.

*Anictangium torquatum* Hook. Musci Exot. **1**: pl. 41. 1818.

*Helicophyllum guatemalense* C. M. Bull. Herb. Boiss. **5**: 201. 1897.

*H. jamaicense* C. M. *Ibid.* 561.

*H. portoricense* C. M. *Ibid.* 562.

*H. cubense* C. M. *Ibid.*

*H. diversifolium* C. M. *Ibid.* 563.

Stems to 4 or 5 cm. long. Lateral leaves 1.5 to 2 mm. long. Ventral leaves small, imbedded in reddish-brown tomentum that covers lower side of stems.

On rock faces, often covering large areas, and on tree trunks, at middle

altitudes in mountains of Puerto Rico; West Indies; Mexico to South America.

## RHACOPILACEAE

Rather coarse, medium-sized plants with creeping, radiculose stems and dimorphous leaves. Lateral leaves 2-ranked, asymmetric, contorted when dry, dorsal leaves also 2-ranked, much smaller; costa single and strong; cells rounded-hexagonal or oval-hexagonal, chlorophyllose, smooth or unipapillose. Male inflorescences terminal; female inflorescences lateral on special, short, rhizoidous branches. Calyptra mostly cucullate, with few to many long, erect hairs. Seta elongate; capsule nodding, ribbed when dry; annulus deciduous; operculum long-rostrate; peristome double, complete.

*Rhacopilum* P.-B., Prodr. 36. 1805.

Lateral leaves obliquely inserted, spreading almost perpendicularly to stem when moist, ovate-lanceolate, acute, plane and serrate at margins, unbordered; dorsal leaves ovate-lanceolate to lanceolate, appressed; cells smooth or nearly so, scarcely differentiated at base. Perichaetial leaves differentiated. Seta red, smooth; peristome teeth lance-acuminate, segments broad, basal membrane high, 3 cilia.

*Rhacopilum tomentosum* (Hedw.) Brid. Bryol. Univ. 2: 719. 1827.

*Hypnum tomentosum* Hedw. Sp. Musc. 240. 1801.

*Rhacopilum angustatum* Schimp. ex Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg. 16: 256. 1872.

*R. tomentosum* var. *gracile* Besch. *Ibid.*

*R. latistipulatum* Card. Rev. Bryol. 38: 41. 1911.

Stems freely branched. Leaves contorted when dry, smaller near branch tips. Lateral leaves up to 2 mm. long, ovate, subulate by long-excurrent costa, coarsely and unevenly serrate above middle; cells small, oval-hexagonal, about 8 to 12  $\mu$  wide. Dorsal leaves smaller, triangular-lanceolate, more gradually acuminate with excurrent part of costa nearly as long as rest of the leaf. Autoicous; perichaetial leaves smaller than stem leaves, subulate-acuminate. Seta red, 1.5 to 3.0 cm. long; urn oblong-cylindric, curved, 3 to 5 mm. long; teeth of peristome brown with pale, papillose tips, endostome pale, papillose, segments split along keel, cilia shorter, nodose to appendiculate (FIGURE 33).

On calcareous rock, from few localities in higher parts of coastal plain of Puerto Rico; common throughout American tropics north to Florida and Louisiana in United States.

## CRYPHAEACEAE

Mostly rigid plants with elongate, creeping primary stems and elongate branches, suberect or rarely pendent secondary stems. Leaves usually imbricate when dry, concave, usually not plicate, ovate-lanceolate or ovate, usually more or less decurrent at base; costa single; cells smooth or nearly

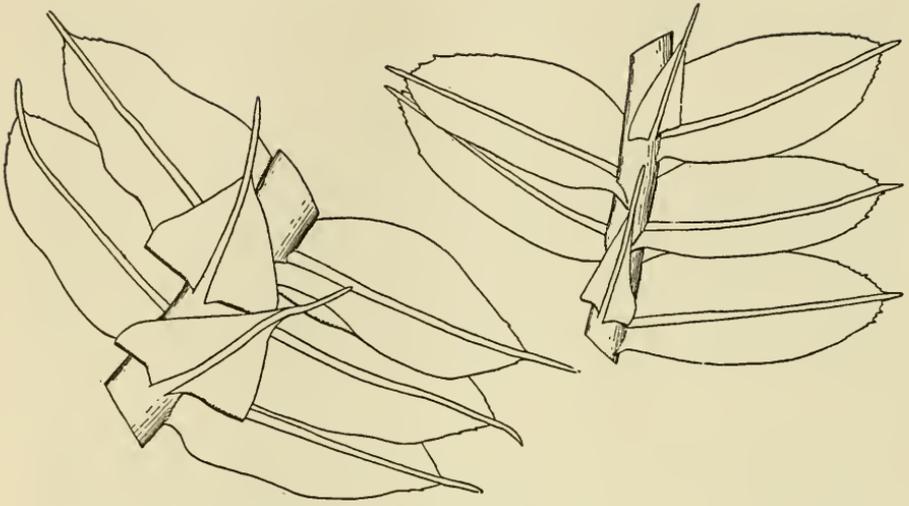


FIGURE 33. Portion of 2 plants of *Rhacopilum tomentosum*, showing variation in size of dorsal (amphigastria) leaves (Steere, 1935).

so, oval or only slightly elongate, usually subquadrate in oblique rows at base angles. Autoicous; inflorescences borne on secondary stems or branches; perichaetial leaves clearly differentiated, sheathing. Calyptra small, conic. Seta short; capsule erect and symmetric, immersed; annulus usually present; peristome inserted below mouth, usually double, the 16 teeth flat, thin, pale, mostly more or less papillose; inner peristome (rarely lacking) with low basal membrane and narrow segments rarely keeled.

Delicate plants in long, pendent masses; leaves lanceolate. . . . . (2) *Dendropogonella*  
Coarse, rigid plants; stems erect or suberect; leaves ovate.

Sporophytes produced at end of very short branches bearing only perichaetial leaves; peristome double. . . . . (1) *Cryphaea*

Sporophytes produced at end of short, leafy branches; peristome single  
(3) *Acrocryphaea*

(1) *Cryphaea* Weber. Tab. Calypt. Operc. Musc. Frond. Gen. 5. 1813.

Secondary stems ascending, subpinnately branched. Leaves ovate, short-pointed; margins more or less recurved, entire or serrate above; costa extending to midleaf or beyond; cells oval, incassate, smooth or faintly papillose, longer near costa and rounded or rhombic toward basal margins. Sporophytes produced on very short branches; inner perichaetial leaves scarious, usually truncate and aristate by long-excurrent costa. Calyptra conic, somewhat rough. Capsule subcylindric; annulus deciduous; peristome nearly always double, pale, more or less papillose, teeth lanceolate, segments linear, about as long as teeth, no cilia.

*Cryphaea funalis* C. M. Hedwigia. 37: 241. 1898.

Rigid, brownish plants in loose, extensive mats. Primary stem creeping, rather long and filiform; branches ascending, straight or flexuose, long and filiform, terete, fragile, shortly branched. Stem leaves small, crowded, ap-

pressed when dry, spreading when moist, ovate-acuminate, subclasping at base, plane and entire at margins; costa vanishing before acumen; cells elliptic, incrassate. Monoicous; perichaetial leaves large, narrowed to long acumen from broad, sheathing base, inner leaves broadly emarginate, costa excurrent as an awn. Calyptra conic, small, smooth, entire at base; operculum conic; annulus narrow; peristome double, normally developed (translation of original description).

Known only from the original collection at Cayey, Puerto Rico, where it was collected by Sintenis on the trunks of trees. It is quite possible that the species is nothing more than *C. filiformis* (Sw.) Brid., which is fairly common in the Caribbean area.

(2) *Dendropogonella* Britt. Bryol. 9: 39. 1906.

Plants rather robust, red-brown, in delicate pendulous mats. Secondary stems very long and slender, flexuose, freely branched, branches long. Leaves lanceolate, acuminate, decurrent; costa slender, ending in acumen; cells elongate, incrassate, smooth. Calyptra small, cucullate, short-lobed at base, smooth. Seta short; capsule ovoid, immersed; operculum conic; peristome teeth pale, nearly smooth, endostome shorter than teeth, basal membrane low, no cilia.

*Dendropogonella rufescens* (Schimp.) Britt. Bryol. 9: 39. 1906.

*Dendropogon rufescens* Schimp. Bot. Zeit. 1: 377. 1843.

Secondary stems up to 20 cm. or more in length, subpinnately branched. Leaves loosely appressed with spreading tips when dry, erect-spreading when moist, 3 to 4 mm. long, lanceolate, gradually long-acuminate, biplicate and decurrent at base; margins narrowly recurved near base, serrulate above; upper cells linear-rhomboidal, oblong at insertion (FIGURE 34).

On trunks and branches of trees, not yet known from Puerto Rico; Virgin Islands (St. Thomas); Mexico, Guatemala, and Costa Rica.

(3) *Acrocryphaea* Schimp. Bryol. Eur. fasc. 44-45. 1850, nom.

Plants rather robust, green or yellowish, becoming brown. Secondary stems rigid, julaceous, spreading, rather unequally branched above. Leaves appressed, ovate, acute to narrowly acuminate; margins plane or recurved, entire or serrulate above; costa vanishing well below apex; upper cells oval, incrassate. Perichaetia terminal on short, leafy branches, inner leaves abruptly awned from broad, sheathing base. Calyptra conic, covering only operculum, rough, lobed. Operculum conic; peristome single, teeth lanceolate-subulate, white, densely papillose.

*Acrocryphaea coffeae* (C. M.) Paris. Index Bryol. Suppl. 1. 1900.

*Cryphaea coffeae* C. M. Hedwigia. 37: 240. 1898.

Secondary stems subpinnately branched, erect-ascending, 2 to 3 cm. long. Stem and branch leaves similar, widely spreading when moist, about 1.5 mm. long, broadly ovate, short-acuminate, broadly decurrent; margins narrowly

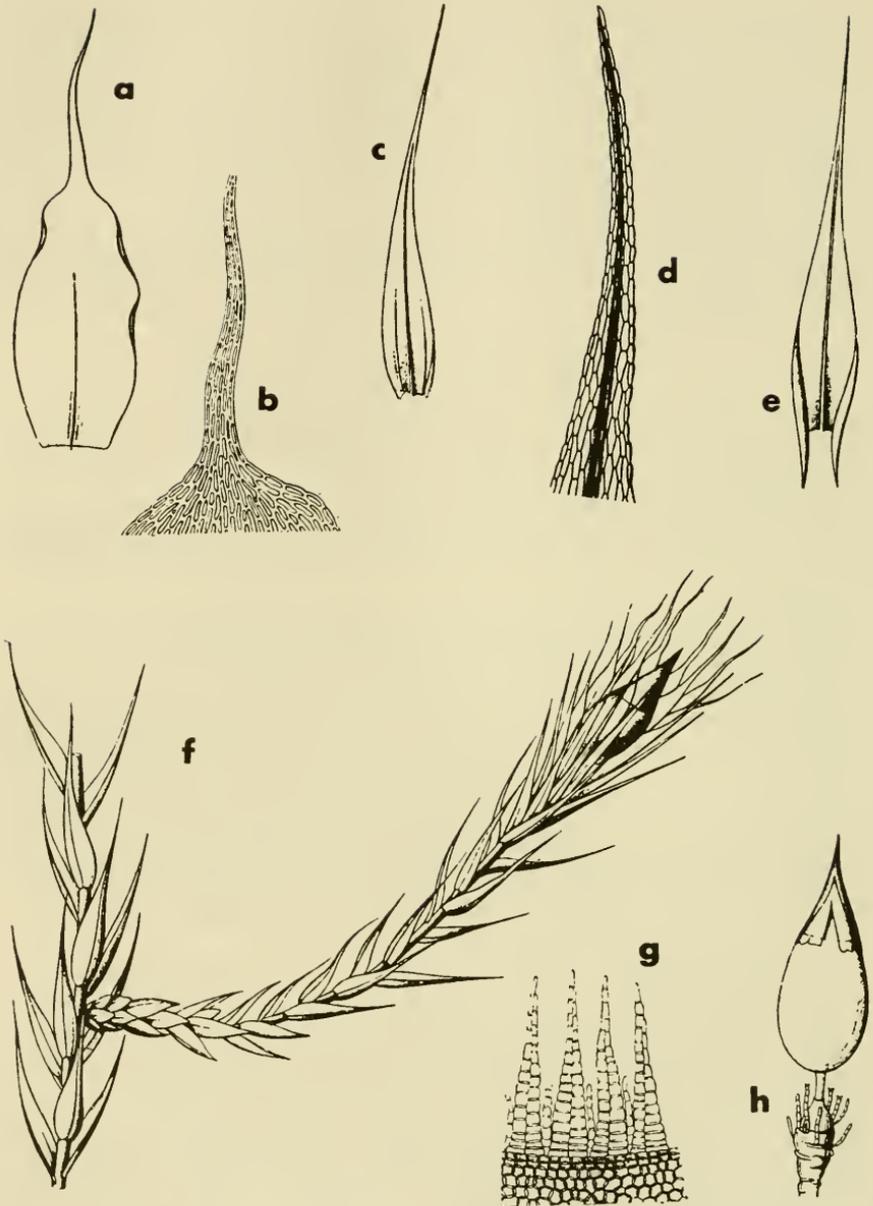


FIGURE 34. *Dendropogonella rufescens*: (a) perichaetial leaf, (b) cells at tip of perichaetial leaf, (c) branch leaf, (d) cells at tip of branch leaf, (e) stem leaf, (f) portion of stem, with fruiting branch, (g) portion of peristome, and (h) sporophyte (Schimper, 1843).

and indistinctly recurved near base, or sometimes plane, serrulate near apex; costa ending  $\frac{1}{2}$  to  $\frac{2}{3}$  up; cells oblong-oval, about 2:1, faintly papillose by projecting cell ends, basal cells linear near costa, obliquely oval in many rows toward margins. Autoicous; perigonia abundant on secondary stems;

perichaetial branches 2 to 8 mm. long, inner leaves pale, oblong-oval, clasping, abruptly contracted to stout, serrulate awn formed by excurrent costa. Calyptra conic, entire at base, moderately scabrous. Seta lacking or very short; capsule immersed, cylindrical, urn about 1.25 mm. long; operculum high-conic; annulus large, white, revoluble. Spores spheric, smooth, or very minutely roughened, 22 to 30  $\mu$ .

On trunks of trees, especially coffee trees, in foothills and at lower altitudes in mountains of Puerto Rico; Cuba, Jamaica, and Haiti.

#### LEUCODONTACEAE

Rather robust plants with creeping primary stems; secondary stems erect or ascending, rarely pendulous, simple or branched, julaceous. Leaves crowded, appressed, ovate or lanceolate, short-pointed, somewhat decurrent, unbordered; costa single or double, sometimes lacking; cells incrassate, mostly smooth and rhomboidal above, elongate below, subquadrate or broader than long in numerous rows at basal angles. Dioicous; inflorescences borne on secondary stems; inner perichaetial leaves elongate, sheathing. Calyptra cucullate, usually naked. Capsules ovoid to oval-cylindrical, erect, usually exerted; annulus usually differentiated; operculum obliquely conic-rostrate; peristome-double, basal membrane of endostome low, segments lacking or rudimentary, no cilia.

Leaf cells smooth; plants bearing small flagelliform branches in leaf axils

Leaf cells papillose; no flagelliform branches. . . . . (2) *Pseudocryphaea*  
 (1) *Leucodontopsis*

- (1) *Leucodontopsis* Ren. & Card. Bull. Soc. Roy. Bot. Belg. 32(1): 177. 1893.

Medium-sized, light green or brownish plants in loose tufts. Primary stems prostrate; secondary stems erect or spreading, short and straight or elongate and bent, generally narrowed toward apex, simple or sparsely branched, often producing septate propagula at leaf axils. Leaves closely appressed and somewhat wrinkled when dry, erect-spreading when moist, oblong-lanceolate, slightly decurrent, acute to apiculate; margins revolute nearly to apex, entire to serrulate at apex; costa single, very slender, ending near mid-leaf, rarely lacking; median cells linear-flexuose, with 1 to 2 low papillae on either surface, rounded or quadrate to oblate in large alar group. Perichaetial leaves erect-appressed, oblong, gradually acuminate, with costa disappearing in slender points, leaf cells papillose. Setae 4.5 to 5 mm. long, straight or slightly flexuose. Capsules erect and symmetric, oblong-cylindrical, 1.5 to 1.7 mm. long; opercula subulate, about 0.7 mm. long; peristome teeth short, lanceolate, smooth, and yellowish.

*Leucodontopsis geniculata* (Mitt.) n. comb.

*Leucodon geniculatus* Mitt. Jour. Linn. Soc. London, Bot. 12: 409. 1869.

*Neckera floridana* Aust. Bot. Gaz. 4: 152. 1879.

*Leucodontopsis plicata* Ren. & Card. Bull. Soc. Roy. Bot. Belg. 32(1): 177. 1893.

*L. horeana* Ren. & Card. *Ibid.* 34(2): 66. 1895.

*L. floridana* var. *latifolia* Thér. Bull. Soc. Bot. Genève II. 17: 255. 1925.  
*L. floridana* var. *gracilis* Thér. *Ibid.*

Secondary stems 1 to 2 cm. long. Leaves 1.5 to 2 mm. long, ovate- or oblong-lanceolate, plicate, concave, acute, slightly serrulate above; costa faint; median leaf cells about  $6 \mu$  wide, 6 to 12:1, differentiated alar cells extending about half way to costa, other basal cells short, incrassate, colored.

On tree trunks, decaying logs, and rarely on rock, widely distributed in foothills and on lower slopes of mountains of Puerto Rico, although apparently not yet collected in eastern end of island; United States (Florida); West Indies; Mexico to South America; Trinidad.

(2) *Pseudocryphaea* Britt. Bull. Torrey Bot. Club. 32: 261. 1905.

Loosely to densely tufted plants. Secondary stems simple below, branched above; branches stiffly spreading julaceous, usually bearing filiform, microphyllous branchlets in leaf axils. Leaves imbricate when dry, erect-spreading when moist, ovate to ovate-lanceolate, acute to broadly short-acuminate; margins plane, serrulate above; costa single, slender, nearly percurrent, serrulate at back above; median cells linear-rhomboidal, shorter and sometimes obscurely papillose above, incrassate, colored and porose at base, smaller, rounded-quadrate in alar regions. Seta long, slender, erect; capsule ovoid, brownish; peristome unknown.

*Pseudocryphaea flagellifera* (Brid.) Britt. Bull. Torrey Bot. Club. 32: 261. 1905.

*Pilotrichum flagelliferum* Brid. Bryol. Univ. 2: 259. 1827.

*Cryphaea leptoclada* Sull. Proc. Amer. Acad. Arts and Sci. 5: 283. 1861.

*Leucodon domingensis* Mitt. Journ. Linn. Soc. London, Bot. 12: 409. 1869.

Rigid, more or less dendroid plants with secondary stems up to 5 or 6 cm. long. Median leaf cells about  $9 \mu$  wide, 5 or 8:1, rounded, sinuose and incrassate in 10 to 12 rows at basal angles.

On trunks and branches of trees, rarely on rock, widespread in foothills and lower slopes of mountains of Puerto Rico; United States (Florida); West Indies; Mexico to South America.

#### PTEROBRYACEAE

Plants usually robust and glossy, often beautifully dendroid or frondose. Primary stems creeping; secondary stems mostly freely branched from woody, stipitate base. Leaves symmetric, acuminate; costa slender, single, or often double or lacking; cells elongate, sometimes incrassate and porose, usually smooth, sometimes differentiated at basal angles. Perichaetial leaves differentiated. Calyptra small, mitrate to cucullate. Seta rather short; capsule erect and symmetric, immersed to exserted; operculum conic to short-rostrate; peristome usually inserted well below mouth, endostome usually rudimentary or lacking.

Leaves widely spreading or squarrose, not seriate; costa variable on same plants

(1) *Jaegerina*

Leaves imbricated, more or less spirally seriate.

Leaves strongly spiralled; costa lacking..... (2) *Orthostichidium*

Leaves sometimes more or less spiralled; costa single..... (3) *Pirella*

(1) *Jaegerina* C. M. Linnaea. 40: 273. 1876.

Rather large, stiff plants in loose, green to brown tufts. Secondary stems erect, rather elongate and flexuose, simple or sparsely branched, often bearing linear, septate propagula in leaf axils. Leaves widely spreading to squarrose, sometimes plicate, lance-acuminate from ovate or cordate base; margins plane, entire or serrulate above; costa sometimes variable, single and slender, reaching nearly to leaf apex, or very short and double, or lacking; cells narrowly linear, smooth or minutely unipapillose, porose, usually laxer at base, scarcely differentiated in small alar groups. Dioicous. Seta straight, 5 to 8 mm. long; capsule oval or subglobose; annulus broad, adhering to rostrate operculum; peristome single, hyaline teeth broadly lanceolate, somewhat paired, without lamellae, smooth or sometimes finely papillose.

*Jaegerina scariosa* (Lor.) Arzeni. Amer. Midland Nat. 52: 12. 1954.

*Meteorium scariosum* Lor. Moosstudien. 165. 1864.

*Jaegerinopsis squarrosa* Britt. Bryol. 21: 48. 1918.

Secondary stems simple, 1 to 4 or 5 cm. high. Leaves crowded, widely spreading, about 1.5 to 3 mm. long, concave, broadly ovate from subcordate base, acute to short-acuminate; margins serrulate to base, often recurved; costa usually single, often ending above midleaf, sometimes short and double, or lacking; cells linear-flexuose, smooth, porose, lax and colored at insertion, scarcely differentiated at basal angles. Perichaetial leaves convolute, about  $\frac{1}{2}$  length of seta. Seta 4 mm. long; urn of capsule oblong-cylindric, about 2.5 mm. long; peristome teeth short, blunt, smooth. Sporophyte not seen (FIGURE 35).

On trunks of trees and rotten wood, known in Puerto Rico from only 2 localities—in mountains south of Maricao and in limestone foothills south of Arecibo; United States (Florida); West Indies; Mexico and Central America.

(2) *Orthostichidium* C. M. ex Dusén. K. Sv. Vet.-Akad. Handl. 28(2): 19. 1895.

Loosly tufted, glossy green or golden-green plants. Secondary stems erect or ascending, sometimes pendent, more or less elongate, densely foliate to base, irregularly pinnate, often bearing hyaline, cylindric propagula; branches spreading, straight or curved, pointed. Leaves imbricate when dry, erect-spreading when moist, very concave, not plicate, spirally seriate on branches, oblong and short-pointed, cordate at base; margins entire, broadly inflexed above; costa lacking; cells smooth, linear, long and sinuose, shorter and laxer at brownish-yellow insertion, oval-hexagonal in small, poorly defined alar groups. Inner perichaetial leaves erect and sheathing, gradually or abruptly long-acuminate, entire. Calyptra mitrate, smooth, covering only operculum. Capsule immersed, ovate or oval; annulus of a single row of cells; peristome teeth inserted below mouth, narrow, smooth, yellow, with preperistome; endostome lacking.

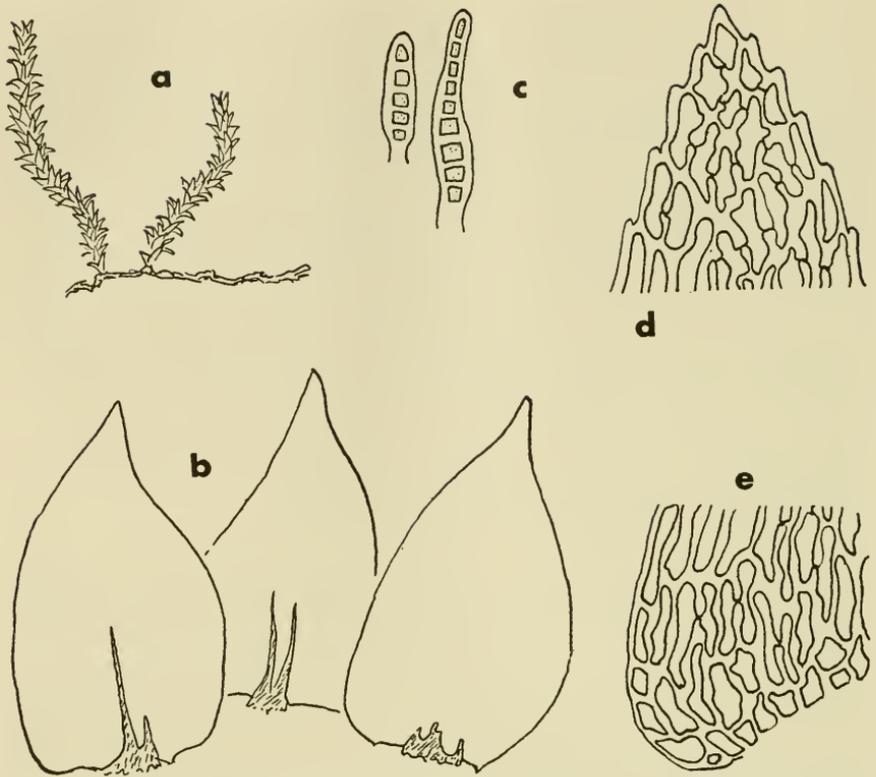


FIGURE 35. *Jaegerina scariosa*: (a) plant, (b) leaves, showing variability of costa, (c) propagula, (d) cells at leaf tip, and (e) alar cells (Britton, 1918).

*Orthostichidium pentagonum* (Hampe & Lor.) C. M. Bull. Herb. Boiss. 5: 205. 1897.

*Pilotrichum pentagonum* Hampe & Lor. Bot. Zeit. 27: 449. 1869.

*Meteorium excavatum* Mitt. Journ. Linn. Soc. London, Bot. 12: 430. 1869.

*Orthostichidium subtetragonum* C. M. Bull. Herb. Boiss. 5: 205. 1897.

Plants loosely tufted or pendent. Secondary stems spreading, 4 to 8 cm. long. Branch leaves usually in 5 distinct spiral rows, 1.5 to 3.0 mm. long, concave, cucullate at acute to short-acuminate apex; cells long-linear, up to  $67 \times 2$  to  $4 \mu$ , often porose. Perichaetial leaves up to 3.5 mm., gradually long-acuminate. Seta 0.8 to 1.0 mm. long, smooth; peristome teeth hyaline, with preperistome of a few short segments. Spores smooth, polymorphous, averaging  $40 \mu$ .

On trunks and branches of trees, rarely on rock, in wet mountain forests of Cordillera Central of Puerto Rico; apparently not yet collected in Luquillo Mts.; West Indies; Mexico and Central America; Ecuador and Peru; Trinidad.

(3) *Pirella* Card. Rev. Bryol. 40: 17. 1913, non *Pirella* Bainier, 1883.

Slender, dark-green to yellowish plants. Secondary stems usually frondose from stipitate base, frequently bearing cylindrical propagula. Stipe-leaves

mostly appressed, ovate, abruptly acuminate, entire, ecostate. Upper stem leaves erect-spreading, ovate, acuminate; margins plane, subentire; costa single, strong, usually ending well below leaf apex. Branch leaves often serrate, similar to stem leaves, or smaller, erect, very concave, ovate-lanceolate, acute, serrulate above; costa ceasing below apex to percurrent; cells oval or oblong-linear, firm-walled, often subquadrate at basal angles. Dioicous. Calyptra cucullate, covering urn, pilose when young. Seta erect or curved, often somewhat roughened above, red; capsule generally exserted, erect, ovoid, brown; operculum small, usually rostrate; exostome teeth slit at base, often adhering in pairs at tips, smooth, without lamellae, endostome rudimentary, consisting of a hyaline membrane, adherent to exostome.

Stipe leaves squarrose.....(c) *P. angustifolia*  
 Stipe leaves appressed.

Plants irregularly branched from base or from very short stipe; costa percurrent; alar cells clearly differentiated.....(a) *P. cymbifolia*  
 Plants frondose above definite stipe; costa ending near midleaf; alar cells not noticeably differentiated.....(b) *P. cavifolia*

(a) *Pirella cymbifolia* (Sull.) Card. Rev. Bryol. 40: 17. 1913.

*Pilotrichum cymbifolium* Sull. Musci and Hepaticae of U. S. 81. 1856.

*Pirella denticulata* Card. & Thér. Rev. Bryol. 40: 17. 1913.

*Pilotrichella nana* Hampe ex Besch. Journ. de Bot. 15: 384. 1901, nom.

Secondary stems 2 to 7 cm. high, irregularly branched from base, or sometimes dendroid from short stipe, often bearing flagelliform branches up to 7 cm. long; gemmae axillary, consisting of 3 to 12 uniseriate cells. Branch leaves distinctly 5-seriate, 1.5 to 2.0 mm. long, oblong-lanceolate, short-acuminate, entire or serrulate above; costa percurrent; cells linear, 5 or 10:1, thin-walled, shorter, yellow and porose at base, 6 to 16 rows of subquadrate cells clearly differentiated at alar regions. Stem leaves similar, up to 3.0 mm. long. Perichaetial leaves 0.8 to 1.0 mm. long, lanceolate, slenderly acuminate, ecostate. Seta smooth, 8 to 10 mm. long; capsule 2 to 2.25 mm. long; exostome teeth very irregular and perforate; endostome consisting of transparent fragments adhering to exostome. Spores spheric, brownish, finely papillose, 22 to 28  $\mu$ .

On tree trunks, occasionally on rock, known in Puerto Rico only from Río Abajo area south of Arecibo (*W. C. S.* 6680), but also collected on Vieques Island and in Virgin Islands (St. Jan); southeastern United States; West Indies; Mexico, Guatemala and British Honduras; Ecuador.

(b) *Pirella cavifolia* (Card. & Herz.) Card. Rev. Bryol. 40: 17. 1913.

*Pirella cavifolia* Card. & Herz. Rev. Bryol. 38: 39. 1911.

*Jaegerinopsis ramosa* Thér. Mem. Soc. Cubana Hist. Nat. 14: 359. 1940.

Secondary stems stipitate, loosely pinnate above, 1.5 to 4.0 cm. high; branches 0.5 to 1.5 cm. long, often bearing minute branchlets with reduced leaves. Stipe leaves appressed; branch leaves 5-seriate, broadly ovate to ovate-lanceolate, apiculate or short-acuminate, not plicate, 0.9 to 2.5 mm. long, entire or serrulate above; costa ending near midleaf; cells linear, 5 to 9:1 in median region, somewhat incrassate, often bearing small papilla at

either end at back, shorter at apex and at yellow insertion, irregularly subquadrate and yellowish in small, poorly defined alar groups. Sporophyte unknown.

On tree trunks, known in Puerto Rico from single locality, Mt. La Torrecilla, near Barranquitas (*W. C. S.* 4657) in Cordillera Central; Cuba and Jamaica; Mexico and Surinam.

(c) *Pireella angustifolia* (C. M.) Arzeni. *Amer. Midland Nat.* 52: 29. 1954.

*Pilotrichum angustifolium* C. M. *Syn. Musc. Frond.* 2: 181. 1851.

*Pterobryum integrifolium* Hampe ex Besch. *Journ. de Bot.* 8: 62. 1894.

Secondary stems about 3 to 4.5 cm. long, pinnately branched above short stipe to form dense, oblong frond. Stipe leaves squarrose-recurved. Frond leaves erect-spreading, about 2 mm. long, lanceolate from broadly ovate base, faintly plicate below; margins serrulate nearly all around; costa percurrent; cells linear, shorter and colored across insertion. Perichaetium conspicuous, inner leaves oblong-lanceolate, costa excurrent. Capsule ovoid, immersed, 2 mm. long; operculum conic-apiculate.

On tree trunks, logs, stumps, and brush, rarely also on humus and boulders; known locally only from Virgin Islands (*vide* C. B. Arzeni); West Indies; Trinidad; Central America.

#### METEORACEAE

Slender to robust plants. Primary stems filiform, creeping, secondary stems elongate, usually pendent, freely branched. Leaves mostly ovate-lanceolate, acuminate; costa usually single and slender, sometimes short and double, or lacking; cells elongate, often papillose. Perichaetial leaves differentiated. Capsule mostly small and symmetric, usually exerted on a short seta; operculum usually short-rostrate from conic base; peristome double.

Costa short and double, or lacking. . . . . (2) *Pilotrichella*  
Costa single.

Cells smooth.

Leaves squarrose or recurved. . . . . (6) *Meteoriopsis*

Leaves loosely or tightly appressed. . . . . (1) *Squamidium*

Cells papillose.

Cells pluripapillose. . . . . (3) *Papillaria*

Cells unipapillose.

Branches more or less flattened, laxly foliate; branch leaves gradually acuminate  
(5) *Aerobryopsis*

Branches terete, densely foliate; branch leaves abruptly acuminate, plicate at least  
when dry. . . . . (4) *Meteorium*

(1) *Squamidium* (C. M.) Broth. *In* E. & P., *Nat. Pfl.* 1(3): 807. 1906.

Glossy plants in lax tufts or mats. Secondary stems numerous, crowded, short or considerably elongated and pendent; branches julaceous. Leaves imbricate, often distinctly spiralled, oval to ovate, abruptly apiculate or filiform-acuminate, deeply concave, not plicate; margins erect, or inflexed above, entire or serrulate above; costa very slender, ending well below leaf apex; cells narrowly linear, smooth, differentiated at basal angles. Calyptra mitrate, lobed, covering only upper part of urn, more or less hairy. Seta

short; capsules large, immersed or shortly exerted; annulus persistent; operculum straight-beaked; peristome teeth subulate-lanceolate, yellow, somewhat papillose, segments yellowish, papillose, subulate, nearly as long as teeth, keeled, basal membrane low, no cilia.

Leaves apiculate.....(a) *S. nigricans*  
 Leaves filiform-acuminate.....(b) *S. leucotrichum*

(a) *Squamidium nigricans* (Hook.) Broth. *In* E. & P., *Nat. Pfl.* 1(3): 808. 1906.

*Hypnum nigricans* Hook. *In* Kunth, *Syn. Pl. Aequin.* 1: 64. 1822.

*Meteorium macranthum* Dozy & Molk. *Prodr. Bryol. Surinam.* 47. 1854.

*M. macranthum* var. *portoricense* C. M. Hedwigia. 37: 241. 1898.

Pale or yellow-green plants, tinged with brown or black. Secondary stems up to 10 cm. or more, loosely and irregularly pinnate, or sometimes closely pinnate. Stem and branch leaves similar. Branch leaves loosely imbricate, sometimes in distinct spiral rows, 1 to 1.5 mm. long, broadly oblong-ovate, abruptly apiculate; margins inflexed above, serrulate in upper half; costa ending well below apex; cells narrowly linear, somewhat pitted at insertion, subquadrate in rather small, greenish-yellow or hyaline groups at basal angles. Perichaetial leaves small, ovate-lanceolate, slenderly acuminate. Capsule immersed, ovoid. Antheridial inflorescences and sporophytes not seen.

On trunks, branches, and twigs of trees, also on rock, in wet forests of higher mountains of Puerto Rico at altitudes of 1000 ft. and over; West Indies; Mexico to South America.

(b) *Squamidium leucotrichum* (Tayl.) Broth. *In* E. & P., *Nat. Pfl.* 1(3): 809. 1906.

*Hypnum leucotrichum* Tayl. *London Journ. Bot.* 7: 196. 1848.

*Neckera tortipilis* C. M. Bot. *Zeit.* 13: 768. 1855.

*N. longebarbata* Hampe, *Linnaea.* 31: 525. 1862.

*Pilotrichella longipila* Schimp. ex Besch. *Ann. Sci. Nat., Bot.* VI. 3: 214. 1876.

Plants robust, yellow or light green becoming brown or black. Secondary stems pendent, up to 30 cm. or more, interruptedly pinnate; branches short and turgid, bristling with hair points of leaves. Stem leaves laxly appressed concave, ending in long, crisped hair points. Branch leaves about 3 to 4 mm. long, oblong-oval from cordate base, rather abruptly narrowed to long, flexuose, denticulate hair point; margins inflexed and serrulate above; costa ending well above midleaf; cells quadrate and incrassate in conspicuous, rounded, colored alar groups. Capsule immersed. Sporophyte not seen.

On trunks and branches of trees, occasionally on rock, in wet forests on mountain sides at elevations usually over 2000 ft. in Puerto Rico; West Indies; Guatemala, El Salvador, and Costa Rica; South America; Galapagos Islands.

- (2) *Pilotrichella* (C. M.) Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg. 16: 222. 1872.

Glossy green or golden, sometimes brownish or reddish plants, usually hanging in long, loose mats. Secondary stems numerous, long and flexuose, distantly pinnate. Leaves usually imbricated, sometimes clearly spiralled, ovate, acute to apiculate, deeply concave, not plicate; margins erect, more or less inflexed above, usually serrulate above; costa short and double, or lacking; cells linear, smooth, shorter and pitted at base, often clearly differentiated in auricles at basal angles. Calyptra cucullate, reaching nearly to middle of capsule, sparsely pilose. Seta mostly very short; capsule exerted; no annulus; operculum obliquely long-rostrate; peristome teeth pale, lanceolate, papillose, sometimes perforate above, segments linear, shorter than teeth, papillose, not keeled, basal membrane scarcely developed.

Secondary stems and branches tumid; leaf margins entire; alar cells in dark brown, sharply delimited groups..... (a) *P. flexilis*  
 Secondary stems and branches slender; leaf margins serrulate all around; alar cells not colored, poorly differentiated..... (b) *P. hexasticha*

- (a) *Pilotrichella flexilis* (Hedw.) Jaeg. Ber. St. Gall. Natur. Ges. 1875-76: 258. 1877.

*Leskea flexilis* Hedw. Sp. Musc. 235. 1801.

*Pilotrichum cochlearifolium* C. M. Linnaea. 17: 599. 1843, non C. M., 1851.

*Neckera turgescens* C. M. Syn. Musc. Frond. 2: 131. 1850.

*Meteorium orbifolium* Mitt. Journ. Linn. Soc. London, Bot. 12: 440. 1869.

*Pilotrichella flagellifera* Besch. In Fourn., Mex. Plantas 1: 39. 1872.

*P. recurvomucronata* C. M. Bull. Herb. Boiss. 5: 563. 1897.

*P. erosomucronata* C. M. *Ibid.*

Robust, yellow-green to red-brown plants with distantly pinnate, pendent secondary stems up to 25 or 30 cm. long; branches usually short and tumid. Leaves crowded, loosely imbricate or widely spreading, about 2.5 mm. long, broadly obovate, cucullate, auriculate, abruptly apiculate; margins entire, broadly inflexed above; cells narrowly linear, incrassate, porose, at basal angles small, rounded, and incrassate in well-defined brown groups. Seta 5 to 11 mm. long, rough above; capsule ovoid, 1.5 mm. long; peristome teeth incurved when dry.

On trees and shrubs, very rarely on rock, in wet mountain forests at elevations of 2000 to 3000 ft., widespread in Puerto Rico; West Indies; Mexico to South America.

This handsome species is reasonably variable throughout its wide range, but it can be distinguished easily from *P. hexasticha* by its larger size, darker color, and rounded groups of brown alar cells.

- (b) *Pilotrichella hexasticha* (Schwaegr.) Jaeg. Ber. St. Gall. Natur. Ges. 1875-76: 257. 1877.

*Hypnum hexastichum* Schwaegr., Suppl. Sp. Musc. I. 2: 210. 1816.

*Isotheceum thunbergii* Brid., Bryol. Univ. 2: 381. 1827.

Graceful, light green plants varying in size and habit of growth, but usually forming loosely tangled, pendent masses, sometimes as long as 15 or 20 cm. Stem leaves loosely imbricated, about 1 mm. long, oblong-ovate or sub-panduriform, cucullate, abruptly short-apiculate, ecostate; margins serrulate all around, broadly inflexed above; cells linear-flexuose, firm-walled, not porose, subquadrate or oblong in small, poorly defined alar groups. Branch leaves smaller, spirally seriate. Sporophytes not seen.

On tree trunks in mountain forests at upper altitudes, apparently restricted in Puerto Rico to Cordillera Central; widespread in West Indies; Costa Rica and Ecuador; probably represented in all other parts of tropical America by numerous synonyms.

(3) *Papillaria* C. M. Öfv. K. Sv. Vet.-Akad. Förh. 4: 34. 1876, nom. conserv., non Dulac, 1864.

Medium-sized to robust, dull green or yellowish plants often tinged with brown or black. Secondary stems numerous, usually elongate and often pendent, usually distantly and irregularly branched. Leaves loosely or tightly appressed, often plicate when dry, ovate or lanceolate from cordate or auriculate base, acute to filiform, rarely apiculate at apex; costa single; cells incrassate, rhomboidal, more or less obscure, bearing several papillae, larger, smooth and transparent at base, diagonally seriate at basal angles. Calyptra cucullate, hairy. Seta short; capsule small, immersed to exserted; annulus small or lacking; operculum rostrate; peristome teeth pale, narrow, papillose, segments of endostome linear, almost as long as teeth, basal membrane low, cilia rudimentary.

*Papillaria nigrescens* (Hedw.) Jaeg. Ber. St. Gall. Natur. Ges. 1875-76: 265. 1877.

*Hypnum nigrescens* Hedw. Sp. Musc. 250. 1801.

*H. appressum* Hornsch. In Mart. Fl. Brasil. 1(2): 90. 1840.

*Pilotrichum funale* Wils. Ann. and Mag. Nat. Hist. I. 20: 378. 1847.

*Meteorium revolutum* Lindb. Krit. Gransk. Moss. Dillenii Hist. Musc. 54. 1883.

Rather rigid, yellowish or brown to black plants in thin mats. Stems creeping, 10 to 15 cm. long, freely branched, often bearing minute, flagelliform branches in leaf axils. Leaves appressed when dry, erect-spreading when moist, faintly plicate, ovate from cordate base, slenderly acuminate, sometimes ending in short, concolorous hair point, up to 1.5 to 1.7 mm. long; margins plane, often undulate, entire above, serrulate below; costa slender, ending above midleaf; cells obliquely arranged, oval or oblong-linear, 5 to 8:1, papillose except near costa at base, subquadrate at basal angles. Seta about 6 mm. long; urn of capsule about 0.5 mm. long, ovoid, erect, exserted (FIGURE 36).

Weedy species, on trees and rock in foothills and on lower and middle slopes of Cordillera Central in Puerto Rico; United States (Florida and Louisiana); West Indies; Mexico to South America; China.

(4) *Meteorium* Dozy & Molk. Musc. Frond. Ined. Arch. Ind. 157. 1854.

Robust, dull or rather glossy plants. Secondary stems numerous, long, pendent, distantly branched. Leaves imbricate when dry, very concave and usually deeply plicate, oblong-ovate, cordate at base, abruptly acuminate or piliferous, sometimes apiculate; costa slender, ending below apex; cells long and narrow, transparent, bearing single papilla, or occasionally more than 1 over lumina, laxer at base and diagonally seriate at basal angles. Calyptra cucullate, hairy. Seta short, rough; capsule exerted, rather large; no annulus; peristome teeth pale, papillose, segments linear, papillose, about as long as teeth, basal membrane very low, cilia rudimentary.

*Meteorium illecebrum* (C. M.) Mitt. Journ. Linn. Soc. London, Bot. 12: 437. 1869.

*Neckera illecebra* C. M. Syn. Musc. Frond. 2: 137. 1851.

Secondary stems long, creeping or pendent, pinnately branched; branches short and blunt, typically tumid. Stem leaves about 3 to 4 mm. long, gradually long-acuminate, less concave, less plicate, and more strongly papillose than branch leaves. Branch leaves loosely appressed when dry, 2 to 3 mm. long, oblong-ovate from cordate base, concave, plicate, more or less abruptly contracted to slender acumen prolonged as jointed, hair point; margins papillose-denticulate, flexuose, inflexed at base of acumen; costa slender, ending near base of acumen; cells linear-flexuose, bearing 1 or sometimes 2 papillae. Seta up to 7 mm. long, scabrous above; urn ovoid, about 1.5 mm. long; operculum obliquely rostrate, about 1.5 mm. long. Sporophyte not seen.

On trees, shrubs, and rotten wood, occasionally on rock, in wet forests on

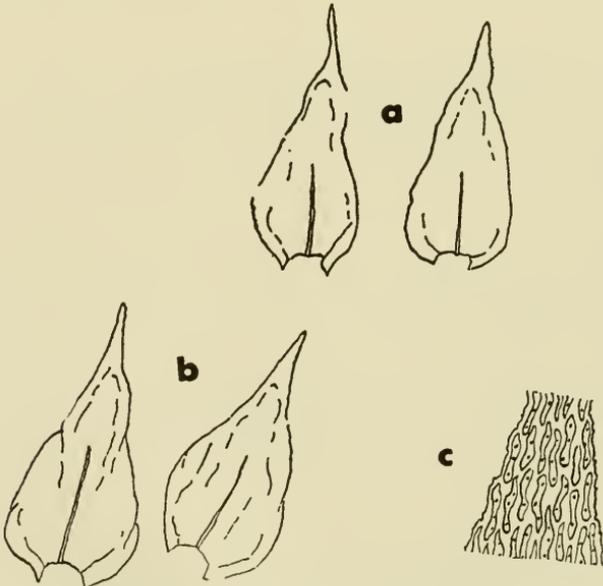


FIGURE 36. *Papillaria nigrescens*: (a and b) leaves, and (c) upper leaf cells.

middle and upper slopes of mountains of Puerto Rico; Mexico to South America; West Indies.

*Meteorium illecebrum* is notoriously variable throughout its wide range, particularly with regard to length and abruptness of acumination of branch leaves. Etiolated and colonizing forms frequently have fewer and less tumid branches associated with gradually acuminate leaves and rather stronger papillae characteristic of stem leaves. This form has been called *M. fuscoviride* (Hampe) Mitt., and it is suspected that *M. dubyanum* (Hampe) Broth. is a variation on the same theme. Although the genus is supposedly characterized by unipapillose cells, in *M. illecebrum* some cells often bear 2 or occasionally 3 small papillae; most cells, however, are unipapillose.

Hampe reported from Puerto Rico *Hypnum cirrhifolium* Schwaegr. (1852), a species of uncertain relationship originally described from Mauritius. Schwaegrichen's illustrations are so suggestive of *Meteorium illecebrum* that we suspect Hampe's report should be referred there.

(5) *Aerobryopsis* Fleisch. Hedwigia. 44: 304. 1905.

Slender to rather robust, somewhat glossy plants. Secondary stems long and flexuose, irregularly branched; branches often pendent, loosely foliate, somewhat complanate-foliate. Leaves concave, erect-spreading, sometimes rugulose, broadly lanceolate, acuminate; margins serrulate; costa slender, usually extending above midleaf; cells narrow, usually unipapillose, shorter and laxer toward base, not differentiated at basal angles. Calyptra cucullate, sparsely pilose. Seta elongate, rather rough; capsule straight, erect or inclined; annulus well developed; peristome teeth from low basal membrane, narrow, papillose, moderately lamellose, segments perforate along keels; papillose, basal membrane low.

*Aerobryopsis mexicana* Card. Rev. Bryol. 37: 8. 1910.

Plants robust, light green or yellow, becoming brown, in soft, tangled tufts. Secondary stems up to 20 cm. or more, creeping, flexuose, irregularly to subpinnately branched; branches slightly flattened. Leaves 2 to 3.5 mm. long, somewhat twisted and undulate when dry, widely spreading from base, oblong-lanceolate, gradually long-acuminate, ending in filiform, flexuose-crispate point, rounded at insertion; margins wavy above, broadly inflexed on 1 side at base, sharply denticulate all around; costa slender, ending well above midleaf; cells linear-flexuose, thin-walled, bearing single small, central papilla, short, porose and smooth at insertion. Dioicous.

On trunks and twigs of trees in wet forests on upper slopes of Cordillera Central, known in Puerto Rico only from 4 localities in high mountains near Cayey, Adjuntas, Jayuya, and Maricao; Jamaica; Mexico.

Cardot (1911) and Bartram (1936) have considered the American species as conspecific with *A. longissima* (Dozy & Molk.) Fleisch., a species widely distributed in the tropics of the Pacific. Although our experience with the variations of *A. longissima* is quite limited, we are doubtful of the strict identity of the 2 species.

(6) *Meteoriopsis* Fleisch. Musci Arch. Ind. Exs. 235. 1902.

Plants medium-sized, glossy, light green, or sometimes tinged with black. Secondary stems numerous, elongate, pendent, pinnately branched; branches wide-spreading. Leaves squarrose or squarrose-recurved, ovate, usually clasping at base, acute to acuminate, serrulate; costa single, ending below leaf apex; cells narrow, smooth, laxer at base, not differentiated at basal angles. Calyptra small, mostly mitrate and hairy. Seta short, smooth; capsule exserted; annulus persistent; operculum rostrate; peristome teeth pale to brownish red, striate or papillose, lamellose, segments papillose, perforate along keels, as long as teeth or somewhat shorter, basal membrane present.

Leaves wide-spreading from insertion; seta 1 mm. long; calyptra scabrous above  
 (a) *M. remotifolia*  
 Leaves wide-spreading from subclasping base; seta 3 mm. long; calyptra pilose  
 (b) *M. patula*

(a) *Meteoriopsis remotifolia* (C. M.) Broth. *In* E. & P., *Nat. Pfl.* 1(3): 825. 1906.

*Leskea remotifolia* C. M. *Linnaea.* 19: 216. 1846.

?*Meteorium torticospis* C. M. *Bull. Herb. Boiss.* 5: 204. 1897.

Robust plants growing in graceful, yellow-green, glossy mats. Secondary stems elongate, loosely prostrate or pendent, flexuose, freely but usually irregularly branched. Leaves wide-spreading, occasionally more or less recurved, not distinctly clasping at base, up to 2 mm. long, broadly ovate from narrower, subcordate base, subulate-acuminate; margins narrowly recurved near insertion, serrulate nearly to base; costa ending above midleaf; cells narrow, long-linear, smooth, subquadrate in small, poorly delimited alar groups. Calyptra scabrous above. Seta about 1 mm. long; capsules oblong, short-exserted; operculum obliquely rostrate. Sporophyte not seen.

On tree trunks, branches, and twigs, rarely on rock, in mountain forests at middle and upper altitudes, widespread in Puerto Rico but most abundant in Luquillo Mts.; Jamaica, St. Vincent, Montserrat, and Dominica; Mexico to South America.

(b) *Meteoriopsis patula* (Hedw.) Broth. *In* E. & P., *Nat. Pfl.* 1(3): 825. 1906.

*Hypnum patulum* Hedw. *Sp. Musc.* 279. 1801.

*Meteorium stellatum* Lor. *Moosstudien.* 165. 1864.

*M. flaccidulum* Mitt. *Journ. Linn. Soc. London, Bot.* 12: 443. 1869.

*M. diversifolium* Besch. *Mém. Soc. Nat. Sci. Natur. Cherbourg.* 16: 226. 1872.

?*Pilotrichum subambiguum* Hampe. *Enum. Musc. Brasil.* 46. 1879.

*Meteorium tenue* Schimp. ex Besch. *Mém. Soc. Nat. Sci. Natur. Cherbourg.* 16: 226. 1872.

*M. viridissimum* C. M. *Malpighia.* 10: 514. 1897.

Light green plants in loosely tangled mats. Secondary stems elongate, up to 15 cm. or more, creeping or pendent, subpinnately branched; branches short. Leaves wide-spreading to squarrose, ovate, clasping at base, slenderly

acuminate; margins plane, serrulate nearly to base; costa slender, ending above midleaf; cells linear, 6 to 10:1, shorter and broader across base, sub-rectangular in small, poorly defined groups at basal angles. Perichaetial leaves reaching base of capsule. Seta about 3 mm. long; urn about 2.5 mm. long, oblong, erect and symmetric; peristome teeth and segments narrow, basal membrane low (FIGURE 37).

On trees, shrubs, and rocks in wet mountain forests at upper altitudes, widespread in Cordillera Central of Puerto Rico, but apparently lacking in Luquillo Mts.; United States (Florida); West Indies; Mexico to South America.

Hampe's report (1852) of *Hypnum protensum* Brid. may be based on a specimen of *Meteoriopsis patula*, rather than to *Campylium protensum* (Brid.) Broth., a species not otherwise recorded from the area.

#### PHYLLOGONIACEAE

Lustrous plants with prostrate primary stems and elongate, pendent, branched secondary stems, both secondary stems and branches flattened. Leaves rigid, equitant in 2 rows, closely imbricate, oblong, concave; costa short and double, or lacking; cells linear, smooth, thin-walled. Dioicous; perichaetial leaves differentiated. Sporophyte lateral on secondary stems. Inner peristome lacking or represented by a rudimentary membrane.

*Phyllogonium* Brid. Bryol. Univ. 2: 671. 1827.

Medium-sized or robust, green, golden, or brown, glossy plants. Secondary stems sometimes very long, distantly and irregularly branched or nearly

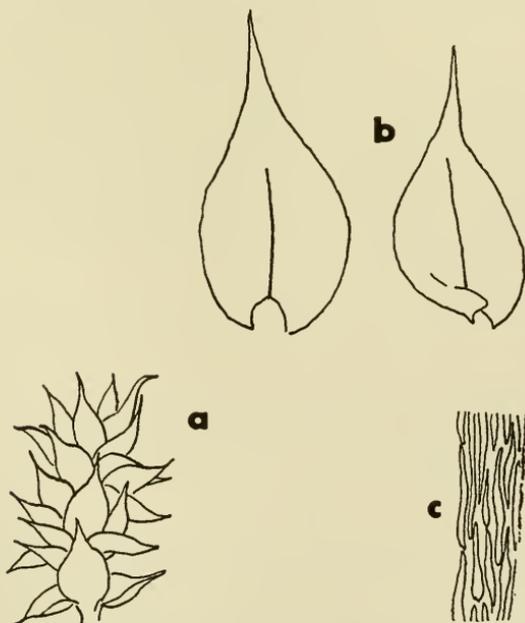


FIGURE 37. *Meteoriopsis patula*: (a) portion of stem, (b) leaves, and (c) median leaf cells.

simple. Leaves widely erect-spreading, oblong from clasping, cordate base, with short, recurved apiculus; cells narrowly linear, sharply differentiated at basal angles as group of short, incrassate, brown cells. Calyptra mostly cucullate, hairy or naked. Seta short or nearly lacking; capsule immersed to exerted; operculum obliquely rostrate; peristome pale.

*Phyllogonium fulgens* (Hedw.) Brid. Bryol. Univ. 2: 671. 1827.

*Pterogonium fulgens* Hedw. Sp. Musc. 86. 1801.

*Phyllogonium viride* Brid. Bryol. Univ. 2: 673. 1827.

*P. aureum* Mitt. Journ. Linn. Soc. London, Bot. 12: 424. 1869.

Secondary stems long and flexuous, sometimes reaching 50 cm. or more in length, distantly pinnate, usually glossy, yellow-green to golden-brown. Branches 3 to 4 mm. wide. Leaves crowded, distichous, 2 to 4 mm. long, cymbiform, auriculate at base, very concave and keeled, entire, obtuse and apiculate, apiculus often recurved; cells narrowly linear, smooth, porose, becoming very incrassate with age, dark-brown and incrassate in usually well-defined alar groups. Seta 3 mm. long; capsule ovoid. Sporophytes lacking in Puerto Rican collections.

On tree trunks, branches, and twigs, also on rock, frequently pendent in long streamers, in wet mountain forests at middle and upper elevations in most parts of Puerto Rico; West Indies; Mexico to South America.

#### NECKERACEAE

Plants usually rather robust and often glossy. Primary stems creeping; secondary stems erect or pendent, pinnately or subpinnately branched. Leaves complanate, frequently undulate or striate, usually somewhat asymmetric; costa slender, single, and long, or more rarely short and double to lacking; cells mostly smooth, rhomboidal above, linear below. Perichaetial leaves differentiated. Calyptra cucullate, usually hairy. Sporophyte lateral on secondary stems or on branches; capsules immersed or exerted; operculum short-rostrate; peristome teeth with low lamellae, endostome with narrow segments from a mostly rather low basal membrane.

Leaves truncate to emarginate at apex..... (1) *Neckeropsis*  
Leaves pointed.

Secondary stems very long and pendent; leaves very asymmetric, cultriform

(4) *Isodrepanium*

Secondary stems shorter, not pendent; leaves often somewhat asymmetric, but not cultriform.

Costa short and double, rarely extending beyond midleaf; leaves serrulate. (2) *Homalia*

Costa single, ending well above midleaf; leaves serrate or dentate.... (3) *Porotrichum*

(1) *Neckeropsis* Reichdt. emend. Fleisch. Laubmoosfl. v. Java  
3: 875. 1907.

Glossy plants with rather long, sparsely branched, flattened secondary stems; no paraphyllia. Leaves in 4 rows, but appearing 2-ranked, horizontally spreading, usually undulate, lingulate, truncate, or broadly rounded at apex; costa single, ending below leaf apex; cells smooth. Perichaetia con-

spicuous. Calyptra small, often hairy. Capsule immersed; teeth of peristome papillose, cilia lacking.

Leaves undulate.....(b) *N. undulata*  
 Leaves smooth, or nearly so.....(a) *N. disticha*

(a) *Neckeropsis disticha* (Hedw.) Kindb., Canad. Rec. Sci. 6: 21. 1894.

*Neckera disticha* Hedw. Sp. Musc. 201. 1801.

*Pilotrichum truncatum* P.-B. Prodr. 83. 1805.

*Neckera retusa* Brid. Bryol. Univ. 2: 243. 1827.

Plants pale green, loosely tufted. Secondary stems about 5 cm. long, about 3 mm. wide with leaves. Leaves oblong-lingulate, asymmetric, subclasping at base, broadly rounded, truncate or emarginate at apex, not undulate; margins plane, entire or serrulate across apex; costa slender, about  $\frac{4}{5}$  leaf length; upper cells irregularly rhomboid, gradually elongate below. Synoicous; perichaetial leaves linear-subulate, scarcely reaching mouth of urn. Calyptra naked. Seta very short; capsule oblong-cylindric, up to 1.2 mm. long; annulus lacking; peristome teeth narrow, rough, segments narrow, as long as teeth (FIGURE 38a).

On trunks and roots of trees and on limestone, very common in coastal plain, calcareous foothills, and lower slopes of mountains of Puerto Rico; Virgin Islands; United States (Florida); West Indies; Mexico to South America.

(b) *Neckeropsis undulata* (Hedw.) Reich., "Novara" Reise, Bot. 1(3): 181. 1870.

*Neckera undulata* Hedw. Sp. Musc. 201. 1801.

*Eleutera jamaicensis* Stuntz. Bull. Torrey Bot. Club. 27: 210. 1900.

Fairly robust, pale green or yellowish plants. Secondary stems up to 5 cm. long and 4 mm. broad, freely branched. Leaves crowded, strongly complanate, oblong-lingulate, asymmetric, clasping at base, broadly truncate, about 2 mm. long, or more; margins plane, erose-denticulate across apex; costa slender, ending well below apex; upper cells irregularly rhomboidal, gradually becoming linear below. Autoicous; perichaetial leaves linear-subulate, exceeding mouth of urn. Capsule immersed on short seta, oblong-cylindric, 1 to 1.5 mm. long; annulus lacking; teeth of peristome narrow, smooth, segments filiform, as long as teeth; operculum about 1 mm. long (FIGURE 38b).

On trunks, twigs, and roots of trees and on limestone in moist forests, not rare at all altitudes from sea level to over 3000 ft. in Puerto Rico; Virgin Islands (St. Jan); United States (Florida and Texas); West Indies; Mexico to South America.

(2) *Homalia* (Brid.) Bruch & Schimp. Bryol. Eur. fasc. 44-45. 1850,  
 as *Omalia*.

Slender to rather robust plants in dark to golden-green, glossy mats. Secondary stems usually irregularly branched, sometimes simple, complanate-

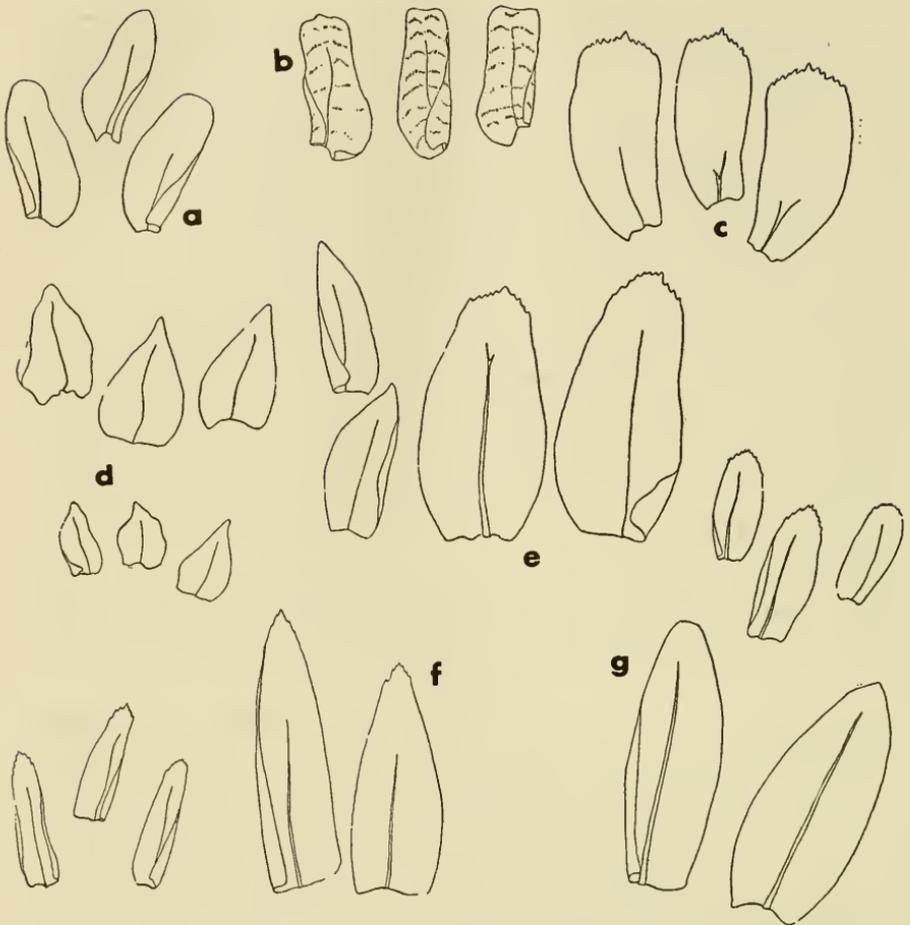


FIGURE 38. Leaves of Neckeraceae: (a) stem leaves of *Neckeropsis disticha*, (b) stem leaves of *N. undulata*, (c) stem leaves of *Homalia glabella*, (d) stem and branch leaves of *Porotrichum plicatum*, (e) stem and branch leaves of *P. cobanense*, (f) stem and branch leaves of *P. insularum*, and (g) stem and branch leaves of *P. fasciculatum* (Wagner, 1951).

foliate, without paraphyllia. Leaves inserted in 4 rows, but flattened into 2 apparent ranks, smooth, lingulate to suborbicular, blunt; margins entire to serrate above, inflexed below; costa weak, single, and ceasing near midleaf, or rarely short and double, or lacking; cells smooth, small, rhomboidal, becoming longer toward base. Seta elongate; capsule erect or inclined, subcylindric; annulus differentiated; operculum obliquely rostrate; peristome teeth narrow, transversely striolate, usually clearly lamellose, segments keeled, as long as teeth or somewhat longer, finely papillose, basal membrane high, cilia rudimentary and deciduous.

*Homalia glabella* (Hedw.) Mitt. Journ. Linn. Soc. London, Bot. 12: 458. 1869.

*Leskea glabella* Hedw. Sp. Musc. 235. 1801.

*Neckera patagonica* Brid. Musc. Recent. 2(2): 4. 1801.

Secondary stems up to 10 cm. long. Leaves imbricate-complanate, widely spreading, 2 to 3 mm. oblong, asymmetric, broadly rounded and apiculate at apex; margins inflexed on 1 side below, serrulate in upper half; costa short and double; upper cells irregularly rhomboidal, incrassate, becoming linear toward base. Dioicous. Seta red, about 14 mm. long; urn ovoid, inclined, less than 2 mm. long; cilia of endostome single, appendiculate. Spores smooth, 10 to 13  $\mu$  (FIGURE 38c).

On rock, in moist mountain forests at middle altitudes, 1500 to 2500 ft., widespread in Puerto Rico; West Indies; Mexico; Guatemala, Costa Rica, and Panama.

(3) *Porotrichum* (Brid.) Hampe. Linnaea. **32**: 154. 1863.

Plants usually rather robust, green or yellowish, dull to somewhat glossy. Secondary stems elongate, simple below, 1- to 2-pinnate above, forming flattened frond; branches complanate-foliate and sometimes flagelliform. Leaves oblong-ovate, serrate above, often faintly striate; costa slender, single, reaching midleaf, or less frequently extending nearly to leaf apex; cells rhomboidal above, becoming elongate toward base, occasionally minutely papillose above because of projecting apical cell angles. Dioicous. Calyptra cucullate, usually smooth. Seta rather short to very long; capsule erect or inclined; annulus present; operculum obliquely rostrate; peristome teeth narrow, bordered or unbordered, somewhat papillose, usually striolate below, endostome papillose, consisting of a mostly high basal membrane, keeled, perforate segments and cilia short to well-developed.

Costa of branch leaves strong, reaching  $\frac{5}{10}$  to  $\frac{9}{10}$  leaf length. . . . . (d) *P. fasciculatum*  
 Costa slender, reaching  $\frac{1}{2}$  to  $\frac{3}{4}$  leaf length.

Upper and median cells 45 $\mu$  long or less. . . . . (a) *P. plicatulum*  
 Median cells longer.

Leaves of ultimate branches very narrow, toothed only at apex. . . (c) *P. insularum*  
 Leaves of ultimate branches broad, toothed in upper third or half. . . (b) *P. cobanense*

(a) *Porotrichum plicatulum* Mitt. Journ. Linn. Soc. London, Bot. **12**: 461. 1869.

Secondary stems slender, 1 to 2 or 3 cm. high, pinnate or bipinnate from short stipe, often forming small, triangular frond, occasionally bearing short, flagelliferous branches. Stipe leaves squarrose, 0.5 to 0.8 mm long, abruptly acuminate from broadly ovate base. Frond leaves more or less plicate when dry, about 1 mm. long, ovate, broadly acute or abruptly short-acuminate; margins plane, serrulate in upper half or sometimes minutely serrulate nearly to base; costa extending about  $\frac{2}{3}$  to  $\frac{4}{5}$  leaf length, often ending in minute dorsal spine; upper and median cells narrowly linear, less than 45  $\mu$  long, minutely papillose at apical angles above. Sporophyte not seen (FIGURE 38d).

On tree bases, dead wood, and rock in wet mountain forests at higher altitudes, both in Luquillo Mts. and Cordillera Central of Puerto Rico; Trinidad; South America; Mexico, Guatemala, and Costa Rica.

(b) *Porotrichum cobanense* C. M. Bull. Herb. Boiss. **5**: 202. 1897.

*P. undulatulum* C. M. *Ibid.* 203.

*P. pringlei* Card. Rev. Bryol. **37**: 8. 1910.

*P. decompositum* Auct. non *Pterygophyllum decompositum* Brid. 1827.

Secondary stems 2.5 to 10 cm. long, laxly pinnate or bipinnate from stipitate base, or irregularly branched and scarcely stipitate; branches blunt or sometimes shortly attenuate, rarely flagelliform. Stipe leaves small and scale-like, appressed below, widely spreading above. Stem leaves complanate, crowded, 2 to 3 mm. long, ovate-lingulate, abruptly acute from broad, obtuse or rounded apex, distantly and irregularly dentate in upper third or half; costa ending about  $\frac{1}{2}$  to  $\frac{3}{4}$  up leaf, often laterally spurred above; cells toward leaf apex oval-rhomboidal, about 2:1 or less, gradually becoming linear below. Ultimate branch leaves similar, about 1 mm. long. Seta about 1.5 cm. long; urn ovoid, inclined, about 2 mm. long (FIGURE 38e).

On moist rock faces and tree trunks in wet mountain forests at upper altitudes in all major sierras of Puerto Rico; West Indies; Mexico and Central America.

Hampe's report (1852) of *Neckera decomposita* (Brid.) C. M. from Puerto Rico probably should be referred here rather than to *Homaliodendron decompositum* (Brid.) Wagner.

(c) *Porotrichum insularum* Mitt. Journ. Linn. Soc. London, Bot. 12: 464. 1869.

*Leskea angustifolia* Tayl. Trans. Bot. Soc. Edinburgh. 3: 23. 1850, non *Porotrichum angustifolium* (Holt.) Dix. 1896.

*Porotrichum pittieri* Ren. & Card. Bull. Soc. Roy. Bot. Belg. 32(1): 188. 1893.

*P. hansenii* C. M. Hedwigia. 37: 243. 1898.

Secondary stems about 3 to 10 cm. high, loosely pinnate or bipinnate above a stipitate base; branches often flagelliform. Stipe leaves appressed below, becoming larger and widely spreading above; stem leaves about 1.5 to 2 mm. long, oblong-ovate, short-acuminate, serrate in upper third; costa extending well above midleaf; cells linear. Leaves of ultimate branches very narrow, ligulate-lanceolate, serrulate above, about 1 mm. long, costate to  $\frac{1}{2}$  or  $\frac{2}{3}$  leaf length. Sporophytes not seen. (FIGURE 38f).

On tree trunks and bases and on rock faces in moist mountain forests near summits of major ranges in Puerto Rico, at altitudes of 2000 to 3000 ft.; West Indies; Costa Rica.

(d) *Porotrichum fasciculatum* (Hedw.) Mitt. Journ. Linn. Soc. London, Bot. 12: 468. 1869.

*Hypnum fasciculatum* Hedw. Sp. Musc. 245. 1801.

*Thamnum thyrsoides* C. M. Nuov. Giorn. Bot. Ital. N. S. 4: 149. 1897.

Secondary stems 5 to 10 cm. high, bipinnate from stipitate base; branches often more or less flattened, not flagelliform, occasionally shortly attenuate. Stipe leaves appressed below, usually erect-spreading above. Stem and branch leaves similar, erect-spreading, not or slightly complanate, 2 to 3 mm. long, ovate-lingulate, obtuse or broadly acute, apiculate, serrate at apex; costa strong, vanishing near leaf apex; cells incrassate, rhomboidal near leaf apex, becoming oblong below and linear at insertion. Seta 15 to 20 mm. long; urn large, oval, curved and inclined (FIGURE 38g).

On rock, soil, and occasionally on tree bases in wet places (as in spray of water falls), and in rain forests at higher altitudes (2000 to 3000 ft.) in mountain systems of Puerto Rico; West Indies; South America.

(4) *Isodrepanium* (Mitt.) Britt. Torrey. 14: 28. 1914.

Rather large, glossy, golden-green plants. Secondary stems elongate, pendent, 1- to 2-pinnate, strongly flattened. Leaves 4-ranked, strongly complanate, cultriform, short-acuminate; margins erect, serrulate; no costa, or very short and double; cells linear, smooth. Dioicous. Seta rather short; capsule horizontal; peristome teeth yellow, papillose above; endostome pale, smooth, with keeled, perforate segments, cilia lacking.

*Isodrepanium lentulum* (Wils.) Britt. Torrey. 14: 28. 1914.

*Omalia lentula* Wils. Ann. and Mag. Nat. Hist. I. 20: 379. 1847.

*Neckera falcifolia* Ren. & Card. Bull. Soc. Roy. Bot. Belg. 32(1): 184. 1893.

Secondary stems up to 20 cm. or more, irregularly pinnate to regularly bipinnate. Leaves wide-spreading with decurved tips, crowded and complanate, very asymmetric, oblong-sigmoid, short-acuminate, about 2 mm. long, serrulate in upper half; costa usually short and double, sometimes lacking; cells narrowly linear, 4 to 8  $\mu$  wide, thin-walled throughout, but porose near leaf base.

On trees, often pendent from twigs and branches, rarely on rock, in very wet mountain forests, near summits of cloud-swept peaks in major sierras of Puerto Rico; West Indies; Mexico, Guatemala, Honduras, and Costa Rica; South America.

In spite of having an aspect similar to *Homalia*, *Isodrepanium* has usually been included in the Hookeriaceae rather than the Neckeraceae. We have placed it in the Neckeraceae, however, in accordance with Kenneth Wagner's discovery that its phyllotaxy is of a distinctive type found only in the subfamily Homalioideae. We are indebted to Wagner for his kindness in permitting us to use this information in advance of his own publication on the subject.

#### PILOTRICHACEAE

Slender to medium-sized, dull, rather rigid plants with creeping primary stems and pinnate to tripinnate secondary stems. Stems showing in section a stereid cortex, outermost layer of which is not enlarged or especially thinner-walled. Leaves imbricate; costa double, strong, ending below leaf apex; cells isodiametric, smooth or papillose, not differentiated at basal angles. Dioicous; perichaetial leaves differentiated. Calyptra small, conic. Seta short to elongate; capsules mostly exserted, generally erect; peristome teeth papillose or striate, segments of endostome sometimes shorter, with a basal membrane, no cilia.

Capsule erect; costae ending well below leaf apex. . . . . (1) *Pilotrichum*  
 Capsule horizontal to subpendent; costae subpercurrent. . . . . (2) *Pilotrichidium*

(1) *Pilotrichum* P.-B. Mag. Encycl. 5: 327. 1804.

Plants slender to rather robust, usually rigid, green or yellowish to brownish. Secondary stems usually horizontal, densely terete-foliate, nearly simple or 1- to 3-pinnate. Leaves nearly uniform, lateral leaves sometimes slightly larger, rather concave, appressed when dry; margins plane or reflexed below, entire to serrulate; costae strong, ceasing well below leaf apex, spurred or toothed at back above; cells rhomboidal, incrassate, smooth or papillose. Propagula frequently produced on stems or at back of costae. Calyptra small, conic, hairy. Seta short; capsule erect; no annulus; peristome teeth papillose, not striate, segments narrow, keeled, papillose, basal membrane narrow.

Costae ceasing near leaf apex; costae of branch leaves broadly winged at back

Costae ceasing far below leaf apex, not conspicuously winged. . . . . (a) *P. lophophyllum*  
 . . . . . (b) *P. cryphaeoides*

(a) *Pilotrichum lophophyllum* Sull. Proc. Amer. Acad. Arts and Sci. 5: 284. 1861.

*P. leoni* Williams. Bryol. 26: 50. 1923.

Rather small plants with creeping primary stems and erect, irregularly 1- to 2-pinnate, frondose secondary stems up to 2.5 cm. high. Stem leaves about 1 mm. or less long, broadly ovate, acute; margins plane, entire or nearly so; costae stout, ending somewhat below leaf apex, with low serrulate wing at back; cells subquadrate to oval, incrassate, papillose, not conspicuously differentiated at basal angles. Branch leaves smaller, serrulate nearly to base, with costae very prominently winged at back, wings sometimes 5 to 6 cells high, often bearing septate propagula. Sporophyte unknown (FIGURE 39).

On trunks and branches of trees and occasionally on rotten woods; in wet mountain forests at higher altitudes in Cordillera Central of Puerto Rico; Cuba, Haiti, and Santo Domingo

(b) *Pilotrichum cryphaeoides* Schimp. ex Besch. Ann. Sci. Nat., Bot. VI. 3: 219. 1876.

Dull green plants with secondary stems erect, loosely 1- to 2-pinnate, 5 to 6 cm. high; branches numerous, about 1 cm. long. Leaves 1 mm. or more long, concave, ovate, acute; margins plane, serrulate above; costae ending well below leaf apex, not ending in dorsal spines; cells narrowly oblong, incrassate, faintly papillose. Seta 1.5 to 2 mm. long; urn oblong, about 1 mm. long.

On trunks and branches of trees in wet mountain forests at middle elevations, known from few but widely separated localities in Puerto Rico; Tobago, Cuba, Martinique, and Guadeloupe; Guatemala and British Honduras.

(2) *Pilotrichidium* Besch. Ann. Sci. Nat., Bot. VI. 3: 243. 1876.

Plants large, stiff, dark green to brownish, not glossy. Primary stems elongate, creeping; secondary stems prostrate or erect-ascending, more or

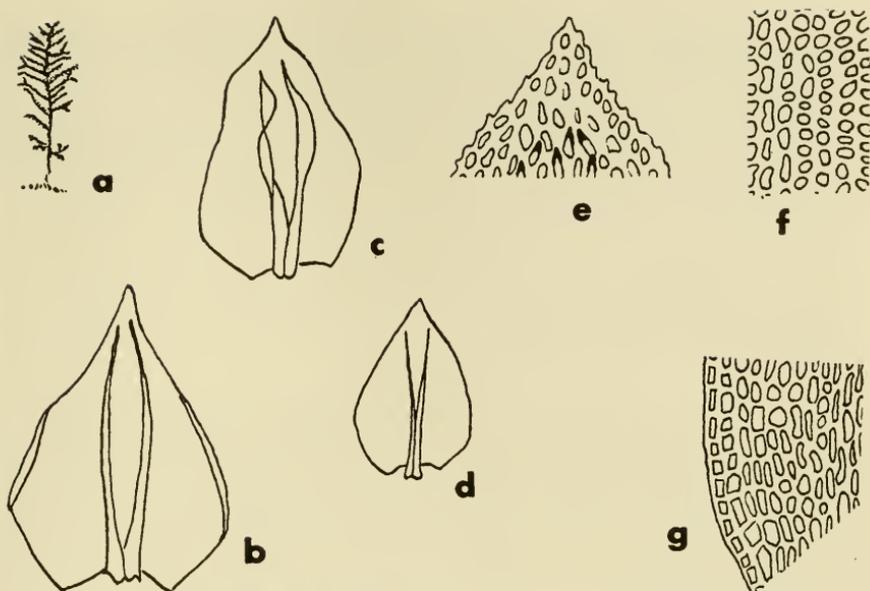


FIGURE 39. *Pilotrichum lophophyllum*: (a) plant, (b) leaf of secondary stem, (c) under-side of median branch leaf, showing lamellae, (d) leaf at branch tip, (e) cells at apex of branch leaf, (f) median cells of branch leaf, and (g) alar cells of branch leaf (Williams, 1923, as *P. leoni*).

less flattened, freely branched; paraphyllia few, subulate. Leaves oblong-ovate, appressed dorsally and ventrally, lateral leaves not markedly differentiated, but more spreading, truncate to broadly pointed; margins plane, entire or nearly so; costae very strong, nearly reaching leaf apex and ending in spurs at back; cells small, rounded-polygonal, firm-walled, smooth or obscurely roughened, longer toward base. Calyptra conic-mitrate, lobed at base, smooth. Seta 1 to 2 cm. long; capsule horizontal to pendent; annulus broad, deciduous; peristome teeth narrow, reddish, furrowed, striate, with high lamellae, endostome yellow, with broad basal membrane and broad, keeled segments.

*Pilotrichidium callicostatatum* (C. M.) Besch. Ann. Sci. Nat., Bot. VI. 3: 243. 1876.

*Hookeria callicostata* C. M. Syn Musc. Frond. 2: 216. 1851.

Secondary stems erect-ascending, up to 5 or 6 cm. high, irregularly to subpinnately branched, showing in section a well-developed cortex of small, incrassate, orange cells and an epidermal layer of small, hyaline cells. Leaves crowded, erect or erect-spreading, moderately contorted when dry, loosely appressed when moist, 1.5 to 2 mm. long, oblong-ovate, rounded and minutely mucronate or truncate at apex, entire except for marginal papillae; costae fleshy, smooth, prominent at back, converging toward apex and ending abruptly in blunt dorsal spines on either side of apiculus; cells small and obscure, incrassate, indistinctly roughened by 1 to 3 minute papillae usually difficult to distinguish except along upper margins, irregularly oblong-

rounded above, gradually becoming oblong-linear below, broader and often porose at insertion. Apparently dioicous. Seta red, obscurely roughened at apex, about 2 cm. long; capsules (immature) horizontal.

Usually on rocks in streams and on seepage banks, occasionally on tree bases or rotten wood in wet places. Although common at higher altitudes in Luquillo Mts. of northeastern Puerto Rico, this species does not seem to extend very far westward into Cordillera Central; Jamaica; Trinidad.

#### *Excluded Species*

*Pilotrichum sinuatum* C. M. ex Hampe Linnaea. 28: 362. 1852, nom.

No material available for study.

#### HOOKERIACEAE

Plants small to robust, often soft. Stems branched, often flattened, showing in section a cortex of thin or moderately thickened but never stereid cells. Leaves sometimes bordered, varying in shape, uniform, or lateral leaves asymmetric; costa single or double, usually strong, sometimes lacking; cells smooth or papillose, varying in shape, size, and degree of wall-thickening; alar cells not differentiated. Calyptra conic-mitrate, lobed or ciliate at base. Seta more or less elongate, smooth or rough; capsule rarely erect; exothecial cells lax, usually thickened at corners; operculum rostrate; peristome double (except for 1 genus), teeth often furrowed, endostome consisting of keeled basal membrane and segments about as long as teeth, cilia mostly lacking or rudimentary.

Costa single.

Leaves uniform, narrowly lanceolate, acuminate. . . . . (1) *Daltonia*

Lateral leaves obovate, asymmetric. . . . . (2) *Leskeodon*

Costa double or lacking.

Costa lacking.

Leaves entire; cells very large and lax. . . . . (3) *Hookeria*

Leaves toothed; cells narrower and smaller.

Leaves gradually acuminate, coarsely toothed. . . . . (13) *Rhynchostegiopsis*

Leaves short-pointed, denticulate. . . . . (10) *Crossomitrium*

Costa double, usually well developed.

Leaves strongly plicate. . . . . (14) *Hemiragis*

Leaves not plicate.

Leaf cells papillose.

Cells nearly isodiametric, unipapillose. . . . . (5) *Callicostella*

Cells elongate, 3- to 4-papillose. . . . . (11) *Hypnella*

Leaf cells smooth.

Cells laxly hexagonal. . . . . (4) *Cyclodictyon*

Cells narrower and prosenchymatous.

Peristome teeth striolate, furrowed.

Teeth broadly furrowed.

Leaves uniform. . . . . (12) *Stenodictyon*

Lateral leaves asymmetric. . . . . (6) *Hookeriopsis*

Teeth appearing delicately furrowed under low power. . . (8) *Lepidopilidium*

Peristome teeth papillose, not furrowed.

Leaves uniform; seta smooth, elongate. . . . . (7) *Actinodontium*

Lateral leaves asymmetric; seta rough, often short. . . . . (9) *Lepidopilum*

(1) *Daltonia* Hook. & Tayl. Musc. Brit. 80. 1818.

Plants slender, yellowish-green, often glossy. Stems suberect, simple or forked. Leaves crowded, uniform, lanceolate, bordered, entire or serrulate

above; costa single, ceasing well below leaf apex; cells oval, smooth, incrassate. Calyptra fringed. Seta more or less elongate; capsule suberect; no annulus; peristome teeth densely papillose, not furrowed, endostome of equal length, consisting of narrow segments perforate along keels and low basal membrane.

Leaves contorted when dry; margins plane.....(a) *D. longifolia*  
 Leaves straight or lightly twisted when dry; margins narrowly revolute... (b) *D. stenophylla*

(a) *Daltonia longifolia* Tayl. London Journ. Bot. 7: 284. 1848.

*D. crispata* Schimp. ex Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg. 16: 228. 1872.

*D. robusta* Ångstr. Öfv. K. Sv. Vet. Akad. Förh. 30(5): 117. 1873.

*D. dussii* Broth. In Urban, Symb. Antill. 3: 426. 1903.

Stems up to 2.5 cm., with leaves 2 to 3 mm. wide, radiculose below. Leaves imbricate, erect-spreading and rather spirally contorted when dry, flexuose when moist, oblong-ligulate, sharply acuminate, keeled with broad median fold, 3 to 3.5 mm. long; margin plane, serrulate toward apex; border 8 to 15 rows wide at base, about 4 rows at midleaf, and 2 rows at apex; costa ending about  $\frac{4}{5}$  up; upper cells oblong-oval, 15 to 25  $\times$  6 to 7  $\mu$ , cells at base narrowly oval, rather incrassate and often somewhat pitted. Autoicous. Calyptra slightly scabrous above. Seta slender, up to 10 or 12 mm., reddish, scabrous above; capsule erect, oval-cylindric, up to 1.5 mm. long; exothecial cells collenchymatous; operculum erect, rostrate, about 1 mm. long. Spores minutely papillose, 12 to 15  $\mu$  (FIGURE 40).

On trunks of trees and shrubs in very wet forests in high mountain areas of Puerto Rico, apparently not known from Luquillo Mts.; West Indies, Mexico; Guatemala; South America; Galapagos Islands.

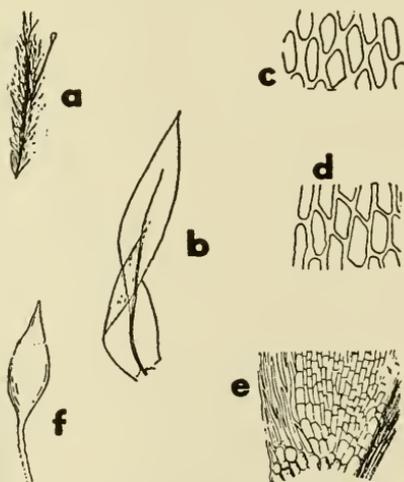


FIGURE 40. *Daltonia longifolia*: (a) plant, (b) leaf, (c) cells of upper part of leaf, (d) cells at leaf base, (e) one side of leaf base, and (f) capsule (Bartram, 1931).

(b) *Daltonia stenophylla* Mitt. Journ. Linn. Soc. London, Bot. 12: 402. 1869.

*D. aristifolia* Bartr. Contr. U. S. Nat. Herb. 26: 99. 1928.

*D. fendleri* C. M. Linnaea. 42: 491. 1879.

*D. tenella* Broth. Acta Soc. Sci. Fenn. 19(5): 19. 1891.

Stems up to 12 mm. high with leaves 1 to 2 mm. broad, radiculose below. Leaves imbricate, straight or lightly twisted when dry, linear-lanceolate, narrowly acuminate, keeled with narrow median fold, up to 3 mm. long; margins narrowly revolute, entire; border rather indistinct below, 5 to 8 rows wide at base, 4 to 6 rows at midleaf and 2 rows above; costa ending about  $\frac{4}{5}$  up; upper cells lenticular, somewhat incrassate, about  $7 \mu$  wide. Autoicous. Calyptra nearly smooth above. Seta up to 9 mm. long, but often shorter, reddish, slightly roughened above; capsule erect, narrowly oval, up to 1.2 mm. long; exothelial cells collenchymatous; operculum erect, rostrate. Spores minutely papillose, 10 to  $12 \mu$  (FIGURE 41).

On twigs, fern stipes, and trunks of trees and shrubs, in very wet forests at high altitudes in all mountain systems of Puerto Rico; Jamaica; Dominica and St. Vincent; Costa Rica; Venezuela, Ecuador, and Brazil.

(2) *Leskeodon* Broth. in E. & P. Nat. Pfl. 1(3): 925. 1907.

Small, soft, usually pale green plants. Stems short, erect or ascending, simple or forked, complanate-foliolate. Leaves symmetric, bordered, dorsal and ventral erect, lateral larger and erect-spreading, oblong-spatulate, usually acute, plane and entire at margins; costa single, slender, ending well below leaf apex; cells small, hexagonal, smooth. Calyptra cucullate, fringed. Seta slender, smooth or rough above; capsule minute, erect or nodding; annulus broad, falling with operculum; peristome teeth papillose, not furrowed, sometimes bordered, endostome densely papillose, about as long as teeth, basal membrane low.

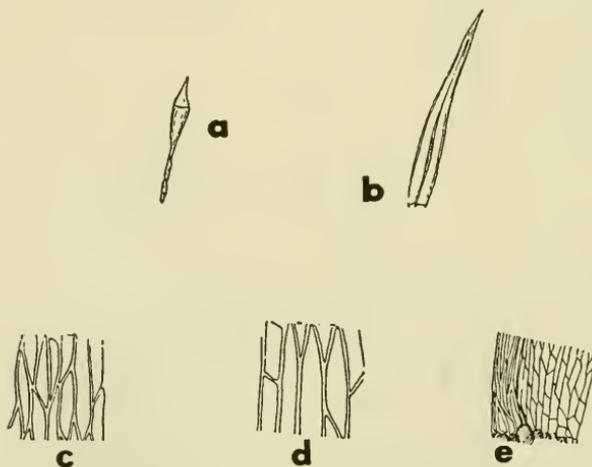


FIGURE 41. *Daltonia stenophylla*: (a) capsule, (b) leaf, (c) upper leaf cells, (d) basal leaf cells, and (e) one side of leaf base (Bartram, 1931).

Leaves apiculate, weakly bordered by single row of linear cells. . . . . (a) *L. andicola*  
 Leaves strongly apiculate to hair-pointed, strongly bordered by 2 to 3 rows of linear  
 cells. . . . . (b) *L. cubensis*

(a) *Leskeodon andicola* (Spruce ex Mitt.) Broth. *In E. & P., Nat. Pfl.* 1(3): 926. 1907.

*Distichophyllum andicola* Spruce ex Mitt. *Journ. Linn. Soc. London, Bot.* 12: 395. 1869.

*Hookeria adnata* var. Sull. *Proc. Amer. Acad. Arts and Sci.* 5: 285. 1861.

Stems 2 to 7 mm. long. Lateral leaves about 2 mm. long, somewhat contorted when dry, oval to obovate, abruptly short-apiculate, narrowly bordered all around by 1 row of linear cells; costa slender, often flexuose above, ending  $\frac{2}{3}$  to  $\frac{3}{4}$  up leaf; cells hexagonal, rather thin-walled, 12 to 16  $\mu$  above, larger near costa and large, lax, and oblong at base. Autoicous. Seta smooth, slender, 3 to 4 mm. long; capsule inclined, about 1 mm. long; peristome teeth white.

On rock or occasionally on tree trunks at high altitudes in wet mountain forests, most common in Luquillo Mts. in Puerto Rico, apparently not extending west of Cayey; Cuba; Guatemala and Costa Rica; South America.

(b) *Leskeodon cubensis* (Mitt.) Thér. *Mem. Soc. Cubana Hist. Nat.* 14: 364. 1940.

*Distichophyllum cubense* Spruce ex Mitt. *Journ. Linn. Soc. London, Bot.* 12: 395. 1869.

Stems up to 6 mm. high. Lateral leaves up to 2.5 or 3 mm. long, somewhat contorted when dry, oval to obovate, gradually or rather abruptly narrowed to strong yellow apiculus or hair-point, strongly bordered all around by 2 to 3 rows of very incrassate, linear cells; costa ending at  $\frac{1}{2}$  to  $\frac{3}{4}$  leaf length; upper cells hexagonal, rather thin-walled, sometimes slightly thickened at corners, about 23 to 30  $\mu$ , not particularly enlarged toward costa, basal cells enlarged, lax and rectangular. Autoicous. Seta smooth, slender,  $\frac{3}{5}$  to 5 mm. long; capsule inclined, 1 mm. long, or less; peristome teeth white.

On rock, rotten wood, tree trunks, bases, and twigs, and on living leaves in very moist places where air is saturated, in wet forests at high altitudes in all major mountain ranges of Puerto Rico; Cuba, Haiti, Grenada, and Trinidad.

(3) *Hookeria* Smith. *Trans. Linn. Soc.* 9: 276. 1809.

Large soft plants in lax, pale green mats. Stems complanate-foliate, sparsely branched. Leaves large, ovate or oblong, entire, plane-margined, ecostate; cells large and lax, narrower at margins, smooth. Calyptra mitrate, smooth, slightly lobed. Seta smooth, elongate; capsules inclined; annulus falling with operculum; peristome teeth papillose, not furrowed, somewhat bordered, segments papillose, perforate, from well-developed basal membrane.

*Hookeria acutifolia* Hook. ex Schwaegr. *Suppl. Sp. Musc.* II. 2(1): 36. 1826.

Stems simple or sparsely branched, 1 to 5 cm. high, with leaves 8 to 10 mm. wide, fragile. Leaves widely spreading, 4 to 5 mm. long, ovate, acute,

often radiculose at apex, ecostate; cells oblong-hexagonal, thin-walled, 45 to 60  $\mu$  wide, 2 or 3:1, small at apex, longer and narrower in marginal row. Seta stout, smooth, 1 to 2 cm. long; urn ovoid, 1 to 2 mm. long; operculum long-rostrate; exothecial cells with thick, dark-red walls. Sporophyte not seen.

On moist, shaded rock faces in wet forests at high altitudes, several localities in Luquillo Mts., but not found elsewhere in Puerto Rico; eastern United States; West Indies; Guatemala and Costa Rica; South America; India, Ceylon, and Java.

(4) *Cyclodictyon* Mitt. Journ. Linn. Soc. London, Bot. 7: 163. 1864.

Medium-sized plants in soft, loose, whitish-green, often iridescent mats. Stems prostrate, branched, complanate-foliolate. Leaves oblong-ovate, bordered, dimorphous, dorsal and ventral leaves obliquely appressed, lateral leaves larger, erect-spreading to wide-spreading, asymmetric; costae 2, strong, ending above midleaf; cells large and lax, hexagonal or oblong-hexagonal, smooth. Calyptra small, smooth, conic-mitrate, lobed at base. Seta elongate, smooth; capsule horizontal, asymmetric; annulus deciduous; operculum long-rostrate; peristome teeth deep red, furrowed, striate; endostome orange, papillose, with broad, keeled segments from broad basal membrane, cilia lacking.

Leaves strongly contorted when dry, bordered by 4 to 6 rows of narrow cells.

(a) *C. riparium*

Leaves not or scarcely contorted, border narrower.

Leaf border of 2 or 3 rows of linear cells.....(b) *C. albicans*

Leaf border of 1, rarely 2 rows of cells.

Leaves indistinctly bordered by short, narrow cells in 1, rarely 2 rows; upper cells isodiametric.....(c) *C. albicaule*

Leaves clearly bordered by 1 row of linear cells; upper cells oblong-hexagonal.

(d) *C. varians*

(a) *Cyclodictyon riparium* (Mitt.) Broth. In E. & P., Nat. Pfl. 1(3): 936. 1907.

*Hookeria riparia* Mitt. Journ. Linn. Soc. London, Bot. 12: 345. 1869.

Plants dull, dark sordid green. Stems loosely branched, 3 or 4 cm. long, 2.5 to 3 mm. wide. Leaves contorted when dry, lateral leaves widely spreading, 2 to 2.5 mm. long, oblong-ovate, rather abruptly short-acuminate, strongly bordered by 4 to 6 rows of greenish, elongate cells, indistinctly serrulate toward apex; costae ending  $\frac{1}{2}$  to  $\frac{3}{4}$  up leaf; cells near apex oblong-hexagonal, about 25  $\mu$  wide, thin-walled, becoming laxer and oblong near base.

On wet rocks and steep, shaded seepage banks, rarely on tree roots in wet places, known from half dozen widely separated localities in high mountains of Puerto Rico; Jamaica and Haiti; South America.

(b) *Cyclodictyon albicans* (Hedw.) Broth. In E. & P., Nat. Pfl. 1(3): 935. 1907.

*Hypnum albicans* Hedw. Sp. Musc. 251. 1801.

Light green plants. Stems freely branched, 2 to 3 cm. long, 2.5 to 3.5 mm. wide. Lateral leaves widely spreading, 1.5 to 2 mm. oblong-ovate, abruptly narrowed to typically short acumen, bordered by 2, rarely 3 rows of long, narrow cells, serrulate in upper third or less; costae ending about  $\frac{4}{5}$  up leaf, weakly toothed on back toward tips; cells near apex rounded-hexagonal, isodiametric or slightly longer than wide, about 25 to 30  $\mu$  wide, thin-walled, becoming laxer and oblong near base. Autoicous. Seta 12 to 18 mm. long; capsule horizontal, ovoid, 1.5 mm. long, including distinct neck, strongly constricted under mouth when dry.

On moist soil, rock, tree bases, or rotten wood in wet mountain forests at middle and higher altitudes, widespread in Puerto Rico; West Indies; Mexico to South America; Galapagos Islands.

(c) *Cyclodictyon albicaule* (Schimp.) Broth. *In* E. & P., *Nat. Pfl.* 1(3): 935. 1907.

*Hookeria albicaulis* Schimp. ex Besch. *Ann. Sci. Nat., Bot.* VI. 3: 232. 1876.

Dull green plants. Stems freely branched, about 3 cm. long, 2.5 to 3 mm. wide. Lateral leaves wide-spreading, 1.5 mm. long, oblong-ovate, gradually short-acuminate, or broadly acute and apiculate, indistinctly bordered by 1, rarely 2 rows of narrow, short cells, serrulate toward apex; costae ending about  $\frac{4}{5}$  up leaf, obscurely toothed at back near tips; cells near apex isodiametric, 25 to 30  $\mu$  wide, firm, becoming laxer and oblong near base. Apparently dioicous. Seta about 15 mm. long; capsule horizontal, ovoid, with rather short neck, about 1.25 mm. long.

On limestone in permanently moist places (as near waterfalls), in calcareous areas at lower altitudes on northern slopes of Puerto Rico; Cuba, Haiti, Guadeloupe, and Martinique.

(d) *Cyclodictyon varians* (Sull.) Broth. *In* E. & P., *Nat. Pfl.* 1(3): 935. 1907.

*Hookeria varians* Sull. *Proc. Amer. Acad. Arts and Sci.* 5: 285. 1861.

*H. blanda* Lor. *Moosstudien.* 166. 1864.

*H. antillarum* Mitt. *Journ. Linn. Soc. London, Bot.* 12: 343. 1869.

*H. pallens* Mitt. *Ibid.* 345.

*Cyclodictyon cubense* Williams. *Bull. Torrey Bot. Club.* 34(1907): 574. 1908.

Plants light green or yellowish. Stems freely branched, 2 to 3 cm. long, about 2 to 3 mm. wide. Lateral leaves wide-spreading, 1.5 to 1.8 mm. long, ovate or oblong-lanceolate, gradually narrowed to short, slender acumen, bordered by single row of linear cells, subentire or serrulate toward apex; costae ending about  $\frac{3}{4}$  leaf length, not or scarcely toothed at back; cells near apex somewhat longer than wide, oblong-hexagonal, about 30 to 35  $\mu$  wide, laxer and oblong near base. Polygamous. Seta 10 to 15 or perhaps 20 mm. long; capsule inclined to horizontal, ovoid, 1 to 1.5 mm. long, including short neck.

On soil, rock, and rotten wood in wet forests at middle and upper altitudes in high mountains of Puerto Rico; United States (Florida); West Indies.

- (5) *Callicostella* (C. M.) Mitt. Journ. Linn. Soc. London, Bot. 1(Suppl.): 136. 1859.

Rather small to medium-sized plants in dull green to yellowish or brownish, flat mats. Stems creeping, freely branched, complanate-foliolate. Leaves oblong, obtuse to short-pointed, unbordered, dimorphous, lateral leaves larger, asymmetric, spreading, somewhat incurved-cripsed when dry, dorsal and ventral obliquely appressed; margins plane, serrulate above; costae double, strong, ending near apex, usually toothed at back above; cells small, oval, usually papillose, becoming longer and smooth below. Calyptra conic-mitrate, usually scabrous above, lobed at base. Seta elongate, smooth or papillose; capsule horizontal, somewhat asymmetric; no annulus; operculum long-rostrate; peristome teeth red-brown, furrowed, striate; endostome yellow, papillose, with narrow, keeled segments from high basal membrane, cilia lacking.

Leaf cells smooth; costae smooth or nearly so. . . . . (a) *C. rivularis*  
 Leaf cells papillose; costae toothed at back above.  
 Autoicous; seta roughened throughout; leaves blunt, truncate to rounded-obtuse  
 (b) *C. pallida*  
 Polygamous; seta not or very slightly roughened below; leaves bluntly pointed.  
 (c) *C. depressa*

- (a) *Callicostella rivularis* (Mitt.) Jaeg. Ber. St. Gall. Natur. Ges. 1875-76: 355. 1877.

*Hookeria rivularis* Mitt. Journ. Linn. Soc. London, Bot. 12: 353. 1869.

Stems freely branched, complanate-foliolate. Lateral leaves oblong-ovate, short-acuminate, about 1 mm. long; margins slightly serrulate in upper third; costae smooth or nearly so; upper cells oblong-hexagonal, rather lax, smooth. Calyptra scabrous above. Dioicous. Seta rough throughout, about 5 to 7 mm. long.

On rocks in streams and on steep, shaded seepage banks, rather common in Luquillo Mts. of northeastern Puerto Rico, but apparently rare elsewhere on island; Guadeloupe; Bolivia, Ecuador, and Peru.

- (b) *Callicostella pallida* (Hornsch.) Ångstr. Öfv. K. Sv. Vet.-Akad. Förh. 33(4): 27. 1876.

*Hookeria pallida* Hornsch. In Mart., Fl. Brasil. 1(2): 64. 1840.

*Callicostella subpallida* Ren & Card. Bull. Soc. Roy. Bot. Belg. 41(1): 87. 1905.

Stems freely branched, complanate-foliolate. Lateral leaves oblong-lingulate, truncate or rounded-obtuse at apex, blunt, often minutely and bluntly apiculate, 1 to 1.25 mm. long; margins serrate in upper half; costae strong, toothed at back above and ending in single or double blunt tooth; upper cells oblong-hexagonal, irregularly isodiametric, unipapillate on either surface. Calyptra slightly scabrous at tip. Autoicous. Seta 5 to 13 mm. long, scabrous throughout; capsule inclined to horizontal, urn about 0.8 to 1.0 mm. long.

On wet soil, rock, and rotten wood in wet mountain forests at middle altitudes, apparently most common in Luquillo Mts. of northeastern Puerto

Rico, but very rare westward on island; West Indies; Mexico to South America.

(c) *Callicostella depressa* (Hedw.) Jaeg. Ber. St. Gall. Natur. Ges. 1876-7: 356. 1877.

*Leskea depressa* Hedw. Sp. Musc. 215. 1801.

*Hookeria longipedunculata* C. M. Syn. Musc. Frond. 2: 221. 1851.

*H. crenata* Mitt. Journ. Linn. Soc. London, Bot. 12: 351. 1869.

*H. belangeriana* Besch. Ann. Sci. Nat., Bot. VI. 3: 233. 1876.

*H. herminieri* Schimp. ex Besch. *Ibid.*

*H. berteriana* C. M. Hedwigia. 37: 247. 1898.

Stems freely branched, sometimes pinnate, complanate-foliate. Lateral leaves oblong, broad at apex and abruptly narrowed to stout, blunt point, 1.25 to 2 mm. long; margins serrate in upper half; costae bluntly toothed at back above, ending in paired, blunt teeth; upper cells irregularly rounded to oval, 1 to 2:1, bearing 1 or sometimes 2 blunt papillae on either surface. Calyptra somewhat scabrous above. Polygamous. Seta 10 to 15 mm. long, rough near tip, very slightly or not at all roughened below; capsule inclined to horizontal, urn about 1 mm. long. Spores smooth, about 10  $\mu$ .

On rock and fallen logs in wet mountain forests at higher altitudes, widespread in high sierras of Puerto Rico; West Indies; Trinidad, British Guiana; British Honduras.

(6) *Hookeriopsis* (Besch.) Jaeg. Ber. St. Gall. Natur. Ges. 1875-76: 358. 1877.

Small to rather large plants in dense mats. Stems creeping, densely branched, usually complanate-foliate. Leaves ovate-lanceolate to oblong, unbordered, rather unsymmetric, usually dimorphous, dorsal and ventral obliquely appressed, lateral larger and somewhat spreading, sometimes secund; margins plane, usually sharply toothed above; costa double, ending above midleaf; cells oblong-hexagonal to linear, smooth, short-lobed at base. Seta elongate, usually smooth; capsules inclined to horizontal; no annulus; operculum long-rostrate; peristome teeth brownish-red, furrowed, transversely striate, endostome yellowish, papillose or nearly smooth, with keeled segments from fairly high basal membrane, cilia lacking.

Leaves broadly oblong, rugose above, 2.5 to 3 mm. long; seta 3.5 cm. long.

(b) *H. acicularis*

Leaves narrower, 2 mm. long or less; seta shorter.

Cells lax and pellucid, thin-walled.

Leaves about 1 mm. long or less, broadly acuminate, minutely denticulate above; seta about 5 mm. long. . . . . (d) *H. dimorpha*

Leaves 1 to 1.5 mm. long, slenderly acuminate, sharply denticulate above; seta 7 to 9 mm. . . . . (c) *H. guadalupensis*

Cells incrassate.

Seta rough at tip; leaves acute, entire or slightly crenulate. . . . (a) *H. fissidentoides*  
Seta smooth; leaves slenderly acuminate, mostly denticulate.

Leaves erect-spreading, subentire. . . . . (e) *H. borinquensis*

Leaves falcate-secund, denticulate above.

Costa ending at or below midleaf, smooth; seta about 15 mm. long.

(f) *H. obsoletinervis*

Costa weakly toothed above, ending well above midleaf; seta 2.5 cm. long.

(g) *H. falcata*

- (a) *Hookeriopsis fissidentoides* (Hook. f. & Wils.) Jaeg. Ber. St. Gall. Natur. Ges. 1875-76: 361. 1877.

*Hookeria fissidentoides* Hook. f. & Wils. Icones Plant. Rar. 8: pl. 746A. 1848.

Small, dull green or brown plants in flat mats. Stems short, prostrate; branches numerous, short, depressed, flattened. Leaves rigid, complanate, scarcely altered on drying; lateral leaves oblong-lingulate, acute, spreading, 1.5 to 2 mm. long, median shorter, slightly broader at base, appressed; margins very minutely crenulate or subentire; costae often unequal, reaching about  $\frac{3}{4}$  leaf length, smooth; cells small, linear-flexuose, incrassate, smooth, larger and laxer, with thinner walls at insertion. Perichaetial leaves erect, broadly ligulate-subulate from broader base, subentire. Calyptra naked. Seta about 13 mm. long, scabrous at tip; capsule small, ovate, horizontal; operculum subulate. Sporophyte not seen.

On limestone, known in Puerto Rico from single locality in Río Abajo area south of Arecibo; Cuba; Jamaica.

- (b) *Hookeriopsis acicularis* (Mitt.) Jaeg. Ber. St. Gall. Natur. Ges. 1875-76: 359. 1877.

*Hookeria acicularis* Mitt. Journ. Linn. Soc. London, Bot. 12: 354. 1869.

Plants robust, dull, green to yellow or brown, growing in deep, dense mats. Primary stems prostrate; secondary stems erect, or ascending, subpinnately branched, forming flat sprays. Leaves laxly erect-appressed, rugose, points crisped when dry, 2.5 to 3 mm. long, oblong- or ovate-lanceolate, gradually narrowed to long acumen; margins plane, serrulate at base of acumen, serrate toward tip, teeth often double; costae unequal, extending  $\frac{1}{2}$  to  $\frac{2}{3}$  leaf length, weakly toothed at back above and projecting as conspicuous tooth; cells oblong-linear, 4 to 9:1, rather thin-walled, but slightly porose, smooth and pellucid, broader and laxer at base. Dioicous. Seta smooth, curved at apex, 3.5 cm. long. Sporophyte not seen.

On soil and rock in very moist mountain forests, at altitudes of 2000 ft. and higher, apparently restricted in Puerto Rico to Luquillo Mts.; Jamaica, Santo Domingo, Guadeloupe, and Trinidad.

Hampe's report (1852) of *Hookeriopsis undata* (Hedw.) Jaeg. (as *Hookeria*) probably refers to this species.

- (c) *Hookeriopsis guadalupensis* (Brid.) Jaeg. Ber. St. Gall. Natur. Ges. 1875-76: 362. 1877.

*Hypnum guadalupense* Brid. Musc. Recent. Suppl. 2: 96. 1812.

*Hookeria repens* Hook. & Grev. Edinb. Journ. Sci. 2: 231. 1825.

*H. herminieri* var. *rubella* Besch. Ann. Sci. Nat., Bot. VI. 3: 233. 1876.

*H. versicolor* Schimp. ex Besch. *Ibid.* 238.

*Hookeriopsis versicolor* (Schimp. ex Besch.) Jaeg. Ber. St. Gall. Natur. Ges. 1875-76: 362. 1877, non (Mitt.) Broth. 1913.

Small, pale green or yellowish-brown plants in thin, flat mats. Stems short,

prostrate, bearing red rhizoids in tufts on underside; branches numerous, horizontal. Leaves 1 to 1.5 mm. long, loosely erect and flexuose to moderately crisped when dry, erect-spreading with flexuose tips when moist, narrowly lanceolate, long and slenderly acuminate; margins plane, sharply denticulate in upper half, teeth small and double; costa weak, usually ending about  $\frac{2}{3}$  up leaf, doubly toothed at back above and projecting at tips; cells laxly linear, 6 to 9:1, smooth, pellucid, thin-walled. Autoicous. Calyptra obscurely roughened above. Seta red, smooth, 7 to 9 mm. long; urn of capsule red, ovoid, nodding, 0.5 to 1 mm. long; exothelial cells regularly subquadrate, somewhat collenchymatous; segments about as long as teeth, papillose, perforate. Spores smooth, 11 to 15  $\mu$ .

On soil, rock, and rotting wood in wet mountain forests at middle and higher altitudes, common and abundant in Luquillo Mts., apparently much rarer in main Cordillera Central of Puerto Rico; Cuba, Jamaica, Dominica, St. Vincent, and Martinique.

(d) *Hookeriopsis dimorpha* (C. M.) Broth. *In* E. & P., *Nat. Pfl.* 1(3): 939. 1907.

*Hookeria dimorpha* C. M. *Bull. Herb. Boiss.* 5: 564. 1897.

Very small, pale green plants. Stems short, prostrate, rhizoidous in tufts, irregularly branched; branches spreading, short. Leaves erect-spreading and twisted when dry, 0.8 to 1 mm. long, lanceolate, broadly acuminate, minutely and doubly denticulate in upper third or half; costae slender, obscurely or densely toothed at back above, sometimes aculeate at tips, ending about  $\frac{2}{3}$  up leaf; cells laxly linear, 4 to 8:1, smooth, pellucid, thin-walled. Autoicous. Calyptra smooth or nearly so. Seta red, smooth, very slender, about 5 mm. long; exothelial cells subquadrate, slightly collenchymatous; segments of endostome perforate, about as long as exostome.

On soil, rock, and rotten wood in wet mountain forests at upper altitudes, known from a few localities in major sierras of Puerto Rico; Jamaica.

(e) *Hookeriopsis borinquensis* Crum & Steere. *Bryol.* 59: 251. 1956.

Rather small, yellowish or red-brown plants, somewhat glossy. Stems red, sometimes bearing a few filiform, multicellular propagula in leaf axils, freely branched; branches spreading, horizontal, often cuspidate because of erect, crowded leaves at tips. Leaves erect-spreading, slightly striate and somewhat twisted at tips when dry, not at all complanate or secund, 1 to 1.5 mm. long, lanceolate, gradually narrowed to slender acumen, entire or serrulate at tips; costae very weak and obsolete, rarely reaching midleaf, usually ending  $\frac{1}{3}$  up leaf or below, yellow, smooth; cells narrowly linear, incrassate. Dioicous. Seta red, smooth, 15 mm. long; urn cylindrical, short-necked, inclined to horizontal, 1 to 1.25 mm. long; teeth of peristome red-brown, furrowed, segments yellowish, keeled, as long as teeth; exothelial cells quadrate, lightly collenchymatous. Spores spheric, smooth, 16 to 17  $\mu$ .

On boulder in trail to West Peak, El Duque Range, Sierra de Luquillo, W. C. S. 5968, Jan. 9, 1940. On dead wood, Mt. Britton, Sierra de Luquillo,

*W. C. S. 7080a*, May 11, 1940. On rotten tree, forest above El Toro trail, Sierra de Luquillo, *W. C. S. 7060*, May 10, 1940. On rock, "The Pinnacles," Sierra de Luquillo, *María Masters 144*, May 20, 1939.

A member of the section *Eu-Hookeriopsis*, this species is closely related to *H. leiophylla* (Besch.) Jaeg. and *H. luteorufescens* (Besch.) Jaeg. of the French Antilles, but differs from both in having leaves that are neither complanate or secund at the tips. It differs more particularly from *H. leiophylla* in its nearly entire leaves with cells less strongly incrassate. Judging from the description, *H. luteorufescens* differs from this or *H. leiophylla* in having stronger costae.

(f) *Hookeriopsis obsoletinervis* Thér. Mem. Soc. Cubana Hist. Nat. 14: 368. 1940.

Plants rather robust, golden-green to red-brown. Stems 4 to 5 cm. long, red, irregularly branched. Leaves oblong-lanceolate, gradually and slenderly acuminate, strongly falcate-secund, with tips twisted when dry, 1.5 to 2 mm. long; margins plane, denticulate toward apex; costae fairly weak, but usually distinct, ending at or below midleaf, smooth; cells long-linear, about 15:1, smooth and incrassate. Dioicous. Seta smooth, 15 mm. long; urn oval, narrowed to base, inclined to horizontal. Sporophyte not seen.

On soil, rock, and roots in very wet cloud forests on summit of several peaks in Luquillo Mts. of Puerto Rico; Cuba and Haiti.

When well-developed this species bears a curious resemblance to *Drepanocladus revolvens* or *D. exannulatus*, because of the reddish color and the strongly falcate leaves with slender, flexuose, and twisted tips. These plants compare favorably in aspect and general structure with the type collection of *H. rufa* (Schimp.) Broth., but differ in being dioicous rather than autoicous and in having a seta slightly shorter (15 rather than 18 to 20 mm. long).

(g) *Hookeriopsis falcata* (Hook.) Jaeg. Ber. St. Gall. Natur. Ges. 1875-76: 363. 1877.

*Hookeria falcata* Hook. Musci Exot. 1: pl. 54. 1818.

*H. harrisi* C. M. Bull. Herb. Boiss. 5: 564. 1897.

Rather robust, light brownish-green plants. Stems about 4 cm. long, red, subpinnately branched. Leaves lanceolate, gradually and slenderly acuminate, strongly falcate-secund, with tips twisted and flexuose when dry, about 2 mm. long; margins plane, denticulate above; costae extending well above midleaf, weakly toothed at back above; cells linear, 8 to 15:1, incrassate, smooth. Dioicous. Seta smooth, red, 1.5 to 3 cm. long; urn oval, horizontal, 2 mm. long; endostome-segments papillose, perforate, nearly as long as exostome, apparently fragile. Spores smooth, 14 to 16  $\mu$ .

On rotten log in very wet cloud forest, known from single locality in Puerto Rico, from near summit of Mt. El Duque in Luquillo Mts. (*W. C. S. 5977*); Cuba, Jamaica, Dominica, and Guadeloupe; northern South America.

The type of *Hookeriopsis falcata* Schimp. is very similar to these plants, differing only in having somewhat shorter leaves (1.5 mm. or less), a shorter seta (17 mm.), and inflorescences autoicous. The present species differs from

Brotherus' key in *Die natürlichen Pflanzenfamilien* (1925) in that the inflorescences are dioicous, the setae are smooth, and the leaf cells are also smooth.

(7) *Actinodontium* Schwaegr. Suppl. Sp. Musc. II. 2(1): 75. 1826.

Small, gregarious or tufted, green or yellowish, glossy plants. Stems ascending, densely foliate on all sides to somewhat complanate-foliate, simple or sparsely branched. Leaves spreading when moist, uniform, concave, lanceolate, acuminate, subentire; costa double, ceasing at or beyond midleaf; cells elongate-rhomboidal, smooth, laxer at base, narrower at margins forming indistinct border. Mostly heteroicous. Calyptra mitrate, smooth, lacinate at base. Seta elongate, smooth; capsule ellipsoid, erect and symmetric; annulus lacking; operculum high-conic, straight-beaked; peristome teeth papillose, with zigzag median line, segments of endostome papillose, keeled, narrow, rising from low basal membrane, cilia rudimentary or lacking.

*Actinodontium portoricense* Crum & Steere. Bryol. 59: 251. 1956.

Plants small, 1 to 1.5 cm. high, gregarious, pale green, moderately glossy, becoming yellowish or brownish. Stems ascending, simple or sparsely branched; branches 4 to 6 mm. long, blunt. Leaves slightly complanate, loosely erect, scarcely altered when dry, 2 to 2.5 mm. long, uniform, oblong-lanceolate, acute or short-acuminate, entire or denticulate at extreme apex; margins recurved in lower half or sometimes nearly to apex; costae slender, smooth, ending  $\frac{1}{2}$  to  $\frac{2}{3}$  up leaf; cells rather laxly elongate-rhomboidal, about  $15 \mu$  wide, 5 to 8:1, slightly incrassate and lightly pitted, narrower at margins, forming an indistinct border becoming brownish with age, cells at insertion shorter and laxer. Heteroicous; most inflorescences containing only antheridia or archegonia; no paraphyses; perichaetial and perigonial leaves similar, ovate, gradually short-acuminate, ecostate, about 1 to 1.5 mm. long. Calyptra mitrate, covering urn, smooth, deeply lacinate. Seta 6 to 10 mm. long, dark red, smooth; urn of capsule 1.5 to 2 mm. long, subcylindric, widest at mouth and gradually tapered to base, dark red, smooth; operculum straight-rostrate from convex base, about 1 mm. high; exothelial cells rectangular or oblong-rhomboidal, not collenchymatous, lateral walls thickened, transverse walls thin, annulus lacking, about 5 to 6 rows below mouth subquadrate and thin-walled; peristome teeth linear-lanceolate, about  $600 \mu$  high, white, densely papillose, with median zigzag line, segments as long as teeth, linear, somewhat keeled below, white, densely papillose, basal membrane very low, cilia lacking. Spores green, spheric, faintly papillose, 13 to  $17 \mu$ .

On base of small tree, west slopes of Sierra de Luquillo, above C. C. C. Camp "Verde," Río Grande, W. C. S. 4983, Nov. 25, 1939. On sierra palm, trail running westward from El Toro ("Torito") to Ciénaga Alta, Sierra de Luquillo, W. C. S. 6458, Feb. 10, 1940 (type). Puerto Rico, without further data, Heller, in herb. Bartram as *A. sprucei*.

This species differs from *A. sprucei* in having larger, longer leaves with relatively shorter, broader points, and particularly in having margins often recurved nearly to the apex.

(8) *Lepidopilidium* (C. M.) Broth. *In* E. & P. Nat. Pfl. 1(3): 942. 1907.

Small to rather large plants in green or yellowish-green mats, sometimes tinged with red or brown. Primary stems prostrate, secondary stems erect or ascending, simple to freely branched, complanate-foliate. Leaves ovate to lanceolate, usually acuminate, serrulate above, asymmetric, dimorphous, dorsal and ventral leaves erect, lateral leaves larger, spreading; 2 costae, reaching midleaf; cells smooth, rhomboidal above, longer at base. Calyptra small, conic-mitrate, smooth or slightly hairy, lobed at base. Seta usually short, smooth or papillose above; capsule erect to horizontal; annulus lacking; operculum long-rostrate; peristome teeth reddish-brown, furrowed, striate; endostome yellow, papillose, with keeled segments from rather high basal membrane, cilia lacking.

*Lepidopilidium portoricense* (C. M.) Crum & Steere. *Bryol.* 59: 253. 1956.

*Crossomitrium portoricense* C. M. Hedwigia. 37: 244. 1898.

Rather robust plants in light green to yellowish mats, sometimes tinged with brown or red, dull or somewhat shiny. Primary stems creeping, secondary stems ascending, simple to freely branched, complanate-foliate, about 4 mm. wide when moist, often bearing pale brood filaments in leaf axils. Leaves ovate to ovate-lanceolate, abruptly acuminate, asymmetric, about 2 to 2.5 mm. long, serrulate in upper third or half, unbordered; costae variable in length, ending near or below midleaf; cells smooth, large, elongate-rhomboidal above, longer toward base. Calyptra bearing a few scattered hairs. Dioicous. Seta 7 to 15 mm. long, smooth; capsule erect, oblong-cylindric; exothecial cells moderately thickened at corners; peristome teeth red-brown, finely transverse-striate, with median zigzag line, but appearing narrowly furrowed under low power; endostome papillose, keeled, segments well-developed, about as long as teeth, cilia lacking.

On tree trunks, rotting logs, and on rock in wet mountain forests, at upper altitudes in Cordillera Central of Puerto Rico, apparently not collected in Luquillo Mts.; Cuba, Dominica, and British Guiana.

*Lepidopilum cubense* (Sull.) Mitt. might be confused with this species because of the pale filaments it often bears in the leaf axils and because of a general resemblance in aspect and structure of the gametophytes. The areolation is more delicate in *L. cubense*, however, and the seta is scabrous above. The furrowed, striolate teeth of the peristome indicate a relationship to *Lepidopilidium* rather than to *Lepidopilum*.

(9) *Lepidopilum* Brid. *Bryol. Univ.* 2: 267. 1827.

Small to large plants in lax, clear or yellow-green, often glossy tufts. Primary stem prostrate; secondary stems suberect, simple to freely branched, usually complanate-foliate. Dorsal and ventral leaves erect, lateral leaves larger and spreading, asymmetric, ovate-lanceolate to oblong or lingulate, apiculate to acuminate, usually serrate above; 2 costae, usually reaching midleaf; cells smooth, narrowly hexagonal, often becoming linear toward margins and forming more or less indistinct border. Calyptra conic-mitrate,

smooth or hairy, lobed. Seta short to fairly long, mostly papillose or bristly; capsule erect; annulus lacking; operculum high conic-rostrate; peristome teeth pale, papillose, not furrowed, usually appearing bordered because of broader dorsal plates; endostome hyaline or yellow, papillose, with keeled segments from low basal membrane, cilia rudimentary or lacking.

Leaves indistinctly bordered by 3 to 6 rows of long-linear cells. . . . (a) *L. polytrichoides*  
Leaves unbordered.

Costae weak or lacking, ending at  $\frac{1}{4}$  or less leaf length.

Small plants with some branches partially or wholly denuded of leaves; leaves 1.5 to 2 mm. long. . . . (c) *L. stolonaceum*

Medium-sized plants; branches not denuded; leaves 2.5 to 3 mm. long.

(b) *L. scabrisetum*

Costae ending at  $\frac{1}{3}$  to  $\frac{1}{2}$  leaf length.

Rather small, yellowish plants; secondary stems 2 to 2.5, rarely 5 cm. high.

(d) *L. robustum*

Rather robust, reddish plants; secondary stems 3.5 to 10 cm. high. . (e) *L. purpurascens*

(a) *Lepidopilum polytrichoides* (Hedw.) Brid. Bryol. Univ. 2: 269. 1827.

*Hypnum polytrichoides* Hedw. Sp. Musc. 244. 1801.

?*Hookeria carionis* C. M. Bull. Herb. Boiss. 5: 205. 1897.

Dull green, rather robust plants. Secondary stems up to 5 or 8 cm. high, simple or sparsely branched, 9 to 12 mm. wide when moist, often attenuate, complanate-foliate. Leaves contorted when dry, lateral leaves widely spreading, 4.5 to 6 mm. long, oblong-ovate, abruptly narrowed to long, slender acumen, serrate in upper half; costae relatively strong, ending shortly above midleaf; cells large, elongate-rhomboidal, linear in 3 to 6 rows at margins, forming an indistinct border; median leaves smaller, ovate. Autoicous (usually synoicous, according to Bartram). Seta about 3 mm. long, bluntly papillose; capsule erect or nearly so, 1.5 to 2 mm. long. Calyptra sparsely pilose.

On tree trunks and rock faces, in wet mountain forests at upper altitudes (2000 to 3000 ft.), apparently not collected in Puerto Rico outside Luquillo Mts.; West Indies; Mexico to South America.

(b) *Lepidopilum scabrisetum* (Schwaegr.) Steere. Bryol. 51: 140. 1948.

*Neckera scabriseta* Schwaegr. Suppl. Sp. Musc. I. 2: 153. 1816.

*Lepidopilum subenerve* Brid. Bryol. Univ. 2: 268. 1827, nom.

*L. pterygophylloides* C. M. Hedwigia. 37: 246. 1898.

Plants yellow-green, shiny. Secondary stems 2 to 6.5 cm. high, branched, complanate-foliate. Lateral leaves 2.5 to 3 mm. long, elliptic to oblong-lanceolate, asymmetric when dry, acuminate, usually carinate at apex and thus appearing cuspidate when dry, serrulate in upper third or half, unbordered; costae very weak and short, seldom exceeding  $\frac{1}{4}$  leaf length; cells narrow, oblong-linear, lax and oblong-hexagonal at insertion. Calyptra pilose. Polyoicous, often appearing autoicous. Seta 6 to 9 mm. long, hispid throughout; capsule inclined, oblong-cylindric, about 9 mm. long.

On trees and shrubs and rock in wet mountain forests at middle and upper altitudes, common and abundant in all higher sierras of Puerto Rico; West Indies; Guatemala and Costa Rica; South America.

(c) *Lepidopilum stolonaceum* C. M. Hedwigia. 37: 245. 1898.

Small, yellow-green, moderately glossy plants. Stems short, freely branched, branches often appearing more or less stoloniform because of readily deciduous leaves. Leaves laxly appressed, complanate; lateral leaves oblong, gradually short-acuminate, somewhat asymmetric, serrulate in upper  $\frac{1}{3}$  to  $\frac{1}{2}$ , unbordered; deciduous leaves similar but narrower; costae very weak, often obsolete, ending at  $\frac{1}{4}$  or less leaf length; cells long and narrow, oblong-linear. Sporophyte unknown.

On trees, rotten wood, and limestone in moist forests in coastal plain and at lower and middle altitudes of major mountain systems of Puerto Rico; Cuba, Montserrat, Martinique, and Guadeloupe.

(d) *Lepidopilum robustum* Mitt. Journ. Linn. Soc. London, Bot. 12: 386. 1869.

*L. daltonioides* Schimp. ex Besch. Ann. Sci. Nat., Bot. VI. 3: 230. 1876.

*L. cladorrhizans* Besch. Journ. de Bot. 8: 63. 1894.

Relatively small, yellowish, dull or moderately shiny plants. Secondary stems 2 to 2.5, rarely 5 cm. high, 4 to 5 mm. broad when moist, moderately complanate-foliate. Leaves crowded, lateral spreading, narrowly oblong, gradually acuminate, concave, entire or minutely serrulate toward the apex, not bordered; costae slender, extending  $\frac{1}{3}$  to  $\frac{1}{2}$  leaf length; cells narrow, oblong-linear, lax and oblong-hexagonal at insertion. Autoicous. Calyptra pilose. Seta 6 to 7 mm. long, hispid; urn of capsule 1.5 mm. long, erect, oblong-cylindric; operculum conic-rostrate, about as long as urn.

On trees and rock in wet mountain forests, at upper altitudes in higher sierras of Puerto Rico; Cuba, Jamaica, Haiti, and Guadeloupe; South America.

(e) *Lepidopilum purpurascens* Schimp. ex Besch. Ann. Sci. Nat., Bot. VI. 3: 229. 1876.

Rather robust plants, yellow-green at growing tips, becoming wine-red, somewhat shiny. Secondary stems 3.5 to 10 cm. high, erect-ascending, simple or sparsely branched, 6 to 7 mm. wide when moist, complanate-foliate. Leaves contorted when dry, 3 to 4 mm. long, oblong-ovate, gradually acuminate, asymmetric, serrulate near apex, unbordered; costae weak, ending  $\frac{1}{3}$  to  $\frac{1}{2}$  up leaf; cells narrow, laxly oblong-linear, broadly oblong-hexagonal at insertion. Dioicous. Sporophyte unknown.

On trunks, branches, and twigs of trees and shrubs and on rock in wet mountain forests at highest altitudes, near summits of major peaks in Puerto Rico; Guadeloupe.

(10) *Crossomitrium* C. M. Linnaea. 38: 611. 1875.

Glossy yellow-green plants, sometimes tinged with brown or red, growing in flat mats. Stems creeping, complanate-foliate, freely branched, frequently producing brown, septate, filiform propagula in clusters on lower side of

stems and branches. Leaves in 4 ranks, median leaves obliquely appressed, lateral leaves widely spreading, larger, somewhat asymmetric, broadly ovate to suborbicular, often plicate at apex, ecostate; margins usually serrulate, teeth often bifid; cells linear, smooth, laxer near insertion. Dioicous. Calyptra conic-mitrate, smooth, filamentous at base. Seta elongate, red, more or less papillose above; capsule erect; no annulus, operculum long-rostrate from swollen base; peristome teeth papillose, not furrowed, endostome papillose with narrow, keeled, and perforate segments from low basal membrane, cilia lacking.

Leaves suborbicular, obtuse, overlapping and strongly appressed when dry

Leaves oblong-ovate, acute, loosely appressed or somewhat shriveled when dry

(a) *C. orbiculatum*

(b) *C. sintenisii*

(a) *Crossomitrium orbiculatum* C. M. Hedwigia. 37: 244. 1898.

Plants bearing red-brown, filamentous propagula in tufts on underside of stems and branches. Leaves crowded, overlapping, not contorted and scarcely shriveled when dry, lateral leaves 0.7 to 0.9 mm. long, 0.5 to 0.6 mm. wide, suborbicular, carinate at obtuse apex, thus appearing mucronate, serrulate in upper half; cells very narrow, linear, laxer at insertion. Seta 6 to 7 mm. long, slightly roughened at apex.

On tree trunks, roots, and twigs, occasionally on living leaves and rock, in very humid habitats in wet mountain cloud forests, common at middle and upper altitudes in all major sierras of Puerto Rico; Haiti, Dominica, Montserrat, Guadeloupe, and Martinique; Trinidad.

According to a manuscript on Puerto Rican mosses (at the New York Botanical Garden) by E. G. Britton, *Lepidopilum epiphyllum* Mitt. and *L. flaccidissima* Besch. are identical and, in her opinion, might not differ specifically from *C. orbiculatum* C. M. and *C. oerstedianum* C. M. The genus is in serious need of further attention. If Mrs. Britton was right concerning these closely related, if not identical species, the range of this species would be extended to include Central America.

(b) *Crossomitrium sintenisii* C. M. Hedwigia. 37: 244. 1898.

*C. jamaicense* C. M. *Ibid.* 245.

Plants with tufts of red-brown, filamentous propagula on underside of stems and branches. Leaves crowded, more or less overlapping when moist, somewhat contorted and loosely complanate when dry, lateral leaves 1.5 to 2 mm. long, oblong-ovate, sometimes oblong-lanceolate, acute, carinate at tip, serrulate nearly all around; cells narrow and linear, laxer at insertion. Seta 8 to 10 mm. long, rough in upper half; urn about 1 mm. long; operculum 1 mm. long.

Generally on living leaves, also on twigs, roots, and trunks of trees, rarely on rock, in very humid mountain cloud forests at middle and higher altitudes in all higher mountainous areas of Puerto Rico; Cuba, Jamaica, Haiti, Dominica, Guadeloupe, and Martinique.

(11) *Hypnella* (C. M.) Jaeg. Ber. St. Gall. Natur. Ges. 1875-76: 365. 1877.

Slender to fairly large plants in dull, pale to dark green mats, sometimes tinged with brown. Stems creeping, regularly branched, slightly to strongly complanate-foliate. Leaves imbricate when dry, sometimes secund, concave, oval to oblong, rounded or truncate or filiform-acuminate at apex; costa double, usually well-developed; cells elongate, 3- to 4-papillose, becoming lax and smooth toward insertion. Calyptra small, mitrate, smooth, lobed at base. Seta elongate, red, mostly rough above; capsule oblong, inclined to pendent; annulus present; operculum rostrate; peristome teeth narrow, red-brown, furrowed, striate, densely lamellose; endostome yellow, papillose to nearly smooth, with narrow, keeled segments, a high basal membrane, no cilia.

Leaves obtuse or rounded at apex; papillae multifid. . . . . (a) *H. cymbifolia*  
 Leaves contracted to long acumen; papillae simple. . . . . (b) *H. filiformis*

(a) *Hypnella cymbifolia* (Hampe) Jaeg. Ber. St. Gall. Natur. Ges. 1875-76: 365. 1877.

*Hookeria cymbifolia* Hampe. Linnaea. 25: 362. 1852.

*Pseudohypnella guianensis* Richards. Kew Bull. Misc. Info. 8: 336. 1934.

Slender plants with short stems; branches somewhat flattened. Leaves erect or loosely appressed, not crowded, oblong-ovate, concave, cucullate at obtuse or rounded apex, denticulate nearly to base, about 1 mm. long; costae weak, often lacking, ending well below midleaf; upper cells linear, thin-walled, bearing several blunt, often multifid papillae in a row, cells at insertion laxer and smooth, not differentiated at basal angles. Synoicous. Seta slender and flexuose, reddish, roughened at tip, 8 to 12 mm. long; urn horizontal to inclined, oblong, roughened at neck, 1 to 1.5 mm. long; endostome segments as long as teeth, papillose and perforate. Spores smooth, about 11  $\mu$  (FIGURE 42).

On rotten wood, bases of trees, and rock in wet mountain forests at high altitudes, known from a few localities in all major sierras of Puerto Rico; West Indies; British Guiana.

Richards himself (personal correspondence) conceded the identity of *Pseudohypnella guianensis* with this species; his description, however, indicates that the plants are autoicous, a point that will bear checking, inasmuch as the Puerto Rican specimens are synoicous.

(b) *Hypnella filiformis* (Hook. ex Spreng.) Jaeg. Ber. St. Gall. Natur. Ges. 1875-76: 367. 1877.

*Hookeria filiformis* Hook. ex Spreng. Syst. Veg. 4: 197. 1827.

*H. pseudopilifera* Hampe. Linnaea. 25: 362. 1852.

*H. erythrochaete* Schimp. ex Besch. Ann. Sci. Nat., Bot. VI. 3: 240. 1876.

Slender plants with short stems; branches scarcely or not at all flattened. Leaves not crowded, erect-spreading and somewhat contorted when dry,

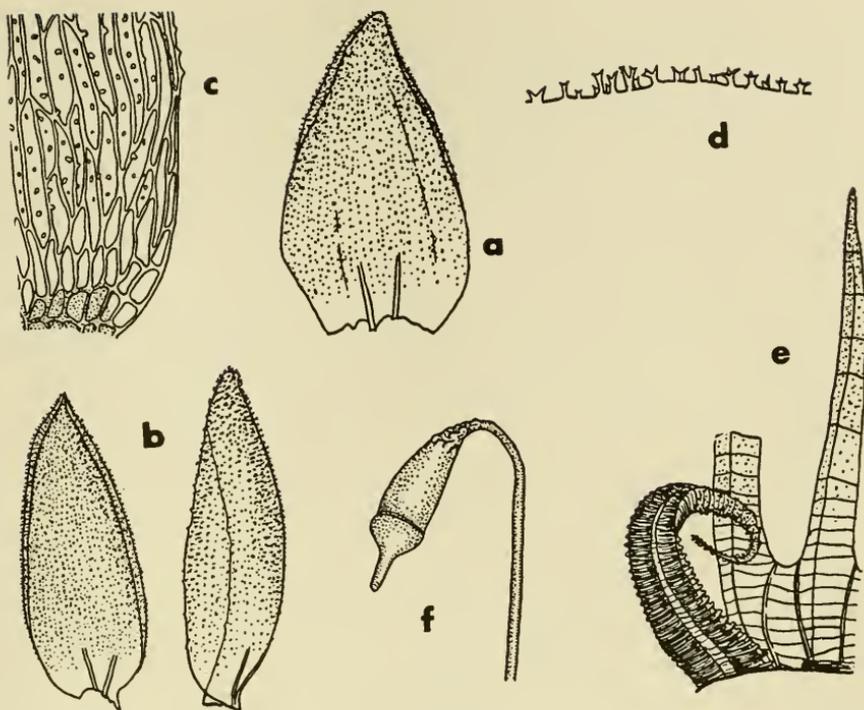


FIGURE 42. *Hypnella cymbifolia*: (a) stem leaf, (b) 2 branch leaves, (c) areolation at basal margin of leaf, (d) papillae of leaf as seen in profile, (e) portion of peristome, and (f) capsule (Richards, 1934, as *Pseudohypnella guianensis*).

wide-spreading when moist, abruptly contracted from oblong, concave base to flat, denticulate, flexuose or crispate acumen  $\frac{1}{2}$  or more as long as base; margins erect, denticulate in upper half of base and in acumen; costae pale, ending near base of acumen; cells linear, thin-walled, bearing minute, simple papillae in a row, shorter, laxer, and smooth at extreme base, not differentiated at basal angles. Dioicous. Seta red, roughened above, 1.5 cm. long; urn broadly oblong, about 1 mm. long, contracted to short, rough neck; endostome segments perforate, papillose. Spores smooth, 12 to 16  $\mu$ .

On trees, rotten wood, and rarely on rock in cloud forests on and near mountain summits, abundant in Sierra de Luquillo but apparently very rare to the west in Puerto Rico; West Indies.

(12) *Stenodictyon* (Mitt.) Jaeg. Ber. St. Gall. Natur. Ges. 1875-76: 358. 1877.

Small to fairly robust, yellowish, shiny plants. Stems elongate, prostrate, rather densely branched. Leaves in 8 rows, loosely appressed when dry, erect-spreading when moist, uniform, symmetric, oblong and concave, rather abruptly prolonged into slender, flexuose awn, unbordered, entire or nearly so; costae thin, smooth, weakly divergent, ending at or well above midleaf.

Calyptra conic-mitrate, lobed at base, smooth, covering only operculum. Seta red, elongate, thin and flexuose, smooth or roughened above; capsule horizontal to nodding, oval, short-necked, smooth; no annulus; operculum conic-rostrate; peristome teeth red-brown, lance-subulate, densely cross-striolate, papillose at tips, broadly furrowed; endostome yellow, papillose, basal membrane low to moderately high, segments lanceolate, keeled, no cilia.

*Stenodictyon pallidum* Britt. ex Crum & Steere. Bryol. 59: 252. 1956.

Plants rather small, soft, whitish or golden green, becoming brown, moderately glossy. Stems creeping, irregularly branched, usually not exceeding 1 cm.; branches short and blunt. Stem leaves slightly larger than branch leaves and more abruptly acuminate. Branch leaves crowded and loosely erect or erect-spreading, scarcely altered when dry, not or slightly complanate, 1 to 1.5 mm. long, symmetric, oblong-lanceolate, concave, gradually or rather abruptly narrowed to slender, flexuose-spreading or recurved awn; margins entire, unbordered, more or less inflexed above; costae weak, smooth, ending at or below midleaf; cells laxly linear-rhomboidal, thin-walled, smooth, 12 to 13  $\mu$  wide, 5 to 8:1, becoming shorter and laxer toward base. Autoicous; both perichaetial and perigonial inflorescences with a few hyaline, simple paraphyses; inner perigonial leaves ovate, gradually acuminate, ecostate, about 0.5 mm. long; perichaetial leaves oblong-ovate or oblong-lanceolate, more or less abruptly and slenderly acuminate, about 1 mm. long, with costae weak or lacking. Calyptra mitrate, rostrate, shallowly lobed at base, smooth and naked, about 1 mm. long, covering only operculum. Seta red, thin and flexuose, smooth throughout, 8 to 14 mm. long; urn of capsule horizontal to pendent, oblong, short-necked, smooth, about 1 mm. long; operculum long-rostrate, 0.8 to 1 mm. long; exothecial cells hexagonal or subquadrate, thin-walled, lightly collenchymatous, scarcely differentiated at mouth, stomatose at neck; no annulus; peristome teeth red-brown, about 300  $\mu$  high, densely cross-striolate, papillose at tips, broadly furrowed along median line; endostome yellow, papillose, keeled, as long as exostome, basal membrane low, no cilia. Spores green, spheric, smooth, 12 to 15  $\mu$  (FIGURE 43).

On rotten logs and soil, near Maricao and also near Jayuya in Puerto Rico; Cuba and Haiti.

(13) *Rhynchostegiopsis* C. M. Nuov. Giorn. Bot. Ital. N. S. 4: 163. 1897.

Rather robust, pale, glossy plants. Stems creeping, irregularly branched. Leaves lanceolate, acuminate, unbordered, sharply serrate above, ecostate; cells large and lax, oblong-hexagonal to linear, smooth. Calyptra cucullate, smooth, entire or lobed at base. Seta elongate, red, smooth; capsule oblong, inclined to pendent; annulus lacking; operculum long-rostrate; peristome teeth red-brown, furrowed, striate, densely lamellose; endostome yellow, finely papillose, with broad, keeled, perforate segments from high basal membrane, cilia well developed, nodose.

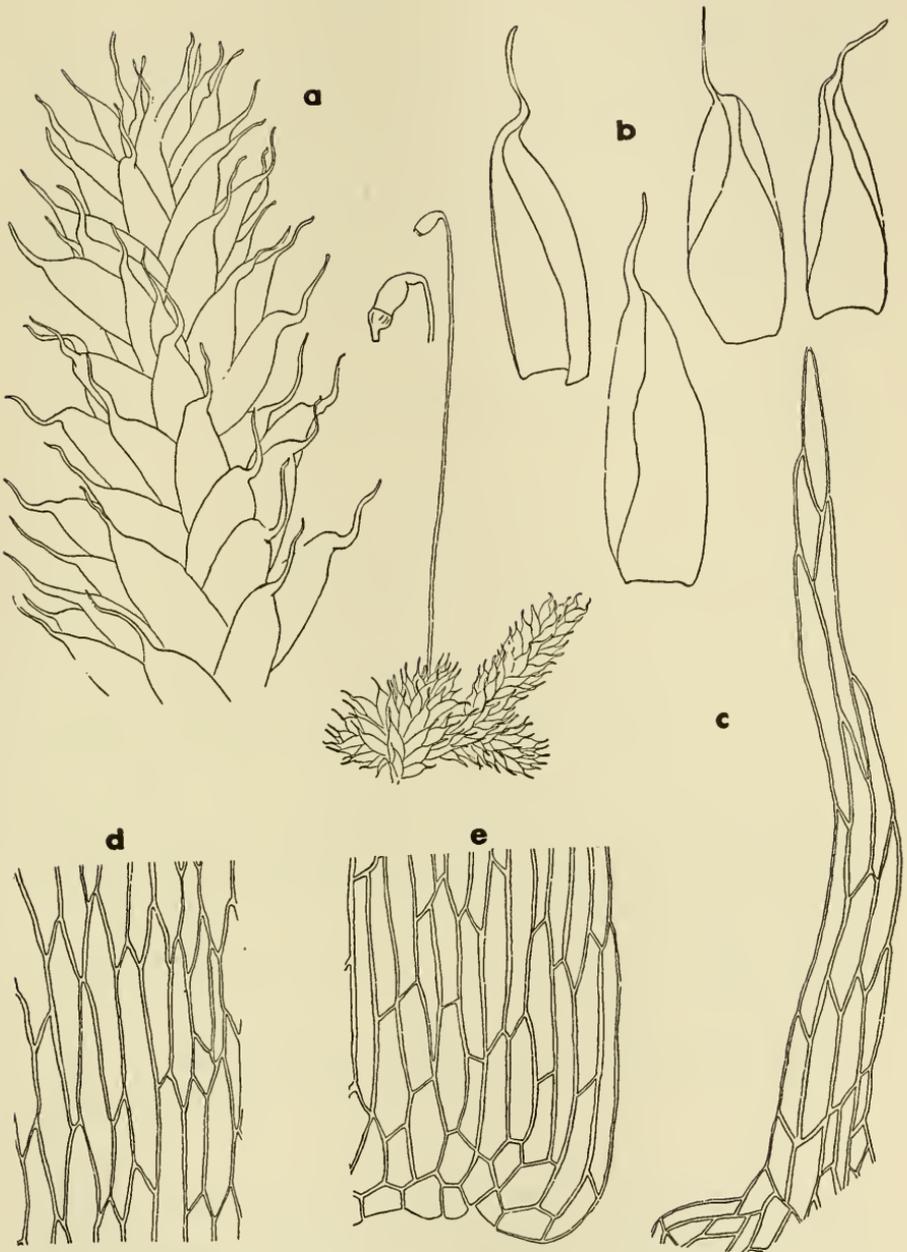


FIGURE 43. *Stenodictyon pallidum*: (a) habit of fruiting plant, (b) portion of stem, (c) leaves, (d) cells of leaf acumen, (e) cells of upper third of leaf, and (f) cells of leaf base.

*Rhynchostegiopsis flexuosa* (Sull.) C. M. Nuov. Giorn. Bot. Ital. N. S. 4: 163. 1897.

*Hypnum flexuosum* Sull. Proc. Amer. Acad. Arts and Sci. 5: 288. 1861.

*Rhynchostegium cupressinum* Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg, 16: 250. 1872.

*Vesicularia auricolor* C. M. Bull. Herb. Boiss. 5: 211. 1897.

Stems 2 to 3 cm. long, irregularly to subpinnately branched, complanate-foliolate, hooked at tips. Leaves crowded, spreading with decurved points, ovate-lanceolate, long-acuminate, serrate in upper half; cells linear, pellucid. Calyptra entire at base. Dioicous. Seta slender, up to 3 cm. long; capsule subcylindric, somewhat curved, inclined to pendent, 1 to 1.5 mm. long.

On rotten wood, rarely on rock, in wet mountain forests at altitudes of 1500 to 2500 ft., apparently restricted to Luquillo Mts. in Puerto Rico; Cuba, Jamaica, Haiti, Dominica, and Guadeloupe; Mexico, Guatemala, Honduras, and Costa Rica.

(14) *Hemiragis* (Brid.) Besch. Ann. Sci. Nat., Bot. VI. 3: 242. 1876.

Large glossy, yellowish to brownish-red plants in loose tufts. Primary stems creeping; secondary stems erect, more or less branching. Leaves loosely appressed or erect-secund when dry, erect-spreading when moist, secund, oblong-lanceolate and slenderly acuminate, plicate; margins plane, unbordered, serrulate throughout; costae double, unequal, slender, toothed at back above, each ending in minute dorsal spine; cells long-linear, smooth, lax and colored at base. Autoicous. Calyptra conic-mitrate, smooth or sparsely hairy, lobed at base. Seta long, red, smooth; capsule oblong, swollen at short, thick neck, inclined to horizontal; annulus lacking; operculum long-rostrate; peristome teeth brownish-yellow, furrowed, finely cross-striate, densely lamellose; endostome about as high as exostome, yellow, finely papillose, with keeled, narrowly perforated segments from high basal membrane, cilia rudimentary.

*Hemiragis aurea* (P.-B.) Ren. & Card. Bull. Soc. Roy. Bot. Belg. 32(1): 197. 1893.

*Mnium aureum* P.-B. Prodr. 74. 1805.

*Leskea striata* Schwaegr. Suppl. Sp. Musc. 1(2): 180. 1816.

*Hemiragis friedrichstaliana* Reich. Sitzungsber. d. Wiener. Akad. 65: 479. 1877.

Secondary stems up to 2 to 6 cm. high, freely and often pinnately branched. Leaves crowded, erect-spreading, 3 to 4 mm. long, broadly lanceolate, gradually long-acuminate, plicate, serrulate all around; costae slender, reaching well into acumen, weakly toothed at back above; cells linear, shorter, brown, thin-walled and porose at insertion. Seta 1.5 to 4 cm. long; urn of capsule oblong, wide-mouthed, 2 mm. long.

On trees and fallen logs, more rarely on rock, in continually wet cloud forests on mountain summits, apparently restricted in Puerto Rico to Luquillo Mts.; West Indies: Guatemala, Costa Rica, and Panama; South America.

## LEUCOMIACEAE

Slender to rather robust, soft, lax plants. Stems creeping or sometimes pendent, branched, complanate-foliate; paraphyllia lacking. Leaves more or less spreading, of various shapes, sometimes asymmetric; costa lacking, or sometimes short and double; cells lax and thin-walled, rhomboidal, smooth, not differentiated at basal angles. Calyptra cucullate. Seta long, mostly roughened above; capsule oblong, horizontal to pendent, usually symmetric; exothecial cells collenchymatous; annulus broad, persistent; peristome teeth cross-striolate, narrowly furrowed, endostome about as long as exostome, with keeled segments, well-developed basal membrane, cilia lacking or rudimentary.

*Leucomium* Mitt. Journ. Linn. Soc. London, Bot. 10:181. 1868.

Slender, pale, rather glossy plants. Stems flattened, irregularly branched to subpinnate. Leaves in several rows, somewhat concave, obliquely inserted, dorsal and ventral leaves nearly asymmetric, appressed, alternately directed to right and left, lateral leaves somewhat asymmetric, spreading, ovate to lanceolate, acuminate, ecostate, entire. Calyptra smooth or sparsely hairy, entire at base. Operculum long-rostrate; peristome teeth lanceolate, red-brown, papillose at tips; endostome yellow, finely papillose, cilia lacking or poorly developed.

*Leucomium compressum* Mitt. Journ. Linn. Soc. London, Bot. 12: 502. 1869.

*Rhaphidostegium molle* Schimp. ex Paris. Index Bryol. 1100. 1897, nom.

*Leucomium connexum* Ren. & Card. Bull. Soc. Roy. Bot. Belg. 41(1): 113. 1905.

Plants pale green or yellowish. Stems creeping, fragile, irregularly branched, about 3 cm. long; branches horizontal, not or slightly tapered. Leaves 1.5 to 2 mm. long, soft, flexuose-spreading when dry, more or less distichous-complanate when moist, lateral leaves oblong-lanceolate, slenderly acuminate, inflexed on 1 side below; cells very lax and pellucid, elongate-rhomboidal or sublinear, narrower at margins. Synoicous. Calyptra smooth or slightly hairy. Seta red, 8 to 18 mm. long; urn about 0.8 mm. long, curved, ovoid, horizontal to pendent.

On rotten wood, occasionally on soil or rock, in wet mountain forests at middle and higher altitudes, widespread in Puerto Rico in major mountain systems; West Indies; northern South America.

## HYPOPTERYGIACEAE

Slender to robust, gregarious, usually dull plants with creeping, tomentose primary stems and erect secondary stems, mostly freely branched and frondose from stipitate base. Leaves dimorphous; lateral leaves complanate, ovate, acute, asymmetric, ventral leaves small, acuminate; margins mostly bordered; costa single; cells isodiametric, mostly smooth, not differentiated at basal angles. Calyptra cucullate or conic, smooth. Seta elongate; capsule usually inclined to pendent, rarely erect, symmetric; exothecial cells collenchymatous; operculum rostrate; peristome inserted below mouth, usually

double, outer sometimes lacking, teeth usually closely cross-striate, with zigzag median line and well-developed lamellae, endostome with keeled basal membrane and segments.

*Hypopterygium* Brid. Bryol. Univ. 2: 709. 1827.

Secondary stems stipitate, frondose. Leaves usually bordered, more or less toothed above, with costa ceasing well below apex; lateral leaves complanate, ovate, acute, asymmetric, ventral leaves much smaller, acuminate. Seta elongate; capsules pendulous; operculum long-rostrate; peristome double, teeth cross-striate, basal membrane and cilia of endostome well developed.

*Hypopterygium tamariscinum* (Hedw.) Brid. Bryol. Univ. 2: 715. 1827.

*Leskea tamariscina* Hedw. Sp. Musc. 212. 1801.

*Hypnum tamarisci* Swartz. Prodr. Fl. Ind. Occ. 3: 1825. 1806.

*Hypopterygium brasiliense* Sull. Proc. Amer. Acad. Arts and Sci. 3: 15. 1854.

*H. pseudotamarisci* C. M. Linnaea. 38: 645. 1874.

Secondary stems about 3 cm. high, stipe tomentose at base or sometimes nearly to frond. Stipe leaves broadly ovate, cordate at base, acuminate; lateral branch leaves about 2 mm. long, ovate, bordered, serrate toward apex; costa about  $\frac{3}{4}$  leaf length; cells rounded-hexagonal, smooth; ventral branch leaves small, abruptly and narrowly acuminate, ovate, with costa ending in acumen. Seta about 1.5 cm. long, reddish; urn ovoid, 2 mm. long, horizontal to pendulous.

On base of trees and on rock in wet places in humid mountain forests, known from only a few localities in Cordillera Central of Puerto Rico; West Indies; Mexico to South America.

FABRONIACEAE

Very slender to minute, delicate plants in thin green mats on bark or rocks. Stem creeping, irregularly branched, branches erect or ascending, simple or divided. Paraphyllia mostly lacking. Leaves appressed when dry, spreading on all sides when moist, rarely secund, more or less concave, unistratose, ovate to lanceolate, acuminate, not plicate; costa single, slender, short, rarely lacking; cells smooth, rhomboidal, mostly thin-walled, quadrate or oblate at basal angles. Calyptra small, cucullate, smooth, naked or rarely sparsely hairy. Capsule exserted, erect and symmetric, oval to subcylindric, with short, thick neck; exothelial cells lax and thin-walled; annulus usually persistent and apparently lacking, rarely deciduous; operculum conic or apiculate to rostrate; peristome teeth (rarely lacking) distantly articulate, without lamellae, endostome lacking or consisting of subulate segments, sometimes consisting of keeled basal membrane and segments.

Peristome single; teeth papillose in longitudinal rows, not transversely striolate.

Peristome double; teeth transversely striolate below, papillose above.. (1) *Fabronia*  
(2) *Helicodontium*

(1) *Fabronia* Raddi. Atti Acad. Sci. Siena. 9: 231. 1808.

Minute, delicate plants growing in thin, soft mats. Stem creeping, irregularly branched; branches often forked, sometimes stoloniferous. Leaves loosely to closely imbricated when dry, sometimes slightly secund, equally spreading when moist, ovate-lanceolate, acuminate, entire or toothed above; costa usually short and slender, sometimes indistinct; cells rhomboidal, usually quadrate in several rows at basal angles. Inner perichaetial leaves sheathing, subulate-acuminate, toothed or ciliate, ecostate. Seta 1 to 7 mm. long, smooth; capsule erect, obovate to pyriform, short-necked; exothecial cells often bulging, usually with crenate outlines; peristome single, rarely lacking, teeth in 8 pairs (later separate), strongly hygrosopic, incurved when moist, broad, blunt, brownish, sometimes perforated along median line, densely papillose, papillae arranged in longitudinal rows.

*Fabronia polycarpa* Hook. Musci Exot. 1: pl. 3. 1818.

Delicate, green, slightly glossy plants in wide, low, dense mats. Stems freely and irregularly branched; stem and branch leaves similar. Leaves loosely appressed with somewhat spreading awn tips when dry, erect-spreading when moist, ovate-lanceolate, slenderly long-acuminate, 0.5 to 0.7 mm. long, entire or irregularly subserrulate, particularly near tips of branches; costa slender,  $\frac{1}{2}$  to  $\frac{2}{3}$  leaf length; cells oblong-linear, thin-walled, quadrate in several rows at basal angles. Autoicous. Capsule obovate; operculum short-rostrate; peristome present. No sporophytes found in Puerto Rican material.

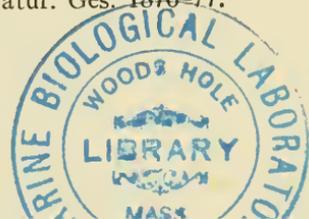
On tree trunks, in moist forest, known in Puerto Rico from single locality, near Penuelas (*Pagán* 423), at altitude of about 1650 ft. in central cordillera; Haiti; Panama; South America.

(2) *Helicodontium* Schwaegr. Suppl. Sp. Musc. III. 2(2): pl. 293. 1830.

Slender plants in dull, brownish-green mats. Stem creeping, freely but irregularly branched. Leaves appressed when dry, erect-spreading when moist, ovate to ovate-lanceolate, acute or gradually acuminate, minutely toothed above, slightly decurrent; costa ceasing above midleaf; cells oval-rhomboidal, somewhat elongate below, quadrate in several rows at basal angles. Autoicous. Inner perichaetial leaves sheathing, more or less long-acuminate. Seta 6 to 8 mm. or rarely up to 15 mm. long, slightly roughened; capsule erect, rarely inclined, ovoid, contracted below mouth when dry; annulus persistent; operculum obliquely rostrate; peristome double, teeth lanceolate, bordered, yellow, closely cross-striolate below, papillose above, endostome as long as teeth, yellowish or brownish, consisting of short, smooth, keeled basal membrane and papillose, narrow, keeled, perforate segments, cilia mostly lacking.

*Helicodontium capillare* (Hedw.) Jaeg. Ber. St. Gall. Natur. Ges. 1876-77. 225. 1878.

*Leskea capillaris* Hedw. Sp. Musc. 221. 1801.



Small dull green plants in intricate, flat mats. Stems creeping, up to 2 cm. long; branches numerous, slender, julaceous when dry, widely spreading. Leaves small, less than 1 mm. long, spreading on all sides when moist, but appressed when dry, ovate, acute; margins crenulate toward apex by projecting cell ends; costa ending  $\frac{2}{3}$  to  $\frac{3}{4}$  up leaf; cells rhomboidal, firm-walled, smooth, elongate near costa at base and quadrate in 4 to 6 rows at basal angles. Seta 5 to 6 mm. long, reddish, indistinctly roughened throughout; capsule erect, oblong-ovoid, about 1 mm. long; peristome teeth pale yellow, with hyaline border, cross-striolate below, papillose above, lamellose; endostome segments nearly as long as teeth, obscurely papillose, perforated along keel, basal membrane low; operculum obliquely rostrate from conic base, 0.6 mm. long. Spores faintly papillose, 15 to 20  $\mu$ .

On tree trunks, occasionally on rotten logs or rock, in moist forests at middle altitudes in mountains throughout Puerto Rico; Cuba, Jamaica, and Haiti; Mexico, Guatemala, and Nicaragua; South America.

#### THUIDIACEAE

Slender to robust plants growing in dull, loose to dense mats or tufts. Stems often wiry, prostrate or ascending, irregularly branched to pinnate, often frondose, branches erect to ascending. Paraphyllia mostly abundant, rarely lacking. Stem and branch leaves usually differentiated. Leaves appressed or incurved when dry, inserted all around, rarely and only slightly complanate, symmetric, or with oblique apices, ovate, acute to acuminate, concave, often plicate below; costa single, strong, or rarely lacking; cells small, parenchymatous, mostly papillose. Perichaetial leaves usually differentiated. Seta elongate, red, mostly smooth; capsule erect and symmetric to inclined and more or less arcuate; annulus mostly differentiated; operculum conic to rostrate; peristome double, teeth with prominent lamellae, and transversely striate or papillose, endostome keeled, usually differentiated into basal membrane and segments, and sometimes into cilia as well.

Apical cells of branch leaves bearing 2 or more papillae. . . . . (1) *Thuidium*  
 Apical cells of branch leaves bearing single, sharp papilla. . . . . (2) *Haplocladium*

#### (1) *Thuidium* Schimp. Bryol. Eur. fasc. 49-51. 1852.

Slender to robust, often wiry plants growing in loose mats. Stems elongate, prostrate or ascending, pinnate to tripinnate; paraphyllia usually very abundant, often multiform, but mostly linear. Stem and branch leaves differentiated; stem leaves ovate, acuminate; branch leaves smaller, ovate, concave, obtuse to acute or short-acuminate, ending in blunt cell with 2 to 4 papillae; costa strong; cells usually unipapillose. Calyptra smooth or nearly so. Seta elongate; capsule usually curved, nodding or horizontal; annulus present, sometimes poorly differentiated; operculum long-rostrate; peristome teeth narrow, yellow, striate below; endostome yellowish, smooth or papillose, consisting of well-developed, keeled, and narrowly perforate segments from high basal membrane, cilia usually well-developed.

- Robust, dioicous plants; leaf cells unipapillose. . . . . (a) *T. urceolatum*  
 Small, autoicous plants; cells pluripapillose. . . . .  
 Seta smooth. . . . . (b) *T. minutulum*  
 Seta rough.  
 Branching pinnate; leaves strongly incurved when dry; perichaetial leaves not ciliate. . . . . (c) *T. involvens*  
 Branching bipinnate; leaves only moderately incurved; perichaetial leaves ciliate. . . . . (d) *T. schistocalyx*

(a) *Thuidium urceolatum* Lor. Moosstudien. 167. 1864.

*T. acuminatum* Mitt. Journ. Linn. Soc. London, Bot. 12: 579. 1869.

*T. perregidum* C. M. Bull. Herb. Boiss. 5: 567. 1897.

Robust yellow-green or brownish plants. Stem flexuose, creeping, 2- or 3-pinnately branched, frondose. Paraphyllia abundant, freely branched. Stem leaves 1 to 1.5 mm. long, deltoid from cordate base, biplicate, abruptly narrowed to long, flat, flexuose-spreading acumen; margins revolute usually to base of acumen; costa vanishing in acumen. Leaves of ultimate branches about 0.2 mm. long, moderately concave, appressed, not incurved, ovate, acute, plane at margins; cells oblong or rounded, incrassate, each bearing single, rather small, blunt papilla; costa ending about  $\frac{3}{4}$  up leaf. Dioicous; inner perichaetial leaves ciliate. Seta red, smooth; urn oblong, horizontal, constricted below mouth when dry.

On tree trunks, soil, and rocks, common and abundant in moist forests at middle and upper altitudes in mountainous areas throughout Puerto Rico; West Indies; Trinidad, British Guiana, and Venezuela.

Hampe's report (1852) of *Hypnum delicatulum* Hedw. almost surely belongs here.

(b) *Thuidium minutulum* (Hedw.) B. S. G., Bryol. Eur. fasc. 49-51. 1852.

*Hypnum minutulum* Hedw. Sp. Musc. 260. 1801.

*H. muricatum* Hampe. Linnaea. 20: 88. 1847.

*H. eccremocarpum* C. M. Syn. Musc. Frond. 2: 495. 1851.

*H. pauperum* C. M. *Op. cit.* 498.

*Thuidium wrightii* Jaeg. Ber. St. Gall. Natur. Ges. 1876-77. 249. 1878, nom.

*T. tuerckheimii* C. M. Bull. Herb. Boiss. 5: 219. 1897.

Small plants in thin, dark-green or yellowish mats. Stems up to 4 cm. long, creeping, closely pinnate, often irregularly or clearly bipinnate; paraphyllia usually abundant on stems and primary branches, 3 to 6 cells long, sometimes branched, ending in truncate, pluripapillose cell. Stem leaves small, ovate, acuminate, 0.3 to 0.6 mm. long. Branch leaves incurved at tips when dry, ovate, short-acuminate, usually about 0.2 to 0.3 mm. long; costa ceasing above middle; cells irregularly hexagonal, 6 to 8  $\mu$  wide, pluripapillose. Autoicous; perichaetial leaves entire or nearly so. Seta 0.7 to 1.7 mm. long, red, smooth; urn of capsule about 0.7 to 1.5 mm. long, inclined to horizontal; operculum long and slenderly rostrate, about 1 mm. long; annulus well developed, nonrevoluble; peristome perfect, usually 2 to 3 cilia. Spores indistinctly roughened, 9 to 12  $\mu$  in diameter.

On soil in mountain forest, known from single locality in Puerto Rico, at Alto de la Bandera, near Adjuntas, in Cordillera Central; widespread in eastern United States; Mexico and Guatemala; northern South America; Bermuda and West Indies; Europe.

- (c) *Thuidium involvens* (Hedw.) Mitt. Journ. Linn. Soc. London, Bot. 12: 575. 1869.

*Leskea involvens* Hedw. Sp. Musc. 218. 1801.

*Thuidium exilissimum* C. M. Hedwigia. 37: 264. 1898, p. p.

Delicate plants in thin, dull green mats. Stems 2 to 3 cm. long, prostrate, once pinnate; paraphyllia few, short, linear. Stem leaves deltoid, ovate-acuminate, rarely more than 0.3 to 0.4 mm. long, entire, with costa ceasing near base of acumen. Branch leaves more or less 2-ranked, wide-spreading with strongly incurved points when dry, oblong, rounded at apex, asymmetric, with costa ceasing well below apex; cells subquadrate or hexagonal, each with several small papillae. Autoicous; perichaetial leaves slenderly long-acuminate, not ciliate. Seta 10 to 15 mm. long, dark red, rough throughout; urn of capsule ovoid, inclined or cernuous; annulus present; operculum long-rostrate, about  $\frac{2}{3}$  length of urn.

On limestone, calcareous soil, and tree bases, widespread in coastal plain of Puerto Rico; Mona Island; United States (Florida); West Indies; Central and South America.

- (d) *Thuidium schistocalyx* (C. M.) Mitt. Journ. Linn. Soc. London, Bot. 12: 575. 1869.

*Hypnum schistocalyx* C. M. Syn. Musc. Frond. 2: 691. 1851.

*Thuidium exilissimum* C. M. Hedwigia. 37: 264. 1898, p. p.

Small plants in low, yellowish or dark green mats. Stems up to 3 cm. long, creeping, bipinnate; paraphyllia abundant on stems and primary branches, 2 to 6, rarely 10 cells long, linear, occasionally branched, ending in truncate, pluripapillose cell. Leaves only moderately incurved when dry; stem leaves ovate, gradually acuminate, 0.2 to 0.5 mm. long, leaves of primary branches ovate, broadly acute, 0.2 to 0.3 mm. long, those of branchlets similar but smaller; costa of branch leaves extending  $\frac{1}{2}$  to  $\frac{3}{4}$  leaf length; cells hexagonal, 6 to 8  $\mu$  in diameter, pluripapillose. Autoicous; inner perichaetial leaves ciliate at margins. Seta red, rough throughout, 9 to 15 mm. long; urn of capsule inclined, asymmetric, 0.7 to 1.0 mm. long; operculum obliquely long-rostrate, 0.8 to 1 mm. long; annulus well developed, nonrevoluble; peristome perfect, 1 to 2 cilia. Spores minutely papillose, 16 to 21  $\mu$ .

On limestone, known in Puerto Rico from only 2 localities in northern coastal plain; United States (Florida); West Indies; Mexico to northern South America.

- (2) *Haplocladium* (C. M.) C. M. Nuov. Giorn. Bot. Ital. N. S. 3: 116. 1896.

Rather small plants in dull, yellow-green, thin mats. Stems elongate, creeping, subpinnately branched; paraphyllia variously branched, often

rather few. Branches terete, spreading, sometimes crowded. Stem leaves ovate-lanceolate, long-acuminate, more or less biplicate; margins recurved below, entire or serrulate above; costa subpercurrent. Branch leaves appressed when dry, sometimes secund, erect-spreading when moist, smaller and shorter acuminate than stem leaves, ending in unipapillose cells; costa shorter; cells unipapillose. Autoicous. Perichaetial leaves differentiated, conspicuously sheathing base of seta. Seta elongate, red, smooth; capsules long-cylindric, curved, contracted below mouth when dry, inclined to horizontal; annulus present; operculum conic-apiculate; peristome teeth narrow, yellow, striate below, papillose above; endostome of well-developed, keeled segments from high basal membrane, cilia in groups of 2 to 3.

*Haplocladium microphyllum* (Hedw.) Broth. *In* E. & P., *Nat. Pfl.* 1(3): 1007. 1907.

*Hypnum microphyllum* Hedw. *Sp. Musc.* 269. 1801.

*H. gracile* Bruch & Schimp. *ex* C. M. *Syn. Musc. Frond.* 2: 488. 1851, non H. f. & W., 1844, nec. Weinm. 1845.

*H. muricolum* C. M. *Op. cit.* 492.

*H. calyptratum* Sull. *Pacific R. R. Report.* 4: 190. 1856.

*Cyrtio-Hypnum subgracile* Hampe. *Dansk Naturh. Foren. Vidensk. Meddel.* 1870: 276. 1870.

*Hypnum stellatifolium* Hampe. *Ibid.* III. 6: 175. 1874.

*Thuidium lignicolum* Kindb. *Ottawa Natur.* 4: 63. 1890.

*T. caldense* Broth. *Bih. K. Sv. Vet.-Akad. Handl.* 21(III, 3): 67. 1895.

*T. longicuspes* Broth. *Ibid.*

*T. mollicolum* Broth. *Ibid.* 26(III, 7): 56. 1900.

*Pseudoleskea laplatae* C. M. *Hedwigia.* 36: 138. 1897.

*P. uruguensis* C. M. *Ibid.*

*Haplocladium pseudogracile* C. M., *Ibid.*

*Thuidium torskii* Kiaer *ex* C. M. *Ibid.*

*T. semilunare* C. M. *Ibid.*

*T. pseudogracile* (C. M.) Paris. *Index Bryol.* 5: 17. 1906, non Kindb. 1896.

Stems to 5 cm. long, irregularly to subpinnately branched. Stem leaves ovate to ovate-lanceolate, slenderly long-acuminate, up to 1.25 mm. long, biplicate; margins plane or revolute below, entire or serrulate; cells irregularly hexagonal, rather incrassate, more elongate at base and apex of leaf; papillae blunt, sometimes obscure. Branch leaves smaller, shorter-acuminate, often more clearly papillose. Autoicous; perichaetia conspicuous, inner leaves sheathing, long-acuminate, costate, to 2.5 mm. long. Seta 2 to 2.5 cm. long; capsule oblong-cylindric, 1.5 to 2.0 mm. long, pale brown.

On calcareous soil and limestone, rarely on rotten wood, widespread in coastal plain of Puerto Rico, especially on northern side of island, and also on lower slopes of Cordillera Central; West Indies; eastern United States; Mexico to South America; Europe and Asia.

#### BRACHYTHECIACEAE

Slender to medium-sized plants in dense, often glossy mats. Stems creeping or ascending, rarely erect, usually irregularly branched. Leaves erect-

spreading, lanceolate or ovate-lanceolate to cordate, often plicate; costa single, usually ceasing in upper half of leaf, rarely lacking; cells elongate, smooth or rarely papillose by projecting cell ends, often differentiated in alar region. Perichaetial leaves differentiated. Seta elongate, sometimes papillose; capsules oblong or ovoid, usually inclined or horizontal, curved, rarely erect and symmetric; annulus usually not or scarcely differentiated; operculum conic, blunt or rostrate; peristome teeth with zigzag median line, usually striate below, lamellae well developed; endostome of keeled segments from usually high basal membrane, cilia usually well developed, sometimes rudimentary or lacking.

Costa lacking; capsule erect and symmetric; segments shorter than teeth.

Costa present; capsule inclined to horizontal; segments as long as teeth or longer.  
 Leaves plicate; operculum not long-rostrate.....(1) *Lepyrodontopsis*  
 Leaves not plicate; operculum long-rostrate.....(2) *Brachythecium*  
 Leaves not plicate; operculum long-rostrate.....(3) *Rhynchostegium*

(1) *Lepyrodontopsis* Broth. In E. & P., Nat. Pfl. 11: 358. 1925.

Soft plants in loose, pale, glossy green to brownish tufts. Stems elongate, creeping, bearing short, simple, often flagelliform branches. Leaves spreading, narrowly lanceolate, slenderly acuminate, plicate at least when dry, ecostate; margins reflexed, serrulate all around; cells linear, smooth, not or slightly differentiated at basal angles. Dioicous. Seta elongate, red; capsule erect, cylindrical; operculum rostrate; peristome teeth papillose, not striate; endostome hyaline, papillose, with moderately well-developed membrane.

*Lepyrodontopsis trichophylla* (Hedw.) Broth. In E. & P., Nat. Pfl. 11: 358. 1925.

*Hypnum trichophyllum* Hedw. Sp. Musc. 274. 1801.

*Lepyrodon trichophyllus* fo. *robustior* Besch. Ann. Sci. Nat., Bot. VI. 3: 224. 1876.

*Taxicaulis andinosubulatus* C. M. Flora. 83: 340. 1897.

*Palamocladium trichophyllum* var. *subtile* C. M. Hedwigia. 37: 240. 1898

Delicate, yellow-green or brownish plants in loose, silky tufts. Stems irregularly to pinnately branched; branches erect, 1 to 2 cm. high, often flagelliform-attenuate. Leaves crowded, erect-spreading, striate when dry, narrowly lance-acuminate, 3 to 4.5 mm. long, ecostate; margins plane, serrulate to base; cells narrow, linear, incassate and porose, shorter and broader in small, indistinct groups at basal angles, forming small, toothed auricles. Calyptra cucullate. Seta 15 to 25 mm. long; urn erect, oblong-cylindric, about 2 mm. long; annulus lacking; peristome teeth narrowly lanceolate, brown, segments of endostome about as long as teeth, not split along keel, basal membrane short, cilia rudimentary or lacking. Spores nearly smooth, 13 to 16  $\mu$  (FIGURE 44).

On tree trunks, soil, and rock, in moist forests at middle and upper altitudes, widespread in all major mountain systems of Puerto Rico; West Indies; Trinidad to Venezuela.

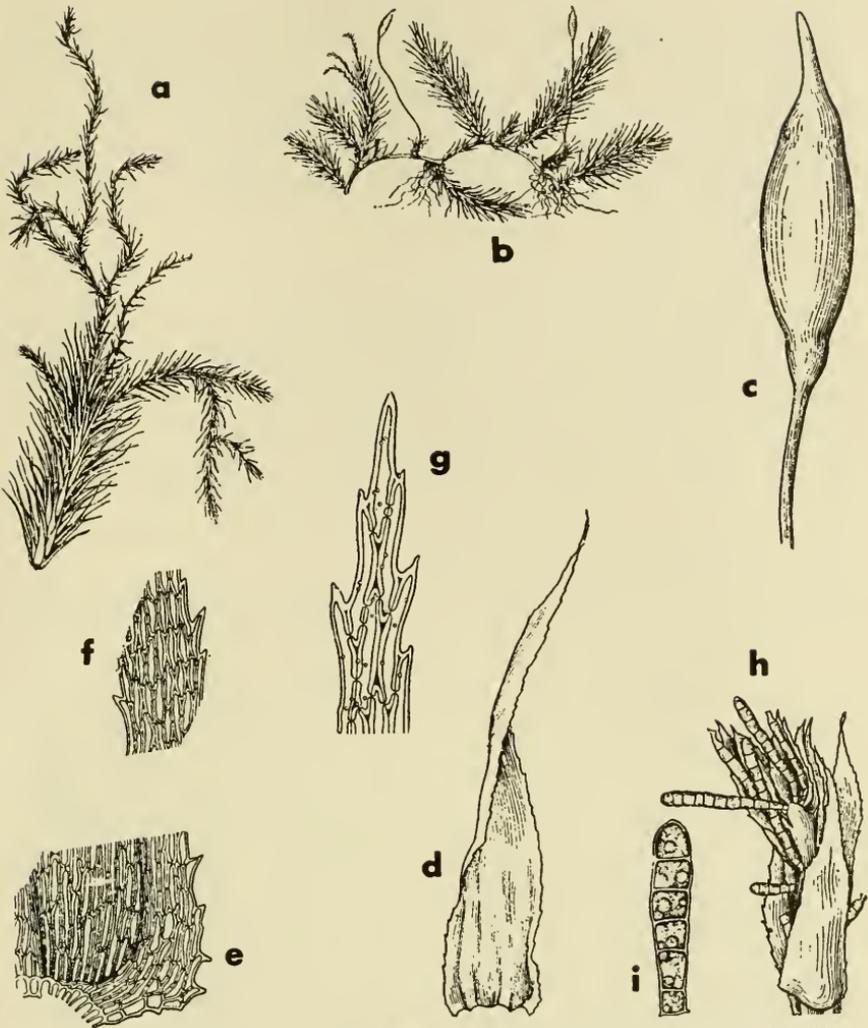


FIGURE 44. *Lepyrodontopsis trichophylla*: (a) portion of plant, showing flagelliform branches, (b) habit, (c) capsule, (d) branch leaf, (e) areolation at leaf base, (f) areolation of upper portion of leaf, (g) tip of leaf, showing porose cells, (h) cluster of propagula, (i) 1 propagulum (Britton, 1913).

(2) *Brachythecium* Schimp. Bryol. Eur. fasc. 52-54. 1853.

Slender to rather robust, often glossy plants in extensive, dense mats. Stems prostrate or ascending, usually irregularly branched. Stem leaves larger and broader than branch leaves, often more slenderly acuminate and less strongly serrate. Branch leaves erect-spreading, ovate-lanceolate, usually concave and plicate, acute to acuminate; costa extending above midleaf; cells linear, often differentiated at basal angles. Seta elongate, smooth or papillose; capsule ovoid, horizontal, rarely erect; operculum conic or short-rostrate; peristome usually complete, teeth striolate below.

*Brachythecium stereopoma* (Spruce ex Mitt.) Jaeg. Ber. St. Gall. Natur. Ges. 1876-77: 327. 1878.

*Hypnum stereopoma* Spruce ex Mitt. Journ. Linn. Soc. London, Bot. 12: 561. 1869.

*Brachythecium pseudolaetum* C. M. Hedwigia. 37: 260. 1898.

?*B. trochalobasis* C. M. Bull. Herb. Boiss. 5: 218. 1897.

?*B. pusilloalbicans* C. M. *Ibid.*

?*B. crocatum* Hampe ex C. M. *Ibid.*

*B. jamaicensis* C. M. *Ibid.* 567.

Plants rather slender, pale or yellow-green, glossy. Stems up to 5 cm. long, freely branched. Leaves loosely erect or erect-spreading with slender, twisted apices. Stem leaves 1.5 to 2 mm. long, ovate, gradually long and slenderly acuminate, faintly plicate; margins serrulate or subentire, slightly recurved below and often near apex; costa slender, ending at or above midleaf; cells linear, thin-walled, shorter and laxer at insertion, subquadrate alar cells extending nearly to costa. Branch leaves smaller and narrower, serrulate all around, biplicate. Dioicous. Seta about 15 mm. long; operculum conic, 0.5 mm. long. Sporophyte not seen.

On soil, rock, and tree bases, in moist forests on middle slopes of most mountainous areas in Puerto Rico; West Indies; Mexico to South America.

(3) *Rhynchostegium* Schimp. Bryol. Eur. fasc. 49-51. 1852.

Medium-sized plants in extensive, thin mats. Stems creeping, irregularly to subpinnately branched; branches often complanate-foliate. Leaves spreading, ovate-lanceolate to broadly ovate, acuminate; margins plane or reflexed at base, serrulate to serrate above; costa single, thin, ceasing at or beyond midleaf; cells elongate, smooth, shorter and broader at base, subquadrate or undifferentiated at basal angles. Mostly autoicous. Calyptra smooth. Seta elongate, smooth; capsule inclined to horizontal, oval to oblong, pale brown, strongly contracted below mouth when dry; annulus present; operculum long-rostrate from conic base; peristome complete, teeth striolate below.

*Rhynchostegium serrulatum* (Hedw.) Jaeg. Ber. St. Gall. Natur. Ges. 1876-77: 370. 1870.

*Hypnum serrulatum* Hedw. Sp. Musc. 238. 1801.

?*H. huitomalconum* C. M. Syn. Musc. Frond. 2: 248. 1851.

?*Rhynchostegium callistomum* Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg. 16: 250. 1872.

?*R. frondicolum* C. M. Hedwigia. 37: 261. 1898.

Pale green or yellowish, somewhat glossy plants in extensive loose mats. Stems up to 6 or 7 cm. long, freely branched. Branch leaves not crowded, 1.5 to 2 mm. long, slightly concave, only slightly altered on drying, ovate, gradually acuminate, serrate or serrulate all around, plane at margins; median cells linear, thin-walled, 7 to 10:1, basal and alar cells broader, shorter, lax; costa slender, faint above, usually ending well above midleaf, but sometimes not reaching middle. Autoicous. Seta smooth, 1.5 to 2 mm. long; capsules horizontal, oval, asymmetric, 1 to 2 mm. long; operculum

obliquely long-rostrate; 2 or 3 cilia of endostome, nearly as long as segments. Spores smooth, about 12  $\mu$ .

On soil, rock, tree bases, and rotten wood in moist areas, widespread in Puerto Rico at all altitudes from near sea level to high mountain summits; eastern North America from Vermont to Gulf of Mexico, west to Texas and Kansas; Mexico and Guatemala; Cuba, Jamaica, and Haiti.

#### ENTODONTACEAE

Small to moderately robust, often glossy plants in extensive, low mats. Stems elongate, creeping, rather regularly branched. Leaves mostly ovate, concave; no costa, or short and double, rarely single; cells mostly smooth, linear above, subquadrate in many rows at basal angles. Calyptra cucullate, usually smooth. Seta elongate, smooth; capsule erect and symmetric; operculum conic-rostrate; peristome teeth usually papillose, sometimes striate, rarely smooth, endostome usually present, consisting of narrow segments from low basal membrane, cilia usually rudimentary or lacking.

*Entodon* C. M. Linnaea. 18: 704. 1844.

Rather glossy, yellow-green plants. Stems bearing numerous, julaceous or somewhat flattened branches. Leaves appressed, concave, smooth, ovate-lanceolate to oblong-ovate; costa short and double, or lacking; cells linear, smooth, subquadrate and hyaline in well-marked alar groups. Seta long, red or yellow; capsule cylindric; operculum conic to short-rostrate; peristome double, inserted well below mouth, teeth often striate below.

*Entodon macropus* (Hedw.) C. M. Linnaea. 18: 707. 1844.

*Neckera macropoda* Hedw. Sp. Musc. 207. 1801.

*Cylindrothecium drummondii* B. S. G. Bryol. Eur. fasc. 46-47. 1851, nom.

Rather robust plants with stems 4 to 8 cm. long; branches flattened with slightly hooked tips. Branch leaves complanate, oblong-ovate, acute, narrowed at insertion, 1.5 to 2.0 mm. long; branches flattened with slightly hooked tips. Branch leaves complanate, oblong-ovate, acute, narrowed at insertion, 1.5 to 2.0 mm. long; margins plane, serrulate at apex; cells green, linear-flexuose, about 15:1, basal shorter and broader, alar numerous, subquadrate, extending nearly to middle of leaf base. Autoicous. Seta 1 to 3 cm. long, slender, yellow; capsule brown, up to 4 mm. long; operculum bluntly conic-rostrate; peristome teeth about 250 to 500  $\mu$  high, hyaline and smooth above, brown and vertically striate for most of length, but diagonally and transversely striate near base; segments narrow, as long as teeth or nearly so, vertically striolate. Spores 10  $\mu$ .

On soil, rock, tree bases, and fallen logs, in moist areas at lower and middle altitudes along Cordillera Central of Puerto Rico; southeastern United States; West Indies; Mexico to South America; also reported from China and Japan.

#### PLAGIOTHECIACEAE

Slender to moderately robust, usually glossy plants. Stems prostrate, irregularly branched; branches more or less complanate-foliate. Leaves

somewhat concave, usually acuminate, lateral leaves somewhat asymmetric; costa single and well developed, or sometimes short and double, rarely lacking; cells rhombic to linear, chlorophyllose, usually smooth. Calyptra cucullate, smooth. Seta elongate, red, smooth; capsule erect or inclined; annulus usually differentiated; operculum conic to obliquely rostrate; peristome teeth usually transversely striolate, endostome free, consisting of broad, keeled segments from well-developed basal membrane, cilia sometimes lacking.

Costa single; quadrate alar cells numerous.....(1) *Stereophyllum*  
 Costa short and double, or lacking; quadrate alar cells few or none....(2) *Plagiothecium*

(1) *Stereophyllum* Mitt. Journ. Proc. Linn. Soc., Bot. 1(Suppl.): 117.  
 1859, non Karst. 1889, nec Heydrick, 1904.

Slender to rather large plants in thin mats. Stems radiculose on lower side, irregularly branched, branches flattened. Leaves dimorphous, ventral lacking, dorsal symmetric, appressed when dry, lateral larger, spreading, asymmetric, acute or obtuse, rarely acuminate; costa single, ceasing near midleaf; cells rhombic to linear, smooth or unipapillose, alar cells quadrate or oblate in numerous rows. Mostly autoicous. Calyptra cucullate, smooth. Seta slender and flexuous; capsule inclined to horizontal, ovoid, often contracted below mouth when dry; annulus usually broad; operculum conic, acute or short-rostrate; peristome double, exostome teeth striate below, inner peristome finely papillose, segments keeled and often perforate, cilia single and well developed, or rudimentary to lacking.

Leaf cells broadly rhombic, smooth or unipapillose.....(a) *S. radiculosum*  
 Leaf cells narrow, linear, smooth.

Leaves acuminate, entire or nearly so.....(b) *S. leucostegum*  
 Leaves acute to obtuse-apiculate, serrulate above.....(c) *S. cultelliforme*

(a) *Stereophyllum radiculosum* (Hook.) Mitt. Journ. Linn. Soc. London, Bot. 12: 542. 1869.

*Hookeria radiculosa* Hook. Musci Exot. 1: pl. 51. 1818.

*Omalia wrightii* Sull. Musci and Hep. U. S. 65. 1856.

*Stereophyllum cubense* Mitt. Journ. Linn. Soc. London, Bot. 12: 544. 1869.

*Hypnum radiculosulum* C. M. Linnaea. 38: 650. 1874.

*Stereophyllum paraguense* Besch. Mém. Soc. Nat. Sci. Natur. Cherbourg. 21: 268. 1877.

*S. guarapense* Besch. *Ibid.* 269.

*Hypnum turgidicaule* C. M. Rev. Bryol. 14: 57. 1887, nom.

*Stereophyllum affixum* C. M. Bull. Herb. Boiss. 5: 217. 1897.

*S. jamaicense* C. M. *Ibid.* 565.

*S. affine* Ren. & Card. Bull. Soc. Roy. Bot. Belg. 41(1): 146. 1905.

*S. turgidulum* Card. Rev. Bryol. 37: 13. 1910.

Rather robust, dull, yellow-green plants. Stems 1 to 3 cm. long, sparsely branched; branches flattened. Leaves crowded, 1.5 to 2.0 mm. long, oblong-ovate, rounded-obtuse to broadly acute, entire or denticulate at apex; costa stout, extending about  $\frac{2}{3}$  up leaf; cells rhombic, rather incrassate, smooth

or unipapillose, shorter below, rounded-quadrate in numerous rows at basal angles, extending to costa and about 20 to 30 cells up basal margins. Autoicous. Seta 10 to 12 mm. long; urn suberect to inclined, 1 to 1.5 mm. long; no annulus; operculum high-conic to rostrate, up to 0.8 mm. long; peristome double, cilia single, rudimentary to well-developed. Spores finely papillose, up to 15  $\mu$ .

On rotten wood at middle altitudes, known in Puerto Rico from only 2 localities, Penuelas and Juana Díaz; West Indies; from Florida and Texas in United States south to Paraguay.

(b) *Stereophyllum leucostegum* (Brid.) Mitt. Journ. Linn. Soc. London, Bot. 12: 543. 1869.

*Leskea leucostega* Brid. Bryol. Univ. 2: 333. 1827.

*Hypnum flavonitens* C. M. Bot. Zeit. 2: 742. 1844, nom.

*H. gardneri* C. M. *Ibid.*, nom.

*H. saxatile* Hook. & Wils. Lond. Journ. Bot. 3: 164. 1844.

*H. subflavum* Hook. & Wils. *Ibid.*

*H. donnellii* Aust. Bot. Gaz. 4: 162. 1879.

?*Stereophyllum pycnoblastum* C. M. Bull. Herb. Boiss. 5: 217. 1897.

*S. leucothallum* C. M. Hedwigia. 37: 261. 1898.

*S. perpusillum* C. M. In Millspaugh. Field Mus. Publ. Bot. 1: 348. 1898.

*S. orcutti* Card. Rev. Bryol. 40: 39. 1913.

Rather slender, bright green, glossy plants. Stems 1 to 2 cm. long. Leaves loosely imbricate, somewhat complanate and homomallous, up to 1.5 mm. long, ovate-lanceolate, gradually acuminate, entire; lateral leaves asymmetric, with margins incurved at base; costa slender, ending near midleaf; cells smooth, linear, 4 to 7: 1, shorter toward base and quadrate in numerous rows extending to costa or nearly so and 30 or more cells up margin. Autoicous. Seta 8 to 10 mm. long; urn inclined, 1 mm. or less long; operculum conic, 0.4 mm. long; cilia of endostome single, usually well developed. Spores smooth, about 15  $\mu$ .

On tree trunks, soil, and rock, in few but widely separated localities in coastal plain of Puerto Rico; Desecheo Is.; Virgin Is.; United States (Florida); West Indies; Mexico to South America; Trinidad.

(c) *Stereophyllum cultelliforme* (Sull.) Mitt. Journ. Linn. Soc. London, Bot. 12: 544. 1869.

*Hypnum cultelliforme* Sull. Proc. Amer. Acad. Arts and Sci. 5: 289. 1861.

*Stereophyllum howei* Williams. Bull. Torrey Bot. Club. 38: 35. 1911.

*S. matoubae* Besch. Journ. de Bot. 16: 11. 1902.

Slender plants in thin, glossy mats. Stems about 1 cm. or more long, sparingly branched. Leaves up to 1.5 mm. long, complanate and loosely erect-spreading, oblong-lanceolate to lingulate, asymmetric, often somewhat cultriform, acute to obtuse-apiculate; margins serrate in upper half or more, sometimes nearly to base, plane except for incurved narrow margin on 1 side at base; costa ending at or slightly above midleaf; cells linear, 8 to 15: 1,

shorter at apex, quadrate alar cells few or lacking on narrower side of leaf, numerous on broader side, extending 20 or more cells up margin. Autoicous. Seta 7 to 12 mm. long; urn inclined, 1 to 1.5 mm. long; annulus lacking; operculum conic-rostrate, about  $\frac{1}{2}$  length of urn; cilia of endostome single, well-developed or rudimentary.

On calcareous rock, rarely on tree bases, widespread in coastal plain of Puerto Rico and rarely at lower altitudes in mountains; West Indies; Mexico, Honduras, Costa Rica, and Panama to Peru.

(2) *Plagiothecium* Schimp. Bryol. Eur. fasc. 48. 1851.

Slender to moderately robust, rather glossy plants in loose, flat mats. Stems prostrate, irregularly branched, usually strongly flattened. Leaves complanate, appearing 2-ranked, lateral leaves more or less asymmetric, oblong-ovate or broadly lanceolate, acuminate, more or less decurrent; margins plane; costa short and double, or lacking; cells linear, smooth, laxer at insertion, not or slightly differentiated at basal angles. Seta elongate, smooth, red; capsule oblong, erect to inclined; annulus present; operculum acute; peristome perfect.

*Plagiothecium jamaicense* C. M. Hedwigia. 40: 61. 1901.

Shiny, yellow-green plants. Stems bearing a few linear paraphyllia. Leaves strongly complanate, widely spreading, oblong-ovate, acuminate, slightly asymmetric, not or slightly decurrent, entire; costae short or lacking; cells long, linear, thin-walled, pellucid. Autoicous. Seta 1 to 2 cm. long; capsule oblong, large-mouthed and constricted below mouth when dry; exostome large, reddish, strongly articulate, endostome pale, cilia single, short and stout.

On humus, rotten wood, and rock, widespread at middle altitudes in mountains of Puerto Rico; Cuba and Jamaica.

SEMATOPHYLLACEAE

Slender to rather robust plants, usually forming dense mats. Stems prostrate to ascending, irregularly or pinnately branched. Leaves often homomalous or clearly secund, usually ovate-acuminate; costa lacking, or short and double; cells smooth or papillose, linear above, usually clearly differentiated at basal angles, sometimes abruptly inflated in sharply distinct groups. Calyptra cucullate, naked. Seta elongate, sometimes rough; capsule small, smooth, usually nodding or horizontal; exothelial cells mostly colenchymatous; annulus usually lacking; operculum usually long-rostrate; peristome teeth variable, often transversely striolate on outer plates, sometimes with median furrow; segments of endostome usually keeled, sometimes filiform, from usually high basal membrane, usually with cilia.

Inner peristome lacking; seta very short.

Alar cells small, quadrate, not inflated.....(1) *Pterogonidium*

Alar cells elongate, inflated.....(2) *Meiothecium*

Peristome double.

Leaf cells papillose.

Leaves truncate or emarginate.....(8) *Glossadelphus*

- Leaves acute or acuminate.  
 Leaf cells unipapillose; exothecial cells collenchymatous.....(6) *Trichosteleum*  
 Leaf cells pluripapillose; exothecial cells smooth-walled.....(7) *Taxithelium*  
 Leaf cells smooth.  
 Peristome teeth furrowed.....(5) *Acroporium*  
 Peristome teeth with zigzag median line.  
 Leaves usually homomallous or secund; capsule inclined to horizontal; seta smooth.  
 (3) *Sematophyllum*  
 Leaves not homomallous or secund; capsule horizontal to pendent; seta rough at tip.....(4) *Rhaphidostichum*

(1) *Pterogonidium* C. M. ex Broth. *In* E. & P., *Nat. Pfl.* 1(3): 1099. 1908.

Very small, soft, yellow-green plants in loose, thin mats. Stems elongate, creeping, irregularly branched. Leaves erect-spreading, oblong-lanceolate, concave, ecostate, serrulate above; cells linear, thin-walled, smooth, small and quadrate at basal angles. Autoicous. Seta short, smooth; urn of capsule erect, cylindric, pale, thin-walled; exothecial cells not collenchymatous; operculum conic-rostrate; peristome single, teeth more or less paired, pale, papillose, not lamellose at back.

*Pterogonidium pulchellum* (Hook.) C. M. *Bull. Herb. Boiss.* 5: 210. 1897.

*Pterogonium pulchellum* Hook. *Musci Exot.* 1: 4. 1818.

*Meiothecium nanum* Besch. *Ann. Sci. Nat., Bot.* VI. 3: 225. 1876.

*Pterogonidium subtilissimum* C. M. *Bull. Herb. Boiss.* 5: 209. 1897.

Delicate plants with irregularly branched stems about 1 mm. long; branches short, slightly flattened. Leaves not crowded, erect- to wide-spreading, oblong-lanceolate, acuminate; margins plane, denticulate above; cells linear, smooth, quadrate in 3 to 4 rows at basal angles. Seta yellowish, 3 to 4 mm. long; urn 1 mm. long; peristome teeth pale brown (FIGURE 45).

On soil and rock at a few widely separated localities in coastal plain of Puerto Rico; West Indies; Mexico, Guatemala, Honduras, and Costa Rica; South America.

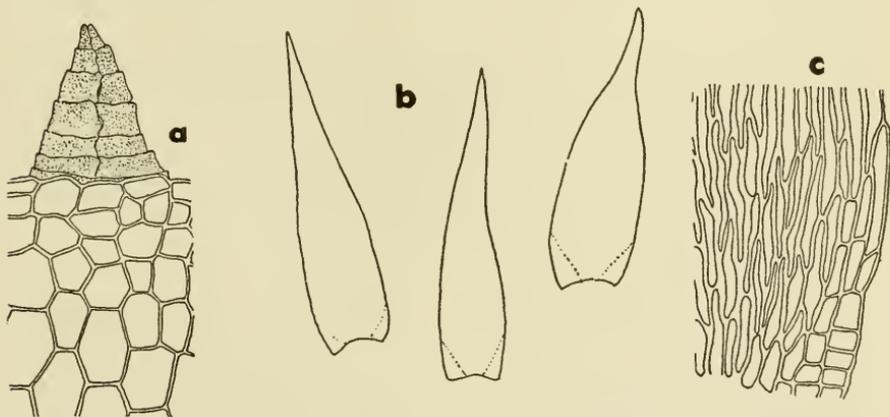


FIGURE 45. *Pterogonidium pulchellum*: (a) exothecial cells and peristome tooth, (b) leaves, and (c) cells at basal angles of leaf.

(2) *Meiothecium* Mitt. Journ. Linn. Soc. London, Bot. **10**: 185. 1868.

Slender to rather robust plants in thin, extensive mats. Stems prostrate, irregularly to pinnately branched; branches ascending, often curved. Leaves imbricate, often homomallous when dry, oblong to oval, acuminate; margins entire, often broadly reflexed; no costa; cells smooth, rhombic above, longer toward base, oblong and more or less inflated at basal angles. Calyptra small, naked, sometimes scabrous above. Seta short, smooth or rough above; capsule erect or inclined, small, ovoid to subcylindric, often somewhat contracted below mouth when dry; operculum short- to long-rostrate; exothecial cells thin-walled, sometimes collenchymatous; exostome pale, not striate, usually densely papillose, but sometimes smooth, without lamellae; endostome lacking or rudimentary.

*Meiothecium boryanum* (C. M.) Mitt. Journ. Linn. Soc. London, Bot. **12**: 469. 1868.

*Neckera boryana* C. M. Syn. Musc. Frond. **2**: 75. 1850.

*Potamium homalophyllum* Besch. Ann. Sci. Nat., Bot. VI. **3**: 256. 1876.

*Sauloma chloropsis* C. M. Hedwigia. **37**: 250. 1898.

Small, pale green or yellowish plants, sometimes tinged with brown, in thin, extensive mats. Stems short, irregularly to subpinnately branched. Leaves appressed, occasionally slightly homomallous, 1 to 1.25 mm. long, oblong-ovate, short-acuminate, concave, with broadly reflexed, entire margins, ecostate; cells smooth, incrassate and moderately porose, rhombic at apex, linear-flexuose toward base, yellow across insertion and enlarged and inflated in 1 to 2 tiers at basal angles, above these is small, triangular group of obliquely oblong, small cells. Autoicous; perichaetial leaves denticulate. Calyptra rough above. Seta 2 to 3 mm. long, smooth; capsule inclined to horizontal, ovoid when moist, subcylindric and often broadest at base and narrowed to mouth when dry, about 1 mm. long; operculum obliquely long-rostrate; exothecial cells moderately collenchymatous; exostome teeth pale, linear, distant, densely papillose; endostome lacking. Spores finely papillose, 19 to 23  $\mu$ .

On trees, widely distributed in coastal plain of Puerto Rico and reaching middle slopes of Cordillera Central and a few localities in Luquillo Mts.; West Indies; Trinidad, Dutch Guiana, and Ecuador.

These plants resemble *Sematophyllum caespitosum* (Hedw.) Mitt. in aspect and in areolation of leaves, but the smaller size, the toothed perichaetial leaves, and the nature of the peristome should make identification easy.

(3) *Sematophyllum* Mitt. Journ. Linn. Soc. London, Bot. **8**: 5. 1864.

Plants small to robust, often glossy, usually in dense mats. Stems prostrate, sparsely to freely branched; branches erect to ascending, densely foliate, often curved. Leaves erect-spreading to homomallous or falcate-secund, ovate to lanceolate, bluntly acute to acuminate, concave, often reflexed at margins, entire or weakly toothed above, ecostate; cells elongate, smooth, alar cells oblong, enlarged and inflated usually in single row. Usually autoicous. Seta elongate, smooth; capsule suberect to pendulous, small,

ovoid, asymmetric; peristome teeth transversely striolate on outer surface, with zigzag median line, lamellae prominent at back, endostome as long as teeth, yellowish, segments keeled, basal membrane high, 1 to 2 cilia, sometimes rudimentary.

Stems subpinnately branched; branches horizontal. . . . . (b) *S. subsimplex*  
 Stems freely but irregularly branched; branches ascending.

Leaves falcate-secund, serrulate above. . . . . (f) *S. xylophyllum*  
 Leaves erect or homomallous, entire or nearly so.

Cells very incrassate, oval-rhomboidal, usually only 3 to 6:1. . . . . (d) *S. caespitosum*  
 Cells less markedly incrassate, longer, linear.

Leaves abruptly narrowed to long acumen; alar cells very large; seta up to 30 mm. long. . . . . (e) *S. lamprophyllum*

Leaves acute or gradually acuminate; alar cells moderately enlarged; seta 1.5 cm. or less.

Leaves ovate-lanceolate; cells oblong-linear; seta 7 to 15 mm. long.

(c) *S. galipense*

Leaves lanceolate, slenderly acuminate; cells linear; seta 5 to 10 mm. long.

(a) *S. sericifolium*

(a) *Sematophyllum sericifolium* Mitt. Journ. Linn. Soc. London, Bot. 12: 483. 1869.

*Rhaphidostegium chrysocladum* Card. Rev. Bryol. 37: 57. 1910.

Small light green or yellow plants, often glossy. Stems 1 to 2 cm. long, freely and irregularly branched; branches short, ascending, usually curved. Leaves crowded, erect-spreading, homomallous, 1 to 1.25 mm. long, narrowly lanceolate, gradually acuminate, concave, with margins more or less reflexed near base, slender tips subtubulose, entire or very faintly irregular near tips; cells linear and elongate, 2 to 4 alar cells moderately inflated, hyaline or pale yellow, subquadrate supra-alar cells rather inconspicuous, extending about 2 to 4 cells up margins. Autoicous; perichaetial leaves about 1 to 1.5 mm. long, sinuolate or entire. Setae 5 to 10 mm. long; capsules 1 mm. long, oblong, inclined to horizontal.

On tree trunks, twigs, and rotten wood, commonly in coastal plain of Puerto Rico and occasionally on lower mountain slopes; Mexico and Guatemala; Cuba and Jamaica.

Rather similar in size and general appearance is *S. admistum* (Sull.) Mitt., which appears to have been confused with this species in many parts of tropical America. It differs in having shorter, oblong-linear cells similar to those of the *S. caespitosum* complex, and its narrow leaves end in flat rather than subtubulose acumina. It is likely that a revision of material in herbaria will result in a broadening of the range of both species considerably, and perhaps *S. admistum* will have to be included in the Puerto Rican flora.

(b) *Sematophyllum subsimplex* (Hedw.) Mitt. Journ. Linn. Soc. London, Bot 12: 494. 1869.

*Hypnum subsimplex* Hedw. Sp. Musc. 270. 1801.

*H. richardi* Schwaegr. Suppl. Sp. Musc. I. 2: 204. 1816.

*Taxicaulis inclinatus* Hampe ex C. M. Hedwigia. 37: 255. 1897.

?*T. crossomitrii* C. M. *Ibid.*

Slender, silky, pale, yellowish- or grayish-green, often glossy plants. Stems red, about 4 cm. long or less, freely branched; branches horizontal, usually wide-spreading, somewhat flattened. Stem leaves remote, erect-spreading, 0.9 to 1.3 mm. long, ovate, slenderly acuminate, concave, entire or nearly so; cells linear, incrassate, shorter and yellow across insertion, alar cells 2 to 4, oblong, abruptly enlarged and inflated, brownish or yellow. Branch leaves smaller, often subsecund. Autoicous. Seta slender, about 1 to 1.5 cm. long; capsule ovoid, nodding, urn about 0.7 to 1 mm. long.

On tree trunks and fallen logs in wet mountain forests at middle altitudes, in all major sierras of Puerto Rico; West Indies; Mexico to South America.

(c) *Sematophyllum galipense* (C. M.) Mitt. Journ. Linn. Soc. London, Bot. 12: 480. 1869.

*Hypnum galipense* C. M. Bot. Zeit. 6: 780. 1848.

*H. dissolutum* Sull. Proc. Amer. Acad. Arts and Sci. 5: 289. 1861.

*Aptychus impressocuspis* C. M. Hedwigia. 37: 258. 1898.

*A. jamaicae* C. M. *Ibid.*

Rather small, yellowish plants. Stems freely branched; branches ascending, blunt, 5 to 10 mm. long, simple or sparsely branched. Leaves concave with reflexed margins, appressed and slightly homomallous when dry, erect-spreading when moist, oblong-lanceolate or oblong-ovate, narrowed at insertion, short- to long-acuminate, 1 to 1.5 mm. long, entire; upper cells oblong-linear, rather incrassate, about 5 to 9:1, shorter at extreme tip of leaf, about 4 inflated alar cells, hyaline or yellow, subquadrate supra-alar cells inconspicuous in triangular patches 3 to 5 cells high at margins. Autoicous; perichaetial leaves about 2 mm. long, entire. Seta 9 to 15 mm. long; urn of capsule inclined to horizontal, about 1 mm. long.

On rock, soil, and rotten wood, in moist forests at all altitudes, from coastal plain to mountain summits in Puerto Rico; West Indies; Guatemala, Honduras, and Costa Rica; Venezuela; Cocos Island and Trinidad.

(d) *Sematophyllum caespitosum* (Hedw.) Mitt. Journ. Linn. Soc. London, Bot. 12: 479. 1869.

*Leskea caespitosa* Hedw. Sp. Musc. 233. 1801.

*L. subpinnata* Brid. Musc. Recent. Suppl. 2: 54. 1812.

*Hypnum loxense* Hook. In Kunth Syn. Pl. Aequin. 1: 62. 1822.

?*Leskea caespitosa* var. *subsquarrosa* Brid. Bryol. Univ. 2: 289. 1827.

*Neckera straminea* Hornsch. In Mart. Fl. Brasil. 1(2): 54. 1840, non C. M. 1850.

*Leskea cavifolia* H. f. & W. Lond. Journ. Bot. 3: 161. 1844.

*L. circinalis* Hampe. Icones Musc. Pl. 5. 1844.

*L. kegeliana* C. M. Linnaea. 21: 198. 1848.

*Hypnum kegelianum* var. *tenue* C. M. Syn. Musc. Frond. 2: 325. 1851.

*H. hampeanum* C. M. *Op. cit.* 326.

*H. concavifolium* Mitt. Journ. Linn. Soc. London, Bot. 12: 486. 1869, hyponym.

*Rhaphidoslegium caespitosum* ssp. *megalodictyon* Besch. Ann. Sci. Nat. Bot. VI. 3: 247. 1876.

*Sematophyllum kegelianum* var. *floridanum* Ren. & Card., Bot. Gaz. 15: 61. 1890.

*Aptychus caespitosulus* C. M. Hedwigia. 37: 256. 1898.

*A. virescentifolius* C. M. *Ibid.* 257.

Rather slender to medium-sized, coarse, dull green to yellowish plants with stems 2 to 4 cm. long, freely branched; branches ascending, often turgid, usually curved, about 0.4 to 1 cm. long. Leaves distinctly homomallous, sometimes strongly so, crowded, appressed or spreading when dry, 1 to 1.25 mm. long, oblong-ovate, acute or broadly short-acuminate, concave with margins reflexed below, entire; areolation opaque, upper cells oval-rhomboidal, 3 to 6:1, rarely as much as 8:1, shorter at extreme apex, very incrassate, inflated alar cells 3 to 4, hyaline or yellow, subquadrate supra-alar cells numerous, extending about 4 to 7, sometimes 10 cells up margins. Autoicous; perichaetial leaves 1 to 1.5 mm. long, entire. Seta 5 to 12 mm. long; urn of capsule suberect, 1 to 1.25 mm. long.

On tree trunks and bases in moist mountain forests, at middle to higher altitudes, in all mountainous areas of Puerto Rico; United States (Florida and Mississippi); West Indies, Mexico to South America.

*Sematophyllum caespitosum* is notoriously variable in size, habit, and leaf structure and, according to Dixon (1920), it ranges throughout the world in tropical and subtropical latitudes. Dixon's concept of the species seems so broad as to include many distinctive forms other than those considered here, which are characterized by having a very opaque, grayish areolation of short, very incrassate cells, entire perichaetial leaves, and rather short setae with suberect capsules. *Sematophyllum galipense* (C. M.) Mitt., at least in so far as it is represented locally, seems to differ from this complex in having more acuminate leaves with longer cells, somewhat longer setae, and capsules more inclined.

(e) *Sematophyllum lamprophyllum* Mitt. Journ. Linn. Soc. London, Bot. 12: 496. 1869.

Plants medium-sized, soft, yellowish or brownish, glossy. Stems freely branched; branches ascending, 6 to 10 mm. long, straight. Leaves heteromallous, erect-spreading to widely spreading wet or dry, oblong-lanceolate or oblong, abruptly narrowed to long, slender, acumen, concave with erect, entire margins, 1.5 to 2 mm. long; cells linear, very narrow, about 15:1, about 3 alar cells, greatly inflated, hyaline or yellow, 3 to 5 slightly inflated roundish, pale cells above them. Autoicous; perichaetial leaves subulate, entire or slightly sinuate above, about 2 to 2.5 mm. long. Seta slender, 18 to 30 mm. long, red, smooth throughout; urn of capsule horizontal, 1 to 1.5 mm. long; teeth of exostome strongly lamellose at back, with median zigzag line, cilia of endostome single or double, well developed. Spores nearly smooth, 16 to 19  $\mu$ .

On rotten wood and tree bases, apparently common in vicinity of Maricao, but not collected elsewhere in Puerto Rico; Cuba; Jamaica.

This attractive species is very similar in appearance and leaf structure to *Rhaphidostichum schwaneckeanum* (C. M.) Broth., which differs, however,

in having leaves that are serrate above, with broader subulae, and seta slightly roughened near the tip and neck of the capsule rugulose.

(f) *Sematophyllum xylophyllum* Mitt. Journ. Linn. Soc. London, Bot. 12: 490. 1869.

*Rhaphidostegium rufulum* Besch. Ann. Sci. Nat., Bot. VI. 3: 250. 1876.

Small, silky, yellow plants with subpinnate branching; branches short, ascending. Leaves loosely falcate-secund at tips, 1 mm. long, lanceolate, slenderly long-acuminate, concave, with margins more or less reflexed below, finely serrulate above; cells linear, about 15:1, 2 to 3 alar cells greatly inflated, yellow, supra-alar inconspicuous. Autoicous; perichaetial leaves narrowly lance-subulate, serrate above. Seta slender, 9 to 11 mm. long; urn of capsule oval, horizontal to pendent, cilia single, well-developed, but shorter than segments.

On tree trunks and decaying logs, in wet mountain forests at higher altitudes on several peaks in Cordillera Central of Puerto Rico; West Indies; Trinidad.

(4) *Rhaphidostichum* Fleisch. Laubmoosfl. v. Java. 4: 1307. 1918.

Rather robust plants in dense, glossy cushions. Stems creeping; branches erect or ascending, somewhat flattened. Leaves erect to spreading, oval to broadly oblong and abruptly narrowed to slender, serrate acumen, deeply concave, ecostate; cells linear, smooth or papillose, oblong and inflated in distinct alar groups. Seta elongate, roughened above; capsule small, oblong-ovoid or subcylindric, inclined to pendent; operculum very long-rostrate; exostome teeth transversely striolate below, with zigzag line and well-developed lamellae; endostome of keeled segments from high basal membrane, 1 to 2 cilia, well-developed.

*Rhaphidostichum schwaneckeanum* (C. M.) Broth. In E. & P., Nat. Pfl. 11: 435. 1925.

*Leskea congesta* Brid. var. *flavicans* Hampe. Linnaea. 25: 362. 1852, nom.

*Hypnum schwaneckeanum* C. M. Bot. Zeit. 16: 172. 1858.

Rather slender plants with red, freely branched stems; branches 1 to 1.5 cm. high. Branch leaves crowded, loosely erect with twisted-flexuose points, 2.5 to 3 mm. long, abruptly contracted from oval, concave base to long, flat acumen; margins serrate above, serrulate nearly to base, plane; cells linear, incrassate and porose, smooth, yellow at insertion, 4 to 5 at basal angles abruptly inflated in subauriculate groups. Dioicous; perichaetial leaves more strongly serrate. Seta red, subscabrous above; capsule oval, inclined, rugose at neck; peristome small. Only immature sporophytes seen.

On rock, known in Puerto Rico with certainty only from single locality, near summit of Mt. El Duque, Luquillo Mts. (W. C. S. 5968). Puerto Rican type locality not specified, but almost surely in Sierra de Luquillo, where Schwanecke collected abundantly; Cuba, Jamaica, and St. Vincent.

(5) *Acroporium* Mitt. Journ. Linn. Soc. London, Bot. 10: 182. 1868.

Slender to rather robust plants, usually forming dense, yellowish mats. Stems elongate, mostly creeping, sometimes hanging; branches numerous,

ascending to erect, densely foliate, often cuspidate at tips. Leaves erect- or wide-spreading, ovate-lanceolate, acuminate, concave to tubulose, ecostate, entire or serrulate at apex; upper cells linear, incrassate and often porose mostly smooth, large and inflated in conspicuous, sharply-defined alar groups. Calyptra cucullate. Seta slender, elongate, red, rough above, or rarely smooth throughout; capsule suberect to nodding, oblong-ovoid; operculum slenderly long-rostrate; exothelial cells collenchymatous; peristome teeth cross-striolate, with median furrow and well-developed lamellae prominent at back; endostome yellowish, with broad, keeled segments from high basal membrane, cilia usually single, sometimes rudimentary.

Slender, autoicous plants; branches less than 1 cm. high; branch leaves not tubulose, serrate in upper half . . . . . (a) *A. acrostegium*  
 Rather robust, synoicous plants; branches up to 4 or 5 cm. high; branch leaves tubulose, entire, or denticulate only at extreme apex . . . . . (b) *A. pungens*

(a) *Acroporium acrostegium* (Sull.) Crum & Steere. Bryol. 59: 254. 1956.

*Hypnum acrostegium* Sull. Proc. Amer. Acad. Arts and Sci. 5: 287. 1861.

*Rhaphidostegium helleri* Ren. & Card. Bull. Soc. Roy. Bot. Belg. 41(1): 95. 1905.

Slender, yellow-green plants in thin mats. Stems red, irregularly branched; branches ascending, mostly less than 1 cm. long. Stem leaves entire to serrulate. Branch leaves erect-spreading to wide-spreading, 1 to 1.5 mm. long, oblong-lanceolate, gradually acuminate, concave, serrate in upper half; cells linear-flexuose, somewhat incrassate, smooth, brownish or yellow at insertion, 2 to 3 cells at basal angles large and inflated, occasionally transversely septate. Autoicous; perichaetial leaves shorter, more strongly serrate and longer pointed than branch leaves. Calyptra smooth. Seta about 1 cm. high, smooth or very slightly roughened at apex, curved just below urn; urn of capsule oblong, about 0.7 to 0.9 mm. long, inclined to nodding; operculum very long-rostrate, often longer than urn; peristome teeth yellow-brown, cross-striolate below, papillose above, prominently lamellose at back, narrowly furrowed along median line; endostome papillose, basal membrane high, segments narrow, cilia nearly as long as segments, single, stout. Spores minutely roughened, about 12 to 15  $\mu$ .

On tree trunks and roots, rotten wood, and occasionally rocks, in wet mountain forests at upper elevations in major sierras of Puerto Rico; Cuba and Haiti.

*Acroporium acrostegium* resembles many species of *Sematophyllum* in general appearance and areolation, but it can be recognized by its serrate branch leaves. *Sematophyllum xylophyllum* Mitt. might be mistaken for this species when sterile, but it has merely serrulate branch leaves.

(b) *Acroporium pungens* (Hedw.) Broth. In E. & P., Nat. Pfl. 11: 436. 1925.

*Hypnum pungens* Hedw. Sp. Musc. 237. 1801.

?*Rhaphidostegium microtheca* Ren. & Card. Bull. Soc. Roy. Bot. Belg. 41(1): 96. 1905.

?*Sematophyllum pungens* var. *repens* Ren. & Card. *Ibid.* 92.

Rather robust, glossy, yellow-green or golden plants. Stems red; branches

erect-ascending, to 4 or 5 cm. long, subpinnately branched. Leaves wide-spreading to squarrose, tubulose and often twisted when dry, appressed at cuspidate branch tips, 2 to 3 mm. long, ovate-lanceolate, slenderly acuminate, contracted and subauriculate at base; margins entire or denticulate at extreme apex, inrolled above; cells linear, smooth, incrassate and porose, shorter and yellow at insertion, 3 to 6 oval cells at angles large and inflated, hyaline or colored, often red, forming conspicuous alar groups. Synoicous; inner perichaetial leaves short, 1 to 1.5 mm. long, erect, ovate, abruptly acuminate, serrulate above. Calyptra obscurely roughened above. Sporophytes usually borne well up on branches; seta slender, red, 7 to 12 mm. long, roughened near tip; capsule suberect to inclined, ovoid-cylindric, constricted below mouth when dry and empty, 0.6 to 1 mm. long; operculum about 1 mm. long, often longer than urn; peristome teeth yellow-brown, transversely striolate below, papillose at tips, endostome as high as exostome, densely papillose, cilia single, or rudimentary to lacking. Spores spheric, smooth or nearly so, 18 to 24  $\mu$ .

On decayed wood, tree bases, and rock in wet mountain forests, usually near or at cloud-shrouded summits at high altitudes in Puerto Rico; West Indies; Guatemala to South America.

(6) *Trichosteleum* (Mitt.) Jaeg. Ber. St. Gall. Natur. Ges. 1876-77: 477. 1878.

Plants slender or sometimes rather robust in thin, yellowish or brownish-green mats. Stems creeping; branches somewhat flattened. Leaves erect-spreading to falcate-secund, ovate-lanceolate, acuminate, concave, subentire to serrate, ecostate; upper cells elongate, mostly thin-walled, bearing 1 to several papillae over lumina, incrassate and pitted at base, alar cells oblong, inflated. Autoicous. Calyptra naked. Seta slender, rather short, nearly always rough; capsule very small, pendent; exothecial cells collenchymatous, usually bulging; operculum slenderly long-rostrate; peristome teeth cross-striolate below, with median furrow and well-developed lamellae; endostome segments keeled, basal membrane high, 1 to 2 cilia, sometimes rudimentary.

*Trichosteleum sentosum* (Sull.) Jaeg. Ber. St. Gall. Natur. Ges. 1876-77: 481. 1878.

*Hypnum sentosum* Sull. Proc. Amer. Acad. Arts and Sci. 5: 288. 1861.

Small yellowish plants with red or orange stems, 2 to 3 cm. long, subpinnately branched, slightly or not at all complanate-foliolate. Leaves 1 to 1.5 mm. long, erect-spreading with flexuous tips, scarcely altered on drying, not crowded, oblong-lanceolate, slenderly acuminate, concave, serrate above, serrulate below; cells narrow, spindle-shaped, thin-walled, bearing single, blunt papilla at center of lumen at back, smooth in marginal row, colored at insertion, 2 to 3 alar cells abruptly enlarged and inflated, yellow or brown. Autoicous. Seta 8 to 10 mm. long, curved at tip, smooth, reddish; capsule pyriform, more or less bulging at short neck, urn 0.6 to 0.7 mm. long; operculum usually longer than urn; endostome papillose, 1 or sometimes 2 cilia, well-developed. Spores smooth, 12  $\mu$ .

On rotten wood and humus, widespread at middle altitudes in moist forests in various mountainous regions of Puerto Rico; West Indies; Trinidad; British Honduras.

(7) *Taxithelium* Spruce ex Mitt. Journ. Linn. Soc. London, Bot. 12: 496. 1869.

Slender to medium-sized plants in pale green or yellowish, thin mats. Stems creeping, subpinnate, often flattened. Leaves ovate, ecostate, concave, usually serrulate, dorsal and ventral leaves appressed, lateral leaves larger and spreading; cells linear, usually bearing several small papillae in row over lumina, rarely papillose by projecting cell angles, or nearly smooth, alar cells usually inflated and colored. Seta elongate, mostly smooth; capsule inclined, asymmetric, contracted below mouth when dry and empty; exothelial cells not collenchymatous; operculum acute or obtuse; peristome teeth fused at base, cross-striolate below, papillose at tips, with prominent lamellae; segments papillose, keeled, basal membrane well-developed, cilia usually single.

Branch leaves oblong-ovate, short-acuminate, about 1 to 1.2 mm. long. . . . (a) *T. planum*  
Leaves oblong-lanceolate, acute, about 0.7 mm. long. . . . . (b) *T. portoricense*

(a) *Taxithelium planum* (Brid.) Mitt. Journ. Linn. Soc. London, Bot. 12: 496. 1869.

*Hypnum planum* Brid. Musc. Recent. Suppl. 2: 97. 1812.

?*Sigmatella pseudoacuminatula* C. M. Bull. Herb. Boiss. 5: 214. 1897.

Rather slender light green to yellow plants. Stems 1 to 4, rarely 10 cm. long; branches horizontal, more or less flattened. Leaves up to 1.2 mm. long, crowded, erect-spreading, oblong-ovate, short-acuminate, serrulate nearly to base; cells linear, thin-walled, bearing 5 to 7 papillae in single row at back of lumina, papillae small and blunt, sometimes bluntly forked or somewhat stellate, basal cells shorter and smooth at insertion, subquadrate in small marginal group just above about 3 moderately large, inflated, hyaline or colored cells at the angles. Autoicous. Seta reddish, smooth, up to 2 cm. long; urn of capsule ovoid, less than 1 mm. Spores smooth, 12 to 15  $\mu$ .

On living trees, rotten wood, humus, soil, and rock, common and weedy species throughout coastal plain and lower-to-middle mountain slopes in Puerto Rico; United States (Florida); West Indies; Mexico to South America.

(b) *Taxithelium portoricense* Williams. Bryol. 30: 37. 1927.

Small pale green plants with stems creeping, irregularly to subpinnately branched, slightly complanate when dry; branches horizontal. Branch leaves erect-spreading, not crowded, about 0.7 mm. long, oblong-lanceolate, acute, concave, serrulate nearly to base; cells narrowly linear, thin-walled, with about 3 to 5 small, rather indistinct papillae in single row over lumen dorsally, very few subquadrate cells in alar region, 2 to 3 at basal angles somewhat enlarged and inflated, hyaline. Autoicous. Seta red-yellow,

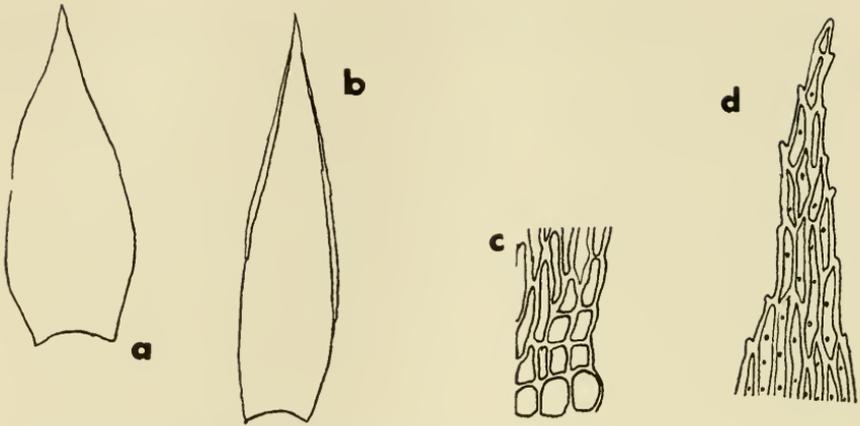


FIGURE 46. *Taxithelium portoricense*: (a) stem leaf, (b) branch leaf, (c) alar cells of stem leaf, and (d) apical cells of stem leaf (Williams, 1927).

smooth, 7 to 8 mm. long; urn of capsule oblong, constricted below mouth when dry, 0.5 to 0.7 mm. long, suberect. Spores smooth, 15 to 18  $\mu$  (FIGURE 46).

On trees and logs in moist forest, known with certainty in Puerto Rico only from vicinity of Cidra, the type locality; Isle of Pines (Cuba); Jamaica, Dominica, and Guadeloupe; Mexico (Yucatán peninsula).

(8) *Glossadelphus* Fleisch. Laubmoosfl. v. Java. 4: 1351. 1920.

Rather slender plants in green to yellowish, flat mats. Stems creeping, subpinnately branched; branches short, complanate-foliate. Leaves often asymmetric, lateral leaves very concave, upper and lower leaves narrower, oblong to ligulate, toothed toward obtuse or rounded (rarely acute) apex; costa short and double, or none; cells papillose at upper ends, or sometimes toward middle of lumina as well. Dioicous, rarely autoicous or synoicous; inner perichaetial leaves lanceolate, acuminate. Seta elongate, smooth, rarely rough above; capsule ovoid, curved and inclined; annulus present; operculum high-conic; peristome teeth fused at base, brownish-yellow and cross-striolate below, hyaline and papillose above, lamellose at back; endostome with high basal membrane, keeled and more or less perforate segments, mostly single cilia.

*Glossadelphus truncatulus* (C. M.) Fleisch. Laubmoosfl. v. Java. 4: 1352. 1920.

*Hypnum truncatulum* C. M. Syn. Musc. Frond. 2: 263. 1851.

Branches up to 12 mm. long, about 1.25 mm. wide with leaves. Leaves erect-spreading and complanate, 0.8 to 1 mm. long, broadly lingulate, broadly rounded to emarginate at apex, sharply and doubly serrate above, serrulate to base; costae short or lacking; cells linear, delicate, thin-walled, bearing small papillae at upper ends and usually 1 or 2 near middle of lumina, alar cells not differentiated. Synoicous (hermaphroditic, according to Müller). Seta red, up to 2.5 cm. long; single cilia of endostome. Sporophyte not seen.

On boulders in streams, in very humid mountain forests at altitude of about 1500 ft., known from several localities but all in Luquillo Mts. of northeastern Puerto Rico; Jamaica, Haiti, and Dominican Republic; British Honduras and Costa Rica; Ecuador, Peru, and possibly Brazil.

It seems doubtful that *G. choiropyxis* (C. M.) Broth., *G. oophyllus* (C. M.) Fleisch. and *G. natans* (C. M.) Fleisch., all of Brazil, differ significantly from this species.

#### Excluded Species

*Sematophyllum longirostratum* (C. M.) Mitt. Journ. Linn. Soc. London, Bot. 12: 490. 1869.

*Hypnum longirostratum* C. M. Syn. Musc. Frond. 2: 393. 1850.

*Aptychus longirostratus* C. M. Hedwigia. 37: 256. 1898.

*Leskia longirostrata* Brid. Bryol. Univ. 2: 311. 1827.

No specimens have been available for study.

#### HYPNACEAE

Slender to robust plants in loose to dense mats. Stems usually prostrate, pinnate or subpinnate. Leaves mostly ovate to ovate-lanceolate, acuminate; costa short and double, or lacking; cells elongate, smooth, or sometimes papillose at back by projection of apical angles, alar cells often differentiated, usually small and subquadrate, sometimes inflated. Calyptra cucullate, usually naked. Seta elongate, usually smooth; capsule horizontal, ovoid and asymmetric, sometimes erect and cylindrical; annulus generally present; operculum conic or short-rostrate; peristome double, teeth usually cross-striolate on outer surface, with well-developed lamellae, endostome usually differentiated into high basal membrane, broad segments and more or less nodose cilia.

Leaf cells lax, oblong-hexagonal or broadly linear. . . . . (4) *Vesicularia*  
Cells long and narrow, not especially lax.

Cells papillose at back by projecting angles. . . . . (5) *Mittenothamnium*  
Cells smooth, or nearly so.

Delicate, pale plants; leaves small and entire or very minutely serrulate.

(2) *Isopterygium*

Coarser plants with larger, noticeably toothed leaves.

Leaves symmetric, complanate and widely spreading. . . . . (3) *Taxiphyllum*

Leaves asymmetric, falcate-secund, not especially complanate. . . . . (1) *Ectropothecium*

(1) *Ectropothecium* Mitt. Journ. Linn. Soc. London, Bot. 12: 22. 1869.

Plants slender to rather robust, pale green, often tinged with yellow or brown, in thin, extensive mats. Stems elongate, creeping, subpinnately branched. Leaves often somewhat asymmetric, ovate to ovate-lanceolate, acuminate, usually more or less complanate and falcate-secund, dorsal and ventral leaves usually differing slightly from lateral; costa short and double, or lacking; cells linear, laxer toward base, not or slightly differentiated at basal angles. Calyptra smooth. Seta elongate, smooth; capsule short, usually ovoid, often contracted below mouth when dry, horizontal to pendent;

annulus differentiated; operculum large, acute to short-rostrate; peristome double, perfect.

*Ectropothecium globilheca* (C. M.) Mitt. Journ. Linn. Soc. London, Bot. 12: 512. 1869.

*Hypnum globilheca* C. M. Syn. Musc. Frond. 2: 300. 1851.

*H. subcircinale* Lor. Moosstudien. 167. 1864.

*Cupressina semiglobosa* C. M. Hedwigia. 37: 259. 1898, nom.

Green or yellow-green, often shiny plants in loose, tangled mats. Stems up to about 4 cm. long, but usually less, irregularly to pinnately branched; branches horizontal. Leaves 1 to 1.5 mm. long, arched from stem and strongly falcate-secund, lanceolate, gradually narrowed to rather broad or sometimes subulate acumen, serrulate in upper half, or sometimes minutely so nearly to base; costae double, short and weak; cells very narrow, linear-flexuose, scarcely differentiated at basal angles except for a few subquadrate cells along margins. Autoicous. Seta red, about 10 to 13 mm. long; capsule about 1 mm. long, horizontal to pendent; operculum convex, bluntly apiculate.

On trees, rotten wood, and rock in moist mountain forests at middle altitudes, common and widespread in major sierras of Puerto Rico; West Indies; Central and South America.

Most of the local collections are small, irregularly branched plants with more or less broadly pointed leaves, but some of them are more robust, with clearly pinnate stems and more sharply pointed leaves. The latter could perhaps be called *E. apiculatum* (Hornsch.) Mitt., but there seems to be no correlation between pinnate-branching and strongly toothed leaves or inconsistently subulate leaves. Because of intergradations between 2 species with doubtful claim to distinctness, all the local collections have been relegated to *E. globilheca*. The numerous tropical American species of the genus are in serious need of critical re-evaluation.

(2) *Isopterygium* Mitt. Journ. Linn. Soc. London, Bot. 12: 21. 1869.

Small plants in pale, yellowish, often glossy mats. Stems creeping, irregularly branched. Leaves often complanate, ventral and dorsal leaves loosely appressed, lateral-spreading and often somewhat asymmetric, lanceolate or oblong-ovate, acuminate, not or slightly decurrent, entire to serrulate; costa short and double, or none; cells linear, smooth, usually not differentiated at basal angles. Setae elongate, smooth; capsules ovoid to cylindrical, inclined to pendent; operculum conic or short-rostrate; peristome double, perfect.

Leaves up to 1.5 mm. long; setae 2 to 4 cm. long. . . . . (b) *I. altisetum*  
Leaves and setae shorter.

Alar cells subquadrate in rather well-marked groups. . . . . (c) *I. micans*  
Alar cells not clearly differentiated; basal cells usually lax.

Plants rather small; leaves oblong-ovate. . . . . (a) *I. tenerum*  
Plants very small; leaves narrowly lanceolate. . . . . (d) *I. sublenerrimum*

- (a) *Isopterygium tenerum* (Swartz) Mitt. Journ. Linn. Soc. London, Bot. 12: 499. 1869.

*Hypnum tenerum* Swartz. Prodr. Fl. Ind. Occ. 3: 1817. 1806.

? *H. brachyneuron* C. M. Bot. Zeit. 3: 109. 1845.

Small yellowish-green, rather glossy plants with freely branched stems and horizontal branches. Stem and branch leaves similar; stem leaves 1.3 to 1.4 mm. long, branch leaves 1 to 1.2 mm. long. Leaves loosely erect-spreading, slightly contorted when dry, usually loosely and indistinctly complanate, ovate-lanceolate or oblong-ovate, acuminate, entire, ecostate or nearly so; cells linear, enlarged, oblong and lax at insertion. Autoicous; perichaetial leaves subentire. Setae 6 to 11 mm. long; urn oblong-cylindric, about 1 mm. long, inclined to horizontal, or sometimes pendent; operculum conic-rostrate. Spores green, smooth, 16 to 21  $\mu$ .

On soil, humus, and rotten wood, very widespread in coastal plain of Puerto Rico and extending upward to middle altitudes in mountainous areas; West Indies and Trinidad; Mexico to northern South America.

- (b) *Isopterygium altisetum* Crum & Steere. Bryol. 59: 254. 1956.

*Ectropothecium longisetum* Schimp. ex Besch. Ann. Sci. Nat., Bot. VI. 3: 258. 1876.

*Isopterygium longisetum* (Schimp.) Broth. In E. & P., Nat. Pfl. 1(3): 1082. 1908, non Broth. 1895.

Rather small, yellowish or brownish, moderately glossy plants. Stems creeping, subpinnately branched; branches horizontal. Stem and branch leaves similar, loosely erect-spreading, up to 1.5 mm. long, ovate-lanceolate, slenderly long-acuminate, entire, ecostate or nearly so; cells linear, very long and narrow, about 5  $\mu$  wide, laxer at insertion. Autoicous; perichaetial leaves subentire. Seta 2 to 4 cm. long, red-yellow, flexuose; urn oblong-cylindric, asymmetric, inclined to pendent, smooth, contracted to short neck and below mouth when dry, up to 1.5 mm. long; operculum stoutly conic-rostrate; endostome as long as exostome, basal membrane high, cilia single, rather short. Spores finely papillose, about 11  $\mu$ .

On soil, known in Puerto Rico from only 2 localities near summits of La Torrecilla and Cerro de la Punta, both high peaks in Cordillera Central; Cuba and Guadeloupe.

- (c) *Isopterygium micans* (Swartz) Broth. In E. & P., Nat. Pfl. 1(3): 1082. 1908.

*Hypnum micans* Swartz. Adnotationes Bot. 175. 1829.

*H. gracillimum* Hornsch. In Mart., Fl. Brasil. 1(2): 78. 1840.

*H. albulum* C. M. Syn. Musc. Frond. 2: 280. 1851.

*H. chlorosum* Hampe. Flora. 64: 414. 1881.

Rather small yellowish plants with freely branched stems and horizontal branches. Leaves loosely erect, scarcely complanate, ovate-lanceolate, about 1 mm. long, gradually acuminate, entire, ecostate; cells narrowly linear,

alar cells subquadrate in small but distinct groups extending 3 to 5 cells up margins. Autoicous. Seta 5 to 10 mm. long; urn less than 1 mm. long, short-necked, more or less contracted below mouth when dry, inclined to pendulous; operculum conic-rostrate; 1 or 2 cilia.

On trees, rotten wood, and humus in moist mountain forest at higher altitudes, widespread in major sierras of Puerto Rico; eastern United States; West Indies; Trinidad and Brazil.

(d) *Isopterygium subtenerrimum* (Hampe ex C. M.) Paris. Index Bryol. Suppl. 221. 1900.

*Taxicaulis subtenerrimus* Hampe ex C. M. Hedwigia. 37: 253. 1898.

*I. pusillum* Ren. & Card. Bull. Soc. Roy. Bot. Belg. 41(1): 107. 1905.

Very small, glossy, pale green plants with freely branched stems and horizontal branches. Leaves erect or more or less complanate, spreading, narrowly lanceolate, gradually and slenderly acuminate, entire and ecostate, branch leaves 0.5 to 0.8 mm. long, stem leaves up to 1 mm.; cells narrowly linear, laxer at insertion, a very few at basal angles subquadrate. Autoicous; perichaetial leaves entire. Seta 7 to 11 mm. long; urn up to 1 mm. long, oblong, inclined to horizontal, smooth, constricted below mouth when dry; operculum bluntly conic-rostrate; endostome as long as teeth, basal membrane well-developed, single cilia.

On trees and rotten wood in moist forests at all altitudes in Puerto Rico from coastal plain to high mountain summits; Cuba, Jamaica and Haiti; Honduras and Costa Rica.

(3) *Taxiphyllum* Fleisch. Laubmoosfl. v. Java. 4: 1434. 1922.

Rather robust, glossy plants in extensive, flat mats. Stems elongate, prostrate, irregularly branched. Leaves complanate, spreading, lanceolate to ovate-lanceolate, acuminate, serrulate nearly all around; costa short and double, or lacking; cells elongate, smooth or minutely papillose by projection of upper angles. Dioicous. Seta elongate; capsule oblong-ovoid, inclined to horizontal; operculum more or less long-rostrate; peristome double, perfect.

*Taxiphyllum planissimum* (Mitt.) Broth. In E. & P., Nat. Pfl. 11: 463. 1925.

*Isopterygium planissimum* Mitt. Journ. Linn. Soc. London, Bot. 12: 498. 1869.

*I. elegantifrons* C. M. Hedwigia. 37: 251. 1898.

Green to yellow plants, often with an oily sheen. Stems 2 to 6 cm. long, up to 3 mm. wide, freely branched, occasionally bearing paraphyllia in leaf axils. Leaves crowded, widely spreading in 2 apparent rows, 1 to 1.5 mm. long, ovate-lanceolate, gradually acuminate; margins plane or narrowly recurved near base, serrulate all around; costa faint, short and double; cells narrowly linear, smooth or faintly papillose at upper ends, shorter at apex and short and oblong in small, inconspicuous groups at basal angles. Sporophyte apparently unknown.

On limestone, rarely on bases of trees, apparently common in calcareous areas in region of Arecibo, but not known elsewhere in Puerto Rico; Florida and Arizona in United States, and south to South America; West Indies.

(4) *Vesicularia* C. M. Flora. 82: 407. 1896.

Slender to medium-sized, soft plants in thin, dull-green or yellowish mats. Stems elongate, creeping, freely branched; branches horizontal, flattened. Leaves widely spreading, often secund at tips, ovate to lanceolate, acuminate, entire or weakly toothed above; costa short and double, or none; cells lax, oblong-hexagonal, smooth, not differentiated at basal angles. Ventral branch leaves usually differentiated, smaller and narrower, often with distinctive areolation. Mostly autoicous. Seta elongate; capsule horizontal to pendent, short, ovoid, usually constricted below mouth when dry; operculum conic or conic-apiculate; peristome double, perfect.

Branch leaves scarcely complanate; cells of dorsal and lateral branch leaves clearly elongate. . . . . (a) *V. poeppigiana*  
 Branch leaves complanate, subdistichous; cells of dorsal and lateral leaves short and lax.  
 Upper cells of ventral branch leaves 40 to 55  $\mu$  long, 2 to 3:1; upper marginal cells of dorsal and lateral leaves scarcely differentiated. . . . . (b) *V. vesicularis*  
 Upper cells of ventral leaves 80 to 100  $\mu$  long, 5 to 6:1; upper marginal cells of dorsal and lateral leaves narrower than median cells. . . . . (c) *V. amphibola*

(a) *Vesicularia poeppigiana* (Hampe) Crum & Steere. Bryol. 59: 254. 1956.

*Hookeria poeppigiana* Hampe. Icones Musc. Pl. 4. 1844.

*Hypnum conostegum* C. M. Syn. Musc. Frond. 2: 242. 1851.

*Ectropothecium flavoviride* Mitt. Journ. Linn. Soc. London, Bot. 12: 518. 1869.

Stem leaves often somewhat secund at tips of stems, ovate, slenderly acuminate, laxly areolate. Dorsal and lateral branch leaves scarcely complanate, more or less secund at tips, oblong-ovate or ovate-lanceolate, gradually more or less long-acuminate, entire or minutely denticulate at apex, upper cells oblong-hexagonal, 45 to 60  $\times$  12 to 15  $\mu$ . Ventral branch leaves similar in shape and areolation, but smaller and somewhat narrower. Autoicous. Seta 15 mm. long; capsule 1.25 mm. long, suburceolate, pendulous; operculum conic-acute; cilia of endostome supposedly double.

On rotten wood and limestone, in moist areas in higher parts of coastal plain and on lower slopes of mountains of Puerto Rico; United States (Florida); Cuba and Santo Domingo; Guatemala.

According to Salmon (1904), intergradations between *V. poeppigiana* and *V. vesicularis* make it desirable to consider the former a varietal form of *V. vesicularis*. It seems doubtful, however, that the 2 should be treated as conspecific, considering a number of rather striking differences, such as the narrower, longer leaves, the scarcely differentiated ventral leaves and, most particularly, the areolation that is much less lax because of uniformly elongate cells.

Hampe's report (1852) of *Hookeria montagnei* Schimp. cannot be placed satisfactorily without access to the specimen but, according to Salmon, a Cuban specimen reported by Montagne under this name is *V. vesicularis* var. *poeppigiana* (Hampe) Broth.

- (b) *Vesicularia vesicularis* (Schwaegr.) Broth. *In* E. & P., *Nat. Pfl.* 1(3): 1094. 1908.

*Hypnum vesiculare* Schwaegr. *Suppl. Sp. Musc.* II. 2(2): 167. 1827.

*Leskea (Omalia) rutilans* Brid. *Bryol. Univ.* 2: 332. 1827.

*Vesicularia malachita* C. M. *Hedwigia.* 37: 251. 1898.

Yellow-green or light green plants in thin mats. Stems subpinnately branched; branches more or less curved, flattened, 0.8 to 1 mm. wide, spreading at right angles to stem. Dorsal and lateral branch leaves wide-spreading, somewhat complanate, more or less secund at tips, broadly ovate, abruptly short-acuminate, subentire; upper cells lax, shortly oblong-hexagonal, about 16 to 20  $\times$  25 to 30  $\mu$ . Ventral branch leaves appressed, much shorter, narrower, upper cells longer, about 15 to 20  $\times$  40 to 55  $\mu$ , marginal cells not noticeably narrower. Autoicous. Seta 10 to 15 mm. long; capsule oblong, 0.8 to 1.25 mm. long; horizontal to pendent; operculum conic-apiculate; peristome perfect, cilia of endostome 2 to 3.

On limestone, soil, and rarely on rotten wood, in several widely separated localities in coastal plain of Puerto Rico; United States (Florida); West Indies; Mexico to South America.

The 3 species of *Vesicularia* presented here grade into one another, as well as into the more robust, yellowish form with more strongly secund leaves called *V. crassicaulis* (Mitt.) Broth. The problem of distinguishing tropical American species of this genus is too complex to be solved in a local study such as this.

- (c) *Vesicularia amphibola* (Spruce ex Mitt.) Broth. *In* E. & P., *Nat. Pfl.* 1(3): 1094. 1908.

*Ectopothecium amphibola* Spruce ex Mitt., *Journ. Linn. Soc. London, Bot* 12: 519. 1869.

?*Vesicularia arcuatipes* C. M., *Bull. Herb. Boiss.* 5: 211. 1897.

?*V. thermalis* C. M. *Ibid.* 212.

Yellow-green plants in thin mats. Stems elongate with short, spreading, slightly flattened branches. Dorsal and lateral branch leaves ovate, short-acuminate, denticulate, cells shortly oblong-hexagonal, noticeably narrower at upper margins. Ventral branch leaves ovate-lanceolate, upper cells longer, about 15  $\times$  80 to 100  $\mu$ . Autoicous. Seta 1 to 15. cm. long; urn of capsule ovoid, about 1 mm. long.

On limestone, soil, and rarely on rotten wood, widespread in coastal plain of Puerto Rico, but also ascending to middle slopes of major mountain systems; United States (Florida); West Indies; Central and South America.

- (5) *Mittenothamnium* Hennings. *Hedwigia (Beiblatt).* 41: 225. 1902.

Slender to fairly robust plants in extensive mats. Stems elongate, creeping, irregularly to pinnately branched, often arched and more or less frondose from stipitate base. Stem and branch leaves differentiated; stem leaves spreading to squarrose from ovate-cordate or triangular base, short- to long-acuminate, usually serrulate; costa double, sometimes reaching midleaf;

cells linear, often papillose at back because of projecting angles, smaller but not markedly differentiated at alar regions; branch leaves smaller, shorter-pointed, more strongly serrate. Usually autoicous. Seta elongate, smooth; capsule inclined to pendent; operculum conic to conic-rostrate; peristome double, perfect.

Stems arched, wiry, often radiculose at tips, freely branching above stipitate base; branches slender, attenuate; cells minutely papillose. . . . . (a) *M. reptans*  
 Stems prostrate, subpinnately branched, not stipitate; branches short and blunt; cells conspicuously papillose at back. . . . . (b) *M. diminutivum*

(a) *Mittenothamnium reptans* (Hedw.) Card. Rev. Bryol. 40: 21. 1913.

*Hypnum reptans* Hedw. Sp. Musc. 265. 1801.

*H. ometepense* Sull. & Lesq. Proc. Amer. Acad. Arts and Sci. 4: 282. 1859.

*Microthamnium tuerckheimii* C. M. Bull. Herb. Boiss. 5: 215. 1897.

Medium-sized yellow to yellow-green plants in loose, tangled mats. Stems arched and wiry, radiculose at tips, freely branching above stipitate base. Stipe leaves distant, ovate-cordate, abruptly acuminate, serrulate, up to 1.5 mm. long; costa short and faint; cells linear, minutely papillose at cell ends at back, oblong, somewhat larger and incrassate at basal angles. Branch leaves more or less complanate, ovate-lanceolate, gradually acuminate, more strongly toothed. Seta 1.5 to 2 cm. long; urn ovoid, inclined to horizontal, up to 1.5 mm. long; operculum conic-rostrate, 1 mm. long.

On trunks and roots of trees, on humus and rock, in wet forests in all major mountainous areas of Puerto Rico; West Indies; Mexico to South America; South Africa [as var. *pseudoreptans* (C. M.) Dixon].

(b) *Mittenothamnium diminutivum* (Hampe) Britt. Bryol. 17: 9. 1914.

*Hypnum diminutivum* Hampe. Linnaea. 20: 86. 1847.

*Hypnum cubense* C. M. Syn. Musc. Frond. 2: 267. 1851.

?*H. thelistegum* C. M. *Op. cit.* 269.

*H. perspicuum* Hampe. Linnaea. 31: 529. 1862.

*H. campaniforme* Hampe. Dansk Vidensk. Meddel. Naturh. Foren. 25: 289. 1870.

Small pale green or yellowish plants in rather dense, thin mats. Stems 1 to 2 cm. long, prostrate, pinnately branched; branches short and blunt, somewhat flattened. Stem leaves spreading, somewhat complanate, reaching 0.8 mm. in length, ovate, acuminate, concave, serrulate; costae short and double, often unequal, sometimes reaching  $\frac{1}{3}$  to  $\frac{1}{2}$  leaf length; cells oblong-linear, conspicuously papillose at back by projecting apical angles, shorter at insertion, scarcely differentiated at basal angles. Branch leaves smaller. Autoicous. Seta 7 to 12 mm. long; urn ovoid, asymmetric, cernuous, up to 1 mm. long; operculum conic-apiculate; annulus narrow; peristome teeth finely striate, endostome segments keeled, perforate, papillose, 2 cilia.

On wood, soil, and moist limestone, widespread in coastal plain of Puerto Rico and ascending to middle slopes of high mountains in a few localities; United States (Florida); West Indies; Mexico to South America; South Africa (as *M. thelistegum*).

*Excluded Species*

*Hypnum pallidisetus* Brid., Bryol. Univ. 2: 591. 1827.

No specimen has been available for study. Judging from the description and remarks provided by Bridel, we suspect that the species is related to *Sematophyllum caespitosum* (Hedw.) Mitt.

*Hypnum richardii* sensu Hampe. Linnaea. 25: 363. 1852, non Schwaegr.

According to notes in the herbarium at the New York Botanical Garden, Hampe's report (1852) may be referred to *Rhaphidorrhynchium flavens* (C. M.) Broth., a species we do not know.

## POLYTRICHACEAE

Usually robust, coarse, rigid plants with erect, simple or sparsely branched stems. Leaves rigid, narrow, usually differentiated into sheathing base and narrow blade bearing green lamellae in many longitudinal rows on upper surface; costa strong, single; cells firm, short-oblong or subquadrate, longer and narrower toward margins of sheath. Calyptra cucullate, often hairy. Seta elongate; capsules erect or inclined, cylindrical or angled; peristome single consisting of 32 to 64 (rarely 16) solid, inarticulate teeth, attached at tips to membrane formed by tip of columella.

Leaves bordered by elongate cells; calyptra naked or sparsely hairy.....(2) *Atrichum*  
 Leaves not bordered; calyptra very hairy.....(1) *Pogonatum*

(1) *Pogonatum* P.-B. Mag. Encycl. 5: 329. 1804.

Plants small and scattered to robust and loosely caespitose. Leaves larger above, scalelike below, often contorted when dry, erect-spreading to square-rose from appressed base when moist; margins incurved above, usually serrate; costa strong, generally serrate at back above; lamellae usually numerous, covering upper side of costa and part of lamina; lamina unistratose at margins, usually bistratose within, cells rounded-hexagonal, incrassate, becoming elongate, hyaline or yellow and thinner-walled in sheath. Calyptra covering capsule, densely pilose. Capsule cylindrical, with hypophysis, no stomata, exothecial cells pitted; operculum usually long-rostrate; 32 peristome teeth.

*Pogonatum tortile* P.-B. Prodr. 84. 1805.

*Polytrichum convolutum* Hedw. Sp. Musc. 94. 1801. p. p., non Linn. f. 1776, nec Schwaegr. 1816.

*P. tortile* Swartz. Prodr. Fl. Ind. Occ. 3: 1839. 1806.

*P. dominghense* Brid. Musc. Recent. Suppl. 1: 75. 1806.

*Pogonatum cubense* Sull. Proc. Amer. Acad. Arts and Sci. 5: 281. 1861.

*P. glaucinum* Besch. Ann. Sci. Nat., Bot. VI. 3: 210. 1876.

*P. husnotianum* Besch. *Ibid.*

*P. crispulum* Besch. *Ibid.* 211.

*P. laxifolium* Besch. *Ibid.*

*P. pleeanum* Besch. *Ibid.* 212.

*Polytrichum sintenisi* C. M. Hedwigia. 37: 222. 1898.

*P. sintenisi* var. *parvum* C. M. *Ibid.*

*P. imbricata* (sic) C. M. *Ibid.*

*P. obscuriviridis* (sic) C. M. *Ibid.*

*Pogonatum sinuolodentatum* Card. Rev. Bryol. 37: 5. 1910.

Rigid green to dark brown, gregarious plants. Stems up to 10 cm. or more high, simple. Leaves erect when moist, tips wide-spreading and incurved when dry, 5 to 7 mm. long, lanceolate from short, ovate, sheathing base, acute, more or less serrate about  $\frac{1}{2}$  or more length of blade; lamellae entire, up to 45, covering nearly all of blade, 3 to 6 cells high, terminal cells single, rarely a few paired, rounded in section, smooth and thin-walled, not or slightly enlarged; costa percurrent or nearly so, usually toothed at back above; basal cells short-rectangular, pellucid, smaller margins. Dioicous. Seta usually single, red, 1.5 to 3.5 cm. long; capsule slightly curved, somewhat nodding, oblong, 2 to 3.5 cm. long; irregularly ridged when old; exothecial cells bulging, especially below. Spores 8 to 12  $\mu$  (FIGURE 47).

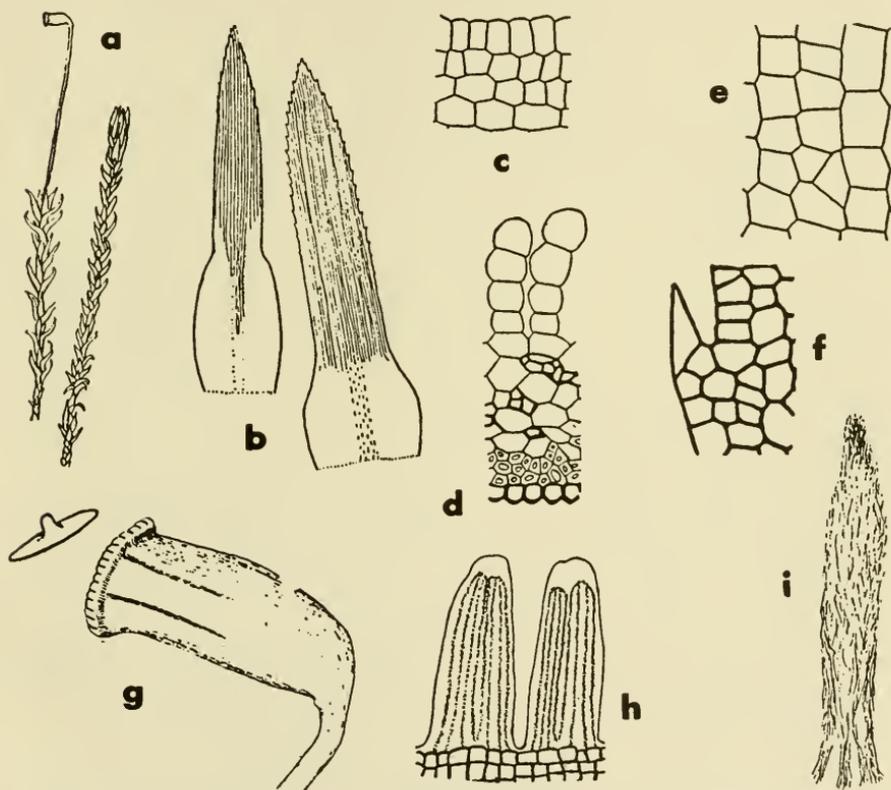


FIGURE 47. *Pogonatum tortile*: (a) habit sketches, (b) leaves, (c) lamella, side view, (d) lamellae, in longitudinal section, (e) median cells of leaf sheath, (f) cells of margin of upper part of leaf, (g) capsule and operculum, (h) portion of peristome, and (i) calyptra (Frye and Duckering, 1946, *P. convolutum*).

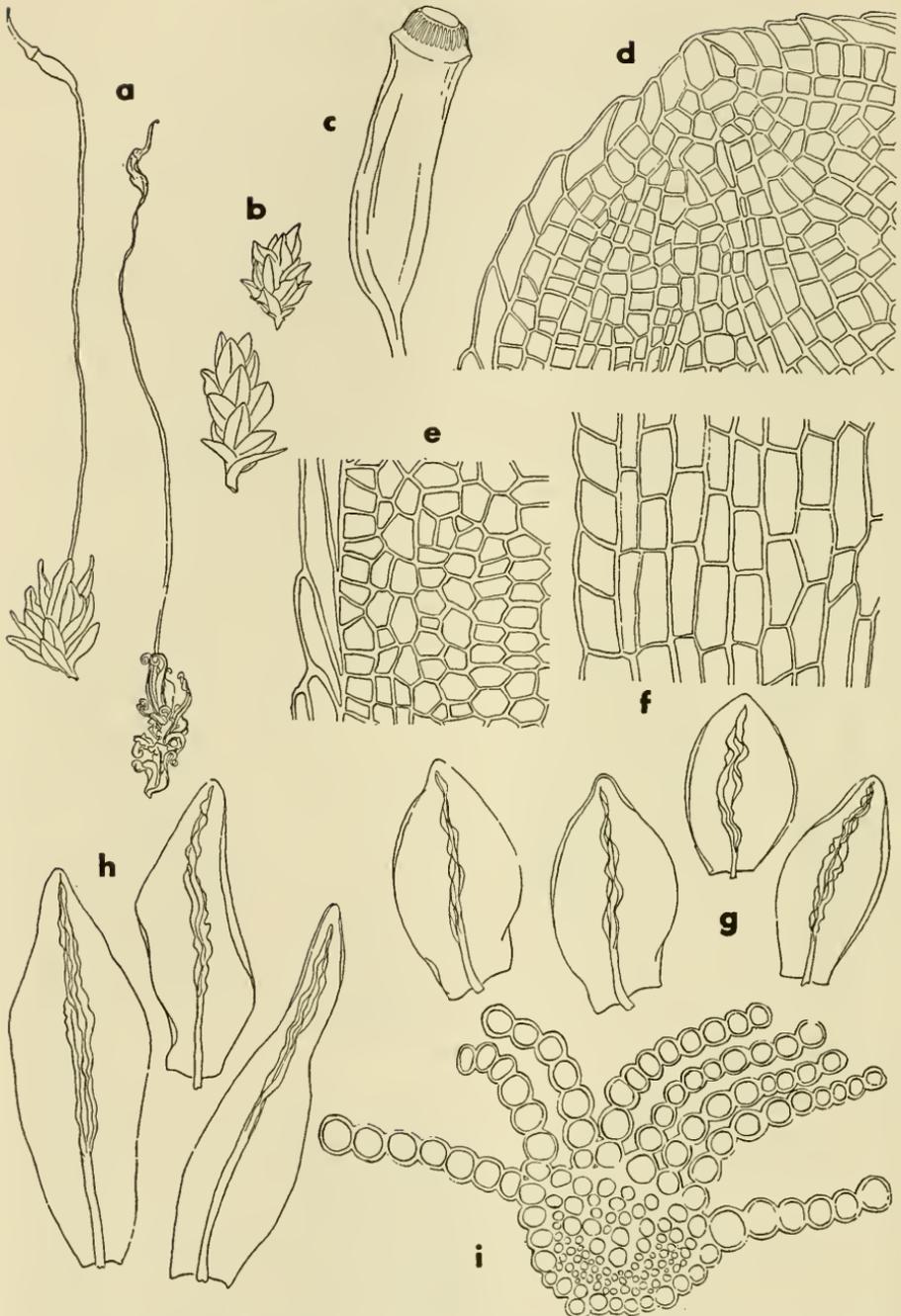


FIGURE 48. *Atrichum portoricense*: (a) habit (moist at left, dry at right), (b) 2 sterile plants, moist, (c) capsule, moist, (d) cells of leaf apex, lamellae removed, (e) cells at margin of upper third of leaf, (f) cells at margin of leaf base, (g) leaves of sterile stems and lower leaves, (h) perichaetial leaves, and (i) cross section of leaf.

On noncalcareous soil, often covering large areas, at middle and upper levels in all mountain systems of Puerto Rico; West Indies; Mexico to South America.

(2) *Atrichum* P.-B. Prodr. 42. 1805.

Plants medium-sized or small, dark green, dull, gregarious. Upper leaves erect- to wide-spreading, often crisped and contorted when dry, more or less rugose, lingulate, scarcely sheathing at base, narrowly bordered by elongate cells, singly or doubly toothed at margins, often serrate at back of costa and lamina; costa ending at or near leaf apex; lamellae few, limited to upper side of costa; cells rounded-hexagonal, smooth, usually rectangular at base. Calyptra cucullate, usually smooth, sometimes sparsely toothed or pilose at apex. Seta single or aggregated; capsule cylindrical, not angled, often curved and suberect, narrow at neck, without stomata; exothecial cells not pitted; operculum long-rostrate.

*Atrichum portoricense* Crum & Steere. Bryol. 59: 254. 1956.

Plants small, brownish-green, gregarious. Stems simple, 0.5 to 1.5 cm. high. Leaves erect-spreading, strongly curled and contorted when dry, becoming larger toward stem apex, upper and perichaetial leaves 3 to 3.5 mm. long, broadly lingulate, rounded or bluntly obtuse at apex, scarcely sheathing at base, weakly toothed at margins near apex, teeth blunt and single, only slightly rugose and not toothed at back of lamina; costa ending just below leaf apex, weakly and bluntly toothed at tip, 2 to 6 ventral lamellae, wavy, 4 to 9 cells high, terminal cells rounded and thin-walled, not differentiated; cells unistratose, subquadrate and hexagonal, often somewhat wider than long, about 20 to 23  $\mu$  wide, smooth, 1 or rarely 2 rows at margins yellow and linear in distinct, narrow border, cells near base rectangular, 2 to 4:1. Seta single, slender, 14 to 18 mm. high; urn of capsule narrowly cylindrical, about 2 mm. long, slightly curved and suberect, narrow at neck; operculum subulate-rostrate, about 1 mm. long (FIGURE 48).

On clay along scenic road on La Divisoria above C. C. C. Camp Dona Juana, near entrance of trail to tower, Toro Negro Purchase Unit, north of Villalba, *W. C. S.* 6162, Jan. 19, 1940. On moist clay in trail east of Cerro de la Punta, Cordillera Central, south of Jayuya, *W. C. S.* 6216 (on exposed clay), 6226, and (on steep, shaded clay bank) 6244, Jan. 20, 1940. On roadside clay bank, km. 1.3, upper Dona Juana road, Toro Negro Unit, *W. C. S.* 6857, March 19, 1940. On rocky bank, along trail from Toro Negro reservoir to Jayuya, *W. C. S.* 6877, with *Rhamphidium borinquense* Crum & Steere (on cliff), 6870, March 20, 1944. On clay bank along trail, upper slopes of Mt. Guilarte, west of Adjuntas, *W. C. S.* 7212, May 25, 1940 (type).

*Atrichum portoricense* differs from any other species of the genus known to us in its small stature and its short, subcucullate leaves which, but for the border of elongate cells, might be mistaken for those of a species of *Psilopilum*.

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